ABATEMENT ACTION GUIDANCE DOCUMENT

I: Purpose

The Purpose of this guidance document is to:

- Provide a basis for determining whether the site or situation in question is appropriate to pursue an "abatement only" order pursuant to Ohio Revised Code (ORC) 6111.03;
- Provide selection procedures that will yield an "abatement action" and associated performance standards for the order;
- Provide guidance for the generation of a justification that will show how technical feasibility, economic reasonableness and benefits to the people of Ohio were considered at the time the "abatement action" was selected and ordered; and,
- Provide guidance for the specifics that can be written into the Administrative Order on Consent (AOC) or Unilateral Administrative Order (UAO) itself.

This is intended to be guidance, and is not a procedure that can be followed with the expectation it will yield a specific result.

II: Basis for Proceeding:

This section of the guidance will provide information on: 1) Determination if ORC 6111 is the appropriate authority for issuing orders at an individual site and 2) Description of the investigatory strategy for the selection of the abatement action(s) under ORC 6111 authority orders.

1) Determination of Appropriate Authority for Response Activity

Generally, use of ORC Chapter 3734 authority for addressing contamination problems is preferable to the use of ORC 6111.03(H). Chapter 3734 provides authority to require investigation, does not require developing information to balance the *technical feasible, economically reasonable* and *of benefit to the people of Ohio* criteria prior to requiring work at a site and, in most situations provides for cost recovery when used in conjunction with CERCLA authority.

Given the advantages of reliance on Chapter 3734, the use of ORC 6111.03(H) to order abatement should only be considered after it has been found that no other remedial authority would effectively address environmental conditions for a given site.

Chapter 6111 abatement authority is a good tool when chapter 3734 requirements cannot be met. Typically, these include instances when it is not possible to categorize contaminants of concern as a statutory or regulatory "Hazardous Waste" and when no violations of hazardous waste law can be documented. Common classes of site contaminants that are often not RCRA Hazardous Wastes include petroleum, fertilizer constituents and modern pesticides. The Director's

determination of whether a chemical poses the hazard to meet the statutory definition of hazardous waste must be on a chemical by chemical basis in conjunction with site characteristics.

Questions regarding the appropriate authority to use as a basis for ordering remedial activities at a specific site should be brought to the attention of enforcement and legal staff. If it is determined that chapter 3734 authority is not applicable, frequently it is also likely that CERCLA 107 cost recovery authority will not be applicable.

2) Description of the Investigatory Strategy for a Site

ORC 6111 statute requires that technical feasibility, economic reasonableness, and benefits to the people of Ohio must all be considered in prior to the issuance of an order requiring an abatement action. In preparing the abatement order, investigation is often needed to gather that information needed to perform the analysis that will satisfy the statutory requirements. An example of such an analysis can be found in Section III of this guidance document.

The Matrix Evaluation Section, Section III, is designed to aid the user in selecting an appropriate Abatement Action in accordance with the statutory requirements. Users may also refer to the elements of matrix as a guide to the investigation process. This process may efficiently identify and eliminate unnecessary investigatory procedures.

The objective of such an investigation is to: 1) gather information that can be used to select an appropriate abatement action; and, 2) document that the selection of the abatement action was based on sufficient information to meet the above mentioned statutory requirements. Prior to initiating an investigation, the Agency must have the following information, at a minimum: 1) confirmation that a discharge has occurred, 2) known chemical type and estimated quantity and 3) a general understanding of the regional geology. It is likely that some of this information can be obtained from an ER Spill Report. Given the limited scope of contaminants expected to utilize ORC 6111 as their only response authority option, users should consult with US EPA's Presumptive Remedy Guidances or with DERR T&PS unit to provide general information regarding suitable technologies and associated effectiveness.

For example, US EPA Remedy Guidance for petroleum, US EPA Document EPA 600SR97120, suggested that enhanced bioremediation is highly effective for BTEX petroleum constituents. A Site Coordinator would need to conduct investigatory procedures to evaluate the costs and effectiveness of this technology under site specific conditions. In this case, it is not necessary to expand the investigation to justify elimination of other technologies.

One strategy is to develop the necessary information is through the use of screening assumptions for the matrix components found in Section III. This can be done with sufficiently conservative assumptions which do not underestimate items like cost and are not likely to overestimate items like effectiveness or benefits. If through the use of these screening assumptions it is demonstrated that an abatement action can be selected and properly supported, significant

additional investigatory information may not be needed. Using the previous example of a recent petroleum spill, the user may be able to make a reasonably accurate estimate regarding the rate and extent of the groundwater plume based on the amount of material spilled. This would limit the need for a traditional site investigation prior to issuance of orders.

The determination that the proposed abatement action can be met using at least one technology or process, and that the matrix evaluation has provided a basis to show how the statutory criteria were considered at the time that technology or process was evaluated is sufficient to document that the Agency has met its statutory obligations for that performance standard in that specific situation. It should be noted that the level of site investigation does not need to equal or exceed the level of detail necessary to implement a selected technology. Rather, the level of investigation needs to provide enough information to demonstrate that using this technology at this site is technically feasible and economically reasonable and of benefit to the people of Ohio .

III: Matrix Evaluation Procedure

The abatement action selected to address the conditions found at a particular site should be composed of three performance standards - the target contamination **level** the action is designed to achieve, the **time frame** in which the action is to achieve that level, and the **point(s) of compliance**. The tables in Appendix B are presented as an aid to users preparing Abatement Action orders in accordance with ORC 6111.03. This guidance does not represent the "only" way to do this, and is not prescriptive. Rather, the matrix procedure will help the user select an appropriate abatement action that will both address the site specific conditions and meet the consideration requirements of ORC 6111.

It is important that the matrix evaluations be completed in the context of the site in question. For example, one might think of SVE as a well proven technology, but only it's expected effectiveness at the site in question should be considered to yield a "score". A simple or complex scoring and ranking system for each of the tables may be developed as desired. The selected scoring method will rely upon the user's best professional judgement, known site specific factors and available data. Users should be prepared provide the scientific basis for decisions based on best professional judgement. In cases where data are meager, these tables may generate numerous potential abatement actions and, in such cases, the decision making process could be challenging. In cases where data are abundant, the tables will help quickly determine an appropriate abatement action(s).

All categories found in the matrix tables are baseline concepts for consideration, any relevant site specific information should be used where possible to further support the result of this decision making process. Should additional categories be appropriate given the statutory requirements, they should be evaluated too. See the definitions in Appendix A for help completing the tables, and appendix B for an example of how this process can be applied.

Upon completing the tables, it is recommended that the decision making methodology be documented. Since it is possible that one or more suitable abatement actions meet all three statutory criteria fairly equally, the merits implementing of each should be discussed with the PRP. In these situations, the abatement action should be supported by the Agency and the PRP, provided they equally satisfy the statutory criteria.

Included below are several steps the user may find helpful in performing the matrix evaluation.

1. The user should consider the contaminant type and general site characteristics in order to select a few preliminary technologies to be considered in the matrix tables.
2. A table scoring scheme should be selected. It can be on a scale like 1-5, or positive, negative, neutral or anything else the user is comfortable with.
3. Each technology should be completely evaluated in each of the Tables.
4. Additional criteria may be added to the tables for a complete analysis, particularly the "cost to achieve __", Table 3. This should be done in accordance with the users best professional judgement.
5. Results of the table should be reviewed to see what the best performance standards that can be met using a technology with the best or most positive "score".
6. The results can be summarized and documented.

IV: Justification

Completion of the matrix evaluation may point the the user toward selection of an abatement action consisting of the three elements noted above - target level, time frame and point(s) of compliance. The PRPs can be ordered to implement the abatement action as defined by the three performance standards, provided the Agency has given consideration to the technical feasibility, economic reasonableness and benefits to the people of Ohio of compliance with the order. The matrix evaluation can provide the basis for a justification that can be written in support of the ordered action. The justification should explain how the matrix evaluation yielded the selected abatement action performance standards, and briefly describe the consideration given as required by the statute and show how the ordered action is warranted. It should provide the basis for any "best professional judgements" made during the analysis. It can be useful to compare the site in question to other sites with similar characteristics that have successfully met the performance standards selected. The impact of not taking the action should be discussed. The long term outlook for the site, and impacts to natural resources should also be evaluated.

V: Technical Specifications of Orders

The Order will have the typical sections DERR always uses (see Appendix C). The core of the order will be the requirement to implement the abatement action which achieves the three elements that the matrix evaluation yields. The specific technology the respondent chooses to implement DOES NOT necessarily have to be the technology the matrix evaluation relied upon to set the three performance standards. Rather, having shown it is technically feasible,

economically reasonable and of benefit to the people of Ohio to meet those performance standards, the order will simply require that these performance standards be achieved. The means by which the performance standards are attained may be at the discretion of the respondent.

Orders may also include Natural Resource Damage recovery or penalties, the development of which is not covered in this guidance.

Appendix A

The following descriptions of selected components of the tables are designed to aid the Site Coordinator in completing the tables.

Table 1: **Technical Feasibility**

Achieves Measurable Action Level: The extent to which a given technology can achieve one or more of the action levels listed in Table 3 (e.g. abate ground water to pre-release conditions, maximum contaminant levels (MCLs), or a risk goal.)

Ability to Enhance or Modify: The degree and relative ease to which a technology can be enhanced or modified if it appears that additional treatment is necessary in order to accomplish the abatement action levels. For example, the ability to increase the amount of oxygen or nutrients to an enhanced biodegradation remedial system.

Proven Technology for Conditions: The remedy has been demonstrated to be effective at other sites with similar characteristics (e.g., type and amount of release, geology/hydrogeology.)

Ease of Installation, Operation and Maintenance: The relative ease of installing, operating and maintaining the technology, without considering costs.

Ability to Monitor: The extent to which an implemented technology can be monitored throughout the remedial implementation to completion.

Energy Efficient Demands/Inputs: Technologies that shoud be considered should require minimal energy sources. This could include a modified system configured to lower electricity or resource demands when compared to typical systems.

Compatibility with Land Use: The extent to which the technology is consistent and compatible with adjacent land use. For example, a loud technology would not be compatible with the property and surrounding land use if the neighboring property is a residential.

The extent to which the abatement action creates **Persistent, Harmful or Nuisance Breakdown Products:** The creation of persistent, harmful or nusiance products due to degradation of the contaminant or changes in water quality due to the remedy. For example, the injection of highly concentrated hydrogen peroxide through chemical oxidation treatment, may destroy 100% of the VOC's, however the process degrades aesthetic (e.g., taste, odor) water quality by elevating the concentration of metals or other compounds.

The extent to which **Permits** slow the process: Are there any complications in obtaining

appropriate permits (or complying with the permit issues) that may delay the installation of the remedial activity?

Extent of **Cross Contamination:** A technology which transfers harmful contamination from one media to another. For example, treating contaminated ground water by pumping and air-stripping may transfer the volatile contaminants from ground water to air.

The extent to which the abatement action **Requires Supplemental Technologies:** A technology which must rely on other technologies to be successful, thus creating a complex treatment train.

Table 2: Benefits to the People of the State of Ohio Derived from an Abatement Action

Abatement Time: Timeliness to achieve desired abatement goal.

Prevent Impact to Human or Other Receptors: Prevent impact to human or other receptors refers to both during the implementation of the remedy and after completion.

Ability to Restore Lost Uses: The extent to which a technology can restore former uses that were lost as a result of the discharge.

Extent of **Protection of Pubic Health and Safety and the Environment:** The extent to which the a technology is protective of Public Health and Safety and the Environment after the abatement is complete.

Public Acceptance: The extent to which the public benefits and accepts any proposed abatement action.

Secondary Water Quaility Considerations: Maintenance of aesthetic water quality standards (i.e., taste, odor, color, laundry effects, etc.).

Community Aesthetics: Affects on community living and/or working in the surrounding area (e.g., dust, noice, disruption of traffic).

Table 3: Economic Reasonableness

Cost to Abate the Effect of a Discharge to Groundwater Achieving the Following Abatement Goals:

> **Pre-release Conditions in Ground Water:** To the extent such conditions can be readily determined

US EPA MCL in Ground Water:

Cumulative Risk in Ground Water: Total system costs to abate to a appropriate risk goal.

Alternative Standard(s): Total system costs to abate to a suitable alternative target groundwater abatement level, provided it meets all of the statutory criteria. This could be generated by site specific modeling.

VAP Leach Based Soil Values: The costs to abate soils to values identified in Ohio EPA Derived Leach-Based Soil Values (1996). These values are protective of MCLs in ground water.

Soils Field Screening Levels: Total system costs to abate soils to PID detection or alternative levels.

Alternative Leach-Based Soils Values: Costs to abate to a suitable alternative target soil abatement goal, provided it meets all of the statutory criteria. This could be generated by site specific modeling or ultilizing Ohio's leach-based values with a site specific dilution factor.

Appendix B: ORC 6111 CORRECTIVE ACTION ABATEMENT MATRIX

Table 1: Technical Feasibility

Technical Feasibility		TECHNOLOGIES																																	
		CONTAINMENT TECHNOLOGIES										TREATMENT TECHNOLOGIES										EXTRACTION TECHNOLOGIES													
		Availability of Alternative Water Resources	Infiltration Prevention	Gradient Control	Slurry Wall	Sheet Piling	Vitrification	UV Oxidation	Bio Reactor	Phyto-remediation		Thermal Desorption	Incineration	Carbon Adsorption	In or Ex Situ Chemical Oxidation	Reactive Barriers	Bioremediation	Natural Attenuation	Bioventing	Recycling			Excavation	Land filling	Air Stripping	Air Sparging	SVE	Bioslurping	Surfactant Enhanced Soil Flushing	Heat Enhanced Flushing	UVB; Re-circulation Wells				
Positive factors	Achieves Measurable Action Level																																		
	Ability to Enhance or Modify																																		
	Proven Technology for Conditions																																		
	Ease of Installation, Operation and Maintenance																																		
	Ability to Monitor																																		
	Energy Efficient Demands/ Inputs																																		
	Compatibility with Land Use																																		
Negative factors	Persistent, Harmful or Nuisance Breakdown Products																																		
	Permits																																		
	Generates Waste Products																																		
	Cross Contamination																																		
	Potential to cause Ecological Damage																																		

Technical Feasibility	TECHNOLOGIES																													
	CONTAINMENT TECHNOLOGIES										TREATMENT TECHNOLOGIES										EXTRACTION TECHNOLOGIES									
	Availability of Alternative Water Resources	Infiltration Prevention	Gradient Control	Slurry Wall	Sheet Piling	Vitrification	UV Oxidation	Bio Reactor	Phyto-remediation		Thermal Desorption	Incineration	Carbon Adsorption	In or Ex Situ Chemical Oxidation	Reactive Barriers	Bioremediation	Natural Attenuation	Bioventing	Recycling			Excavation	Land filling	Air Stripping	Air Sparging	SVE	Bioslurping	Surfactant Enhanced Soil Flushing	Heat Enhanced Flushing	UVB; Re-circulation Wells		
Requires Supplemental Technologies																														

ORC 6111 CORRECTIVE ACTION ABATEMENT MATRIX

Table 2: Benefits to the People of the State of Ohio Derived from an Abatement Action

Benefits	TECHNOLOGIES																													
	CONTAINMENT TECHNOLOGIES										TREATMENT TECHNOLOGIES										EXTRACTION TECHNOLOGIES									
	Availability of Alternative Water Resources	Infiltration Prevention	Gradient Control	Slurry Wall	Sheet Piling	Vitrification	UV Oxidation	Bio Reactor	Phyto-remediation		Thermal Desorption	Incineration	Carbon Adsorption	In or Ex Situ Chemical Oxidation	Reactive Barriers	Bioremediation	Natural Attenuation	Bioventing	Recycling			Excavation	Land filling	Air Stripping	Air Sparging	SVE	Bioslurping	Surfactant Enhanced Soil Flushing	Heat Enhanced Flushing	UVB; Re-circulation Wells		

Abatement Time																																	
Ability to Abate to Pre-release Conditions within 30 years																																	
Prevent Further Contamination Spread																																	
Prevent Impact to Human or other Receptors																																	
Ability to Restore Lost Uses																																	
Protection of Public Health and Safety and Environment																																	
Restoration and Maintenance of Property Values																																	
Restoration of Unrestrictive Use																																	
Strong Public Acceptance																																	
Secondary Water Quality Considerations																																	
Community Aesthetics																																	

ORC 6111 CORRECTIVE ACTION ABATEMENT MATRIX

Table 3: Economic Reasonableness

Cost to Abate the Effect of a Discharge to Groundwater Achieving the Following Abatement Goals:	TECHNOLOGIES																																	
	CONTAINMENT TECHNOLOGIES										TREATMENT TECHNOLOGIES										EXTRACTION TECHNOLOGIES													
	Availability of Alternative Water Resources	Infiltration Prevention	Gradient Control	Slurry Wall	Sheet Piling	Vitrification	UV Oxidation	Bio Reactor	Phyto-remediation		Thermal Desorption	Incineration	Carbon Adsorption	In or Ex Situ Chemical Oxidation	Reactive Barriers	Bioremediation	Natural Attenuation	Bioventing	Recycling			Excavation	Land filling	Air Stripping	Air Sparging	SVE	Bioslurping	Surfactant Enhanced Soil Flushing	Heat Enhanced Flushing	UVB: Re-circulation Wells			
Pre-release Conditions in Groundwater																																		
US EPA MCLs in Groundwater																																		
Cumulative Risk in Groundwater																																		
Alternative Groundwater Standards																																		
VAP Leach Based Soil Values																																		
Soils Field Screening Levels																																		
Alternative Leach Based Soils Values																																		

Appendix C - Order Sections*

I. JURISDICTION
II. PARTIES BOUND
III. DEFINITIONS
IV. FINDINGS OF FACT, DETERMINATIONS, AND CONCLUSIONS OF LAW
V. GENERAL PROVISIONS
8. Objectives of the Parties
9. Commitment of Respondents
10. Compliance With Law
VI. PERFORMANCE OF THE WORK BY RESPONDENTS
11. Supervising Contractor
12. three elements - the target contamination **level** the action is designed to achieve, the **time frame** in which the action is to achieve that level, and the **point(s) of compliance**.
VII. ADDITIONAL WORK
VIII. SAMPLING AND DATA AVAILABILITY
IX. ACCESS
X. DESIGNATED SITE COORDINATORS
XI. PROGRESS REPORTS AND NOTICE
XII. REVIEW OF SUBMITTALS
XIII. DISPUTE RESOLUTION
XIV. UNAVOIDABLE DELAYS
XV. RESERVATION OF RIGHTS
XVII. ACCESS TO INFORMATION
XVIII. INDEMNITY
XIX. OTHER CLAIMS
XX. LAND USE AND CONVEYANCE OF TITLE
XXI. EFFECTIVE DATE AND SUBSEQUENT MODIFICATION
XXII. TERMINATION
WAIVER AND AGREEMENT

* Additions or deletions may be appropriate depending on the circumstances of the case.

APPENDIX D: ABATEMENT PROCESS EXAMPLE

I. SITE DATA

Site Name: Edzoil Company

Important Features:

- Fuel storage and transfer depot.
- 10,000 gallon gasoline (BTEX) spill from AST.
- Site overlies sand/gravel buried valley aquifer, no confining layer, water table at 13 feet bgs.
- Based on Regional data, aquifer is capable of yielding more than 300 gpm.
- Based on Regional analytical water quality data, it is reasonable to use this aquifer as a potential future drinking water source.
- No visible surface staining, spill soaked into ground.
- 2000 feet to nearest residential well, nondetect of contaminants in that well.
- Down gradient monitoring wells: 34 feet away, 6 inches of free product; 70 feet away, 750 ppb of Benzene.
- So far only 200 gallons of product have been recovered from product recovery well.
- Site is located in commercial area, little prospect of future residential uses.
- Little public interest in the site.

Data Needs:

- Soil Microbial parameters.
- Soil contamination data, core samples.
- Groundwater chemical parameters; dissolved oxygen, pH, nutrient parameters.
- Define free phase and dissolved phase areas.

Data Results:

- BTEX degrading microbes present on fringes of dissolved phase plume, but not present in free phase area.
- 400 cubic yards of free phase contaminated soil.
- Oxygen is limiting factor for the microbial colonies on the plume fringes, absent in free phase area.
- Plume data obtained with SIFU & geoprobe.

II. CONSIDERATIONS FOR COMPLETING THE MATRIX TABLES

Prior to completing the matrix tables, it is important to have some understanding of the nature and extent of the contamination. It is likely that this information will be gathered from the ER Spill Report and/or as a result of the Agency's investigation. The Site Coordinator should consider the contaminant type and general site characteristics in order to select preliminary technologies to be considered before completing the matrix tables.

In our example, the Edzoil Company released 10,000 gallons of gasoline primarily composed of benzene, toluene, ethylbenzene, xylenes (BTEX) and methyl tertiary butyl ether (MTBE). Armed with a basic understanding of petroleum characteristics, we reviewed the following technologies after consulting US EPA and BUSTR guidance. Furthermore, we relied on the transport characteristics of MTBE to imply the general direction and extent of the BTEX migration in the groundwater.

Based upon our available data and research, we selected Pump and Treat, Enhanced Bio-Remediation, In Situ Chemical Oxidation, Excavation and Soil Vapor Extraction technologies to evaluate. Our information suggested that all of these technologies could achieve one or more of the Table 3 abatement goals. The technologies must be completely evaluated in each of the Tables in order to demonstrate that one or more technologies meet the statutory requirements of ORC 6111.

Because of the amount of available data, we selected the following simple scoring scheme to complete the example Matrix Tables:

+	Indicative of a characteristic which will support the data element.
–	Indicative of a characteristic which will not support the data element.
o	Indicative of a neutral characteristic.
unk	Indicative of an unknown characteristic, too many unknowns should suggest additional investigation is needed.

It is critical that Site Coordinators carefully consider each data element for the specific technology in terms of the site's conditions. A potential pitfall, would occur if the Site Coordinator completed the Matrix Tables using generic information from similarly contaminated sites. A successful evaluation should include specific considerations (e.g. physical, socio-economic, chemical, aesthetic, etc.) to the site. While it is possible that two sites may share contaminate nature and extent similarities, it is possible that these tables will yield different results depending upon a full evaluation.

III. EXAMPLE CONCLUSION

Summary of Example Matrix Results

Following careful review and consideration of the completed Example Matrix Tables, the Ohio EPA will issue an Order requiring the Respondent (Edzoil Company) to implement an abatement action defined by the 3 performance standards, capable of abating the benzene discharge to groundwater. After completing the Edzoil Company matrix tables, Ohio EPA can conclude that enhanced bioremediation combined with excavation are technologies capable of achieving performance standards of

- a benzene contaminant level of **US EPA's MCL** in groundwater
- within a **ten year time frame**
- measured **in all Edzoil Companies monitoring wells**,

and to do so is *technically feasible, economically reasonable and of benefit to the people of Ohio*

By completing the Edzoil Company matrix tables, Ohio EPA has determined that the enhanced bioremediation can achieve the benzene contaminant level of **US EPA's MCL** in groundwater within a **ten year time frame** measured **in all Edzoil Companies monitoring wells**, if combined with a removal of contaminant source soils to a benzene contaminant level consistent with Ohio EPA's VAP Leach Based Soils Values. That it can be done, that it is not cost prohibitive, and that there is some benefit to the people of Ohio is established by the (+) scores in the tables. Despite the fact a "scoring system" is employed, this is NOT a quantifiable process. Simply "counting" the (+) frequency is inappropriate - no relative weighting was given to the categories. Rather, the matrix allows one to organize and layout information such that qualitative conclusions can be readily drawn and the justification written.

After completing the Edzoil Company matrix tables, Ohio EPA has concluded that enhanced bioremediation combined with excavation are technologies capable to achieve the above referenced performance standards. However, Edzoil Company may, subject to Ohio EPA approval, elect to implement an alternative technology(s) capable of achieving those performance standards; the matrix evaluation merely shows that it is *technically feasible, economically reasonable and of benefit to the people of Ohio* to order those standards be met.

IV. Justification: Why Negative (-) Values were assigned; listed by Technology

Gradient Control

Table 1.

- Ease of Installation, Operation and Maintenance: Challenging to install and configure, requires detailed knowledge of geology.
- Energy Efficient Demands/Inputs: Constant power supply creates a high demand system.
- Permits: Requires renewal and permit monitoring for discharge to POTW.

- Generates Waste Products: Must dispose and/or treat large quantities of BTEX contaminated water.
- Cross Contamination: Media transfer to air and contamination of clean water with contaminated water.
- Requires Supplemental Technologies: Requires treatment train.

Table 2.

- Ability to Abate to Pre-release Conditions within 30 years: Residual contaminants will cause excess of pre-release conditions.
- Restoration and Maintenance of Property Values: Gradient Control System will devalue property values.
- Restoration of Unrestrictive Use: Residual contaminants will preclude unrestrictive use.

Table 3.

- Cumulative Risk in Groundwater: Estimates has suggested that achieving 10^{-5} risk goals for benzene could cost as much as $300,000 to achieve goal. Additionally, achieving more stringent goals will further increase the cost.

In Situ Chemical Oxidation

Table 1.

- Proven Technology for Conditions: Technology is still considered innovative for this scenario.
- Ease of Installation, Operation and Maintenance: Challenging to install and configure, requires detailed knowledge of geology.
- Persistent Harmful or Nuisance Breakdown Products: Technology increases metals precipitation from soil matrix.
- Cross Contamination: Off gas to air media.
- Potential to Cause Ecological Damage: Oxidation of microbes and burrowing critters in soils.

Table 2.

- Secondary Water Quality Concerns: Increased metals cause taste and smell concerns with water. Can also gray laundry.
- Community Aesthetics: Acid smell.

Table 3.

- Cumulative Risk in Groundwater: Estimates have suggested that achieving 10^{-5} risk goals for benzene could cost as much as $250,000 to achieve goal. Additionally, achieving more stringent goals will further increase the cost.

Enhanced Bioremediation

Table 2.

- Abatement Time: Time to achieve goal may take up to 10 years.

Table 3.

- US EPA MCLs in Groundwater: Estimates suggest that Enhanced Bio could cost from $15,000 to $30,000 to achieve goals.

Excavation

Table 1.

- Ease of Installation, Operation and Maintenance: Labor, time and space intensive to excavate and manage materials.
- Energy Efficient Demands/Inputs: Short term high demand system.
- Generates Waste Products: Must dispose and/or treat large quantities of BTEX contaminated soils.
- Cross Contamination: Media transfer to air from off gas of vapors.
- Requires Supplemental Technologies: Excavation alone will not address dissolved phase BTEX.

Table 2.

- Abatement Time: Slow to see direct effects from excavation activities.
- Prevent Further Contamination Spread: Disturbance of source soils could increase infiltration rate and accelerate contaminant migration.

Table 3.

- VAP Leach Based Soil Values: Excavation of estimated material could cost up to $14,000.

SVE

Table 1.

- Energy Efficient Demands/Inputs: Constant power supply creates a high demand system.
- Generates Waste Products: Generates contaminated vapor water and requires air discharge.
- Cross Contamination: Media transfer to air from off gas of vapors.
- Requires Supplemental Technologies: Requires carbon treatment train and may require special handling.

Table 3.

- Cumulative Risk in Groundwater: Estimates for a system to address BTEX may range from $60,000 to $180,000. Upgrading may be necessary based on preliminary capture and effectiveness results.

Table 1: Technical Feasibility

Technical Feasibility		TECHNOLOGIES																													
		CONTAINMENT TECHNOLOGIES										TREATMENT TECHNOLOGIES										EXTRACTION TECHNOLOGIES											
		Availability of Alternative Water Resources	Infiltration Prevention	Gradient Control	Slurry Wall	Sheet Piling	Vitrification	UV Oxidation	Bio Reactor	Phyto-remediation		Thermal Desorption	Incineration	Carbon Adsorption	In or Ex Situ Chemical Oxidation	Reactive Barriers	Bioremediation	Natural Attenuation	Bioventing	Recycling			Excavation	Land filling	Air Stripping	Air Sparging	SVE	Bioslurping	Surfactant Enhanced Soil Flushing	Heat Enhanced Flushing	UVB: Re-circulation Wells		
Positive factors	Achieves Measurable Action Level			+											+		+						+				+					
	Ability to Enhance or Modify			+											+		+						+				+					
	Proven Technology for Conditions			+											I		+						+				+					

Technical Feasibility	TECHNOLOGIES																												
	CONTAINMENT TECHNOLOGIES										TREATMENT TECHNOLOGIES										EXTRACTION TECHNOLOGIES									
	Availability of Alternative Water Resources	Infiltration Prevention	Gradient Control	Slurry Wall	Sheet Piling	Vitrification	UV Oxidation	Bio Reactor	Phyto-remediation		Thermal Desorption	Incineration	Carbon Adsorption	In or Ex Situ Chemical Oxidation	Reactive Barriers	Bioremediation	Natural Attenuation	Bioventing	Recycling		Excavation	Land filling	Air Stripping	Air Sparging	SVE	Bioslurping	Surfactant Enhanced Soil Flushing	Heat Enhanced Flushing	UVB: Re-circulation Wells	
Ease of Installation, Operation and Maintenance			-											-		+					-				+				
Ability to Monitor			+											+		+					+				+				
Energy Efficient Demands/ Inputs			-											o		+					-				-				
Compatibility with Land Use			o											o		o					o				o				

Technical Feasibility		TECHNOLOGIES																												
		CONTAINMENT TECHNOLOGIES										TREATMENT TECHNOLOGIES										EXTRACTION TECHNOLOGIES									
		Availability of Alternative Water Resources	Infiltration Prevention	Gradient Control	Slurry Wall	Sheet Piling	Vitrification	UV Oxidation	Bio Reactor	Phyto-remediation		Thermal Desorption	Incineration	Carbon Adsorption	In or Ex Situ Chemical Oxidation	Reactive Barriers	Bioremediation	Natural Attenuation	Bioventing	Recycling			Excavation	Land filling	Air Stripping	Air Sparging	SVE	Bioslurping	Surfactant Enhanced Soil Flushing	Heat Enhanced Flushing	UVB: Re-circulation Wells		
Negative factors	Persistent, Harmful or Nuisance Breakdown Products			+											-		+					+				+					
	Permits			-											o		o					o				o					
	Generates Waste Products			-											+		+					-				-					
	Cross Contamination			-											-		+					-				-					
	Potential to cause Ecological Damage			+											-		+					+				+					

Technical Feasibility	TECHNOLOGIES																													
	CONTAINMENT TECHNOLOGIES										TREATMENT TECHNOLOGIES										EXTRACTION TECHNOLOGIES										
	Availability of Alternative Water Resources	Infiltration Prevention	Gradient Control	Slurry Wall	Sheet Piling	Vitrification	UV Oxidation	Bio Reactor	Phyto-remediation		Thermal Desorption	Incineration	Carbon Adsorption	In or Ex Situ Chemical Oxidation	Reactive Barriers	Bioremediation	Natural Attenuation	Bioventing	Recycling			Excavation	Land filling	Air Stripping	Air Sparging	SVE	Bioslurping	Surfactant Enhanced Soil Flushing	Heat Enhanced Flushing	UVB: Re-circulation Wells		
Requires Supplemental Technologies			-											+		+						-				-					

Table 2: Benefits to the People of the State of Ohio Derived from an Abatement Action

Benefits	TECHNOLOGIES																																
	CONTAINMENT TECHNOLOGIES										TREATMENT TECHNOLOGIES										EXTRACTION TECHNOLOGIES												
	Availability of Alternative Water Resources	Infiltration Prevention	Gradient Control	Slurry Wall	Sheet Piling	Vitrification	UV Oxidation	Bio Reactor	Phyto-remediation		Thermal Desorption	Incineration	Carbon Adsorption	In or Ex Situ Chemical Oxidation	Reactive Barriers	Bioremediation	Natural Attenuation	Bioventing	Recycling			Excavation	Land filling	Air Stripping	Air Sparging	SVE	Bioslurping	Surfactant Enhanced Soil Flushing	Heat Enhanced Flushing	UVB: Re-circulation Wells			
Abatement Time			+											+		-						-				o						
Ability to Abate to Pre-release Conditions within 30 years			-											+		+						o				+						
Prevent Further Contamination Spread			+											+		o						-				+						

Benefits	TECHNOLOGIES																																
	CONTAINMENT TECHNOLOGIES										TREATMENT TECHNOLOGIES										EXTRACTION TECHNOLOGIES												
	Availability of Alternative Water Resources	Infiltration Prevention	Gradient Control	Slurry Wall	Sheet Piling	Vitrification	UV Oxidation	Bio Reactor	Phyto-remediation		Thermal Desorption	Incineration	Carbon Adsorption	In or Ex Situ Chemical Oxidation	Reactive Barriers	Bioremediation	Natural Attenuation	Bioventing	Recycling			Excavation	Land filling	Air Stripping	Air Sparging	SVE	Bioslurping	Surfactant Enhanced Soil Flushing	Heat Enhanced Flushing	UVB: Re-circulation Wells			
Prevent Impact to Human or other Receptors			+											+		+						o				+						
Ability to Restore Lost Uses																																
Protection of Public Health and Safety and Environment			+											+		+						+				+						

Benefits	TECHNOLOGIES																															
	CONTAINMENT TECHNOLOGIES										TREATMENT TECHNOLOGIES										EXTRACTION TECHNOLOGIES											
	Availability of Alternative Water Resources	Infiltration Prevention	Gradient Control	Slurry Wall	Sheet Piling	Vitrification	UV Oxidation	Bio Reactor	Phyto-remediation		Thermal Desorption	Incineration	Carbon Adsorption	In or Ex Situ Chemical Oxidation	Reactive Barriers	Bioremediation	Natural Attenuation	Bioventing	Recycling			Excavation	Land filling	Air Stripping	Air Sparging	SVE	Bioslurping	Surfactant Enhanced Soil Flushing	Heat Enhanced Flushing	UVB: Re-circulation Wells		
Restoration and Maintenance of Property Values			-											+		+						o				+						
Restoration of Unrestrictive Use			-											+		+						o				+						
Strong Public Acceptance																																
Secondary Water Quality Considerations			o											-		o						o				o						

Benefits	TECHNOLOGIES																																
	CONTAINMENT TECHNOLOGIES										TREATMENT TECHNOLOGIES										EXTRACTION TECHNOLOGIES												
	Availability of Alternative Water Resources	Infiltration Prevention	Gradient Control	Slurry Wall	Sheet Piling	Vitrification	UV Oxidation	Bio Reactor	Phyto-remediation		Thermal Desorption	Incineration	Carbon Adsorption	In or Ex Situ Chemical Oxidation	Reactive Barriers	Bioremediation	Natural Attenuation	Bioventing	Recycling			Excavation	Land filling	Air Stripping	Air Sparging	SVE	Bioslurping	Surfactant Enhanced Soil Flushing	Heat Enhanced Flushing	UVB: Re-circulation Wells			
Community Aesthetics			o											-		o						o				o							

Table 3: Economic Reasonableness

Cost to Abate the Effect of a Discharge to Groundwater Achieving the Following Abatement Goals:	TECHNOLOGIES																												
	CONTAINMENT TECHNOLOGIES										TREATMENT TECHNOLOGIES										EXTRACTION TECHNOLOGIES									
	Availability of Alternative Water Resources	Infiltration Prevention	Gradient Control	Slurry Wall	Sheet Piling	Vitrification	UV Oxidation	Bio Reactor	Phyto-remediation		Thermal Desorption	Incineration	Carbon Adsorption	In or Ex Situ Chemical Oxidation	Reactive Barriers	Bioremediation	Natural Attenuation	Bioventing	Recycling			Excavation	Land filling	Air Stripping	Air Sparging	SVE	Bioslurping	Surfactant Enhanced Soil Flushing	Heat Enhanced Flushing	UVB: Re-circulation Wells		
Pre-release Conditions in Groundwater			-											-		o									-						
US EPA MCLs in Groundwater			-											-		+									-						
Cumulative Risk in Groundwater			-											-		+									-						

Cost to Abate the Effect of a Discharge to Groundwater Achieving the Following Abatement Goals:	TECHNOLOGIES																													
	CONTAINMENT TECHNOLOGIES										TREATMENT TECHNOLOGIES										EXTRACTION TECHNOLOGIES											
	Availability of Alternative Water Resources	Infiltration Prevention	Gradient Control	Slurry Wall	Sheet Piling	Vitrification	UV Oxidation	Bio Reactor	Phyto-remediation		Thermal Desorption	Incineration	Carbon Adsorption	In or Ex Situ Chemical Oxidation	Reactive Barriers	Bioremediation	Natural Attenuation	Bioventing	Recycling			Excavation	Land filling	Air Stripping	Air Sparging	SVE	Bioslurping	Surfactant Enhanced Soil Flushing	Heat Enhanced Flushing	UVB: Re-circulation Wells		
Alternative Groundwater Standards																														
VAP Leach Based Soil Values																					+									
Soils Field Screening Levels																														

Cost to Abate the Effect of a Discharge to Groundwater Achieving the Following Abatement Goals:	TECHNOLOGIES																													
	CONTAINMENT TECHNOLOGIES										TREATMENT TECHNOLOGIES										EXTRACTION TECHNOLOGIES										
	Availability of Alternative Water Resources	Infiltration Prevention	Gradient Control	Slurry Wall	Sheet Piling	Vitrification	UV Oxidation	Bio Reactor	Phyto-remediation		Thermal Desorption	Incineration	Carbon Adsorption	In or Ex Situ Chemical Oxidation	Reactive Barriers	Bioremediation	Natural Attenuation	Bioventing	Recycling			Excavation	Land filling	Air Stripping	Air Sparging	SVE	Bioslurping	Surfactant Enhanced Soil Flushing	Heat Enhanced Flushing	UVB: Re-circulation Wells		
Alternative Leach Based Soils Values																														