Table 4-1
Screening of Remedial Technologies, Focused Feasibility Study,
Colesville Landfill,
Colesville, New York.

General Response Action	Remedial Technology Type	Process Options	Technology Description	Effectiveness	Implementability	Relative Cost	Favorable, Moderately Favorable, Unfavorable
Continue Operation of Existing Remedy	Groundwater Extraction	Extraction Wells	Groundwater pumped from vertical extraction wells and conveyed to ex-situ treatment system.	Site geology does not allow for efficient extraction of groundwater. The amount of mass removed through groundwater extraction is negligible.	Already implemented; However; would require a significant well infrastructure upgrade to provide any meaningful reduction in the overall site remedial timeframe.	Very High	Unfavorable
	In-Situ Groundwater Treatment	Enhanced Biodegradation	Organic substrate injected into groundwater to stimulate existing microbial communities that degrade VOCs through reductive dechlorination.	Conventional technology to treat VOCs in groundwater; Already proven effective at the site.	Already implemented; However; would require a significant well infrastructure upgrade to provide any meaningful reduction in the overall site remedial timeframe.	Moderate to High	Moderately Favorable
	Spring Water Treatment	Adsorption	Liquid phase granular activated carbon (LPGAC) used to remove VOCs from spring water at existing spring SP-5.	Conventional technology to treat VOCs in spring water. Proven effective at existing spring SP-5.	Already implemented.	Low	Favorable
	Groundwater Monitoring	Groundwater monitoring can be used alone or in conjunction with other remedial technologies and/or engineering controls.	Existing monitoring wells (see Figure 2) are used to collect groundwater samples to document levels of impact to the groundwater at the Site and to track COC migration.	Does not achieve ARARs, but can be used in conjunction with other remedial technologies and/or engineering controls to ensure protection of human health and the environment.	Already implemented.	Low	Favorable
	Surface Water and Spring Water Sampling	Surface water and spring water sampling can be used alone or in conjunction with other technologies.	Surface water and spring water samples are collected at predetermined locations along the North Stream (see Figure 2) to provide information that indicates the levels of impact associated with COCs in the North Stream.	Does not achieve ARARs, but can be used in conjunction with other remedial technologies and/or engineering controls to ensure protection of human health and the environment.	Already implemented.	Low	Favorable
	Engineering Inspections	Engineering inspections can be used alone or in conjunction with other technologies.	Visual inspections of site conditions are completed to ensure existing remedy components necessary for the protection of human health and the environment remain in place and effective. Inspections also evaluate for new and changing site conditions that could adversely affect operation of existing remedy components.	Does not achieve ARARs, but can be used in conjunction with other remedial technologies and/or engineering controls to ensure protection of human health and the environment.	Already implemented.	Low	Favorable
	Deed Restrictions on Groundwater and Surface Water Use	Deed restrictions can be used alone or in conjunction with other technologies.	Deed restrictions or local zoning restrictions are imposed.	Restrictions have been proven effective in minimizing contact with impacted media.	Implementable; Some restrictions have already been implemented. Restrictions may become administratively burdensome to implement.	Low to Moderate	Favorable

See notes on last page.

Table 4-1
Screening of Remedial Technologies, Focused Feasibility Study,
Colesville Landfill,
Colesville, New York.

General Response Action	Remedial Technology Type	Process Options	Technology Description	Effectiveness	Implementability	Relative Cost	Favorable, Moderately Favorable, Unfavorable
Institutional Controls and Monitoring	Revised Groundwater Monitoring Program	Groundwater monitoring can be used alone or in conjunction with other remedial technologies and/or engineering controls.	Existing monitoring wells (see Figure 2) used to collect groundwater samples to document levels of impact to the groundwater at the Site and to track COC migration.	Does not achieve ARARs, but can be used in conjunction with other remedial technologies and/or engineering controls to ensure protection of human health and the environment.	Implementable	Low	Favorable
In-Situ Treatment	In-Situ Groundwater Treatment	In-Situ Chemical Oxidation (ISCO)	Chemical oxidant injected into groundwater to break down VOCs into non-toxic compounds. Requires direct contact of oxidants with target compounds.	Conventional technology to treat VOCs in groundwater; however, will have limited effectiveness at the site due to site hydrology. Specifically, existing storage zones within the aquifer (i.e., clays, silts, immobile porosity zones) will prevent the direct contact of oxidant with target compounds.	Implementable; Difficult to implement. Requires numerous injection and monitoring wells. Requires a significant volume of oxidant which will result in storage, handling, and transfer of hazardous materials.	Very High	Unfavorable
		Zero-Valent Iron Permeable Reactive Barrier	Zero-valent iron media is installed through trenching or other means as a vertical barrier oriented perpendicular to the direction of groundwater flow. The zero-valent iron degrades chlorinated VOCs through abiotic reductive dehalogenation to harmless end products.	Conventional technology to treat VOCs in groundwater. **However, will not treat concentrations of chloroethane that are present in groundwater.**	**Implementable; however, would be difficult to implement due to the depth and footprint requirements for construction.**	Very High	Unfavorable - provides no additional benefit over the existing reductive dechlorination technology implemented at the site (ERD) and is significantly more cost prohibitive.
		Injectable GAC	**Injectable GAC can either be emplaced via pressurized injection using direct push tooling or injected as a fine-grained slurry through permanent monitoring wells. Injection locations installed perpendicular to groundwater and plume flow to sorb contaminants passing through in situ media. Supplemental organic carbon dosing is required to enhance dechlorination of sorbed VOCs and sustain long-term GAC sorption capacity.**	**GAC-based treatment is a conventional technology for VOC sorption, but injection-based GAC delivery is an emerging application. Effective for short-term VOC sorption, but longevity must be sustained via periodic organic carbon delivery to dechlorinate VOCs and sustain sorption benefits. In addition, site-related VOCs that are excessively small organic molecules, such as vinyl chloride and chloroethane, cannot be effectively treated by**	**Implementable; however, would require use of existing injection wells to provide organic carbon for long-term sorption capacity, with placement of injection well or direct push injection point barrier on downgradient side of well network. Will require additional infrastructure or injection wells for GAC delivery.**	**High**	**Unfavorable - GAC injection near the existing ERD injection well network will provide a redundant mechanism for VOC retention in the delivery area, but will not expedite cleanup of VOC concentrations further downgradient any faster than had occurred with the ERD program. This technology provides an equivalent means of barrier-based VOC treatment comparable to the ERD program.**

Table 4-1
Screening of Remedial Technologies, Focused Feasibility Study,
Colesville Landfill,
Colesville, New York.

General Response Action	Remedial Technology Type	Process Options	Technology Description	Effectiveness	Implementability	Relative Cost	Favorable, Moderately Favorable, Unfavorable
		Air Sparging	Air is injected into groundwater enabling the transfer of dissolved phase VOCs into the vapor phase. Volatilized VOCs are captured by a vapor extraction system for treatment prior to discharge to the atmosphere.	Conventional technology to treat VOCs in groundwater; however, will have limited effectiveness at the site due to site hydrology. Specifically, existing storage zones within the aquifer (i.e., clays, silts, immobile porosity zones) will prevent the direct contact of air with target compounds.	Likely would generate uncontrolled VOC vapors in subsurface soils. Would require significant well infrastructure.	Very High	Unfavorable
		In-Well Air Stripping	Air lift pumping used to volatilize VOCs from groundwater to the vapor phase. Pumped/partially treated water is discharged to an upper screen interval where a portion is re-circulated to the lower screen, as required, to meet RAOs. Off-gas is collected and treated through a variety of treatment methods.	Effectiveness is diminished by the presence of clay layers or variations in permeability that reduce stripping efficiency, cause uncontrolled migration of contaminants, and prevent reinjection of groundwater.	Difficult to implement; requires numerous remedial wells and associated infrastructure.	Very High	Unfavorable
	In-Situ Groundwater Treatment Continued	Natural Attenuation	Naturally occurring processes (e.g., dilution, dispersion, sorption, biodegradation) attenuate low concentrations of contaminants.	Site-related groundwater contaminants treatable by natural attenuation processes. Natural/existing site geochemistry is reductive and conducive for natural attenuation of chlorinated VOCs.	Implementable; Readily implementable; no construction required, except for additional monitoring well installation, as necessary.	Low	Favorable

Notes:

ARAR	Applicable and relevant or appropriate requirements.
ARI	Automated reagent injection.
COC	Contaminant of concern.
NYSDEC	New York State Department of Environmental Conservation.
O&M	Operation and maintenance.
RAOs	Remedial action objectives.
VOC	Volatile organic compounds.

Table 5-1
Evaluation Criteria for Remedial Alternatives, Focused Feasibility Study,
Colesville Landfill,
Colesville, New York.

Evaluation Criteria	Criteria Definition
Overall Protection of Public Health and the Environment	Ability to protect public health and the environment, assessing how risks posed by existing and potential exposure pathways are eliminated or reduced, through removal, treatment, engineering controls, or institutional controls. Ability to achieve the RAOs is also evaluated.
Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)	Ability to meet requirements of environmental laws, regulations, standards and guidance. If one or more ARARs are not met upon implementation of a remedial alternative, evaluation of whether a waiver is required is provided.
Long Term Effectiveness and Permanence	If wastes or residuals will remain at the site after implementation, then the following are evaluated: (1) the magnitude and nature of the residual risks posed by the remaining wastes; (2) the adequacy of the controls intended to limit the risks; (3) the reliability of these controls; and (4) the ability of the remedy to continue to meet the RAOs in the future.
Reduction of Toxicity, Mobility, or Volume through Treatment	Ability of an alternative to permanently and significantly reduce toxicity, mobility or volume of the wastes.
Short Term Effectiveness	Potential short-term impacts of a remedial action upon the community, the site workers, and the environment. The period of time required to achieve RAOs is estimated.
Implementability	The technical and administrative feasibility of implementing a remedial alternative. For technical feasibility, the difficulties associated with the construction and operation of the alternative and the ability to monitor the effectiveness of the remedy are evaluated. For administrative feasibility, the availability of the necessary personnel and material is evaluated, along with the difficulties in obtaining permits, rights-of-way, and site access.
Cost	Capital costs and O&M costs are estimated on a present worth basis. Although cost is the last criterion evaluated, where two or more alternatives have satisfied the other evaluation criteria, cost effectiveness should be used as the basis for final remedy selection.

Definitions

O&M Operation and maintenance.
RAOs Remedial Action Objectives.

Table 5-2
Detailed Evaluation of Remedial Alternatives, Focused Feasibility Study,
Colesville Landfill,
Colesville, New York.

ARCADIS Design & Consultancy for natural and built assets

Alternatives	ALTERNATIVE 1 No Action	ALTERNATIVE 2 Monitored Natural Attenuation and Engineering and Institutional Controls until MCLs are Achieved (Approximately Fifty Nine (59) Years)	ALTERNATIVE 3 Operation of the Existing ARI System until Groundwater MCLs are Achieved (Approximately Thirty Seven (37) Years) and Engineering and Institutional Controls	ALTERNATIVE 4 No Further Action/Continued Operation of the Existing Remedies until MCLs are Achieved (Approximately Thirty Seven (37) Years)
Alternative Description	- Discontinue operation of the existing landfill cap, groundwater extraction, ARI, and SP-5 remediation systems and SP-4 spring remedy. - Discontinue implementation of existing institutional controls (Section 2.3.8) and engineering controls (Section 2.3.9) and groundwater monitoring.	- Discontinue operation of the existing groundwater extraction and ARI remediation systems. - Continue operation of the existing SP-5 remediation system for 21-years (time for clean water front to reach SP-5; Appendix A-6). - Continue implementation of current SP-4 spring water remediation system. - Continue implementation of existing institutional controls (Section 2.3.8). - Continue implementation of existing engineering controls (Section 2.3.9). - Implement additional institutional and engineering controls (Section 4). - Implement MNA through a revised groundwater monitoring program until MCLs are achieved (approximately 59-years).	- Discontinue operation of the existing groundwater extraction system and operate the existing ARI system until MCLs are achieved (approximately 37-years). - Continue operation of the existing SP-5 remediation system for 21-years (time for clean water front to reach SP-5; Appendix A-6). - Continue implementation of current SP-4 spring water remediation system. - Continue implementation of current institutional controls (Section 2.3.8). - Continue implementation of existing engineering controls (Section 2.3.9). - Implement additional institutional and engineering controls (Section 4). - Implement a revised groundwater monitoring program until MCLs are achieved (approximately 37-years).	- Continue operation of the existing groundwater extraction system and ARI system until MCLs are achieved (approximately 37-years). - Continue operation of the existing SP-5 remediation system for 21-years (time for clean water front to reach SP-5; Appendix A-6). - Continue implementation of current SP-4 spring water remediation system. - Continue implementation of current institutional controls (Section 2.3.8). - Continue implementation of existing engineering controls (Section 2.3.9). - Implement additional institutional and engineering controls (Section 4). - Implement a revised groundwater monitoring program until MCLs are achieved (approximately 37-years).
Overall Protectiveness of Public Health and the Environment	Not protective of human health and the environment. Institutional controls are required for protection of human health and the environment. Not Favorable.	Protective of human health and the environment through engineering and institutional controls and groundwater monitoring. Remedy will achieve MCLs within approximately 59-years.' Favorable.	Same as Alternative 2 except Remedy will achieve MCLs within approximately 37-years. Favorable.	Same as Alternative 2 except Remedy will achieve MCLs within approximately 37-years. Favorable.
Applicable or Relevant and Appropriate Requirements (ARARs)	Will not be in compliance with ARARs until MCLs are achieved (approximately 59-years). Not Favorable.	Will be in compliance with all ARARs with the exception of MCLs in groundwater. Will achieve MCLs in groundwater within approximately 59-years. Moderately Favorable	Same as Alternative 2; however, will achieve MCLs within approximately 37-years. Moderately Favorable	Same as Alternative 2; however, will achieve MCLs within approximately 37-years. Moderately Favorable
Long Term Effectiveness and Permanence	Not effective. Residual waste is uncontrolled and not managed or monitored through engineering and institutional controls or groundwater monitoring. Not Favorable.	Proven and reliable remedial technologies and associated controls. Effective. Existing engineering and institutional controls and groundwater monitoring combined with the SP-5 remediation system are already protective of human health and the environment. All ARARs are achieved with the exception of MCLs in groundwater. Favorable.	Same as Alternative 2. Favorable.	Same as Alternative 2. Favorable.

Table 5-2
Detailed Evaluation of Remedial Alternatives, Focused Feasibility Study,
Colesville Landfill,
Colesville, New York.

Alternatives	ALTERNATIVE 1 No Action	ALTERNATIVE 2 Monitored Natural Attenuation and Engineering and Institutional Controls until MCLs are Achieved (Approximately Fifty Nine (59) Years)	ALTERNATIVE 3 Operation of the Existing ARI System until Groundwater MCLs are Achieved (Approximately Thirty Seven (37) Years) and Engineering and Institutional Controls	ALTERNATIVE 4 No Further Action/Continued Operation of the Existing Remedies until MCLs are Achieved (Approximately Thirty Seven (37) Years)
Reduction of Toxicity, Mobility, or Volume of Contamination through Treatment	Residual contamination will ultimately be eliminated through intrinsic remediation (i.e., natural attenuation). Intrinsic remediation permanently and significantly reduces toxicity, mass, and volume through biodegradation and other abiotic processes which have been demonstrated at the site. Mobility is reduced through non-destructive processes such as sorption. Moderately Favorable	Same as Alternative 1. Moderately Favorable	Same as Alternative 1; however, timeframe to achieve equivalent reduction in mass is shorter. Favorable	Same as Alternative 3. Groundwater extraction provides insignificant added mass reduction. Favorable
Short Term Impacts and Effectiveness	Potential short-term impacts to human health and the environment due to discontinuation of engineering and institutional controls and inspections and monitoring. Unfavorable	No short term impacts. Favorable	No short term impacts. Favorable	No short term impacts. Favorable
Implementability	Technically and administratively implementable. Requires no activities. Favorable.	Technically and administratively implementable. Favorable.	Technically and administratively implementable. Favorable.	Technically and administratively implementable. Favorable.
Cost (1)	$0 Favorable.	Capital Costs: $312K O&M Costs (Years 1 through 2): $70K O&M Costs (Years 3 through 7): $52K O&M Costs (Years 8 through 59): $22K Total: $1.9M Favorable	Capital Costs: $312K O&M Costs (Years 1 through 37): $120K Total: $4.8M Unfavorable	Capital Costs: $312K O&M Costs (Years 1 through 37): $142K Total: $5.6M Unfavorable

Notes:

1. Refer to Appendix B for detailed cost calculations.

MCL Maximum contaminant level.
MNA Monitored natural attenuation.

Table 6-1
Summary of Recommended Remedy, Focused Feasibility Study,
Colesville Landfill,
Colesville, New York.

ARCADIS Design & Consultancy for natural and built assets

Media/Area	Recommended Alternative (Alternative 2) and Rationale	Cost [1]
Groundwater	- Discontinue operation of the existing groundwater extraction system and existing ARI system and transition to MNA. - Continue to implement existing institutional controls (Section 2.3.8) for fifty nine (59)-years. - Continue to implement existing engineering controls (Section 2.3.9) for fifty nine (59)-years. - Implement additional engineering and institutional controls (Section 4) for fifty nine (59)-years. - Conduct natural attenuation monitoring for residual VOCs via groundwater/surface water/spring water monitoring. Implement revised long-term monitoring plan. - Continue operation of the existing SP-5 remediation system for twenty one (21)-years (Appendix A Table A-6) and continue to maintain the existing SP-4 infiltration bed and landfill cap for fifty nine (59)-years. Alternative 2 is recommended because it is capable of achieving groundwater MCLs in a timeframe comparable to Alternatives 3 and 4, is effective in the short-term and long-term, and is cost effective. Alternative 1 is not recommended because it is not protective of public health and the environment. Alternatives 3 and 4 are not recommended because, although each alternative achieves groundwater MCLs in a timeframe less than Alternative 2, the costs associated with these alternatives are significantly higher than the costs associated with Alternative 2 but provide little additional benefit to the overall remedial timeframe and no additional benefit to the protection of human health and the environment.	Capital Costs: $312K O&M Costs (Years 1 through 2): $70K O&M Costs (Years 3 through 7): $52K O&M Costs (Years 8 through 59): $22K Total: $1.9M

Notes:

1. Detailed cost breakdowns are provided in Appendix B.

ARI Automated reagent injection.
MNA Monitored natural attenutation.
OMM Operation, maintenance and monitoring.
VOC Volatile organic compound.