NOTICE

All drawings located at the end of the document.

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RF-46469(Rev.1/97)

RMRS Rocky Mountain Remediation Services, L.L.C.
... protecting the environment

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464
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November 4, 1997

Jennifer Uhland
ER/WM&I Operations
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SOLAR PONDS PLUME REMEDIATION AND INTERCEPTOR TRENCH SYSTEM WATER TREATMENT STUDY - JKH-025-97

Rocky Mountain Remediation Services. L.L.C. (RMRS) is pleased to provide the enclosed report entitled "Solar Ponds Plume Remediation and Interceptor Trench System Water Treatment Study" (RF/RMRS-97-093.UN). This report provides an evaluation of alternatives for the remediation of the solar ponds plume and recommends the four highest ranking alternatives for further evaluation. This report also provides a summary of current information about the interceptor trench system and water quality currently being produced by the system. It will be a valuable tool in working with regulators and stakeholders in planning and implementing the next stages of final remediation for this area.

RMRS is looking forward to working with you and Kaiser-Hill as we move forward to take those steps. If you have any questions about this report, please feel free to call me at extension 4974 or Bob Fiehweg at extension 7403.

John Hopkins
Manager, Site Closure Projects

RF/aw

Attachment:
As Stated

RF/RMRS-97-093.UN

KAISER•HILL
COMPANY

Solar Ponds Plume Remediation and Interceptor Trench System Water Treatment Study

RMRS Rocky Mountain Remediation Services, L.L.C.
...protecting the environment

• Environmental Restoration •
Rocky Flats Environmental Technology Site

September 1997

RF/RMRS-97-093.UN

Solar Ponds Plume Remediation and Interceptor Trench System Water Treatment Study

Rocky Mountain Remediation Services, L.L.C.
and
Resource Technologies Group, Inc.

September, 1997

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TABLES

ACRONYMS, ABREVIATIONS AND INITIALISMS

AWTS	Alternate Water Treatment System
BOD	Biochemical Oxygen Demand
CBOD	Carbonaceous Biochemical Oxygen Demand
DOE	Department of Energy
FWS	Free Water Surface
gpm	Gallons per Minute
HDPE	High Density Polypropylene
ITPH	Interceptor Trench Pump House
ITS	Interceptor Trench System
K-H	Kaiser-Hill Company, L.L.C.
MCL	Maximum Contaminant Level
mg/L	Milligrams per Liter
MST	Modular Storage Tanks
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NTS	Nevada Test Site
O&M	Operations and Maintenance
OU	Operable Unit
PAM	Proposed Action Memorandum
pCi/L	PicoCuries per Liter
PIDAS	Perimeter Intrusion Detection and Assessment System
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RMRS	Rocky Mountain Remediation Services, L.L.C.
SFS	Subsurface Flow System
WWTP	Wastewater Treatment Plant
ZVI	Zero-valent Iron

EXECUTIVE SUMMARY

This study evaluates alternatives for the management and treatment of groundwater and surface water collected by a system of trenches and French drains known as the Interceptor Trench System (ITS). In the past, contaminants from wastes disposed of in the Solar Evaporation Ponds seeped into the groundwater underlying the ponds and began migrating with the groundwater flow. The ITS was installed to intercept this water and allow for its collection and treatment. Recent analyses show that the contaminant with the greatest concentration in the Solar Pond Plume is nitrate; uranium is also found in smaller quantities. The current treatment method is to pump ITS-recovered groundwater to the Rocky Flats process waste treatment facility, Building 374. At a cost of up to $2.00 per gallon for about 3 million gallons per year, this treatment option has become very expensive. In the development of the new Rocky Flats Cleanup Agreement (RFCA), temporary changes in water quality standards were proposed to allow for more cost effective treatment of the ITS water. This study reports the results of a formalized matrix evaluation of eleven alternatives for management and treatment of the ITS water.

The eleven alternatives evaluated are: 1.) Direct Release, 2.) Managed Release, 3.) Evaporation at Building 374, 4.) Treatment at Building 995, 5.) Treatment at MSTs, 6.) Constructed Wetland, 7.) Off-Channel Evaporation, 8.) Dispersion Field, 9.) Phytoremediation, 10.) Iron/Peat Passive Treatment, and 11.) Enhanced Evaporation. These alternatives are evaluated against a set of criteria that include: Effectiveness, Implementability, Ability to Meet Specific Goals and Objectives, Inclusion of Cost Minimization Elements, Ease of Post Site Closure Operations, and Regulatory Agency and Local Community Acceptance. Each alternative is rated on a scale of 1-5, 5 being best, in terms of its performance or anticipated performance for that criterion. The criteria are assigned a weighting factor and, in a matrix of alternatives and criteria, a unique rating is calculated for each alternative. The four highest ranking alternatives are discussed in detail, and plans further evaluation described.

The four highest ranking alternatives are: 1.) Managed Release, 2.) Treatment at Building 995, 3.) phytoremediation, and 4.) Enhanced Evaporation. Each of these alternatives requires further study to determine its suitability and implementability in the Solar Pond Plume. Plans call for additional work in Fiscal Year 1998 that will lead to a final recommendation for remediation.

1. INTRODUCTION

The Solar Ponds Plume Remediation and ITS Water Treatment Study was completed to develop and evaluate potential alternatives for the management of contaminated water associated with the Solar Ponds Plume at Rocky Flats Environmental Technology Site (RFETS). Specifically, the alternatives target groundwater and surface water containing nitrate and uranium contaminants that have spread from the Solar Evaporation Ponds. These ponds and their associated residual contaminant sludges have been removed; however, contaminants have formed a groundwater contaminant plume with a long-term potential to impact surface water via seeps that contribute to the total surface water flow through the North Walnut Creek drainage. Data indicate that surface water standards may soon be compromised extending beyond site closure if action addressing the Solar Ponds contaminants in surface water and groundwater is not taken. It should be noted that an investigation is underway at RFETS to determine the source of uranium contamination in groundwater at RFETS, including the Solar Ponds Plume contaminated groundwater. It is possible that naturally occurring uranium significantly contributes to the total uranium contaminant level

Based on the Rocky Flats Cleanup Agreement (RFCA), which considered future uses of the Rocky Flats area and associated human health and environmental risks, protection of surface water quality is a fundamental element of environmental restoration at the Site. As such, the development of alternatives in this study focused on compliance with surface water standards in Walnut Creek, and not groundwater quality as per RFCA. The RFCA identified some changes in water quality standards that the parties agreed should be presented to the Colorado Water Quality Control Commission. Among these changes was a change in the applicable nitrate standard to a less stringent level. The justification for this change, in part, was to allow for a more cost effective solution to the Solar Pond Plume problem. The Commission approved the changes described in the RFCA, including the change in the nitrate standard from 10 mg/L to 100 mg/L for the duration of the active remediation period at Rocky Flats, after which the standard returns to 10 mg/L. Finally, under RFCA the Solar Ponds Plume remediation has been identified as a proposed milestone for 1999.

The remaining sections of this study present background information, descriptions and evaluations of alternatives, and a detailed analysis of the top two ranking alternatives that remain after alternative screening.

2. ALTERNATIVES DEVELOPMENT / EVALUATION BACKGROUND INFORMATION

General information that is pertinent to the alternatives development/evaluation process includes existing Interceptor Trench System (ITS) and Modular Storage Tank (MST) use and condition, sources of ITS-collected water, surface water standards for contaminants of concern, expected future site operations, and descriptions of alternative evaluation criteria.

2.1 EXISTING ITS/MST USE AND CONDITION

The current practice for dealing with the Solar Ponds Plume involves: 1) the collection of both surface water and groundwater along the northern area of the Solar Ponds using the ITS, 2) the storage of collected water in three 500,000-gallon MSTs, and 3) the treatment of collected water with the Building 374 evaporator system.

The ITS provides capture of potentially contaminated surface water that flows from the area of the Solar Ponds north toward North Walnut Creek. The effectiveness of the ITS French drains in capturing all contaminated groundwater is not clear. Groundwater monitoring at sampling locations north of the Solar Ponds has indicated the presence of elevated concentrations of nitrate. This groundwater is beyond the capture zone of the ITS; the potential for this contaminated groundwater to negatively impact the quality of water in Walnut Creek has not yet been thoroughly evaluated. As such, the protection of surface water by the alternatives considered in this study that rely on the ITS may change over time. Such changes must be monitored, and possible modifications to the ITS must be considered if contaminated groundwater recovery requires improvement. It is known, however, that the French drains are effective at directing collected water through pipelines in the subsurface to the interceptor trench pumphouse (ITPH) sump, which is located near the base of the slope extending from the Solar Ponds to North Walnut Creek. The ITPH sump transfers collected water to the MSTs. The transfer capacity of the ITPH sump is 100 gallons per minute (gpm). Each of the three MSTs is lined with HDPE, has a straight side height of approximately 11 feet and a diameter of 90 feet, and is constructed of bolted steel panels. The capacity of each MST is approximately 500,000 gallons, although the working volume of each is approximately 400,000 gallons.

The ITS French drains and the ITPH appear to provide adequate protection of surface water in North Walnut Creek—there are no plans to significantly upgrade or maintain these components. The MSTs are structurally sound, but there have been recent concerns about the stability of the hillside where the MSTs sit as some movement down the hillside has been detected. As such, the long-term use of the MSTs is uncertain.

Future remedial actions at RFETS, such as capping of the Solar Ponds and other areas, may impact the movement and recovery of contaminated groundwater. Caps would likely reduce the movement of the contaminated groundwater and, consequently, the recovery of contaminated groundwater by the ITS.

2.2 SOURCES AND VOLUMES OF COLLECTED WATER

Water entering the ITS, stored in the MSTs, and treated in Building 374 originates as both surface water runoff and alluvial groundwater. The surface water runoff includes precipitation that drains from the Building 779 area. For an average precipitation year, surface water runoff from the Building 779 area comprises approximately 35 percent of the total water collected by the ITS. Groundwater inflow into the ITS is estimated to average 2 gpm, resulting in a total annual inflow of approximately 1.05 million gallons. Table 2-1 presents average monthly ITS groundwater inflow volumes.[i] These are estimated volumes based on mean monthly precipitation levels for RFETS.

Table 2-1 Average Monthly ITS Groundwater Inflow

MONTH	INFLOW (GALLONS)
January	60,000
February	79,000
March	101,000
April	122,000
May	119,000
June	111,000
July	99,000
August	92,000
September	91,000
October	74,000
November	56,000
December	47,000
Total	**1,051,000**

Annually, with precipitation amounts that are typical for the RFETS area, the combined volume of surface water and groundwater collected by the ITS is 2 to 3 million gallons. Because data on the amount of water collected by the ITS covers only a few years, it is difficult to predict a volume for an "average year." As such, for purposes of evaluating alternatives, this study has assumed that 3 million gallons is the amount that the ITS would collect annually, i.e., the higher end of a typical year at RFETS. Also, the maximum amount of water collected over a 30 day period is assumed to be 1 million gallons, based on the volume of water collected during May 1995. Each alternative will be evaluated for its ability to achieve surface water standards for these typical and peak flows—see Section 2.1.3 below. It is possible that the amount of contaminated water collected over a typical year would increase if the ITS is expanded to recover deeper groundwater. The need to expand the treatment capacity of any alternative treating ITS-collected water would require evaluation.

2.3 CONTAMINANTS OF CONCERN AND SURFACE WATER STANDARDS

The main contaminants of concern in this evaluation for surface waters and groundwater entering North Walnut Creek are nitrate and total uranium. Nitrate and total uranium, monitored at the ITPH, averaged approximately 430 mg/l and 130 pCi/l, respectively, over the long term [ii]. Higher concentrations of nitrate and uranium are known to exist in localized areas within the Solar Pond Plume. Other contaminants have been detected at or near background levels or have not been detected, as shown in Appendix A. The movement of water in the plume region containing the greatest concentrations of nitrate and uranium will be evaluated with a groundwater assessment scheduled to begin in the fall of 1997. This assessment will provide an estimate of long-term impacts to surface water and will take into consideration potential future site actions such as capping of the Solar Ponds area and removal or closure of the ITS.

The area of the nitrate plume is shown in Figure 1, based on the most recent analyses of groundwater from monitoring wells and well points through 1996. Additional monitoring work is planned to update this information and refine the description of the area. Uranium is found in a number of groundwater wells in and around the solar ponds area, although it is not clear that these data represent a plume of contamination. Figures 2, 3, and 4 show the locations where uranium has been detected for the isotopes U-233,234, U-235, and U-238, respectively.

The current and long-term (after Site closure) standard for nitrate in Walnut Creek is 10 mg/l. Beginning January 1, 1998, nitrate will have an interim standard of 100 mg/l. The 100 mg/l standard is based on the Agricultural Use designation and is consistent with uses assigned to waters further downstream of Rocky Flats. The standard was adopted by the Colorado Water Quality Control Commission as an interim standard at RFETS during site cleanup, and is renewable every three years, as needed. In its Statement of Basis and Purpose (March, 1997) for the new standards, the Commission justified the temporary modification by saying it would allow for a more cost effective alternative (relative to current Building 374 treatment operations) for ITS water treatment. The interim standard is enforceable at the point of compliance (Pond A-4 outfall) and may also be monitored at "points of evaluation" upstream of Pond A-4 within North Walnut Creek. The "points of evaluation" will be used to track progress toward remediating or controlling the Solar Ponds Plume. Thus, the ability to attain the long-term 10 mg/l nitrate standard and maintain the applicable uranium standard can be evaluated.[a] An alternative's

[a] The current stream standard for uranium is 10 pCi/l based on ambient conditions measured in 1989. Colorado may adopt a new health-based standard if in the next three years, as anticipated, EPA promulgates

effectiveness is measured by its ability to protect human health and the environment by achieving and maintaining the surface water standards. It should be noted that an alternative may have to remain operational for a period (unknown duration at this time) beyond site closure in order to maintain compliance with the standards.

2.4 ALTERNATIVE EVALUATION CRITERIA

The criteria against which ITS alternatives are evaluated include:

- Effectiveness
- Implementability
- Ability to Meet Specific Goals and Objectives
- Inclusion of Cost Minimization Elements
- Ease of Post Site Closure Operations
- Regulatory Agency and Local Community Acceptance

The following sections describe the evaluation criteria.

2.4.1 Effectiveness

The fundamental element against which an alternative's effectiveness is evaluated is protection of human health and the environment and compliance with surface water standards. For surface water in Walnut Creek, the ability of an alternative to protect human health and the environment is gauged by assessing its performance in terms of attaining the short-term, 100 mg/l, and long-term, 10 mg/l, surface water standards for nitrate as well as the applicable surface water standard for uranium (for purposes of this evaluation, the current ambient standard of 10 pCi/l is used).

2.4.2 Implementability

Alternative implementability includes both technical and administrative elements. Generally, technical implementability is used as an initial alternative screening element. Technical implementability evaluations consider the ability to construct and reliably operate an alternative. Once an alternative is considered technically implementable, the alternative is evaluated in terms of administrative implementability, with emphasis on the ability to obtain necessary permits, licenses, etc., the availability of necessary equipment and workers, and schedule requirements to meet the Vision.

An alternative considered technically infeasible is precluded from further consideration unless efforts such as treatability studies are planned to refine the understanding of the alternative, thereby enhancing its technical feasibility. Elements contributing to lessened

new drinking water standards for radionuclides including uranium. Preliminary proposals for uranium in drinking water are higher than 10pCi/L.

administrative feasibility do not necessarily eliminate an alternative from further consideration, as an alternative can often be modified somewhat to satisfy administrative deficiencies. Such modifications usually do not alter the fundamental technical approach and overall effectiveness of the alternative.

2.4.3 Ability to Meet Specific Goals and Objectives

This criterion assesses an alternative's ability to meet site-specific goals and objectives. For the ITS alternatives, these goals and objectives are:

- Compliance with applicable surface water standards for nitrate and uranium, including the interim standard for nitrate,

- Consistency of an alternative's actions with the goals of RFCA, Site Vision, and Site Closure Plan.

- Provision of a significant reduction in costs over the current ITS water management practices of storing collected water in the MSTs and periodically treating stored water at the Building 374 evaporators.

The RFCA identifies action level strategies for groundwater. For the Solar Ponds Plume, it has been determined that nitrate exists at concentrations exceeding Tier I action levels—i.e., it exists at concentrations exceeding 100 times the MCLs. As a result, RFCA requires an evaluation to determine if action is necessary to prevent contaminants from exceeding surface water standards. Under this criterion, each alternative is evaluated for its ability to meet interim standards and long term goals.

One of the drivers for developing and evaluating ITS alternatives is the high cost of the current ITS practices, namely, storage of collected water in the MSTs and treatment in the Building 374 evaporators. Under this criterion alternatives are evaluated with regard to their ability to reduce the costs of ITS water management relative to current practice.

2.4.4 Inclusion of Cost Minimization Elements

This criterion evaluates an alternatives use of existing equipment to the greatest extent practicable. Those alternatives which require substantial new construction, especially outside the industrial area, rank lower than those which utilize existing facilities, or which do not rely on an infrastructure for continued treatment.

2.4.5 Ease of Post Site Closure Operations

Each alternative is evaluated in terms of its long-term operations and maintenance (O&M) requirements. Specifically, those O&M requirements for maintaining the alternative's performance after site closure are identified.

2.4.6 Regulatory Agency and Local Community Acceptance

Each alternative is evaluated for its prospective acceptability to regulatory agencies and the local community. This criterion includes an evaluation of the alternative's ability to meet the terms and conditions of permits, regulations, and agreements and of possible public perception of the alternative.

3. ALTERNATIVES PRESENTATION AND INITIAL SCREENING

This section presents the alternatives considered for management and/or treatment of contaminated water associated with the Solar Ponds evaporation area at RFETS. For each alternative, a conceptual level description and an evaluation against criteria described in Section 2 are provided.

3.1 ALTERNATIVES

The alternatives considered for screening are listed and briefly described in Table 3-1; major elements of each alternative are identified in Table 3-2. Those alternatives that include groundwater collection for management and treatment require periodic evaluation of the Solar Ponds Plume to assess the need to continue management and treatment. It is expected that the period of operations for collection, management, and treatment will vary for given alternatives.

Table 3-1 Alternatives

Alternative	Description
Alternative 1: Direct Release	Closure of the ITS and ITPH; Allow seepage of groundwater into North Walnut Creek.
Alternative 2: Managed Release	Phased release of ITS-collected water to Walnut Creek without treatment. First phase requires use of MSTs.
Alternative 3: Evaporation at Building 374	Continued use of ITS and MSTs with periodic treatment of collected surface water and groundwater in Building 374 evaporators (or a replacement facility).
Alternative 4: Treatment at Building 995	Continued use of ITS and MSTs with periodic treatment of collected surface water and groundwater in Building 995, the Site's wastewater treatment plant.
Alternative 5: Treatment at MSTs	Treatment for denitrification and uranium removal using the MSTs as process vessels. Requires continued use of ITS.

Table 3-1 (Continued)

Alternative	Description
Alternative 6: Constructed Wetland	Use of an appropriately sized area with wetland-type plants to receive water collected by the ITS for denitrification and uranium retention. Requires continued use of MSTs.
Alternative 7: Off-Channel Evaporation Pond	Use of an evaporation pond outside of the Walnut Creek drainage for evaporation of ITS-collected surface water and groundwater. MSTs can be closed.
Alternative 8: Dispersion Field	Continued use of ITS and MSTs with distribution of collected surface water and groundwater in a leach field for denitrification and uranium retention.
Alternative 9: Phytoremediation	Use of deep-rooted vegetation to passively intercept/treat Solar Ponds Plume groundwater.
Alternative 10: Iron/Peat Passive Treatment	Use of a passive zero-valent iron and peat moss system for uranium retention.
Alternative 11: Enhanced Evaporation	Continued use of ITS; use of a spray evaporation system at the MSTs to evaporate collected surface water and groundwater.

3.1.1 Alternative 1: Direct Release

Alternative 1, Direct Release, includes the closure of the existing ITS and ITPH and the discontinued use of the MSTs. Under this alternative, surface water and groundwater from the Solar Ponds Plume would flow into North Walnut Creek via preferred pathways—i.e., along natural conveyance pathways for surface water and groundwater and/or conveyance pathways resulting from past activities in the vicinity of the Solar Ponds. The ITS and ITPH would be closed so that a direct pathway for groundwater and surface water to move from the source area—the Solar Ponds Plume—to North Walnut Creek is eliminated. Closure of the ITS would entail grouting and/or removal of the buried pipeline and associated high permeability trenches at various locations. For the purpose of estimating a cost for Alternative 1, it was assumed that grouting would adequately close the ITS and eliminate direct pathways to North Walnut Creek for surface water and groundwater. Grouting would include the use of cement and bentonite (See Calculation Set #1 in Appendix B).

Table 3-2 Major Elements of Alternative

	Continued Use of ITS	Continued Use of MSTs	Ex-Situ Treatment	Use of Existing Equipment	Use of Undisturbed Land Outside of Solar Ponds Immediate Area	Treated Water Discharge to Walnut Creek	Generation of Waste Solids Requiring Further Treatment/Handling or other Potential Future Action	Untreated Water Discharge to Walnut Creek	In Situ Treatment
Alt. 1- Direct Release								✓	
Alt. 2 - Managed Release	✓	✓		✓				✓	
Alt. 3 - Evap. at Bldng. 374	✓	✓	✓	✓		✓	✓		
Alt. 4 - Treatment at Bldng. 995	✓	✓	✓	✓		✓	✓		
Alt. 5 - Treatment at MSTs	✓	✓	✓	✓		✓	✓		
Alt. 6 - Constructed Wetland	✓	✓	✓	✓	✓	✓	✓		
Alt. 7 - Off-Channel Evap. Pond	✓		✓	✓	✓		✓		
Alt. 8 - Dispersion Field	✓	✓	✓	✓	✓		✓		
Alt. 9 - Phytoremediation	✓ (1)	✓ (1)		✓ (1)		✓			✓
Alt. 10 - Iron/Peat Passive Treat.						✓	✓		✓
Alt. 11 - Enhanced Evaporation	✓	✓	✓	✓			✓		

(1) Continued ITS and MSTs use for a period not expected to exceed 3 years.

3.1.1.1 Effectiveness

Grouting would render the ITS ineffective at transporting surface water and groundwater to the ITPH and, hence, North Walnut Creek. Elimination of the ITS pathway would increase the time required for potentially contaminated surface water runoff from the area of the Solar Ponds and contaminated groundwater comprising the Solar Ponds Plume to reach North Walnut Creek. As such, Alternative 1 may provide a reduction in the mobility of contaminants. Alternative 1 does not, however, include elements that would allow the exercise of any control over the release of Solar Ponds Plume contaminants to North Walnut Creek.

Based on current average nitrate and total uranium concentrations in water collected by the ITS—430 mg/l and 130 pCi/l, respectively—it is possible that, under this alternative , contaminants could enter North Walnut Creek in concentrations high enough to cause an exceedance of applicable surface water standards, including the interim nitrate standard, 100 mg/l. It should be noted, however, that an assessment of Solar Ponds Plume contaminant migration that considers that the ITS is either removed or otherwise rendered inoperable, is under development. Further, based on modeling done for Alternative 2, Managed Release, Phase II (to be discussed), direct release of ITS-collected water at the ITPH would not result in any exceedences of the 100 mg/l interim surface water standard for nitrate and the 10 pCi/l standard for uranium. Direct release via preferred pathways under Alternative 1 may similarly meet the applicable surface water standards, although there is currently some uncertainty in predicting contaminant concentrations that would be seen in North Walnut Creek.

Unless groundwater assessments suggests otherwise, under Alternative 1 there is the potential for contaminant release from the Solar Ponds Plume at rates resulting in nitrate and uranium concentrations in North Walnut Creek that are greater than applicable standards, both now and at the end of active remediation. Nitrates in excess of 10 mg/l would not, however, constitute an unacceptable risk to human health as the future uses for Walnut Creek do not include drinking water supply The future placement of an engineered cover over the Solar Ponds area may also significantly reduce the migration of the Solar Ponds Plume contaminants to surface water. Groundwater assessments are underway to evaluate impacts of nitrate and uranium on surface water assuming a cover is in place.

3.1.1.2 Implementability

Alternative 1 is readily implementable from a technical standpoint as grouting and/or removal of sections of the ITS would not utilize any unique construction or technologies requiring further development. Alternative 1 is also readily implementable from an administrative standpoint as it does not require permits, licenses, an environmental assessment, or a complex, lengthy schedule, and it utilizes available, proven techniques and resources. An administrative complication may arise from potentially compromising the integrity of security zones that cross the area of the ITS. Finally, it may be difficult to definitively demonstrate that the 10 mg/l long-term nitrate standard could be maintained throughout Walnut Creek.

3.1.1.3 Ability to Meet Specific Goals and Objectives

Based on concentrations of nitrate and uranium in water consolidated at the ITPH averaging 430 mg/l and 130 pCi/l, respectively, it is possible that under Alternative 1, applicable surface water standards, including the interim standard for nitrate, would be exceeded at various "points of evaluation" in North Walnut Creek. It should be noted, however, that The *Management Plan for Interceptor Trench System Water*[ii] evaluated a direct release option under which the ITPH would be allowed to overflow into North Walnut Creek. The evaluation concluded that the short-term interim standard for nitrate of 100 mg/l and the 10 pCi/l uranium standard would not be exceeded in North Walnut Creek. Compliance with surface water standards under Alternative 2 is reliant on an adequate base flow in North Walnut Creek to provide mixing, and low base flow in North Walnut Creek may cause surface water standards to be exceeded. It is reasonable that Alternative 1 would similarly meet the short-term standards while adequate flow exists in North Walnut Creek, but it is likely that the long-term nitrate standard would be exceeded. A significant level of effort in assessing the Solar Ponds Plume is needed to effectively evaluate the performance of Alternative 1.

Alternative 1 would probably not be considered consistent with the goals of RFCA in that it does not include measures to ensure compliance with surface water standards for the long term. Also, Alternative 1 does not include active measures to remediate the Solar Ponds Plume to lessen the potential for long-term surface water impacts.

Alternative 1 allows flexibility in determining future actions supporting closure of the Site in 10 years in that it would not interfere with other actions such as the placement of a cover over the area of the Solar Ponds. However, Alternative 1 eliminates "manageability" of the Solar Ponds Plume because it entails the closure of the ITS. Options for treatment are reduced with the elimination of the ITS/French drain system, although passive treatment systems (e.g., phytoremediation) may not be negatively impacted.

Alternative 1 would eliminate the current high cost associated with ITS water collection, storage, and periodic treatment at Building 374. Alternative 1 costs have been estimated at $107,000 for ITS closure. Groundwater assessment costs could approach $100,000. Additional significant costs would likely be associated with modifying the security zone crossing the area of the ITS.

3.1.1.4 Inclusion of Cost Minimization Elements

The cost of closing the ITS can be minimized by opting for grout/bentonite injections instead of complete ITS removal. A removal option would require the excavation of approximately 8,000 feet of buried pipeline—an arduous and costly activity relative to grouting at limited locations.

3.1.1.5 Ease of Post Site Closure Operations

Once closure of the ITS and ITPH is complete, there would be no operations activities associated with Alternative 1.

3.1.1.6 Regulatory Agency and Local Community Acceptance

Given Alternative 1 does not include any elements of Solar Ponds Plume remediation, it is likely that Alternative 1 would be unacceptable to the regulatory agencies and the local community. Also, because there is significant uncertainty associated with predicting impacts to long-term water quality in Walnut Creek under Alternative 1, it is likely that closure of the ITS, an action that would eliminate a significant existing means of contaminant control, would not be acceptable.

3.1.2 Alternative 2: Managed Release

Alternative 2, Managed Release, is described in detail in the *Management Plan for Interceptor Trench System Water.*[ii] The plan proposes the managed release of ITS water into North Walnut Creek in a manner that protects water quality at all times. The plan includes three phases that lead to the eventual closure of the ITS as part of complete site closure. Phase I entails the cessation of current treatment practices—evaporation at Building 374—and the institution of ITS water transfers from the MSTs directly to Pond A-4, which is the final point of discharge of surface water from the Site in the Walnut Creek drainage. This plan demonstrated that the 10 mg/l nitrate standard could be met by the managed release of ITS water via pipeline into Pond A-4. Building 374 would remain available during Phase I to treat collected ITS water if necessary. Phase I would be maintained until January 1, 1998, at which time Phase II would be implemented. Phase II entails the direct release of ITS-collected water into North Walnut Creek without the use of the MSTs. Pumping activities would cease, and the ITS water would be allowed to overflow the ITPH. Phase II would only be implemented when the 100 mg/l nitrate standard goes into effect. Phase III entails complete decommissioning of the ITS through grouting. Phase III of Alternative 2 is comparable to Alternative 1 except that Phase III would be implemented after other remediation tasks in the solar ponds area have been completed (e.g., capping the Solar Ponds with an engineered cover). The *Management Plan for the Interceptor Trench System Water* provides a technical evaluation of all three phases of Alternative 2.

3.1.2.1 Effectiveness

Alternative 2 is effective at protecting human health and the environment, although it takes no steps to reduce the amount of contaminants present in the Solar Ponds Plume or the amount of contaminants being released to Walnut Creek. Alternative 2 is a water management alternative designed to afford protection of human health and the environment by controlling the release of ITS-collected water in a manner that ensures that contaminant dilution in North Walnut Creek achieves applicable surface water standards.

The *Management Plan for the Interceptor Trench System Water*[ii] presents detailed calculations that show controlled releases of ITS-collected water into Pond A-4 can effectively protect human health and the environment by maintaining contaminant concentrations below surface water standards applicable at the Pond A-4 outfall during Phase I. The technical evaluation also shows that the 100 mg/l nitrate standard and the 10 pCi/l uranium standard can be met during Phase II operation. Under Phase II, the average predicted seasonal nitrate concentration ranges from 18 to 35 mg/l in North Walnut Creek, and the uranium concentration ranges from 6.6 to 9.7 pCi/l. Because these are seasonal averages, there will likely be times when, due to low baseline flow in North Walnut Creek, the surface water standards will be exceeded. However, Ponds A-3 and A-4 will attenuate the contaminant concentrations prior to release at the Pond A-4 outfall.

The effectiveness of Phase III cannot be predicted without a groundwater assessment as discussed for Alternative 1. Also, as noted for Alternative 1, unless an assessment suggests otherwise, Alternative 2 would not likely meet the 10 mg/l nitrate standard in North Walnut Creek once Phase III begins. Nitrates in excess of 10 mg/l would not, however, constitute an extraordinary risk to human health and the environment as the future use for Walnut Creek is primarily agricultural, not drinking water supply. As noted for Alternative 1, the placement of an engineered cover over the Solar Ponds area may significantly reduce the contaminant migration in Phase III.

3.1.2.2 Implementability

Phase I of Alternative 2 is readily implementable from a technical standpoint as the water collection (ITS) and storage (MST) systems are already in place. Monitoring systems are available and can be easily installed within North Walnut Creek to monitor contaminant concentrations as part of a controlled release. Phase I should be readily implementable from an administrative standpoint because it would not likely require permits or licenses, and it would not require any special expertise or resources. The only significant documentation required for the implementation of Alternative 2 is a Proposed Action Memorandum (PAM). Similarly, Phase II is readily implementable from both a technical and administrative standpoint. Phase III, which entails closure of the ITS, is readily implementable from technical and administrative standpoints (see discussion under Alternative 1). Phase III may, however, have the same potential administrative difficulties as identified for Alternative 1, that is, satisfying security needs and demonstrating future nitrate standard compliance.

3.1.2.3 Ability to Meet Specific Goals and Objectives

Based on the technical evaluation conducted in the *Management Plan for the Interceptor Trench System Water*[ii] Phase I of Alternative 2 would meet the surface water standards for nitrate and uranium in Pond A-4, which is the point of compliance. Likewise, the 100 mg/l interim standard for nitrate and the 10 pCi/l standard for uranium would be met under Phase II, although it is possible that standards for nitrate and uranium would be exceeded in North Walnut Creek during periods of low baseline flow. Ponds A-3 and A-4 would attenuate the elevated contaminant concentrations during such periods. As discussed under Effectiveness (Section 3.1.2.1), groundwater assessments must be completed to determine whether surface water standards would be met during Phase III. In the long term, Phase III is the desirable mode of Solar Ponds Plume water management toward the final closure of RFETS; in order for Phase III to be implemented, it must be demonstrated that the 10 mg/l standard for nitrate would be met throughout Walnut Creek. A long-term compliance evaluation would include considering the impacts of placing an engineered cover over the Solar Ponds area.

Alternative 2 is consistent with RFCA in that it includes water management activities to ensure compliance with surface water standards for Walnut Creek at the point of compliance, i.e., the Pond A-4 outfall. It is possible that the goals of RFCA would not be maintained over the long term without active ITS water management. Elements of final site closure must be integrated with assessment efforts to determine whether surface water standards would be met over the long term without management.

Alternative 2 would eliminate the current high cost associated with ITS water collection, storage, and periodic treatment at Building 374. Alternative 2 costs have been estimated at $107,000 for ITS closure under Phase III. Groundwater assessment costs could approach $100,000.

3.1.2.4 Inclusion of Cost Minimization Elements

Alternative 2 incorporates the use of the existing ITS and MSTs. Also, as discussed for Alternative 1, under Phase III, grout/bentonite for ITS closure minimizes the cost associated with this activity.

3.1.2.5 Ease of Post Site Closure Operations

Once closure of the ITS and ITPH is complete, there would be no operations activities associated with Alternative 2.

3.1.2.6 Regulatory Agency and Local Community Acceptance

In late summer 1996, Alternative 2 was presented to the regulatory agencies and the local communities as the *Management Plan for the Interceptor Trench System Water.*[ii] The agencies and community considered Alternative 2 unacceptable given that it proposes to achieve compliance with surface water standards through dilution of collected Solar Ponds Plume water rather than through treatment.

3.1.3 Alternative 3: Evaporation at Building 374

The current practice for treating ITS-collected water includes the periodic transfer of stored water from the MSTs to Building 374 for evaporation. Under Alternative 3, Solar Ponds Plume contaminated water would continue to be collected by the ITS, stored in the MSTs, and periodically transferred to Building 374 for evaporation. Product water from B374 is used for steam plant and cooling tower make-up; blow-down is discharged to Building 995, the Site's Wastewater Treatment Plant, from which treated water is discharged to the B-series ponds. Currently, water from the B-series ponds is transferred to Pond A-4 for discharge offsite. According to the RFETS Ten Year Plan, Building 374 is scheduled for decommissioning. Alternative 3 could continue with water treatment for as long as is necessary to maintain surface water standards. Continued treatment would require a replacement facility for Building 374 such as Building 910 or the Alternate Water Treatment System (AWTS).

3.1.3.1 Effectiveness

Alternative 3 is effective at providing protection of human health and the environment. Past operations under this alternative have demonstrated that the contaminant concentrations can be maintained below the surface water standards applicable to Walnut Creek under varying site conditions, i.e., varying precipitation levels. It is expected that Alternative 3 would maintain compliance with both the short-term (including the 100 mg/l interim nitrate standard) and long-term surface water standards.

Alternative 3 would continue with a replacement facility, such as Building 910 or the AWTS, once decommissioning of Building 374 begins. Such a replacement facility would maintain the effectiveness of Alternative 3 at complying with both short- and long-term surface water standards.

3.1.3.2 Implementability

Alternative 3 is currently readily implementable from both a technical and administrative standpoint as it has been the ITS water management practice for several years. Building 374 operations can readily support continued treatment of ITS-collected water until decommissioning begins.

Based on several studies to date, the use of an alternative treatment system once Building 374 is no longer available is readily implementable from a technical standpoint. Administrative implementability would be impacted by the type of alternative treatment system selected, e.g., license, permit, and documentation requirements that are associated with treatment system discharges. Currently considered alternative treatment facilities include Building 910 and the Alternate Water Treatment System (AWTS). Building 910 was originally constructed for the treatment (evaporation) of ITS water at a maximum rate of 36 gpm—a rate that adequately meets the 25 gpm (approximate) treatment rate needed for a high precipitation month during which up to 1 million gallons of ITS-collected water would require treatment. The AWTS has not been designed as of completion of this study. It is known, however, that the planned treatment capacity for the AWTS would have to be increased to accommodate the ITS-collected water.

3.1.3.3 Ability to Meet Specific Goals and Objectives

Alternative 3 would continue Site compliance with surface water standards for nitrate and uranium, including the interim and final standards for nitrate.

Alternative 3 is consistent with RFCA in that it includes water management and treatment activities to ensure compliance with surface water standards for Walnut Creek at the point of compliance, i.e., the Pond A-4 outfall. It is possible that the goals of RFCA would not be maintained over the long term—i.e., beyond site closure—without active ITS water management, including continued treatment of ITS-collected water so that surface water standards are maintained in Walnut Creek. Groundwater assessments must be conducted to determine whether surface water standards would be met over the long term. The need for treatment may be reduced if, over the time up to site closure, significant contaminant level reductions are achieved in the Solar Ponds Plume. Such reductions would possibly preclude the need for a long-term treatment facility to maintain compliance with surface water standards in Walnut Creek.

Alternative 3 can not satisfy the goal of providing a reduction in current costs because it is the current treatment method. However, the cost of treatment may decrease in the future with the use of an alternative treatment facility.

3.1.3.4 Inclusion of Cost Minimization Elements

There are no elements for cost minimization that have been incorporated into Alternative 3 while treatment continues at Building 374. Cost may reduced once a successor facility to B374 is in operation.

3.1.3.5 Ease of Post Site Closure Operations

Continued treatment of ITS-collected water may be required beyond site closure. Continued operation of a treatment facility, such as Building 910 or the AWTS, would likely require significant worker presence for at least six months of each year. There would also likely be significant waste handling requirements to manage treatment process waste streams. It should be noted that treatment requirements would likely be less in the long term because of the placement of an engineered cover over the Solar Ponds area. An engineered cover may contribute to a reduction in the volume of water collected by the ITS.

3.1.3.6 Regulatory Agency and Local Community Acceptance

Based on the reliable past performance of Alternative 3, it is likely that continued collection and treatment of Solar Ponds Plume groundwater would be acceptable to the regulatory agencies and the local community. Acceptance would likely be enhanced if, over the time up to site closure, significant contaminant level reductions are achieved in the Solar Ponds Plume. Such reductions would possibly reduce concerns over the need for a long-term presence of a treatment facility and personnel in order to maintain compliance with surface water standards in Walnut Creek.

3.1.4 Alternative 4: Treatment at Building 995

Alternative 4, Treatment at Building 995 (RFETS' wastewater treatment plant), requires the continued use of the ITS and MSTs. Water stored in the MSTs would be transferred to Building 995 periodically for treatment. This alternative may require the installation of a transfer line (about 2-inches in diameter) between the MSTs and Building 995, although it is possible that existing lines between the MSTs and Building 374 and between Building 374 and Building 995 may be utilized. Pumps currently used to transfer water from the MSTs to Building 374 could support water transfers under Alternative 4. Alternative 4 does not require modification of the existing ITS and MSTs. Building 995 has the same unit processes found at typical municipal wastewater plants, including primary clarification, activated sludge with secondary clarification and disinfection. Additional treatment is provided by chemical addition and tertiary clarification followed by sand filtration. Biosolids are anaerobically digested and mechanically dewatered. Biosolids are currently disposed of as low-level waste at the Nevada Test Site (NTS), however, future use of land application is being investigated as an alternative to off-site shipment. Building 995 presently treats about 180,000 gallons of water per day and has the capacity to treat about 400,000 gallons per day.

The ITS-collected water would be discharged along with other RFETS wastewater treated at Building 995 and regulated by a National Pollutant Discharge Elimination System (NPDES) Permit. Discharge through the permitted outfall is directed to Pond B-3 from which it flows downstream to the Site's storm water management system and discharge into Walnut Creek. Surface water standards that apply in South Walnut Creek—i.e., the B-series ponds drainage—are the same as those that apply in North Walnut Creek—i.e., the A-series ponds drainage.

Alternative 4 would continue as needed to maintain compliance with surface water standards in Walnut Creek. It is possible that Building 995 would require modifications as site facilities are closed and a reduced wastewater flow is realized. A reduced flow may affect the performance of Building 995 in treating ITS-collected water—i.e., system upsets may affect biological degradation performance.

3.1.4.1 Effectiveness

Alternative 4 is effective at providing protection of human health and the environment. The nitrate concentration in the ITS-collected water would be reduced through biological denitrification. Uranium would concentrate in the solids generated at the wastewater treatment plant—see Appendix B, Calculation Set #2. Solids are currently transported offsite to the NTS for disposal as a low-level waste. It is expected that treatment operations at Building 995 will achieve short- and long-term surface water standards.

3.1.4.2 Implementability

Because there is generally no biochemical oxygen demand (BOD) in the ITS-collected water, the rate of transfer to Building 995 would be limited, based on treatment optimization. However, according to Building 995's Manager of Operations,[iii] the nitrate concentration of 400 to 500 mg/l in collected water should not hinder the performance of the wastewater treatment plant. Also, a transfer rate of 25 gpm—based on the need to treat approximately 1 million gallons during a "wet" month—should not exceed or impair the treatment capacity of the facility, although, as the site facilities begin to close and flow to Building 995 is reduced, it is possible that Building 995 modifications would be required to maintain acceptable treatment performance. Resources required to implement Alternative 4 are readily available.

Under this alternative, most of the dissolved uranium would be expected to concentrate in the solids generated at Building 995. The concentration of uranium in the biosolids impacts the land application disposal alternative currently being investigated. The current gross alpha activity level in biosolids is 40 to 60 pCi/g. This activity level could increase as much as twofold due to uranium from ITS-collected water and may impact the suitability of the biosolids for on-site disposal. However if the option of land applying Building 995 sludge cannot be practiced, other disposal methods are available for the short and long term. In any event, the additional radionuclide load at Building 995 would not require any significant changes in treatment plant personnel operations and personnel protection measures.

Treatment of ITS-collected water would require notification of the permitting authority and, potentially, a modification of the facility's permit. There would be no licensing requirements associated with Alternative 4.

3.1.4.3 Ability to Meet Specific Goals and Objectives

It is expected that Alternative 4 would meet the short- and long-term surface water standards for nitrate and uranium, although the mechanism by which the alternative would meet the standards for each contaminant cannot be identified with any certainty without treatability studies.

Alternative 4 is consistent with RFCA in that it includes water management and treatment activities to ensure compliance with surface water standards for Walnut Creek at the point of compliance, i.e., the Pond B-5 outfall. It is possible that the goals of RFCA would not be maintained over the long term—i.e., beyond site closure—without active ITS water management with continued treatment of ITS-collected water so that surface water standards are maintained in Walnut Creek. The ability to maintain the goals of RFCA under Alternative 4 can only be assessed when final site closure plans, especially those plans for the Solar Ponds area, are defined. Elements of final site closure must be integrated with groundwater assessment efforts to determine whether surface water standards would be met over the long term without treatment.

Alternative 4 provides a significant reduction in costs relative to the current ITS water management practice of treatment in the Building 374 evaporators. The treatment cost per gallon at Building 995 is approximately $0.033, or $99,000 annually for 3 million gallons of ITS-collected water, while the treatment cost per gallon at Building 374 ranges from $1 to $2 per gallon, or approximately $3 to $6 million annually for 3 million gallons of ITS water [(b)]. The cost of placing and operating a transfer line from the MSTs to Building 995 is relatively low. Current solids disposal costs for solids generated at Building 995 are approximately $50,000 to $100,000 per year for disposal at NTS. Disposal costs may be reduced significantly if land application is permitted in the future.

[(b)] Historically, treatment costs have been at the higher end of this range; recent budgets for operation of B374 are closer to the $1 per gallon cost.

3.1.4.4 Inclusion of Cost Minimization Elements

Alternative 4 includes the use of the MSTs to provide ITS water collection surge capacity. This surge capacity is needed so that ITS-collected water can be treated at Building 995 at relatively small flowrates that will not upset treatment system conditions at Building 995. An additional cost minimization element that may be included with Alternative 4 is the use of existing transfer lines from the MSTs to Building 995 via Building 374.

3.1.4.5 Ease of Post Site Closure Operations

Continued treatment of ITS-collected water may be required beyond site closure. Continued operation of Building 995 would likely require operator presence for at least six months of each year. There would also likely be significant waste handling requirements to manage treatment process waste streams and significant modification to the unit operations may be necessary to meet surface water standards when treating only ITS-collected water. It should be noted that treatment requirements would likely be less in the long term because of the placement of an engineered cover over the Solar Ponds area and, as the Site closes, a reduced level of recharging to groundwater attributable to Site distribution and sewage system leakage.

3.1.4.6 Regulatory Agency and Local Community Acceptance

Based on the acceptance of the current practice, it is likely that continued collection and treatment of the Solar Ponds Plume contaminated groundwater would be acceptable to the regulatory agencies and the local community. Acceptance would likely be enhanced if, over the time up to site closure, significant contaminant level reductions are achieved in the Solar Ponds Plume. Such reductions would possibly eliminate concerns over the need for a long-term presence of a treatment facility, such as Building 995, and operations personnel in order to maintain compliance with surface water standards in Walnut Creek.

3.1.5 Alternative 5: Treatment at MSTs

Alternative 5, Treatment at MSTs, would require the ITS and MSTs to remain. Alternative 5 was evaluated in a previous report titled *Conceptual Process Design, Rocky Flats ITS Water Treatment Facility.*[iv] This report presented the conceptual design of a system with a treatment capability of 1 million gallons per month—refer to the aforementioned conceptual design report for details on this alternative. The conceptual design assumed 24 hour per day operations at the MSTs and a treatment capacity of approximately 30 gpm. The treatment system includes flow equalization, two-stage chemical precipitation, membrane filtration, neutralization, sludge handling, and biological treatment with preheating. A combination of new equipment and existing tankage and process lines would be used.

The first step of treatment under Alternative 5 includes the removal of uranium through chemical precipitation followed by membrane filtration and filter press solids drying. Chemical precipitation utilizes one of the three MSTs as a surge tank for feed to a precipitation process. Chemical precipitation requires multiple new tanks for reaction, concentration, flushing, reagent storage, etc. Precipitated solids would be concentrated using a combination of membrane filters and a filter press. Concentrated solids would be collected and packaged for disposal.

After uranium removal, water is directed to either of the two remaining MSTs for biological treatment. The biological treatment of nitrate, biodenitrification, is a bacterial metabolic process that converts nitrate to nitrogen gas and carbon dioxide under anoxic conditions. A carbon source such as methanol is required in this process. The MST bioreactors would be operated in batches. The conceptual design report identifies the need for a clarifier, ion exchange polishing unit (used as necessary to ensure removal of nitrate to surface water standard), and a water heating unit. After uranium and nitrate removal, treated water would be discharged to Pond A-4.

Precipitated uranium is concentrated in the 25 to 45 percent solids present in the filter cake generated by filter press operations. Filter cake would be drummed for further processing or disposal. Biosolids generated as a result of the biodenitrification process would be managed by periodically transferring them via tanker to the Site's wastewater treatment plant (Building 995). Solids would be added to the clarifiers of Building 995 in a controlled manner and eventually removed as densified sludge for disposal. Uranium would not have an impact on the B995 biosolids because the uranium is removed prior to Alternative 5's biological process.

Alternative 5 would continue as needed to maintain compliance with surface water standards in Walnut Creek. Biosolids transfer offsite for disposal may be possible without processing through Building 995—an option that may be necessary if Building 995 closed prior to the end of Alternative 5.

3.1.5.1 Effectiveness

Alternative 5 is effective at protecting human health and the environment and meeting water quality standards. The uranium and nitrate levels in the ITS-collected water would be reduced to levels that are compliant with both the short- and long-term applicable surface water standards. Actual treatment performance would require assessment through treatability studies.

A deficiency in this treatment system may appear during periods of very high precipitation at RFETS in that there may be insufficient time to allow for biodenitrification to a desired level before an MST would have to be emptied to make room for the next batch. In such instances, the standby ion exchange system, which uses a nitrate-selective ion exchange resin, would be used to polish the biodenitrification effluent to achieve the nitrate standard.

3.1.5.2 Implementability

Conventional, proven technologies that are readily adaptable to the treatment of ITS-collected water comprise Alternative 5. As discussed above, the ability to achieve the desired nitrate level is impacted only during periods of heavy precipitation, which could lead to ITS water collection at a rate that exceeds the system's biodenitrification capacity based on required residence time in the MSTs.

Operators of Alternative 5's treatment facility would require special training which would be outlined by a facility operations and maintenance manual. The training requirements would not be extraordinary relative of those of other water treatment facilities at RFETS. The conceptual design report did not identify any permit or license requirements to construct and operate the Alternative 5 treatment facility, however, as a treatment facility with a discharge directly into Walnut Creek, a NPDES permit would be required.

3.1.5.3 Ability to Meet Goals and Objectives

It is expected that Alternative 5 would meet the short- and long-term surface water standards for nitrate and uranium. Alternative 5 would remain in place as long as the need for treatment to maintain surface water standards exists.

Alternative 5 is consistent with RFCA in that it includes water management and treatment activities to ensure compliance with surface water standards for Walnut Creek at the point of compliance, i.e., the Pond A-4 outfall. It is possible that the goals of RFCA would not be maintained over the long-term—i.e., beyond site closure—without active ITS water management and the continued use of Alternative 5. The ability of Alternative 5 to maintain the goals of RFCA can only be assessed when final site closure plans, especially those plans for the Solar Ponds area, are defined. Elements of final site closure must be integrated with groundwater assessment efforts to determine whether surface water standards would be met over the long term without treatment.

The *Technology Justification for the Interceptor Trench System*[v] estimated the capital cost of Alternative 5 to be $2.4 million and the annual O&M costs to be $370,000. These are significant costs that are difficult to compare with the cost of treating ITS water using the current practice of evaporation at Building 374. Treatment costs at Building 374 are shared and would continue to be shared with other users of the facility. The capital costs are a significant element of the total cost of Alternative 5; however, these may be matched or exceeded by the capital costs of a planned replacement facility for Building 374. Assuming the Alternative 5 treatment facility treats 3 million gallons of ITS-collected water each year, and the design life of the facility is 10 years, its cost per gallon is approximately $0.26 (see Calculation Set #3 of Appendix B). The cost per gallon of ITS water treated at Building 374 ranges from $1 to $2(b).

More exact construction costs cannot be estimated at this time. The MSTs, as described in Section 2.1, have shown some signs of geotechnical instability. Correcting this problem would add to the construction costs estimated above.

3.1.5.4 Inclusion of Cost Minimization Elements

Alternative 5 includes the use of existing pumps, piping, tanks, etc. to minimize the cost of treatment facility construction. The most significant contribution to cost minimization stems from the use of the MSTs as process vessels.

3.1.5.5 Ease of Post Site Closure Operations

Continued treatment of ITS-collected water may be required beyond site closure. Continued operation of the Alternative 5 treatment system would likely require operator presence for at least six months of each year. There would also be significant waste handling requirements to manage treatment process waste streams. It should be noted that treatment requirements would likely be less in the long term because of the placement of an engineered cover over the Solar Ponds area. An engineered cover would likely reduce the volume of water collected by the ITS.

3.1.5.6 Regulatory Agency and Local Community Acceptance

Based on the acceptance of the current practice, it is likely that continued collection and treatment of Solar Ponds Plume contaminated groundwater would be acceptable to the regulatory agencies and the local community. Acceptance would likely be enhanced if, over the time up to site closure, significant contaminant level reductions are achieved in the Solar Ponds Plume. Such reductions would possibly eliminate concerns over the need for a long-term presence of a treatment facility, such as proposed under Alternative 5, and operations personnel in order to maintain compliance with surface water standards in Walnut Creek.

3.1.6 Alternative 6: Constructed Wetland

Alternative 6 involves the use of a man-made wetland to treat ITS-collected water. Such a wetland would be constructed in an area away from the existing A-series ponds so as not to alter the current configuration of the surface water management system. A number of treatability studies are required to identify the type of wetland that would be most effective at treating the nitrate and uranium present in ITS-collected water.

The following provides a general discussion of the use of wetlands for wastewater treatment. This information was derived from various sources, including the EPA Design Manual: *Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment.*[vi]

The primary mechanisms of wastewater treatment with wetlands are bacterial metabolism and physical sedimentation. Plant life, such as cattails, are generally supportive components of the wetland environment that tend to favor contaminant removal. Submerged roots and stems provide surfaces for bacterial growth and assist in filtration and adsorption of suspended solids. Stems and leaves above the water surface limit algae growth by attenuating sunlight, reduce the effects of wind, i.e., gas exchange between the water and atmosphere, and assist in the transfer of gases to and from the submerged parts of the plant. Wetlands provide a means to physically entrap contaminants through sorption in the surface soils and organic litter. In addition, the numerous microorganisms present in a typical wetland can utilize and transform many common wastewater contaminants.

A constructed wetland would be either a free water surface system (FWS) with shallow water depths or a subsurface flow system (SFS) with water flowing through sand or gravel. An effective constructed wetland would be shallow (2 ft.), long, and narrow. The EPA design manual states that a constructed marsh is usually 23 to 37 acres per million gallons per day of water to be treated. With this areal requirement, the wetland needed for ITS-collected water, based on volume alone, would be approximately 0.2 to 0.3 acre. Another areal estimate provided to RFETS by Pintail Systems for a constructed wetland to treat OU7 seepage (1 to 7 gpm) was 1 acre. It is reasonable to assume that a significant level of treatability testing must be performed to accurately estimate wetland size requirements for the treatment of ITS-collected water.

The ITS and MSTs would be required for this alternative. The MSTs are necessary to provide a regulated, relatively constant flow of ITS water to the wetlands. Treated water would overflow the wetland and drain off site via the Walnut Creek drainage (unless the wetland is located in the Woman Creek drainage).

Due to the presence of nitrates, it is expected that a SFS wetland with significant regions of anaerobic conditions would provide a greater degree of denitrification than a FWS. Nitrogen removal by constructed wetlands can vary significantly with a range of 25 to 85 percent.[vii] Uranium removal, however, would likely be effected to a greater degree under aerobic conditions such as those found in a FWS. This suggests that a "hybrid" wetland providing regions of aerobic and anaerobic conditions would likely be required to treat ITS-collected water to contaminant levels that are compliant with applicable surface water standards.

3.1.6.1 Effectiveness

There is significant uncertainty in evaluating the potential effectiveness of a constructed wetland, particularly with regards to its ability to achieve both short- and long-term surface water standards for nitrate and uranium and, thus, provide adequate protection of human health and the environment. Literature reports success with denitrification; however, the reported removal range of 25 to 85 percent would still leave nitrate ranging in concentration from approximately 322 mg/l to 64 mg/l—based on the current nitrate concentration average of 430 mg/l in the ITPH. Wetlands have been utilized to successfully lower metals concentrations in a variety of wastewaters; however, the use of wetlands to treat uranium has not been reliably demonstrated on a large scale.

3.1.6.2 Implementability

Wetlands have been constructed for the treatment of a variety of wastewaters at multiple locations throughout the United States.[v] A wetland treatment system for ITS-collected water would require construction in an area of the Site that is relatively flat, most likely the buffer zone. Construction of a wetland for ITS water treatment may provide required wetland area for the Site to make up for wetland destruction as a result of site closure activities; however, it is possible that a new wetland would impact previously undisturbed land. The resources required to construct a wetland are readily available. Such resources would likely include research personnel from local universities and consultant firms.

The contamination of previously uncontaminated land with uranium that deposits in a newly constructed wetland presents an administrative difficulty. Wetland construction would have to occur in an area away from the Walnut Creek drainage, with the most probable location being in the buffer zone. Such construction is discouraged, given the desire to leave the buffer zone undisturbed. Also, any significant construction in the buffer zone would require an evaluation under the National Environmental Policy Act (NEPA). Such an evaluation would add to the lead time for implementing this alternative.

3.1.6.3 Ability to Meet Specific Goals and Objectives

There is a significant level of uncertainty as to whether Alternative 6 would meet the short- and long-term surface water standards for nitrate and uranium. As discussed under Effectiveness, literature reports a denitrification removal range of 25 to 85 percent—a removal efficiency that may not be adequate to achieve the interim nitrate standard of 100 mg/l and would almost certainly not achieve the long-term nitrate standard of 10 mg/l. The ability of a constructed wetland to achieve the uranium standard of 10 pCi/l cannot be estimated without treatability studies. Treatability studies conducted on uranium-contaminated water at Oak Ridge, Tennessee, indicated that a constructed wetland may reduce uranium concentration.[vii] The Oak Ridge study showed uranium removal rates that averaged approximately 46 percent. The study suggested that in order to maintain uranium removal capacity in a constructed wetland, it may be necessary to replenish the biomass periodically so that active sites of uranium adsorption can be renewed.

Alternative 6 is consistent with RFCA in that it includes water management and treatment activities to achieve surface water standards for Walnut Creek at the point of compliance, i.e., the Pond A-4 outfall (Note that significant uncertainty exists in Alternative 6's treatment performance). It is possible that the goals of RFCA would not be maintained over the long term—i.e., beyond site closure—without active ITS water management and the continued use of Alternative 6. The ability to maintain the goals of RFCA under Alternative 6 can only be assessed when final site closure plans, especially those plans for the Solar Ponds area, are defined. Elements of final site closure must be integrated with groundwater assessment efforts to determine whether surface water standards would be met over the long term without treatment.

It is expected that Alternative 6 would provide a reduction in costs relative to the current ITS water management practice of treatment in the Building 374 evaporators. Although there would be a significant capital cost associated with construction of a wetland, the O&M costs should be significantly less than those for operating the Building 374 evaporators.

3.1.6.4 Inclusion of Cost Minimization Elements

Alternative 6 includes the use of the existing MSTs to provide ITS water collection surge capacity. The surge capacity is needed to maintain the feed of ITS-collected water to the constructed wetland at a relatively constant rate so as not to upset system conditions. Use of the MSTs precludes the need for constructing new surge tanks.

3.1.6.5 Ease of Post Site Closure Operations

Alternative 6 would remain as long as the need for treatment of ITS-collected water exists. Use of Alternative 6 over the long-term (i.e., beyond site closure) would require periodic oversight to ensure proper conditions are maintained at the wetland. The ITS and MSTs would also require periodic inspection and maintenance over the long term. Such activities are not expected to present significant difficulties.

3.1.6.6 Regulatory Agency and Local Community Acceptance

Alternative 6 would likely be viewed skeptically by the regulatory agencies and the local community because of its uncertainty in treatment performance and its potential to radioactively contaminate previously uncontaminated areas.

3.1.7 Alternative 7: Off-Channel Evaporation Pond

Under Alternative 7, Solar Ponds Plume contaminated water continues to be collected by the ITS, but it is no longer be stored in the MSTs. Instead, the water is sent to a lined evaporation pond isolated from the Walnut Creek drainage area. The estimated pond size for evaporation of 3 million gallons of ITS water annually is 4 to 5 acres (See Supplemental Testimony of John Law, November 26, 1996 included with Calculation Set #4 in Appendix B). The pond's size would require its construction in the buffer zone. Solids generated by evaporation are expected to be less than 500 cubic feet per year. Solids would not have a measurable impact on the evaporation rate achievable with the pond.

3.1.7.1 Effectiveness

This alternative would provide the same level of protection to human health and the environment, in terms of minimizing contamination of Walnut Creek, as the current practice of evaporation at Building 374—i.e., it would meet the short- and long-term surface water standards. The construction of a 4 to 5 acre pond in the buffer zone may have a significant negative impact on the environment, and would leave a very large excavation that would likely require closure in the future.

3.1.7.2 Implementability

Alternative 7 is implementable from a technical standpoint, but would require considerable design for groundwater protection measures and monitoring at the location of the newly constructed pond. From an administrative standpoint, Alternative 7 would require a NEPA review and decision process. Such an evaluation could impact the timeline for implementing this alternative. In addition, the evaporation pond would have to meet the requirements of the State groundwater protection program.

3.1.7.3 Ability to Meet Specific Goals and Objectives

Alternative 7 would comply with surface water standards for nitrate and uranium, including the interim standard for nitrate.

Alternative 7 is consistent with RFCA in that it includes water management and treatment activities to ensure compliance with surface water standards for Walnut Creek at the point of compliance, i.e., the Pond A-4 outfall. It is possible that the goals of RFCA would not be maintained over the long term—i.e., beyond site closure—without active ITS water management and continued use of Alternative 7. The ability to maintain the goals of RFCA under Alternative 7 can only be assessed when final site closure plans, especially those plans for the Solar Ponds area, are defined. Elements of final site closure must be integrated with groundwater assessment efforts to determine whether surface water standards would be met over the long term without treatment. It should be noted that construction of a 4 to 5 acre evaporation pond at the Site may interfere with site closure and future site activities.

Alternative 7 would provide a reduction in utility and operating costs since pond evaporation is simpler and less energy intensive than mechanical evaporation. The benefit of reduced operating costs, however, would be offset somewhat by the cost of capital and environmental monitoring expenses. The capital cost of Alternative 7 is estimated as $1.1 million; the O&M costs are estimated as $31,000 annually. There may also be significant costs associated with the possible closure of the evaporation pond in the future.

3.1.7.4 Inclusion of Cost Minimization Elements

Alternative 7 includes continued use of the existing ITS and ITPH.

3.1.7.5 Ease of Post Site Closure Operations

Alternative 7 would remain as long as the need for treatment of ITS-collected water exists. Use of this alternative over the long term (i.e., beyond site closure) would require periodic inspection and maintenance of the ITS and ITPH. Such activities are not expected to present significant difficulties.

3.1.7.6 Regulatory Agency and Local Community Acceptance

Alternative 7 would not likely be accepted by the regulatory agencies and local community because the creation of an evaporation pond would raise concerns about impacting previously undisturbed areas of the buffer zone. Also, closure of a new evaporation pond that would contain concentrated nitrate salts and, possibly, elevated concentrations of particulate and dissolved uranium would be a concern.

3.1.8 Alternative 8: Dispersion Field

Under Alternative 8, Solar Ponds Plume water continues to be collected by the ITS and stored in the MSTs; however, collected is sent to a leach field outside of the Walnut Creek drainage area instead of to Building 374. The estimated size of the leach field for treatment of 3 million gallons of ITS water annually is 0.44 acres (See Interceptor Trench System, Infiltration System, Preliminary Draft Conceptual Design, by John Law, November 25, 1996, included as Calculation Set #5 in Appendix B). The preliminary design includes a subsurface infiltration system consisting of 54 parallel trenches each sixty feet in length and six feet apart. Each trench contains a 4-inch diameter perforated plastic pipe located 30 inches below the surface. Water distributed to soils at the leach field would likely exit the leach field area and migrate to groundwater. Some surface water runoff may also form. In order to define the dispersion field's necessary operating parameters, a pilot study is required. Nitrate could be utilized by vegetation that is sustained in the area of the dispersion field and some denitrification could occur in any anaerobic regions of the subsurface. The fate of uranium is uncertain, although it would likely be adsorbed onto subsurface organic materials.

3.1.8.1 Effectiveness

This alternative would provide the same level of protection to human health and the environment, in terms of minimizing contamination of Walnut Creek, as the current practice of evaporation at Building 374 as the leach field would not discharge to Walnut Creek. It should be noted, however, that because of the large flowrate and high concentration of nitrate being processed by the leach field, it is possible that contaminated water could be re-introduced to the environment in the event of a system upset. The risk of contaminating other groundwater at the Site makes it advisable to use an enclosed system such as a bioreactor or a lined pond. The construction of a leach field in the buffer zone may have a significant negative impact on the environment. The overall effectiveness of the leach field operation is highly questionable as it is dependent on maintaining an anaerobic environment and supplying a carbon source (e.g. plant sugar or methanol) for nitrate removal. Also, in order to sustain anaerobic conditions, it would be necessary to keep the flow rate high enough to maintain saturation of the soil. If the flowrate is too low, aerobic denitrification may occur with resultant biomass formation and fouling. The only likely mechanism for uranium removal in a dispersion field is adsorption onto soils, organic materials, root systems, etc. Uranium retention may be highly variable, depending on flowrate, concentration, organic content in subsurface, etc.

The ability of Alternative 8 to treat ITS water so that surface water standards are met and additional groundwater at the Site is not contaminated would have to be verified with treatability studies. It is quite possible that uranium retention in a leach field would be temporary, with uranium releases being a long-term potential problem.

3.1.8.2 Implementability

Alternative 8 is implementable from a technical standpoint, but it would require considerable design for groundwater protection measures and monitoring. From an administrative standpoint, Alternative 8 would require a NEPA review and decision process. In addition, the leach field would have to meet the requirements of the State groundwater protection program.

3.1.8.3 Ability to Meet Specific Goals and Objectives

Alternative 8 would comply with surface water standards in Walnut Creek for nitrate and uranium, including the interim standard for nitrate. Protection of surface water may not, however, be maintained at the leach field, depending on the leach field's ability to treat the ITS-collected water. Also, groundwater quality may be compromised.

Alternative 8 is consistent with RFCA in that it includes water management and treatment activities to achieve compliance with surface water standards for Walnut Creek at the point of compliance, i.e., the Pond A-4 outfall. It is possible that the goals of RFCA would not be maintained over the long term—i.e., beyond site closure—without active ITS water management and continued use of Alternative 8. The ability to maintain the goals of RFCA under Alternative 8 can only be assessed when final site closure plans, especially those plans for the Solar Ponds area, are defined. Elements of final site closure must be integrated with groundwater assessment efforts to determine whether surface water standards would be met over the long term without treatment.

Alternative 8 would provide a reduction in costs for ITS-collected water treatment relative to current practice. The benefit of reduced operating costs, however, may be offset somewhat by the cost of leach field construction. Additional capital expenses include the cost of a new pipeline from the MSTs to the leach field and the cost of the carbon source for the microorganisms.

3.1.8.4 Inclusion of Cost Minimization Elements

Alternative 8 includes the use of the existing ITS and MSTs. Also, existing pump and piping systems would likely be incorporated into the leach field system.

3.1.8.5 Ease of Post Site Closure Operations

Operation of Alternative 8 would require an operator's presence for much of the year to ensure proper conditions at the leach field are maintained. Alternative 8 would require a formal closure process after ITS water management is no longer needed.

3.1.8.6 Regulatory Agency and Local Community Acceptance

The uncertainty of treatment performance and the potential to negatively impact groundwater under Alternative 8 would likely be unacceptable to the regulatory agencies and the local community. The creation of a leach field would raise concerns about impacting previously undisturbed areas of the buffer zone. Also, closure of an area that would possibly contain elevated concentrations of particulate and dissolved uranium at the end of the dispersion field's use would likely be a concern.

3.1.9 Alternative 9: Phytoremediation

Alternative 9, Phytoremediation, utilizes vegetation to remove or immobilize nitrate and uranium present in the Solar Ponds Plume. In general, phytoremediation is an emerging soil, groundwater, and wastewater remediation technology that makes use of engineered plant systems to remove, contain, or change the form of metals, organics, and radioactive compounds.[viii] Phytoremediation can be in the form of active and/or passive systems. Active systems may include herbaceous plants (such as grasses or alfalfa), or woody plants (trees and shrubs) that would be irrigated with contaminated water. Passive systems take advantage of plants, such as cottonwood trees, that are relatively deep rooted and, once established, do not require irrigation. The latter systems are most common for soil and groundwater remediation.

Both active and passive phytoremediation systems have the potential of meeting the goals and objectives associated with Solar Ponds Plume contaminated water management. As such, several options for the Solar Ponds Plume have been suggested by knowledgeable phytoremediation experts. In the interest of considering an alternative that can remain in place after closure of the Site and possibly not require operations and maintenance personnel, a passive system was selected for development as Alternative 9. Such a system has been outlined as follows by Dr. John Dickey of CH2M Hill, Redding, California.

The Alternative 9 passive system focuses on the minimization of surface water recharge by groundwater from the Solar Ponds Plume. The passive system would cover an area of approximately 12 acres with 725 trees per acre on the hillside just north of the Solar Ponds (Note that deep-rooted shrubs could be used if tests indicate improved performance over trees). Tree roots (e.g., cottonwood) would be near maximum springtime groundwater elevations. The trees must be established to an extent that allows the interception of shallow groundwater, thus reducing the potential for contaminated groundwater to exit in a quantity that would lead to nitrate and uranium contaminant concentrations exceeding applicable surface water standards in Walnut Creek. Other key elements of Alternative 9 include:

- The passive system would require irrigation initially to establish the trees. Irrigation could be removed eventually, at least from the areas with adequate groundwater to sustain a healthy stand of trees.

- Irrigation with water collected by the ITS can occur, although nitrogen loading to the trees should be limited to an amount that can be beneficially used. Water for irrigation would be stored in the existing MSTs.

- Supplemental "clean" water would be required to meet the young trees' water requirement. The Site's wastewater treatment plant (Building 995) effluent would be a good source of this supplemental water.

- An irrigation system would be designed and managed to train root systems for maximum interception of plume flow. That is, irrigation frequency should be low, and the profile should be wetted deeply with each irrigation.

- An irrigation system would be a subsurface type so that contaminated water collected by the ITS, when used as irrigation water, does not get applied at the surface—a practice that could contaminate the surface with uranium.

- Peak springtime groundwater levels do not coincide with peak consumptive use of water by plants. Therefore, control of the plume may not be complete. The existing ITS will eventually be closed, but should remain for a period during which the effectiveness of the passive system can be assessed.

Alternative 9 would require that the ITS, MSTs, and an optional ITS-collected water treatment capability (e.g., Building 374 or Building 995) remain until the effectiveness of the passive system could be assessed. It is expected that up to four years would be needed to establish trees that are mature enough to survive without irrigation and provide indicative monitoring data.

3.1.9.1 Effectiveness

Based on successful applications at other sites with a variety of contaminants, it is reasonable to assume that Alternative 9 would be effective at reducing the amount of Solar Ponds Plume groundwater and, consequently, nitrates and uranium that exit to surface water in North Walnut Creek. Research conducted by the University of Iowa indicated that a stand of trees was highly effective at reducing nitrate levels in groundwater. Specifically, an experiment that utilized three-year old poplar trees to act as a buffer between nitrate-contaminated groundwater and surface water showed reductions in the nitrate concentration from 150 mg/l to 3 mg/l.[ix] As such, there is the potential for Alternative 9 to meet the short- and long-term surface water standards for nitrate.

It is believed that deep-rooted vegetation would retard the mobility of uranium in the subsurface, although the specific mechanism by which such a reduction would occur is unclear without a site-specific treatability study. Possible mechanisms include the fixation of uranium in the region of the root system and the reduction in the amount of water available for uranium transport due to significant uptake of water by the plant—i.e., evapotranspiration would lessen the amount of water exiting the ground to North Walnut Creek. Previous studies using phytoremediation for the removal of uranium from groundwater with active systems were successful.[x] These studies were conducted using hydroponic growing techniques in a controlled nursery environment with plants that have the ability to take up uranium into the plant's tissues.

A full-size tree can transpire 5,000 gallons of water on a hot day.[vii] This study was not able to predict an evapotranspiration rate for each of the trees to be planted under Alternative 9; however, even if a small tree can only transpire an average of 50 gallons a day, then the proposed 12 acre stand of 8,700 trees (725 trees per acre) could transpire over 400,000 gallons of water per day. Based on the ITS water collection rates (see Section 2.1.2) the evapotranspiration of water through planted trees could significantly reduce the amount of groundwater that exits to the surface at North Walnut Creek.

3.1.9.2 Implementability

The placement of a stand of trees and a subsurface irrigation system on the sloped area just north of the Solar Ponds should be implementable from a technical standpoint. Further evaluation of seasonal groundwater variations in this area is required to optimize the density of tree placement and identify potential irrigation needs.

Alternative 9 should be readily implementable from an administrative standpoint, although there is a security concern with locating trees near the Site's Perimeter Intrusion Detection and Assessment System (PIDAS), which surrounds the protected area. Long range plans call for reducing the area surrounded by the PIDAS, at which time a tree plantation would not present a security risk. There are no special permits, licenses, etc. associated with Alternative 9.

3.1.9.3 Ability to Meet Specific Goals and Objectives

It is expected that Alternative 9 would meet the surface water standards for nitrate based on success with similar phytoremediation applications.[x] The ability of the alternative to meet the uranium surface water standard can only be assessed through treatability studies that are representative of site conditions and utilize the same types of deep-rooted plants that would be used for a full-scale application.

Alternative 9 is consistent with RFCA in that it includes water management and treatment activities to achieve surface water standards for Walnut Creek at the point of compliance, i.e., the Pond A-4 outfall. Alternative 9 may also significantly reduce the concentration of nitrate in the Solar Ponds Plume, thus increasing the probability that the goals of RFCA would be maintained over the long term—i.e., beyond site closure—without active management. The ability to maintain adherence to the goals of RFCA under Alternative 9, however, can only be assessed when final site closure plans, especially those plans for the Solar Ponds area, are defined. Elements of final site closure must be integrated with groundwater assessment efforts to determine whether surface water standards would be met over the long term without treatment.

Alternative 9 would provide a significant reduction in costs relative to the current ITS water management practice of treatment in the Building 374 evaporators. Although there would be a capital cost associated with placement of a stand of trees and a subsurface irrigation system, the O&M costs would be much less than those for operating the Building 374 evaporators. O&M costs for Alternative 9 would decrease as trees mature and the need for irrigation decreases. Monitoring and reporting costs would continue at current levels to meet requirements imposed by regulatory agencies.

A rough cost estimate for Alternative 9 is $175,000 (capital) and $15,000 annually (O&M). Closure of the ITS (if deemed necessary) once the trees reach maturity would cost $150,000 to $200,000—see Alternative 1. Because Alternative 9 would likely require three to four years to be fully functional (i.e., adequately protect surface water), an optional collection/treatment alternative must be utilized initially. The volume of collected water requiring treatment would likely decrease due to the maturation of planted trees (or other deep-rooted plants) through the three- to four-year period, thus the cost of treatment with an alternative such as Alternatives 3 and 4 would decrease through the Alternative 9 startup period.

3.1.9.4 Inclusion of Cost Minimization Elements

Alternative 9 includes the use of the MSTs for ITS-collected water storage. This saves approximately $50,000 to $100,000 for creating a new water storage impoundment.

3.1.9.5 Ease of Post Site Closure Operations

Once the tree stand (or other deep-rooted vegetation) proposed under Alternative 9 reaches maturity, very little long-term maintenance would be required. In fact, the only long-term operations that may continue after site closure is periodic tree replacement to ensure that the stand as a whole is healthy and continues to intercept groundwater prior to it exiting at North Walnut Creek.

3.1.9.6 Regulatory Agency and Local Community Acceptance

Because Alternative 9 is truly a viable, long-term, passive treatment alternative, it is likely to be viewed with favor by the regulatory agencies and the local community. Alternative 9 is also compatible with plausible alternatives for site closure, including capping of areas near the proposed Alternative 9 passive system. As such, Alternative 9 is likely to maintain desired surface water standards.

3.1.10 Alternative 10: Iron/Peat Passive Treatment

Alternative 10 includes the use of zero-valent iron (ZVI) and peat moss for the removal of uranium from groundwater. Alternative 10 is a passive, flow-through system integrated in the hillside between the Solar Ponds and North Walnut Creek. Conceptually, ZVI and peat moss would be used to fill select branches of the existing ITS, particularly the northernmost branch that extends east to west and is linked to the ITPH. This application would require excavation of a significant length of the ITS.

Based on the current level of development for remediation applications of ZVI and peat moss, the most plausible application of these technologies would be for uranium removal from groundwater. Studies evaluating various remediation alternatives conducted at Oak Ridge, Tennessee, indicate significant uranium removal efficiencies for both of these technologies.[vii] The Oak Ridge work alluded to future studies in which a biomass would be established within a ZVI and peat moss environment in order to effect denitrification of nitrate. This evaluation did not reveal any information that would support consideration of Alternative 10 as a stand-alone installation—i.e., an alternative that would address nitrates and uranium. As such, at the current level of technologies development, Alternative 10 should only be considered as a supplemental treatment employed with other alternatives.

In terms of uranium removal, it is known that ZVI interacts with groundwater to produce redox conditions and particulates that may retain metals. The Oak Ridge study of ZVI[vii] concluded that uranium removal is associated with ZVI corrosion. Peat moss acts strictly as an adsorbent for uranium removal. Its efficiency at uranium removal decreases with an increase in dissolved solids. It should be noted that the Oak Ridge study commented that uranium removal is likely lessened for absorptive technologies by the presence of nitrate. Extensive treatability study work would be required if Alternative 10 is to be applied at the Solar Ponds area.

Because the Alternative 10 technologies do not meet the minimum requirements of addressing the Solar Ponds Plume (the technologies do not have a proven ability to treat nitrate), Alternative 10 is not evaluated in detail against this study's evaluation criteria. However, Alternative 10 is still subjectively ranked, based on the Oak Ridge experience, in comparison to the other alternatives in Section 3.2.

3.1.11 Alternative 11: Enhanced Evaporation

Under Alternative 11, Solar Ponds Plume water continues to be collected by the ITS and stored in the MSTs. The MSTs are equipped with spray nozzles to provide enhanced evaporation of collected water. A series of beams would be installed around the perimeter of each MST to support truss members which in turn support three platforms. Pipe headers would be attached to the platforms, providing a total of 132 spray nozzles in each MST. The nozzles would be positioned in order to minimize overspray. Overspray would also be reduced by means of six foot high vertical louvers attached along the top perimeter of each tank. Four pumps (3 running, 1 standby) would circulate water from the top surface of water in the MST to its nozzle system at a total rate of approximately 2,000 gpm (15 gpm at each nozzle). A representation of a spray system on a MST is included with Calculation Set #6 in Appendix B. It is estimated that an evaporation rate of approximately 10 gallons per minute at each MST (an evaporation rate of 0.5 percent of the water sprayed) would be achievable during a seven month period beginning in April and ending in October. Building 374 (or its successor) can accept the high concentration of dissolved solids generated as a result of spray evaporation. Solids that accumulate in the bottom of the tank would periodically be removed for further processing. It should be noted, however, that the total amount of solids generated would be a relatively small and would not hinder evaporation rates nor require frequent removal.

3.1.11.1 Effectiveness

This alternative would provide the same level of protection to human health and the environment, in terms of minimizing contamination of Walnut Creek, as the current practice of evaporation at Building 374. Continued collection of water with the ITS and subsequent elimination of the water through evaporation would effectively maintain compliance with applicable surface water standards in Walnut Creek. Overspray would be controlled as a pollution prevention measure to eliminate concerns over contamination being taken up in storm water runoff.

Assuming 10 gpm evaporation at each tank for at least 8 hours per day during a 7 month period, the total amount of water that would be evaporated is approximately 3 million gallons annually. In order for Alternative 11 to be viable over the long term, the solids generated by enhanced evaporation must be treatable in Building 374 or an alternative facility.

3.1.11.2 Implementability

Alternative 11 is implementable from a technical standpoint. Construction of the spray evaporation system is straightforward and does not require any unique design. Issues relating to the long term stability of the MSTs (Section 2.1) would have to be addressed. From an administrative standpoint, Alternative 11 is also readily implementable in that it does not require permits, licenses, or a complex schedule; however, there may be some concerns about contaminants, especially uranium, in overspray. Such concerns may limit the periods of spray evaporation and, consequently, the net effectiveness of the alternative at eliminating ITS collected water. Creating a concentrate of dissolved solids for treatment in B374 or its successor locks in the alternative to the continued existence of the treatment facilities.

3.1.11.3 Ability to Meet Specific Goals and Objectives

Since Alternative 11 is similar to Alternative 3 it would comply with surface water standards for nitrate and uranium in Walnut Creek, including the interim standard for nitrate. Alternative 11 would remain in place as long as the need for treatment to maintain surface water standards exists.

Alternative 11 is consistent with RFCA in that it includes water management and treatment activities to ensure compliance with surface water standards for Walnut Creek at the point of compliance, i.e., the Pond A-4 outfall. It is possible that the goals of RFCA would not be maintained over the long term—i.e., beyond site closure—without active ITS water management and continued use of Alternative 11. The ability to maintain the goals of RFCA under Alternative 11 can only be assessed when final site closure plans, especially those plans for the Solar Ponds area, are defined. Elements of final site closure must be integrated with groundwater assessment efforts to determine whether surface water standards would be met over the long term without management and treatment.

Alternative 11 would provide a reduction in utility and operating costs since spray evaporation is simpler and more cost effective than mechanical evaporation. The capital cost of Alternative 11 is estimated at approximately $1.5 million. O&M costs would be approximately $50,000 to $100,000 per year.

3.1.11.4 Inclusion of Cost Minimization Elements

Alternative 11 continues the use of the ITS, MSTs, and associated piping systems to the greatest extent practicable.

3.1.11.5 Ease of Post Site Closure Operations

Alternative 11 would remain as long as the need for treatment of ITS-collected water exists. Use of this alternative over the long term (i.e., beyond site closure) would require periodic inspection and maintenance of the ITS, MSTs, and spray systems. Such activities are not expected to present significant difficulties, although they would require the full-time presence of an operator.

3.1.11.6 Regulatory Agency and Local Community Acceptance

Based on the current treatment practice of evaporation under Alternative 3, it is likely that continued collection and treatment of Solar Ponds Plume groundwater through evaporation would be acceptable to the regulatory agencies and the local community. However, there may be some concern by the agencies and local community over the potential for the spread of contamination due to overspray at the MSTs. Acceptance may be enhanced if, over the time up to site closure, significant contaminant level reductions are achieved in the Solar Ponds Plume.

3.2 ALTERNATIVES RANKING AFTER INITIAL SCREENING

A ranking of the alternatives against the evaluation criteria was performed (see Table 3-3). Note that the criteria "Inclusion of Cost Minimization Elements" and "Ease of Post Site Closure Operations" were not included—the former because it does not add any value to a relative comparison of alternatives; the latter because it was assumed that all of the alternatives, except Alternative 9, would require about the same level of operations after site closure in order to achieve long-term surface water standards. Values in Table 3-3 were assigned subjectively for each alternative using a scale of 1 to 5, with 1 being poor and 5 being excellent.

The assignment of values in Table 3-3 considered the multiple elements that comprise each criterion. For example, the criterion "Ability to Meet Goals and Objectives" includes three elements: 1) compliance with surface water standards, 2) consistency with RFCA, etc., and 3) provision of significant cost reduction relative to current practice. In comparing Alternatives 4 and 9 against this criterion, Alternative 4 performs well for elements 1 and 3, but, because it does not include steps to actively remove contaminants from the subsurface (i.e., it does not include any measures to expedite the removal of contaminants from the Solar Ponds Plume), it does not get as good a rating for element 2. Alternative 9 performs well for elements 2 and 3, but, because of a lack of data to predict with any certainty the ability of Alternative 9 to achieve surface water standards, it does not get as good a rating for element 1. The tradeoffs in performance of these two alternatives tend to "balance" their rating against this evaluation criterion. Assignment of values for the remaining criteria followed the same approach; i.e., consideration of various elements comprising each criterion.

The ranking of alternatives based on weighted totals is noted below.

#1	Alternative 4, Treatment at Building 995
	Alternative 9, Phytoremediation (tie)
#3	Alternative 2, Managed Release
	Alternative 11, Enhanced Evaporation (tie)
#5	Alternative 5, Treatment at MSTs
#6	Alternative 7, Off-Channel Evaporation
#7	Alternative 3, Evaporation at Building 374
#8	Alternative 1, Direct Release
#9	Alternative 6, Constructed Wetland
#10	Alternative 8, Dispersion Field
#11	Alternative 10, Iron/Peat Passive Treatment

The weighting factors used to obtain the totals noted in Table 3-3 were subjectively assigned. It is believed that the criterion "Ability to Meet Goals and Objectives" is the most important of the evaluation criteria as it includes three significant elements (see Section 2.1.4.3).

The results of the subjective ranking indicate four alternatives warrant further consideration for the management of contaminated water associated with the Solar Ponds Plume: Alternative 4, Treatment at Building 995; Alternative 9, Phytoremediation; Alternative 2, Managed Release; and Alternative 11, Enhanced Evaporation. Alternatives 4 and 9 received the highest subjective weighted score, while Alternatives 2 and 11 received only slightly lower scores. Section 4 provides some additional details on these four alternatives.

Table 3-3 Subjective Ranking of Alternatives (1)

	Effectiveness WF = 0.2 (2)		Implementability WF = 0.2	Goals & Object. WF = 0.3	Acceptance WF = 0.1	Cost WF = 0.2	Weighted Totals
	ST	LT (3)					
Alt. 1- Direct Release	4	1	4	1	1	5	3.2
Alt. 2 - Managed Release	4	2	5	3	2	5	4.3
Alt. 3 - Evap. at Bldng. 374	5	5	3	2	2	1	3.6
Alt. 4 - Treatment at Bldng. 995	4	3	4	4	3	4	4.5
Alt. 5 - Treatment at MSTs	5	5	3	3	3	2	4.2
Alt. 6 - Constructed Wetland	3	2	1	3	2	3	2.9
Alt. 7 - Off-Channel Evap. Pond	5	5	2	3	2	3	4.1
Alt. 8 - Dispersion Field	3	3	1	2	2	3	2.8
Alt. 9 - Phytoremediation	3	3	4	4	5	4	4.5
Alt. 10 - Iron/Peat Passive Treat.	2	2	1	2	1	3	2.3
Alt. 11 - Enhanced Evaporation	5	5	4	3	2	3	4.3

(1) Ranking Scale: 1 = Poor; 5 = Excellent.
(2) WF = Weighting Factor.
(3) ST = Short Term; LT = Long Term.

4. PROJECT IMPLEMENTATION ASPECTS OF THE TOP RANKING SELECTED ALTERNATIVES

Based on the alternatives evaluation and ranking presented in Section 3, Alternatives 2, 4, 9, and 11 are the most appropriate alternatives for further consideration. The following discussion evaluates each of these top alternatives as if the alternative were to be implemented as a project at RFETS. The four components of project implementation are 1.) planning, 2.) construction, 3.) operation and 4.) completion of desired outcomes and closure.

4.1 ALTERNATIVE 2: MANAGED RELEASE

4.1.1 Project Planning

A project plan for managed release has already been prepared as described in Section 3.0. Planning elements included a review of historical hydrological data and pond operations to assure that the managed release of ITS water into Pond A-4 would not exceed established stream standards. Planning also includes the continued use of infrastructure, primarily the modular storage tanks (MSTs), a pipeline to Pond A-4, and monitoring equipment to track nitrate levels. Planning assumptions, as presented in the managed release report, included an expectation that compliance with the stream standard for nitrate would also accommodate compliance with the stream standard for uranium. Planning for this project does not include treatment.

At this time, there are no further evaluations or studies necessary to answer specific questions about this alternative with respect to project planning and implementation. Evaluations are planned and underway, however, to assess the impacts of source removal and capping the solar pond area, as well as groundwater assessment efforts that have a view toward site closure.

4.1.2 Project Construction

The infrastructure required to implement this project is already in existence except for the installation of monitoring equipment, either at the MSTs or at the point of discharge into Pond A-4. A connection must be made between the MSTs and an existing pipeline leading to Pond A-4 for the project to be operational.

4.1.3 Project Operation

Project operations involve the development of a work instruction to control the release of water from the MSTs to Pond A-4. The work instruction directs the activities of operators responsible for the movement of liquid wastes, including the ITS water. Valve operation is limited to trained personnel managed by a supervisor who is responsible for operating the managed release to meet water quality requirements.

Operations would continue until the ITS water meets underlying standards. The project plan proposes the closure of the ITS and no further management of the system once groundwater quality meets surface water standards. At this time, there is no reliable prediction of how long it will take to reach this point.

4.1.4 Project Completion and Closure

Completion of managed release is marked by groundwater quality meeting surface water standards. At that time, operation of the ITS and the MSTs and pipeline can be halted and the equipment removed. A final determination of ITS closure has not been made, but it is likely that closure of the ITS will call for at least partial grouting of some of the trenches.

4.2 ALTERNATIVE 4: TREATMENT AT BUILDING 995

4.2.1 Project Planning

There has been no active planning effort for this alternative. Planning for the redirection of ITS collected water to the wastewater treatment plant involves very little modification to the Site's infrastructure, as most of the necessary components are in place and useable. However, changes in operations at the wastewater treatment plant must be planned to accommodate the new flow introduced from the MSTs. Treatability studies must be done to assure the performance of the treatment processes with the introduction of water with low carbonaceous biochemical oxygen demand (CBOD) and high nitrate concentration. Operational changes will be developed, as necessary, to provide treatment for changes in the influent load.

Directing ITS water into the WWTP is not expected to have a major impact on operations at the facility. Under normal conditions ITS flows, on a daily basis, would be less than 4% of the normal influent volume to the WWTP. This is less than fluctuations caused by wet weather conditions. Based on current nitrate concentrations in the ITS collected water, concentrations of nitrate could be as high as 10 ppm in the activated sludge process, a level compatible with alternative operating conditions. These factors suggest that potential changes in effluent concentrations are not large enough to require a formal permit modification (the regulations specify that any changes which increase the levels of pollutants in the discharge require a modification to the National Pollutant Discharge Elimination System (NPDES) permit). Both the amount of flow and the level of contaminants would be taken into account in evaluating the impacts to treatment operations and removal efficiency.. As part of the planning process, however, formal notification would be made to the permitting authority, which can then make an independent evaluation.

The potential impact of uranium on the biosolids is discussed below. Treatability studies are necessary to quantify the actual partitioning of uranium into the biosolids and assess the overall impact on biosolids management practices. Project planning efforts include laboratory tests to provide the necessary information.

4.2.2 Project Construction

No new construction is required to implement the treatment of ITS water at the Site's WWTP. A modification of the sanitary collection system is needed to allow for the redirection of the ITS water from Building 374 to a suitable location in the transmission system. Once accomplished, no further modifications are required.

4.2.3 Project Operation

Operational changes are the most significant component of project implementation. Current operations at the WWTP are typical for an activated sludge treatment facility; unit processes are monitored using conventional operating parameters. Introduction of higher levels of nitrate will require modification to operating procedures to facilitate the biological removal of nitrate. Under the anticipated terms in the renewal of the discharge permit, nitrate limitations are relaxed and allow for more latitude in operations. However, the goal of operations is to reduce the level of all pollutants in the discharge to the greatest extent possible, including nitrates. Therefore, operational changes will be made to address nitrate removal. This will require the development of anoxic or anaerobic conditions to promote denitrification. It is possible to introduce these changes in an aerobic process by cycling aeration equipment on and off. On/off aeration, a demonstrated process for nitrate reduction, is an alternative to the construction of dedicated facilities for denitrification, and, for small facilities, is a feasible alternative to a capital project.

While biological treatment is ideally suited for nitrate removal, it is ineffective for the removal of uranium. Assuming that 80 % of the uranium would go to the sludge, the current activity level of 40 to 60 pCi/g could increase to about 88 pCi/g (See Calculation

Set #2 of Appendix B). This level could vary, depending on rates of sludge production at Building 995. For example, if, as anticipated, wastewater flows diminish in the coming years as closure activities progress, fewer biosolids would be received. If there is no concomitant reduction in uranium in ITS water, activity levels in the sludge could rise. Sludge management practices may be subject to change depending on levels of accumulated uranium in the sludge.

4.2.4 Project Completion and Closure

Redirection of the ITS water by way of the MSTs to the WWTP will continue until groundwater in the Solar Ponds Plume area meets surface water standards and is, therefore, acceptable for free flow into North Walnut Creek. Closure activities for the ITS would be the same as described in Section 4.1.4. As discussed previously, there is no current information predicting the longevity of the nitrate plume. It is anticipated that operations of the ITS and the WWTP will continue through the active remediation period at the Site, and that period will be adequate to allow removal of sufficient quantities of contaminants to achieve the desired end state. This must be verified, and activities described in Section 5 under the path forward are designed to better quantify the project duration.

4.3 ALTERNATIVE 9: PHYTOREMEDIATION

4.3.1 Project Planning

There have been no planning activities for this alternative beyond preliminary feasibility discussions, based on existing phytoremediation projects. Planning activities include treatability studies to assess project impacts on uranium mobility, and preliminary investigations of agronomic conditions to determine the suitability of the Solar Ponds Plume area for installing a plantation. Agronomic data will also assist in the evaluation of prospective irrigation systems, and will provide a screening step in the selection of the most appropriate plant species for this alternative. The final planning activity will involve an overall evaluation of the uranium studies, site assessment, and agronomic data to guide the identification of the most appropriate plant species for project implementation.

The phytoremediation alternative, alone, has the potential to remain active beyond the life expectancy of the infrastructure of the Site. This presents a unique challenge in project planning, especially with respect to long term maintenance.

4.3.2 Project Construction

Installation of the phytoremediation plantation will require construction activities in the RFETS buffer zone. Once installed, the plantation will require routine maintenance, especially during the period when active irrigation is required. No other construction is required, although some portions of the infrastructure are required, such as storage of irrigation water in the MSTs.

4.3.3 Project Operation

Growing a tree plantation requires active irrigation, especially in the early stages of plant growth. As the plantation matures, less attention is required, although routine plant care will prolong the life and effectiveness of the plantation. In its final stages, no active care is required for the trees, and it is anticipated that as the work of the plantation is completed, the plantation will take its natural course. If sufficient groundwater is available, the trees may persist. It conditions are such that water is not available, the trees will decline and the area, over time, would revert to open space.

4.3.4 Project Completion and Closure

There is no closure requirement, per se. Once installed, the plantation would be considered complete, and except for the early requirements for routine maintenance and irrigation, no further project activities would be scheduled.

4.4 ALTERNATIVE 11: ENHANCED EVAPORATION

4.4.1 Project Planning

Installation of the enhanced evaporation system at the MSTs requires planning for the continued existence of both the tanks and subsequent treatment in B374 or its replacement facility. Specifications for the system will be based on the anticipated amount of water and the waste acceptance criteria for the treatment facility. Evaporating water and concentrating the salts may require special handling of the resulting concentrate. Process design will evaluate the range of concentration of contaminants and provide specially handing provisions.

4.4.2 Project Construction

Of the four final alternatives, enhanced evaporation requires the most intense construction effort. Construction and installation of the spray nozzle system is relatively straight forward, but it presents some challenges. The MSTs were originally installed as a short term measure for remediation of the former Operable Unit 4, the Solar Evaporation Ponds. There are some geotechnical concerns that may impact the long term future use of the tanks. Selection of this alternative will require some stabilization measures in the future. While this is true for alternatives 2 and 4 as well, the impact of construction activities around the MSTs, expanded structures, and increased operator presence in the area of the tanks intensify the structural impact of this alternative to the MSTs area.

4.4.3 Project Operation

Operations of the spray system will be under the control of plant personnel and approved procedures. Environmental conditions, especially wind, will dictate when the system can be operated safely and in order to minimize the potential for sprayed water to escape the confines of the MSTs and re-enter the environment. The concentrated ITS water will be high in dissolved solids, especially nitrate. If there is a 90% volume reduction, for example, nitrate concentration could be as high as 4,000 ppm. Only one treatment alternative is available a waste stream of this type, B374 or its successor. Selection of Alternative 11 will lock in treatment at the Site's process waste facility.

4.4.4 Project Completion and Closure

As discussed previously, there is no current information predicting the longevity of the nitrate plume. It is anticipated that operations of the ITS and the process waste facility, including enhanced evaporation, will continue through the active remediation period at the Site, and that period will be adequate to allow removal of sufficient quantities of contaminants to achieve the desired end state.

5. CONCLUSIONS

The original collection of eleven alternatives for remediating the Solar Ponds Plume represents a spectrum of treatment from existing, proven methods to experimental and emerging technology. Screening the original field with criteria representing the best assessment of desired attributes has narrowed the field of potential technologies to four viable alternatives. Given the current level of understanding of conditions in the plume area, none of the four final options is an ideal solution. Further work is required to allow the selection of a final option that can be implemented to meet regulatory milestones and with a level of assurance that the project will achieved the desired end state.

5.1 THE PATH FORWARD

In the implementation discussion of each of the final four alternatives several studies and further evaluations were identified. These evaluations will be conducted in concert with a broader effort, the major components of which are described below, aimed at establishing the current boundaries of the problem. The combination of these efforts will allow for the final alternatives screening and selecting the most promising solution.

5.1.1 Solar Ponds Plume Delineation

A broad effort is planned for fiscal year 1998 (FY98) aimed at delineation of the Solar Ponds Plume and analysis of groundwater flow and contaminant transport conditions. The primary objective of this effort is to describe the physical boundaries, as they currently exist, and to develop an understanding of the dynamics of the major contaminants, nitrate and uranium.

Another objective of this effort is to estimate how long active remediation will be required in the solar pond plume area. This information will have an impact on the final alternative selection as it relates to overall planning for Site closure. Active remediation at the Site is currently anticipated to be complete within 10 years, after which time the infrastructure will no longer exist. If the groundwater analyses indicate that the plume will persist long after active remediation, alternatives relying on the continued use of Site facilities will not be suitable.

5.1.2 Treatability Studies

Several alternative-specific studies were discussed in the planning and implementation discussions of the final alternatives. Treatability studies will be conducted at Building 995 to evaluate the potential impact of elevated nitrate and uranium levels on the unit processes at the wastewater treatment plant. Bench-scale studies of the activated sludge will assess the impacts of the ITS water on the current operating regime, as well as the proposed alternative on/off aeration operations conversion. These studies will also include analyses to determination the distribution of uranium among the components of the activated sludge process, mainly the secondary effluent and the waste activated sludge.

Concurrently with the treatability study at B995, field and laboratory tests will be conducted to answer questions related to the implementation of phytoremediation. An agronomic survey of soil conditions within the proposed area of the plantation is necessary to allow for selection of candidate plant species, predict their performance, and develop specifications for an irrigation system. Literature reviews and laboratory investigations are necessary to answer questions about the interaction of plants and plant root systems with soil borne uranium. A preliminary survey will be undertaken to test existing plant material from the plume area for uranium content.

5.1.3 Combination of Alternative Components

The initial screening process was based on the use of each alternative as a stand alone project, although it was noted that there is the potential to combine some alternatives or parts of alternatives to produce a hybrid remediation technology. A combination of alternatives could also include sequential implementation of alternatives, such as Alternative 4 as an interim method while Alternative 9 is taking root. FY98 activities will include a reevaluation of this report with special emphasis on the potential to use more than one alternative if it is cost effective to do so.

5.2 THE END OF THE PATH

Completion of groundwater assessment work and treatability studies in the first two or three quarters of the year will allow for the final selection of a remediation technology during the latter part of FY98. Time will be allowed to develop budget requirements for project implementation during FY99, as required by the anticipated milestone. Preliminary regulatory documentation will also be prepared to assure that changes in collection and treatment are compatible with all enforceable plans and agreements. Final documentation will be prepared for approval to allow for the timely implementation of the final solution.

6. REFERENCES

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[iii] Personal communication with Mr. Frank Huffman, Wednesday, July 2, 1997.

[iv] *Conceptual Process Design, Rocky Flats ITS Water Treatment Facility*, Rocky Mountain Remediation Services, L.L.C., February 5, 1996.

[v] *Technology Justification for the Interceptor Trench System*, Rocky Mountain Remediation Services, L.L.C., February 6, 1996.

[vi] *Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment*, U.S. Environmental Protection Agency, EPA/625/1-88/022, September 1988.

[vii] *Phase I Report on the Bear Creek Valley Treatability Study*, Science Applications International Corporation, Oak Ridge, TN, April 1997.

[viii] *Phytoremediation: Using Green Plants to Clean Up Contaminated Soil, Groundwater, and Wastewater*, Reprint from: Proceedings, International Topical Meeting on Nuclear and Hazardous Waste Management, Spectrum 96, Seattle, WA, August 1996. American Nuclear Society.

[ix] *Tree Buffers Protect Shallow Ground Water at Contaminated Sites*, L.A. Licht and J.L. Schnoor, University of Iowa, U. S. EPA Publication: Ground Water Currents, EPA/542/N-93/011, Dec. 1993.

[x] Numerous publications from Phytotech, Monmouth Junction, NJ

APPENDIX A

RECENT MONITORING RESULTS FOR INTERCEPTOR TRENCH SYSTEM WATER

TABLE 1
ORGANIC ANALYTES NOT DETECTED

DATE	ANALYTE	RESULT	UNIT	QUALIFIER*
5/16/95	(1,1'-BIPHENYL)-4-AMINE	20	UG/L	U
5/16/95	[1,1'-BIPHENYL]-4,4'-DIAMINE, 3,3'-DIMET	10	UG/L	U
9/25/92	1,1,1,2-TETRACHLOROETHANE	0.1	UG/L	U
12/9/92	1,1,1,2-TETRACHLOROETHANE	0.1	UG/L	U
5/16/95	1,1,1,2-TETRACHLOROETHANE	10	UG/L	U
2/25/92	1,1,1-TRICHLOROETHANE	5	UG/L	U
9/25/92	1,1,1-TRICHLOROETHANE	0.1	UG/L	U
12/9/92	1,1,1-TRICHLOROETHANE	0.1	UG/L	U
5/16/95	1,1,1-TRICHLOROETHANE	5	UG/L	U
2/25/92	1,1,2,2-TETRACHLOROETHANE	5	UG/L	U
9/25/92	1,1,2,2-TETRACHLOROETHANE	0.1	UG/L	U
12/9/92	1,1,2,2-TETRACHLOROETHANE	0.1	UG/L	U
5/16/95	1,1,2,2-TETRACHLOROETHANE	5	UG/L	U
2/25/92	1,1,2-TRICHLOROETHANE	5	UG/L	U
9/25/92	1,1,2-TRICHLOROETHANE	0.1	UG/L	U
12/9/92	1,1,2-TRICHLOROETHANE	0.1	UG/L	U
5/16/95	1,1,2-TRICHLOROETHANE	5	UG/L	U
2/25/92	1,1-DICHLOROETHANE	5	UG/L	U
9/25/92	1,1-DICHLOROETHANE	0.2	UG/L	U
12/9/92	1,1-DICHLOROETHANE	0.2	UG/L	U
5/16/95	1,1-DICHLOROETHANE	5	UG/L	U
2/25/92	1,1-DICHLOROETHENE	5	UG/L	U
9/25/92	1,1-DICHLOROETHENE	0.2	UG/L	U
12/9/92	1,1-DICHLOROETHENE	0.2	UG/L	U
5/16/95	1,1-DICHLOROETHENE	5	UG/L	U
9/25/92	1,1-DICHLOROPROPENE	0.1	UG/L	U
12/9/92	1,1-DICHLOROPROPENE	0.1	UG/L	U
5/16/95	1,1-DICHLOROPROPENE	5	UG/L	U
5/16/95	1,2,3,4,10,10-HEXACHLORO-1,4,4A,5,8,8A-H	20	UG/L	U
9/25/92	1,2,3-TRICHLOROBENZENE	0.1	UG/L	U
12/9/92	1,2,3-TRICHLOROBENZENE	0.1	UG/L	U
9/25/92	1,2,3-TRICHLOROPROPANE	0.1	UG/L	U
12/9/92	1,2,3-TRICHLOROPROPANE	0.1	UG/L	U
5/16/95	1,2,3-TRICHLOROPROPANE	10	UG/L	U
5/16/95	1,2,4,5-TETRACHLOROBENZENE	10	UG/L	U
9/25/92	1,2,4-TRICHLOROBENZENE	0.1	UG/L	U
12/9/92	1,2,4-TRICHLOROBENZENE	0.1	UG/L	U
5/16/95	1,2,4-TRICHLOROBENZENE	10	UG/L	U
9/25/92	1,2-DIBROMOETHANE	0.5	UG/L	U
12/9/92	1,2-DIBROMOETHANE	0.5	UG/L	U
5/16/95	1,2-DIBROMOETHANE	20	UG/L	U
9/25/92	1,2-DICHLOROBENZENE	0.1	UG/L	U
12/9/92	1,2-DICHLOROBENZENE	0.1	UG/L	U
5/16/95	1,2-DICHLOROBENZENE	10	UG/L	U
2/25/92	1,2-DICHLOROETHANE	5	UG/L	U
9/25/92	1,2-DICHLOROETHANE	0.1	UG/L	U
12/9/92	1,2-DICHLOROETHANE	0.1	UG/L	U

DATE	ANALYTE	RESULT	UNIT	QUALIFIER*
5/16/95	1,2-DICHLOROETHANE	5	UG/L	U
2/25/92	1,2-DICHLOROETHENE	5	UG/L	U
2/25/92	1,2-DICHLOROPROPANE	5	UG/L	U
9/25/92	1,2-DICHLOROPROPANE	0.1	UG/L	U
12/9/92	1,2-DICHLOROPROPANE	0.1	UG/L	U
5/16/95	1,2-DICHLOROPROPANE	5	UG/L	U
5/16/95	1,2-ETHANEDIAMINE, N,N-DIMETHYL-N'-2PYRI	100	UG/L	U
5/16/95	1,3,4-METHENO-2H-CYCLOBUTA(CD)PENTALEN-2	50	UG/L	U
5/16/95	1,3,5-TRINITROBENZENE	50	UG/L	U
9/25/92	1,3-DICHLOROBENZENE	0.1	UG/L	U
12/9/92	1,3-DICHLOROBENZENE	0.1	UG/L	U
5/16/95	1,3-DICHLOROBENZENE	10	UG/L	U
9/25/92	1,3-DICHLOROPROPANE	0.1	UG/L	U
12/9/92	1,3-DICHLOROPROPANE	0.1	UG/L	U
5/16/95	1,3-DICHLOROPROPANE	5	UG/L	U
5/16/95	1,3-DINITROBENZENE	20	UG/L	U
9/25/92	1,4-DICHLOROBENZENE	0.1	UG/L	U
12/9/92	1,4-DICHLOROBENZENE	0.1	UG/L	U
5/16/95	1,4-DICHLOROBENZENE	10	UG/L	U
5/16/95	1,4-NAPHTHOQUINONE	10	UG/L	U
5/16/95	1-NAPHTHYLAMINE	10	UG/L	U
5/16/95	2,2-DICHLOROPROPANE	5	UG/L	U
12/9/92	2,2-DICHLOROPROPANOIC ACID	10	UG/L	U
5/16/95	2,3,4,6-TETRACHLOROPHENOL	10	UG/L	U
5/16/95	2,3,7,8-TCDD	0.014	UG/L	U
9/25/92	2,4,5-TRICHLOROPHENOL	50	UG/L	U
12/9/92	2,4,5-TRICHLOROPHENOL	50	UG/L	U
5/16/95	2,4,5-TRICHLOROPHENOL	10	UG/L	U
12/9/92	2,4,5-TRICHLOROPHENOXYACETIC ACID	10	UG/L	U
5/16/95	2,4,5-TRICHLOROPHENOXYACETIC ACID	2	UG/L	U
9/25/92	2,4,6-TRICHLOROPHENOL	10	UG/L	U
12/9/92	2,4,6-TRICHLOROPHENOL	10	UG/L	U
5/16/95	2,4,6-TRICHLOROPHENOL	10	UG/L	U
12/9/92	2,4-DB	10	UG/L	U
9/25/92	2,4-DICHLOROPHENOL	10	UG/L	U
12/9/92	2,4-DICHLOROPHENOL	10	UG/L	U
5/16/95	2,4-DICHLOROPHENOL	10	UG/L	U
9/25/92	2,4-DICHLOROPHENOXYACETIC ACID, SALTS AN	0.47	UG/L	U
12/9/92	2,4-DICHLOROPHENOXYACETIC ACID, SALTS AN	10	UG/L	U
5/16/95	2,4-DICHLOROPHENOXYACETIC ACID, SALTS AN	12	UG/L	U
9/25/92	2,4-DIMETHYLPHENOL	10	UG/L	U
12/9/92	2,4-DIMETHYLPHENOL	10	UG/L	U
5/16/95	2,4-DIMETHYLPHENOL	10	UG/L	U
9/25/92	2,4-DINITROPHENOL	50	UG/L	U
12/9/92	2,4-DINITROPHENOL	50	UG/L	U
5/16/95	2,4-DINITROPHENOL	50	UG/L	U
9/25/92	2,4-DINITROTOLUENE	10	UG/L	U
12/9/92	2,4-DINITROTOLUENE	10	UG/L	U
5/16/95	2,4-DINITROTOLUENE	10	UG/L	U
5/16/95	2,6-DICHLOROPHENOL	10	UG/L	U
9/25/92	2,6-DINITROTOLUENE	10	UG/L	U

DATE	ANALYTE	RESULT	UNIT	QUALIFIER*
12/9/92	2,6-DINITROTOLUENE	10	UG/L	U
5/16/95	2,6-DINITROTOLUENE	10	UG/L	U
5/16/95	2-BUTANONE	10	UG/L	U
5/16/95	2-CHLORO-1,3-BUTADIENE OR CHLOROPRENE	100	UG/L	U
9/25/92	2-CHLORONAPHTHALENE	10	UG/L	U
12/9/92	2-CHLORONAPHTHALENE	10	UG/L	U
5/16/95	2-CHLORONAPHTHALENE	10	UG/L	U
9/25/92	2-CHLOROPHENOL	10	UG/L	U
12/9/92	2-CHLOROPHENOL	10	UG/L	U
5/16/95	2-CHLOROPHENOL	10	UG/L	U
2/25/92	2-HEXANONE	10	UG/L	U
5/16/95	2-HEXANONE	10	UG/L	U
9/25/92	2-METHYLNAPHTHALENE	10	UG/L	U
12/9/92	2-METHYLNAPHTHALENE	10	UG/L	U
5/16/95	2-METHYLNAPHTHALENE	10	UG/L	U
9/25/92	2-METHYLPHENOL	10	UG/L	U
12/9/92	2-METHYLPHENOL	10	UG/L	U
5/16/95	2-METHYLPHENOL	10	UG/L	U
9/25/92	2-NITROANILINE	50	UG/L	U
12/9/92	2-NITROANILINE	50	UG/L	U
5/16/95	2-NITROANILINE	50	UG/L	U
9/25/92	2-NITROPHENOL	10	UG/L	U
12/9/92	2-NITROPHENOL	10	UG/L	U
5/16/95	2-NITROPHENOL	10	UG/L	U
5/16/95	2-PICOLINE	20	UG/L	U
9/25/92	3,3'-DICHLOROBENZIDINE	20	UG/L	U
12/9/92	3,3'-DICHLOROBENZIDINE	20	UG/L	U
5/16/95	3,3'-DICHLOROBENZIDINE	20	UG/L	U
5/16/95	3-CHLOROPROPENE	10	UG/L	U
9/25/92	3-NITROANILINE	50	UG/L	U
5/16/95	3-NITROANILINE	50	UG/L	U
9/25/92	4,4'-DDD	0.52	UG/L	U
12/9/92	4,4'-DDD	0.1	UG/L	U
5/16/95	4,4'-DDD	0.11	UG/L	U
9/25/92	4,4'-DDE	0.52	UG/L	U
12/9/92	4,4'-DDE	0.1	UG/L	U
5/16/95	4,4'-DDE	0.04	UG/L	U
9/25/92	4,4'-DDT	0.52	UG/L	U
12/9/92	4,4'-DDT	0.1	UG/L	U
5/16/95	4,4'-DDT	0.12	UG/L	U
9/25/92	4,6-DINITRO-2-METHYLPHENOL	50	UG/L	U
12/9/92	4,6-DINITRO-2-METHYLPHENOL	50	UG/L	U
5/16/95	4,6-DINITRO-2-METHYLPHENOL	50	UG/L	U
9/25/92	4-CHLORO-3-METHYLPHENOL	10	UG/L	U
12/9/92	4-CHLORO-3-METHYLPHENOL	10	UG/L	U
5/16/95	4-CHLORO-3-METHYLPHENOL	20	UG/L	U
9/25/92	4-CHLOROANILINE	10	UG/L	U
5/16/95	4-CHLOROANILINE	20	UG/L	U
9/25/92	4-CHLOROPHENYL PHENYL ETHER	10	UG/L	U
12/9/92	4-CHLOROPHENYL PHENYL ETHER	10	UG/L	U
5/16/95	4-CHLOROPHENYL PHENYL ETHER	10	UG/L	U

DATE	ANALYTE	RESULT	UNIT	QUALIFIER*
9/25/92	4-ISOPROPYLTOLUENE	0.2	UG/L	U
12/9/92	4-ISOPROPYLTOLUENE	0.2	UG/L	U
2/25/92	4-METHYL-2-PENTANONE	10	UG/L	U
5/16/95	4-METHYL-2-PENTANONE	10	UG/L	U
9/25/92	4-METHYLPHENOL	10	UG/L	U
12/9/92	4-METHYLPHENOL	10	UG/L	U
5/16/95	4-METHYLPHENOL	10	UG/L	U
9/25/92	4-NITROANILINE	50	UG/L	U
5/16/95	4-NITROANILINE	20	UG/L	U
9/25/92	4-NITROPHENOL	50	UG/L	U
12/9/92	4-NITROPHENOL	50	UG/L	U
5/16/95	4-NITROPHENOL	50	UG/L	U
5/16/95	5-NITRO-o-TOLUIDINE	10	UG/L	U
5/16/95	7,12-DIMETHYLBENZ(a)ANTHRACENE	10	UG/L	U
9/25/92	ACENAPHTHENE	2.58	UG/L	U
9/25/92	ACENAPHTHENE	10	UG/L	U
12/9/92	ACENAPHTHENE	10	UG/L	U
5/16/95	ACENAPHTHENE	10	UG/L	U
9/25/92	ACENAPHTHYLENE	2.58	UG/L	U
9/25/92	ACENAPHTHYLENE	10	UG/L	U
12/9/92	ACENAPHTHYLENE	10	UG/L	U
5/16/95	ACENAPHTHYLENE	10	UG/L	U
5/16/95	ACETAMIDE, N-(4-ETHOXYPHENYL)-	20	UG/L	U
5/16/95	ACETAMIDE, N-9H-FLUOREN-2-yl	20	UG/L	U
2/25/92	ACETONE	10	UG/L	U
5/16/95	ACETONE	10	UG/L	U
5/16/95	ACROLEIN	500	UG/L	U
5/16/95	ACRYLONITRILE	100	UG/L	U
9/25/92	ALDRIN	0.26	UG/L	U
12/9/92	ALDRIN	0.05	UG/L	U
5/16/95	ALDRIN	0.04	UG/L	U
9/25/92	alpha-BHC	0.26	UG/L	U
12/9/92	alpha-BHC	0.05	UG/L	U
5/16/95	alpha-BHC	0.03	UG/L	U
9/25/92	alpha-CHLORDANE	2.6	UG/L	U
12/9/92	alpha-CHLORDANE	0.5	UG/L	U
9/25/92	ANTHRACENE	0.154	UG/L	U
9/25/92	ANTHRACENE	10	UG/L	U
12/9/92	ANTHRACENE	10	UG/L	U
5/16/95	ANTHRACENE	10	UG/L	U
9/25/92	AROCLOR-1016	2.6	UG/L	U
12/9/92	AROCLOR-1016	0.5	UG/L	U
5/16/95	AROCLOR-1016	1	UG/L	U
9/25/92	AROCLOR-1221	2.6	UG/L	U
12/9/92	AROCLOR-1221	0.5	UG/L	U
5/16/95	AROCLOR-1221	1	UG/L	U
9/25/92	AROCLOR-1232	2.6	UG/L	U
12/9/92	AROCLOR-1232	0.5	UG/L	U
5/16/95	AROCLOR-1232	1	UG/L	U
9/25/92	AROCLOR-1242	2.6	UG/L	U
12/9/92	AROCLOR-1242	0.5	UG/L	U

DATE	ANALYTE	RESULT	UNIT	QUALIFIER*
5/16/95	AROCLOR-1242	1	UG/L	U
9/25/92	AROCLOR-1248	2.6	UG/L	U
12/9/92	AROCLOR-1248	0.5	UG/L	U
5/16/95	AROCLOR-1248	1	UG/L	U
9/25/92	AROCLOR-1254	5.2	UG/L	U
12/9/92	AROCLOR-1254	1	UG/L	U
5/16/95	AROCLOR-1254	1	UG/L	U
9/25/92	AROCLOR-1260	5.2	UG/L	U
12/9/92	AROCLOR-1260	1	UG/L	U
5/16/95	AROCLOR-1260	1	UG/L	U
5/16/95	BENZ[j]ACEANTHRYLENE, 1,2-DIHYDRO-3-METH	10	UG/L	U
5/16/95	BENZAMIDE, 3,5-DICHLORO-N-(1,1-DIMETHYL-	20	UG/L	U
5/16/95	BENZENAMINE	10	UG/L	U
5/16/95	BENZENAMINE, N,N-DIMETHYL-4-(PEHNYLAZO)-	10	UG/L	U
2/25/92	BENZENE	5	UG/L	U
9/25/92	BENZENE	0.2	UG/L	U
12/9/92	BENZENE	0.2	UG/L	U
5/16/95	BENZENE	5	UG/L	U
9/25/92	BENZENE, 1,2,4-TRIMETHYL	0.1	UG/L	U
12/9/92	BENZENE, 1,2,4-TRIMETHYL	0.1	UG/L	U
9/25/92	BENZENE, 1,3,5-TRIMETHYL-	0.1	UG/L	U
12/9/92	BENZENE, 1,3,5-TRIMETHYL-	0.1	UG/L	U
5/16/95	BENZENEACETIC ACID, 4-CHLORO-alpha-(4-CH	10	UG/L	U
5/16/95	BENZENEETHANAMINE, alpha, alpha-DIMETHYL	10	UG/L	U
9/25/92	BENZO(a)ANTHRACENE	0.206	UG/L	U
9/25/92	BENZO(a)ANTHRACENE	10	UG/L	U
12/9/92	BENZO(a)ANTHRACENE	10	UG/L	U
5/16/95	BENZO(a)ANTHRACENE	10	UG/L	U
9/25/92	BENZO(a)PYRENE	0.154	UG/L	U
9/25/92	BENZO(a)PYRENE	10	UG/L	U
12/9/92	BENZO(a)PYRENE	10	UG/L	U
5/16/95	BENZO(a)PYRENE	10	UG/L	U
9/25/92	BENZO(b)FLUORANTHENE	0.258	UG/L	U
9/25/92	BENZO(b)FLUORANTHENE	10	UG/L	U
12/9/92	BENZO(b)FLUORANTHENE	10	UG/L	U
5/16/95	BENZO(b)FLUORANTHENE	10	UG/L	U
9/25/92	BENZO(ghi)PERYLENE	0.618	UG/L	U
9/25/92	BENZO(ghi)PERYLENE	10	UG/L	U
12/9/92	BENZO(ghi)PERYLENE	10	UG/L	U
5/16/95	BENZO(ghi)PERYLENE	10	UG/L	U
9/25/92	BENZO(k)FLUORANTHENE	0.154	UG/L	U
9/25/92	BENZO(k)FLUORANTHENE	10	UG/L	U
12/9/92	BENZO(k)FLUORANTHENE	10	UG/L	U
5/16/95	BENZO(k)FLUORANTHENE	10	UG/L	U
9/25/92	BENZOIC ACID	50	UG/L	U
12/9/92	BENZOIC ACID	50	UG/L	U
9/25/92	BENZYL ALCOHOL	10	UG/L	U
12/9/92	BENZYL ALCOHOL	10	UG/L	U
5/16/95	BENZYL ALCOHOL	20	UG/L	U
9/25/92	beta-BHC	0.26	UG/L	U
12/9/92	beta-BHC	0.05	UG/L	U

DATE	ANALYTE	RESULT	UNIT	QUALIFIER*
5/16/95	beta-BHC	0.06	UG/L	U
5/16/95	beta-NAPHTHYLAMINE	10	UG/L	U
9/25/92	BIS(2-CHLOROETHOXY)METHANE	10	UG/L	U
12/9/92	BIS(2-CHLOROETHOXY)METHANE	10	UG/L	U
5/16/95	BIS(2-CHLOROETHOXY)METHANE	10	UG/L	U
9/25/92	BIS(2-CHLOROETHYL)ETHER	10	UG/L	U
12/9/92	BIS(2-CHLOROETHYL)ETHER	10	UG/L	U
5/16/95	BIS(2-CHLOROETHYL)ETHER	10	UG/L	U
9/25/92	BIS(2-CHLOROISOPROPYL)ETHER	10	UG/L	U
12/9/92	BIS(2-CHLOROISOPROPYL)ETHER	10	UG/L	U
5/16/95	BIS(2-CHLOROISOPROPYL)ETHER	10	UG/L	U
9/25/92	BIS(2-ETHYLHEXYL)PHTHALATE	10	UG/L	U
12/9/92	BIS(2-ETHYLHEXYL)PHTHALATE	10	UG/L	U
5/16/95	BIS(2-ETHYLHEXYL)PHTHALATE	25	UG/L	B
9/25/92	BROMOBENZENE	0.2	UG/L	U
12/9/92	BROMOBENZENE	0.2	UG/L	U
2/25/92	BROMODICHLOROMETHANE	5	UG/L	U
9/25/92	BROMODICHLOROMETHANE	0.2	UG/L	U
12/9/92	BROMODICHLOROMETHANE	0.2	UG/L	U
5/16/95	BROMODICHLOROMETHANE	5	UG/L	U
2/25/92	BROMOFORM	5	UG/L	U
9/25/92	BROMOFORM	0.5	UG/L	U
12/9/92	BROMOFORM	0.5	UG/L	U
5/16/95	BROMOFORM	5	UG/L	U
2/25/92	BROMOMETHANE	10	UG/L	U
9/25/92	BROMOMETHANE	1	UG/L	U
12/9/92	BROMOMETHANE	1	UG/L	U
5/16/95	BROMOMETHANE	10	UG/L	U
9/25/92	BUTYL BENZYL PHTHALATE	10	UG/L	U
12/9/92	BUTYL BENZYL PHTHALATE	10	UG/L	U
5/16/95	BUTYL BENZYL PHTHALATE	10	UG/L	U
2/25/92	CARBON DISULFIDE	5	UG/L	U
5/16/95	CARBON DISULFIDE	5	UG/L	U
5/16/95	CHLORDANE	0.14	UG/L	U
2/25/92	CHLOROBENZENE	5	UG/L	U
9/25/92	CHLOROBENZENE	0.1	UG/L	U
12/9/92	CHLOROBENZENE	0.1	UG/L	U
5/16/95	CHLOROBENZENE	5	UG/L	U
2/25/92	CHLOROETHANE	10	UG/L	U
9/25/92	CHLOROETHANE	0.5	UG/L	U
12/9/92	CHLOROETHANE	0.5	UG/L	U
5/16/95	CHLOROETHANE	10	UG/L	U
2/25/92	CHLOROMETHANE	10	UG/L	U
9/25/92	CHLOROMETHANE	0.5	UG/L	U
12/9/92	CHLOROMETHANE	0.5	UG/L	U
5/16/95	CHLOROMETHANE	10	UG/L	U
9/25/92	CHRYSENE	1.24	UG/L	U
9/25/92	CHRYSENE	10	UG/L	U
12/9/92	CHRYSENE	10	UG/L	U
5/16/95	CHRYSENE	10	UG/L	U
2/25/92	cis-1,3-DICHLOROPROPENE	5	UG/L	U

DATE	ANALYTE	RESULT	UNIT	QUALIFIER*
9/25/92	cis-1,3-DICHLOROPROPENE	0.1	UG/L	U
12/9/92	cis-1,3-DICHLOROPROPENE	0.1	UG/L	U
5/16/95	cis-1,3-DICHLOROPROPENE	5	UG/L	U
9/25/92	delta-BHC	0.26	UG/L	U
12/9/92	delta-BHC	0.05	UG/L	U
5/16/95	delta-BHC	0.09	UG/L	U
9/25/92	DIBENZO(a,h)ANTHRACENE	1.03	UG/L	U
9/25/92	DIBENZO(a,h)ANTHRACENE	10	UG/L	U
12/9/92	DIBENZO(a,h)ANTHRACENE	10	UG/L	U
5/16/95	DIBENZO(a,h)ANTHRACENE	10	UG/L	U
9/25/92	DIBENZOFURAN	10	UG/L	U
12/9/92	DIBENZOFURAN	10	UG/L	U
5/16/95	DIBENZOFURAN	10	UG/L	U
2/25/92	DIBROMOCHLOROMETHANE	5	UG/L	U
9/25/92	DIBROMOCHLOROMETHANE	0.2	UG/L	U
12/9/92	DIBROMOCHLOROMETHANE	0.2	UG/L	U
5/16/95	DIBROMOCHLOROMETHANE	5	UG/L	U
9/25/92	DIBROMOMETHANE	0.5	UG/L	U
12/9/92	DIBROMOMETHANE	0.5	UG/L	U
5/16/95	DIBROMOMETHANE	20	UG/L	U
12/9/92	DICAMBA	10	UG/L	U
9/25/92	DICHLORODIFLUOROMETHANE	0.5	UG/L	U
12/9/92	DICHLORODIFLUOROMETHANE	0.5	UG/L	U
5/16/95	DICHLORODIFLUOROMETHANE	20	UG/L	U
12/9/92	DICHLORPROP	10	UG/L	U
9/25/92	DIELDRIN	0.52	UG/L	U
12/9/92	DIELDRIN	0.1	UG/L	U
5/16/95	DIELDRIN	0.02	UG/L	U
9/25/92	DIETHYL PHTHALATE	10	UG/L	U
12/9/92	DIETHYL PHTHALATE	10	UG/L	U
5/16/95	DIETHYL PHTHALATE	10	UG/L	U
5/16/95	DIMETHOATE	20	UG/L	U
9/25/92	DIMETHYL PHTHALATE	10	UG/L	U
12/9/92	DIMETHYL PHTHALATE	10	UG/L	U
5/16/95	DIMETHYL PHTHALATE	10	UG/L	U
9/25/92	DI-n-BUTYL PHTHALATE	10	UG/L	U
12/9/92	DI-n-BUTYL PHTHALATE	10	UG/L	U
5/16/95	DI-n-BUTYL PHTHALATE	10	UG/L	U
9/25/92	DI-n-OCTYL PHTHALATE	10	UG/L	U
12/9/92	DI-n-OCTYL PHTHALATE	10	UG/L	U
5/16/95	DI-n-OCTYL PHTHALATE	10	UG/L	U
5/16/95	DISULFOTON	10	UG/L	U
9/25/92	ENDOSULFAN I	0.26	UG/L	U
12/9/92	ENDOSULFAN I	0.05	UG/L	U
5/16/95	ENDOSULFAN I	0.14	UG/L	U
9/25/92	ENDOSULFAN II	0.52	UG/L	U
12/9/92	ENDOSULFAN II	0.1	UG/L	U
5/16/95	ENDOSULFAN II	0.04	UG/L	U
9/25/92	ENDOSULFAN SULFATE	0.52	UG/L	U
12/9/92	ENDOSULFAN SULFATE	0.1	UG/L	U
5/16/95	ENDOSULFAN SULFATE	0.66	UG/L	U

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9/25/92	ENDRIN	0.52	UG/L	U
12/9/92	ENDRIN	0.1	UG/L	U
5/16/95	ENDRIN	0.06	UG/L	U
5/16/95	ENDRIN ALDEHYDE	0.23	UG/L	U
9/25/92	ENDRIN KETONE	0.52	UG/L	U
12/9/92	ENDRIN KETONE	0.1	UG/L	U
5/16/95	ETHANE, PENTACHLORO-	10	UG/L	U
5/16/95	ETHYL CYANIDE	100	UG/L	U
5/16/95	ETHYL METHACRYLATE	5	UG/L	U
2/25/92	ETHYLBENZENE	5	UG/L	U
9/25/92	ETHYLBENZENE	0.2	UG/L	U
12/9/92	ETHYLBENZENE	0.2	UG/L	U
5/16/95	ETHYLBENZENE	5	UG/L	U
5/16/95	FAMPHUR	50	UG/L	U
9/25/92	FLUORANTHENE	1.24	UG/L	U
9/25/92	FLUORANTHENE	10	UG/L	U
12/9/92	FLUORANTHENE	10	UG/L	U
5/16/95	FLUORANTHENE	10	UG/L	U
9/25/92	FLUORENE	0.309	UG/L	U
9/25/92	FLUORENE	10	UG/L	U
12/9/92	FLUORENE	10	UG/L	U
5/16/95	FLUORENE	10	UG/L	U
9/25/92	gamma-BHC (LINDANE)	0.26	UG/L	U
12/9/92	gamma-BHC (LINDANE)	0.05	UG/L	U
5/16/95	gamma-BHC (LINDANE)	0.04	UG/L	U
9/25/92	gamma-CHLORDANE	2.6	UG/L	U
12/9/92	gamma-CHLORDANE	0.5	UG/L	U
9/25/92	HEPTACHLOR	0.26	UG/L	U
12/9/92	HEPTACHLOR	0.05	UG/L	U
5/16/95	HEPTACHLOR	0.03	UG/L	U
9/25/92	HEPTACHLOR EPOXIDE	0.26	UG/L	U
12/9/92	HEPTACHLOR EPOXIDE	0.05	UG/L	U
5/16/95	HEPTACHLOR EPOXIDE	0.83	UG/L	U
9/25/92	HEXACHLOROBENZENE	10	UG/L	U
12/9/92	HEXACHLOROBENZENE	10	UG/L	U
5/16/95	HEXACHLOROBENZENE	10	UG/L	U
9/25/92	HEXACHLOROBUTADIENE	0.1	UG/L	U
12/9/92	HEXACHLOROBUTADIENE	0.1	UG/L	U
5/16/95	HEXACHLOROBUTADIENE	10	UG/L	U
9/25/92	HEXACHLOROCYCLOPENTADIENE	10	UG/L	U
12/9/92	HEXACHLOROCYCLOPENTADIENE	10	UG/L	U
5/16/95	HEXACHLOROCYCLOPENTADIENE	10	UG/L	U
5/16/95	HEXACHLORODIBENZOFURAN	0.0096	UG/L	U
5/16/95	HEXACHLORODIBENZO-p-DIOXIN	0.0074	UG/L	U
9/25/92	HEXACHLOROETHANE	10	UG/L	U
12/9/92	HEXACHLOROETHANE	10	UG/L	U
5/16/95	HEXACHLOROETHANE	10	UG/L	U
5/16/95	HEXACHLOROPHENE	100	UG/L	U
5/16/95	HEXACHLOROPROPENE	10	UG/L	U
9/25/92	INDENO(1,2,3-cd)PYRENE	0.309	UG/L	U
9/25/92	INDENO(1,2,3-cd)PYRENE	10	UG/L	U

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12/9/92	INDENO(1,2,3-cd)PYRENE	10	UG/L	U
5/16/95	INDENO(1,2,3-cd)PYRENE	10	UG/L	U
5/16/95	IODOMETHANE	10	UG/L	U
9/25/92	ISOPHORONE	10	UG/L	U
12/9/92	ISOPHORONE	10	UG/L	U
5/16/95	ISOPHORONE	10	UG/L	U
9/25/92	ISOPROPYLBENZENE	0.2	UG/L	U
12/9/92	ISOPROPYLBENZENE	0.2	UG/L	U
5/16/95	ISOSAFROLE	10	UG/L	U
9/25/92	m+p XYLENE	0.2	UG/L	U
12/9/92	m+p XYLENE	0.2	UG/L	U
12/9/92	MCPA	1000	UG/L	U
12/9/92	MCPP	1000	UG/L	U
5/16/95	METHACRYLONITRILE	100	UG/L	U
5/16/95	METHANESULFONIC ACID, ETHYL ESTER	20	UG/L	U
9/25/92	METHOXYCHLOR	2.6	UG/L	U
12/9/92	METHOXYCHLOR	0.5	UG/L	U
5/16/95	METHOXYCHLOR	1.8	UG/L	U
5/16/95	METHYL METHACRYLATE	5	UG/L	U
5/16/95	METHYL METHANESULFONATE	10	UG/L	U
9/25/92	NAPHTHALENE	1.24	UG/L	U
9/25/92	NAPHTHALENE	0.2	UG/L	U
12/9/92	NAPHTHALENE	2.8	UG/L	U
5/16/95	NAPHTHALENE	10	UG/L	U
9/25/92	n-BUTYLBENZENE	0.2	UG/L	U
12/9/92	n-BUTYLBENZENE	0.2	UG/L	U
9/25/92	NITROBENZENE	10	UG/L	U
12/9/92	NITROBENZENE	10	UG/L	U
5/16/95	NITROBENZENE	10	UG/L	U
5/16/95	N-NITROSODIBUTYLAMINE	10	UG/L	U
5/16/95	N-NITROSODIETHYLAMINE	20	UG/L	U
5/16/95	N-NITROSODIMETHYLAMINE	10	UG/L	U
9/25/92	N-NITROSO-DI-n-PROPYLAMINE	10	UG/L	U
12/9/92	N-NITROSO-DI-n-PROPYLAMINE	10	UG/L	U
5/16/95	N-NITROSO-DI-n-PROPYLAMINE	10	UG/L	U
9/25/92	N-NITROSODIPHENYLAMINE	10	UG/L	U
12/9/92	N-NITROSODIPHENYLAMINE	10	UG/L	U
5/16/95	N-NITROSODIPHENYLAMINE	10	UG/L	U
5/16/95	N-NITROSOMETHYLETHYLAMINE	10	UG/L	U
5/16/95	N-NITROSOMORPHOLINE	10	UG/L	U
5/16/95	N-NITROSOPIPERIDINE	20	UG/L	U
5/16/95	N-NITROSOPYRROLIDINE	40	UG/L	U
9/25/92	n-PROPYLBENZENE	0.2	UG/L	U
12/9/92	n-PROPYLBENZENE	0.2	UG/L	U
5/16/95	O,O,O-TRIETHYL PHOSPHOROTHIOATE	20	UG/L	U
9/25/92	o-CHLOROTOLUENE	0.2	UG/L	U
12/9/92	o-CHLOROTOLUENE	0.2	UG/L	U
5/16/95	o-TOLUIDINE	10	UG/L	U
9/25/92	o-XYLENE	0.2	UG/L	U
12/9/92	o-XYLENE	0.2	UG/L	U
5/16/95	PARATHION, ETHYL	10	UG/L	U

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5/16/95	PARATHION, METHYL	10	UG/L	U
9/25/92	p-BROMODIPHENYL ETHER	10	UG/L	U
12/9/92	p-BROMODIPHENYL ETHER	10	UG/L	U
5/16/95	p-BROMODIPHENYL ETHER	10	UG/L	U
9/25/92	p-CHLOROTOLUENE	0.2	UG/L	U
12/9/92	p-CHLOROTOLUENE	0.2	UG/L	U
5/16/95	PENTACHLOROBENZENE	10	UG/L	U
5/16/95	PENTACHLORODIBENZOFURAN	0.011	UG/L	U
5/16/95	PENTACHLORODIBENZO-p-DIOXIN	0.01	UG/L	U
5/16/95	PENTACHLORONITROBENZENE	20	UG/L	U
9/25/92	PENTACHLOROPHENOL	50	UG/L	U
12/9/92	PENTACHLOROPHENOL	50	UG/L	U
5/16/95	PENTACHLOROPHENOL	50	UG/L	U
9/25/92	PHENANTHRENE	1.03	UG/L	U
9/25/92	PHENANTHRENE	10	UG/L	U
12/9/92	PHENANTHRENE	10	UG/L	U
5/16/95	PHENANTHRENE	10	UG/L	U
9/25/92	PHENOL	10	UG/L	U
12/9/92	PHENOL	10	UG/L	U
5/16/95	PHENOL	10	UG/L	U
12/9/92	PHENOL, 2-(1-METHYLPROPYL)-4,6-DINITRO-	10	UG/L	U
5/16/95	PHENOL, 2-(1-METHYLPROPYL)-4,6-DINITRO-	0.7	UG/L	U
5/16/95	PHENOL, 2-(1-METHYLPROPYL)-4,6-DINITRO-	20	UG/L	U
5/16/95	PHORATE	10	UG/L	U
5/16/95	p-PHENYLENEDIAMINE	100	UG/L	U
12/9/92	PROPANE, 1,2-DIBROMO-3-CHLORO-	2	UG/L	U
5/16/95	PROPANE, 1,2-DIBROMO-3-CHLORO-	100	UG/L	U
9/25/92	PROPANOIC ACID, 2-(2,4,5-TRICHLOROPHENOX	0.47	UG/L	U
12/9/92	PROPANOIC ACID, 2-(2,4,5-TRICHLOROPHENOX	10	UG/L	U
5/16/95	PROPANOIC ACID, 2-(2,4,5-TRICHLOROPHENOX	1.7	UG/L	U
9/25/92	PYRENE	0.618	UG/L	U
9/25/92	PYRENE	10	UG/L	U
12/9/92	PYRENE	10	UG/L	U
5/16/95	PYRENE	10	UG/L	U
5/16/95	PYRIDINE	10	UG/L	U
5/16/95	QUINOLINE, 4-NITRO-1-OXIDE-	40	UG/L	U
5/16/95	SAFROLE	10	UG/L	U
9/25/92	sec-BUTYLBENZENE	0.2	UG/L	U
12/9/92	sec-BUTYLBENZENE	0.2	UG/L	U
2/25/92	STYRENE	5	UG/L	U
9/25/92	STYRENE	0.1	UG/L	U
12/9/92	STYRENE	0.1	UG/L	U
5/16/95	STYRENE	5	UG/L	U
5/16/95	SULFOTEP	40	UG/L	U
9/25/92	tert-BUTYLBENZENE	0.2	UG/L	U
12/9/92	tert-BUTYLBENZENE	0.2	UG/L	U
5/16/95	TETRACHLORODIBENZOFURAN	0.0086	UG/L	U
5/16/95	TETRACHLORODIBENZO-p-DIOXIN	0.027	UG/L	U
2/25/92	TETRACHLOROETHENE	5	UG/L	U
9/25/92	TETRACHLOROETHENE	0.1	UG/L	U
12/9/92	TETRACHLOROETHENE	0.1	UG/L	U

DATE	ANALYTE	RESULT	UNIT	QUALIFIER*
5/16/95	TETRACHLOROETHENE	5	UG/L	U
5/16/95	THIONAZIN	20	UG/L	U
5/16/95	TIC	10	UG/L	U
2/25/92	TOTAL XYLENES	5	UG/L	U
5/16/95	TOTAL XYLENES	5	UG/L	U
9/25/92	TOXAPHENE	5.2	UG/L	U
12/9/92	TOXAPHENE	1	UG/L	U
5/16/95	TOXAPHENE	2.4	UG/L	U
9/25/92	trans-1,2-DICHLOROETHENE	0.1	UG/L	U
12/9/92	trans-1,2-DICHLOROETHENE	0.1	UG/L	U
5/16/95	trans-1,2-DICHLOROETHENE	5	UG/L	U
2/25/92	trans-1,3-DICHLOROPROPENE	5	UG/L	U
12/9/92	trans-1,3-DICHLOROPROPENE	0.1	UG/L	U
5/16/95	trans-1,3-DICHLOROPROPENE	5	UG/L	U
5/16/95	trans-1,4-DICHLORO-2-BUTENE	100	UG/L	U
9/25/92	TRICHLOROFLUOROMETHANE	0.5	UG/L	U
12/9/92	TRICHLOROFLUOROMETHANE	0.5	UG/L	U
5/16/95	TRICHLOROFLUOROMETHANE	20	UG/L	U
2/25/92	VINYL ACETATE	10	UG/L	U
5/16/95	VINYL ACETATE	10	UG/L	U
2/25/92	VINYL CHLORIDE	10	UG/L	U
9/25/92	VINYL CHLORIDE	0.2	UG/L	U
12/9/92	VINYL CHLORIDE	0.2	UG/L	U
5/16/95	VINYL CHLORIDE	10	UG/L	U

TABLE 2
INORGANIC ANALYTES

DATE	ANALYTE	RESULT	UNIT	QUALIFIER*
12/9/92	ALUMINUM	139	UG/L	B
11/8/93	ALUMINUM	22.4	UG/L	
2/15/94	ALUMINUM	97.5	UG/L	
5/9/94	ALUMINUM	99	UG/L	
8/16/94	ALUMINUM	83.7	UG/L	B
11/7/94	ALUMINUM	56.99	UG/L	B
2/7/95	ALUMINUM	78.82	UG/L	B
5/4/95	ALUMINUM	187.58	UG/L	B
12/9/92	ANTIMONY	14	UG/L	U
11/8/93	ANTIMONY	18.2	UG/L	
2/15/94	ANTIMONY	24.2	UG/L	U
5/9/94	ANTIMONY	24.4	UG/L	U
8/16/94	ANTIMONY	13	UG/L	U
11/7/94	ANTIMONY	13	UG/L	U
2/7/95	ANTIMONY	11.2	UG/L	U
5/4/95	ANTIMONY	11	UG/L	U
12/9/92	ARSENIC	1	UG/L	U
11/8/93	ARSENIC	1.5	UG/L	U
2/15/94	ARSENIC	1.6	UG/L	U
5/9/94	ARSENIC	1.3	UG/L	U
8/16/94	ARSENIC	2	UG/L	U
11/7/94	ARSENIC	1	UG/L	U
2/7/95	ARSENIC	1.4	UG/L	U
5/4/95	ARSENIC	2.7	UG/L	U
12/9/92	BARIUM	170	UG/L	B
11/8/93	BARIUM	125	UG/L	
2/15/94	BARIUM	141	UG/L	
5/9/94	BARIUM	136	UG/L	
8/16/94	BARIUM	146	UG/L	B
11/7/94	BARIUM	163.3	UG/L	B
2/7/95	BARIUM	138.8	UG/L	B
5/4/95	BARIUM	139	UG/L	B
12/9/92	BERYLLIUM	1	UG/L	U
11/8/93	BERYLLIUM	0.3	UG/L	U
2/15/94	BERYLLIUM	1.2	UG/L	
5/9/94	BERYLLIUM	0.6	UG/L	U
8/16/94	BERYLLIUM	1	UG/L	U
11/7/94	BERYLLIUM	1	UG/L	U
2/7/95	BERYLLIUM	0.2	UG/L	U
5/4/95	BERYLLIUM	0.2	UG/L	U
12/9/92	CADMIUM	3	UG/L	U
11/8/93	CADMIUM	3.1	UG/L	U
2/15/94	CADMIUM	3.1	UG/L	U
5/9/94	CADMIUM	2.3	UG/L	U
8/16/94	CADMIUM	3	UG/L	U
11/7/94	CADMIUM	2	UG/L	U

DATE	ANALYTE	RESULT	UNIT	QUALIFIER*
2/7/95	CADMIUM	1.6	UG/L	U
5/4/95	CADMIUM	2	UG/L	U
12/9/92	CALCIUM	285000	UG/L	
11/8/93	CALCIUM	226000	UG/L	
2/15/94	CALCIUM	263000	UG/L	
5/9/94	CALCIUM	219000	UG/L	
8/16/94	CALCIUM	285000	UG/L	
11/7/94	CALCIUM	251065	UG/L	
2/7/95	CALCIUM	301328	UG/L	
5/4/95	CALCIUM	163305	UG/L	
2/25/92	CARBON TETRACHLORIDE	1	UG/L	J
9/25/92	CARBON TETRACHLORIDE	1.2	UG/L	
12/9/92	CARBON TETRACHLORIDE	1.1	UG/L	
5/16/95	CARBON TETRACHLORIDE	1	UG/L	J
12/9/92	CESIUM	33	UG/L	U
11/8/93	CESIUM	500	UG/L	U
2/15/94	CESIUM	500	UG/L	U
5/9/94	CESIUM	500	UG/L	U
8/16/94	CESIUM	43	UG/L	U
11/7/94	CESIUM	79	UG/L	U
2/7/95	CESIUM	64.6	UG/L	U
5/4/95	CESIUM	40.1	UG/L	U
12/9/92	CHROMIUM	2	UG/L	U
11/8/93	CHROMIUM	3.5	UG/L	
2/15/94	CHROMIUM	4.4	UG/L	U
5/9/94	CHROMIUM	2.2	UG/L	U
8/16/94	CHROMIUM	2	UG/L	U
11/7/94	CHROMIUM	2	UG/L	U
2/7/95	CHROMIUM	2.06	UG/L	B
5/4/95	CHROMIUM	2.11	UG/L	B
12/9/92	COBALT	3	UG/L	U
11/8/93	COBALT	2.4	UG/L	U
2/15/94	COBALT	4.3	UG/L	U
5/9/94	COBALT	3.7	UG/L	U
8/16/94	COBALT	3	UG/L	U
11/7/94	COBALT	4.68	UG/L	B
2/7/95	COBALT	1.97	UG/L	B
5/4/95	COBALT	2	UG/L	U
12/9/92	COPPER	2	UG/L	U
11/8/93	COPPER	1.7	UG/L	
2/15/94	COPPER	5	UG/L	
5/9/94	COPPER	2.8	UG/L	
8/16/94	COPPER	4.2	UG/L	B
11/7/94	COPPER	5.18	UG/L	B
2/7/95	COPPER	3.03	UG/L	B
5/4/95	COPPER	2.89	UG/L	B
2/25/92	CYANIDE	1.5	UG/L	UN
9/25/92	CYANIDE	10	UG/L	U
12/9/92	CYANIDE	3	UG/L	U
12/9/92	IRON	125	UG/L	
11/8/93	IRON	25.7	UG/L	
2/15/94	IRON	117	UG/L	
5/9/94	IRON	153	UG/L	
8/16/94	IRON	253	UG/L	
11/7/94	IRON	104.1	UG/L	
2/7/95	IRON	132.99	UG/L	
5/4/95	IRON		UG/L	
12/9/92	LEAD	1	UG/L	U
11/8/93	LEAD	1.3	UG/L	U

DATE	ANALYTE	RESULT	UNIT	QUALIFIER*
2/15/94	LEAD	1.8	UG/L	
5/9/94	LEAD	2.7	UG/L	
8/16/94	LEAD	1	UG/L	U
11/7/94	LEAD	1	UG/L	U
2/7/95	LEAD	4.76	UG/L	
5/4/95	LEAD	4.72	UG/L	
12/9/92	LITHIUM	368.0	UG/L	
11/8/93	LITHIUM	260.0	UG/L	
2/15/94	LITHIUM	256.0	UG/L	
5/9/94	LITHIUM	260.0	UG/L	
8/16/94	LITHIUM	316.0	UG/L	
11/7/94	LITHIUM	250.6	UG/L	
2/7/95	LITHIUM	318.2	UG/L	
5/4/95	LITHIUM	179.1	UG/L	
12/9/92	MAGNESIUM	75900	UG/L	
11/8/93	MAGNESIUM	60400	UG/L	
2/15/94	MAGNESIUM	68700	UG/L	
5/9/94	MAGNESIUM	61300	UG/L	
8/16/94	MAGNESIUM	76500	UG/L	
11/7/94	MAGNESIUM	63780	UG/L	
2/7/95	MAGNESIUM	82566	UG/L	
5/4/95	MAGNESIUM	43526	UG/L	
12/9/92	MANGANESE	6.5	UG/L	B
11/8/93	MANGANESE	1.9	UG/L	
2/15/94	MANGANESE	5.4	UG/L	
5/9/94	MANGANESE	5	UG/L	
8/16/94	MANGANESE	4.2	UG/L	B
11/7/94	MANGANESE	3.61	UG/L	B
2/7/95	MANGANESE	5.51	UG/L	B
5/4/95	MANGANESE	3.98	UG/L	B
12/9/92	MERCURY	0.2	UG/L	U
11/8/93	MERCURY	0.2	UG/L	U
2/15/94	MERCURY	0.2	UG/L	U
5/9/94	MERCURY	0.2	UG/L	U
8/16/94	MERCURY	0.2	UG/L	U
11/7/94	MERCURY	0.2	UG/L	U
2/7/95	MERCURY	0.216	UG/L	
5/4/95	MERCURY	0.2	UG/L	U
2/25/92	METHYLENE CHLORIDE	5	UG/L	U
9/25/92	METHYLENE CHLORIDE	7.8	UG/L	
12/9/92	METHYLENE CHLORIDE	3	UG/L	
5/16/95	METHYLENE CHLORIDE	5	UG/L	U
12/9/92	MOLYBDENUM	7	UG/L	U
11/8/93	MOLYBDENUM	10.3	UG/L	U
2/15/94	MOLYBDENUM	7.7	UG/L	U
5/9/94	MOLYBDENUM	7.4	UG/L	U
8/16/94	MOLYBDENUM	3	UG/L	U
11/7/94	MOLYBDENUM	3	UG/L	U
2/7/95	MOLYBDENUM	2.5	UG/L	U
5/4/95	MOLYBDENUM	3.2	UG/L	U
12/9/92	NICKEL	7.4	UG/L	B
11/8/93	NICKEL	10.4	UG/L	U
2/15/94	NICKEL	12.3	UG/L	U
5/9/94	NICKEL	11.5	UG/L	
8/16/94	NICKEL	9.2	UG/L	B
11/7/94	NICKEL	8.14	UG/L	B
2/7/95	NICKEL	6.93	UG/L	B
5/4/95	NICKEL	4.1	UG/L	U

DATE	ANALYTE	RESULT	UNIT	QUALIFIER*
34073	NITRATE	8570	UG/L	
33872	NITRATE	47600	UG/L	
34859	NITRATE	57000	UG/L	
34823	NITRATE	194000	UG/L	
34835	NITRATE	285000	UG/L	
34463	NITRATE	304000	UG/L	
34645	NITRATE	320000	UG/L	
34380	NITRATE	337000	UG/L	
34737	NITRATE	344000	UG/L	
34562	NITRATE	370000	UG/L	
34281	NITRATE	372000	UG/L	
33947	NITRATE	380000	UG/L	
33659	NITRATE	440000	UG/L	
12/9/92	POTASSIUM	66300	UG/L	
11/8/93	POTASSIUM	42600	UG/L	
2/15/94	POTASSIUM	33500	UG/L	
5/9/94	POTASSIUM	41700	UG/L	
8/16/94	POTASSIUM	56500	UG/L	
11/7/94	POTASSIUM	36858	UG/L	
2/7/95	POTASSIUM	39422	UG/L	
5/4/95	POTASSIUM	36083	UG/L	
12/9/92	SELENIUM	7.8	UG/L	S
11/8/93	SELENIUM	4.1	UG/L	
2/15/94	SELENIUM	9.9	UG/L	
5/9/94	SELENIUM	7.4	UG/L	
8/16/94	SELENIUM	7.8	UG/L	SN
11/7/94	SELENIUM	4.5	UG/L	B
2/7/95	SELENIUM	7.96	UG/L	
5/4/95	SELENIUM	4.07	UG/L	B
12/9/92	SILICON	5720	UG/L	
11/8/93	SILICON	5840	UG/L	
2/15/94	SILICON	6000	UG/L	
5/9/94	SILICON	6060	UG/L	
8/16/94	SILICON	7360	UG/L	
11/7/94	SILICON	6520.7	UG/L	
2/7/95	SILICON	7553.8	UG/L	
5/4/95	SILICON	5283.4	UG/L	
12/9/92	SILVER	3	UG/L	U
11/8/93	SILVER	2.3	UG/L	U
2/15/94	SILVER	2.9	UG/L	U
5/9/94	SILVER	2.3	UG/L	U
8/16/94	SILVER	2	UG/L	U
11/7/94	SILVER	2	UG/L	U
2/7/95	SILVER	2	UG/L	U
5/4/95	SILVER	2.5	UG/L	U
12/9/92	SODIUM	428000	UG/L	
11/8/93	SODIUM	334000	UG/L	
2/15/94	SODIUM	322000	UG/L	
5/9/94	SODIUM	316000	UG/L	
8/16/94	SODIUM	377000	UG/L	
11/7/94	SODIUM	336238	UG/L	
2/7/95	SODIUM	391260	UG/L	
5/4/95	SODIUM	241663	UG/L	
12/9/92	THALLIUM	1	UG/L	UW
11/8/93	THALLIUM	1.9	UG/L	U
2/15/94	THALLIUM	1.5	UG/L	U
5/9/94	THALLIUM	1.8	UG/L	U
8/16/94	THALLIUM	1	UG/L	UN
11/7/94	THALLIUM	1	UG/L	U
2/7/95	THALLIUM	4.2	UG/L	U

DATE	ANALYTE	RESULT	UNIT	QUALIFIER*
5/4/95	THALLIUM	2.9	UG/L	U
12/9/92	TIN	10	UG/L	U
11/8/93	TIN	26.2	UG/L	U
2/15/94	TIN	13.8	UG/L	U
5/9/94	TIN	10.5	UG/L	U
8/16/94	TIN	12	UG/L	U
11/7/94	TIN	13	UG/L	U
2/7/95	TIN	8.9	UG/L	U
5/4/95	TIN	7.3	UG/L	U
2/25/92	TOLUENE	5	UG/L	U
9/25/92	TOLUENE	0.49	UG/L	
12/9/92	TOLUENE	0.2	UG/L	U
5/16/95	TOLUENE	5	UG/L	U
2/25/92	TRICHLOROETHENE	4	UG/L	J
9/25/92	TRICHLOROETHENE	3.6	UG/L	
12/9/92	TRICHLOROETHENE	3.3	UG/L	
5/16/95	TRICHLOROETHENE	4	UG/L	J
12/9/92	VANADIUM	3	UG/L	U
11/8/93	VANADIUM	3.1	UG/L	U
2/15/94	VANADIUM	3.4	UG/L	U
5/9/94	VANADIUM	2.7	UG/L	U
8/16/94	VANADIUM	2.1	UG/L	B
11/7/94	VANADIUM	2.81	UG/L	B
2/7/95	VANADIUM	4.23	UG/L	B
5/4/95	VANADIUM	2.7	UG/L	B
12/9/92	ZINC	7.3	UG/L	U
11/8/93	ZINC	10.2	UG/L	
2/15/94	ZINC	10.6	UG/L	
5/9/94	ZINC	9.1	UG/L	
8/16/94	ZINC	9.5	UG/L	U
11/7/94	ZINC	10.44	UG/L	B
2/7/95	ZINC	10.45	UG/L	B
5/4/95	ZINC	14.02	UG/L	B

* Qualifiers

B Less than method detection limit but greater than or equal to instrument detection limit
J Estimated value less than sample's detection limit
N Spiked recovery not within control limits
S Determined by mass spectroscopy
U Undetected, analyzed for but not detected
W Post-digest spike outside of control limits

TABLE 3
RADIONUCLIDE ANALYTES

DATE	ANALYTE	RESULT	UNIT	DET. LIM.
04/14/93	GROSS ALPHA	24	PCI/L	5
11/08/93	GROSS ALPHA	38	PCI/L	2
02/15/94	GROSS ALPHA	20	PCI/L	1
05/09/94	GROSS ALPHA	48	PCI/L	6
08/16/94	GROSS ALPHA	72	PCI/L	4
11/07/94	GROSS ALPHA	150	PCI/L	10
02/07/95	GROSS ALPHA	52	PCI/L	8
02/07/95	GROSS ALPHA	54	PCI/L	7
05/04/95	GROSS ALPHA	36	PCI/L	2
06/09/95	GROSS ALPHA	24	PCI/L	2
06/27/95	GROSS ALPHA	51	PCI/L	2
06/27/95	GROSS ALPHA	42	PCI/L	2
06/27/95	GROSS ALPHA	44	PCI/L	2
06/27/95	GROSS ALPHA	48	PCI/L	2
06/27/95	GROSS ALPHA	59	PCI/L	2
06/27/95	GROSS ALPHA	44	PCI/L	2
06/27/95	GROSS ALPHA	50	PCI/L	2
06/27/95	GROSS ALPHA	52	PCI/L	2
04/14/93	GROSS BETA	29	PCI/L	7
11/08/93	GROSS BETA	11	PCI/L	2
02/15/94	GROSS BETA	13	PCI/L	1
05/09/94	GROSS BETA	66	PCI/L	6
08/16/94	GROSS BETA	39	PCI/L	5
11/07/94	GROSS BETA	110	PCI/L	9
02/07/95	GROSS BETA	43	PCI/L	5
02/07/95	GROSS BETA	51	PCI/L	6
05/04/95	GROSS BETA	20	PCI/L	2
06/09/95	GROSS BETA	25	PCI/L	4
06/27/95	GROSS BETA	49	PCI/L	4
06/27/95	GROSS BETA	43	PCI/L	4
06/27/95	GROSS BETA	42	PCI/L	4
06/27/95	GROSS BETA	47	PCI/L	4
06/27/95	GROSS BETA	38	PCI/L	4
06/27/95	GROSS BETA	45	PCI/L	4
06/27/95	GROSS BETA	45	PCI/L	4
06/27/95	GROSS BETA	39	PCI/L	4
11/07/94	RADIUM-226	1.8	PCI/L	1

DATE	ANALYTE	RESULT	UNIT	DET. LIM.
04/14/93	TRITIUM	-42.55	PCI/L	248.4
11/08/93	TRITIUM	960	PCI/L	200
02/15/94	TRITIUM	1100	PCI/L	200
05/09/94	TRITIUM	1100	PCI/L	200
08/16/94	TRITIUM	1100	PCI/L	300
11/07/94	TRITIUM	930	PCI/L	300
02/07/95	TRITIUM	1000	PCI/L	300
05/04/95	TRITIUM	570	PCI/L	300
06/09/95	URANIUM-233,-234	13.7	PCI/L	0.09
06/09/95	URANIUM-233,-234	14.5	PCI/L	0.06
06/09/95	URANIUM-235	0.75	PCI/L	0.05
06/09/95	URANIUM-235	0.75	PCI/L	0.05
06/09/95	URANIUM-238	8.74	PCI/L	0.09
06/09/95	URANIUM-238	8.79	PCI/L	0.06

RESOURCE TECHNOLOGIES GROUP, INC.	SUBJECT Calculation Set # 1		
	Project No. Client	Prepared by: C Hand Checked: Reviewed:	Sheet of Date: 7-10-97

Closure of ITS

1) For estimating purposes, it is assumed that a typical trench/French drain is 5 ft deep, 13-inches wide, and contains gravel with a porosity of 50 percent. Bentonite injection locations are approximated as shown with "X" on attached ITS figure. At each of these locations, bentonite would be injected from the surface to fill the voids of a trench section that is approximately 5 ft deep, 3 ft long and 1 foot wide.

Cost: 40 locations * 10 locations/day * $1,000/day = $4,000

Bentonite = $10,000

Misc. Expenses $500/day * 4 day = $2,000

2) Grout (cement) should be used to plug the 4" pipe in the drain outlining the northern limit of the ITS (approx. 2,000 ft). Grout placement can be achieved with a "coil unit", which is commonly used in the petroleum industry.

Cost: 2 days * $20,000/day = $40,000

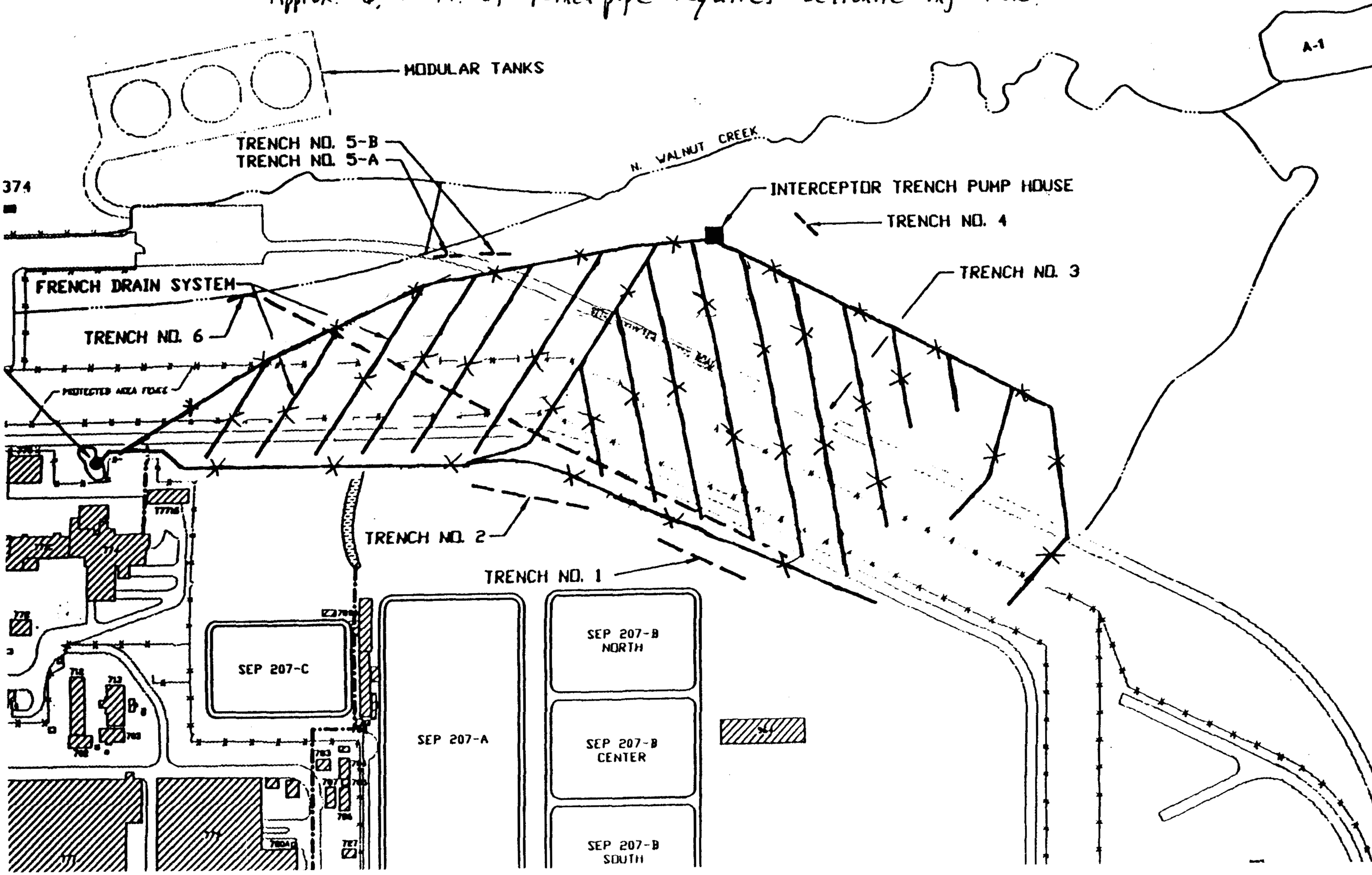
3) Bentonite would be used to close each of the remaining branches of the French drain (6,000 linear feet of 4" pipe).

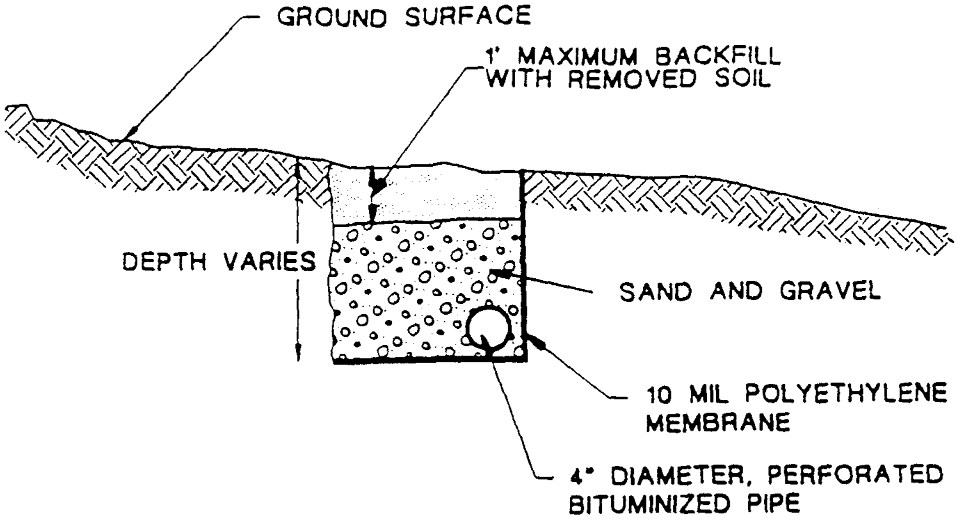
Cost: 3 day * $1,000/day = $3,000
500 ft³ of grout = $10,000
Grout Conveyance Appurtenances $10,000

$79,000

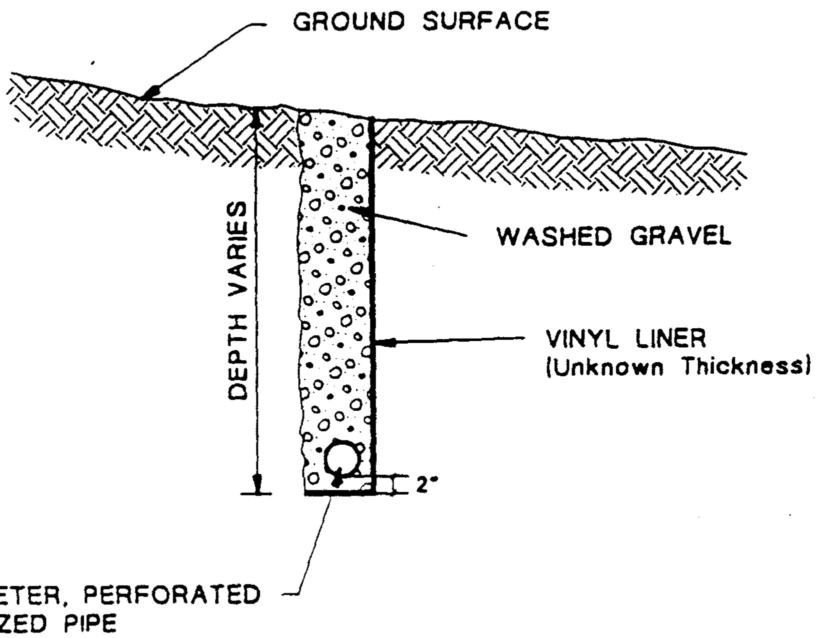
recycled paper

- 40 Locations for Bentonite Injection to Effect Trench Closure
- Approx. 2,000 ft. of 4-inch pipe requires grout injection
- Approx. 6,000 ft. of 4-inch pipe requires bentonite injection





CROSS SECTION OF TYPICAL TRENCH AND FRENCH DRAIN SYSTEM NOT ALONG SEGMENT D-D'
(Not to scale)



CROSS SECTION OF TYPICAL FRENCH DRAIN ALONG SEGMENT D-D'
(Not to scale)

PREPARED FOR:
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

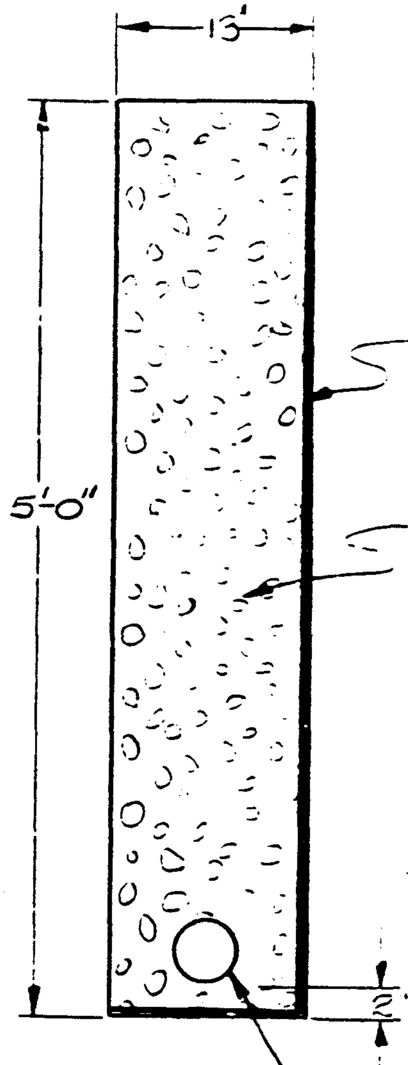
FIGURE 2-8

TITLE:
TYPICAL TRENCH AND ITS (FRENCH DRAIN) CROSS SECTIONS

PROJ. NO.	304909	DWG. NO.	304909-A61	SHEET
DESIGN BY	C. BRAND	CHECKED	[illegible]	OF
DRAWN BY	KRONER	APPROVED		
DATE	10-21-91	SCALE	NA	

REFERENCE: MODIFIED AFTER ROCKWELL INTERNATIONAL SOLAR EVAPORATION POND CLOSURE PLAN, JULY 1988, VOLUME I, FIGURE 7.

4909A61 10/30/91 0:40pm AWK



SECTION A

26637-1 SCALE: 1" = 1'-0"

SEE
(REF.

RESOURCE TECHNOLOGIES GROUP, INC.	SUBJECT Calculation Set #2		
	Project No.	Prepared by: C. Hamel	Sheet of
	Client:	Checked:	Date:
		Reviewed:	

Alt. 4 - Uranium Loading @ B995

- An alternative for ITS-collected water treatment is collection of water in MSTs and periodic transfer to B995 for treatment. This calculation provides a rough estimate of uranium loading in the solids generated by B995 treatment operations.

Assumptions

1) The B995 treatment operations generate approx. 2,900 ft^3 of solids annual.
2) Solids density approx. 60 lb/ft^3
3) 80% of Uranium from ITS-collected water is removed with the B995 solids.
4) ITS-collected water (3,000,000 gal) is treated at B995 over a period of 6 months. Assume homogeneous distribution of Uranium in the solids during this period.

Calculation

$$\frac{3\times10^6\ gal}{6\ months} * \frac{1\ month}{30\ d} * \frac{1\ d}{24\ h} * \frac{1\ h}{60\ min} = 11.6\ gpm$$

1) $$\frac{3{,}000{,}000\ gal}{0.5\ yr} * \frac{1\ yr}{2{,}900\ ft^3\ solids} * \frac{1\ ft^3\ solids}{60\ lb\ solids} * \frac{3.785\ l}{gal} * \frac{120\ pCi\ U}{l}$$

$$* \ 0.8 * \frac{1\ lb\ solids}{454\ g} = 27.6\ pCi\ U/g\ solids$$

The current radionuclide loading on B995 sludge is 40-60 pCi/g. As such, the loading range could increase to 67 to 88 pCi/g. If the ITS-collected water were to be treated in batches over the 6-month period, e.g., 2 weeks per month, the contribution of uranium to the solids generated during those periods would double:

2) $$\frac{3{,}000{,}000\ gal}{0.25\ yr} * \frac{1\ yr}{2900\ ft^3} \ldots\ldots$$ etc. (see calculation #1)

= 55.2 pCi/g U with a total loading of 95.2 - 115.2 pCi/g

recycled paper

RESOURCE TECHNOLOGIES GROUP, INC.	SUBJECT Calculation Set # 3		
	Project No.	Prepared by: C. Hamel	Sheet of
	Client:	Checked:	Date:
		Reviewed:	

Subject: Cost Per Gallon Under Alternative 5

The "Technology Justification for the Interceptor Trench System" lists capital and annual O+M costs at $2,351,000 and $366,200, respectively. The design basis was for 1,000,000 gallons during a "wet" month. however, O+M costs were based on treating approx. 2,000,000 gallons a year.

Assumptions:

- Design / Operating Life of Alt. 5 Facility is 10 yrs.
- Adjust cost based on 3,000,000 gallons per year (doesn't affect total capital cost).

Capital Cost Spread Over 10 Years

$$\$2{,}351{,}000 / 10\,yr = \$235{,}100/yr$$

O+M Cost Adjusted for 3,000,000 Gallons/yr

$$\frac{\$366{,}200}{2\times10^6\,gal\cdot yr} \times 3\times10^6\,gal = \$549{,}300/yr$$

Cost per Gallon

$$(\$549{,}300 + \$235{,}100) / 3\times10^6\,gallons = \$0.26/gallon$$

recycled paper

RESOURCE TECHNOLOGIES GROUP, INC.	SUBJECT Calculation Set No. 4		
	Project No. 970280 Client:	Prepared by: RCK Checked: Reviewed:	Sheet 1 of 1 Date: July 10, 1997

Alt. 7 - Evap. Pond

Purpose: Estimate the Capital and Operating + Maintenance costs for a 5 acre evaporation pond with a total depth of 7 ft (including 2 ft of freeboard)

Capital Cost:

Assumptions 1) Typical cost for excavation is $3 / ft³ (see Richardsons)
2) Cost of pond liner (assume double lined with geomembrane) is $2.50 / ft²

Cubic yards: $\frac{5 \text{ acres} \times 43{,}560 \text{ ft}^2/\text{acre} \times 7 \text{ ft}}{27} = 56{,}467$ cu. yd.

Excavation cost = 56,467 yd³ × $3 / yd³ = $169,401

Sq. ft. of pond liner = 5 acres × 43,560 ft²/acre + $7 \times 4 \times \sqrt{5 \times 43{,}560}$ = 230,367 ft²
(assume square pond)

Liner cost = 230,367 ft² × $2.50 / ft² = $577,168

Sub Total = 169,401 + 577,169 = $746,569

Add 10% for monitoring equipment and controls

Materials Price = 1.1 (746,569) = $821,226
Add 15% for engineering
Add 20% for construction + project management
Total Capital Cost = 1.35 (821,226) = $1.11 × 10⁶

Operating + Maintenance Costs

Assume 1 operator, 8 hours per week for sampling and monitoring.
Assume an hourly wage of $50/hr

Annual Operating cost = $50/hr × 8 hrs/wk × $\frac{52 \text{ wks}}{\text{yr}}$ = $20,800 / yr

Assume miscellaneous maintenance costs of $10,000/yr

Total O&M Cost = $30,800/yr

RESOURCE TECHNOLOGIES GROUP, INC.	SUBJECT Calculation Set No. 4		
	Project No. 970280 Client	Prepared by: RCK Checked: Reviewed:	Sheet 1 of 1 Date: July 8, 1997

Alt. 7 - Evap. Pond

Purpose: Calculate the depth of sludge generated annually in the proposed evaporation pond.

Assumptions: Sludge is 30% solid by weight.
Sp. Gravity of dry sludge is 2.3

Basis: 3 million gallon per year of water with TDS of 3,423 mg/liter (Ref. No. 1)
Pond size = 5 acres

Reference 1) RFETS Radioactive Liquid Waste Quantity and Quality Estimates, June 10, 1997, Table 4.5

$$\text{Apparent gravity of Sludge} = \frac{1}{.3/2.3 + .7} = 1.2$$

$$\text{Annual Dry solids} = \frac{3{,}000{,}000 \text{ gal}}{\text{yr}} \times \frac{.3423 \text{ g}}{\ell} \times \frac{3.785 \ \ell}{\text{gal}} \times \frac{\text{lb}}{453.6 \text{ g}} = 8{,}569 \text{ lb/yr}$$

$$\text{Annual Sludge} = 8{,}570 / 0.30 = 28{,}563 \text{ lbs}$$

$$\text{Volume of Sludge} = \frac{28{,}563 \text{ lbs}}{(62.4 \times 1.2) \text{ lbs/ft}^3} = 381 \text{ ft}^3/\text{yr}$$

$$\text{Area of Pond} = 5 \text{ acres} = 217{,}800 \text{ ft}^2$$

$$\text{Depth of Sludge/yr} = \frac{381 \text{ ft}^3/\text{yr}}{217{,}800 \text{ ft}^2} \times \frac{12 \text{ in}}{\text{ft}} = .02 \text{ inches/yr}$$

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

COLORADO WATER QUALITY CONTROL COMMISSION

SUPPLEMENTAL TESTIMONY OF JOHN E. LAW, P.E., ROCKY MOUNTAIN REMEDIATION SERVICES, L.L.C.

IN THE MATTER OF THE AMENDMENT OF WATER QUALITY CLASSIFICATIONS AND STANDARDS, 5 CCR 1002-8, FOR:
SEGMENTS OF BIG DRY CREEK IN THE SOUTH PLATTE RIVER BASIN, § 3.8.0;
SITE-SPECIFIC GROUND WATER CLASSIFICATIONS AND STANDARDS FOR GROUND WATER IN THE VICINITY OF ROCKY FLATS, § 3.12.0;
BASIC STANDARDS AND METHODOLOGIES FOR SURFACE WATER, § 3.1.0; and
BASIC STANDARDS FOR GROUND WATER, § 3.11.0

I. Alternative Management Of Nitrate-Contaminated Ground Water in a New On-Site Pond

As I have already stated in testimony (p. 5, Pre-hearing Statement of DOE/KH), the Site is evaluating alternatives to the current, high-cost treatment of the nitrate-contaminated ground water in the process waste treatment facility. As previously explained, this contaminated ground water is collected by the Interceptor Trench System (ITS) downgradient of the Solar Evaporation Ponds in the North Walnut Creek drainage. The Colorado Division of Wildlife (DOW) has proposed in its pre-hearing statement alternatives, involving impoundment of the ITS water in an on-site pond, which are purported to be feasible and cost-effective for meeting the underlying nitrate standard of 10 mg/l. The DOW claims on that basis that the request for a temporary modification for nitrate in segments 4a, 4b and 5 should be denied.

The alternatives proposed by DOW would include a 1 acre lined pond for evaporation disposal or treatment of an average of 3 million gallons of ITS water annually. My comments below address the actual sizing and siting requirements for such a facility and the feasibility of developing a new waste impoundment at Rocky Flats. Comments on the alternative which involves a pond with cover for treatment and discharge are included in the DOE and Kaiser-Hill rebuttal statement, Section I.B.2.d.

A. Design Considerations

First, the DOW pond alternatives are based upon an incorrect understanding of the ITS water. The volumes of ITS water that must be used in sizing an evaporation pond are not only the average of 3 million gallons per year but a wet year flow of 4.6 million gallons such as occurred in 1995, with a peak month volume of 1.55 million gallons (May, 1995).

I have reviewed the DOW's assertion that a 1 acre lined pond would be large enough to dispose of the ITS water by solar evaporation. Based on evaporation and precipitation records and ITS water production rates, a 4 to 5 acre pond would actually be needed to allow evaporation of a wet year flow similar to 1995, and, after an average ITS water volume year, the peak month ITS water volume of 1.55 million gallons could be collected and stored without reducing pond freeboard below a design level of 1 foot. The 1 acre pond proposed by DOW would not meet even the average evaporation requirement for the ITS water. Costs for the 4 to 5 acre pond would be commensurately higher than the 1 acre pond envisioned by DOW.

I have made an initial evaluation of siting considerations for a new, off-channel impoundment 4 to 5 acres in size. Since the ITS central sump is located in the incised valley of North Walnut Creek adjacent to the Rocky Flats Industrial Area, a suitably flat site of sufficient area for a 4 to 5 acre pond would probably not be available in the already disturbed Industrial Area without interfering with other activities including remediation of areas of contamination and closure of the existing industrial facilities. The Rocky Flats Buffer Zone would probably have to be used as the pond location. For a pumped discharge from the sump, a location would be available about one-half mile away. If the pond were to receive ITS water by gravity flow, a pipeline over one mile long would be required to reach beyond the incised valley to the flatter eastern slopes of Rocky Flats. The new, one-half to one mile plus pipeline would add to the cost of an evaporation pond alternative.

B. Environmental and Administrative Factors

Besides design considerations and implementation costs, a number of other environmental and administrative factors are being evaluated as the Site searches for a cost-effective alternative to the current, high-cost pumping and evaporation treatment approach. A new evaporation pond would not be a favored alternative when considered against these factors.

A key environmental consideration is the leak and spill controls and ground water monitoring that would be required. Although the ITS water is not a hazardous waste and is considered low-risk in terms of toxic constituents, an evaporation pond would have to meet requirements of the State ground water protection program, which would entail on-going surveillance, monitoring and maintenance, and the attendant record-keeping and reporting of ground water conditions around the pond. The pond would also have to go through a formal closure process after ITS water management is no longer needed. Lining and leak detection systems would be installed for the pond to assure that another area of ground water contamination is not created at the Site, adding to environmental remediation liabilities that must be addressed as the Site moves toward final closure.

Rocky Flats takes as a serious matter the environmental stewardship of the Rocky Flats Buffer Zone, where a new, 4 to 5 acre evaporation pond would be sited. Construction in the buffer zone, except associated with remediation at existing areas of contamination, is discouraged. Direct construction impacts on ecological resources (wildlife habitat, threatened/endangered species, wetlands, etc.) associated with the pipeline and evaporation pond would be significant. A National Environmental Policy Act (NEPA) review, environmental assessment and decision process would be required. As compared to management alternatives which would take much less land, use existing facilities and be sited in the existing Industrial Area, the evaporation pond suggested by DOW would have much greater direct environmental impacts.

Besides its high cost, the existing pumping and evaporation treatment method for the ITS water negatively impacts the Walnut Creek drainage as a water resource. Yet, total evaporation in a pond would be worse from this perspective because the current system allows commercial recycle of the product water. Recycling reduces potable water use in the Building 371 cooling system and the Building 443 steam generation system, and blowdowns from these systems are discharged to the Walnut Creek drainage via the Site sewage treatment system. Although there are water losses at these commercial reuse points, total evaporation of the ITS water in a pond would further decrease flow to the Walnut Creek drainage by several acre-feet per year. Such a loss would impact aquatic life and downstream water rights. As substantiated in my initial testimony and Exhibit K of the DOE and Kaiser-Hill pre-hearing statement, nitrates in the ITS water will not substantially impact classified water uses (aquatic life and agricultural use) downstream in the Walnut Creek drainage and Big Dry Creek. So, other alternatives which return this water to the drainage are favored over the evaporation pond suggested by DOW from a water resource perspective.

C. Summary of Problems with Pond Management Alternatives

In summary, disposal or treatment of the ITS water in a pond is not an approach currently favored by the Site because:

- The pond would have to be 4 to 5 times the size suggested by the DOW and require a new pipeline;
- A site of suitable size would only be available in the Rocky Flats Buffer Zone, with attendant serious environmental effects;
- A pond would be subject to the State ground water protection program and would need protection measures, monitoring/reporting and site closure; and
- An evaporation pond would further deplete the water resources of the Walnut Creek drainage.

POND EVAPORATION FOR ITS DISPOSAL				
CALCULATIONS FOR RANGE OF POND AREAS				
GIVEN:	ITS Avg. Yr =	3,000,000 gal.		
	ITS Wet Yr =	4,600,400 gal.	(1995)	
	Peak Month =	1,545,700 gal.	(May, 1995)	
Monthly Avg. Pan Evap (Inches)		[COE,Omaha; Cherry Cr Res,. 1959-1995]		
Precip. (Inches)		[Monthly Precip. RFETS, 1988-1996]		
& ITS Vol. (Monthly % of Yr)		[RMRS TM on ITS Water Management, 4/96]		
	Pan Evap.*	Precip.	ITS Vol.	
January	0.76	0.37	3.35	
February	0.92	0.34	4.35	
March	1.68	1.37	8.08	
April	3.91	1.57	21.08	
May	6.51	2.74	24.11	
June	8.41	1.46	13.92	
July	9.46	1.28	5.31	
August	8.37	1.47	4.57	
September	6.58	1.95	3.53	
October	4.47	0.64	3.59	
November	2.47	0.91	4.73	
December	0.99	0.25	3.38	
Annual Total	54.53	14.35	100.00	
* Winter month evaporation (Nov. -- Feb.) will approach zero				
in cold, snowy years.				
ASSUME:	Pan Coefficient = 0.7			
CALCULATION:	Monthly Evap Vol and Increase/Decrease in			
Pond Storage	for 1, 2, 3 and 4 acre pond sizes.			

1 ACRE POND -- AVG EVAP RATES				
		(all in gallons)		
MONTH	ITS VOLUME(avg)	EVAP VOL(Avg)	POND STORAGE	
January	100500	7413	93087	
February	130500	11024	119476	
March	242400	5892	236508	
April	632400	44476	587924	
May	723300	71655	651645	
June	417600	132096	285504	
July	159300	155475	3825	
August	137100	131146	5954	
September	105900	88001	17899	
October	107700	72796	34904	
November	141900	29650	112250	
December	101400	14065	87335	
Annual Totals	3000000	763688	2236312	

2 ACRE POND – AVG EVAP RATES					
		(all in gallons)			
MONTH	ITS VOLUME(Avg	EVAP VOL(Avg)	POND STORAGE		
January	100500	14825	85675		
February	130500	22048	108452		
March	242400	11784	230616		
April	632400	88951	543449		
May	723300	143310	579990		
June	417600	264193	153407		
July	159300	310949	-151649		
August	137100	262292	-125192		
September	105900	176002	-70102		
October	107700	145591	-37891		
November	141900	59301	82599		
December	101400	28130	73270		
Annual Totals	3000000	1527377	1472623		

3 ACRE POND -- AVG EVAP RATES				
		(all in gallons)		
MONTH	ITS VOLUME(avg)	EVAP VOL(Avg)	POND STORAGE	
January	100500	22238	78262	
February	130500	33072	97428	
March	242400	17676	224724	
April	632400	133427	498973	
May	723300	214966	508334	
June	417600	396289	21311	
July	159300	466424	-307124	
August	137100	393438	-256338	
September	105900	264003	-158103	
October	107700	218387	-110687	
November	141900	88951	52949	
December	101400	42195	59205	
Annual Totals	3000000	2291065	708935	

3 ACRE POND – WET YEAR ITS VOLUME					
		(all in gallons)			
MONTH	ITS VOLUME(wet	EVAP VOL (Avg	POND STORAGE		
January	154113	22238	131876		
February	200117	33072	167046		
March	371712	17676	354036		
April	969764	133427	836337		
May	1109156	214966	894191		
June	640376	396289	244086		
July	244281	466424	-222143		
August	210238	393438	-183200		
September	162394	264003	-101609		
October	165154	218387	-53232		
November	217599	88951	128648		
December	155494	42195	113299		
Annual Totals	4600400	2291065	2309335		

3 ACRE POND – WET/COLD YEAR EVAP RATES				
		(all in gallons)		
MONTH	ITS VOLUME(wet	EVAP VOL(Cold	POND STORAGE	
January	154113	0	154113	
February	200117	0	200117	
March	371712	23568	348144	
April	969764	177903	791862	
May	1109156	286621	822536	
June	640376	528386	111990	
July	244281	621899	-377617	
August	210238	524584	-314346	
September	162394	352004	-189610	
October	165154	291182	-126028	
November	217599	0	217599	
December	155494	0	155494	
Annual Totals	4600400	2806146	1794254	

POND LEVEL CHANGES – 3 ACRE POND					
ASSUME: 5 ft deep pond plus 2 ft minimum freeboard					
Pond Capacity:	5ft x 43560 x 3acres x 7.48 =		4,887,400 gal.		
Avg. Yr:	- 109303 gal. /7.48 /(3 x 43560) =			0.11 ft drop	
Wet Yr:	+ 1491097 gal. /7.48/(3 x 43560) =			1.52 ft rise	
Wet/Cold Yr:	+ 1784180 gal. /7.48/(3 x 43560) =			1.83 ft rise	
Sequence A - 1 Avg Yr, 1 Wet Yr, 1 Wet/Cold Yr =					
	-0.11+1.52+1.83 = +3.24 ft		NOT OK		
Sequence B - 1 Avg Yr, 2 Wet/Cold Yrs =					
	-0.11+2(1.83) = +3.55 ft		NOT OK (if pond is starts full.)		
NOTE: Starting from initial/empty operation, about 3 Wet or Wet/Cold Years required to fill pond.					
CONCLUSION: 3 acre pond will not be large enough for evaporation of ITS water.					

4 ACRE POND -- AVG EVAP RATES				
		(all in gallons)		
MONTH	ITS VOLUME(avg)	EVAP VOL(Avg)	POND STORAGE	
January	100500	29650	70850	
February	130500	44095	86405	
March	242400	23568	218832	
April	632400	177903	454497	
May	723300	286621	436679	
June	417600	528386	-110786	
July	159300	621899	-462599	
August	137100	524584	-387484	
September	105900	352004	-246104	
October	107700	291182	-183482	
November	141900	118602	23298	
December	101400	56260	45140	
Annual Totals	3000000	3054754	-54754	

4 ACRE POND -- WET YEAR ITS VOLUME					
		(all in gallons)			
MONTH	ITS VOLUME(wet	EVAP VOL (Avg	POND STORAGE		
January	154113	29650	124463		
February	200117	44095	156022		
March	371712	23568	348144		
April	969764	177903	791862		
May	1109156	286621	822536		
June	640376	528386	111990		
July	244281	621899	-377617		
August	210238	524584	-314346		
September	162394	352004	-189610		
October	165154	291182	-126028		
November	217599	118602	98997		
December	155494	56260	99234		
Annual Totals	4600400	3054754	1545646		

4 ACRE POND -- WET/COLD YEAR EVAP RATES				
		(all in gallons)		
MONTH	ITS VOLUME(wet	EVAP VOL(Cold	POND STORAGE	
January	154113	0	154113	
February	200117	0	200117	
March	371712	23568	348144	
April	969764	177903	791862	
May	1109156	286621	822536	
June	640376	528386	111990	
July	244281	621899	-377617	
August	210238	524584	-314346	
September	162394	352004	-189610	
October	165154	291182	-126028	
November	217599	0	217599	
December	155494	0	155494	
Annual Totals	4600400	2806146	1794254	

POND LEVEL CHANGES – 4 ACRE POND					
ASSUME: 5 ft deep pond plus 2 ft minimum freeboard					
Pond Capacity:	5ft x 43560 x 4acres x 7.48 =		6,516,576 gal.		
Avg. Yr:	- 54754 gal. /7.48 /(4 x 43560) =			0.04 ft drop	
Wet Yr:	+ 1545646 gal. /7.48/(4 x 43560) =			1.19 ft rise	
Wet/Cold Yr:	+ 1794254 gal. /7.48/(4 x 43560) =			1.38 ft rise	
Sequence A - 1 Aag Yr, 1 Wet Yr =					
	-0.04+1.19 =	+1.15 ft	NO GOOD		
Sequence B - 1 Avg Yr, 1 Wet Yr, 1 Wet/Cold Yr =					
	-0.04+1.19+1.38 = +2.53 ft		NO GOOD		
CONCLUSION: 4 acre pond will not be large enough for evaporation of ITS water					
if a wet/cold year occurs.					

5 ACRE POND – AVG EVAP RATES				
		(all in gallons)		
MONTH	ITS VOLUME(avg)	EVAP VOL(Avg	POND STORAGE	
January	100500	37063	63437	
February	130500	55119	75381	
March	242400	29460	212940	
April	632400	222378	410022	
May	723300	358276	365024	
June	417600	660482	-242882	
July	159300	777373	-618073	
August	137100	655730	-518630	
September	105900	440005	-334105	
October	107700	363978	-256278	
November	141900	148252	-6352	
December	101400	70325	31075	
Annual Totals	3000000	3818442	-818442	

5 ACRE POND -- WET YEAR ITS VOLUME					
		(all in gallons)			
MONTH	ITS VOLUME(wet	EVAP VOL (Avg	POND STORAGE		
January	154113	37063	117050		
February	200117	55119	144998		
March	371712	29460	342252		
April	969764	222378	747386		
May	1109156	358276	750881		
June	640376	660482	-20106		
July	244281	777373	-533092		
August	210238	655730	-445492		
September	162394	440005	-277611		
October	165154	363978	-198824		
November	217599	148252	69347		
December	155494	70325	85169		
Annual Totals	4600400	3818442	781958		

5 ACRE POND – WET/COLD YEAR EVAP RATES				
		(all in gallons)		
MONTH	ITS VOLUME(wet	EVAP VOL(Cold	POND STORAGE	
January	154113	0	154113	
February	200117	0	200117	
March	371712	29460	342252	
April	969764	222378	747386	
May	1109156	358276	750881	
June	640376	660482	-20106	
July	244281	777373	-533092	
August	210238	655730	-445492	
September	162394	440005	-277611	
October	165154	363978	-198824	
November	217599	0	217599	
December	155494	0	155494	
Annual Totals	4600400	3507683	1092717	

POND LEVEL CHANGES – 5 ACRE POND					
ASSUME: 5 ft deep pond plus 2 ft minimum freeboard					
Pond Capacity:	5ft x 43560 x 5acres x 7.48 =		8,145,720 gal.		
Avg. Yr:	- 818442 gal. /7.48 /(5 x 43560) =			0.50 ft drop	
Wet Yr:	+ 781958 gal. /7.48/(5 x 43560) =			0.48 ft rise	
Wet/Cold Yr:	+ 1092717 gal. /7.48/(5 x 43560) =			0.67 ft rise	
Sequence A - 1 Avg Yr, 1 Wet Yr =					
	-0.50+0.48 =	-0.02ft	OK		
Sequence B - 1 Avg Yr, 1 Wet Yr, 1 Wet/Cold Yr =					
	-0.50+0.48+0.67 = +0.65 ft		NO GOOD		
CONCLUSION: 5 acre pond will be large enough for evaporation of ITS water					
if two or more wet/cold years do not occur in succession.					
A pond size between 4 & 5 acres would be used to evaporate					
the ITS water with capability to handle a wet year.					

.S. ARMY CORPS OF ENGINEERS - OMAHA DISTRICT

CHERRY CREEK RESERVIOR, COLORADO
MONTHLY EVAPORATION PAN IN INCHES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1959		1.10	3.90	7.00	7.00	9.50	12.10	11.60	6.92	3.00	2.00	1.40	65.52
1960	1.40	1.00	1.40	4.40	8.20	10.30	11.90	12.30	8.50	4.10	2.90	1.20	67.60
1961	1.24	1.20	2.40	5.77	7.69	9.20	10.80	10.80	5.55	4.60	1.10	0.79	61.14
1962	0.60	0.60	1.55	3.33	7.80	9.20	11.80	12.20	8.40	6.30	3.00	1.50	66.28
1963	1.30	1.70	2.50	5.60	7.10	10.00	10.80	9.20	6.50	4.90	3.10	0.88	63.58
1964	0.88	1.30	2.00	4.00	6.90	11.70	10.00	8.80	7.60	5.80	2.40	0.98	62.36
1965	0.73	1.20	1.70	3.40	5.70	7.40	8.60	8.80	5.50	2.60	2.30	0.94	48.87
1966	0.76	0.77	1.50	2.70	7.92	8.05	8.40	8.80	6.10	2.80	1.49	1.07	50.36
1967	0.64	0.85	1.70	3.75	5.83	6.10	6.80	7.00	6.40	3.72	1.90	1.00	45.69
1968	0.61	0.80	1.40	5.35	6.50	9.40	9.80	7.20	6.10	5.00	2.20	1.10	55.46
1969	0.63	0.64	0.55	5.70	6.31	6.60	7.80	8.64	5.74	3.60	2.30	1.20	49.71
1970	0.70	0.75	1.50	4.50	7.20	8.80	8.60	8.20	6.30	3.00	1.90	1.70	53.15
1971	0.70	0.80	1.80	3.50	6.70	8.77	7.97	8.31	6.00	3.90	2.30	1.00	51.75
1972	0.80	0.80	1.50	3.80	6.61	7.94	8.75	8.70	5.25	4.27	2.50	0.75	51.67
1973	0.70	0.90	1.80	3.50	6.80	8.57	8.22	8.35	5.37	4.10	1.80	0.80	50.91
1974	0.80	0.80	1.50	4.00	8.32	7.50	9.70	7.90	5.69	4.00	1.80	0.86	52.87
1975	0.80	0.80	1.00	3.50	6.00	7.88	9.45	8.33	6.23	6.43	2.00	0.80	53.22
1976	0.60	1.20	1.90	3.60	5.85	8.80	9.69	7.72	5.40	3.54	2.00	0.80	51.10
1977	0.60	0.70	1.60	3.10	8.06	9.85	9.03	7.35	8.15	6.13	2.10	1.30	57.17
1978	0.70	0.90	1.60	5.60	6.69	8.76	10.54	8.96	8.64	5.60	2.70	0.90	61.59
1979	0.70	0.90	1.60	3.20	6.00	8.20	9.33	7.97	6.48	4.46	2.00	0.90	51.74
1980	0.70	0.90	1.60	3.20	6.75	10.33	11.05	8.45	7.07	5.80	2.70	1.00	59.55
1981	0.80	0.90	1.60	5.14	5.46	8.72	9.53	7.17	6.74	4.00	2.70	0.90	53.66
1982	0.70	0.90	1.70	4.00	5.90	7.26	8.81	7.30	5.79	3.67	2.70	0.90	49.63
1983	0.70	0.90	1.60	3.20	5.00	4.29	10.41	8.59	8.85	8.87	2.70	0.90	55.21
1984	0.70	0.90	1.60	3.20	5.00	6.93	10.48	7.34	6.07	4.10	2.70	0.90	49.92
1985	0.70	0.90	1.60	3.20	7.00	9.72	11.80	8.17	6.96	3.90	2.70	0.90	57.55
1986	0.70	0.90	1.60	3.20	5.00	8.22	8.97	7.78	6.37	3.90	2.70	0.90	50.24
1987	0.70	0.90	1.60	3.20	5.00	9.54	9.69	8.04	8.86	5.14	2.70	0.90	56.27
1988	0.70	0.90	1.60	3.20	5.00	8.22	7.83	8.03	6.60	4.80	2.70	0.90	50.48
1989	0.70	0.90	1.60	3.20	6.80	6.94	9.98	7.64	6.57	4.30	2.70	0.90	52.23
1990	0.80	0.80	1.60	3.20	6.27	9.97	7.72	7.71	6.37	4.40	2.69	0.90	52.43
1991	0.80	0.80	1.60	3.10	7.13	8.09	9.14	7.51	6.62	4.78	3.90	0.90	54.37
1992	0.70	0.90	1.60	4.62	6.50	6.44	7.96	6.69	6.49	5.64	3.90	0.90	52.34
1993	0.70	0.90	1.60	3.20	5.89	8.34	9.05	6.69	5.61	3.51	2.90	0.90	49.29
1994	0.70	0.90	1.60	3.20	6.71	9.22	9.67	7.78	6.85	3.93	2.70	0.90	54.16
1995	0.70	0.90	1.60	3.20	6.42	7.40	7.99	7.57	4.94	3.62			44.34
AVE	0.76	0.92	1.68	3.91	6.51	8.41	9.46	8.37	6.58	4.47	2.47	0.99	54.42

NOTES: 1. INITIAL FILL OF CONSERVATION POOL WAS DURING MARCH 1960.
2. CURRENT PAN READINGS AVAILABLE DURING APRIL THROUGH SEPTEMBER - WEATHER PERMITTING. OTHER MONTHES ARE ESTIMATED VALUES.

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL # of pages ▸ 1

To Paul Pigeon 966-5611		From Scott Franklin	
Dept./Agency Rocky Flats		Phone # (402) 221-4608	
Fax # 966-2256		Fax # (402) 221-3408	

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

2.1.2 Physical Setting

The Site is situated at an elevation of about 6,000 feet on the eastern edge of an essentially flat bench described geologically as an alluvial fan and known locally as Rocky Flats. This bench is approximately five miles wide in an east to west direction. To the east, the topography slopes gradually downward toward the Denver basin at an average grade of 95 feet per mile. Approximately 20 miles to the west, the continental divide rises to elevations exceeding 14,000 feet (EG&G 1990).

2.1.3 Meteorology/Climate

Meteorologic measurements, including precipitation and wind speed, have been made at the Site since 1953. Data collected under this program are primarily used in analysis of airborne emissions, but are also used for surface water management operations. Precipitation data are used to estimate the plant pond inflows. This information, in turn, is factored into the decision-making process for pond releases.

The climate at the Site is characterized by dry, cool winters and warm summers. The average precipitation for the site is 15.4 inches per year (EG&G 1993a) with a range of 7.8 to 24.9 inches based on 24 years of data (1953 to 1976) (Rockwell 1976). Typically, more than 70 percent of the precipitation falls as rain between April and September.

Relative humidity at the Site averages 46 percent, and the annual mean temperature is approximately 50 degrees Fahrenheit. While the average wind velocity is between 8 and 9 miles per hour, wind gusts up to 90 miles per hour have been reported. The number of sunny days averages over 250 annually.

Estimates of yearly evaporation for the Site vary depending on yearly precipitation and pan constants used. According to National Oceanic and Atmospheric Administration (NOAA) data for 1956 to 1970, gross shallow lake evaporation averages 39 inches per year (NOAA 1982). Net evaporation, which takes into account average precipitation, is approximately 28.2 inches per year based on methodology recommended by the State Engineer's Office (SEO) (SEO 1990). Additional detail regarding evaporative losses from the ponds is found in Section 2.2.3.4.

2.1.4 Hydrology

The Site is located within the following four watersheds: Woman Creek, Walnut Creek, Rock Creek, and a small sub-basin associated with an unnamed tributary to Big Dry Creek (Figure 2-1). These drainage basins generally traverse the plant from west to east. Rock Creek flows from the west through the northeast section of the plant site, and is not addressed in this document because it is hydrologically unimpacted by Site operations. Walnut Creek and

3. Evaporation from the pond surface; or

4. Enhanced evaporation of pond water.

Since the ponds are constructed with impermeable cores extending to bedrock, the outflow via seepage through or under the ponds is expected to be negligible compared with other sources of outflow. A summary of the types of outflow associated with each of the ponds is presented in Table 2-4. Each of these outflow mechanisms are discussed below.

2.2.3.2 Releases

Releases can be made to downstream waters from the Terminal Ponds A-4, B-5, and C-2. A-4 releases into North Walnut Creek. B-5 can release to South Walnut Creek but is usually transferred to Pond A-4 where it is batch-sampled prior to release. Pond C-2 can be released off-site via a pipeline to the Broomfield Diversion Ditch or directly to Woman Creek. When possible, releases are made to downstream waters only from Ponds A-4 and C-2. Since April 1990, Pond C-2 has only been discharged through the Broomfield Diversion Ditch. Data are available regarding releases made to downstream waters for the period August 1989 through July 1994. A summary of the data regarding the releases is presented in Table 2-8.

2.2.3.3 Transfers

Transfers are made between various ponds for the purpose of water quality and water supply management. Possible transfer routes are described in Table 2-4 and the most frequently used routes are illustrated in Figure 2-3.

2.2.3.4 Evaporation

Each of the ponds loses water through evaporation from the pond surface. The amount of water lost depends on the surface area, which is a function of the amount of water stored in the pond at any given time. As discussed previously, net evaporation using SEO methodology is estimated at 28.2 inches.

[illegible] from numerous pan evaporation studies and guidance concerning evaporative loss estimates for this region of Color[illegible]. Sources of evaporative loss estimates include the National Oceanic and Atmospheric Administration's (NOAA's) Technical Report 33, 1982; EPA SW-874, 1983; Kohler, *Evaporation from Pans and Lakes*, 1955; Fiske, *Evaporation from Seven Reservoirs in the Denver Water-Supply System, Central Colorado*, 1977; Koffer, *Investigation of the Surface and Groundwater Flow Mechanics of an Evaporation Spray Field at the Rock[illegible] Nuclear Weapons Plant, Jefferson County, Colorado*, 1989 and Advanced Sciences, Inc., [illegible] *and Water Quality Study of Walnut Creek and Woman Creek Watersheds, Rocky Flats Plant Sites*, 1990.

Values for net evaporation from these various sources range from 27 to 46 inches per year, placing the SEO evaporative loss estimates on the low side of the reported range of net evaporative losses. Regardless of the value used, evaporative losses are low relative to off-site discharges or transfers for the ponds that manage WWTP effluent and stormwater. Losses are significant for the interior ponds such that water periodically must be added to keep sediments covered.

2.2.3.5 Spray Evaporation and Spray Irrigation

Spray evaporation was used throughout the 1980s and early 1990s as a method of pond water volume reduction for Ponds A-1, A-2, B-1, B-2, and the Landfill Pond. Water was sprayed above the surface of the pond through the use of fog nozzles. The practice was discontinued in 1993.

Beginning in 1979, WWTP effluent was discharged to Pond B-3 and then piped to various "spray field" locations. Spray irrigation was conducted for the purpose of pond water volume reduction, and was discontinued in March 1990 primarily due to concerns related to hazardous waste issues and management practices.

2.2.4 Summary of Overall Hydrologic Balance

A detailed analysis of pond water management requires quantification of pond inflows and outflows. Such a water balance will assist the evaluation of operational management alternatives in Chapter 6. The flow monitoring network at the Site has been upgraded over the past several years such that a reasonably accurate water balance for the drainage ponds can be established on an annual basis.

Using data collected in 1992 and 1993, inflows and outflows for Ponds A-3, A-4, B-3, B-4, B-5, and C-2 were quantified. In instances where several records or data sets were available for a particular input or output parameter, the data thought to be the most reliable and complete was used. These values are summarized in Tables 2-9 and 2-10 and are shown, along with the generalized water routing scheme, on Figure 2-4. The interior ponds (A-1, A-2, B-1, and B-2) were not included in this analysis because they are isolated from the majority of inflows and are not routinely involved in water transfers or discharges.

The accuracy of the data was evaluated by preparing a water balance. Ideally, inflows minus outflows to the system should equal the change in stored volume to satisfy the basic relationship:

$$\text{Inflow} - \text{Outflow} = \text{Change in Stored Volume}$$

$$\text{Inflow} = \text{Outflow} + \text{Change in Stored Volume}$$

some types of pans the ratio of annual lake-to-pan evaporation (*pan coefficient*) is quite consistent, year by year, and does not vary excessively from region to region.

Pan observations There are three types of exposures employed for pan installations—sunken, floating, and surface—and divergent views on the best exposure persist. Burying the pan tends to eliminate objectionable boundary effects, such as radiation on the side walls and heat exchange between the atmosphere and the pan itself, but creates observational problems. Sunken pans collect more trash; they are difficult to install, clean, and repair; leaks are not easily detected; and height of vegetation adjacent to the pan is quite critical. Moreover, appreciable heat exchange does take place between the pan and the soil [31], depending on such factors as soil type, moisture content, and vegetative cover. Heat exchange with the soil can readily change the annual evaporation from a 2-m pan 10 percent and a 5-m pan 7 percent. It is therefore obvious that such heat exchange will produce large climatic variation in the pan coefficient of a small, sunken, uninsulated pan.

Sunken

The evaporation from a pan floating in a lake more nearly approximates evaporation from the lake than that from an on-shore installation but, even so, the boundary effects are appreciable. Observational difficulties are prevalent with floating pans (splashing frequently renders the data unreliable), and installation and operational expense is excessive. Since relatively few such installations are now in existence, floating pans are not considered in the subsequent discussion.

floating

Pans exposed above ground experience greater evaporation than sunken pans, primarily because of the radiant energy intercepted by the side walls, and heat exchange through the pan produces unrealistic effects which must be taken into account. Both deficiencies can be minimized by insulating the pan. The principal advantages of surface exposure are economy and ease of installation, operation, and maintenance.

surface

Of the various sunken pans used, only three have gained prominence in the United States: the Young screened pan, the Colorado pan, and the Bureau of Plant Industry (BPI) pan. The Young pan [32] is 2 ft (61 cm) in diameter and 3 ft (91.5 cm) deep and is covered with ¼-in.-mesh (6-mm) hardware cloth. The screen modifies the pan coefficient to near unity, on an average, but the small size of the pan leads to an unstable coefficient and the overall effect of screening may be adverse. The Colorado pan is 3 ft (91.5 cm) square and 18 in. (46 cm) deep. The BPI pan, 6 ft (183 cm) in diameter by 2 ft (61 cm) deep, provides by far the best index to lake evaporation because of its size.

The standard Weather Bureau Class A pan is the most widely used evaporation pan in the United States; in 1974 records were published for

FIGURE 5-3
Class A evaporation station: 1 = instrument shelter, 2 = evaporation pan, 3 = anemometer, 4 = standard 8-in. precipitation gage, 5 = weighing-type recording precipitation gage. (*U.S. National Weather Service.*)

about 450 stations. It is of unpainted galvanized iron 4 ft (122 cm) in diameter by 10 in. (25.4 cm) deep and is exposed on a wood frame to let air circulate beneath the pan (Fig. 5-3). It is filled to a depth of 8 in. (20 cm), and instructions [33] require that it be refilled when the depth has fallen to 7 in. (18 cm). Water-surface level is measured daily with a hook gage in a stilling well, and evaporation is computed as the difference between observed levels, adjusted for any precipitation measured in a standard rain gage. ←* Alternatively, water is added each day to bring the level up to a fixed point in the stilling well. This method assures proper water level at all times.

Many other types of pans are in use in different parts of the world, and the need for international standardization has long been recognized by the World Meteorological Organization. Pending standardization, many intercomparisons of the various types of pans have been made [34] which show that pan-to-pan ratios display appreciable geographic (climatic) variation. The two most widely used pans are the Class A and the GGI-3000 [35]. The latter pan is circular, 3000 cm^2 in area (61.8 cm or 24.3 in. in diameter). The depth is 60 cm (23.6 in.) at the wall and somewhat greater at the center. It is fabricated of galvanized sheet iron. The pan and a precipitation gage of similar dimensions are both sunk into the ground.

The value of a pan as an index to lake evaporation must depend on energy-exchange considerations rather than aerodynamic similarities. As a

Rocky Flats Precipitation Totals (inches) by Month and Year

										1988-95	1988-95	1988-95	1988-95	1952-76	1952-76	1952-76
	1988	1989	1990	1991	1992	1993	1994	1995	1996	Low	Average	High	Std Dev	Low	Average	High
Jan	0.27	0.53	0.28	0.19	0.30	0.13	0.45	0.39	0.74	0.13	0.36	0.53	0.13	0.06	0.50	1.73
Feb	0.55	0.11	0.17	0.04	0.02	0.54	0.77	0.67	0.12	0.02	0.33	0.77	0.30	0.07	0.65	1.81
Mar	1.10	0.21	2.59	0.41	3.37	1.52	1.05	0.87	1.20	0.21	1.37	3.37	1.08	0.13	1.22	2.60
Apr	1.22	0.51	1.33	1.50	0.53	1.78	2.46	3.94	0.85	0.51	1.57	3.94	1.12	0.10	1.71	4.73
May	2.20	2.20	1.82	3.77	1.53	1.13	1.13	7.65	3.26	1.13	2.74	7.65	2.18	0.08	2.88	9.70
June	0.95	0.02	0.12	2.30	2.19	1.79	0.62	4.05	1.09	0.02	1.46	4.05	1.36	0.22	1.69	4.79
July	1.66	0.55	3.16	2.53	1.30	0.48	0.21	0.54	1.05	0.21	1.28	3.16	1.08	0.30	1.38	5.10
Aug	1.60	2.43	0.24	2.45	2.97	0.42	1.50	0.70	0.92	0.24	1.47	2.97	1.02	0.10	1.19	3.69
Sep	1.36	6.03	2.00	0.84	0.00	1.58	0.68	1.87	3.15	0.00	1.95	6.03	1.84	0.00	1.61	4.53
Oct	0.09	0.11	1.22	0.50	0.59	1.41	0.97	0.49	0.40	0.09	0.64	1.41	0.49	0.03	0.99	4.83
Nov	0.40	0.11	0.57	1.72	1.25	1.27	1.15	0.82		0.11	0.91	1.72	0.53	0.15	0.81	2.00
Dec	0.54	0.32	0.01	0.06	0.43	0.35	0.05	0.12		0.01	0.24	0.54	0.20	0.09	0.53	1.50
Total	11.94	13.13	13.51	16.31	14.48	12.40	11.04	22.11	12.78	11.04	14.35	22.11	3.52	7.78	15.24	24.87

RESOURCE TECHNOLOGIES GROUP, INC.	SUBJECT Calculation Set No. 5		
	Project No. 970280 Client:	Prepared by: RCK Checked: Reviewed:	Sheet 1 of 1 Date: July 10, 1997

Alt. 8 - Dispersion Field Supporting Info.

Purpose: To estimate the annual operating & maintenance costs for a dispersion field accepting water from the interceptor trench

Assume: 1 operator is required 16 hours per week for 52 weeks per year at a rate of $50/hr.

Annual Operating Cost = 16 hrs/week × 52 weeks/yr × $50/hr = $41,600

Assume annual maintenance costs are equal to 5% of capital cost.

Annual Maintenance Cost = $275,000 × .05 = $13,750

Total Annual O+M Cost = $41,600 + $13,750 = $55,350

INFILTRATION SYSTEM
PRELIMINARY DRAFT CONCEPTUAL DESIGN

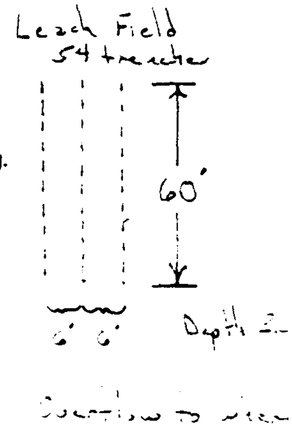
Designed by: John E. Law
Date: 25-Nov-96

Problem : Design a subsurface infiltration system for the Interceptor Trench System discharges from the central sump.

References:

1. Management Plan for the Interceptor Trench System Water (RF/ER-96-0031.UN)
2. Standard Handbook for Civil Engineers, Third Ed.

Assumptions:



1. A system of this type will be more acceptable than direct discharge to N. Walnut Creek.
2. A standard septic system design will be suitable.
3. Pipe will be laid 2.5 feet deep (Ref. 2). I have selected maximum depth to minimize impacts from freezing.
4. A distribution box will be used feed flows to a series of parallel lines which are 6 ft. apart (Ref. 2)
5. The maximum line length is 60 feet (Ref. 2).
6. Maximum pipe slope is 1/16 in/ft (Ref. 2)
7. Pipes will be plastic perforated.
8. Gravel bedding will be placed 12 inches below and 2 inches above the perforated pipe (Ref. 2).
9. An average soil percolation rate of 11-15 inches per minute is assumed.
   Note: This number has no basis and should be verified as part of actual design.
10. The sump or distribution system will be allowed to overflow at times.
11. I have assumed that the recharge location is 2' above the water table and 5' above bedrock.

From Ref. 1, Table 2-5	(gal/yr)	(gal/day)	(gal/min)	(cfs)
Average Annual Flow	3,000,000	8,219	6	0.01
Peak Flow	4,600,385	12,604	9	0.02
Peak Monthly Flow	958,026	30,904	21	0.05

Select Design Flow :

The average monthly flow rate for 1995 (an extremely wet year) are only exceeded during three months, May June and July. None of the average monthly flows in a more typical year 1994, are greater than the average monthly 1995 rate.

Therefore, select the average monthly flow for 1995 as the design flow.

DESIGN FLOW (gal/day) = **12,600**

Calculate Design Trench Lenth & No. of Trenches

For 11-15" Infiltration Rate lenth = 256 ft/1000 gpd

Length Required (ft)= 3,226

Number of Trenches at 60 ft/trench 54

Based on John's design layout, the leach field will require:

53 * 6 ft * 60 ft = 19,000 ft^2 or 0.44 acres

This would likely require a "flat" area for construction.

Calculate Quantities:

Length of Drain Pipe (ft) =	3225.6	
Pipe Size (in.)	4	Standard Size of Plastic Perforated Drain
Pipe Area (ft^2)	0.09	

Gravel Bedding for drains

Width of Trench (ft, Table 22-10) =	3	
Depth (ft) =	1.50	(1ft + pipe dia. + 2 in.)
Area/ft (ft^2)	4.41	(depth *width -area pipe)
Volume (cy)	527	

Compacted Fill over Drains

Depth of Trench (ft) =	3.5	(2.5 ft +1ft)
Depth of Fill (ft) =	2.0	(3.5 ft - 1ft - 4in -2in)
Volume of Compacted Fill (cy)	717	

Excavation for Drains

Depth of Trench (ft) =	3.5 (2.5 ft +1ft)
Length of Drain Pipe (ft) =	3,226
Width of Trench (ft, Table 22-10) =	3
Excavation for Drains (cy) =	1,254

Length of Connecting Pipes

Number of Connecting Pipes =	54
Spacing Between Pipes (ft) =	6
Total Interconnecting Pipes	320
Assume 1000 ft. header	1,000
Assume 100 ft Misc.	100
Total Quantity of Pipe (ft) =	1,420

Select Size of Connecting Pipes

Assume 50% design flow (cfs)	0.01	
Pipe velocity (ft/s)	3	Per good design practice,3-5 cfs limits scour & keep pipes clean
Required Area (ft^2)	0.0033	A = Q/V
Pipe velocity (ft/s)	5	
Required Area (ft^2)	0.0020	
Pipeline Selected (in)	1	
Use LDPE?		

Assume 50% full, open channel flow

Dia. (in.)	Area (ft^2)	Area/2 (ft^2)
1	0.0055	0.0027
1.5	0.0123	0.0061
2	0.0218	0.0109
2.5	0.0341	0.0170
3	0.0491	0.0245

Estimate Excavation for Connecting Pipes

Compacted Fill/Excavation Volume

Depth of Trench (ft) =	2.5	Invert of 4 in drains, Assume no bedding required
Width of Trench (ft) =	1.0	Assume 1 ft wide trenching machine. Could possibly pull pipe w/o trench
Volume of Excavation/Fill (cy)	131	Ignore volume of pipeline

Calculate No. of Connectors

Number of 4" Tee's	54	Number of 60' lines
Number of 4" endcaps	108	2 per tee

Surface Area to be Reseeded

Length of all Pipe (ft) =	4,646	
Width of Damaged Area (ft) =	8	
Laydown Area (ft2)	10000	Assume 100' x 100'
Area to be reseeded (AC) =	**1.0828**	

Summary of Quantities

Length of Drain Pipe (ft) =	3,230
Length of 1' Connecting Pipe (ft) =	1,420
Excavation (cy) =	1,390
Gravel Bedding (cy) =	530
Compacted Fill (CY) =	850
Number of 4" Tee's	54
Number of 4" endcaps	108
Reseeding (AC)	1

Notes:

1. Actual design should probably look at a range of methods for dealing with ITS waters in addition to the option considered here.
2. The assumption that runs can be no longer than 60 feet should be ivestigated - longer runs will be cheaper to install.
3 The actual topography of the recharge area has not been considered. I have assumed that the recharge location is above the water table.

ITEM DESCRIPTION	LOCATION	TAKEOFF QTY	Wt	CONVERSION	ORDER QTY	UNIT PRICE	AMOUNT
ED&I Requirements							
Engineering							
001100 Engineering (Integrator)							
---- Ttl I -- Altrnt Anly	Site	1.00 ls	Lab	240.00000 mh/ls	240.00 mh	40.18	9,643
Crew: E05R							
Alternate Analysis							
4.33wks/mo x 1mo = 4wks x 40hrs = 160hrs x 1.5men = 240hrs							
---- Title II	Site	1.00 ls	Lab	560.00000 mh/ls	560.00 mh	40.18	22,501
Crew: E05R							
4.33wks/mo x 1.5mo = 7wks x 40hrs = 280hrs x 2men = 560hrs							
---- Title III	Site	1.00 ls	Lab	90.00000 mh/ls	90.00 mh	40.18	3,616
Crew: E05R							
4.33wks/mo x 2mo = 9wks x 10hrs = 90hrs x 1man = 90hrs							
---- Engineering Supervsn	Site	1.00 ls	Lab	36.00000 mh/ls	36.00 mh	40.18	1,446
Crew: E05R							
4.33wks/mo x 2mo = 9wks x 4hr/wk = 36hrs							
---- Engineering Secretry	Site	1.00 ls	Lab	36.00000 mh/ls	36.00 mh	27.63	995
Crew: G04R							
4.33wks/mo x 2mo = 9wks x 4hr/wk = 36hrs							
				Engineering (Integra	962.00 Labor hrs		38,201
001200 Construction Inspection							
---- Construction Inspctn	Site	1.00 ls	Lab	90.00000 mh/ls	90.00 mh	34.59	3,113
Crew: P05R							
4.33wks/mo x 2mo = 9wks x 10hrs = 90hrs							
					Engineering 1,052.00 Labor hrs		41,314
Project Management							
001300 Project Management							
---- Project Manager	Site	1.00 ls	Lab	180.00000 mh/ls	180.00 mh	48.72	8,770
Crew: M03R							
Pre Construction Activities: 4.33wks/mo x 2mo = 9wks x 10hrs = 90hrs. During Construction: 4.33wks/mo x 2mo = 9wks x 10hr/wk = 90hrs.							
---- Cost Estimating	Site	1.00 ls	Lab	78.00000 mh/ls	78.00 mh	34.59	2,698
Crew: P05R							
Estimate: 1.5wks x 40hrs = 60hrs							
Change Orders: 9hrs/mo x 2mo = 18hrs							
---- Scheduling	Site	1.00 ls	Lab	58.00000 mh/ls	58.00 mh	36.15	2,097
Crew: P07R							
Schedule: 1.0wks x 40hrs = 40hrs.							
Weekly Updates: 4.33wks/mo x 2mo = 9wks x 2hrs/wk = 18hrs.							
---- Prjct Mangmnt Suprvs	Site	1.00 ls	Lab	72.00000 mh/ls	72.00 mh	48.72	3,508
Crew: M03R							

ITEM DESCRIPTION	LOCATION	TAKEOFF QTY	W%	CONVERSION	ORDER QTY	UNIT PRICE	AMOUNT
·.33wks/mo x 4mo = 18wks x 4hr/wk = 72hrs							
---- Prjct Mangmnt Scrtry	Site	1.00 ls	Lab	72.00000 mh/ls	72.00 mh	27.63	1,989
Crew: G04R							
4.33wks/mo x 4mo = 18wks x 4hr/wk = 72hrs							
				Project Management			19,062
					460.00 Labor hrs		
					Project Management		19,062
					460.00 Labor hrs		
Typ-Const Mgnt							
001400 Construction Management							
---- Const. Supertindent	Site	1.00 ls	Lab	130.00000 mh/ls	130.00 mh	48.72	6,334
Crew: M03R							
Pre Construction Activities: Allow 45hrs							
Construction: 4.33wks/mo x 2mo = 9wks x 5hrs = 45hrs.							
---- Field Engineer	Site	1.00 ls	Lab	270.00000 mh/ls	270.00 mh	48.72	13,154
Crew: M03R							
4.33wks/mo x 2mo = 9wks x 30hrs/wk = 270hrs							
---- Const. Mgnt Supervsn	Site	1.00 ls	Lab	36.00000 mh/ls	36.00 mh	48.72	1,754
Crew: M03R							
4.33wks/mo x 2mo = 9wks x 4hrs/wk = 36hrs							
---- Const. Mgnt Secretry	Site	1.00 ls	Lab	36.00000 mh/ls	36.00 mh	27.63	995
Crew: G04R							
.33wks/mo x 2mo = 9wks x 4hrs = 36hrs							
				Construction Managem			22,237
					472.00 Labor hrs		
					Typ-Const Mgnt		22,237
					472.00 Labor hrs		
Non-Typ Const Mgnt							
001400 Construction Management							
---- Planner	Site	1.00 ls	Lab	80.00000 mh/ls	80.00 mh	36.15	2,892
Crew: P07R							
2wks x 40hrs = 80hrs							
---- Radiation Monitoring	Site	1.00 ls	Lab	40.00000 mh/ls	40.00 mh	37.60	1,504
Crew: R05R							
Allow: 40hrs							
---- H&S Support	Site	1.00 ls	Lab	130.00000 mh/ls	130.00 mh	32.98	4,287
Crew: T06R							
Health & Safety Report = 40hrs							
4.33wks/mo x 2mo = 9wks x 10hrs/wk = 90hrs							
---- Industrial Hygiene	Site	1.00 ls	Lab	80.00000 mh/ls	80.00 mh	39.09	3,127
Crew: P09R							
4wks x 20hrs = 80hrs							
---- QA/QC Support	Site	1.00 ls	Lab	40.00000 mh/ls	40.00 mh	41.29	1,652
Crew: E11R							
wks x 40hrs = 40hrs							
---- Waste Inspector	Site	1.00 ls	Lab	40.00000 mh/ls	40.00 mh	37.60	1,504
Crew: R05R							

ITEM DESCRIPTION	LOCATION	TAKEOFF QTY		W%	CONVERSION	ORDER QTY		UNIT PRICE	AMOUNT
wks x 40hrs = 40hrs									
---- Trainers	Site	1.00 ls	Lab		40.00000 mh/ls	40.00	mh	35.16	1,406
Crew: P1SR									
Train General Contractor's People									
Allow: 40hrs									
---- Rad Engineering	Site	1.00 ls	Lab		20.00000 mh/ls	20.00	mh	37.60	752
Crew: R0SR									
Allow: 20hrs									
---- Soil Sampling	Site	1.00 ls	Lab		160.00000 mh/ls	160.00	mh	34.59	5,534
Crew: P0SR			Mat	0		1.00	ls	10,000.00	10,000
Labor: 2wks x 40hrs = 80hrs x 2men = 160hrs									
Material: Allow $10,000									
---- Groundwater Sampling	Site	1.00 ls	Lab		160.00000 mh/ls	160.00	mh	34.59	5,534
Crew: P0SR			Mat	0		1.00	ls	2,000.00	2,000
Labor: 2wks x 40hrs = 80hrs x 2men = 160hrs									
Material: Allow $2,000									

Construction Managem 40,193
790.00 Labor hrs

Non-Typ Const Mgnt 40,193
790.00 Labor hrs

ED&I Requirements 122,806
2,774.00 Labor hrs

General Requirement

Fix Price Contractor

010001 General Requirements

ITEM DESCRIPTION	LOCATION	TAKEOFF QTY		W%	CONVERSION	ORDER QTY		UNIT PRICE	AMOUNT
---- Project Manager	Site	2.00 mo	Lab		65.00000 mh/mo	130.00	mh	32.12	4,176
Crew: ADMN									
15 hr x 4.33 wk/mo = 65 hrs/mo									
---- Superintendent	Site	2.00 mo	Lab		173.00000 mh/mo	346.00	mh	32.12	11,114
Crew: ADMN									
40 hr/wk x 4.33 hrs/mo = 173 hrs/mo									
---- Surveying	Site	1.00 ls	Lab		180.00000 mh/ls	180.00	mh	32.12	5,782
Crew: ADMN			Mat	0		1.00	ls	150.00	150
Labor: 3men x 40hrs = 120hrs x 1.5 wks = 180hrs									
Material: $100/wk									
---- Hlth, Safty & Cmplnc	Site	2.00 mo	Lab		173.00000 mh/mo	346.00	mh	32.12	11,114
Crew: ADMN			Mat	0		2.00	mo	50.00	100
Labor: 40hrs x 4.33wks/mo = 173hrs/mo									
Material: $100/wk x 4.33wks/mo = $433/mo									
---- Training	Site	1.00 ls	Lab		128.00000 mh/ls	128.00	mh	26.087	3,339
Crew: EQHV CLAB PLUM									
16hrs per person x 8 people = 128hrs									
-- As Built Drawings	Site	1.00 ls	Lab		36.00000 mh/ls	36.00	mh	32.12	1,156
Crew: ADMN									
---- Grndwtr Montrng/Hndl	Site	1.00 ls	Lab		90.00000 mh/ls	90.00	mh	17.57	1,581
Crew: CLAB			Mat	0		1.00	ls	400.00	400

ITEM DESCRIPTION	LOCATION	TAKEOFF QTY	W%	CONVERSION	ORDER QTY	UNIT PRICE	AMOUNT
abor: 2mo x 4.33wks/mo = 9wks x 10hrs = 90hrs							
Maetial: $100/wk x 4wks = $400							
---- Decontaminatn Eqpmnt	Site	1.00 ls	Lab	24.00000 mh/ls	24.00 mh	22.075	530
Crew: CLAB EQHV			Mat 0		1.00 ls	50.00	50
Labor: 2each items x 4hrs each = 8hrs x 3men = 24hrs							
Material: 2each items x $25each = $50							
---- Mobilization/Dmblztn	Site	1.00 ls	Lab	32.00000 mh/ls	32.00 mh	27.89	892
Crew: TRHV			Eq		1.00 ls	1,600.00	1,600
Labor: 2ea items of equip x 16hrs = 32hrs							
Equipment: 32hrs x $50/hr = $1,600							
(Backhoe & Seeding Equip)							
---- Healty & Safety Plan	Site	1.00 ls	Lab	120.00000 mh/ls	120.00 mh	32.12	3,854
Crew: ADMN							
3wks x 40hrs = 120hrs							
				General Requirements			45,838
					1,432.00 Labor hrs		
014108 Testing							
---- Contractor's QA/QC	Site	1.00 ls	Lab	40.00000 mh/ls	40.00 mh	32.12	1,285
Crew: ADMN			Mat 0		1.00 ls	250.00	250
Includes: Soil, and Other Materials							
Labor: Allow 40hrs							
Material: Allow $250							
				Testing			1,535
					40.00 Labor hrs		
015904 Office							
-- Pre-Evolution Meetng	Site	1.00 ls	Lab	27.00000 mh/ls	27.00 mh	26.58	718
Crew: EQHV							
4.33wks x 2mo = 9wks x 0.5hrs/wk = 4.5hrs x 6men = 27hrs							

Fix Price Contractor 48,090
1,499.00 Labor hrs

General Requirement 48,090
1,499.00 Labor hrs

Interceptor Trench

Drain Pipe

ITEM DESCRIPTION	LOCATION	TAKEOFF QTY	W%	CONVERSION	ORDER QTY	UNIT PRICE	AMOUNT
027168 Ppng,drng&sewg,plyv chlrd							
2000 Piping, 10' lengths, s.d.r 35, 4" diameter							
2000 P, 10' l, s.. 35, 4"	Site	3,230.00 lf	Lab	.06400 mh/lf	206.72 mh	27.847	5,757
Crew: B20			Mat 0		3,230.00 lf	1.109	3,582
Perforated							
				Ppng,drng&sewg,plyv			9,339
					206.72 Labor hrs		
1551 Pipe, plastic							
5940 Pipe, plastic, CPVC, cplgs 10' o.c., hgrs 3 per 10', sched 80, 4" dia							
5940 P, p, CPVC, c 10' o.	Site	120.00 lf	Lab	.34783 mh/lf	41.74 mh	27.195	1,135

ITEM DESCRIPTION	LOCATION	TAKEOFF QTY		W%	CONVERSION	ORDER QTY		UNIT PRICE	AMOUNT
Crew: Q1			Mat	0		120.00	lf	16.484	1,978
Allow 12" stub on each end of tee fitting									
						Pipe, plastic			3,113
							41.74	Labor hrs	
151558 Pipe, plastic, fittings									
2480 Pipe, plastic ftngs, PVC, high impact/pressure, schedule 80, tee, 4"									
2480 P, p f, PVC, h i/, s	Site	54.00 ea	Lab		2.00000 mh/ea	108.00	mh	27.195	2,937
Crew: Q1			Mat	0		54.00	ea	17.532	947
3460 Pipe, plastic ftngs, PVC (white), schedule 40, socket jts, cplg, 4"									
3460 P, p f, PVC (), s 40	Site	323.00 ea	Lab		1.00000 mh/ea	323.00	mh	27.195	8,784
Crew: Q1			Mat	0		323.00	ea	4.745	1,533
3680 Pipe, plastic fittings, cap sch 40 PVC socket, 4"									
3680 P, p f, 40 PVC s, 4"	Site	108.00 ea	Lab		.53333 mh/ea	57.60	mh	27.195	1,566
Crew: Q1			Mat	0		108.00	ea	5.894	637
8320 Pipe, plstc, insr type, nyl, 160 & 250 psi, CW, clamp ring SS, 1" IPS									
8320 P, p, i t, n, 160 &	Site	108.00 ea	Lab		.07477 mh/ea	8.075	mh	34.11	275
Crew: PLUM			Mat	0		108.00	ea	.669	72
8380 Pipe, plstc ftngs, insr type, nyl, 160 & 250 psi, CW, cplg, 1" IPS									
8380 P, p f, i t, n, 160	Site	15.00 ea	Lab		.42105 mh/ea	6.316	mh	34.11	215
Crew: PLUM			Mat	0		15.00	ea	.529	8
8500 Pipe, plstc, insr type, nyl, 160&250 psi, CW, M adptr, 1" ipsx1" MPT									
8500 P, p, i t, n, 160&25	Site	108.00 ea	Lab		.38095 mh/ea	41.143	mh	34.11	1,403
Crew: PLUM			Mat	0		108.00	ea	.529	57
---- 1" Polyethylene Pipe	Site	1,420.00 lf	Lab		.02000 mh/lf	28.40	mh	34.11	969
Crew: PLUM			Mat	0		1,420.00	lf	.20	284
Labor: Allow 2hrs per 100lf of pipe									
Material: MMC Page 1579 (4884K13)									
---- Drill & Tap 1" NPT	Site	108.00 ea	Lab		1.00000 mh/ea	108.00	mh	34.11	3,684
Crew: PLUM			Mat	0		108.00	ea	.50	54
Labor: 2men x .5hr = 1.0hr									
Material: Drill Bit & Tap									
						Pipe, plastic, fitti			23,426
							680.533	Labor hrs	
						Drain Pipe			35,877
							928.993	Labor hrs	

Earthwork

ITEM DESCRIPTION	LOCATION	TAKEOFF QTY		W%	CONVERSION	ORDER QTY		UNIT PRICE	AMOUNT
022222 Compaction									
0600 Compaction, vibratory plate, 8" lifts, common fill									
0600 C, vb p, 8" l, cm fl	Site	860.00 cy	Lab		.04000 mh/cy	34.40	mh	17.57	604
Crew: A1			Eq		.04000 mh/cy	34.40	mh	7.30	251
---- Water Truck @ Cmpctn	Site	860.00 cy	Lab		.00600 mh/cy	5.16	mh	27.89	144
Crew: TRHV			Eq			860.00	cy	.25	215
Richardson 2-5, Page 4									
4,000 Water Truck @ $47.00/hr/188cy per hr = $.25									
Labor @ 1hr/188cy per hr = .006mh									
						Compaction			1,214
							39.56	Labor hrs	
							34.40	Equip hrs	
022254 Excavating, trench									
0050 Excav, trench/cont ftg, NO sht/dewtrg, 1'-4'd, 3/8cy tractor lder/backhoe									

ITEM DESCRIPTION	LOCATION	TAKEOFF QTY	W%	CONVERSION	ORDER QTY	UNIT PRICE	AMOUNT
50 E,/ f,NO s/,1'-4',3/	Site	1,390.00 cy	Lab	.10667 mh/cy	148.271 mh	21.975	3,258
Crew: B11C			Eq	.05333 mh/cy	74.129 mh	24.95	1,850
				Excavating, trench			5,108
						148.271 Labor hrs	
						74.129 Equip hrs	
022262 Fill							
0010 Fill spread dumped material, by dozer, NO compaction							
0010 Fl sp dm m, d, NO cm	Site	1,390.00 cy	Lab	01200 mh/cy	16.68 mh	23.443	391
Crew: B10B			Eq	00800 mh/cy	11.12 mh	102.45	1,139
					Fill		1,530
						16.68 Labor hrs	
						11.12 Equip hrs	
026012 Bedding							
0050 Bedding, crushed or screened bank run gravel							
0050 Be, crs scr bn rn gr	Site	530.00 cy	Lab	.16000 mh/cy	84.80 mh	20.35	1,726
Crew: B6			Mat 0		530.00 cy	16.19	8,581
			Eq	.05333 mh/cy	28.265 mh	24.95	705
					Bedding		11,012
						84.80 Labor hrs	
						28.265 Equip hrs	
					Earthwork		18,864
						289.311 Labor hrs	
						147.914 Equip hrs	

Landscaping

ITEM DESCRIPTION	LOCATION	TAKEOFF QTY	W%	CONVERSION	ORDER QTY	UNIT PRICE	AMOUNT
029304 Seeding							
0310 Seeding, incl. fine grade, seed, fertilizer, lime, with equipment							
0310 Sdng,. g,.,., wth eqp	Site	4,840.00 sy	Lab	.04800 mh/sy	232.32 mh	22.148	5,145
Crew: B14			Mat 0		4,840.00 sy	.194	939
4,840 sq yd/acre x 1 acres = 4,840sy			Eq	.00800 mh/sy	38.72 mh	24.95	966
					Seeding		7,050
						232.32 Labor hrs	
						38.72 Equip hrs	
					Landscaping		7,050
						232.32 Labor hrs	
						38.72 Equip hrs	
					Interceptor Trench		61,792
						1,450.624 Labor hrs	
						186.634 Equip hrs	

ESTIMATE TOTALS

	194,341	Labor	5,723.624 hrs		
	31,621	Material			
	6,726	Equipment	186.634 hrs		

232,688					
	-232,688	Negative Spreadsheet Balance		T	-100.00000%

	-232,688				

	102,832	Fixed Price Base Construction		C	100.00000%
	8,353	Fixed Price Misc. Labor & Matl		C	10.00000%
	7,050	Fixed Price Subcontracted Cost		C	100.00000%
	705	Fixed Price Subcontract Markup		C	10.00000%
	30,092	Fixed Price OH&P		T	25.30000%

	149,032				

149,032					
	122,806	IMC Labor (ED&I Requirements)		C	100.00000%

	122,806				

271,838					
	3,162	Contingency		T	1.16320%

275,000	TOTAL ESTIMATE				

RESOURCE TECHNOLOGIES GROUP, INC.	SUBJECT Calculation Set #6		
	Project No. Client	Prepared by: J. Page Checked: Reviewed:	Sheet of Date:

Alt. 11 - Enhanced Evaporation

MATERIAL/LABOR EST.

WIND DEFLECTORS & MISC. STEEL	$52,400.00
PIPING, NOZZEL & PUMPS	$61,000.00
ELECTRICAL & PLATFORM Lighting	$43,760.00
CONCRETE WORK	$25,000.00
TRUSS WORK (SEE WORK SHT)	$97,897.5[illegible]
STAIRS & PLATFORMS (SEE WORK SHT)	$73,448.7[illegible]
TOTAL	$353,506.25

Engineering (15%)	$53,026
Constr. Mngmt (20%)	$70,701
	$477,233

per MST

recycled paper

RESOURCE TECHNOLOGIES GROUP, INC.

SUBJECT		
Project No.	Prepared by:	Sheet of
Client:	Checked:	Date:
	Reviewed:	

MATERIAL / LABOR EST.

PLATFORMS & STAIRS

STEEL WORK CONT.

ITEM No. 2 PLATFORMS

a. CHANNEL & ∠

C8 x 18.75	16,875 lbs @ \$2.25/lb		\$37,968.75
∠ 3"x3"x 3/8"	6,480 lbs @ \$2.25/lb		\$14,580.00
		SubTotal	\$52,548.75

b. GRATING (FIBERGLASS w/ S.S. clips) \$9,500.00

ITEM No. 3 STAIRS. \$11,400

STAIR & PLATFORM TOTAL \$73,448.75

RESOURCE TECHNOLOGIES GROUP, INC.	SUBJECT		
	Project No.	Prepared by:	Sheet of
	Client	Checked:	Date:
		Reviewed:	

MATERIAL / LABOR EST.

STEEL WORK

ITEM No. 1 TRUSSES

a. 95'-0" Lg ± (1 REQ'D)

W6x25	4750 lbs	@ $2.25/lb	$10,687.50
W8x24	960 lbs	@ $2.25/lb	$2,160.00
4" Sq Tube	4560 lbs	@ $2.25/lb	$10,260.00
		SUB-TOTAL	$23,107.50

b. 85'-0" Lg ± (2 REQ'D)

W6X25	4250 lbs	@ $2.25/lb	$9562.50
W8X24	960 lbs	@ $2.25/lb	$2160.00
4" Sq Tube	4080 lbs	@ $2.25/lb	$9180.00
		(Sub Total Each)	$20,902.50
		X	2
		Sub Total	$41,805.00

c. 65'-0" Lg ± (2 REQ'D)

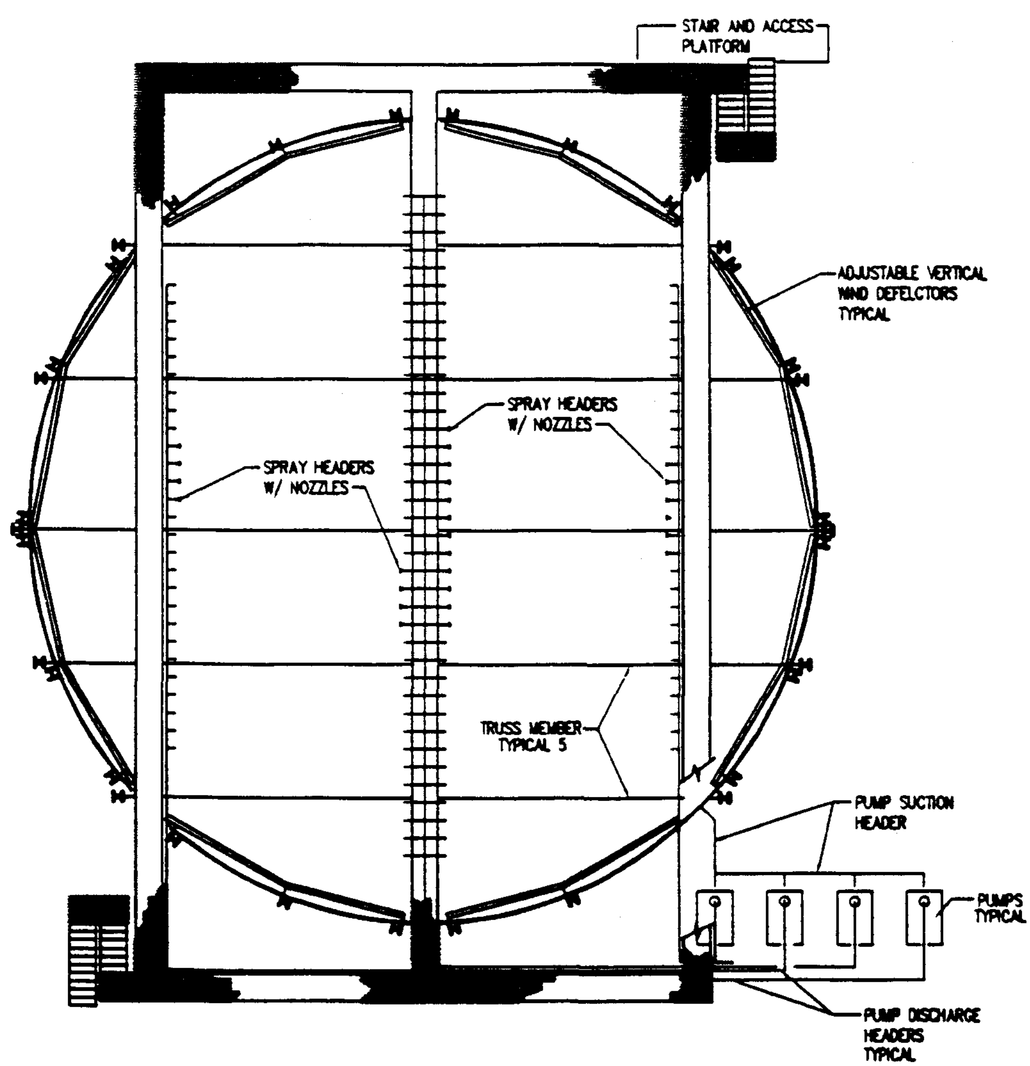
W6X25	3250 lbs	@ $2.25/lb	$7,312.50
W8X24	960 lbs	@ $2.25/lb	$2,160.00
4" Sq Tube	3120 lbs	@ $2.25/lb	$7,020.00
		(Sub Total Each)	$16,492.50
		X	2
		Sub Total	32,985.00

TOTAL TRUSS WORK $97,897.50 ±

recycled paper

Alt. 11

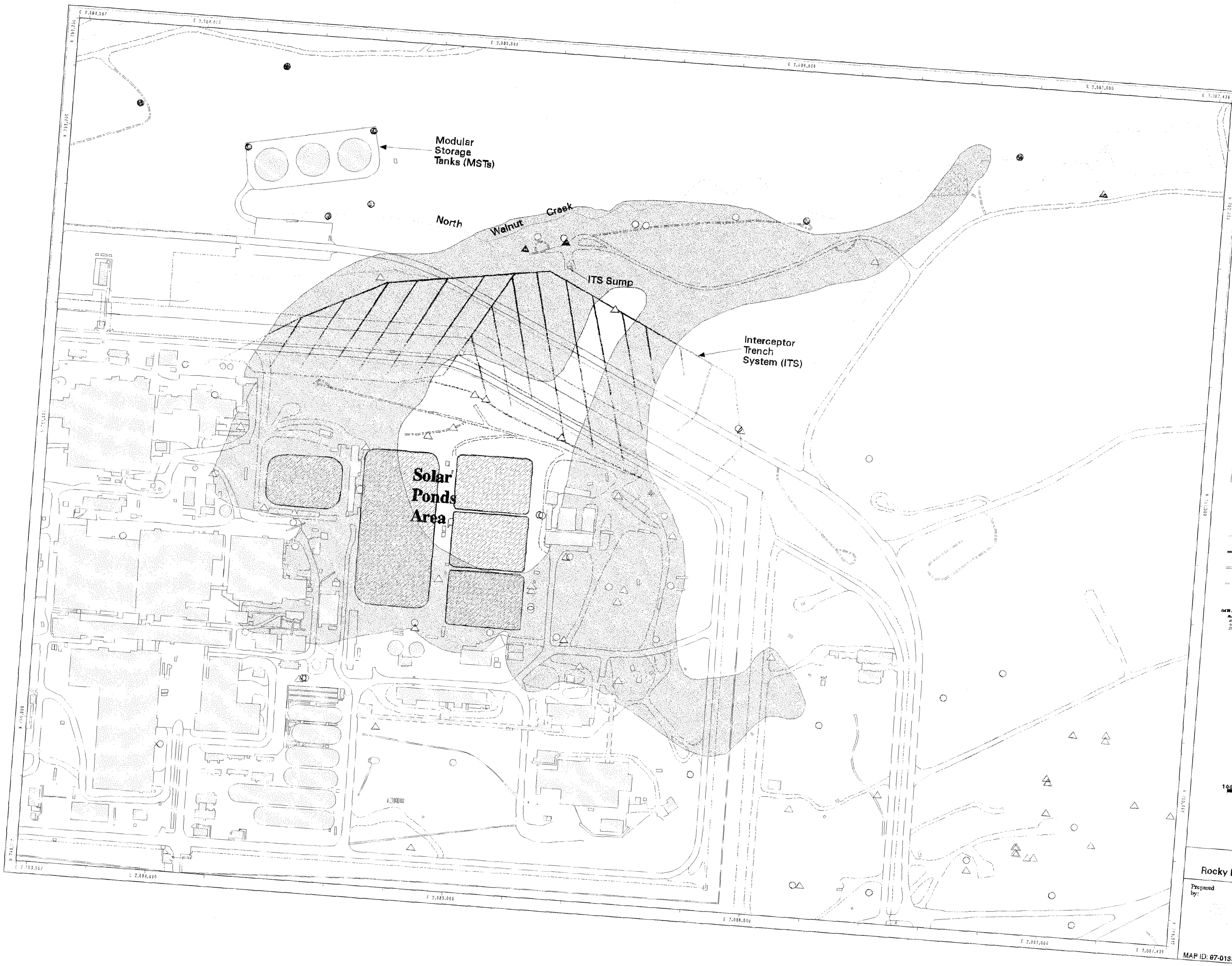
MST Enhanced Evap. Arrangement



NOTICE

All drawings located at the end of the document.

Figure 1
Selected Nitrate Plumes
(Nitrate Standard and 100 x Standard)



EXPLANATION

- 100 x Nitrate Standard (1000 mg/l)
- Nitrate Standard (10 mg/l)

Nitrate Concentration (mg/l) (1991-95)

- 0 - 4.66
- 4.66 - 10
- 10 - 100
- 100 - 1000
- > 1000
- Alluvium Wells
- Bedrock Wells

Standard Map Features

- Buildings or other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

Scale = 1 : 3760
1 inch represents approximately 313 feet

100 0 200 400 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

Rocky Mountain Remediation Services, L.L.C.
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

MAP ID: 97-0133

September 29, 1997

/gis2/projects/fy97/97-0133/int_trench.aml

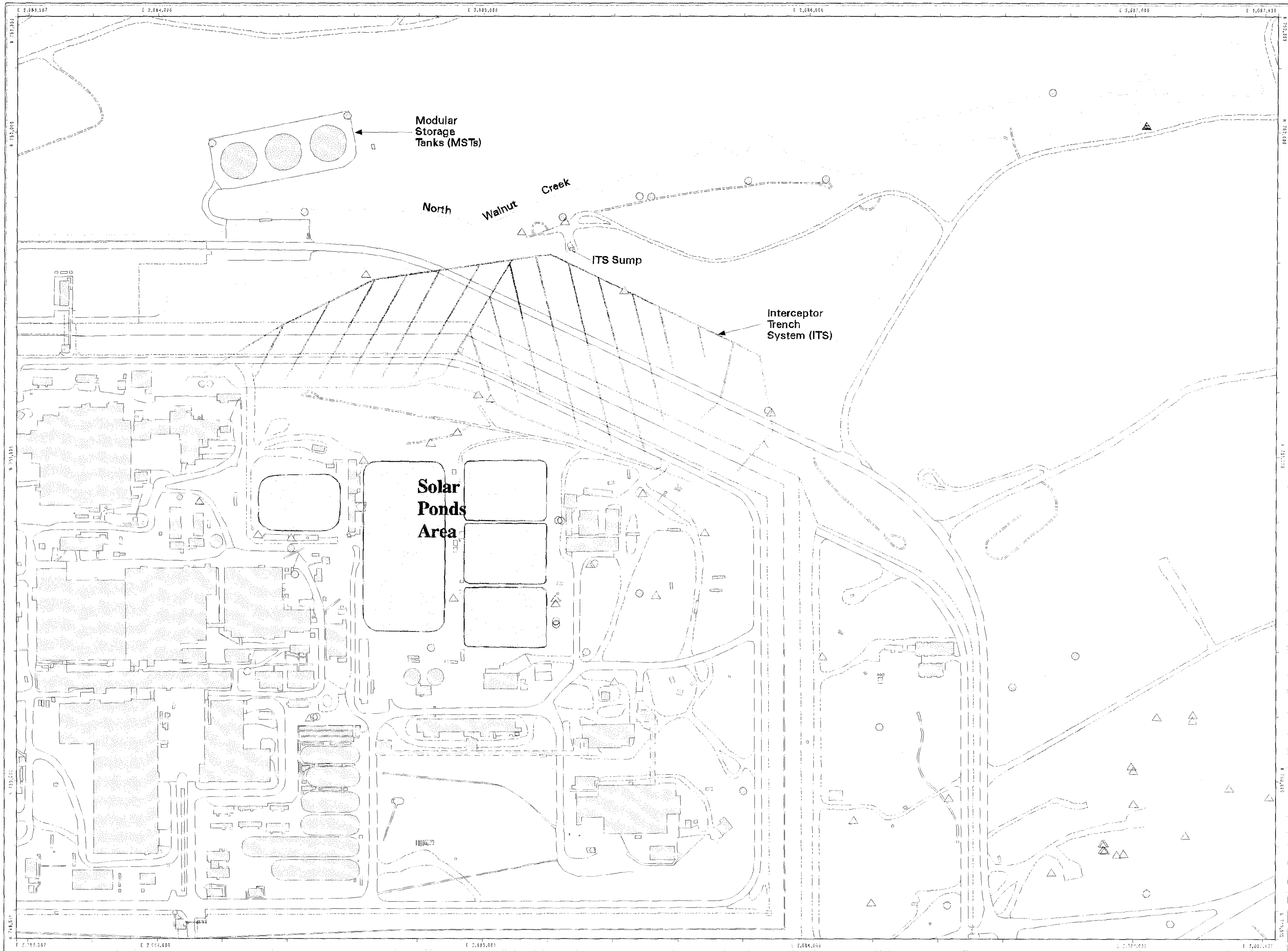


Figure 2
Filtered Uranium 233/234
in Groundwater
1991-1995

Uranium 233/234 Activity-Concentration (pCi/l)
0 - 1
1 - 5
5 - 40
40 - 60.7
60.7 - 100
> 100

Alluvium Wells
Bedrock Wells
Background Benchmark = 60.7 pCi/L
Action Level = 1.07 pCi/L

Standard Map Features
Buildings or other structures
Solar evaporation ponds
Lakes and ponds
Streams, ditches, or other drainage features
Fences
Rocky Flats boundary
Paved roads
Dirt roads

Scale = 1 : 3760
1 inch represents approximately 313 feet

100 0 200 400 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:
Rocky Mountain Remediation Services, L.L.C.
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

MAP ID: 97-0133
September 30, 1997

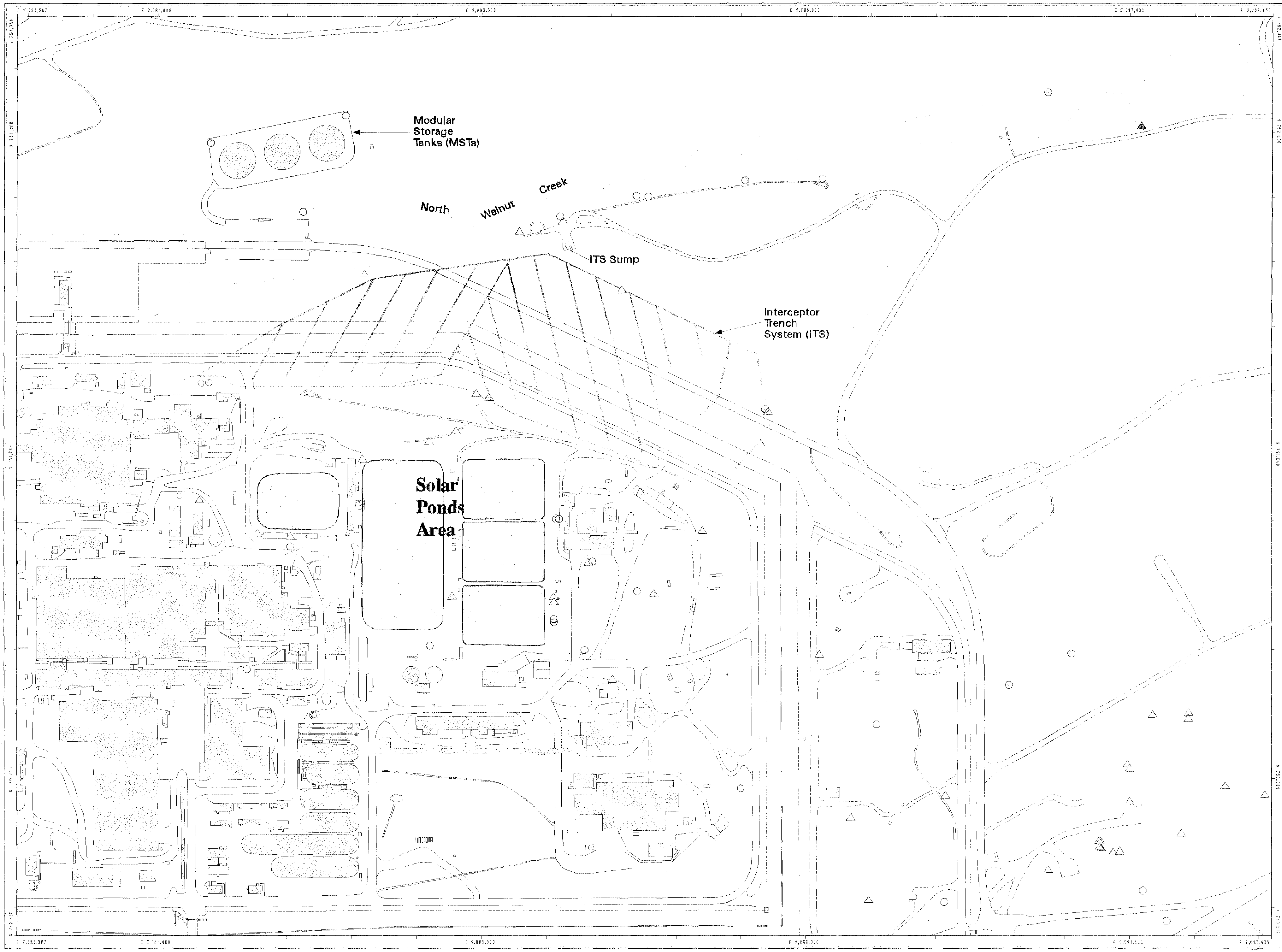


Figure 3
Filtered Uranium 235 in Groundwater 1991-1995

Uranium 235 Activity-Concentration (pCi/l)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1.0
- 1.0 - 1.79
- 1.79 - 5
- > 5

- Alluvium Wells
- Bedrock Wells

Background Benchmark = 1.79 pCi/L
Action Level = 1.01

Standard Map Features

- Buildings or other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

Scale = 1 : 3760
1 inch represents approximately 313 feet

100 0 200 400 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

Rocky Mountain Remediation Services, L.L.C.
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P.O. Box 464
Golden, CO 80402-0464

MAP ID: 97-0133 September 30, 1997

/gis2/projects/fy97/97-0133/int_trench.aml

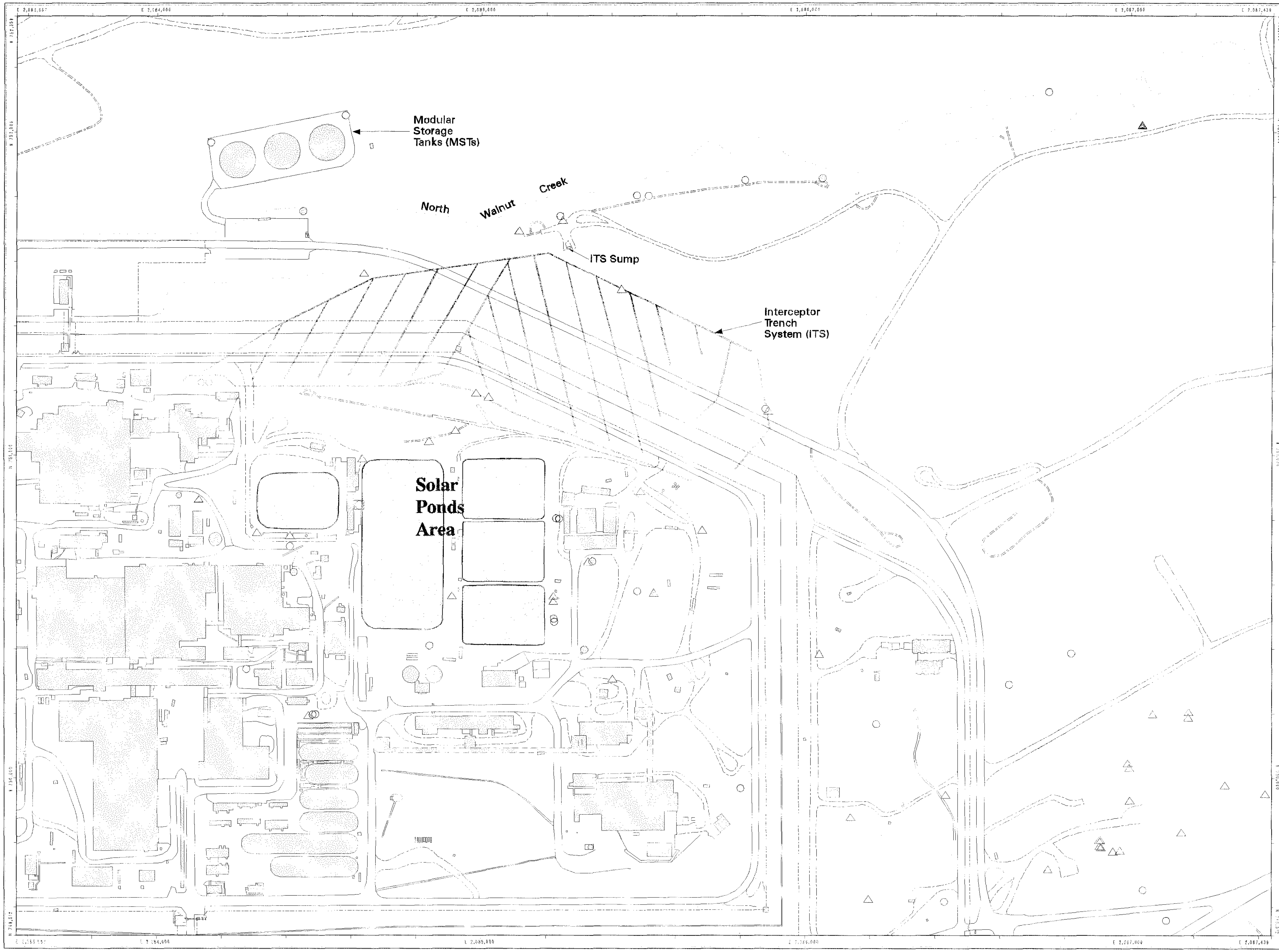

Figure 4
Filtered Uranium 238 in Groundwater 1991-1995

Uranium 238 Activity-Concentration (pCi/l)

- 0 - 0.77
- 0.77 - 5
- 5 - 10
- 10 - 41.8
- 41.8 - 100
- > 100
- Alluvium Wells
- Bedrock Wells

Background Benchmark = 41.8 pCi/L
Action Level = 0.767 pCi/

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