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SECTION 5

DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

The detailed analysis of alternatives consists of the analysis and presentation of relevant information required to allow decision-makers to select a site remedy. In this detailed analysis, each alternative under consideration has been assessed against the evaluation criteria specified in Subsection 5.1.

The alternatives are first independently analyzed without consideration of the other alternatives. A comparative analysis is then presented to evaluate each alternative's relative performance in relation to the specific evaluation criteria. The results of this comparative analysis are presented in Section 6.

5.1 EVALUATION CRITERIA

In accordance with the NCP and U.S. EPA Superfund guidance documents, the following nine criteria are to be utilized for evaluation of each of the developed site alternatives that were selected for detailed analysis and represent the basis for comparing these alternatives:

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

The first two criteria (compliance with ARARs and overall protection of human health and the environment) are categorized as "threshold" criteria in that each alternative must meet them (or a variance obtained). The middle five criteria listed are categorized as the "primary balancing criteria" upon which the analysis is based. The final two criteria (state acceptance and community acceptance) are categorized as "modifying" criteria.

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This FS report specifically addresses the first seven evaluation criteria for each of the alternatives developed for detailed analysis. The remaining two criteria (state acceptance and community acceptance) will be addressed in the record of decision (ROD) after comments on this FS report are received. The seven criteria utilized for detailed analysis are discussed further below, while the detailed analysis of each alternative is presented in subsequent sections.

5.1.1 Compliance with Applicable or Relevant and Appropriate Requirements

This criterion is used to determine how each alternative complies with ARARs, as previously detailed in Section 2. The chemical, location, and action-specific requirements are discussed along with any other appropriate criteria, advisories, and guidance as they apply to each alternative.

5.1.2 Short-Term Effectiveness

This evaluation criterion involves consideration of the short-term effectiveness of the alternative during construction and implementation. The evaluation focuses on the protection of the community and the on-site personnel during implementation of remedial measures, potential human health and environmental impacts, and the time required to achieve remedial response objectives.

5.1.3 Long-Term Effectiveness and Permanence

This evaluation criterion involves consideration of the long-term effectiveness and permanence of the alternative once it has been implemented. The evaluation focuses on defining the extent and effectiveness (adequacy and reliability) of the controls that may be required to manage the residual risk remaining from untreated waste and/or treatment residues.

5.1.4 Overall Protection of Human Health and the Environment

This evaluation criterion involves consideration of the overall protection of human health and the environment. The overall assessment of protection draws on the assessments conducted for other evaluation criteria, particularly long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Evaluation of the overall protectiveness of an alternative focuses on achievement of remedial action objectives and how risks posed through potential exposure routes are eliminated, reduced, or controlled through treatment, engineering, or institutional controls. This evaluation also allows for consideration of whether an alternative poses any unacceptable short-term or cross-media impacts.

5.1.5 Reduction of Toxicity, Mobility, or Volume of Contaminants

Consideration of this evaluation criterion is a result of recent statutory preference for selecting remedial actions that permanently and significantly reduce the toxicity, mobility, and volume of the contaminants and associated media.

The following factors are considered in this evaluation:

- The treatment process and materials to be treated.
- The amount of hazardous materials to be treated.
- The degree of expected reduction in toxicity, mobility, or volume.
- The degree to which treatment will be irreversible.
- The type and quantity of treatment residuals that remain after treatment.

5.1.6 Implementability

This evaluation criterion establishes the technical and administrative feasibility of implementing an alternative. Technical aspects evaluated for each alternative include: ability to construct and operate the technologies involved; reliability of the technologies involved; ease of undertaking

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additional remedial action; and ability to monitor the effectiveness of the remedy after completion of activities. Other aspects may include technical uncertainties and predesign data requirements. Administrative concerns include establishing contact with appropriate agencies to implement remedial actions (e.g., obtaining approval for construction and operation of a treatment unit, and coordination with various agencies). Availability of materials and services needed is another factor considered, specifically in regard to availability of: treatment, storage, and disposal facilities; necessary equipment and specialists; and prospective technologies.

5.1.7 Cost

A remedial program must be implemented and operated in a cost-effective manner and must mitigate the environmental and human health concerns at the site. In considering the cost-effectiveness of the various alternatives, the following categories are evaluated:

- Capital Costs - These costs include direct (construction) and indirect (non-construction and overhead) costs. Direct costs include, but are not limited to, expenditures for equipment, labor, and materials necessary to install remedial actions, and auxiliary materials (e.g., chemicals), energy (e.g., fuel and electricity), and disposal of residues required during operation of short term actions (e.g., excavation and treatment). Indirect costs may be incurred for engineering, permitting, construction management, or other services not directly involved with installation of remedial alternatives, but necessary for completion of this activity.

- Operating and Maintenance (O&M) Costs - These costs include post-construction and long-term expenditures incurred to ensure effective implementation of the alternative. Such costs may include, but are not limited to, operating labor, maintenance materials and labor, rental equipment, administrative, and insurance costs necessary for long-term operations. Additional requirements include monitoring and inspections to assure proper performance and compliance.

A present worth analysis is utilized for the cost evaluation utilizing a discount rate of 5% as recommended under the Superfund Program. To account for increases in estimated annual O&M costs due to inflation, a 5% uniform gradient factor was utilized for the present worth analysis. Cost sensitivity concerns are identified and discussed as required for each alternative.

The cost estimates presented in this report are order-of-magnitude level estimates. An order-of-magnitude cost estimate is defined by the American Association of Cost Engineers as an estimate performed without the benefit of preliminary design work with an assigned accuracy value of +50% to -30%. The cost estimates are based on a variety of information, including estimates from suppliers, construction unit costs, vendor information, conventional cost estimating guides, and prior experience. The Feasibility Study-level cost estimates shown have been prepared for guidance in project evaluation comparison and selection based on the information available at the time of the estimate. The actual costs of the project will depend on true labor and material costs, actual site conditions, competitive market conditions, final project scope, implementation schedule, and other variable factors. A significant uncertainty that would affect the cost is the actual volume of contaminated materials. Most of these uncertainties would similarly affect all of the costs presented in this Feasibility Study.

5.2 ALTERNATIVE 1 - NO ACTION

5.2.1 Description

The no action alternative has been developed as required by the NCP, which requires consideration of this alternative to provide a baseline by which to compare other remedial alternatives.

Under this alternative, the existing contaminated surface soils and sediments would be remain in place, and no restriction of future site use would be imposed. The existing covers on the soil piles would remain, but no further maintenance or inspection of the covers would be performed. The sediment basin would remain in place with no further activities for upgrading or closure of this facility. No additional groundwater-related activities would be performed. The existing groundwater recovery and treatment system operation would be discontinued.

5.2.2 Compliance with ARARs

ARARs have been identified in Section 2. Under this alternative, contaminant concentrations will remain above chemical-specific ARARs. Specifically, no action would be taken to mitigate

the contaminant migration in groundwater and exceedance of MCL levels as the contaminants move off-site. Continued groundwater discharge to the unnamed tributary and Red Lion Creek may degrade the surface water quality, resulting in exceedance of Delaware surface water quality criteria. No applicable chemical-specific criteria exist for soils and sediments. However, the soil piles and sediment basin would not receive proper closure and contaminants could migrate from these areas over time, into the soils and groundwater. Location and action-specific requirements are not applicable as no actions are taking place.

5.2.3 Short-Term Effectiveness

This evaluation criterion involves consideration of the short-term effectiveness of the alternative during construction and implementation. Because this alternative involves no activities to remediate the site, and a curtailment of active groundwater remediation short-term risks will increase when the groundwater extraction wells are shut down and contaminants in the groundwater move off-site into surface seeps, the unnamed tributary, and Red Lion Creek. Erosional control devices would not be maintained and contaminated sediments from surface soils and drainage ditches would be transported into wetland areas and surface water.

5.2.4 Long-Term Effectiveness and Permanence

This criteria involves consideration of the long-term effectiveness and permanence of the alternative once it has been implemented. This alternative does not involve a remedial action, and therefore long-term risk will be present until natural attenuation occurs. The long-term risk will increase as the containment features of the soil piles and sediment basin deteriorate and contaminants are released to soil and groundwater.

5.2.5 Overall Protection of Human Health and the Environment

Under this alternative the overall protection of human health and the environment can be evaluated quantitatively through the Baseline Risk Assessment performed as part of the RI

(WESTON, 1992). This risk assessment has been summarized in Subsection 1.5. This baseline risk assessment includes both current and future use scenarios.

5.2.6 Reduction of Toxicity, Mobility, or Volume

This alternative provides no active recovery and treatment process for groundwater. As a result, contaminants would migrate from the site and will only be attenuated by passive, natural processes including dilution, retardation, biodegradation, and dispersion. Toxicity and mobility of the contaminated material is expected to decrease very slowly with time. The rate of the biodegradation mechanism is currently under investigation. The attenuation rates of other natural attenuation processes would require extensive experimental research, and therefore could not be completed before submission of this FS.

5.2.7 Implementability

This alternative can be readily implemented because no remedial actions are performed.

5.2.8 Cost

There are no costs associated with the No Action alternative.

5.3 ALTERNATIVE 2 - CONTAINMENT

5.3.1 Description

The containment alternative has been developed as a remedial approach to provide on-site containment and treatment of the contaminated groundwater and contaminated soils on-site. Soils from the soil piles, the western drainage gulley, the eastern drainage ditch, and CB1 would be removed, stabilized, and contained on-site to prevent off-site migration. The sediments in the sedimentation basin would also be stabilized (in place). The five existing groundwater extraction wells would be supplemented with additional extraction wells to enhance containment

and treatment of groundwater and reduce the flux of contaminants into the unnamed tributary and Red Lion Creek.

Definitions of surface soils, and readily accessible, highly contaminated surface soils and sediments were presented in Subsection 4.2.5.

The components of Alternative 2 are as follows:

- Soil Removal and Consolidation - Readily accessible, highly contaminated surface soils along the western drainage gulley, eastern drainage ditch, and CB1 will be removed, and consolidated into the basin, followed by in situ stabilization/solidification. Surface soil removals in these areas will proceed to a maximum depth of 3 feet. A conceptual layout of planned activities are shown in Figure 5-1.

  Subsurface soil removal (i.e., soils below 3 feet) will be performed, as necessary, in the western drainage gulley, and in the vicinity of CB1. The criteria to determine the need for excavation in these areas is as follows:

  Western Drainage Gulley - Excavation in the western drainage gulley will be performed for soils that exceed 625 mg/kg total SCD target analytes (response level for on-site surface soils) to maximum specified depth of 7 feet below ground surface (bgs). 7 feet bgs is specified for several reasons. First, samples collected from below 7 feet along the 1986 release pathway (which includes the western drainage gulley) had concentrations less than 625 mg/kg total SCD target analytes. Second, the intent of subsurface soil excavations is to remove the soils by implementing open excavations techniques (e.g., without sheeting or shoring). Because there are no geotechnical borings in this area, the feasibility of excavating to a depth of 7 feet without sheeting or shoring will require evaluation during remedial design. It is assumed in this FS that approximately 50 percent of the western drainage gulley will require subsurface excavation.

  Catch Basin No. 1 - In the CB1 area, excavations will not proceed beyond the depth of the basin (approximately 15 feet) to protect the basin's structural integrity.

  Eastern Drainage Ditch - Subsurface soil excavation along the eastern drainage ditch is not necessary based on samples collected in this area (i.e., no samples greater than 625 mg/kg total SCD target analytes below three feet).

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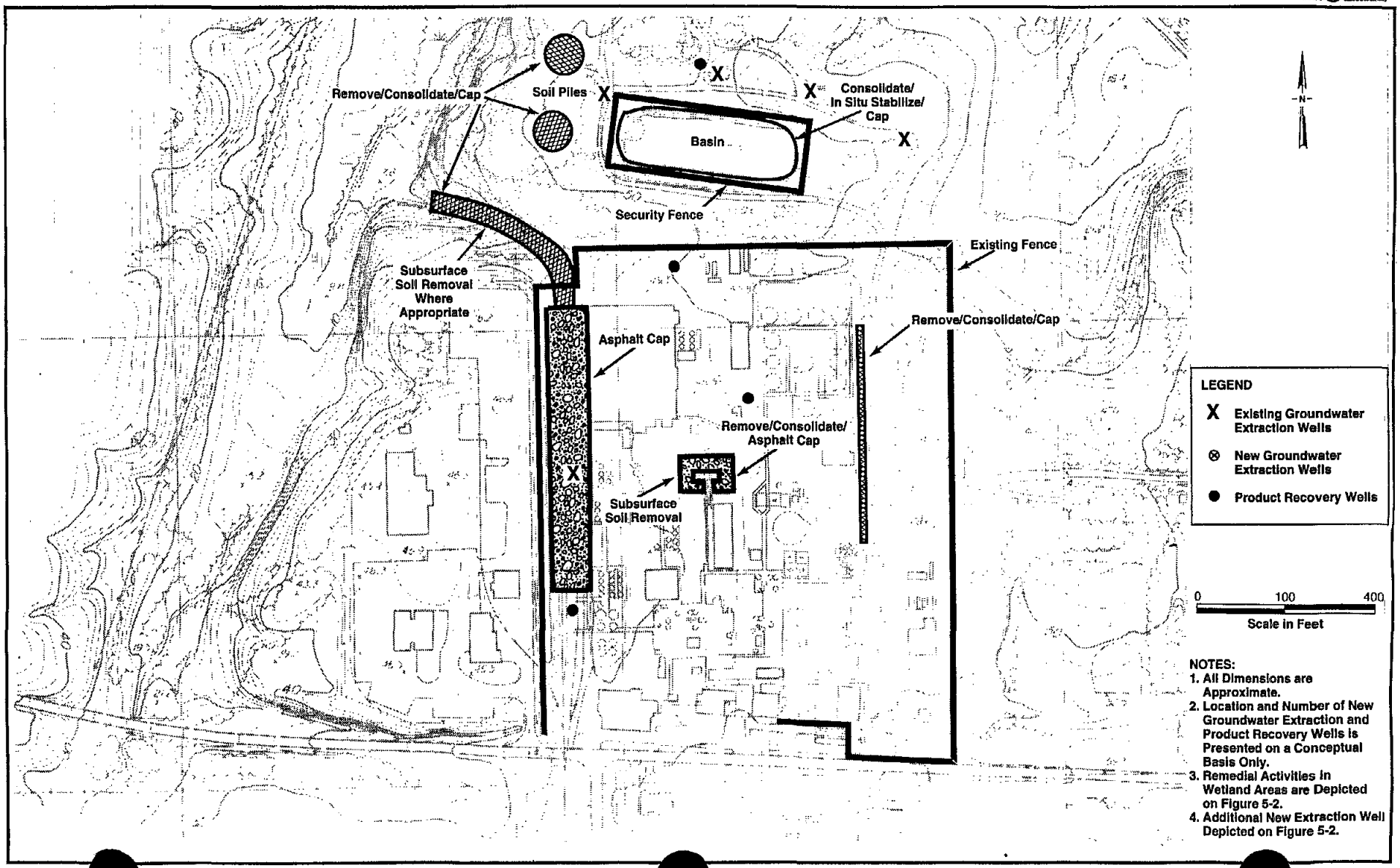

NOTES:
1. All Dimensions are Approximate.
2. Location and Number of New Groundwater Extraction and Product Recovery Wells is Presented on a Conceptual Basis Only.
3. Remedial Activities in Wetland Areas are Depicted on Figure 5-2.
4. Additional New Extraction Well Depicted on Figure 5-2.

FIGURE 5-1 ALTERNATIVE 2 – CON[illegible]AL LAYOUT OF PROPOSED REMEDIAL [illegible]NS
STANDARD CHLORINE OF DELAWARE, INC.
DELAWARE CITY, DELAWARE

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- Consolidation of Soil Pile - The soil pile material will be consolidated into the sediment basin. Any contaminated soils under the pile will also be consolidated.

- Stabilization of Sediment Basin - The soil and sediments in the basin will be stabilized to reduce free moisture and improve bearing strength to support the final cap. Stabilization will occur by in-place admixing taking special care not to damage the existing basin liner system. Treatability testing will be required to select the preferred admixture agent and mix ratios.

- Final Capping - A multilayer cap will be installed over the basin to prevent infiltration and provide a physical barrier to potential human contact.

- Subsurface Contaminated Soil Containment - In excavated areas where high concentration subsurface soils remain, a flexible membrane liner (FML) or asphalt will be used for capping of the backfilled excavations. This capping system. will prevent infiltration of precipitation into the remaining high concentration subsurface soils, thus minimizing migration of contaminants remaining in the soil profile to groundwater. In the area of CB1, an asphalt cap will be used to prevent infiltration. This cap will be joined with other asphalted areas in the vicinity. Because the railroad area soils are inaccessible to excavation, an asphalt cap will be placed in this area.

- Sediment Containment - Installation of new silt fences in the unnamed tributary to prevent contaminated sediment migration. The existing silt fence across the mouth of the unnamed tributary wetland area would be reconstructed, and additional silt fences, as depicted on Figure 5-2, would be installed.

- Sediment Control - Existing silt fences and other sediment control features in site drainageways would be maintained to prevent surface transport of contaminated sediment due to storm run-off.

- Expanded Groundwater Extraction and Treatment - Recovery of contaminated groundwater from the Columbia using the existing 5 extraction wells, and 5 additional wells. The precise number and location of the additional extraction wells is to be determined during remedial design, but have been presented conceptually in this FS to facilitate detailed evaluation of this alternative. The additional wells will be installed and operated to reduce the flux of contaminants to surrounding surface water via the groundwater pathway. Four low volume product recovery wells will also be installed to attempt to remove DNAPL. The extracted groundwater will be conveyed to the existing on-site air stripper for treatment.

- Institutional Controls - Deed restrictions to limit future land and groundwater use. Deed restrictions would be made to implement the following: 1) prohibit installation of groundwater wells for potable water production in the affected area

of the site, 2) prohibit future use of the land at the site for residential dwelling, 3) annotate the site deed to alert prospective property buyers to the presence of hazardous substances on site, 4) continuation of the fishing ban and recreational swimming use in Red Lion Creek and unnamed tributary area, and 5) purchase easements or access agreements to provide long-term control of the remedial measures which are not on SCD-owned property.

- Site Security - Fencing of several areas to prevent unintentional entry into areas of contamination. These areas are identified on Figures 5-1 and 5-2.

- Monitoring - Semi-annual collection and analysis of groundwater and surface water to track performance of the remedial measures and notify decision-makers of changes in site characteristics.

5.3.2 Compliance with ARARs

ARARs have been identified in Section 2. Under this alternative, on-site groundwater contaminant concentrations will remain above chemical-specific ARARs. Specifically, the groundwater MCLs would continue to be exceeded in the on-site Columbia aquifer groundwater. The planned groundwater extraction and treatment procedures are expected to gradually reduce the concentrations of site contaminants in groundwater, however attainment of MCLs in groundwater is not expected in the foreseeable future. It is important to remember, however, that the receptors to groundwater are indirect, via groundwater discharge to surface water. To reduce the impact of groundwater on surface water (as measured by the surface water quality criteria), additional groundwater extraction wells would be installed. Contaminated groundwater will continue to discharge to the unnamed tributary and into Red Lion Creek, but due to the flux reduction caused by the additional extraction and product recovery wells, it's impact to surface water will be such that surface water quality criteria are not exceeded.

ARARs for the treatment of extracted groundwater and NPDES discharge in addition to discharge of air to the plant boilers should continue to be met since there is no change from the current system. No construction, excavation, or large scale removal activities will occur in the wetland or floodplain areas.

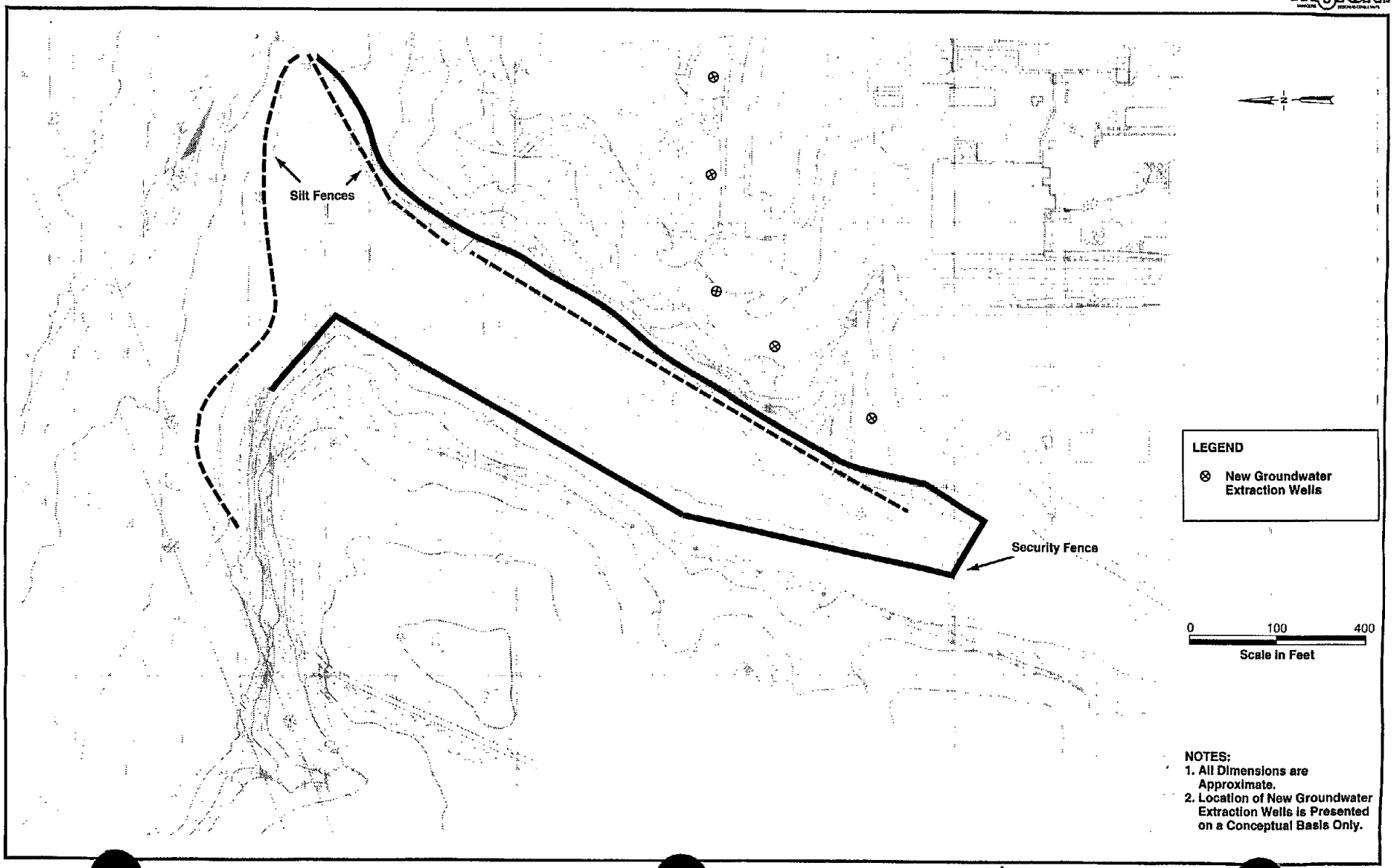

FIGURE 5-2 ALTERNATIVE 2 – CONCE[illegible] LAYOUT OF PROPOSED REMEDIAL A[illegible] IN WETLANDS STANDARD CHLORINE OF [illegible]WARE, INC. DELAWARE CITY, DELAWARE

The soil piles and sediment basin will be consolidated with other contaminated materials excavated from designated site areas, stabilized and then closed. No placement or moving material outside the Area of Contamination (AOC) will occur under this Alternative so that land disposal restrictions will not apply. The final capping and closure will address the RCRA cap design criteria for surface impoundment closure. A multi-layer cap will be used, and the materials underlying the cap will be stabilized to provide sufficient bearing strength to support the final cover. The cap will restrict infiltration using a low permeability comparable to the existing liner system. The existing witness zone between the liners will have to be dewatered to the extent possible so that it can function as a monitoring point after sediment stabilization and basin closure.

5.3.3 Short-Term Effectiveness

This evaluation criterion involves consideration of community/site personnel protection and environmental impacts during implementation of remedial actions. Under this alternative, implementation would include supplemental fence installation to provide a fence encompassing those areas posing the highest potential exposure risk to the surrounding environment. It is expected that site contaminants would be encountered during such activities, although fence installation is not a very intrusive activity. Proper personnel safety procedures, such as those employed during previous remedial activities would be employed to reduce the exposure risk to construction personnel. Establishment of work zones during construction will also reduce the potential exposure to plant workers and other potential receptors.

Removal, stabilization, and capping of the soils could result in localized airborne emissions, although the generally low volatility of site contaminant indicates that fugitive dust emissions would pose the greatest threat. Safe engineering practices would be employed to minimize the exposures during these activities. As indicated by previous remedial measures, the materials handling procedures (removal of soils, stabilization of soils and sediment) can be conducted in a safe manner utilizing general engineering practices.

Installation of additional extraction wells and low volume product recovery wells is not expected to result in significant exposure to on-site personnel. The procedures employee during these construction activities would be similar to those implemented during the RI.

Short-term impacts to the wetlands are not expected, as installation of additional silt fences does not involve extensive intrusive activities.

5.3.4 Long-Term Effectiveness and Permanence

This evaluation criterion involves consideration of the long-term effectiveness and permanence of the alternative once it has been implemented. Institutional controls will reduce potential human exposure to site contaminants through ingestion of groundwater by preventing the installation of drinking water wells in the future. Contact with surface water and ingestion of fish would also be reduced by the fencing and institutional controls.

The effectiveness of institutional controls in the wetland areas, as implemented under this alternative, will be dependant on the enforcement of these restrictions. Posting warning signs at regular intervals may inform a person of the dangers presented, but will not preclude that person from continuing activities in the restricted areas. Site security measures will limit exposure to the site contaminants, however, the fencing will have to be maintained.

Property access agreements or other measures will be needed to service the sediment basin, extraction wells, sediment control measures, and security fence lines.

By consolidating and stabilizing many of the materials having the highest concentrations of contaminants, the exposure will be reduced. As presented in the baseline risk assessment, all the exposure pathways except for groundwater ingestion, involve a contactable, surficial material. In this alternative, many of the materials with the highest concentrations of contaminants would no longer be available for direct contact, since a surface cap would be present as a physical barrier. Engineered control measures and capping of the basin would be used to provide permanence and long-term effectiveness.

Addition of more groundwater extraction wells to increase the effectiveness of groundwater capture should improve surface water quality in the wetland areas by limiting the release of groundwater contaminants into the unnamed tributary and Red Lion Creek. In order to estimate the long-term effectiveness of the on-site groundwater extraction and treatment system, a conceptual groundwater flux model was performed. The conceptual model was used to estimate the impact on surface water quality criteria (SWQC) of groundwater extraction on-site. For example, as additional chlorobenzenes are removed by means of groundwater extraction, the loading of contaminants from groundwater discharge to surface water (unnamed tributary and Red Lion Creek) is reduced. This would result in lower concentration of chlorobenzene in surface water. Using the SWQC in comparison with actual stream quality sample results, benzene has been identified as the compound which most often exceeds the standards. An estimate has been prepared using this conceptual flux model of the groundwater withdrawal necessary to reduce the contaminant loading to the surface water to a level which would result in benzene concentrations below SWQC. This estimate is based in part on estimate of the benzene flux into the surface water from groundwater. This flux calculation amounts to first developing an estimate of the concentrations being contributed from current groundwater discharge to the surface water and then estimating the reduction in groundwater discharge that would result in the necessary associated reduction in contaminant loading. The estimate of current loading was developed using a flow net type analysis of the groundwater flow system in the Columbia sediments. The flow net and associated analyses are provided in Appendix A.

The estimated groundwater contribution to the unnamed tributary was then multiplied by the concentration of benzene associated with each groundwater flow zone based on groundwater sampling results. The resulting benzene mass loading rate was then used in conjunction with an estimate of the expected water flow in the unnamed tributary to estimate a benzene concentration of 0.95 ppm or 950 ppb. This calculated concentration was then compared to the SWQC value of 71 ppb and the associated target reduction calculated. The ratio of estimated groundwater flux to resulting stream water concentrations of benzene was then used to calculate the change in groundwater base flow contribution which would be required to achieve the calculated reduction in stream concentration. The resulting value of 81 gpm represents the target combined pumping rate for the additional groundwater recovery wells included as part of

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Alternative 2. This 81 gpm withdrawal is in addition to the existing withdrawal and the exact distribution of pumping rates will depend on the final distribution of pumping from the existing wells. The final pumping scheme and well locations is therefore an issue that will be resolved at the remedial design stage.

The low volume DNAPL product wells will attempt to recover product present on top of the confining geologic unit underlying the Columbia Formation. As is commonly acknowledged, the success of any form of DNAPL recovery may be limited. Location and removal of DNAPLs are extremely difficult, as DNAPLs may be very thin and discontinuous. The treatment of extracted groundwater (and product) represents a permanent treatment of the contaminants.

5.3.5 Overall Protection of Human Health and the Environment

This alternative provides protection via the access and deed restrictions that limit the potential future exposure of receptors to site contaminants. These controls reduce potential exposure by restricting property access both physically (through fencing and groundwater restrictions) and through legal channels (through property deed annotation alerting prospective purchasers to the presence of hazardous substances on site and legal groundwater restrictions). Fishing and recreational use restrictions would be continued in Red Lion Creek and unnamed tributary areas. Institutional measures would be used to prohibit use of site groundwater for human consumptive purposes.

This alternative adds additional protection by consolidating and stabilizing those soils and sediments containing the highest concentration of contaminants, and managing those materials in a controlled manner in the sedimentation basin. This would result in a risk reduction to the surrounding environment by reducing the potential exposure to receptors through soil ingestion, dermal contact, and inhalation of airborne dust exposure pathways. Managing those materials in the lined and capped sedimentation basin would also reduce the volume of leachate generated by those materials, thus having a positive impact on the subsurface soils and groundwater quality.

5.3.6 Reduction of the Toxicity, Mobility, or Volume of Contaminants

This alternative implements several measures to reduce the mobility of the contaminants by consolidation, stabilization, and capping. Those materials that are removed under this alternative would be consolidated into the sedimentation basin. In situ stabilization/solidification in the sedimentation basin would be performed on the removed materials. These stabilization/solidification agents serve to bind free-phase organics, and to reduce the free moisture present in the material. The net result of this process will be a material that is less likely to produce leachate. The sedimentation basin will also be capped, thus reducing the infiltration of water which causes leachate generation.

The expanded groundwater extraction and treatment system will reduce the flux of contaminants into surrounding surface water. The groundwater treatment system will destroy the extracted contaminants in the plant boilers and further control the mobility of contaminants in the groundwater.

5.3.7 Implementability

The institutional controls, and site security measures in this alternative can be readily implemented after access agreements are developed for off-property areas. Property deed annotation and groundwater restrictions involve nominal legal actions. Restrictions of the wetland areas, and other property not owned by SCD will require cooperation from the respective authorized parties. Site fencing does not pose implementation difficulties. Site preparation will be required prior to installation of the fence to clear the area of trees and shrubs.

The other actions implemented as part of this alternative do not pose substantial implementation difficulties. Excavation of the soils would be performed using conventional excavation equipment. Access roads, for transport of the excavated soils to the sedimentation basin, would be required. In situ stabilization/solidification of the removed materials in the sedimentation basin could be performed using long-reach excavation equipment to mix in the additives in most

of the areas. The homogeneity of the resultant mix will depend on the mixing method employed. Special care must be taken during in-place mixing to prevent damage to the basin liner system.

5.3.8 Estimated Cost

The estimated capital cost items for this alternative is $2,243,000 as presented in Table 5-1. The estimated operating and maintenance (O&M) costs are $80,100 as presented in Table 5-2. Present worth cost for this alternative is estimated at $3,474,000. All costs have been estimated assuming outside contractors, and equipment are utilized except for analytical costs. Cost benefits may be possible if SCD is directly involved in the implementation of the alternative (e.g., through direct purchase of capital equipment, installation of site fences, etc.). Other assumptions are noted on Tables 5-1 and 5-2. Other elements that may significantly impact this cost estimate include:

- Level of personnel protection (Level B, Level C, etc.)
- Lateral extent of excavations.
- Stabilization/solidification agent used.
- Condition of existing sedimentation basin liner.

5.4 ALTERNATIVE 3 - CLOSURE

5.4.1 Description

This alternative addresses those media posing a risk to human health and the environment through removal, treatment, and containment of media exceeding response levels. This alternative would implement a program of selective removal, treatment, and containment of soils (surface and subsurface) and sediments, and enhanced groundwater extraction and treatment. Institutional controls, site security measures, and monitoring as described under Alternative 2 would also be implemented. The key elements of this alternative are as follows:

- Groundwater Extraction and Treatment - In addition to the current groundwater extraction and treatment activities in place at the site, a groundwater containment system will be installed along the shoreline with the unnamed tributary and Red

TABLE 5-1

Capital Costs for Alternative 2
Standard Chlorine of Delaware, Inc.
Delaware City, Delaware

Tasks	Quantity	Unit Cost ($)	Total Costs ($)
1 Security Fencing	4,500 ft	15 /ft	67,500
2 Surface and Subsurface Soil Excavation	12,500 cy	15 /cy	187,500
3 In-Situ Stabilization	15,850 cy	30 /cy	475,500
4 Sedimentation Basin Multilayer Cap	7,400 sy	46 /sy	340,400
5 Backfill of Excavations			
a. Clean Borrow Soil	7,800 cy	10 /cy	78,000
6 Cap Systems			
a. Western Drainage Gulley (FML)	1,400 sy	46 /sy	64,400
b. Eastern Drainage Ditch (asphalt)	300 sy	12 /sy	3,600
c. Railroad Track Area (asphalt)	4,500 sy	12 /sy	54,000
d. Catch Basin (asphalt)	700 sy	12 /sy	8,400
7 Silt Fencing	2,300 ft	15 /ft	34,500
8 Erosion and Sedimentation Controls	4,000 ft	10 /ft	40,000
9 Implementation and Verification Sampling		Lump Sum	50,000
9 Add'l Groundwater/Product Recovery Wells	9	2,000 ea	18,000
10 Modifications to Groundwater Treatment System		Lump Sum	100,000
11 Deed/Groundwater Restrictions and Access Agreements		Lump Sum	25,000
SUBTOTAL			1,546,800
12 Administrative and Construction Services (20%)			309,360
13 Contingency (25%)			386,700
CONSTRUCTION TOTAL (rounded)			2,243,000

plementation requirements for technical issues, testing, plans, approvals, engineering, etc. is not cluded in the construction total and could range between $100,000 - $200,000.

TABLE 5-2

Operation and Maintenance (O&M) Costs for Alternative 2
Standard Chlorine of Delaware, Inc.
Delaware City, Delaware

Tasks	Total Costs ($)
1 Fence Maintenance	3,400
2 Silt Fencing Maintenance	1,700
3 Maintenance of Multilayer Cap	10,000
4 Site Monitoring (Sample Analyses Performed by SCD)	25,000
5 Groundwater Treatment System O&M	40,000
TOTAL ANNUAL O&M COSTS	80,100

Lion Creek to capture lateral groundwater flow prior to exiting the site. One of several alternatives for groundwater containment may be used based on information gathered during the remedial design phase. These include, but are not limited to: a deep interceptor trench (i.e., a trench extending through the surface aquifer and keyed into the underlying confining unit, sheet piling or slurry wall coupled with a shallow interceptor trench or vertical groundwater extraction wells, or a series of vertical groundwater extraction wells (without slurry wall or sheet piling)). This approach differs from the groundwater remedial strategy presented under Alternative 2 in that the goal of this system is complete containment of contaminated groundwater.

A deep interceptor trench system is presented in this study to facilitate evaluation of the groundwater containment approach, and to develop estimated costs. To this end, a conceptual layout of the interceptor trench system was performed. This conceptual layout may change based on information gathered during remedial design. The locations of the extraction wells and interceptor trench are presented on Figures 5-3 and 5-4, respectively. The trench would be installed between the site and Red Lion Creek and the unnamed tributary for a length of approximately 1,700 feet. It will intercept groundwater and drain it to collection sumps where it will be pumped to the air stripper for treatment. Air discharge from the stripper will be burned in the boilers as combustion air. SCD is currently evaluating alternate treatment technologies for plant wastewater treatment. If a technology other than air stripping is chosen by SCD, the extracted groundwater will be treated in this new system. Other technologies that were evaluated favorably in this FS include carbon adsorption, and advanced oxidation. Biological treatment may also be appropriate pending results of the biological treatability study.

The example interception trench would be excavated through the Columbia Formation to the top of the Merchantville, or the Potomac Clays. The depth of such a trench would vary along its length as determined by a predesign boring program. A working bench would be excavated along the length of the trench for equipment access and to facilitate trench installation. Construction of the trench would require shoring to maintain the open excavation. The downslope side of the trench would be fitted with an impermeable geomembrane liner. The trench would be backfilled with a perforated collection pipe and granular fill to collect and convey the intercepted groundwater. The piping would be sloped to drain by gravity to collection sumps where it would be pumped out and conveyed back to the air stripper. The piping and sumps would be constructed of material compatible with the groundwater chemistry to maintain long-term integrity. The granular fill for the trench would have to be designed to minimize the potential for clogging. After backfilling, the trench would be capped to minimize surface water infiltration. It has been estimated that this trench will collect approximately 100-120 gpm of groundwater flow. Figure 5-5 depicts a schematic cross-section of the interceptor trench.

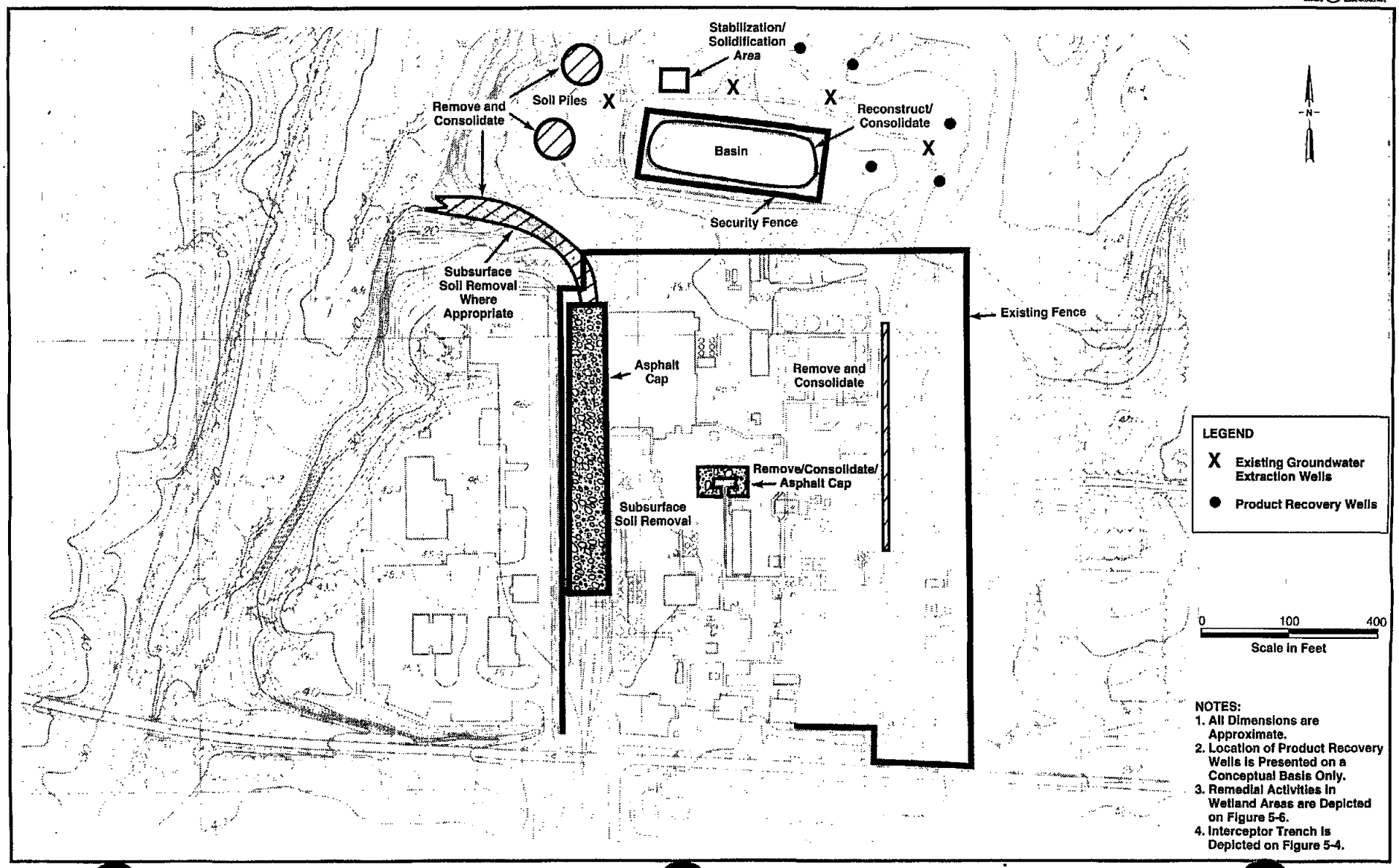

FIGURE 5-3 ALTERNATIVE 3 – CON[illegible]AL LAYOUT OF PROPOSED REMEDIA[illegible]NS
STANDARD CHLORINE [illegible]ELAWARE, INC.
DELAWARE CITY, DELAWARE

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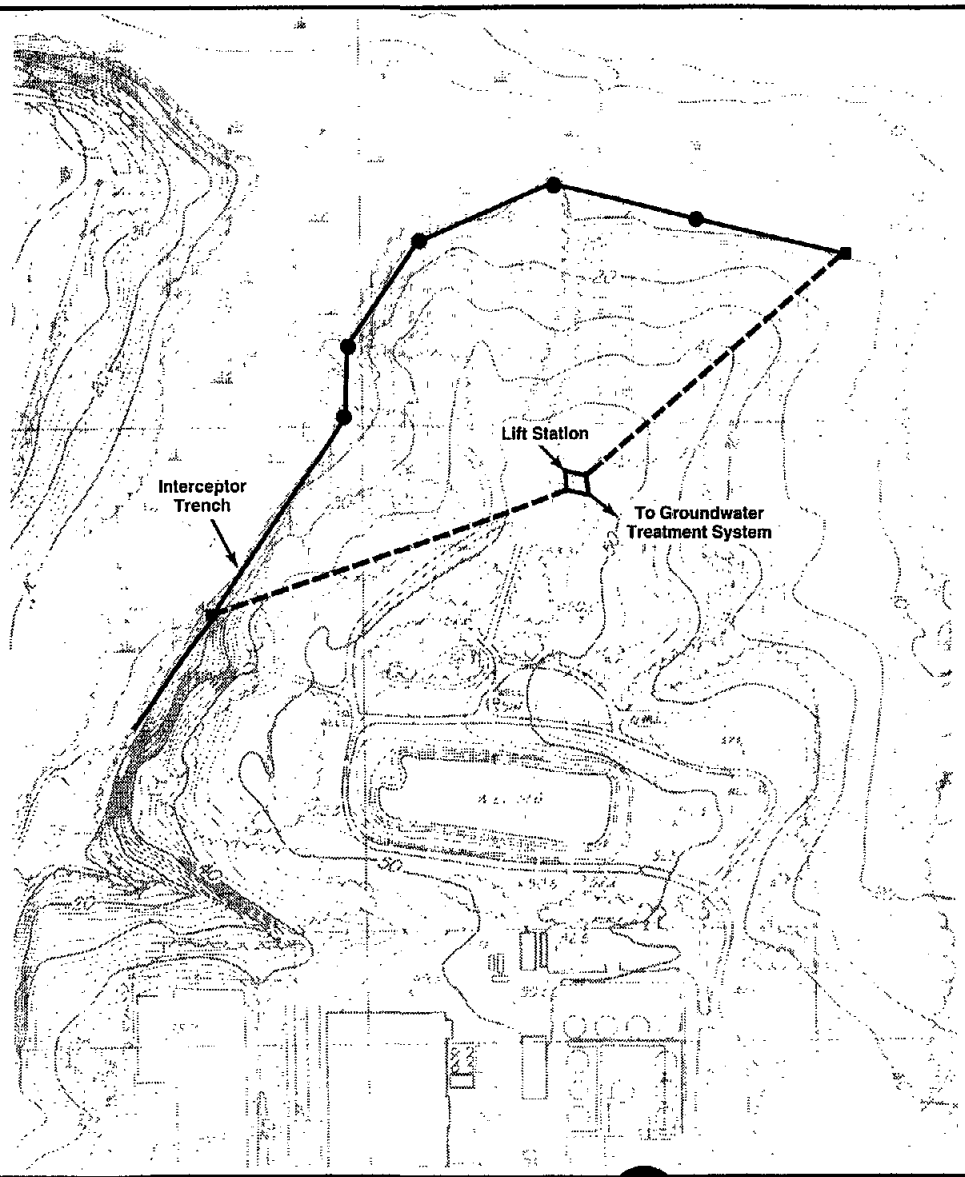
AR3074



N

LEGEND

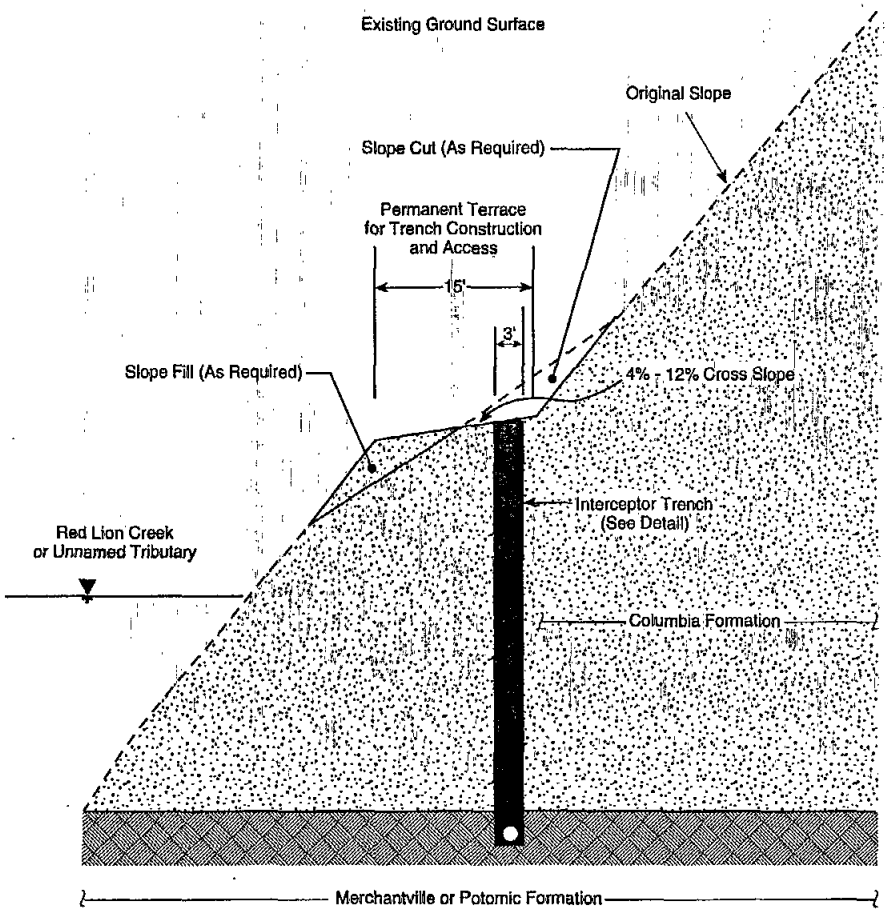
- Approximate Manhole Locations
- Approximate Sump Locations

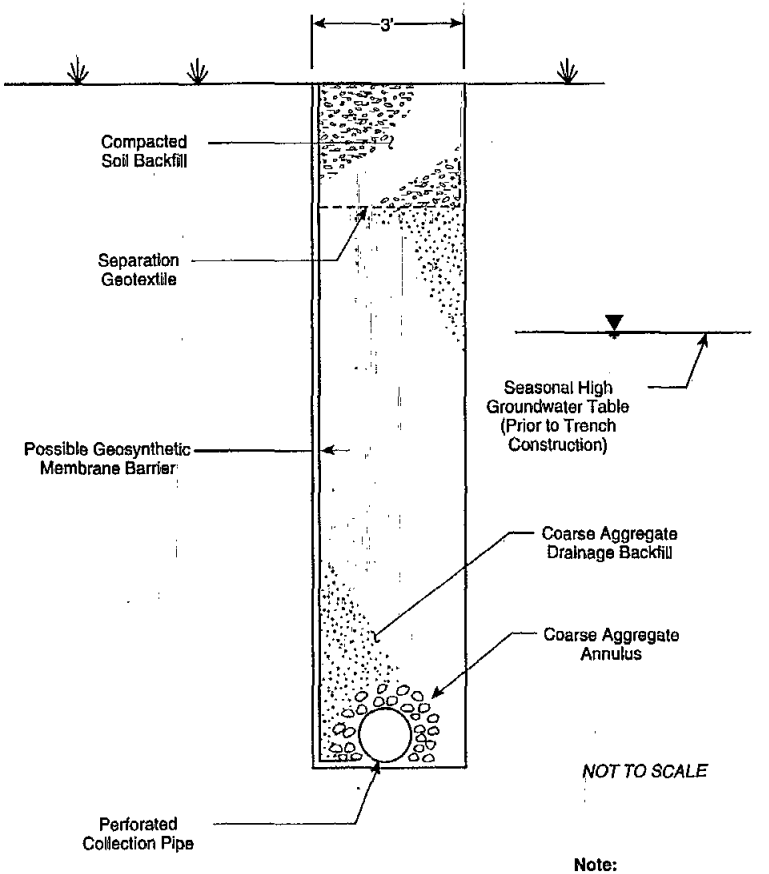
0 100 400

Scale in Feet

NOTES:
1. All Dimensions are Approximate.
2. Location and Layout of Interceptor Trench is Depicted on a Conceptual Basis. Design of Interceptor Trench to be Performed During Remedial Design.

FIGURE 5-4 CONCEPTUAL INTERCEPT[illegible]NCH LOCATION
STANDARD CHLORINE OF [illegible]ARE, INC.
DELAWARE CITY, DELAWAR[illegible]





Groundwater Interceptor Trench
Typical Detail

Note:
1. All Dimensions are Approximate

FIGURE 5-5 GROUNDWATER INTERCEPTOR TRENCH TYPICAL CROSS-SECTION
STANDARD CHLORINE OF DELAWARE, INC.
DELAWARE CITY, DELAWARE

1306-825 1/15/93

AR307495

The impermeable liner proposed for the interceptor trench is included for several reasons. First, the liner controls downgradient (from the unnamed tributary and Red Lion Creek) groundwater infiltration into the trench system. In the absence of the liner, the trench would draw water from both sides and would result in treatment of additional volume of groundwater, and may adversely impact the wetlands along the shoreline. Second, the liner prevents upgradient groundwater from traveling through the trench. In the absence of the liner, any hydraulic head buildups in the trench, groundwater could infiltration through the downgradient side of the trench, and discharge into surrounding surface water.

As indicated above, groundwater containment could be achieved using slurry walls coupled with vertical groundwater extraction wells. To implement this approach, slurry wall(s) would be substituted for the interceptor trench as described above. Vertical groundwater extraction wells would then be installed to extract contaminated groundwater from the area upgradient of the slurry wall. The implementation of the groundwater extraction system (interceptor trench or slurry walls, etc.) should be decided during remedial design, as more information concerning the geologic stratigraphy along the shoreline of the unnamed tributary and Red Lion Creek is gathered.

- Soil Consolidation - Readily accessible, highly contaminated surface soils (i.e., soils with greater than 625 mg/kg total chlorobenzene to a maximum depth of 3 feet) along the western drainage gulley, eastern drainage ditch, and CB1 will be removed, and consolidated into the basin, followed by in situ stabilization/solidification. Because the railroad track area is inaccessible to excavation, an asphalt cap will be placed in this area. The materials designated for consolidation are presented in Figure 5-3. These soils would be stabilized and consolidated into a reconstructed sediment basin.

  Subsurface soil removal will be performed as described for Alternative 2.

- Sediment Consolidation - Excavation of readily accessible, highly contaminated sediments from the shoreline of the unnamed tributary and Red Lion Creek. The materials designated for removal are presented in Figure 5-6. These

  sediments would be stabilized and consolidated into a reconstructed sediment basin.

- Ex-situ Stabilization - Excavated sediments and soils would be stabilized in a mechanical mixing plant. This will achieve a more thorough and homogenous mix compared to in-place mixing and stabilization. It also allows better process control for addition of the admixtures. Sediments would be removed from the basin and processed through the stabilization plant.

- Materials Staging - Stabilized material would be staged outside the sediment basin until the basin can be reconstructed and the material redeposited. This staging

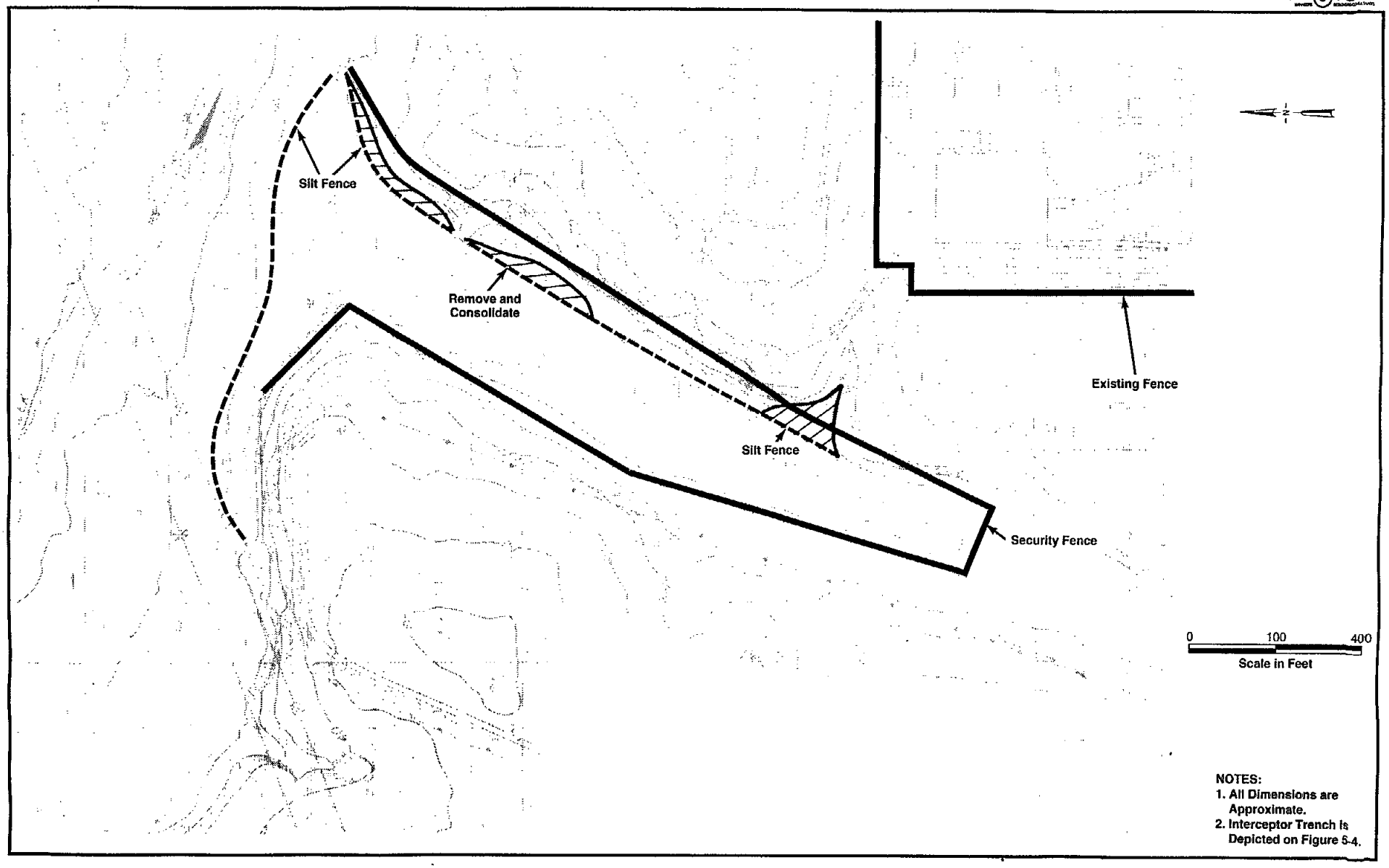


FIGURE 5-6 ALTERNATIVE 3 PROPOSED REMEDIAL ACTIONS
STANDARD CHLORINE OF DELAWARE, INC.
DELAWARE CITY, DELAWARE

AR307497
AR30749

area would be constructed with an impermeable surface to prevent contaminant leaching to the underlying soils. This pad would then be decontaminated after the material is removed.

- Basin Reconstruction - The basin would be retrofitted with a new liner and leachate collection system. After the sediments are removed, the existing liner would be cleaned, checked and repaired (if necessary). During sediment removal, care would be taken to prevent damage to the existing lines so that they will remain intact and be reused. A new geomembrane liner will be placed over the existing primary liner in the basin. A leachate collection system consisting of collection piping and flow zone on the bottom and on the sides will be installed over the new liner. The sediments/soils would then be stabilized and placed into the basin.

- Basins Capping and Closure - After the stabilized material is placed into the basin, it will be covered by a final cap system. The cap will utilize a multi-layer design to minimize infiltration and provide long-term integrity.

- Subsurface Contaminated Soil Containment - In excavated areas where high concentration subsurface soils remain, a FML or asphalt will be used during capping of the excavations. This capping system will prevent infiltration of precipitation into the subsurface soils, thus minimizing migration of contaminants remaining in the soil profile to groundwater. In the area of CB1, an asphalt cap will be used to prevent infiltration. This cap will be joined with other asphalted areas in the vicinity.

- Containment - Capping of the surface soils above the response levels that are not removed as described above. Soils around the railroad track area cannot be excavated and would be capped with asphalt. Excavation in this area is not feasible since it would shut down the rail yard and plant operations. Surface water diversion measures would be implemented to control runon and runoff. New silt fences in the unnamed tributary would be installed to prevent sediment migration. The existing silt fence across the unnamed tributary/wetland area would be reconstructed, and additional silt fences would be installed. The location of the silt fences is presented on Figure 5-6.

- Institutional Controls, Site Security, and Site Monitoring - Those measures, as identified in Alternative 2, would be performed where appropriate.

Definitions of surface soils, and readily accessible, highly contaminated surface soils and sediments were presented in Subsection 4.2.5.

5.4.2 Compliance with ARARs

The current groundwater extraction and treatment system is not fully effective in capturing groundwater exiting to the north of site (into Red Lion Creek and the unnamed tributary). The construction of the interception trench will enhance the effectiveness of groundwater remediation by improving the capture of groundwater contaminants and limiting their lateral movement off-site. The trench will not substantially accelerate on-site groundwater remediation but will accelerate improvement in surface water quality in the unnamed tributary and Red Lion Creek area. Even with the new interceptor trench and operation of the new low volume DNAPL recovery wells and existing contaminated groundwater extraction wells, on-site groundwater quality is not expected to achieve MCL levels in the foreseeable future.

When basin sediments are removed and treated ex-situ, land disposal restrictions must be considered as an ARAR before the material is returned to the basin. Minimum technology requirements also must be considered and these include landfill design standards under RCRA. These ARARs have been addressed by stabilizing the sediments in a mechanical mixing system and retrofitting the basin with a liner and leachate collection system. Final capping and closure of the basin would use a multilayer cap system consistent with RCRA Landfill Design Guidance.

Groundwater extracted from the on-site recovery wells and collected in the interceptor trench would be treated in the existing air stripper and treated water discharged at the NPDES point. Air from the stripper would be burned in the boiler. These activities are consistent with current practices and expected to meet ARARs.

Construction of the access bench for the interception trench will require proper erosion and sedimentation controls to protect wetland areas. This work may also occur in the 100-year floodplain which will require proper design and protective measures, and could be designed to comply with ARARs.

5.4.3 Short-Term Effectiveness

This evaluation criterion involves consideration of community/site personnel protection and environmental impacts during implementation of remedial actions. Under this alternative, several construction and materials handling activities will be implemented. The short-term effectiveness of this alternative is discussed for each activity in the following paragraphs.

Implementation of institutional controls involves no site-intrusive activities and therefore poses no risks. Site monitoring activities are generally non-intrusive (e.g., visual inspections, recordkeeping). Sampling activities implemented under site monitoring would be performed in accordance with health and safety protocols similar to those of previous investigations, thus protecting workers.

Site-intrusive activities (e.g., excavation of soils and sediments, construction associated with the sedimentation basin and the groundwater interception trench, installation of erosion barriers) employ conventional construction and materials handling techniques. Health and safety protocols will be implemented similar to those of previous remedial actions at the site. Engineering controls, such as dust suppressants, may be employed if significant airborne particulates are released during these activities. Earth moving and disturbance would occur along the wetland areas due to the trench construction and would result in some localized impacts. A staging pad and stabilization mixing plant area would be constructed near the sediment basin and result in localized impact to surface cover. Space constraints may affect the location and layout of this staging and mixing operation.

Construction of the interceptor trench will impose several short-term risks to construction personnel. Both chemical and physical hazards are expected. The chemical hazards associated with handling potentially contaminated materials will be addressed using standard health and safety protocols. Contaminated soils removed from the trench will have a high moisture content and site related contaminants, and must be properly disposed or placed on-site. The limited amount of workspace on the constructed bench (see Figure 5-5) poses the risks of injury due to

close proximity with operating heavy equipment, the steep slopes, and the open trench. Safe construction practices will be employed to minimize these hazards.

Construction activities associated with the surface soils in areas of heavy plant traffic, namely along the railroad tracks, will present additional risks to construction and plant workers. In these high traffic areas, risk associated with physical hazards are increased. These physical hazards include: limited working space, close proximity to heavy equipment, and railroad traffic associated with normal plant operations. Coordination with plant personnel, and alertness on the part of both construction and plant workers will reduce the risk of injury.

Contaminated soils in the rail yard will be capped with asphalt to reduce infiltration which could mobilize contaminants from the soils to the groundwater. The ballast and track areas will require regrading and preparation prior to asphalting. This could affect rail car movements into the plant and related operations.

5.4.4 Long-Term Effectiveness and Permanence

This evaluation criterion involves consideration of the long-term effectiveness and permanence of the alternative once it has been implemented. This alternative implements several measures to reduce the long-term risk to the surrounding environment.

The groundwater interception trench will provide a subsurface barrier to lateral groundwater flow and should result in improvement to surface water quality by reducing the release of groundwater contaminants into the unnamed tributary and Red Lion Creek. The low volume DNAPL product wells will attempt to recover DNAPL present on top of the confining geologic unit underlying the Columbia Formation. As is commonly acknowledged, the success of any form of DNAPL recovery may be limited. Location and removal of DNAPLs are extremely difficult, as these DNAPLs may be very thin and discontinuous. The treatment of extracted groundwater (and DNAPL) represents a permanent treatment of the contaminants.

The effectiveness of the interceptor trench system will be dependant on both the chemical compatibility of the construction materials with the site contaminants, and the physical properties encountered in the surrounding soils. The coarse aggregate backfill must be gradationally compatible with the surrounding Columbia Formation soils to prevent soil clogging the aggregate while maintaining an acceptable inflow of groundwater. All treatment system components (e.g., geosynthetic membrane barrier, collection pipe, manholes, pumps, sumps, etc.) used within the trench system must be constructed of materials that are compatible with the site contaminants. This ensures that their structural and barrier properties are maintained for an extended duration.

Removal and containment of the readily accessible, highly contaminated surface soils and sediments will reduce the potential exposure from these materials. Removal of subsurface soils, as well as using FML or asphalt to cap backfilled excavations, will reduce the potential for contaminant migration from soils to groundwater. Capping in high traffic areas such as the rail yard, and CB1 will utilize asphalt which will have high durability.

Utilizing additional sediment barriers to prevent further migration of contaminants in the sediments in combination with institutional controls to limit the wetlands use will reduce the exposure to these materials.

Some negative impacts can be expected with regard to removal of sediments. The removal of sediments along the edge of the wetland will impact approximately 1,050 square yards. Most of the area to be excavated in this alternative has been impacted during past remediation. The area is dominated by early successional herbaceous species such as goldenrods (*Solidago spp.*), asters (*Aster spp.*), and grasses (Graminae). The area is probably a food source (seed and insects) for small mammals and birds as well as having a developed macroinvertebrate community.

Short-term impacts will include removal of vegetation, a food source and the invertebrate community. Restoration will include backfilling, fine grading and hydroseeding, with natural succession occurring to repopulate the area. Long-term ecological effects will be dependent upon the extent of the excavation and subsequent restoration effects.

The construction of a interception trench will impact approximately 1,700 feet of forest. The forest type is beech (*Fagus grandifolia*), white oak (*Quercus alba*), and tulip poplar (*Liriodendron tulipifera*) with a sassafras (*Lindera benzoin*)-flowering dogwood (*Cornus florida*) understory. This habitat probably serves as a food source and cover for several species of small mammals as well as white-tailed deer. It may also provide nesting habitat for raptors or passerines. The removal of soil will also remove thin vertebrate community inhabiting the soil.

Within the surrounding landscape, wetland, agricultural field and mature forest, are present. Mature forest is located on the side slopes adjacent to the Red Lion Creek floodplain. Since this forest habitat is abundant and the area to be disturbed is minimal, no severe long-term ecological impacts are expected from this alternative since ample cover and food sources are available within the surrounding area. However, depending on the time of initiation of work, some animals may be displaced from their nesting, feeding, and cover areas.

Remediation of temporary impacts due to construction of the trench include backfilling, fine grading and hydroseeding. It is expected that natural succession will occur and reforest a portion of the area and with reforestation, the animals will return. Reforestation of the immediate trench area should not be allowed so that the trench is not damaged by roots. In addition, the macroinvertebrate community will repopulate from the surrounding community into the area after construction is complete.

Monitoring of the area to determine if it has recovered after the disturbance would typically consist of an annual field visit by an ecologist or botanist to determine if vegetation is established and its aerial coverage and if evidence of animal use (tracks, scat) is present. The establishment of vegetation will be considered a positive indicator of animal use if no animal signs are observed. If the aerial coverage is less than 85% after one year, additional restoration may need to be considered. The annual visits will cease upon recommendation of the ecologist.

The retrofitting of the basin with a new liner and leachate collection system will enhance the long-term integrity and environmental control of the basin. Any liquids or leachate which is produced would be collected for removal and treatment. Liner and leachate collection of

construction materials of construction must be compatible with the waste material and expected leachate. The final cap system will be a multilayer design for high performance and long-term integrity.

Ex-situ stabilization of soils and sediments will provide an improved mix by better process control. Stabilization will reduce the contaminant mobility by solidification. Chemical fixation is not anticipated, however, a testing program is recommended to select the optimal admixture material.

5.4.5 Overall Protection of Human Health and the Environment

Alternative 3 achieves the remediation objectives by reducing the risks posed through potential exposure routes as follows:

- Enhancement of the existing groundwater extraction system using an interceptor trench to recover groundwater that currently exits the site. This increases the effectiveness of current groundwater remediation activities, thus reducing the exposure to off-site receptors that indirectly contact groundwater (as groundwater discharges into neighboring surface water bodies). It should be noted that there are no known direct users of groundwater from the Columbia Formation, and thus direct consumption of groundwater is not expected. The characteristics of the on-site Columbia aquifer in comparison to the upper Potomac aquifer indicate that it is unlikely that the Columbia aquifer would be used as a potable water source in the future.

- Removal and containment of the readily accessible, highly contaminated surface soils (surface and subsurface) and sediments will minimize their potential for leaching contaminants to surface and groundwater. The removal of these materials will also reduce the potential exposure to receptors through ingestion, contact, and inhalation pathways. In addition, managing these materials in the relined and capped sedimentation basin will reduce both the volume of leachate generated, and improve the containment measures of the basin. Remaining high concentration subsurface soils will be subject to decreased surface water infiltration due to the cap construction materials used during excavation closure. By targeting those materials that are most accessible, the greatest benefit from the removal action is achieved, as these materials are generally accessible to potential receptors, as well as excavation equipment (i.e., if heavy equipment can easily reach it, so can a potential receptor). Some negative impacts can be expected with regard to removal of sediments. Regrading and reseeding of the dredged

areas is often required as a restoration step after sediments are removed. The effectiveness of these techniques is variable and may change the natural conditions of the wetlands.

- Containment, through capping, of the soils in the rail yard will reduce potential exposure from these soils through soil ingestion, dermal contact, and inhalation of airborne dust pathways. The cap will also reduce the volume of leachate generated due to reduced surface water infiltration, thus having a positive impact on subsurface soils and groundwater. Containment of the sediments through the use of sediment barriers (i.e., silt fences), will reduce the migration potential of those sediments exhibiting high contaminant concentrations.

- Institution controls to limit future use and site access. Limiting future groundwater use at the site, and restricting use of the wetland areas will reduce potential exposure through groundwater ingestion, and surface water dermal exposure routes. Extension of fishing and recreational bans in Red Lion Creek will limit potential exposure.

- Site monitoring will track performance of site remediation and notify decision-makers of any future changes in site conditions that may warrant reevaluation of remedial strategy.

5.4.6 Reduction in Toxicity, Mobility, or Volume of Contaminants

Under this alternative, reduction of the TMV would be implemented for groundwater, soils, and sediments. Implementation of the groundwater extraction and interception system would capture larger volumes of contaminated groundwater. The extracted groundwater would undergo treatment via air stripping. Air stripping has been used effectively at the site since 1986, for the treatment of extracted groundwater.

The mobility of the contaminants would be reduced for surface soils exceeding the response levels. Those materials that are removed under this alternative would be consolidated into the sedimentation basin with the addition of stabilization/solidification agents. These agents serve to bind organics in a solid matrix, and to reduce the free moisture present in the material. The net result of this process will be a material that is less likely to produce leachate. Testing would be required to determine the most effective stabilization agent and mix ratios. The sedimentation basin will also be reconstructed to include an additional liner, a leachate collection system, and a cap, thus minimizing the infiltration of water which causes leachate generation. Any liquids

which may accumulate in the basin would be removed by the leachate collection system and treated in the on-site wastewater treatment system.

The surface soils above the response levels that remain in place (i.e., railroad track area) will be capped. The closure of excavations will be performed using FMLs, and asphalt. This results in a reduction of the mobility of the contaminants within these areas. The caps serve to reduce the infiltration of water into the soils, thus reducing contaminant mobility and the volume of leachate generated.

The construction of additional sediment barriers will reduce the mobility of the sediments, thus reducing the mobility of the contaminants within the sediments. The existing silt fence at the confluence of the unnamed tributary and Red Lion Creek would be replaced. The new silt fences would serve to minimize contaminated sediment migration from the unnamed tributary.

5.4.7 Implementability

Technical/administrative considerations for implementation of institutional controls, site security measures, and site monitoring have been previously discussed under Alternative 2. Additional off-property land will be needed for this alternative on an interim basis for setup of the staging and stabilization activities during basin retrofitting. This area near the basin would be decontaminated and closed after the ex-situ stabilization is completed.

Because of the interaction between the various media at the site, and the quantities of materials requiring staging and treatment, careful phasing of this alternative would be required during implementation. For example, removal of the sediments along the shoreline of the unnamed tributary cannot take place until the groundwater interception system is installed. Further, a monitoring period would be required after installation of the groundwater interception system to verify the effectiveness of the interception system. This will assure that contaminant input into the unnamed tributary, via the groundwater pathway, is controlled prior to the implementation of remedial activities for sediments. As another example, the limited space

available for staging and treatment prohibits removal and treatment of all the materials at one time.

The actual depth and location of the trench would have to be confirmed by an investigative soil boring program prior to trench installation. The details discussed in this program are based on a conceptual layout of the system, and may change based on information gathered during remedial design. It is anticipated that the interceptor trench could be constructed using conventional, potentially deep, excavation sheeting and shoring techniques. The depth of the trench is currently estimated to average approximately 25 feet, with a length of approximately 1700 feet. A permanent bench or terrace would be constructed adjacent to the interceptor trench to allow construction and maintenance vehicles access to the trench and manholes. Construction of this terrace requires clearing and grubbing, and grading along the path of the trench. A cross-section schematic of the trench is presented in Figure 5-5. Perforated piping and granular material would be installed in the trench to collect groundwater. The piping would be sloped to drain to collection sumps. Materials of construction would need to be chemically compatible with the site contaminants. Manholes sumps would be separated by a maximum distance of approximately 300 feet to allow for cleaning, inspection, and maintenance. Soils excavated from the trench may be contaminated and will need to be analyzed to determine concentrations. In particular, surface soils and soils in the saturated zone below the water table would be subject to contaminants. Depending on the contaminant concentrations, these soils may require dewatering, stabilization and placement in the sediment basin.

It is estimated that the interception trench will collect approximately 100-120 gpm of groundwater. This groundwater will be pumped and conveyed to the existing air stripper for treatment. The stripper is currently operating hydraulically below maximum capacity and should be able to handle the additional flow of water. Based on this additional contaminant loading, the stripper performance should be checked to make sure it will continue to operate at the desired removal levels.

Removal of the surface soils, subsurface soils and sediments will employ conventional construction techniques. An access road, and staging/stabilization area would be constructed.

The limited space available for staging will require that a phased removal be implemented. Stabilization/solidification would be implemented using one of the techniques discussed in Section 3. As indicated in Section 3, the stabilizing agent will be determined based on performance tested using site-specific soils.

Reconstruction of the sedimentation basin would also employ standard construction methods. Sediment removal would be accomplished using extra care to prevent damage to the existing liner. As the basin sediments are removed they would be partially stabilized and staged on an impervious pad. The pad would be bermed/diked to collect run-off which would be treated. After all the basin materials are removed, partially stabilized and staged, the basin would be prepared for retrofitting. The existing HDPE primary liner would be cleaned, inspected and repaired (if necessary). The new liner and leachate collection system would be installed on top of the existing primary liner. The liner and collection materials must be chemically compatible with the site contaminants and testing may be required to confirm this. The staged material and other soils would be processed for final stabilization and placed/compacted into the basin. After the removed materials are consolidated into the basin, the final multi-layer low permeability cap system would be constructed.

5.4.8 Estimated Cost

The present worth estimated of this alternative is $6,720,000. The estimated capital cost for this alternative is $5,157,000 as presented in Table 5-3. The estimated annual O&M costs are $101,700 as presented in Table 5-4. All costs have been estimated assuming outside contractors, and equipment are utilized except for analytical costs. Cost benefits may be possible if SCD is directly involved in the implementation of the alternative (e.g., through direct purchase of capital equipment, installation of site fences, etc.). Other assumptions are noted on Tables 5-3 and 5-4. Other elements that may significantly impact this cost estimate include:

- Level of personnel protection (Level B, Level C, etc.)
- Lateral extent of excavations.
- Stabilization/solidification agent used.
- Condition of existing sedimentation basin liner.

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TABLE 5-3

Capital Costs for Alternative 3
Standard Chlorine of Delaware, Inc.
Delaware City, Delaware

Tasks	Quantity	Unit Cost ($)	Total Costs ($)
1 Excavation			
a. Surface and Subsurface Soils	12,500 cy	15 /cy	187,500
b. Wetlands Sediments	1,050 cy	19 /cy	19,688
c. Basin Sediments	3,350 cy	26 /cy	87,100
2 Basin Reconstruction			
a. Liner and Leachate Collection System	8,700 sy	40 /sy	348,000
b. Multilayer Cap System	7,400 sy	46 /sy	340,400
3 Staging Area		Lump Sum	15,000
4 Ex-Situ Stabilization			
(Includes excavation soils/sediments and interceptor trench soils)			
a. Initial Stabilization of Basin Sediments	3,350 cy	25 /cy	83,750
b. Stabilization of All Materials	19,300 cy	25 /cy	482,500
5 Cap Systems			
a. Western Drainage Gulley (FML)	1,400 sy	46 /sy	64,400
b. Eastern Drainage Ditch (asphalt)	300 sy	12 /sy	3,600
c. Railroad Track Area (asphalt)	4,500 sy	12 /sy	54,000
d. Catch Basin (asphalt)	700 sy	12 /sy	8,400
6 Backfill of Excavations			
a. Clean Borrow Soil	7,800 cy	10 /cy	78,000
7 Wetlands Reconstruction			
a. Backfill	1,050 cy	18 /cy	18,900
b. Fine Grading	3,000 sy	1 /sy	3,000
c. Revegetation	3,000 sy	7 /sy	21,000
8 Interceptor Trench	Lump Sum		1,430,100
9 Product Recovery Wells	4	2,000 ea	8,000
10 Silt Fencing	2,300 ft	15 /ft	34,500
11 Implementation and Verification Sampling		Lump Sum	100,000
12 Erosion and Sedimentation Controls	4,400 ft	10 /ft	44,000
13 Modifications to Groundwater Treatment System		Lump Sum	100,000
14 Deed/Groundwater Restrictions and Access Agreements		Lump Sum	25,000
SUBTOTAL			3,556,838

TABLE 5-3 (cont'd)

Capital Costs for Alternative 3
Standard Chlorine of Delaware, Inc.
Delaware City, Delaware

Tasks	Quantity	Unit Cost ($)	Total Costs ($)
15 Administrative and Construction Services (20%)			711,368
16 Contingency (25%)			889,209
TOTAL (rounded)			5,157,000

Implementation requirements for technical issues, testing, plans, approvals, engineering, etc. is not included in the construction total and could range between $200,000 - $300,000.

TABLE 5-4

Operation and Maintenance (O&M) Costs for Alternative 3
Standard Chlorine of Delaware, Inc.
Delaware City, Delaware

Tasks	Total Costs ($)
1 Maintenance of Multilayer Cap	10,000
2 Asphalt Cap Maintenance	5,000
3 Maintenance of Interceptor Trench	10,000
4 Silt Fence Maintenance (5% of installed cost)	1,700
5 Site Monitoring (Sample Analyses Performed by SCD)	35,000
6 Groundwater Treatment System O&M	40,000
TOTAL ANNUAL O&M COSTS	101,700

- Actual depth of interceptor trench.
- Final design and materials of construction used for the sedimentation basin reconstruction, and the interceptor trench.

5.5 ALTERNATIVE 4 - THERMAL TREATMENT

5.5.1 Description

This alternative includes the treatment of soils and sediments using the thermal desorption technology. Thermal desorption has been tested previously on a bench scale basis and has been shown to be effective in removing chlorobenzene contaminants from site soils/sediments. The ultimate objective of thermal desorption is to treat the soils/sediments to a level whereby they can be deposited on-site as clean backfill. This will require treatment to a level equivalent to that required for delisting. Previous testing results have shown a very high level of treatment in the range of 99.9% to 99.999% removal (WESTON, 1986). Predesign testing should be used to confirm treatment levels and establish operating parameters.

In the event that the material cannot be treated sufficiently for use as clean backfill, it would have to be redeposited in the lined sediment basin. The basin would be retrofitted with a liner and leachate collection system as described for Alternative 3.

In addition to soil/sediment treatment, this alterative includes groundwater recovery and treatment using the five existing extraction wells, a new interception trench (as presented for Alternative 3), and DNAPL recovery wells. The contaminated groundwater would be collected and conveyed for treatment in the air stripper with treated water discharged at the NPDES outfall. Low volume recovery wells would be strategically located on-site in an attempt to recover some of the DNAPL.

This alternative includes two options identified as Options A and B which relate to the extent of sediment removal; both options remove surface and subsurface soils as described under Alternative 3. The surface and subsurface soils identified for removal and treatment include those located along the eastern drainage ditch (surface soils only), western drainage gulley (surface and subsurface soils), and CB1 (surface and subsurface soils). Due to its inaccessibility,

the soils in the railroad track area will be contained with an asphalt cap. Under Option A, only the readily accessible, highly contaminated sediments would be removed for treatment. Under Option B, all sediments exceeding response levels would be removed and treated.

The components of Alternative 4 are presented on Figures 5-7 and 5-8. The key components are as follows:

Options A and B

- Groundwater Extraction and Treatment - In addition to the current groundwater extraction and treatment activities in place at the site, a groundwater containment system will be installed along the shoreline with the unnamed tributary and Red Lion Creek to intercept contaminated groundwater prior to exiting the site. One of several alternatives for groundwater interception may be used based on information gathered during the remedial design phase. These include, but are not limited to: a deep interceptor trench (i.e., a trench extending through the surface aquifer and keyed into the underlying confining unit, sheet piling or slurry wall coupled with a shallow interceptor trench or vertical groundwater extraction wells, or a series of vertical groundwater extraction wells (without slurry wall or sheet piling)). This remedial strategy is identical to that proposed under Alternative 3.

  A deep interceptor trench system is presented in this study to facilitate evaluation of the groundwater containment approach, and to estimate costs. To this end, a conceptual layout of the interceptor trench system was performed. This conceptual layout may change based on information gathered during remedial design. The locations of the extraction wells and interceptor trench are presented on Figures 5-4 and 5-7, respectively. The trench would be installed between the site and Red Lion Creek and the unnamed tributary for a length of approximately 1,700 feet. It will intercept groundwater and drain it to collection sumps where it will be pumped to the air stripper for treatment. Air discharge from the stripper will be burned in the boilers as combustion air. SCD is currently evaluating alternate treatment technologies for plant wastewater treatment. If a technology other than air stripping is chosen by SCD, the extracted groundwater will be treated in this new system. Other technologies that were evaluated favorably in this FS include carbon adsorption, and advanced oxidation. Biological treatment may also be appropriate pending results of the biological treatability study.

  The example interception trench would be excavated through the Columbia Formation to the top of the Merchantville, or the Potomac Clays. The depth of such a trench would vary along its length as determined by a predesign boring program. A working bench would be excavated along the length of the trench for

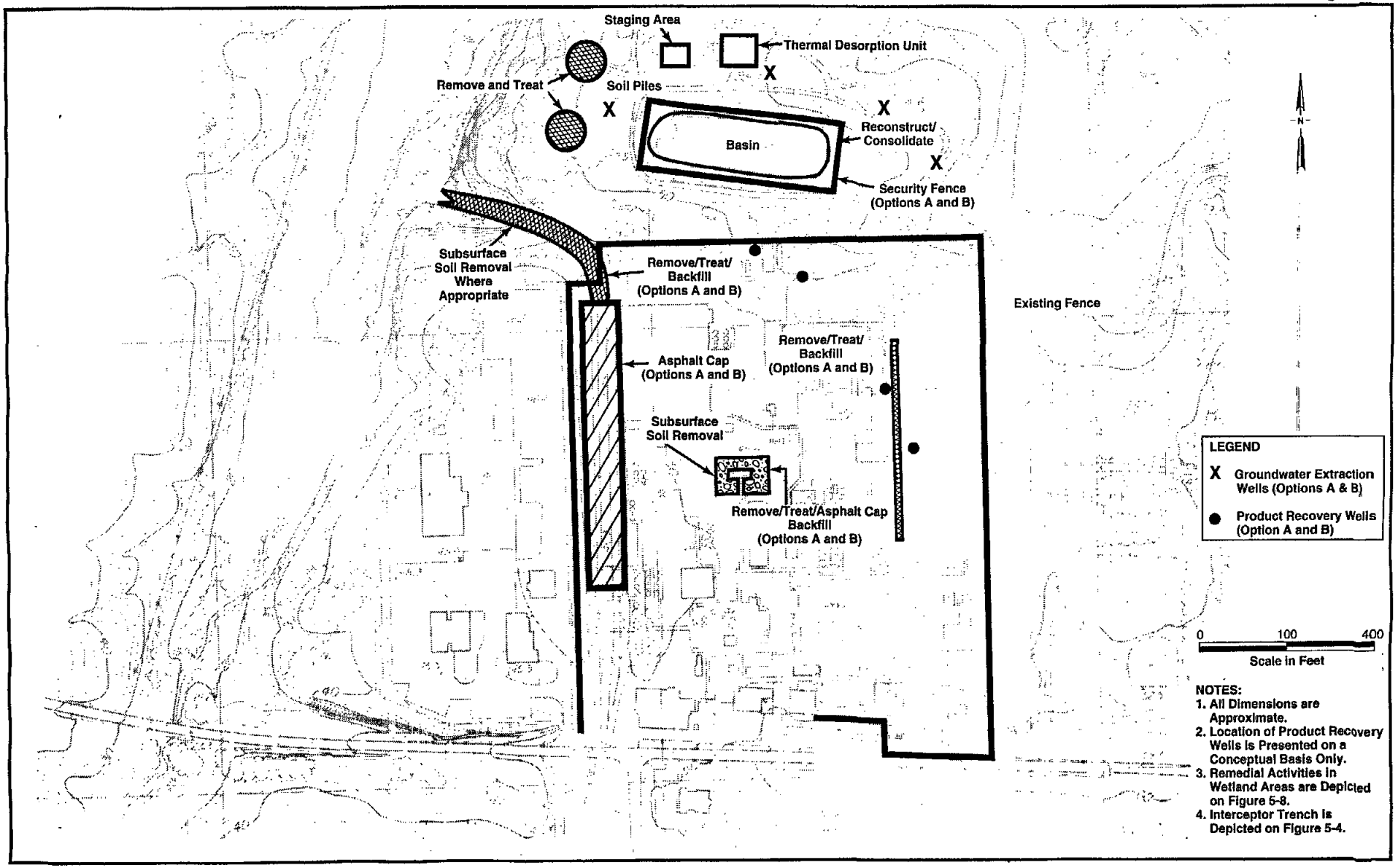

FIGURE 5-7 ALTERNATIVE 4 PROPOSED REMEDIAL ACTIONS
STANDARD CHLORINE OF DELAWARE, INC.
DELAWARE CITY, DELAWARE

AR 307514
AR307514

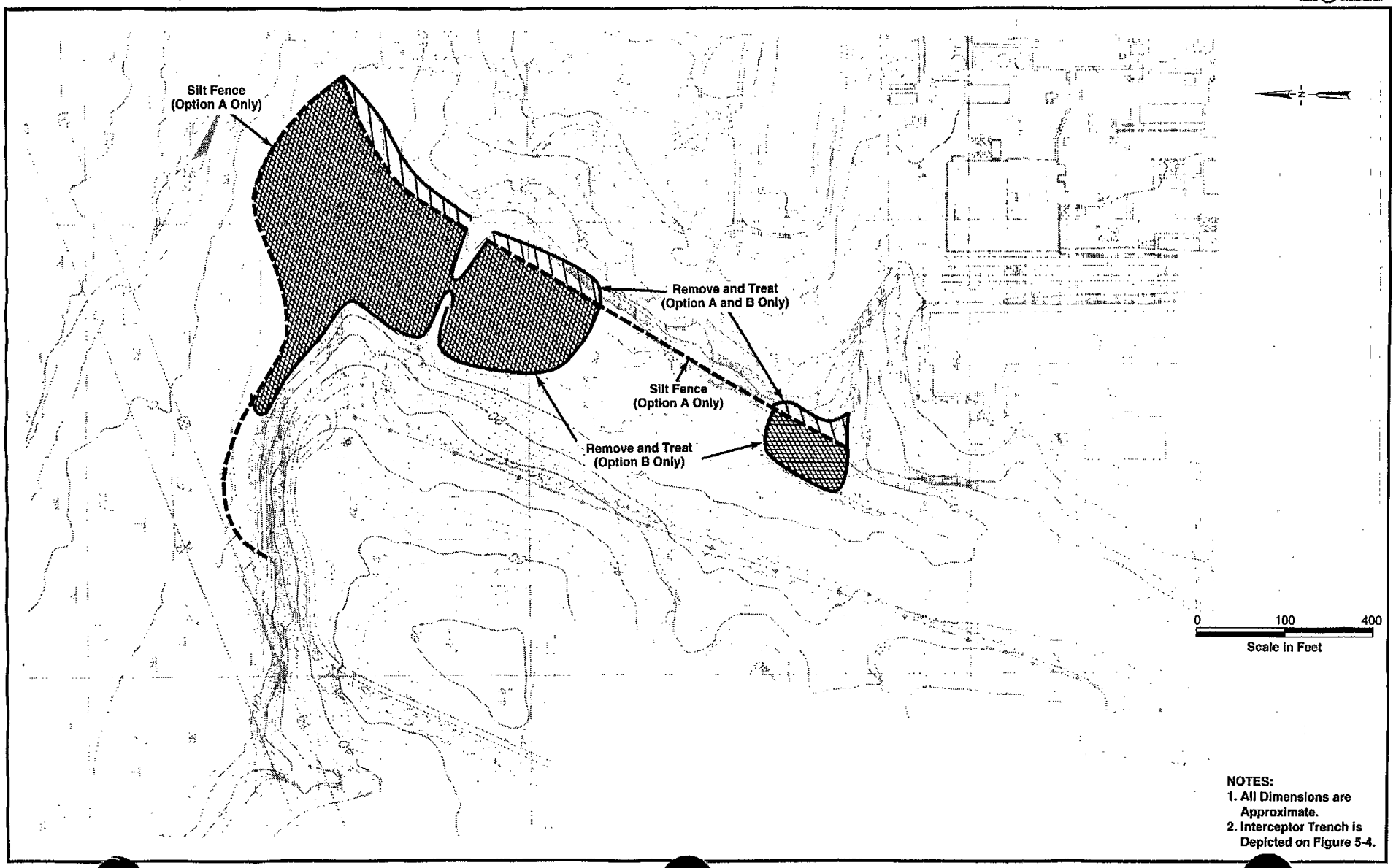

FIGURE 5-8 ALTERNATIVE 4 PROPOSED REMEDIAL A[illegible]N WETLANDS
STANDARD CHLORINE OF DELAWARE, IN[illegible]
DELAWARE CITY, DELAWARE

equipment access and to facilitate trench installation. Construction of the trench would require shoring to maintain the open excavation. The downslope side of the trench would be fitted with an impermeable geomembrane liner. The trench would be backfilled with a perforated collection pipe and granular fill to collect and convey the intercepted groundwater. The piping would be sloped to drain by gravity to collection sumps where it would be pumped out and conveyed back to the air stripper. The piping and sumps would be constructed of material compatible with the groundwater chemistry to maintain long-term integrity. The granular fill for the trench would have to be designed to minimize the potential for clogging. After backfilling, the trench would be capped to minimize surface water infiltration. It has been estimated that this trench will collect 100-120 gpm of groundwater flow. Figure 5-5 depicts a schematic cross-section of the interceptor trench.

The impermeable liner proposed for the interceptor trench is included for several reasons. First, the liner controls downgradient (from the unnamed tributary and Red Lion Creek) groundwater infiltration into the trench system. In the absence of the liner, the trench would draw water from both sides and would result in treatment of additional volume of groundwater, and may adversely impact the wetlands along the shoreline. Second, the liner prevents upgradient groundwater from traveling through the trench. In the absence of the liner, any hydraulic head buildups in the trench, groundwater could infiltration through the downgradient side of the trench, and discharge into surrounding surface water.

As indicated above, groundwater containment could be achieved using slurry walls coupled with vertical groundwater extraction wells. To implement this approach, slurry wall(s) would be substituted for the interceptor trench as described above. Vertical groundwater extraction wells would then be installed to extract contaminated groundwater from the area upgradient of the slurry wall. The implementation of the groundwater extraction system (interceptor trench or slurry walls, etc.) should be decided during remedial design, as more information concerning the geologic stratigraphy along the shoreline of the unnamed tributary and Red Lion Creek is gathered.

- Soil Removal - Readily accessible, highly contaminated surface soils (i.e., greater than 625 mg/kg total chlorobenzene to a maximum depth of 3 feet) along the western drainage gulley, eastern drainage ditch, and CB1 will be removed, and consolidated into the basin, followed by in situ stabilization/solidification. Because the railroad track area is inaccessible to excavation, an asphalt cap will be placed in this area. The materials designated for consolidation are presented in Figure 5-7. These soils would be stabilized and consolidated into a reconstructed sediment basin.

Subsurface soil removal will be performed as described for Alternative 2.

- Sediment Removal - Removal of readily accessible, highly contaminated sediments accessible from the shoreline with the unnamed tributary and Red Lion Creek. The sediment materials designated for removal are presented in Figure 5-8. Option B additionally provides for removal of all sediment above response levels as described below.

- Treatment - Treatment of the removed materials using thermal desorption. Recovered product from the treatment would be sent to the plant for reuse, recovered aqueous phase liquids will be conveyed to the existing air stripper for treatment. Treated soils and sediments would be delisted and used as backfill of the excavations, and those treated materials not delisted would be consolidated into the sedimentation basin. Potentially, all treated materials could be delisted and used as backfill.

- Basin Reconstruction (if needed) - Installation of a new liner and leachate collection system in the sedimentation basin would be planned if treatment cannot achieve levels required for use of this material as clean backfill on-site. The retrofitting would be similar to that described under Alternative 3. A multilayer cap would be placed over the materials upon completion of treatment activities.

- Stabilization/Solidification - Addition of a stabilization/solidification agent, if required, to the treated materials. This would be performed, if required, prior to backfilling the treated materials into the excavations, or sedimentation basin. Stabilization/solidification would be required if the treated materials (soils and sediments) do not meet LDRs. Those materials being used as clean backfill for the excavation would be required to meet delisting criteria.

- Containment - Capping of the surface soils above the response levels that are not removed as described above; specifically, in the railroad track area where removal is not feasible. Surface water diversion measures would be implemented to control runon and runoff. Containment of the sediments in the wetlands, specifically those in the unnamed tributary, would be performed by replacing the existing silt fence.

Option B Only

- Sediment Removal - Removal of all sediments above response levels.

5.5.2 Compliance with ARARs

The current groundwater extraction and treatment system is not fully effective in capturing groundwater exiting to the north of site (into Red Lion Creek and the unnamed tributary). The construction of the interception trench will enhance the effectiveness of groundwater remediation

by improving the capture of groundwater contaminants and limiting their lateral movement off-site. The trench will not substantially accelerate on-site groundwater remediation but will accelerate improvement in surface water quality in the unnamed tributary and Red Loin Creek area. Even with the new interceptor trench and operation of the new DNAPL and existing contaminated groundwater extraction wells, on-site groundwater quality is not expect to achieve MCL levels in the foreseeable future.

When basin sediments are removed and treated ex-situ, land disposal restrictions must be considered as an ARAR before the material is returned to the basin. Minimum technology requirements also must be considered and these include landfill design standards under RCRA. These ARARs have been addressed by thermally treating the removed materials and retrofitting the basin with a liner and leachate collection system. Final capping and closure of the basin would use a multilayer cap system consistent with RCRA Landfill Design Guidance.

Groundwater extracted from the on-site recovery wells, and collected in the interceptor trench would be treated in the existing air stripper and treated water discharged at the NPDES point. Air from the stripper would be burned in the boiler. These activities are consistent with current practices and expected to meet ARARs.

Construction of the access bench for the interception trench will require proper erosion and sedimentation controls to protect wetland areas. This work may also occur in the 100-year floodplain which will require proper design and protective measures, and could be designed to comply with ARARs.

5.5.3 Short-Term Effectiveness

This evaluation criterion involves consideration of community/site personnel protection and environmental impacts during implementation of remedial actions. Under both options of this alternative, several construction and materials handling activities will be implemented. The short-term effectiveness of this alternative is discussed for each activity in the following paragraphs. These discussions apply to both Options A and B except where noted.

Implementation of institutional controls involves no site-intrusive activities and therefore poses no risks. Site monitoring activities are generally non-intrusive (e.g., visual inspections, recordkeeping). Sampling activities implemented under site monitoring would be performed in accordance with health and safety protocols similar to those previous of previous investigations, thus protected workers.

Site-intrusive activities (e.g., removal of soils and sediments, construction associated with the sedimentation basin and the enhanced groundwater recovery system, installation of erosion barriers) generally employ conventional construction and materials handling techniques. Health and safety protocols will be implemented similar to those of previous remedial actions at the site. Engineering controls, such as dust suppressants, may be employed if significant airborne particulates are released these activities.

Thermal desorption is a low temperature method to remove the contaminants from the soils. Because of the low temperature, products of incomplete combustion, as would be associated with a high temperature incinerator, would not be expected. Proper operation of the treatment system, including maintaining a slightly negative pressure in the desorption chamber, will minimize the potential for fugitive emissions. Proper handling of the product-phase treatment residual will also be required to ensure worker safety. Existing plant procedures for handling this residual material will be employed. Option B of this alternative would be expected to pose higher short-term risks due to the additional time required to implement this technology.

5.5.4 Long-Term Effectiveness and Permanence

This evaluation criterion involves consideration of the long-term effectiveness and permanence of the alternative once it has been implemented. The options of this alternative implement several measures to reduce the long-term risk to the surrounding environment.

Enhancement of the current groundwater extraction system (i.e., installation of the interceptor trench) to increase the effectiveness of groundwater contaminant capture should improve surface water quality by reducing the release of groundwater contaminants into the unnamed tributary

and Red Lion Creek. The DNAPL product wells will attempt to recover DNAPL present on top of the confining geologic unit underlying the Columbia Formation. As is commonly acknowledged, the success of any form of DNAPL recovery may be limited. Location and removal of DNAPLs are extremely difficult, as DNAPLs may be very thin and discontinuous. The treatment of extracted groundwater (and DNAPL) represents a permanent treatment of the contaminants.

The effectiveness of the interceptor trench system, under Options A and B, will be dependant on both the chemical compatibility of the construction materials with the site contaminants, and the physical properties encountered in the surrounding soils. The coarse aggregate backfill must be gradationally compatible with the surrounding Columbia Formation soils to prevent soil clogging the aggregate while maintaining an acceptable inflow of groundwater. All treatment system components (e.g., geosynthetic membrane barrier, collection pipe, manholes, pumps, etc.) used within the trench system must be constructed of materials that are compatible with the site contaminants. This ensures that their structural and barrier properties are maintained for an extended duration.

Removal and containment of the readily accessible, highly contaminated surface soils and sediments will reduce the potential exposure from these materials. Removal of subsurface soils, as well as using FML or asphalt to cap backfilled excavations where high concentration subsurface soils remain, will reduce the potential for contaminant migration from soils to groundwater. Capping in high traffic areas such as the rail yard, and CB1 area will utilize asphalt which will have high durability.

Utilizing additional sediment barriers to prevent further migration of contaminants in the sediments in combination with institutional controls to limit the wetlands use will reduce the exposure to these materials.

The removal of sediments along the edge of the wetland will impact approximately 1,050 square yards. Most of the area to be excavated in this alternative has been impacted during past remediation. The area is dominated by early successional herbaceous species such as goldenrods

(*Solidago spp.*), asters (*Aster spp.*), and grasses (Graminae). The area is probably a food source (seed and insects) for small mammals and birds as well as having a developed macroinvertebrate community.

Short-term impacts will include removal of vegetation, a food source and the invertebrate community. Restoration will include backfilling, fine grading and hydroseeding, with natural succession occurring to repopulate the area. Long-term ecological effects will be dependent upon the extent of the excavation and subsequent restoration effects.

The construction of a interception trench will impact approximately 1,700 feet of forest. The forest type is beech (*Fagus grandifolia*), white oak (*Quercus alba*), and tulip poplar (*Liriodendron tulipifera*) with a sassafras (*Lindera benzoin*)-flowering dogwood (*Cornus florida*) understory. This habitat probably serves as a food source and cover for several species of small mammals as well as white-tailed deer. It may also provide nesting habitat for raptors or passerines. The removal of soil will also remove thin vertebrate community inhabiting the soil.

Within the surrounding landscape, wetland, agricultural field and mature forest, are present. Mature forest is located on the side slopes adjacent to the Red Lion Creek floodplain. Since this forest habitat is abundant and the area to be disturbed is minimal, no severe long-term ecological impacts are expected from this alternative since ample cover and food sources are available within the surrounding area. However, depending on the time of initiation of work, some animals may be displaced from their nesting, feeding, and cover areas.

Remediation of temporary impacts due to construction of the trench include backfilling, fine grading and hydroseeding. It is expected that natural succession will occur and reforest a portion of the area and with reforestation, the animals will return. Reforestation of the immediate trench area should not be allowed so that the trench is not damaged by roots. In addition, the macroinvertebrate community will repopulate from the surrounding community into the area after construction is complete.

Monitoring of the area to determine if it has recovered after the disturbance would typically consist of an annual field visit by an ecologist or botanist to determine if vegetation is established and its aerial coverage and if evidence of animal use (tracks, scat) is present. The establishment of vegetation will be considered a positive indicator of animal use if no animal signs are observed. If the aerial coverage is less than 85% after one year, additional restoration may need to be considered. The annual visits will cease upon recommendation of the ecologist.

Option B offers additional effectiveness and permanence. The removal and treatment of all sediments above response levels will further reduce the potential exposure from the wetlands. The wetland area to be impacted is dominated by common reed (*Phragmites australis*) , with isolated pockets of diverse species, including: rice cutgrass (*Leersia oryzoides*), umbrella sedge (*Cyperus spp.*), green bulrush (*Scirpus atrovirens*), boneset (*Eupatorium spp.*), smartweed (*Polygonum punctinatum*) and purple loosestrife (*Lythrum salicaria*). These isolated pockets appear to be found in areas with a greater water depth. Evidence of use by animal species was recorded during field visits. The presence of tadpoles and mosquitos fish (*Gambusia holbrooki*) was also recorded. It is expected that a developed invertebrate community exists.

Short-term impacts will include the construction haul roads into the wetland as well as excavation of the sediments. Haul roads may be placed in areas not previously disturbed; this may result in short-term impacts by the placement of construction mats and fill in areas not previously disturbed. Long-term ecological effects will be dependent upon the extent of the excavation and subsequent restoration effects.

The proposed remediation of the wetland area is expected to leave the area at the excavation depth and allow natural succession. Keeping the area at its excavation depth may inhibit the invasion of the ubiquitous common reed. It is expected that the invertebrate community will reestablish and repopulate/migrate from upstream or downstream of the area and wildlife will inhabit and use the area with the establishment of vegetation. Hydroseeding is not proposed in this area because it will be ineffective due to the water depth, and it has already been shown that the area will revegetate.

Monitoring of the area to determine if it has recovered after the disturbance will consist of a field visit by an ecologist or botanist to determine if vegetation is established and its aerial coverage. Evidence of animal use of the area will be recorded, however, it is expected that with the establishment of vegetation that the area will be used by wildlife. If the aerial coverage is less than 85% in areas not covered by water after one year, additional remediation may need to be considered. Areas covered with water will be allowed additional time for aerial coverage. No special consideration will be given to the species present since common reed is common throughout the area and it covered the area prior to remediation. The annual visits will cease upon recommendation of the ecologist.

5.5.5 Overall Protectiveness of Human Health and Environment

Alternative 4 achieves the remediation objectives by reducing the risks posed through potential exposure routes as follows:

- Under Options A and B, enhancement of the existing groundwater extraction system to recover groundwater that currently exits the site, and DNAPL present beneath the site. This increases the effectiveness of current groundwater remediation activities, thus reducing the exposure to off-site receptors that contact groundwater indirectly (as groundwater discharges into neighboring surface water bodies). It should be noted that there are no known direct users of groundwater from the Columbia Formation. The characteristics of the aquifer in comparison to the Upper Potomac aquifer indicate that it is unlikely that this aquifer would be used as a potable water source in the future.

- Removal and treatment of the readily accessible, highly contaminated surface soils (surface and subsurface) and sediments will minimize their potential for leaching contaminants to surface and groundwater. The removal of these materials will also reduce the potential exposure to receptors through ingestion, contact, and inhalation pathways. Treatment of these materials will reduce the volume of contaminants. Management of the treated materials in the relined and capped sedimentation basin will reduce both the volume of leachate generated, and improve the containment measures of the basin. Remaining high concentration subsurface soils will be subject to decreased surface water infiltration due to the cap construction materials used during excavation closure. These effects are intensified under Option B, as additional sediments are removed.

  Some negative impacts can be expected with regard to removal of sediments. Restoration of the dredged areas would be required after sediments are removed.

The effectiveness of these techniques is variable and may change the natural conditions of the wetlands. Again, these effects are intensified under Option B, as additional sediments are removed.

- Containment, through capping, of the soils in the rail yard will reduce potential exposure from these soils through soil ingestion, dermal contact, and inhalation of airborne dust pathways. The cap will also reduce the volume of leachate generated due to reduced surface water infiltration, thus having a positive impact on subsurface soils and groundwater. Containment of the sediments through the use of sediment barriers (i.e., silt fences) under Option A, will reduce the migration potential of those sediments exhibiting high contaminant concentrations.

- Institution controls to limit future use and site access. Limiting future groundwater use at the site, and restricting use of the wetland areas will reduce potential exposure through groundwater ingestion, and surface water dermal exposure routes. This applies to Options A and B.

- Site monitoring to notify decision-makers of any future changes in site conditions that may warrant reevaluation of remedial strategy. This applies to Options A and B.

5.5.6 Reduction of Toxicity, Mobility, or Volume of Contaminants

Under this alternative, reduction of the TMV would be implemented for groundwater, soils and sediments. Implementation of an enhanced groundwater extraction and interception system would capture larger volumes of groundwater. In addition, low volume DNAPL recovery wells would be utilized to extract DNAPLs situated at the bottom of the Columbia aquifer. The extracted groundwater would undergo treatment via air stripping. Air stripping has been used effectively at the site since 1986, for the treatment of extracted groundwater.

Thermal desorption of soils, and sediments results as prescribed under Options A and B in the permanent removal of contaminants. The contaminants are concentrated into a non-aqueous (product) phase to be reused by the plant. The toxicity of the treated soils and sediments will be confirmed by analytical testing.

5.5.7 Implementability

Technical/administrative considerations for implementation of institutional controls, site security measures, site monitoring, basin reconstruction, the interceptor trench have been previously discussed in Subsection 5.3.7.

Because of the interaction between the various media at the site, and the quantities of materials requiring staging and treatment, careful phasing of this alternative (either option) would be required during implementation. For example, removal of the sediments along the shoreline of the unnamed tributary cannot take place until the groundwater interception system is installed. Further, a monitoring period would be required after installation of the groundwater interception system to verify the effectiveness of the system. This will assure that contaminant input into the unnamed tributary, via the groundwater pathway, is controlled prior to the implementation of remedial activities for sediments. As another example, the limited space available for staging and treatment prohibits removal and treatment of all the materials at one time.

Removal of soils will employ conventional construction techniques. An access road, and staging/stabilization area would be constructed. Dredging of all the sediments above the response levels (as prescribed under Option B only) would be technically difficult, but not impossible. Removing these sediments will require the use of multiple dredging techniques depending on the water level in the area to be dredged. These techniques may include mechanical and hydraulic dredging. Once the materials are removed, dewatering the sediments may be necessary prior to treatment, thus requiring additional support facilities.

Thermal desorption of contaminated materials has been implemented at several other waste sites. Mobile thermal desorption systems are available from several vendors. These transportable units vary in size from approximately 5 to 25 tons per hour. The method of heat input includes direct-fired, indirect-fired, and hot screw conveyor systems. Although all units use desorption as the principal contaminant removal mechanism, the method of off-gas treatment varies. Some of the units are equipped with afterburners (high temperature chamber where off-gases are combusted), while others use a condensation recovery system. A unit with condensation

recovery is advantageous in this application because it allows for product recovery. As the contaminants are desorbed from the soils, the contaminant-laden off-gas enters the condenser where the off-gas is cooled to form liquid condensate. This condensate then goes through phase separation to separate and concentrate the organic phases. The aqueous phase would be discharged to the groundwater treatment system. The recovered organic phase could be reused by the plant.

Utilities, such as electricity, gas, and water are expected to be available in sufficient quantity. A minimum of 5,000 square feet of land surface is required for treatment equipment and support facilities. Access roads may be necessary depending on the placement of the treatment unit.

5.5.8 Estimated Cost

The present worth of Option A and B are $11,680,000 and $17,563,000 respectively. A cost savings (based on present worth) of $1,305,000 for each option would be realized if all removed materials can be delisted and used as backfill. The estimated capital costs are $10,040,000, and $16,026,000 for Option A and B respectively and are presented in Table 5-5. The estimated O&M costs are $106,700, and $100,000 for Option A and B respectively and are presented in Table 5-6.

All costs have been estimated assuming outside contractors, and equipment are utilized except for analytical costs. Cost benefits may be possible if SCD is directly involved in the implementation of the alternative (e.g., through direct purchase of capital equipment, installation of site fences, etc.). Other assumptions are noted on Tables 5-5 and 5-6. Other elements that may significantly impact this cost estimate include, but are not limited to:

- Level of personnel protection (Level B, Level C, etc.)
- Lateral extent of excavations.
- Water content of removed materials.
- Condition of existing sedimentation basin liner.
- Actual depth of interceptor trench.
- Materials of construction used for the sedimentation basin reconstruction, and the interceptor trench.

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TABLE 5-5

Capital Costs for Alternative 4
Standard Chlorine of Delaware, Inc.
Delaware City, Delaware

Tasks	Quantity	Unit Cost ($)	Total Costs ($)
Option A			
1 Excavation			
a. Surface and Subsurface Soils	12,500 cy	15 /cy	187,500
b. Wetlands Sediments	1,050 cy	19 /cy	19,688
c. Basin Sediments	3,350 cy	26 /cy	87,100
2 Site Preparation		Lump Sum	50,000
3 Thermal Desorption Treatment (19,300 cy @ 100 lbs/cf)	26,100 ton	150 /ton	3,915,000
4 Basin Reconstruction			
a. Liner and Leachate Collection System	8,700 sy	40 /sy	348,000
b. Multilayer Cap System	7,400 sy	46 /sy	340,400
5 Backfill of Basin with Treated Sediments (includes soil piles, and trench soils)	12,700 cy	3 /cy	38,100
6 Backfill - Surface and Subsurface Soil Areas			
a. Treated Soils	7,800 cy	3 /cy	23,400
7 Cap Systems			
a. Western Drainage Gulley (FML)	1,400 sy	46 /sy	64,400
b. Eastern Drainage Ditch (asphalt)	300 sy	12 /sy	3,600
c. Railroad Track Area (asphalt)	4,500 sy	12 /sy	54,000
d. Catch Basin (asphalt)	700 sy	12 /sy	8,400
8 Wetlands Reconstruction			
a. Backfill	1,050 cy	18 /cy	18,900
b. Fine Grading	3,000 sy	1 /sy	3,000
c. Revegetation	3,000 sy	7 /sy	21,000
9 Interceptor Trench		Lump Sum	1,430,100
10 Product Recovery Wells	4	2,000 ea	8,000
11 Silt Fencing	2,300 ft	15 /ft	34,500
12 Implementation and Verification Sampling		Lump Sum	100,000
13 Erosion and Sedimentation Controls	4,400 ft	10 /ft	44,000
14 Modifications to Groundwater Treatment System		Lump Sum	100,000
15 Deed/Groundwater Restrictions and Access Agreements		Lump Sum	25,000

TABLE 5-5 (cont'd)

Capital Costs for Alternative 4
Standard Chlorine of Delaware, Inc.
Delaware City, Delaware

Tasks	Quantity	Unit Cost ($)	Total Costs ($)
SUBTOTAL			6,924,088
16 Administrative and Construction Services (20%)			1,384,818
17 Contingency (25%)			1,731,022
CONSTRUCTION TOTAL (rounded)			10,040,000

Implementation requirements for technical issues, testing, plans, approvals, engineering, etc. is not included in the construction total and could range between $200,000 - $300,000.

TABLE 5-5 (cont'd)

Capital Costs for Alternative 4
Standard Chlorine of Delaware, Inc.
Delaware City, Delaware

Tasks	Quantity	Unit Cost ($)	Total Costs ($)
Option B			
1 Excavation			
a. Surface and Subsurface Soils	12,500 cy	15 /cy	187,500
b. Wetlands Sediments	12,000 cy	19 /cy	225,000
c. Basin Sediments	3,350 cy	26 /cy	87,100
2 Site Preparation		Lump Sum	50,000
3 Thermal Desorption Treatment (30,250 cy @ 100 lbs/cf)	40,800 ton	180 /ton	7,344,000
4 Basin Reconstruction			
a. Liner and Leachate Collection System	8,700 sy	40 /sy	348,000
b. Multilayer Cap System	7,400 sy	46 /sy	340,400
5 Backfill of Basin with Treated Sediments (includes soil piles, and trench soils)	23,650 cy	3 /cy	70,950
6 Backfill - Surface and Subsurface Soil Areas			
a. Treated Soils	7,800 cy	3 /cy	23,400
7 Cap Systems			
a. Western Drainage Gulley (FML)	1,400 sy	46 /sy	64,400
b. Eastern Drainage Ditch (asphalt)	300 sy	12 /sy	3,600
c. Railroad Track Area (asphalt)	4,500 sy	12 /sy	54,000
d. Catch Basin (asphalt)	700 sy	12 /sy	8,400
8 Wetlands Reconstruction			
a. Backfill	12,000 cy	18 /cy	216,000
b. Fine Grading	36,000 sy	1 /sy	36,000
c. Revegetation	36,000 sy	7 /sy	252,000
9 Interceptor Trench		Lump Sum	1,430,100
10 Product Recovery Wells	4	2,000 ea	8,000
11 Silt Fencing	2,300 ft	15 /ft	34,500
12 Implementation and Verification Sampling		Lump Sum	100,000
13 Erosion and Sedimentation Controls	4,400 ft	10 /ft	44,000
14 Modifications to Groundwater Treatment System		Lump Sum	100,000
15 Deed/Groundwater Restrictions and Access Agreements		Lump Sum	25,000

TABLE 5-5 (cont'd)

Capital Costs for Alternative 4
Standard Chlorine of Delaware, Inc.
Delaware City, Delaware

Tasks	Quantity	Unit Cost ($)	Total Costs ($)
SUBTOTAL			11,052,350
14 Administrative and Construction Services (20%)			2,210,470
15 Contingency (25%)			2,763,088
TOTAL (rounded)			16,026,000

Implementation requirements for technical issues, testing, plans, approvals, engineering, etc. is not included in the construction total and could range between $200,000 - $300,000.

TABLE 5-6

Operation and Maintenance (O&M) Costs for Alternative 4
Standard Chlorine of Delaware, Inc.
Delaware City, Delaware

Tasks	Total Costs ($)
Option A	
1 Maintenance of Multilayer Cap	10,000
2 Asphalt Cap Maintenance	5,000
3 Maintenance of Interceptor Trench	10,000
4 Silt Fence Maintenance (5% of installed cost)	1,700
5 Site Monitoring (Sample Analyses Performed by SCD)	35,000
6 Groundwater Treatment System O&M	45,000
TOTAL ANNUAL O&M COSTS	106,700
Option B	
1 Maintenance of Multilayer Cap	10,000
2 Maintenance of Interceptor Trench	10,000
3 Site Monitoring (Sample Analyses Performed by SCD)	35,000
4 Groundwater Treatment System O&M	45,000
TOTAL ANNUAL O&M COSTS	100,000

- Ability of treated soils/sediments to be used as clean backfill.

5.6 ALTERNATIVE 5

5.6.1 Description

Two options (Option A and Option B) are included in this alternative. Control measures, including institutional controls, site security, and monitoring, are implemented under both options as described under Alternative 2. Option A of this alternative addresses media posing a risk to human health and the environment by removal, and treatment via ex situ biological methods. Option B of this alternative implements a program of in situ treatment.

The key components of Alternative 5 are as follows:

Options A and B

- Enhanced Groundwater Interception and Treatment - This is the same program as described for Alternative 4.

Option A

- Removal - Removal of accessible surface soils and sediments above response levels. The materials designated for removal are identical to those identified for Alternative 4, Option B (see Figures 5-7 and 5-8).

- Ex Situ Biological Treatment - Treatment of the surface soils and sediments using ex situ biological treatment. Recovered aqueous phase liquids will be conveyed to the groundwater treatment system for treatment. Treated soils and sediments would be used for backfill of the excavations, and those treated materials not used as backfill would be consolidated into the sedimentation basin.

- Basin Reconstruction (if needed) - Installation of a new liner and leachate collection system in the sedimentation basin. If treated soils/sediments do not meet acceptable residual concentrations, a multilayer cap would be placed over the materials upon completion of treatment activities.

- Stabilization/Solidification - Addition of a stabilization/solidification agent, if required, to the treated materials. This would be performed, if required, prior to backfilling the treated materials into the excavations, or sedimentation basin. Stabilization/solidification would be required if the treated materials (soils and

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sediments) do not meet LDRs. Those materials being used as clean backfill for the excavation would need to meet acceptable residual concentrations.

Option B

- In Situ Biological Treatment - Treatment of all materials exceeding response levels would be performed using in situ biological treatment. This would include: surface soils, sediments, soil piles, and sediments in the sedimentation basin. Subsurface soils underlying surface soils above the response levels would also be treated.

5.6.2 Compliance with ARARs

The current groundwater extraction and treatment system is not fully effective in capturing groundwater exiting to the north of site (into Red Lion Creek and the unnamed tributary). The construction of the interception trench will enhance the effectiveness of groundwater remediation by improving the capture of groundwater contaminants and limiting their lateral movement off-site. The trench will not substantially accelerate on-site groundwater remediation but will accelerate improvement in surface water quality in the unnamed tributary and Red Lion Creek area. Even with the new interceptor trench and operation of the new low volume DNAPL and existing contaminated groundwater extraction wells, on-site groundwater quality is not expected to achieve MCL levels in the foreseeable future.

When basin sediments are removed and treated ex-situ (Option A only), land disposal restrictions must be considered as an ARAR before the material is returned to the basin. Minimum technology requirements also must be considered and these include landfill design standards under RCRA. These ARARs have been addressed by biologically treating the removed materials and retrofitting the basin with a liner and leachate collection system. Final capping and closure of the basin would use a multilayer cap system consistent with RCRA Landfill Design Guidance. Under Option B, land disposal restrictions are not applicable as treatment is performed in situ.

Groundwater extracted from the wells and collected in the trench would be treated in the existing air stripper, and the treated water discharged at the NPDES point. Air from the stripper would

be burned in the boiler. These activities are consistent with current practices and expected to meet ARARs.

Construction of the access bench for the interception trench will require proper erosion and sedimentation controls to protect wetland areas. This work may also occur in the 100-year floodplain which will require proper design and protective measures, and could be designed to comply with ARARs.

5.6.3 Short-Term Effectiveness

This evaluation criterion involves consideration of community/site personnel protection and environmental impacts during implementation of remedial actions. Under both options of this alternative, several construction and materials handling activities will be implemented. The short-term effectiveness of this alternative is discussed for each activity in the following paragraphs.

Under Option A of this alternative, short-term impacts to the surrounding environment are mainly expected from the removal actions taking place. These impacts have been previously discussed in Subsection 5.4.3.

Under Option B of this alternative, additional short-term impacts may be expected from the injection of microorganisms and/or nutrients into the soils. Capture of these materials, and the mobile byproducts of biodegradation, prior to exiting off-site will be accomplished by the enhanced groundwater extraction system. Capture of amendments added to the wetland areas is not likely, and therefore the impacts would require investigation.

5.6.4 Long-Term Effectiveness and Permanence

This evaluation criterion involves consideration of the long-term effectiveness and permanence of the alternative once it has been implemented. The long-term effectiveness of biological treatment, either in situ or ex situ, is currently undergoing investigation (WESTON, 1992).

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Specifically, the limited amount of literature and experience has instigated a treatability study to determine the potential of biological activity to degrade the site contaminants. Results of this treatability study will be incorporated into this FS as they become available. Biological treatment at other sites has proven to be a reliable, permanent remedy.

The removal of sediments along the edge of the wetland under Option A will impact approximately 1,050 square yards. Most of the area to be excavated in this alternative has been impacted during past remediation. The area is dominated by early successional herbaceous species such as goldenrods (*Solidago spp.*), asters (*Aster spp.*), and grasses (Graminae). The area is probably a food source (seed and insects) for small mammals and birds as well as having a developed macroinvertebrate community.

Short-term impacts will include removal of vegetation, a food source and the invertebrate community. Restoration will include backfilling, fine grading and hydroseeding, with natural succession occurring to repopulate the area. Long-term ecological effects will be dependent upon the extent of the excavation and subsequent restoration effects.

The construction of a interception trench will impact approximately 1,700 feet of forest. The forest type is beech (*Fagus grandifolia*), white oak (*Quercus alba*), and tulip poplar (*Liriodendron tulipifera*) with a sassafras (*Lindera benzoin*)-flowering dogwood (*Cornus florida*) understory. This habitat probably serves as a food source and cover for several species of small mammals as well as white-tailed deer. It may also provide nesting habitat for raptors or passerines. The removal of soil will also remove thin vertebrate community inhabiting the soil.

Within the surrounding landscape, wetland, agricultural field and mature forest, are present. Mature forest is located on the side slopes adjacent to the Red Lion Creek floodplain. Since this forest habitat is abundant and the area to be disturbed is minimal, no severe long-term ecological impacts are expected from this alternative since ample cover and food sources are available within the surrounding area. However, depending on the time of initiation of work, some animals may be displaced from their nesting, feeding, and cover areas.

Remediation of temporary impacts due to construction of the trench include backfilling, fine grading and hydroseeding. It is expected that natural succession will occur and reforest a portion of the area and with reforestation, the animals will return. Reforestation of the immediate trench area should not be allowed so that the trench is not damaged by roots. In addition, the macroinvertebrate community will repopulate from the surrounding community into the area after construction is complete.

Monitoring of the area to determine if it has recovered after the disturbance would typically consist of an annual field visit by an ecologist or botanist to determine if vegetation is established and its aerial coverage and if evidence of animal use (tracks, scat) is present. The establishment of vegetation will be considered a positive indicator of animal use if no animal signs are observed. If the aerial coverage is less than 85 % after one year, additional restoration may need to be considered. The annual visits will cease upon recommendation of the ecologist.

The wetland area to be impacted is dominated by common reed (*Phragmites australis*) , with isolated pockets of diverse species, including: rice cutgrass (*Leersia oryzoides*), umbrella sedge (*Cyperus spp.*), green bulrush (*Scirpus atrovirens*), boneset (*Eupatorium spp.*), smartweed (*Polygonum punctinatum*) and purple loosestrife (*Lythrum salicaria*). These isolated pockets appear to be found in areas with a greater water depth. Evidence of use by animal species was recorded during field visits. The presence of tadpoles and mosquitos fish (*Gambusia holbrooki*) was also recorded. It is expected that a developed invertebrate community exists.

Short-term impacts will include the construction access roads into the wetland. Access roads may be placed in areas not previously disturbed; this may result in short-term impacts by the placement of construction mats and fill in areas not previously disturbed. Long-term ecological effects will be dependent upon the extent of the disturbance and subsequent restoration effects.

Monitoring of the area to determine if it has recovered after the disturbance will consist of a field visit by an ecologist or botanist to determine if vegetation is established and its aerial coverage. Evidence of animal use of the area will be recorded, however, it is expected that with the establishment of vegetation that the area will be used by wildlife. If the aerial coverage is

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less than 85% in areas not covered by water after one year, additional remediation may need to be considered. Areas covered with water will be allowed additional time for aerial coverage. No special consideration will be given to the species present since common reed is common throughout the area and it covered the area prior to remediation. The annual visits will cease upon recommendation of the ecologist.

5.6.5 Overall Protectiveness of Human Health and Environment

Both options of Alternative 5 achieve the remediation objectives by reducing the risks posed through potential exposure routes as follows:

- Institution controls to limit future use and site access. Limiting future groundwater use at the site, and restricting use of the wetland areas will reduce potential exposure through groundwater ingestion, and surface water dermal exposure routes.

- Site monitoring to notify decision-makers of any future changes in site conditions that may warrant reevaluation of remedial strategy.

- Enhancement of the existing groundwater extraction interception system to recover groundwater that currently exits the site, and DNAPL present beneath the site. This increases the effectiveness of current groundwater remediation activities, thus reducing the exposure to off-site receptors that contact groundwater either directly (as a potable water source) or indirectly (as groundwater discharges into neighboring surface water bodies). It should be noted that there are no known direct users of groundwater from the Columbia Formation. The characteristics of the aquifer in comparison to the upper Potomac aquifer indicate that it is unlikely that the Columbia aquifer would be used as a potable water source in the future.

- Treatment of contaminated surface soils and sediments. Under both options, the treatment of these materials will reduce the potential exposure to receptors through soil ingestion, soil and sediment dermal contact, inhalation of airborne dust, and surface water dermal contact pathways. Option B offers additional protection because subsurface soils also are treated. Treatment of these subsurface soils may have a positive impact on groundwater quality.

5.6.6 Reduction of Toxicity, Mobility, or Volume of Contaminants

Under this alternative, reduction of the TMV would be implemented for groundwater. Implementation of an enhanced groundwater extraction system would capture larger volumes of contaminated groundwater. In addition, low volume product recovery wells would be utilized to extract DNAPL situated at the bottom of the Columbia aquifer. The extracted groundwater would undergo treatment via air stripping. Air stripping has been used effectively at the site since 1986, for the treatment of extracted groundwater.

As previously stated, the ability of biological treatment to reduce the TMV of site contaminants is currently under investigation. If successful, biological treatment could be expected to mineralize (i.e., break down organics to CO_2 and H_2O) and/or dechlorinate the site contaminants. Based on available literature, it is expected that an aerobic process would resultant in mineralization, while an anaerobic process would result in dechlorination. The applicability of aerobic processes lies primarily with the lower chlorinated benzenes, particularly monochlorobenzene, while anaerobic processes may be more suitable for the more highly substituted chlorinated benzenes.

5.6.7 Implementability

Technical/administrative considerations for implementation of institutional controls, site security measures, and site monitoring have been previously discussed in Subsection 5.3.7. Considerations for implementing the enhanced groundwater extraction and treatment system (implemented under Options A and B), basin reconstruction (implemented under Option A, if necessary) and excavation/dredging (implemented under Option A) activities have been previously discussed in Subsection 5.5.7.

Because of the interaction between the various media at the site, and the quantities of materials requiring staging and treatment, careful phasing of Option A of this alternative would be required during implementation. For example, removal of the sediments along the shoreline of the unnamed tributary cannot take place until the groundwater interception system is installed.

Further, a monitoring period would be required after installation of the groundwater interception system to verify the effectiveness of the interception system. This will assure that contaminant input into the unnamed tributary, via the groundwater pathway, is controlled prior to the implementation of remedial activities for sediments. The limited space available for staging and treatment prohibits removal and treatment of all the materials at one time. The expected slower reaction rate of biological treatment, when compared to thermal treatment, makes it necessary to handle smaller quantities so that these materials are not staged for extended periods of time.

The specific method for biological treatment (in situ or ex situ) of the soils and sediments will be identified pending completion of treatability studies. As previously indicated, a treatability study investigating both aerobic and anaerobic degradation is currently being conducted. This study will help to identify the viability of these treatment mechanisms, and can focus future studies to develop process-implementation information. In general, an ex situ treatment system would require a cleared level area for process equipment and support facilities. Utilities, such as gas, electric, and water are assumed to be available. An in situ system would require less facilities, as no materials staging and few aboveground process equipment are required.

Removal of contaminated surface soils (Option A only) will employ conventional construction techniques. An access road, and staging/stabilization area would be constructed. Dredging of all the sediments above the response levels (as prescribed under Option A only) would be technically difficult, but not impossible. Removing these sediments may require the use of multiple dredging techniques depending on the water level in the area to be dredged. These techniques may include mechanical and hydraulic dredging. Once the materials are removed, dewatering the sediments may be necessary prior to treatment, thus requiring additional support facilities.

In situ application of biological treatment (as prescribed under Option B) to soils would involve the installation of a network of injection points or infiltration galleries. An aqueous mixture of microbes (if required), and nutrients (nitrogen, phosphorous, and trace metals) would be injected in the target areas. The flow of water would contact targeted materials, promoting microbial degradation. The enhanced groundwater extraction system, with possible modification, would

be used to recover the aqueous mixture. Application in the soil piles and sedimentation basin would operate similarly, although the aqueous mixture recovery would be performed within the unit (soil pile or basin).

In situ application in the wetland areas would potentially involve periodical direct application of amendments (microbes and nutrients) to the sediments. It is anticipated that these amendments would not be mixed directly into the sediments, rather, natural percolation, diffusion, and other transport mechanisms would allow the amendments to penetrate the sediments. Application in areas of high concentration (such as seeps) would require more extensive treatment. This extensive treatment might involve construction of treatment plots. These treatment plots would be contained areas (bounded by silt fences), into which amendments could be directly applied to the sediments.

5.6.8 Estimated Cost

Present worth estimated costs for this alternative ranged from $10,594,000 to $12,863,000 and $6,615,000 to $7,827,000 for Options A and B, respectively. The estimated capital costs range from $9,057,000 to $11,326,000, and $4,931,000 to $6,443,000 for Options A and B respectively and are presented in Table 5-7. The estimated annual O&M costs are $100,000, and $90,000 for Options A and B respectively and are presented in Table 5-8. All costs have been estimated assuming outside contractors, and equipment are utilized unless otherwise noted. Cost benefits may be expected if SCD is directly involved in the implementation of the alternative (e.g., through direct purchase of capital equipment, installation of site fences, etc.). Other assumptions are noted on Tables 5-7 and 5-8. Other elements that may significantly impact this cost estimate include:

- Level of personnel protection (Level B, Level C, etc.)
- Lateral extent of excavations.
- Stabilization/solidification agent used.
- Length of time required for treatment.
- Condition of existing sedimentation basin liner.
- Actual depth of interceptor trench.
- Effectiveness of the biological treatment system.

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- Materials of construction used for the sedimentation basin reconstruction, and the interceptor trench.
- Ability to use treated soils/sediment as clean backfill.

TABLE 5-7

Capital Costs for Alternative 5
Standard Chlorine of Delaware, Inc.
Delaware City, Delaware

Tasks	Quantity	Unit Cost ($)	Total Costs ($)
Option A			
1 Excavation			
a. Surface Soils	12,500 cy	15 /cy	187,500
b. Wetlands Sediments	12,000 cy	22 /cy	268,500
c. Basin Sediments	3,350 cy	26 /cy	87,100
2 Site Preparation		Lump Sum	50,000
3 Biological Treatment System (a)	30,250 cy	75-150 /cy	2,268,750 to 4,537,500
4 Basin Reconstruction			
a. Liner and Leachate Collection System	8,700 sy	40 /sy	348,000
b. Multilayer Cap System	7,400 sy	46 /sy	340,400
5 Backfill - Surface Soil Areas			
a. Treated Soils	7,800 cy	3 /cy	23,400
6 Cap Systems			
a. Western Drainage Gulley (FML)	1,400 sy	46 /sy	64,400
b. Eastern Drainage Ditch (asphalt)	300 sy	12 /sy	3,600
c. Railroad Track Area (asphalt)	4,500 sy	12 /sy	54,000
d. Catch Basin (asphalt)	700 sy	12 /sy	8,400
7 Wetlands Reconstruction			
a. Backfill	12,000 cy	18 /cy	216,000
b. Fine Grading	33,000 sy	1 /sy	33,000
c. Revegetation	33,000 sy	7 /sy	231,000
8 Interceptor Trench		Lump Sum	1,430,100
9 Product Recovery Wells	4	2,000 ea	8,000
10 Silt Fencing	1,000 ft	15 /ft	15,000
11 Implementation and Verification Sampling			100,000
12 Erosion and Sedimentation Controls	5,700 ft	10 /ft	57,000
13 Modifications to Groundwater Treatment System		Lump Sum	100,000

TABLE 5-7 (cont'd)

Capital Costs for Alternative 5
Standard Chlorine of Delaware, Inc.
Delaware City, Delaware

Tasks	Quantity	Unit Cost ($)	Total Costs ($)
SUBTOTAL			5,894,150 to 8,162,900
12 Administrative and Construction Services (25%) (b)			1,757,100
13 Contingency (20%) (b)			1,405,700
TOTAL (rounded)			9,057,000 to 11,326,000

Implementation requirements for technical issues, testing, plans, approvals, engineering, etc. is not included in the construction total and could range between $300,000 - $400,000.

Notes:

(a) - Due to uncertainties associated with this treatment technolgy, a range of costs is provided.
(b) - Administrative and contingency percentages applied to subtotal average.

TABLE 5-7 (cont'd)

Capital Costs for Alternative 5
Standard Chlorine of Delaware, Inc.
Delaware City, Delaware

Tasks	Quantity	Unit Cost ($)	Total Costs ($)
Option B			
1 In - Situ Biological Treatment (a) (includes maintenance of injection system)	30,250 cy	50-100 /cy	1,512,500 to 3,025,000
2 Interceptor Trench		Lump Sum	1,430,100
3 Product Recovery Wells	4	2,000 ea	8,000
4 Silt Fencing	1,000 ft	15 /ft	15,000
5 Verification Sampling		Lump Sum	100,000
6 Modifications to Groundwater Treatment System		Lump Sum	100,000
SUBTOTAL			3,165,600 to 4,678,100
6 Administrative and Construction Services (25%) (b)			980,500
7 Contingency (20%) (b)			784,400
TOTAL (rounded)			4,931,000 to 6,443,000

Implementation requirements for technical issues, testing, plans, approvals, engineering, etc. is not included in the construction total and could range between $500,000 - $600,000.

Notes:
(a) - Due to uncertainties associated with this treatment technolgy, a range of costs is provided.
(b) - Administrative and contingency percentages applied to subtotal average.

TABLE 5-8

Operation and Maintenance (O&M) Costs for Alternative 5
Standard Chlorine of Delaware, Inc.
Delaware City, Delaware

Tasks	Total Costs ($)
Option A	
1 Maintenance of Multilayer Cap	10,000
2 Maintenance of Interceptor Trench	10,000
3 Site Monitoring (Sample Analyses Performed by SCD)	35,000
4 Groundwater Treatment System O&M	45,000
TOTAL ANNUAL O&M COSTS	100,000
Option B	
1 Maintenance of Interceptor Trench	10,000
2 Site Monitoring (Sample Analyses Performed by SCD)	35,000
3 Groundwater Treatment System O&M	45,000
TOTAL ANNUAL O&M COSTS	90,000

SECTION 6

COMPARATIVE ANALYSIS OF ALTERNATIVES

In this section, the alternatives are evaluated in relation to one another for each of the evaluation criteria identified in Subsection 5.1. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative. These remedial alternatives, named after the primary remedial approach taken by each alternative are:

- Alternative 1: No action
- Alternative 2: Containment
- Alternative 3: Closure
- Alternative 4: Thermal Treatment
- Alternative 5: Biological Treatment

Table 6-1 presents a summary matrix of the remedial actions undertaken for each alternative. Table 6-2 summarizes and compares the alternatives in terms of the evaluation criteria. In addition, Table 6-2 contains the estimated total present worth cost for implementing each of the alternatives. Where significant cost uncertainties were identified for a particular alternative, an estimated range of cost is provided.

6.1 COMPLIANCE WITH ARARS

Table 6-3 provides a comparative summary of the five alternatives in terms of compliance with ARARs previously identified in Section 2. Based upon this comparative analysis:

- Alternatives 2, 3, 4, and 5 were judged to meet the ARARs, although the sediment removal/in situ treatment actions provided in Alternatives 3, 4, and 5 are expected to have negative impacts on the wetlands. The degree to which these alternative were protective of groundwater varied in the amount of source removal.

- Alternative 1 was judged to have limitations with the ARARs compliance evaluation criterion. This was due to the fact that no provisions were provided for compliance with MCLs, continued discharge of groundwater to the Unnamed Tributary and Red Lion Creek may result in surface water quality criteria exceedances, and no provisions were provided for closure of the sedimentation

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TABLE 6-1

Remedial Action Alternatives Summary
Standard Chlorine of Delaware, Inc.

General Response Action			1	2	3	4A	4B	5A	5B
Medium	Technology Type	Area or Volume	No Action	Containment	Closure	Thermal Treatment	Thermal Treatment	Biological Treatment	Biological Treatment
Soil	Institutional Controls (fencing)	Sedimentation Basin		•	•	•	•	•	•
	Removal (Excavation)	Readily accessible, highly contaminated		•	•	•	•	•	
		Selected subsurface		•	•	•	•	•	
		Sedimentation basin sediments			•	•	•	•	
	In Situ (in basin) Stabilization	Excavated materials		•					
	Ex Situ Stabilization	Excavated materials			•	O	O	O	
	Capping	Excavated areas		•	•	•	•	•	
		Catch Basin		•	•	•	•	•	
		Railroad Track Area		•	•	•	•	•	
	Basin Reconstruction	Sedimentation Basin .			•	O	O	O	
	Thermal Desorption	Excavated materials				•	•		
	Biological Treatment	Ex Situ						•	
		In Situ							•

NOTES:

- • - Included as part of remedial alternative.
- O - May be included, if necessary, as part of remedial alternative.

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TABLE 6-1(cont'd)

Remedial Action Alternatives Summary
Standard Chlorine of Delaware, Inc.

General Response Action			1	2	3	4A	4B	5A	5B
Medium	Technology Type	Area or Volume	No Action	Containment	Closure	Thermal Treatment	Thermal Treatment	Biological Treatment	Biological Treatment
Sediment	Institutional Controls (fencing)	Unnamed Tributary		•	•	•		•	•
	Institutional Controls (silt fencing)	Unnamed Tributary		•	•	•			
	Institutional Controls (deed restrictions)	Red Lion Creek and Unnamed Tributary		•	•	•			
	Institutional Controls (monitoring)	Wetlands		•	•	•	•	•	•
	Removal (dredging/excavation)	Readily accessible, highly contaminated			•	•	•	•	
		All sediments above response levels					•	•	
	In Situ (in basin) Stabilization	Removed materials		•					
	Ex Situ Stabilization	Removed materials			•	O	O	O	
	Thermal Desorption	Removed materials				•	•		
	Biological Treatment	Ex Situ						•	
		In Situ							•

NOTES:

- • - Included as part of remedial alternative.
- O - May be included, if necessary, as part of remedial alternative.

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TABLE 6-1 (cont'd)

Remedial Action Alternatives Summary
Standard Chlorine of Delaware, Inc.

General Response Action			1	2	3	4A	4B	5A	5B
Medium	Technology Type	Area or Volume	No Action	Containment	Closure	Thermal	Thermal	Biological	Biological
Ground-water	Institutional Controls (deed restrictions)	Entire site		•	•	•	•	•	•
	Institutional Controls (well restrictions)	Entire site		•	•	•	•	•	•
	Institutional Controls (monitoring)	Entire site		•	•	•	•	•	•
	Extraction	Using existing extraction wells		•	•	•	•	•	•
		Using additional extraction wells		•					
		Using product		•	•	•	•	•	•
	Interception	Using interceptor			•	•	•	•	•
	Treatment (air stripping)	All removed groundwater		•	•	•	•	•	•
	Discharge	Local stream		•	•	•	•	•	•

NOTES:

- • - Included as part of remedial alternative.
- o - May be included, if necessary, as part of remedial alternative.

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TABLE 6-2

Summary and Comparison of Remedial Alternatives
Standard Chlorine of Delaware, Inc.

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Containment	Alternative 3 Closure[1]	Alternative 4 Thermal Treatment[1]		Alternative 5 Biological Treatment[1]	
				Option A	Option B	Option A	Option B
Compliance with ARARs	Will not meet several ARARs. (MCLs, Surface water quality criteria (SWQC), and RCRA closure)	Closure of basin is provided. Not expected to meet MCLs in on-site groundwater in forseeable future. Expected to reduce groundwater flux of contaminants into surface water to address SWQC. Site monitoring to track remedial progress.	Closure of basin is provided. Not expected to meet MCLs in on-site groundwater in the foreseeable future. Provides a barrier to groundwater contaminant flux into surface water to address SWQC. Land Disposal Restrictions (LDRs) and landfill MTRs addressed. Negative impacts to wetlands and surface water during dredging may conflict with Executive Order on Wetlands Protection.	Same as Alternative 3 except: 1) RCRA LDRs are addressed through thermal treatment.	Same as Alternative 4, Option A.	Same as Alternative 3 except: 1) RCRA LDRs are addressed through biological treatment.	Same as Alternative 3 except: 1) RCRA LDRs are not applicable to in situ treatment, and 2) Onsite groundwater expected to meet MCLs sooner due to extensive surface and subsurface soil treatment.

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TABLE 6-2 (Cont'd)

Summary and Comparison of Remedial Alternatives
Standard Chlorine of Delaware, Inc.

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Containment	Alternative 3 Closure[1]	Alternative 4 Thermal Treatment[1]		Alternative 5 Biological Treatment[1]	
				Option A	Option B	Option A	Option B
Overall Protection of Human Health and the Environment	Evaluated quantitatively through the baseline risk assessment (Subsection 1.5).	An improved groundwater extraction and treatment system, including provisions for DNAPL recovery, is provided to reduce offsite migration of groundwater contaminants. Removal and containment, in the capped basin, of surface and subsurface soils with high concentrations is provided to reduce potential future exposure. Containment, through capping, of subsurface soils and railroad area soils expected to reduce migration of contaminants into groundwater. Access and deed restrictions are provided to limit potential future exposure.	An enhanced groundwater extraction and treatment system, including provisions for DNAPL recovery, is provided to eliminate offsite migration of groundwater contaminants. Removal, and containment, in the reconstructed basin, of those materials with high concentrations is provided to reduce potential future exposure. Basin reconstruction will provide more effective capture of generated leachate. Capping of subsurface soils will reduce infiltration to groundwater. Access and deed restrictions are provided to limit potential future exposure.	Same as Alternative 3 except: 1) Additional protection from the permanent removal of contaminants from excavated materials.	Same as Alternative 4, Option A except: 1) Removal and treatment of all sediments exceeding response levels provides maximum protection.	Same as Alternative 4, Option B.	An enhanced groundwater extraction and treatment system, including provisions for DNAPL recovery, is provided to eliminate offsite migration of groundwater contaminants. In situ biological treatment will provide treatment of surface and subsurface soils, reducing possible contaminant migration into groundwater.

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Summary and Comparison of Remedial Alternatives
Standard Chlorine of Delaware, Inc.

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Containment	Alternative 3 Closure[1]	Alternative 4 Thermal Treatment[1]		Alternative 5 Biological Treatment[1]	
				Option A	Option B	Option A	Option B
Short-Term Effectiveness	Short-term impacts are expected to increase as the groundwater extraction system operation ceases.	Removal and treatment of soils could result in localized airborne emissions, particularly dust. Safe engineering practices would be employed to minimize exposure. Installation of fences (on-site and in wetlands) is not very intrusive; engineering controls can be utilized to minimize exposure.	Same as Alternative 2 except: 1) Negative impacts to wetlands due to sediment removal, and 2) more potential exposure during groundwater interception system construction.	Same as Alternative 3 except: 1) Thermal desorption of soils and sediments could result in localized airborne emissions. Air pollution control equipment is present on all thermal desorption to minimize these emissions.	Same as Alternative 4, Option A except: 1) Additional short-term impacts are expected due to the increased volume of material being handled, and the increased time required for completion of treatment. 2) Additional adverse impacts to wetlands due to extensive sediment removals.	Removal of sediments would have negative impacts on wetlands and surface water. Hazards, both physical and chemical, are present during the construction of the enhanced groundwater extraction system. Biological treatment is a relatively slow reaction rate process (when compared to thermal treatment), therefore, impacts during implementation would be spread over a longer period of time (when compared to Alternative 4).	Short-term impacts are reduced due to the reduced materials handling required. Hazards, both physical and chemical, are present during the construction of the enhanced groundwater extraction system. The short-term impacts of in situ biological treatment in the wetland and non-wetland areas would require study.

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TABLE 6-2 (Cont'd)

Summary and Comparison of Remedial Alternatives
Standard Chlorine of Delaware, Inc.

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Containment	Alternative 3 Closure[1]	Alternative 4 Thermal Treatment[1]		Alternative 5 Biological Treatment[1]	
				Option A	Option B	Option A	Option B
Long-Term Effectiveness and Permanence	No permanent measures implemented. Contaminant migration expected to increase as the containment features of the soil piles and sedimentation basin deteriorate.	Long-term effects would reduced by consolidating, stabilizing, and capping those surface and subsurface soils of high concentration. Long-term effects would be expected to decrease, improved onsite groundwater extraction and treatment continues. Effect of product recovery uncertain. Deed and access restrictions would further limit the future potential exposure. Effectiveness of restrictions in the wetland areas will depend on enforcement. Stabilization effectiveness must be demonstrated.	Interception trench provides a more effective barrier to off-site groundwater flow. Containment of materials in the basin, and installation of caps will reduce exposure to those materials and reduce contaminant migration into groundwater. New liner system in sedimentation basin improves permanence and allows leachate collection. Long-term effects as described in Alternative 2 also apply.	Interception trench provides a more effective barrier to off-site groundwater flow. Thermal treatment of the removed materials, and installation of caps will reduce exposure to those materials and reduce contaminant migration into groundwater. Thermal treatment represent a permanent destruction of the contaminants. Long-term effects as described in Alternative 2 also apply.	Same as Alternative 4, Option A except: 1) More materials are removed and treated.	Interception trench provides a more effective barrier to off-site groundwater flow. Biological treatment of the removed materials will reduce exposure to those materials and reduce contaminant migration into groundwater. Biological treatment effectiveness must be demonstrated. Long-term effects as described in Alternative 2, Option A also apply.	Interception trench provides a more effective barrier to off-site groundwater flow. Biological treatment of surface and subsurface materials will reduce exposure to those materials and significantly reduce contaminant migration into groundwater. Biological treatment effectiveness must be demonstrated. Long-term effects as described in Alternative 2, Option A also apply.

AR307553

Summary and Comparison of Remedial Alternatives
Standard Chlorine of Delaware, Inc.

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Containment	Alternative 3 Closure[1]	Alternative 4 Thermal Treatment[1]		Alternative 5 Biological Treatment[1]	
				Option A	Option B	Option A	Option B
Reduction of Toxicity, Mobility, or Volume	Reduction expected only through natural attenuation processes.	The mobility of high concentration contaminants in surface and subsurface soils and the railroad area is reduced by consolidation, stabilization, and capping (in the basin). The mobility of contaminants in remaining subsurface soils is reduced by capping. Improved groundwater extraction and treatment removes and permanently destroys groundwater contaminants, and will limit migration of contaminants into surrounding surface water.	Enhanced groundwater capture will permanently remove and destroy groundwater contaminants. Interceptor trench expected to provide more effective barrier than extraction wells. The mobility of high concentration contaminants in soils and sediments is reduced by consolidation, stabilization, and capping. Subsurface soils and railroad track area soils (surface & subsurface) are capped, thus reducing potential mobility of contaminants in these areas.	Enhanced groundwater capture will permanently remove and destroy groundwater contaminants. Interceptor trench expected to provide more effective barrier than extraction wells. The toxicity of high concentration contaminated soils and sediments is greatly reduced by thermal treatment. Pilot tests performed on SCD contaminated soils and sediments have demonstrated a 99.9% to 99.999% destruction efficiency. Subsurface soils remaining below excavations and soils in railroad track area are capped, thus reducing potential contaminant mobility.	Same as Alternative 4, Option A except: 1) More materials are removed and treated.	Enhanced groundwater capture will permanently remove and destroy groundwater contaminants. Interceptor trench expected to provide more effective barrier than extraction wells. The toxicity of contaminated soils and sediments may be significantly reduced by biological treatment. Treatability testing is currently being performed to determine the effectiveness of biological treatment.	Enhanced groundwater capture will permanently remove and destroy groundwater contaminants. Interceptor trench expected to provide more effective barrier than extraction wells. The toxicity of contaminated surface soils, subsurface soils, and sediments may be significantly reduced by biological treatment. Treatability testing is currently being performed to determine the effectiveness of biological treatment.

AR307554

TABLE 6-2 (Cont'd)

Summary and Comparison of Remedial Alternatives
Standard Chlorine of Delaware, Inc.

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Containment	Alternative 3 Closure[1]	Alternative 4 Thermal Treatment[1]		Alternative 5 Biological Treatment[1]	
				Option A	Option B	Option A	Option B
Implementability	Can be readily implemented.	The limited space available, and the interaction between media, requires phased implementation. Care must be taken during in situ stabilization of the materials in the basin to maintain liner integrity. Otherwise this alternative can be readily implemented.	The limited space available, and the interaction between media, requires phased implementation. Construction of the enhanced groundwater extraction system will employ conventional construction techniques. The specific process option employed (interceptor trench, sheet piling, etc.) will affect implementability. Limited space available for material staging and stabilizing. Ex situ stabilization of the materials prior to consolidation provides greater control when compared with in situ stabilization.	The limited space available, and the interaction between media, requires phased implementation. Construction of the enhanced groundwater extraction system will employ conventional construction techniques. The specific process option employed (interceptor trench, sheet piling, etc.) will affect implementability. Limited space available for staging and thermally treating. Moisture reduction may be required prior to thermal desorption.	Same as Alternative 4, Option A except: 1) The extensive volume of material to be treated will cause logistical difficulties due to the limited available space.	The limited space available, and the interaction between media, requires phased implementation. Construction of the enhanced groundwater extraction system will employ conventional construction techniques. The specific process option employed (interceptor trench, sheet piling, etc.) will affect implementability. Limited space available for material staging and biological treatment. Process-specific information still being gathered.	Does not require a significant amount of available land space for implementation. Construction of the enhanced groundwater extraction system will employ conventional construction techniques. The specific process option employed (interceptor trench, sheet piling, etc.) will affect implementability. Process-specific information still being gathered.
Cost	No cost is associated with this No Action alternative.	Present worth cost is estimated at $3,474,000.	Present worth cost is estimated at $6,720,000.	Present worth cost is estimated at $11,680,000.	Present worth cost is estimated at $17,563,000.	Present worth cost is estimated to range from $10,594,000 to $12,863,000.	Present worth cost is estimated to range from $6,315,000 to $7,827,000.

NOTES:

1 - Discussions concerning institutional control, site security, and site monitoring, as discussed for Alternative 2, also apply.

AR307555

TABLE 6-3

ARARs Compliance Summary
Standard Chlorine of Delaware, Inc.

	Alternative 1 No Action	Alternative 2 Containment	Alternative 3 Closure	Alternative 4 Thermal Treatment		Alternative 5 Biological Treatment	
				Option A	Option B	Option A	Option B
I. Chemical-Specific							
A. Federal Drinking Water Standards 1) Primary Maximum Contminant Levels (MCLs) 2) Secondary MCLs (1)	No provisions for future compliance.	Future compliance in the Unnamed Tributary and Red Lion Creek would be expected. Onsite compliance not expected in the foreseeable future.	Future compliance in the Unnamed Tributary and Red Lion Creek would be expected. Onsite compliance not expected in the foreseeable future.	Future compliance in the Unnamed Tributary and Red Lion Creek would be expected. Onsite compliance not expected in the foreseeable future.	Future compliance in the Unnamed Tributary and Red Lion Creek would be expected. Onsite compliance not expected in the foreseeable future.	Future compliance in the Unnamed Tributary and Red Lion Creek would be expected. Onsite compliance not expected in the foreseeable future.	Future compliance in the Unnamed Tributary and Red Lion Creek would be expected. Onsite compliance not expected in the foreseeable future.
B. Federal Surface Water Quality Criteria	No provisions for future compliance.	Improved groundwater extraction implemented as a measure for future compliance.	Limited source removal (sediments) and groundwater interception implemented as a measure for future compliance.	Limited source removal (sediments) and groundwater interception implemented as a measure for future compliance .	Limited source removal (sediments) and groundwater interception implemented as a measure for future compliance .	Limited source removal (sediments) and groundwater interception implemented as a measure for future compliance .	Extensive source treatment (sediments) and groundwater interception implemented as a measure for future
C. Federal Ambient Air Quality Standards 1) Primary Standards 2) Secondary Standards	Will meet; not currently exceeded.	Will meet; not currently exceeded.	Will meet; not currently exceeded.	Will meet; not currently exceeded.	Will meet; not currently exceeded.	Will meet; not currently exceeded.	Will meet; not currently exceeded.
D. Delaware Water Pollution Control Regulations 1) NPDES Discharge	---	Will meet.	Will meet.	Will meet.	Will meet.	Will meet.	Will meet.
E. Delaware Water Quality Standards (see Federal Surface Water Quality Criteria)							

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TABLE 6-3 (continued)

ARARs Compliance Summary
Standard Chlorine of Delaware, Inc.

	Alternative 1 No Action	Alternative 2 Containment	Alternative 3 Closure	Alternative 4 Thermal Treatment		Alternative 5 Biological Treatment	
				Option A	Option B	Option A	Option B
I. Chemical-Specific (cont'd)							
F. Delaware Regulations Governing the Control of Air Pollutio	---	Will meet.	Will meet.	Will meet.	Will meet.	Will meet.	Will meet.
G. Delaware River Basin (DRBC) Water Quality Regulations (see Federal Drinking Water Standards)							

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TABLE 6-2 (Continued)

ARARs Compliance Summary
Standard Chlorine of Delaware, Inc.

	Alternative 1 No Action	Alternative 2 Containment	Alternative 3 Closure	Alternative 4 Thermal Treatment		Alternative 5 Biological Treatment	
				Option A	Option B	Option A	Option B
II. Location-Specific							
A. National Historic Preservation Act	---	Applicability to be determined.	Applicability to be determined.	Applicability to be determined.	Applicability to be determined.	Applicability to be determined.	Applicability to be determined.
B. Endangered Species Act	---	Will meet.	Will meet.	Will meet.	Will meet.	Will meet.	Will meet.
C. Fish and Wildlife Coordination Act	---	Will meet.	Will meet.	Will meet.	Will meet.	Will meet.	Will meet.
D. Protection of Wetlands (Executive Order 11990)	---	Will meet.	May meet. Removal of sediments may have negative impact on wetlands.	May meet. Removal of sediments may have negative impact on wetlands.	May meet. Removal of sediments may have negative impact on wetlands.	May meet. Removal of sediments may have negative impact on wetlands.	May meet. In situ treatment of sediments may have negative impact on wetlands.
E. Delaware Wetlands Regulations	---	Will meet permitting requirements.	Will meet permitting requirements.	Will meet permitting requirements.	Will meet permitting requirements.	Will meet permitting requirements.	Will meet permitting requirements.
F. Protection of Floodplains (Executive Order 11988)	---	Applicability to be determined.	Applicability to be determined.	Applicability to be determined.	Applicability to be determined.	Applicability to be determined.	Applicability to be determined.

AR307558

TABLE 6-3 (continued)

ARARs Compliance Summary
Standard Chlorine of Delaware, Inc.

	Alternative 1 No Action	Alternative 2 Containment	Alternative 3 Closure	Alternative 4 Thermal Treatment		Alternative 5 Biological Treatment	
				Option A	Option B	Option A	Option B
III. Action-Specific							
A. Clean Water Act 1) Discharge of Treatment System Effluent 2) Dredge and Fill Requirements	---	Will meet discharge requirements.	Will meet discharge, and dredge and fill requirements.	Will meet discharge, and dredge and fill requirements.	Will meet discharge, and dredge and fill requirements.	Will meet discharge, and dredge and fill requirements.	Will meet discharge requirements.
B. Resource Conservation and Recovery Act (RCRA) 1) Land Disposal Restrictions 2) Treatment Requirements 3) Landfill Requirements 4) Surface Impoundment Requirements 5) TSDF General Requirements 6) Boiler and Industrial Furnace Requirements 7) Transporter Requirements 8) Air Emission Standards for Process Vents	Will not meet due to lack of closure of the sedimentation basin.	Will meet. Land disposal restrictions ar not ARAR, as the materials moved within the area of contamination	LDRs addressed by stabilization. Landfill standards addressed by retrofitting basin with a liner and leachate collection system.	LDRs addressed by thermal desorption. Landfill standards addressed by retrofitting basin with a liner and leachate collection system.	LDRs addressed by thermal desorption. Landfill standards addressed by retrofitting basin with a liner and leachate collection system.	LDRs addressed by biological treatment. Landfill standards addressed by retrofitting basin with a liner and leachate collection system.	LDRs not applicable to in situ treatment. RCRA closure of basin would be performed.
C. Delaware Regulations Governing Solid and Hazardous Waste (see RCRA)							
D. Delaware Erosion and Sedimentation Control Law	---	Will meet.	Will meet.	Will meet.	Will meet.	Will meet.	Will meet.
E. DRBC Groundwater Extraction Requirements	---	Will meet.	Will meet.	Will meet.	Will meet.		

AR307559

basin.

6.2 SHORT-TERM EFFECTIVENESS

This evaluation criterion involves consideration of community and site personnel protection and environmental impacts during implementation of remedial actions. Comparative analysis of the alternatives indicates that:

- Alternative 1 involves no further remedial action, thus short-term risks during implementation are not present.

- Alternative 5, Option B offers a high degree of short-term effectiveness. The non-intrusive nature of in situ remediation is conducive to minimizing short-term impacts. Due to the high concentration of contaminants encountered, in situ biological treatment is likely to be an extended process. The enhanced groundwater extraction system provided in this alternative would involve some short-term risks during construction. The short-term risks for the groundwater extraction system installation are the same as those presented under Alternatives 3 and 4.

- Alternative 2, Alternative 3, and Alternative 4, Option A pose similar short-term risks. The removal actions under these alternatives will entail materials handling that could potentially result in localized airborne emissions of dust. Dredging activities provided under Alternative 3 and Alternative 4, Option A could have adverse impacts to the wetlands ecosystem. The short-term risks associated with thermal desorption (Alternative 4, Option A) will also increase short-term risks.

- Alternative 4, Option B, and Alternative 5, Option A pose similar short-term risks. The extensive removal and treatment actions provided in these alternatives result in higher short-term risks than with the other alternatives. The substantial dredging activities in the wetland areas is expected to have adverse impacts to this ecosystem. The migration of contaminants during these dredging activities must be weighed carefully against the benefit of source removal. The expected length of treatment under Alternative 5, Option B would spread the short-term risks over a longer period of time.

6.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

This evaluation criterion involves consideration of the long-term effectiveness and performance of the alternative once it has been implemented. The evaluation focuses on defining the extent

and effectiveness (adequacy and reliability) of the controls that may be required to manage the residual risk remaining from untreated waste and/or treatment residues.

Comparative analysis of the five alternatives indicates the following:

- Alternative 4, Option B, and Alternative 5, Options A and B are expected to offer the highest degree of long-term effectiveness and permanence. Alternatives 4, Option B and Alternative 5, Option A involve the removal and treatment of those soils and sediments exceeding the response levels. Alternative 5, Option B provides in situ treatment of these materials. It should be noted that the level of treatment achievable under Alternative 5 is not known at this time, but is currently under investigation. The enhanced groundwater extraction and treatment system, including attempted DNAPL recovery, provided in Alternatives 2, 3, 4, and 5 would result in the permanent removal and destruction of the groundwater contaminants.

- Alternative 3 and Alternative 4, Option A offer a moderate degree of long-term effectiveness and permanence. Under both these alternatives, removal and treatment of surface soils, subsurface soils, and sediments will be performed. Thermal desorption of the removed materials is a permanent method. Stabilization/solidification may offer similar effectiveness. Treatability testing would be required to more accurately define the achievable treatment levels.

- Alternative 2 offers a less moderate degree of long-term effectiveness and permanence. Alternative 2 is slightly less effective than Alternative 3 due to the lack of sediment removal, and the expected lower effectiveness of additional groundwater extraction wells when compared to the interceptor trench. In situ stabilization/solidification is also expected to result in a less homogeneous mix when compared with ex situ stabilization/solidification.

- Alternative 1 provides the lowest degree of long-term effectiveness and permanence. This is due to the lack of action for groundwater, soils, and sediments under this alternative.

6.4 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

This evaluation criterion involves consideration of the overall protection of human health and the environment. The overall assessment of protection draws on the assessments conducted for other evaluation criteria, particularly long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Comparative analysis of the five alternatives indicates the following:

- Alternative 3, Alternative 4, Option A, and Alternative 5, Option B offer the highest degree of overall protection of human health and the environment. This is arrived at by considering compliance with ARARs, and the short-, and long-term risks associated with these alternatives. All these alternatives focus on those materials that pose the greatest risk, thus reducing the negative impacts of removing extensive quantities of sediments from the wetland areas. Alternative 5, Option B addresses significant quantities of materials, but treatment is performed in situ. All these alternatives implement an enhanced groundwater extraction and treatment system, and attempt DNAPL recovery.

- Alternative 2 provides a moderate level of protection of human health and the environment. This alternative provides improved groundwater recovery, and attempts DNAPL recovery. Surface and subsurface soils are also removed and treated.

- Alternative 4, Option B, and Alternative 5, Option A provide a moderate level of protection of human health and the environment. A major drawback of both of these alternatives is the negative impacts due to the dredging of large quantities of sediments from the Unnamed Tributary. These alternatives implement an enhanced groundwater extraction and treatment system, and attempt DNAPL recovery.

- Alternative 1 provides the lowest degree of overall protection of human health and the environment mainly due to the long-term effectiveness of the alternative. As stated in Subsection 6.3, the long-term effectiveness of Alternatives suffers because of unsatisfactory groundwater contaminant discharge into the Unnamed Tributary and Red Lion Creek is not addressed.

6.5 REDUCTION OF THE TOXICITY, MOBILITY, OR VOLUME

Consideration of this evaluation criterion is a result of recent statutory preference for selecting remedial actions that permanently and significantly reduce the toxicity, mobility, and volume of the contaminants and associated media. Comparative analysis of the six alternatives indicates the following:

- Alternatives 4 and 5 provide the highest degree of reduction of the toxicity, mobility, and volume of contaminants. These alternatives achieves contaminant reduction via toxicity and/or volume reduction. Alternative 4 achieve near complete destruction of the contaminant through thermal treatment, while

Alternative 5 achieves toxicity and/or volume reduction through biological treatment. The level of treatment achievable using biological treatment is currently under investigation. Both alternatives provide reduction of the volume of contaminated groundwater through the enhanced groundwater extraction and treatment system. DNAPL recovery could also reduce the source for further groundwater contamination.

- Alternative 2 and Alternative 3 offer a moderate reduction of the toxicity, mobility, and volume of contaminants. Both alternatives reduce the mobility of the contaminants through treatment, using stabilization/solidification and consolidation. Reduction of the volume of contaminants in groundwater is achieved in both alternatives by implementing improved groundwater extraction measures.

- Alternative 1 offers the least reduction in the toxicity, mobility, and volume of contaminants. Alternative 1 offers a reduction only through natural attenuation processes.

6.6 IMPLEMENTABILITY

This criterion establishes the technical and administrative feasibility of implementing an alternative. Comparative analysis of the alternatives indicates the following:

- Alternative 1 is the most easily implemented. Alternative 1 involves no remedial action, and therefore, requires no implementation.

- Alternative 5, Option B provides a high degree of implementability for soils and sediments treatment. In situ biological treatment could involve the use of injection wells, where amendments are added, and extraction points where the excess additives and treated groundwater are extracted. In the wetland areas, the implementation may involve periodic direct application of amendments to the sediments, possibly including some localized mixing. The specifics of the in situ application of biological treatment are still under investigation.

- Alternative 2, Alternative 3, and Alternative 4, Option A offer a moderate degree of implementability. Removal and treatment (in situ stabilization for Alternative 2, ex situ stabilization for Alternative 3, thermal desorption for Alternative 4) are commonly employed remedial techniques. In situ stabilization, as prescribed under Alternative 2 will require careful implementation to ensure liner integrity. The installation of the enhanced groundwater extraction and treatment system (as prescribed in Alternatives 3, 4, and 5) will employ conventional construction techniques, although the expected average depth of the trench (25 feet), might make construction difficult. An

investigative soil boring program prior to installation of the trench is required. The limited space available for staging and treatment requires a phased implementation.

- Alternative 4, Option B, and Alternative 5, Option A provide the least degree of implementability. The removal of significant quantities of sediments from the Unnamed Tributary will be difficult to implement, while still maintaining the viability of the wetland ecosystem. The limited space available for staging and treatment makes the logistics of a phased implementation difficult.

6.7 COST

A present worth analysis for the cost evaluation utilizes a discount rate of 5% as recommended under the Superfund Program. A uniform gradient factor of 5% was also applied to account for inflationary effects. The cost estimates presented in Table 6-1 are order-of-magnitude (+50 to -30%) level estimates. These costs are based on a variety of information, including estimates from suppliers, engineering and technical analysis unit costs, construction unit costs, vendor information, conventional cost estimating guides, and prior experience. The Feasibility Study-level cost estimates shown have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The actual costs of the project will depend on true labor and material costs, actual site conditions, competitive market conditions, final project scope, implementation schedule, and other variable factors.

AR307564

APPENDIX A

FLUX CALCULATIONS

AR307565

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET ____ of ____

CLIENT/SUBJECT SCD W.O. NO. ____

TASK DESCRIPTION Flow Calculations TASK NO. ____

PREPARED BY SJ DEPT 530 DATE 5/26/93

MATH CHECK BY ____ DEPT ____ DATE ____

METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY ____ DEPT ____ DATE ____

FLOW CALCULATIONS

	← FLOW PATHS →				
	1	2	3	4	
WIDTH (ft)	130	190	160	320	
SAT THICKNESS	16	13	12	10	- X-SECTIONS
HYD COND (ft/day)	300	300	300	300	(based on TW-6A pump test)
GRADIENT	.0055	.0059	.0071	.0073	
Q ft³/day	16632	4372	4090	7008	
Q lbs/day	1.01×10^6	272800	255200	437300	
[Benzene] (ppm)	5	.1	.1	0	
LOADING lbs/D	5.2	0.027	0.025	—	

Q = HYD. COND × GRADIENT × WIDTH × SAT. THICKNESS

1 ft³ H2O = 62.4 lbs

AR307566

RFW 10-05-003/A-5/85
512-5643

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET ____ of ____

CLIENT/SUBJECT SLD W.O. NO. ____

TASK DESCRIPTION Flux Calculations TASK NO. ____

PREPARED BY SY DEPT 530 DATE 5/26/93

MATH CHECK BY ____ DEPT ____ DATE ____

METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY ____ DEPT ____ DATE ____

Drainage area of wetlands receiving ≈ 2000' x 9100' from Fig 2-11 in R-I (topo map)
≈ .34 mi²

Using estimated base flow of 1 MGD/mi² = expected flow into

1 MGD/mi² x 0.34 mi² = 340,000 gallons/day
= 2.8 x 10⁶ lbs/day

For SEGMENTS ② + ③ + 1/2 of Segment ①
loading = 2.6 + 0.027 + 0.025 = 2.65 lbs/day

Resulting 2.65 lbs/day Benz. / 2.8 x 10⁶ lbs/day water = 0.95 ppm Benzene

Calculated at SW-18, SW-17, SW-16 are .15, .14 and .02 respectively

Assuming that concentrations won't change gw flow can be related to final concentrations!

The gw flow thru segments ② + ③ plus 1/2 of ① is 16778 ft³/day = 87 gpm

87 gpm / 950 = .092 gpm/ppb

RFW 10-05-003/A-5/85
512-5643

AR307567

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET ____ of ____

CLIENT/SUBJECT SCD W.O. NO. ____

TASK DESCRIPTION Flux Calculation TASK NO. ____

PREPARED BY SY DEPT 530 DATE 5/27/93

MATH CHECK BY ____ DEPT ____ DATE ____

METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY ____

DEPT ____ DATE ____

To reach the target concentration of 71 ppb benzene
A reduction of 879 ppb is needed (950-71)

879 ppb x .092 gpm/ppb = 81 gpm

AR307568

RFW.10-05-003/A-5/85
512-5643

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET ____ of ____

CLIENT/SUBJECT SCD W.O. NO. ____

TASK DESCRIPTION GW Discharge to Red Lion TASK NO. ____

PREPARED BY SL DEPT 530 DATE 5/26/93

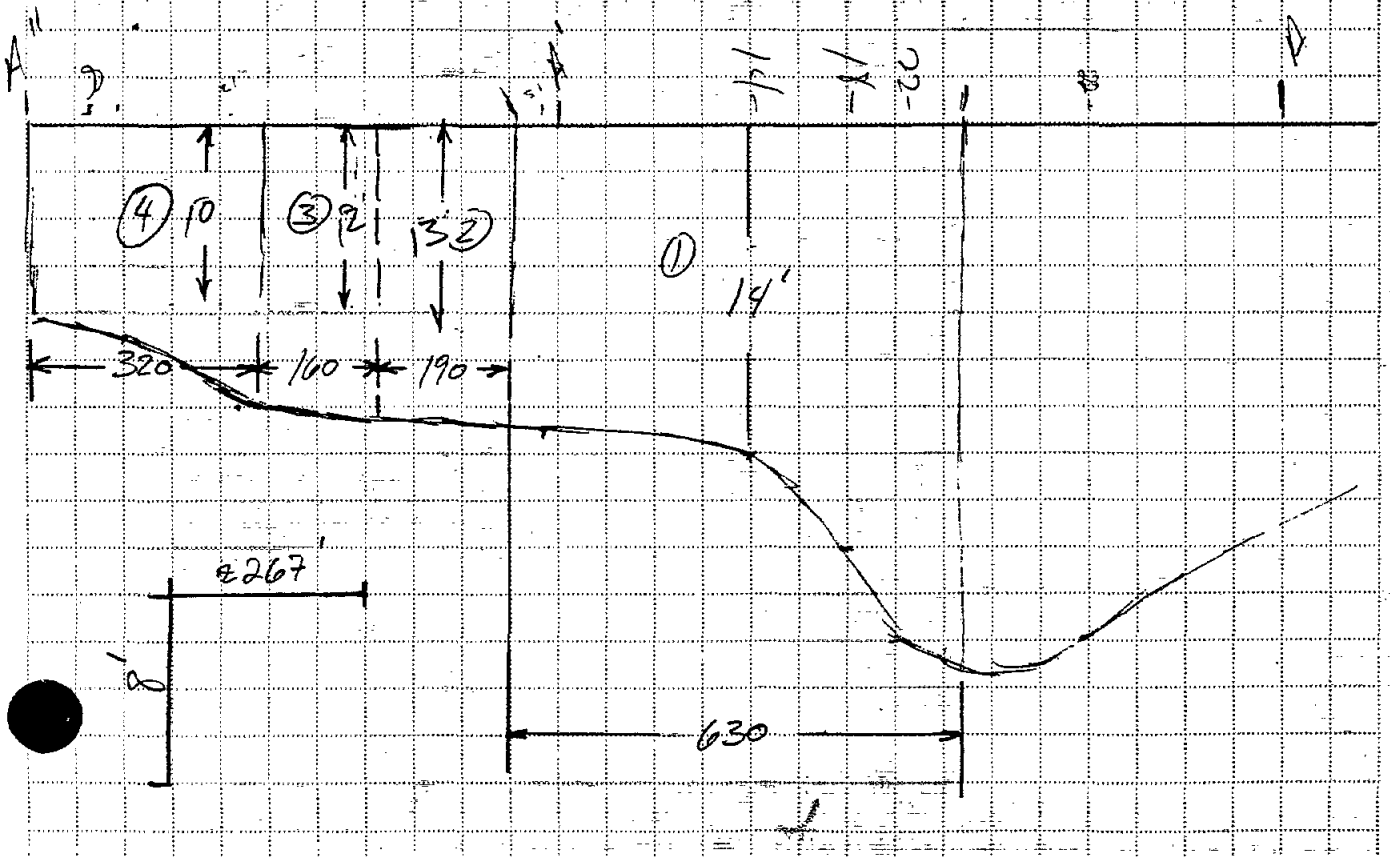
MATH CHECK BY ____ DEPT ____ DATE ____

METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY ____ DEPT ____ DATE ____

SCHEMATIC X-SECT

SCD SITE @ RED LION CREEK



RFW 10-05-003/A-5/85
512-5643

AR307569

AR 307570

WESTON

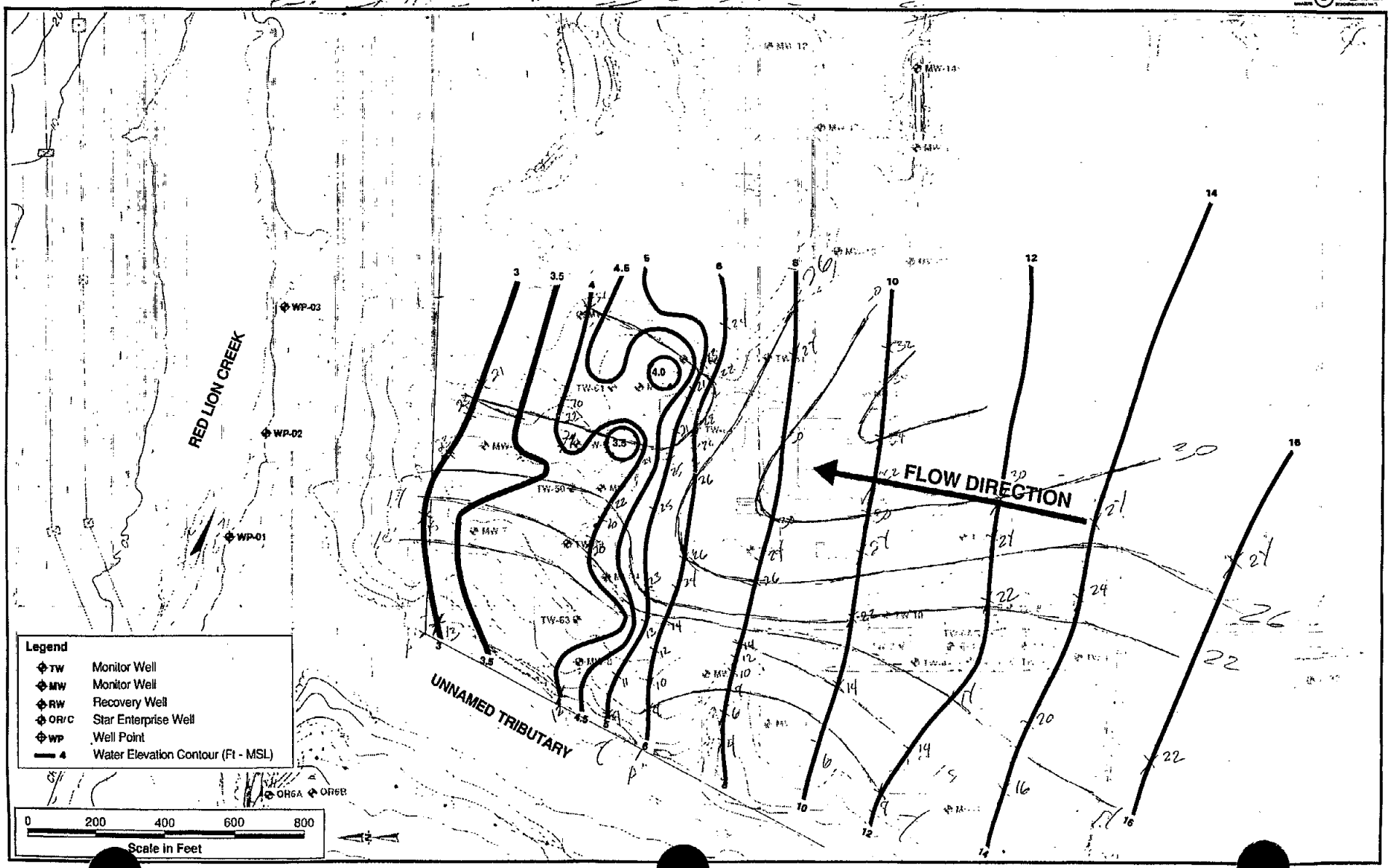


FIGURE 4-2 WATER TABLE CONTOUR MAP
COLUMBIA WELLS, AUGUST 23, 1990
STANDARD CHLORINE OF DELAWARE, INC.

AR 307571

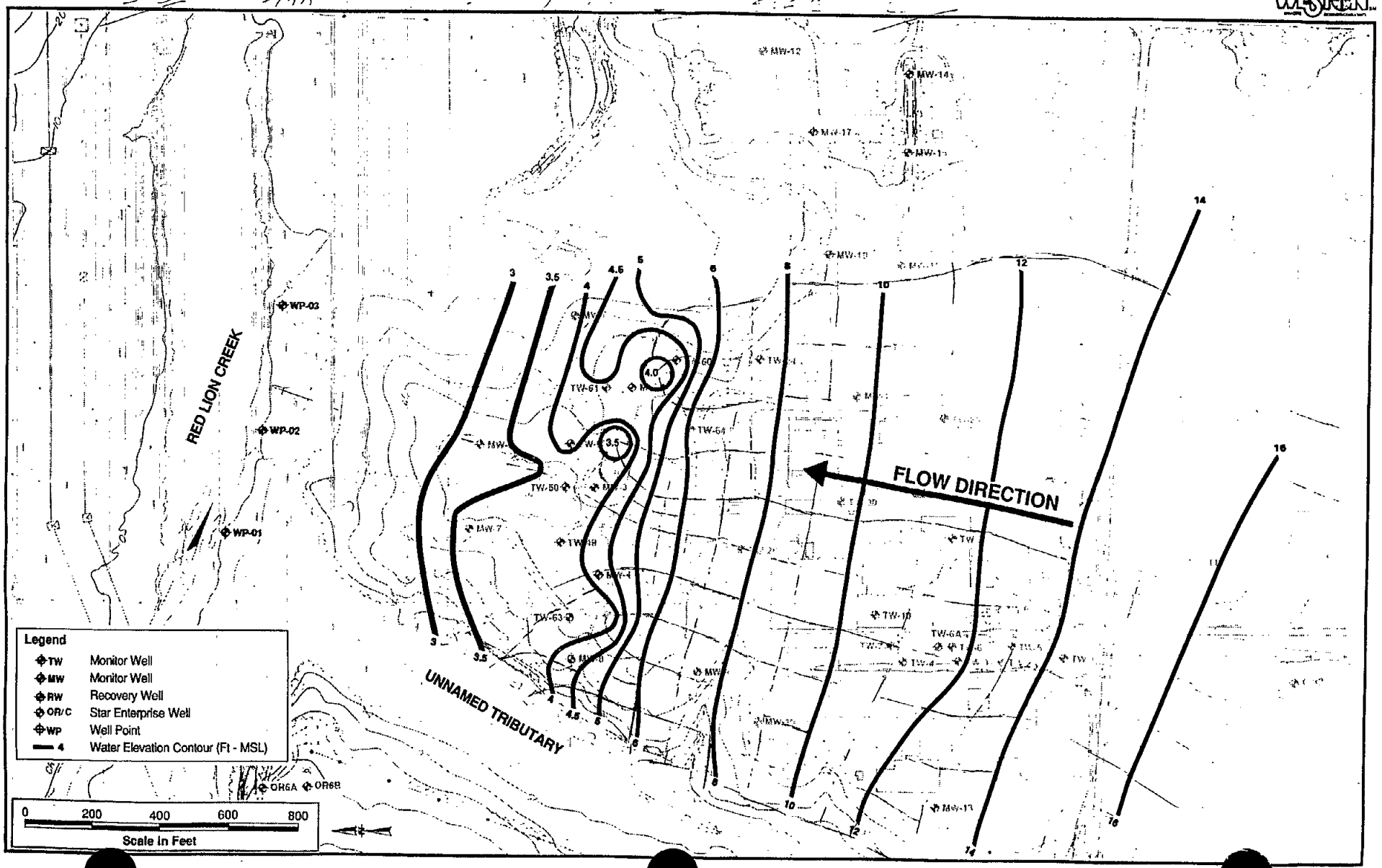


FIGURE 4-2 WATER TABLE CONTO[illegible]
COLUMBIA WELLS, AU[illegible]3, 199[illegible]
STANDARD CHLORINE OF [illegible]ELAWARE, INC.

AR307571
AR307571

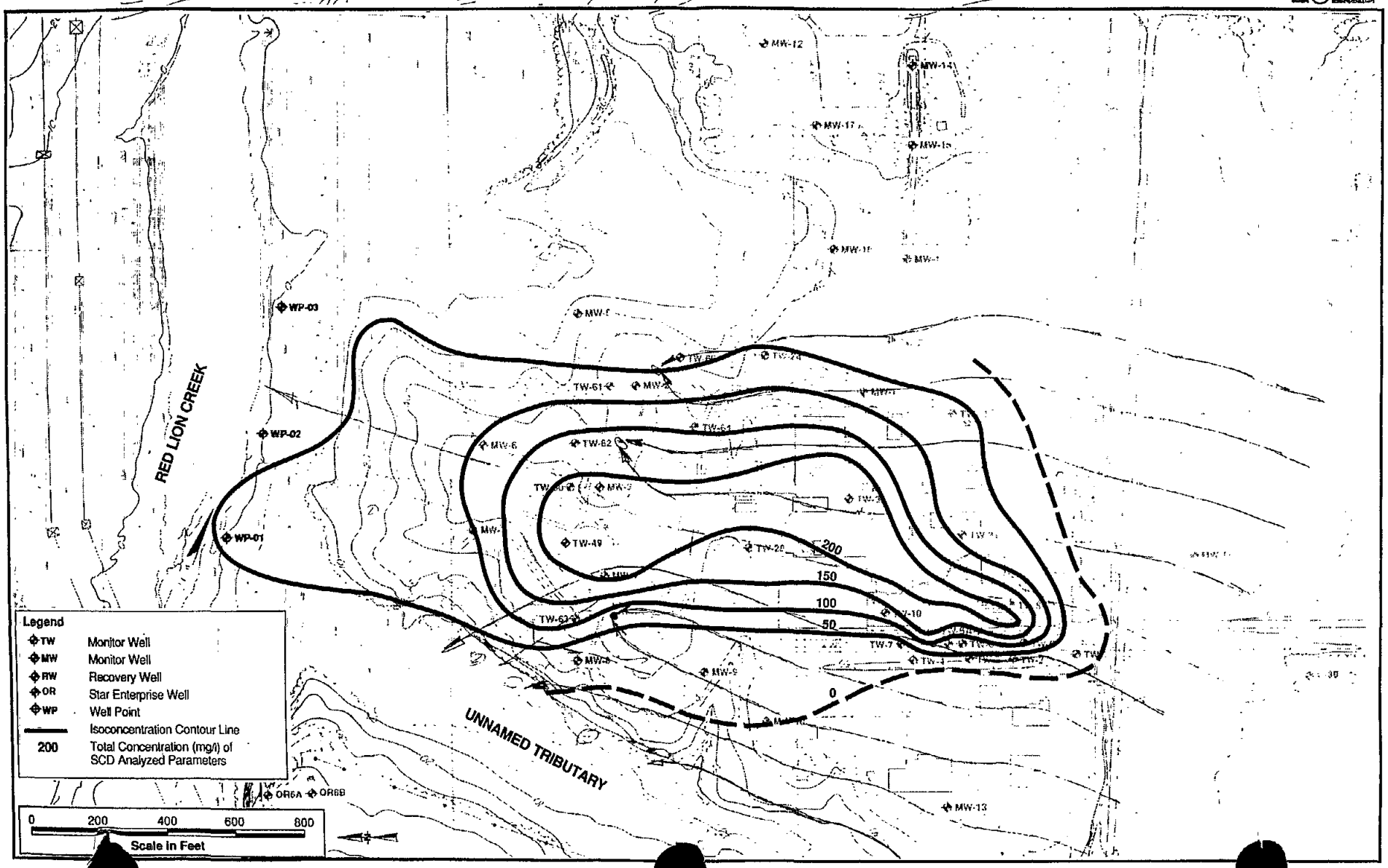


FIGURE 4-3 ISOCONCENTRATION MAP OF TOTAL C[illegible]TRATIONS OF SCD ANALYZED PARAMETERS COLUMBI[illegible]RMATION STANDARD CHLORINE OF DELAWARE, INC.

AR307572