TABLES

Table 1-1. Summary of Monitor Well Construction Details, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Monitor Well	Date of Installation	Measuring Point Elevation (Top of Casing) (ft msl)	Depth of Surface Casing (ft bls)	Total Drilled Depth (ft bls)	Screened Interval (ft bls)
MW-1	INA	483.11	NA	28.3	INA
MW-2	INA	484.30	NA	29	INA
MW-3	INA	483.34	NA	20	INA
MW-4	INA	472.18	NA	24.6	INA
MW-5	INA	454.62	NA	15	INA
MW-6	4/11/95	472.55	NA	22	12.0-22.0
* MW-7	4/21/95	475.01	22	48	38.0-48.0
* MW-9	4/21/95	476.25	NA	43.5	20.0-35.0
* MW-11	4/18/95	472.78	NA	36	26.0-36.0
MW-12	4/13/95	464.21	NA	22	12.0-22.0
* MW-13	4/19/95	467.60	NA	23	13.0-23.0
* MW-14	8/11/95	481.67	29	175	165.0-175.0
* MW-15	7/20/95	465.04	40	60.5	50.0-60.0
* MW-16	7/21/95	467.14	16	82	22.0-42.0
* MW-17	7/24/95	478.99	26	71	60.0-70.0
MW-18	7/19/95	467.96	NA	16	5.0-15.0
MW-19	7/19/95	473.90	NA	10	5.0-10.0
MW-20	7/27/95	475.03	NA	25	14.0-24.0
* MW-21	7/21/95	463.28	NA	22	11.0-21.0
MW-22	7/26/95	460.78	NA	10	5.0-10.0
* MW-23	8/17/95	458.92	17	89	78.0-88.0
* MW-24	1/19/96	465.32	105	200	175.0-195.0
MW-25	1/23/96	458.74	NA	15	5.0-15.0
* MW-26	2/5/96	458.79	20	180	75.0-95.0
* MW-28	1/15/96	480.40	NA	46	36.0-46.0
* MW-29	11/14/96	480.73	55	170	160.0-170.0
* MW-30	11/12/96	468.57	NA	40	25.0-40.0
* MW-31	11/13/96	468.45	50	90	75.0-90.0
* MW-32	11/12/96	462.06	NA	43	28.0-43.0
* MW-33	11/13/96	461.46	50	85	70.0-85.0

Footnotes appear on page 2.

Table 1-1. Summary of Monitor Well Construction Details, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

*	Bedrock wells - This designation indicates that the entire screened interval is set in bedrock.
ft msl	Feet above mean sea level.
NA	Not Applicable.
ft bls	Feet below land surface.
INA	Information not available.
Note:	Monitor Wells MW-8, MW-10, and MW-27 were not installed.

Table 1-2. Water Level Elevations, December 11, 1996, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Monitor Well ID	Measuring Point Elevation (ft, msl)	Depth to Water (ft, toc)	Groundwater Elevation (ft, msl)
MW-1	483.11	10.67	472.44
MW-2	484.30	11.72	472.58
MW-3	483.34	2.85	480.49
MW-4	472.18	9.10	463.08
MW-5	454.62	1.34	453.28
MW-6	472.55	5.06	467.49
*MW-7	475.01	5.78	469.23
*MW-9	476.25	5.77	470.48
*MW-11	472.78	15.30	457.48
MW-12	464.21	3.48	460.73
*MW-13	467.60	7.47	460.13
*MW-14	481.67	14.11	467.56
*MW-15	465.04	0.35	464.69
*MW-16	467.14	5.42	461.72
*MW-17	478.99	9.32	469.67
MW-18	467.96	4.52	463.44
MW-19	473.90	3.43	470.47
MW-20	475.03	9.98	465.05
*MW-21	463.28	2.18	461.10
MW-22	460.78	3.14	457.64
*MW-23	458.92	flowing	458.92+
*MW-24	465.32	1.95	463.37
MW-25	458.74	4.55	454.19
*MW-26	458.79	4.21	454.58
*MW-28	480.40	8.10	472.30
*MW-29	480.73	10.41	470.32
*MW-30	468.57	13.52	455.05
*MW-31	468.45	12.89	455.56
*MW-32	462.06	10.35	451.71
*MW-33	461.46	9.52	451.94

ft, toc Feet below top of casing.
ft, msl Feet above mean sea level.
* Bedrock Wells - This designation indicates that the entire screened interval is set in bedrock.

Table 1-3. Summary of Detectable Soil Sample Analytical Results, January 1996, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Constituents	East-Central North Carolina Background[1]	Soil Sample ID: Depth: Date Sampled:	GP-2 (6-8') 1/27/96	GP-3 (6-8') 1/28/96	GP-5 (4-5') 1/28/96	SB-1 (3-5') 1/27/96	SB-2 (7-8.5') 1/27/96
Volatile Organics by USEPA Method 8260 (ppb dw)							
Methylene chloride	INA		ND	ND	ND	ND	10
Chloroform	INA		ND	ND	ND	8	20
Semivolatile Organics by USEPA Method 8270 (ppb dw)	INA		ND	ND	ND	ND	ND
Metals by USEPA Method 6010 (ppm dw)							
Aluminum	100000		11800	6660	3960	11500	7380
Arsenic	6.5		2.11	1.24	1.58	2.84	1.57
Barium	700		46	26.3	30	45	28.3
Beryllium	<1.00		0.953	ND	ND	ND	0.729
Calcium	7900		ND	ND	ND	2160	ND
Chromium	70		1.34	1.33	5.76	11	1.52
Cobalt	45		ND	ND	ND	10.7	ND
Copper	30		15.1	3.8	15.2	25.6	8.88
Iron	30000		27900	13400	12700	18400	17200
Lead	365		3.88	2.41	6.74	16	2.69
Magnesium	6000		4460	726	1330	3440	2700
Manganese	250		181	28.1	92.1	295	135
Nickel	20		ND	ND	135	7.03	ND
Potassium	45000		2490	ND	591	ND	ND
Selenium	0.30		1.41	ND	ND	ND	ND
Sodium	57500		ND	ND	ND	ND	683
Thallium	INA		1.36	ND	ND	ND	ND
Vanadium	325		36.6	17.3	11.5	43.3	25.3
Zinc	28		52.7	8.57	30.9	51.3	47.9
Cyanide by Method 9010A (ppm dw)							
Total Cyanide	INA		ND	ND	ND	ND	ND
Amenable Cyanide	INA		ND	ND	ND	ND	ND

ppm dw Parts per million equivalent to milligrams per kilogram on a dry weight basis.
ppb dw Parts per billion equivalent to micrograms per kilogram on a dry weight basis.
J Estimated; matrix spike recovery exceeds upper control limit.
ND Constituent was not detected.
NA Constituent was not analyzed.
INA Information not available.
1 Values obtained from USGS, 1984. Values represent elemental concentrations of a single soil sample obtained from east-central North Carolina.
[box] All boxed numbers represent data above background concentrations.

aproject\univnc\nc239.004\fs-rap\tables\1-3POR.XLS\2/19/97

Table 1-4. Summary of Analytical Results for Groundwater Samples Collected December 12 and 13, 1996, The University of North Carolina at Chapel Hill, Airport Road Wast Disposal Area, Chapel Hill, North Carolina.

Constituent		MW-1	MW-3	MW-12	MW-14	MW-15	MW-22	MW-23	MW-25	MW-31	MW-32
VOCs (ppb) (EPA Method 8260)	15A NCAC 2L Standard (ppb)										
Acetone	700	48,000	<5	<125	<125	<2,500	<12.5	<5	<5	<25	<5
Benzene	1	68,000D	<1	2,000D	330	2,300	47	<1	<1	28	<1
Chlorobenzene	50	<2,500	<1	21J	3.2J	<500	11	<1	<1	1.8J	<1
Chloroform	0.19	130,000D	<1	12,000D	110	13,000	<2.5	<1	<1	45	<1
1,1-Dichloroethane	700	<2,500	<1	4.2J	<25	<500	0.5J	<1	<1	0.7J	<1
1,2-Dichloroethane	0.38	<2,500	<1	480	<25	<500	16	<1	<1	17	<1
1,2-Dichloroethene	70	<2,500	<1	8.2J	<25	<500	2.1J	<1	<1	1.4J	<1
Methylene Chloride	5	93,000D	<1	7,200D	32	7,700	<2.5	<1	<1	<5	<1
Toluene	1000	950J	<1	<25	<25	<500	0.2J	<1	<1	<5	<1
Trichloroethene	2.8	2,200J	<1	44	15J	70J	3.9	<1	<1	3.4J	<1
Vinyl chloride	0.015	<2,500	<1	14J	<25	<500	1.8J	<1	<1	3.6J	<1
Xylenes	530	<12,500	<5	<25	5.8	—	<12.5	<5	<5	<25	<5
Total VOCs	-	342,150	ND	21,771.4	496	23,070	82.5	ND	ND	100.9	ND

ppb Parts per billion equivalent to micrograms per liter.
VOCs Volatile organic compounds.
NS No standards have been established for this compound. Any reported concentration above the quantitation limit is considered in excess of the 15A NCAC 2L Standard
ND Constituents were not detected.
J Constituent concentration was detected between the method detection limit and quantitation limit and is qualified as estimated.
D Constituent concentration detected was quantitated using a secondary dilution.

Table 2-1. Potential Regulatory Requirements, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Standard Requirements or Criteria	Citation	Description	Probable Impact on Site Remediation/Status
North Carolina Groundwater Standards	NCAC, Title 15A, Subchapter 2L	NC Water Classification and Standards - govern protection and restoration of groundwater resources. Subchapter 2L provides numerical standards for up to 88 water-quality parameters for Class GA and GSA.	The groundwater standards are potentially applicable for the site and will influence the groundwater remediation process.
National Primary Drinking Water Standards	40 CFR Part 141	National Primary Drinking Water Standard MCLs are enforceable standards for contaminants in public water-supply systems. They are based on health, economic, and technical feasibility of removing a contaminant in water. MCLGs are nonenforceable guidelines that do not consider the technical feasibility of contaminant removal.	Surficial/bedrock aquifer at the site is not being used as a current source of drinking water on the property. MCLs will be potentially enforceable when groundwater is used for drinking purposes. However, MCLs can be used conservatively, along with State Groundwater Standards, in establishing cleanup goals.
CWA Section 404	(33 CFR Part 320-330) Executive Order 11990 (Wetlands Protection) 40 CFR Part 230	Wetlands as defined by U.S Army Corps of Engineers (Reference Manual). To minimize destruction, loss, degradation of wetlands. Action to prohibit discharge of dredged or fill material into wetlands without permit. Action to prevent impacted storm water runoff from entering the wetlands.	The nearest upstream wetlands were identified 1 mile upstream of Crow Branch Creek in the SIP report. The nearest downstream wetlands frontage was found where Crow Branch Creek enters Eastwood Lake (approximately 1.8 to 1.9 miles). Remediation activities will consider impacts to any on-site wetlands, if any.
North Carolina Hazardous Waste Management Regulations	NCAC, Title 15A, Chapter 13A	USEPA has authorized State of North Carolina to implement RCRA program in the state. Standards for owners/operators of hazardous waste treatment, storage and disposal facilities. LDR restricts placement or disposal of certain wastes on the land unless they meet specified Best Demonstrated Available Technology treatment standards, which are expressed as concentration or as specified technologies for listed and characteristic hazardous wastes.	Potentially significant impact for response actions involving excavation, treatment, transportation, and disposal of wastes. Potentially relevant and appropriate requirement.
DOT Rules for Hazardous Materials Transport	49 CFR Parts 107, 171-179	Regulates transport of hazardous materials.	Potential impact on response actions involving off-site shipment of wastes for treatment/disposal.
Standards Applicable to Generators of Hazardous Waste	NCAC Title 15A, Chapter 13A.0007 (adopts 40 CFR Parts 262)	RCRA regulations pertaining to labeling, placarding, packaging, and spill reporting.	Potentially applicable if the excavated source material is a hazardous waste.

Table 2-1. Potential Regulatory Requirements, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Standard Requirements or Criteria	Citation	Description	Probable Impact on Site Remediation/Status
Standards Applicable to Transporters of Hazardous Waste	NCAC Title 15A, Chapter 13A.0007 (adopts 40 CFR Parts 263	RCRA regulations establish standard applicable to transportion of hazardous wastes. Additional requirements include manifest system and record keeping.	Potentially applicable for transporting excavated hazardous waste to a permitted treatment/disposal facility.
North Carolina Solid Waste Regulations	NCAC, Title 15A, Chapter 13B	Design, operation, and closure requirements for solid waste disposal facilities.	Potential impact on response actions involving on or off-site disposal of solid waste generated during remedial action.
North Carolina Water Pollution Control Regulations Classification and Water Quality Standards Applicable to the Surface Waters of North Carolina	NCAC, Title 15A, Chap. 2, Section .0100 NCAC Title 15A, Subchapter 2B	Regulates surface-water discharges and discharges to POTWs; implements NPDES permitting program. Establishes effluent limitations, in terms of both quantity and quality, for point discharges to surface bodies. Requires NPDES permits for discharge of pollutants into surface waters.	Potentially applicable for discharge of treated water, if the disposal is to a surface-water body (Crow Branch Creek) or a POTW. For surface-water discharges, an NPDES permit should be obtained.
Waste not Discharged to Surface Waters	NCAC, Title 15A, 2H.0200	State regulation requiring non-discharge permit for waste not discharged to surface waters.	This is applicable only if the treated groundwater is discharged to below land surface via infiltration galleries, spray irrigation, or drip irrigation.
Underground Injection Control (UIC)	NCAC 15A, Chapter 2C.0200	Underground Injection Control (UIC) program provides standards applicable to construction of injection wells and permit requirements to operate an injection well.	Potential impacts on response actions involving injection of chemicals/contaminated groundwater using injection wells (example: in-situ chemical oxidation).
North Carolina Air Pollution Control Requirements	NCAC, Title 15A, Chapter 2D	All regulations in Chapter 2D are part of the federally approved State Implementation Plan for North Carolina or have been submitted for approval. State regulations adopt USEPA regulations by reference with USEPA authority delegated to the State by USEPA. Discusses air pollution control requirements.	Potentially impact on treatment alternatives involving air emissions during source excavation/treatment and groundwater remediation. Generally, an air pollution control device, subsequently an air permit, is not required for emissions from groundwater and soil remediation systems. However, a registration with the DAQ is required.
North Carolina Air Quality Permit	NCAC, Title 15A, Subchapter 2H	Section .0610 provides permit requirements for toxic air pollutants.	Potentially impact on treatment alternatives involving emissions of air toxics during source excavation/treatment and groundwater remediation.

Table 2-1. Potential Regulatory Requirements, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Standard Requirements or Criteria	Citation	Description	Probable Impact on Site Remediation/Status
Occupational Safety and Health Administration (OSHA)	29 CFR Parts 1904, 1910, and 1926	OSHA requirements applicable to workers engaged in on-site work during implementation of remedial actions.	Potential impacts on response actions involving excavation, collection, treatment (all media), and disposal. Additionally, installation of recovery wells or trenching for piping installations in the hot spot may require appropriate PPE.
Location Standards: Flood Plains	40 CFR 264.18 (b)	Design , construct, operate, and maintain facilities to avoid washout or any hazardous waste by a 100-year flood.	According to Flood Insurance Map, the site is located in Zone C (areas of minimum flooding).
Protection of Flood Plains	40 CFR 6, Appendix A	Action occurring in a flood plain, i.e., lowlands, and relatively flat areas adjoining inland and coastal waters and other flood-prone areas. Action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values.	According to Flood Insurance Map, the site is located in Zone C (areas of minimum flooding).

Table 2-2. Maximum Observed Groundwater Contaminants and Pertinent Groundwater/Drinking Water Standards, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Constituent of Interest	Maximum Observed Concentration in Groundwater	North Carolina Water Quality Standard (for Class GA/GSA)	Federal Drinking Water Standard MCL[1]	Remediation Goals[4]
VOLATILES:				
Acetone	48,000	700	NA	700
Benzene	100,000	1	5	1
Chloroform	140,000	0.19	100[2]	0.19
Chlorobenezene	130J	50	100	50
Diethylether	240,000	NA	NA	NA
1,2-dichloroethane	2400	0.38	5	0.38
Methylene chloride	110,000	5	5	5
Trichloroethylene	2,200J	2.8	5	2.8
Toluene	950J	1000	1000	1000
1,1,2,2-Tetrachloroethane	1200	NA	NA	0.167
Vinyl chloride	14J	0.015	.002	0.015
SEMI-VOLATILES:				
Phenol	290	300	NA	300
INORGANICS:				
Barium	333	2000	2000	2000
Chromium	28.3	50	100	50
Lead	19.8	15	NA	15
Nickel	70	100	100	100
Iron	2380	300	300[3]	NA
Manganese	204	50	50[3]	NA
Zinc	1700	2100	5000[3]	2100

All concentrations are in parts per billion.

1 Maximum Contaminant Limit.
2 Standard for total trihalomethanes.
3 Secondary Drinking Water Standards.
4 Adapted from Table C-2, Groundwater Remediation Goals, Attachment C, Guidelines for Responsible Party Voluntary Site Remedial Action, Inactive Hazardous Sites Program, October, 1996.

NA Not available.
J Estimated value.

Table 2-3. Soil Remediation Goals, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Constituent of Interest	Remediation Goals[1]
VOLATILES:	
Acetone	1560
Benzene	22
Chloroform	100
Chlorobenezene	320
Diethyl Ether	NA
1,2 dichloroethane	7
Methylene Chloride	85
Trichloroethylene	58
Toluene	3200
1,1,2,2 Tetrachloroethane	3.2
Vinyl Chloride	0.34
SEMI-VOLATILES:	
Phenol	9400

All concentrations are in parts per million (ppm).

1 Adapted from Table C-1, Soil Remediation Goals, Attachment C, Guidelines for Responsible Party Voluntary Site Remedial Action, Inactive Hazardous Sites Program, October, 1996.

NA Not available.

Table 2-4. Evaluation of Source Control Alternatives, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Source Control Alternative 1 (SCA-1)	Source Control Alternative 2 (SCA-2)	Source Control Alternative 3 (SCA-3)	Source Control Alternative 4 (SCA-4)
	No Action for either Primary Source (waste material/containers) or Secondary Source (contaminated soil underneath the primary source).	Excavation of Primary and Secondary Sources, Off-Site Treatment and Off-Site Disposal facility.	Excavation of primary source & Off-Site Treatment/Disposal, and In-Situ Volatilization of Secondary Source.	In-Situ Volatilization and Solidification of Primary and Secondary Sources.
Protection of Human Health and the Environment	• Not protective of human health. • Impacts from continued release of chemicals into the environment.	• Expected to be protective of human health due to source removal/remediation. • Threats of further chemical releases into the environment will be reduced due to source removal/remediation.	• Expected to be protective of human health due to source removal. • Threats of further chemical releases into the environment will be reduced due to source removal/remediation.	• Expected to be protective of human health due to source removal. • Threats of further chemical releases into the environment will be reduced due to source removal/remediation.
Compliance with Regulatory Requirements	• Not expected to meet the Remedial Action Objectives (RAOs). • Does not comply with the State and Federal Requirements.	• Expected to meet RAOs. • Requires State's water quality and air pollution control permits. • Required to meet OSHA requirements for PPE and excavation standards. • Required to comply with transportation and disposal requirements under DOT and RCRA regulations. • May need to meet treatment standards (LDRs) for the excavated waste. • Soils in the source area are expected to achieve Remediation Goals (RG) listed in Table 2-3.	• Expected to meet RAOs. • Requires State's water quality and air pollution control permits. • Required to meet OSHA requirements for PPE & excavation standards. • Required to comply with transportation and disposal requirements under DOT and RCRA regulations. • May need to meet treatment standards (LDRs) for the excavated waste. • In-situ treatment will not remove waste out of the ground; therefore, LDRs may not apply. • Soils in the source area are expected to meet RGs.	• Expected to meet RAOs. • Requires State's water quality and air pollution control permits. • Required to meet OSHA requirements for PPE and excavation standards. • Required to comply with transportation and disposal requirements under DOT and RCRA regulations. • May need to meet treatment standards (LDRs) for the excavated waste. • In-situ treatment will not remove waste out of the ground; therefore, LDRs may not apply. • Soils in the source area are expected to meet RGs.

Table 2-4. Evaluation of Source Control Alternatives, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Source Control Alternative 1 (SCA-1)	Source Control Alternative 2 (SCA-2)	Source Control Alternative 3 (SCA-3)	Source Control Alternative 4 (SCA-4)
Long-Term Effectiveness and Permanence	• Risks are not expected to be reduced. High potential for continued release of chemicals. • No Action will not be effective. Potential for natural attenuation of sources before impacting the receptor (groundwater) is very low.	• Risks are expected to be significantly reduced to source removal. • This option is a commonly used remedy which is expected to be highly effective. Quality control process can be used to ensure effective source removal. • Can optimize the degree of cleanup required (to meet RGs).	• Risks are expected to be significantly reduced due to source removal/treatment. • Excavation of primary source is expected to be highly effective. In-situ volatiliza-tion is new approach, but application at other sites indicates that it is a highly effective approach. • Quality control techniques can be used to ensure the effectiveness of the excava-tion and volatilization process. • Some residual contamina-tion may be left in place, but is not expected to be significant to impact the environment/human health.	• Risks are expected to be significantly reduced due to source removal/treatment. • Fairly new approach with limited application at similar sites. • Effectiveness assessment of the remedy can be measured by a comprehensive quality control/ sampling program. • Some residues may be left in the subsurface, but are not expected to be significant to impact the environment or human health. • May need to maintain soil cover over the solidified material to prevent erosion.
Reduction of Toxicity, Mobility and Volume	• Does not reduce the mobility, toxicity or volume of contaminants, with the exception of natural attenuation (insignificant).	• Significant reductions in toxicity, mobility, and volume are expected through removal and off-site treatment and disposal.	• Significant reduction in toxicity, mobility, and volume are expected through removal and in-situ treatment processes.	• Significant reduction in toxicity, mobility, and volume are expected through in-situ treatment processes.

Table 2-4. Evaluation of Source Control Alternatives, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Source Control Alternative 1 (SCA-1)	Source Control Alternative 2 (SCA-2)	Source Control Alternative 3 (SCA-3)	Source Control Alternative 4 (SCA-4)
Short-Term Effectiveness	• No impact to community/ worker, since no construction activities/exposure.	• Potential threats to workers or community during implementation can be reduced by taking precautions such as using proper PPE, enclosure for off-gas capture/treatment, use of blast shields, etc. • High potential for reaction between two incompatible materials during implement-ation.	• Potential threats to workers or community during excavation/in-situ treatment can be reduced by taking precautions such as using proper PPE, enclosure, off-gas capture/treatment, blast shields, etc. • Potential impact from in-situ volatilization (exposure vapor) can be controlled by using a shroud over the mixing area and treatment of off-gases. • Water removed from the excavation will require treatment before discharge.	• Potential impact from in-situ treatment (exposure vapor) can be reduced by using a shroud over the mixing area and treatment of off-gases. • In-situ process will be below ground which will reduce potential impacts from mixing of small quantities of incompatible chemicals. • Careful ambient monitoring is required during implementation.

Table 2-4. Evaluation of Source Control Alternatives, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Source Control Alternative 1 (SCA-1)	Source Control Alternative 2 (SCA-2)	Source Control Alternative 3 (SCA-3)	Source Control Alternative 4 (SCA-4)
Implementability	• Readily implementable (no disturbance of source material).	• Conventional construction techniques and equipment can be used to excavate. • Labor intensive due to removal and segregation of soil/containers (primary source). • A very slow process and may require 4 - 6 months. • Requires extensive planning and permitting process. • Requires shoring/sheet piling, dewatering, treatment, etc. • Potential impacts due to vehicular traffic from the transportation of excavated material.	• Primary source excavation is implementable (see SCA-2). • In-situ treatment requires a specialized rig, which is available from a very few vendors. • Equipment for in-situ treatment can be easily mobilized. • Implementation will require short time frame compared to SCA-2 (1 - 3 weeks for secondary source treatment). • Potential impacts due to vehicular traffic from the transportation of excavated material (primary source). • Shoring/sheet piling and dewatering will be required during primary source removal.	• In-situ treatment requires a specialized rig, which is available from a very few vendors. • Equipment for in-situ treatment can be easily mobilized. • Can be implemented in a shorter time frame compared to SCA-2 (3 - 5 weeks for both primary and secondary source treatment). • Potential exposure is reduced due to treatment performed below ground, (reduced chances of potential exposure). • No large size drums or buried utilities are expected at the site, so this technology is expected to be easily implementable.
Cost	• No capital costs. • Annual soil sampling and inspection will be required. • Opinion of probable PW cost for sampling/inspection is estimated to be $446,700.	• High implementation cost. • Opinion of probable PW of total costs is estimated to be $16,529,900.	• Moderately implementation cost compared to SCA-2. • Opinion of probable PW of total costs is estimated to be $10,751,950.	• Low implementation cost compared to SCA-2 and SCA-3. • Opinion of probable PW of total costs is estimated to be $3,432,650.
Community Acceptance	• Currently unknown. A public meeting is planned in the near future to obtain the community input.	• Currently unknown. A public meeting is planned in the near future to obtain the community input.	• Currently unknown. A public meeting is planned in the near future to obtain the community input.	• Currently unknown. A public meeting is planned in the near future to obtain the community input.

Table 2-5. Opinion of Probable Costs for SCA-1: No Action, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Items/Description		Cost
<u>Annual Review Costs</u>		
Collection of soil samples, analysis, and reporting		$30,000
Contingency (20 percent)		$6,000
	Subtotal	**$36,000**
	TOTAL PRESENT WORTH COSTS	**$446,700**

- Present-worth costs were estimated using a 7 percent discount factor for a project life of 30 years.
- Costs rounded to nearest $100.

g:\aproject\univnc\nc0239.004\fs-rap\tables\2-5POR.XLS 2/19/97

Table 2-6. Opinion of Probable Costs for SCA-2: Excavation of Primary and Secondary Sources, Off-Site Treatment, and Off-Site Disposal, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Items/Description		Cost
Site Preparation		$38,400
Dewatering/Groundwater Treatment		$172,150
Sheet Piling/Removal		$143,300
Enclosure Rental/Setup		$81,150
Excavation/Backfill		$520,150
Vapor Phase Treatment		$92,750
Miscellaneous Equipment Rental		$265,000
Health and Safety		$183,000
Transportation/Treatment/Disposal of Source Material		$12,070,700
	Subtotal	**$13,566,600**
Engineering/Oversight		$250,000
Contingency (20 percent)		$2,713,300
	TOTAL PRESENT WORTH COSTS	**$16,529,900**

- Costs for contingency are rounded to nearest $100.
- Engineering/oversight costs are approximate and assumed to be between 15 percent and 30 percent of the excavation costs, excluding transportation, treatment, and disposal.

Table 2-7. Opinion of Probable Costs for SCA-3: Excavation of Primary Source and Off-Site Treatment/Disposal, and In-Situ Volatilization of Secondary Source, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Items/Description		Cost
Primary Source Removal/Disposal		
Site Preparation		$38,400
Dewatering/Groundwater Treatment		$133,150
Sheet Piling/Removal		$77,600
Enclosure Rental/Setup		$71,000
Excavation/Backfill		$355,400
Vapor Phase Treatment (Excavation)		$92,750
Miscellaneous Equipment Rental		$229,250
Health and Safety		$165,000
Transportation/Treatment/Disposal of Source Material		$6,881,500
Secondary Source Treatment: In-Situ Mixing/Volatilization		
Test Pit		$5,000
Pilot Scale Test		$36,600
Full-Scale In-Situ Mixing/Volatilization		$450,500
Vapor Treatment		$50,600
Water Treatment/Disposal		$9,500
Health and Safety		$5,400
Post-Remediation Sampling		$50,000
Miscellaneous		$100,000
	Subtotal	$8,751,650
Engineering/Oversight		$250,000
Contingency (20 percent)		$1,750,300
	TOTAL PRESENT WORTH COSTS	$10,751,950

- Costs for engineering/oversight and contingency are rounded to nearest $100.
- Engineering/oversight costs are approximate and assumed to be between 15 percent and 30 percent of the excavation and in-situ mixing costs, excluding transportation, treatment, and disposal costs.

Table 2-8. Opinion of Probable Costs for SCA-4: In-Situ Volatilization and Solidification of Primary and Secondary Sources, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Items/Description		Cost
Test Pit		$25,000
Bench-Scale Test		$15,000
Pilot Scale Test		$47,000
Full-Scale In-Situ Mixing/Volatilization		$2,417,300
Vapor Treatment		$70,850
Water Treatment/Disposal		$20,000
Health and Safety		$5,400
Miscellaneous Equipment Rental		$10,000
Post-Remediation Sampling		$50,000
Miscellaneous		$100,000
	Subtotal	**$2,760,550**
Engineering/Oversight		$120,000
Contingency (20 percent)		$552,100
	TOTAL PRESENT WORTH COSTS	**$3,432,650**

Notes:
- Costs for engineering/oversight and contingency are rounded to nearest $100.
- Engineering/oversight costs are approximate and assumed to vary between 20 percent and 35 percent of in-situ mixing/solidification costs, excluding contractors costs.

Table 2-9. Evaluation of Groundwater Remediation Alternatives, The University of North Carolina, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Groundwater Alternative 1 (GWA-1)	Groundwater Alternative 2 (GWA-2)	Groundwater Alternative 3 (GWA-3)	Groundwater Alternative 4 (GWA-4)
	No Action (no active remediation)	Vacuum-Enhanced Recovery (VER) of Shallow Groundwater (Hot-Spot), and Conventional Recovery of Bedrock Groundwater, Treatment, and Disposal. • Conventional recovery of bedrock groundwater to contain the plume near the creek. • Air Stripping and carbon polishing are selected groundwater treatment components. • Disposal of treated water to Crow Branch Creek/infiltration gallery.	Funnel and gate for Shallow Hot Spot Groundwater Remediation, and Conventional Recovery of Bedrock Groundwater, Treatment, and Disposal. • Funnel-&-gate using air sparge curtain and vapor extraction. • Conventional recovery of bedrock groundwater for plume containment near the creek. • Air Stripping and carbon polishing for groundwater treatment. • Disposal of treated water to Crow Branch Creek.	In-situ Chemical Treatment of Shallow and Bedrock Hot Spot Groundwater, Conventional Recovery of Bedrock Groundwater, Treatment, and Disposal. • Chemical oxidation (CleanOX®) using hydrogen peroxide. • Plume containment in the bedrock near the creek using conventional recovery wells. • Air stripping and carbon polishing for treatment of recovered groundwater. • Disposal of treated water to Crow Branch Creek.
Protection of Human Health and the Environment	• Not protective of human health or the environment. • Will not meet the Remedial Action Objectives (RAOs). • No reduction of risks is expected.	• Protective of human health. • Expected to meet RAOs. • Proper implementation is expected to contain and remediate groundwater. • Will reduce further migration of the contaminant plume and potential threat/risk to the environment (example; Crow Branch Creek).	• Protective of human health and the environment. • Expected to meet RAOs. • Proper implementation will contain and remediate groundwater. • Will reduce further migration of the contaminant plume and potential threat/risk to the environment (example: Crow Branch Creek).	• Protective of human health and the environment. • Expected to meet RAOs. • Proper implementation will contain and remediate groundwater controlling further migration of the contaminant plume and reducing potential threat/risk to the environment (example: Crow Branch Creek).

Table 2-9. Evaluation of Groundwater Remediation Alternatives, The University of North Carolina, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Groundwater Alternative 1 (GWA-1)	Groundwater Alternative 2 (GWA-2)	Groundwater Alternative 3 (GWA-3)	Groundwater Alternative 4 (GW-4)
Compliance with Appropriate Laws and Regulations	• Violates North Carolina Groundwater Standards (NCGWS). • Will not meet Inactive Hazardous Sites Program requirements. • Will not meet groundwater Remediation Goals (RGs) listed in Table 2-2.	• Assists in achieving NCGWS. • Disposal of treated groundwater to the creek requires an NPDES permit to meet Water Quality Standards (WQS). • Infiltration of treated groundwater requires a Non-Discharge Permit from the Division of Water Quality. • Air emissions should meet requirements of NCAC Title 15A, Chapter 2D and 2H. Air emissions from the recovery/treatment process may not require a control device (generally accepted practice by NC Division of Air Quality [DAQ]); therefore, an air permit is not required. • Requires a recovery well construction permit. • Need to meet groundwater RGs (Tabke 2-2).	• Expected to remediate to NCGWS. • Disposal of treated groundwater will require NPDES permit. • Air emissions should meet requirements of NCAC Title 15A, Chapter 2D and 2H. Air emissions from the groundwater recovery and treatment process may not require a control device (generally accepted practice by NC Division of Air Quality [DAQ]); therefore, an air permit is not required. • Requires a recovery well construction permit. • Need to meet groundwater RGs (Table 2-2).	• Expected to remediate to NCGWS. • Disposal of treated groundwater requires NPDES permit. • Air emissions should meet requirements of NCAC Title 15A, Chapter 2D and 2H. Air emissions from the recovery and treatment process may not require a control device (generally accepted practice by NC Division of Air Quality [DAQ]); therefore, an air permit is not required. • Requires an injection well permit to inject CleanOx® chemicals into the ground as required by NCAC Title 15A, Chapter 2C. • Requires a recovery well construction permit. • Need to meet groundwater RGs (Table 2-2).

Table 2-9. Evaluation of Groundwater Remediation Alternatives, The University of North Carolina, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Groundwater Alternative 1 (GWA-1)	Groundwater Alternative 2 (GWA-2)	Groundwater Alternative 3 (GWA-3)	Groundwater Alternative 4 (GW-4)
Long-Term Effectiveness and Permanence	• No action alternative will not reduce risks and has potential to impact the environment (surface water). • Limited natural attenuation will assist in reducing contaminant concentrations.	• Expected to reduce long-term risk and potential threats. • Expected to meet RAOs. • Potential for air emissions from the remedial system can be reduced by using a suitable control device. • Shallow hot-spot remediation (VER system) is expected to significantly reduce contamination due to accelerated mass recovery. • Pump-and-treat will require long-term operation.	• Expected to reduce long-term risk and potential threats. • Expected to meet RAOs. • Potential for air emissions from the remedial system can be reduced by using a suitable control device. • Funnel and gate is a passive remediation system, and therefore, accelerated mass reductions cannot be expected. • Pump-and-treat will require long-term operation.	• Expected to reduce long-term risk and potential threats. • Expected to meet RAOs. • Potential for air emissions from the remedial system can be reduced by using a suitable control device. • If the oxidation system can be effectively implemented, significant contaminant reduction can be achieved in a short period. • Expected to accelerate the mass removal of contaminants in both shallow and deep hot spots. • Pump-and-treat may require long-term operation.
Reduction of Toxicity, Mobility, and Volume	• Will not reduce toxicity, mobility, or volume of contaminated groundwater except for a portion, which may naturally attenuate.	• Expected to significantly reduce toxicity, mobility, and volume due to active remediation.	• Expected to significantly reduce toxicity, mobility, and volume due to active remediation.	• Expected to significantly reduce toxicity, mobility, and volume due to active remediation. • Based on the effectiveness of in-situ oxidation process, project life can be significantly reduced.

Table 2-9. Evaluation of Groundwater Remediation Alternatives, The University of North Carolina, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Groundwater Alternative 1 (GWA-1)	Groundwater Alternative 2 (GWA-2)	Groundwater Alternative 3 (GWA-3)	Groundwater Alternative 4 (GW-4)
Short-Term Effectiveness	• Since no action alternative will not involve construction, no impact during its implementation.	• Impact during construction is expected to be negligible with proper personnel protection (standard construction technique will be used). • No impact to community or environment is anticipated.	• Impact during construction is expected to be negligible with proper personnel protection (standard construction technique will be used). • High potential for workers exposure to soil vapors during construction of a funnel and gate system and may require shoring/dewatering. • No impact to community or environment is anticipated.	• Impact during construction is expected to be negligible with proper personnel protection (standard construction technique will be used). • In-situ chemical oxidation process, if not properly designed and carefully implemented, can cause reactions which will be uncontrollable and may impact on-site workers. • No impact to community is anticipated.
Implementation	• No construction Is involved.	• The pump-and-treat system construction involves use of traditional well drilling and construction techniques. • Easy to implement. • A full-scale design will require pump testing of the deep bedrock aquifer and a pilot testing (VER) of the shallow unconsolidated aquifer.	• The pump-and-treat system construction involves use of the traditional well drilling and construction techniques. • Funnel and gate system (a sheet pile wall and a permeable gate) requires shoring/sheet piling. • A full-scale design will require pump testing of the deep bedrock aquifer.	• The pump-and-treat system construction involves use of traditional well drilling and construction techniques. • In-situ oxidation can be achieved using CleanOX® system (patented process). • CleanOX® technology can be implemented in a short time frame. However, the recovery and treatment system requires a long-term operation and maintenance. • Requires aquifer pump test for the deep bedrock aquifer recovery system design. • Requires a pilot test for evaluating the effectiveness of the oxidation process.

Table 2-9. Evaluation of Groundwater Remediation Alternatives, The University of North Carolina, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Groundwater Alternative 1 (GWA-1)	Groundwater Alternative 2 (GWA-2)	Groundwater Alternative 3 (GWA-3)	Groundwater Alternative 4 (GW-4)
Costs	• No capital costs. • Annual groundwater sampling may be required. • Opinion of probable PW cost for sampling/ inspection is estimated to be $446,700.	• High capital costs. • Assumed project life of 30 years. • Opinion of probable PW cost for sampling/inspection is estimated to be $2,203,000.	• High capital costs. • Low O&M for funnel and gate system. • Assumed project life of 30 years. • Opinion of probable PW cost for sampling/inspection is estimated to be $2,848,500.	• High capital costs for in-situ oxidation and pump-and-treat system. • No O&M associated with CleanOX® process. • High potential for reduced project life due to mass contaminant removal by oxidation process. • Assumed groundwater recovery project life of 10 years. • Opinion of probable PW cost for sampling/inspection is estimated to be $2,293,000.
Community Acceptance	• Currently unknown. A public meeting is planned in the near future to obtain the community input.	• Currently unknown. A public meeting is planned in the near future to obtain the community input.	• Currently unknown. A public meeting is planned in the near future to obtain the community input.	• Currently unknown. A public meeting is planned in the near future to obtain the community input.

Table 2-10. Opinion of Probable Costs for GWA-1: No Action, The University of North Carolina at Chapel Hil Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Items/Description		Cost
Annual Review Costs		
Collection of 10 groundwater samples, analysis, and reporting		$30,000
Contingency (20 percent)		$6,000
	Subtotal	**$36,000**
	TOTAL PRESENT WORTH COSTS	**$446,700**

Notes:
- Present worth costs were estimated using a 7 percent discount factor for a project life of 30 years.
- Costs rounded to nearest $100.

Table 2-11. Opinion of probable costs for GWA-2: Groundwater Recovery, Air Stripping, Carbon Polishing, and Disposal to Crow Branch Creek, UNC Chemical Waste Site, Chapel Hill, North Carolina

Items/Description		Cost
Capital Costs		
Aquifer Pump Test and VER Pilot Test		$40,000
Permitting		$5,000
Total Capital Equipment Costs		$89,700
Recovery Wells Installation (5 deep and 5 shallow wells)		$169,100
Remedial System Construction (Treatment System, Piping, Electrical, etc.)		$201,000
	Subtotal	**$504,800**
Engineering/Oversight (20%)		$101,000
Contingency (20%)		$101,000
	Total Capital Costs	**$706,800**
Operation, Maintenance, and Monitoring (OMM) Costs		
First Year Costs		
Analytical		$22,800
Utilities		$17,200
Liquid Phase Carbon Polishing System		$6,000
Labor (Maintenance, Sampling, Monitoring)		$34,000
Reporting		$20,000
Contingency (20% of analytical, utilities, labor, & reporting)		$20,000
	Subtotal First Year Costs	**$120,000**
Annual Costs (2nd Year Onwards)		
Analytical		$19,000
Utilities		$17,200
Liquid Phase Carbon Polishing System		$6,000
Labor (Maintenance, Sampling, Monitoring)		$30,200
Reporting		$20,000
Contingency (20% of analytical, utilities, labor, & reporting)		$18,500
	Sub-total Annual Costs (2nd Year Onwards)	**$110,900**
	Present -Worth of OMM Costs (Yr. 2 - 30)	**$1,496,200**
	TOTAL PRESENT WORTH CAPITAL AND OMM COSTS	**$2,203,000**

NOTE:
- Costs for engineering/oversight and contingency are rounded to nearest $100.
- Present worth costs were estimated using a 7% discount factor for a project life of 30 years

g:\aproject\univnc\nc0239.004\fs-rap\tables\2-5POR.XLS 2/19/97

Table 2-12. Opinion of Probable Costs for GWA-3: Funnel-and-Gate for Hot-Spots Remediation, and Conventional Groundwater Recovery of Bedrock, Air Stripping, Carbon Polishing, and Disposal to Crow Branch Creek, UNC Chemical Waste Site, Chapel Hill, North Carolina.

Items/Description		Cost
Capital Costs		
Funnel-and-Gate System Construction		$681,600
Aquifer Pump Test and VER Pilot Test		$25,000
Permitting		$5,000
Total Capital Equipment Costs		$55,000
Recovery Wells Installation (4 deep wells)		$170,700
Remedial System Construction (Treatment System, Piping, Electrical, etc.)		$141,800
	Subtotal	$1,079,100
Engineering/Oversight (20%)		$215,800
Contingency (20%)		$215,800
	Total Capital Costs	**$1,510,700**
Operation, Maintenance, and Monitoring (OMM) Costs		
First Year Costs		
Analytical		$23,800
Utilities		$7,900
Liquid Phase Carbon Polishing		$4,000
Labor (Maintenance, Sampling, Monitoring)		$33,600
Reporting		$28,000
Contingency (20% of analytical, utilities, labor, & reporting)		$19,500
	Subtotal First Year Costs	$116,800
Annual Costs (2nd Year Onwards)		
Analytical		$8,500
Utilities		$7,900
Liquid Phase Carbon Polishing		$4,000
Labor (Maintenance, Sampling, Monitoring)		$33,600
Reporting		$28,000
Contingency (20% of analytical, utilities, labor, & reporting)		$16,400
	Subtotal Annual Costs (2nd Year Onwards)	**$98,400**
	Present-Worth of OMM Costs (Yr. 2 - 30)	**$1,337,800**
	TOTAL PRESENT WORTH CAPITAL AND OMM COSTS	**$2,848,500**

NOTE:
- Costs are rounded to nearest $100.
- Present worth costs were estimated using a 7% discount factor for a project life of 30 years

Table 2-13. Opinion of Probable Costs for GWA-4: In-Situ Chemical Treatment of Hot Spots, and Recovery Bedrock Groundwater Recovery, Air Stripping, Carbon Polishing, and Disposal to Crow Branch Creek, UNC Chemical Waste Site, Chapel Hill, North Carolina

Items/Description		
Capital Costs		
In-Situ Chemical Oxidation		
Workplan/Permitting		$20,000
Bench-Scale Test		$5,000
Pilot Test		$62,100
Injection Wells Installation		$63,500
Full-Scale Design/Implementation		$588,000
	Subtotal	$738,600
Groundwater Recovery/Treatment System		
Aquifer Pump Test		$25,000
Permitting		$3,000
Total Capital Equipment Costs		$45,600
Recovery Wells Installation (4 deep wells)		$136,600
Remedial System Construction (Treatment System, Piping, Electrical, etc.)		$94,200
	Subtotal	$304,400
Engineering/Oversight (20% of Capital Costs)		$208,600
Contingency (20% of Capital Costs)		$208,600
	Total Capital Costs	**$1,460,200**
Operation, Maintenance, and Monitoring (OMM) Costs		
First Year Costs		
Analytical		$23,800
Utilities		$7,500
Liquid Phase Carbon Polishing		$6,000
Labor (Maintenance, Sampling, Monitoring)		$25,200
Reporting		$20,000
Contingency (20% of analytical, utilities, labor, & reporting)		$16,500
	Subtotal First Year Costs	$99,000
Annual Costs (2nd Year Onwards)		
Analytical		$8,500
Utilities		$7,500
Liquid Phase Carbon Polishing		$6,000
Labor (Maintenance, Sampling, Monitoring)		$25,200
Reporting		$20,000
Contingency (20% of analytical, utilities, labor, & reporting)		$13,400
	Subtotal Annual Costs (2nd Year Onwards)	$80,600
	Present-Worth of OMM Costs (Yr. 2 - 10)	**$833,100**
	TOTAL PRESENT WORTH CAPITAL AND OMM COSTS	**$2,293,300**

NOTE:
- Costs for engineering/oversight and contingency are rounded to nearest $100.
- Present worth costs estimated using a 7% discount factor for a life of 10 years for pump-and-treat system.

g:\aproject\univnc\nc0239.004\fs-rap\tables\2-5POR.XLS 2/19/97

Table 2-14. Comparison of Source Control Alternatives, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Source Control Alternative 1 (SCA-1)	Source Control Alternative 2 (SCA-2)	Source Control Alternative 3 (SCA-3)	Source Control Alternative 4 (SCA-4)
	No Action for either primary source (waste material/containers) or secondary source (contaminated soil underneath the primary source).	Excavation of Primary and Secondary Sources, Transport to an Off-Site Treatment and Off-Site Disposal Facility.	Excavation of Primary Source & Off-Site Treatment/Disposal, and In-Situ Volatilization of the Secondary Source.	In-Situ Volatilization and Solidification of Primary and Secondary Sources.
Protection of Human Health and the Environment	• Not protective of human health or the environment due to potential for continued release of chemicals into the environment. • This alternative is not expected to meet the Remedial Action Objectives (RAOs).	• This alternative is expected to significantly reduce further threats of impacting the environment due to removal, treatment, and off-site disposal of primary and secondary sources. • This alternative is expected to provide better protection compared to that of Alternative SCA-3 or SCA-4 due to removal of source material (no residual contamination). • Vapor controls to be used in this alternative will reduce risk of exposure to community/environment. • As in Alternatives SCA-3 or SCA-4, this alternative has a potential for mixing of incompatible chemicals during implementation. • This alternative is expected to meet the RAOs.	• This alternative is expected to provide a better protection of the environment than Alternative SCA-4 due to removal of primary source. • Compared to Alternative SCA-2, residual contamination is expected to be higher after in-situ volatilization of secondary source. However, the residual contamination is not expected to significantly impact the groundwater. • As in Alternative SCA-2, the potential for vapor production and mixing of incompatible chemicals exists. • This alternative is expected to meet the RAOs.	• This alternative is expected to reduce further threat of impacting human health and the environment due to the treatment of source material. • The amount of residual contamination after volatilization is expected to be higher than that in Alternative SCA-2 or Alternative SCA-3. However, the solidification process is expected to encapsulate the residuals. Residuals are not expected to significantly impact the environment. • As in Alternatives SCA-2 and SCA-3, vapor control will be required. • As in Alternatives SCA-2 and SCA-3, the potential for mixing of incompatible chemicals exists during implementation of this alternative. However, the presence of existing soil cover and use of a shroud is expected to minimize impacts. • Expected to meet the RAOs.

Table 2-14. Comparison of Source Control Alternatives, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Source Control Alternative 1 (SCA-1)	Source Control Alternative 2 (SCA-2)	Source Control Alternative 3 (SCA-3)	Source Control Alternative 4 (SCA-4)
Compliance with Regulatory Requirements	• No action alternative is not expected to comply with the Inactive Hazardous Sites Program requirements.	• Implementation of this alternative is expected to meet Inactive Hazardous Sites Program requirements. • Appropriate permits for transportation, treatment, and disposal of waste are required prior to implementation. In addition, water quality and air quality permits are also required. • May need to meet treatment standards (Land Disposal Restrictions - LDRs) for the excavated waste.	• As in Alernatives SCA-2 and SCA-3, implementation of this alternative is expected to meet Inactive Hazardous Sites Program requirements. • Appropriate permits as indicated in alternative SCA-2 are required for the treatment and disposal of excavated waste. • In-situ treatment will not remove waste material out of the ground; therefore, LDRs may not apply.	• Implementation of this alternative is expected to meet Inactive Hazardous Sites Program requirements. • No major permitting is required. However, this alternative requires compliance with state's air pollution control requirements. • As in Alternative SCA-3, this alternative will not remove waste material out of the ground; therefore, LDRs may not apply.
Long-Term Effectiveness and Permanence	• No action alternative is not an effective alternative since no reduction in risks is expected.	• Compared to Alternatives SCA-3 and SCA-4, Alternative SCA-2 is expected to be more effective since sources and residuals can be removed by excavation. • Since treatment of source material will be in aboveground reactors, processes can be properly controlled to ensure proper treatment. • Due to source removal, risks are expected to be significantly reduced.	• Compared to Alternative SCA-4, Alternative SCA-3 is expected to be more effective since the primary source is excavated and secondary source will be treated in-place. • Some residuals are expected after implementation of in-situ volatilization process in the secondary source area. The residual contamination is expected to be minimum and no significant impacts to human health or the environment are expected. • Risks are expected to be significantly reduced due to source removal/treatment.	• This alternative follows Alternatives SCA-2 and SCA-3 in ranking for long-term effectiveness since some residuals will be left in-place. • Residuals from the volatilization step will be encapsulated in the solidification step, thus providing better protection. • Residuals left in-place are not expected to significantly impact the environment. • Risks are expected to be significantly reduced due to source removal/treatment. • Fairly new approach with limited application at similar

Table 2-14. Comparison of Source Control Alternatives, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Source Control Alternative 1 (SCA-1)	Source Control Alternative 2 (SCA-2)	Source Control Alternative 3 (SCA-3)	Source Control Alternative 4 (SCA-4)
				sites.
Reduction of Toxicity, Mobility, and Volume	• Does not reduce the mobility, toxicity, or volume of contaminants, with the exception of natural attenuation (insignificant).	• Significant reductions in toxicity, mobility, and volume are expected through removal and off-site treatment and off-site disposal.	• Significant reduction in toxicity, mobility, and volume are expected through removal and in-situ volatilization process.	• Significant reduction in toxicity, mobility, and volume are expected through in-situ treatment processes.
Short-Term Effectiveness	• This alternative will not have short-term impact to community/construction worker, since no construction activities or exposure are involved.	• During implementation, potential for exposure to workers/community will be reduced with use of PPE and enclosure/off-gas treatment. • Exposure to potential reactions between two incompatible materials during implementation can be reduced using blast shields. • This alternative has high potential impact on the community due to vehicular traffic from the transportation of excavated material.	• Similar to Alternatives SCA-2 and SCA-4, potential for exposure to workers or community during excavation/in-situ treatment will be reduced by using proper PPE and enclosure with off-gas treatment (similar to Alternative SCA-2). • Potential air emissions will be reduced by capturing vapors using enclosure during excavation and a shroud over the mixing area during volatilization. • Potential impacts due to vehicular traffic from the transportation of excavated material is minimum compared to that of Alternative SCA-2.	• Similar to Alternatives SCA-2 and SCA-3, potential impact from in-situ treatment (exposure vapor) will be reduced by using an off-gas control (shroud over the mixing area) and treatment. • In-situ process will be below ground which will reduce potential impacts from mixing small quantities of incompatible chemicals. • Minimum impacts from vehicular traffic compared to Alternative SCA-2 or SCA-3.

Table 2-14. Comparison of Source Control Alternatives, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Source Control Alternative 1 (SCA-1)	Source Control Alternative 2 (SCA-2)	Source Control Alternative 3 (SCA-3)	Source Control Alternative 4 (SCA-4)
Implementability	• This alternative is readily implementable (no disturbance of source material).	• This alternative is easily implementable using conventional construction techniques and equipment. However, this is a labor intensive and slow process.	• Implementation of primary source removal is similar to that of Alternative SCA-2. • In-situ treatment requires a specialized rig, which is available from a very few vendors. However, this method will require less time compared to that for excavation (as in Alternative SCA-2).	• In-situ treatment requires a specialized rig, which is available from only a few vendors. • This alternative can be implemented in a shorter time frame compared to that of Alternatives SCA-2 and SCA-3. • No large size drums or buried utilities are expected at the site, so this technology is expected to be easily implementable.
Cost	• No capital costs. • Annual soil sampling and inspection of the facility is assumed to be required (refer to Table 2-5).	• Higher capital costs for excavation, transportation, treatment, and disposal (refer to Table 2-6).	• Lower capital cost compared to Alternative SCA-2, but these costs are expected to be higher than those of Alternative SCA-4 (refer to Table 2-7).	• Lower implementation costs compared to Alternatives SCA-2 and SCA-3 (refer to Table 2-8).
Community Acceptance	• No action alternative is not expected to be an acceptable alternative.	• Currently unknown. A public meeting is planned in the near future. Active remediation is expected to be acceptable to the community.	• Currently unknown. A public meeting is planned in the near future. Active remediation is expected to be acceptable to the community.	• Currently unknown. A public meeting is planned in the near future. Active remediation is expected to be acceptable to the community.

Table 2-15. Comparison of Groundwater Remediation Alternatives, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Groundwater Alternative 1 (GWA-1)	Groundwater Alternative 2 (GWA-2)	Groundwater Alternative 3 (GWA-3)	Groundwater Alternative 4 (GWA-4)
	No Action (no active remediation).	Vacuum-Enhanced Recovery (VER) of Shallow Groundwater (Hot Spot) and Conventional Recovery of Bedrock Groundwater, Treatment, and Disposal.	Funnel-and-Gate for Shallow Hot-Spot Groundwater Remediation and Conventional Recovery of Bedrock Groundwater, Treatment, and Disposal	In-Situ Chemical Treatment of Shallow and Bedrock Hot Spot Groundwater, Conventional Recovery of Bedrock Groundwater, Treatment, and Disposal.
Protection of Human Health and the Environment	• This alternative is not protective of human health and has a high potential for continued impacts to the environment. • This alternative will not meet Remedial Action Objectives (RAOs).	• Alternative SCA-2 is expected to contain contaminated groundwater and reduce impacts to the environment. In addition, shallow hot-spot remediation using VER (active) is expected to reduce further migration of contamination into bedrock aquifer. • This alternative is expected to meet RAOs.	• Similar to Alternative GWA-2, this alternative is expected to contain contaminated groundwater and reduce impacts to the environment. In addition, funnel-and-gate system in the shallow aquifer is expected to reduce further migration of contamination. However, this process is passive compared to a VER system in Alternative SCA-2 or a chemical treatment process in Alternative GWA-3. • This Alternative is expected to meet RAOs.	• Similar to Alternatives GWA-2 and GWA-3, this alternative is also expected to be protective of human health and the environment. • Chemical treatment (oxidation) is a more active remediation method compared to funnel-and-gate or VER technologies. However, chemical oxidation is an innovative technology and is not completely proven to be effective at similar sites. • This alternative is expected to meet RAOs.
Compliance with Appropriate Laws and Regulations	• Implementation of this alternative will continue to violate North Carolina Groundwater Standards (NCGWS).	• This alternative is expected to assist in achieving compliance with appropriate regulatory requirements (NCGWS). • Disposal options will comply with appropriate regulatory requirements (NPDES & Non-Discharge Permit). • Air emissions should meet requirements of NCAC Title 15A, Chapters 2D and 2H.	• As in Alternative GWA-2, this alternative is expected to assist in achieving compliance with NCGWS, NPDES, and air emission requirements.	• As in Alternatives GWA-2 and GWA-3, this alternative is expected to assist in achieving compliance with NCGWS, NPDES, injection well permitting, and air emission requirements.

Table 2-15. Comparison of Groundwater Remediation Alternatives, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Groundwater Alternative 1 (GWA-1)	Groundwater Alternative 2 (GWA-2)	Groundwater Alternative 3 (GWA-3)	Groundwater Alternative 4 (GWA-4)
Long-Term Effectiveness and Permanence	• This alternative will not reduce risks and has potential to impact the environment.	• Due to active recovery (VER) in the shallow aquifer, this alternative is expected to significantly reduce contaminant migration and further risks. • Proper implementation of a pump-and-treat will provide effective plume containment, but it is not an aggressive cleanup alternative. Contaminant removal rates will achieve asymptotic levels. • Pump-and-treat can be used to reduce contamination to levels where natural attenuation or risk assessment can be used for site closure.	• Similar to Alternative GWA-2, funnel-and-gate system will contain plume migration in the shallow aquifer. However, it is a passive mechanism (no accelerated mass reduction). • Remediation of bedrock groundwater is similar to that of Alternatives GWA-2 and GWA-3. Therefore, the pump-and-treat system will contain the plume migration.	• Similar to the VER system in Alternative GWA-2, chemical treatment (oxidation) is an active process for reducing contaminant mass. However, at this site, the rate of application will be slower due to low-permeability aquifer material. • In-situ chemical oxidation is a relatively new technology. According to the vendor (CleanOX®) this technology has been applied in remediating bedrock aquifers with significant mass reduction in a short time. However, its long-term effectiveness is unknown. • As in Alternatives GWA-2 and GWA-3, pump-and-treat is expected to be an effective plume containment option for the bedrock aquifer.
Reduction of Toxicity, Mobility, and Volume	• No action alternative will not reduce toxicity, mobility, or volume of contaminated groundwater except for a portion, which may naturally attenuate.	• As in Alternatives GWA-3 and GWA-4, this alternative is expected to significantly reduce toxicity, mobility, and volume of dissolved contaminants due to remediation.	• As in Alternatives GWA-2 and GWA-4, this alternative is expected to significantly reduce toxicity, mobility, and volume of the dissolved contaminants.	• As in Alternatives GWA-2 and GWA-3, this alternative is expected to significantly reduce toxicity, mobility, and volume of the dissolved contaminants. In addition, the chemical oxidation process is expected to completely destroy the chemicals in groundwater.

Table 2-15. Comparison of Groundwater Remediation Alternatives, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Groundwater Alternative 1 (GWA-1)	Groundwater Alternative 2 (GWA-2)	Groundwater Alternative 3 (GWA-3)	Groundwater Alternative 4 (GWA-4)
Short-Term Effectiveness	• Since no action alternative will not involve construction, no impacts are expected during its implementation.	• During implementation, some potential for exposure to construction workers is expected. However, these impacts are negligible and can be reduced using proper personnel protection. • No significant impact to community or the environment is anticipated.	• Compared to Alternatives GWA-2 or GWA-3, construction workers will be subjected to higher exposure (soil vapors) during construction of a funnel and gate system. Impact during construction can be reduced using proper personnel protection. • No significant impact to community or the environment is anticipated.	• Potential for worker exposure to chemical reactions exists during implementation of this alternative. Implementation of proper health and safety measures will reduce any impact. • No significant impact to community or the environment is anticipated.
Implementability	• Easily implementable since no construction is involved.	• This alternative is easily implementable compared to Alternatives GWA-3 and GWA-3 due to use of standard construction techniques. • A VER pilot test and a bedrock aquifer pumping test are required for designing a full-scale system.	• Construction of an air sparge/vapor extraction system (part of the funnel and gate system) will require shoring/dewatering/sheet piling. These are standard construction techniques. • Implementation of the pump-and-treat portion of this alternative is similar to that in Alternative GWA-2.	• In-situ oxidation can be achieved using CleanOX® system (patented process). • CleanOX® technology can be implemented in a short time frame. However, a pilot study should be performed to demonstrate its effectiveness. • Implementation of the pump-and-treat portion of this alternative is similar to that in Alternative GWA-2 or GWA-3.
Costs	• No capital costs and low annual groundwater sampling costs (see Table 2-10).	• Higher capital costs compared to Alternative GWA-1 which is expected to be lower than Alternative GWA-3 or GWA-4. • Annual operation, maintenance, and monitoring (OMM) are expected to be slightly higher than Alternative GWA-4, but comparable with that of Alternative GWA-3 (refer to Table 2-11).	• Higher capital costs compared to Alternative GWA-1, GWA-2, or GWA-4. • OMM cost is expected to be lower than Alternative GWA-2, but higher than Alternative GWA-4 (refer to Table 2-12).	• Higher capital costs compared to Alternative GWA-2, but comparable to that of Alternative GWA-3. • OMM cost expected to be lower than that of Alternatives GWA-2 and GWA-3. • Expected to reduce project life due to mass contaminant removal by oxidation process (seeTable 2-13).

Table 2-15. Comparison of Groundwater Remediation Alternatives, The University of North Carolina at Chapel Hill, Airport Road Waste Disposal Area, Chapel Hill, North Carolina.

Criteria	Groundwater Alternative 1 (GWA-1)	Groundwater Alternative 2 (GWA-2)	Groundwater Alternative 3 (GWA-3)	Groundwater Alternative 4 (GWA-4)
Community Acceptance	• No action alternative is not expected to be accepted by the community.	Currently unknown. A public meeting is planned in the near future. Active remediation is expected to be acceptable to the community.	Currently unknown. A public meeting is planned in the near future. Active remediation is expected to be acceptable to the community.	Currently unknown. A public meeting is planned in the near future. Active remediation is expected to be acceptable to the community.