EPA/ROD/R07-99/075
1999

EPA Superfund
Record of Decision:

57TH AND NORTH BROADWAY STREETS SITE
EPA ID: KSD981710247
OU 01
WICHITA HEIGHTS, KS
09/29/1999

RECORD OF DECISION

57TH & N. BROADWAY SITE

OPERABLE UNIT 1

WICHITA-PARK CITY, KANSAS

SEPTEMBER 1999

RECORD OF DECISION
DECLARATION

SITE NAME-AND LOCATION

57th & N. Broadway site, Operable Unit 1 (OU1), Wichita-Park City, Kansas

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedy for the 57th & N. Broadway site OU 1, in Park City - Wichita, Kansas, chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record for this site. The state of Kansas concurs on the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances at and from this site, if not addressed by implementation of the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

This decision document is for the second and final action for the site. A ground water plume split into two parts has been discovered at the site, the northern plume and the southern, Riverview, plume. This action will address contaminated ground water and soils. An in-well treatment system will be designed for the northern plume to contain and treat the plume to the point that contaminant levels fall below Maximum Contaminant Levels (MCLs). Additional in-well strippers may be added to the Riverview plume to complete the treatment of the southern plume to MCLs. In addition, in-situ vapor extraction will be utilized

to treat contaminated soils at the former Wilko Paint facility. Additional soil sampling will take place on the Midland Refinery and Wilko properties to determine if in-situ vapor extraction will be necessary to treat soils which could constitute a source for ground water contamination at these locations. This remedy also includes ground water monitoring to determine the effectiveness of the treatment system and institutional controls to prevent exposure to contaminated ground water.

The major components of the selected remedy will include the following actions.

- Design and install a system of in-situ vapor extraction wells to prevent the migration of contaminated ground water for the northern plume, while treating the plume to reduce contaminants to levels below the MCLs. If necessary, additional in-situ vapor extraction wells will be added to the system in the Riverview plume to prevent migration of ground water contamination and to treat ground water contamination to MCLs.

- An in-situ vapor extraction system will be installed to treat the contaminated soils at the former Wilko Paint facility.

- Soil sampling will take place to ensure that no source areas of soil contamination remain on the Midland Refinery or Wilko Paint properties. If source areas are discovered, they will be treated with in-situ vapor extraction.

- Ground water monitoring will be conducted to determine the effectiveness of the treatment system.

- Institutional controls will be implemented to prevent exposure to contaminated ground water.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes

permanent solutions and alternative treatment technologies to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

Because this remedy may result in hazardous substances, pollutants, or contaminants above health-based levels remaining on site for up to ten years, a five-year review will be conducted to ensure that the remedy continues to provide adequate protection of human health and the environment.

ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary Section of this Record of Decision (ROD). Additional information can be found in the Administrative Record file for this site.

- Chemicals of concern and their respective concentrations.
- Baseline risk represented by the chemicals of concern.
- Clean-up levels established for chemicals of concern and the basis for these levels.
- How source materials constituting principal threats are addressed.
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of ground water used in the baseline risk assessment and ROD.
- Potential land and ground water use that will be available at the site as a result of the selected remedy.
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected.
- Key factor(s) that led to selecting the remedy.

Michael J. Sanderson, Director
Superfund Division

9/29/99
Date

RECORD OF DECISION

DECISION SUMMARY

57TH & N. BROADWAY SITE

OPERABLE UNIT 1

WICHITA-PARK CITY, KANSAS

SEPTEMBER 1999

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RECORD OF DECISION

DECISION SUMMARY

1.0 SITE NAME, LOCATION AND DESCRIPTION

The 57th & N. Broadway site (KSD981710247) is located in and near the northern portion of the city of Wichita, Kansas (see Figure 1). The actual location of the site lies on a diagonal that runs from the extension of West 58th Street north and Broadway Avenue to the southwest to approximately West 46th Street north and Armstrong Drive. The United States Environmental Protection Agency (EPA) is the lead agency while the state of Kansas serves in the role of support agency. This Record of Decision (ROD) is written in anticipation of negotiating a settlement with the Potentially Responsible Parties (PRPs) for the site to conduct the remedy. A split contaminated ground water plume extends beneath this residential, commercial, and industrial area. Nearly all domestic water in the site was obtained from private wells in the contaminated aquifer. Currently, ground water above Maximum Contaminant Levels (MCLs) is not being used for domestic consumption. However, contaminated wells may be being used for non-consumptive purposes; and water from that contaminated aquifer which does not exceed MCLs is being used for private residential consumption. To the south of the site is the Little Arkansas River.

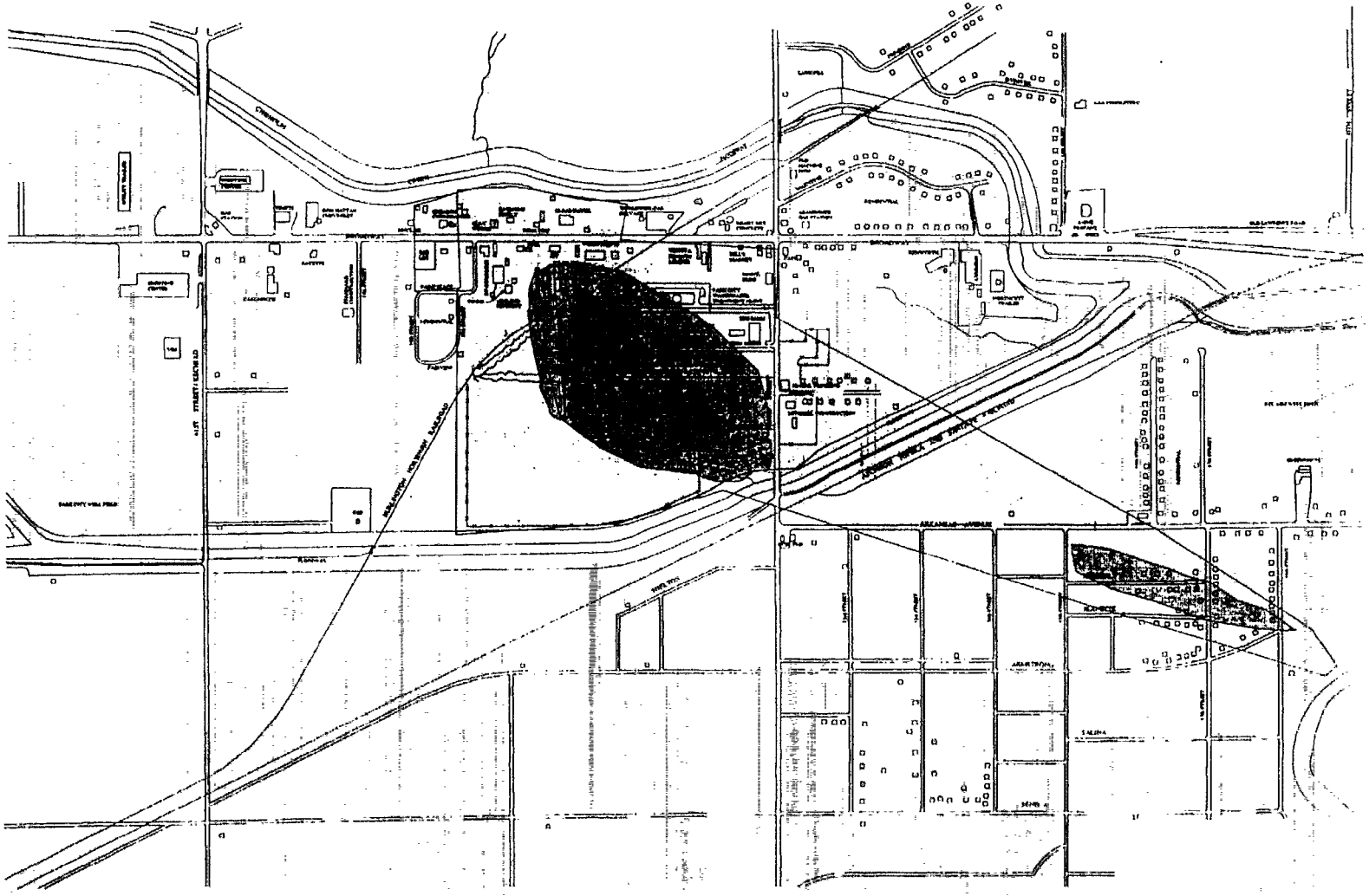
The apparent source of the ground water contamination is from several facilities located near 57th and N. Broadway. Ground water exceeding drinking water standards for volatile organic compounds (VOCs) including 1,1-dichloroethene (DCE), trichloroethene (TCE), tetrachloroethene (PCE), and vinyl chloride is found at the site. One area of contaminated soil will require remediation. It is located on the former Wilko Paint property.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The site includes established residential neighborhoods, commercial, municipal, and industrial institutions. Parts of the site are in Park City, the city of Wichita, and unincorporated

57th & N. Broadway Site

Figure 1



Site Boundary

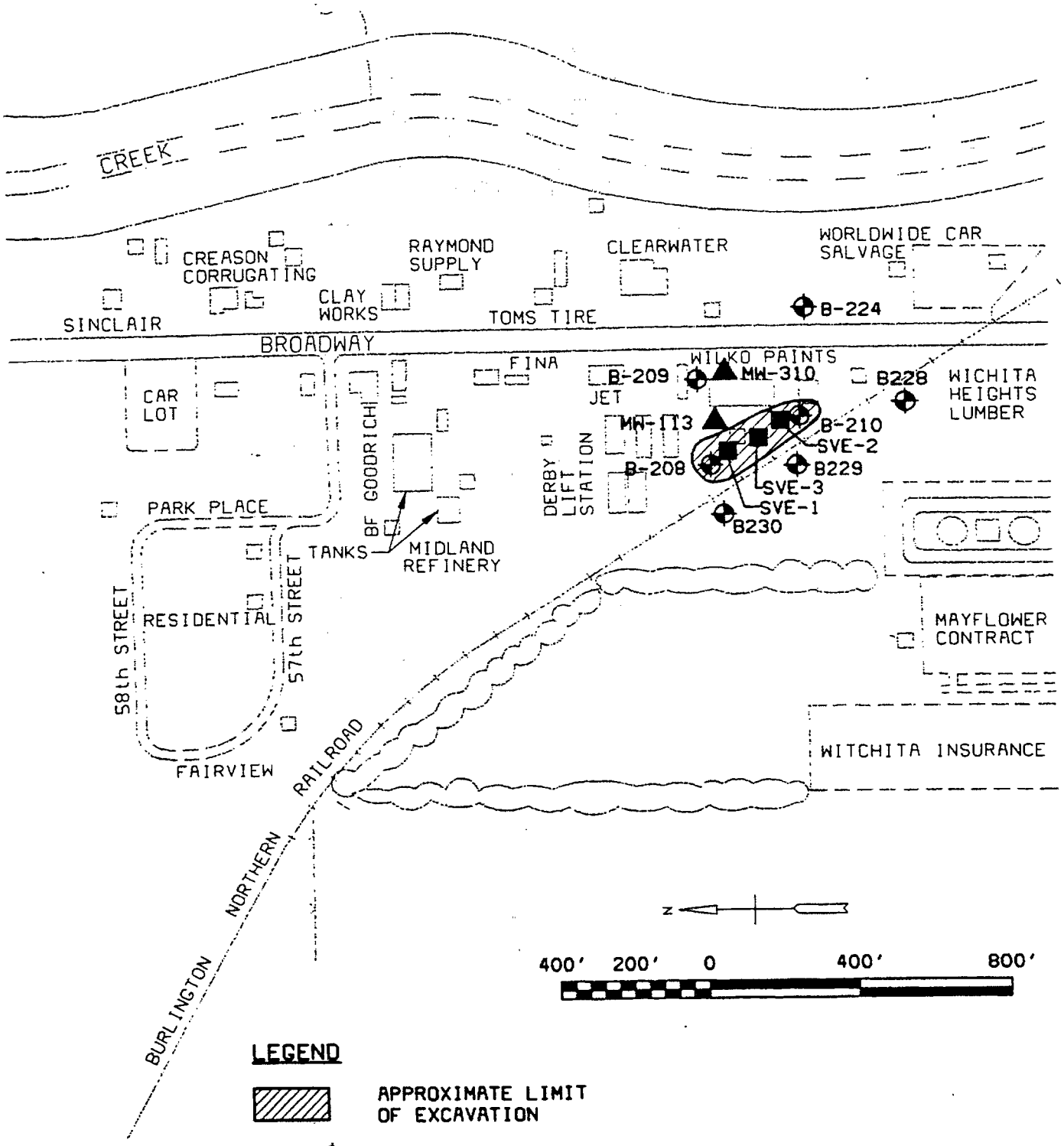


FIGURE 2
SOIL ALTERNATIVE 5
SITE PLAN - IN SITU
SOIL VAPOR EXTRACTION
57TH AND NORTH BROADWAY SITE

Sedgwick County, Kansas. Much of the total area and all of the area which is underlain by the contaminated plume exceeding drinking water standards is now served by public water.

The contamination found in the Riverview Operable Unit (OU), or the Riverview plume, is an extension of a volatile organic contaminant ground water plume originating from near 57th & N. Broadway. The Kansas Department of Health and Environment (KDHE) completed a site investigation of the site in 1989. The site investigation identified ground water contamination and several potential sources of contamination of a variety of compounds which were detected in the ground water. Further work on the site resulted in its being placed on the National Priorities List in 1992.

The EPA performed a removal action from August 1990 until May of 1992 which provided bottled water to the residences and businesses in the then known affected area of the 57th & N. Broadway site. That area is now served by Park City's public water supply system.

The EPA and KDHE facilitated the formation of a local group to sponsor the installation of a public water supply to the area. This resulted in the construction of a public water supply, owned by Park City, Kansas, which was capable of providing public water to the known affected area. The public water system for the area was completed in 1992.

There have been several enforcement activities at the 57th & N. Broadway Superfund site. In 1985, the state of Kansas issued an Administrative Order to Midland Refining Company (Midland), which required Midland to develop a plan to investigate ground water contamination around the Midland facility. Midland complied with the order and completed a report of the investigation in July 1985.

Three Administrative Orders have been issued by EPA for the 57th & N. Broadway site. The first two orders were issued concurrently on October 4, 1993, along with a notice of liability to four parties: Coastal Refining and Marketing, Inc.; Farmland Industries, Inc. (Farmland); Midland Refining Company; and Wilko Paint, Inc. (Wilko). The first order was an Emergency Administrative Order issued along with a Finding of Imminent and

Substantial endangerment to the Health of Humans under Section 1431 of the Safe Drinking Water Act (SWDA), to provide a potable water source to all persons who may be effected by contaminated ground water form the site. The second order was a draft Consent Order issued along with a Statement of Work under Sections 104, 122 (a) and 122 (d) (3) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Section 1431 (a) of SDWA, for investigation of the site.

On October 13, 1993, Coastal Refining and Marketing, Inc., filed a petition for review with the Tenth Circuit Court of Appeals of the Finding of Imminent and Substantial Endangerment to the Health of Persons and Emergency Administrative Order. A similar petition was filed by Wilko and Farmland on November 10 and November 12, 1993, respectively. Since several of the issues involved were of first impression and due to changing policy considerations, the EPA did not wish to litigate the issues on appeal. Additionally, because of pre-enforcement review under the SDWA, the EPA did not want to incur potential long delays before being able to provide water to those people in need. Therefore, the SDWA Order was withdrawn by EPA as to all four parties on December 23, 1993; and the negotiations for actions under a Consent Order ended.

The third order issued at the site was a Unilateral Administrative Order issued pursuant to Section 106 (a) of CERCLA to Midland and Wilko on June 6, 1994. Midland and Wilko were ordered to provide hookups to a public water supply to those residents within the site, designated by EPA, who wanted to be hooked up and had potential exposure to contaminated ground water. It was further ordered that Midland and Wilko would perform sampling and analysis of drinking water wells down gradient of the known contamination and provide hookups to those people with contaminated water who wished to be added to the public water supply. Midland and Wilko complied with the order, and all physical work was completed in 1995. In July 1996, the order was amended to include a payment schedule for reimbursement of oversight costs. Midland and Wilko reimbursed EPA for $17,891.30 in oversight costs, and all activities under the order were completed by February 1997.

In July 1997, the EPA issued general notice letters to six parties associated with the 57th & N. Broadway Superfund site: Mindland; Wilko; Farmland; Clearwater Truck Company, Inc.; Koch Industries, Inc.; and Lewis Williams Jr. The EPA entered tolling agreements with these six parties in August 1997 to toll the statute of limitations with regard to the removal action completed in 1992.

In late 1997 while completing the remedial investigation for the site, the EPA discovered ground water contamination further down gradient from the initially identified sources than was expected. The ground water had crossed what was originally thought to be a ground water divide. The contamination was located in the neighborhood community of Riverview. Because people in this neighborhood were drinking contaminated water, the EPA had to act quickly. The EPA identified the Riverview area as a separate operable unit (OU 2) and performed a focused feasibility study and signed a ROD for this OU in June 1998. The remedial action for Riverview was initiated as fund-lead in June 1998 to attach those people drinking contaminated water to the Wichita public water supply. An additional component of the remedy was in-situ treatment of contaminated ground water to prevent any further migration of the contamination. The people in the Riverview area have been attached to public water, and the remaining response actions are ongoing.

In a February 1998 letter, the EPA notified the six PRPs of the need for action in the Riverview area and offered them the opportunity to perform the work. All six parties declined. The EPA did not negotiate with the PRPs for performance of the work because the work needed to be initiated immediately, and the EPA believed it would take months to develop an agreement that would satisfy the interests of all parties.

3.0 COMMUNITY PARTICIPATION ACTIVITIES

A community Action Group (CAG), intended to serve as a conduit for information between the community and EPA, was formed early on in the remedial investigation process of the 57th & N. Broadway site. A community relations plan which included community interviews was prepared early in the site activities. Meeting to exchange information with the CAG have been conducted since 1996. The CAG has held monthly meetings nearly every month

during this period, and EPA has attended all meetings which they received a request to attend. A community-wide meeting was held on February 11, 1998, to explain EPA's anticipated response actions for the Riverview OU. Many of the planning documents leading to the development of this ROD were provided to the CAG as drafts to solicit community comment.

The city of Wichita sponsored a meeting which was held in the City Council Chambers on February 25, 1998. The EPA attended and responded to questions concerning the Riverview OU. On March 2, 1998, a Kansas State Legislative Subcommittee sponsored a public hearing on the site at which EPA was requested to be available to answer questions from the subcommittee and attending citizens on the Riverview OU. The announcement of the Proposed Plan for this OU was published in two local papers on July 14, and 15, 1999; and the public comment period was initiated on July 14, 1999. A request for an extension was made by the CAG and granted by EPA. The public comment period ended on September 13, 1999. A copy of the remedial investigation was provided for the Administrative Record and CAG review on July 9, 1999. A public hearing was held on July 29, 1999. Announcements of the public hearing and copies of the Proposed Plan were mailed to those on the EPA mailing list for the site. Upon the completion of the public comment period on September 13, 1999, a Responsiveness Summary addressing all comments and questions pertaining to the Proposed Plan was prepared and appears as Appendix A to this ROD.

4.0 SCOPE AND ROLE OF RESPONSE ACTION

The problem at the 57th & N. Broadway site are complex. As a result, the EPA has organized the work into two OUs:

- OU 1 is the site-wide ground water and soil contamination, which includes all actions within the entire site; and

- OU 2 addresses only the ground water contamination in the Riverview neighborhood.

The EPA has already selected the remedy for OU 2 in the Record of Decision signed on June 5, 1998.

The remediation portion of the Riverview OU will be taken over by the actions detailed in this ROD. The actions at the Riverview OU have three components. First, providing an alternate water supply to resident by hooking them to the public water supply. The second was the treatment of the contaminated ground water plume in the Riverview neighborhood, and the third is the ongoing monitoring of the plume.

The response action selected in this ROD will address contamination at the entire site. In addition, it will take over the activity of the second and third elements of the Riverview OU. This response action involves the control and treatment of the ground water contaminant plumes, both the northern plume and the Riverview plume and the treatment of contaminated soils that may present a hazard for direct contact and serve as source areas for further contamination for ground water. Also involved will be the determination of potential soil contamination at the Midland Refinery and former Wilko Paint properties and if necessary the treatment of those soils.

The ground water containment/treatment system is to be designed to contain the plumes as well as treating both the northern plume and the Riverview plume. All actions identified in this ROD will be completed under remedial authorities.

5.0 SUMMARY OF SITE CHARACTERISTICS

This section of the ROD presents the results, conclusions, and recommendations of the Remedial Investigation Report for the 57th & N. Broadway site. Further details of the characterization of the Riverview plume in the Riverview OU may be found in the June 1998 ROD for the OU.

5.1 Physical Characteristics

The 57th & N. Broadway site is a residential/commercial/ agricultural area covering portions of Park City, unincorporated Sedgwick County, and the city of Wichita, all in Sedgwick County, Kansas, as shown on Figure 1. The site is located in and adjacent to Park City and Wichita, Kansas.

The geology in the Wichita area consists primarily of sedimentary rock overlain by alluvium, colluvium, and loess. The 57th & N.

Broadway site lies within the eastern portion of the Arkansas River flood plain and terrace complex. The geology of the Arkansas River valley beneath the site consists of two distinct sediment types: a fine grained zone; and a sandy zone with minor amounts of gravel. Beneath the topsoil lies a brown to light brown layer of silty clay and silt approximately 10 to 15 feet thick. The clayey zone is continuous across the site and has a low plasticity. The clayey zone grades into a fine to coarse grained sand zone near the water table. The sand zone may contain significant amounts of silt in the upper 10 feet of the sand zone. The sand grades into coarser sand toward the bottom of the alluvium where the sand may contain some gravel. The sandy zone is approximately 30 feet thick and lies unconformably on the blue to gray shale of the Wellington Formation. The shale is blocky to finely laminated and can appear as a clay where it is intensely weathered.

The alluvial aquifer is the principal aquifer at the site and consists of unconsolidated Pliocene, Pleistocene, and Holocene sediments found in the Arkansas River valley. This aquifer is the principal source of water for the city of Wichita and the surrounding areas, supplying 70 percent of the city's public drinking water supply. The portion of the alluvial aquifer that supplies the city's water is located northwest of Wichita within a triangular-shaped area roughly delineated by the cities of Hutchinson, Newton, and Wichita, Kansas. The 57th & N. Broadway site lies within this triangle. This region of the aquifer is locally called the Equus Beds Aquifer.

The alluvial aquifer is an unconfined system that flows to the south-southwest at a gradient of approximately 0.001 feet/foot. Depth to the water table ranges from 8 to 20 feet below ground surface (bgs). Slug tests were performed on ten shallow and ten deep monitoring wells. Because of the high hydraulic conductivity of the aquifer, the results of the slug tests were conductivity of the aquifer, the results of the slug tests were inconclusive; therefore, the hydraulic conductivity data were estimated using historic pump test data. Results of the pump test indicate that the hydraulic conductivity at the site ranges from 50 feet/day to 400 feet/day. The ground water velocity ranges from 0.51 feet/day to 1.6 feet/day across the site. No federally listed threatened or endangered wildlife species are known to inhabit the vicinity of the site.

5.2 Nature and Extent of Contamination

The primary contaminants present in the ground water at the site are PCE and the breakdown components of PCE and/or TCE, 1,1-DCE,cis-1,2-DCE, and vinyl chloride. In addition, 1,2-DCA has also been detected in ground water samples from the area. The ground water contamination has migrated from the northeast portion of the 57th & N. Broadway site to the southwest to the Riverview area. The contaminant plume is split forming a northern plume and a southern plume (the Riverview plume). The Chisom Creek floodway is the division between the two plumes. The northern plume terminates at approximately the northern edge of the floodway and the Riverview plume begins approximately 1,200 feet southwest of the southern edge of the floodway.

The northern plume is oriented from the northeast near the extension of 58th Street and N. Broadway to the southwest terminating approximately at 53rd Street on the south and the Chisom Creek Floodway on the west and just prior to their intersection on the southwest. The plume is approximately 2,600 feet long and ranges from 800 to 1,600 feet in width. From the currently available information, it appears that the ground water contaminant plume in the Riverview residential area is narrow, approximately 400 feet across at its widest point and approximately 2,600 feet long. The approximate location of the Riverview plume is from the intersection of West 50th Street north and Arkansas Avenue on the north to beyond the intersection of West 46th Street north and Armstrong Drive on the south as shown on Figure 1. The alignment of the plume follows the direction of the ground water flow in this area.

The concentrations of TCE and vinyl chloride in the ground water of the Riverview plume indicate the contaminants are in a dissolved form rather than in a pure phase in the ground water[1]. The concentrations of most contaminants in the northern plume are

[1]Generally, if the concentration of a compound in ground water is grater than or equal to 1 percent of the solubility limit of the compound in water, then a pure phase of compound may be present in the ground water. The concentrations of these chemicals in the ground water in the Riverview plume were at least two orders of magnitude less than these solubility limits in the ground water samples collected at the site.

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about two orders of magnitude greater than those in the Riverview plume; and therefore, it is more difficult to determine if pure phase contaminants exist in the northern plume. Concentrations of contaminants of concern are summarized in Tables 7-1 and 7-2.

5.2.1 Delineation of Areas and Volumes of Contaminated Ground water

Information concerning the nature and extent of contamination in ground water was used to estimate the volume of contaminated ground water that will need to be remediated at the 57th & N. Broadway site. Ground water that is contaminated at concentrations exceeding those proposed for remedial actions (i.e., MCLs) for the site will be considered the portion of the contaminant plume that will require response actions. The MCLs for the contaminants of concern are presented in Table 5-1.

In the Riverview plume the area of ground water containing vinyl chloride above MCLs is the largest and encompasses the areas of the remaining contaminants exceeding MCLs. Therefore, vinyl chloride was the contaminant used to estimate the volume of contaminated ground water in the Riverview OU of the site. The MCL for vinyl chloride is two micrograms per liter (µg/L). The areal extent of contaminated ground water in the Riverview plume is estimated to be approximately 800,000 square feet (ft^2). For estimation purposes, the areal extent of vinyl chloride will be considered to be evenly spread vertically in the aquifer. The approximate saturated thickness of the aquifer ranges from 15 to 35 feet. The approximate total contaminated ground water plume in the Riverview OU will be 30 million gallons, assuming an average saturated thickness of 25 feet and an effective pore volume of 20 percent.

Similar calculations were used for the volumetric measurements of the northern plume. The contaminants of concern in the northern plume are primarily PCE, TCE, and their breakdown components 1,2-DCE, chloroethene, and vinyl chloride. The plume extends approximately from the Midland Refinery area at 57th and North Broadway 2600 feet southwest to the Chisom Creek Floodway. The northern plume is approximately five million square feet in area.

Table 5-1
Chemical-Specific ARARs and Other Criteria and Standards, or
Guidance to be Considered for Compounds in Ground water

Contaminant	Maximum Concentration Detected in the 57th & N. Broadway area (µg/L)	MCL[1] (µg/L)	MCL[2] (µg/L)	USEPA Health Advisories[5]				
				1-Day Child[3] (µg/L)	10-Day Child[4] (µg/L)	Longer-Term Child[5] (µg/L)	Longer-Term Adult[5] (µg/L)	Lifetime[6] (µg/L)
1,1-Dichloroethane	99	-	-	-	-	-	-	-
1,1-Dichloroethane	16	7	7	2,000	1,000	1,000	4,000	7
cis-1,2-Dichloroethane	59	70	70	4,000	3,000	3,000	11,000	70
Tetrachloroethene	3.8	5	0	2	2	1	5	-
Trichloroethene	6.9	5	0					
Vinyl chloride	34	2	0	3,000	3,000	10	50	

Notes:
Blanks indicate no value is available.

1 Maximum contaminant level (MCL), 440 CFR Part 141, the maximum permissible level of a contaminant in water which is delivered to any user of public water system..

2 Maximum contaminant level goal (MCLG), 40 CFR Part 141, a non-enforceable concentration of a drinking water contaminant that is protective of adverse human health effect and allow an adequate margin of safety.

3 The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to 5 consecutive days of exposure

4 The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to 14 consecutive days of exposure.

5 The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to approximately 7 consecutive days of exposure

6 The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects over a lifetime of exposure..

Table 5-2
Chemical -Specific ARARs for Soil

Contaminant	KDHE Interim Remedial Guidelines (mg/kg)		Soil Screening Levels[2] (mg/kg)		USEPA Region III Risked-Based Criteria[3] (mg/kg)	
	Residential	Non-Residential	Migration to Groundwater[5]	Ingestion	Industrial Exposure	Residential Exposure
Acetone	1,300	1,975	16	7,800	200,000	7,800
Arsenic	7	100	29	0.4	3.8 [4]	0.43 [4]
Benzene	1	2	0.03	22	200	22
Benzene, 1,3,5-trimethyl-						
Benzene, 1-ethyl-2-methyl-						
Benzene, 1-ethyl-3-methyl-						
Benzene, (1-methylethyl)-						
Benzene, propyl-						
Benzene, 1,2,3-trimethyl						
2-Butanone						
n-Butylbenzene						
sec-Butylbenzene					20,000	780
tert-Butyl					20,000	780
Cadmium	12	170	8	78	1,000	39
Chlorobenzene	55	90	1	1,600		

Table 5-2 (Continued)
Chemical-Specific ARARs for Soil

Contaminant	KDHE Interim Remedial Guidelines [1] (mg/kg)		Soil Screening Levels[2] (mg/kg)		USEPA Region III Risk-Based Criteria[3] (mg/kg)	
	Residential	Non-Residential	Migration to Groundwater[5]	Ingestion	Industrial Exposure	Residential Exposure
Cyclohexane, 1,2,4-trimethyl						
Cyclohexane, ethyl-						
Decane						
1,1-Dichloroethene	0.02	0.035	0.06	1	9.5	1.1
Ethylbenzene	1,980	1,980	13	7,800	200,000	7,800
2-Hexanone						
Isopropylbenzene						
Lead	400	1000		400		
4-Methyl-2-pentanone	1,170	17,000	84	5,100	160,000	6,300
Naphthalene	500	500			82,000	3,100
n-Propylbenzene						
Toluene	980	1,500	12	16,000	410,000	16,000
Trichloroethene	6	11	0.06	58	520	58
Trichlorofluoromethane					610,000	23,000
1,2,4-Trimethylbenzene					100,000	3,900

Table 5-2 (Continued)
Chemical-Specific ARARs for Soil

Contaminant	KDHE Interim Remedial Guidelines[1] (mg/kg)		Soil Screening Levels[2] (mg/kg)		USEPA Region III Risk-Based Criteria[3] (mg/kg)	
	Residential	Non-Residential	Migration to Groundwater[5]	Ingestion	Industrial Exposure	Residential Exposure
1,3,5-Trimethylbenzene					100,000	3,900
m/p-Xylene			210	160,000	1,000,000	160,000
o-Xylene			190	160,000	1,000,000	160,000
Xylene (total)	630	630			1,000,000	160,000

Notes:

Blanks indicate no value is available.

1 KDHE Interim Remedial Guidelines for Contaminated Soil, October 1995.

2 Soil Screening Guidance, USEPA 1996.

3 USEPA Region III Risk-Based Concentration for Soil Ingestion, April 1996.

4 Arsenic as a carcinogenic compound.

5 Based on DAF (dilution and attenuation factor) of 20.

6.0 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

6.1 Current On-Site Land Use

The 57th & N. Broadway site consists of residential neighborhoods comprised of single family dwellings, municipal, commercial, and industrial facilities as well as some open land, part of which is used for agriculture.

6.2 Current Adjacent Land Use

The area immediately adjacent to the site currently consists of single family residential homes, business, and i ndustrial facilities. The area to the south of the site is predominantly agricultural and open space adjacent to the Little Arkansas River.

6.3 Anticipated Future Land Use

The Riverview OU and adjacent area is a well established residential neighborhood with a few small businesses, religious institutions, and farming. The area of the northern plume contains a variety of business, municipal facilities, and industries as well as some residences and farm and open land. It is not anticipated that significant changes will be made in the land use of either area in the near future. With the availability of city water, there is some additional opportunity for additional business or commercial interests to locate in the area, especially where there are currently open spaces.

6.4 Current Ground Water Use

The ground water was previously the sole source of domestic water for the majority of the site. Residences and businesses in the area previously relied upon private wells to supply ground water as the only source of water. The Park City water system and the city of Wichita water system currently supply a majority of the residences in the general area with domestic water. Some residences within the site boundaries continue to use ground water for domestic drinking water use. None of these residences are known to have ground water contaminated at levels greater

than the MCLs. In addition, ground water is used for watering, filling swimming pools, and other uses associated with residential neighborhoods.

6.5 Potential Future Ground Water Use

It is anticipated that even with the availability of public water supplies the ground water will continue to be used as a source of domestic water at many residences. There is a public water supply available, as well, for those who are not affected by the volatile organic contamination. There is a concern with the general quality of the ground water in the area. The general satisfaction of some residents in the general quality of the ground water seems to have diminished over the last several years. Therefore, it is not known how many residents will take advantage of the new public water system and how many will continue to use their private wells. There seems to be a general consensus that many of those who elect to connect to public water will retain the use of their private wells for lawn and garden use. Another factor that may affect the future use of ground water is the unavailability of sanitary sewers in the area. Much of the site and the surrounding area use septic tanks for domestic sewage treatment, although Park City is currently actively installing sewer lines within its city limits.

6.6 Time Frame of Projected Future Drinking Water Use

This action is intended to restore the aquifer in the 57th & N. Broadway site. It is anticipated that it will take ten years for the treatment to restore the aquifer. It is assumed that not every residence in the vicinity of the site will take advantage of the availability of the public water supply and that ground water will continue to be used for domestic supplies. Many of those residents that do take advantage of the availability of the public water supply will likely continue to use ground water for some purpose. Some of the public water supply comes from the Bel Aire well field which is located cross gradient to the contaminant plume. At some future time if the plume is not treated and the Bel Aire wells are pumped at high capacity, there is the potential that the plume may be drawn towards the Bel Aire well field.

6.7 Current or Potential Future Natural Resource Use

The ground water, gardening, and small-scale farming are the present, and likely, the only future use anticipated for the natural resources at the site.

7.0 SUMMARY OF SITE RISKS

The baseline risk assessment estimates what risks the site poses if no action was taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline risk assessment for this site.

The site's risk are two fold. The first is a risk to the health of the residents who are currently using ground water as their domestic water supply, and the second is to workers who may come into contact with contaminated soils or ground water. VOCs at concentrations above the MCLs have been found in the wells of the residents, and additional ground water monitoring has delineated a plume of contamination which contains a variety of VOCs in excess of the MCLs. The area of concern has been defined as that which is currently known or suspected to have contaminated ground water above the MCLs. The response action selected in this ROD is necessary to protect the public health or welfare of the environment from actual or threatened releases of hazardous substances into the environment.

7.1 Human Health Risk

Several contaminants detected in the ground water were found to exceed MCLs. They include PCE, 1,1-DCE, TCE, and vinyl chloride. Of these, vinyl chloride presents the greatest risk and is the most prevalent in the Riverview plume, but almost absent in the northern plume where levels of the other contaminants are significantly higher than in the Riverview plume. In addition, the presence of levels of 4-methyl-2-pentanone, ethylbenzene, and toluene in soils on the former Wilko Paint facility presents direct contact concern for the soils there.

At this time, the exposure of the population to ground water above MCLs 'and soils exceeding health-based levels is sufficient to establish risk. The actions proposed in this ROD will remove the contamination from the ground water and soils so the risk to the exposed population will be reduced to acceptable levels. it is anticipated that the measures will prevent future migration of the plume from the site while treating the plumes until they are below MCLs. The treatment of the soils will reduce the contaminant concentrations to below health-based levels of concern. The results of the risk assessment indicate that, based on current data, there are risks to workers through exposure to soil. The primary risk is from dermal contact to surface soil containing high levels of 4-methyl-2pentanone, ethylbenzene, and toluene on the former Wilko Paint property.

7.1.1 Chemicals of Concern

The following tables are comprehensive listings of the contaminants found at the site. The contaminants listed in the tables were used to identify the risks at the site.

Table 7-1 Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations

Scenario Time Frame: Current
Medium: Ground Water
Exposure Medium: Ground Water

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration
		Min	Max			
Ground Water on-site-Ingestion	1,1-Dichloroethane	0.61	54	PPB	18/47	54
	1,1-Dichloroethene	0.59	4.9	PPB	07/47	4.9
	1,1,1-Trichloroethane	O.53	13	PPB	08/47	13
	1,2-Dichloroethane	1.2	1.2	PPB	01/47	1.2
	Cis-1,2-Dichlorotthene	0.7	64	PPB	19/47	64
	1,2,4-Trimethylbenzene	0.67	4.6	PPB	02/47	4.6
	Acetone	8	10	PPB	03/47	10
	Benzene	0.52	15	PPB	10/47	15
	Chloroethane	1.3	120	PPB	08/478	120
	Ethyl Benzene	5	120	PPB	03/47	120

Table 7-1 Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations

Scenario Time Frame: Current
Medium: Ground Water
Exposure Medium Ground Water

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration
		Min	Max			
Ground Water on-site - Ingestion	Isopropylbenzene	2.2	10	PPB	02/47	10
	Methylene Chloride	0.51	0.57	PPB	02/47	0.57
	Naphtalene	1	1	PPB	01/47	1
	Tetrachloroethene	0.55	3.8	PPB	04/47	3.8
	Toluene	4	53	PPB	02/47	53
	Trichloroethene	0.65	7.1	PPB	14/47	7.1
	Vinyl Chloride	7.2	8.7	PPB	02/47	8.7
	Xylene (total)					

Table 7-1 Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations

Scenario Time Frame: Current
Medium: Ground Water
Exposure Medium Ground Water

Key
ppm: Parts per billion
MAX: Maximum Concentration

The table presents the chemicals of concern and exposure point concentrations for each of the chemicals of concern detected in ground water (i.e., the concentrations that will be used to estimate the exposure risk from each chemical of concern in the ground water). The table includes the ranges of concentrations detected for each chemical of concern, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the site), the exposure point concentration (EPC), and how the EPC was derived. The table indicates that cis-1,2-Dichloroethene is the most frequently detected chemical of concern in ground water at the site.

TABLE 7-2 Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations

Scenario Time Frame: Current
Medium: soil
Exposure Medium Soil

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Statistical Measure
		Min	Max				
Soil on-site-Direct Contact	4-methyl-2-pentone	160	160	ppm	01/10	160	MAX
	Ethylbenzene	320	600	ppm	02/10	600	MAX
	Toluene	13	330	ppm	6/10	330	MAX

Key
ppm: Parts per million
MAX: Maximum Concentration

The table presents the chemicals of concern and exposure point concentrations for each of the chemicals of concern detected in soil (i.e., the concentrations that will be used to estimate the exposure risk from each chemical of concern in the soil). The table includes the ranges of concentrations detected for each chemical of concern, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the site), the exposure point concentration (EPC), and how the EPC was derived. The table indicates that Toluene is the most frequently detected chemical of concern in soil at the site.

7.1.2 Exposure Assessment

There are three distinct steps for the exposure assessment process: (1) characterizing the exposure setting; (2) identifying exposure pathways; and (3) quantifying exposure. The exposure setting is characterized by describing the site's physical features as well as identifying potentially exposed populations. Potentially exposed populations include those individuals potentially exposed under current or future land use.

The exposure pathway for the site consists of four elements: (1) a source and mechanism of contaminant release; (2) a retention or transport medium; (3) a point of potential human contact with the contaminated medium (i.e., the exposure point); and (4) an exposure route (i.e., ingestion, inhalation, and dermal contact) at the contact point. If all four elements are present, the exposure pathway is considered "complete". Points of potential human contact and exposure routes are evaluated under both current and future land-use scenarios. Exposure routes represent the means of contact between the potentially exposed population and a medium such as soil or ground water. This would include human contact by ingestion or dermal absorption (skin contact). The last step involves the calculation of the data using approved formulas for determining exposure.

The maximum detected concentration for each contaminant in the ground water was used as the reasonable maximum exposure (RME) in the risk calculations. The maximum was used to conservatively predict the risk from a point source of contamination such as a residential well. To arrive at an appropriately conservative estimate of exposure to contaminated soil, the 95^{th} percent upper one-sided confidence limit (95^{th} UCL) on the log normally transformed data were used to calculate a RME. If the data contained less than ten samples or the 95^{th} UCL exceeded the maximum detected concentrations, the maximum concentration was used.

7.1.3 Toxicity Assessment

The toxicity data were obtained from the EPA's 1997 Integrated Risk Information System (IRIS) database. When data were not available in IRIS, supplemental sources of information were used,

such as values from the Health Effects Assessment Summary Tables or interim values used by the agency. Tables found in Appendix B provide a summary of the carcinogenic and non-carcinogenic toxicity data used to calculate the risk of each chemical of concern.

7.1.4 Risk Characterization

The information generated by the toxicity assessment is combined with information from the site-specific exposure assessment to quantify the carcinogenic and non-carcinogenic effects associated with the chemicals of potential concern.

Carcinogenic and non-carcinogenic effects are calculated for each pathway of exposure and each chemical of potential concern. Carcinogenic and non-carcinogenic values, respectively, are added
for all chemicals in an exposure pathway (e.g., incidental ingestion of soil). The totals for all exposure pathways in a given population (e.g., current on-site resident) are added to give an estimate of the population risks. These values may be found in the tables located in Appendix B.

7.1.5 Conclusions

Both current and future risks to all evaluated populations are above acceptable levels. These values indicate concern for both non-carcinogens and carcinogens for the current and future populations expected to occur at the 57th & N. Broadway site.

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. A RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). A HQ of less than 1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all chemical (s) of concern that affect the same target organ (e.g., liver) or that through the same mechanism of action within a medium or across all media to which a given individual may

reasonably be exposed. A HI greater than 1 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic non-carcinogenic effects from all contaminants are unlikely. A HI greater than 1 indicates that site-related. exposures may present a risk to human health. The population hazard index for current and future residents is 5.38, which is above the acceptable hazard index of 1.0. The primary non-carcinogenic risk is from incidental ingestion of ground water containing arsenic, which is present in the industrial portion of the site. For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. These risks are probabilities that usually are expressed in scientific notation (e.g., $1xl0^{-6}$). An excess lifetime cancer risk of $1x10^{-6}$ indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as the result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes. The EPA's generally acceptable risk range for site-related exposures is 10^{-4} to 10^{-6}. The population risk for current and future residents is 1.2×10^{-3}, which is above the acceptable risk range of 1×10^{-6} to 1×10^{-4}. This carcinogenic risk is primarily due to the incidental ingestion of ground water containing vinyl chloride.

The population hazard index for current workers is 1.85, which is above the acceptable hazard index of 1.0. The primary non-carcinogenic risk is from dermal contact with surface soil containing 4-methyl-2-pentanone, ethylbenzene, and toluene. The population risk for a current worker is 2.87×10^{-4}, which is above the acceptable risk range of $1x\ 10^{-6}$ to 1×10^{-4}. This carcinogenic risk is primarily due to the incidental ingestion of ground water containing vinyl chloride. The population hazard index for current workers is 1.85, above the acceptable hazard index of 1.0. The primary non-carcinogenic risk is from dermal contact with soil containing 4-methyl-2-pentanone, ethylbenzene, and toluene. The population risk for future workers is 2.88×10^{-4}, which is above the acceptable risk range of 1×10^{-6} to 1×10^{-4}. This carcinogenic risk is primarily due to the incidental ingestion of ground water containing vinyl chloride.

In conclusion, the 57th & N. Broadway site represents both non-carcinogenic and carcinogenic risks to both current and future on-site residents and worker populations.

7.2 Ecological Risks

An ecological characterization was completed for the site and presented in a technical memorandum, "Ecological Site Characterization". The ecological assessment of the site was performed to determine the ecological resources present and their general condition. Data were obtained through a review of existing literature and observations made during the reconnaissance site visit on March 31 and April 1, 1997. The assessment included an evaluation of wetlands, demographics, wildlife, and available habitat at the site.

There is no designated critical habitat for threatened or endangered wildlife species within the site. Off site, threatened and endangered species were identified within a four-mile radius of the site. In addition, wetlands were identified within 15 miles downstream of the site.

The majority of contamination identified at the site included VOCs detected in the ground water. The floodways on site act as a recharge to the ground water. Therefore, ecological exposure to contaminants at the site is not expected.

8.0 REMEDIAL ACTION OBJECTIVES

This section presents the remedial action objectives developed to address the ground water and soil contamination at the 57th & N. Broadway site. CERCLA, as amended by Section 121(b) of SARA, 42 USC § 9621 (b) , requires selection of remedial actions to attain a degree of clean up that ensures protection of human health and the environment, is cost-effective, and uses permanent solutions and alternative treatment technologies or resource technologies to the maximum extent practicable.

To satisfy CERCLA requirements, remedial action objectives were developed for the 57th & N. Broadway site. Remedial action objectives were used to develop remedial action alternatives.

Remedial action objectives developed for contaminated ground water and soils include the following:

- Prevent ingestion, inhalation, or direct contact with ground water having vinyl chloride, PCE, TCE, or 1,1-DCE at concentrations in excess of current federal and state regulatory drinking water standards. Current regulatory drinking water standards include MCLs, which are maximum permissible levels as established by the SDWA, (42 U.S. C.§ 300(f) et seg.] for a contaminant in water that is delivered to any user of a public water system;

- Prevent further migration of contaminants to prevent degradation of natural resources and the potential contamination of additional water supply wells; and

- Treat soils above health-based levels to prevent direct contact or subsequent contamination of ground water.

9.0 DESCRIPTION OF ALTERNATIVES

This section presents the remedial action alternatives developed to address the ground water and soil contamination in the 57th N. Broadway site. These alternatives have been developed to determine the appropriate remedial action necessary for the site. Seven remedial action alternatives have been developed to address the ground water contamination at the site. Five remedial action alternatives have been developed to address the soil contamination at the site.

Ground Water Alternatives

Alternative 1 - No Action
Alternative 2 - Natural Attenuation
Alternative 3 - Containment/Air Stripping w/Tray Aeration
Alternative 4 - Containment/In Situ Vapor Extraction
Alternative 5 - Active Restoration/Air Stripping w/Tray Aeration
Alternative 6 - Active Restoration/In Situ Vapor Extraction
Alternative 7 - Active Restoration/In Situ Chemical oxidation and In Situ Vapor Extraction

Soil Alternatives

Alternative 1 - No Action
Alternative 2 - Containment/Slurry Wall & Cap
Alternative 3 - Excavation and Off-site Incineration
Alternative 4 - Excavation and Off-site Landfill Disposal
Alternative 5 - In Situ Soil Vapor Extraction

9.1 Ground Water Alternatives

9.1.1 Alternative 1: No Action

The Superfund Program requires that the "no action" alternative be evaluated at every site to establish a baseline for comparison. Under this alternative, EPA will take no further actions and the site is left "as is." No funds will be expended for monitoring, control, or clean up of the contaminated ground water. Operation and Maintenance (O&M) is the average annual cost for five-year reviews. Cost estimates for this remedy are found in Appendix C. The time for the contaminants to degrade below MCLs is unknown. Thirty years have been used for estimating purposes.

Capital Cost: $0
Annual O&M: $1,390
Present Worth: $41,700 (using a 5 percent discount rate)
Months to Implement: None

9.1.2 Alternative 2: Natural Attenuation

Alternative 2 would consist of a focused ground water monitoring program and the use of institutional controls. Focused ground water modeling and aquifer screening models would be used to determine if natural attenuation is occurring. The institutional controls would consist of access and use restrictions, public education, voluntary deed restrictions, and permits. A detailed sampling and quality assurance plan would be written to perform the ground water monitoring. The sampling and quality assurance plans would include sample locations, sample frequency, sample procedures, sample analysis methods, and sample documentation. For the purpose of developing this alternative, it was assumed that four new monitoring well nests would be installed. Because

contaminants have been found at the top and bottom of the aquifer, each well nest would consist of two wells, one screened at the top of the ground water table and a second screened at the bottom of the aquifer. The design of the monitoring system and procedures and installation of the new wells is estimated to take about two months. Detailed cost estimates are in Appendix C.

Description of Remedy Components

- Natural attenuation - the ability of the subsurface to naturally treat the contaminants, via biodegradation, chemical reactions, dispersion and dilution, sorption, and volatilization.
    - Both the northern and the Riverview plumes will be treated using natural attenuation.
    - Contaminant levels have decreased several orders of magnitude in the last ten years; this indicates the potential for natural attenuation to achieve clean-up levels.
    - If it is determined that natural attenuation is not successful, an alternative remedy will be selected to complete the clean up.
- Monitoring System - a system of monitoring wells to monitor the plumes and to determine if the natural processes are in fact continuing to clean up the contaminants.
- Voluntary deed restrictions such as easements or covenants and permits would restrict the use of contaminated ground water for drinking purposes. Local government would be responsible to implement and maintain the restrictions and permits.

Capital Cost: $10,600
Annual O&M Costs: $11,200 to $49,100
Present Worth: $333,900 (using a 5 percent discount rate)
Estimated Implementation Time: 2 months to implement and an estimated 30-year total duration

9.1.3 Alternative 3: Containment/Air Stripping with Tray Aeration

Alternative 3 includes the extraction of ground water at a rate to contain the contaminant plume. It is estimated that three extraction wells, pumping at a rate of approximately 100 gallons per minute (gpm) each, for a combined capacity of 300 gpm would be necessary to contain the plume. Extracted ground water would be piped from each well and treated by air stripping with tray aeration at a single air stripper. The treated ground water would then be discharged to the nearby Chisholm Creek Floodway. The alternative also includes ground water monitoring to determine the effectiveness of the treatment system and institutional controls to prevent exposure to the ground water until remediation goals are achieved. It is estimated that the time required to achieve clean-up goals would be in excess of 30 years; for cost purposes, 30 years have been used. Detailed cost figures are in Appendix C. It is estimated that the engineering design will take approximately eight months to complete; then it will require an additional eight months to obtain the required equipment, install monitoring and extraction wells. Actual construction and startup of the ground water treatment system will take an additional eight months. It is estimated that the time for the notice to proceed with the design to limited startup would be approximately fifteen to twenty-four months.

Description of Remedy Components

- Ground water will be extracted via three extraction wells, each extracting ground water at the rate of 100 gpm from the northern plume.

- No additional treatment of the Riverview plume is necessary as that is being contained and treated under the OU 2 action.

- The rate of pumping is sufficient to contain and treat the ground water in the northern plume.

- Treated water will be discharged to the Chisom Creek Floodway.

- The pumped ground water will be treated via tray aeration air stripping.

- As treatment decreases the size of the plume, pumping rates will be adjusted to address smaller plume size as appropriate.

- Ground water monitoring would continue for a period of time once clean-up levels are reached to ensure effectiveness of treatment.

- Voluntary deed restrictions such as easements or covenants and permits would restrict the use of contaminated ground water for drinking purposes. Local government would be responsible to implement and maintain the restrictions and permits.

Capital Cost: $630,800
Annual O&M Costs: 1st year $114,800; thereafter $59,800 to $83,700
Present Worth: $1,680,900 (using a 5 percent discount rate)
Estimated Implementation Time: 24 months to implement and an estimated 30-year total duration.

9.1.4 Alternative 4: Containment/In Situ (in place) vapor Extraction

Ground Water Alternative 4 includes in situ treatment of contaminated ground water through use of a series of in situ vapor stripping wells to contain the ground water contaminant plume. The contaminants would be transferred from the ground water to the air by creating a circulation zone of aerated water. The vapors are extracted by using a blower and discharged to the atmosphere. The alternative also includes ground water monitoring to determine the effectiveness of the treatment system and institutional controls to prevent contact with ground water until remediation goals are achieved. The cost estimate is based upon ten wells, the actual number required will be determined during the design of the remedy. Details on the cost estimate are in Appendix C. The time required to achieve clean-up goals is estimated to be greater than 30 years. The time to actually

construct the alternative would require about eight months for the engineering design and another eight months for obtaining the equipment necessary and installation of the in-situ vapor extraction wells and monitoring wells. Some of these tasks could be conducted concurrently with equipment lead time. It is estimated that the time from the notice to proceed with the design to limited startup would be approximately twelve months.

Description of Remedy Components

- Ground water will be treated via a series of in-well strippers designed to contain the plume as it is treated.

- No additional treatment of the Riverview plume is necessary as that plume is being contained and treated under OU 2 remedial action.

- Continuous evaluations will be made to determine if one or more of the in-well strippers may be turned off once the plume is reduced by the treatment system.

- Ground water monitoring would continue for a period of time once clean-up levels are reached to ensure effectiveness of treatment.

- Voluntary use restrictions such as easements or covenants and permits will be required to prohibit the use of the ground water for drinking purposes. Local government will be responsible to implement and maintain the voluntary use restrictions and permits.

Capital Cost: $356,200
Annual O&M Costs: 1st year $104,300; thereafter $49,300 to $73,200
Present Worth: $1,244,900 (using a 5 percent discount rate)
Estimated Implementation Time: 12 months to implement and an estimated 30-year total duration.

9.1.5 Alternative 5: Active Restoration/Air Stripping with Tray Aeration

Alternative 5 includes the extraction of ground water at a rate to actively restore the aquifer. Six extraction wells, pumping at a rate of approximately 75 gpm each, for a combined capacity of 450 gpm, would be necessary to actively restore the plume. Extracted ground water would be treated by air stripping with tray aeration. The treated ground water would then be discharged to the nearby Chisholm Creek Floodway. The alternative also includes ground water monitoring to determine the effectiveness of the treatment system and institutional controls to prevent exposure to the ground water until remediation goals are achieved. The time required to achieve clean-up goals is estimated to be 20 years. The estimate for initiation of the project includes eight months for engineering design, eight months for obtaining the necessary equipment and installation of monitoring and extraction wells, and eight months for construction and startup of the ground water treatment facility. Some of these tasks could be performed concurrently. It is conservatively estimated that the time from the notice to proceed with design to limited startup would be fifteen to twenty-four months. Details of the cost estimate are in Appendix C.

Description of the Remedy Components

- Ground Water will be extracted via six extraction wells, each extracting ground water at the rate of 75 gpm.
- The rate of pumping is sufficient to treat the ground water in the northern plume and the Riverview plume will be treated as it is contained.
- Treated water will be discharged to the Chisom Creek Floodway.
- The pumped ground water will be treated via tray aeration air stripping.
- Upon shrinking the plume, pumping rates will be adjusted to address smaller plume size as appropriate.

- Ground water monitoring would continue for a period of time once clean-up levels are reached to ensure effectiveness of treatment.

- Voluntary deed restrictions such as easements or covenants and permits would restrict the use of contaminated ground water for drinking purposes. Local government will be responsible for implementation and maintenance of the voluntary deed restrictions and permits.

Capital Cost: $844,000
Annual O&M Costs: 1st year $139,900 thereafter $82,600 to $104,900
Present Worth: $1,989,700 (using a 5 percent discount rate)
Estimated Implementation Time: 12 months to implement and an estimated 20-year total duration.

9.1.6 Alternative 6: Active Restoration/In Situ Vapor Extraction

Ground water Alternative 6 includes in situ treatment of contaminated ground water through use of a series of in situ vapor stripping wells to actively restore the aquifer. The contaminants would be transferred from the ground water to the air by creating a circulation zone of aerated water. The vapors are extracted by using a blower and discharged to the atmosphere. The alternative also includes ground water monitoring to determine the effectiveness of the treatment system and institutional controls to prevent exposure to ground water until remediation goals are achieved. The cost estimate is based upon 20 wells; the actual number required will be determined during the design of the remedy. Detailed cost estimates are in Appendix C. The time required to achieve clean-up goals is estimated to be ten years. The time to actually construct the alternative is estimated to be eight months for engineering design and ten months to acquire the necessary equipment and install the in-situ vapor extraction and monitoring wells. Some of these tasks could be performed concurrently. It is estimated that from the time the notice to proceed with the design to limited startup would be approximately fourteen months.

Description of Remedy Components

- Ground water will be treated via a series of in-well strippers designed to contain and treat the plume.

- Additional treatment of the Riverview plume may be necessary to supplement the action taken under the OU 2 remedial action. If so, additional wells will be added as necessary.

- Continuous evaluations will be made to determine the effectiveness of the system.

- Ground water monitoring would continue for a period of time once clean-up levels are reached to ensure effectiveness of treatment.

- Voluntary deed restrictions such as easements or covenants and permits would restrict the use of contaminated ground water for drinking purposes. Local government will be responsible for implementation and maintenance of the voluntary deed restrictions and permits.

Capital Cost: $658,700
Annual O&M Costs: 1st year $127,300; thereafter $81,200 to $96,200
Present Worth: $1,350,600 (using a 5 percent discount rate)
Estimated Implementation Time: 14 months to implement and an estimated 10-year total duration.

9.1.7 Alternative 7: Active Restoration/In Situ Chemical oxidation and In Situ Vapor Extraction

Ground Water Alternative 7 includes the in situ treatment of contaminated ground water through the use of in situ chemical oxidation and in situ vapor extraction to obtain active restoration of the aquifer in the northern plume and in situ vapor extraction of the plume in the Riverview area as discussed in Alternative 6. Chemical oxidants, the most commonly used are hydrogen peroxide (H2O2) and potassium permanganate MM1104), will be injected into the ground water through temporary wells to degrade the contaminants. The in-situ chemical oxidization will we used in the areas of the northern plume that have the highest

concentrations, and in-situ vapor extraction will be used in the areas where the contamination is lower. The alternative also includes ground water monitoring to determine the effectiveness of the treatment system and institutional controls to prevent exposure to ground water until remediation goals are achieved. The cost estimate is based upon 1,000 injection points; the actual number required will be determined during the design of the remedy. O&M is the average annual cost for five-year reviews and the operation of the in-well strippers. The time required to achieve this remedial action alternative is estimated to be ten years. The in-situ chemical oxidation portion would be completed approximately one year after installation, and the in-situ vapor extraction portion would continue to run for ten years to complete restoration of the aquifer. The time to actually construct the alternative would require eight months for engineering design and twelve months for equipment lead time and installation of the in-situ chemical oxidation wells, the in-situ vapor extraction wells and the monitoring wells. Some of the tasks could be performed concurrently, and it is estimated that the time from the notice to proceed with the design to limited startup would be approximately fourteen months. Cost estimate details are in Appendix C.

Description of the Remedy Components

- The northern plume will be treated through a number of locations. The cost estimate is based on 1,000 injection points with an oxidation compound and down gradient in-well strippers that will treat the remainder of the plume.

- Evaluations will be made to determine if additional in-well strippers will be required in the Riverview plume.

- Voluntary deed restrictions such as easements or covenants and permits would restrict the use of contaminated ground water for drinking purposes. Local government will be responsible for implementation and maintenance of the voluntary deed restrictions and permits.

Capital Cost: $2,375,100
Annual O&M Cost:1st year $121,100 thereafter; $72,600 to $87,600
Present Worth: $3,002,900 (using a 5 percent discount rate)
Estimated Implementation Time: 14 months to implement and an estimated 10-year total duration.

9.2 Soil Remedial Action Alternatives

9.2.1 Alternative 1: No Action

The Superfund Program requires that the "no action" alternative be evaluated at every site to establish a baseline for comparison. Under this alternative, EPA will take no further actions and the site is left "as is." No funds will be expended for monitoring, control, or clean up of the contaminated soil. O&M is the average annual cost for five-year reviews. Cost estimates for this remedy are found in Appendix C.

Capital Cost: $0
Annual O&M Costs: $1,000
Present Worth: $27,800 (using a 5 percent discount rate)
Estimated Implementation Time: 0 months to implement and an estimated 30-year total duration.

9.2.2 Alternative 2: Containment

This alternative includes construction of a slurry wall and cap to contain the contaminated soil. The slurry wall would encircle the area of contaminated soil and be keyed into the confining layer below the aquifer. This wall circling the contaminated soil would prohibit contamination from moving away from the site, while the cap would keep rain water and other water from infiltrating through the contaminated soil. These two together would keep the contaminated soil on site and prevent it from migrating to adjacent areas while eliminating any direct contact threat. The cap would be constructed of asphalt or asphaltic concrete. The useful life of the cap is estimated to be 30 years. The time to actually construct the alternative would be estimated at six months for the engineering design and six months to construct the slurry wall and the cap. From notification to

proceed to completing of the cap and wall is estimated to take twelve months. O&M would include the repair and inspection of the cap. Details of the cost estimate are contained in Appendix C .

Capital Cost: $1,337,300
Annual O&M Costs: $3,700 to $21,300
Present Worth: $1,457,500 (using a 5 percent discount rate)
Estimated Implementation Time: 12 months to implement and maintained for at least 30 Years.

9.2.3 Alternative 3: Excavation and Off-site Treatment

This alternative includes excavation of the estimated 700 cubic yards of contaminated soil, transportation to, and treatment at an off-site Resource Conservation and Recovery Act (RCRA) incineration facility. The time to implement the alternative would require three months for the engineering design and approximately three months to excavate and transport the material off site. The excavation time may be dependent on the capacity available at the off-site facility, but prior planning and scheduling could reduce the possibility of delays. The estimated time from the notice to proceed to the completion of the alternative is six months. Six months is also the total duration of the remedy. Details of the cost for this alternative are in Appendix C.

Capital Cost: $2,434,200
Annual O&M Costs: 0
Present Worth: $2,434,200 (using a 5 percent discount rate)
Estimated Implementation Time: 6 months to implement and an estimated 6-month total duration.

9.2.4 Alternative 4: Excavation and off-site Disposal

This alternative includes excavation of the 700 cubic yards of contaminated soil, transportation to, and disposal at an off-site RCRA landfill. The time to implement the alternative would require three months for the engineering design and approximately three months to excavate and transport the material off site.

The excavation time may be dependent on the capacity available at the off-site facility, but prior planning and scheduling could reduce the possibility of delays. The estimated time from the notice to proceed to the completion of the alternative is six months. Six months is also the total duration of the remedy. Details of the cost for this alternative are in Appendix C.

Capital Cost: $1,030,500
Annual O&M Costs: $0
Present Worth: $1,030,500 (using a 5 percent discount rate)
Estimated Implementation Time: 6 months implementation
6-month total duration.

9.2.5 Alternative 5: In Situ Soil Vapor Extraction (SVE)

Under Soil Alternative 5, the VOC-contaminated soils at the site would be treated in-place using SVE. Three SVE wells and a series of observation wells would be installed. The soil vapor containing the VOC contamination would be extracted through the extraction wells using vacuum pumps. Due to the low volume of contaminants that will be extracted, the extracted contaminants will be able to be released to the atmosphere. Treatment will continue until the contaminant levels in the soil reach clean-up goals as defined by the levels of contaminant vapor being extracted; see Table 2-5 in Appendix B. It is estimated that the SVE system will take eight months for the engineering design, four months to acquire the required equipment and to install the system, and two months to fine tune the system to site conditions. Some concurrent actions will be taken so it is estimated that the time from the notice to proceed until the system is functional will be ten months. The total time of operation once the system is operational is estimated to be three-hundred days. Since the system will not be in operation more than one year, no annual O&M cost will be incurred. Details of the cost estimate for the alternative are in Appendix C.

Capital Cost: $237,950
Annual O&M Costs: $0
Present Worth: $237,950
Estimated Implementation Time: 10 months to implement and an
estimated 300-day duration.

10.0 Comparative Analysis of Alternatives

In this section, the remedial alternatives are evaluated with respect to certain criteria so that the advantages and disadvantages associated with each clean-up option for the 57th & N. Broadway site are clearly understood. Each alternative is compared to each other relative to each of the nine criteria identified in the NCP.

The remedial alternative evaluation criteria have evolved as a result of statutory requirements that must be addressed in the ROD. CERCLA requires that remedial actions meet the following criteria:

- Be protective of human health and the environment;
- Attain ARARs or provide grounds for invoking a waiver;
- Be cost-effective;
- Use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and
- Satisfy the preference for treatment that reduces toxicity, mobility, or volume as a principal element or provide an explanation in the ROD of why it does not.

The NCP and the “Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA” provide nine evaluation criteria to address the CERCLA statutory requirements considerations:

- Overall protection of human health and the environment;
- Compliance with ARARs;
- Long-term effectiveness and permanence,
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability;
- Cost;
- State acceptance; and
- Community acceptance.

The following discussion presents the primary components of each of the nine criteria that are used to complete the detailed

evaluation of alternatives. The first two criteria, overall protection of human health and the environment and compliance with ARARs, are considered threshold criteria. These criteria must be met for an alternative to be considered a remedy for a site. The next five criteria are considered balancing criteria. Tradeoffs are made between the alternatives with respect to the balancing criteria; however, specific weighing factors are not used. State acceptance and community acceptance are considered modifying criteria, and are used to assist in identifying and/or modifying the selected remedy after the public comment period.

10.1 EVALUATION OF GROUND WATER ALTERNATIVES

10.1.1 *Overall Protection of Human Health and the Environment*

This criterion provides an overall assessment of whether each alternative will adequately protect human health and the environment. The overall protectiveness focuses on whether an alternative will achieve adequate protection and how site risks will be eliminated, reduced, or controlled through treatment, engineering, or institutional controls. This criterion is considered a threshold criterion; that is, overall protection must be provided for an alternative to be considered as a remedy for the site.

Alternative 1 is not protective of human health or the environment. Because no actions will be taken under Alternative 1, the ground water contaminants may continue to migrate and contaminate the public supply wells and produce a larger contaminant plume. Although no active remediation would occur in Alternative 2, this alternative would provide continuing monitoring of the contaminant plumes to determine their migration route and to determine if natural attenuation is occurring. Alterative 2 would be protective of human health because the monitoring would allow detection of contaminants at unacceptable levels if the plumes migrate. Some protection of the environment would occur by determining if the contaminant concentrations are decreasing. However if concentrations do not decrease, the potential for migration of ground water contamination is also likely.

Alternatives 3 and 4 would provide more protection of human health and the environment than Alternatives 1 and 2. The containment and treatment systems in Alternatives 3 and 4 would be effective in ensuring that further migration of contaminants does not occur; thus, the contaminants would not come into contact with the public supply wells. However, protection of the environment would take longer to occur because, although ground water would be extracted and treated, it would not be actively remediated. Thus, contaminated ground water would remain for an extended period.

Alternatives 5, 6, and 7 would be protective of human health and the environment because all ground water with contaminant concentrations greater than clean-up levels would be actively remediated. The clean-up goals would be reached earlier with Alternatives 6 and 7 than with Alternatives 2, 3, 4, and 5. The technology used in Alternatives 3 and 5 (extraction and treatment with air stripping) is proven effective for the removal of volatiles from ground water and has been used at numerous sites. The technologies used in Alternatives 4, 6, and 7 (in situ vapor extraction and in situ chemical oxidation), are also effective in the removal of volatiles from ground water. However, the in situ extraction and chemical oxidation technologies are innovative technologies that do not have as long a history of success as does the extraction and treatment with air stripping technology.

Only minor exposure to contaminants is expected during the installation and operation of the various treatment systems. Workers and the public are not expected to be exposed at any time to levels exceeding appropriate risk levels. If it is anticipated that workers might be exposed to contaminant levels that are unacceptable, that exposure will be mitigated by the use of personal protective equipment. Although the contaminants are released into the air during treatment in Alternatives 3, 4, 5, 6, and 7, the potential for cross-media contamination is low because the emission concentrations are not expected to be significant and would have to conform with allowable emissions rates set forth in the applicable air regulations. Alternatives 6 and 7 provide the greatest protection to human health and the environment. These two alternatives provide treatment in-situ.

10.1.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

This criterion, also a threshold criterion, assesses whether an alternative will meet all federal and state ARARs for the site, including action-specific ARARs. ARARs were identified for the site in the *Technical Memorandum on identification of Applicable or Relevant and Appropriate Requirements* which was produced in preparation for the 57th & N. Broadway site remedial investigation/feasibility study. Section 121(d) of CERCLA and the NCP § 300(f)(l)(ii)(B) require that remedial actions at CERCLA sites attain ARARs, unless such ARARs are waived under CERCLA Section 121(d)(4).

Applicable requirements are those clean-up standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental of facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. Relevant and appropriate requirements are those clean-up standards, standards of control and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental of facility siting laws that while not “applicable” to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be relevant and appropriate.

Alternative 1, if implemented, would not comply with the chemical-specific ARARs because ground water that contained contaminants with concentrations in excess of the clean-up goals would remain unmonitored. Location- and action-specific ARARs would not be applicable because no action would occur. The remaining alternatives would comply with all state and federal location-, chemical-, and action-specific ARARs.

10.1.3 Long-Term Effectiveness and Permanence

This balancing criterion assesses the residual risk that will remain at the site after the remedial action objectives are achieved. The extent and effectiveness of the controls needed to manage any treatment residuals or untreated media are assessed by qualitatively determining the magnitude of any residual risk remaining at the site at the conclusion of the remedial activities. Also, the adequacy and reliability of the controls that are used to manage any treatment residuals or monitor untreated media remaining at the site are assessed.

Because no remedial actions would occur, a long-term risk would be associated with Alternative 1 as long as clean-up goals are exceeded. The possibility exists for greater volumes of contaminated ground water to be generated. This is also true for Alternative 2. However, in Alternative 2 an active monitoring program would be put in place to determine if natural attenuation is occurring and to determine the migration pathway of the plumes. For Alternative 1, no mechanism exists to determine if concentrations are increasing or decreasing. Thus, the long-term risk is greater with Alternative 1 than with Alternative 2.

Alternatives 3, 4, 5, 6, and 7 would have no long-term risk. A long-term risk would not be associated with the treated ground water in Alternatives 3, 4, 5, 6, and 7. Alternatives 6 and 7 would offer effectiveness and permanence earlier than Alternatives 3, 4, and 5 because water would be remediated at a faster rate.

Five-year reviews would be required for all alternatives. Alternatives 1 and 2 would require the greatest number of five year reviews because restoration would take the longest. Fewer reviews would be required for Alternatives 6 and 7 than for Alternatives 3, 4, and 5.

The proposed monitoring plans and/or treatment technologies in Alternatives 2, 3, 4, 5, 6, and 7 should adequately and permanently achieve the performance specifications established in the remedial action objectives. However, some site conditions including the high ground water hardness and low level of contamination would reduce the effectiveness of the in situ

chemical oxidation in Alternative 7. Because no action would occur in Alternative 1, there would be no mechanism to determine if remedial action objectives are being met.

Alternatives 5, 6, and 7 would all provide long-term effectiveness and be permanent. Alternatives 6 and 7 would do so more quickly.

10.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This balancing criterion assesses the degree to which site media will be treated to permanently and significantly reduce the toxicity, mobility, or volume of site contaminants through treatment. This is accomplished by analyzing the destruction of toxic contaminants, the reduction of the total mass of toxic contaminants, the irreversible reduction in contaminant mobility, or the reduction in total volume of contaminated material.

Alternative 1 does not include treatment as a component. Monitoring would be performed in Alternative 2; however, it may take several rounds of sampling to determine if natural attenuation is reducing the toxicity, mobility, or volume of the contaminants. A reduction in toxicity, mobility, or volume of contaminants would occur in Alternatives 3, 4, 5, 6, and 7. The two containment alternatives, Alternatives 3 and 4, would reduce the mobility of the contaminants by containing the plume and slowly reducing the contaminant concentrations. Alternatives 5, 6, and 7, through active restoration of the aquifer, would reduce the toxicity, mobility, and volume of the contaminants. The ground water treatment would be irreversible. No residuals would be produced from any of the alternatives. All the alternatives except Alternatives 1 and 2 would meet the statutory preference for treatment as a principal element. Alternatives 5, 6, and 7 achieve the reduction more effectively than Alternatives 3 and 4.

10.1.5 Short-Term Effectiveness

This balancing criterion addresses the effects of an alternative on site surroundings during the construction and implementation phases of the remedial action, before remedial action objectives are achieved. These effects include consideration of the

protection of workers and the community during remedial action implementation, environmental impacts that might result from construction or implementation, and the length of time until the remedial action objectives are achieved.

The risk to community and workers would be minimal for all alternatives. None of the risks would be uncontrollable. Nearby residents may be exposed to contaminated dusts during installation of monitoring and extraction wells. These risks would be controlled by the use of dust suppressants. The risk to workers would be controlled by proper use of personal protection equipment and monitoring during site activities. The reduction would take much longer under Alternative 3 than Alternatives 4, 5, 6, or 7. Alternatives 4 and 5 would take longer than Alternative 6 or 7 to reach clean-up goals and reduce the toxicity, mobility, or volume of the contaminants.

The time to achieve clean-up levels would be greatest for Alternatives 2, 3, and 4: 30 years. Alternative 5 will take less time than Alternatives 2, 3, and 4, but would take a much longer time than Alternatives 6 and 7. It is estimated that the time to achieve clean-up goals for Alternative 5 will be 20 years. The time to achieve clean-up levels for Alternatives 6 and 7 is estimated to be 10 years. Because no monitoring would be performed in Alternative 1, it would be unknown if clean-up levels would ever be met.

10.1.6 Implementability

This balancing criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during implementation. Technical feasibility encompasses the technical difficulties and unknowns associated with the alternative, the reliability of the technologies, the ease of undertaking additional remedial actions if necessary, and monitoring requirements. Administrative feasibility includes the activities required for coordination with other offices and agencies. Availability of services and materials includes the availability of necessary equipment and specialists, the ability to obtain competitive bids, and the availability of prospective technologies.

Because no actions would be taken during Alternative 1, this criterion is not applicable. Alternative 2 would be the easiest of the alternatives to implement. Alternative 2 requires the installation of only four ground water monitoring well nests and implementing a ground water sampling program. Alternatives 3, 4, 5, 6, and 7 also include installation of the four monitoring wells nests and a ground water sampling program, and in addition require the installation of additional wells (extraction or treatment) and treatment system components. Alternative 4 would be easier to implement than Alternative 3 because the large amount of piping to a treatment facility included in Alternative 3 would not be required. The ground water treatment system components (pumps, piping, trays, etc.) in Alternative 5 would be larger and may require more maintenance than in Alternative 3. Alternatives 4, 6, and 7 would be the more technically challenging of the alternatives because they involve the use of an innovative technology and fewer contractors are available who can install an in-situ vapor extraction system (Alternates 4 and 6) or an in situ chemical oxidation system (Alternative 7).

Alternative 2 involves natural attenuation to reduce the concentrations of the contaminants. It is presently uncertain to what extent natural attenuation will occur. It may take several years to determine the rate of natural attenuation. Alternatives 3 and 5 are proven and reliable. The high hardness and low contamination levels found at the site could pose a problem with the effectiveness of the in situ chemical oxidation used in Alternative 7. Fouling problems associated with the ground water hardness would also effect Alternatives 3, 4, 5, and 6, but experience has proven that they are manageable. The in-situ technologies of Alternatives 4 and 6 could more easily resolve the problem than those requiring external pumping. The technologies used in Alternatives 4, 6, and 7 are innovative technologies that have not been in use as long as the technology in Alternatives 3 and 5, but have been used in a number of locations with good success.

Implementation of Alternatives 4, 6, and 7 would be consistent with the Riverview area remedial action. The in-situ treatment system installed as part of the Riverview remedial action could be used if either Alternative 4, 6, or 7 was implemented.

No additional remedial actions are anticipated for each of the alternatives with the exception of Alternative 2. Again, for Alternative 2 it is presently uncertain if natural attenuation would occur at a rate fast enough to prevent migration of the contaminants into the public water supply wells. However, if the alternative is not effective in meeting the remedial action objectives, additional remedial actions could be evaluated and implemented. All migration or exposure pathways can be monitored adequately and easily.

The necessary equipment and personnel required to implement each alternative are readily available. Pilot-scale and bench-scale tests may be required for Alternatives 3, 4, 5, 6, and 7. More than one vendor is available for each alternative to provide a competitive bid.

Alternatives 2, 3, 4, 5, 6, and 7 will require some construction activity involving at least three political subdivisions of the state of Kansas: Sedgwick County, Park City, and the city of Wichita. Concern with the location of public utilities will impact the design of each of the remedies. Use of public and private property will be necessary for the installation and operation of the various systems required by the alternatives.

These concerns are not foreseen as presenting unsurmountable obstacles, but the greater the number of wells, etc., required by an alternative, the greater the implementation problem in this area. Alternative 7 with an estimated 1,000 injection points could result in the greatest overall burden in this area.

10.1.7 Cost

The cost criterion involves an evaluation of the capital costs, the annual O&M costs, and a present worth analysis. The cost estimates are approximate estimates made without detailed engineering data. It is normally expected that an estimate of this type will be accurate to +50 percent and -30 percent. The actual costs of the project will depend on the final scope of the remedial action, the schedule of implementation, actual labor and material costs at the time of implementation, competitive market conditions, and other variable factors that may impact the project costs.

Only O&M costs, the five-year reviews, converted to a total present worth would be associated with Alternative 1. The total present worth of Alternative 1 would be the lowest at a cost of $41,700. The total present worth cost of Alternative 7 would be the greatest at a cost of $3,002,900. The total present worth costs of Alternatives 2, 3, 4, 5, and 6 are $333,900, $1,680,900, $1,244,900, $1,989,700, and $1,350,600, respectively. It should be noted that there is little significant cost difference among four of the five treatment Alternatives - 3, 4, 5, and 6. Because of the variables involved in the estimates of the costs, one or all of the four alternatives could increase or decrease significantly. Alternative 7 is the most costly and will be under any expected conditions. Details of the cost estimates are located in Appendix B.

10.1.8 State Acceptance

The state of Kansas has expressed support for the treatment remedies which reduce the contaminant concentrations to safe drinking water levels.

10.1.9 Community Acceptance

In general, the community is supportive of the remedies which treat the contaminant plumes, and provide low levels of intrusion into the residential neighborhoods. Specific comments and responses are found in the Responsiveness Summary, Appendix A.

10.2 EVALUATION OF THE SOIL REMEDIAL ALTERNATIVES

10.2.1 Overall Protection of Human Health and the Environment

This criterion provides an overall assessment of whether each alternative will adequately protect human health and the environment. The overall protectiveness focuses on whether an alternative will achieve adequate protection and how site risks will be eliminated, reduced, or controlled through treatment, engineering, or institutional controls.

Alternative 1 would not protect human health and the environment from the contaminants in the soil. Because no actions would occur under Alternative 1, the soil contaminants may migrate to

the ground water and no reduction of the direct contact threat is achieved. Alternative 2 would be protective by providing containment of the contaminated soil and monitoring of the containment system. Alternative 2 would be protective of human health because the threat of direct contact with contaminated soil would be controlled as well as limiting the further contamination of ground water.

Alternatives 3, 4, and 5 would be protective of human health and the environment. Excavation of the contaminated soil under Alternatives 3 and 4 would remove contaminants above clean-up criteria from the site. Soil verification sampling would be performed to ensure that clean-up criteria are met. Alternative 4 would result in off-site landfilling of contaminated soil. Alternative 5 would treat the soil in situ using SVE, thereby removing the contaminants from the soil.

10.2.2 Compliance with ARARs

This criterion, also a threshold criterion, assesses whether an alternative will meet all federal and state ARARs for the site, including action-specific ARARs. ARARs were identified for the site in the *Technical Memorandum on Identification of Applicable or Relevant and Appropriate Requirements* which was produced in preparation for the 57th & N. Broadway site remedial investigation/feasibility study. Section 121(d) of CERCLA and the NCP § 300(f)(l)(ii)(B) require that remedial actions at CERCLA sites attain ARARs, unless such ARARs are waived under CERCLA Section 121(d)(4). See Section 10.1.2 for the definition of ARARs.

Alternative 1, if implemented, would not comply with the chemical-specific ‘to be considered’ (TEC) criteria because soils that contain contaminants with concentrations in excess of the clean-up goals would remain unmonitored. Location- and action-specific ARARs would not be applicable because no action would occur. The remaining alternatives would comply with all state and federal location- and action-specific ARARs, and chemical-specific TBCs.

10.2.3 Long-Term Effectiveness and Permanence

This balancing criterion assesses the residual risk that will remain at the site after the remedial action objectives are achieved. The extent and effectiveness of the controls needed to manage any treatment residuals or untreated media are assessed by qualitatively determining the magnitude of any residual risk remaining at the site at the conclusion of the remedial activities. Also, the adequacy and reliability of the controls that are used to manage any treatment residuals or monitor untreated media remaining at the site are assessed.

Because no remedial actions would occur, a long-term risk would be associated with Alternative 1. The possibility exists for migration of the contaminants from the soil to the ground water and direct contact. Alternative 2 would contain the contaminated soils in place. Alternative 2 is dependent upon a long-term maintenance and monitoring program to ensure the effectiveness and permanence of the remedy. Alternative 2 is not a permanent action and would have more residual risk than Alternative 3, 4, and 5. The effective life of a cap is estimated at 30 years.

Alternatives 3, 4, and 5 would have less of a long-term risk than Alternative 2. A long-term risk would not be associated with the treated soil in Alternatives 3 and 5. Off-site land filling, as in Alternative 4, is less permanent than Alternatives 3 and 5.

Five-year reviews would be required for Alternatives 1 and 2. No five-year reviews would be required for Alternatives 3, 4, or 5.

The proposed treatment technologies in Alternatives 3 and 5 should adequately and permanently achieve the performance specifications established in the remedial action objectives. Since no action would occur in Alternative 1, there is no way to determine if remedial action objectives are being met.

10.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment

This balancing criterion Assesses the degree to which site media will be treated to permanently and significantly reduce the toxicity, mobility, or volume of site contaminants. This is

accomplished by analyzing the destruction of toxic contaminants, the reduction of the total mass of toxic contaminants, the irreversible reduction in contaminant mobility, or the reduction in total volume of contaminated material.

Alternatives 1, 2, or 4 do not include treatment as a component of the remedy. However, Alternative 2 would reduce the mobility of the contaminants by construction of a containment system. Alternative 4 would reduce the mobility of the contaminants by containment in an off-site landfill. A reduction in toxicity, mobility, and volume of VOC contaminants occurs with Alternatives 3 and 5. VOC contaminants in the soil would be destroyed at the off-site incinerator under Alternative 3. Alternative 5 would remove the VOCs from the soil.

10.2.5 Short-Term Effectiveness

This balancing criterion addresses the effects of an alternative on site surroundings during the construction and implementation phases of the remedial action, before remedial action objectives are achieved. These effects include consideration of the protection of workers and the community during remedial action implementation, environmental impacts that might result from construction or implementation, and the length of time until the remedial action objectives are achieved.

The risk to community and workers would be minimal for all alternatives other than Alternative 1. All of the risks would be controllable. Nearby residents may be exposed to contaminated dusts during excavation activities. These risks would be controlled by the use of dust suppressants. The risk to workers would be controlled by proper use of personal protection equipment and monitoring during site activities. Alternatives 3 and 4 would present risks associated with transportation. Alternative 3 would involve incineration and any short-term risks associated with incineration.

The time to achieve clean-up goals would be greatest for Alternative 2, 30 years. Alternatives 3 and 4 would take less time, 6 months, than Alternative 5, 300 days.

10.2.6 Implementability

This balancing criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during implementation. Technical feasibility encompasses the technical difficulties and unknowns associated with the alternative, the reliability of the technologies, the ease of undertaking additional remedial actions if necessary, and monitoring requirements. Administrative feasibility includes the activities required for coordination with other offices and agencies. Availability of services and materials includes the availability of necessary equipment and specialists, the ability to obtain competitive bids, and the availability of prospective technologies.

Because no actions would be taken during Alternative 1, this criteria is not applicable. Alternative 2 would be the most difficult of the alternatives to implement. Alternative 2 requires the installation of a slurry wall and cap. Construction of the slurry wall may be difficult because of the depth. Alternative 5 would be more difficult to implement than Alternatives 3 and 4 because it involves the use of an innovative technology, and fewer contractors are available who can install an in-situ vapor extraction system. Alternatives 3 and 4 would be the easiest alternatives to implement. Excavation and transportation are easily implemented and contractors that specialize in these types of work are readily available. All the alternatives are proven and reliable. No additional remedial actions are anticipated for each of the alternatives.

The necessary equipment and personnel required to implement each alternative are readily available. Pilot-scale and bench-scale tests may be required for Alternative 5. More than one vendor is available for each alternative to provide a competitive bid.

There will be impacts with truck traffic and/or excavation equipment with all of the alternatives. Alternatives 3 and 4 will create the greatest disruption with both excavation and off-site hauling. Alternative 2 will create less disruption due to the location and size of the soil contaminated area; however, the installation of the slurry wall and cap will require significant

on-site activity. Alternative 5 will only require the ingress and egress of the construction equipment and the installation of wells and some minor above ground equipment which should not create a problem in implementation, thereby being the easiest to implement.

10.2.7 Cost

The cost criterion involves an evaluation of the capital costs, the annual O&M costs, and a present worth analysis. The cost estimates are approximate estimates made without detailed engineering data. It is normally expected that an estimate of this type will be accurate to +50 percent and -30 percent. The actual costs of the project will depend on the final scope of the remedial action, the schedule of implementation, actual labor and material costs at the time of implementation, competitive market conditions, and other variable factors that may impact the project costs.

Only O&M costs converted to a total present worth would be associated with Alternative 1. The total present worth of Alternative 1 which includes only cost for five-year reviews would be the lowest at a cost of $27,800. The total present worth cost of Alternative 3 would be the greatest at a cost of $2,434,200. The total present worth costs of Alternatives 2, 4, and 5 are $1,457,500, $1,030,500 and $237,950, respectively.

10.2.8 State Acceptance

The state of Kansas supports all alternatives which permanently treat or remove soil contamination from the site.

10.2.9 Community Acceptance

The community supports Alternative 5. The community appears to be supportive of any remedy that results in the contaminated soil being removed or cleaned up. One commentor pointed out that the limited soil sampling done on the Wilko paint property was insufficient to definitely rule out the presence of significant soil sources of contamination. In response to that comment,

additional soil sampling on the former Wilko Paint property as well as that of the Midland Refinery will be required. Specific comments may be found in Appendix A.

11.0 Summary of the Selected Remedy

The selected remedial action represents the combination of ground water and soil remediation alternatives that EPA determines to provide the best balance of tradeoffs with respect to the criteria discussed in Section 10. Ground Water Alternative 6, active restoration through in-situ vapor extraction, is selected for remediation of the ground water. Soil Alternative 5, in-situ vapor extraction, is selected for the remediation of the soil contamination. No significant change has taken place between the presentation of the Proposed Plan and the selection of this remedy. However, a minor modification which requires additional soil sampling at the former Wilko Paint property has resulted from review of comments received during the public comment period.

It should be noted that the soil remedy calls for investigation for soil contamination on the Midland Refinery and former Wilko Paint properties. If contaminated soil or buried containers are found, Soil Alternative 5 is to be implemented at those locations, along with the removal of any contaminated buried objects and associated soils. One specific element of the soil investigation will consist of a test well on each property. This well will be utilized as a Soil Vapor Extraction test well to determine if VOC contamination is present in the subsurface.

The selected remedy will achieve substantial risk reduction through treatment of the contaminated ground water and soils. The selected remedy provides equal or greater protection of human health and the environment than any of the other alternatives and complies with ARARs. The long-term effectiveness and permanence of the selected remedy is equal to or greater than any of the alternatives. The selected remedy reduces the toxicity, mobility, and volume of contaminants through treatment at levels greater than or roughly equivalent to any of the other alternatives. The short-term effectiveness of the selected remedy is greater than any other alternative. The selected remedy is easily implementable. The selected remedy is in the

same or lesser cost range as any of the active treatment alternatives, given the variables associated with each of the estimates. The state and the community support the selected remedy. Therefore, it is believed that the selected remedy provides the best balance of trade-offs among alternatives with respect to the nine criteria used to evaluate the remedial action alternatives. Based on information available at this time, the EPA and the state believe that the selected alternatives will protect human health and the environment, attain ARARs, be cost-effective, and will use permanent solutions and alternative treatment technologies to the maximum extent practicable.

The specific number and placement of in-situ treatment wells will be determined during the remedial design. This will be accomplished using data obtained from the pilot test ongoing in the Riverview OU. At present, the entire area of the contaminated ground water plumes is served by public water supplies. Not all residents in the plume areas are currently connected to public water, but no resident within the site is currently known to be drinking contaminated water. Current county regulations are sufficient to prohibit the introduction of new wells in the contaminated plume, and there are provisions to prohibit the use of existing wells which become contaminated.

It is possible that a fouling problem may develop with the treatment wells. If that occurs, system adjustments will be required which may include the introduction of compounds to the system to eliminate the fouling problem. This could result in an increase in cost.

The following are the components of the selected remedy.

- Ground water Remedy

    - Ground water will be treated via a series of in-well strippers. The ground water clean-up level will be the MCL for each of the Chemicals of Concern.
    - Add wells for the treatment of the Riverview plume if determined necessary from enhanced design.
    - Design of a complete monitoring system to evaluate the effectiveness of the treatment system as well as continually evaluate the plume location. This will

assist in determining if the plume is being reduced or is migrating.
- Quarterly monitoring of the monitoring system until such time definite evidence that the plume size is reducing. At that time, the frequency of monitoring will be re-evaluated.
- Quarterly evaluations of the treatment system to determine if modifications will produce more efficient treatment of the plumes.
- Ground water monitoring will continue for a period of time specified in the design document after the monitoring demonstrates that remediation goals have been reached.
- Voluntary deed restrictions such as easements or covenants and permits would restrict the use of contaminated ground water for drinking purposes. Local government will be responsible for implementation and maintenance of the voluntary deed restrictions and permits.

- Soil Remedy

  - Design, of in-situ soil vapor extraction system for the site. The soils will be cleaned up to health-based levels for the Contaminants of Concern (Table 11-1).
  - Investigation for soil contamination on the Midland Refinery and former Wilko Paint properties.
  - Installation of SVE system.

The cost estimate for the selected remedy is detailed in Appendix C. Total estimated cost for the selected remedy is estimated as the summation of the cost for ground water Alternative 6, $1,350,600, the cost for soil Alternative 5, $237,950, and the cost for the soils investigation at Midland Refinery and the former Wilko Paint property, estimated at $100,000, which totals to be $1,688,550.

Table 11-1
Risk Based Soil Cleanup Levels

Contaminant of Concern	Non-Carcinogenic Cleanup Level	Carcinogenic Cleanup Level (Risk =1x10^{-6})	Ground Water Protection Level
2-Butanone (MEK)	3900 ppm	na	na
4-Methyl -2-Pentanone	520 ppm	na	84 ppm
Acetone	560 ppm	na	16ppm
Benzene	180000 ppm	11 ppm	na
Ethylbenzene	11,000 ppm	na	13 ppm
Naphtalene	850 ppm	na	na
Toluene	130 ppm	na	12 ppm
Xylene (mixed)	220000 ppm	na	210
ppm = parts per million		na = not applicable	

12.0 STATUTORY DETERMINATIONS

Under its legal authority, EPA's primary responsibility at Superfund sites is to undertake remedial actions that achieve protection of human health and the environment. Ground water will be treated to bring the contaminants of concern levels to meet the minimum standard required for public drinking water supplies. Soil remediation will take place to reduce the risk from contaminated soils determined to require treatment to between 10^{-4} and 10^{-6} and the Hazard Index to below 1. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences. These specify that when complete, the selected remedial action for this site must comply with ARARs unless a statutory waiver is justified. The selected remedial action must also be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatments that permanently and significantly reduce the volume, toxicity,

or mobility of the hazardous waste as their principal element. The following subsections discuss how the selected remedy for the 57th & N. Broadway site meets these statutory requirements.

12.1 Protection of Human Health and the Environment

The selected remedy protects human health and the environment by treating the contaminated ground water plume and preventing movement to areas currently not contaminated. Additionally, the contaminated soils at the site will be treated so as to remove the source of potential ground water contamination and direct contact threat.

Implementation of the selected remedy will not pose any unacceptable short-term risks or cross-media impacts to the site, the workers, or the community.

12.2 Compliance with Applicable or Relevant and Appropriate Requirements

The selected alternative for the 57th & N. Broadway site will comply with all ARARs for the site. The following are the federal and state chemical-specific ARARs and TBCs that pertain to the selected remedy.

- Safe Drinking Water Act.
  - National Primary Drinking Water Standards; 40 CFR Part 141, Subparts B & G.
  - National Secondary Drinking Water Standards; 40 CFR Part 143.
  - Maximum Contaminant Level Goals; 40 CFR Part 141, Subpart F.
  - USEPA Soil Screening Guidance (USEPA 1996).
  - USEPA Region III Risk-Based Concentration Table (USEPA 1998).
  - KDHE Interim Remedial Guidelines for Contaminated Soils (KDHE 1985).
- Clean Water Act.
  - Ambient Water Quality Criteria; 40 CFR Part 131.

- Clean Air Act.
  - National Primary and Secondary Ambient Air Quality Standards; 40 CFR Part 50.
  - National Emissions Standards for Hazardous Air Pollutants; 40 CFR Part 61.
- Kansas Ambient Air Quality Standards and Air Pollution Control Regulations; KAR 28.19.
- Kansas Water Quality Standards; KAR 28.16.28.
- Kansas Drinking Water Rules; KAR 28.15.

Remedial standards for ground water remediation have been adopted from the National Primary Drinking Water Standards and the Kansas Water Quality Standards. Discharge of the off gases to the atmosphere will be regulated by standards set forth in the Clean Air Act and the Kansas Ambient Air Quality Standards and Air Pollution Control Regulations.

The following are the federal and state action-specific ARARs that pertain to the selected remedy.

- Occupational Safety and Health Act.

- Clean Water Act.
  - Ambient Water Quality Criteria; 40 CFR Part 131.

- Clean Air Act.
  - National Ambient Air Quality Standards;40 CFR Part 50
  - Noise Control Act of 1972; 42 USC Section 4901 et seq.

- Environmental Protection Act.
  - Kansas Ambient Air Quality Standards and Air Pollution Control Regulations, KAR 28.19.

Off-gas discharge will be managed in accordance with the Clean Air Act and the Kansas Ambient Air Quality Standards and Air Pollution Control Regulations. The treatment wells will be registered with the state of Kansas. All activities at the site will comply with the Occupational Safety and Health Administration. This alternative will comply with ARARs by containing and treating the plume and removing the direct contact

threat. The ground water will be treated to levels appropriate for public drinking water standards. Soils will be treated to reduce the risk range to between 10^{-4} and 10^{-6} and reduce the Hazard Index below 1.

12.3 Cost Effectiveness

The selected remedy is cost-effective because it has been determined to provide overall effectiveness proportional to its cost, estimated at a present worth of $1,688,550. Other remedies have been determined to be cost-effective as well; however, for the selected remedy, the overall permanence and reduction of risk to human health is achieved in significantly less time for the cost than for the other remedies.

12.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The EPA believes that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner. Of those alternatives that are protective of human health and the environment, and that comply with ARARs, EPA has determined that this selected remedy provides the best balance of tradeoffs in terms of: long-term effectiveness and permanence; reduction in toxicity, mobility, or volume achieved through treatment; short-term effectiveness; implementability; and cost. The selected remedy considers the statutory preference for treatment as a principal element, as well as state and community input. The selected remedy cost effectively treats and destroys a greater amount of the site contaminants than the other alternatives. The selected remedy reduces the toxicity, mobility, and volume of contaminated material at the site through treatment.

12.5 Preference for Treatment as a Principal Element

By treating the contaminated soils by SVE and the contaminated ground water with in-situ vapor extraction wells, the selected remedy addresses threats posed by the site through the use of treatment technologies. By utilizing treatment as a significant portion of the remedy, the statutory preference for remedies that employ treatment as a principal element is satisfied.

12.6. Five-Year Review Requirements

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure, for a period greater than five years, a statutory review will be conducted within five years after initiation of the remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

APPENDIX A

RESPONSIVENESS SUMMARY

This Responsiveness Summary addresses all questions pertaining to the Proposed Plan received during the public comment period. It is broken down into the following sections: Comments received during the public hearing on July 29, 1999; Comments received from the general public; Comments received from Political Subdivisions of the State of Kansas; Comments received from Business and Industry; and Comments received from the Community Advisory Group (CAG).

COMMENTS RECEIVED DURING THE PUBLIC HEARING, JULY 29, 1999

The following questions concerning the proposed remedy were raised during the public meeting held at the Best Western Red Coach Inn in Park City on July 29, 1999. Other questions raised during that public meeting which did not directly concern the Proposed Plan are not included in this Responsiveness Summary.

1. COMMENT: The Kansas Department of Health and Environment (KDHE) is in agreement with the Proposed Plan. The KDHE agrees with the Environmental Protection Agency's (EPA) decision to actively remediate the soil and groundwater at the site.

RESPONSE: None required.

2. COMMENT: Local Resident - "How can the EPA be issuing a Proposed Plan when we do not have adequate data from the pilot test?"

RESPONSE: The information that will be gained from the pilot test of an in-well stripper in the Riverview Operable Unit is not to determine if the technology works, but to determine how well and over how large an area the unit will treat groundwater in the specific environment found at the 57th & N. Broadway site. This information will be used to determine the number and placement of wells in the Riverview Operable Unit. This same information will be used to determine the number and placement of wells in the northern plume and if additional wells should be placed in the Riverview Operable Unit, to speed up the treatment process.

3. COMMENT: Local Resident - "What will happen if EPA is not satisfied with those results? Then what? Another Proposed Plan?

RESPONSE: As stated in the previous response, the test well is for design purposes only, although it may become part of the permanent treatment system. If the results demonstrated that the technology was not effective, then we may need to look at other alternatives. The EPA believes this is an effective technology that has been successful in similar situations.

4. COMMENT: Local Resident - “How will that be presented to the public?”

RESPONSE: In the event that an alternative remedy is required, it will be presented in a public forum with an appropriate opportunity to comment. Again, EPA believes in-well stripping is an effective technology

5. COMMENT: Local Resident - The commentor expressed concern for potential contamination of the Bel Aire well field, through migration of the contaminants and/or the plume being drawn towards the well field as a result of potential increases in pumping rates.

RESPONSE: Under the present conditions, there is no expectation that either the northern or the Riverview plume would ever impact the Bel Aire well field. If over a period of time a significant increase in pumping of the Bel Aire well field took place, the northern plume might be drawn towards the Bel Aire well field. This would require continuous pumping and take several years for the plume to be drawn all the way to the well field. Treatment of the plume will commence prior to that becoming a possibility. In addition, monitoring will be established to monitor both plumes on a quarterly basis. If contamination is found to be threatening the Bel Aire well field, measures to prevent that occurrence will be taken.

6. COMMENT: Local Resident - The commentor was concerned with the possible effects the remediation efforts would have on the direction of the plume migration.

RESPONSE: The nature of the proposed remedy is such that there should be no effect on the direction of migration. Once the treatment system is operational, the plume will no longer expand and, in fact, should begin to shrink.

7. COMMENT: Local Resident - “Will the contamination reach the Bel Aire well field?”

RESPONSE: There is no expectation that either the northern or the Riverview plume will impact the Bel Aire well field.

8. COMMENT: Local Resident - The resident concurred with the soil remediation alternative.

RESPONSE: None required.

9. COMMENT: Local Resident - “I believe that EPA's choice of groundwater treatment is not aggressive enough. I believe that a combination of Alternatives 5 and 6, using 6 up in the northern portion of the plume, would most aggressively treat the groundwater and prevent it form migrating.”

RESPONSE: The EPA believes that use of in-well strippers, Alternative 5, is as aggressive in

addressing the groundwater contamination as the use of Alternative 6, a pump and treat system. Cost estimates indicate that it would cost more than twice as much to treat the plume as aggressively with a pump and treat system as is planned for the proposed in-well stripper system. The proposed remedy is the more aggressive treatment system of the two, considering all factors including cost.

10. COMMENT: Local Resident - "...aren't no action and natural attenuation the same thing, does EPA take credit for Mother Nature too?"

RESPONSE: No action is just that no further action of any kind is taken. Monitored natural attenuation requires ongoing monitoring efforts to determine the location and concentrations of the contaminant plume. This does not result in any treatment induced by man's intervention, but it does ensure ongoing knowledge of the plume's location and the rate of attenuation of the contaminant plume.

11. COMMENT: Local Resident - "I live at 53rd and Broadway to the south. This latest map doesn't show me within that area. Now, am I to believe now that there is no contaminated water in that area? Is it all cleared up?"

RESPONSE: The groundwater contamination originally found in your immediate area was not from chlorinated volatile organic chemicals, it was the result of petroleum products from other sources. That contamination is currently being addressed through treatment by the state of Kansas through the state's Underground Storage Tank Program. The Superfund Program under which this action is proposed can only address the chlorinated volatile organic contaminant groundwater plume. The two programs together are addressing all of the contaminants in the groundwater.

12. COMMENT: Park City Council Member - "...on behalf of Park City, we do support the remediation of the 57th & N. Broadway Site."

RESPONSE: None required.

13. COMMENT: Park City Council Member - "...I think we need to do something to protect the Bel Aire well fields. I know that they're in danger right now from petroleum products."

RESPONSE: The state's program is currently addressing the petroleum problems, and EPA has no authority to do so under Superfund.

14. COMMENT: Local Resident - "...on page 20 in the papers that you sent to us it says, "It is possible that a fouling problem may develop with the treatment wells. If that occurs, system adjustments will be required which may include the introduction of compounds to the system to eliminate the fouling problem. This could result in a significant increase in costs." What does it do to those of us who are using the water?"

RESPONSE: We have experienced some initial problem with biologic fouling of the pilot well. That was easily fixed by the addition of a small amount of chlorine to the well. This addition was small and will only impact the area immediately surrounding the pilot well. There should be no impact on any private well. A second type of fouling could potentially impact the pilot well and that is from the iron found naturally in the groundwater. To date, that has not been a problem. If there is, it can be easily corrected by adding a small amount of acid to the well to slightly lower the Ph. This will clear up the iron fouling. Again, the amount of acid introduced to the well would be small and would only affect the area immediately surrounding the pilot well. There should be no impact on any private well.

COMMENTS RECEIVED FROM THE GENERAL PUBLIC

15. COMMENT: Local Resident - " We have reviewed the Proposed Plan and are in agreement with it. Our question to you is three-fold: 1) how will this be paid for ? 2) how will the Responsible Parties be held accountable? 3) will any formal document or letters be sent to commercial property owners who are not RPs and do not have contamination or pollution on their property, that can be utilized to satisfy real estate agents, lending institutions and potential buyers so that our property can become viable, valuable and salable? Would appreciate a response at your earliest convenience."

RESPONSE: Once a ROD is written, EPA will begin formal negotiations with the PRPs for the site. The expected outcome is that a formal Consent Decree will be developed to regulate the PRPs actions in executing the remedy for the site. If that fails, EPA has several other options, one of which is to implement the remedy using government funds as was done in the Riverview Operable Unit and seek recovery of our costs from the PRPs at a later date. No formal documents will be provided to any commercial property owners who are not PRPs and do not have pollution on their property. However, comfort letters can be provided under certain conditions to parties, upon request, to assist with the transfer of their property.

16. COMMENT: " A proven treatment system, with pump and treat type extraction wells, should be utilized for the northern plume to prevent any migration towards the Bel Aire PWS. The in-well vapor extraction wells will not create a cone of depression that would draw the contaminants in one direction. There is also the continued concern, that if all of the wells in the Bel Aire well field were pumping at the same time, the northern plume could be drawn towards the well field if a pump and treat containment system is not in place."

RESPONSE: See response to Comments 5 and 9.

17. COMMENT: The commentor expressed continued concern that adequate monitoring is not being proposed for the entire site to ensure the protection of the Bel Aire well field.

RESPONSE: The EPA will be establishing a multi-well monitoring system prior to the initiation of the remedial action. The EPA believes it is important that this system is in place as soon as possible. It is anticipated that monitoring will begin in October or November and continue on a quarterly basis until the plume is treated.

COMMENTS FROM POLITICAL SUBDIVISIONS OF THE STATE OF KANSAS

The following comment comes from Mid-Kansas Engineering Consultants, Inc., on behalf of the city of Bel Aire.

18. COMMENT: "We have reviewed the subject document on the technical behalf of the city of Bel Aire. The city of Bel Aire and we feel very strongly that the situation described in the document is serious and that appropriate efforts need to be made toward final remediation and resolution of the contamination. We support the technical recommendations made in the Proposed Plan. We only request that they be implemented and brought to closure as expeditiously as possible."

RESPONSE: None required.

The following comments are from Park City.

19. COMMENT: Park City is particularly interested in the protection of the public water supply provided by the Bel Aire well field. The city would like to see a monitoring schedule and notification mechanism included in the ROD.

RESPONSE: The ROD includes language that will require the remedial action to include monitoring. The EPA will put a monitoring and notification system into effect this fall.

20. COMMENT: Park City request "...that the ROD mentions the possibility of the future need for a water treatment facility; and if the contamination can be proven to have come from the
responsible parties of the Superfund site contamination, that they should share in the costs."

RESPONSE: The EPA has determined that the selected remedy will treat the contaminants of concern, chlorinated volatile organic chemicals, and reduce the contamination levels to such a degree that they will no longer pose a threat to the public drinking water supply in the area. The EPA will pursue the PRPs for the performance of the remedy.

21. COMMENT: "The city feels that the site needs to be cleaned up. Our only comment in regard to the clean up is that it takes place. We assume that EPA will select a system that will accomplish this task. Should additional sources of contamination be located or if the plume has migrated, we trust that remediation will occur."

RESPONSE: If conditions change, EPA is prepared to evaluate the situation and take appropriate action.

22. COMMENT: "For many years stories have circulated concerning Midland Refinery property and allegations concerning the disposal of material on the site. Because of the number of rumors that have surfaced over the years, we feel that additional sampling needs to be reviewed for the Midland Refinery property.

RESPONSE: The EPA has included additional soil sampling for both the Midland Refinery and the former Wilko Paint properties in the selected remedy.

23. COMMENT: "Riverview CAG has expressed concerns for health education and physician training. With the type of contamination they are dealing with, and the exposure that has occurred, the city supports their requests for both health education and physician training. We feel that a continued dialog on this subject should take place."

RESPONSE: The EPA is continuing to coordinate between ATSDR and the residents of the 57th & N. Broadway site concerning the resident's health concerns. Arrangements are currently underway to permit the residents to contact EPA and request a direct call from an ATSDR physician to discuss their concerns. The EPA does not have the authority to provide health education or physician training directly. However, the EPA is happy to help coordinate these efforts.

24. COMMENT: "Finally, we feel that the ROD should address some form of a schedule of activities with time table that all persons involved could have. The schedule should address implementation for clean up and monitoring."

RESPONSE: The law under which the Superfund Program is governed sets out specific procedures, which include some time frames. Given the many unknown factors existing at the time of the signing of the ROD, especially in regard to enforcement, it is not possible to establish specific time tables in the ROD. The EPA will be implementing a monitoring system this fall and will provide wide distribution of the timing and results of the sampling efforts. Fact sheets will be provided on a regular basis which discuss recent activities and identify planned activities.

COMMENTS FROM BUSINESS AND INDUSTRY

The following comments were provided by Integrated Solutions on behalf of Midland Refinery and Clearwater Trucking.

25. COMMENT: The commentor states that no sources of contaminated soils have been identified on the Midland Refinery property based upon the soil sampling done during the remedial investigation or since; therefore, no additional soil sampling is warranted.

RESPONSE: Minimal soil sampling was done during the remedial investigation, and it did not identify areas of soil contamination on the Midland Refinery property. However, previous data sampling indicated very high contaminant levels which would lead investigators to believe that the potential for source areas was very real. The proposal is to do sufficient sampling to assure that no sources of soil contamination remain.

26. COMMENT: The commentor expressed concern that there was as strong or stronger evidence that sources of soil contamination existed at the former Wilko Paint property than exist for the Midland Refinery property.

RESPONSE: The EPA agrees that there is not sufficient evidence to rule out the presence of major soil contamination sources on the former Wilko Paint facility. As a response, the ROD has been modified to include the sampling of the former Wilko Paint property as well as the Midland Refinery property.

27. COMMENT: The commentor was concerned with the accuracy of Figure 3-5 in the Remedial Investigation Report.

RESPONSE: Figure 3-5 was revised by EPA. The Administrative Record will be checked to assure it contains the most up-to-date figure.

28. COMMENT: The commentor requested information on the cost differential between Alternative 4 and Alternative 6.

RESPONSE: Review of the most recent Feasibility Study does not indicate that there is an unexpected cost variance between the cost of Alternative 4 and Alternative 6. Perhaps the commentor was not reviewing the most current copy of the Feasibility Study. The Administrative Record will be checked to assure it contains the most up-to-date information.

COMMENTS FROM THE 57th & N. BROADWAY COMMUNITY ADVISORY GROUP

The following comment was received via e-mail from the CAG chair. It contains nine areas of concern. The comment letter is reproduced in its entirety below. The EPA responses are presented in italicized print within the document.

CAG Response
To the Proposed Plan
for the 57th and North Broadway Superfund Site

September 10, 1999

The CAG is pleased the EPA is moving toward active treatment and clean up at the 57th and N. Broadway site. The community favors use of an aggressive treatment and monitoring system. They want assurance that public water supply wells and private wells will not become contaminated; and that if new contamination or migration of the plume is discovered, additional remediation will occur. In particular, there is concern about the Bel Aire well field.

The purpose of the EPA remedial action is to protect the public health and safety. At this site, the primary source of exposure to contamination has been from contaminated drinking water. While the present exposure to contaminated water has been reduced or eliminated, there is a risk of future exposure as long as some residents use private wells and public water supply wells are used for the community water supply. The community needs to have a high level of confidence in its water supply. This will come from monitoring the groundwater, eliminating potential sources of groundwater pollution, and providing treatment of water to insure exposure is prevented.

The CAG continues to have concerns about the following issues.

1. Monitoring of plume to determine if new exposure or danger of exposure exists.

a. The CAG is concerned there is not an adequate number of monitoring wells planned to protect the Bel Aire well field. The CAG noted that in the revised Feasibility Study dated May 1999, Section 3.2.5 Groundwater Alternative 5, the following sentence was deleted from the draft. “It was assumed for the purpose of developing this alternative that two new nests of monitoring wells would be installed.” The CAG believes that it is not acceptable that monitoring wells would be eliminated when we should be adding more. One specific suggestion by the CAG is to place one or more additional nested monitoring wells between the floodway and the Bel Aire well field. One location might be near Borehole B263. The CAG also suggests that the Bel Aire PWS wells be sampled as part of the monitoring program. Although these wells are periodically tested for contaminants, it is not done at the frequency that would be done with quarterly monitoring.

The EPA is currently designing a monitoring system for the entire site, including the Bel Aire well field. Due to design time and other factors that will be required regardless of the funding mechanism used for implementation of the site-wide ROD, the monitoring system will be designed and implemented separately from and prior to the remedial action. The monitoring system will be designed to adequately monitor the plume and any movement on a quarterly basis; if it is determined that monitoring of the Bel Aire well field is necessary to accomplish that end, their the well field will be included in the monitoring system.

b. The community requests the ROD includes a clear monitoring schedule, presumably on a quarterly basis. The ROD should also clearly state how the community would be informed of the results of groundwater monitoring on a regular basis. The CAG understands that the monitoring program will proceed irrespective of the funding mechanism for the final clean up, so there will not be a delay in establishing the monitoring system and schedule.

As stated above, the monitoring system will be established prior to implementation of the remedial action. However, a statement will be included in the ROD that will require the continuation of the established monitoring system as a component of the remedial action.

c. The CAG understands that several residential wells in the Riverview area will continue to be monitored near the border of the plume. The CAG believes residential wells on the both the east and the west side of the plume should be monitored. The CAG prefers to be very cautious in defining the edge of the plume to prevent the potential for exposure to the community in the future. Even though monitoring will continue to take place, the frequency of monitoring and placement of monitoring points will not be sufficient to detect small changes in the plume and random variations in sample results. The community must live with this uncertainty and therefore prefers that a larger buffer area be used. If, for example, a residence has a reading of 0.3 of the maximum contaminant level (MCL) for a compound, members of the CAG think it is likely that due to variation in sampling, such a residence will be above the MCL some of the time. Members of the CAG feel strongly that these residences should be hooked up to the public water supply.

The MCL is a very conservative number. The MCLs are calculated so exposure to water contaminated in excess of MCLs for a period of 70 years result in a one in one million increase in the risk of contracting cancer. We have taken the conservative approach that if a residence shows contaminant levels in excess of the MCLs, we will connect that household. This was done under the Riverview ROD. The EPA has sampled households on the east and west side of the plume and found no contaminants in excess of the MCLs and no contaminants in the majority of the wells. Those where EPA did find levels of contamination above the detection limit will be monitored in the quarterly monitoring currently being planned. Given the low levels of contaminants

currently present, the short time frame that there is, and the potential for exposure prior to detection, there is little to no potential for adverse health effects. Once the treatment system is installed, further reduction of contaminant levels is expected and the plume should begin to shrink.

2. Additional sampling required at Midland refinery.

The CAG supports the need for additional soil sampling at the Midland Refinery to determine if there are still existing sources of soil and groundwater contamination. The statement of the need for this sampling is not detailed in the Proposed Plan. The CAG would like to know that this sampling will be required on a timely basis regardless of how the final clean up is funded. The CAG would like the ROD to specify the requirements for the soil sampling or the process and schedule that will be used to determine the sampling work plan. If additional sources of contamination are located, the CAG expects appropriate redemption would take place,

The Proposed Plan requires sampling for source material at the Midland Refinery. If source areas are discovered, they are to be remediated using the technology prescribed. The specific sampling will require approval and oversight of EPA. The Proposed Plan does not prescribe the exact sampling plan for the investigation; this is better done in a design document that can insure that the required details are included. The sampling for unknown source areas is an appropriate activity for the remedy and should be a part of that remedy.

3. Action plans if monitoring shows continued spread or movement of contaminated groundwater.

The CAG would like to know what specific actions would be taken if the monitoring results show a change in the pattern of contamination. The CAG believes the following actions should be taken.

a. Bell Aire Well Field: If monitoring wells upgrading of the Bell Aire well field have detectable contamination (for example, locations B263, MW307, MW313, and MW312), then a separate removal action and operable unit should be created to protect and treat the public water supply wells.

b. Riverview: If there is a residential well in or near the current River view buffer zone that shows detectable contamination, then the residence should be connected to the public water supply and the buffer zone should be expanded to include the next nondetect residence to prevent additional exposure potential.

If it is determined through monitoring that additional wells are posing a public health risk, appropriate action will be taken. The EPA does not agree that detection of any level of contaminant presents a health threat. The MCLs have been established to present conservative levels of contamination that represent the bench mark for public health concerns for public water supply. It is appropriate that they continue to be used in the 57th & N. Broadway site.

4. Selected clean-up technology.

a. The CAG would like an aggressive technology selected to clean up the contaminated groundwater. Concern has been raised about whether a 'proven' pump-and-treat type system would be more aggressive or effective than an 'unproven' in-well vapor extraction system, especially in the northern plume area that is not in a residential community and where there are concerns about migrating contamination reaching the Bel Aire PWS. CAG members noted Alternative 6, In-Situ Vapor Extraction, is not a proven technology, especially with the hardness of this groundwater; and the Proposed Plan stated that it was not a proven technology (i.e., "With the exception of Alternatives 2, 4, 6, and 7, all the alternatives are proven and reliable."). The EPA began to address this issue at the August 5, 1999, CAG meeting, but it would be helpful to have this discussion in the Responsiveness Summary.

The remedy selected by EPA is the more aggressive of the treatment remedies considered, while being cost effective at the same time. Pump and treat systems experience significant challenges when operated under hard water conditions. The in-well treatment system will face similar challenges, but design modifications can be made to adjust for field conditions. If the technique is viable for one area of the site, there is no reason that it should not be viable for another. In-well treatment systems are not considered unproven. They have been used many times with success. The concern for the use of In-Situ Vapor Extraction because it is not a proven technology is erroneous. In-Situ Vapor Extraction is a proven technology; however, it has not been used as often as pump and treat systems. Any problems resulting from the hardness of the water can be remedied with system modifications, as has been done on numerous other sites.

b. A test unit for the in-well vapor extraction system has been installed in the Riverview neighborhood. The CAG would like EPA to present the results from that test and explain how that information will be used to design a treatment system for the whole site. CAG members had several specific questions and concerns regarding iron content of the aquifer and the potential for screen plugging. Will both the upper and lower screens in the recirculation well remain unplugged over a long period of time? How is this tested? How do you determine how much water is actually circulating in the system?

We will be providing the data from the pilot test to the CAG when it is available. Design and operation of the in-well treatment system will include maintenance to ensure the system remains fully operational. Monitoring of piezometers will provide continuing information on the circulation characteristics of each treatment well.

5. Potential future need for a water treatment facility.

In the view of the community, it is difficult to separate exposure to contaminated water from the Superfund site and all other sources of contamination in the area. The community needs to have a high level of confidence in its water supply for present and future development. In light of the multiple sources of present and potential future contamination, it may be prudent to build a water treatment facility for treatment of water from the public water supply wells to reduce future exposure risks. Although funding for such a facility would come from multiple sources, all parties that have contributed to contamination of groundwater in the area bear some responsibility for this need. While the need for a water treatment facility is still under consideration, the community would like the ROD to state that a portion of the need for this facility would rest with the parties responsible for contamination and clean up of groundwater at the 57th and North Broadway site.

The need for a water treatment plant is a community decision which takes into consideration many factors. It is inappropriate for the EPA Superfund Program to be involved in this type of community decision making. The EPA is addressing the contamination at the 57th & N. Broadway site to the extent allowed by law. Contamination from the 57th & N. Broadway site is not anticipated to impact the Bel Aire well fields if the plume treatment is initiated within the next few years. It would be inappropriate to make the statement requested in a ROD. This is a viable endeavor for the CAG to continue to purse as a non-Superfund activity.

6. Health education/physician training.

The community has continuing concerns about the need for health education and physician training regarding the health effects of exposure to contaminated drinking water. While ATSDR has been involved in some physician training, the community is still not satisfied that enough information has been properly communicated to both physicians and the local residents. While the CAG appreciates the EPA is responding to this need, it would be helpful for the EPA to explain what will be done to insure adequate health education is accomplished. The residents need to know who the trained physicians are and where they can seek answers to their questions concerning exposures risks and health concerns in the community.

The EPA will continue to work with ATSDR and the community to provide additional health information. There are currently plans to develop a means of doing some one-on-one calling between ATSDR physicians and community residents and their physicians. We will continue to coordinate these efforts with the CAG, the state of Kansas, and the city-county health department. See response to Comment 23.

7. Schedule of activity once the ROD is signed.

Please explain the sequence of events to follow the signing of the ROD. How soon will clean up activities begin? Will clean up begin right away or will clean up be put on hold while EPA pursues PRP funding? The CAG understands that clean up in the Riverview area will continue regardless of the funding of the area-wide clean up. The CAG also expects the groundwater monitoring program will be put in place. The community would like to see separate schedules for monitoring, implementation of the Operable Unit 2 ROD (the Riverview area), and the procedure for implementing the Operable Unit 1 ROD (the area-wide ROD).

The above question is not considered to be directly commenting on the Proposed Plan, but it does relate to the process. Not all of the information requested is currently available, but the information will be conveyed to the CAG after it is available. The implementation of the remedial alternative selected in the ROD will be implemented by either the PRPs for the site or the EPA. Once the ROD is signed, letters will be sent to the PRPs offering them the opportunity to negotiate a settlement for implementation of the remedy. There is a 120-day moratorium (which can be extended) on initiating action while the negotiation is ongoing. The EPA would prefer that the PRPs perform the clean up so as not to spend federal monies. At the end of the moratorium, decisions as to the future course of the project will be made. Until that time, it is not possible to be more specific. You are correct that implementation of the remedial action for the Riverview ROD will proceed under federal funding. Monitoring of the plume will be initiated prior to the implementation of the remedial action and will be continued by whomever executes the remedy. Further coordination with the CAG and thus the community on scheduling and reporting results will continue throughout the project.

The CAG appreciates the EPA has addressed some of these issues at the meeting on August 5, 1999. It would be helpful for the explanations to be available to the whole community.

Respectfully Submitted,

Beth White
Chair
57th and North Broadway
Citizens Advisory Group

This concludes the comments that have been received. The Administrative Record will contain copies of all comments and a copy of the Public Hearing transcript.

APPENDIX B

Table B-1
Chemical-Specific Toxicity Values
Soil Ingestion Exposures
57th & Broadway
Risk Assessment

Contaminants of Chemicals	Ingestion Exposures					
	Oral Slope Factor (SF) mg/kg day	Wt of Ev	Oral Reference Dose (RfD) mg/kg day	R e f	Refe-rence Data	Target Organ or System
Volatiles						
2-Butanone (MEK)		D	6.0E-001	I	03/15/97	liver
2-Hexanone						liver/liver
4-Methyl-2-Pantanone			8.0E-002	I	03/15/97	
Acetone		D	1.0E-001	I	03/15/97	fetotoxic
Benzene	2.9E-002	A		I	03/15/97	stomach/nasal
Ethylbenzene		D	1.0E-001	I	03/15/97	lung/liver,RCBs
Naphthalene		D	4.0E-002	H	03/15/97	splenic capsule
Toluene		D	2.0E-001	I	03/15/97	liver, kidney
Xylene (mixed)		D	2.0E+000	I	03/15/97	felotoxic
Inorganics						
Arsenic	1.5E+000	A	3.0E-004	C/I	03/15/97	increased BP
Cadmium (food)		B1	1.0E-003	I	03/15/97	
Lead		B2				

NOTES:
I - Integrated Risk Information System (USEPA 1997a)
H - Health Effects Assessment Summary Tables
WT OF EV = Weight of Evidence Classification for Carcinogens, refer to Section 5.4 for definitions.

Table B-2
Chemical-Specific Toxicity Values
Soil Ingestion Exposures
57th & Broadway
Risk Assessment

Contaminants of Chemicals	Ingestion Exposures							
	Inhalation Slope Factor (SF) kg day/mg	Wt of Ev	Reference Conc. (RfD) mg/cu m	Inhalation RfD Converted from RfC mg/kg day	Ref	Refe-rence Data	Volit-ization Rate	Target Organ or System
Volatiles								
2-Butanone (MEK)		D	1.0E-003	2.9E-001	I	03/15/97	1	CNS
2-Hexanone							1	
4-Methyl-2-Pantanone			8.0E-002	2.3E-002	H	03/15/97	1	liver, kidney
Acetone							1	
Benzene	2.9E-002			1.7E-003	I	03/15/97	1	leukemia
Ethylbenzene		A	1.0E+000	2.9E-001			1	
Naphthalene							0.1	
Toluene			4.0E-001	1.1E-001	I	03/15/97	1	CNS, eye, nose
Xylene (mixed)		D	3.0E-001	8.6E-002	H	03/15/97	1	CNS, nose, throat
Inorganics								
Arsenic	1.50E+001				H	03/15/97	0	respiratory tract
Cadmium (food)	6.3E+000	A					0	
Lead							0	

NOTES:
I - Integrated Risk Information System (USEPA 1997a)
H - Health Effects Assessment Summary Tables
WT OF EV = Weight of Evidence Classification for Carcinogens, refer to Section 5.4 for definitions.

Table B-3
Chemical-Specific Toxicity Values
Dermal Exposures to Soil
57th & Broadway
Risk Assessment

Chemicals	Oral Absorption Efficiency percent	Oral Absorption Efficiency Reference	Dermal Reference Dose (RfD) mg/kg day	Dermal Gastrointestinal Absorption Factor (GIAF) kg day/mg	Dermal Permeability Constant (PC) cm/hr	Dermal Absorption Factor (unitless)	Weight of Evidence / Cancer Guideline Description
Volatiles							
2-Butanone (MEK)			3.0E-002		5.0E-003	2.5E-001	A
2-Hexanone						2.5E-001	
4-Methyl-2-Pentanone			4.0E-003			2.5E-001	
Acetone			5.0E-003			2.5E-001	
Benzene	9.0E+001	ATSDR, 1987		3.2E-002	1.1E-001	2.5E-001	A
Ethylbenzene	9.2E+001	ATSDR, 198	9.2E-002		1.4E+000	2.5E-001	A
Naphthalene	Unknown	ATSDR, 198	2.0E-003		6.6E-002	1.0E-001	B
Toluene			1.0E-002		1.0E+000	2.5E-001	A
Xylene (mixed)	9.2E+001	ATSDR, 198	1.8E+000		5.5E-004	2.5E-001	B
Inorganics							
Arsenic	9.5E+001	ATSDR, 198	2.9E-004	1.6E+000	8.6E-004	1.0E-002	B
Cadmium (food)			5.0E-005			1.0E-002	
Lead	1.5E+001	ATSDR,88 Adult			1.3E-004	1.0E-002	B

A - Predicted value listed in "EPA Resesarch and Development, Interim Guidance for Dermal Exposure Assessment," (USEPA 1992?)
B - Modeled value listed in "EPA Research and Development, Interim Guidance for Dermal Exposure Assessment," (USEPA 1992?)
ATSDR = Agency for Toxic Substances and Disease Registry

Table B-4
Chemical-Specific Toxicity Values
Groundwater Ingestion Exposures
57th & Broadway
Risk Assessment

Contaminants of Chemicals	Ingestion Exposures					
	Oral Slope Factor (SF) mg/kg day	Wt of Ev	Oral Reference Dose (RfD) mg/kg day	Ref	Refe-rence Data	Target Organ or System
Volatiles						
1,1-Dichloroethane	6.0E-001	C	1.0E-001	H	3/15/95	red blood cells
1,1-Dichloroethane		C	9.0E-003	I	3/15/97	NA
1,1,1-Trichlaroethane	9.1E-002	D	9.0E-002	I	3/15/97	liver, liver
1,2-Dichloroethane		B2		I	3/15/97	fetotoxic
1,2-Dichloroethane(cis)			1.0E-002	H	3/15/95	serum
1,2,4-Trimiethylbenzene			5.0E-002	E	3/15/97	chemistry
Acetone	2.9E-002	D	1.0E-001	I	3/15/97	
Benzene		A		I	3/15/97	fetotoxic
Chlorcethane			4.0E-001	E	3/15/97	stomach/nasal
EtInyberizene		D	1.0E-001	I	3/15/97	liver
Isopropythenzene	7.5E-003					lung/liver,RBCs
Methylene Chloride		B2	6.0E-002	I	3/15/97	
Naphthalene		D	4.0E-002	H	3/15/95	liver, kidney
sec-Butylbenzene			1.0E-002	E		splenic capsule
tert-Butyilbezene	5.2E-002		2.0E-002	E		
Tetrachloroethene			1.0E-002	EI	3/15/97	
Toluene	1.1E-002	D	2.0E-001	I	3/15/97	liver
Trichloroethene		B2	6.0E-003	H	3/15/95	liver, kidney
Trichlorofluoromethane	1.9E+000		3.0E-001	I	3/15/97	liver
Vinyl Chloride		A		H	3/15/95	
Xylene (mixed)		D	2.0E+000	I	3/15/97	
						fetotoxic
Inorganics	1.8E+000					
Arsenic		A	3.0E-004	C/I	3/15/97	
Lead		B2				increased BP

NOTES:
I - Integrated Risk Information System (USEPA 1997a)
H - Health Effects Assessment Summary Tables (USEPA 1995b)
C - Value based on unit risk
E - Value based on EPA-EGAO Guidance
RfD = Reference Dose RfC = Reference Concentration
WT OF EV = Weight of Evidence Classification for Carcinogens, refer to Section 5.4 for definition.

Table B-5
Chemical-Specific Toxicity Values
Dermal Exposures to Groundwater
57th & Broadway
Risk Assessment

Contaminants of Chemicals	Dermal Exposures						
	Oral Absorption Efficiency percent	Oral Absorption Efficiency Reference	Dermal Extrapolated Reference Dose (RfD) mg/kg day	Dermal Extrapolated Slope Factor (SF) kg day/mg	Perm-ability Constant (PC) cm/hr	Soil Absorp-tion Factor (unitless)	Ref
Volatiles							
1,1-Dichloroethane	Unknown	ASTDR, 1989	5.0E-003		1.3E-002	2.5E-001	B
1,1-Dichloroethane	1.0E+002	ASTDR, 1988	9.0E-003	6.0E-001	6.0E-003	2.5E-001	B
1,1,1-Trichlaroethane	Unknown	ASTDR, 1989	4.5E-003		1.8E-002	2.5E-001	B
1,2-Dichloroethane	1.0E+002	ASTDR, 1988		9.1E-002	9.7E-003	2.5E-001	B
1,1-Dichloroethane(cis)	Unknown	ASTDR, 1989	5.0E-004		1.7E-002	2.5E-001	B
1,2,4-Trimiethylbenzene							
Acetone			5.0E-003			2.5E-001	
Benzene	9.0E+001	ASTDR, 1987		3.2E-002	1.1E-001	2.5E-001	A
Chlorcethane			2.0E-002		9.0E-003	2.5E-001	B
Ethyberizene	9.2E+001	ASTDR, 1989	9.2E-002		1.4E+000	2.5E-001	A
Isopropythenzene							
Methylene Chloride	5.5E+001	ASTDR, 1987	3.3E-002	1.4E-002	5.1E-003	2.5E-001	B
Naphthalene	Unknown	ASTDR, 1989	2.0E-003		6.6E-002	1.0E-001	B
sec-Butylbenzene							
tert-Butyilbezene							
Tetrachloroethene	1.0E+002	ASTDR, 1987	1.0E-002	5.2E-002	4.5E-002	2.5E-001	B
Toluene			1.0E-002		1.0E+000	2.5E-001	A
Trichloroethene	9.8E+001	ASTDR, 1988	5.9E-003	1.1E-002	1.6E-002	2.5E-001	B
Trichlorofluoromethane							
Vinyl Chloride	1.0E+002	ASTDR, 1988		1.9E+000	8.3E-003	2.5E-001	B
Xylene (mixed)	9.2E+001	ASTDR, 1989	1.85E+000		5.5E-004	2.5E-001	B
Inorganics							
Arsenic	9.5E+001	ASTDR, 1987	2.9E-004	1.8E+000	8.6E-004	1.0E-002	B
Lead	1.5E+001	ASTDR, 88 Adult			1.3E-004	1.0E-002	B

NOTES:
A - Predicted value listed in Interim Guidance for Dermal Exposure Assessment (USEPA 1992c)
B - Modeled value listed in Interim Guidance for Dermal Exposure Assessment, (USEPA 1992c)
RfD= Reference Dose FfC= Reference Concentration
ATSDR = Agency for Toxic Substances and Disease Registry

Table B-6
Summary of Exposure Pathways
Current & Future Land Use
57th & N. Broadway

Potentially Exposed Population	Exposure Route and Point	Exposure Medium	Pathway Quantitatively Evaluated	Reason for Selection or Exclusion
Residents (On Site)	Incidental ingestion of, inhalation of, and dermal contact with contaminants	Soil (0-3' bgs)	No	Contamination limited to historically commercial/industrial property; therefore, exposure pathway is incomplete.
Residents (On Site)	Incidental ingestion of, inhalation of, and dermal contact with contaminants	Groundwater	Yes	Some Residents so not have city water for potable use.
Residents (On Site)	Incidental ingestion of, inhalation of, and dermal contact with contaminants	Sediment	No	Evidence does not indicate a complete exposure pathway.
Residents (On Site)	Incidental ingestion of, inhalation of, and dermal contact with contaminants	Surface water	No	Evidence does not indicate a complete exposure pathway.
Residents (On Site)	Incidental ingestion of, inhalation of, and dermal contact with contaminants	All	No	Evaluating on site exposure to residents is the most conservative approach.
Trespassers (On Site)	Incidental ingestion of, inhalation of, and dermal contact with contaminants	All	No	Evaluating on site exposure to residents is the most conservative approach.
Workers (On Site)	Incidental ingestion of, inhalation of, and dermal contact with contaminants	Soil (0-3' bgs) current Soil (0-12' bgs) future	Yes	Workers currently working on site.
Workers (On Site)	Incidental ingestion of, and dermal contact with contaminants	Groundwater	Yes	Some businesses do not have city water for potable use.
Workers (On Site)	Inhalation of contaminants	Groundwater	No	It is assumed that the workers will not be showering on site.

Table B-7
Incidental Ingestion of Soil
Adult Worker
(Current Worker Scenario)
57th & Broadway
Risk Assessment

Chemicals of Concern	Soil Conc. (CS) mg/kg	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Chronic Non-Carcinogenic Effects: Daily Intake mg/kg-day	Chronic Non-Carcinogenic Effects: Oral RfD mg/kg-day	Chronic Non-Carcinogenic Effects: Hazard Quotient (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Lifetime Carcinogenic Effects: Daily Intake mg/kg-day	Lifetime Carcinogenic Effects: Oral Slope Factor kg-day/mg	Lifetime Carcinogenic Effects: Risk unitless
Volatiles									
2-Butanone (MEK)	8.00E+000	4.89E-007	3.91E-006	6.00E-001	6.52E-006	1.75E-007	1.40E-006		
2-Hexanone	8.00E+000	4.89E-007	3.91E-006			1.75E-007	1.40E-006		
4-Methyl-2-Pentanone	1.60E+002	4.89E-007	7.83E-005	8.00E-002	9.78E-004	1.75E-007	2.80E-005		
Acetone	8.00E+000	4.89E-007	3.91E-006	1.00E-001	3.91E-004	1.75E-007	1.4E-006		
Benzene	8.00E+000	4.89E-007	3.91E-006			1.75E-007	1.4E-006	2.90E-002	4.05E-008
Ethylbenzene	6.00E+002	4.89E-007	2.94E-004	1.00E-001	2.94E-003	1.75E-007	1.05E-004		
Naphthalene	3.30E-003	4.89E-007	1.61E-009	4.00E-002	4.04E-008	1.75E-007	5.77E-010		
Toluene	2.80E+002	4.89E-007	1.37E-004	2.00E+001	6.85E-004	1.75E-007	4.89E-005		
Xylene (mixed)	5.40E+003	4.89E-007	2.64E-003	2.00E+000	1.32E-003	1.75E-007	9.44E-004		
Inorganics									
Arsenic	6.89E+000	4.89E-007	3.00E-004	3.00E-004	1.14E-002	1.75E-007	1.22E-006	1.50E+000	1.83E-006
Cadmium (food)	2.85E-001	4.89E-007	1.00E-003	1.00E-001	1.39E-004	1.75E-007	4.89E-008		
Lead	1.32E+003	4.89E-007				1.75E-007	2.31E-006		
NA - Data Not Available		Total Pathway Hazard Index--------			1.7E-002		Total Pathway Risk-----		1.9E-006

INCIDENTAL INGESTION OF SOIL
CS = Concentration of chemical in soil (mg/kg)

# - Assumed Value	1.00E-006	Conversion Factor
	5.00E+001	Ingestion Rate of soil by an adult worker
	1.00E+000	Fraction of Intake from source, 100 percent
	2.50E+001	Exposure Duration for an adult worker
	2.50E+002	Exposure Frequency for an adult worker
	7.00E+001	Body weight for adult worker
	2.50E+001	Averageing Time for non-carcinogenic compounds
	7.00E+001	Averageing Time for carcinogenic compounds
HIF--NON-CARCINOGENIC--------	4.89E-007	HIF = ((CF * IR * FI * ED * EF / BW)) / (ATN)(365)
HIF--CARCINOGENIC----------	1.75E-007	HIF = ((CF * IR * FI * ED * EF / BW)) / (ATC)(365)

DAILY INTAKE = (CS * HIF)
RISK (non-carcinogenic) = (INTAKE / RfD)
RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table B-8
Dermal Contact with Soil
Adult Worker
(Current Worker Scenario)
57th & Broadway
Risk Assessment

Volatiles										
2-Butanone (MEK)	8.00E+000	2.50E-001	3.05E-005	6.11E-005	3.00E-002	2.04E-002	1.09E-005	2.18E-005		
2-Hexanone	8.00E+000	2.50E-001	3.05E-005	6.11E-005			1.09E-005	2.18E-005		
4-Methyl-2-Pentanone	1.60E+002	2.50E-001	3.05E-005	1.22E-003	4.00E-003	3.05E-001	1.09E-005	4.36E-004		
Acetone	8.00E+000	2.50E-001	3.05E-005	6.11E-005	5.00E-003	1.22E-002	1.09E-005	2.18E-005		
Benzene	8.00E+000	2.50E-001	3.05E-005	6.11E-005			1.09E-005	2.18E-005	3.22E-002	7.02E-007
Ethylbenzene	6.00E+002	2.50E-001	3.05E-005	4.58E-003	9.20E-002	4.98E-002	1.09E-005	1.64E-003		
Naphthalene	3.30E-003	1.00E-001	3.05E-005	1.01E-008	2.00E-003	5.04E-006	1.09E-005	3.60E-009		
Toluene	2.80E+002	2.50E-001	3.05E-005	2.14E-003	1.00E-002	2.14E-001	1.09E-005	7.63E-004		
Xylene (mixed)	5.40E+003	2.50E-001	3.05E-005	4.12E-002	1.84E+000	2.24E-002	1.09E-005	1.47E-002		
Inorganics										
Arsenic	6.89E+000	1.00E-002	3.05E-005	2.13E-006	2.85E-004	7.48E-003	1.09E-005	7.61E-007	1.58E+000	1.20E-006
Cadmium (food)	2.85E-001	1.00E-002	3.05E-005	8.70E-008	5.00E-005	1.74E-003	1.09E-005	3.11E-008		
Lead	1.32E+003	1.00E-002	3.05E-005	4.03E-006			1.09E-005	1.44E-006		
NA - Data Not Available			Total Pathway Hazard Index--------->			6.1E-001		Total Pathway Risk----->		1.9E-006

DERMAL CONTACT WITH SOIL
CS = Concentration of chemical in soil (mg/kg)
ABS = Absorption Factor - Assumed to be 0.25 for volatiles, 0.1 for semivolatiles, 0.01 for metals (Ryan,1987)

- Assumed Value

1.00E-006 Conversion Factor
3.12E+003 Skin Surface Area Available for Contact, hands, arms,
1.00E+000 Fraction of Intake from Source, 100 percent
2.50E+002 Esposure Frequency for an adult worker (5 dys/wk for 50 wks)
2.50E+001 Exposure Duration for an adult worker
7.00E+001 Body Weight for adult worker
2.50E+001 Averaging Time for Non-carcinogenic compounds
7.00E+001 Averaging Time for carcinogenic compounds
1.00E+000 Adherence Factor #

HIF--NON-CARCINOGENIC----------> 3.05E-005 HIF = (CF * SA * FI * EF * ED * AF / BW)) / (ATN)(365)]
HIF--CARCINOGENIC----------> 1.09E-005 HIF = (CF * SA * FI * EF * ED * AF / BW)) / (ATC)(365)]
DAILY INTAKE = (CS * ABS * HIF)
RISK (non-carcinogenic) = (INTAKE / RfD)
RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table B-9
Inhalation of Dust (Suspended Particulate)
Adult Worker
(Current Worker Scenario)
57th & Broadway
Risk Assessment

Contaminants of Concern	Soil Conc. (CS) mg/kg	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Inhalation RfC mg/cu.m	Inhalation RfD mg/kg-day	Hazard Quotient (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Inhalation Slope Factor kg-day/mg	Inhalation Risk unitless
Volatiles										
2-Butanone (MEK)	8.00E+000	9.25E-009	7.4E-008	1.00E-003	2.86E-001	2.59E-007	3.30E-009	2.64E-008		
2-Hexanone	8.00E+000	9.25E-009	7.4E-008				3.30E-009	2.64E-008		
4-Methyl-2-Pentanone	1.60E+002	9.25E-009	1.48E-008	8.00E-002	2.29E-002	6.47E-005	3.30E-009	5.28E-007		
Acetone	8.00E+000	9.25E-009	7.4E-008				3.30E-009	2.64E-008		
Benzene	8.00E+000	9.25E-009	7.4E-008		1.71E-003	4.33E-005	3.30E-009	2.64E-008	2.90E-002	7.66E-010
Ethylbenzene	6.00E+002	9.25E-009	5.55E-008	1.00E+000	2.86E-001	1.94E-005	3.30E-009	1.98E-006		
Naphthalene	3.30E-003	9.25E-009	3.05E-011				3.30E-009	1.09E-011		
Toluene	2.80E+002	9.25E-009	2.59E-006	4.00E-001	1.14E-001	2.27E-005	3.30E-009	9.25E-007		
Xylene (mixed)	5.40E+003	9.25E-009	4.99E-005	3.00E-001	8.57E-002	5.83E-004	3.30E-009	1.78E-005		
Inorganics										
Arsenic	6.89E+000	9.25E-009	6.45E-008				3.30E-009	2.31E-008	1.51E+001	3.48E-007
Cadmium (food)	2.85E-001	9.25E-009	2.64E-009				3.30E-009	9.41E-010	6.30E+000	5.93E-008
Lead	1.32E+003	9.25E-009	1.22E-007				3.30E-009	4.36E-008		
			Total pathway Hazard Index------->			7.3E-004		Total pathway Risk---->		3.5E-007

INHALATION DUE TO AIRBORNE DUST

1.00E-006	Conversion Factor
3.00E+001	Skin Surface Area Available for Contact, hands, arms,
3.15E-002	Fraction of Intake from Source, 100 percent
1.00E+000	Esposure Frequency for an adult worker (5 dys/wk for 50 wks)
2.50E+002	Exposure Duration for an adult worker
2.50E+001	Body Weight for adult worker
7.00E+001	Averaging Time for Non-carcinogenic compounds
2.50E+001	Averaging Time for carcinogenic compounds
7.00E+001	Adherence Factor #

HIF--NON-CARCINOGENIC--> 9.25E-009 HIF = (IR * CF * DL * FI * EF * ED / BW) / (ATN)(365)
HIF--CARCINOGENIC-------> 3.30E-009 HIF = (IR * CF * DL * FI * EF * ED / BW) / (ATC)(365)
INTAKE = (C * HIF)

4.29E-001 RfD = (RfC * 30 cu.cm/day / 70 kg); (30 / 70) = 0.429
RISK (non-carcinogenic) = (INTAKE/RfD) Note: Not applicable to the inhalation rout
RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table B-10
Incidental Ingestion of Soil
Adult Worker
(Future Worker Scenario)
57th & Broadway
Risk Assessment

Chemicals	SFO Conc. (CS) mg/kg	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral RfD mg/kg-day	Hazard Quotient (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral Slope Factor kg-day/mg	Risk unitless
Volatiles									
2-Butanone (MEK)	1.55E+001	4.98E-007	7.58E-006	6.01E-001	1.26E-005	1.75E-007	2.71E-006		
2-Hexanone	1.55E+001	4.98E-007	7.58E-006			1.75E-007	2.71E-006		
4-Methyl-2-Pentanone	1.60E+002	4.98E-007	7.83E-005	8.00E+002	9.78E-005	1.75E-007	2.80E-005		
Acetone	1.55E+001	4.98E-007	7.58E-006	1.00E-001	7.58E-005	1.75E-007	2.71E-006		
Benzene	1.55E+001	4.98E-007	7.58E-006			1.75E-007	2.71E-006	2.90E-002	7.85E-008
Ethylbenzene	6.00E+002	4.98E-007	2.94E-004	1.00E-001	2.94E-003	1.75E-007	1.05E-004		
Naphthalene	3.30E-003	4.98E-007	1.61E-009	4.00E-002	4.04E-008	1.75E-007	2.77E-010		
Toluene	3.30E+002	4.98E-007	1.61E-004	2.00E-001	8.07E-004	1.75E-007	2.77E-005		
Xylene (mixed)	5.40E+003	4.98E-007	2.64E-003	2.00E+000	1.32E-003	1.75E-007	9.44E-004		
Inorganics									
Arsenic	6.98E+000	4.98E-007	3.41E-006	3.00E-004	1.14E-002	1.75E-007	1.22E-006	1.50E+000	1.83E-006
Cadmium (food)	2.85E-001	4.98E-007	1.39E-007	5.00E-003	2.79E-005	1.75E-007	4.98E-008	5.00E-004	2.49E-011
Lead	1.32E+001	4.98E-007	9.46E-006			1.75E-007	2.31E-006		
NA - Data Not Available		Total Pathway Hazard Index--------->			1.8E-002		Total Pathway Risk---->		1.9E-006

INCIDENTAL INGESTION OF SOIL
CS = Concentration of chemical in soil (mg/kg)

- Assumed Value

1.00E-006	Conversion Factor
5.00E+001	Ingestion Rate of soil by an adult worker
1.00E+000	Fraction of Intake from source, 100 percent
2.50E+001	Exposure Duration for an adult worker
2.50E+002	Exposure Frequency for an adult worker
7.00E+001	Body weight for adult worker
2.50E+001	Averageing Time for non-carcinogenic compounds
7.00E+001	Averageing Time for carcinogenic compounds

HIF--NON-CARCINOGENIC--------->	4.89E-007	HIF = ((CF * IR * FI * ED * EF / BW)) / (ATN)(365)
HIF--CARCINOGENIC--------->	1.75E-007	HIF = ((CF * IR * FI * ED * EF / BW)) / (ATC)(365)

DAILY INTAKE = (CS * HIF)
RISK (non-carcinogenic) = (INTAKE / RfD)
RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table B-11
Dermal Contact with Soil
Adult Worker
(Future Worker Scenario)
57th & Broadway
Risk Assessment

Chemical of Concern	Soil Concentration (CS) mg/kg	Absorption Factor (ABS) unitless	Chronic Non-Carcinogenic Effects: Hazard Intake Factor (HIF) kg/kg-day	Chronic Non-Carcinogenic Effects: Daily Intake mg/kg-day	Chronic Non-Carcinogenic Effects: Adjusted Dermal RfD mg/kg-day	Chronic Non-Carcinogenic Effects: Hazard Quotient (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Lifetime Carcinogenic Effects: Daily Intake mg/kg-day	Lifetime Carcinogenic Effects: Adjusted Dermal Slope Factor kg-day/mg	Lifetime Carcinogenic Effects: Risk unitless
Volatiles										
2-Butanone (MEK)	1.55E+001	2.50E-001	3.05E-005	1.18E-004	3.00E-002	3.94E-003	1.09E-005	4.22E-005		
2-Hexanone	1.55E+001	2.50E-001	3.05E-005	1.18E-004			1.09E-005	4.22E-005		
4-Methyl-2-Pentanone	1.60E+002	2.50E-001	3.05E-005	1.22E-003	4.00E-003	3.05E-001	1.09E-005	4.36E-004		
Acetone	1.55E+001	2.50E-001	3.05E-005	1.18E-004	5.00E-003	2.37E-002	1.09E-005	4.22E-005		
Benzene	1.55E+001	2.50E-001	3.05E-005	1.18E-004			1.09E-005	4.22E-005	3.22E-002	1.36E-006
Ethylbenzene	6.00E+002	2.50E-001	3.05E-005	4.58E-003	9.20E-002	4.98E-002	1.09E-005	1.64E-003		
Naphthalene	3.30E-003	1.00E-001	3.05E-005	1.01E-008	2.00E-003	5.04E-006	1.09E-005	3.60E-009		
Toluene	3.30E+002	2.50E-001	3.05E-005	2.52E-003	1.00E-002	2.52E-001	1.09E-005	8.99E-004		
Xylene (mixed)	5.40E+003	2.50E-001	3.05E-005	4.12E-002	1.84E+000	2.24E-002	1.09E-005	1.47E-002		
Inorganics										
Arsenic	6.98E+000	1.00E-002	3.05E-005	2.13E-006	2.85E-004	7.48E-003	1.09E-005	7.61E-007	1.58E+000	1.20E-006
Cadmium (food)	2.85E-001	1.00E-002	3.05E-005	8.70E-008	2.50E-004	3.48E-004	1.09E-005	3.11E-008	1.00E-002	3.11E-010
Lead	1.32E+001	1.00E-002	3.05E-005	4.03E-006			1.09E-005	1.44E-006		
NA - Data Not Available			Total Pathway Hazard Index---------			6.6E-001		Total Pathway Risk-----		2.6E-006

DERMAL CONTACT WITH SOIL
CS = Concentration of chemical in soil (mg/kg)

1.00E-006	Conversion Factor
3.12E+003	Skin Surface Area Available for Contact, hands, arms,
1.00E+000	Fraction of Intake from Source, 100 percent
2.50E+002	Esposure Frequency for an adult worker (5 dys/wk for 50 wks)
2.50E+001	Exposure Duration for an adult worker
7.00E+001	Body Weight for adult worker
2.50E+001	Averaging Time for Non-carcinogenic compounds
7.00E+001	Averaging Time for carcinogenic compounds
1.00E+000	Adherence Factor #
3.05E-005	HIF = (CF * SA * FI * EF * ED * AF / BW)) / (ATN)(365)]
1.09E-005	HIF = (CF * SA * FI * EF * ED * AF / BW)) / (ATC)(365)]

- Assumed Value

HIF--NON-CARCINOGENIC---------->
HIF--CARCINOGENIC---------->

DAILY INTAKE = (CS * ABS * HIF)
RISK (non-carcinogenic) = (INTAKE / RfD)
RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table B-12
Inhalation of Dust (Suspended Particulate)
Adult Worker
(Future Worker Scenario)
57th & Broadway
Risk Assessment

Chemical	Soil Conc. (mg/kg)	Chronic Non-Carcinogenic Effects: Normal Intake Factor (IIF) (mg/kg-day)	Chronic Non-Carcinogenic Effects: Daily Intake (mg/kg-day)	Chronic Non-Carcinogenic Effects: Inhalation RfD (mg/kg-m3)	Chronic Non-Carcinogenic Effects: Inhalation RfD (mg/kg-day)	Chronic Non-Carcinogenic Effects: Hazard Quotient (HQ) (unitless)	Lifetime Carcinogenic Effects: Normal Intake Factor (IIF) (mg/kg-day)	Lifetime Carcinogenic Effects: Daily Intake (mg/kg-day)	Lifetime Carcinogenic Effects: Slope Factor (kg-day/mg)	Lifetime Carcinogenic Effects: Inhalation Risk (unitless)
Volatiles										
2-Butanone (MEK)	1.55E+001	9.25E-009	1.43E-007		2.86E-001	5.01E-007	3.30E-009	5.12E-008		
2-Hexanone	1.55E+001	9.25E-009	1.43E-007				3.30E-009	5.12E-008		
4-Methyl-2-Pentanone	1.60E+001	9.25E-009	1.48E-008	8.00E-002	2.29E-002	6.47E-005	3.30E-009	5.28E-007		
Acetone	1.55E+001	9.25E-009	1.43E-007				3.30E-009	5.12E-008		
Benzene	1.55E+001	9.25E-009	1.43E-007		1.71E-003	8.38E-005	3.30E-009	5.12E-008	2.90E-002	1.48E-009
Ethylbenzene	6.00E+002	9.25E-009	5.55E-008	1.00E+000	2.86E-001	1.94E-005	3.30E-009	1.98E-006		
Naphthalene	3.30E-003	9.25E-009	3.05E-011				3.30E-009	1.09E-011		
Toluene	3.30E+002	9.25E-009	3.05E-006	4.00E-001	1.14E-001	2.67E-005	3.30E-009	1.09E-006		
Xylene (mixed)	5.40E+003	9.25E-009	4.99E-005	3.00E-001	8.57E-002	5.83E-004	3.30E-009	1.78E-005		
Inorganics										
Arsenic	6.98E+000	9.25E-009	6.45E-008				3.30E-009	2.31E-008	1.51E+001	3.48E-007
Cadmium (food)	2.85E-001	9.25E-009	2.64E-009				3.30E-009	9.41E-010		
Lead	2.32E+000	9.25E-009	1.22E-007				3.30E-009	4.36E-008		
			Total pathway Hazard Index------->			7.8E-004		Total pathway Risk---->		3.5E-007

Assumed values

INHALATION DUE TO AIRBORNE DUST

1.00E-006	Conversion Factor
3.00E+001	Skin Surface Area Available for Contact, hands, arms,
3.15E-002	Fraction of Intake from Source, 100 percent
1.00E+000	Esposure Frequency for an adult worker (5 dys/wk for 50 wks)
2.50E+002	Exposure Duration for an adult worker
2.50E+001	Body Weight for adult worker
7.00E+001	Averaging Time for Non-carcinogenic compounds
2.50E+001	Averaging Time for carcinogenic compounds
7.00E+001	Adherence Factor #

HIF--NON-CARCINOGENIC-->
HIF--CARCINOGENIC----->

9.25E-009 HIF = (IR * CF * DL * FI * EF * ED / BW) / (ATN)(365)
3.30E-009 HIF = (IR * CF * DL * FI * EF * ED / BW) / (ATC)(365)
INTAKE = (C * HIF)

4.29E-001 RfD = (RfC * 30 cu.cm/day / 70 kg); (30 / 70) = 0.429
RISK (non-carcinogenic) = (INTAKE/RfD) Note: Not applicable to the inhalation route
RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table B-13
Ingestion of Groundwater
Onsite Child/Adult
(Current & Future Residential Scenario)
57th & Broadway
Risk Assessment

Volatiles										
1,1-Dichloroethane	5.40E-002	3.74E-002	1.87E-003	1.00E-001	1.87E-002	1.49E-002	8.03E-004			
1,1-Dichloroethene	5.00E-003	3.74E-002	1.74E-004	9.00E-003	1.93E-002	1.49E-002	7.44E-005	6.00E-001	4.46E-004	
1,1,1-Trichloroethane	1.30E-002	3.74E-002	4.51E-004	9.00E-002	5.01E-003	1.49E-002	1.93E-004			
1,2-Dichloroethane	5.00E-003	3.74E-002	1.74E-004			1.49E-002	7.44E-004	9.10E-002	6.77E-006	
1,2-Dichloroethene(cis)	6.40E-002	3.74E-002	2.22E-003	1.00E-002	2.22E-001	1.49E-002	9.52E-004			
1,2,4-Trimethylbenzene	4.60E-003	3.74E-002	1.60E-004	5.00E-002	3.19E-003	1.49E-002	6.84E-005			
Acetone	8.00E-003	3.74E-002	2.78E-004	1.00E-001	2.78E-003	1.49E-002	1.19E-004			
Benzene	1.50E-002	3.74E-002	5.21E-004			1.49E-002	2.23E-004	2.90E-002	6.47E-006	
Chloroethane	1.20E-001	3.74E-002	4.16E-003	4.00E-001	1.04E-002	1.49E-002	1.78E-003			
Ethylbenzene	1.20E-001	3.74E-002	4.16E-003	1.00E-001	4.16E-002	1.49E-002	1.78E-003			
Isopropylbenzene	1.00E-002	3.74E-002	3.47E-004			1.49E-002	1.49E-004			
Methylene Chloride	5.00E-003	3.74E-002	1.74E-004	6.00E-002	2.89E-003	1.49E-002	7.44E-005	7.50E-003	5.58E-007	
Naphthalene	1.50E-002	3.74E-002	5.21E-004	4.00E-002	1.30E-002	1.49E-002	2.23E-004			
sec-Butylbenzene	2.50E-003	3.74E-002	8.68E-005	1.00E-001	8.68E-003	1.49E-002	3.72E-005			
tert-Butylbenzene	1.00E-003	3.74E-002	3.74E-005	2.00E-002	1.74E-003	1.49E-002	1.49E-005			
Tetrachloroethene	5.00E-003	3.74E-002	1.74E-004	1.00E-002	1.74E-002	1.49E-002	7.44E-005	5.20E-002	3.87E-006	
Toluene	5.30E-002	3.74E-002	1.84E-003	2.00E-002	9.20E-003	1.49E-002	7.88E-004			
Trichloroethene	7.10E-003	3.74E-002	2.46E-004	6.00E-003	4.11E-002	1.49E-002	1.06E-004	1.10E-002	1.16E-006	
Trichlorofluoromethane	2.00E-003	3.74E-002	6.94E-005	3.00E-001	2.31E-004	1.49E-002	2.97E-005			
Vinyl Chloride	8.70E-003	3.74E-002	3.02E-004			1.49E-002	1.29E-004	1.90E+000	2.46E-004	
Xylene (mixed)	4.60E-001	3.74E-002	1.60E-002	2.00E+000	7.98E-003	1.49E-002	6.48E-003			
Inorganics										
Arsenic	3.00E-002	3.74E-002	1.04E-003	3.00E-004	3.47E+000	1.49E-002	4.46E-004	1.75E+000	7.81E-004	
Lead	7.00E-003	3.74E-002	2.43E-004			1.49E-002				
		Total Pathway Hazard Index--------->			3.9E+000		Total Pathway Risk----->		1.1E-OC	

INGESTION OF GROUNDWATER
CW = Concentration of chemical in water (mg/L)
1 IRC = 1 L/day - Ingestion Rate of water by a child (1-4 yrs.), (USEPA 1991c)
2 IRA = 2 L/day - Ingestion Rate of water by an adult (6-30 yrs.), (USEPA 1991c)
6 EDC = 6 yrs - Exposure Duration for a child (0-6 yrs), (USEPA 1991c)
24 EDA = 24 yrs - Exposure Duration for an adult (6-30 yrs), (USEPA 1991c)
350 EFC = 350 days/yr - Exposure Frequency for a child (0-6 yrs), (USEPA 1991c)
350 EFA = 350 days/yr - Exposure Frequency for an adult (6-30 yrs), (USEPA 1991c)
15 BWC = 15 kg - Body Weight for a child (1-6 yrs), (USEPA 1991c)
70 BWA = 70 kg - Body Weight for adult, (USEPA 1991c)
30 ATN = 30 yrs - Averaging Time for non-carcinogenic compounds, (USEPA 1991c)
70 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (USEPA 1991c)

HIF-NON-CARCINOGENIC ------> ERR HIF = {(IRC * EFC * EDC / BWC) + (IRA * EFA * EDA / BWA)) / (ATN)(365)
HIF-CARCINOGENIC ------> ERR HIF = {(IRC * EFC * EDC / BWC) + (IRA * EFA * EDA / BWA)) / (ATC)(365)
DAILY INTAKE = (CW * HIF)
RISK (non-carcinogenic) = (INTAKE / RfD)
RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table B-14
Dermal Contact with of Groundwater
Onsite Child/Adult
(Current &Future Residential Scenario)
57th & Broadway
Risk Assessment

Chemicals			Chronic Non-Carcinogenic Effects				Lifetime Carcinogenic Effects			
			Human Intake Factor (IAF) (L/kg-day)	Daily Intake (mg/kg-day)	Adjusted Dermal RfD (mg/kg-day)	Hazard Quotient (unitless)	Human Intake Factor (IAF) (L/kg-day)	Daily Intake (mg/kg-day)	Adjusted Dermal Slope Factor (kg-day/mg)	Risk (unitless)
Volatiles										
1,1-Dichloroethane	5.40E-002	1.30E-002	5.83E-002	4.09E-005	5.00E-003	8.19E-003	2.50E-002	1.75E-005		
1,1-Dichloroethene	5.00E-003	5.99E-003	5.83E-002	1.75E-006	9.00E-003	1.94E-004	2.50E-002	7.48E-007	6.00E-001	4.49E-007
1,1,1-Trichloroethane	1.30E-002	1.75E-002	5.83E-002	1.33E-005	4.50E-003	2.96E-003	2.50E-002	5.72E-006		
1,2-Dichloroethane	5.00E-003	9.67E-003	5.83E-002	2.82E-006			2.50E-002	1.21E-006	9.10E-002	1.10E-007
1,2-Dichloroethene(cis)	6.40E-002	1.88E-002	5.83E-002	6.27E-005	5.00E-004	1.25E-001	2.50E-002	2.69E-005		
1,2,4-Trimethylbenzene	4.60E-003	0.00E+000	5.83E-002				2.50E-002			
Acetone	8.00E-003	0.00E+000	5.83E-002		5.00E-003		2.50E-002			
Benzene	1.50E-002	1.11E-001	5.83E-002	9.71E-005			2.50E-002	4.16E-005	3.22E-002	1.34E-006
Chloroethane	1.20E-001	9.01E-003	5.83E-002	6.30E-005	2.00E-002	3.15E-003	2.50E-002	2.70E-005		
Ethylbenzene	1.20E-001	1.37E+000	5.83E-002	9.58E-003	9.20E-002	1.04E-001	2.50E-002	4.11E-003		
Isopropylbenzene	1.00E-002	0.00E+000	5.83E-002				2.50E-002			
Methylene Chloride	5.00E-003	5.12E-003	5.83E-002	1.49E-006	3.30E-002	4.52E-005	2.50E-002	6.40E-007	1.36E-002	8.72E-009
Naphthalene	1.50E-002	6.59E-002	5.83E-002	5.76E-005	2.00E-003	2.88E-002	2.50E-002	2.47E-005		
sec-Butylbenzene	2.50E-003	0.00E+000	5.83E-002				2.50E-002			
tert-Butylbenzene	1.00E-003	0.00E+000	5.83E-002				2.50E-002			
Tetrachloroethene	5.00E-003	4.54E-002	5.83E-002	1.32E-005	1.00E-002	1.32E-003	2.50E-002	5.67E-006	5.20E-002	2.95E-007
Toluene	5.30E-002	1.01E+000	5.83E-002	3.12E-003	1.00E-002	3.12E-001	2.50E-002	1.34E-003		
Trichloroethene	7.10E-003	1.62E-002	5.83E-002	6.71E-006	5.88E-003	1.14E-003	2.50E-002	2.87E-006	1.12E-002	3.23E-008
Trichlorofluoromethane	2.00E-003	0.00E+000	5.83E-002				2.50E-002			
Vinyl Chloride	8.70E-003	8.32E-003	5.83E-002	4.22E-006			2.50E-002	1.81E-006	1.90E+000	3.44E-006
Xylene (mixed)	4.60E-001	5.52E-004	5.83E-002	1.48E+000	1.84E+000	8.05E-006	2.50E-002	6.34E-006		
Inorganics										
Arsenic	3.00E-002	8.57E-004	5.83E-002	1.50E-002	2.85E-004	5.26E-003	2.50E-002	6.42E-007	1.84E+000	1.18E-006
Lead	7.00E-003	1.34E-004	5.83E-002	5.47E-008			2.50E-002	2.34E-008		
NA = Data Not Available			Total Pathway Hazard Index---------->			5.9E-001		Total Pathway Risk---->		6.9E-006

DERMAL CONTACT DUE TO SHOWERING

CW = Concentration of chemical in water (mg/L)

7200 SAC = 7200 sq. cm - Skin Surface Area Available for Contact, (Child), (USEPA 1989a)

18200 SAA = 18,200 sq. cm - Skin Surface Area Available for Contact (Adult), (USEPA 1989a)

350 EF = 350 days/year - Exposure Frequency, (USEPA 1991c)

0.2 ET = 0.2 hours/day - Exposure Time, (USEPA 1989a)

6 EDC = 6 years - Exposure duration for child (1-6 yrs), (OSWER 1991)

24 EDA = 24 years - Exposure duration for adult (6-30 yrs), (OSWER 1991)

15 BWC = 15 kg - Body Weight for a child (1-6 yrs), (OSWER 1991)

70 BWA = 70 kg - Body Weight for adult, (OSWER 1991)

30 ATN = 30 years - Averaging Time for non-carcinogenic compounds, (OSWER 1991)

70 ATC = 70 years - Averaging Time for carcinogenic comounds, (OSWER 1991)

0.001 CF = Conversion Factor, (1L / 1000 cu.cm), (USEPA 1989a)

PC = Permeability Constant (Chemical Specific)

HIF--NON-CARCINOGENIC---------> ERR HIF = CF[{(SAC * ET * EF * EDC / BWC) + (SAA * ET * EF * EDA / BWA)} / (ATN)(365)]

HIF--CARCINOGENIC----------> ERR HIF = CF[{(SAC * ET * EF * EDC / BWC) + (SAA * ET * EF * EDA / BWA)} / (ATC)(365)]

INTAKE = (CW * HIF * PC)

RISK (non-carcinogenic) = (INTAKE / RfD)

RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table B-15
Inhalation of Groundwater
(Volatilized Contaminants)
Onsite Child/Adult
(Current & Future Residential Scenario)
57th & Broadway
Risk Assessment

Chemicals of Concern	RME Conc. (CW) (mg/L)	Volat. Fraction Rate (unitless)	Human Intake Factor (HIF) (L/kg-day)	Daily Intake (mg/kg-day)	Inhalation RfD (mg/kg-day)	Inhalation Cancer Slope Factor (per mg/kg-day)	Human Intake Factor (HIF) (L/kg-day)	Daily Intake (mg/kg-day)	Inhalation Cancer Slope Factor (per mg/kg-day)	Inhalation Risk (unitless)
Volatiles										
1,1-Dichloroethane	5.40E-002	1.00E+000	1.03E-001	2.77E-003	1.43E-001	1.94E-002	4.40E-002	1.19E-002		
1,1-Dichloroethene	5.00E-003	1.00E+000	1.03E-001	2.57E-004			4.40E-002	1.10E-004	1.75E-001	1.93E-005
1,1,1-Trichloroethane	1.30E-002	1.00E+000	1.03E-001	6.68E-004	2.86E-001	2.34E-003	4.40E-002	2.86E-004		
1,2-Dichloroethane	5.00E-003	1.00E+000	1.03E-001	2.57E-004	2.86E-003	8.98E-002	4.40E-002	1.10E-004	9.10E-002	1.00E-005
1,2-Dichloroethene(cis)	6.40E-002	1.00E+000	1.03E-001	3.29E-003			4.40E-002	1.41E-003		
1,2,4-Trimethylbenzene	4.60E-003	0.00E+000	1.03E-001				4.40E-002			
Acetone	8.00E-003	1.00E+000	1.03E-001	4.11E-004			4.40E-002	1.76E-004		
Benzene	1.50E-002	1.00E+000	1.03E-001	7.71E-004	1.70E-003	4.53E-001	4.40E-002	3.30E-004	2.90E-002	9.58E-006
Chloroethane	1.20E-001	1.00E+000	1.03E-001	6.16E-003	2.86E+000	2.16E-003	4.40E-002	2.64E-003		
Ethylbenzene	1.20E-001	1.00E+000	1.03E-001	6.16E-003	2.86E-001	2.16E+002	4.40E-002	2.64E-003		
Isopropylbenzene	1.00E-002	0.00E+000	1.03E-001				4.40E-002			
Methylene Chloride	5.00E-003	1.00E+000	1.03E-001	2.57E-004	8.57E-001	3.00E-004	4.40E-002	1.10E-004	1.60E-003	1.76E-007
Naphthalene	1.50E-002	1.00E-001	1.03E-001	7.71E-005			4.40E-002	3.30E-004		
sec-Butylbenzene	2.50E-003	0.00E+000	1.03E-001				4.40E-002			
tert-Butylbenzene	1.00E-003	0.00E+000	1.03E-001				4.40E-002			
Tetrachloroethene	5.00E-003	1.00E+000	1.03E-001	2.57E-004			4.40E-002	1.10E-004	1.80E-003	1.98E-007
Toluene	5.30E-002	1.00E+000	1.03E-001	2.72E-003	1.14E-001	2.38E-002	4.40E-002	1.17E-003		
Trichloroethene	7.10E-003	1.00E+000	1.03E-001	3.65E-004			4.40E-002	1.56E-004	6.00E-003	9.38E-007
Trichlorofluoromethane	2.00E-003	0.00E+000	1.03E-001		2.00E-001		4.40E-002			
Vinyl Chloride	8.70E-003	1.00E+000	1.03E-001	4.47E-004			4.40E-002	1.92E-004	3.00E-001	5.75E-005
Xylene (mixed)	4.60E-001	1.00E+000	1.03E-001	2.36E-002	8.57E-002	2.76E-001	4.40E-002	1.01E-002		
Inorganics										
Arsenic	3.00E-002	0.00E+000	1.03E-001				4.40E-002		5.00E+001	
Lead	7.00E-003	0.00E+000	1.03E-001				4.40E-002			
			Total pathway Hazard Index------->			8.9E-001			Total pathway Risk---->	9.8E-005

- Assumed Values

INHALATION DUE TO "WHOLE HOUSE" ACTIVITIES

0.5	K = Volatilization Factor (.0005 x 1000 L/ cu. m), (Andelman, 1990)
0	VRM = Volatilization Rate (Metals = 0.0 %)#
0.1	VRS = Volatilization Rate (Semi-Volatiles = 10.0 %)#
1	VRV = Volatilization Rate (Volatiles = 100.0 %)#
15	IRA = 15 cu. m/hr - Inhalation Rate, indoor activity (Adult), (USEPA 1989a
350	EF = 350 days/ year - Exposure Frequency, (USEPA 1991c)
30	ED = 30 years - Exposure duration for adult, (USEPA 1991c)
70	BWA = 70 kg - Body Weight for adult, (USEPA 1991c)
30	ATN = 30 years - Averaging Time for non-carcinogenic compounds (OSW
70	ATC = 70 years - Averaging Time for carcinogenic compounds, (USEPA 1

HIF--NON-CARCINOGENIC--------->
HIF--CARCINOGENIC------------->

1.03E-001 HIF = (K * IRA * EF * ED / BWA)) / (ATN)(365)
4.40E-002 HIF = (K * IRA * EF * ED / BWA) / (ATC)(365)
RfD = (RfC * 20 cu.m/day / 70 kg)
INTAKE = (CW * HIF)
RISK (non-carcinogenic) = (INTAKE / RfD)
RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table B-16
Ingestion of Groundwater
Adult Worker
(Current & Future Worker Scenario)
57th & Broadway
Risk Assessment

		Chronic Non-Carcinogenic Effects				Lifetime Carcinogenic Effects			
Contaminant of Concern	Water Conc. (CW) (mg/L)	Human Intake Factor (HIF) (L/kg-day)	Daily Intake (mg/kg-day)	Oral RfD (mg/kg-day)	Hazard Quotient (HQ) (unitless)	Human Intake Factor (HIF) (L/kg-day)	Daily Intake (mg/kg-day)	Oral Slope Factor (kg-day/mg)	Risk (unitless)
Volatiles									
1,1-Dichloroethane	5.40E-002	8.15E-003	4.40E-004	1.00E-001	4.40E-003	3.49E-003	1.89E-004		
1,1-Dichloroethene	5.00E-003	8.15E-003	4.08E-005	9.00E-003	4.53E-003	3.49E-003	1.75E-005	6.00E-001	1.05E-005
1,1,1-Trichloroethane	1.30E-002	8.15E-003	1.06E-004	9.00E-002	1.18E-003	3.49E-003	4.54E-005		
1,2-Dichloroethane	5.00E-003	8.15E-003	4.08E-005			3.49E-003	1.75E-005	9.10E-002	1.59E-006
1,2-Dichloroethene(cis)	6.40E-002	8.15E-003	5.22E-004	1.00E-002	5.22E-002	3.49E-003	2.24E-004		
1,2,4-Trimethylbenzene	4.60E-003	8.15E-003	3.75E-005	5.00E-002	7.50E-004	3.49E-003	1.61E-005		
Acetone	8.00E-003	8.15E-003	6.52E-005	1.00E-001	6.52E-004	3.49E-003	2.80E-005		
Benzene	1.50E-002	8.15E-003	1.22E-004			3.49E-003	5.24E-005	2.90E-002	1.52E-006
Chloroethane	1.20E-001	8.15E-003	9.78E-004	4.00E-001	2.45E-003	3.49E-003	4.19E-004		
Ethylbenzene	1.20E-001	8.15E-003	9.78E-004	1.00E-001	9.78E-003	3.49E-003	4.19E-004		
Isopropylbenzene	1.00E-002	8.15E-003	8.15E-005			3.49E-003	3.49E-005		
Methylene Chloride	5.00E-003	8.15E-003	4.08E-005	6.00E-002	6.79E-004	3.49E-003	1.75E-005	7.50E-003	1.31E-007
Naphthalene	1.50E-002	8.15E-003	1.22E-004	4.00E-002	3.06E-003	3.49E-003	5.24E-005		
sec-Butylbenzene	2.50E-003	8.15E-003	2.04E-005	1.00E-001	2.04E-003	3.49E-003	8.74E-006		
tert-Butylbenzene	1.00E-003	8.15E-003	8.15E-006	2.00E-002	4.08E-004	3.49E-003	3.49E-006		
Tetrachloroethene	5.00E-003	8.15E-003	4.08E-005	1.00E-002	4.08E-003	3.49E-003	1.75E-005	5.20E-002	9.09E-007
Toluene	5.30E-002	8.15E-003	4.32E-004	2.00E-001	2.16E-003	3.49E-003	1.85E-004		
Trichloroethene	7.10E-003	8.15E-003	5.79E-005	6.00E-003	9.65E-003	3.49E-003	2.48E-005	1.10E-002	2.73E-007
Trichlorofluoromethane	2.00E-003	8.15E-003	1.63E-005	3.00E-001	5.44E-005	3.49E-003	6.99E-006		
Vinyl Chloride	8.70E-003	8.15E-003	7.09E-005			3.49E-003	3.04E-005	1.90E+000	5.78E-005
Xylene (mixed)	4.60E-001	8.15E-003	3.75E-003	2.00E+000	1.88E-003	3.49E-003	1.61E-003		
Inorganics									
Arsenic	3.00E-002	8.15E-003	2.45E-004	3.00E-004	8.15E-001	3.49E-003	1.05E-004	1.75E+000	1.83E-004
Lead	7.00E-003	8.15E-003	5.71E-005			3.49E-003	2.54E-005		
		Total Pathway Hazard Index----------			9.2E-001		Total Pathway Risk-----		2.6E-004

INGESTION OF GROUNDWATER
CW = Concentration of chemical in water (mg/L)
1 IR = 1.0 L/day - Ingestion Rate of water by an adult (6-30 yrs.), (USEPA 1991c)
25 ED = 25 yrs - Exposure Duration for an adult worker, (USEPA 1991c)
250 EF = 250 days/yr - Exposure Frequency for an adult worker, (USEPA 1991c)
70 BWA = 70 kg - Body Weight for adult, (USEPA 1991c)
30 ATN = 30 yrs - Averaging Time for non-carcinogenic compounds, (USEPA 1991c)
70 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (USEPA 1991c)

HIF--NON-CARCINOGENIC---------- 8.15E-003 HIF = (IR * EF * ED / BW) / (ATN)(365)
HIF--CARCINOGENIC----------> 3.49E-003 HIF = (IR * EF * ED / BW) / (ATC)(365)
DAILY INTAKE = (CW * HIF)
RISK (non-carcinogenic) = (INTAKE / RfD)
RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table B-17
Dermal Contact with of Groundwater
Adult Worker
(Current & Future Worker Scenario)
57th & Broadway
Risk Assessment

Contaminants of Concern	RME Conc. (CW) (mg/L)	Permeability Constant (cm/hr)	Non-Carcinogenic Effects: Human Intake Factor (HIF) (L/kg-day)	Non-Carcinogenic Effects: Daily Intake (mg/kg-day)	Non-Carcinogenic Effects: Adjusted Dermal RfD (mg/kg-day)	Non-Carcinogenic Effects: Hazard Quotient (HQ) (unitless)	Carcinogenic Effects: Human Intake Factor (HIF) (L/kg-day)	Carcinogenic Effects: Daily Intake (mg/kg-day)	Carcinogenic Effects: Adjusted Dermal Slope Factor (kg-day/mg)	Carcinogenic Effects: Risk (unitless)
Volatiles										
1,1-Dichloroethane	5.40E-002	1.30E-002	2.97E-002	2.08E-005	5.00E-003	4.17E-003	1.27E-002	3.71E-005		
1,1-Dichloroethene	5.00E-003	5.99E-003	2.97E-002	8.89E-007	9.00E-003	9.88E-005	1.27E-002	3.18E-007	6.00E-001	1.91E-007
1,1,1-Trichloroethane	1.30E-002	1.76E-002	2.97E-002	6.79E-006	4.50E-003	1.51E-003	1.27E-002	2.51E-006		
1,2-Dichloroethane	5.00E-003	9.67E-003	2.97E-002	1.44E-006			1.27E-002	3.18E-007	9.10E-002	2.89E-008
1,2-Dichloroethene(cis)	6.40E-002	1.68E-002	2.97E-002	3.19E-005	5.00E-004	6.38E-002	1.27E-002	5.21E-005		
1,2,4-Trimethylbenzene	4.60E-003	0.00E+000	2.97E-002				1.27E-002	2.69E-007		
Acetone	8.00E-003	0.00E+000	2.97E-002		5.00E-003		1.27E-002	8.14E-007		
Benzene	1.50E-002	1.11E-001	2.97E-002	4.94E-005			1.27E-002	2.86E-006	3.22E-002	9.22E-008
Chloroethane	1.20E-001	9.01E-003	2.97E-002	3.21E-005	2.00E-002	1.60E-003	1.27E-002	1.83E-004		
Ethylbenzene	1.20E-001	1.37E+000	2.97E-002	4.88E-003	9.20E-002	5.30E-002	1.27E-002	1.83E-004		
Isopropylbenzene	1.00E-002	0.00E+000	2.97E-002				1.27E-002	1.27E-006		
Methylene Chloride	5.00E-003	5.12E-003	2.97E-002	7.60E-007	3.30E-002	2.30E-005	1.27E-002	3.18E-007	1.36E-002	4.34E-009
Naphthalene	1.50E-002	6.59E-002	2.97E-002	2.93E-005	2.00E-003	1.47E-002	1.27E-002	2.86E-006		
sec-Butylbenzene	2.50E-003	0.00E+000	2.97E-002				1.27E-002	7.95E-008		
tert-Butylbenzene	1.00E-003	0.00E+000	2.97E-002				1.27E-002	1.27E-008		
Tetrachloroethene	5.00E-003	4.54E-002	2.97E-002	6.74E-006	1.00E-002	6.74E-004	1.27E-002	3.18E-007	5.20E-002	1.65E-008
Toluene	5.30E-002	1.01E+000	2.97E-002	1.59E-003	1.00E-002	1.59E-001	1.27E-002	3.57E-005		
Trichloroethene	7.10E-003	1.62E-002	2.97E-002	3.41E-006	5.88E-003	5.81E-004	1.27E-002	6.41E-007	1.12E-002	7.20E-009
Trichlorofluoromethane	2.00E-003	0.00E+000	2.97E-002				1.27E-002	5.09E-008		
Vinyl Chloride	8.70E-003	8.32E-003	2.97E-002	2.15E-006			1.27E-002	9.63E-007	1.90E+000	1.83E-006
Xylene (mixed)	4.60E-001	5.52E-004	2.97E-002	7.54E-006	1.84E+000	4.10E-006	1.27E-002	2.69E-003		
Inorganics										
Arsenic	3.00E-002	8.57E-004	2.97E-002	7.63E-007	2.85E-004	2.68E-003	1.27E-002	1.14E-005	1.84E+000	2.11E-005
Lead	7.00E-003	1.34E-004	2.97E-002	2.78E-008			1.27E-002	6.23E-007		
NA - Data Not Available			Total Pathway Hazard Index---------->			3.0E-001		Total Pathway Risk----->		2.3E-005

DERMAL CONTACT DUE TO SHOWERING
CW = Concentration of chemical in water (mg/L)

18200	SA = 18,200 sq. cm - Skin Surface Area Available for Contact (Adult), (USEPA 1989a)
250	EF = 250 days/year - Exposure Frequency for Adult Worker, (USEPA 1991c)
0.2	ET = 0.2 hours/day - Exposure Time, (USEPA 1989a)
25	ED = 25 years - Exposure duration for adult worker, (OSWER 1991)
70	BW = 70 kg - Body Weight for adult, (OSWER 1991)
30	ATN = 30 years - Averaging Time for non-carcinogenic compounds, (OSWER 1991)
70	ATC = 70 years - Averaging Time for carcinogenic comounds, (OSWER 1991)
0.001	CF = Conversion Factor, (1L / 1000 cu.cm), (USEPA 1989a)
	PC = Permeability Constant (Chemical Specific)

HIF--NON-CARCINOGENIC---------- 2.97E-002 HIF = CF[(SA * ET * EF * ED / BW) / (ATN)(365)]
HIF--CARCINOGENIC----------> 1.27E-002 HIF = CF[(SA * ET * EF * ED / BW) / (ATC)(365)]
INTAKE = (CW * HIF * PC)
RISK (non-carcinogenic) = (INTAKE / RfD)
RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table B-18
Summary of Non-Carcinogenic Risks
57th and North Broadway

Population	Medium	Exposure Pathway	Exposure Table Number	Hazard Quotient
Current Resident	Groundwater, Shallow Aquifer	Incidental Ingestion	5.21	3.90E+000
		Dermal Contact	5.22	5.90E-001
		Inhalation	5.23	8.90E-001
		Total Risk:		5.38E+000
		Population Hazard Index		**5.38E+000**
Current Worker	Surface Soil (0-3')	Incidental Ingestion	5.15	1.70E-002
		Dermal Contact	5.16	6.10E-001
		Inhalation	5.17	7.30E-004
		Total Risk:		6.28E-001
	Groundwater, Shallow Aquifer	Incidental Ingestion	5.24	9.20E-001
		Dermal Contact	5.25	3.00E-001
		Total Risk:		1.22E+000
		Population Hazard Index		**1.85E+000**
Future Resident	Groundwater, Shallow Aquifer	Incidental Ingestion	5.21	3.90E+000
		Dermal Contact	5.22	5.90E-001
		Inhalation	5.23	8.90E-001
		Total Risk:		5.38E+000
		Population Hazard Index		**5.38E+000**
Future Worker	Surface and Subsurface Soil (0-12')	Incidental Ingestion	5.18	1.80E-002
		Dermal Contact	5.19	6.60E-001
		Inhalation	5.20	7.80E-004
		Total Hazard Index:		6.79E-001
	Groundwater, Shallow Aquifer	Ingestion	5.24	9.20E-001
		Dermal Contact	5.25	3.00E-001
		Total Hazard Index:		1.22E+000
		Population Hazard Index		**1.90E+000**

Table B-19
Summary of Carcinogenic Risks
57th and North Broadway

Population	Medium	Exposure Pathway	Exposure Table Number	RME RISK
Current Resident	Groundwater, Shallow Aquifer	Incidental Ingestion	5.21	1.10E-003
		Dermal Contact	5.22	6.90E-006
		Inhalation	5.23	9.80E-005
		Total Risk:		1.20E-003
		Population Risk:		**1.20E-003**
Current Worker	Surface Soil (0-3')	Incidental Ingestion	5.15	1.90E-006
		Dermal Contact	5.16	1.90E-006
		Inhalation	5.17	3.50E-007
		Total Risk:		4.15E-006
	Groundwater, Shallow Aquifer	Incidental Ingestion	5.24	2.60E-004
		Dermal Contact	5.25	2.30E-005
		Total Risk:		2.83E-004
		Population Risk:		**2.87E-004**
Future Resident	Groundwater, Shallow Aquifer	Incidental Ingestion	5.21	1.10E-003
		Dermal Contact	5.22	6.90E-006
		Inhalation	5.23	9.80E-005
		Total Risk:		1.20E-003
		Population Risk:		**1.20E-003**
Future Worker	Surface and Subsurface Soil (0-12')	Incidental Ingestion	5.18	1.90E-006
		Dermal Contact	5.19	2.60E-006
		Inhalation	5.20	3.50E-007
		Total Hazard Index:		4.85E-006
	Groundwater, Shallow Aquifer	Ingestion	5.24	2.60E-004
		Dermal Contact	5.25	2.30E-005
		Total Hazard Index:		2.83E-004
		Population Risk:		**2.88E-004**

Table 2-5
Numerical Values of Chemical-Specific TBCs for Contaminants of Concern in Soil

Contaminant	Soil Screening Levels - Transfer from Soil to:		USEPA Region III Risk-Based Concentrations		KDHE IRGs*
	Groundwater	Air	Industrial Exposure	Residential Exposure	
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Toluene	12	650	410,000	16,000	1,500
4-Methyl-2-pentanone			160,000	6,300	17,000
Ethylbenzene	13	400	200,000	7,800	1,980
Xylenes	190**	410**	1,000,000	160,000	630

Notes:
No chemical-specific ARARs were identified for the contaminants of concern in soil at the site.
Values listed are TBCs.
Blanks indicate data not available.
*KDHE "Interim Remedial Guidelines (IRGs) for Contaminated Soils," October 1995. Values listed are for non-residential areas.
**The values listed are for o-xylene, which has the lowest soil screening values.

APPENDIX C

Table C- 1
Present Worth Cost Estimate
Groundwater Alternative 1- No Action

Cost Estimated Component	Quantity	Units	Units Cost	Capital Cost	Annual Cost
CAPITAL COST					
TOTAL CAPITAL COST				$0	
ANNUAL O&M COST					
Five-Year Review @ 5, 10, 15, 20, 25, and 30 yrs	1	LS	$15,000		$15,000
TOTAL PRESENT WORTH O&M COST				$41,700	
TOTAL PRESENT WORTH				$41,700	

5 percent discount rate used to calculate present worth.

Table C-2
Present Worth Cost Estimate
Groundwater Alternative1 - No Action
Total

Year	Yearly O& M Cost*	Intermittent O&M Costs	Annual 0& M Cost	Intermittent O&M Costs Include:
1	$0	$0	$0	
2	$0	$0	$0	
3	$0	$0	$0	
4	$0	$0	$0	
5	$0	$15,000	$15,000	5 yr review
6	$0	$0	$0	
7	$0	$0	$0	
8	$0	$0	$0	
9	$0	$0	$0	
10	$0	$15,000	$15,000	5 yr review
11	$0	$0	$0	
12	$0	$0	$0	
13	$0	$0	$0	
14	$0	$0	$0	
15	$0	$15,000	$15,000	5 yr review
16	$0	$0	$0	
17	$0	$0	$0	
18	$0	$0	$0	
19	$0	$0	$0	
20	$0	$15,000	$15,000	5 yr review
21	$0	$0	$0	
22	$0	$0	$0	
23	$0	$0	$0	
24	$0	$0	$0	
25	$0	$15,000	$15,000	5 yr review
26	$0	$0	$0	
27	$0	$0	$0	
28	$0	$0	$0	
29	$0	$0	$0	
30	$0	$15,000	$15,000	5 yr review
Present Worth of Annual O&M			$41,730	
* There are no yearly O&M costs for this alternative.				

Table C-3
Present Worth Cost Estimate
Groundwater Alternative 2 - Natural Attenutation

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
CAPITAL COST					
Monitoring Wells (4 sets of 2,2" PVC wells installed to depths of 25 and 40 feet)	260	VLF	$25	$6,500	
DIRECT CAPITAL COST SUBTOTAL				$6,500	
Bid Contingency (15%)				$1,000	
Scope Contingency (15%)				$1,000	
TOTAL DIRECT CAPITAL COST				$8,500	
Permitting and Legal (5%)				$400	
Construction Services (10%)				$900	
CONSTRUCTION COST TOTAL				$9,800	
Engineering Design (8%)				$800	
TOTAL CAPITAL COST				$10,600	
ANNUAL O&M COST					
Five-Year Review @ 5, 10, 15, 20, 25, and 30 yrs	1	LS	$15,000		$15,000
Groundwater Monitoring (Analysis only)					
Years 1 through 5 Quarterly sampling of 20 monitoring wells for VOCs, DO, Nitrates, Iron (II),Sulfate, Sulfide, Bromide, Oxidation/Reduction Potential, pH, Temperature, and TOC	80	EA	$300		$24,000
Years 6 through 30 Semi-annual sampling of 20 monitoring wells for VOCs.	40	EA	$125		$5,000
Groundwater Monitoring (Labor only)					
Years 1 through 5 2 Level P1 persons for 2-8 hour days per sampling event	128	HR	$60		$7,700
Years 1 through 5 Evaluation of Sample results	40	HR	$60		$2,400
Years 6 through 30 2 Level P1 persons for 2-8 hour day per sampling event	64	HR	$60		$3,800
Years 6 through 30 Evaluation of Sample Results	40	HR	$60		$2,400
Preparation of Health and Safety Plan (Year 1 only)	40	HR	$60		$2,400
Preparation of O&M Manual (Year 1 only)	80	HR	$60		$4,800
Preparation of QA/Sampling Plan (Year 1 only)	60	HR	$60		$3,600
TOTAL PRESENT WORTH O&M COST				$323,300	
TOTAL PRESENT WORTH				$333,900	

5 percent discount rate used to calculate present worth.

Table C-4
Present Worth Cost Estimate
Groundwater Alternative 2 - Natural Attenutation
Total

Year	Yearly O& M Cost*	Intermittent O&M Costs	Annual O& M Costs	Intermittent O&M Costs Include:
1	$0	$44,900	$44,900	Year 1 (plans and gw monitoring)
2	$0	$34,100	$34,100	Years 1-5
3	$0	$34,100	$34,100	Years 1-5
4	$0	$34,100	$34,100	Years 1-5
5	$0	$49,100	$49,100	Years 1-5 and 5yr review
6	$0	$11,200	$11,200	Years 6-30
7	$0	$11,200	$11,200	Years 6-30
8	$0	$11,200	$11,200	Years 6-30
9	$0	$11,200	$11,200	Years 6-30
10	$0	$26,200	$26,200	Years 6-30 and 5 yr review
11	$0	$11,200	$11,200	Years 6-30
12	$0	$11,200	$11,200	Years 6-30
13	$0	$11,200	$11,200	Years 6-30
14	$0	$11,200	$11,200	Years 6-30
15	$0	$26,200	$26,200	Years 6-30 and 5 yr review
16	$0	$11,200	$11,200	Years 6-30
17	$0	$11,200	$11,200	Years 6-30
18	$0	$11,200	$11,200	Years 6-30
19	$0	$11,200	$11,200	Years 6-30
20	$0	$26,200	$26,200	Years 6-30 and 5 yr review
21	$0	$11,200	$11,200	Years 6-30
22	$0	$11,200	$11,200	Years 6-30
23	$0	$11,200	$11,200	Years 6-30
24	$0	$11,200	$11,200	Years 6-30
25	$0	$26,200	$26,200	Years 6-30 and 5 yr review
26	$0	$11,200	$11 200	Years 6-30
27	$0	$11,200	$112200	Years 6-30
28	$0	$11,200	$11,200	Years 6-30
29	$0	$11,200	$11,200	Years 6-30
30	$0	$26,200	$26,200	Years 6-30 and 5 yr review
Present Worth of Annual O&M			$323,333	

* There are no yearly O&M costs for this alternative.

Table C-5
Present Worth Cost Estimate
Groundwater Alternative 3 - Containment/Air Stripping with Tray Aeration

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
CAPITAL COST					
Extraction Wells (3 - 8" PVC wells intalled to depth of 40 feet)	120	VLF	$60	$7,200	
Submersible Pump (wire tlow and control devices)	3	EA	$2,000	$6,000	
Groundwater Collection Double Containment Piping (includes PVC piping, bedding, and trenching)	6700	LF	$22.50	$150,800	
Chain-Link Fencing (6 ft high)	60	LF	$13.53	$800	
Swing Gate (6 ft high, 12 ft opening)	1	EA	$400	$400	
Concrete Well Vaults (Extraction wells only)	4	EA	$1,100	$4,400	
Prefabricated Structure	1	EA	$3,000	$3,000	
Purchased Package (Air Stripper)	1	LS	$50,000	$50,000	
Other Direct Costs for Packaged System (includes acid wash system)	1	LS	********	$130,000	
Discharge Piping to Drainage Ditch (includes PVC piping, bedding, and trenching)	160	LF	$10	$1,600	
Monitoring Wells (4 sets of 2, 2 PVC wells installed to depths of 25 and 40 feet)	260	VLF	$25	$6,500	
Treatability Study	1	LS	$30,000	$30,000	
DIRECT CAPITAL COST SUBTOTAL				$390,700	
Bid Contingency (15%)				$58,600	
Scope Contingency (15%)				$58,600	
TOTAL DIRECT CAPITAL COST				$507,900	
Permitting and Legal (5%)				$25,400	
Construction Services (10%)				$50,800	
CONSTRUCTION COST TOTAL				$584,100	
Engineering Design (8%)				$46,700	
TOTAL CAPITAL COST				$630,800	
ANNUAL O&M COST					
Electrical Cost (810 K Wh/day) *	295700	KWh	$0.08		$23,700
Groundwater Monitoring (Analysis only)					
Year 1 Monthly sampling of 20 monitoring wells for VOCs (standard turnaround)	240	EA	$125		$30,000

Table C-5
Present Worth Cost Estimate
Groundwater Alternative 3 - Containment/Air Stripping with Tray Aeration

Cost Estimate Componet	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
Years 7 through 6 Quarterly sampling of 20 monitoring wells for VOCs (standard turnaround)	80	EA	$125		$10,000
Years 7 through 30 Semi-annual sampling of 20 monitoring wells for VOCs (standard turnaround)	40	EA	$125		$5,000
Groundwater Monitoring (Labor only)					
Y ear 1 2 Level P1 persons for 2-8 hour days per sampling event	384	HR	$60		$23,000
Years 2 through 6 2 Level P1 persons for 2-8 hour days per sampling event	128	HR	$60		$7,700
Years 7 through 30 2 Level P1 persons for 2-8 hour days per sampling event	64	HR	$60		$3,800
Treatment Plant Effluent Monitoring (Monthly monitoring for VOCs, standard turnaround)	12	EA	$125		$1,500
Preparation or Health and Safety Plan (Year 1only	40	HR	$60		$2,400
Preparation of O&M Manual (Year 1 only)	80	HR	$60		$4,800
Preparation ot QA/Sampling Plan (Year 1 only)	60	HR	$60		$3,600
Five-Year Review @ 5, 10, 15, 20, 25 and 30 years	1	LS	$15,000		$15,000
Maintenance Allowance (15% of purcharsed equiment delivered) (includes acid feed)	1	LS	$7,500		$7,500
Operator Requirement (2 hour/day)	730	HR	$25		$18,300
TOTAL PRESENT WORTH O&M COST				$1,050,100	
TOTAL PRESENT WORTH				$1,680,900	

5 percent discount rate used to calculate present worth.

* Electrical costs include costs to operate 3 - 10 hp extraction well pumps and a 15 hp compressor.

Table C-6
Present Worth Cost Estimate
Groundwater Alternative 3 - Containment/Air Stripping with Tray Aeration

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
CAPITAL COSTS					
Extraction Wells (3 - 8" PVC wells installed to depth of 40 feet)	120	VLF	$60	$7,200	
Submersible Pump (wire flow and control devices)	3	EA	$2,000	$6,000	
Groundwater Collection Double Containment Piping (includes PVC piping, bedding, and trenching)	6700	LF	$22.50	$150,800	
Chain-Link Fencing (6 ft high)	60	LF	$13.53	$800	
Swing Gate (6 ft high, 12 ft opening)	1	EA	$400	$400	
Concrete Well Vaults (Extraction wells only)	4	EA	$1,100	$4,400	
Prefabricated Structure	1	EA	$3,000	$3,000	
Purchased Packaged (Air Stripper)	1	LS	$50,000	$50,000	
Other Direct Costs for Packaged System (includes acid wash system)	1	LS	********	$130,000	
Discharge Piping to Drainage Ditch (includes PVC piping, bedding, and trenching)	160	LF	$10	$1,600	
Monitoring Wells (4 sets of 2, 2" PVC wells installed to depths of 25 and 40 feet)	260	VLF	$25	$6,500	
Treatability Study	1	LS	$30,000	$30,000	
DIRECT CAPITAL COST SUBTOTAL				$390,00	
Bid Contingency (15%)				$58,600	
Scope Contingency				$58,600	
TOTAL DIRECT CAPITAL COST				$507,900	
Permitting and Legal (5%)				$25,400	
Construction Services (10%)				$50,800	
CONSTRUCTION COSTS TOTAL				$584,100	
Engineering Design (8%)				$46,700	
TOTAL CAPITAL COST				$630,800	
ANNUAL O&M COSTS					
Electrical Costs (810 KWh/day)*	295700	KWh	$0.08		$23,700
Groundwater Monitoring (Analysis only)					
Year 1 Monthly sampling of 20 monitoring walls for VOCs (standard turnaround)	240	EA	$125		$30,000

Table C-6
Present Worth Cost Estimate
Groundwater Alternative 3 - Containment/Air Stripping with Tray Aeration

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
Years 2 through 6 Quarterly sampling of 20 monitoring wells for VOCs (standard turnaround)	80	EA	$125		$10,000
Years 7 through 30 Semi-annual sampling of 20 monitoring wells for VOCs (standard turnaround)	40	EA	$125		$5,000
Groundwater Monitoring (Labor only)					
Year 1 2 Level P1 persons for 2-8 hour days per sampling event	384	HR	$60		$23,000
Years 2 through 6 2 Level P1 persons for 2-8 hour days per sampling event	128	HR	$60		$7,700
Years 7 through 30 2 Level P1 persons for 2-8 hour days per sampling event	64	HR	$60		$3,800
Treatment Plant Effluent Monitoring (Monthly monitoring for VOCs, standard turnaround)	12	EA	$125		$1,500
Preparation of Health and Safety Plan (Year 1 only)	40	HR	$60		$2,400
Preparation of O&M Manual (Year 1 only)	80	HR	$60		$4,800
Preparation of QA/Sampling Plan (Year 1 only)	60	HR	$60		$3,600
Five-Year Review @ 5, 10, 15, 20, 25 and 30 years	1	LS	$15,000		$15,000
Maintenance Allowance (15% of purchased equipment delivered) (includes acid feed)	1	LS	$7,500		$7,500
Operator Requirement (2 hour/day)	730	HR	$25		$18,300
TOTAL PRESENT WORTH O&M COST				$1,050,100	
TOTAL PRESENT WORTH				$1,680,900	

5 percent discount rate used to calculate present worth.
* Electrical costs include costs to operation 3 - 10 hp extraction well pumps and a 15 hp compressor.

Table C-6
Present Worth Cost Estimate
Groundwater Alternative 3 - Containment/Air Stripping with Tray Aeration
Total

Year	Yearly O& M Cost*	Intermittent O&M Costs	Annual O& M Costs	Intermittent O&M Costs Include:
1	$51,000	$63,800	$114,800	Year 1 (plans, monitoring)
2	$51,000	$17,700	$68,700	Years 2-6
3	$51,000	$17,700	$68,700	Years 2-6
4	$51,000	$17,700	$68,700	Years 2-6
5	$51,000	$32,700	$83,700	Years 2-6 and 5 yr review
6	$51,000	$17,700	$68,700	Years 2-6
7	$51,000	$8,800	$59,800	Years 7-30
8	$51,000	$8,800	$59,800	Years 7-30
9	$51,000	$8,800	$59,800	Years 7-30
10	$51,000	$23,800	$74,800	Years 7-30 and 5 yr review
11	$51,000	$8,800	$59,800	Years 7-30
12	$51,000	$8,800	$59,800	Years 7-30
13	$51,000	$8,800	$59,800	Years 7-30
14	$51,000	$8,800	$59,800	Years 7-30
15	$51,000	$23,800	$74,800	Years 7-30 and 5 yr review
16	$51,000	$8,800	$59,800	Years 7-30
17	$51,000	$8,800	$59,800	Years 7-30
18	$51,000	$8,800	$59,800	Years 7-30
19	$51,000	$8,800	$59,800	Years 7-30
20	$51,000	$23,800	$74,800	Years 7-30 and 5 yr review
21	$51,000	$8,800	$59,800	Years 7-30
22	$51,000	$8,800	$59,800	Years 7-30
23	$51,000	$8,800	$59,800	Years 7-30
24	$51,000	$8,800	$59,800	Years 7-30
25	$51,000	$23,800	$74,800	Years 7-30 and 5 yr review
26	$51,000	$8,800	$59,800	Years 7-30
27	$51,000	$8,800	$59,800	Years 7-30
28	$51,000	$8,800	$59,800	Years 7-30
29	$51,000	$8,800	$59,800	Years 7-30
30	$51,000	$23,800	$74,800	Years 7-30 and 5 yr review
Present Worth of Annual O&M			$1,050,081	

*****Yearly O&M costs include: electricity, treatment plant effluent monitoring, maintenance, and operator.

Table C-7
Present Worth Cost Estimate
Groundwater Alternative 4 - Containment/In Situ Vapor Stripping

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
CAPITAL COSTS					
In Situ Vapor Stripping Wells (10 - 8" PVC installed to depth of 40 feet with 2 screened intervals	400	VLF	$125	$50,000	
System Component Piping (includes PVC piping, trenching, installation, bedding materials, and backfill)	1700	LF	$18.00	$30,600	
Mechanical System Components	1	LS	$30,000	$30,000	
Other Direct Costs for Mechanical System Components (includes acid feed system)	1	LS	$80,000	$80,000	
Treatability Study	1	LS	$30,000	$30,000	
DIRECT CAPITAL COST SUBTOTAL				$220,600	
Bid Contingency (15%)				$33,100	
Scope Contingency (15%)				$33,100	
TOTAL DIRECT CAPITAL COST				$286,800	
Permitting and Legal (5%)				$14,300	
Construction Services (10%)				$28,700	
CONSTRUCTION COSTS TOTAL				$329,800	
Engineering Design (8%)				$26,400	
TOTAL CAPITAL COST				$356,200	
ANNUAL O&M COSTS					
Electrical Costs (432 K Wh/day)*	157700	KWh	$0.08		$12,600
Groundwater Monitoring (Analysis Only)					
Year 1 Monthly sampling of 20 monitoring wells for VOCs (standard turnaround)	240	EA	$125		$30,000
Years 2 through 6 Quarterly sampling of 20 monitoring wells for VOCs (standard turnaround)	80	EA	$125		$10,000
Years 7 through 30 Semi-annual sampling of 20 monitoring wells for VOCs (standard turnaround)	40	EA	$125		$5,000

Table C-7
Present Worth Cost Estimate
Groundwater Alternative 4 - Containment/In Situ Vapor Stripping

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
Groundwater Monitoring (Labor only)					
Year 1 2 Level P1 persons for 2-8 hour days per sampling event	384	HR	$60		$23,000
Years 2 through 6 2 Level P1 persons for 2-8 hour days per sampling event	128	HR	$60		$7,700
Years 7 through 30 2 Level P1 persons for 2-8 hour days per sampling event	64	HR	$60		$3,800
Preparation of Health and Safety Plan (Year 1 only)	40	HR	$60		$2,400
Preparation of O&M Manual (Year 1 only)	80	HR	$60		$4,800
Preparation of QA/Sampling Plan (Year 1 only)	60	HR	$60		$3,600
Five-Year @ 5, 10, 15, 20, 25, and 30 yrs	1	LS	$15,000		$15,000
Maintenance Allowance (12% of purchased equipment delivered)	1	LS	$3,600		$3,600
Acid Feed Addition Costs (includes chemical costs	12	HR	$500		$6,000
Operator Requirement (2 hour/day)	730	HR	$25		$18,300
TOTAL PRESENT WORTH O&M COST				$888,700	
TOTAL PRESENT WORTH				$1,244,900	

5 percent discount rate used to calculate present worth.

* Electrical costs include costs to operate 12 - 2 hp blowers. 24 hours per day, 365 days per year.

Table C-8
Present Worth Cost Estimate
Groundwater Alternative 4 - Containment/In Situ Vapor Stripping

Year	Yearly O&M Cost*	Intermittent O&M Costs	Total Annual O&M Costs	Intermittent O&M Costs Include:
1	$40,500	$63,800	$104,300	Year 1 (plans, monitoring)
2	$40,500	$17,700	$58,200	Years 2-6
3	$40,500	$17,700	$58,200	Years 2-6
4	$40,500	$17,700	$58,200	Years 2-6
5	$40,500	$32,700	$73,200	Years 2-6 and 5 yr review
6	$40,500	$17,700	$58,200	Years 2-6
7	$40,500	$8,800	$49,300	Years 7-30
8	$40,500	$8,800	$49,300	Years 7-30
9	$40,500	$8,800	$49,300	Years 7-30
10	$40,500	$23,800	$64,300	Years 7-30 and 5 yr review
11	$40,500	$8,800	$49,300	Years 7-30
12	$40,500	$8,800	$49,300	Years 7-30
13	$40,500	$8,800	$49,300	Years 7-30
14	$40,500	$8,800	$49,300	Years 7-30
15	$40,500	$23,800	$64,300	Years 7-30 and 5 yr review
16	$40,500	$8,800	$49,300	Years 7-30
17	$40,500	$8,800	$49,300	Years 7-30
18	$40,500	$8,800	$49,300	Years 7-30
19	$40,500	$8,800	$49,300	Years 7-30
20	$40,500	$23,800	$64,300	Years 7-30 and 5 yr review
21	$40,500	$8,800	$49,300	Years 7-30
22	$40,500	$8,800	$49,300	Years 7-30
23	$40,500	$8,800	$49,300	Years 7-30
24	$40,500	$8,800	$49,300	Years 7-30
25	$40,500	$23,800	$64,300	Years 7-30 and 5 yr review
26	$40,500	$8,800	$49,300	Years 7-30
27	$40,500	$8,800	$49,300	Years 7-30
28	$40,500	$8,800	$49,300	Years 7-30
29	$40,500	$8,800	$49,300	Years 7-30
30	$40,500	$23,800	$64,300	Years 7-30 and 5 yr review
Present Worth of Annual O&M			$888,671	

*****Yearly O&M costs include: electricity, maintenance, and operator.

Table C-9
Present Worth Cost Estimate
Groundwater Alternative 5 - Active Restoration/Air Stripping with Tray Aeration

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
CAPITAL COSTS					
Extraction Wells (6 - 8" PVC wells installed to depth of 40 feet)	240	VLF	$60	$14,400	
Submersible Pump (wire flow and control devices)	6	EA	$2,500	$15,000	
Groundwater Collection Double Containment Piping (includes PVC piping, bedding, and trenching)	10000	LF	$22.50	$225,000	
Chain-Link Fencing (6 ft high)	60	LF	$13.53	$800	
Swing Gate (6 ft high, 12 ft opening)	1	EA	$400	$400	
Concrete Well Vaults (Extraction wells only)	6	EA	$1,100	$6,600	
Prefabricated Structure	1	EA	$5,000	$5,000	
Purchased Packaged (Air Stripper)	1	LS	$60,000	$60,000	
Other Direct Costs for Packaged System (includes acid wash system)	1	LS	$155,000	$155,000	
Discharge Piping to Drainage Ditch (includes PVC piping, bedding, and trenching)	400	LF	$10	$4,000	
Monitoring Wells (4 sets of 2, 2" PVC wells installed to depths of 25 and 40 feet)	260	VLF	$25	$6,500	
Treatability Study	1	LS	$30,000	$30,000	
DIRECT CAPITAL COST SUBTOTAL				$522,700	
Bid Contingency (15%)				$78,400	
Scope Contingency (15%)				$78,400	
TOTAL DIRECT CAPITAL COST				$679,500	
Permitting and Legal (5%)				$34,000	
Construction Services (10%)				$68,000	
CONSTRUCTION COSTS TOTAL				$781,500	
Engineering Design (8%)				$62,500	
TOTAL CAPITAL COST				$844,000	
ANNUAL O&M COSTS					
Electrical Costs (1620 K Wh/day)	591300	KWh	$0.08		$47,300
Groundwater Monitoring (Analysis only)					
Year 1 Monthly sampling of 20 monitoring wells for VOCs (standard turnaround)	240	EA	$125		$30,000
Years 2 through 6 Quarterly sampling of 20 monitoring wells for VOCs (standard turnaround)	80	EA	$125		$10,000
Years 7 through 20 Semi-annual sampling of 20 monitoring wells for VOCs (standard turnaround)	40	EA	$125		$5,000
Groundwater Monitoring (Labor only)					
Year 1	384	HR	$60		$23,000

Table C-9
Present Worth Costs Estimate
Groundwater Alternative 5 - Active Restoration/Air Stripping with Tray Aeration

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
2 Level P1 persons for 2-8 hour days per sampling event					
Years 2 through 6 2 Level P1 persons for 2-8 hour days per sampling event	128	HR	$60		$7,700
Years 7 through 20 2 Level P1 persons for 2-8 hour days per sampling event	64	HR	$60		$3,800
Treatment Plant Effluent Monitoring (Monthly monitoring for VOCs, standard turnaround)	12	EA	$125		$1,500
Preparation of Health and Safety Plan (Year 1 only)	40	HR	$60		$2,400
Preparation of O&M Manual (Year 1 only)	80	HR	$60		$4,800
Preparation of QA/Sampling Plan (Year 1 only)	60	HR	$60		$3,600
Five-Year Review @ 5, 10, 15, and 20 yrs	1	LS	$15,000		$15,000
Maintenance Allowance (15% of purchased equipment delivered) (includes acid feed)	1	LS	$9,000		$9,000
Operator Requirement (2 hour/day)	730	HR	$25		$18,300
TOTAL PRESENT WORTH O&M COST				$1,145,700	
TOTAL PRESENT WORTH				$1,989,700	

5 percent discount rate used to calculate present worth.

* Electrical costs include costs to operate 6 - 10 hp extraction well pumps and a 30 hp compressor.

Table C-10
Present Worth Cost Estimate
Groundwater Alternative 5 - Active Restoration/Air Stripping with Tray Aeration

Year	Yearly O&M Cost*	Intermittent O&M Costs	Total Annual O&M Costs	Intermittent O&M Costs Include:
1	$76,100	$62,800	$139,900	Year 1
2	$76,100	$13,800	$89,900	Year 2-6
3	$76,100	$13,800	$89,900	Year 2-6
4	$76,100	$13,800	$89,900	Year 2-6
5	$76,100	$28,800	$104,900	Year 2-6 and 5 yr review
6	$76,100	$13,800	$89,900	Year 2-6
7	$76,100	$6,500	$82,600	Year 7-20
8	$76,100	$6,500	$82,600	Year 7-20
9	$76,100	$6,500	$82,600	Year 7-20
10	$76,100	$20,000	$96,100	Year 7-20 and 5 yr review
11	$76,100	$6,500	$82,600	Year 7-20
12	$76,100	$6,500	$82,600	Year 7-20
13	$76,100	$6,500	$82,600	Year 7-20
14	$76,100	$6,500	$82,600	Year 7-20
15	$76,100	$20,000	$96,100	Year 7-20 and 5 yr review
16	$76,100	$6,500	$82,600	Year 7-20
17	$76,100	$6,500	$82,600	Year 7-20
18	$76,100	$6,500	$82,600	Year 7-20
19	$76,100	$6,500	$82,600	Year 7-20
20	$76,100	$20,000	$96,100	Year 7-20 and 5 yr review
Present Worth of Annual O&M			$1,145,673	

* Yearly O&M costs include: electricity, treatment plant effluent monitoring, maintenance, and operator.

Table C-11
Present Worth Cost Estimate
Groundwater Alternative 6 - Active Restoration/In Situ Vapor Stripping

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
CAPITAL COST					
In Situ Vapor Stripping Wells (20 - 8" PVC installed to depth of 40 feet with 2 screened intervals)	800	VLF	$125	$100,000	
System Component Piping (includes PVC piping, trenching, installation, bedding materials, and backfill)	2000	LF	$18.00	$36,000	
Mechanical System Components	1	LS	$67,000	$67,000	
Other Direct Costs for Mechanical System Components (includes acid feed system)	1	LS	********	$175,000	
Treatability Study	1	LS	$30,000	$30,000	
DIRECT CAPITAL COST SUBTOTAL				$408,000	
Bid Contingency (15%)				$61,200	
Scope Contingency (15%)				$61,200	
TOTAL DIRECT CAPITAL COST				$530,400	
Permitting and Legal (5%)				$26,500	
Construction Services (10%)				$53,000	
CONSTRUCTION COSTS TOTAL				$609,900	
Engineering Design (8%)				$48,800	
TOTAL CAPITAL COST				$658,700	
ANNUAL O&M COSTS					
Electrical Costs (864 K Wh/day)*	315400	KWh	$0.08		$25,200
Groundwater Monitoring (Analysis Only)					
Year 1 Monthly Sampling of 20 monitoring wells for VOCs (standard turnaround)	240	EA	$125		$30,000
Years 2 through 10 Quarterly sampling of 20 monitoring wells for VOCs (standard turnaround)	80	EA	$125		$10,000
Groundwater Monitoring (Labor Only)					
Year 1 2 Level P1 persons for 2-8 hour days per sampling event	384	HR	$60		$23,000
Years 2 through 10 2 Level P1 persons for 2-8 hour days per sampling event	128	HR	$60		$7,700
Preparation of Health and Safety Plan (Year 1 only)	40	HR	$60		$2,400
Preparation of O&M Manual (Year 1 only)	80	HR	$60		$4,800
Preparation of QA/Sampling Plan (Year 1 only)	60	HR	$60		$3,600

Table C-11
Present Worth Cost Estimate
Groundwater Alternative 6 - Active Restoration/In Situ Vapor Stripping

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
Five-Year Review @ 5 and 10 yrs	1	LS	$15,000		$15,000
Maintenance Allowance (12% of purchased equipment delivered)	1	LS	$8,040		$8,000
Acid Feed Addition Costs (includes chemical costs)	24	EA	$500		$12,000
Operator Requirement (2 hour/day)	730	HR	$25		$18,300
TOTAL PRESENT WORTH O&M COST				$691,900	
TOTAL PRESENT WORTH				$1,350,600	

5 percent discount rate used to calculate present worth.
* Electrical costs include costs to operate 24 - 2 hp blowers, 24 hours per day, 365 days per year.

Table C-12
Present Worth Cost Estimate
Groundwater Alternative 6 - Active Restoration/In Situ Vapor Stripping

Total

Year	Yearly O& M Cost*	Intermittent O&M Costs	Annual O& M Costs	Intermittent O&M Costs Include:
1	$63,500	$63,800	$127,300	Year 1 (plans and monitoring)
2	$63,500	$17,700	$81,200	Years 2-10
3	$63,500	$17,700	$81,200	Years 2-10
4	$63,500	$17,700	$81,200	Years 2-10
5	$63,500	$32,700	$96,200	Years 2-10 and 5 yr review
6	$63,500	$17,700	$81,200	Years 2-10
7	$63,500	$17,700	$81,200	Years 2-10
8	$63,500	$17,700	$81,200	Years 2-10
9	$63,500	$17,700	$81,200	Years 2-10
10	$63,500	$32,700	$96,200	Years 2-10 and 5 yr review
Present Worth of Annual O&M			$691,871	

* Yearly O&M costs include: electricity, treatment plant effluent monitoring, maintenance, and operator.

Table C-13
Present Worth Cost Estimate
Groundwater Alternative 7 - Active Restoration/In Situ Chemical Oxidation

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
CAPITAL COSTS					
In Situ Chemical Oxidation System (includes geoprobe installation, reagent costs, etc., at each of 1000 locations) (assume 10 lines of injection points, 1000 feet long, with 10-foot spacing located in the high contaminant concentration areas)	1000	EA	$800	$800,000	
In Situ Vapor Stripping Wells (12-8" PVC installed to depth of 40 feet with 2 screened intervals)	480	VLF	$125	$60,000	
System Component Piping (includes PVC piping, trenching, installation, bedding materials, and backfill)	2000	LF	$18.00	$36,000	
Mechanical System Components	1	LS	$150,000	$150,000	
Other Direct Cost for Mechanical System Components (includes acid feed systems)	1	LS	$375,000	$375,000	
Treatability Study	1	LS	$50,000	$50,000	
DIRECT CAPITAL COST SUBTOTAL				41,471,000	
Bid Contingency (15%)				$220,700	
Scope Contingency (15%)				$220,700	
TOTAL DIRECT CAPITAL COST				$1,912,400	
Permitting and Legal (5%)				$95,600	
Construction Services (10%)				$191,200	
CONSTRUCTION COST TOTAL				$2,199,200	
Engineering Design(8%)				$175,900	
TOTAL CAPITAL COST				$2,375,100	
ANNUAL O&M COST					
Electrical Cost (432 K Wh/day)*	157700	KWh	$0.08		$12,600
Groundwater monitoring (Analysis Only)					
Year 1 Monthly sampling of 20 monitoring wells for VOCs (standard turnaround)	240	EA	$125		$30,000
Years 2 through 10 Quarterly sampling of 20 monitoring wells for VOCs (standard turnaround)	80	EA	$125		$10,000
Groundwater Monitoring (Labor only)					
Year 1 2 Levels P1 person for 2-8 hour days per sampling events	384	HR	$60		$23,000
Years 2 through 10 2 Levels P1 person for 2-8 hour days per sampling events	128	HR	$60		$7,700

Table C- 13
Present Worth Cost Estimate
Groundwater Alternative 7 - Active Restoration/In Situ Chemical Oxidation

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
Preparation of Health and Safety Plan (Year 1 only)	80	HR	$60		$4,800
Preparation of O&M Manual (Year 1 only)	80	HR	$60		$4,800
Preparation of QA/Sampling Plan (Year 1 only)	60	HR	$60		$3,600
Five-year Review @ 5 and 10 yrs	1	LS	$15,000		$15,000
Maintenance Allowance (12% of purchased equipment delivered)	1	LS	$18,000		$18,000
Acid Feed Addition Cost (includes chemical costs)	12	EA	$500		$6,000
Operator Requirement (2 hour/day)	730	HR	$25		$18,300
TOTAL PRESENT WORTH O&M COST				$627,800	
TOTAL PRESENT WORTH				$3,002,900	

5 percent discount rate used to calculate present worth.
* Electrical costs include costs to operate 12 - 2 hp blowers. 24 hours per day, 365 days per year.

Table C-14
Present Worth Cost Estimate
Groundwater Alternative 7 Active Restoration/ In Situ Chemical Oxidation
Total

Year	Yearly O& M Cost*	Intermittent O&M Costs	Annual O& M Cost	Intermittent O&M Cost Include:
1	$54,900	$66,200	$121,100	Year 1 (plans and monitoring)
2	$54,900	$17,700	$72,600	Year 2-10
3	$54,900	$17,700	$72,600	Year 2-10
4	$54,900	$17,700	$72,600	Year 2-10
5	$54,900	$32,700	$87,600	Year 2-10 and 5 yr review
6	$54,900	$17,700	$72,600	Yea 2-10
7	$54,900	$17,700	$72,600	Year 2-10
8	$54,900	$17,700	$72,600	Year 2-10
9	$54,900	$17,700	$72,600	Year 2-10
10	$54,900	$32,700	$87,600	Year 2-10 and 5 yr review
Present Worth of Annual O&M		$627,750		
* Yearly O&M cost include: electricity, treatment plant effluent monitoring, maintenance, and operator.				

Table C- 15
Present Worth Cost Estimate
Soil Alternative I - No Action

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
CAPITAL COST					
TOTAL CAPITAL COST				$0	
ANNUAL O&M COSTS					
Five-year Review @ 5, 10, 20, 25, and 30 yrs	1	LS	$10,000		$10,000
TOTAL PRESENT WORTH O&M COST				$27,800	
TOTAL PRESENT WORTH				$27,800	

5 present discount rate used to calculate present worth

Table C-16
Present Worth Cost Estimate
Soil Alternative 1- No Action

Year	Yearly O& M Cost*	Intermittent O&M Costs	Total Annual O& M Costs	Intermittent O&M Costs Include:
1	$0	$0	$0	
2	$0	$0	$0	
3	$0	$0	$0	
4	$0	$0	$0	
5	$0	$10,000	$10,000	5 yr review
6	$0	$0	$0	
7	$0	$0	$0	
8	$0	$0	$0	
9	$0	$0	$0	
10	$0	$10,000	$10,000	5 yr review
11	$0	$0	$0	
12	$0	$0	$0	
13	$0	$0	$0	
14	$0	$0	$0	
15	$0	$10,000	$10,000	5 yr review
16	$0	$0	$0	
17	$0	$0	$0	
18	$0	$0	$0	
19	$0	$0	$0	
20	$0	$10,000	$10,000	5 yr review
21	$0	$0	$0	
22	$0	$0	$0	
23	$0	$0	$0	
24	$0	$0	$0	
25	$0	$10,000	$10,000	5 yr review
26	$0	$0	$0	
27	$0	$0	$0	
28	$0	$0	$0	
29	$0	$0	$0	
30	$0	$10,000	$10,000	5 yr review
Present Worth of Annual O&M			$27,820	

* There are no yearly O&M cost for this alternative.

Tables C-17
Present Worth Cost Estimate
Soil Alternative 2- Containment

Cost Estimate Component	Quantity	Units	Units Cost	Capital Cost	Annual Cost
CAPITAL COSTS					
Slurry Wall Installation	40000	SF	$20	$800,000	
Asphaltic Cap	1250	SF	$10	$12,500	
Monitoring Well Abandonment	1	LS	$300	$300	
Monitoring Well (3-2"PVC, 40 feet deep)	120	VLF	$25	$3,000	
Soil Borings	1000	VLF	$7.50	$7,500	
Soil Sample Analysis	40	EA	$125	$5,000	
DIRECT CAPITAL COST SUBTOTAL				$828,300	
Bid Contingency (15%)				$124,200	
Scope Contingency (15%)				$124,200	
TOTAL DIRECT CAPITAL COST				$1,076,700	
Permitting and Legal (5%)				$53,800	
Construction Services (10%)				$107,700	
CONSTRUCTION COSTS TOTAL				$1,238,200	
Engineering Design (8%)				$99,100	
TOTAL CAPITAL COST				$1,337,300	
ANNUAL O&M COSTS					
Five-Year Review @ 5, 10, 15, 20, 25, sand 30 yrs	1	LS	$15,000		$15,000
Groundwater Monitoring (Analysis only)					
Year 1 through 5 Quarterly sampling of 3 monitoring wells for VOCs	12	EA	$125		$1,500
Years 6 through 30 Semi-annual sampling of 3 monitoring wells for VOCs.	6	EA	$125		$800
Groundwater Monitoring (Labor only, includes containment system inspection)					
Years 1 through 5 2 Level P1 person for 1-8 hour day per sampling event	64	HR	$60		$3,800
Years 6 through 30 2 Levels P1 person for 1-8 hour day per sampling event	32	HR	$60		$1,900
Maintenance	1	LS	$1,000		$1,000
Preparation of Health and Safety Plan (year 1 only	40	HR	$60		$2,400
Preparation of O&M Manual (year 1 only)	80	HR	$60		$4,800
Preparation of QA/Sampling Plan (Year 1 only)	60	HR	$60		$3,600
TOTAL PRESENT WORTH O&M COST				$120,200	
TOTAL PRESENT WORTH				$1,457,500	

5 percent discount rate used to calculate present worth.

Table C-18
Present Worth Cost Estimate
Soil Alternative 2 - Containment

Year	Yearly O& M Cost*	Intermittent O&M Costs	Total Annual O& M Costs	Intermittent O&M Costs Include:
1	$1,000	$16,100	$17,100	Year 1 (plans and gw monitoring)
2	$1,000	$5,300	$6,300	Years 1-5
3	$1,000	$5,300	$6,300	Years 1-5
4	$1,000	$5,300	$6,300	Years 1-5
5	$1,000	$20,300	$21,300	Years 1-5 and 5 yr review
6	$1,000	$2,700	$3,700	Years 6-30
7	$1,000	$2,700	$3,700	Years 6-30
8	$1,000	$2,700	$3,700	Years 6-30
9	$1,000	$2,700	$3,700	Years 6-30
10	$1,000	$17,700	$18,700	Years 6-30 and 5 yr review
11	$1,000	$2,700	$3,700	Years 6-30
12	$1,000	$2,700	$3,700	Years 6-30
13	$1,000	$2,700	$3,700	Years 6-30
14	$1,000	$2,700	$3,700	Years 6-30
15	$1,000	$17,700	$18,700	Years 6-30 and 5 yr review
16	$1,000	$2,700	$3,700	Years 6-30
17	$1,000	$2,700	$3,700	Years 6-30
18	$1,000	$2,700	$3,700	Years 6-30
19	$1,000	$2,700	$3,700	Years 6-30
20	$1,000	$17,700	$18,700	Years 6-30 and 5 yr review
21	$1,000	$2,700	$3,700	Years 6-30
22	$1,000	$2,700	$3,700	Years 6-30
23	$1,000	$2,700	$3,700	Years 6-30
24	$1,000	$2,700	$3,700	Years 6-30
25	$1,000	$17,700	$18,700	Years 6-30 and 5 yr review
26	$1,000	$2,700	$3,700	Years 6-30
27	$1,000	$2,700	$3,700	Years 6-30
28	$1,000	$2,700	$3,700	Years 6-30
29	$1,000	$2,700	$3,700	Years 6-30
30	$1,000	$17,700	$18,700	Years 6-30 and 5 yr review
Present Worth of Annual O&M			$120,151	

*Yearly O&M costs for this alternative include maintenance.

Table C-19
Present Worth Cost Estimate
Soil Alternative 3 - Excavation and Offsite Treatment

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
Excavation	700	CY	$30	$21,000	
Backfill	700	CY	$6	$4,200	
Transportation (20 cy truck, 135 miles)	4725	LD-MI	$3.25	$15,400	
Incineration	1050	TON	$1,500	$1,575,000	
Soil Confirmation/Verification Samples (10 sidewall, 3 floor, VOCs)	13	EA	$125	$1,600	
Site Restoration	1	LS	$3,500	$3,500	
Soil Borings	1000	VLF	$7.50	$7,500	
Soil Sample Analysis	40	EA	$125	$5,000	
DIRECT CAPITAL COST SUBTOTAL				$1,633,200	
Bid Contingency (5%)				$81,700	
Scope Contingency (15%)				$245,000	
TOTAL DIRECT CAPITAL COST				$1,959,900	
Permitting and Legal (5%)				$98,000	
Construction Services (10%)				$196,000	
CONSTRUCTION COSTS TOTAL				$2,253,900	
Engineering Design (8%)				$180,300	
TOTAL CAPITAL COST				$2,434,200	

There are no annual costs associated with this alternative.

Table C-20
Present Worth Cost Estimate
Soil Alternative 4 - Excavation and Mite Disposal

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
CAPITAL COST					
Excavation	700	CY	$30	$21,000	
Backfill	700	CY	$6	$4,200	
Transportation (20 cy trucks, 625 miles)	21875	LD-MI	$3.25	$71,100	
Landfilling	1050	TON	$550	$577,500	
soil Confirmation/Verification Samples (10 sidewall, 3 floor, VOCs)	13	EA	$125	$1,600	
Site Restoration	1	LS	$3,500	$3,500	
Soil Borings	1000	VLF	$7.50	$7,500	
Soil Sample Analysis	40	EA	$125	$5,000	
DIRECT CAPITAL COST SUBTOTAL				$691,400	
Bid Contingency (5%)				$34,600	
Scope Contingency (15%)				$103,700	
TOTAL DIRECT CAPITAL COST				$829,700	
Permitting and Legal (5%)				$41,500	
Construction Services (10%)				$83,000	
CONSTRUCTION COSTS TOTAL				$954,200	
Engineering Design (8%)				$76,300	
TOTAL CAPITAL COST				$1,030,500	

There are no annual costs associated with this alternative.

Table C-21
Present Worth Cost Estimate
Soil Alternative 5 - In Situ Soil Vapor Extraction

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Cost	Annual Cost
CAPITAL COSTS					
Site Preparation	1	LS	$3,500	$3,500	
SVE Extraction Wells (3 @ 20 Feet)	3	EA	$1,100	$3,300	
SVE Oberservation Wells Points (4 @ 20 feet)	4	EA	$975	$3,900	
Mobil Extraction System	1	LS	$57,600	$57,600	
GAC Air Scrubber	1	LS	$44,000	$44,000	
Soil Probes (8)	8	EA	$600	$4,800	
Soil Sample Analysis (VOCs)	24	EA	$125	$3,000	
Site Restoration	1	LS	$3,500	$3,500	
Treatability Study	1	LS	$15,000	$15,000	
Soil Borings	500	VLF	$7.50	$3,750	
Soil Sample Analysis	40	EA	$125	$5,000	
DIRECT CAPITAL COST SUBTOTAL				$147,350	
Bid Contingency (15%)				$22,100	
Scope Contingency (15%)				$22,100	
TOTAL DIRECT CAPITAL COST				$191,550	
Permitting and Legal (5%)				$9,600	
Construction Services (10%)				$19,200	
CONSTRUCTION COSTS TOTAL				$220,350	
Engineering Design (8%)				$17,600	
TOTAL CAPITAL COST				$237,950	

There are no costs associated with this alternative.