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100-HR-3 Operable Unit Focused Feasibility Study

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EXECUTIVE SUMMARY

~~This focused feasibility study (FFS) report presents the detailed analysis of alternatives for interim remedial measures (IRM) for the 100 HR-3 Operable Unit. The 100 HR-3 Operable Unit is one of seven operable associated with the 100-D/DR and 100-H Areas of the Hanford Site. Three of the 100-D/DR operable units (100-DR-1, DR-2, and DR-3), two of the 100-H operable units (100-HR-1 and HR-2), and the 100-IU-4 Operable Unit are source units. The 100-HR-3 Groundwater Operable Unit includes the groundwater beneath the source operable units and the adjacent groundwater, surface water, fluvial sediments, and aquatic biota impacted by the overlying source operable unit. The 100-HR-3 Operable Unit also includes that portion of the 600 Area that lies between the 100-D/DR and 100-H Reactors.~~

~~This focused feasibility study (FFS) report presents a detailed analysis of alternatives for an interim remedial measure (IRM) in the 100-HR-3 Operable Unit. The operable unit includes the groundwater beneath waste site source operable units in the 100-D/DR Area (100-DR-1 and 100-DR-2) and in the 100-H Area (100-HR-1 and 100-HR-2), and beneath a source operable unit located between 100-D/DR and 100-H Areas (100-IU-4). The 100-HR-3 Operable Unit also includes the adjacent groundwater, surface water, fluvial sediments, and aquatic biota that may have been impacted by the overlying source operable units.~~

~~The key assumptions that form the basis for the FFS are as follows:~~

- ~~The IRM addresses an identified threat to human health or the environment.~~
- ~~The IRM protects ecological receptors in the Columbia River, and to abate offsite migration of contaminants.~~
- ~~To meet the objective stated above, remediation alternatives are targeted at plume containment and control, and removal of contaminants from the aquifer.~~
- ~~Cost estimates used for alternatives comparison are based on a finite lifecycle 5-year operation period during the IRM, of 12 years. An additional estimate for a 5-year operation of a pump and treat system using ion exchange technology is presented also, to be consistent with CERCLA National Contingency Plan methods.~~
- ~~The *100 Area Feasibility Study Phases 1 & 2* (DOE/RL 1994a) forms the basis for the alternatives evaluated in the FFS. Additional alternatives or deviations from the alternatives are only considered when the defined alternative does not meet the operable unit specifics. The *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) does, however, allow the flexibility of specifying different process options at any point in the remedial investigation/feasibility study process if warranted by site circumstances.~~
- ~~Disposal to the Environmental Restoration Disposal Facility is assumed for all solid wastes generated. This includes the assumption that sufficient space is available and that the facility will be operating on a schedule consistent with the IRM.~~

~~Based on the qualitative risk assessment performed for the operable unit, analyses based on the occasional use scenario resulted in the identification of tritium in the 100-D/DR Area, technetium-99 in the 100-H Area, and arsenic in the 600 Area as human health contaminants of potential concern (COPC); however, it should be noted that all these COPC had incremental cancer risks in the low or very low range (<1E-4). Therefore, none of these COPC represent an unacceptable human health risk under this exposure scenario. Based on a frequent use scenario, the qualitative risk assessment indicated that several additional radionuclides and inorganic constituents would be considered as contaminants of potential concern for human health risk. Contaminants associated with human health risks will be addressed in other IRMs or final remediation activities.~~

~~A qualitative risk assessment (QRA) was performed as part of the limited field investigation (LFI). Ecological scenarios were evaluated using biological receptors that live in or near the Columbia River. The ecological risk assessment identified potential risks from bis(2-ethylhexyl) phthalate, chromium, and sulfide in the 100-D/DR Area based on exceedances of Ambient Water Quality Criteria. In the 100-H Area, chromium, iron, and sulfide were identified. These exceedances were based on the maximum concentrations detected in the near river wells. Following an additional analysis of LFI data, chromium is identified as the contaminant of concern (COC) for the ecological receptors in the operable unit. In the context of the FFS, COC are those constituents that must be addressed by remedial actions.~~

~~The QRA also analyzed human health risk scenarios. Contaminants associated with human health risks are not part of the current IRM. They will be addressed in other IRMs or the final remedy feasibility study, as appropriate.~~

~~The FFS process evaluates remedial action objectives (RAO). The RAO are medium specific or operable unit specific objectives that protect human health and the environment. The RAO are based on the land use, COC, applicable or relevant and appropriate requirements (ARAR), and exposure pathways and include specific remediation goals so that an appropriate range of remedial options can be developed for analysis.~~

~~The RAO for environmental protection are as follows:~~

- ~~Control groundwater movement to minimize the release of contaminants of concern into surface waters that would result in concentrations in the Columbia River in excess of the EPA Ambient Water Quality Criteria~~

- ~~Control groundwater movement to preclude the release of radionuclides in the Columbia River that would result in a dose to an ecological receptor that would exceed 1 rad/day~~

- ~~Prevent erosion of soil during remediation that would contribute to surface water concentrations exceeding Ambient Water Quality Criteria~~

- ~~Prevent destruction of sensitive wildlife habitat, minimize the destruction or disruption of wildlife habitat in general, and prevent adverse impacts to threatened or endangered species.~~

~~The preliminary remediation goal (PRG) at the location of exposure (e.g., riverbed sediments used or potentially available for salmon spawning habitat) is 11 ug/L hexavalent chromium (EPA Ambient Water Quality Criteria for Protection of Freshwater Aquatic Life). Monitoring water quality in riverbed sediments is logistically difficult, and efforts will be made to develop alternative sampling methodologies for performance monitoring. The PRGs for alternative sampling locations along the shoreline and in near river wells will be refined as new information from preremedial design activities are completed becomes available.~~

~~In the *100 Area Feasibility Study Phases 1 and 2* (DOE-RL-1994a), alternatives were developed and screened for the 100 Areas as a whole. The FFS modifies these alternatives to meet site specific conditions. The alternatives considered in the FFS are:~~

- ~~GW-1 - No action~~
- ~~GW-2 - Institutional controls/continued current actions~~
- ~~GW-3 - Containment~~
- ~~GW-4 - In situ treatment~~
- ~~GW-5 - Removal, treatment, disposal using ion exchange~~
- ~~GW-6 - Removal, treatment, disposal using reverse osmosis.~~

~~Table ES-1 lists the processes included in each alternative. Alternative GW-4 was not considered in the FFS because this alternative applies to organic contaminants and nitrate, neither of which are COC for the operable unit.~~

~~The alternatives are defined in the FFS to facilitate the detailed analysis. The detailed analysis is presented in tables where each alternative is compared to seven of the nine CERCLA criteria. These criteria are as follows:~~

- ~~Overall protectiveness~~
- ~~Compliance with ARAR~~
- ~~Long term effectiveness~~
- ~~Reduction of toxicity, mobility, or volume~~
- ~~Short term effectiveness~~
- ~~Implementability~~
- ~~Cost.~~

~~The comparative analysis uses the results of the detailed analysis to compare alternatives to each other for their relative ability to meet the CERCLA criteria. The results of the detailed and comparative analyses are summarized in Table ES-2. The FFS will support the proposed plan for the IRM in the operable unit.~~

This Focused Feasibility Study (FFS) report presents a detailed analysis of alternatives for an interim remedial measure (IRM). The IRM addresses groundwater contamination in the 100-HR-3 Operable Unit. The focus of the FSS is chromium, a waste constituent that is

transported by groundwater flow from the 100 Area into the Columbia River. Ecological receptors in the river ecosystem may be exposed to chromium concentrations that exceed criteria established for the protection of aquatic life.

The 100-HR-3 Operable Unit includes the groundwater beneath the 100-D/DR and 100-H reactor areas, and the intervening area (600 Area), as bounded by the Columbia River shoreline and the southern extent of the two reactor areas. Environmental restoration activities within the operable unit may be influenced by potential adverse impacts in adjacent areas, including groundwater, river water, riverbed sediments, and aquatic biota that may be exposed to contaminants as the result of groundwater flow from the operable unit.

The starting point for selecting remedial alternatives for detailed analysis in the FSS is the *100 Area Feasibility Study, Phases I and 2* (DOE-RL 1994a). This study presents a generalized view of applicable and implementable remedial technologies for contaminants of potential concern that are typical of all 100 Area operable units. The FSS refines the analysis of remedial technologies for groundwater by incorporating contaminant characteristics and hydrogeologic conditions that are specific to the 100-HR-3 Operable Unit.

Key assumptions contained in the FSS are:

- The FSS is justified by a potential threat to the environment caused by chromium in groundwater that discharges into the Columbia River. The potential threat was identified during a limited field investigation and qualitative risk assessment.

- The objective of an IRM associated with the identified threat is protection of ecological receptors that are part of the Columbia River ecosystem.

- Remedial alternatives analyzed in the FSS are targeted at chromium plume containment, groundwater movement control, and reducing chromium contamination in the aquifer.

- Human health risks are not included in the comparative analysis of remedial alternatives, since the FSS is directed at protecting ecological receptors.

- Cost estimates for comparing remedial alternatives are for 5-year operations periods.

- Solid wastes generated during implementation of the selected remedial alternative will be disposed of in the Environmental Restoration Disposal Facility.

A limited field investigation (LFI) and qualitative risk assessment (QRA) were conducted for the operable unit in accordance with the *Hanford Past-Practice Strategy* (DOE-RL 1991). Maximum values for contaminants of potential concern in groundwater samples from 4 quarters of sampling were used to estimate risks for ecological and human health exposure scenarios. No radiological contaminants of potential concern to ecological receptors were identified as exceeding the DOE standard of 1 rad/day (DOE Order 5400.5). However, chromium, sulfide, and iron exceeded Ambient Water Quality Criteria (AWQC) for protection of freshwater aquatic life. An organic compound, bis(2-ethylhexyl) phthalate, had

sporadic results that also exceeded the AWQC; it is a common laboratory contaminant. Subsequent analysis of data from the LFI resulted in identifying chromium as the contaminant of concern for ecological receptors, and an IRM was deemed appropriate to address this potential threat to the environment.

The QRA also addressed human health risks for various scenarios. The analysis determined that unacceptable human health risks were associated with the use of groundwater as a drinking water supply. However, current institutional controls and access restrictions for the Hanford Site preclude use of groundwater from the 100 Area as a potable water source. This control is expected to continue for the duration of an IRM to address chromium contamination. Although a description of human health risk has been included as background information in the FSS, human health risks are not included in the comparative analysis of remedial alternatives.

The FSS process includes developing remedial action objectives (RAO), which are specific to the medium that is contaminated (e.g., soil, groundwater) and to IRM objectives for each operable unit. RAOs for the 100-HR-3 Operable Unit are developed to protect ecological receptors from exposure to chromium that is dispersed with groundwater flow. RAOs are based on risk reduction goals and on applicable or relevant and appropriate requirements (ARARs). They are an expression of the objectives established for the IRM.

The RAOs for the 100-HR-3 Operable Unit are:

- Control the movement of groundwater to reduce the discharge of chromium into the Columbia River, such that chromium concentrations in riverbed sediments do not exceed AWQC for hexavalent chromium (11 ug/L).

- During remediation activities, prevent soil erosion, which could potentially contribute to exceeding AWQC in the Columbia River.

- During remediation activities, prevent destruction of sensitive wildlife habitat, minimize the disruption of wildlife habitat, and prevent adverse impacts to threatened or endangered species.

An IRM to address groundwater contamination in the 100-HR-3 Operable Unit will serve several purposes. It will:

- Protect ecological receptors in the aquatic and riparian (river shoreline) ecosystems from the toxic effects of hexavalent chromium.

- Develop information that will lead to selection and design of a final remedy for the Operable Unit.

- Accelerate activities that are consistent with potential final remedies for groundwater (100-HR-3) and source operable units (100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-IU-4), whenever possible.

Remedial alternatives for an IRM may include activities that will contain chromium plumes in their present locations; retard the movement of plumes toward the river; and/or reduce the amount of chromium in groundwater that is entering the Columbia River.

The *100 Area Feasibility Study, Phases I and II* (DOE-RL 1994a) contained general response action alternatives for groundwater remediation, which could potentially be applicable to all the 100 Area groundwater operable units. For the 100-HR-3 Operable Unit FSS, all but one alternative was retained for more detailed analysis (GW-4 "In Situ Treatment" was not analyzed further in the FSS). Table ES-1 summarizes the remediation alternatives and process options that were analyzed in the FSS.

Cost estimates for the various remedial alternatives were prepared using assumptions based on site-specific experience, established engineering practices, and best professional judgement. Methods to estimate the number, placement, and extraction rate for groundwater wells associated with several alternatives evolved during the FSS process, in response to new information and requirements.

Following detailed analysis of the remedial alternatives using 100-HR-3 Operable Unit-specific information, the alternatives were compared using seven of nine CERCLA criteria (EPA 1988) for evaluating remedial alternatives. (The remaining two criteria concern State agency and community acceptance, and are evaluated following comment on the proposed plan for an IRM). The seven criteria and results of the comparative analysis are summarized in Table ES-2. Alternative GW-5 "Removal/Ion Exchange Treatment/Disposal" contains the optimal balance of characteristics for addressing chromium contamination in groundwater that enters the Columbia River along the 100-D/DR and 100-H Area shorelines.

Table ES-1. Alternatives and Process Options.

ALTERNATIVE	TECHNOLOGY/PROCESSES
GW-1: No Action	Groundwater monitoring
GW-2: Institutional Controls	Access restrictions Continued current actions: Pilot-scale treatability test Groundwater/river interaction Chromium speciation Columbia River Comprehensive Impact Assessment In Situ Redox Manipulation Experiment Groundwater monitoring
GW-3: Containment	Vertical barriers Hydraulic controls Groundwater monitoring
GW-5: Removal, Treatment, and Disposal Using Ion Exchange	Groundwater extraction Treatment: Filtration Ion exchange Treated effluent disposal: Injection back into aquifer Solids disposal: ERDF Groundwater monitoring
GW-6: Removal, Treatment, and Disposal Using Reverse Osmosis	Groundwater extraction Treatment: Filtration Reverse osmosis Forced evaporation Treated effluent disposal: Injection back into aquifer Solids disposal: Stabilization/solidification ERDF Groundwater monitoring

ERDF = Environmental Restoration Disposal Facility

Table ES-2
Summary of Comparative Analysis
HR-3 Operable Unit

Remedial Action	CERCLA Evaluation Criteria							
	Overall Protection of Human Health and Environment	Compliance with ARARs	Long Term Effectiveness and Permanence	Reduction in Toxicity, Mobility, and Volume	Short Term Effectiveness	Implementability	Cost (Present Worth in millions)	
							H Area	D/DR Area
No Action GW-1	Poor - Ecological risks not quantified and not expected to significantly reduce concentrations of chromium in groundwater.	Poor - Chromium concentrations will exceed ambient water quality criteria in near-river wells and possibly in salmon spawning habitat.	Fair - Potential ecological risks to river will remain, but alternative compatible with potential final actions.	Poor - no significant reduction during IRM period	Fair - no additional adverse impacts, but threat to river not mitigated.	Good - groundwater monitoring technology well established	0	0
Institutional Control/Continue Current Action GW-2	Poor - Ecological risks not quantified and not expected to significantly reduce concentrations of chromium in groundwater	Poor - Chromium concentrations will exceed ambient water quality criteria in near-river wells and possibly in salmon spawning habitat.	Fair - Potential ecological risks to river will remain, but alternative compatible with potential final actions.	Poor - no significant reduction during IRM period	Fair - no additional adverse impacts, but threat to river not mitigated.	Good - groundwater monitoring technology well established.	0.5	0.5
Containment GW-3	Good - immediate reduction in concentrations of chromium entering the river in contained areas.	Fair - Chromium concentrations in the river will decrease and may fall below AWQC. However, chromium mass in groundwater will not be reduced.	Fair - Groundwater may eventually migrate around barrier. Option may require future remedial action to remove chromium.	Fair - mobility reduced, but toxicity and volume not affected	Fair - chromium will immediately be prevented from migrating towards river. However, some environmental impacts due in installation of barrier wall.	Poor - Cannot drive sheet piles in H Area; uncertain in D/DR Area.	2.8	22.6
Removal/Ion Exchange Treatment/Disposal GW-5	Good - immediate reduction in chromium mass in groundwater expected; however, the mass removal rate relative to total inventory will likely become apparent during compliance monitoring. Chromium concentrations entering the river are expected to decline, thus providing protection of aquatic organisms.	Good - IRM system will be designed with intention of meeting AWQC in the river. ARARs must also be met for disposal of removed chromium.	Good - chromium permanently removed from system. IRM system could be expanded to meet changing objectives.	Good - chromium removed from system, mobility limited by groundwater extraction wells	Good - potential risks to environment and to workers are expected to be minimal	Good - technology well established; equipment and specialists are available.	9.5	9.1

Table ES-2
Summary of Comparative Analysis
HR-3 Operable Unit

Remedial Action	CERCLA Evaluation Criteria							
	Overall Protection of Human Health and Environment	Compliance with ARARs	Long Term Effectiveness and Permanence	Reduction in Toxicity, Mobility, and Volume	Short Term Effectiveness	Implementability	Cost (Present Worth in millions)	
Removal/Reverse Osmosis Treatment/Disposal GW-6	Good - immediate reduction in chromium mass in groundwater expected; however, the mass removal rate relative to total inventory will likely become apparent during compliance monitoring. Chromium concentrations entering the river are expected to decline, thus providing protection of aquatic organisms.	Good - IRM system will be designed with intention of meeting AWQC in the river. ARARs must also be met for disposal of removed chromium.	Fair - Reverse osmosis system may not be effective at removing chromium if groundwater discharge rates are increased, and may require updating or replacement.	Good - chromium removed from system, mobility limited by groundwater extraction wells	Fair - potential risks to environment and to workers are expected to be minimal, but more land required for sludge disposal.	Fair - Requires installation of high pressure pumps, more difficult and expensive to implement than ion exchange.	15.0	13.8

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ACRONYMS

ARAR	applicable or relevant and appropriate requirement
BAT	best available technology
CAD	computer-aided design
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFR	Code of Federal Regulations
COPC	contaminants of potential concern
COC	contaminants of concern
CRCIA	*Columbia River Comprehensive Impact Assessment*
CSCF	continuously stirred continuous flow
CSTR	continuously stirred - tank bioreactors
DF	decontamination factor
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DOT	U.S. Department of Transportation
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
EHQ	environmental hazard quotient
ERA	expedited response action
ERDF	Environmental Restoration Disposal Facility
FBR	fluidized-bed bioreactors
FFS	focused feasibility study
FS	feasibility study
GRA	general response action
HEIS	Hanford Environmental Information System
HMOC	Hybrid Method of Characteristics
HQ	hazard quotient
HRA-EIS	Hanford Remedial Action Environmental Impact Statement
HSRAM	Hanford Site Risk Assessment Methodology
ICR	incremental lifetime cancer risk
IRM	interim remedial measures
LFI	limited field investigation
LOEL	lowest observable effects level
MCL	maximum contaminant level
MMOC	modified method of characteristics
MOC	method of characteristics
NEPA	*National Environmental Policy Act*
NCP	*National Contingency Plan*
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	operations and maintenance
PNL	Pacific Northwest Laboratory
QRA	qualitative risk assessment
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act

ACRONYMS (Continued)

RI	remedial investigation
ROD	record of decision
SIP	Strongly Implicit Procedure
SDWA	*Safe Drinking Water Act*
SVE	soil vapor extraction
TBC	to be considered
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSS	total suspended solids
USGS	United States Geological Survey
VOC	volatile organic compounds
WAC	Washington Administrative Code

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1.0 INTRODUCTION

~~This focused feasibility study (FFS) is in support of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial investigation/feasibility study (RI/FS) activities for the 100 HR-3 Groundwater Operable Unit. The RI/FS process is described in the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988). The 100 Areas is one of four areas on the Hanford Site that are on the U.S. Environmental Protection Agency's (EPA) National Priorities List (NPL) under CERCLA (Figure 1-1). The 100 HR-3 Operable Unit is one of seven operable units associated with the 100 D/DR and 100 H Areas of the Hanford Site (Figure 1-2). Three of the 100 D/DR operable units (100 DR-1, DR-2, and DR-3), two of the 100 H operable units (100 HR-1 and HR-2), and the 100 IU-4 Operable Unit are source units. The 100 HR-3 Groundwater Operable Unit includes the groundwater beneath the source operable units and the adjacent groundwater, surface water, fluvial sediments, and aquatic biota impacted by the overlying source operable units. The 100 HR-3 Operable Unit also includes that portion of the 600 Area that lies between the 100 D/DR and 100 H Reactors.~~

~~The approach for the RI/FS activities for the 100 Areas operable units has been further defined in the *Hanford Past-Practice Strategy* (DOE-RL 1991). This strategy streamlines the past practice remedial action process with a bias for action through optimizing the use of interim remedial measures (IRMs) and expedited response actions (ERAs).~~

~~All work conducted at the 100 Areas waste sites is in accordance with the conditions set forth in the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990), and its amendments, signed by the Washington State Department of Ecology (Ecology), EPA, and the U.S. Department of Energy (DOE).~~

This focused feasibility study (FFS) presents a detailed analysis of alternatives for an interim remedial measure (IRM) in the 100-HR-3 Operable Unit. The FFS has been conducted as part of the remedial investigation/feasibility study (RI/FS) process included under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). ~~The 100 Areas, which include the 100 HR-3 Operable Unit, is one of four areas on the Hanford Site that are on the U.S. Environmental Protection Agency (EPA) National Priorities List (NPL) under CERCLA (Figure 1-1).~~The 100-HR-3 Operable Unit includes the groundwater beneath the 100-D/DR and 100-H reactor areas, which are two of nine retired production reactors located in the northern portion of the Hanford Site (Figure 1-1). All of the operable units associated with the retired reactor areas are collectively referred to as the 100 Area, one of four groupings of waste sites at Hanford that are on the U.S. Environmental Protection Agency (EPA) National Priorities List (NPL) under CERCLA.

~~The operable unit includes the groundwater beneath waste site source operable units in the 100 D/DR Area (100 DR-1 and 100 DR-2) and in the 100 H Area (100 HR-1 and 100 HR-2). It also includes groundwater beneath a source operable unit located between 100 D/DR and 100 H Areas (100 IU-4), in a region referred to as the 600 Area. The scope of 100 HR-3 Operable Unit activities extends to groundwater, surface water, fluvial sediments, and aquatic biota in areas adjacent to source operable units, where that source~~

~~may result in adverse impacts to human health or the environment.~~The 100-HR-3 Operable Unit includes the groundwater beneath the 100-D/DR and 100-H reactor areas, and the intervening area (600 Area), as bounded by the Columbia River shoreline and the southern extent of the two reactor areas. Waste sites in the 100-D/DR Area are grouped into source operable units 100-DR-1 and 100-DR-2; in the 100-H Area they are grouped into 100-HR-1 and 100-HR-2. An independent source operable unit (100-IU-4) is located in the 600 Area between 100-D/DR and 100-H Areas. Environmental restoration activities within the 100-HR-3 Operable Unit may be influenced by potential adverse impacts in adjacent areas, including groundwater, river water, riverbed sediments, and aquatic biota that may be exposed to contaminants as the result of groundwater flow from the operable unit.

The *Hanford Past-Practice Strategy* (DOE-RL 1991) describes a streamlined approach for RI/FS activities on the Hanford Site. The strategy adopts a bias for action that uses interim remedial measures (IRM) and expedited response actions (ERA) to move forward with active remediation where contamination problems exist. Focused feasibility studies (FS) are intended to provide the technical basis for selecting IRM and expedited response action (ERA) activities.

Figure 1-3 depicts the interrelationships and sequencing of steps and activities that must be integrated to bring an operable unit from field investigation through record of decision (ROD). The diagram is consistent with the approach outlined in the *Hanford Past-Practice Strategy* (DOE-RL 1991).

1.1 PURPOSE AND SCOPE

The *Hanford Past-Practice Strategy* (DOE-RL 1991) defines the FFS as an evaluation of a limited number of alternatives that are focused to the scope of the response action planned. The FFS constitutes the detailed analysis phase that completes the FS evaluation process for the targeted IRM. In addition to the alternative evaluation in the *100 Areas Feasibility Study, Phases 1 and 2* (DOE-RL 1994a), the detailed analysis phase in this FFS integrates the results of area-wide studies, such as river impact, shoreline, ecological, cultural resources, treatability, and background studies, as well as information from operable unit-specific limited field investigations (LFI) and qualitative risk assessments (QRA).

The FFS accomplishes the following:

- Updates and refines remedial action objectives (RAO), contaminants of potential concern ~~(COC)~~(COPC), applicable or relevant and appropriate requirements (ARAR), and remedial alternatives based on new information developed since the *100 Areas Feasibility Study, Phases 1 and 2* (DOE-RL 1994a).

- Performs detailed and comparative analyses of IRM alternatives.

~~The FFS is performed primarily to provide a detailed analysis of remedial action alternatives for sites remaining on the IRM pathway as identified in the LFI.~~

The objective of the FFS is to provide decisionmakers sufficient information on waste-site conditions and remedial alternatives to allow them to make an appropriate and timely decision on remediation of sites to be addressed through IRM. The FFS evaluates alternatives identified in the *100 Areas Feasibility Study, Phases 1 and 2* (DOE-RL 1994a) and considers new information on technologies, operable unit characteristics, and areawide studies.

Concurrently, FFS's are being prepared for some of the 100 Areas source operable units. For a final ~~S~~source cleanup is integral to successful remediation of groundwater; therefore, the cleanup of groundwater is closely tied to the cleanup of the sources of contamination. The source FFS's currently under preparation are aimed at the high-priority sites, mainly the liquid waste sites. Remediation of these sites may play a major role in the final cleanup of ~~the~~ groundwater by eliminating a pathway for continued contamination.

1.2 REPORT ORGANIZATION

The FFS is organized into the following sections:

- Section 1.0--introduction and discussion of purpose of report; summaries of 100 Areas studies that support the FFS
- Section 2.0--operable unit background and summaries of operable-unit specific reports
- Section 3.0--discussion of RAOs, including ~~land use~~, COPCs, ARARs, and remediation goals
- Section 4.0--detailed descriptions of the groundwater remedial alternatives identified in the 100 Areas FS, including any modifications to the alternatives based on new information concerning contaminants or technologies; discussion of uncertainties associated with the alternatives
- Section 5.0--description of groundwater flow modeling conducted for the various remediation alternatives
- Section 6.0--detailed evaluation of remedial alternatives using CERCLA evaluation and NEPA criteria
- Section 7.0--qualitative sensitivity analysis of FSS assumptions
- Section 8.0--comparative analysis of remedial alternatives using CERCLA criteria
- Section 9.0--a list of references used in the FFS
- Appendix A--a tabulation of ARARs
- Appendix B--detailed descriptions of technologies developed and screened in the 100 Areas FS, Phases 1 and 2.

- Appendix C--modeling details
- Appendix D--cost models.

1.3 ~~SUMMARY OF THE HANFORD PAST-PRACTICE STRATEGY~~ KEY ASSUMPTIONS FOR FSS

~~The strategy streamlines the past practice remedial action process with a bias for action by using ERA and IRM. The strategy focuses on reaching early decisions to initiate and complete cleanup projects, maximizing the use of existing data, coupled with focused, short time frame investigations where necessary.~~

~~This chart describes the entire process of characterization activities, risk assessments, treatability studies, and FS for the high and low priority sites within an operable unit and for the operable unit as a whole.~~

~~To understand each figure activity element and their interrelationships, each element is described in the *100 Areas Feasibility Study Phases 1 and 2* (DOE-RL 1994a).~~

Key assumptions contained in the FSS are:

- The FSS is justified by a potential threat to the environment caused by chromium in groundwater that discharges into the Columbia River. The potential threat was identified during a limited field investigation and qualitative risk assessment.
- The objective of an IRM associated with the identified threat is protection of ecological receptors that are part of the Columbia River ecosystem.
- Remedial alternatives analyzed in the FSS are targeted at chromium plume containment, groundwater movement control, and reducing chromium contamination in the aquifer.
- Human health risks are not included in the comparative analysis of remedial alternatives, since the FSS is directed at protecting ecological receptors.
- Cost estimates for comparing remedial alternatives assume a 5-year period of operations.
- Solid wastes generated during implementation of the selected remedial alternative will be disposed of in the Environmental Restoration Disposal Facility.

1.4 SUMMARY OF 100 Areas FEASIBILITY STUDY PHASES 1 AND 2

The 100 Areas FS, Phases 1 and 2 (DOE-RL 1994A), evaluated the known characteristics of the Hanford 100 Areas and identified the range of remedial alternatives that were most

appropriate for protection of human health and the environment for the entire aggregate area. The purpose of the 100 Areas FS was as follows:

- To provide a generalized view of applicable and workable remedial technologies as applied to the site contamination problems as a whole.

- To evaluate groups of sites based on similarity, as opposed to geographical location and operable-unit designation.

- To develop and screen remedial alternatives to be used in the detailed analysis phase of the FFS for IRM or the final FS for individual operable units.

The 100 Areas FS, Phases 1 and 2, consisted of ~~the following~~ four principal tasks:

- Identify COCs for ~~the~~ various media ~~of concern~~(e.g., soil, groundwater).

- Identify ARARs pertinent to all general response actions (GRA).

- Develop remedial alternatives (Phase 1) applicable to the 100 Areas including development of RAO and GRA, identification and screening of technologies and process options, and assembly of remedial alternatives from representative technology types.

- Screen alternatives (Phase 2) developed in Phase 1 for implementability, effectiveness, and costs to identify those alternatives that warrant advancement to the detailed analysis phase of future FFSs.

Contaminants of potential concern (COPCs) and ARARs identified in the 100 Areas FS, Phases 1 and 2, are refined in the FFS based on the evaluation of additional operable unit- and waste site-specific information gathered in the LFI. The GRAs and alternatives retained as a result of the 100 Areas FS are evaluated in detail in the FFS. The GRAs identified whereas ~~follows~~:

- No action
- Institutional actions
- Containment actions
- In situ treatment actions
- Removal/treatment/disposal actions.

Alternatives retained from the 100 Areas FS, Phases 1 and 2, for this FSS are listed in Table 1-1.

1.5 100 AREAWIDE AND AGGREGATE AREA STUDIES

The 100 Areas aggregate studies and Hanford Site studies, such as the Hanford Site background studies, provide integrated analyses of selected issues on a scale larger than an

operable unit. The 100 Areas groundwater operable-unit work plans (DOE-RL 1992a-d) address studies common to the 100 Areas covering topics such as river impact, shoreline ecology, and cultural resources. These studies are reported individually and provide data to select IRMs. Results of these studies are summarized below. Details of the studies can be found in the corresponding references.

1.5.1 Hanford Site Background

The natural inorganic chemical composition of groundwater in the unconfined aquifer system beneath the Hanford Site is presented in *Hanford Site Groundwater Background* (DOE-RL 1992e). The characterization effort identifies the types and concentrations of inorganic analytes that exist naturally in the groundwater. Provisional threshold levels for 40 inorganic analytes developed in this effort are listed in the LFI. Background values for most radionuclides and organic constituents have not been developed.

~~1.5.2 Hanford Remedial Action Environmental Impact Statement~~

~~In accordance with DOE Order 5400.4 and Chapter 10 *Code of Federal Regulations* (CFR) Part 1021, the values of the *National Environmental Policy Act of 1969* (NEPA) must be incorporated in the CERCLA process. Many of the NEPA values are addressed in the detailed analysis of remedial alternatives within this FFS; however, Hanford Site and areawide impacts are being addressed by the *Hanford Remedial Action Environmental Impact Statement* (HRA EIS).~~

~~The HRA EIS analyzes the impacts caused by remediating the CERCLA/*Resource Conservation and Recovery Act* past practice waste sites on the Hanford Site. The NEPA strategy follows a tiered approach that allows the issues addressed in the HRA EIS to be incorporated into subsequent assessments by reference alone (40 CFR 1502.20).~~

1.5.~~3~~2 Ecological Summary

Bird, mammal, and plant surveys were conducted and reported in Sackschewsky and Landeen (1992). Current contamination data~~, including ecological pathways~~ and lists of ~~all~~ wildlife and plants at the Hanford Site~~, have been compiled from a variety of sources. These sources include~~ are presented in several individual project reports and routine environmental monitoring reports produced by Pacific Northwest Laboratory (PNL) and Westinghouse Hanford Company (WHC). A comprehensive bibliography of sources is presented in Weiss and Mitchell (1992). Another report (Cadwell 1994) discusses aquatic species on the Hanford Reach of the Columbia River; mapping activities of vegetation on the site, and efforts to survey species of concern~~; shrub-steppe bird surveys; and mule deer and elk population monitoring~~. Report conclusions state that intrusive activities, such as remedial actions, that are conducted inside the controlled-area fences will not have a significant impact on the wildlife. Intrusive activities outside the controlled-area fences should ~~have minimal~~

~~impact on wildlife if the~~ follow recommendations contained in the three documents listed below ~~are followed~~ (Landeen et al. 1993):

- *Bald Eagle Management Plan* (Fitzner and Weiss 199~~2~~4)
- *Biological Assessment of Threatened and Endangered Species* (Fitzner et al. 199~~2~~4)
- *Biological Assessment for State Candidate and Monitor Species* (Stegen 1992).

The ecology of the riverine and riparian zones associated with the Columbia River is summarized in the *Columbia River Impact Evaluation Plan* (DOE-RL 1993a). Additional information sources are included as references in the evaluation plan. The DOE policy also states that site-specific ecological surveys will be conducted at all sites where cleanup and remedial actions are performed.

1.5.4~~3~~ Groundwater/River Interaction

Several projects are contributing to a better understanding of how contaminated groundwater from the Hanford Site enters the Columbia River along the 100 Areas. This topic was included in an earlier Tri-Party Agreement milestone that addressed general investigations in the 100 Areas (M-30-00 series). A submilestone required the installation of equipment and the initiation of monitoring activities to perform long-term evaluation of river/aquifer interaction; both milestone requirements were completed by September 1993. Information from these activities will be incorporated into the conceptual site model that is used to support remedial design, including establishing appropriate performance monitoring activities.

Automated equipment is installed in wells at each reactor area to measure water levels at hourly intervals. Similar stations are operating at four reactor areas to measure river stage changes. Selected stations also contain sensors to record temperature and ~~electrical conductivity~~ specific conductance. In the 100-H Area, simultaneous recording of water levels, temperature, and conductivity are being made in the nearshore river, in riverbank seepage, and in a shoreline monitoring well. Each station will be operated for a time period sufficient to describe daily, weekly, and seasonal river cycles. Operation of the equipment and selected results are described in annual progress reports (Campbell 1994).

Monitoring activities include data collection by the equipment just described, as well as data collection for operable-unit sampling tasks, as listed in work plans. Groundwater, riverbank seepage, and shoreline sediments are all sampled as part of operable-unit sampling. Non-environmental restoration program activities, such as *Resource Conservation and Recovery Act* (RCRA) groundwater monitoring and Sitewide Environmental surveillance conducted under DOE Order 5400.1, also contribute data that are relevant to river/aquifer interaction investigations. A summary of water quality data from near-river monitoring wells, riverbank seepage, and nearshore river water is present in Peterson and Johnson (1992). Riverbank seepage, shoreline sediment, and river water data for sampling activities conducted for the environmental restoration program are published in DOE-RL (1992f) and WHC (1993a).

The data are also available from the Hanford Environmental Information System (HEIS). Recently, a method has been devised to sample pore water from riverbed sediment that serves as spawning habitat for chinook salmon (Hope 1995). The gravel riverbed used for redds (nest for eggs and hatching) is potentially exposed to contaminants in groundwater that upwells through the riverbed.

Interpretation of river/aquifer interaction data is in progress. Initial results show that groundwater is affected by river stage changes in several ways. River fluctuations can be observed as water level changes in wells throughout the reactor areas, with a time lag and amplitude decrease occurring as the well's distance from the river increases. This information has potential use for inferring aquifer hydraulic properties (McMahon and Peterson 1992). River stage changes also affect water quality, but only within several hundred feet of the river, and to varying degrees depending on the magnitude and duration of stage changes. Evidence for some degree of groundwater dilution by river water before crossing the channel interface is found in riverbank seepage concentrations of contaminants. Seepage concentrations are almost always intermediate between values in shoreline wells and nearshore river water (Peterson and Johnson 1992).

An understanding of the physical and chemical environment at the aquifer/river interface, and of the processes occurring at the interface, is fundamental for assessing the impact of Hanford Site groundwater on the Columbia River water quality and ecosystems. It is also relevant in assessing the performance of remediation activities. Continued investigation of aquifer/river exchange is strongly encouraged to support future RODs for environmental restoration.

1.5.54 Columbia River Comprehensive Impact Assessment

The *Columbia River Comprehensive Impact Assessment* (CRCIA), established in *Tri-Party Agreement* Milestone M-13-80 (subsequently changed to M-15-80), will evaluate the current human and ecological risks associated with the Columbia River and attributable to past and present activities on the Hanford Site. The CRCIA is being conducted by PNL. Human risk from exposure to radioactive and hazardous materials will be addressed for a range of river-use options. Ecological risk will be evaluated relative to the health of the current river ecosystem (Eslinger et al. 1994).

1.5.65 Investigations of Chromium in Groundwater

Chromium has been introduced to groundwater in the 100 Areas from several sources. Known sources for chromium in the 100-HR-3 Operable Unit are (1) coolant water leakage from the retention basins and underground piping; (2) sodium dichromate stock solution leakage associated with preparing coolant water; (3) decontamination solution disposal in cribs, french drains, and trenches; and (4) leakage and/or spillage of waste solutions placed in the 183-H Solar Evaporation Basins. Groundwater containing chromium has moved from the 100-D/DR Area, where sources (1) through (3) above were present until the mid-1960s, into the 100-H Area, and the region immediately north. Wells located in the 600 Area between 100-D/DR and 100-H reactor areas (699-97-43, 699-46-43, and 699-91-46) are

monitored semiannually for chemical and radiological waste indicators to help track this plume.

Several projects have been completed or are underway that contribute to a better understanding of groundwater contamination by chromium in the 100-HR-3 Operable Unit. Estimates for the volume of contaminated groundwater, the mass of chromium within that volume, and the changes in characteristics between 1988 and 1992 in the 100-H Area are presented in Peterson and Connelly (1993). Their estimates suggest a chromium plume with concentrations in excess of 50 ug/L that has a volume of about 310,000 m^3 and contains about 36 kg (79.3 lb) of chromium. The results indicate a slight increase in the plume size during the time interval studied. Three explanations for this apparent increase were suggested: (1) Influx of chromium-bearing groundwater from upgradient sources, (2) an unidentified continuing source in the 100-H Area, and (3) an increased release from the soil column (Peterson and Connelly 1992).

An effort is under way to describe how chromium moves with groundwater and where chromium fixation might occur ~~(DOE-RL 1993a)~~ (Thornton et al, 1995). This study of chromium speciation looks at the concentrations and valence state of chromium in the unconfined aquifer, at the interface between the aquifer and the river, and in the nearshore river. Analysis of the various valence states in sediments and periphyton coatings on sediments is included, along with tests involving potential changes in valence state that occur when groundwater is mixed with river water. ~~Initial interpretations suggest that some hexavalent chromium in groundwater is reduced to the less toxic and less mobile trivalent state at the aquifer/river interface.~~

1.6 SUMMARY OF 100 Areas GROUNDWATER TREATABILITY STUDIES

Treatability tests were conducted for several of the COPC listed in the 100-HR-3 LFI report (DOE-RL 1993b {DOE/RL-93-43}). Bench-scale tests of biodenitrification used batch studies to determine if biodenitrification could reduce the nitrate concentration to a residual of <45 mg/L (as NO_3), the current maximum contaminant level (MCL) as defined in the *Safe Drinking Water Act* (SDWA) (40 CFR 141). The tests were conducted under the *100-HR-3 Groundwater Treatability Test Plan* (DOE-RL 1992g), the *Treatability Study Program Plan* (DOE-RL 1992h), and the *100 Areas Groundwater Biodenitrification Bench-Scale Treatability Study Procedures* (Peyton and Martin 1993). The results of the test are presented in *100 Areas Groundwater Biodenitrification Bench-Scale Treatability Study -- Final Report* (Peyton 1994). Because the treatability test was directed at nitrates and organics, the information is not relevant to the COPCs for the 100-HR-3 Operable Unit. Therefore, no additional discussion of the treatability test is provided in the FFS.

Treatability tests were also conducted to test the removal of chromate, nitrate, and uranium (VI) using precipitation/reduction and/or ion exchange treatments. The tests are described in the *100-HR-3 Groundwater Treatability Test Plan* (DOE-RL 1992g). Procedures for the tests are specified in *100-HR-3 Area Groundwater Treatment Tests for Ex Situ Removal of Chromate, Nitrate, and Uranium (VI) by Precipitation/Reduction and/or Ion Exchange* (WHC 1993b); results are presented in *Treatment Tests for Ex Situ Removal of Chromate, Nitrate,*

and Uranium (VI) from Hanford (100-HR-3) Groundwater Final Report (Beck and Duncan 1994). Results of each test are summarized below.

The performance goals adopted for the *100-HR-3 Groundwater Treatability Test Plan* are total chromium (100 ug/L); nitrate (45,000 ug/L); and uranium (22 ug/L) (DOE-RL 1992g). Detection limits for analyses conducted during the testing are total chromium (29 ug/L); nitrate (10,000 ug/L); and uranium (1 ug/L) (Beck and Duncan 1994).

1.6.1 Precipitation/Reduction

1.6.1.1 Sulfide Precipitation. A ferrous sulfate/sodium sulfide method was tested to first reduce the chromium (VI) to chromium (III) and then to coprecipitate the reduced chromium with the resulting ferric hydroxide and/or ferric sulfide (WHC 1993c). The possible reduction and/or precipitation of uranium was also investigated. The ferrous sulfate/sodium sulfide treatment was effective at removing the chromium (decontamination factor [DF] of 64); however, the treatment failed to remove uranium or nitrate and generated significant quantities of sludge. (The DF is defined as the original concentration of the contaminant divided by the concentration after treatment. A DF less than 2 is considered insignificant.) The method resulted in a colloidal suspension, which was not removed by centrifugation.

1.6.1.2 Brushite Coprecipitation. Disodium hydrogen phosphate was used to precipitate brushite from the contained calcium ion naturally present in the groundwater to determine the potential for removing uranium. The incidental removal of chromate from solution by coprecipitation with brushite was also investigated. The brushite treatment produced significant DF for uranium (DF = 32). This treatment did not result in significant DF (>2) for chromate and had little effect on nitrate concentrations. Because neither precipitation method resulted in removal of both chromate and uranium, and because both generated significant quantities of sludge or flocculent, no further tests were conducted.

1.6.2 Ion Exchange

Three different strong-base anion exchange resins were tested based on recommendations of resin manufacturers (Dowex 21k™ from Dow Chemical Company and Amberlite 402™ and 410™ from Rohm and Haas Company). All three resins had excellent DF for uranium (90 ± 70 to 110 ± 70) and chromate (60 ± 46 to 90 ± 12). The Dowex 21K™ had a much higher DF for nitrate (40 ± 20) than the Amberlite 410™ (12 ± 2) or Amberlite 402™ (6 ± 1). The Dowex 21K™ removed the high concentration of contaminants down to the level of detection for several hundred column volumes.

The test was a full factorial experiment, which means that all combinations of the variables of interest were explored. Tests conducted included batch tests, equilibrium tests, and breakthrough tests.

The following summarizes the results of the anion exchange resin test results.

- No pretreatment requirements were identified in the treatability tests; however, a prefilter is recommended for field application.

- Based on the results of the test, the optimum resin for treatment of chromate, nitrate, and uranium is Dowex 21K™, a strong-base anion exchange resin.

- No breakthrough was observed in water from Well 199-H4-4 for chromium or uranium after a total of 1660 column runs. Nitrate showed breakthrough after 445 column volumes. The concentrations from this well were 84,600 ppb nitrate, 49 ppb uranium, 66 ppb chromate, and 79 ppb total chromium.

- Breakthrough for water from Well 199-D5-15 occurred at 450 column volumes for nitrate and 1,100 column volumes for chromium. Initial concentrations were 49,700 ppb nitrate, 12 ppb uranium, 1,930 ppb chromate, and 2,025 ppb total chromium. When breakthrough for chromium was first observed, the effluent concentration was 100 ppb chromium. The capacity of the Dowex 21K™ is 2.79 μg chromium per mg of resin, based on the test results for this well water.

- No degradation of resin or resin life was noted during multiple cycles.

- During the multiple cycles, the contaminant concentrations were below the performance goals, except for uranium. This may not be too significant, because the levels of uranium introduced in the test were much higher (8 times) than typical 100 Areas groundwater uranium concentrations.

- The ion exchange was eluted with four to five column volumes of 4 M sodium chloride, then washed with one to two column volumes to regenerate the resin for reuse. The concentrations in the eluate were typically several hundred thousand ppb chromium, ten million ppb nitrate, and thirty thousand ppb uranium. Both the eluate and wash contained uranium and were considered mixed waste.

As part of the breakthrough tests, a low flow rate (16 column volumes per hour [3.4E-4 gal/min]) test using groundwater spiked with 700 ppb uranium, 1,700 ppb chromium (VI), 2,020 ppb total chromium, and 192,300 ppb nitrate showed that 1,800 column volumes were insufficient to show breakthrough for uranium. Chromium concentrations at 1,800 column volumes were near the performance level at 3 to 4% of original concentrations. Nitrate showed breakthrough at 350 column volumes, which corresponds to a resin loading capacity of 1.2 meq/mL for the Dowex 21K™ resin. (Breakthrough is defined as 50% of the original concentration.)

A high flow rate (27 column volumes per hour [5.7E-4 gal/min]) test using groundwater spiked with 820 ppb uranium, 2,100 ppb chromium, 1,990 ppb chromate, and 212,700 ppb nitrate showed no breakthrough for chromium; however, the test was ended prematurely because of equipment failures. Uranium concentrations were slightly higher in the effluent than in the slow flow rate test, which may indicate that the kinetics of uranium adsorption are slow. The uranium concentration was always less than the performance level (22 μg/L).

1.7 PILOT-SCALE TREATABILITY STUDY

Milestone M-15-06E required that DOE begin pilot-scale pump and treat operations for the 100-HR-3 Operable Unit by August 1994. The pilot scale study is to address chromium. Assuming that the pilot scale pump-and-treat operation is successful, it would continue to operate until the ROD. Full-scale operation would be implemented if it were determined to be the selected remedy under the 100-HR-3 ROD. If the pump-and-treat operation is the selected remedy under the ROD, it would continue until the three parties evaluated the operation using the following criteria, as quoted from Tri-Party Agreement (TPA) Change Control Form, Change Number M-15-93-02, dated January 25, 1994:

- Hexavalent chromium measured in wells near the Columbia River fall below the *Model Toxics Control Act* (MTCA) standard for chromium of 50 μg/L for two consecutive sampling periods.

  NOTE: In the 100-D/DR Area, the closest wells to the river are 199-D5-20, 199-D8-55, 199-D8-54, and 199-D8-53. Routinely monitored riverbank seepage locations are SP-110-1 and SP-110-2 (see Figure 2-1 for location map).

  In the 100-H Area, the closest wells to the river are 199-H4-10, 199-H4-15, 199-H4-12, 199-H4-4, 199-H4-11, and 199-H4-13. Riverbank seepage locations include SP-150-1, SP-152-2/3, and SP-153-1 (see Figure 2-2 for location map).

- Sampling of water occurring in the river bottom substrate environment, where springs are suspected to discharge contaminated groundwater, in concentrations representative of the plume, indicates that hexavalent chromium in this environment is below, and will remain below, the chronic Ambient Water Quality Criterion for protection of freshwater aquatic life for hexavalent chromium (11 μg/L) set by the EPA.

- Groundwater/Columbia River interaction studies, numerical models, or physical models indicate that predicted levels of hexavalent chromium within the riverbed substrate environment, where contaminated groundwater is suspected to discharge, in concentrations representative of the plume, are below the chronic Ambient Water Quality Criterion for the protection of freshwater aquatic life for hexavalent chromium (11 μg/L) set by the EPA.

- Biological surveys, such as aerial photographic records, of Columbia River sections where contaminated groundwater discharges may occur, indicate that contemporary salmonid redd distributions are at concentrations and locations expected if hexavalent chromium were not an influence.

- The effectiveness (including cost/unit of hexavalent chromium removed) of the treatment technology does not justify further operation.

- An alternate treatment technique, such as chemical reduction of the hexavalent chromium to a less toxic valence, that is more effective or is less costly is substituted.

Assumptions associated with the Tri-Party Agreement Change Control Form (Ecology et al. 1994) for the pilot-scale treatability test are as follows.

- The LFI activities do not identify hexavalent chromium data inconsistent with data to date.
- The QRA justifies the need for remediation.
- Treated effluent containing contaminants above state water quality standards can be disposed of in the soil column or aquifer.
- Hazardous, radioactive, and/or mixed waste (e.g., resins) will be stored and/or disposed of on site at locations agreed to by the Tri-Parties.
- Bench-scale tests will confirm treatment assumptions.
- The pilot-scale treatability test will be performed in accordance with the *100-HR-3 Groundwater Treatability Test Plan* (DOE-RL 1992h).

~~The *Pilot Scale Treatability Test Plan for the 100 HR-3 Operable Unit* (DOE-RL 1994b) provides an outline for the pilot-scale test using the Dowex 21K™ resin in an ion exchange pump and treat system.~~

~~1.8 KEY ASSUMPTIONS FOR FFS~~

~~The key assumptions that form the basis for the FFS are as follows.~~

- ~~The purpose of the IRM is to address an identified threat to human health or the environment.~~
- ~~The objective of the IRM is to protect ecological receptors in the Columbia River, and to abate offsite migration of contaminants.~~
- ~~To meet the objectives, remediation alternatives are targeted at plume containment and control, and removal of contaminants from the aquifer, of contaminant plumes.~~
- ~~Cost estimates used for alternative comparisons are based on a 5-year operation during the IRM. finite lifecycle for the IRM of 12 years. An additional estimate for a 5-year operation of a pump and treat system using ion exchange technology is presented also, to be consistent with CERCLA National Contingency Plan methods.~~
- ~~The *100 Areas Feasibility Study Phases 1 and 2* (DOE-RL 1994a) forms the basis for the alternatives evaluated in the FFS. Additional alternatives or deviations from the alternatives are only considered when the defined alternative does not match the operable unit characteristics. However, CERCLA allows the flexibility of specifying~~

~~different process options at any point in the RI/FS process if warranted by site circumstances.~~

- ~~Disposal to the Environmental Restoration Disposal Facility (ERDF) is assumed for all solid wastes generated. This includes the assumption that sufficient space is available and that the facility will be operating on a schedule consistent with the IRM.~~

~~Each assumption is discussed in Sections 2.0 through 6.0 of the FFS. The sensitivities associated with these assumptions are discussed in Section 7.0.~~

Figure 1-1. Hanford Site.

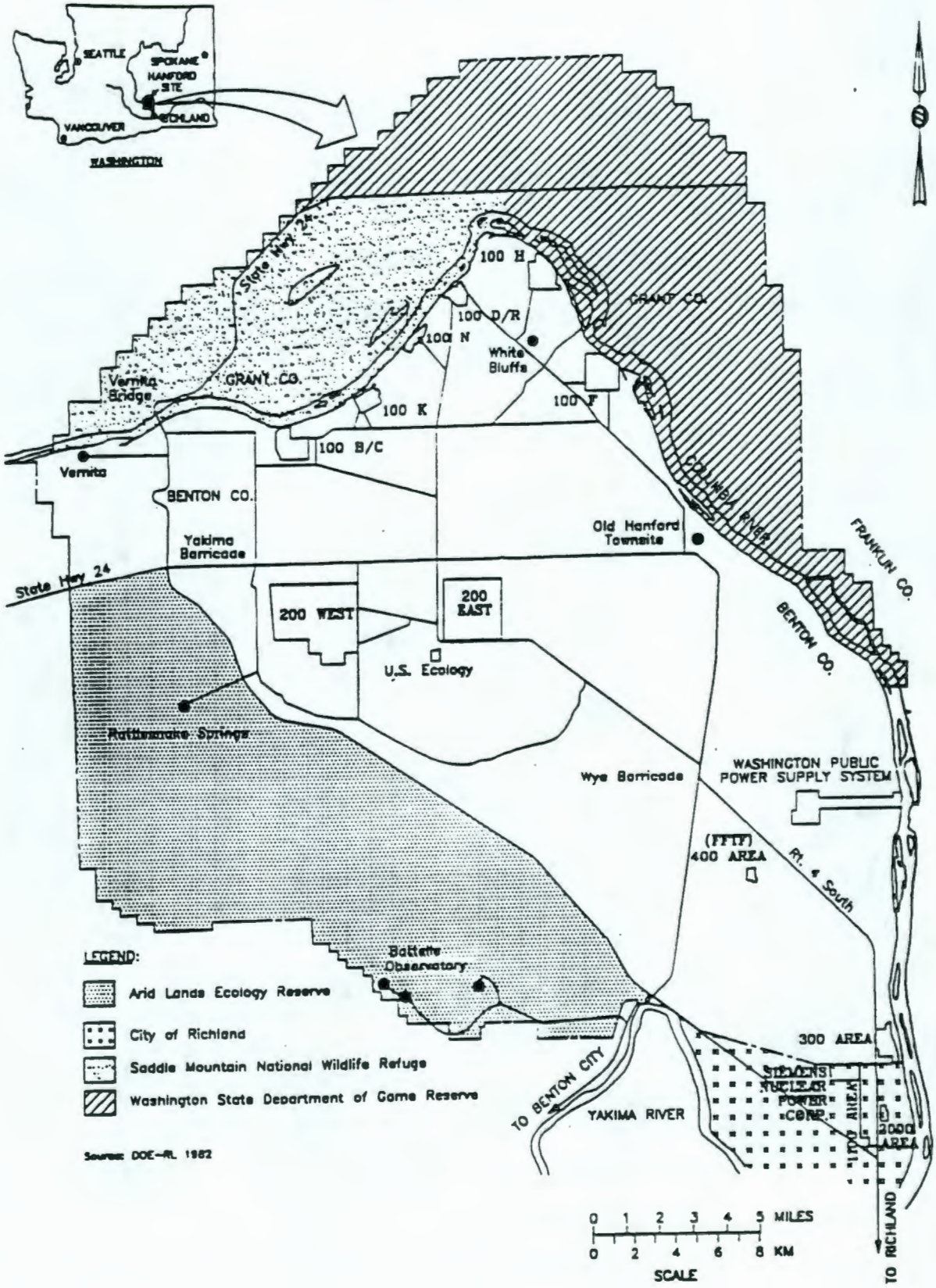
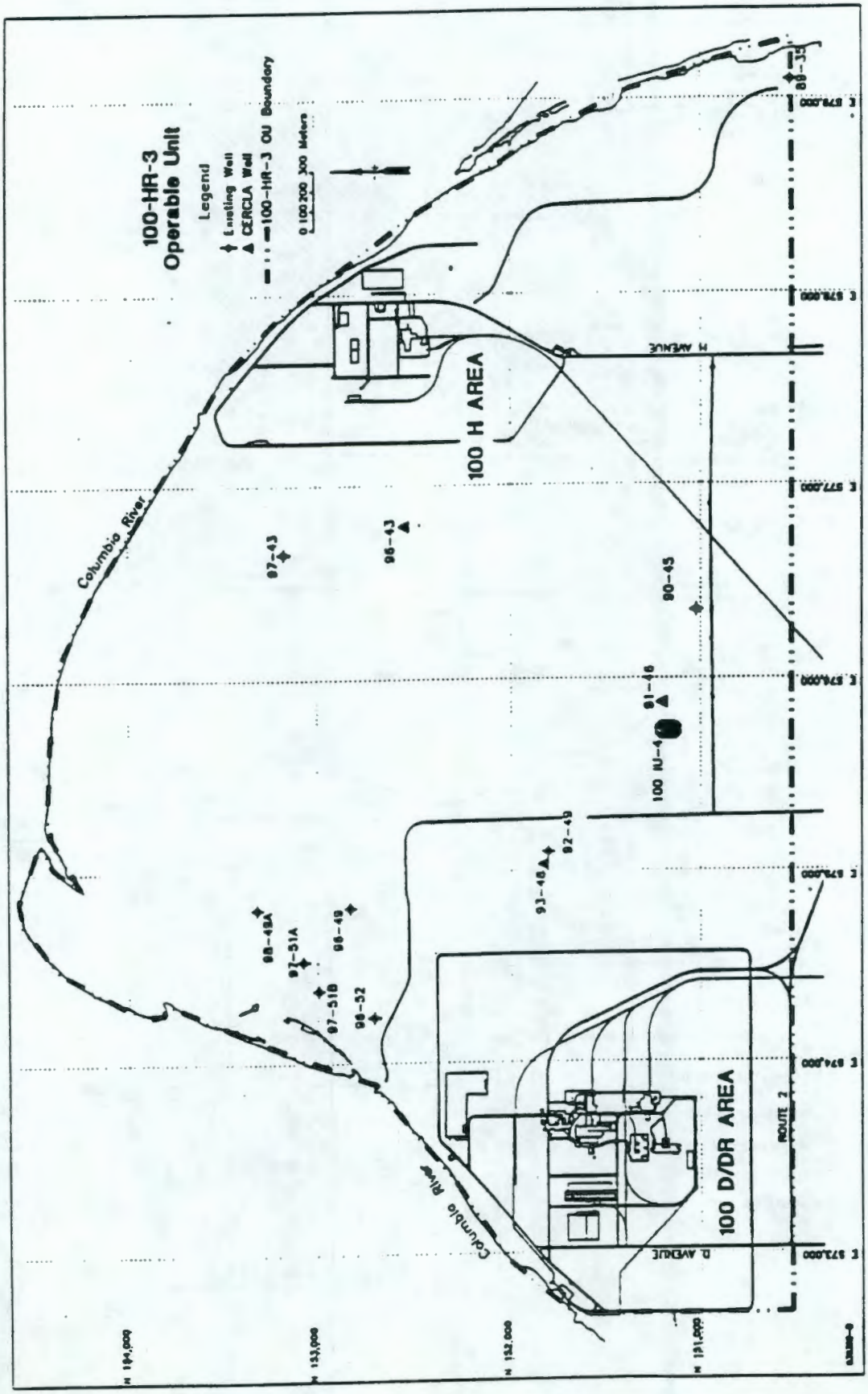


Figure 1-2. 100-HR-3 Operable Unit.



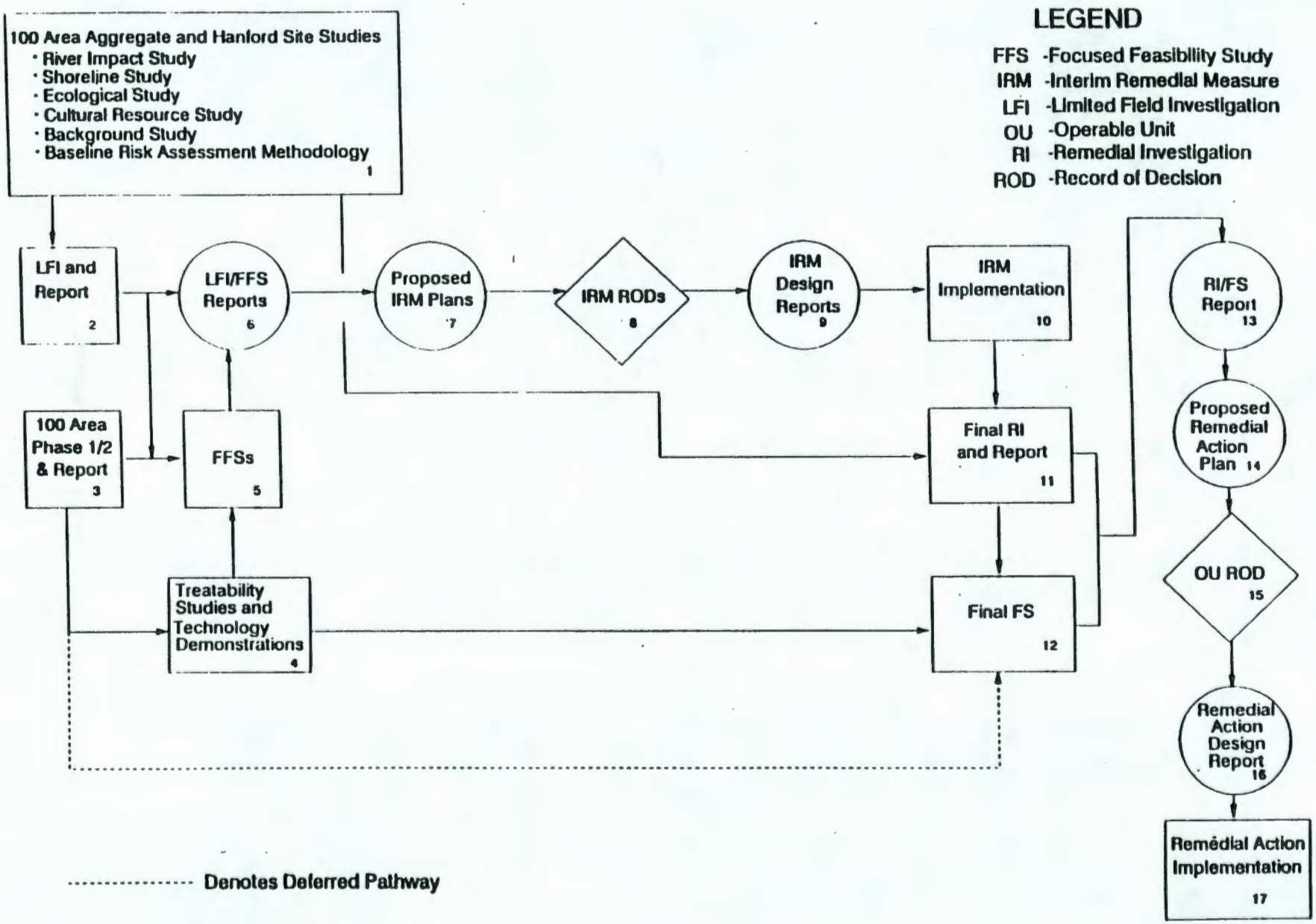


Figure 1-3. Hanford Past-Practice Strategy Diagram.

Table 1-1 Alternatives Retained from the 100 Areas Feasibility Study.

Alternative	Description		Recommendation
GW-1	No Action		Retain for detailed analysis and risk assessment data.
GW-2	Institutional:	Water rights and deed restrictions Groundwater monitoring Columbia River as alternate water supply	Retain to preserve range of GRA to be evaluated in FFS.
GW-3	Containment:	Slurry walls Extraction wells	Retain to preserve range of GRA to be evaluated in FFS.
~~GW-4~~	~~In Situ Treatment:~~	~~Biodenitrification~~ ~~Air stripping~~	~~Retain as an in situ treatment action.~~
GW-5	Removal, Treatment, & Disposal:	Extraction wells Biodenitrification Chemical oxidation, precipitation, and chemical reduction Media filtration and ion exchange Cement-based solidification Injection into aquifer ERDF	Retain as a removal, treatment, and disposal action based on chemical treatment processes.
GW-6	Removal, Treatment, & Disposal:	Extraction Wells Biodenitrification Air stripping, forced evaporation, media filtration, and reverse osmosis Cement-based solidification Crib disposal, vaults, and trenches/pits ERDF	Retain as a removal, treatment, and disposal action based on physical treatment processes.

GRA = general response action
FFS = focused feasibility study
ERDF = Environmental Restoration Disposal Facility

2.0 OPERABLE UNIT BACKGROUND

The 100-HR-3 Operable Unit is located in the north-central portion of the Hanford Site along the southern shoreline of the Columbia River (see Figures 1-1 ~~and 1-2~~). It includes the groundwater within 100-D/DR Area, the 100-H Area, and the intervening 600 Area. The southern boundary of the operable unit is the southern edge of Sections 21, 22, 23, and 24 of T 14 N, R 26 E of the Willamette Meridian, and continuing east along the southern edge of Sections 19 and 20, T 14 N, R 27 E of Willamette Meridian to the Columbia River. The operable unit includes outfall structures and effluent pipelines that extend into the Columbia River, but excludes that portion (116-N-3 Crib) of the 100-NR-2 Operable Unit that extends north of the southern boundary. The outfall structures and river effluent pipelines are being addressed as part of the river pipeline Expedited Response Action (DOE-RL 1994e).

Since the preparation of the *100 Areas Feasibility Study Phases 1 and 2* report (DOE-RL 1994a), additional data have been collected relevant to the 100 Areas in general, as well as to the 100-D/DR and 100-H Areas and the 100-HR-3 Operable Unit. An LFI has been conducted and reported in *Limited Field Investigation Report for the 100-HR-3 Operable Unit* (DOE-RL 1993b). A QRA (WHC 1993d) and a variety of aggregate area studies were performed to evaluate risk, cultural resources, the area's ecosystem, the Columbia River, and the river sediments.

2.1 LIMITED FIELD INVESTIGATION

The LFI is an integral part of the RI/FS process and is based on Hanford Site-specific agreements discussed in the *Hanford Federal Facility and Consent Order* (Fourth Amendment) (Ecology et al. 1994), the *Hanford Site Risk Assessment Methodology* (HSRAM) (DOE-RL 1994c), the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-HR-3 Operable Unit* (DOE-RL 1992c), and the *Hanford Past-Practice Strategy* (HPPS) (DOE-RL 1991). The HPPS emphasizes initiating and completing waste-site cleanup through interim actions.

The primary purpose of the LFI at the 100-HR-3 Operable Unit was to collect sufficient data to determine if the groundwater within the 100-H and 100-D/DR Areas is contaminated to the extent that an IRM was warranted. The data gathered during the LFI are also used to conduct a QRA for human and ecological receptors (see the following subsection), and to evaluate the remedial alternatives in this FFS.

As part of the LFI, 22 new groundwater wells were installed in the 100-HR-3 Operable Unit. These wells were constructed to help define groundwater quality in areas downgradient of the priority waste sites in the area that are sources of the contaminants, and estimate groundwater quality at locations where human and ecological receptors may be exposed to groundwater.

Groundwater samples were collected from these new wells and existing monitoring wells (Figures 2-1 and 2-2). A total of 262 samples, exclusive of duplicates and splits, was collected over four rounds of sampling. These samples were analyzed for organic, inorganic, and radioactive constituents. Soil samples were collected during well-drilling activities and analyzed for physical properties. Tables 2-1, 2-2, and 2-3 present the maximum concentrations ~~found in groundwater samples~~ of constituents that are potential contaminants in groundwater, in springs and seeps, and in the Columbia River within and adjacent to the 100-H and 100-D/DR Areas. These maximum concentrations ~~of the constituents in the groundwater, river, and springs or seeps~~ were used to evaluate risks to receptors according to the protocol for QRAs in the HSRAM (DOE-RL 1994c).

2.2 QUALITATIVE RISK ASSESSMENT

A QRA was performed as part of the LFI, and determined the principal risk drivers at the 100-HR-3 Operable Unit (WHC 1993d). Another purpose of the QRA was to qualitatively evaluate human health and environmental risks to help determine if the Operable Unit is a candidate for an IRM. The QRA evaluated risks for a predefined set of human and environmental exposure scenarios. ~~and~~ If the estimated risks exceeded certain thresholds, IRMs were considered necessary to reduce the risks posed by the contaminants as described in the HPPS (DOE-RL 1991). The QRA is not intended to replace or be a substitute for the baseline risk assessment that will be conducted in association with determining the final action at the site. The QRA used the groundwater data from the first four rounds of the LFI sampling, and the data were evaluated for consistency and compliance with EPA data management guidance (EPA 1989).

2.2.1 Human Health Risks

For the human health risk assessment, frequent- and occasional-use scenarios were evaluated to provide bounding estimates of risks consistent with the residential (frequent) and recreational (occasional) exposure scenarios presented in the *Hanford Site Risk Assessment Methodology* (DOE-RL 1994c). The QRA considered only two human health exposure scenarios (frequent- and occasional-use) and two pathways (groundwater ingestion and inhalation of volatile contaminants during groundwater use).~~, based on the methodology in the HSRAM (DOE-RL 1994c).~~ The frequent-use exposure scenario in this FFS uses the same input parameters as the residential scenario described in the HSRAM (DOE-RL 1994c), while the occasional-use exposure scenario uses input values similar to the recreational scenario in the HSRAM. The inhalation pathway is evaluated only in the frequent-use scenario because it is assumed that exposure to volatile contaminants would occur during domestic water use within the confines of a residence, and would not be expected to occur in an occasional-use (recreational) setting.

The constituents detected in the 100-HR-3 groundwater samples, in the Columbia River adjacent to the 100-HR-3 Operable Unit, and in the springs and seeps in the area were used

to evaluate human health risks. These data were first screened against Hanford Site background values (DOE-RL 1992e). The constituents that were present at concentrations less than background were not considered further for assessing human health ~~(or ecological)~~ risks. These data were also screened against conservative health-risk criteria, and if the constituents met the following criteria they were not used to evaluate human health risks (DOE-RL 1994c).

- The concentration of the contaminant posed an incremental cancer risk less than 1×10^{-7}, based on a frequent-use scenario.

- The concentration of the contaminant resulted in a hazard index less than 0.1, based on a frequent-use scenario.

Lifetime incremental cancer risks (ICR) were calculated for the radionuclides and carcinogenic inorganic and organic contaminants, and hazard quotients (HQ) and hazard indices (HI) were calculated for the inorganic and organic contaminants that posed systemic health risks (Tables 2-4, 2-5, and 2-6).

Based on the frequent-use exposure scenario, several radionuclides in the 100-H Area were at concentrations that presented ICRs ranging between 1×10^{-5} to 9×10^{-6} (Table 2-5). Only two radionuclides in the 100-D/DR Area (tritium and strontium-90), and one in the 600 Area (tritium) exceeded an ICR of 1×10^{-5} (Tables 2-4 and 2-6). Chloroform in the 100-H Area and arsenic in the 600 Area were the only organic and inorganic carcinogenic contaminants, respectively, that presented an ICR greater than 1×10^{-5}. Six contaminants exceeded a hazard quotient of 1.0.: chromium, manganese, arsenic, ammonia, fluoride, and nitrate.

Based on the occasional-use scenario, only two radionuclides (tritium in the 100-D/DR Area and technetium-99 in the 100-H Area), and one inorganic (arsenic in the 600 Area), were present at concentrations that posed an ICR greater than 1×10^{-6} (Tables 2-4, 2-5, and 2-6). There were no contaminants present in concentrations that exceeded a hazard quotient or hazard index of 1.0, based on the occasional-use scenario. ~~identified as contaminants of potential concern (Tables 2-4 through 2-5).~~

The COPCs identified above~~, for both human and ecological receptors,~~ are evaluated further to determine if risks are at a level that warrant an IRM. For human health risks, an ICR greater than 1×10^{-4} or a hazard index greater than 1.0 is considered to be an indicator of risk requiring an IRM. The EPA generally considers ICRs in the range of 1×10^{-6} (one in a million) to 1×10^{-4} (one in ten thousand) as not requiring remedial action unless there is a potential for offsite migration of the contaminant(s), an ecological risk, or other extenuating circumstances. ~~For ecological receptors, the total radiological dose estimated using CRITR2 is compared to the DOE benchmark of 1 rad per day (DOE Order 5400.2).~~

Based on ~~the above analyses, and using~~ an occasional-use exposure scenario for humans, the QRA data (Tables 2-4 through 2-6) indicate that human health risks at the 100-HR-3 Operable Unit do not exceed levels that warrant an interim remedial measure. Human health

risks, based on a frequent-use exposure scenario, would warrant an IRM. ~~However, there are a few inorganic contaminants such as chromium that pose an ecological risk requiring an interim remedial measure.~~

2.2.2 Ecological Risks

Ecological risks were evaluated based on the exposure of biological receptors that live in or near the Columbia River to contaminants in surface water, as a result of contaminated groundwater migrating into the river. Plants and animals can also be exposed to contaminants where groundwater surfaces in springs and seeps ~~and then flows into the river~~. Most contaminants are also transferred through the food web.

~~Sampling efforts at The Hanford Site have shown that~~ It is logistically difficult to get water samples that represent the conditions at the groundwater-river water interface. Therefore, for the purposes of the QRA, maximum concentrations of the contaminants from near-river well samples were used to represent concentrations potentially available to aquatic receptors at the groundwater-river water interface. Contaminant concentrations in the open water column in the river represent concentrations after thorough mixing has occurred, and are not representative of contaminant concentrations in the transition zone between groundwater and surface water. Existing data clearly show that concentrations of contaminants in the open water column within the river are lower than concentrations observed in the near-river wells and in the springs and seeps (Peterson and Johnson 1992). Therefore, an important exposure point to consider for aquatic receptors is the river sediments and the pore water within those sediments. The QRA presents a discussion of the uncertainties associated with the ecological risk assessment. ~~The QRA considered the area between, and including, the 100-D/DR and 100-H Areas.~~

To estimate ecological risks, the total daily doses to animals in aquatic and riparian habitats from radiological contaminants are estimated using the CRITR2 computer code (Baker and Soldat 1992). These doses are then compared to the DOE benchmark of 1 rad/day (DOE Order 5400.5), which is considered protective of aquatic communities (IAEA 1992, EPA 1993, ICRP 1977). For the inorganic and organic contaminants, the maximum representative groundwater concentrations from four rounds of LFI sampling are compared to EPA's acute and chronic Ambient Water Quality Criteria (AWQC) for the protection of aquatic organisms. ~~For the inorganic and organic contaminants, the maximum representative groundwater concentrations are compared to EPA's acute and chronic Ambient Water Quality Criteria (AWQC) for the protection of aquatic organisms.~~ If groundwater concentrations exceed the 1 rad/day benchmark or the AWQC, an ecological risk was presumed present, and ~~requiring~~ an IRM justified ~~was assumed to occur~~.

~~The ecological risk assessment, based on the QRA protocol, identified potential risks from a few inorganic and organic constituents, but none of the radionuclides were present in concentrations that exceeded the 1 rad per day DOE benchmark. The ecological contaminants of potential concern that exceeded AWQC included bis(2-ethylhexyl)phthalate,~~

~~chromium, and sulfide in the 100 D/DR Area and chromium, iron, and sulfide in the 100 H Area.~~

~~The ecological evaluation in the QRA assessed the potential effects of contaminants on selected animals present in and near the Columbia River, such as fish and herons. Total daily doses to animals in aquatic and riparian habitats from radiological contaminants are estimated using the CRITR2 computer code (Baker and Soldat 1992). In addition, t~~

~~The ecological evaluation also includes comparing the contaminants in the Columbia River, and the springs and seeps near the river, with the maximum representative groundwater concentrations.~~

~~The results of the QRA for human health risks are presented by area (100 D/DR, 100 H, and 600 areas) in Tables 2-4 through 2-6. The risk assessment based on the frequent-use scenario identified tritium, strontium 90, ammonia, chromium, manganese, and nitrate as contaminants of potential concern in the 100 D/DR Area. For the 100 H Area, tritium, carbon 14, strontium 90, technetium 99, uranium 233/234, uranium 238, americium 241, ammonia, chloroform, chromium, fluoride, manganese, and nitrate were identified as contaminants of potential concern based on frequent use. In the 600 Area, three constituents were identified as contaminants of potential concern; these were tritium, arsenic, and chromium.~~

The ecological risk analyses indicated that none of the ecological receptors living in or near the Columbia River that were addressed in the QRA will receive a radiological dose in excess of the 1 rad/day benchmark (DOE Order 5400.5). The ecological assessment, however, identified ~~a few~~ inorganic and organic contaminants that exceeded the AWQC (Table 2-8). These included chromium, sulfide, and bis(2-ethylhexyl)phthalate in the 100-D/DR Area and chromium, iron, and sulfide in the 100-H Area. Chromium is the most toxic with respect to aquatic animals, and is the contaminant that has been consistently observed in groundwater in the 100-HR-3 Operable Unit.

Chromium is the most toxic of these four contaminants with respect to aquatic animals, and the hexavalent form of chromium (chromium VI) is the contaminant of concern at the Hanford Site. Most chromium in groundwater at the Hanford Site is chromium VI, because of the original sources and prevailing geochemical conditions. Chromium VI is also substantially more mobile and more toxic than the trivalent form (chromium III). Hanford groundwater samples are routinely analyzed for total chromium, but for the purposes of the ecological risk assessment, it is assumed that the total chromium concentration is an appropriate estimate for chromium VI.

2.3 AREA RESOURCES

~~As part of a comprehensive cultural resources review of the 100 Areas operable unit, several archaeological surveys have been conducted in the 100-HR-3 Operable Unit. These surveys included literature and record reviews, as well as pedestrian surveys of the area. Figure 2-1~~

~~shows those areas of the operable unit which have been surveyed. These efforts were conducted following the procedures set forth in the *Hanford Cultural Resources Management Plan* (Chatters 1989). These surveys have located three historic and five prehistoric sites within the 100 D/DR and 100 H Areas that could potentially be impacted by IRM activities.~~

~~Two historic sites (3-176 and 3-178) have the potential of being impacted by activities in the 100 H Area by construction and support activities associated with remedial actions. One historic site, 3-180, and one prehistoric site, 45BN176, have the potential of being impacted by activities in the 100 D/DR Area. Four prehistoric sites 45BN147, 45BN148, 45BN439, 45BN459 and 45BN176 are near the river in the 100 D/DR Area in the potential zone of remedial activities. Three of these sites are village sites with pit houses.~~

~~All of the potential impact sites within the 100 HR-3 Operable Unit will need to be evaluated for National Register of Historic Places eligibility. Any sites found eligible for listing should be avoided during activities or plans for data recovery/mitigation will be required.~~

The following sections provide 100 Areas specific information regarding physical, cultural, and ecological resources. Discussions are also included regarding Hanford Site recreation, noise levels, socioeconomics, employment, transportation, health care, police and fire protection, and utilities.

2.3.1 Physical Resources

The 100 Areas extend along the Columbia River in the northern portion of the Pasco (geological) Basin. All of the 100 Areas, except the 100-B/C Area, lies on the north limb of the Wahluke syncline. The 100-B/C Area lies over the axis of the syncline (WHC 1993b). The top of the basalt in the 100 Areas ranges in elevation from 46 m (150 ft) near the 100-H Area to 64 m (210 ft) below sea level near the 100-B/C Area.

The Ringold Formation, a major geologic strata at the Hanford Site, shows a marked west-to-east variation in the 100 Areas. The main channel of the ancestral Columbia River flowed along the front of Umtanum Ridge and through the 100-B/C and 100-K areas, before turning south to flow along the front of Gable Mountain and/or through the Gable Mountain-Gable Butte gap, leaving relatively thin deposits of sand and gravel in the 100-B/C and 100-K Areas. In the 100 Areas, the Hanford Formation consists primarily of Pasco Gravels facies, with local occurrences of the sand-dominated or slackwater facies (Cushing 1994).

The predominant soil types in this area are Burbank loamy sand (34%), Ephrata sandy loam, Ephrata stony loam, and Quincy sand. Other soil types include Pasco silt loam, Kiona silt loam, and river wash (Hajek 1966).

Surface water at the 100 Areas of the Hanford Site is limited to the Columbia River and springs along the riverbank. The Columbia River is the second largest river in North America and the dominant surface-water body on the Hanford Site. The existence of the

Hanford Site has precluded development of this section of river for irrigation and power, and the Hanford Reach is now being considered for designation as a National Wild and Scenic River as a result of congressional action in 1988 (Cushing 1994).

The primary uses of the Columbia River include the production of hydroelectric power, extensive irrigation in the Mid-Columbia Basin, and river (barge) transportation to the west coast. Several communities located on the Columbia River rely on the river as their source of drinking water. Water from the Columbia River along the Hanford Reach is also used as a source of drinking water by several onsite facilities and for industrial uses (Dirkes 1993). In addition, the Columbia River is used extensively for recreation, including fishing, hunting, boating, waterskiing, and swimming (Cushing 1994).

Washington State has classified the stretch of the Columbia River from Grand Coulee to the Washington-Oregon border, which includes the Hanford Reach, as Class A, Excellent (Ecology 1992). Class A waters are suitable for essentially all uses, including raw drinking water, recreation, and wildlife habitat.

Radiological monitoring indicates that levels of tritium, strontium, iodine-129, iodine-131, uranium, and cobalt-60 in the river are below concentration guidelines established by DOE and the EPA drinking water standards (PNL 1990). Nonradiological water quality parameters measured during 1989 were similar to those reported in previous years and were within Washington State Water Quality Standards (PNL 1990).

The seepage of groundwater, or springs, into the Columbia River has been known to occur for many years. Riverbank springs are monitored for radionuclides at 100-N, the old Hanford townsite, and the 300 Area. These relatively small springs flow intermittently, apparently influenced primarily by changes in river level. Hanford-origin contaminants have been documented in these groundwater discharges along the Hanford Reach (Dirkes 1990; DOE 1992; McCormack and Carlile 1984; Peterson and Johnson 1992).

Columbia River floods have occurred in the past (DOE 1987), but the likelihood of recurrence of large-scale flooding has been reduced by the construction of several flood-control/water-storage dams upstream of the Hanford Site. Major floods on the Columbia River typically result from rapid melting of the winter snowpack over a wide area augmented by above-normal precipitation. The probability of flooding at the magnitude of the 1894 and 1948 floods has been greatly reduced because of upstream regulation by dams. There are no Federal Emergency Management Agency floodplain maps for the Hanford Reach of the Columbia River. The Federal Emergency Management Agency only maps developing areas, and the Hanford Reach is specifically excluded (Cushing 1994).

The unconfined aquifer at the Hanford Site is referred to as the upper or suprabasalt aquifer system because portions of the upper aquifer system are locally confined or semiconfined. However, because the entire suprabasalt aquifer system is interconnected on a sitewide scale, it will be called the Hanford Site unconfined aquifer for the purpose of this report. Aquifers

located within the Columbia River Basalts are referred to as the confined aquifer system (Cushing 1994).

Confined aquifers within the Columbia River Basalts are within relatively permeable sedimentary interbeds and the more porous tops and bottoms of basalt flows. Hydraulic-head information indicates that groundwater in the confined aquifers flows generally toward the Columbia River and, in some places, toward areas of enhanced vertical flow communication with the unconfined system (Bauer et al. 1985; Spane 1987; DOE 1988).

Groundwater in the unconfined aquifer at the Hanford Site generally flows from recharge areas in the elevated region near the western boundary of the Hanford Site toward the Columbia River on the eastern and northern boundaries. The Columbia River is the primary discharge area for the unconfined aquifer. Natural areal recharge from precipitation across the entire Hanford Site is thought to range from almost 0 to 10 cm (0 to 4 in.) per year, but is probably less than 2.5 cm (1 in.) per year (Gee and Heller 1985; Bauer and Vaccaro 1990). Since 1944, the artificial recharge from Hanford Site wastewater disposal operations has been significantly greater than the natural recharge. An estimated 1.68 by 10^{12} L (4.4 by 10^{11} gallons) of liquid was discharged to disposal ponds, trenches, and cribs (Cushing 1994).

The Hanford Site is located in a semiarid region of southeastern Washington State. The Cascade Mountains, beyond Yakima to the west, greatly influence the climate of the Hanford Site by means of their "rain shadow" effect; this mountain range also serves as a source of cold air drainage, which has a considerable effect on the wind regime on the Hanford Site (Cushing 1994).

The EPA has established the Prevention of Significant Deterioration (PSD) program to protect existing ambient air quality. Air quality in the vicinity of the Hanford site is considered satisfactory. Air pollutants are generated from a limited number of industrial sources as well as natural wind blown particulates. Two facilities, the Plutonium Uranium Extraction (PUREX) and Uranium Oxide (UO_3) on the Hanford site operate under a PSD permit issued by EPA in 1980. This permit sets specific limits for emissions of nitrogen oxides from these two facilities, therefore, ensuring that air quality continues to be satisfactory or improves.

2.3.2 Biological Resources

The Hanford Site is one of the few large areas of land in the region that has not been developed for agricultural or commercial uses. It is unique because public use of the area has been limited by the Department of Energy's operations, and the biological resources have to a large extent been protected. The dominant topographical features of the Hanford Site include Rattlesnake Mountain along the western perimeter, the Columbia River running through the northern area, sand dunes near the Columbia River, Gable Mountain and Gable Butte south of the river that interrupt the rolling landscape, and the centrally located plateau area. The Columbia River is an important fishery resource; its many islands serve as nesting

grounds for waterfowl and shorebirds, and the adjacent riparian area provides a valuable habitat in this otherwise arid environment. Numerous ecological studies have characterized the biological resources of the Hanford Site, including the terrestrial, riparian, and aquatic habitats (Sackschewsky and Landeen 1992; Stegen 1992; Weiss and Mitchell 1992; and Caldwell 1994).

The plant communities near the 100-H Area have been broadly described as a riparian community immediately adjacent to the Columbia River and a cheatgrass community away from the river. The shoreline immediately adjacent to the 100-H Area is steeply sloped with a narrow riparian zone, dominated by reed canarygrass and bluegrass with white mulberry and golden currant. Much of the river shoreline consists of large cobbles and boulders. Near the south boundary of the 100-H Area, the shoreline abruptly flattens into an extensive backwater wetland known as the H-slough that supports a wide variety of plants and animals. To the north, upriver of the 100-H Area, is another small wetland area. The White Bluffs ferry site, south of the 100-H Area, is dominated by stands of mature cottonwood and black locust trees.

The area within the 100-H Area boundary, but away from the river is primarily a cheatgrass/rabbitbrush community (Stegen 1994). Many areas within the 100-H Area have been physically disturbed by the original construction and operation of the reactor, and more recently by remedial work on the buildings and waste sites. The vegetation in the vicinity of, but outside the 100-H Area, consists primarily of cheatgrass communities, abandoned agricultural fields, or smaller areas of sagebrush/bitterbrush.

The habitats along the Columbia River support a wide variety of mammals, birds, reptiles, and insects. Habitats or vegetation that should be protected from damage during remedial work at the 100-H Area include the small areas of sagebrush/bitterbrush, the trees in the area, and riparian and wetland communities along the river. The dryland areas of the Hanford Site were treeless before agricultural activities in the early 1900s. During that time, prior to 1943, trees were planted and irrigated on most farms to provide windbreaks and shade. Today these trees provide nesting sites for many species of passerines and raptors, and roosting sites for eagles, hawks, owls, and other birds.

The largest mammal common in the 100-H Area is the mule deer. Mule deer are found throughout the Hanford Site, but are more common to riparian areas along the Columbia River. The islands in the river serve as deer-fawning sites, and the river shoreline supports beaver, muskrat, and raccoon. Other mammal species include predators such as badgers and coyotes; medium sized mammals such as jackrabbits, skunks, porcupines, and ground squirrels; and small mammals such as pocket mice, pocket gophers, Norway rats, and deer mice. The Great Basin pocket mouse is the most abundant small mammal in the upland areas. This species lives entirely on seeds from native and introduced plant species.

Numerous terrestrial and aquatic invertebrates have been identified at the Hanford Site (ERDA 1975). Grasshoppers, darkling beetles and harvester ants are common in upland areas, and aquatic insect larvae and aquatic worms provide a major portion of the aquatic

food base for fish and waterfowl. Relatively few species of amphibians and reptiles are known to occur at the Hanford Site (Fitzner and Gray 1991), but side-blotched, short-horned, and sagebrush lizards are common; along with gophersnakes and western rattlesnakes. About 238 species of birds have been observed at the Hanford Site (Landeen et al. 1992). Common passerine birds include starlings, horned larks, meadow larks, western kingbirds, cliff swallows, and rock doves. The horned lark and meadow lark are the most common nesting species in areas away from the river. Game birds include chukar, mourning dove, ring-necked pheasant, and California quail. In recent years, the number of nesting ferruginous hawks has increased because of their use of transmission lines as nesting sites. Other raptor species that nest at the Hanford Site include the prairie falcon, American kestrel, Swainson's hawk, and the red-tailed hawk. Several species of owls also nest at the Hanford Site.

The Columbia River is the dominant aquatic ecosystem and supports a large and diverse community of plankton, benthic invertebrates, and fish. Macrophytes in the slackwater areas, such as rushes and sedges, provide food and shelter for a variety of aquatic invertebrates and fish. Over 43 species of fish have been collected in the Hanford Reach of the Columbia River. This section of the river is a major spawning grounds for chinook salmon. Native fish species include chinook salmon, steelhead trout, coho salmon, sockeye salmon, mountain whitefish, white sturgeon, and the sandroller. Some of the nonnative resident fish in the area include smallmouth bass, largemouth bass, and walleye.

There are several species of plants and animals in the 100 Areass that have been designated as species of concern by state and/or federal agencies. These designations may be as a state or federal threatened, endangered, candidate, monitor, or sensitive species. A list of these species is presented in Table 3-2 of the *100 Areas Source Operable Unit Focused Feasibility Study* (DOE-RL 1995a). No plant species are listed as threatened or endangered by the federal government. Only two animal species are listed as threatened or endangered by the federal government: the endangered peregrine falcon and the threatened bald eagle. The American bald eagle resides along the Columbia River from November through March, feeding on waterfowl and dead salmon. There are several frequently used bald eagle perch trees at the north end of the 100-H Area and several frequently used ground perches north and south of the 100-H Area. The bald eagles have not nested at the Hanford Site, although nest building activities have been observed in previous years. Guidance on issues dealing with bald eagles is presented in the *Bald Eagle Site Management Plan for the Hanford Site, South Central Washington* (Fitzner and Weiss 1992). Peregrine falcons have been observed infrequently at the Hanford Site.

Twelve plant species on or near the Hanford Site are listed by the Washington State Natural Heritage Program (1990) as endangered, threatened, or sensitive (Sackschewsky et al. 1992). Of these 12 species, the Columbia or persistent sepal yellowcress (Rorippa colubiae) has been found at many locations along the shoreline of the Columbia River.

Several bird species in the 100 Areas have been classified as species of concern (state or federal candidate, sensitive, or monitor species). Some of the important and/or common

species of concern in the 100 Areass include the American white pelican, sandhill crane, ferruginous hawk, loggerhead shrike, Swainson's hawk, common loon, burrowing owl, western grebe, and caspian and Forster's terns.

Two habitat types are especially important to the 100 Areas: the riparian zone along the Columbia River and the undisturbed shrub-steppe habitat in the upland areas. The riparian zones are sensitive because they contain (1) wetlands with a wide variety of plant and animal species, (2) wintering bald eagle roosting and perching areas, (3) Columbia yellowcress and other plants of concern, and (4) large numbers of shorebirds and waterfowl. The undisturbed shrub-steppe habitat supports sensitive bird species, such as loggerhead shrike and sage sparrows (Poole 1992), and important foraging areas for avian and mammalian predators. The shrub steppe habitat is classified as a priority habitat by the Washington Department of Wildlife (1991). State and federal wildlife refuges adjacent to the 100 Areas, along the north side of the Columbia River, are also important biological resources.

2.3.3 Cultural Resources

The 100 Areas are rich in cultural resources because the Hanford Reach was occupied continuously during the past 10,000 years. Burials, prehistoric, and historic archaeological sites, sacred and traditional cultural areas, and historic structures are all examples of cultural resources that must be considered in planning and implementing cleanup activities. Human burials are the category of cultural resource that pose the most serious concern. In the 100 Areas, several historic Wanapum cemetery locations are known, some of which are near areas scheduled for remediation. Burial locations that predate the memories of Wanapum people, however, are not known. ~~, one can expect to uncover burials anytime ground-disturbing activities occur within 400 m (1,300 ft) of the Columbia River's edge or on upland areas.~~

In addition to burial sites, cultural and archaeological sites representing major Indian villages, fishing camps, religious areas, and traditional use areas (e.g., areas where plants with subsistence, medicinal, and ceremonial value were collected) are commonly found along the Hanford Reach, especially between the 100-B/C Area and 100-F Area. These sites have special significance to the tribes, and are generally considered as sacred connections to the past, and important places to preserve for future tribal generations. As the last free flowing stretch of the Columbia River, cultural and archaeological sites located along the Hanford Reach are the only remaining sites above water in the entire Columbia River system. This fact adds additional significance to these sites both to the Native American community and to the scientific community, who value this information resource potential for learning about Columbia River human adaptive systems during the past 10,000 years.

There are also historic-archaeological sites related to historic Indian and non-Indian habitations (e.g., townsites, farmsteads) that are important in understanding the history of human occupation of the Hanford Site. These sites must also be considered during project

planning. Finally, many of the structures comprising the Hanford Site itself are historic. Impacts on these structures must be considered as projects are developed and implemented.

For the Hanford Site 100 Areas, most of the operable units have been surface surveyed for archaeological resources. More than 150 sites have been found. Several are eligible for listing in the National Register; however, the vast majority have yet to be evaluated. These sites are known because surface evidence exists. ~~We do not know~~It is not known where buried sites are located, ~~and~~although there are probably many. Buried sites pose problems because they are often not discovered until construction is underway, at which point work must stop while the find is evaluated, and mitigation, if required, is completed. ~~The Operable Unit specific Focused Feasibility Studies (Appendices E, F, and G) describe the cultural and historic resources known to occur within the operable unit, and discuss mitigation measures that may be taken prior to and during remedial actions.~~

As part of a comprehensive cultural resources review of the 100 Areas, several archaeological surveys have been conducted in the 100-HR-3 Operable Unit. These surveys included literature and record reviews, as well as pedestrian surveys of the area. Figure 2-2 shows those areas of the operable unit that have been surveyed. These efforts were conducted following the procedures set forth in the Hanford Cultural Resources Management Plan (Chatters 1989). These surveys have located 25 prehistoric sites and 58 historic sites within the 100-HR-3 Operable Unit that could potentially be impacted by IRM activities (Wright 1994).

Only six prehistoric sites have been evaluated for eligibility to the National Register of Historic Places. Site 45BN176 has been determined eligible for listing; it is located within the Locke Island Archaeological District. Sites 45BN141, 45BN144, 45BN145, 45BN146, and 45BN147 have been determined eligible for listing; all lie within the Wahluke Archaeological District. None of the 58 historic sites have been evaluated for National Register eligibility (Wright 1994).

All prehistoric and historic sites within the 100-HR-3 Operable Unit must be evaluated against National Register criteria. Sites found eligible for listing should be avoided during remedial activities if avoidance is possible. Where avoidance is not possible, a data recovery/mitigation plan must be prepared and carried out for each eligible site impacted by remedial activities.

2.3.4 Other Resources

Recreation and Aesthetics. The convergence of the Columbia, Snake, and Yakima Rivers offers the residents of the Tri-Cities a variety of recreational opportunities. The Lower Snake River Project provides boating, camping, and picnicking facilities in nearly a dozen different areas along the Snake River. The Columbia River also provides ample water recreational activities on the reservoirs formed by the dams upstream and downstream from the Hanford Reach. The Hanford Reach is a popular recreational sport fishing area.

The Columbia Basin is a popular recreational hunting area, where deer, rabbits, waterfowl, and upland game birds are harvested. However, no hunting is allowed on the Hanford Site except within the Wahluke Slope Wildlife Area located north of the Columbia River.

Land in the 100 Areas on the Hanford Site is generally flat with little relief. The Columbia River, flowing across the northern part of the site, and the spring-blooming desert flowers provide visual enjoyment to people.

Noise. Studies at the Hanford Site on the propagation of noise have been concerned primarily with occupational noise at work sites. Environmental noise levels have not been extensively evaluated because of the remoteness of most Hanford Site activities and isolation from receptors covered by federal or state statutes. Wind was identified as the primary contributor to background noise levels with winds exceeding 19 km/hr (12 mph) significantly affecting noise levels. Periods of high wind, which normally occur in the spring, elevates background noise levels (Cushing 1994).

Most industrial facilities on the Hanford Site are located far enough away from the boundary that noise levels at the boundary are not measurable or are barely distinguishable from background noise levels. However, there is the potential for noise from field activities, such as well-drilling activities involving operation of heavy equipment.

To protect Hanford Site workers and comply with the Occupational Safety and Health Administration standards for noise in the workplace, the Hanford Environmental Health Foundation has monitored noise levels resulting from several routine operations performed at the Hanford Site. Occupational sources of noise propagated in the field are summarized in Cushing (1994).

Socioeconomic. The Hanford Site plays a dominant role in the socioeconomics of the Tri-Cities (Richland, Pasco, and Kennewick) and other parts of Benton and Franklin counties. The agricultural community also has a significant effect on the local economy. Major changes in Hanford Site activity and employment would potentially affect the Tri-Cities and other areas of Benton and Franklin counties.

Two major sectors are currently the principal driving forces of the economy in the Tri-Cities: (1) the DOE and its contractors, operating the Hanford Site; and (2) the agricultural community, including a substantial food-processing component. The unemployment rate fluctuates seasonally primarily because of the agricultural sector. The 1992 average unemployment for the Tri-Cities was 8.5% (Washington State Department of Employment Security 1993). In 1993, Hanford Site employment accounted directly for 25% of total nonagricultural employment in Benton and Franklin counties and slightly more than 0.6% of all nonagricultural statewide jobs (Cushing 1994). Hanford directly or indirectly accounts for more than 40% of all jobs in Benton and Franklin Counties (Cushing 1994).

Transportation. The Tri-Cities serve as a regional transportation and distribution center with major air, land, and river connections. The Tri-Cities have direct rail service, provided

by Burlington Northern and Union Pacific, that connects the area to more than 35 states (Cushing 1994). The Hanford Site railroad system extends from the west side of Richland, Washington throughout the Hanford Site. The DOE controls the rail access into the Hanford Site; the agency rail system ties in with the Union Pacific Railroad southeast of the Richland "Y" area near the U.S. Highway 12 and Route 240 interchange. Burlington Northern and Union Pacific have priority rights over the DOE rail system between the Richland "Y" area and the DOE 1100 Areas. The DOE tracks serving the Hanford Site are installed parallel to the Route 240 bypass around the Richland, Washington urban area (DOE 1986).

Docking facilities at the Ports of Benton, Kennewick, and Pasco are important aspects of this region's infrastructure. These facilities are located on the 525 km (326 mi) long commercial waterway, which comprises the Snake and Columbia Rivers, that extends from the Ports of Lewiston-Clarkston in Idaho to the deep-water ports of Portland, Oregon, and Vancouver, Washington.

Daily air passenger and freight services connect the area with most major cities through the Tri-Cities Airport located in Pasco. The airport is served by one national and two regional commuter airlines.

The Tri-Cities are linked to the region by five major highways. Route 395 joins the area with Spokane to the northeast. Routes 395 and 240, which cross through the Hanford Site, connect with Interstate 90 to the north. Route 12 links the region with Yakima to the northwest, with Lewiston, Idaho to the east, and Walla Walla to the southeast. The area is also linked to Interstate 84 to the south, via Interstate 82 and Route 14. Interstate 82 also connects the area to the Yakima Valley and Interstate 90 in Ellensberg. Routes 240 and 24 traverse the Hanford Site and are maintained by Washington State.

Area roads are those roads that provide access within the individual areas on the Hanford Site. Paved surfaces for parking and walkways are included as part of the area road category. There are roughly 196 km (122 mi) of road and 836,000 m^2 (1,000,000 yd^2) of paved surfaces within the combined areas. There are an estimated 19 km (12 mi) of paved roads in the 100 Areas (DOE-RL 1989).

Health Care and Human Services. The Tri-Cities have three major hospitals and five minor emergency centers. All three hospitals offer general medical services and include a 24-hour emergency room, basic surgical services, intensive care, and neonatal care (Cushing 1994).

The Tri-Cities offer a broad range of social services. State human service offices in the Tri-Cities include the Job Services of the Employment Security Department; Food Stamp; the Division of Developmental Disabilities; Financial and Medical Assistance; Child Protective Service; emergency medical service; a senior companion program; and vocational rehabilitation (Cushing 1994).

Police and Fire Protection. Police protection in Benton and Franklin counties is provided by Benton and Franklin counties' sheriff departments, local municipal police departments, and the Washington State Patrol Division headquartered in Kennewick (Cushing 1994).

The Hanford Fire Patrol, including 126 firefighters, is trained to dispose of hazardous waste and to fight chemical fires. To perform their responsibilities, Hanford Fire Patrol has access to a hazardous material response vehicle that is equipped with chemical fire extinguishing equipment; a truck that carries foam, Halon, and Purple-K dry chemical; a mobile air truck that provides air for gasmasks; and a transport tanker that supplies water to six brush trucks. They have five ambulances and contact with local hospitals (Cushing 1994).

Utilities. The principal source of water for the Tri-Cities and the Hanford Site is the Columbia River. Each city operates its own supply and treatment system. Richland and Pasco use Columbia River water; the Kennewick system gets its water from two wells and the Columbia River.

The water systems at the Hanford Site consist of a complex assortment of pumping, distribution, treatment, and storage facilities. These facilities have been constructed throughout the Hanford Site and use a variety of raw water sources to meet demand. The largest quantities of raw water are supplied through the Export Water System from the Columbia River.

Electricity in the Tri-Cities is provided by the Benton County Public Utility District, Benton Rural Electrical Association, Franklin County Public Utility District, and City of Richland Energy Services Department. All the power that these utilities provide in the local area is purchased from the Bonneville Power Administration, a federal power marketing agency. Electrical power for the Hanford Site is purchased wholesale from the Bonneville Power Administration.

Power to the 100/200 Areas electrical system is provided by the Bonneville Power Administration Midway Substation at the northwest site boundary, and a transmission line from the Bonneville Power Administration Ashe Substation in the southeast portion of the Hanford Site.

2.4 ONGOING ACTIONS

Sampling of pore-water from the Columbia River sediments was conducted recently to obtain samples from salmon-spawning areas adjacent to the 100-H Area. The samples were analyzed specifically for chromium, which is a toxic and mobile contaminant that is known to migrate via groundwater into the river. Samples were collected from 17 transects that included two sampling sites each: one 30 m (98.4 ft) from the shoreline, and a second 70 m (229.6 ft) offshore. Of the 39 pore-water samples collected, five exceeded the AWQC of 11 μg/L. ~~with~~ The highest ~~result being~~ concentration measured was 130 μg/L, which is a typical value found in the 100-H Area groundwater plume. Seventeen river water samples

were also collected immediately above the pore-water sample sites--none contained hexavalent chromium in excess of the AWQC. Riverbank seepage near the transects was sampled and showed hexavalent chromium at levels ranging between 17 and 67 μg/L. ~~The results of this effort along a 5,000 foot reach of the river, indicated that at a few locations, the chromium concentrations exceeded the AWQC for hexavalent chromium.~~

Aquifer tests are planned for the operable unit as ~~documented~~described in the *Aquifer Test Plan for the 100-HR-3 Operable Unit* (Swanson 1994). New wells were completed in August 1994, and field tests began in 1994. In addition, seven wells in the 100-D/DR Area were pumped in June 1994 to determine their capacity for producing water in support of the treatability test in the 100-HR-3 Operable Unit. The withdrawal tests were of short duration, about 1 to 2 hours, and produced results similar to earlier estimates.

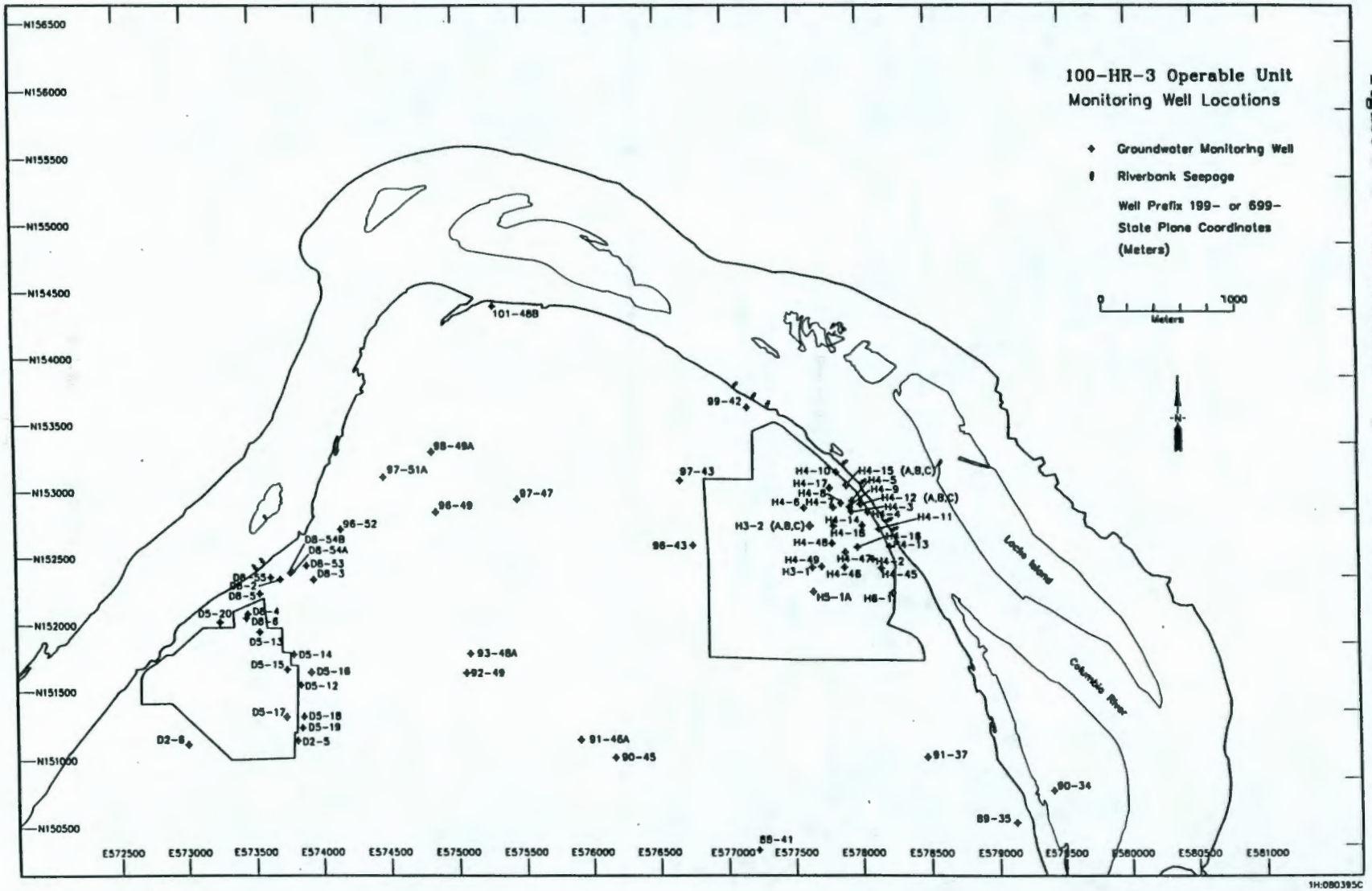


Figure 2-1. Well Location Map for the 100-HR-3 Operable Unit.

Figure 2-2. Cultural Resource Survey Areas for the 100-HR-3 Operable Unit.

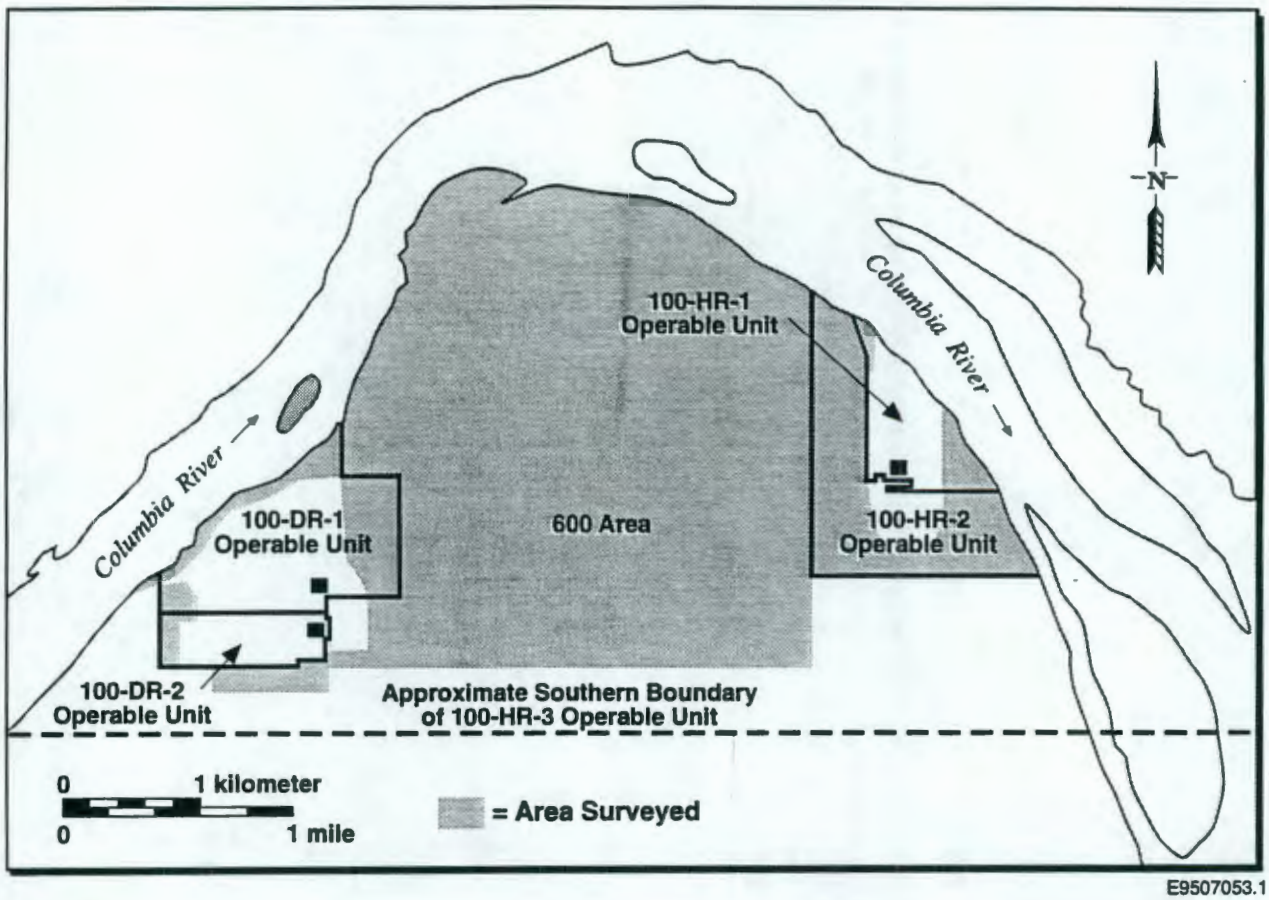


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Table 2-1. Summary of Maximum Concentrations for Contaminants of Potential Concern for the 100-D/DR Area.

Groundwater Contaminants	All Groundwater Wells	Near-River Groundwater Wells	D/DR Area Springs	D/DR Area Columbia River	MCL (pCi/L or mg/L)
Radionuclides (pCi/L)					
Tritium	78,000	19,000	3,100	<200	20,000[a,b]
Strontium-90	41(J)	7.6	4.5	<1	8[a,b]
Uranium 233/234	1.5	1.1	1.0[e]	0.33[e]	NA
Uranium 238	1.4	1.1	1.0[e]	0.33[e]	NA
Inorganics (mg/L)					
Barium	0.164	0.092	0.055	0.026	2.0[a]
Chromium[f]	2.09	0.44(J)	0.12	0.009(U)	0.05[b]
Iron	0.550	0.550	0.072	0.102	0.3
Manganese	0.19	0.056	0.004(B)	0.007(U)	0.05[c]
Vanadium	0.020	0.020	0.005	(U)	NA
Organics (mg/L)					
Bis(2-ethylhexyl)phthalate	0.003	0.003	(U)	(U)	0.006
Anions (mg/L)					
Ammonia as N	0.75	0.26	0.1(J)	<0.5(UJ)	0.27[d]
Nitrate as N	32.7	14.1	0.68	(U)	10[a,b]
Sulfide	1	1	(U)	(U)	NA

[a] 40 CFR 141 (Primary MCL)
[b] WAC 173-200-040 (Primary MCL)
[c] 40 CFR 143 (Secondary MCL)
[d] Concentration in mg/L at an inhalation Hazard Quotient of 0.1.
[e] Value reported is for Total Uranium.
[f] Value reported is for total chromium.
(J) Estimated value.
(B) Analyte detected at a concentration below the contract required detection limit, but above the instrument detection limit.
(U) Undetected.
NA Not applicable.

Source: QRA for the 100-HR-3 Groundwater Operable Unit (WHC 1993d)

Table 2-2. Summary of Maximum Concentrations for Contaminants of Potential Concern for the 100-H Area.

Groundwater Contaminants	All Groundwater Wells	Near-River Groundwater Wells	H Area Springs	H Area Columbia River	MCL (pCi/L or mg/L)
Radionuclides (pCi/L)					
Tritium	11,000	7,100	3,800(J)	400(J)	20,000[b,c]
Carbon-14	72	72	NA	NA	2,000[d]
Strontium-90	33	33	12.7	0.7(J)	8[b,c]
Technetium-99	2,270	500	12	3.4	900[d]
Uranium-233/234	26.8	26.8	NA	NA	NA
Uranium 235	2.43	2.43	1.22[a]	0.53[a]	NA
Uranium-238	18.6	18.6	1.22[a]	0.53[a]	NA
Americium-241	0.28(J)	0.28(J)	NA	NA	NA
Inorganics (mg/L)					
Barium	0.14	0.10	0.054	0.031	2.0
Chromium[h]	0.49	0.046	0.052	0.006(U)	0.05[c]
Iron	5.4	1.5	0.924	0.183	0.3
Manganese	0.18	0.002(B)	0.038	0.012(B)	0.05[e]
Organics (mg/L)					
Chloroform	0.053	0.031	NA	NA	0.0017[c]
Anions (mg/L)					
Ammonia as N	0.29	0.29	(U)	(U)	NA
Fluoride	1.3	0.21	0.21	0.45	4.0[b,c]
Nitrate as N	170	32	1.01	0.12	10[b,c]
Sulfide	1	1	(U)	(U)	NA

[a] Value reported is for total Uranium
[b] 40 CFR 141 (Primary MCL)
[c] WAC 173-200-040 (Primary MCL)
[d] Calculated based on annual average concentration yielding 4 mrem/yr for 2 liter/day daily intake (National Interim Primary Drinking Water Regulations, EPA-570/9-76-03).
[e] 40 CFR 143 (Secondary MCL)
[f] Concentration in mg/L at an inhalation Hazard Quotient of 1.0.
[g] This is equivalent to 170 mg/L nitrate as N.
[h] Value reported is for total chromium.
(J) Estimated value.
(B) Analyte detected at a concentration below the contract required detection limit, but above the instrument detection limit.
(U) Undetected.
NA Not Analyzed For or Not Available.

Source: QRA for the 100-HR-3 Groundwater Operable Unit (WHC 1993d)

Table 2-3. Summary of Maximum Concentrations for Contaminants of Potential Concern for the 600 Area Between the 100-D/DR and 100-H Areas.

Groundwater Contaminants	All Groundwater Wells	Near-River Groundwater Wells	600 Area Springs	600 Area Columbia River	MCL (pCi/L or mg/L)
Radionuclides (pCi/L)					
Tritium	11,000	NA	NA	NA	20,000[a,b]
Inorganics (mg/L)					
Arsenic	0.012	NA	NA	NA	0.05[a]
Chromium[c]	0.17	NA	NA	NA	0.05[b]

[a] 40 CFR 141 (Primary MCL)
[b] WAC 173-200-040 (Primary MCL)
[c] Value reported is for total chromium
NA Not Applicable

Source: QRA for the 100-HR-3 Groundwater Operable Unit (WHC 1993d)

Table 2-4. Human Health Risk Assessment Summary for the 100-D/DR Area

Contaminant Type	Frequent-Use Scenario[b]		Occasional-Use Scenario[c]	
	Refined COPC	Incremental Cancer Risk or Hazard Quotient[a]	Refined COPC	Incremental Cancer Risk or Hazard Quotient[a]
Radioactive	Tritium Strontium-90 Total ICR for all radioactive contaminants	9×10^{-5} 3×10^{-5} 1×10^{-4}	Tritium Total ICR for all radioactive contaminants	2×10^{-6} 3×10^{-6}
Nonradioactive, Carcinogenic	None of the Nonradioactive Carcinogenic Chemicals exceeded an ICR of 1×10^{-6}		None of the Nonradioactive Carcinogenic Chemicals exceeded an ICR of 1×10^{-6}	
Nonradioactive, Noncarcinogenic	Ammonia[e] Chromium Manganese Nitrate Hazard Index	3 30 2 1 37	None of the Inorganic or Organic Chemicals exceeded a Hazard Quotient of 1.0	

a Based on maximum contaminant concentrations in groundwater.
b Frequent-use scenario is based on residential exposure parameters (DOE-RL 1994c).
c Occasional-use scenario is based on recreational exposure parameters (DOE-RL 1994c).
d The inhalation pathway is evaluated for volatile nonradioactive contaminants only.
e Ammonia is evaluated in the ingestion and inhalation pathways. All other contaminants are evaluated in the ingestion pathway only. Also, the laboratory analysis and reporting for ammonia may not be the same as the use in the reference dose for ammonia; associated risks may be over-estimated.

Table 2-5. Human Health Risk Assessment Summary for the 100-H Area.

Contaminant Type	Frequent-Use Scenario[b]		Occasional-Use Scenario[c]	
	Key Contaminants	Incremental Cancer Risk or Hazard Quotient[a]	Key Contaminants	Incremental Cancer Risk or Hazard Quotient[a]
Radioactive	Tritium	1×10^{-5}	Technetium-99	1×10^{-6}
	Carbon-14	1×10^{-6}		
	Strontium-90	3×10^{-5}		
	Technetium-99	6×10^{-5}		
	Uranium-233/234	9×10^{-6}		
	Uranium 238	1×10^{-5}		
	Americium-241	1×10^{-6}		
	Total ICR for all radioactive contaminants	1×10^{-4}	Total ICR for all radioactive contaminants	2×10^{-6}
Nonradioactive, Carcinogenic	Chloroform[d]	1×10^{-5}	None of the Nonradioactive Carcinogenic Chemicals exceeded an ICR of 1×10^{-6}	
Nonradioactive, Noncarcinogenic	Ammonia[e]	1	None of the Inorganic or Organic Chemicals exceeded a Hazard Quotient of 1.0	
	Chromium	6		
	Fluoride	1		
	Manganese	2		
	Nitrate	7		
	Hazard Index	17		

[a] Based on maximum contaminant concentrations in groundwater.
[b] Frequent-use scenario is based on residential exposure parameters (DOE-RL 1994c).
[c] Occasional-use scenario is based on recreational exposure parameters (DOE-RL 1994c).
[d] This compound is a common laboratory contaminant, therefore the concentrations identified for this compound may not be representative of groundwater in the 100 H area, and the associated risks may be over-estimated.
[e] Ammonia and chloroform are evaluated in the ingestion and inhalation pathways. All other contaminants are evaluated in the ingestion pathway only. Also, the laboratory analysis and reporting for ammonia may not be the same as the use in the reference dose for ammonia; associated risks may be over-estimated.

Table 2.6. Human Health Risk Assessment Summary for the 600 Area.

Contaminant Type	Frequent-Use Scenario[b]		Occasional-Use Scenario[c]	
	Key Contaminants	Incremental Cancer Risk or Hazard Quotient[a]	Key Contaminants	Incremental Cancer Risk or Hazard Quotient[a]
Radioactive	Tritium	1×10^{-5}	None of the Radioactive Chemicals exceeded an ICR of 1×10^{-6}	
	Total ICR for all radioactive contaminants	1×10^{-5}		
Nonradioactive, Carcinogenic	Arsenic[d]	2×10^{-4}	Arsenic[e]	5×10^{-6}
	Total ICR for all radioactive contaminants	2×10^{-4}	Total ICR for all radioactive contaminants	5×10^{-6}
Nonradioactive, Noncarcinogenic	Arsenic	2	None of the Inorganic or Organic Chemicals exceeded a Hazard Quotient of 1.0	
	Chromium	2		
	Hazard Index	5		

[a] Based on maximum contaminant concentrations in groundwater.
[b] Frequent-use scenario is based on residential exposure parameters.
[c] Occasional-use scenario is based on recreational exposure parameters.
[d] The ICR for arsenic includes background contribution. The ICR for arsenic subtracting background contribution is 3×10^{-5}.
[e] The ICR for arsenic includes background contribution. The ICR for arsenic subtracting background contribution is 6×10^{-7}.

Table 2-7. Ecological Risk Assessment Summary for Radionuclides.

Radionuclides	Near-River Wells	
	Dose >EHQ	
	100-D/DR	100-H
Americium-241	Not detected	No
Carbon-14	Not detected	No
Strontium-90	No	No
Technetium-99	Not detected	No
Tritium	No	No
Uranium-233/234	No	No
Uranium-235	Not detected	No
Uranium-238	No	No
Total Dose	No	No

Table 2-8. Ecological Risk Assessment for Nonradionuclides.

Chemical	Near-River Wells	
	100-D/DR	100-H
Bis(2-ethylhexyl) phthalate	Above chronic LOEL - Yes	Not detected
Barium	Above background - No value for LOEL	Above background - No value for LOEL
Chromium	Above acute and chronic LOEL - Yes	Above acute and chronic LOEL - Yes
Fluoride	Below background	No LOEL
Iron	Below background	Above acute LOEL
Nitrate as N	No value for LOEL	No value for LOEL
Manganese	No value for LOEL	Below background
Sulfide	Above chronic LOEL -Yes	Above chronic LOEL-Yes
Vanadium	No value for LOEL	Below background
NOTE: All other concentrations were below the Acute and Chronic LOEL or below background levels.		

3.0 REMEDIAL ACTION OBJECTIVES

Remedial action objectives are based on CERCLA guidance (EPA 1988) and are general descriptions of the objectives the remedial action is expected to accomplish. The RAOs are developed to provide a basis to evaluate the ability of ~~a specific~~ the remedial alternatives or IRMs to achieve compliance with ARARs and the intended level of risk protection to human and ecological receptors. ~~Remedial action objectives, therefore, are developed before evaluating remedial alternatives or IRMs. The remedial action objectives are defined as specifically as possible, without limiting the range of IRMs that could be applied, and address the following:~~

~~- The media of interest (groundwater)~~
~~- The types of contaminants at the site (radionuclides, inorganic chemicals, and organic chemicals)~~
~~- The potential receptors (humans and ecological receptors)~~
~~- The possible exposure pathways~~
~~- The levels of contaminants acceptable after remediation~~

The RAOs in this FFS are quantitative and qualitative expressions of the risk reduction goals for the IRM. Risk reduction can be accomplished by reducing the concentrations of the toxic COC, or by retarding or eliminating the transport of those contaminants from the source to the receptor. Therefore, the RAOs consider the media of interest (groundwater for this FFS), the possible receptors, the exposure pathways, and the types of contaminants.

3.1 RECEPTORS AND EXPOSURE PATHWAYS

The DOE currently limits access to the Hanford Site, including the 100 Areas located along the Columbia River. This limited access will continue during the time period needed to construct and operate the IRM. The groundwater in the 100 Areas is not currently used for potable water, and this restriction will continue during the IRM period. Therefore, human use of groundwater within the 100-HR-3 Operable Unit will not occur, and no human risks have been identified (under the current exposure conditions) that would necessitate an IRM. Although the QRA (WHC 1993d) identified potential health risks based on a frequent-use exposure scenario, that scenario included drinking onsite groundwater as the principal exposure route. The occasional-use exposure scenario evaluated in the QRA also included drinking groundwater as a main exposure route (but not daily use), and concluded ~~there were no~~ that risks associated with the less frequent use of groundwater were within acceptable limits. Because the exposure route between humans and contaminated groundwater is eliminated by current DOE controls, human health risks are not considered relative to the IRM for groundwater and are not considered in this FFS.

Site workers who conduct the remediation are not considered as receptors for purposes of developing the groundwater RAOs because they would not use the groundwater. Short-term

risks to workers who will be involved in the remedial actions are addressed in Section 6.2.2.5.

The Hanford Reach of the Columbia River, including the land adjacent to the river, is a valuable ecological resource largely because the natural habitats have been preserved as a result of the establishment of the Hanford Nuclear Reservation. Ecological receptors in the area, with respect to contaminated groundwater, include fish and aquatic invertebrates living in the river; muskrats, waterfowl, and shorebirds that use the river and adjacent marsh areas; and predators such as herons and mergansers that eat fish. These receptors may come in contact with contaminants in groundwater as the groundwater flows into and mixes with the surface water in the river, or as groundwater surfaces through springs and seeps and then flows into the river. The contaminants are also transferred through the food web, entering the food web via aquatic and wetland plants, or via direct uptake from water by fish and aquatic invertebrates. One critical area of exposure is the riverbed sediments because the concentrations of contaminants are expected to be higher in the sediment pore-water than in the open water column in the river. Chinook salmon spawn in the riverbed sediments along the Hanford Reach and the eggs are deposited in redds (nests) dug ~~several centimeters~~ to depths as great as 40 cm into the sediments. Furthermore, the salmon eggs and young alevin are generally more sensitive to radionuclides and inorganic contaminants than the adult salmon. Aquatic macroinvertebrates living in the riverbed sediments are also important receptors to consider because they form the food base for many species of aquatic and semiaquatic organisms.

Based on the ~~above human and ecological~~ conceptual exposure models discussed above, ecological risks will be ~~the occasional use exposure scenario is used to assess potential human health risks associated with groundwater contamination at the 100-HR-3 Operable Unit, and the exposure of plants and animals that live in and adjacent to the Columbia River is~~ used to assess potential risks associated with contaminated groundwater at the 100-HR-3 Operable Unit during the time period associated with implementing and operating an IRM.

3.2 CONTAMINANTS OF POTENTIAL CONCERN

The ecological COPCs are those constituents detected in groundwater samples from near-river wells, and present at concentrations that exceeded Hanford Site Background values for inorganic constituents (DOE-RL 1992e). Because there are currently no established Hanford Site background values for radionuclides and organic compounds, these constituents are considered COPCs if they are present in samples above detection limits. In contrast to the procedure used to identify COPCs for human health assessments, no risk-based screening was employed to initially reduce the ecological COPC. Risk-based screening is impractable because many species of plants and animals are involved, and the availability of widely accepted risk-based standards for ecological receptors is limited. The initial list of COPCs for ecological receptors is discussed in Section 2.0 (see Tables 2-7 and 2-8).

The ecological COPCs initially identified in the QRA were evaluated further by comparing the maximum concentrations of these constituents in near-river wells to DOE's radiological exposure limit of 1 rad/day, and to EPA's Ambient Water Quality Criteria (AWQC). The CRITR2 computer code (Baker and Soldat 1992) was used to convert the concentrations of the radionuclides to total daily dose estimates received by representative plants and animals. The DOE benchmark of 1 rad/day for ecological receptors is considered protective of populations of organisms and ecosystems (EPA 1993b, ~~ICRP 1977~~ IAEA 1992), and EPA's AWQC are considered protective of aquatic life (EPA 1986).

The total daily dose for radionuclides, which accounts for the effects of all radionuclides observed in the near-river well samples, was ~~were~~ found to be less than 1 rad/day in both the 100-D/DR Area and the 100-H Area. The QRA analysis, therefore, concluded there was no ecological risk resulting from radionuclides in the 100-HR-3 groundwater that would warrant an IRM for groundwater.

The maximum concentrations of inorganic and organic constituents in near-river wells in the 100-H Area exceeded AWQC for chromium, iron, and sulfide. In the 100-D/DR Area, maximum concentrations of chromium, sulfide, and bis(2-ethylhexyl)phthalate exceeded AWQC. The data and site information for these constituents were examined further to evaluate the frequency of detection for each constituent, the frequency at which each constituent exceeded the AWQC, and other factors that collectively determine whether the constituent should be considered a COC. This final review concluded that iron, sulfide, and bis(2-ethylhexyl)phthalate should be deleted from the list of COPCs relative to ecological risks. The rationale for deleting these three are as follows:

- Iron: Only three groundwater well samples taken in 1993 and 1994 had concentrations above the chronic AWQC of 1,000 ug/L. Each sample was taken from wells completed with carbon steel casings. Two of the samples exceeding the AWQC were from well H4-4; a January 1993 sample at 18,000 ug/L and a September 1993 sample at 1,600 ug/L. During the January 1993 through June 1994 period, 27 samples were analyzed for iron and only those two exceeded 1,000 ug/L. A more recent sample in June 1994 from this well had a concentration of 180 ug/L. A sample collected in April 1993 from well H4-5 had an iron concentration of 1,700 ug/L. Ten samples were collected from this well during the January 1993 through June 1994 period, and only this sample exceeded the AWQC; the next highest concentration detected from this well was 530 ug/L, and a more recent sample had a concentration of 380 ug/L.

- Bis(2-ethylhexyl)phthalate: The sampling data for this constituent were not consistent, and bis(2-ethylhexyl)phthalate is a common laboratory contaminant. The data from several samples were qualified because of contamination in blanks (B qualifier) or were considered estimated values at the detection limit (J qualifier). The erratic values for this constituent resulted from laboratory contamination rather than a reflection of aquifer conditions.

- Sulfides: The sulfide concentrations in most of the groundwater samples were at or below the 1 mg/L level of detection. One sample had a concentration of 26 mg/L, but was determined to be inconsistent with the remaining samples and eliminated from the data set in the LFI. Of 107 samples analyzed for sulfides, 74 were qualified with nondetect qualifiers. Because the concentrations in nonqualified samples were at or below the level of detection, sulfides will not be considered as COCs in this FFS. Additional data will be collected and evaluated, and this decision will be reevaluated in the future.

Based on this ~~final~~ analysis, chromium is the only inorganic or organic contaminant of concern for ecological risks for the 100-HR-3 Operable Unit. An IRM is considered to be an appropriate response to reduce risks associated with chromium, because chromium has been consistently detected in groundwater and springs and seeps at this operable unit for several years. Also, the prevalent form of chromium in the groundwater at the Hanford Site (hexavalent chromium) is ~~very~~ toxic to aquatic organisms and highly soluble in water. Hexavalent chromium is expected to migrate in groundwater to the Columbia River, where it is available to ecological receptors.

3.3 REMEDIAL ACTION OBJECTIVES

Remedial action objectives were initially developed in the *100 Areas Feasibility Study Phases 1 and 2* (DOE-RL 1994a) for soils, solid wastes, groundwater, and riverbank sediments.~~Because this Groundwater FFS addresses actions primarily to remediate groundwater (in order to protect riverbank sediments and surface water in the Columbia River),~~ The initial RAOs for groundwater and riverbank sediments, ~~surface water~~ as presented in Table 4-2 of the *100 Areas Feasibility Study Phases 1 and 2* Report, serve as a starting point for this FFS. These initial RAOs have been refined below in light of the additional information that has become available since the Phase 1 and 2 Report was completed, and considering the conceptual exposure models relative to the IRM period.

~~Once the remedial action objectives have been established, they can be numerically expressed as preliminary remediation goals. For this FFS, the preliminary remediation goals are chemical and radionuclide concentrations in groundwater and surface water that protect human health and the environment. These preliminary remediation goals consider exposure pathways, the locations where the receptors come in contact with the contaminants of concern, and the mechanisms whereby the receptors take up the contaminants (e.g., ingestion or exposure to ionizing radiation). The numeric remediation goals developed in this Groundwater FFS are preliminary and serve as a basis to define the extent of contamination, to compare interim remedial measure alternatives, and to establish a set of goals for monitoring the progress of the interim remedial measure that will be implemented. The final remediation goals will be defined when final land use and appropriate exposure scenarios are defined.~~

~~The assumptions used to develop the remedial action objectives for the 100 HR-3 Operable Unit are as follows:~~

- ~~The main objective of the interim remedial action at the 100 HR-3 Operable Unit is protection of ecological receptors in the Columbia River and abatement of migration of contaminated groundwater to areas outside the Operable Unit.~~

- ~~To estimate human health risks, an occasional use exposure scenario was considered most appropriate for the interim remedial measure period. Other exposure scenarios, including frequent use, will be addressed in additional IRMs or selection of the final remedy.~~

- ~~The results of the Qualitative Risk Assessment (WHC 1993d) for human health, using the occasional use scenario, indicated that none of the potential contaminants at the 100 HR-3 Operable Unit exceeded an Incremental Cancer Risk of 1E-04 or a Hazard Quotient of 1.0. The QRA for ecological receptors, however, indicated that some contaminants exceeded an Environmental Hazard Quotient of 1.0. Therefore, the contaminants at this Operable Unit are a concern because of their potential ecological risks, not because of their potential human health risk.~~

- ~~The IRM will continue for several years, during which time the final action for the Operable Unit will be evaluated, selected, and implemented. As long as wastes remain within the Operable Unit, the CERCLA requires a review of the interim or final remedial action at 5 year intervals.~~

The RAOs~~of~~ for the 100-HR-3 Operable Unit are as follows:

- Control groundwater movement to ~~prevent~~ reduce the release of ~~contaminants~~ chromium into the Columbia River such that concentrations in riverbed sediments 46 cm (18 in.) into the sediments do not exceed the AWQC of 11 μg/L for hexavalent chromium (EPA 1986). ~~excess of EPA's Ambient Water Quality Criteria (EPA 1986).~~

- ~~Control groundwater movement to preclude the release of radionuclides in the Columbia River that would result in a dose to an ecological receptor that would exceed 1 rad per day.~~

- Prevent erosion of soil during remediation that would contribute to Columbia River water concentrations exceeding AWQC.

- Prevent destruction of sensitive wildlife habitat, minimize the destruction or disruption of wildlife habitat in general, and prevent adverse impacts to threatened or endangered species.

The purpose ~~objective~~ of the IRM to address groundwater contamination at the 100-HR-3 Operable Unit is to protect ecological receptors ~~in the aquatic and riparian ecosystems~~ from the toxic effects of chromium, provide information that will lead to a final remedy selection for the 100-D/DR and 100-H Areas, and implement an IRM that will be consistent with the possible final remedies at the groundwater and source operable units. The IRM may include activities that will contain chromium plumes in their present locations, retard the movement of plumes toward the river, and/or reduce the amount of chromium in groundwater that is entering the Columbia River.

The potential human health risks associated with exposure scenarios different from the exposure considered relevant to this groundwater IRM will be addressed during selection of the final remedy for this area, or during another IRM effort.

~~3.2 LAND USE~~

~~**Hanford Site Land Use.** The Hanford Site encompasses 1,450 square kilometers (560 square miles) and includes several DOE operational areas. The major areas are:~~

~~The entire Hanford Site has been designated a National Environmental Research Park.~~

~~The 100 Areas, bordering the south shore of the Columbia River, is the site of the nine retired plutonium production reactors. The 100 Areas encompasses about 68 square km (26 square mi).~~

~~The 200 West and 200 East Areas are located on a plateau about 8 and 11 km (5 and 7 mi), respectively, from the Columbia River (Figure 1-1). These areas have been dedicated to waste management and disposal activities. The 200 Areas cover about 16 square km (6.2 square mi).~~

~~The 300 Area, located just north of the City of Richland, is the site of nuclear research and development. This are encompasses 1.5 square km (0.6 square mi).~~

~~The 400 Area is about 8 km (5 mi) north of the 300 Area and is the site of the Fast Flux Facility formerly used in the testing of breeder reactor systems. Also included in this area is the Fuels and Material Examination Facility.~~

~~The 1100 Areas includes the 3000 Area and Horn Rapids Landfill. It is used for Hanford Site support services.~~

~~The 600 Area includes all of the Hanford Site not occupied by the 100, 200, 300, 400, or 1100 Areas. Land uses within the 600 Area include the~~

~~Fitzner Eberhardt Arid Land Ecology Reserve, a U. S. Fish and Wildlife Service wildlife refuge, support facilities for controlled access areas, and other lands leased to the State of Washington and the Washington Public Power Supply System (Cushing 1994).~~

~~**100 Areas Land Use.** Existing land use in the 100 Areas includes land with support facilities, land for waste management, and undeveloped land. Facilities support activities include operations such as water treatment, storage of nuclear fuels, and maintenance of the reactor buildings. The waste management use results from past practice waste sites such as the contaminated soil and solid waste sites. There are undeveloped lands located throughout the 100 Areas. These undeveloped lands are the least disturbed areas, contain very few structures, but do include roads and other infrastructure. The immediate shoreline of the Columbia River is largely undeveloped and is a valued ecological area.~~

~~The Hanford Future Site Uses Working Group (DOE-RL 1992a) has recommended that the 100 Areas be considered for the following four future use options:~~

- ~~Native American uses~~
- ~~Limited recreation, recreation-related commercial use, and wildlife use~~
- ~~B Reactor as a museum and visitor center~~
- ~~Wildlife and recreation.~~

~~Furthermore, the Final River Conservation Study (National Park Service 1994) and Environmental Impact Statement for the Hanford Reach of the Columbia River (National Park Service 1993) has proposed that the Hanford Reach of the Columbia River and approximately 102,000 acres of adjacent lands be designated as a National Wild and Scenic River and a National Wildlife Refuge, respectively.~~

~~None of the Working Group's recommendations included potential future residential use by definition; however, the scenarios include a range of restricted and unrestricted uses. The DOE currently limits the access to the 100 Areas, and this access restriction is assumed to continue during the IRM period. Therefore, for purposes of this FFS, and given the relative timeframe of the IRM, an occasional use scenario has been used to determine remedial action goals for the IRM. As defined in the Hanford Past Practice Strategy, the 100 Areas will be reevaluated in the future for removal from the National Priority List. Land use will be reevaluated at that time, including a comprehensive baseline risk assessment.~~

~~3.3 RECEPTORS AND EXPOSURE PATHWAYS~~

~~Because remedial action objectives can be met by reducing contaminant concentrations at the site and/or by reducing or eliminating exposure to those contaminants; the receptors, exposure pathways, points of contact, and uptake mechanisms must all be considered during development of remedial action objectives. This section describes the receptors and exposure pathways considered in the development of remedial action objectives and the assessment of risks for the groundwater Operable Unit.~~

~~**Human Health Risks.** The HPPS promotes the use of interim remedial measures to expedite the reduction of human health or environmental risks, if those risks exceed certain benchmark values and the proposed IRMs are consistent with the possible final action at the Operable Unit. At the 100 Areas Operable Units, DOE will retain control of the land during the time that the IRMs are implemented and operated. Therefore, land use controls, similar to existing conditions, are expected to continue throughout the IRM period. These land use restrictions preclude residential use of the land in the 100 Areas, and limit public access to the 100 Areas.~~

~~The Hanford Reach of the Columbia River, adjacent to the 100 Areas, is open to the public for recreational uses such as fishing and water skiing, but use of the land along the river is restricted. Since there are springs and seeps along the river shoreline where groundwater surfaces and flows into the Columbia River, there is the potential for humans to occasionally come in contact with contaminated groundwater. However, during the time that the IRMs are conducted in the 100 Areas, frequent use exposure scenarios like the residential scenario described in the HSRAM (DOE RL 1995) are not appropriate for assessing potential risks to humans, or for comparing the relative risk of the possible interim remedial measures. The occasional use scenario, based on the recreational use scenario described in the HSRAM is appropriate for the IRM time period, and is used in this FFS to determine if risks at the 100-HR-3 Operable Unit exceed levels that would require the use of an IRM. The occasional use scenario also provides appropriate human health risk estimates for comparing the relative risks of the remedial alternatives considered for interim action.~~

~~For the purposes of establishing the preliminary remediation goals, the human receptors are assumed to be limited to individuals that will visit the site for recreational or other occasional use purposes. Site workers who would work in the area to conduct the remediation are not considered as receptors for purposes of developing preliminary remediation goals because the preliminary remediation goals define site conditions after remediation is completed. Short term risks to workers who will be involved in the remedial actions are addresses in Section 5.?.? in this Groundwater FFS.~~

~~3.4 CONTAMINANTS OF POTENTIAL CONCERN~~

~~The contaminants of potential concern for the 100-HR-3 groundwater operable unit were defined in the LFI and QRA (DOE-RL 1993b and WHC 1993d). These contaminants of potential concern are specifically those contaminants in groundwater that were identified by the QRA as exceeding one or both of the following criteria:~~

- ~~Exceedance of Hanford Site Background (95% upper tolerance limit for inorganic constituents).~~

- ~~Exceedance of preliminary human health risk based screening values based on a 1E-07 incremental cancer risk and a noncancer hazard quotient of 0.1 (developed using a frequent use exposure scenario).~~

~~To identify the contaminants of potential concern for ecological receptors, the constituents were screened only against background concentrations. No risk based screening was used because there are numerous species of ecological receptors, and there are no standard EPA recognized risk based levels for animals for all the potential radionuclide and chemical contaminants within the operable unit.~~

~~Since CERCLA requires that actions selected to remediate hazardous waste sites be protective of human health and the environment, the contaminants of potential concern identified in the QRA were further evaluated to see which of these would pose a risk to human and animal receptors, based on the exposure scenarios discussed in section 3.3.~~

~~Based on the occasional use exposure for humans, none of the contaminants of potential concern exceeded an incremental cancer risk of 1E-04 or a hazard quotient of 1.0. Interim remedial measures, therefore, are not required on the basis of human health risks.~~

~~The ecological contaminants of concern for the 100 HR-3 Operable Unit, identified by comparing the maximum concentrations of the contaminants of potential concern to DOE's radiological exposure limit of 1 rad/day or EPA's Ambient Water Quality Criteria for the protection of aquatic organisms, are:~~

- ~~For the 100-H Area: chromium, iron, and sulfides~~
- ~~For the 100-D/DR Area: chromium, sulfides, and bis(2-ethylhexyl)phthalate~~
- ~~For the 600 Area: no ecological contaminants of concern~~

~~As part of the FFS, the contaminants of concern identified in the QRA are further evaluated to ensure that the data and site information support the selection of site contaminants of concern. Based on this additional analysis, iron, sulfides, and bis (2-ethylhexyl) phthalate were deleted from the list of contaminants of potential concern developed in the QRA (WHC 1993d). The rationale for deleting these three are as follows:~~

~~As a result of this final analysis, chromium is the contaminant of concern for ecological risks for the 100 HR-3 Operable Unit.~~

~~Data from groundwater wells in the undeveloped 600 Area between the 100-D/DR and 100-H Areas indicated that arsenic concentrations in some groundwater samples exceeded incremental cancer risk levels of 1E-06 for humans, based on an occasional use scenario. However, if the normal background levels of arsenic are subtracted from the total concentrations, the ICR for arsenic is 6E-07. This is well below the range EPA uses for considering remediation. Arsenic was not considered to be a contaminant of potential concern for human health for the 100 HR-3 Operable Unit because 1) arsenic was apparently not used during the operation of the reactors in the 100 Areas (based on records and interviews), 2) arsenic was likely used as a pesticide or herbicide for agricultural purposes in the 600 Area prior to Hanford Site operations, and 3) the presence of natural arsenic contributes to the concentrations measured in groundwater samples.~~

3.4 POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121 of CERCLA requires that any remedial action selected for a Superfund site be protective of human health and the environment. A component of an action's protectiveness is its ability to comply with ARARs. An ARAR is a promulgated Federal or State environmental cleanup standard, standard of control, substantive environmental protection requirement, criteria, or limitation. It must be one of the following:

- "Applicable" (i.e., specifically addressing the substances, locations, or action being considered)

- "Relevant and Appropriate" (i.e., addressing a situation sufficiently similar to that encountered at the CERCLA site that its use is well suited to the particular site). A standard or criterion must be both relevant and appropriate to be an ARAR.

There are three categories of ARARs:

- Chemical-specific - numerical values or methodologies used to determine acceptable concentrations or doses of a contaminant

- Location-specific - requirements that dictate or restrict actions at or surrounding the CERCLA site because of sensitive or unique conditions

- Action-specific - technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes.

In addition to ARARS, to-be-considered (TBC) guidance consists of nonpromulgated criteria, advisories, guidelines, or proposed regulations. Because TBC guidance is not legally binding, it does not have the status of ARARS. However, TBCs are identified and considered if ARARs do not exist for the substance or situations of concern, or the ARAR alone would not be sufficiently protective.

Appendix A discusses the major ARARs and lists the ARARs and TBC requirements that have been identified for the 100-HR-3 Operable Unit. ~~Table 3-1 lists the chemical-specific ARARs and TBCs for the contaminants of potential concern for this Operable Unit.~~

~~3.6 INTERIM REMEDIAL MEASURE GOAL AND POINTS OF COMPLIANCE~~

~~The interim remediation measure (IRM) goal for the 100-HR-3 Operable Unit is to conduct activities that are protective of the Columbia River and its sensitive ecological receptors. This may include activities that will contain chromium plumes in their present locations; retard the movement of plumes toward the river; and reduce the amount of chromium in~~

~~groundwater that is entering the river. Alternatives for an IRM are targeted to accomplish one or more of the above.~~

~~Performance of the preferred alternative may be measured at the location of exposure for sensitive ecological receptors in the river, and/or inferred from other techniques for estimating the exposure at receptor locations. For the pilot scale chromium treatability test being conducted in the 100 D/DR reactor area, the Tri Parties agreed to using six criteria for evaluating the success of future full scale operation of the system (TPA Milestone M-15-06, Change Number M-15-93-02, January 25, 1994). These six criteria are:~~

~~1) Hexavalent chromium measured in wells near the Columbia River fall below the MTCA standard (50 ug/L) for two consecutive sampling periods.~~

~~2) Sampling of water occurring in the river bottom substrate environment, where springs are suspected to discharge contaminated groundwater, in concentrations representative of the plume, indicates that hexavalent chromium in this environment is below and will remain below the chronic ambient water quality criterion for the protection of freshwater aquatic life for hexavalent chromium (11 ug/L) set by the EPA.~~

~~3) Groundwater/Columbia River interaction studies, numerical models, or physical models indicate that predicted levels of hexavalent chromium within the riverbed substrate environment, where contaminated groundwater is suspected to discharge, in concentrations representative of the plume, are below the chronic ambient water quality criterion for the protection of freshwater aquatic life for hexavalent chromium (11 ug/L) set by the EPA.~~

~~4) Biological surveys, such as aerial photographic records, of Columbia River sections where contaminated groundwater discharges may be reasonably expected to occur, indicate that contemporary salmonid redd distributions are at concentrations and locations expected if hexavalent chromium were not an influence.~~

~~5) The effectiveness (including cost/unit of hexavalent chromium removed) of the treatment technology does not justify further operation.~~

~~6) An alternative treatment technique, such as chemical reduction of the hexavalent chromium to a less toxic valence, that is more effective or is less costly, is substituted.~~

~~These six criteria should be considered when performance goals for the IRM are established in the record of decision.~~

~~Performance goals for the IRM include reducing the concentration of chromium at locations in the Columbia River where sensitive ecological receptors may be exposed. The target concentration is the EPA Ambient Water Quality Criteria for Protection of Freshwater Aquatic Life, which for chromium is 11 ug/L, as measured at the location of exposure. The~~

~~criterion applies to the riverbed sediments that are used by chinook salmon for spawning habitat.~~

~~During the IRM, the concentration of chromium in groundwater will be monitored in the extraction well network, along the river shoreline, and within the salmon spawning habitat in the vicinity of chromium plumes. Since sampling the spawning habitat is logistically very difficult, an alternative performance monitoring methodology will be developed that is based on samples from locations along the shoreline and from existing near river monitoring wells. Evaluation of the new monitoring data may reveal an acceptable alternative to monitoring at the location of exposure in the riverbed sediments.~~

~~A preliminary remediation goal (PRG) at the location of exposure (e.g., salmon spawning habitat in the riverbed sediments) is 11 ug/L hexavalent chromium, as established by the EPA criteria. PRGs for other sampling locations along the shoreline and in near river wells will be refined as new information from pre remedial design activities are completed.~~

4.0 ALTERNATIVES DEVELOPMENT

Groundwater remediation alternatives considered for ~~treatment of the~~all 100 Areas groundwater operable units were developed and screened in the *100 Areas Feasibility Study Phases 1 and 2* (DOE-RL 1994a). These alternatives (referred to as the baseline alternatives) ~~provide a range of remedial actions applicable to the 100 Areas groundwater operable units. The baseline alternatives~~ are intended to be generally applicable anywhere in the 100 Areas. In this FFS, the baseline alternatives are further defined and modified ~~based on~~ using additional information from the 100-HR-3 Operable Unit LFI (DOE-RL 1993b), 100 Areas aggregate studies, treatability testing, and refined RAOs. ~~This section of the FFS presents detailed descriptions of each groundwater alternative retained from the 100 Areas FS for more detailed analysis. Descriptions for the baseline alternatives are expanded from the information presented in the 100 Areas FS and are modified as needed to reflect new information gathered since the preparation of the FS. The baseline descriptions are then refined to reflect 100 HR-3 Operable Unit site specific requirements and characteristics.~~ This section ~~specifically~~ describes the groundwater remediation alternatives relative to an IRM for the 100-HR-3 Operable Unit.

New and emerging treatment technologies may be incorporated into operable unit restoration activities as they become available. They would be introduced as a refined or new IRM, or as part of the final remedy. One new technology involves a method to immobilize hexavalent chromium in the aquifer. It is currently undergoing testing in the 100-H Area (~~Fruchter et al. 1995 {~~Final Draft: Test Plan for the 100-H Area In Situ Redox Manipulation Experiment: Part I Bromide Tracer Experiment, Revision 1, May 1995)~~ ?referenceable?})~~

The DOE's Environmental Management (EM) Office of Technology Development (OTD) (EM-50) ~~is~~ manage~~sing~~ an aggressive national program for applied research, development, demonstration, testing, and evaluation. The objective of this program is to develop technologies to clean up the DOE nuclear production and manufacturing sites and to manage DOE-generated wastes more cost effectively than current environmental cleanup technologies. The program ~~is~~ addresses~~ing~~ several major problem areas, including cleanup of groundwater and soil ~~cleanup~~, ~~and~~ waste retrieval, and waste processing. General descriptions of the various integrated programs within DOE's EM-50 office are published in Technical Summary reports ~~(e.g., Siegrist et al. 1994).~~

4.1 ALTERNATIVE GW-1: NO ACTION

~~Alternative GW-1, t~~The no action alternative is required by the National Contingency Plan (NCP) to serve as a baseline for evaluating other alternatives. The no action alternative may be selected for sites where contamination does not exceed a level of unacceptable risk, where site contamination is in compliance with ARARs, where short-term risks associated with the remedial action exceed the risk of no action, or where the cost of remediation is excessive compared to the benefit gained in risk reduction.

4.1.1 Baseline Description

The no action alternative assumes no further action at a site. ~~For example, no action for the groundwater operable unit consists of continued existing access controls and groundwater monitoring events through 2008, at which time these activities cease.~~ Contamination is allowed to dissipate through natural attenuation processes. For radionuclides, this includes natural radioactive decay. ~~The effectiveness of the natural attenuation process is related to the half-life of the radionuclide~~ and the affinity of the radionuclide to adsorb to the Hanford Site soils. For other contaminants, such as chromium, the major attenuation factor is advection/dispersion, which depends on natural groundwater flow ~~and the river flushing action~~ to reduce concentrations at any particular location.

4.1.2 Application to the 100-HR-3 Operable Unit

Application of the no action alternative is independent of any site-specific considerations, as this alternative requires no restrictions, controls, or active remedial measures. Therefore, the baseline description for this alternative is directly applicable to the 100-HR-3 Operable Unit without modification. Contaminant plumes within the 100-D/DR Area, 100-H Area, and the 600 Area of the 100-HR-3 Operable Unit are allowed to dissipate through natural attenuation processes. ~~Existing access controls and monitoring activities are continued through the IRM period (year 2008).~~

4.2 ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS

~~Alternative GW-2 has been developed as an institutional controls GRA.~~ This alternative was ~~initially~~ developed in the 100 Areas FS (DOE-RL 1994a) to prevent public access to contaminated groundwater plumes beneath the 100 Areas. The following process options are specified for the alternative:

- Access restrictions
  - Deed restrictions
  - Water rights restrictions

- Monitoring
  - Groundwater monitoring

- Continued current actions
  - Pilot-scale treatability test in the 100-D/DR reactor area
  - Groundwater/river interaction studies
  - Chromium speciation investigation
  - Columbia River Comprehensive Impact Assessment
  - In Situ Redox Manipulation Experiment in the 100-H reactor area.

4.2.1 Access Restrictions

~~The access restrictions included in this alternative are unique to groundwater media.~~ Government control of the Hanford Site~~, and therefore the operable unit,~~ is anticipated through the IRM period. Sitewide access restriction measures already existing at the Hanford Site, such as security fences and guarded entrances, will ensure that 100-HR-3 groundwater is not accessible to the general public. Deed restrictions and water rights are not required during the period of government control. Therefore, the institutional controls alternative does not require implementation, but only continued maintenance and enforcement.

4.2.2 Monitoring

In addition to restricting groundwater use and access to groundwater, the institutional action alternative includes groundwater and environmental monitoring. Monitoring is required to determine if and when institutional controls to restrict access to groundwater are no longer necessary.

4.2.3 Continued Current Actions

The continued current actions listed are efforts currently under way to refine the conceptual site models for the groundwater operable units and to generate ~~more certain technology performance data.~~ information to select a final remedy, including data for remedial design purposes. These efforts support the selection of the most appropriate remedial action for the 100 Areas groundwater operable units. The treatability test will provide data on technology performance and optimization, on waste generation, and possibly on aquifer response. The river/groundwater interaction studies will help describe the mixing zone to better predict the hydrologic actions affecting concentrations. The speciation studies will better quantify the amount of hexavalent chromium to provide a more realistic conceptual model of contaminant movement in the aquifer and interaction with the sediments. The river impact assessment will provide risk assessment data specific to the receptors in the river. The in situ redox manipulation experiment will provide new information on remediation alternatives for chromium. All the information will be assessed to determine the best solution for the remediation of the operable unit. When the results of the current actions are available, the conceptual site models may be complete enough to identify a final action for the operable unit.

4.3 ALTERNATIVE GW-3: CONTAINMENT

~~The containment alternative consists of remedial actions designed to ensure the containment of contaminated groundwater plumes. For the FFS, groundwater modeling results were used to estimate the optimum configuration of the cutoff wall and hydraulic control wells for evaluating alternatives (Note: additional detailed modeling would be required for remedial system design).~~

The containment options described in Alternative GW-3 rely on various characteristics of the geology and hydrogeology of each reactor area for their success. Intercepting contamination that is migrating along with groundwater toward the Columbia River requires a knowledge of the geometry of the sedimentary units containing the contamination, as well as the pathways that the flow follows. Construction of some of the containment systems requires a detailed understanding of the sediment physical properties at the actual site. Also, when assessing the performance of the containment system by numerical modeling, the accuracy of the model output is determined by the level of detail in the geometry and hydraulic characteristics of the aquifer.

Background information on the geology and hydrology of the 100-HR-3 Operable Unit can be found in Lindsey and Jaeger (1993) and Hartman and Peterson (1992), respectively. Cross sections drawn through monitoring wells located along the 100-D/DR and 100-H shorelines are shown in Figures 4-1 and 4-2 (see Figure~~s~~ 2-1 ~~and 2-2~~ for monitoring well locations).

4.3.1 Baseline Description

Alternative GW-3 ~~was initially developed in 100 Areas FS Phases 1 and 2 (DOE-RL 1994a)~~ is based on remedial technologies and associated process options for containment of contaminated groundwater plumes (Section 1.3 of Appendix B). These technologies and process options are as follows:

- Vertical barriers
  - cutoff walls
- Hydraulic control
  - Extraction wells
  - Injection wells, as necessary.
- Monitoring
  - Groundwater monitoring.

4.3.2 Application to the 100-HR-3 Operable Unit

The containment option appropriate for use at the 100-HR-3 Operable Unit is determined on the basis of site-specific implementation requirements at the 100-D/DR and 100-H Areas. These requirements include consideration of the site geologic formation and wall depth requirements. Detailed groundwater modeling results would be used to design the optimum configuration of the cutoff walls and hydraulic control wells in the 100-D/DR and 100-H Areas.

Use of cutoff wall technology ~~considered most appropriate for the 100-HR-3 Operable Unit~~ is based primarily on the following requirements:

- The technology must be implementable to a depth sufficient to anchor into the uppermost confining layer beneath the unconfined aquifer (i.e., the Ringold Formation Upper Mud Unit).

- The technology must be implementable in the Ringold Formation, Unit E (sandy, gravel sediments).

- Application of the technology must minimize exposure to contaminated soil and groundwater during implementation.

- The technology must be implementable within the spatial constraints imposed by proximity of the Columbia River and the past practice disposal facilities (e.g., retention basins, cribs, and trenches).

- Construction must occur close to the shoreline, to minimize penetration of the Hanford Site gravels.

4.3.2.1 100-D/DR Area ~~Cutoff Wall Containment Technology~~ Selection. The cutoff wall technology considered most appropriate for the 100-D/DR Area is a sheet pile. ~~Sheet pile technology is not applicable in the Hanford Formation, which consists of cobbles and boulders. The sandy gravels and silty sands comprising Ringold soils are more amenable than Hanford Site gravels to the pile driving associated with sheet pile construction. Based on the 23 to 30 m (75 to 100 ft) depth to the confining unit in the 100-D/DR Area,~~ Based on a depth of less than 7 m (25 ft) from the surface along the shoreline to the confining layer at the bottom of the uppermost unconfined aquifer (see Figure 4-1), sheet pile construction is considered implementable. ~~A technical implementation concern involves an area along the river in the 100-D/DR Area where the riverbank becomes steep before flattening out again. Along this area of the river, excavation may be required to facilitate sheet pile installation. ; however, t~~The sheet pile wall presents ~~the best~~ a good option to intercept flow to the river, ease of future removal ~~(if needed)~~, and minimal disturbance to the environment.

Other wall installation methods could be used at the 100-D/DR Area. The primary drawback to slurry wall construction at the 100-HR-3 Operable Unit is the unavoidable contact with contaminated groundwater and soil within the unconfined aquifer. Downgradient placement of a slurry wall to intercept migration of the ~~COPC plume into the river~~ contaminants would require excavation into the contaminated portion of the aquifer. This would result in significant contamination control requirements, as well as handling and disposal of excavated soils and excess slurry. Slurry wall technology is, therefore, not considered appropriate for use at the 100-HR-3 Operable Unit because of unavoidable contact with contamination resulting in waste generation (contaminated slurry and excavated spoils).

While the ~~conventional~~ slurry wall, ~~the~~ grout injection barrier, and ~~the~~ deep soil-mixed barrier ~~would likely~~ might be implementable at the 100-D/DR Area and perform comparably to the sheet pile wall, the retrievability of these methods is considered more difficult than

that of the sheet pile wall. Retrieval of any of these barriers would require excavation, drilling, or blasting to penetrate the barrier.

4.3.2.2 100-D/DR Area Containment System Configuration. ~~Within the 100-HR-3 Operable Unit, groundwater in the unconfined aquifer generally flows toward the Columbia River (DOE-RL 1993b). In the 100-D/DR Area, groundwater will flow parallel to the Columbia River during high river stages (DOE-RL 1993b). Therefore,~~ Downgradient placement of the sheet pile cutoff wall as close to the river as reasonably possible is proposed. Based on the near river topography in the 100-D/DR Area, the location proposed for placement of the cutoff wall is between the river and the 9-m (30-ft) high riverbank. This space is about 15 m (50 ft) wide, except for a small area where the space between the river and the embankment narrows before widening out again. This area may require excavation to enable emplacement of the cutoff wall. The subsurface in this region is comprised primarily of Ringold Formation soils, which do not contain boulders that would otherwise inhibit pile-driving activities.

Immediately adjacent to the river, the unconfined aquifer is just below the ground surface. Assuming that the thickness of the aquifer is similar to other locations in the 100-D/DR Area, the aquifer ranges from 4 to 7 m (13 to 24 ft) thick (Figure 4-1). The clay/silt layer beneath the unconfined aquifer provides a less permeable zone in which to anchor the wall. The required depth of the wall at this location is about 8 m (26 ft). This depth includes an additional 1 m (3 ft) for penetration into the clay/silt layer.

The 100-D/DR Area cutoff wall would be constructed along the Columbia River and span the length of the chromium plume identified in the LFI (DOE-RL 1993b). This wall would also contain the other contaminants ~~plumes identified at the 100-D/DR Area~~ that coexist within the ~~larger~~ chromium plume (e.g., nitrate, tritium, and strontium-90). The configuration of the cutoff wall must also account for groundwater flow parallel to the Columbia River during high river stages. Initial groundwater modeling and plume mass from the LFI indicate the length of the wall required for the 100-D/DR Area to be about 1,300 m (4,300 ft).

The hydraulic gradient in the 100-D/DR Area may be sufficiently small to eliminate the need for hydraulic control wells. However, ~~results of groundwater modeling indicate that~~ locating a pumping well at each end of the cutoff wall would enhance plume containment by preventing contaminated groundwater from escaping around the ends of the wall. Because the extracted groundwater will likely contain chromium (and possibly other contaminants), reinjection in the upgradient portion of the contaminant plume is required to prevent the spread of contamination.

4.3.2.3 100-D/DR Area Containment System Implementation. Implementation of a sheet piling wall at the 100-D/DR Area involves pile driving thick steel sheets into the soils of the Ringold Formation near the bank of the Columbia River. The sheet piles will be constructed with sealable joints to ensure that a continuous cutoff wall can be formed. To accomplish this, each sheet pile is constructed such that the contacting edges between successive sheet piles form an annulus that can be injected with a sealant (such as cement). Sheet pile construction equipment requirements include a hoist truck (to place sheet pilings), a mobile

crane (to perform pile driving), and a generator (Waterloo Center for Groundwater Research 1992). Sheet pile installation will not require excavation or large construction areas.

The ~~specified~~ sheet piling cutoff wall must provide strength to maintain structural integrity and sufficiently reduced permeability relative to the unconfined aquifer to ensure containment. Steel sheet thicknesses of 11 to 15 mm are considered ~~applicable~~ appropriate for constructing a cutoff wall to depths of (100 ft) (Waterloo Center for Groundwater Research 1992). The hydraulic conductivity of the unconfined aquifer along the river in the 100-HR-3 Operable Unit ranges from 3.6×10^{-3} to 2.0×10^{-1} cm/s (DOE-RL 1993b). Sealable joint sheet piling walls can attain hydraulic conductivities between 10^{-7} to 10^{-10} cm/s depending on the joint sealant material (Starr et al. 1992).

4.3.2.4 100-H Area ~~Cutoff Wall~~ Containment Technology Selection. ~~Similarly to the 100-D/DR area, the cutoff wall technology should be able to reach the confining layer beneath the unconfined aquifer, if constructed adjacent to the shoreline. Boring logs from the near river wells in the 100-H Area indicate that the uppermost, continuous confining layer beneath the unconfined aquifer is approximately 18 m (60 ft) below the surface. However, construction in the Hanford Formation is unavoidable, since the water table, and the hydrologic unit containing contaminants, is in the Hanford Formation.~~ Depth requirements for a cutoff wall along the 100-H Area shoreline are similar to those at 100-D/DR Area (see Figure 4-2). However, the uppermost part of the unconfined aquifer, which is presumed to contain the contamination of potential concern, is in Hanford Formation gravels. Successful construction of sheet pile walls in this stratigraphic unit is questionable.

Because of problems associated with construction in the Hanford Formation, none of the ~~cutoff wall~~vertical barriers technologies described in the baseline containment alternative are considered implementable in the 100-H Area. ~~Based on the need to penetrate the Hanford Formation, the sheet pile cutoff wall technology specified for use in the 100-D/DR Area is not applicable.~~ Deep soil mixing has been applied to depths of (200 ft) (in limestone); however, the technology is not considered feasible at 100-H Area because of the depth and nature of the Hanford formation (i.e., cobbles and boulders that can jam the auger or ~~deviate~~cause the direction of boring to deviate). Slurry wall construction ~~can~~ would be impacted by slurry losses into the porous, unconsolidated soils of the Hanford Formation. ~~Furthermore, p~~Poorly sorted, unconsolidated soils could result in trench collapse during slurry wall construction, especially at the required depth.

Based on the technical difficulties associated with implementing a cutoff wall in the 100-H Area, hydraulic controls are specified for containment of the chromium plume in the 100-H Area. ~~As described in the methodology document, h~~Hydraulic control involves the use of extraction and reinjection of groundwater to contain contaminant plumes. Detailed groundwater modeling ~~is~~ would be used to ~~determine~~design the most effective configuration of extraction and injection wells to contain the 100-H Area chromium plume.

The advantages of the hydraulic control system include ease of installation, compatibility with final pump and treat remedial actions ~~(if required)~~, versatility in well depth (i.e., it does not have to extend to a confining layer), and lesser impact to ecological and cultural resources. ~~Because the contaminants are removed near the river and injected upgradient, the~~

~~magnitude of risk in the near river zone is reduced by the increased travel time for the chromium to reach the river.~~ Disadvantages include difficulty maintaining hydraulic control ~~near~~close to the river, which experiences daily fluctuations up to 2.4 m (8 ft); removal and injection of contaminated water with no intermediate treatment; and the need for long-term maintenance. ~~In addition, b~~Because chromium is persistent in the environment, the hydraulic barrier would have to be maintained until other actions are taken to address the contaminant risk from chromium.~~or until the risk from the chromium is determined to be acceptable through additional assessment. Because the injected water is not treated, well scaling and biofouling may be more of a problem than for the injection of treated water.~~

~~One consideration that cannot be addressed because of the lack of information is the use of a hanging wall. This is a vertical barrier that does not extend to a confining layer, but is installed to a depth below the contamination (i.e., the contamination is confined to the upper layers of the aquifer). Additional borings to characterize the partitioning distribution of chromium contamination in the formation aquifer would be required to determine the suitability of the hanging wall. If the contamination is confined to the upper portion of the aquifer, then the vertical barrier may become a viable option at the 100-H Area.~~

4.3.2.5 100-H Area Containment System Configuration. The containment system configuration required at the 100-H Area consists primarily of a line of extraction wells placed along the Columbia River and a line of injection wells placed in an upgradient ~~region~~portion of the chromium plume. About ~~seven~~nine wells spaced ~~200 m (660 ft)~~160 m (520 ft) apart, as close as reasonably possible to the Columbia River, ~~are required~~ were estimated for extraction. The total extraction rate required from the wells is about ~~350~~225 gpm. ~~Three i~~Injection wells with the same injection rate (~~350~~225 gpm) are required along the upgradient end of the plume. Placement of the injection wells is such that the size and location of the chromium plume are not significantly influenced. This hydraulic control system will also contain other contaminant plumes ~~identified at the 100-H Area~~ that coexist within the larger chromium plume (e.g., nitrate, strontium-90, technetium-99, uranium-238).

4.3.2.6 100-H Area Containment System Implementation. ~~The containment system selected above involves the use of extraction wells to remove chromium contaminated groundwater before it enters the Columbia River.~~ Implementation of injection and extraction wells is relatively simple compared to cutoff wall construction. Construction concerns include designing ~~involve~~ (1) proper well screening to capture the chromium plume, and (2) plumbing between extraction and injection wells. ~~Figure 4-3 illustrates the approximate location of the well system, based on groundwater modeling results.~~

Chromium contamination in the 100-H Area is assumed to exist throughout the vertical ~~depth~~extent of the aquifer. Based on this assumption, extraction and injection wells would ~~need to~~ be screened ~~across the depth of~~ for the full thickness of the unconfined aquifer. ~~Additional characterization to verify this assumption may be appropriate.~~ If that contamination is limited to the upper portion of the aquifer, the construction depth and pumping rate of the extraction and injection wells may be decreased.

~~**4.3.2.8 100-H Area Containment System Modeling Results.** Groundwater modeling results for Alternative GW-3 in the 100-H Area are similar to the modeling results obtained~~

~~for the 100-D/DR Area. Essentially, containment can significantly reduce the mass of chromium entering the Columbia River during the period of interim action. Modeling results for the 100-H Area show a 92% reduction in the mass of chromium entering the river in comparison to the baseline (no action).~~

4.4 ALTERNATIVE GW-4: IN SITU TREATMENT

The general description of Alternative GW-4 (see Section 1.4 of Appendix B) includes remedial technologies for in situ treatment of nitrate and volatile organic compounds in the groundwater beneath the 100 Areas. ~~This alternative is not considered applicable to the 100-HR-3 Operable Unit, because the contaminants addressed by this alternative are not COPCs for the operable unit. On this basis,~~ Because chromium is the COPC for this FSS, no further discussion of the in situ treatment alternative is presented.

4.5 ALTERNATIVE GW-5: REMOVAL, TREATMENT, AND DISPOSAL USING ION EXCHANGE

~~Alternative GW-5 has been developed as a removal, treatment, and disposal GRA. The objective of Alternative GW-5 is to contain the contaminant plumes from reaching the river or migrating outside the operable unit and to eliminate source to receptor pathways by removing, treating, and disposing of contaminated groundwater.~~
Alternative GW-5 is designed to remove contamination ~~nt plumes~~ from the unconfined aquifer; treat extracted groundwater to levels established by remedial action goals; isolate ~~and dispose of~~ treatment residuals from the accessible environment; and inject treated groundwater back into the unconfined aquifer. ~~or discharge it to the river.~~ This pump and treatment alternative also functions as a containment system if the extraction well network is placed along the shoreline to intercept contaminant plumes that are discharging into the river.

4.5.1 Baseline Description

The general description of Alternative GW-5 presented in Section 1.5 of Appendix B specifies remedial technologies for removal, treatment, and disposal of contaminated groundwater beneath the 100 Areas. Modifications to the baseline description are required based on the COPC identified for the 100-HR-3 Operable Unit LFI (DOE-RL 1993b), and on site-specific conditions at 100-D/DR and 100-H Areas. ~~Because the removal, disposal, and monitoring aspects of this alternative are independent of the site-specific conditions at each 100-Area groundwater operable unit, modifications to the baseline alternative are specific to the proposed treatment system.~~

4.5.2 ~~Treatment System Modification~~Application to the 100-HR-3 Operable Unit

~~The baseline treatment system described for Alternative GW-5 is modified initially on the basis of COC identified in the 100-D/DR Area and 100-H Area groundwater.~~ Chromium is

identified as the COC in both 100-D/DR Area and 100-H Area groundwater. Because there are no organic COCs identified in 100-D/DR Area or 100-H Area groundwater, the chemical oxidation process for the destruction of organic contaminants can be eliminated from the baseline treatment system. Similarly, because nitrate is not identified as a COC ~~in 100-D/DR Area or 100-H Area groundwater based on the occasional use scenario~~for the ecological risk assessment, the biodenitrification process can be eliminated also from the baseline treatment system. The results of the ion exchange treatability study did, however, show that nitrate is removed by the ion exchange media.

The baseline treatment system can be further modified on the basis of treatability study results. Chemical precipitation and ion exchange were investigated for removal of chromate, nitrate, and uranium-238 from 100-HR-3 groundwater (WHC 1993c). Although nitrate and uranium-238 are present in 100-HR-3 groundwater, only chromium is specifically identified as a COC. Results of this treatability study indicate ion exchange to be more effective than precipitation for removal of chromium (as well as nitrate and uranium-238). Ion exchange reduced chromium levels in 100-HR-3 groundwater to below the detection limits of the chemical analysis techniques used in the studies (29 μg/L total chromium, 19 μg/L hexavalent chromium) (WHC 1993c). The chemical precipitation process generated larger quantities of secondary waste requiring disposal than did ion exchange. Hexavalent chromium had to be reduced to its trivalent state before it could be precipitated. Hence, the process generated greater amounts of secondary waste. In addition, the precipitants formed were found to be difficult to separate from the groundwater (WHC 1993c). Based on these results, the chemical precipitation and reduction processes can be eliminated from the baseline treatment system.

The modifications described above reduce the baseline treatment system to a single treatment process consisting of ion exchange. Filtration of the groundwater feed entering the treatment system is required to remove particulate and suspended solids. ~~Resin regeneration is performed, as necessary, with annual recharge of all resin vessels. Spent resin is pneumatically blown from the exchange columns into a dewatering vessel, followed by load-out into disposal containers. Cement solidification is retained for treatment of secondary wastes (such as settling tank sludge and resin regeneration solids) on an as needed basis.~~

4.5.2.1 Treatment System Modifications. Based on the high concentrations of iron detected in 100-H Area groundwater, the treatment system developed for Alternative GW-5 must provide a means for iron removal. ~~Based on the presence of~~ Since iron and chromium are present within the same location in the unconfined aquifer, a condition in which iron is in the ferrous ion (Fe^{+2}) state and chromium is in the hexavalent state is highly improbable. Chromium would ~~have been~~ also exist in a reduced ~~to~~state as the trivalent ~~state~~ form in the presence of dissolved ferrous ion.

The EQ3/6 model, developed by the Lawrence Livermore National Laboratory, was used to determine the chemistry of this situation. The model predicted the speciation of iron and chromium in the groundwater using thermodynamic data of the chemical components present in the groundwater. As an input to the model, iron was assumed to be present as the ferrous ion in a dissolved state. The model predicted that the iron would be oxidized to the ferric state and the hexavalent chromium would be reduced to the trivalent state. ~~The unfiltered~~

~~samples were used for the chemical analysis.~~ These findings suggest that iron is most likely present as the ferrous ion and contained within suspended solids in the 100-H Area groundwater. The iron could thus be removed by ~~the using~~ filtration ~~methods~~ before ion exchange column treatment.

~~The ion exchange treatment system will be applicable to both 100-D/DR Area and 100-H Area groundwater. Figure 4-4 presents a conceptual flow diagram of the modified treatment system proposed for application of Alternative GW-5 to the 100-HR-3 Operable Unit.~~

~~**4.5.2.2 Size and Configuration.** Several options are available for implementing groundwater treatment, including a single treatment facility for all contaminated groundwater within the 100 Areas or separate treatment facilities for each groundwater operable unit. Although past practices at the 100 Areas reactor sites may have resulted in the release of the same contaminants to the environment, sampling and analysis indicates that the concentrations of contaminants in each operable unit are not the same. Therefore, separate treatment facilities at each operable unit are recommended to prevent cross-contamination and enable tailoring treatment systems to specific COC at each reactor area.~~

4.5.2.2 Site-Specific Implementation. Alternative GW-5 can be implemented as a single treatment system for the entire 100-HR-3 Operable Unit or as separate treatment systems at the 100-D/DR Area and 100-H Area. Separate treatment systems eliminate potential cross contamination between 100-D/DR and 100-H Area groundwater, reduce the distance over which contaminated groundwater is transported, minimize environmental impacts due to pipeline construction between the 100-D/DR and 100-H Areas, and enable tailoring system designs to the COC and capacity requirements at each area. ~~Cost benefit analyses and other engineering studies beyond the scope of this FFS would be required to establish the optimum location of a single treatment system. Therefore, b~~Because of the distance separating 100-D/DR and 100-H Area contaminant plumes and the diversity of contamination within those plumes, ~~and for the purpose of developing costs for this FFS,~~ Alternative GW-5 is ~~assumed to be~~ applied separately at the 100-D/DR Area and 100-H Area.

~~Application of Alternative GW-5 to the 100-D/DR Area was simulated by groundwater modeling to facilitate optimization of implementation design parameters. Modeling results indicate that a line of five extraction wells placed 30 m (100 ft) from the Columbia River and spaced about 200 m (660 ft) apart maximized capture of the chromium plume and minimized leakage into the river. An additional extraction well located near the 105-D reactor facility was included to reduce the peak concentration in the chromium plume. The combined extraction rate of all six wells is about 56 gpm.~~

~~Application of Alternative GW-5 to the 100-H Area was also simulated by groundwater modeling to facilitate optimization of implementation design parameters. Modeling results indicate that a line of seven extraction wells placed 30 m (100 ft) from the Columbia River and spaced about 200 m (660 ft) apart maximized capture of the chromium plume and minimized leakage into the river. The peak concentration within the chromium plume occurs within the radius of influence of the wells placed along the river. The combined extraction rate of all seven wells is about 350 gpm.~~

An analysis of capture zones for a line of extraction wells was used to estimate the spacing and number of wells necessary to intercept the chromium plumes along each reactor area shoreline (see Appendix D for assumptions). At 100-D/DR Area, a total of ten extraction wells spaced approximately 160 m (515 ft) apart were estimated to produce a composite flow of 100 gpm (379 L/min), with an average composite chromium concentration of 215 μg/L. At 100-H Area, nine extraction wells with approximately the same spacing were estimated to produce a composite flow of 225 gpm (852 L/min), with an average composite chromium concentration of 90 μg/L. The hydraulic conductivity at 100-H is higher than at 100-D/DR, which results in the higher extraction rate.

4.5.2.3 Operational Considerations. Although the COCs identified in 100-D/DR Area groundwater are limited to chromium, low concentrations of other contaminants, such as nitrate and strontium-90, are also present (DOE-RL 1993b). Similarly, low concentrations of nitrate, strontium-90, technetium-99, and uranium-238 coexist within the chromium plume in 100-H Area groundwater (DOE-RL 1993b). ~~The potential for t~~These additional contaminants ~~to enter the treatment system~~ must be considered in the design of the treatment system.

Based on treatability study results, the anion exchange system required to remove chromium will also remove other anionic contaminants such as nitrates, technetium-99, and uranium-238. Although these contaminants will compete with chromium for binding sites on the resin, no significant operational impacts to the system will result. ~~Treatability study results indicate that no interaction between chromium, nitrate, and uranium occur with Dowex 21k resin. Interactions with other constituents in the groundwater are possible and can be minimized with appropriate pretreatment (filtration, pH adjustment, etc.).~~ Experience with the chromium-specific resin WBG-30 at the Boomsnub NPL site in Vancouver, Washington and at the 100-HR-3 pilot-scale test has shown that resin to be effective in reducing chromium concentrations. The performance of WBG-30 resin will be optimized by adjusting the pH of the inflow. Effluent monitoring will ~~enable determination of chromium breakthrough that will~~ be used to signal the need for~~require~~ resin changeout~~ or regeneration~~.

Strontium-90 exists in groundwater as a cation and will not be removed in the anion exchange system. However, the peak concentration of strontium-90 observed during the LFI is only 41 pCi/L[1] (DOE-RL 1993b) in the 100-D/DR Area and 33 pCi/L in the 100-H Area. Once groundwater from the line of extraction wells is combined before entering the ion exchange treatment system in each area, concentrations of strontium-90 will be diluted to negligible levels. ~~That is, the plume is small, with an even smaller area at the peak concentration. Reinjecting water from the entire front of the chromium plume will dilute the area of peak concentration for the strontium 90.~~

The baseline description ~~effor~~ Alternative GW-5 specifies reinjection into the unconfined aquifer. ~~for effluent from treatment systems that contains tritium activity concentrations above the SDWA MCL (20,000 pCi/L).~~ The location of reinjection will be sufficiently upgradient from the Columbia River to ensure that natural radioactive decay will reduce tritium levels to below the SDWA MCL (20,000 pCi/L) before reaching the Columbia River.

[1]This concentration is qualified with a "J" or estimated qualifier.

This situation may ~~potentially~~ occur in the 100-D/DR Area, where the peak concentration of tritium has been observed to be about 78,000 pCi/L (DOE-RL 1993b).

~~**4.5.2.5 Modeling Results.** Groundwater modeling results indicate the benefit of the removal, treatment, and disposal alternatives to be twofold. The extraction system acts as an effective hydraulic control measure by minimizing further migration of the chromium plume, and the treatment system effectively reduces the concentration of chromium within the extracted groundwater. Modeling results are independent of the treatment system because the groundwater model does not account for above ground activities. However, the ion exchange treatability study results have demonstrated that the treatment system for Alternative GW-5 can effectively remove chromium from groundwater extracted from the 100-HR-3 Operable Unit.~~

~~In comparison to the baseline (no action), an approximate 97% reduction in the mass of chromium entering the river from 100-D/DR Area and 100-H Area groundwater is achieved during the interim remedial measure. Although the modeling results show that chromium concentrations in groundwater entering the river will remain above the EPA AWQC level of 11 ppb, the hydraulic effects of the extraction system significantly reduce the flow rate of contaminated groundwater into the river.~~

~~The disposal aspect of this alternative is not included in the groundwater modeling results. Effluent from the treatment systems is to be discharged directly into the Columbia River (if at acceptable levels for such discharge) or reinjected to the aquifer. Based on the results of the ion exchange treatability study (WHC 1993e), chromium concentrations below 29 ppb total chromium and 19 ppb chromium (VI) are achievable[2]. If injection into the aquifer becomes a necessary alternative to discharge into the river, additional detailed hydrologic analysis and numerical modeling will be conducted to simulate the effects. This detailed modeling will be conducted as part of the design of the pump and treatment system well network.~~

4.6 ALTERNATIVE GW-6: REMOVAL, TREATMENT, AND DISPOSAL USING REVERSE OSMOSIS

Alternative GW-6 is similar to Alternative GW-5 in that both alternatives specify remedial technologies for the removal, treatment, and disposal of contaminated groundwater beneath the 100 Areas. The primary difference between these alternatives is the treatment technology~~ies specified~~. Therefore, the general description of Alternative GW-6 also requires modification for application to the COCs identified in the 100-HR-3 Operable Unit. Because the removal, disposal, and monitoring aspects of this alternative are independent of the site- specific conditions at each 100 Area groundwater operable unit, modifications to the baseline alternative are specific to the proposed treatment system. The aspects of Alternative GW-6 that are different from GW-5 are summarized below.

~~[2]These are the detection limits for the treatability study. The Contract Required Detection Limit (CRDL) for chromium is 10 µg/L (REF).~~

- Chemical treatment - No chemical treatments are specified in GW-6.
- Physical treatment - Only physical treatments are specified in GW-6.
- Disposal - Crib disposal is specified in GW-6 to allow flexibility in disposal options.

The general treatment system described for Alternative GW-6 (see Section 1.6 of Appendix B) is modified on the basis of the COCs identified in 100-HR-3 groundwater. As described for Alternative GW-5, no organic COCs are identified in 100-HR-3 groundwater. Therefore, the air stripping/carbon adsorption process for removal of organic contaminants can be eliminated from the baseline treatment system. No other modifications to the baseline treatment system for Alternative GW-6 are required.

The modification described above reduces the baseline treatment system to reverse osmosis followed by evaporation. Groundwater feed into the treatment system is pretreated by pH adjustment and a crystallization inhibitor to maximize the efficiency of reverse osmosis. Cement solidification is retained for treatment of concentrate from the evaporator and other secondary wastes (settling tank sludge). Liquid effluent from the process is disposed as described in the baseline description of this alternative. The iron removal process specified in Alternative GW-5 for 100-H Area groundwater is also applicable to this alternative. The reverse osmosis/evaporation treatment system will be applicable to the 100-D/DR Area and 100-H Area groundwater. ~~Figure 4-5 presents a conceptual flow diagram of the modified treatment system proposed for application of Alternative GW-6 to the 100-HR-3 Operable Unit.~~

4.6.1 Size and Configuration

The same description for Alternative GW-5 applies to GW-6.

4.6.2 Site-Specific Implementation

The site-specific implementation discussion for Alternative GW-6 is the same as that described previously for Alternative GW-5.

4.6.3 Operational Considerations

In addition to the chromium identified in 100-D/DR Area groundwater, low concentrations of other constituents such as nitrate, strontium-90, and tritium are also present (DOE-RL 1993b). Similarly, nitrate, strontium-90, technetium-99, and uranium-238 ~~also~~ coexist within the chromium plume in 100-H Area groundwater (DOE-RL 1993b). The potential for these additional constituents to enter the treatment system must be considered. In the absence of treatability study data, the effect of additional contaminants on each treatment process is assessed below on the basis of whether the technology has been previously applied to the COCs in similar situations.

Reverse osmosis is specified as a best available technology (BAT) for removing chromium and nitrate to MCL in the SDWA [40 CFR 141.62(c)]. Reverse osmosis has been effectively demonstrated for removing inorganic contaminants such as hexavalent chromium, trivalent chromium, nitrates, and uranium (Porter 1990; Huxstep and Sorg 1988). Decontamination factors over 100 have been achieved for removing strontium by reverse osmosis (Ebra et al. 1987). Similarly, reverse osmosis has been shown to achieve >95% removal of uranium from groundwater (Huxstep and Sorg 1988). The effectiveness of reverse osmosis to reject other radionuclides is considered high on the basis of engineering judgment. The effectiveness of reverse osmosis to treat the AWQC for chromium of 11 μg/L is uncertain. Treatability testing on a pilot scale would be required to develop cost and performance data to this level.

Evaporation technologies have been used extensively for treatment of radioactive liquid wastes. As discussed in the baseline description of this alternative, the purpose of the evaporation process is to reduce the volume of contaminated groundwater requiring further treatment. Contaminated water from the Three Mile Island accident was treated with a vapor recompression evaporator. The evaporation process also included an auxiliary evaporator, flash vaporizer, and a concentrate dryer. The process was shown to effectively concentrate strontium-90, technetium-99, and uranium isotopes, as well as other radionuclides (Williams and Strand 1990). The process resulted in a 56:1 volume reduction (Williams and Strand 1990). Nonradioactive contaminants, such as chromium, can also be expected to concentrate in the evaporator bottoms.~~, but nitrate will likely be volatilized with water vapor.~~

Effluent from the reverse osmosis/evaporation treatment system that is contaminated with tritium at concentrations above the SDWA MCL (20,000 pCi/L) is disposed, as described previously for Alternative GW-5 (see Section 4.5.2.~~31.5.3~~). Based on a peak tritium concentration of 78,000 pCi/L in the 100-D/DR Area, disposal of tritium-contaminated groundwater may be necessary.

~~4.6.4 Modeling Results~~

~~The groundwater modeling results described previous for Alternative GW-5 (see Section 4.1.5.4) are also applicable to Alternative GW-6. As noted previously, the results presented are independent of the treatment process because the groundwater model does not include the effects of aboveground activities. Because of the effectiveness of reverse osmosis for chromium removal, the groundwater modeling results are considered valid for this alternative. The effect of removal, treatment, and disposal is significantly reduced chromium concentrations in the contaminant plumes and minimized plume migration.~~

4.7 UNCERTAINTY ISSUES

Application of the groundwater alternatives at the 100-HR-3 Operable Unit involves ~~some degree of~~ uncertainty as to implementability and effectiveness. Although other considerations such as community and regulatory acceptance of an alternative will also be uncertain, only

technical uncertainty will be addressed here. The following sections describe the uncertainty associated with each alternative relative to the 100-HR-3 Operable Unit.

Technical uncertainties that are common to each alternative include the following:

- Horizontal and vertical extent of the plumes
- Heterogeneity in aquifer hydraulic properties, including hydraulic conductivity, retardation mechanisms, and preferential pathways
- Locations and identity of sensitive ecological receptors in the Columbia River
- Processes that occur in the zone of interaction between contaminated groundwater and river water that might influence sensitive receptor exposure
- Effectiveness of groundwater withdrawal systems to capture contamination from the aquifer.

These uncertainties limit the completeness of the conceptual site model for contamination at each reactor area. They also place significant limitations on numerical modeling results used to simulate groundwater flow and contaminant transport, and to compare alternatives for remedial actions.

As part of planning the IRM, new information will be obtained to lessen the technical uncertainties associated with remedial design. A more detailed analysis of the hydrologic framework for each plume will be conducted, which will improve the conceptual site model and provide a better basis for the numerical groundwater flow model that supports design of the extraction and injection well networks. Field activities to measure chromium concentrations in salmon-spawning habitat and to collect data on the zone of interaction between groundwater and river water, will continue during the IRM. Performance monitoring during the initial operation of active remediation systems will be used to evaluate the effectiveness of the alternative, and to refine its design, if appropriate.

4.7.1 Alternative GW-1

(None, other than as described above).
~~The objective of the IRM (protection of the Columbia River) will not be achieved with no action. Uncertainty exists in the COCs identified for the operable unit. Because the COCs are based on the concentrations in the near river wells, they may not represent accurate concentrations available for uptake by biological resources. The uncertainty could be reduced by modeling the interaction between the riverwater and groundwater to determine an appropriate mixing relationship. This uncertainty applies to all the alternatives and is a major factor in the analysis of benefits versus costs.~~

4.7.2 Alternative GW-2

Implementation of the institutional controls alternative is relatively straightforward, requiring only administrative effort and legal enforcement. Because the Hanford Site will remain under government control throughout the interim action period ~~(year 2008)~~, this alternative is essentially in place. ~~Uncertainty issues are similar to GW-1.~~

4.7.3 Alternative GW-3

The uncertainty associated with the containment alternative in the 100-D/DR Area is the ability to implement a sheet piling wall along the bank of the Columbia River. Construction of a sheet piling wall requires pile driving steel sheets into the soil formation directly adjacent to the river. These soils are ~~considered to be~~ predominately Ringold Formation soils. However, the presence of subsurface obstructions, such as cobbles or boulders, can inhibit pile driving activities. Excavation may be applicable for infrequent subsurface obstruction removal requirements. An additional concern involves the ability to construct the sheet piling wall in the area along the river where a steep embankment exists close to the river. Excavation of this embankment may be required to enable construction of the sheet pile wall in this area. Additional characterization of the 100-D/DR Area along the riverbank, and treatability testing, may be required to verify implementability of the sheet piling wall.

The primary concern associated with the containment system specified for the 100-H Area is the ability of hydraulic control wells to effectively contain the chromium plume. The extent of contamination in the vertical direction within the unconfined aquifer is important to effective hydraulic control. The well system (screening) should only extract and inject groundwater within the plume area. Extraction and injection throughout the vertical extent of the aquifer could result in the spread of contamination and ineffective containment. Withdrawal of water from near the river will result in induced flow from the river. This portion of river water will then be added to the groundwater, resulting in a net increase in the quantity of water in the flow system and an increase in hydraulic gradient. Daily and seasonal fluctuations in the river stage will add to the operational difficulties associated with the use of hydraulic control in the 100-H Area. Additional characterization of 100-H Area groundwater will enable more precise definition of the chromium plume and, consequently, of the containment system.

~~An additional consideration uncertainty for the 100-H Area is the suitability of a hanging wall. Data concerning deep contamination may is unavailable to show that keying in to a confining layer is notmay not be necessary and that the vertical a hanging barrier is an acceptable alternative at 100-H Area.~~

4.7.4 Alternative GW-4

(Not applicable.)~~The in situ treatment alternative is not applicable to the conditions in the 100-HR-3 Operable Unit (see Section 4.4). Therefore, no discussion of uncertainties is presented for this alternative.~~

4.7.5 Alternative GW-5

The primary uncertainty associated with this alternative is the effectiveness of pump and treat system to satisfy ~~in satisfying~~ RAOs for preventing the migration of contaminated groundwater into the Columbia River. ~~Groundwater modeling results for the 100-D/DR Area indicate a significant reduction in the mass of chromium and volume of contaminated groundwater reaching the river. However, t~~The concentration of chromium in groundwater entering the river may remains above the EPA AWQC level (11 μg/L). Conventional pump and treat methods have been shown to reduce contaminant mass and prevent further migration, but the ability to reduce contaminant levels to drinking water standards has been limited (PE 1993). Contaminants adsorbed onto soil particles may dissolve into the groundwater once pumping stops, thereby recontaminating the aquifer. Contaminants held in moisture in the vadose zone will continue to slowly diffuse into the saturated zone for the foreseeable future.

~~The adsorption characteristics of chromium in the unconfined aquifer beneath the 100-D/DR and 100-H Areas are critical to the evaluation of the pump and treat alternatives. Chromium must be removable from the aquifer in order for pump and treat to be effective and efficient. Because of the site specific variability of contaminant adsorption coefficients, additional site characterization or testing could be performed to more accurately determine the ability to remove chromium from the unconfined aquifer.~~

4.7.6 Alternative GW-6

The uncertainties associated with groundwater extraction and re-injection for this alternative are identical to those identified for Alternative GW-5. Alternatives GW-5 and GW-6 are essentially the same, except for the technologies specified for treating contaminated groundwater. Uncertainty exists in the ability of reverse osmosis to treat to the 11 μg/L level. Treatability testing of operable unit-specific groundwater would help resolve the uncertainty.

Figure 4-1. Cross-Section Through Near-River Wells, 100-D/DR Area. (See Figure 2-1 for well location map)

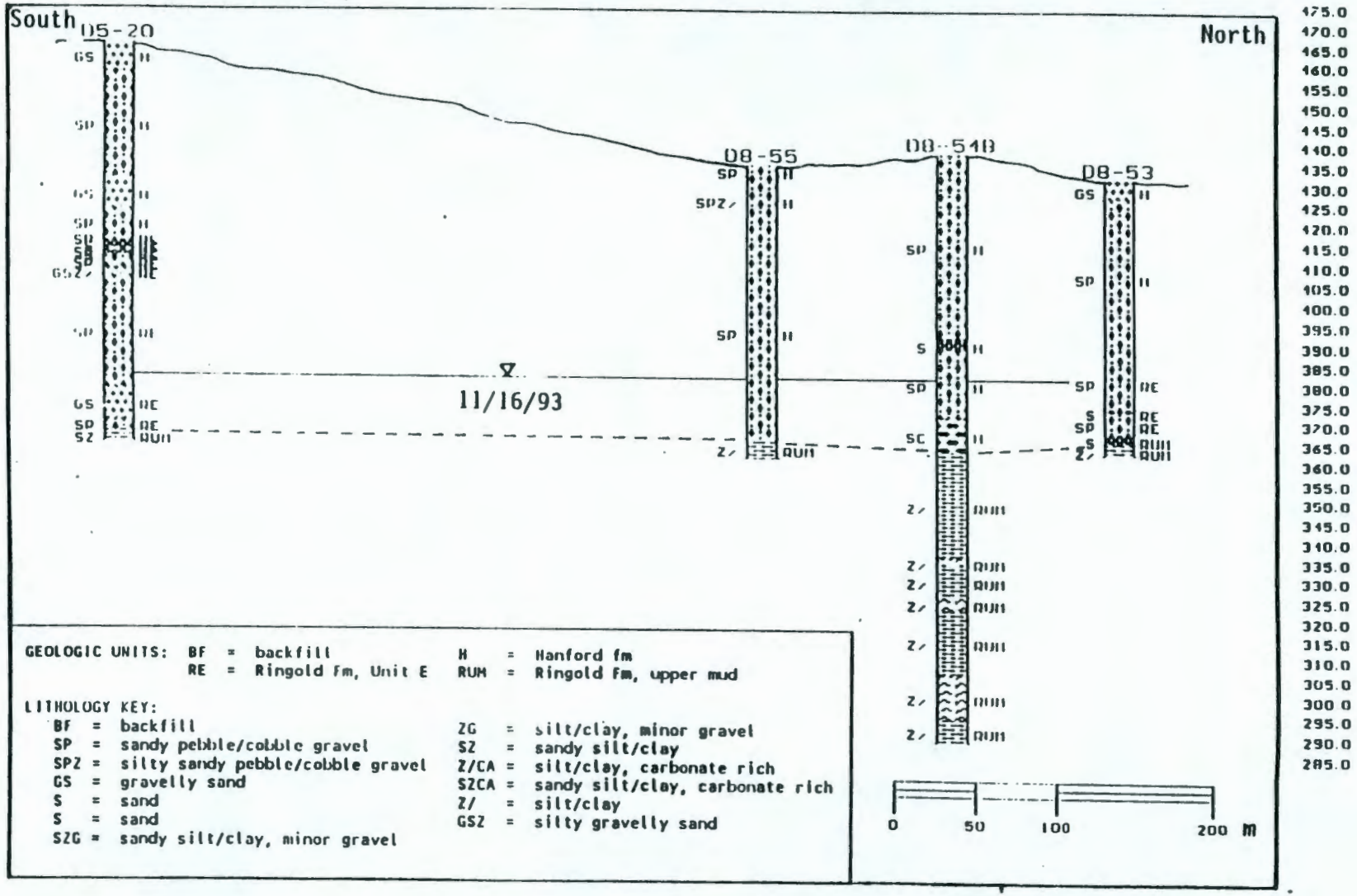
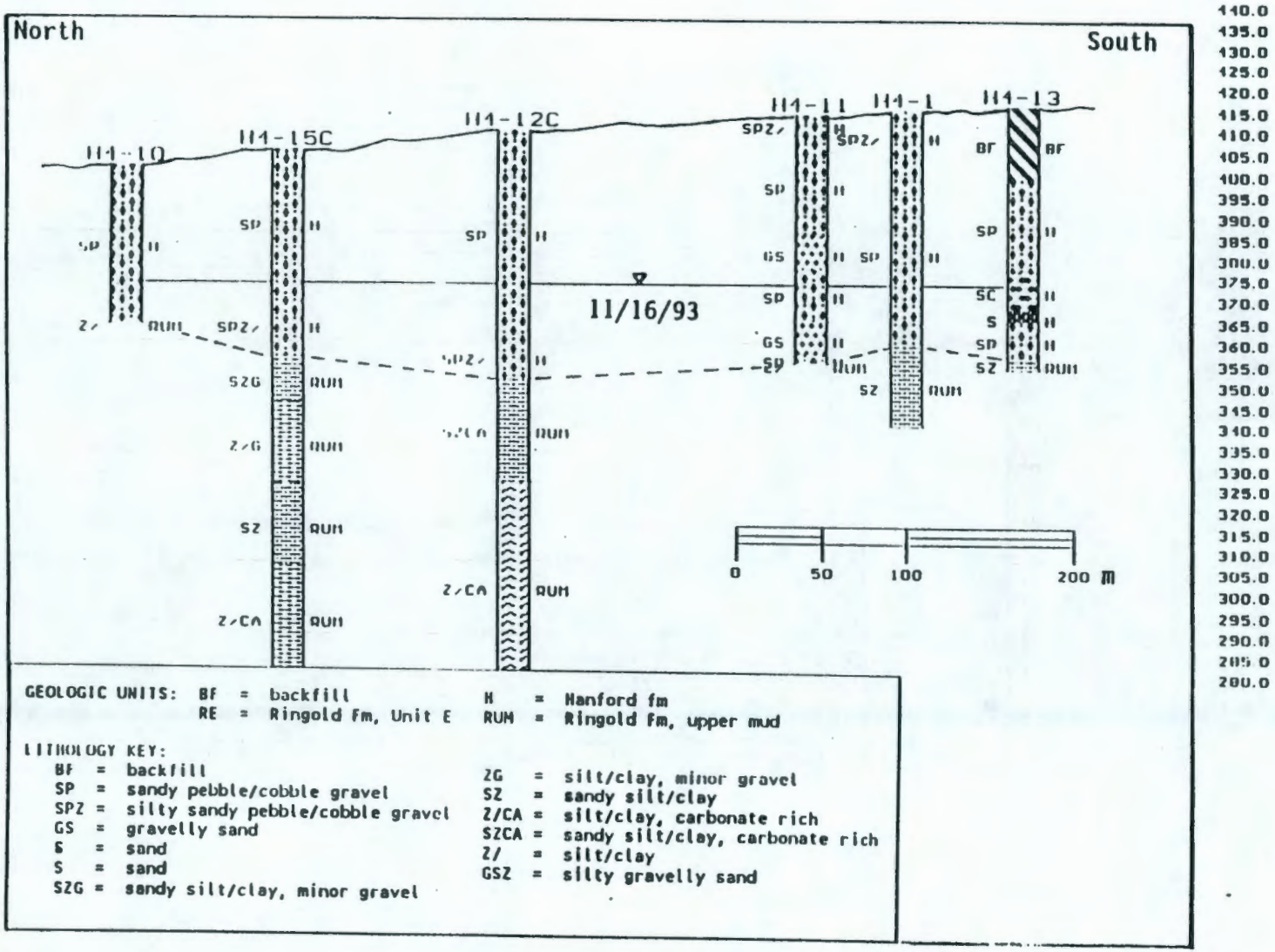


Figure 4-2. Cross-Section Through Near-River Wells, 100-H Area. (See Figure 2-1 for well location map)



5.0 MODELING RESULTS

~~Numerical groundwater flow and solute transport models of the unconfined groundwater flow systems in the 100-D/DR and 100-H Areas were developed to evaluate alternative remedial actions for minimizing further migration of chromium to the Columbia River. Existing data and information were not sufficient to support more than a qualitative comparison of the alternatives, especially when the uncertainties generally associated with modeling are factored in. The results and predictions provide a relative basis for comparison, but the values should not be considered absolute, nor a reliable estimate of alternative effectiveness or efficiency. The model results provide the description of intended impacts to the aquifer and contaminant plumes, and the numbers provide a basis to convey the anticipated magnitude of change. This section describes the design of these numerical models and the assumptions used in constructing the models.~~

The following section describes the numerical models developed for the FFS to aid in selecting a preferred alternative. The results were intended to describe contaminant plumes, and simulate the implementation of the various remedial alternatives. Because of the limited available input data, the model results contain a high degree of uncertainty. As a consequence, the model results provide only a qualitative basis for use in comparing the remediation alternatives.

The estimates and predictions from the modeling effort are not to be construed as quantitatively accurate or reliable indicators of alternative effectiveness and efficiency. Subsequent estimates for selected remedial design parameters have been developed for cost estimates that are used to compare alternatives (see Appendix D). Improved estimates and predictions will be produced as part of remedial design activities for an IRM, depending on the preferred alternative selected.

5.1 GROUNDWATER FLOW MODELS

5.1.1 Model Design

One groundwater flow model was developed for the 100-H Area, and one model was developed for the 100-D/DR Area. Both groundwater flow models were designed and constructed with ModelCad^{386}™, a computer-aided design (CAD) software package for groundwater modeling (Geraghty and Miller 1993). ModelCad^{386}™ has an interactive graphical interface, which provides a fast and accurate method for designing and constructing numerical groundwater flow models.

5.1.1.1 Model Code. The groundwater flow code that was used for the 100-D/DR and 100-H Area models was MODFLOW (McDonald and Harbaugh 1988), a finite-difference groundwater flow model code developed by the United States Geological Survey (USGS). MODFLOW was selected for this evaluation because it is capable of simulating the unconfined aquifer on a personal computer. The code can be linked to MT3d, a well

documented transport code. The intent was to describe in relative terms the impact of the alternatives. The modeling serves only as a tool for comparison.

5.1.1.2 Assumptions of Model Design. All exact hydrogeologic conditions that control the movement of groundwater in an aquifer system are not known. Therefore, some assumptions and simplifications must be made in constructing numerical models that simulate groundwater flow. The following assumptions were made in the construction of the groundwater flow models.

- The unconfined aquifer receives recharge by infiltration of precipitation.
- There is no vertical flow of groundwater between the unconfined aquifer and the underlying layers.
- The Columbia River has a uniform streambed thickness and a uniform depth along the entire reach of the river within the model grid; it can be adequately simulated with the River Package in MODFLOW.
- The groundwater flow can be adequately simulated using steady state conditions, given the objective of the modeling effort (to evaluate the relative effectiveness of alternatives).
- The contaminants are uniformly distributed vertically throughout the aquifer.
- The baseline (no action) simulations do not provide a quantitatively accurate estimate of chromium transport to the river, but serve only as a common basis for comparison of the other remedial alternatives.

The scope of the modeling effort was to develop models to compare the relative effectiveness of the various alternatives, not for design purposes, or quantifying measures of effectiveness or efficiency. Therefore, it was not feasible to model all of the details of the aquifer system, in particular the large daily and seasonal variations in the Columbia River stage. Because all of the alternatives are simulated in the same manner and use the average river stage, the modeling is adequate for the comparison of the relative performance of alternatives. To date, little vertical profiling of the contamination has been performed in the 100 Areas, so the contamination was assumed to be uniformly distributed vertically. The modeling did not include dilution effects at the river-aquifer interface, where water from the river and water from the aquifer mix, or contaminant mobilization from the vadose zone during ~~periods~~ periods of high river stage. While the contaminant concentration would decrease because of the dilution, the concentration would tend to increase where and when contaminants were mobilized from the vadose zone into the aquifer. Because these effects were considered beyond the scope and intent of the purpose of the modeling, and the magnitude of these effects is currently unknown, they were not included in the modeling effort.

Rigorous and thorough calibration of the models was neither intended or attempted. Data and information were sufficient to support only a rough approximation of the hydrologic conditions. Estimated values for hydraulic properties range over as many as three orders of magnitude, and aquifer testing and analysis to map out the heterogeneities has not been

performed. Consequently, only a simple calibration to hydraulic head, as determined from water table maps, was considered adequate. The modeling results are intended to provide a relative basis for comparison, not an absolute estimate or evaluation of any alternative's performance or effectiveness. The calibration is intended to show that the model, using the information that is available, can simulate each remedial alternative for the purpose of relative comparison.

5.2 100-D/DR AREA GROUNDWATER FLOW MODEL

5.2.1 100-D/DR Area Model Grid

A 135-row by 95-column, two-dimensional (one-layer), finite-difference grid was constructed for the 100-D/DR Area groundwater flow model (Figure 5-1). The grid was uniformly spaced, with a row and column spacing of 20 m (66 ft). The y-direction of the grid was oriented in a north-south direction, approximately parallel to the principal direction of groundwater flow in the 100-D/DR Area.

5.2.2 Boundary Conditions

The boundary conditions of a model define the head elevation or groundwater flow rate along the boundaries of the model domain and were used to simulate hydrogeologic conditions that control the flow of groundwater in an aquifer system. The boundary conditions used in the 100-D/DR Area groundwater flow model were as follows:

- Top of the model - Water table (free-surface boundary)
- Bottom of the model - No flow
- Northeast, south, southwest and east boundaries - Constant head
- Northwest boundary - River nodes (head-dependent flow).

The lower boundary of the model grid was represented as a no-flow boundary because the unconfined aquifer in the 100-D/DR area is underlain by low-hydraulic-conductivity clays (DOE-RL 1993a). It was necessary to simulate the northeast, south, southwest, and east boundaries as constant head boundaries because of the unusual groundwater flow patterns in this area (i.e., flow is not perpendicular to the Columbia River).

The Columbia River was simulated in the model as river nodes, a type of head-dependent flow boundary. The model adjusted the direction and rate of flow across the river nodes, based on the difference in the groundwater levels simulated by the model and the stage elevations of the river nodes. When the simulated groundwater levels were higher than the stage elevations of the river nodes, flow was outward from the model along the nodes. When the simulated groundwater levels were lower than the stage elevations of the river

nodes, flow was inward to the model along the nodes. The river nodes were used to simulate, in a simplified manner, the hydraulic interaction between the Columbia River and the unconfined aquifer in the 100-D/DR Area.

5.2.3 Initial Conditions

The head elevations for the constant-head boundaries were estimated by constructing a groundwater elevation contour map of the unconfined aquifer from water levels measured in the monitoring wells on November 16, 1993, and projecting the elevation contours to the model grid boundaries. River stage elevations were estimated by extrapolating the mean daily stage elevation recorded at the 100-N gaging station on November 16, 1993, to the 100-D/DR Area using the river gradient measured on the USGS Vernita Bridge and Coyote Rapids 1:24,000 scale topographic quadrangle maps of the area. The November 1993 time period was selected because a review of river stage data showed that the November stage was near the yearly average. In addition, no large seasonal variations were occurring at that time. November 16 was selected because it corresponded with the date of groundwater elevation measurement (Figure 5-2).

5.2.4 Bottom Elevations of Model Grid

A contour map of the ~~bottom elevations~~ base of the unconfined aquifer (Unit E of the Ringold Formation) (Lindsey and Jaeger 1993) was constructed from the geologic logs of the monitoring wells in the 100-D/DR Area using the computer graphics software package SURFER™ (Golden Software 1991). The bottom elevation contour map was discretized to the model grid nodes for input to MODFLOW using ModelCad^{386}™ (Figure 5-3).

5.2.5 Recharge

The aquifer recharge is reported to range from 0 to 10 cm/yr (Gee 1987). A uniform recharge of 5 cm/yr (2 in/yr) was used in the flow model. This recharge rate was determined by calibration of the flow model under steady-state flow conditions.

5.2.6 Aquifer Hydraulic Conductivity

The hydraulic conductivities of the 100-D/DR Area are reported to range from 3 to 160 m/d (10 to 530 ft/d) (Hartman and Peterson 1992). Two values of aquifer hydraulic conductivity were used in the flow model. A hydraulic conductivity of 5 m/d (16 ft/d) was used in model grid in the vicinity of wells 199-D5-13, 199-D5-20, 199-D8-4, and 199-D8-6. A hydraulic conductivity of 15 m/day (49 ft/day) was used elsewhere in the model grid. These two zones of hydraulic conductivity were used to provide the best match between model-predicted and observed water-level elevations.

5.2.7 Specific Yield and Porosity

For the transient flow modeling performed to describe the changes to the aquifer caused by some of the alternatives, a value of 0.02 was input for the specific yield. For the contaminant transport modeling, a value of 0.20 was used for the porosity to calculate the apparent velocity of the groundwater and groundwater contaminants. Hartman and Peterson (1992) reported that specific yield values calculated from data collected from the unconfined aquifer ranged from 0.01 to 0.20 at the Hanford Site.

5.2.8 River Nodes

The MODFLOW River Package is used to simulate the Columbia River in the flow model. This package simulates the interaction of the Columbia River with the unconfined aquifer in the 100-D/DR Area. The River Package requires the following as input for each node simulating the Columbia River in the model grid:

- River stage elevation
- Bottom elevation of the river bed
- Hydraulic conductance of the river bed.

River stage elevations were estimated by extrapolating the mean daily stage elevation recorded at the 100-N gaging station on November 16, 1993, to the 100-D/DR Area. A uniform river depth of 4 m (13 ft) was assumed to estimate the elevation of the river bed bottom at each river node.

The river bed hydraulic conductance is defined by the following equation (McDonald and Harbaugh 1988):

$$C_{RIV} = K\,L\,W\,/\,M$$

where:

C_{RIV} = hydraulic conductance of the river bed
K = vertical hydraulic conductivity of the river bed material
L = length of the river reach within the model grid cell
W = width of the river reach within the model grid cell
M = thickness of the river bed or distance between the river bed and adjacent aquifer node, depending on whether the head losses occur across a discrete streambed layer or are distributed more gradually throughout the aquifer.

The hydraulic conductance of the river nodes representing the Columbia River in the flow model was calculated assuming a uniform river bed thickness of 1 m (3 ft) for the river in the 100-D/DR Area. A vertical hydraulic conductivity of 5 m/d (16 ft/d) for the river bed was used in the river bed conductance calculations for the model. The river bed hydraulic

conductance was adjusted in the calibration process to determine the best match between model-predicted and observed groundwater elevations.

5.2.9 Model Calibration

The 100-D/DR Area groundwater flow model was calibrated to the water levels in the monitoring wells measured on November 16, 1993. The stage of the Columbia River, which is controlled by upstream dam releases, can vary daily from 1.8 to 2.5 m (6 to 8 ft) and seasonally from 2.5 to 3.1 m (8 to 10 ft) (DOE-RL 1993a). Groundwater flow direction is primarily to the north. This flow direction varies during the year based on river stage and recharge.

The flow model was calibrated by inputing initial estimates of recharge, aquifer hydraulic conductivity, and river bed conductance into the flow model, then solving the model for steady-state flow conditions. These estimated input parameters were then varied in successive simulations until the steady-state head solution output by the model reasonably matched the November 1993 water levels in the monitoring wells (see Figure 5-4). A comparison of the steady-state head solution of the calibrated model and the November 1993 water levels is presented in Table 5-1. Additional calibration details are provided in Appendix C.

5.3 100-H AREA GROUNDWATER FLOW MODEL

5.3.1 100-H Area Model Grid

A 160-row by 106-column, three-dimensional (two-layer), finite-difference grid was constructed for the 100-H Area groundwater flow model (Figure 5-5). Most of the grid was uniformly spaced, with a row and column spacing of 10 m (30 ft). A variable row spacing (ranging from 15 to 85 m [49 to 280 ft]) was used in the Columbia River to reduce the number of elements. The grid was rotated 52º degrees so that the Columbia River was parallel to the X axis.

5.3.2 Boundary Conditions

The boundary conditions used in the 100-H Area groundwater flow model were as follows.

- Top of the model - Water table (free-surface boundary)
- Bottom of the model - No flow
- Southwest boundary - Constant head

- Northeast boundary - River nodes (head-dependent flow)

- Southeast and northwest boundaries - No flow (parallel to groundwater flow).

The bottom of the model was represented as a no-flow boundary because the unconfined aquifer in the 100-H Area is underlain by low-hydraulic-conductivity sediments (Lindsey and Jaeger 1993). The southeast and northwest boundaries are represented as no-flow boundaries because the groundwater flow is parallel to the boundary; therefore, there is no flow across the boundary. The Columbia River was simulated in the model with river nodes, as discussed previously. The southwest boundary was determined by extrapolating the water table data for November 16, 1993. This boundary was simulated as constant head because it is perpendicular to the groundwater flow direction.

5.3.3 Initial Conditions

The head elevations for the constant-head boundaries were estimated by constructing a groundwater elevation contour map of the unconfined aquifer from water levels measured in the monitoring wells in November 1993, and projecting the elevation contours to the model grid boundaries. River stage elevations were obtained from the 100-H Area gauge. A gradient was then imposed in the river based on the gradient measured from the USGS Vernita Bridge and Coyote Rapids 1:24,000 scale topographic quadrangle maps. The November 1993 time period was selected because a review of river stage data showed that the November stage was near the yearly average. In addition, no large seasonal variations were occurring at that time. November 16 was selected because it corresponded with the date of groundwater elevation measurement.

5.3.4 Bottom Elevations of Model

The Ringold/Hanford Formation contact formed the base of model Layer 1. A contour map of the Ringold/Hanford Formation contact was constructed from the geologic logs of the monitoring wells in the 100-H Area, using the computer graphics software package SURFER™ (Golden Software 1991). This contour map was discretized to the model grid nodes for input to MODFLOW using ModelCad^{386}™. The bottom of model Layer 2 was set at a constant elevation of 55.5 m (182 ft) based on average bottom of Ringold Unit E data from Lindsey and Jaeger (1993).

5.3.5 Recharge

The aquifer recharge is reported to range from 0 to 10 cm/yr (Gee 1987). A uniform recharge of 7.3 cm/yr (3 in/yr) was used in the flow model. This recharge rate was determined by calibration of the flow model under steady-state flow conditions.

5.3.6 Aquifer Hydraulic Conductivity

The hydraulic conductivities in the 100-H Area are reported to range from 21 to 37 m/d (70 to 120 ft/d) for the Hanford Formation and from 0.04 to 107 m/d (0.14 to 350 ft/d) for the Ringold Formation (Hartman and Peterson 1992). A hydraulic conductivity of 28.6 m/d (94 ft/d) was used for Layer 1 (the Hanford Formation) and a hydraulic conductivity of 2.86 m/day (9 ft/day) was for Layer 2 (Ringold Unit E). These values of aquifer hydraulic conductivity were determined by calibration of the flow model under steady-state flow conditions.

5.3.7 Specific Yield and Porosity

For the transient flow modeling performed to describe the changes to the aquifer caused by some of the alternatives, a value of 0.02 was input for the specific yield. For the contaminant transport modeling, a value of 0.20 was used for the porosity to calculate the apparent velocity of the groundwater and groundwater contaminants. Hartman and Peterson (1992) reported that specific yield values calculated from data collected from the unconfined aquifer ranged from 0.01 to 0.20 at the Hanford Site.

5.3.8 River Nodes

The MODFLOW River Package is used to simulate the Columbia River in the flow model. River stage elevations were estimated by extrapolating the stage data recorded at the 100-H gauging station from the time period of groundwater level data collection on November 16, 1993. A uniform river depth of 3 m (10 ft) was assumed to estimate the elevation of the river bed bottom at each river node.

The hydraulic conductance of the river nodes representing the Columbia River in the flow model was calculated assuming a uniform river bed thickness of 1 m (3 ft). A vertical hydraulic conductivity of 2.86 m/d (9 ft/d) for the river bed was used in the river bed conductance calculations for the model. This river bed hydraulic conductance was adjusted in the calibration process to determine the best match between model-predicted and observed groundwater elevations.

5.3.9 Model Calibration

Groundwater flow directions in the 100-H Area are primarily to the northeast. Flow reversals occur occasionally during periods of high river stage. The 100-H Area groundwater flow model was calibrated to the water levels in the monitoring wells measured on November 16, 1993. The flow model was calibrated by inputing initial estimates of recharge, aquifer hydraulic conductivity, and river bed conductance into the flow model, then solving the model for steady-state flow conditions. These estimated input parameters were then varied in successive simulations until the steady-state head solution output by the model reasonably matched the November 16, 1993, water levels in the monitoring wells. A

comparison of the steady-state head solution of the calibrated model and the November 1993 water levels is presented in Table 5-2, and the calibrated water table surface is shown in Figure 5-7. Additional calibration details are provided in Appendix C.

5.4 SOLUTE TRANSPORT MODELS

5.4.1 Model Design

The 100-D/DR and 100-H Area solute transport models were designed and constructed with ModelCad^{386}™ (Geraghty and Miller 1993).

5.4.1.1 Transport Code. The solute transport code that was used for the 100-D/DR and 100-H Areas was MT3D, a finite-difference code developed by S. S. Papadopulos and Associates (1991). MT3D simulates the advection, dispersion, and chemical reactions of dissolved contaminants in groundwater flow systems. The code uses a combination of the method of characteristics (MOC) and the modified method of characteristics (MMOC) for the solution of the advection-dispersion-reaction equation. The MOC technique was originally developed for solute transport models by the USGS (Konikow and Bredehoeft 1978). MT3D was selected for this evaluation because it is well documented and is designed to be used in conjunction with the groundwater flow model code MODFLOW.

5.4.2 100-D/DR Area Technical Approach

Solute transport models are typically developed by calibration of the models to both past and present water quality conditions in a groundwater flow system. Because the available historical water quality data from the 100-D/DR Area are very limited, a different approach was used to develop the transport model for this area. The solute transport model for the 100-D/DR Area was developed by first performing a sensitivity analysis of the model to the transport parameters porosity, dispersivity, and retardation. The remedial action alternatives were then evaluated using a range of values for the transport parameters to which the model solution was determined to be sensitive.

5.4.2.1 Sensitivity Analysis. A sensitivity analysis was performed on the 100-D/DR Area solute transport model to determine the uncertainty of the model solutions due to the uncertainty in the estimates of the transport parameters used in the model. Transport simulations were run using a range of porosities, dispersivities, and retardation factors to determine the sensitivity of the model solutions to these transport parameters.

The October-December 1992 unfiltered chromium concentrations (DOE-RL 1993b) were used as initial concentrations for the transport simulations. No source term was simulated due to the lack of data. In addition, the model assumes that no chromium is added to the groundwater system after 1997. Migration of the chromium plume was simulated for a period of 16 years (to 2008) using the flow field solution from the calibrated steady-state flow model. Sensitivity simulations were run using porosities of ~~15%, 20%, and 25%~~ 0.15,

0.20, and 0.25; longitudinal to transverse dispersivities of 10/1 m (30/3 ft) and 100/10 m (300/30 ft); and retardation factors of 10, 25, and 50. The porosities, dispersivities, and retardation factors used in the sensitivity simulations were considered to represent the widest plausible range of values for the unconfined aquifer in the 100-D/DR Area, based on solute transport modeling at other areas within the Hanford site (for example, Connelly [1991]).

The sensitivity analyses indicated that the transport model solutions were sensitive to both dispersivity and retardation. The model solutions were most sensitive to the dispersivity and less sensitive to the retardation factor used in the simulations. The model solutions were not significantly sensitive to porosity at retardation factors >10 or to retardation values >25. The results of the sensitivity analysis are presented in Table 5-3 and are discussed in more detail in Appendix C.

5.4.3 100-H Area Technical Approach

The 100-H Area solute transport model was developed by inputing 1987 unfiltered chromium data as initial conditions and calibrated by matching 1992 data. The 1987 data set was selected for the initial concentrations because that time period marked the beginning of RCRA monitoring. Therefore, it was the oldest data set with sufficient data to develop initial conditions. The 1992 data set was used for calibration because there are some uncertainties in more recent metals data (Peterson 1993). No source term was simulated due to the lack of data. The model assumes that there no chromium has been added to the groundwater system since 1987.

The initial concentration data were input to the model and the retardation and dispersivity were adjusted to obtain the best match between observed and model-predicted chromium concentrations. The best match was obtained with a longitudinal dispersivity of 5 m (16 ft), a transverse dispersivity of 0.5 m (1.6 ft), and a retardation of 25. Because a calibration approach was used for the 100-H Area model, a separate sensitivity analysis was not performed. Calibration details are provided in Appendix C.

5.5 MODELING RESULTS

5.5.1 100-D/DR Area No Action Alternative

For the no action alternative, chromium plume migration was simulated to the year 2008. The October-December 1992 unfiltered chromium concentrations were used as the initial concentrations for the solute transport simulation. Plume migration was simulated using the flow field solution from the calibrated steady-state groundwater flow model. The transport simulation was run using a porosity of ~~20%~~ 0.20, longitudinal to transverse dispersivities of 10/1 m (30/3 ft) and 100/10 m (300/30 ft), and retardation factors of 10 and 25. Total simulation time was 16 years (to 2008). The chromium concentration contour map from the transport simulation solution using ~~20%~~ 0.20 porosity, 10 m (30 ft) longitudinal dispersivity, 1 m (3 ft) transverse dispersivity, and a retardation factor of 25 is shown in Figure 5-8.

5.5.2 100-D/DR Area Vertical Barrier Alternative

The vertical barrier alternative consisted of a vertical, low permeability wall placed near the Columbia River to act as a barrier for the further migration of contaminated groundwater into the river. In the model, a single groundwater extraction well was simulated at each end of the vertical barrier to minimize the migration of groundwater around the ends of the wall.

For the barrier wall simulations, the calibrated groundwater flow model was modified by changing the aquifer hydraulic conductivity in a line of grid nodes along the Columbia River to 1×10^{-6} cm/s to represent the barrier wall. Based on the grid size, the effective width of the wall is 20 m (66 ft) and the wall is 1,300 m (4,300 ft) long. The 20 m (66 ft) width and 10^{-6} cm/s hydraulic conductivity result in a conservative estimate of chromium entering the river. If the actual barrier used was the sheet pile, the effective hydraulic conductivity would be lower. Two well nodes were also added to the model near the ends of the simulated barrier wall to represent the groundwater extraction wells. The discharge rate of the well nodes was set at 109 m^3/d (20 gpm). Plume migration was then simulated using the flow field solution from the modified calibrated groundwater flow model. Transport simulations were run using the same range of transport parameters as for the no action alternative. Total simulation time was 16 years for both the flow and transport simulations.

The chromium concentration contour map from the barrier wall simulation solution using a value of ~~20%~~ 0.20 for porosity, 10 m (30 ft) longitudinal dispersivity, 1 m (3 ft) transverse dispersivity, and a retardation factor ~~or~~ of 25 is shown in Figure 5-9. Chromium concentration contours shown in the figure to extend from the wall to the river represent chromium which began the simulation between the barrier wall and the river, and which remained in place because the barrier wall eliminated the hydraulic gradient transporting it to the river. The water table map for this simulation is shown in Figure 5-10. The vertical barrier wall simulations showed that the barrier wall, with the two wells located near the ends, reduced the amount of chromium entering the river by about 95 percent. Such a high percentage of reduction indicates that under the conditions simulated by the model, the vertical barrier wall would block the path of the majority of chromium to the river. Compared with the no action simulations, these simulations indicate that a vertical barrier wall would be effective in minimizing further migration of contaminated groundwater into the Columbia River.

5.5.3 100-D/DR Area Groundwater Extraction and Treatment Alternative

Modeling the groundwater extraction and treatment alternative consisted of a line of extraction wells along the Columbia River to control further migration of the contaminated groundwater into the river. A single groundwater extraction well was also installed near the 105-D reactor facility to reduce contaminant concentrations in this area.

For the groundwater extraction and treatment simulations, the calibrated groundwater flow model was modified by adding six well nodes to the model to represent the boundary control and reactor facility extraction wells. Five well nodes were placed along the Columbia River.

The locations, spacing, and discharge rates of these well nodes were varied in successive simulations to maximize plume capture and to minimize the leakage of water from the river nodes simulating the Columbia River due to the well nodes (minimizing the uptake of river water by the boundary control wells). The discharge rates of the well nodes were also restricted so that the water levels in the grid cells with the well nodes were at least 2 m (7 ft) above the bottom of the model, allowing sufficient water for operation of the pumps in the extraction wells. A well spacing of approximately 200 m (660 ft) with discharge rates between 38 and 82 m^3/day (7 and 15 gpm) maximized plume capture and minimized the river leakage in the model due to the well nodes.

Plume migration was then simulated using the flow field solution from the modified calibrated groundwater flow model. Transport simulations were run using the same range of transport parameters as for the no action alternative. Total simulation time was 16 years for both the flow and transport simulations.

The chromium concentration contour map from the extraction and treatment simulation solution using ~~20%~~ a value of 0.20 for porosity, 10 m (30 ft) longitudinal dispersivity, 1 m (3 ft) transverse dispersivity, and a retardation factor of 25 is shown in Figure 5-11. The water table map for this simulation is shown in Figure 5-12. The extraction and treatment simulations showed that the well network reduced the amount of chromium entering the river by over 95 percent. Such a high percentage of reduction indicates that under the conditions simulated by the model, the extraction and treatment system would intercept the path of the majority of chromium to the river. Compared with the no action simulations, these simulations indicate that a groundwater extraction and treatment system would be effective in minimizing further migration of contaminated groundwater into the Columbia River. Chromium concentration contours shown in figure 5-11 to extend from the extraction and treatment system to the river represent chromium which began the simulation between the system and the river, and which remained in place because the pumping eliminated the hydraulic gradient transporting it to the river.

5.5.4 100-H Area No Action Alternative

For the no action alternative, chromium plume migration was simulated to the year 2008. The 1987 unfiltered chromium concentrations were used as the initial concentrations for the solute transport simulation. Plume migration was simulated using the flow field solution from the calibrated steady-state groundwater flow model. The chromium concentration contour map for the no action simulation in 2008 is shown in Figure 5-13.

5.5.5 100-H Area Vertical Barrier Alternative

The vertical barrier alternative consisted of a vertical, low permeability wall placed near the Columbia River, which would act as a barrier for the further migration of contaminated groundwater into the river. In the model, a single groundwater extraction well was installed at each end of the vertical barrier to minimize migration of groundwater around the ends of the wall.

For the barrier wall simulations, the calibrated groundwater flow model was modified by changing the aquifer hydraulic conductivity in a line of grid nodes along the Columbia River to 1 x 10^{-6} cm/s to represent the barrier wall. Based on the grid size, the effective width of the wall is 10 m (33 ft) and the wall is 1,300 m (4,300 ft) long. Two well nodes were also added to the model near the ends of the simulated barrier wall to represent the groundwater extraction wells. The discharge rate of the well nodes was set at 136 m^3/d (25 gpm). Plume migration was then simulated using the flow field solution from the modified calibrated groundwater flow model. The simulation was run with the 1994 concentrations from the no action simulation to represent the installation of the wall in 1994. The total simulation time was for both the flow and transport simulations was 14 years (to 2008).

The chromium concentration map and water table map from the barrier wall simulation at 2008 are shown in Figures 5-14 and 5-15. The wall is not specifically marked on Figure 5-11, but the location can be identified by the bunched contours parallel to the river. The vertical barrier wall simulations showed that the barrier wall, with the two wells located near the ends, reduced the amount of chromium entering the river by over 90 percent. Such a high percentage of reduction indicates that under the conditions simulated by the model, the vertical barrier wall would block the path of the majority of chromium to the river. Compared with the no action simulation, this simulation indicates that a vertical barrier wall would be effective in minimizing further migration of contaminated groundwater into the Columbia River.

5.5.6 100-H Area Hydraulic Control Alternative

The hydraulic control alternative model consisted of a line of extraction wells along the Columbia River to control further migration of the contaminated groundwater into the river. For the groundwater extraction simulations, the calibrated groundwater flow model was modified by adding seven well nodes along the Columbia River. Three injection wells were simulated upgradient of the pumping wells near the edge of the chromium plume.

The location, spacing, and discharge rates of these well nodes were varied in successive simulations to maximize plume capture and to minimize the additional leakage of water from the river nodes simulating the Columbia River due to the well nodes (minimizing the uptake of river water by the boundary control wells). The well pumping was split between the two layers, and 80 % percent of the water was extracted from the lower layer (Ringold Formation) and 20 % percent from the upper layer (Hanford Formation). A well spacing of approximately 200 m (660 ft) with a discharge rate of 270 m^3/day (50 gpm) from wells 1, 4, 5, 6, and 7 and a rate of 135 m^3/d (25 gpm) from wells 2 and 3 maximized plume capture and minimized the river leakage in the model due to the well nodes. The lower pumping rate at wells 2 and 3 were needed to keep them from going dry. The amount of river water being pumped was minimal compared to the total amount of extracted water. The extracted water was injected back to the aquifer in 3 upgradient wells at a rate of 545 m^3/d (100 gpm) per well.

Plume migration was then simulated using the flow field solution from the modified calibrated groundwater flow model. The total simulation time was 21 years (from 1987 to

2008) for both the flow and transport simulations, with the pumping beginning in 1994 (note that 1992 was the year for calibration). The hydraulic barrier simulations showed that the barrier wells pumping at 50 gpm reduced the amount of chromium entering the river by over 95 percent. Increasing the pumping rate to 100 gpm showed no significant improvement in performance. Such a high percentage of reduction indicates that under the conditions simulated by the model, the hydraulic barrier would block the path of the majority of chromium to the river. Compared with the no action simulation, this simulation indicates that a hydraulic barrier wall would be effective in minimizing further migration of contaminated groundwater into the Columbia River.

5.5.7 100-H Area Groundwater Extraction and Treatment Alternative

The model for the groundwater extraction and treatment alternative consisted of a line of extraction wells along the Columbia River to control further migration of the contaminated groundwater into the river. For the groundwater extraction and treatment simulations, the calibrated groundwater flow model was modified by adding seven well nodes along the Columbia River. The location, spacing, and discharge rates of these well nodes were varied in successive simulations to maximize plume capture and to minimize the additional leakage of water from the river nodes simulating the Columbia River due to the well nodes (minimizing the uptake of river water by the boundary control wells). The well pumping was split between the two layers, with 80 ~~%~~ percent of the water coming from the lower layer and 20 ~~%~~ percent from the upper layer. A well spacing of approximately 200 m (660 ft) with a discharge rate of 270 m^3/day (50 gpm) maximized plume capture and minimized the additional river leakage in the model due to the well nodes. The amount of river water being pumped was minimal compared to the total amount of water pumped. The capture zone, as defined by a drawdown of 0.1 m (0.3 ft), is shown in Figure 5-16.

Plume migration was then simulated using the flow field solution from the modified calibrated groundwater flow model. The total simulation time was 21 years (to 2008) for both the flow and transport simulations, with the pumping beginning in 1994. The chromium concentration map and the water table map from the seven well extraction system at 2008 are shown Figures 5-17 and 5-18. The extraction and treatment simulations showed that the well network pumping at 50 gpm reduced the amount of chromium entering the river by over 95 percent. Increasing the pumping rate to 100 gpm showed no significant improvement in performance. Decreasing the pumping rate to 25 gpm reduced the amount of chromium entering the river by less than 90 percent, so there may be a difference in performance at that pumping rate. In any case, such a high percentage of reduction indicates that under the conditions simulated by the model, the extraction and treatment system would intercept the path of the majority of chromium to the river.

Figure 5-1. 100-D/DR Area Model Grid.

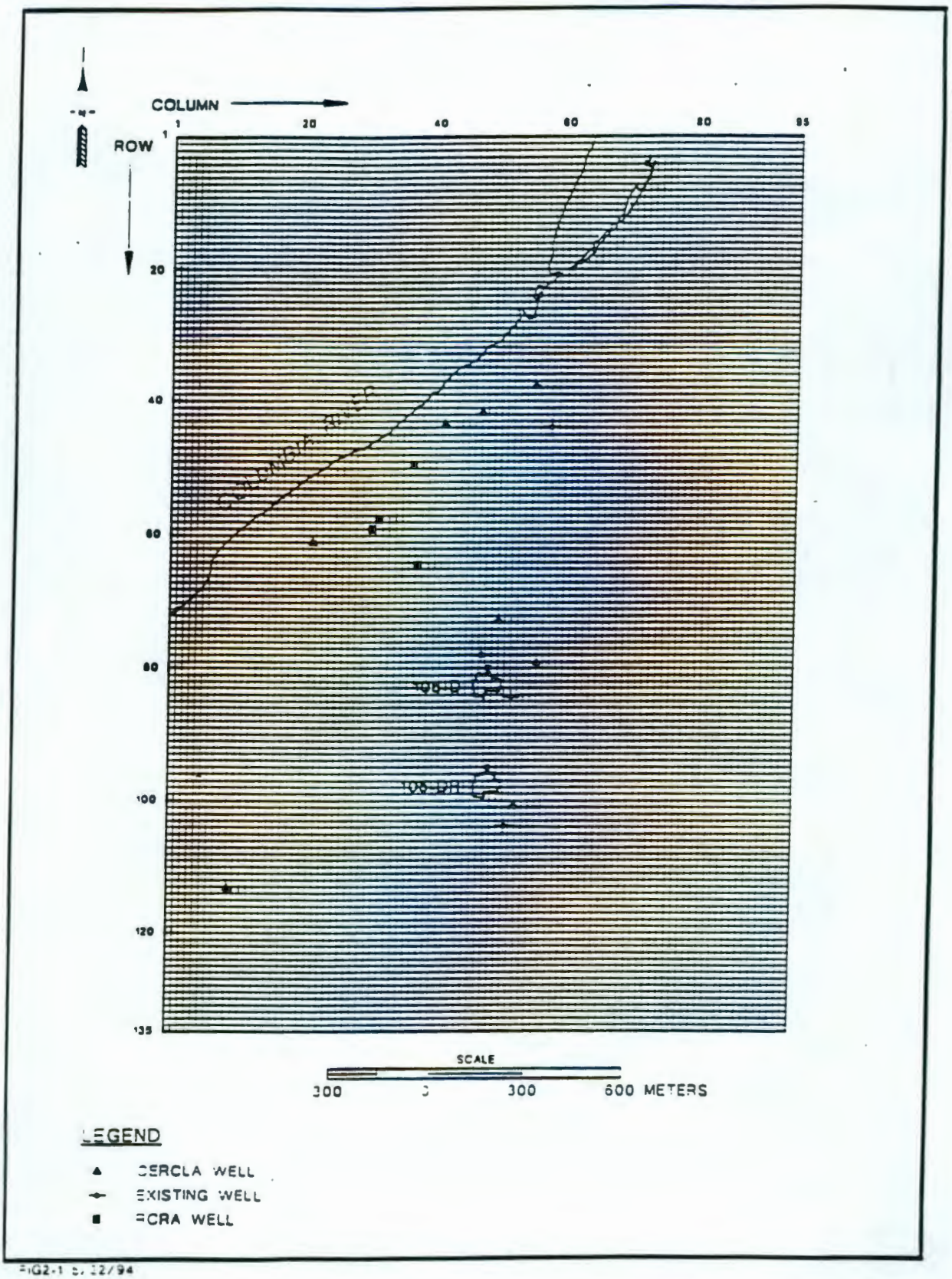


FIG2-1 5/12/94

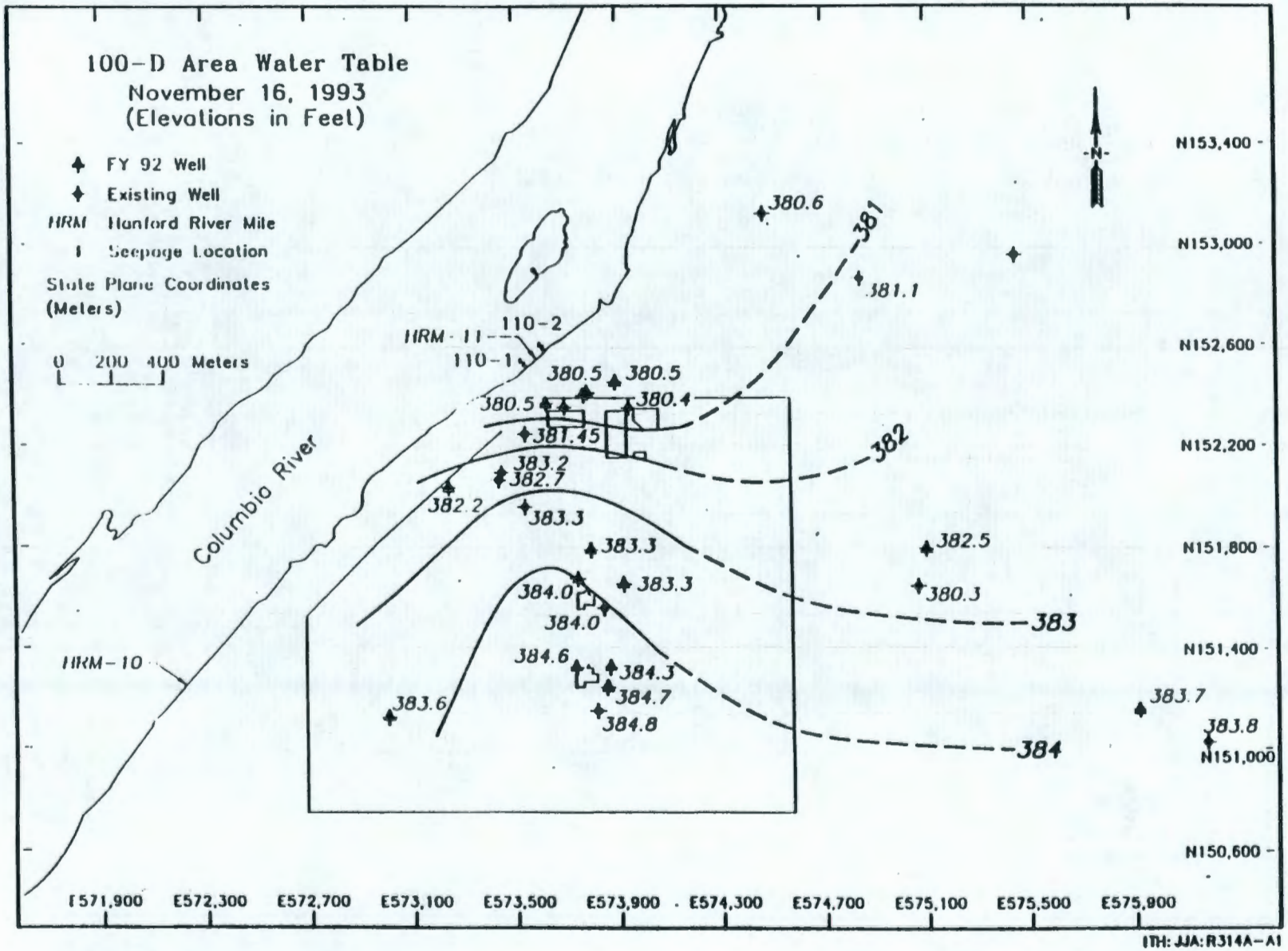


Figure 5-2. 100-D/DR Area Water Table, November 16, 1993.

Figure 5-3. Base of Unit E of the Ringold Formation.

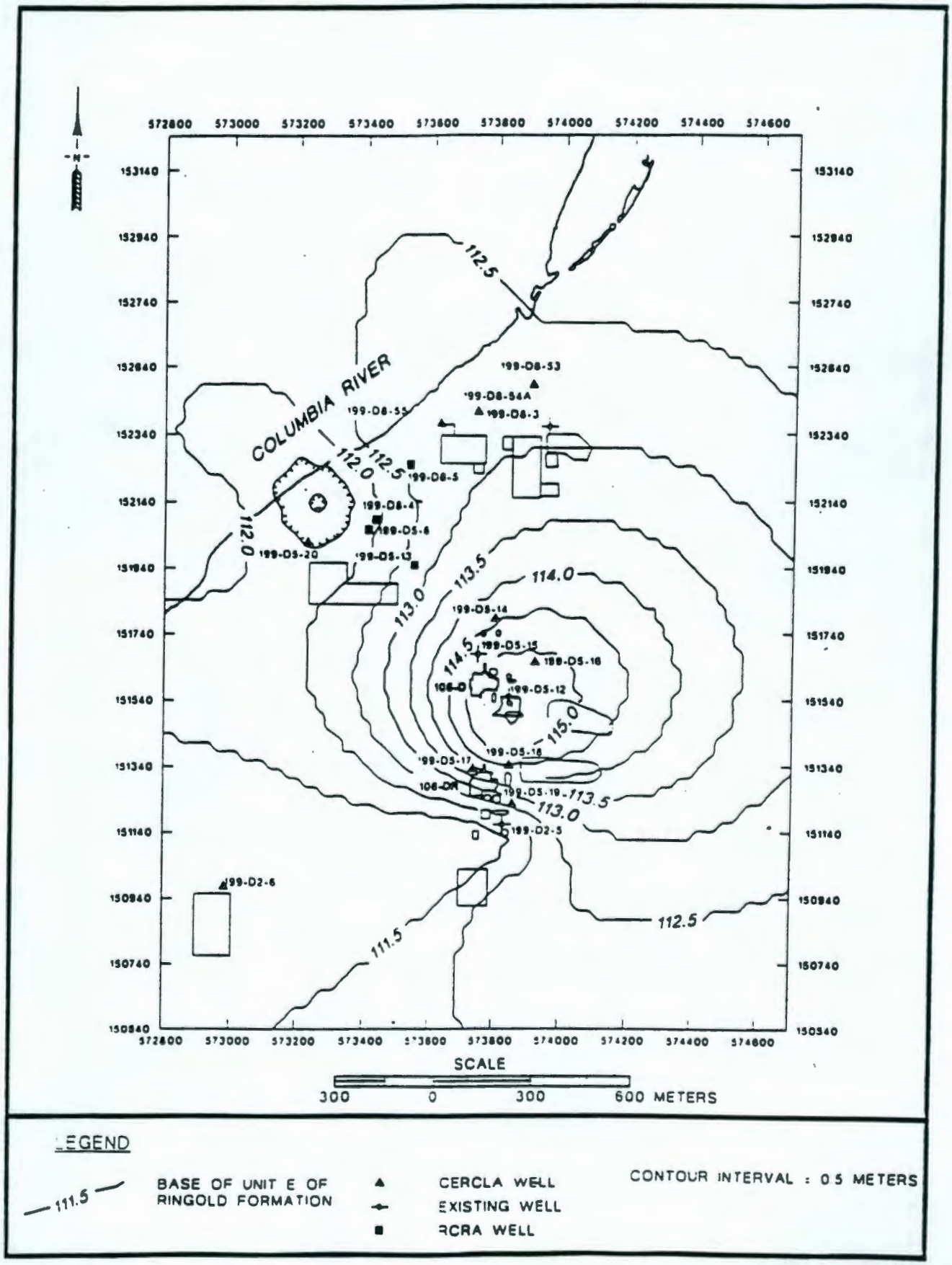


Figure 5-4. Model Calibrated Water Table for the 100-D/DR Area.

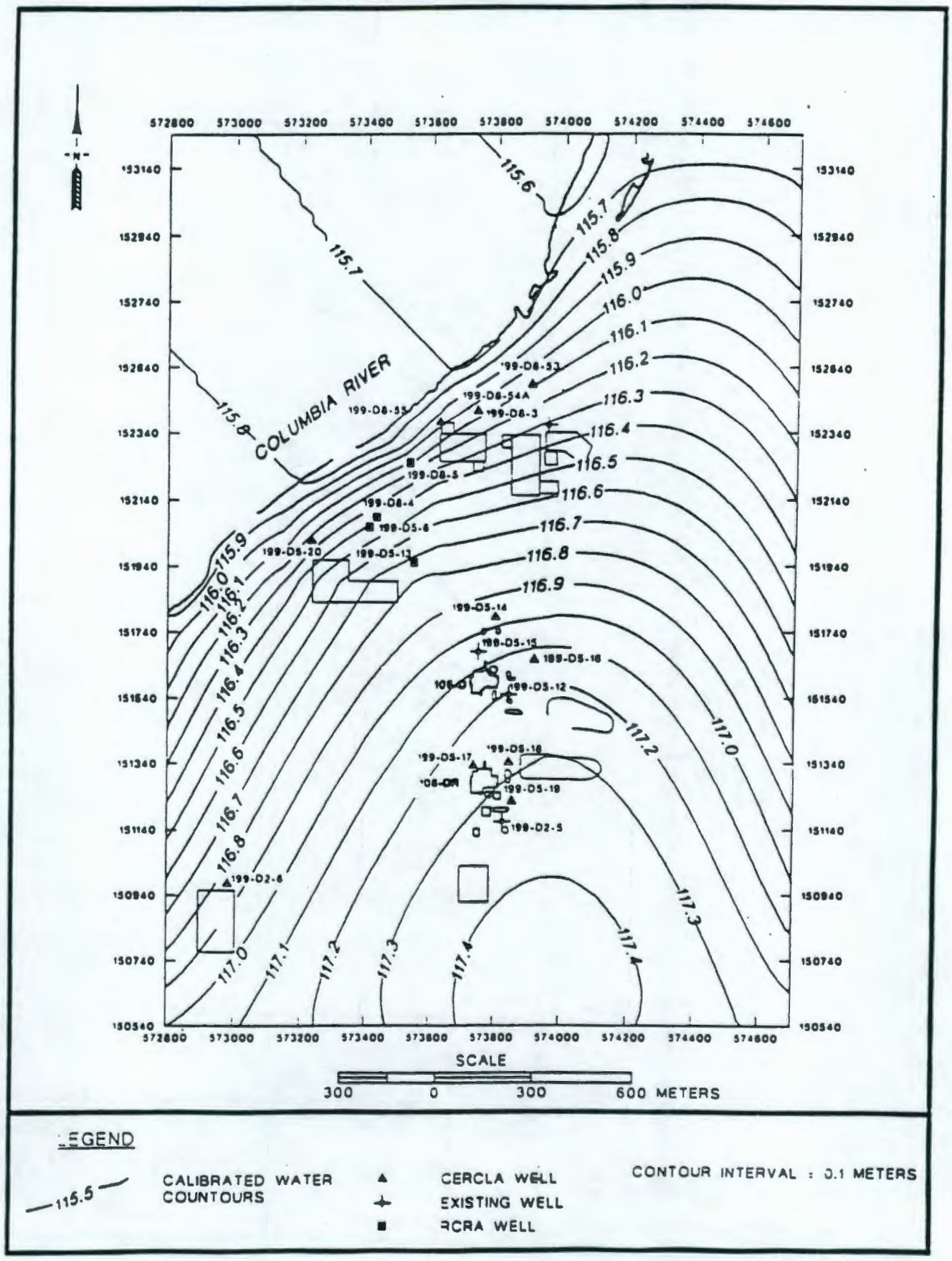
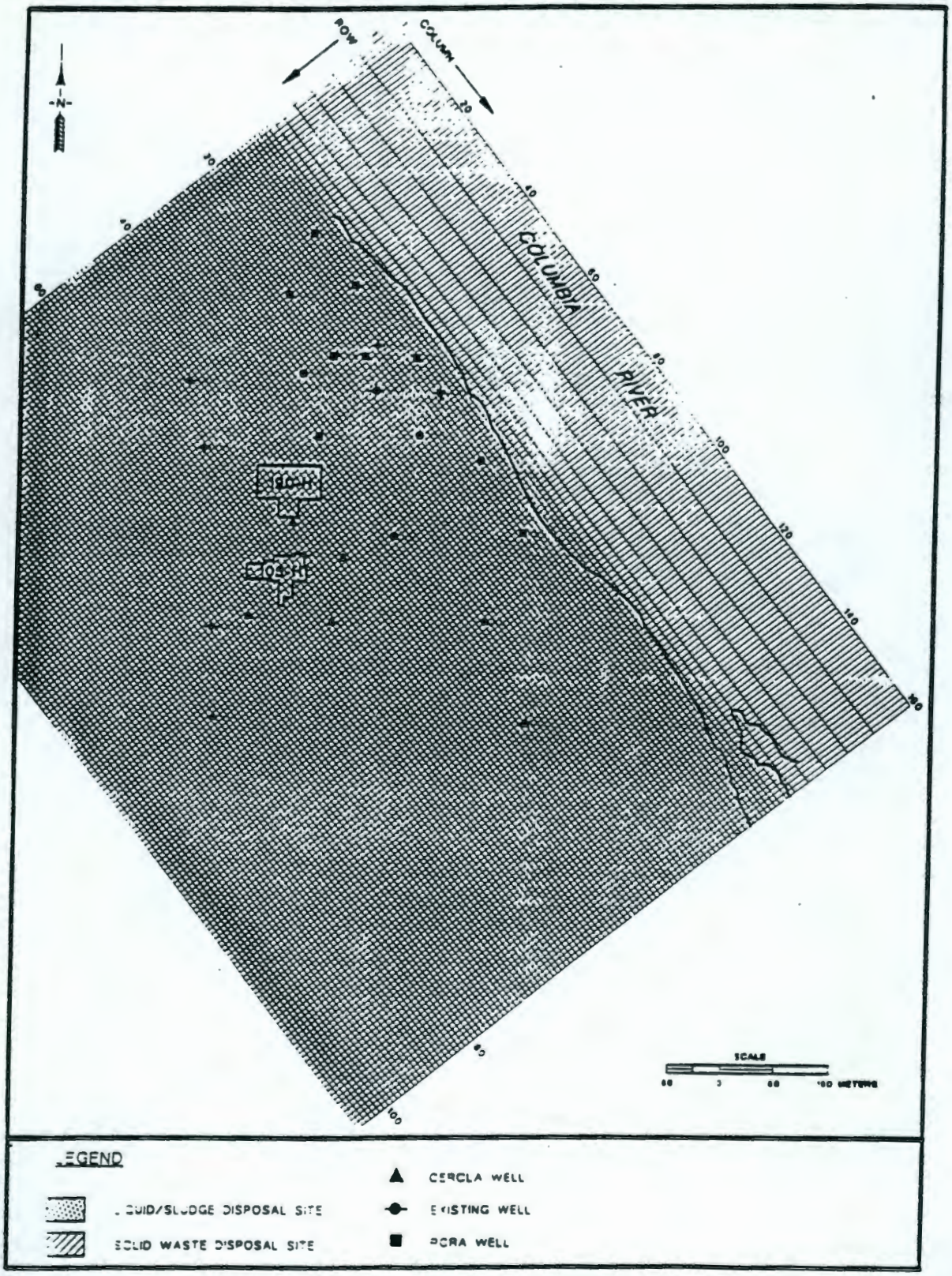


Figure 5-5. 100-H Area Model Grid.



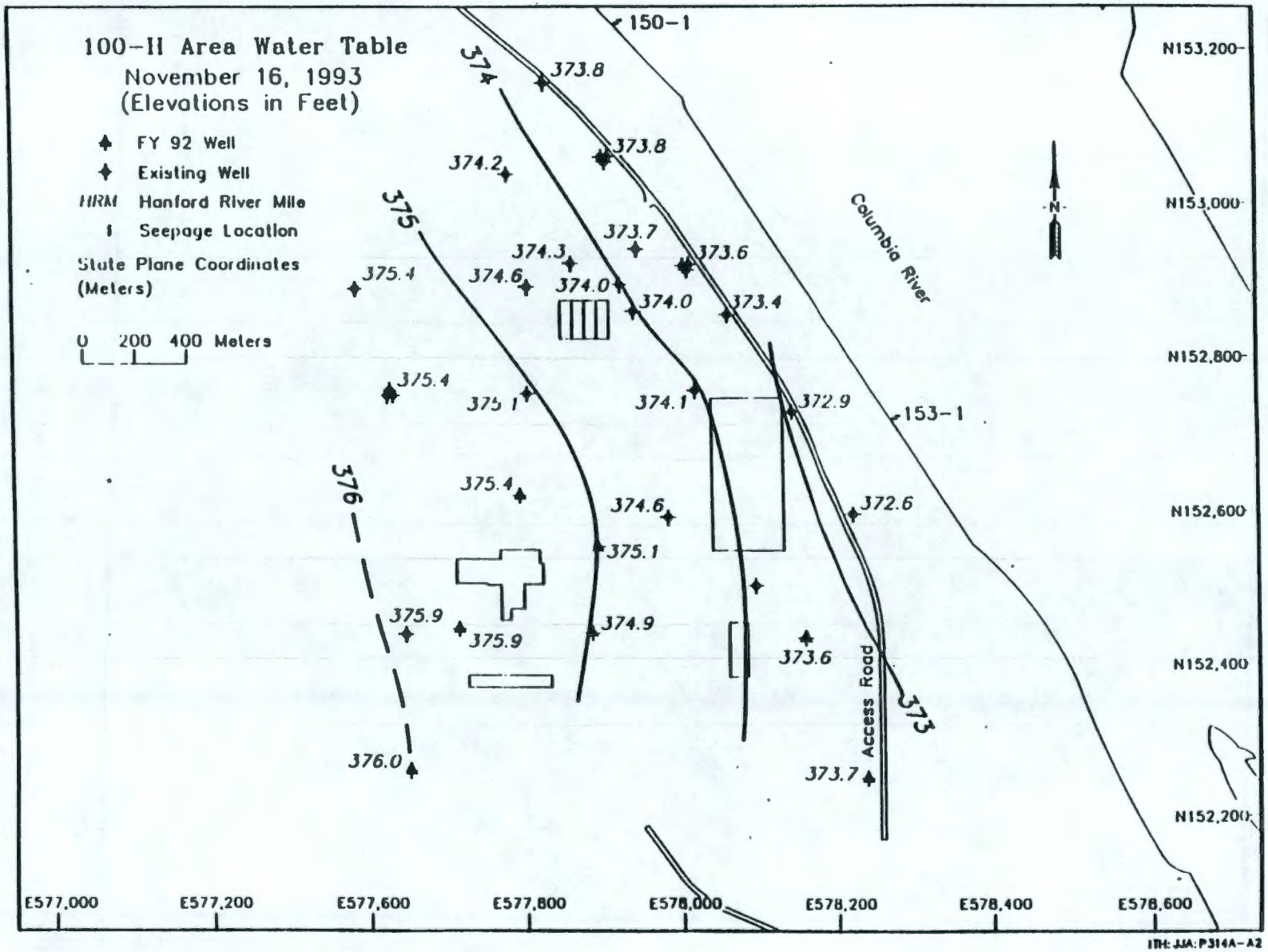


Figure 5-6. 100-H Area Water Table, November 16, 1993.

Figure 5-7. Model Calibrated 1992 Chromium Plume for the 100-H Area.

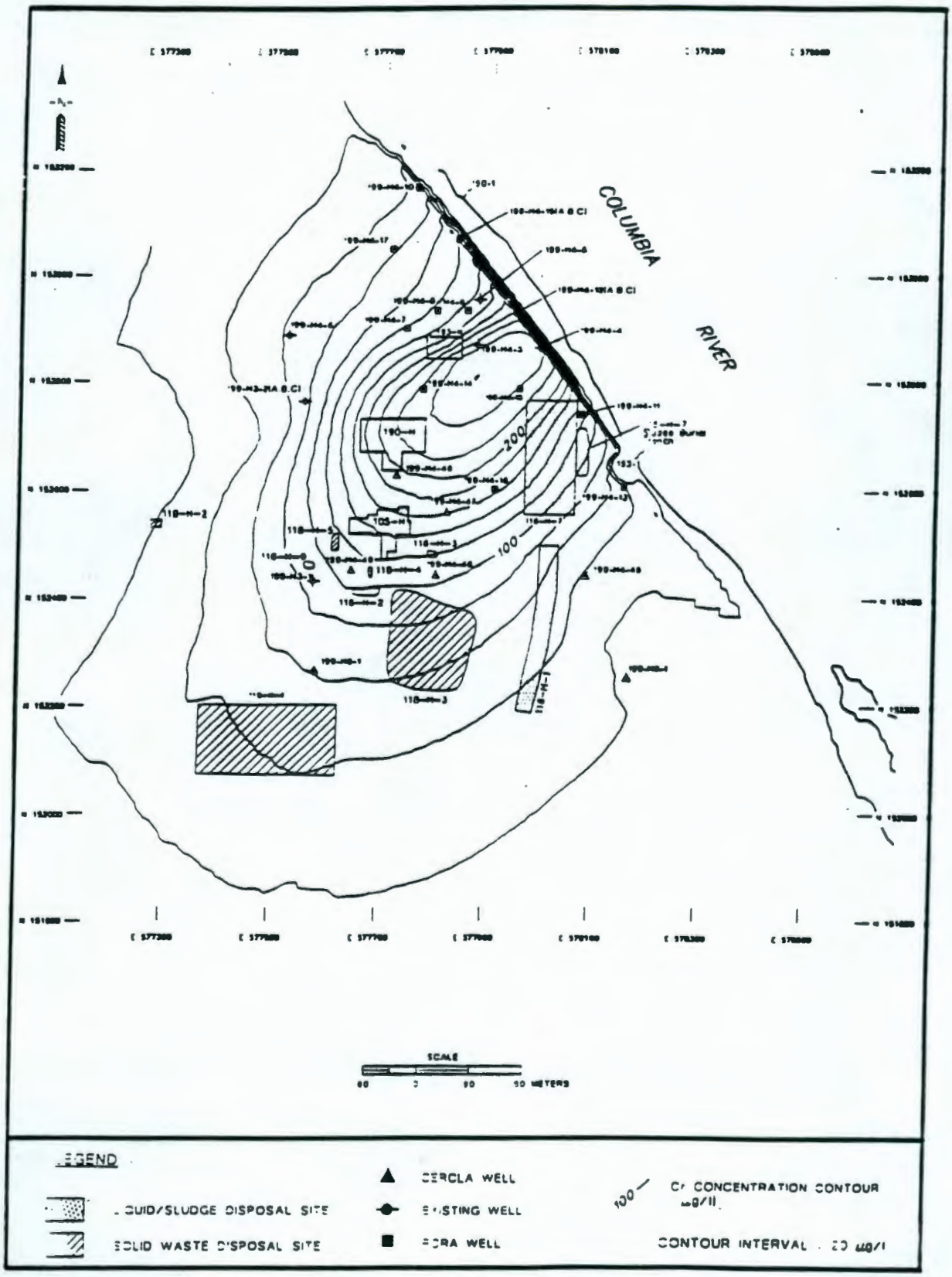


Figure 5-8. Chromium Concentrations in 2008 for the 100-D/DR Area No Action Scenario (Concentrations in ppb).

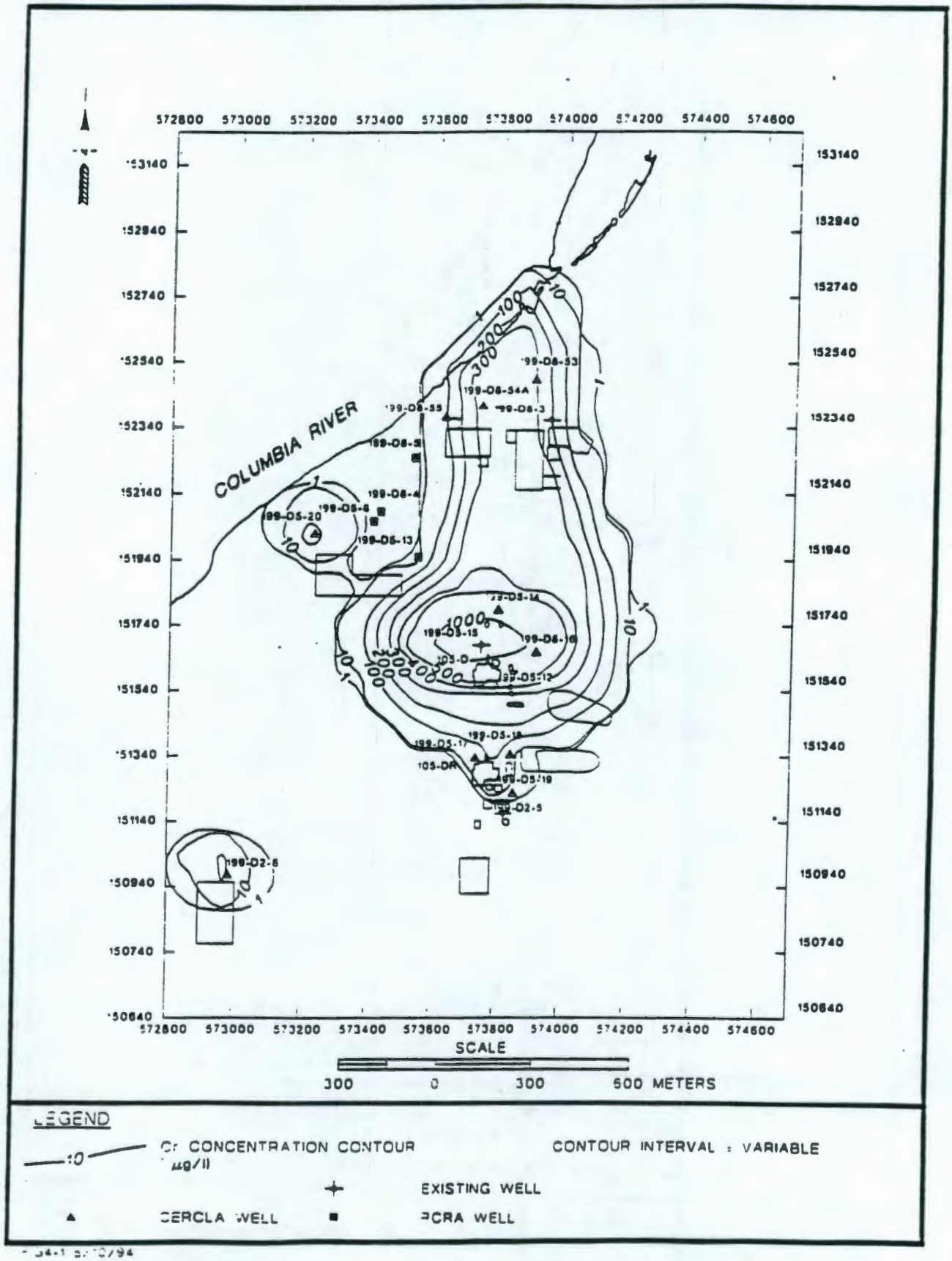


Figure 5-9. Chromium Concentrations in 2008 for the 100-D/DR Area Barrier Wall Simulation (Concentrations in ppb).

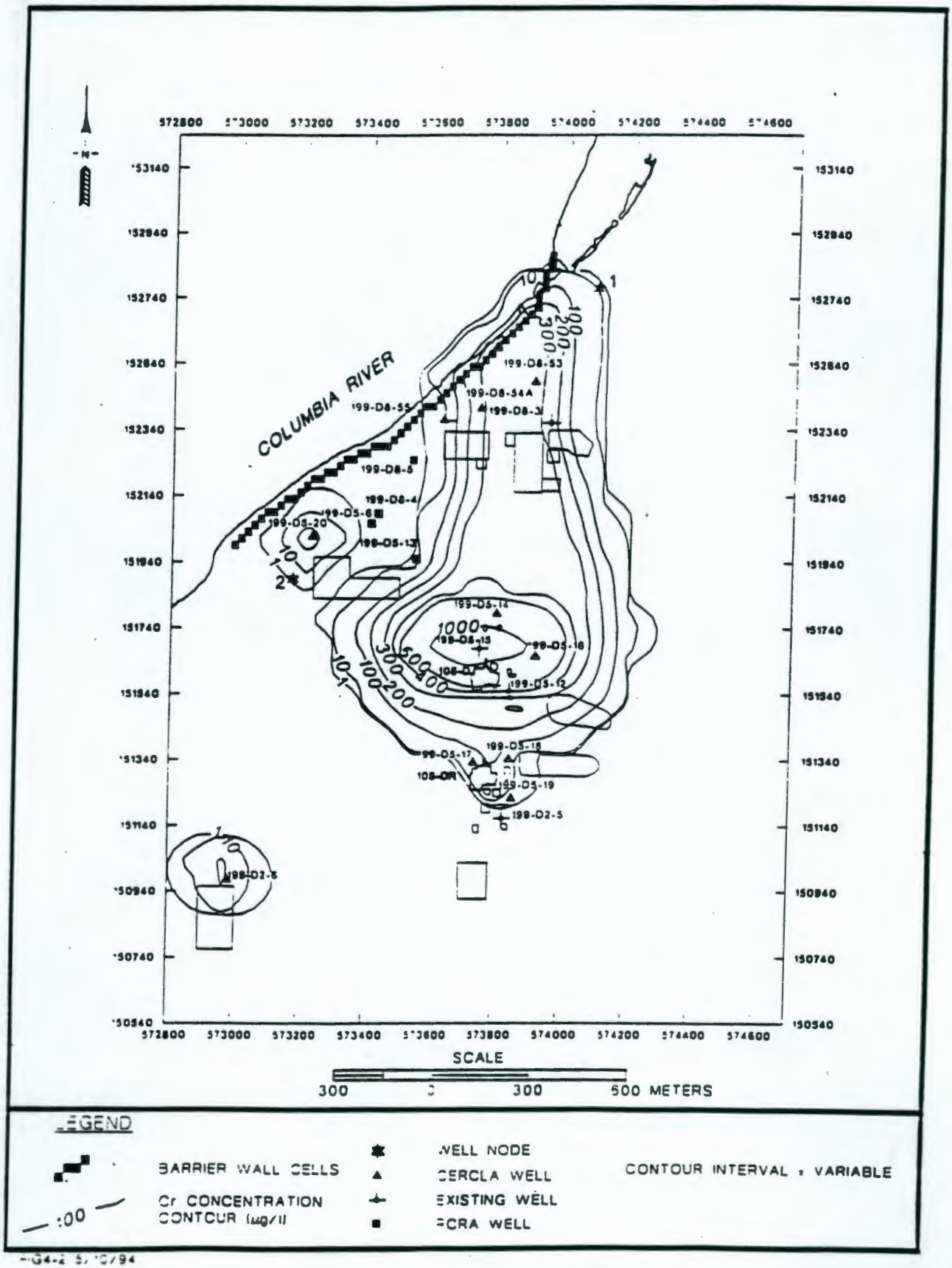


Figure 5-10. Water Table Elevations in 2008 for the 100-D/DR Area Barrier Wall Simulation (Elevations in Meters).

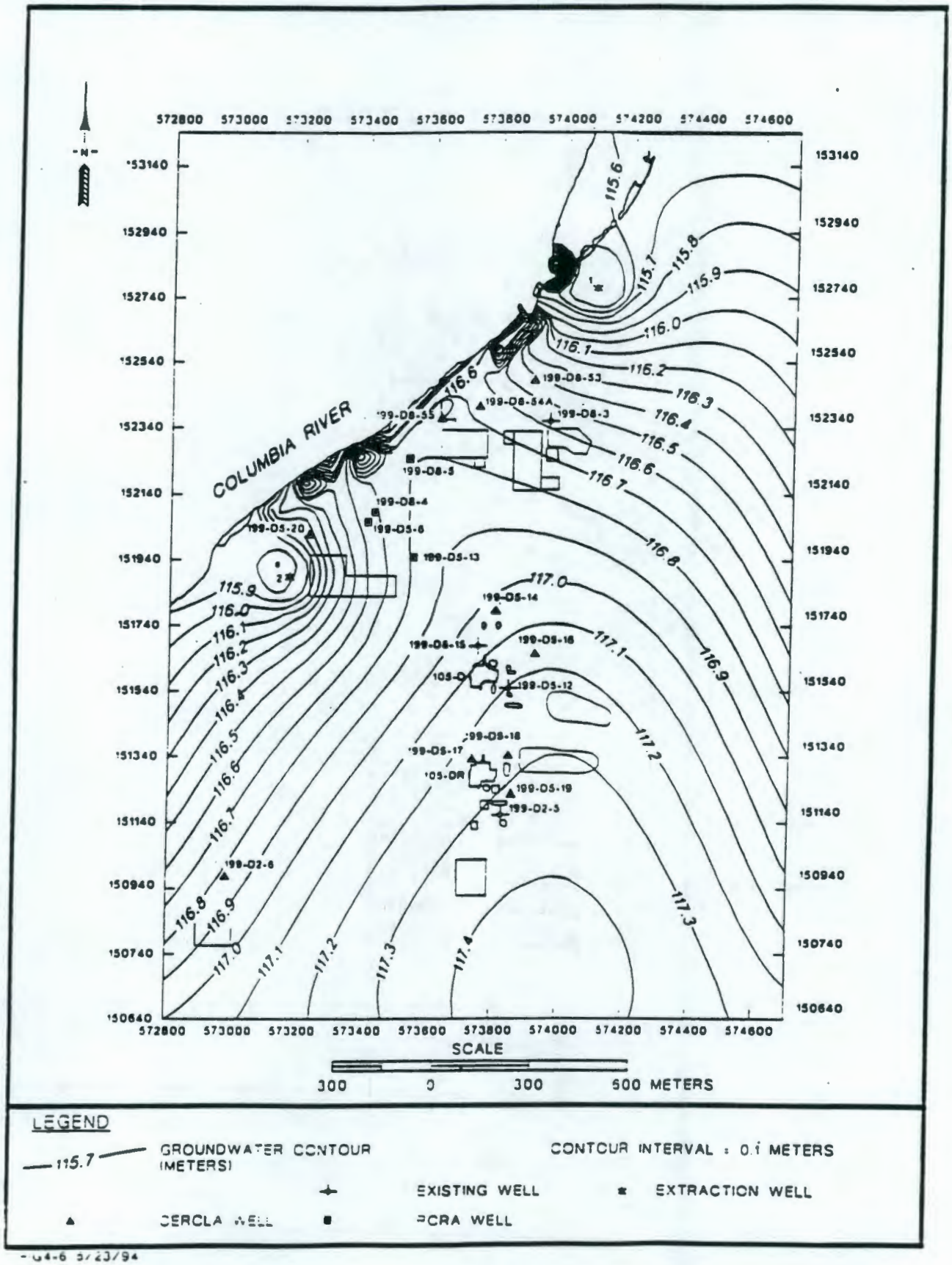


Figure 5-11. Chromium Concentrations in 2008 for the 100-D/DR Area Pump and Treat Simulation (Concentrations in ppb).

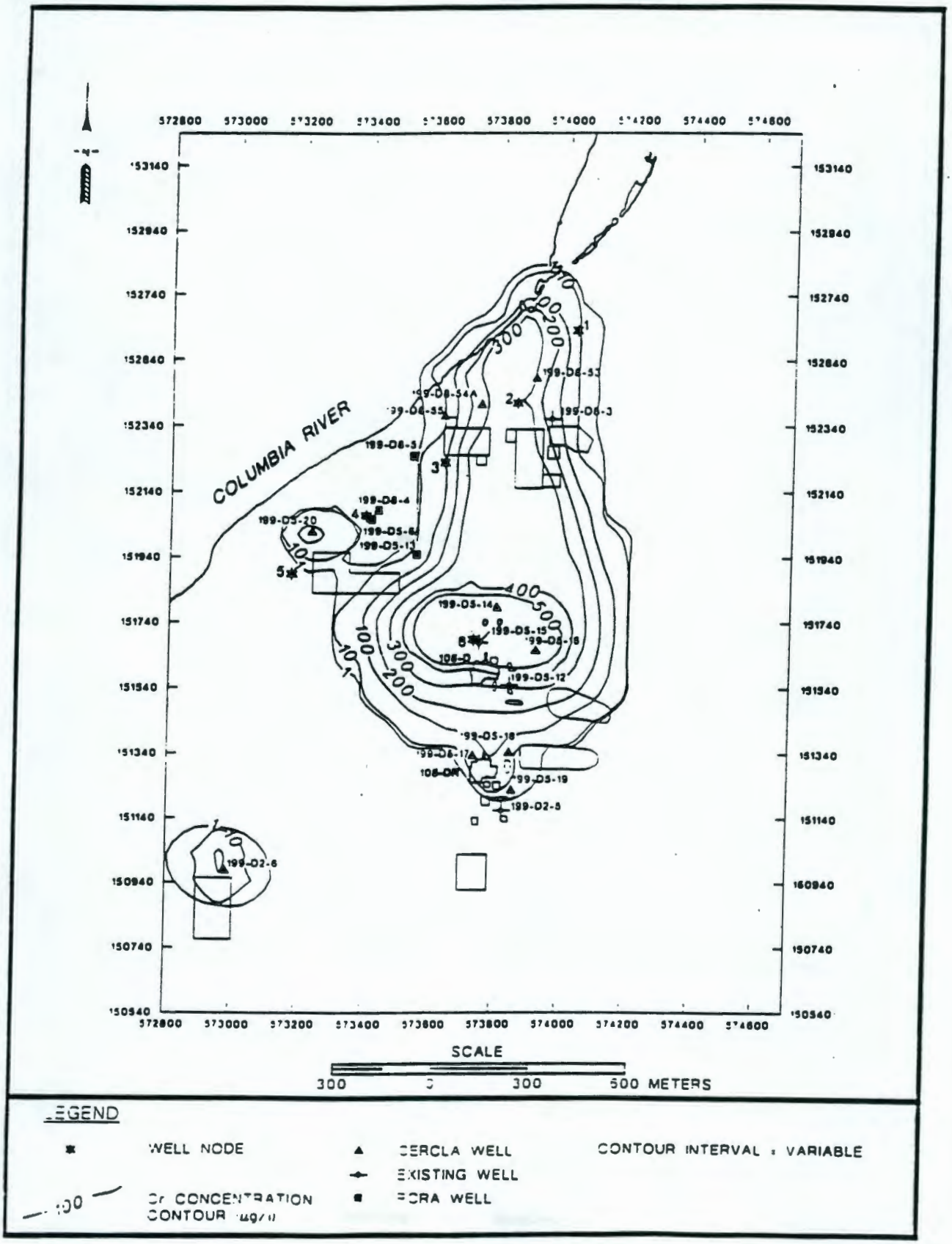


Figure 5-12. Water Table Elevations in 2008 for the 100-D/DR Area Pump and Treat Simulation (Elevations in Meters).

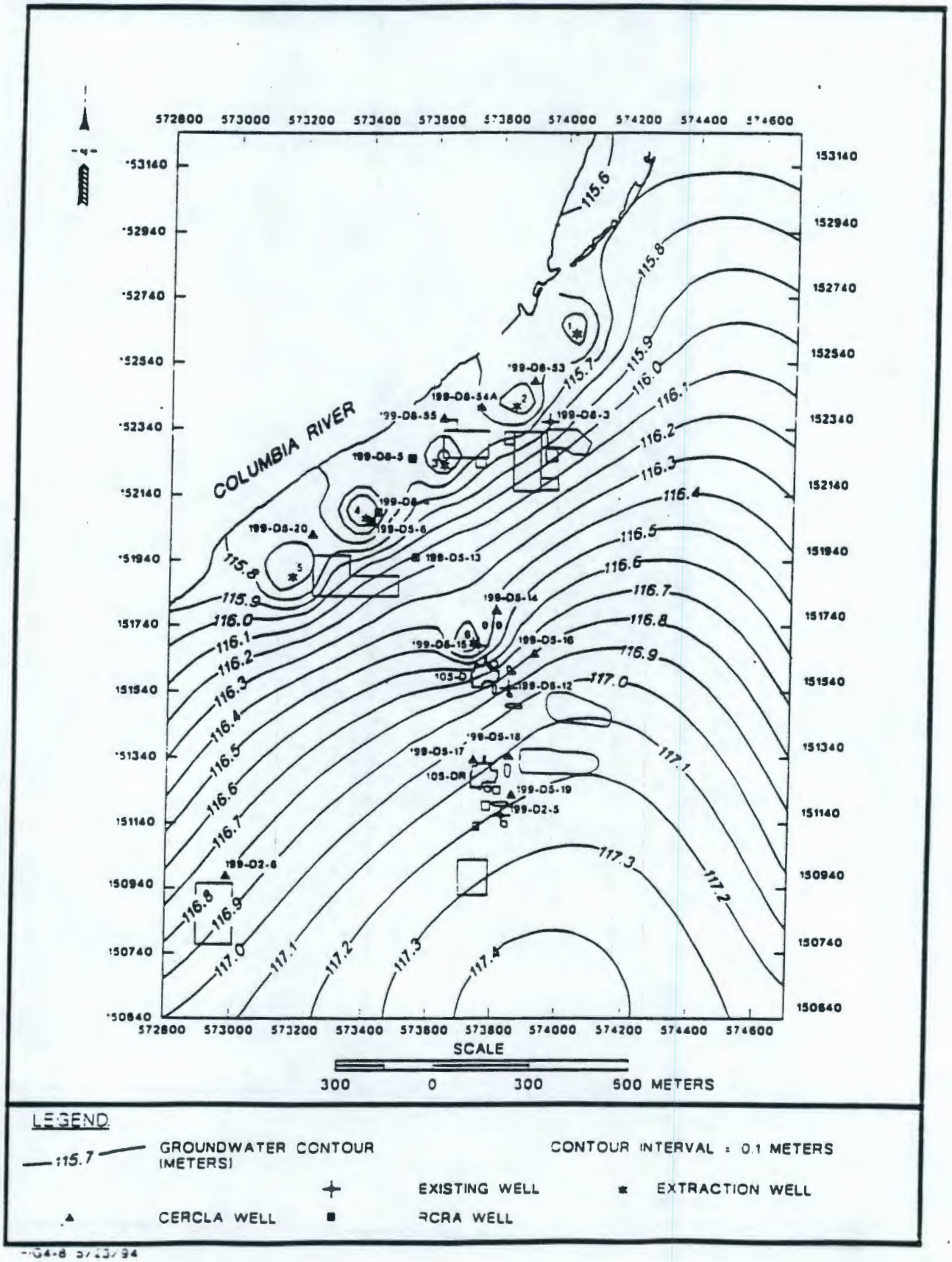


Figure 5-13. Chromium Concentrations in 2008 for the 100-H Area No Action Scenario (Concentrations in ppb).

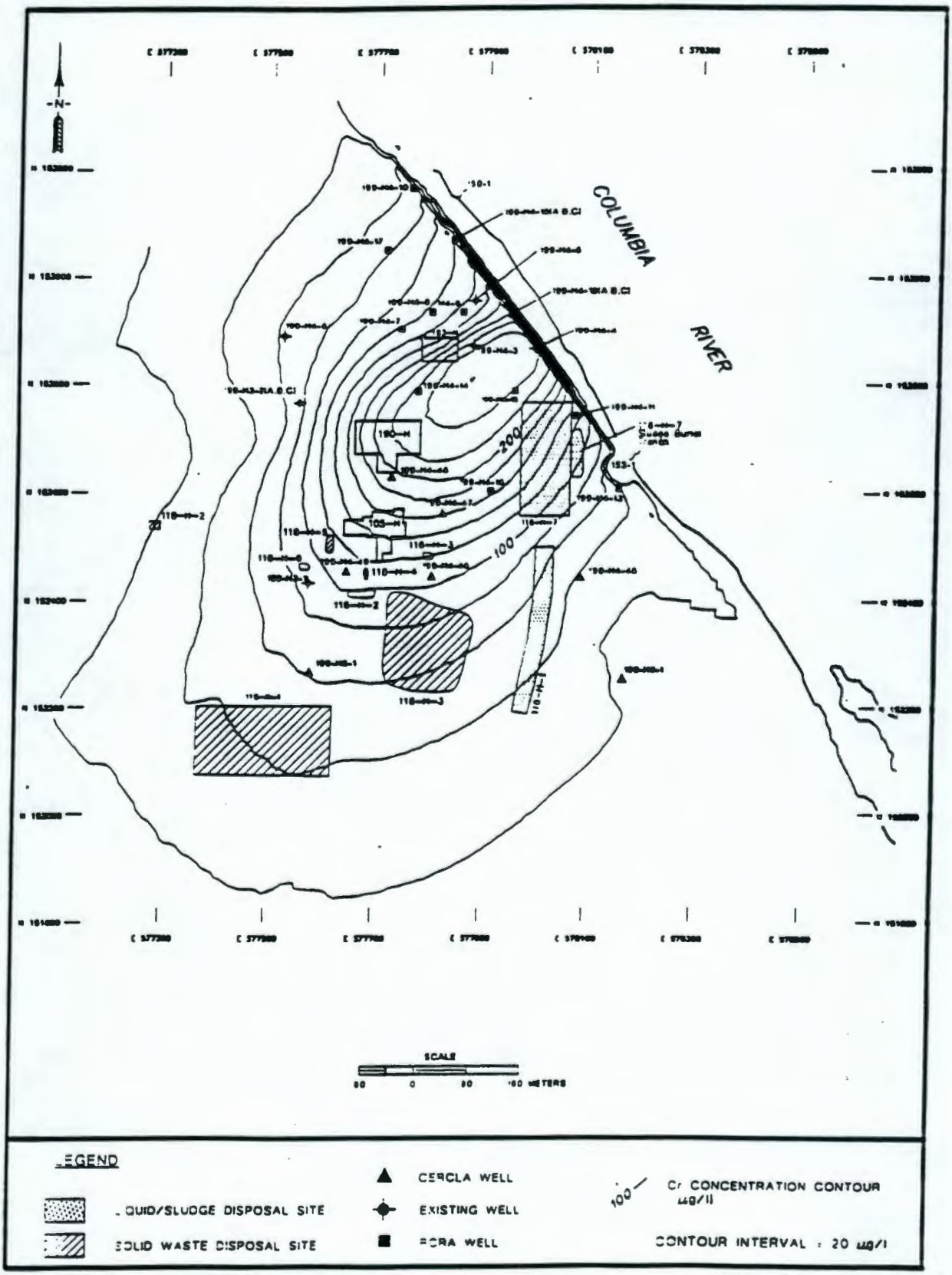


Figure 5-14. Chromium Concentrations in 2008 for the 100-H Area Barrier Wall Simulation (Concentrations in ppb).

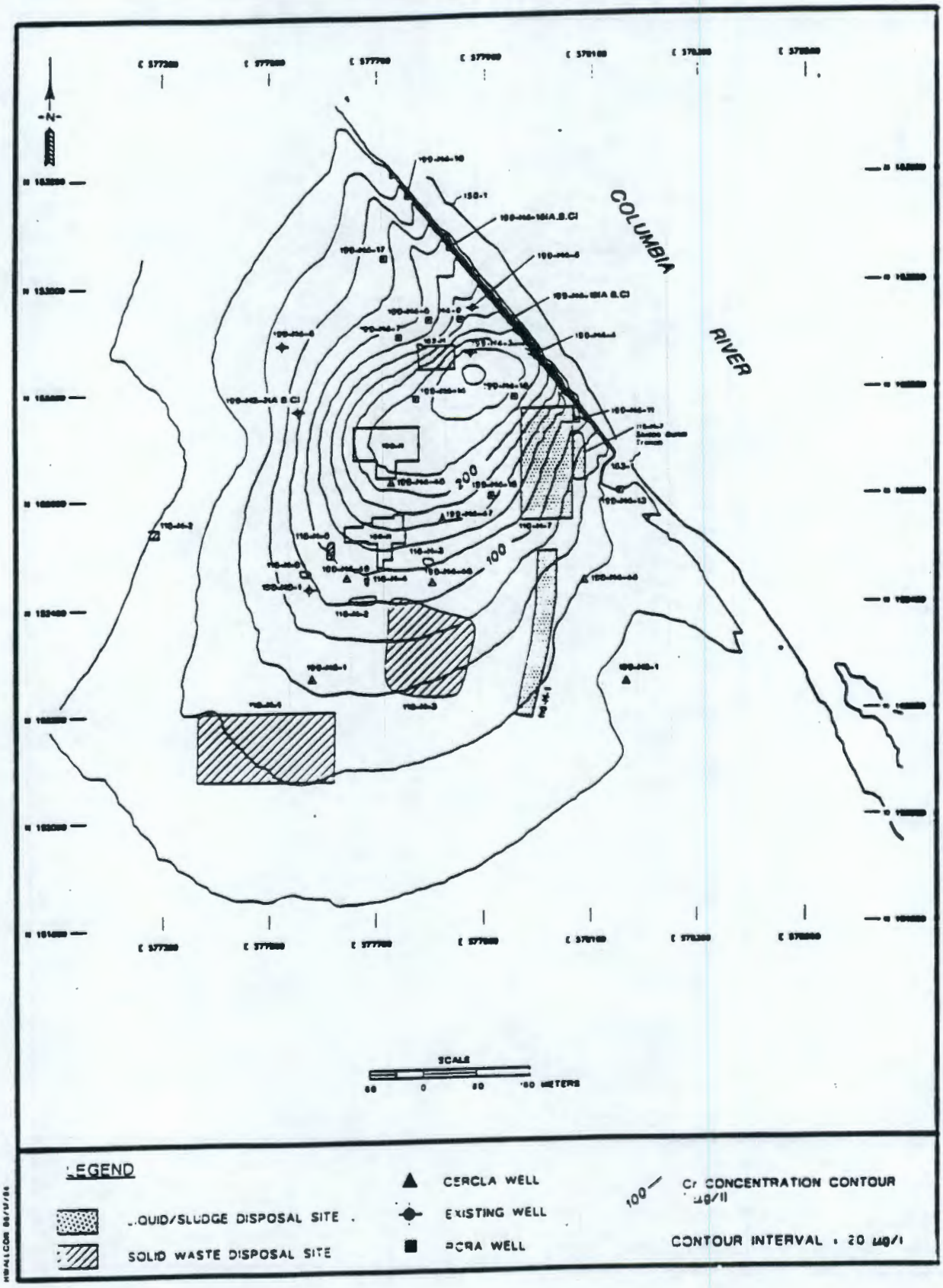


Figure 5-15. Water Table Elevations in 2008 for the 100-H Area Barrier Wall Simulation (Elevations in Meters).

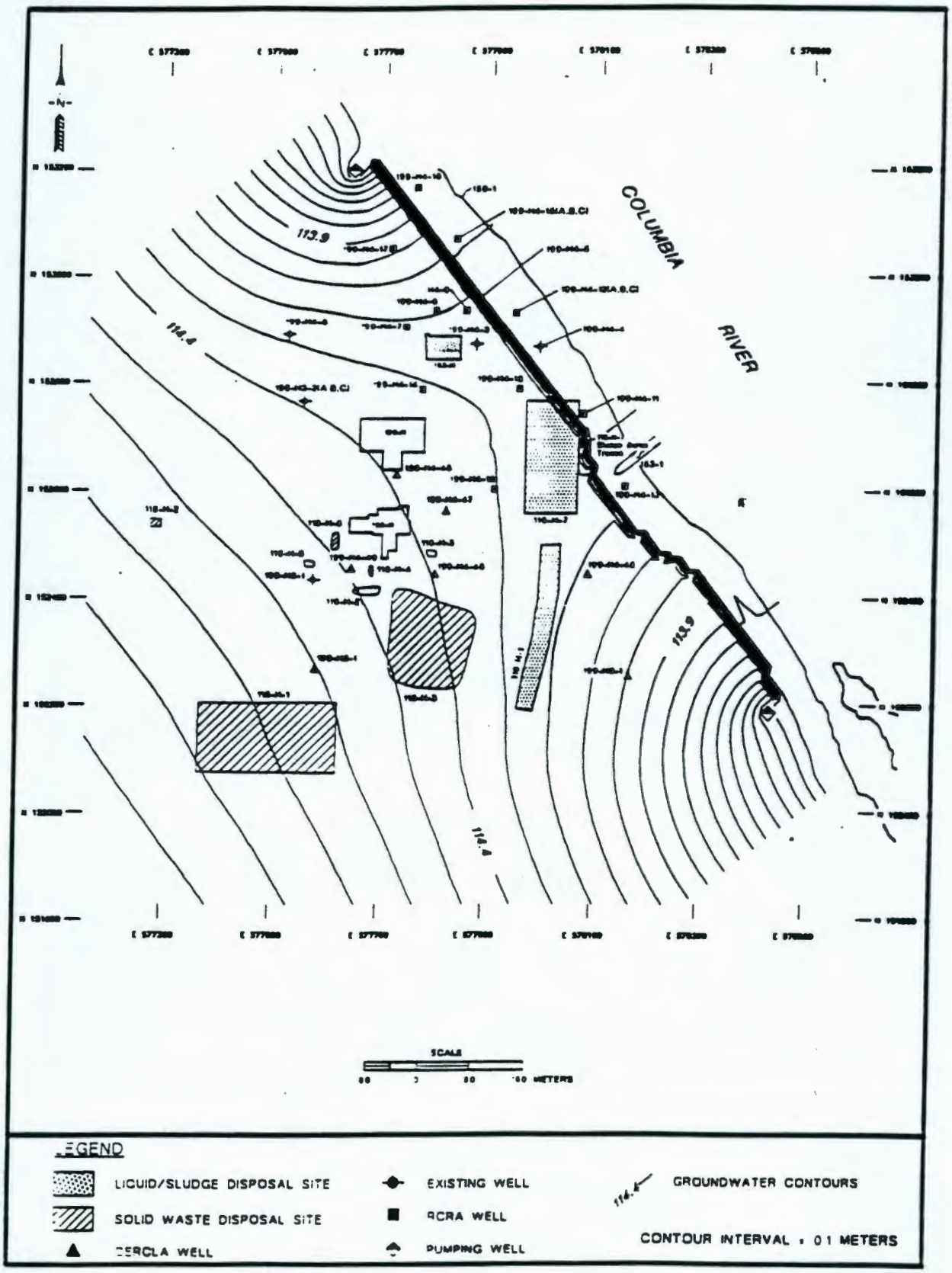


Figure 5-16. Water Table Drawdown for the 100-H Area Pump and Treat Simulation (Elevations in Meters).

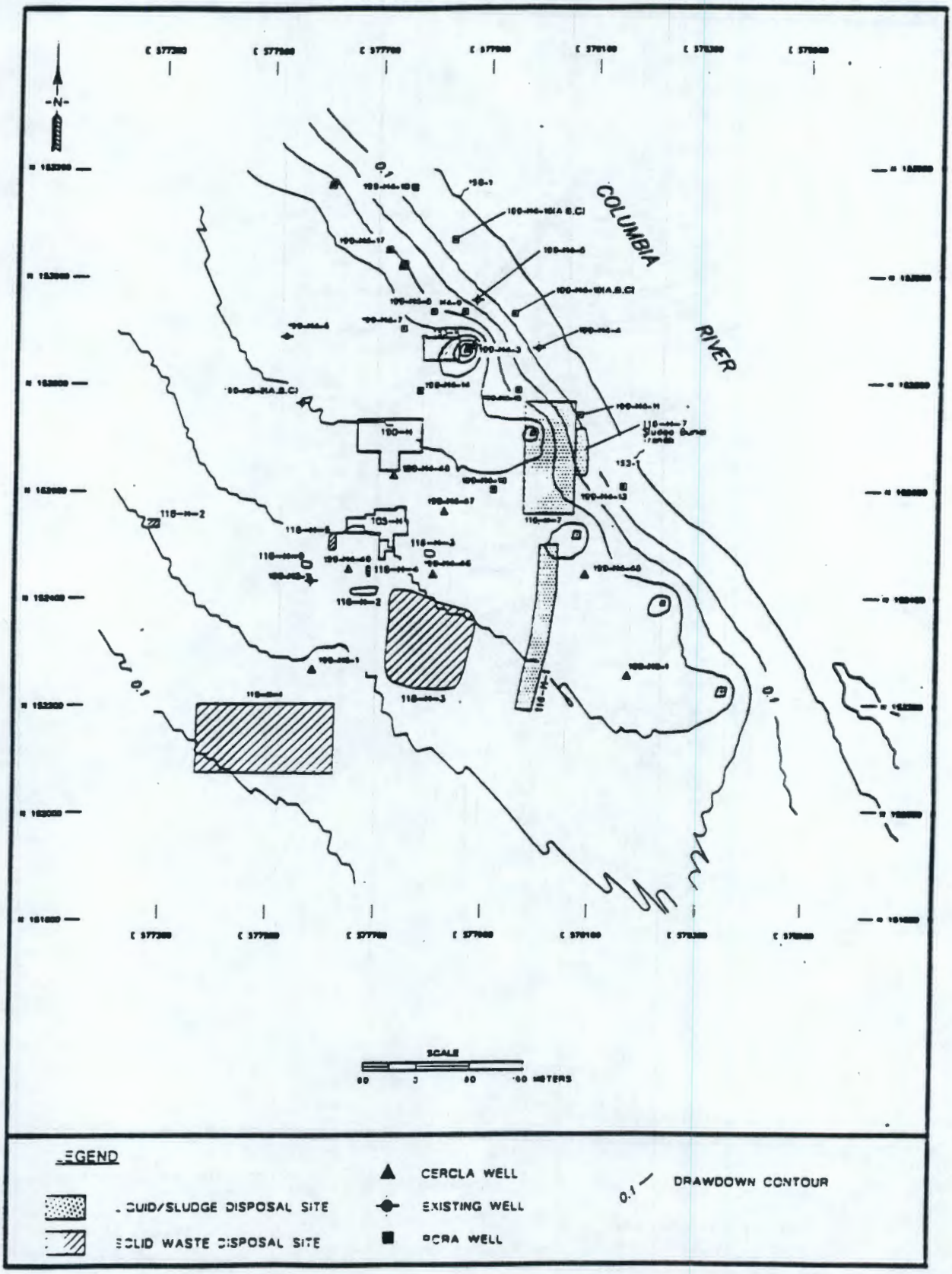


Figure 5-17. Chromium Concentrations in 2008 for the 100-H Area Pump and Treat Simulation (Concentrations in ppb).

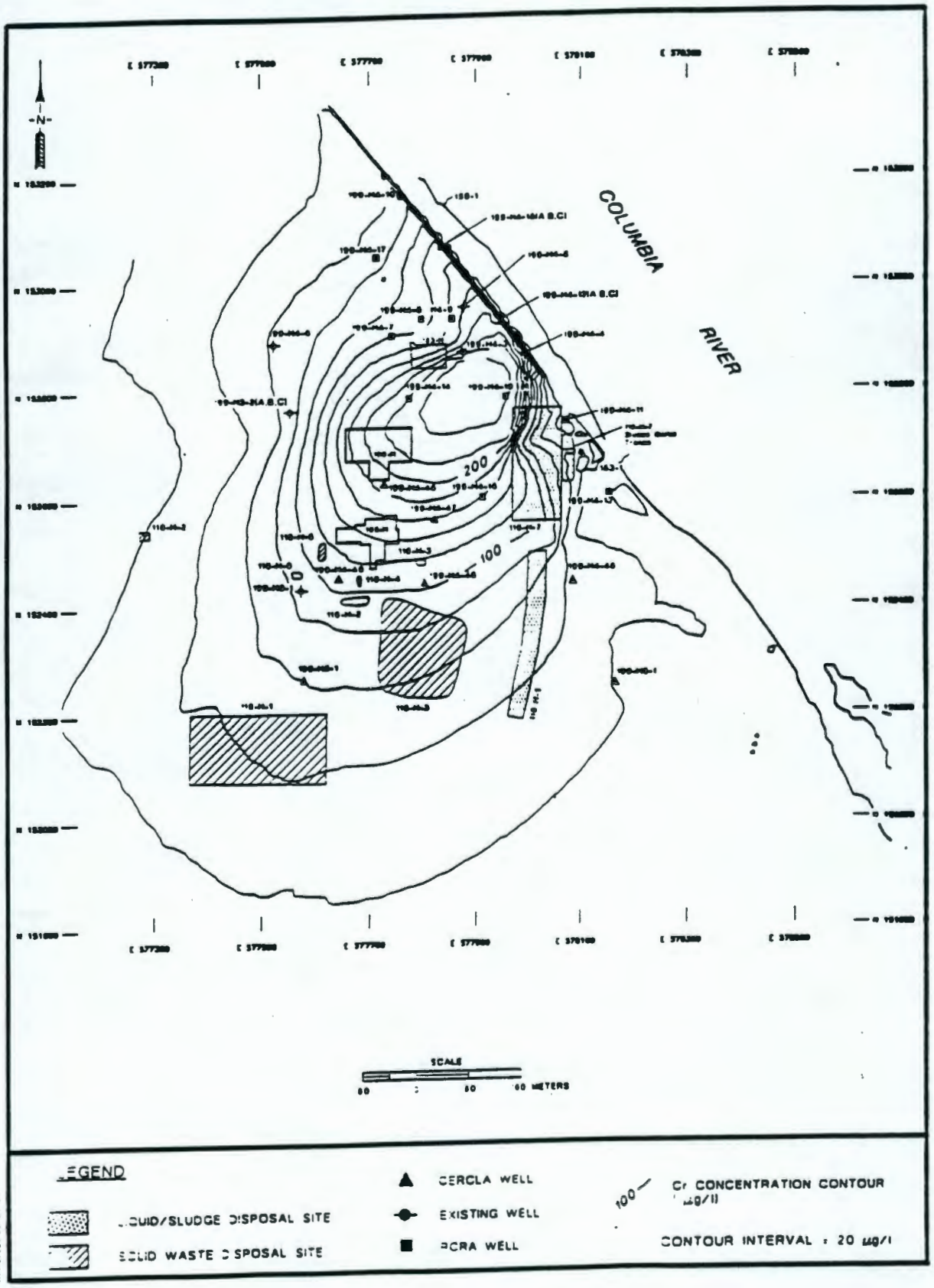


Figure 5-18. Water Table Elevations in 2008 for the 100-H Area Pump and Treat Simulation (Elevations in Meters).

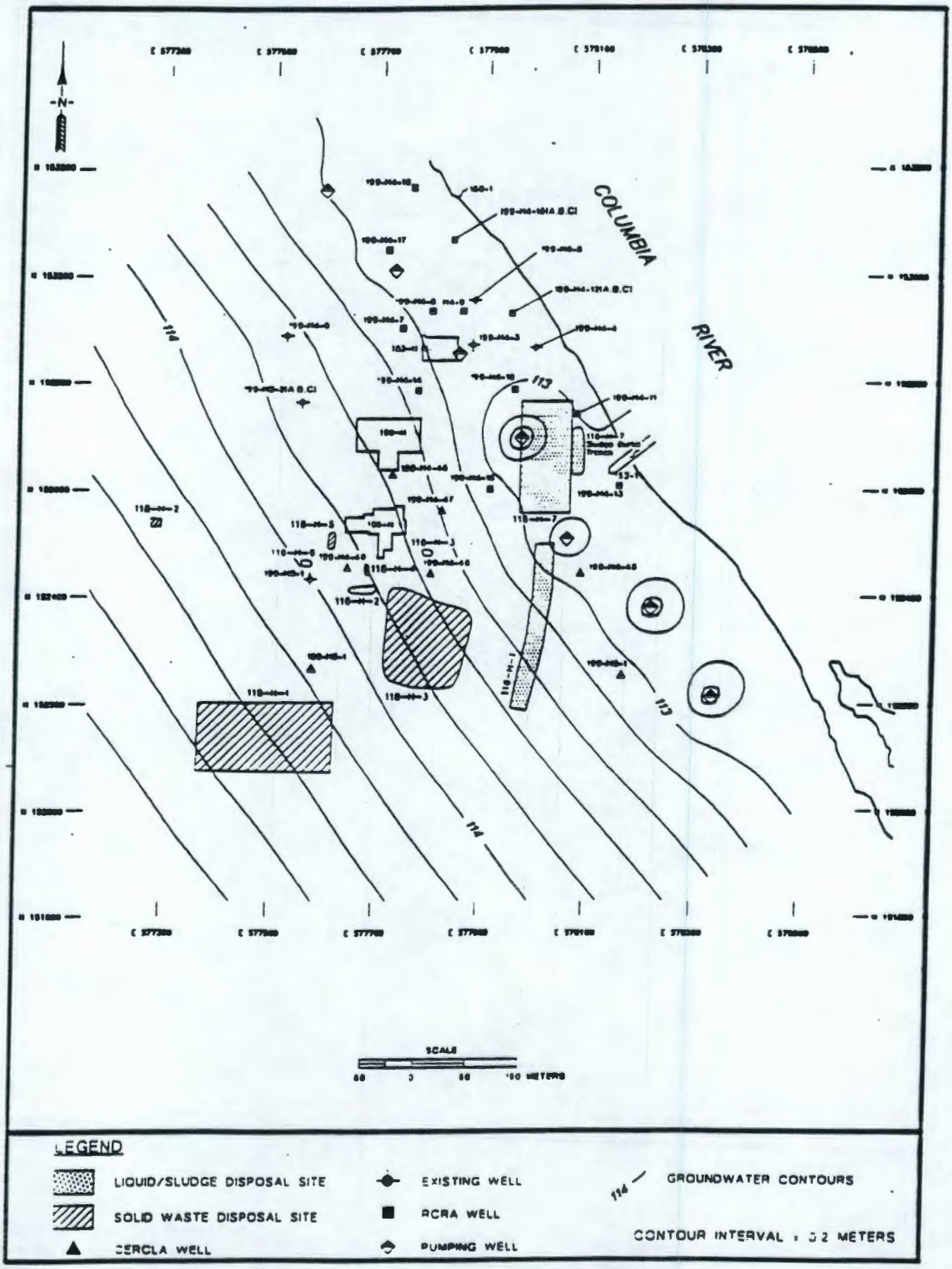


Table 5-1. Comparison of Model Predicted vs. Observed Water Level Elevations for the 100-D/DR Area.

Well Number	Observed Groundwater Head (meters)	Modeled Groundwater Head (meters)	Model Error (meters)
199-D2-5	117.31	117.34	0.03
199-D2-6	116.91	116.85	-0.06
199-D5-12	117.07	117.21	0.14
199-D5-13	116.83	116.73	-0.10
199-D5-14	116.90	116.96	0.06
199-D5-15	117.03	117.06	0.03
199-D5-16	116.94	117.14	0.20
199-D5-17	117.22	117.25	0.03
199-D5-18	117.13	117.29	0.16
199-D5-19	117.25	117.32	0.07
199-D5-20	116.49	116.24	-0.25
199-D8-3	115.97	116.32	0.35
199-D8-5	116.27	116.10	-0.17
199-D8-53	115.96	116.08	0.12
199-D5-54A	115.97	116.03	0.06
199-D8-55	115.97	115.97	0.00
199-D8-6	116.66	116.43	-0.23
Mean Error		0.03 meters	
Mean Absolute Error		0.12 meters	
Root Mean Square Error		0.15 meters	

Table 5-2. Comparison of Model Predicted vs. Observed Water Level Elevations for the 100-H Area.

Well Number	Observed Groundwater Head (meters)	Modeled Groundwater Head (meters)	Model Error (meters)
199-H3-1	114.59	114.41	0.18
199-H3-2A	114.45	114.14	0.31
199-H4-4	113.64	113.15	0.49
199-H4-7	114.04	113.69	0.35
199-H4-8	113.93	113.51	0.42
199-H4-9	113.83	113.44	0.39
199-H4-10	113.78	113.24	0.54
199-H4-11	113.51	113.14	0.37
199-H4-12A	113.72	113.17	0.55
199-H4-13	113.41	113.12	0.29
199-H4-14	114.19	113.82	0.37
199-H4-15A	113.78	113.21	0.57
199-H4-45	113.87	113.54	0.33
199-H5-1	114.58	114.59	-0.01
199-H6-1	113.90	113.64	0.26
Mean Error		0.36 meters	
Error Standard Deviation		0.15 meters	

Table 5-3. Sensitivity Analysis Results

Remedial Action Alternative	Model Simulation	Initial Concentrations	Porosity	Retarda-tion Factor	Dispersivity		Simulation Time (Years)	Mass Removed at River Nodes (Kg)	Mass Removed at Well Nodes (Kg)
					Longitudinal (Meters)	Transverse (Meters)			
No Action	MTNA11	Oct.-Dec 1992	0.20	25	10	1	16	76.61	na
	MTNA15	Oct.-Dec 1992	0.20	10	10	1	16	88.83	na
	MTNA21	Oct.-Dec 1992	0.20	25	100	10	16	88.50	na
	MTNA24	Oct.-Dec 1992	0.20	10	100	10	16	93.84	na
Vertical Barrier Wall	MTBW211	Oct.-Dec 1992	0.20	25	10	1	16	3.03	1.30
	MTBW212	Oct.-Dec 1992	0.20	10	10	1	16	3.16	12.77
	MTBW221	Oct.-Dec 1992	0.20	25	100	10	16	5.01	10.65
	MTBW222	Oct.-Dec 1992	0.20	10	100	10	16		
Groundwater Extraction and Treatment	MTPT11	Oct.-Dec 1992	0.20	25	10	1	16	1.88	418.20
	MTPT12	Oct.-Dec 1992	0.20	10	10	1	16	1.72	346.50
	MTPT21	Oct.-Dec 1992	0.20	25	100	10	16	3.32	377.12
	MTPT22	Oct.-Dec 1992	0.20	10	100	10	16		

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6.0 DETAILED ANALYSIS OF ALTERNATIVES

This section presents the methodology and criteria used in the detailed analysis, and presents the evaluation of alternatives ~~against the~~based on NEPA and CERCLA evaluation criteria.

6.1 METHODOLOGY AND CRITERIA

Nine evaluation criteria have been identified in EPA guidance to evaluate remedial actions. The evaluation criteria are the basis for the detailed analysis task during the FS. The criteria, as defined in *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988), are discussed below.

6.1.1 Overall Protection of Human Health and the Environment

This criterion provides an assessment of whether or not each alternative provides adequate protection of human health and the environment. The evaluation focuses on the ability of a specific alternative to achieve adequate protection, and describes how the site risks posed through each pathway being evaluated by the FFS are eliminated, reduced, or controlled through natural processes, treatment, engineering, or institutional controls. This criterion attempts to minimize or avoid impacts to natural resources. This evaluation also considers unacceptable short-term or cross-media impacts associated with each alternative. The following questions represent the information included in the analysis of this criterion.

- Will risk be at acceptable levels?
- What is the time frame to achieve acceptable levels?
- Will additional threats be minimized?
- Will it be easy to avoid or minimize impacts to natural resources, or can unavoidable impacts be mitigated?

The focus of this IRM is protection of aquatic organisms in the Columbia River, and the remedial alternatives are evaluated accordingly.

6.1.2 Compliance with ARAR

This criterion is used to determine whether or not each alternative will meet Federal and state ARARs and TBCs, and whether or not there is justification for an ARAR waiver. The CERCLA defines six types of ARAR waivers, as follows:

- Interim actions
- Greater risk to health and the environment
- Technical impracticability
- Equivalent standard of performance
- Inconsistent application of state requirements
- Fund-balancing.

Questions concerning compliance with ARARs that are addressed in the detailed analysis include the following.

- ~~Are ARARs available?~~
- What are the potential ARARs?
- Will the potential ARARs be met and how?
- What is the basis for waivers?
- If ARARs are not available, what are the potential TBCs?
- Is the alternative consistent with the potential TBCs?
- Will the alternative comply with ARARs and TBCs protecting the environment?

6.1.3 Long-Term Effectiveness and Permanence

This criterion addresses the risk remaining at the site after RAOs have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes. The following questions are addressed in the detailed analysis.

- What is the magnitude of the remaining risk?
- What remaining sources of risk can be identified? How much is due to treatment residuals and how much is due to untreated residual contamination?

- ~~Will a 5-year review be required?~~

- What is the likelihood that the technologies will effectively meet ~~required process efficiencies of~~ performance specifications?

- What type and degree of long-term management is required?

- What are the requirements for long-term monitoring?

- What operation and maintenance functions must be performed?

- What difficulties and uncertainties are associated with long-term operation and maintenance?

- What is the potential need for replacement of technical components?

- What is the magnitude of the threats or risks should the remedial action need replacement?

- What is the degree of confidence that controls can adequately handle potential problems?

- What are the uncertainties associated with land disposal of residuals and untreated waste?

- Will the alternative provide effective long-term protection of the environment?

- Will important habitats be protected, enhanced, degraded, or destroyed?

6.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The goal of this criterion is to address the statutory preference for remedial actions employing treatment technologies that permanently and significantly reduce toxicity, mobility, and volume. This evaluation focuses on the following questions.

- Does the treatment process employed address the principal threats?

- Are there any special requirements for the treatment process?

- What portion (mass, volume) of contaminated material is destroyed?

- What portion (mass, volume) of contaminated material is treated?

- To what extent is the total mass of toxic contaminants reduced?

- To what extent is the mobility of toxic contaminants reduced?

- To what extent is the volume of toxic contaminants reduced?

- To what extent are the effects of treatment irreversible?
- ~~What residuals remain?~~
- What are the quantities and characteristics of the residuals?
- What risks do treatment residuals pose?
- Are principal threats within the scope of the action?
- Is treatment used to reduce inherent hazards posed by principal threats at the site?
- How does the proposed treatment impact natural resources?
- Is mitigation easily implemented?

6.1.5 Short-Term Effectiveness

This evaluation criterion addresses the effects of the alternative during the construction and implementation phase, until the RAOs are met. The following factors should be addressed, as appropriate, for each alternative.

- Has the health and safety of the community during remedial actions been addressed?
- Has the health and safety of workers during remedial actions been addressed?
- Have environmental impacts (impacts to natural resources) been addressed?
- Has the time until remedial response objectives are achieved been addressed?
- Have the risks or impacts that cannot be controlled or mitigated been addressed?

6.1.6 Implementability

The implementability criterion addresses the technical and administrative feasibility of implementing an alternative, as well as the availability of various services and materials required during its implementation. This criterion involves analysis of the following factors:

- Technical feasibility
  - Construction and operation
  - Reliability of technology
  - Ease of undertaking additional remedial action
  - Monitoring considerations
  - Ability of technology to meet RAOs, including detection limits

- Administrative feasibility
  - Activities needed to coordinate with other offices and agencies

- Availability of services and materials
  - Availability of adequate offsite treatment, storage capacity, and disposal services
  - Availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources
  - Availability of services and materials plus the potential for obtaining competitive bids, which may be particularly important for innovative technologies
  - Availability of prospective technologies.

6.1.7 Cost

This criterion addresses capital costs, both direct and indirect; annual operations and maintenance (O&M) costs; the accuracy of the cost estimate; and a present worth analysis. ~~and a cost sensitivity analysis of alternatives.~~

6.1.7.1 Direct Capital Costs. Direct capital costs include the following:

- Construction costs
- Equipment costs
- Land and site development costs
- Buildings and services costs
- Relocation expenses
- Disposal costs.

6.1.7.2 Indirect Capital Costs. Indirect capital costs include the following:

- Engineering expenses
- License or permit costs
- Startup and shakedown costs
- Contingency allowances.

6.1.7.3 Annual O&M Costs. Annual operations and maintenance costs include the following:

- Operating labor costs

- Maintenance materials and labor costs
- Auxiliary material and energy
- Disposal of residues
- Purchased services
- Administrative costs
- Insurance, taxes, and licensing costs
- Maintenance reserve and contingency funds
- Rehabilitation costs
- Costs of periodic site reviews.

6.1.7.4 Accuracy of Cost Estimates. Study estimates of costs are expected to provide an accuracy of +50% to -30% and are prepared using data available from the LFI, treatability studies, and ongoing projects.

6.1.7.5 Present Worth Analysis. Present worth analysis is used to evaluate expenditures that occur over different time periods by discounting all future costs to a common base year, usually the current year. This allows all alternatives to be assessed based on current costs of the remedial action. The present worth analysis requires assumptions to be made regarding the discount rate and the period of performance. A discount rate of 5%, before taxes and after inflation, is recommended. The period of performance should not exceed 30 years.

6.1.8 Regulatory Acceptance

Regulatory acceptance evaluates the technical and administrative concerns of the regulating agency. These concerns are generally addressed in the ROD by the regulatory agencies, so they will not be addressed in this FFS.

6.1.9 Community Acceptance

This is an evaluation of the concerns of the public and is addressed by the regulatory agencies in the ROD.

6.2 COMMON EVALUATION CONSIDERATIONS

In addition to the nine CERCLA criteria, specific environmental resources (such as air quality) and NEPA issues (such as cumulative impacts) are considered during the selection of

remedial alternatives. Consideration of environmental resources and NEPA issues are required to meet the DOE Secretarial Policy on NEPA, and provide a complete evaluation of the remedial alternatives. Several of the CERCLA evaluation criteria involve consideration of environmental resources, but the emphasis is frequently directed at the potential effects of chemical contaminants on living organisms. The NEPA evaluation considers chemical, physical, and biological stressors. Environmental resources in the NEPA context also include consideration of potential effects on resources, such as transportation, air quality, surface water, and visual resources. Also, the NEPA process involves consideration of several issues, such as indirect and cumulative impacts, the irreversible and irretrievable commitment of resources, and the actions that may be taken to avoid or mitigate environmental impacts. The NEPA-related resources and issues are described in Sections 6.2.1 and 6.2.2 below.

6.2.1 Resources

6.2.1.1 Transportation Impacts. The remedial alternatives evaluated in this FFS are not expected to create any long-term negative transportation impacts. If adverse impacts to transportation are detected, remedial activities will be modified or stopped until the problem is mitigated.

The No Action and Institutional Control Alternatives will not affect transportation. These alternatives will not require the transport of any equipment, construction materials, or waste. Commuter traffic flow would not increase or decrease. The Containment and Removal/Treatment/ Disposal Alternatives will require transport of equipment, construction materials and solid waste that could result in transportation impacts, primarily within the boundaries of the Hanford Site. The construction-related traffic for the Containment~~/Removal/Disposal and~~ Alternative would be ~~higher~~ lower than for the Removal/Treatment/Disposal Alternatives

6.2.1.2 Ecological Impacts.. The No Action and Institutional Control Alternatives would not affect existing natural resource conditions. However, these alternatives do not include revegetation or other habitat enhancement actions. Without revegetation or other habitat enhancement efforts, most sites would not be restored to a native condition.

The Containment and Removal/Treatment/Disposal Alternatives would destroy some existing vegetation in the 100 Areas as a result of surface activities such as construction of access roads, pile driving, well installation, and treatment system construction. The amount of vegetation that may be impacted is expected to be small since most of the waste sites in the 100 Areas have already been disturbed and contain mostly weed species. However, mitigation measures such as buffer zones, seasonal controls, and spatial restrictions will be implemented. ~~In most cases, this is a minor impact because most waste sites in the 100 Areas have already been severely disturbed, and because the surface areas required to implement the actions are relatively small.~~ The Containment Alternative would require activities close to the river, with limited opportunities to place facilities in the least sensitive environments. It would potentially impact natural resources more than the

Removal/Treatment/Disposal Alternative. Restoration efforts ~~following installation of containment walls~~ would benefit natural resources in the long term.

6.2.1.3 Air Quality Impacts. Hanford Site air quality is generally good. The proposed remediation alternatives are not expected to cause long-term negative impacts to existing air quality. Site restoration efforts will preclude long-term wind erosion problems due to remediation activities.

The No Action and Institutional Control Alternatives would not affect short-term air quality. However, the Containment and Removal/Treatment/Disposal Alternatives will generate fugitive dust. Dust controls and other mitigative measures will be used as needed to ensure that short-term impacts on air quality are minimized.

6.2.1.4 Cultural Resource Impacts. Where cultural resources are present, mitigative measures will be implemented to address cultural resource concerns. ~~are properly addressed.~~

The No Action and Institutional Control Alternatives are not expected to disturb cultural resources. However, if cultural resources are contaminated or legitimate access to cultural resources is denied due to contamination levels, these activities may be considered as impacts on cultural resources.

The Containment and Removal/Treatment/Disposal Alternatives could potentially impact cultural resources during the construction phase. Actions to mitigate potential adverse impacts to significant cultural resources would be required before initiating these alternatives.

There is latitude regarding where the wells and treatment units are located for the Removal/Treatment/Disposal Alternative, while there is little latitude regarding the placement of the barrier wall for the Containment Alternative. Therefore, the potential impact on known cultural resources could be more easily mitigated by the Removal/Treatment/Disposal Alternative.

6.2.1.5 Socioeconomic Impacts. The outlook for the Tri-Cities economy is uncertain. The local economy could decline or grow in the next 30 years depending on economic activity not directly related to DOE and the Hanford Site. Near-term reductions in the Hanford Site work force will probably have a negative impact on the local economy.

If the No Action and Institutional Control Alternatives are implemented, activities in the 100 Areas would be limited to maintenance, security and routine monitoring. These alternatives fail to achieve the principles adopted by the Hanford Advisory Board Work Group for cultural/socioeconomic impacts. There would be no transition of the work force to provide economic stability. These alternatives would do little to provide economic diversification because of the minimum employment levels. The demand for recreational services, social services, facilities, and activities exerted by the few employees associated with the 100 Areas and their families would be minimal.

The socioeconomic impacts of the Containment and Removal/Treatment/Disposal Alternatives would be relatively minimal. Workers would be employed for several years to

perform the work associated with these alternatives. These alternatives meet the principles established by the Hanford Advisory Board Work Group for cultural/socioeconomic impacts. These alternatives allow for work force transition from scientific/engineering to the excavation and construction trades. Effects on social services and recreation would probably be imperceptible because of the few employees involved. The effects on public services such as water supplies and waste water treatment facilities would be minimal.

6.2.1.6 Noise and Visual Resources Impacts. No long-term noise impacts are anticipated from any of the remedial alternatives under consideration. For the Containment and Removal/Treatment/Disposal Alternatives, construction activities would cause a temporary increase in noise. However, noise levels would return to near background levels following construction. Noise mitigation would be instituted to minimize short-term impacts. All equipment and vehicles would be equipped with mufflers or other noise-reduction devices.

The Containment and Removal/Treatment/Disposal alternatives would have an impact on visual resources. Extraction and reinjection wells, above ground piping, and water treatment equipment would be visible during operation of a groundwater Removal/Treatment/Disposal system. A hydraulic containment system would also contain wells and piping, which would have a visual impact. Visual impact from a barrier wall is expected to be minimal. For both the Removal/Treatment/Disposal and Containment options, access roads and maintenance and monitoring facilities would have visual impacts during the period in which the remediation system is operating.

~~If the DOE relinquishes control of the 100 Areas, long term impacts are anticipated for noise and visual resources for all the alternatives, except the No Action Alternative. The anticipated impacts would be from increased noise levels and/or impacts to visual resources from developments (e.g., housing, agriculture) of the 100 Areas.~~

No adverse short-term impacts to noise or visual resources are anticipated for the No Action or Institutional Control Alternatives. Sporadic and temporary short-term impacts to noise levels would occur because of transportation and construction activities under any of the action alternatives. Short-term visual resource impacts are anticipated during site remediation. These short-term impacts could be mitigated by minimizing the size of the remediation zone and the number of aboveground facilities to the extent possible.

6.2.2 Issues

6.2.2.1 Mitigation Measures. The primary objective of mitigation is avoidance. If adverse impacts cannot be avoided, remedial action planning should minimize adverse impacts to the extent practicable. ~~through implementation of mitigation measures.~~ Mitigation measures may also include restoring or protecting other areas within or off the Hanford Site to compensate for ~~damages~~ adverse impacts that may be incurred during the cleanup effort.

Natural resources, for the purposes of mitigation, are considered to be physical resources such as land, water, and air; biological resources such as wildlife habitat or plants and

animals; human resources such as remedial workers, and cultural resources such as Indian artifacts or historical sites. Studies have been conducted at the operable units within the 100 Areas to characterize these resources. There are current ongoing and planned studies to complete the characterization of these resources where necessary. With this information, the natural resources will be fully described before developing the conceptual designs for remedial action.

This section presents information on general mitigation approaches and actions. However, because the remedial alternative has not been selected yet, this report does not present specific mitigation plans. ~~The completion of detailed mitigation plans will occur during the conceptual and preliminary design of the selected remedial alternative.~~ The mitigation actions will be addressed in the Record of Decision and detailed planning will occur during the conceptual and preliminary design of the selected remedial alternative.

Natural resources can be impacted in a variety of ways during implementation of remedial actions. For example, excavation, treatment, and construction activities can unnecessarily destroy wildlife habitat; disrupt normal breeding, nesting, or feeding activities of animals; increase wind and water erosion; or unearth native Indian artifacts. Final mitigation measures, to either eliminate or reduce the adverse consequences of the remedial activities, will be developed as an integral component of the remedial design and incorporated into the design specifications. In that way, mitigation becomes an integral component of the remedial activities.

The following general mitigation measures are examples of actions that may be taken to protect the physical, biological, human, and cultural resources that occur in the 100 Areas:

Physical Resources

- ~~Stockpile~~Salvage topsoil when possible.
- Minimize the width of construction corridors, the size of equipment yards and parking lots, and the amount of cut and fill required.
- Place equipment yards, treatment systems, and support services in formerly disturbed areas when possible.
- Develop and implement erosion control plans.
- Curtail or halt operations during high wind periods.
- Suppress fugitive dust with water, commercial suppressants, or temporary mulches.
- Prevent runoff and sediment transport to wetlands and the Columbia River.

Biological Resources

- Avoid wetlands, riparian habitats, and other sensitive areas when possible.
- Restrict the removal or destruction of trees.
- Plan for successional replacement of temporary ground cover with native species, when possible.
- Comply with the bald eagle management plan.
- Schedule construction activities to avoid breeding, nesting, winter roosting, and other sensitive seasonal activities of wildlife.
- Prepare biological resource management plans.
- Work with DOE, the U.S. Fish and Wildlife Service, Hanford Natural Resource Trustees, and the U.S. Army Corps of Engineers to mitigate impacts to wetlands.
- When possible, rectify impacts that cannot be avoided or minimized.

Human Resources

- Develop health and safety plans to protect onsite workers.
- Implement rigorous health and safety protocols.
- Minimize exposure to contaminants.
- Minimize generation of fugitive dust.
- Monitor air quality.
- Practice ALARA.

Cultural Resources

- Complete cultural resource surveys of areas to be remediated before implementing any action.
- Develop cultural resource action plans for each reactor area.
- Complete data recovery and analysis plans, have these approved by the State Historic Preservation Office, and conduct data recovery and analysis before initiating remedial actions.
- Train construction workers to recognize and report potential cultural resources.
- Work with the Indian nations to identify traditional use sites, prepare cultural resource mitigation plans, and evaluate the sensitivity of each waste site area.

6.2.2.2 Irreversible and Irretrievable Commitment of Resources. Remediation of groundwater in the 100 Areas will require the irreversible commitment of millions of federal dollars. ~~Depending on the remedial alternative, other irreversible commitments of resources would be necessary, include using consumables such as fuel, electricity, chemicals, and disposable protective equipment.~~ In addition, consumable use of geologic resources (e.g., sand and gravel) and petroleum products will be required for removal, construction, and treatment/disposal activities.

If sensitive habitats or cultural resources are involved in remedial actions, mitigation measures will be taken to minimize impacts. However, irreversible damage could occur to habitats, flora, and fauna during remediation. It is also possible that cultural resources could be destroyed during the remedial action.

6.2.2.3 Indirect and Cumulative Impacts. Based on improvements to the overall protection of human health and the environment, the net cumulative impact of the remedial actions is expected to be positive. ~~Remedial actions will remove or isolate the contaminants, make land in the 100 Areas available for other uses, and generally restore natural resources.~~ Remedial actions will remove or isolate chromium, thus providing a cumulative benefit for salmon spawning. Negative impacts from remediating the operable units within the 100 Areas, as discussed in Sections 6.0, 7.0, and 8.0, are expected to be minor and short term. However, there is potential for indirect and cumulative impacts as a result of remediating any one operable unit within the 100 Areas.

Remedial activities in the 100 Areas may potentially involve cumulative impacts due to interactions with other projects within the 100 Areas, as well as interactions with other projects within the Hanford Site or along the Columbia River. For the purposes of this Groundwater Operable Unit FFS, it was assumed that interactions with projects outside the Hanford Site, except for the Columbia River, would be insignificant because of the remote location of the 100 Areas relative to the Tri-Cities and major agricultural operations in the region.

The potential indirect and cumulative impacts of remedial actions ~~and other activities~~ within the 100 Areas will be dependent upon the scheduling of the remedial action at one site relative to the remedial actions at the other numerous operable units, and the scheduling of other activities within the 100 Areas. Indirect and cumulative impacts may result from the interaction of activities at:

- Other groundwater operable units
- Source operable units
- D&D activities
- Treatability studies
- Expedited response actions

Cumulative and indirect impacts in the 100 Areas will generally be greater if remedial activities at several operable units occur at the same time. Conversely, if the work can be properly sequenced cumulative impacts can be reduced or avoided. Because most of the above remedial actions and activities are still in the planning stage, coordination during the

planning and ~~initial~~ implementation of the various projects ~~will be necessary to~~ can reduce indirect and cumulative impacts.

Indirect and cumulative impacts may also occur because of interactions with projects outside of the 100 Areas. Remedial actions, treatability studies, and D&D work are also occurring in the 200 and 300 Areas, and other portions of the Hanford Site. Also, there are two central disposal facilities (located within the 200 Area) that are currently being developed to accept wastes from most of the waste sites. ~~, including drilling spoils or other types of wastes that may be generating during construction activities.~~ Likewise, clean fill materials needed to remediate many of the waste sites may come from a limited number of borrow pits. The schedules, demands on labor and equipment resources, requirements for disposal volume and fill material, and budget needs must all be considered under the issue of cumulative impacts. The indirect effects of these numerous projects on transportation, restoration of natural resources, and future land use must also be considered.

Implementation of an IRM for groundwater in the 100 Areas should lead to long-term cumulative benefits to natural resources as a result of removing or controlling contaminants, revegetating currently disturbed and denuded areas, and restoring natural habitats. The Columbia River and the riparian ecosystem along the river should also benefit from the cumulative actions at the 100 Areas and other portions of the Hanford Site.

6.2.2.4 Environmental Justice. The Environmental Justice Executive Order (E.O. 12898, February 1994) states:

> "Each federal agency shall make achieving environmental justice part of its mission by identifying and addressing as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations."

Low-income and minority populations involved in Hanford Site remedial actions include members of the Native American groups and local agricultural employees. The proposed alternatives have been assessed for potential disproportionate impacts to these low-income and/or minority populations.

The objectives of the Environmental Justice Executive Order may not be met by the No Action and Institutional Control Alternatives. Native American groups that use the Columbia River for fishing, hunting, and recreation are concerned about potential adverse human health effects from contaminants located on the Hanford Site. These contaminants would remain under the No Action and Institutional Control Alternatives. Compared to other alternatives, the No Action and Institutional Control Alternatives represent a low risk of inadvertent excavation of Native American cultural resources.

The Containment and Removal/Treatment/ Disposal Alternatives comply with the objectives of the Environmental Justice Executive Order. Construction activities would provide employment for the low-income workers, including a small number of new general labor (unskilled) jobs. However, drilling, excavation, and pile-driving activities always poses the risk of disturbing Native American burials. Consequently, the risk of an adverse impact on

Native Americans is disproportionately large compared to other segments of the population. The containment or removal alternatives, however, reduce or preclude the possibility of long-term lateral migration of contaminants from current locations to the Columbia River. These alternatives, with appropriate mitigation actions, will generally address Native American concerns.

6.2.2.5 Short-term Impacts to Human Health. Short-term impacts to human health during implementation of a remedial action can be grouped either as potential impacts to workers performing the remedial action, or potential impacts to the community. Potential impacts to workers performing the remedial action include physical hazards associated with construction activities and exposure to chemical and radionuclide contaminants. Physical hazards to workers include slips, trips and falls, operation of motor vehicles, excavation and trenching, drilling hazards, sharp objects, lifting hazards, heat and cold stress, and noise. Contaminant exposure hazards include incidental ingestion of soil, inhalation of fugitive dust generated during remedial action, and external exposure to radionuclides. Potential impacts to the community would largely be associated with inhalation of fugitive dust generated during remedial action. Generally, remedial alternatives would involve very little dust generation, hence potential impacts to the community are anticipated to be very low for all alternatives. Relative comparisons of the physical and contaminant exposure risks to workers associated with each alternative are presented below.

Institutional controls would involve relatively low physical and contaminant exposure hazards to workers. This alternative is unlikely to bring workers in proximity regularly with contaminants; and involves limited operation of heavy equipment or vehicles. Containment would involve low contaminant exposure hazards, but medium physical hazards. Installation of sheet pilings would involve increased use of heavy equipment, increased noise, and more physical hazards to workers. Both of the removal/treatment and disposal alternatives would involve medium contaminant exposure and physical hazards. Both alternatives would involve heavy equipment operation and vehicle traffic, noise and physical hazards from installation of extraction wells, pipelines and treatment plants. Treatment plant operation would involve potential exposures to contaminants in groundwater and chemical reagents. Exposures to contaminants in soils should be low under all alternatives; or because contaminants in soils are limited to defined source areas, ~~which are not likely to be sites for work locations or pipeline corridors.~~and it will be possible to avoid these sites in many cases.

6.3 DETAILED ANALYSIS

The detailed analysis for the 100-HR-3 Operable Unit is presented in Tables 6-1 through 6-5, and an analysis of the compliance with ARARs is presented in Table 6-6. Tables 6-1 through 6-6 also include a summary of estimated costs for each alternative, and cost details are presented in Appendix D. ~~Because the IRM period was originally planned to last 12 years, the cost estimates assume an interim remediation period of 1996-2008. Costs for alternative GW-5 (groundwater removal and treatment with ion exchange) were also estimated assuming a 5-year IRM period (1996-2001) to support the DOE and EPA planning and review process and incorporate lessons learned from a similar pump and treat remediation in Washington State (EPA 1995); these costs are presented in Section 8.0.~~

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Table 6-1. Detailed Analysis for GW-1, No Action Alternative.
(Page 1 of 16)

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
Will risk be at acceptable levels?	Uncertain, potential ecological risk exists based on chromium concentrations in near river wells exceeding ecological ARAR level (EPA Ambient Water Quality Criteria of 11 μg/L). Near-river well concentrations do not account for mixing at river-aquifer interface; chromium levels in the Columbia River are generally nondetectable (DOE-RL 1993c). Recent pore water samples collected from river sediments indicate that chromium concentrations in pore water exceed 11 ug/L at some locations (BHI, 1995). No actual ecological risk has been derived based on actual concentrations at the river-aquifer interface, and no quantification of risk in the substrate has been made.	Same as D/DR Area for chromium. Near-river well concentrations do not account for mixing at river-aquifer interface.
Timeframe to achieve acceptable levels?	The no action alternative will not achieve acceptable chromium levels by the end of the interim action period (year 2001). Although mixing within the river results in nondetectable chromium levels, concentrations in near-river wells are approximately 400 μg/L (DOE-RL 1993b). Groundwater modeling results indicate that chromium concentrations are not likely to decrease significantly by the year 2001.	The no action alternative will not achieve acceptable chromium levels by the end of the IRM period (year 2001). Although mixing within the river results in non-detectable chromium levels, the maximum concentrations in near river wells is approximately 500 μg/L (DOE-RL 1993b). Groundwater modeling results indicate that chromium concentrations are not likely to decrease significantly by the year 2001.
Will additional threats be minimized?	No additional threats result from implementation of this alternative.	Same as the D/DR Area.
Will the alternative pose any unacceptable short-term or cross-media impacts?	Yes, groundwater will remain contaminated and contamination may spread to the Columbia River.	Yes, groundwater will remain contaminated and contamination may spread to the Columbia River.

Table 6-1. Detailed Analysis for GW-1, No Action Alternative. (Page 2 of 16)

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
What restoration actions may be necessary?	No restoration is proposed.	No restoration is proposed.
Will residual contamination (following remediation) be a potential problem?	Not Applicable.	Not Applicable.

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Table 6-1. Detailed Analysis for GW-1, No Action Alternative. (Page 3 of 16)

COMPLIANCE WITH ARAR	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
What are the potential ARAR?	See Table 6-6.	See Table 6-6.
Will the potential ARAR be met? How?	See Table 6-6.	See Table 6-6.
Basis for waivers?	This alternative may represent an interim action preceding a final remedial action to be implemented by the year 2001. The final remedial action will be selected to ensure compliance with ARAR. Reduction of chromium concentrations in groundwater entering the Columbia River to below the EPA Ambient Water Quality Criteria level of 11 μg/L may be technically impractical. Although the purpose of the interim action is not aquifer restoration, contaminant concentrations in the aquifer represent the contaminant concentrations potentially entering the river. Due to the persistence of chromium in the environment, removal would be the only means of ensuring permanent compliance with ARAR. However, conventional pump-and-treat may never result in sufficient chromium reduction in the aquifer to comply with ARAR.	This alternative may represent an interim action preceding a final remedial action to be implemented by the year 2001. The final remedial action will be selected to ensure compliance with ARAR. Reduction of chromium concentrations in groundwater entering the Columbia River to below the EPA Ambient Water Quality Criteria level of 11 μg/L may be technically impractical. Although the purpose of the interim action is not aquifer restoration, contaminant concentrations in the aquifer represent the contaminant concentrations potentially entering the river. Due to the persistence of chromium in the environment, removal would be the only means of ensuring permanent compliance with ARAR. However, conventional pump-and-treat may never result in sufficient chromium reduction in the aquifer to comply with ARAR.
What are the potential TBC?	See Table 6-6.	See Table 6-6.
Is the alternative consistent with TBC listed above	See Table 6-6.	See Table 6-6.

Table 6-1. Detailed Analysis for GW-1, No Action Alternative. (Page 4 of 16)

COMPLIANCE WITH ARAR	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
Will implementation of the alternative comply with ARARs regarding protection, restoration, and enhancement of natural resources and protection of cultural resources?	See Table 6-6.	See Table 6-6.
What difficulties may be associated with compliance to ARARs?	See Table 6-6.	See Table 6-6.

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Table 6-1. Detailed Analysis for GW-1, No Action Alternative.
(Page 5 of 16)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
What is the magnitude of the remaining risk?	The potential ecological risk identified in the QRA will remain. Chromium concentrations in the near-river wells will not be significantly reduced from the current 400 μg/L levels. Groundwater modeling results indicate the near-river well concentrations will not significantly change during the IRM period.	The potential ecological risk identified in the LFI QRA will remain. Chromium levels in the near river wells will not be reduced from the approximate 500 ppb level (LFI 1993). Groundwater modeling results indicate the near-river well concentrations will not significantly change during the IRM period.
What remaining sources of risk can be identified?	The source of risk remaining after implementation of the no action alternative will be the chromium concentrations remaining in groundwater and potentially discharging into the river. Actual ecological risk from the chromium has never been quantified.	The source of risk remaining after implementation of the no action alternative will be the chromium concentrations remaining in groundwater and potentially discharging into the river. Actual ecological risk from the chromium has never been quantified.
What is the likelihood that the technologies will meet performance needs?	Remedial technologies are not included in the no action alternative. However, monitoring of the site is assumed to continue through 2001. The no action alternative does not ensure protection of the Columbia River.	Remedial technologies are not included in the no action alternative. However, monitoring of the site is assumed to continue through 2001. The no action alternative does not ensure protection of the Columbia River.
What type and degree of long-term management is required?	No long-term management requirements are required for this alternative. Monitoring of the operable unit is conducted under existing programs. Long-term management requirements beyond the IRM period will be addressed by the final remedial action.	No long-term management requirements are required for this alternative. Monitoring of the operable unit is conducted under existing programs. Long-term management requirements beyond the IRM period will be addressed by the final remedial action.

Table 6-1. Detailed Analysis for GW-1, No Action Alternative. (Page 6 of 16)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
What are the requirements for long-term monitoring?	The current monitoring program will continue through the duration of the interim action period (year 2001). Evaluations will be made periodically to determine need for additional remedial action or changes to the monitoring program. Long-term monitoring requirements beyond the IRM period will be addressed by the final remedial action selected.	The current monitoring program will continue through the duration of the interim action period (year 2001). Evaluations will be made periodically to determine need for additional remedial action or changes to the monitoring program. Long-term monitoring requirements beyond the IRM period will be addressed by the final remedial action selected.
What O&M functions must be performed?	No O&M functions will be required.	No O&M functions will be required.
What difficulties may be associated with long-term O&M?	None.	None.
What is the potential need for replacement of technical components?	None.	None.
What is the magnitude of risk should the remedial action need replacement?	No different than current risk.	No different than current risk.
What is the degree of confidence that controls can adequately handle potential problems?	The number of monitoring wells currently in place is considered adequate to effectively monitor migration of contaminant plumes within the 100 D/DR Area. The frequency of sampling and the number of samples taken ensure accurate monitoring results.	The number of monitoring wells currently in place is considered adequate to effectively monitor migration of contaminant plumes within the 100 H Area. The frequency of sampling and the number of samples taken ensure accurate monitoring results.
How is the removed contamination disposed of?	Not applicable. No contaminants are removed from the aquifer (other than for monitoring).	Not applicable. No contaminants are removed from the aquifer (other than for monitoring).

Table 6-1. Detailed Analysis for GW-1, No Action Alternative. (Page 7 of 16)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
What are potential final actions?	Potential final actions likely include no action, institutional controls, and pump and treat for mass reduction. The vertical barrier option is not considered for final action because chromium is persistent in the environment and does not readily degrade. The wall will contain the chromium by lengthening the travel time for the contaminants to reach the river; however, the contamination will eventually migrate around the wall.	Same as D/DR Area. The hydraulic barrier is not considered because of the logistics of maintaining the barrier indefinitely due to the persistence of the chromium.
Is the alternative for the IRM compatible with potential final actions?	Yes. The no action alternative for IRM would allow time for source cleanup and additional information collection through the treatability test in 100-HR-3 prior to implementing a final action. The no action alternative is compatible with both the no action and institutional controls final actions in that these are simply an extension of the IRM no action alternative.	Yes. The no action alternative for IRM would allow time for source cleanup and additional information collection through the treatability test in 100-HR-3 prior to implementing a final action. The no action alternative is compatible with both the no action and institutional controls final actions in that these are simply an extension of the IRM no action alternative.
What are the uncertainties associated with land disposal of residuals and untreated wastes?	Not Applicable.	Not Applicable.
Will the alternative provide long-term protection of natural resources?	No, the no-action alternative provides no restoration or environmental enhancements.	No, the no-action alternative provides no restoration or environmental enhancements.
Will important habitats be degraded or enhanced?	There will be no change from current habitat quality.	There will be no change from current habitat quality.

Table 6-1. Detailed Analysis for GW-1, No Action Alternative. (Page 8 of 16)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
How will the remedial action affect the overall quality of the ecosystem?	Because no action is taken, the quality of the ecosystem will remain in its current state.	Because no action is taken, the quality of the ecosystem will remain in its current state.

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Table 6-1. Detailed Analysis for GW-1, No Action Alternative. (Page 9 of 16)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
Does the treatment process address the principal threats?	The principal threat (chromium release into the river) is not addressed by this alternative.	The principal threat (chromium release into the river) is not addressed by this alternative.
Are there any special requirements for the treatment process?	No special requirements are associated with this alternative.	No special requirements are associated with this alternative.
What portion of the contaminated material is treated/destroyed?	Contaminated material is neither treated nor destroyed.	Contaminated material is neither treated nor destroyed.
To what extent is total mass of toxic contaminants reduced?	The mass of chromium entering the river is not significantly affected by this alternative. Groundwater modeling results indicate that chromium concentrations will not change significantly during the IRM period (until 2001).	The mass of chromium entering the river is not significantly affected by this alternative. Groundwater modeling results indicate that chromium concentrations will not change significantly during the IRM period (until 2001).
To what extent is the mobility of toxic contaminants reduced?	Contaminant mobility is not reduced.	Contaminant mobility is not reduced.
To what extent is the volume of toxic contaminants reduced?	Contaminant volume is not reduced.	Contaminant volume is not reduced.
To what extent are the effects of the treatment irreversible?	Contaminant migration into the river as well as movement of contaminant plumes is irreversible.	Contaminant migration into the river as well as movement of contaminant plumes is irreversible.
What are the quantities of residuals and characteristics of the residual risks?	No treatment residuals result from this alternative.	No treatment residuals result from this alternative.
What risks do treatment of residuals pose?	No risk from treatment is associated with this alternative.	No risk from treatment is associated with this alternative.

Table 6-1. Detailed Analysis for GW-1, No Action Alternative. (Page 10 of 16)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
Is treatment used to reduce inherent hazards posed by principal threats at the site?	The inherent hazards associated with the principal threat are not reduced by this alternative. No treatment is included in this alternative.	The inherent hazards associated with the principal threat are not reduced by this alternative. No treatment is included in this alternative.
How does the proposed treatment impact natural resources?	Not Applicable.	Not Applicable.
Does the alternative result in a gain or loss of quality at the site for natural resources?	Existing groundwater is contaminated and a loss of natural resource quality will result with the spread of contamination.	Existing groundwater is contaminated and a loss of natural resource quality will result with the spread of contamination.
Will implementation of the alternative result in short-term impacts to natural resources (e.g., exposure of ecological receptors to physical or chemical impacts, noise, intrusion to habitat and special breeding areas, temporary displacement, or seasonal restrictions on habitat use)?	Not Applicable.	Not Applicable.
Will the natural resource restoration activities associated with this alternative be easily implemented?	Not Applicable.	Not Applicable.

Table 6-1. Detailed Analysis for GW-1, No Action Alternative. (Page 11 of 16)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
Will long-term maintenance and monitoring of mitigation/restoration efforts be necessary?	Not Applicable.	Not Applicable.

Table 6-1. Detailed Analysis for GW-1, No Action Alternative. (Page 12 of 16)

SHORT-TERM EFFECTIVENESS	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
What are the risks to the community during remedial actions that must be addressed?	None.	None.
How will the risks to the community be addressed and mitigated?	See above.	See above.
What risks remain to the community that cannot be readily controlled?	None.	None.
What are the risks to the workers that need to be addressed?	None.	None.
What risks remain to the workers that cannot be readily controlled?	None.	None.
How will the risks to the workers be addressed and mitigated?	None.	None.
What environmental impacts are expected with the construction and implementation of the alternative?	None, based on the use of existing monitoring wells.	None, based on the use of existing monitoring wells.
What are the impacts that cannot be avoided should the alternative be implemented?	None.	None.

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Table 6-1. Detailed Analysis for GW-1, No Action Alternative. (Page 13 of 16)

SHORT-TERM EFFECTIVENESS	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
How long until remedial action objectives are achieved?	The RAO (protection of the river) will not be achieved by this alternative within the time frame of the IRM (year 2001), due to continued unrestricted migration of chromium contamination into the Columbia River. The final remedial action should ensure the RAO are appropriate to changes in objectives and achieved within a selected reasonable timeframe.	The RAO (protection of the river) will not be achieved by this alternative within the time frame of the IRM (year 2001), due to continued unrestricted migration of chromium contamination into the Columbia River. The final remedial action should ensure the RAO are appropriate to changes in objectives and achieved within a selected reasonable timeframe.

Table 6-1. Detailed Analysis for GW-1, No Action Alternative. (Page 14 of 16)

IMPLEMENTABILITY	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
What difficulties and uncertainties are associated with construction?	None.	None.
What is the likelihood that technical problems will lead to schedule delays?	None.	None.
What likely future remedial actions are anticipated?	None anticipated within the time frame of interim action (year 2001), final remedial actions should be determined by year 2001.	None anticipated within the time frame of interim action (year 2001), final remedial actions should be determined by year 2001.
What risks of exposure exist should monitoring be insufficient to detect failure?	Since this alternative does not involve the use of active remedial measures, groundwater monitoring failure would not result in exposure risks other than what is currently present (chromium migration into the Columbia River at concentrations above ecological ARAR, EPA Water Quality Criteria of 11 μg/L).	Since this alternative does not involve the use of active remedial measures, groundwater monitoring failure would not result in exposure risks other than what is currently present (chromium migration into the Columbia River at concentrations above ecological ARAR, EPA Water Quality Criteria of 11 μg/L).
What activities are proposed which require coordination with other agencies?	None.	None.
Are adequate treatment, storage capacity, and disposal services available?	Treatment, storage, and disposal are not applicable to this alternative.	Treatment, storage, and disposal are not applicable to this alternative.
Are the necessary equipment and specialists available?	Yes, groundwater monitoring is well established technology; equipment and specialists are readily available.	Yes, groundwater monitoring is well established technology; equipment and specialists are readily available.

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Table 6-1. Detailed Analysis for GW-1, No Action Alternative.
(Page 15 of 16)

IMPLEMENTABILITY	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
What additional equipment and specialists are required and what are their potential impacts to implementation?	None.	None.
Are technologies under consideration generally available and sufficiently demonstrated?	Yes, groundwater monitoring technology is well established technology and readily available.	Yes, groundwater monitoring technology is well established technology and readily available.
Will technologies require further development before they can be applied at the site?	No.	No.
Will more than one vendor be available to provide a competitive bid?	Yes, groundwater monitoring equipment and services are commercially available.	Yes, groundwater monitoring equipment and services are commercially available.

Table 6-1. Detailed Analysis for GW-1, No Action Alternative.
(Page 16 of 16)

COST COMPONENT	ALTERNATIVE GW-1: NO ACTION	
	D/DR Area	H Area
Capital?	$0	$0
Operation and Maintenance?	$0	$0
Present Worth?	$0	$0

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Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions. (Page 1 of 16)

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
Will risk be at acceptable levels?	Uncertain; potential ecological risk exists based on chromium concentrations in near river wells exceeding ecological ARAR level (EPA Ambient Water Quality Criteria of 11 μg/L). Near-river well concentrations do not account for mixing at river-aquifer interface; chromium levels in the Columbia River are nondetectable (DOE-RL 1993c). Pore water samples collected recently from river sediments indicate that chromium concentrations exceed 11 μg/L at some locations (BHI 1995). No actual ecological risk has been derived based on actual concentrations at the river aquifer interface, and no quantification of risk associated with the substrate has been made.	Uncertain; potential ecological risk exists based on chromium concentrations in near river wells exceeding ecological ARAR level (EPA Ambient Water Quality Criteria of 11 μg/L). Near-river well concentrations do not account for mixing at river-aquifer interface; chromium levels in the Columbia River are nondetectable (DOE-RL 1993c). Pore water samples collected recently from river sediments indicate that chromium concentrations exceed 11 μg/L at some locations (BHI 1995). No actual ecological risk has been derived based on actual concentrations at the river aquifer interface, and no quantification of risk associated with the substrate has been made.
Timeframe to achieve acceptable levels?	The institutional controls/continued current actions alternative will not achieve acceptable chromium levels by the end of the interim action period (year 2001). Although mixing within the river results in nondetectable chromium levels, concentrations in near-river wells are approximately 400 μg/L (DOE-RL 1993b). Groundwater modeling results indicate that chromium concentrations in near river wells will not change significantly during the interim action period.	The no action alternative will not achieve acceptable chromium levels by the end of the interim action period (year 2001). Although mixing within the river results in non-detectable chromium and iron levels, maximum concentrations in near river wells are approximately 500 μg/L (DOE-RL 1993b). Groundwater modeling results indicate that chromium concentrations in near river wells will not change significantly during the interim action period.
Will additional threats be minimized?	No additional threats result from implementation of this alternative.	Same as the D/DR Area.

Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions. (Page 2 of 16)

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
Will the alternative pose any unacceptable short-term or cross-media impacts?	Yes, groundwater will remain contaminated and contamination may spread to the Columbia River.	Yes, groundwater will remain contaminated and contamination may spread to the Columbia River.
What restoration actions may be necessary?	No restoration is proposed.	No restoration is proposed.
Will residual contamination (following remediation) be a potential problem?	Not Applicable	Not Applicable

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Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions. (Page 3 of 16)

COMPLIANCE WITH ARAR	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
What are the potential ARAR?	See Table 6-6.	See Table 6-6.
Will the potential ARAR be met? How?	See Table 6-6.	See Table 6-6.
Basis for waivers?	This alternative may represent an interim action preceding a final remedial action to be implemented by the year 2001. The final remedial action will be selected to ensure compliance with ARAR. Reduction of chromium concentrations in groundwater entering the Columbia River to below the EPA Ambient Water Quality Criteria level of 11 μg/L may be technically impractical. Although the purpose of the interim action is not aquifer restoration, contaminant concentrations in the aquifer represent the contaminant concentrations potentially entering the river. Due to the persistence of chromium in the environment, removal would be the only means of ensuring permanent compliance with ARAR. However, conventional pump-and-treat may never result in sufficient chromium reduction in the aquifer to comply with ARAR.	This alternative may represent an interim action preceding a final remedial action to be implemented by the year 2001. The final remedial action will be selected to ensure compliance with ARAR. Reduction of chromium concentrations in groundwater entering the Columbia River to below the EPA Ambient Water Quality Criteria level of 11 μg/L may be technically impractical. Although the purpose of the interim action is not aquifer restoration, contaminant concentrations in the aquifer represent the contaminant concentrations potentially entering the river. Due to the persistence of chromium in the environment, removal would be the only means of ensuring permanent compliance with ARAR. However, conventional pump-and-treat may never result in sufficient chromium reduction in the aquifer to comply with ARAR.
What are the potential TBC?	See Table 6-6.	See Table 6-6.
Is the alternative consistent with TBC listed above	See Table 6-6.	See Table 6-6.

Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions. (Page 4 of 16)

COMPLIANCE WITH ARAR	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
Will implementation of the alternative comply with ARARs regarding protection, restoration, and enhancement of natural resources and protection of cultural resources?	See Table 6-6.	See Table 6-6.
What difficulties may be associated with compliance to ARARs?	See Table 6-6.	See Table 6-6.

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Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions. (Page 5 of 16)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
What is the magnitude of the remaining risk?	The potential ecological risk identified in the QRA will remain. Chromium concentrations in the near-river wells will not be significantly reduced from the current 400 μg/L levels. Groundwater modeling results indicate the near-river well concentrations will not significantly change during the IRM period.	The potential ecological risk identified in the LFI QRA will remain. Chromium levels in the near river wells will not be reduced from the approximate 500 ppb level (LFI 1993). Groundwater modeling results indicate the near-river well concentrations will not significantly change during the IRM period.
What remaining sources of risk can be identified?	The source of risk remaining after implementation of the no action alternative will be the chromium concentrations remaining groundwater and potentially discharging to the Columbia River. Actual ecological risk from the chromium has not been quantified.	The source of risk remaining after implementation of the no action alternative will be the chromium concentrations remaining groundwater and potentially discharging to the Columbia River. Actual ecological risk from the chromium has not been quantified.
What is the likelihood that the technologies will meet performance needs?	Remedial technologies are not included in the no action alternative. However, monitoring and government control of the site is assumed to continue through 2001. These actions will ensure restriction against public access and warning of changes in contaminant concentration migration. However, no action does not ensure protection of the Columbia River.	Remedial technologies are not included in the no action alternative. However, monitoring and government control of the site is assumed to continue through 2001. These actions will ensure restriction against public access and warning of changes in contaminant concentration migration. However, no action does not ensure protection of the Columbia River.
What type and degree of long-term management is required?	Long-term management requirements for this alternative involve continued access restriction enforcement and groundwater monitoring through the duration of the interim action period (year 2001). Remedial actions beyond the interim action period will be addressed by a comprehensive risk assessment and final remedial action; no other long-term management is required. Long-term management requirements beyond 2001 will be addressed by the final remedial action.	Long-term management requirements for this alternative involve continued access restriction enforcement and groundwater monitoring through the duration of the interim action period (year 2001). Remedial actions beyond the interim action period will be addressed by a comprehensive risk assessment and final remedial action; no other long-term management is required. Long-term management requirements beyond 2001 will be addressed by the final remedial action.

Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions. (Page 6 of 16)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
What are the requirements for long-term monitoring?	The current monitoring program will continue through the duration of the interim action period (year 2001). Evaluations will be made periodically to determine need for additional remedial action or changes to the monitoring program. Long-term monitoring requirements beyond 2001 will be addressed by the final remedial action selected.	The current monitoring program will continue through the duration of the interim action period (year 2001). Evaluations will be made periodically to determine need for additional remedial action or changes to the monitoring program. Long-term monitoring requirements beyond 2001 will be addressed by the final remedial action selected.
What O&M functions must be performed?	O&M will be required throughout the interim action period to perform and maintain groundwater monitoring activities.	O&M will be required throughout the interim action period to perform and maintain groundwater monitoring activities.
What difficulties may be associated with long-term O&M?	None foreseeable, based on government control maintained through the IRM period.	None foreseeable, based on government control maintained through the IRM period.
What is the potential need for replacement of technical components?	Periodic replacement or refurbishing of groundwater monitoring wells may be required on an as needed basis.	Periodic replacement or refurbishing of groundwater monitoring wells may be required on an as needed basis.
What is the magnitude of risk should the remedial action need replacement?	Negligible risk is associated with maintenance or replacement of groundwater monitoring wells. These activities primarily involve physical hazards to workers such as those associated with drilling activities.	Negligible risk is associated with maintenance or replacement of groundwater monitoring wells. These activities primarily involve physical hazards to workers such as those associated with drilling activities.
What is the degree of confidence that controls can adequately handle potential problems?	The number of monitoring wells currently in place is considered adequate to effectively monitor migration of contaminant plumes within the 100-H Area. The frequency of sampling and the number of samples taken ensure accurate monitoring results.	The number of monitoring wells currently in place is considered adequate to effectively monitor migration of contaminant plumes within the 100-H Area. The frequency of sampling and the number of samples taken ensure accurate monitoring results.

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Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions. (Page 7 of 16)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
How is the removed contamination disposed of?	Not applicable. No contaminants are removed from the aquifer (other than for monitoring).	Not applicable. No contaminants are removed from the aquifer (other than for monitoring).
What are potential final actions?	Potential final actions likely include no action, institutional controls, and pump and treat for mass reduction. The vertical barrier option is not considered for final action because chromium is persistent in the environment and does not readily degrade. The wall will contain the chromium by lengthening the travel time for the contaminants to reach the river; however, the contamination will eventually migrate around the wall.	Same as D/DR Area. The hydraulic barrier is not considered because of the logistics of maintaining the barrier indefinitely due to the persistence of the chromium.
Is the alternative for the IRM compatible with potential final actions.	Yes. The institutional controls/continued current actions alternative for IRM would allow time for source cleanup and additional information collection through the treatability test in 100 D/DR prior to implementing a final action. The institutional controls/continued current actions alternative is compatible with both the no action and institutional controls final actions in that these are simply an extension of the IRM institutional controls/continued current actions alternative.	Yes. The institutional controls/continued current actions alternative for IRM would allow time for source cleanup and additional information collection through the treatability test in 100-HR-3 prior to implementing a final action. The institutional controls/continued current actions alternative is compatible with both the no action and institutional controls final actions in that these are simply an extension of the IRM institutional controls/continued current actions alternative.
What are the uncertainties associated with land disposal of residuals and untreated wastes?	Not Applicable	Not Applicable

Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions. (Page 8 of 16)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
Will the alternative provide long-term protection of natural resources?	No, this alternative provides no restoration or environmental enhancements, although continuing current action will help develop technology performance data for identifying a final action for the operable unit.	No, this alternative provides no restoration or environmental enhancements, although continuing current action will help develop technology performance data for identifying a final action for the operable unit.
Will habitats be degraded or enhanced?	There will be no change from current habitat quality.	There will be no change from current habitat quality.
How will the remedial action affect the overall quality of the ecosystem?	Because no remedial action is taken, the quality of the ecosystem will remain in its current state.	Because no remedial action is taken, the quality of the ecosystem will remain in its current state.

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Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions. (Page 9 of 16)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
Does the treatment process address the principal threats?	The principal threat (chromium release into the river) is not addressed by this alternative.	The principal threat (chromium release into the river) is not addressed by this alternative.
Are there any special requirements for the treatment process?	No special requirements are associated with this alternative.	No special requirements are associated with this alternative.
What portion of the contaminated material is treated/destroyed?	Contaminated material is neither treated nor destroyed.	Contaminated material is neither treated nor destroyed.
To what extent is total mass of toxic contaminants reduced?	The mass of chromium entering the river is not affected by this alternative. Groundwater modeling results indicate the contaminant concentrations in near-river wells do not significantly change during the interim action period.	The mass of chromium and iron entering the river will not be affected by this alternative. Groundwater modeling results indicate the contaminant concentrations in near-river wells do not significantly change during the interim action period.
To what extent is the mobility of toxic contaminants reduced?	Contaminant mobility is not reduced.	Contaminant mobility is not reduced.
To what extent is the volume of toxic contaminants reduced?	Contaminant volume is not reduced.	Contaminant volume is not reduced.
To what extent are the effects of the treatment irreversible?	Contaminant migration into the river as well as movement of contaminant plumes is irreversible.	Contaminant migration into the river as well as movement of contaminant plumes is irreversible.
What are the quantities of residuals and characteristics of the residual risks?	No treatment residuals result from this alternative.	No treatment residuals result from this alternative.

Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions. (Page 10 of 16)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
What risk do treatment of residuals pose?	No risk from treatment is associated with this alternative.	No risk from treatment is associated with this alternative.
Is treatment used to reduce inherent hazards posed by principal threats at the site?	The inherent hazards associated with the principal threat are not reduced by this alternative. No treatment is included in this alternative.	The inherent hazards associated with the principal threat are not reduced by this alternative. No treatment is included in this alternative.
How does the proposed treatment impact natural resources?	Not Applicable.	Not Applicable.
Does the alternative result in a gain or loss of quality at the site for natural resources?	Existing groundwater is contaminated and a loss of natural resource quality will result with the spread of contamination.	Existing groundwater is contaminated and a loss of natural resource quality will result with the spread of contamination.
Will implementation of the alternative result in short-term impacts to natural resources (e.g., exposure of ecological receptors to physical or chemical impacts, noise, intrusion to habitat and special breeding areas, temporary displacement, or seasonal restrictions on habitat use)?	Not Applicable	Not Applicable
Will the natural resource restoration activities associated with this alternative be easily implemented?	Not Applicable	Not Applicable

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Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions. (Page 11 of 16)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
Will long-term maintenance and monitoring of mitigation/restoration efforts and activities be necessary?	Not Applicable	Not Applicable

Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions. (Page 12 of 16)

SHORT-TERM EFFECTIVENESS	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
What are the risks to the community during remedial actions that must be addressed?	None.	None.
How will the risks to the community be addressed and mitigated?	See above.	See above.
What risks remain to the community that cannot be readily controlled?	None.	None.
What are the risks to the workers that need to be addressed?	Risks to workers are associated with groundwater monitoring. Minimal exposure risks are anticipated with monitoring activities. The exposure duration associated with monitoring is estimated to be approximately 12 hours per year per worker.	Risks to workers are associated with groundwater monitoring. Minimal exposure risks are anticipated with monitoring activities. The exposure duration associated with monitoring is estimated to be approximately 12 hours per year per worker.
What risks remain to the workers that cannot be readily controlled?	None.	None.
How will the risks to the workers be addressed and mitigated?	Workers involved with monitoring activities will be required to undergo extensive training in sample collection and handling procedures. Health and safety protocols will be established and enforced, such as specification of personal protection equipment, safe work practices, contamination control measures, and decontamination procedures.	Workers involved with monitoring activities will be required to undergo extensive training in sample collection and handling procedures. Health and safety protocols will be established and enforced, such as specification of personal protection equipment, safe work practices, contamination control measures, and decontamination procedures.

Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions. (Page 13 of 16)

SHORT-TERM EFFECTIVENESS	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
What environmental impacts are expected with the construction and implementation of the alternative?	None, based on the use of existing monitoring wells. Negligible impacts are anticipated if periodic well maintenance is required.	None, based on the use of existing monitoring wells. Negligible impacts are anticipated if periodic well maintenance is required.
What are the impacts that cannot be avoided should the alternative be implemented?	Impacts are minimal.	Impacts are minimal.
How long until remedial action objectives are achieved?	The RAO (protection of the river) will not be achieved by this alternative within the time frame of the interim remedial action (year 2001), due to continued unrestricted migration of chromium contamination into the Columbia River. The final remedial action should ensure the RAO are appropriate to changes in objectives and achieved within a selected reasonable timeframe.	The RAO (protection of the river) will not be achieved by this alternative within the time frame of the interim remedial action (year 2001), due to continued unrestricted migration of chromium contamination into the Columbia River. The final remedial action should ensure the RAO are appropriate to changes in objectives and achieved within a selected reasonable timeframe.

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Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions. (Page 14 of 16)

IMPLEMENTABILITY	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
What difficulties and uncertainties are associated with construction?	None.	None.
What is the likelihood that technical problems will lead to schedule delays?	None.	None.
What likely future remedial actions are anticipated?	None anticipated within the time frame of interim action (year 2001), final remedial actions should be determined by year 2001.	None anticipated within the time frame of interim action (year 2001), final remedial actions should be determined by year 2001.
What risks of exposure exist should monitoring be insufficient to detect failure?	Since this alternative does not involve the use of active remedial measures, groundwater monitoring failure would not result in exposure risks other than what is currently present (chromium migration into the Columbia River at concentrations above ecological ARAR, EPA Water Quality Criteria of 11 μg/L).	Since this alternative does not involve the use of active remedial measures, groundwater monitoring failure would not result in exposure risks other than what is currently present (chromium migration into the Columbia River at concentrations above ecological ARAR, EPA Water Quality Criteria of 11 μg/L).
What activities are proposed which require coordination with other agencies?	None.	None.
Are adequate treatment, storage capacity, and disposal services available?	Treatment, storage, and disposal are not applicable to this alternative.	Treatment, storage, and disposal are not applicable to this alternative.
Are the necessary equipment and specialists available?	Yes, groundwater monitoring is well established technology; equipment and specialists are readily available.	Yes, groundwater monitoring is well established technology; equipment and specialists are readily available.

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Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions. (Page 15 of 16)

IMPLEMENTABILITY	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
What additional equipment and specialists are required and what are their potential impacts to implementation?	None.	None.
Are technologies under consideration generally available and sufficiently demonstrated?	Yes, groundwater monitoring technology is well established technology and readily available.	Yes, groundwater monitoring technology is well established technology and readily available.
Will technologies require further development before they can be applied at the site?	No.	No.
Will more than one vendor be available to provide a competitive bid?	Yes, groundwater monitoring equipment and services are commercially available.	Yes, groundwater monitoring equipment and services are commercially available.

Table 6-2. Detailed Analysis for GW-2, Institutional Controls/ Continued Current Actions (Page 16 of 16)

COST COMPONENT	ALTERNATIVE GW-2: INSTITUTIONAL CONTROLS/CONTINUED CURRENT ACTIONS	
	D/DR Area	H Area
Capital?	$0	$0
Operation and Maintenance?	$600,000	$600,000
Present Worth?	$500,000	$500,000

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Table 6-3. Detailed Analysis for GW-3, Containment Alternative.
(Page 1 of 22)

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	ALTERNATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
Will risk be at acceptable levels?	Uncertain. Groundwater modeling results indicate the sheet piling cutoff wall in combination with hydraulic control will effectively intercept the chromium plume upgradient of the Columbia River. Groundwater modeling suggests that containment will prevent most of the chromium from reaching the Columbia River. However, chromium located between the containment system and the river will not be obstructed from reaching the river. The risk associated with the substrate of the Columbia River has not been quantified.	Groundwater modeling results indicate that hydraulic control (downgradient extraction followed by upgradient injection) will effectively intercept the chromium plume upgradient of the Columbia River. Groundwater modeling suggests that containment will prevent most of the chromium from reaching the Columbia River. However, chromium located between the containment system and the river will not be obstructed from reaching the river. The risk associated with the substrate of the Columbia River has not been quantified.
Will additional threats be minimized?	Additional threats to workers resulting from implementation of this alternative will be minimized by developing health and safety protocols defining training requirements, safe work practices, personal protection equipment, contamination control measures, and decontamination procedures. Additional threats to the environment resulting from implementation of this alternative will be minimized by limiting habitat disturbances to the extent possible and performing construction activities during seasons when threatened or endangered species, such as the bald eagle, do not inhabit the area.	Additional threats to workers resulting from implementation of this alternative will be minimized by developing health and safety protocols defining training requirements, safe work practices, personal protection equipment, contamination control measures, and decontamination procedures. Additional threats to the environment resulting from implementation of this alternative will be minimized by limiting habitat disturbances to the extent possible and performing construction activities during seasons when threatened or endangered species, such as the bald eagle, do not inhabit the area.

Table 6-3. Detailed Analysis for GW-3, Containment Alternative. (Page 2 of 22)

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	ALTERNATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
Will the alternative pose any unacceptable short-term or cross-media impacts?	All contaminants are left in place or returned to the aquifer, so additional media are not impacted.	Contaminants are left in place or returned to the aquifer, so additional media are not impacted.
What restoration actions may be necessary?	Revegetation of excavated area will be necessary. Revegetation techniques are well established, but arid lands require time.	Revegetation of excavated area will be necessary. Revegetation techniques are well established, but arid lands require time.
Will residual contamination (following remediation) be a potential problem?	Contaminants will remain at the site. Monitoring is required because of possible offsite migration.	Contaminants will remain at the site. Monitoring is required because of possible offsite migration.

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Table 6-3. Detailed Analysis for GW-3, Containment Alternative.
(Page 3 of 22)

COMPLIANCE WITH ARAR	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
What are the potential ARAR?	See Table 6-6.	See Table 6-6.
Will the potential ARAR be met? How?	See Table 6-6.	See Table 6-6.
Basis for waivers?	This alternative may represent an interim action preceding a final remedial action. The final remedial action will be selected to ensure compliance with ARAR. Reduction of hexavalent chromium concentrations in groundwater entering the Columbia River to below the EPA Ambient Water Quality Criteria level of 11 μg/L may be technically impractical. Although the purpose of the interim action is not aquifer restoration, contaminant concentrations in the aquifer represent the contaminant concentrations potentially entering the river. Due to the persistence of chromium in the environment, removal would be the only means of ensuring permanent compliance with ARAR. However, conventional pump and treat may never result in sufficient chromium reduction in the aquifer to comply with ARAR.	This alternative may represent an interim action preceding a final remedial action. The final remedial action will be selected to ensure compliance with ARAR. Reduction of hexavalent chromium concentrations in groundwater entering the Columbia River to below the EPA Ambient Water Quality Criteria level of 11 μg/L may be technically impractical. Although the purpose of the interim action is not aquifer restoration, contaminant concentrations in the aquifer represent the contaminant concentrations potentially entering the river. Due to the persistence of chromium in the environment, removal would be the only means of ensuring permanent compliance with ARAR. However, conventional pump and treat may never result in sufficient chromium reduction in the aquifer to comply with ARAR.
What are the potential TBC?	See Table 6-6.	See Table 6-6.
Is the alternative consistent with TBC listed above	See Table 6-6.	See Table 6-6.

Table 6-3. Detailed Analysis for GW-3, Containment Alternative. (Page 4 of 22)

COMPLIANCE WITH ARAR	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
Will implementation of the alternative comply with ARARs regarding protection, restoration, and enhancement of natural resources and protection of cultural resources?	See Table 6-6.	See Table 6-6.
What difficulties may be associated with compliance to ARARs?	See Table 6-6.	See Table 6-6.

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Table 6-3. Detailed Analysis for GW-3, Containment Alternative. (Page 5 of 22)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
What is the magnitude of the remaining risk?	Although groundwater modeling results indicate this alternative can reduce the mass of chromium entering the Columbia River during the interim action period, chromium contaminated groundwater will remain in the unconfined aquifer. The integrity of the containment system (sheet piling cutoff wall and hydraulic control wells) can be maintained through the duration of the interim action period, but final remedial action will likely be required to address the remaining chromium contaminated groundwater.	Although groundwater modeling results indicate this alternative can reduce the mass of chromium entering the Columbia River during the interim action period, chromium contaminated groundwater will remain within the unconfined aquifer. Hydraulic containment using downgradient extraction followed by upgradient injection can be maintained through the duration of the interim action period, but final remedial action will likely be required to address the remaining chromium contaminated groundwater.
What remaining sources of risk can be identified?	Chromium contaminated groundwater contained by the sheet piling wall will remain at concentrations above the 11 μg/L EPA Ambient Water Quality Criteria level.	Chromium contaminated groundwater contained by the hydraulic barrier will remain at concentrations above the 11 μg/L EPA Ambient Water Quality Criteria level.
What is the likelihood that the technologies will meet performance needs?	Sheet piling cutoff wall technology is well developed. The use of hydraulic control measures (extraction wells at the ends of the sheet piling wall) can enhance the effectiveness of the wall. Groundwater modeling results indicate this containment system will be effective in reducing the mass of chromium entering the river. However, since chromium contamination within the aquifer is not reduced, additional remedial actions would be required in the future.	Hydraulic control within aquifers by downgradient extraction wells and upgradient injection wells is well developed technology. Groundwater modeling results indicate this containment system will be effective in reducing the mass of chromium entering the river. However, since chromium contamination within the aquifer is not reduced, additional remedial actions would be required in the future.

Table 6-3. Detailed Analysis for GW-3, Containment Alternative. (Page 6 of 22)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
What type and degree of long-term management is required?	Long-term (through year 2001) management requirements for this alternative include monitoring and maintenance of the containment system. Groundwater monitoring between the river and the sheet piling wall can be used to determine unacceptable leakage from the cutoff wall. Additional sheet piles can be installed where leakage is identified.	Long-term (through year 2001) management requirements for this alternative include monitoring and maintenance of the containment system. Groundwater monitoring near the river will be required to identify unacceptable contamination leakage past the extraction wells. Additional extraction or injection wells, or maintenance (such as pump replacement) of existing wells may be required.
What are the requirements for long-term monitoring?	Groundwater monitoring as well as sheet piling wall integrity monitoring is required to assess the effectiveness of the containment system for as long as containment is required.	Groundwater monitoring is required to assess the effectiveness of the containment system. Continuous process monitoring of the extraction and injection system is required to ensure operation within design parameters (flow rate, pressure, etc.). Due to above ground transport of contaminated groundwater (from extraction wells to injection wells), unanticipated equipment failures within the system (such as pumps) must be corrected promptly.

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Table 6-3. Detailed Analysis for GW-3, Containment Alternative. (Page 7 of 22)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
What O&M functions must be performed?	Operating requirements are specific to monitoring activities. Maintenance of the monitoring system as well as the components of the containment system is required on an as needed basis.	An extraction and injection system will require continuous operation as long as containment is required. Although the system will be automated (to the extent possible), utility requirements will be high to maintain pumping operations. Personnel will be required to continuously monitor system operations and perform any immediately needed maintenance requirements to the system (such as pump replacements or plumbing repair). Monitoring well O&M requirements are the same as described for D/DR Area.
What difficulties may be associated with long-term O&M?	No O&M difficulties are anticipated during the period of interim action (through year 2001). Final remedial actions will be selected and implemented to reflect changes to objectives.	Operational difficulties may result from seasonal as well as daily fluctuations in the hydrologic conditions of the unconfined aquifer. Groundwater flow near the river is strongly influenced by variations in Columbia River stage (DOE-RL 1993b). Frequent adjustments to the containment system operating conditions (such as pumping rates) may be required to ensure the effectiveness of the containment system. In addition, uncertainties in the hydraulic properties and heterogeneities in the hydrology of the unconfined aquifer may also result in long-term O&M difficulties.

Table 6-3. Detailed Analysis for GW-3, Containment Alternative. (Page 8 of 22)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
What is the potential need for replacement of technical components?	Assuming proper installation of the sheet piling wall, replacement will not likely be required within the IRM timeframe (year 2001). However, maintenance and repair requirements as described above may be necessary on an as needed basis. Replacement of groundwater monitoring wells and equipment may also be required on an as needed basis.	Replacement of extraction or injection system components are anticipated only on a maintenance specific basis. Similarly, groundwater monitoring components may require replacement on an as needed basis.
What is the magnitude of risk should the remedial action need replacement?	The magnitude of risk to workers and the environment during replacement of the sheet piling wall would be equivalent to the risk during initial installation. However, migration of the chromium plume during replacement will likely result in additional contamination release to the river.	The magnitude of risk to workers and the environment during replacement of the sheet piling wall would be equivalent to the risk during initial installation. However, migration of the chromium plume during replacement will likely result in additional contamination release to the river.
What is the degree of confidence that controls can adequately handle potential problems?	Sheet piling wall technology is considered well established. Groundwater monitoring downgradient from the wall can effectively determine potential problems associated with the containment system. Repair of the wall is relatively simple and involves installation of additional sheet piles.	Groundwater control by extraction and injection is considered well established technology. Groundwater monitoring between the extraction wells and the river can effectively determine potential problems associated with the containment system. Repair may involve maintenance of the well system or installation of additional wells.

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Table 6-3. Detailed Analysis for GW-3, Containment Alternative. (Page 9 of 22)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
How is the removed contamination disposed of?	Sheet piling wall construction will not require contact with contaminated soil. Installation of hydraulic control wells may generate contaminated material in the form of drill cuttings. Sonic drilling may be used to reduce the generation of cuttings requiring disposal. In the event well installations, monitoring activities, or standard operations generate contaminated materials, ERDF is the specified disposal site.	Installation of hydraulic control wells for extraction and injection may generate contaminated materials in the form of drill cuttings. Sonic drilling may be used to reduce the generation of cuttings requiring disposal. In addition, equipment may become contaminated as a result of operation. In the event well installation, monitoring activities, or maintenance generates contaminated materials, ERDF is the specified disposal site.
What are potential final actions?	Potential final actions include no action, institutional controls, or pump and treat for mass reduction. The vertical barrier option is not considered for final action because chromium is persistent in the environment and does not readily degrade. The wall will contain the chromium by lengthening the travel time for the contaminants to reach the river; however, the contamination will eventually migrate around the wall.	Same as D/DR Area. The hydraulic barrier is not considered as a final action because of the logistics of maintaining the barrier indefinitely due to the persistence of the chromium.

Table 6-3. Detailed Analysis for GW-3, Containment Alternative. (Page 10 of 22)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
Is the alternative for the IRM compatible with potential final actions?	Yes. The vertical barrier is compatible with all the potential final actions. If the barrier is installed as an IRM, it will not have an adverse effect on a no action or institutional controls final action and in fact will provide additional protection above and beyond that provided by no action or institutional controls. The wall would augment the mass reduction pump and treat by reducing the effects of the river on the pumping system and the amount of river water extraction. The wall would contain the plume pending source remediation and treatability test results. This would allow optimization of the pump and treat system based on maximum information.	Same as D/DR Area. Hydraulic control may mobilize and relocate contaminants to the upgradient segment of the plume. The technology can be readily modified to a pump and treat system for final action.
What are the uncertainties associated with land disposal of residuals and untreated wastes?	Untreated wastes will be contained at the site. Containment will not be complete.	Untreated wastes will be contained at the site. Containment will not be complete.
Will the alternative provide long-term protection of natural resources?	This alternative can reduce contamination to the Columbia River, but the contaminated groundwater will remain.	This alternative can reduce contamination to the Columbia River, but the contaminated groundwater will remain.
Will terrestrial habitats be degraded or enhanced?	Terrestrial habitats will be restored after construction; sensitive habitats will be avoided as much as possible.	Terrestrial habitats will be restored after construction; sensitive habitats will be avoided as much as possible.

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Table 6-3. Detailed Analysis for GW-3, Containment Alternative.
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LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
How will the remedial action affect the overall quality of the ecosystem?	Contamination entering the Columbia River will be reduced; groundwater will still be contaminated; the revegetation and restoration of habitats will enhance the environment.	Contamination entering the Columbia River will be reduced; groundwater will still be contaminated; the revegetation and restoration of habitats will enhance the environment.

Table 6-3. Detailed Analysis for GW-3, Containment Alternative. (Page 12 of 22)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
Does the treatment process address the principal threats?	Yes. The majority of chromium contaminated groundwater within the unconfined aquifer would be contained and therefore prevented from entering the Columbia River. However, due to the persistence of chromium in the environment, groundwater contained by the sheet piling wall will remain contaminated.	Yes. The majority of chromium contaminated groundwater within the unconfined aquifer would be contained and therefore prevented from entering the Columbia River. However, due to the persistence of chromium in the environment, groundwater contained by the extraction and injection system will remain contaminated until additional remedial actions are implemented.
Are there any special requirements for the treatment process?	The effectiveness of the sheet piling wall requires key-in to a confining geologic formation (aquitard) below the unconfined aquifer. This requires wall construction adjacent to the Columbia River to approximately 15 m (50 ft) below the surface.	None foreseeable.
What portion of the contaminated material is treated/destroyed?	The purpose of this alternative is containment; therefore contaminated material is neither treated or destroyed.	The purpose of this alternative is containment; therefore contaminated material is neither treated or destroyed.
To what extent is total mass of toxic contaminants reduced?	The total mass of chromium will not be reduced by this alternative. However, the majority of chromium contamination within the unconfined aquifer will be prevented from migrating into the Columbia River.	The total mass of chromium will not be reduced by this alternative. However, the majority of chromium contamination within the unconfined aquifer will be prevented from migrating into the Columbia River.
To what extent is the mobility of toxic contaminants reduced?	Contaminant mobility is significantly reduced by the sheet piling wall. The hydraulic conductivity of the wall (10^{-7} to 10^{-10} cm/sec) will be several orders of magnitude less than the hydraulic conductivity of the unconfined aquifer near the river (10^{-2} cm/sec).	The extraction and injection system will reduce the mobility of chromium contaminated groundwater in the H Area by isolation within the existing plume boundary.

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Table 6-3. Detailed Analysis for GW-3, Containment Alternative.
(Page 13 of 22)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
To what extent is the volume of toxic contaminants reduced?	The volume of contamination is not reduced by containment.	The volume of contamination is not reduced by containment.
To what extent are the effects of the treatment irreversible?	Isolation of chromium contaminated groundwater by installation of a sheet piling wall and hydraulic control wells is reversible. Isolation is temporary and dependent on maintaining the integrity of the containment system.	Isolation of chromium contaminated groundwater by operation of an extraction and injection well system is reversible. Isolation is temporary and dependent on maintaining operation of the well system.
What are the quantities of residuals and characteristics of the residual risks?	The majority of hexavalent chromium contaminated groundwater will remain isolated by the containment system. The chromium concentrations within the contained plume will be above the EPA Ambient Water Quality Criteria of 11 μg/L level.	The majority of hexavalent chromium contaminated groundwater will remain isolated by the containment system. The chromium concentrations within the contained plume will be above the EPA Ambient Water Quality Criteria of 11 μg/L level.
What risks do treatment of residuals pose?	The contaminated groundwater isolated by the containment system will not be treated during the interim action period. Selection and implementation of the final remedial action will address the disposition of isolated chromium contaminated groundwater.	The contaminated groundwater isolated by the containment system will not be treated during the interim action period. Selection and implementation of the final remedial action will address the disposition of isolated chromium contaminated groundwater.
Is treatment used to reduce inherent hazards posed by principal threats at the site?	This alternative does not involve treatment and therefore does not reduce the inherent hazards posed by the contaminated groundwater.	This alternative does not involve treatment and therefore does not reduce the inherent hazards posed by the contaminated groundwater.
How does the proposed treatment impact natural resources?	Containment will reduce contamination entering the Columbia River; the groundwater will still be contaminated. Habitat along the river will be impacted.	Containment will reduce contamination entering the Columbia River; the groundwater will still be contaminated. Habitat along the river will be impacted.

Table 6-3. Detailed Analysis for GW-3, Containment Alternative.
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REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
Does the alternative result in a gain or loss of quality at the site for natural resources?	The Columbia River will gain in natural resource quality while the groundwater will remain contaminated. The riparian habitat will be impacted.	The Columbia River will gain in natural resource quality while the groundwater will remain contaminated. The riparian habitat will be impacted.
Will implementation of the alternative result in short-term impacts to natural resources (e.g., exposure of ecological receptors to physical or chemical impacts, noise, intrusion to habitat and special breeding areas, temporary displacement, or seasonal restrictions on habitat use)?	At the present time, the majority of waste site are severely disturbed, therefore, short-term impacts would be moderate. The containment alternative will cause more impacts than other alternatives because physical structures must be located next to the river. Mitigation efforts will include scheduling activities to reduce intrusion during sensitive life stages, controlling fugitive dust, and establishing buffer zones if needed.	At the present time, the majority of waste site are severely disturbed, therefore, short-term impacts would be moderate. The containment alternative will cause more impacts than other alternatives because physical structures must be located next to the river. Mitigation efforts will include scheduling activities to reduce intrusion during sensitive life stages, controlling fugitive dust, and establishing buffer zones if needed.
Will the natural resource restoration activities associated with this alternative be easily implemented?	Revegetation of excavated area will be necessary. Revegetation techniques are well established, but arid lands require time.	Revegetation of excavated area will be necessary. Revegetation techniques are well established, but arid lands require time.
Will long-term maintenance and monitoring of mitigation/restoration efforts and activities be necessary?	No.	No.

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Table 6-3. Detailed Analysis for GW-3, Containment Alternative.
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SHORT-TERM EFFECTIVENESS	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
What are the risks to the community during remedial actions that must be addressed?	Construction of the sheet piling wall will pose minimal risk to the surrounding communities. Due to the remote location of the 100 D/DR Area, construction activities are not expected to impact the surrounding community. Based on the nature of sheet piling wall construction, no contact with contamination is required.	Based on previous well construction activities at the Hanford Site, construction of the hydraulic containment system will pose negligible risk to the surrounding communities. Due to the remote location of the 100 H Area, construction activities are not expected to impact the surrounding community.
How will the risks to the community be addressed and mitigated?	No risks to the community will result from implementation of this alternative.	No risks to the community will result from implementation of this alternative.
What risks remain to the community that cannot be readily controlled?	Potential risks to humans through contact with spring water with elevated chromium concentrations.	Potential risks to humans through contact with spring water with elevated chromium concentrations.
What are the risks to the workers that need to be addressed?	The primary risk to workers during implementation of this alternative is physical hazards relating to construction activities. These physical hazards are associated with pile driving, handling and placement of the sheet pilings, and vehicle operations. Contaminated materials in the form of drill cuttings from the installation of hydraulic control wells may also present risk to workers, however, these can be reduced by the use of sonic drilling. The containment alternative has the greatest potential for impacts to the worker. Use of heavy equipment and the physical size of the project result in a medium to high worker risk from physical hazards. Exposure risks are expected to be low.	The primary risk to workers during implementation of this alternative is physical hazards relating to construction activities. These physical hazards are associated with drilling, pipeline installation, and vehicle operations. Contaminated materials in the form of drill cuttings from the installation of hydraulic control wells may also present risk to workers, however, these can be reduced by the use of sonic drilling. Risks to workers from groundwater extraction and handling are expected to be low.

Table 6-3. Detailed Analysis for GW-3, Containment Alternative. (Page 16 of 22)

SHORT-TERM EFFECTIVENESS	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
What risks remain to the workers that cannot be readily controlled?	None.	None.
How will the risks to the workers be addressed and mitigated?	Health risks to workers resulting from physical hazards associated with construction activities will be minimized by development of health and safety protocols defining training requirements, safe work practices, and personal protection equipment.	Health risks to workers resulting from physical hazards associated with construction activities will be minimized by development of health and safety protocols defining training requirements, safe work practices, and personal protection equipment.

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Table 6-3. Detailed Analysis for GW-3, Containment Alternative. (Page 17 of 22)

SHORT-TERM EFFECTIVENESS	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
What environmental impacts are expected with the construction and implementation of the alternative?	The primary environmental impacts from this alternative will result from implementation of the sheet piling wall. The wall is to be construction near the shore of the Columbia River. In the area surrounding the location of the wall, physical disturbances to habitat will result from equipment and vehicle operations. Construction activities may be confined to summer and fall when bald eagles are not present. The barrier would be located in a potential wetland/ floodplain zone. Assessment of impacts would be required prior to implementation. Impacts would be minimized by proper design and placement of the sheet piling. This alternative presents the greatest potential for environmental impacts through implementation. The barrier wall alternative has the greatest potential for adverse impacts to both ecological and cultural resources. The implementation of the wall would require several pieces of heavy equipment to construct roads and access ways for the actual wall installation. Impacts to habitat would occur along the entire proposed length of the wall. Cultural resources have been identified in the area near the proposed wall locations; additional assessment of these resources would be necessary to optimize the wall placement.	Environmental impacts resulting from installation of the extraction and injection well containment system are considered minimal. The primary impacts are associated with well drilling activities and construction of the piping system connecting the wells. These activities will likely result in physical disturbances to habitat potentially inhabited by bald eagles. However, construction during seasons when such species are not within the area will minimize potential impacts. Environmental and cultural surveys required prior to implementation.

Table 6-3. Detailed Analysis for GW-3, Containment Alternative. (Page 18 of 22)

SHORT-TERM EFFECTIVENESS	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
What are the impacts that cannot be avoided should the alternative be implemented?	Environmental impacts resulting from sheet piling wall construction cannot be avoided. Physical disturbances to habitat will be temporary and limited to approximately 1,300 m of the Columbia River shoreline. No significant impacts such as disturbances to threatened or endangered species are anticipated.	Environmental impacts resulting from construction of the extraction/injection containment system cannot be avoided. Physical disturbances to habitat will be temporary and limited to surface area above the location of the contaminant plume. No significant impacts such as disturbances to threatened or endangered species are anticipated.
How long until remedial action objectives are achieved?	The RAO for protection of the Columbia River will be achieved upon installation of the sheet piling wall and operation of the hydraulic control wells for the zone behind the wall. However, contamination between the wall and the river will continue to migrate to the river. As noted previously, procurement and installation of this containment system is estimated to require approximately one year. However, the time required to obtain the required permits and agreements to begin construction is unknown.	The RAO for protection of the Columbia River will be achieved upon operation of the extraction and injection well system. As noted previously, procurement and installation of this containment system is estimated to require approximately one year. However, the time required to obtain the required permits and agreements to begin construction is unknown.

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Table 6-3. Detailed Analysis for GW-3, Containment Alternative.
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IMPLEMENTABILITY	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
What difficulties and uncertainties are associated with construction?	The primary uncertainty associated with construction of the sheet piling wall is the presence of subsurface obstructions in the formation below the specified location of the wall. Sheet piling wall construction is not considered implementable in the Hanford formation. However, near the Columbia River shore the geologic formation is primarily the Ringold Formation. Since the distinction between the formations is not exact, the presence of subsurface obstructions could damage or deflect the piles and render the wall ineffective.	No uncertainties or difficulties are associated with construction of the extraction and injection wells specified for containment of chromium contaminated groundwater in the H Area.
What is the likelihood that technical problems will lead to schedule delays?	Sheet piling wall construction is well established. However, if the presence of subsurface obstructions have not been determined prior to installation, such problems will lead to schedule delays. Subsurface obstructions could be removed by excavation on a limited basis, otherwise the wall may not be implementable.	Based on previously installed wells throughout the Hanford Site, no difficulties are anticipated. Any difficulties that may arise would not be considered significant to affect schedule.
What likely future remedial actions are anticipated?	Since the containment system proposed in this alternative does not reduce chromium concentrations in the groundwater, future remedial actions after the interim action period may be required. These include pump and treat, innovative in situ techniques, or other alternatives. Current activities are being directed toward improving estimates of risks to the river and the future need for remedial actions.	Since the containment system proposed in this alternative does not reduce chromium concentrations in the groundwater, future remedial actions after the interim action period may be required. These include pump and treat, innovative in situ techniques, or other alternatives. Current activities are being directed toward improving estimates of risks to the river and the future need for remedial actions.

Table 6-3. Detailed Analysis for GW-3, Containment Alternative. (Page 20 of 22)

IMPLEMENTABILITY	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
What risks of exposure exist should monitoring be insufficient to detect failure?	Failure of the sheet piling wall containment system would result in the continued chromium release into the river at concentrations above EPA Ambient Water Quality Criteria levels (11 μg/L). The resulting exposure risk would be no greater than the current conditions at the 100 D/DR Area.	Failure of the extraction/injection containment system would result in the continued chromium release into the river at concentrations above EPA Ambient Water Quality Criteria levels (11 μg/L). The resulting exposure risk would be no greater than the current conditions at the 100 H Area.
What activities are proposed which require coordination with other agencies?	Construction of the sheet piling wall immediately adjacent to the shore of the Columbia River may require permission from other agencies such as the U.S. Army Corps of Engineers, the Washington State Department of Fish and Wildlife, and the National Park Service.	Installation of extraction and injection wells would be coordinated with other agencies, such as the U.S. Army Corps of Engineers and the Washington State Department of Ecology.
Are adequate treatment, storage capacity, and disposal services available?	Containment does not involve contact with contamination, and therefore does not require treatment, storage, and disposal services.	Containment does not involve contact with contamination, and therefore does not require treatment, storage, and disposal services.
Are the necessary equipment and specialists available?	Yes, sheet piling cutoff wall construction equipment and specialists are commercially available. All other equipment and specialists required are available with the Hanford Site contractors.	Yes, well and piping construction equipment and specialists are considered available within the Hanford Site contractors.
What additional equipment and specialists are required and what are their potential impacts to implementation?	Sheet piling wall construction specialists and equipment are required to ensure proper installation.	None required.

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Table 6-3. Detailed Analysis for GW-3, Containment Alternative. (Page 21 of 22)

IMPLEMENTABILITY	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
Are technologies under consideration generally available and sufficiently demonstrated?	Yes, however treatability studies would be needed to demonstrate the implementability of sheet piling walls in the 100 D/DR Area conditions. This activity may be conducted at N Springs upriver of the D/DR Area.	Yes, hydraulic control using extraction and injection well systems is well developed technology.
Will technologies require further development before they can be applied at the site?	No, however treatability studies to demonstrate the implementability of sheet piling walls at the 100 D/DR Area would be needed.	No, hydraulic control using extraction and injection well systems is well developed technology.
Will more than one vendor be available to provide a competitive bid?	Yes, sheet piling wall construction technology is commercially available.	Yes, groundwater well construction technology is commercially available.

Table 6-3. Detailed Analysis for GW-3, Contianment Alternative (Page 22 of 22)

COST COMPONENT	ALTERATIVE GW-3: CONTAINMENT	
	D/DR Area	H Area
Capital?	$11,400,000	$800,000
Operation and Maintenance?	$13,000,000	$2,300,000
Present Worth?	$22,600,000	$2,800,000

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Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 1 of 22)

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
Will risk be at acceptable levels?	Uncertain. The potential ecological risk identified in the LFI QRA from chromium concentrations in near river wells exceeding the EPA Ambient Water Quality Criteria of 11 μg/L can be significantly reduced by this alternative. Treatability study results indicate ion exchange can remove hexavalent chromium from 100-HR-3 groundwater to concentrations less than 20 μg/L (based on 19 μg/L detection limit) (WHC 1993b). Groundwater modeling results indicate that a five well extraction system positioned along the Columbia River (plus an additional well located above the peak chromium concentration in the plume) can remove a significant amount of chromium entering the river relative to the baseline (no action). The risk associated with the Columbia River substrate has not been quantified.	The potential ecological risk identified in the LFI QRA from chromium concentrations in near river wells exceeding the EPA Ambient Water Quality Criteria of 11 μg/L can be significantly reduced by this alternative. Treatability study results indicate ion exchange can remove hexavalent chromium from 100-HR-3 groundwater to concentrations less than 20 μg/L (based on 19 μg/L detection limit) (WHC 1993b). Groundwater modeling results indicate that a seven well extraction system positioned along the Columbia River can remove a significant amount of chromium entering the river relative to the baseline (no action). The risk associated with the Columbia River substrate has not been quantified.
Timeframe to achieve acceptable levels?	Based on modeling results, operation of the pump-and-treat system in the 100 D/DR Area will be required for the duration of the IRM period (year 2001) in order to maintain protection of the Columbia River. However, reductions in the volume of chromium contaminated groundwater entering the river will be achieved once pump-and-treat is initiated. It should be noted that the intent of the pump-and-treat system is protection of the river and not aquifer restoration.	Based on modeling results, operation of the pump-and-treat system in the 100 H Area will be required for the duration of the IRM period (year 2001) in order to maintain protection of the Columbia River. However, reductions in the volume of chromium contaminated groundwater entering the river will be achieved once pump-and-treat is initiated. It should be noted that the intent of the pump-and-treat system is protection of the river and not aquifer restoration.

Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 2 of 22)

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
Will additional threats be minimized?	Additional threats posed by chromium removed from groundwater will be insignificant. All treatment residuals will be disposed at ERDF, W-025, or another site. Chromium contaminated ion exchange resin may be classified as mixed waste in the event radionuclides such as technetium-99 are also removed. It is not anticipated that resins will require replacement and disposal during the IRM period. Other treatment residues (such as effluent tank sludge) will be solidified in cement prior to disposal at ERDF.	Additional threats posed by chromium removed from groundwater will be insignificant. All treatment residuals will be disposed at ERDF, W-025, or another site. Chromium contaminated ion exchange resin may be classified as mixed waste in the event radionuclides such as technetium-99 are also removed. It is not anticipated that resins will require replacement and disposal during the IRM period. Other treatment residues (such as settling tank sludge) will be solidified in cement prior to disposal at ERDF.
Will the alternative pose any unacceptable short-term or cross-media impacts?	No. Chromium concentrations in groundwater and in the Columbia River are expected to decline.	No. Chromium concentrations in groundwater and in the Columbia River are expected to decline.
What restoration actions may be necessary?	If the system is removed following remediation, regrading and revegetation may be necessary to restore the area.	If the system is removed following remediation, regrading and revegetation may be necessary to restore the area.
Will residual contamination (following remediation) be a potential problem?	Not applicable for interim action. It is anticipated that final remedial action will address residual contamination.	Not applicable for interim action. It is anticipated that final remedial action will address residual contamination.

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Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 3 of 22)

COMPLIANCE WITH ARAR	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What are the potential ARAR?	See Table 6-6.	See Table 6-6.
Will the potential ARAR be met? How?	See Table 6-6.	See Table 6-6.
Basis for waivers?	This alternative may represent an interim action preceding a final action. The final remedial action will be selected to ensure compliance with ARAR. Reduction of chromium concentrations in groundwater entering the Columbia River to below the EPA Ambient Water Quality Criteria level of 11 μg/L may be technically impractical. Although the purpose of the interim action is not aquifer restoration, contaminant concentrations in the aquifer represent the contaminant concentrations potentially entering the river. Due to the persistence of chromium in the environment, removal would be the only means of ensuring permanent compliance with ARAR. However, conventional pump-and-treat may never result in sufficient chromium reduction in the aquifer to comply with ARAR. Ion exchange treatability study results for chromium removal from 100-HR-3 OU groundwater do not indicate the 11 μg/L EPA Ambient Water Quality Criteria level can be achieved. Although chromium concentrations could be significantly reduced (below 20 μg/L hexavalent chromium and 29 μg/L total chromium), concentration reductions were not sufficient to meet the 11 μg/L ARAR.	Same as D/DR Area
What are the potential TBC?	See Table 6-6.	See Table 6-6.
Is the alternative consistent with TBC listed above	See Table 6-6.	See Table 6-6.

Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 4 of 22)

COMPLIANCE WITH ARAR	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
Will implementation of the alternative comply with ARARs regarding protection, restoration, and enhancement of natural resources and protection of cultural resources?	See Table 6-6.	See Table 6-6.
What difficulties may be associated with compliance to ARARs?	See Table 6-6.	See Table 6-6.

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Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 5 of 22)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What is the magnitude of the remaining risk?	Reduction of chromium concentrations in groundwater extracted from the unconfined aquifer can be reduced to the levels achieved in the ion exchange treatability study (detection limits, 29 μg/L total chromium and 19 μg/L chromium (VI)). Groundwater modeling results indicate the mass of chromium entering the river can be reduced relative to no action. However, groundwater modeling results also indicate pump-and-treat would be required beyond the period of interim action (year 2001) in order to maintain protection of the river.	Reduction of chromium concentrations in groundwater extracted from the unconfined aquifer can be reduced to the levels achieved in the ion exchange treatability study (detection limits, 29 μg/L total chromium and 19 μg/L chromium (VI)). Groundwater modeling results indicate the mass of chromium entering the river can be reduced relative to no action. However, groundwater modeling results also indicate pump-and-treat would be required beyond the period of interim action (year 2001) in order to maintain protection of the river.
What remaining sources of risk can be identified?	Untreated groundwater remaining in the aquifer, treated groundwater discharged to the Columbia River, and untreated groundwater leakage past the extraction system are the remaining sources of risk. However, final remedial action will address risk due to chromium contaminated groundwater remaining in the aquifer after the IRM period.	Untreated groundwater remaining in the aquifer, treated groundwater discharged to the Columbia River, and untreated groundwater leakage past the extraction system are the remaining sources of risk. However, final remedial action will address risk due to chromium contaminated groundwater remaining in the aquifer after the IRM period.

Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 6 of 22)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What is the likelihood that the technologies will meet performance needs?	Groundwater modeling results indicate the extraction system can reduce the mass of chromium entering the Columbia River relative to the baseline. Treatability study results indicate chromium removal from 100-HR-3 groundwater by ion exchange can reduce concentrations to below 20 μg/L.	Groundwater modeling results indicate the extraction system can reduce the mass of chromium entering the Columbia River relative to the baseline. Treatability study results indicate chromium removal from 100-HR-3 groundwater by ion exchange can reduce concentrations to below 20 μg/L.
What type and degree of long-term management is required?	Long-term management is required for the duration of the interim action period to maintain operation of the ion exchange treatment system and extraction wells, satisfy annual reporting requirements, and perform periodic groundwater monitoring.	Long-term management is required for the duration of the interim action period to maintain operation of the ion exchange treatment system and extraction wells, satisfy annual reporting requirements, and perform periodic groundwater monitoring.
What are the requirements for long-term monitoring?	The current monitoring program will continue through the IRM period. Evaluations will be made periodically to ensure the effectiveness of the treatment is maintained.	The current monitoring program will continue through the IRM period. Evaluations will be made periodically (i.e. every 5 years) to ensure the effectiveness of the treatment is maintained.
What O&M functions must be performed?	O&M will be required for the duration of the IRM period (year 2001) to ensure continuous treatment and monitoring.	O&M will be required for the duration of the IRM period (year 2001) to ensure continuous treatment and monitoring.
What difficulties may be associated with long-term O&M?	None foreseeable within the timeframe of the IRM period (year 2001).	None foreseeable within the timeframe of the IRM period (year 2001).

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Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 7 of 22)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What is the potential need for replacement of technical components?	Periodic replacement of ion exchange system components (e.g., pumps, columns), materials (resins), extraction wells, monitoring wells, and associated ancillary equipment will be required.	Periodic replacement of ion exchange system components (e.g., pumps, columns), materials (resins), extraction wells, monitoring wells, and associated ancillary equipment will be required.
What is the magnitude of risk should the remedial action need replacement?	The time required to replace treatment system components is not considered significant. However, in the event treatment is unavailable for extended periods, untreated contaminated groundwater could enter the river.	The time required to replace treatment system components is not considered significant. However, in the event treatment is unavailable for extended periods, untreated contaminated groundwater could enter the river.
What is the degree of confidence that controls can adequately handle potential problems?	Potential problems associated with operation of the treatment system include equipment failure, leaks or spills, and contaminant removal inefficiency. Control measures can adequately protect human health and the environment should such problems arise. The treatment system will be equipped with automated shut-down controls, secondary containment measures, and effluent concentration monitoring.	Potential problems associated with operation of the treatment system include equipment failure, leaks or spills, and contaminant removal inefficiency. Control measures can adequately protect human health and the environment should such problems arise. The treatment system will be equipped with automated shut-down controls, secondary containment measures, and effluent concentration monitoring.

Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 8 of 22)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
How is the removed contamination disposed of?	Spent ion exchange resins will be disposed following dewatering. It is not anticipated that resins will be spent during the IRM period. Other treatment residuals (such as effluent tank sludge and solids) will be solidified in cement. All treatment residuals will be disposed on the Hanford Site at ERDF.	Spent ion exchange resins will be disposed following dewatering. It is not anticipated that resins will be spent during the IRM period. Other treatment residuals (such as effluent tank sludge and solids) will be solidified in cement. All treatment residuals will be disposed on the Hanford Site at ERDF.
What are potential final actions?	Potential final actions likely include no action, institutional controls, and pump and treat for mass reduction. The vertical barrier option is not considered for final action because chromium is persistent in the environment and does not readily degrade. The wall will contain the chromium by lengthening the travel time for the contaminants to reach the river; however, the contamination will eventually migrate around the wall.	Potential final actions likely include no action, institutional controls, and pump and treat for mass reduction. The vertical barrier option is not considered for final action because chromium is persistent in the environment and does not readily degrade.
Is the alternative for the IRM compatible with potential final actions?	The IRM pump-and-treat alternative for containment and mass reduction, as proposed in this FFS is consistent with future pump-and-treat scenarios focused at greater mass removal. A pump-and-treat system has been installed in the 100 D Area as part of a treatability study. This smaller system can be expanded to be an IRM. The system would not be very compatible with the no action and institutional controls alternatives because of the expense involved in installing and operating the pumping system during the treatability test and IRM periods only to shut it down for final action.	The pump and treat alternative for containment and mass reduction as proposed in this FFS is consistent with future pump and treat scenarios for mass removal. The IRM system can be expanded to meet changing objectives, such as greater mass removal. The IRM system would not be very compatible with the no action and institutional controls alternatives because of the expense involved in installing and operating the pumping system during the IRM period only to shut it down for final action.

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Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 9 of 22)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What are the uncertainties associated with land disposal of residuals and untreated wastes?	Residuals and wastes will be disposed at existing or new waste management facilities at Hanford. It is anticipated that the facilities will remain in operation during the IRM period.	Residuals and wastes will be disposed at existing or new waste management facilities at Hanford. It is anticipated that the facilities will remain in operation during the IRM period.
Will the alternative provide long-term protection of natural resources?	Yes. Contribution of chromium to the Columbia River will be reduced during the IRM period. Some chromium will be removed from groundwater, but it is anticipated that final action will be required to address residual contamination.	Yes. Contribution of chromium to the Columbia River will be reduced during the IRM period. Some chromium will be removed from groundwater, but it is anticipated that final action will be required to address residual contamination.
Will terrestrial habitats be degraded or enhanced?	There will be some degradation of terrestrial habitat during the construction phase. Habitat impacts during system operation will be minor.	There will be some degradation of terrestrial habitat during the construction phase. Habitat impacts during system operation will be minor.
How will the remedial action affect the overall quality of the ecosystem?	This alternative will improve the quality of the ecosystem by reducing the flux of chromium to the Columbia River.	This alternative will improve the quality of the ecosystem by reducing the flux of chromium to the Columbia River.

Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 10 of 22)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
Does the treatment process address the principal threats?	Yes. The ion exchange resin selected would be highly effective for hexavalent chromium removal as well as other ionic contaminants (such as nitrates).	Yes. The ion exchange resin selected would be highly effective for hexavalent chromium removal as well as other ionic contaminants (such as nitrates).
Are there any special requirements for the treatment process?	Pretreatment such as filtration prior to the ion exchange column will be required. Process monitoring and control capabilities will also be required. Resins that are disposable at ERDF or other acceptable sites will be required, i.e., only non-hazardous resins would be used.	Pretreatment such as filtration prior to the ion exchange column will be required. Process monitoring and control capabilities will also be required. Resins that are disposable at ERDF or other acceptable sites will be required, i.e., only non-hazardous resins would be used.
What portion of the contaminated material is treated/destroyed?	The volume of chromium contaminated groundwater treated would be equivalent to the design flow rate (100 gal/min) multiplied by the operation time. Assuming continuous operation throughout the duration of the IRM period (1996 to 2001), the volume of contaminated groundwater treated would be approximately 3.0×10^8 gallons.	The volume of chromium and iron contaminated groundwater treated would be equivalent to the design flow rate (225 gal/min) multiplied by the operation time. Assuming continuous operation for the duration of the interim action period (1996 to 2001), the volume of contaminated groundwater treated would be approximately 6.0×10^8 gallons.

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Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 11 of 22)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
To what extent is total mass of toxic contaminants reduced?	Groundwater modeling indicates the effects of the extraction system can reduce the mass of chromium entering the Columbia River relative to the baseline (no action). The concentration of chromium in the treatment effluent will be reduced to the levels indicated by the treatability studies for ion exchange. Results of the treatability study indicate chromium concentrations can be reduced to at least 29 μg/L total chromium and 19 μg/L hexavalent chromium, based on the limitations of the analytical methods used (WHC 1993b).	Same as the D/DR Area.
To what extent is the mobility of toxic contaminants reduced?	The mobility of chromium removed by ion exchange will be minimized by subsequent disposal at an approved facility. Other treatment residuals (such as effluent tank sludge) will be solidified in cement prior to disposal. The mobility of residual chromium remaining in treated groundwater or that has leaked past the extraction system will not be reduced. Only nontoxic resins will be used.	The mobility of chromium removed by ion exchange will be minimized by subsequent disposal at an approved facility. Other treatment residuals (such as effluent tank sludge and resin regeneration sludge) will be solidified in cement prior to disposal. The mobility of residual chromium remaining in treated groundwater or that has leaked past the extraction system will not be reduced. Only nontoxic resins will be used.
To what extent is the volume of toxic contaminants reduced?	The reduction in volume of contaminated groundwater is equal to the volume treated, approximately 3.0×10^8 gallons by the end of the interim action period (year 2001).	The reduction in volume of contaminated groundwater is equal to the volume treated, approximately 6.0×10^8 gallons by the end of the interim action period (year 2001).

Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 12 of 22)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
To what extent are the effects of the treatment irreversible?	Removal of chromium from the unconfined aquifer is considered irreversible.	Removal of chromium from the unconfined aquifer is considered irreversible.
What are the quantities of residuals and characteristics of the residual risks?	The volume of chromium treatment residuals will be dependent on the treatment system design and chromium concentration in the feed stream. Spent ion exchange resin is the primary source of treatment residuals. Preliminary estimates indicate that the WBL-30 resin will last greater than 5 years. At the end of the 5 year IRM period, the resin will be destroyed and disposed of at ERDF.	The volume of chromium treatment residuals will be dependent on the treatment system design and chromium concentration in the feed stream. Spent ion exchange resin is the primary source of treatment residuals. Preliminary estimates indicate that the WBL-30 resin will last greater than 5 years. At the end of the 5 year IRM period, the resin will be destroyed and disposed of at ERDF.
What risks do treatment of residuals pose?	Spent resins will be dewatered and then disposed without additional treatment. Cement solidification of other treatment residuals (such as settling tank sludge and resin regeneration solids) is well developed and used for both radioactive and hazardous wastes. Thus, risk from residuals treatment is considered minimal.	Spent resins will be dewatered and then disposed without additional treatment. Cement solidification of other treatment residuals (such as settling tank sludge and resin regeneration solids) is well developed and used for both radioactive and hazardous wastes. Thus, risk from residuals treatment is considered minimal.

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Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 13 of 22)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
Is treatment used to reduce inherent hazards posed by principal threats at the site?	Yes. Chromium removal from 100 D/DR Area OU groundwater will reduce the threat posed by chromium migration into the river. Treatment residuals will pose minimal risk to human health and the environment based on disposal at an approved facility. Although ion exchange resins may be disposed without additional treatment, cement solidification will be available for other treatment residuals such as settling tank sludge and resin regeneration solids. Only non-hazardous resins would be used.	Yes. Chromium removal from 100 H Area OU groundwater will reduce the threat posed by chromium migration into the river. Treatment residuals will pose minimal risk to human health and the environment based on disposal at an approved facility. Although ion exchange resins may be disposed without additional treatment, cement solidification will be available for other treatment residuals such as settling tank sludge and resin regeneration solids. Only non-hazardous resins would be used.
How does the proposed treatment impact natural resources?	Reduction of chromium flux to the Columbia River and removal of chromium from groundwater will reduce potential exposure of aquatic organisms to chromium.	Reduction of chromium flux to the Columbia River and removal of chromium from groundwater will reduce potential exposure of aquatic organisms to chromium.
Does the alternative result in a gain or loss of quality at the site for natural resources?	The reduction of chromium concentrations in groundwater entering the Columbia River will have a positive impact on natural resources. There will be some negative impacts during construction of the removal/treatment system.	The reduction of chromium concentrations in groundwater entering the Columbia River will have a positive impact on natural resources. There will be some negative impacts during construction of the removal/treatment system.

Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 14 of 22)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
Will implementation of the alternative result in short-term impacts to natural resources (e.g., exposure of ecological receptors to physical or chemical impacts, noise, intrusion to habitat and special breeding areas, temporary displacement, or seasonal restrictions on habitat use)?	Some minor impacts due to noise and intrusion on terrestrial habitats are possible during construction. Only minor impacts are likely during system operation.	Some minor impacts due to noise and intrusion on terrestrial habitats are possible during construction. Only minor impacts are likely during system operation.
Will the natural resource restoration activities associated with this alternative be easily implemented?	Yes. Some revegetation and grading may be required.	Yes. Some revegetation and grading may be required.
Will long-term maintenance and monitoring of mitigation/restoration efforts and activities be necessary?	No.	No.

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Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 15 of 22)

SHORT-TERM EFFECTIVENESS	ALTERNATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What are the risks to the community during remedial actions that must be addressed?	None.	None.
How will the risks to the community be addressed and mitigated?	Not applicable.	Not applicable.
What risks remain to the community that cannot be readily controlled?	None.	None.
What are the risks to the workers that need to be addressed?	Risks to worker are associated with handling treatment residuals, operation and maintenance of treatment process equipment, and groundwater monitoring. The risks to workers associated with groundwater extraction and handling is considered to be low.	Risks to worker are associated with handling treatment residuals, operation and maintenance of treatment process equipment, and groundwater monitoring. The risks to workers associated with groundwater extraction and handling is considered to be low.
What risks remain to the workers that cannot be readily controlled?	None.	None.

Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 16 of 22)

SHORT-TERM EFFECTIVENESS	ALTERNATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
How will the risks to the workers be addressed and mitigated?	Standard operating procedures will be established to define proper treatment system operating parameters and maintenance requirements. Health and safety plans will establish training requirements, identify personal protection equipment needs, specify treatment residual handling procedures, and define general safe work practices.	Standard operating procedures will be established to define proper treatment system operating parameters and maintenance requirements. Health and safety plans will establish training requirements, identify personal protection equipment needs, specify treatment residual handling procedures, and define general safe work practices.

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Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 17 of 22)

SHORT-TERM EFFECTIVENESS	ALTERNATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What environmental impacts are expected with the construction and implementation of the alternative?	Environmental impacts resulting from treatment system construction are considered minimal. The primary impact to the environment will be associated with installation of extraction wells and construction of a piping system to transport groundwater to and from wells. These activities may result in physical disturbances of habitat potentially inhabited by threatened or endangered species (such as bald eagles). These however will be of short duration. The treatment process (ion exchange) will likely reside within the facilities area of the 100 D/DR Area and therefore will not result in additional impacts to the environment. Ecological and cultural surveys required prior to implementation. A floodplain/wetlands assessment may also be required. The installation of extraction, injection, and monitoring wells would have minimal impact on ecological and cultural resources. There is enough flexibility in the placement of wells that sensitive areas and cultural resources could be avoided through prudent location of wells.	Environmental impacts resulting from treatment system construction are considered minimal. The primary impact to the environment will be associated with installation of extraction wells and construction of a piping system to transport groundwater to and from wells. These activities may result in physical disturbances of habitat potentially inhabited by threatened or endangered species (such as bald eagles). These however will be of short duration. The treatment process (ion exchange) will likely reside within the facilities area of the 100 H Area and therefore will not result in additional impacts to the environment. Ecological and cultural surveys required prior to implementation. A floodplain/wetlands assessment may also be required. The installation of extraction, injection, and monitoring wells would have minimal impact on ecological and cultural resources. There is enough flexibility in the placement of wells that sensitive areas and cultural resources could be avoided through prudent location of wells.

Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 18 of 22)

SHORT-TERM EFFECTIVENESS	ALTERNATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What are the impacts that cannot be avoided should the alternative be implemented?	Physical disturbances to habitat resulting from construction activities will be unavoidable. However, construction activities will be conducted to avoid or minimize such impacts (such as during seasons when endangered species are not present in the area).	Physical disturbances to habitat resulting from construction activities will be unavoidable. However, construction activities will be conducted to avoid or minimize such impacts (such as during seasons when endangered species are not present in the area).
How long until remedial action objectives are achieved?	Since the primary goal of the IRM is protection of the river as opposed to aquifer restoration, pump-and-treat will be required for the duration of the IRM period to maintain protection of the river. Aquifer restoration will be addressed by the final remedial action selected.	Since the primary goal of the IRM is protection of the river as opposed to aquifer restoration, pump-and-treat will be required for the duration of the IRM period to maintain protection of the river. Aquifer restoration will be addressed by the final remedial action selected.

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Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 19 of 22)

IMPLEMENTABILITY	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What difficulties and uncertainties are associated with construction?	None. Construction of extraction wells and ion exchange treatment systems is well developed technology.	None. Construction of extraction wells and ion exchange treatment systems is well developed technology.
What is the likelihood that technical problems will lead to schedule delays?	Since ion exchange treatment and groundwater extraction are well developed technologies, technical problems are not likely to cause significant delays. One potential problem considered possible is the potential for the system to fail to achieve performance objectives (effluent chromium concentration). This situation could result in schedule delays.	Since ion exchange treatment and groundwater extraction are well developed technologies, technical problems are not likely to cause significant delays. One potential problem considered possible is the potential for the system to fail to achieve performance objectives (effluent chromium concentration). This situation could result in schedule delays.
What likely future remedial actions are anticipated?	No additional remedial actions are considered necessary during the IRM period. Since modeling results indicate pump-and-treat will be required for the duration of IRM, a final remedial action may be required. The final remedial action will be addressed through a final risk assessment and feasibility study.	No additional remedial actions are considered necessary during the IRM period (year 2001). Since modeling results indicate pump-and-treat will be required for the duration of IRM, a final remedial action may be required. The final remedial action will be addressed through a final risk assessment and feasibility study.

Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 20 of 22)

IMPLEMENTABILITY	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What risks of exposure exist should monitoring be insufficient to detect failure?	Monitoring failure could lead to prematurely ending treatment operations. The resulting risk would depend on the extent of treatment up to that point in time, but would be no greater than the baseline conditions identified in the QRA.	Monitoring failure could lead to prematurely ending treatment operations. The resulting risk would depend on the extent of treatment up to that point in time, but would be no greater than the baseline conditions identified in the QRA.
What activities are proposed which require coordination with other agencies?	Discharge of treated groundwater into the Columbia River will likely require coordination with other agencies, such as EPA, Ecology, U.S. Army Corps of Engineers, National Parks Department, or the Washington State Department of Fish and Wildlife.	Discharge of treated groundwater into the Columbia River will likely require coordination with other agencies, such as EPA, Ecology, U.S. Army Corps of Engineers, National Parks Department, or the Washington State Department of Fish and Wildlife.
Are adequate treatment, storage capacity, and disposal services available?	Ion exchange treatment services are commercially available. Disposal services will be available within the Hanford Site at ERDF.	Ion exchange treatment services are commercially available. Disposal services will be available within the Hanford Site at ERDF.
Are the necessary equipment and specialists available?	Yes. Ion exchange equipment and specialists are available within DOE and private industry.	Yes. Ion exchange equipment and specialists are available within DOE and private industry.

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Table 6-4. Detailed Analysis for GW-5, Removal, Treatment, and Disposal Alternative With Ion Exchange Treatment. (Page 21 of 22)

IMPLEMENTABILITY	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What additional equipment and specialists are required and what are their potential impacts to implementation?	No adverse impacts to implementation are anticipated, equipment and specialists are available.	No adverse impacts to implementation are anticipated, equipment and specialists are available.
Are technologies under consideration generally available and sufficiently demonstrated?	Yes. Ion exchange is well developed and proven effective for 100-HR-3 groundwater in recently conducted treatability studies (WHC 1993b). Groundwater extraction and monitoring are well developed technologies.	Yes. Ion exchange is well developed and proven effective for 100-HR-3 groundwater in recently conducted treatability studies (WHC 1993b). Groundwater extraction and monitoring are well developed technologies.
Will technologies require further development before they can be applied at the site?	No.	No.
Will more than one vendor be available to provide a competitive bid?	Yes.	Yes.

Table 6-4. Detailed Analysis for GW-4, Removal, Treatment, and Disposal Alternative with Ion Exchange. (Page 22 of 22)

COST COMPONENT	ALTERATIVE GW-5: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
Capital?	$3,300,000	$3,300,000
Operation and Maintenance?	$6,600,000	$7,100,000
Present Worth?	$9,100,000	$9,500,000

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Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 1 of 20)

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
Will risk be at acceptable levels?	Uncertain; the potential ecological risk identified in the QRA from chromium concentrations in near river wells exceeding the EPA Ambient Water Quality Criteria of 11 μg/L may be significantly reduced by this alternative. Reverse osmosis has been shown to obtain rejection efficiencies for chromium (VI) in groundwater between 95 and 99 percent (Huxstep and Sorg 1988). This would correspond to a reduction from 2,090 μg/L [highest concentration reported in LFI (DOE-RL 1993b)] to between 21 and 104 μg/L. Groundwater modeling results indicate that a five well extraction system positioned along the Columbia River (plus an additional well located above the peak chromium concentration in the plume) can remove enough contaminated groundwater to reduce the mass of chromium entering the river relative to the baseline (no action). The risks associated with the substrate of the Columbia River has not been quantified.	Uncertain; the potential ecological risk identified in the QRA from chromium concentrations in near river wells exceeding the EPA Ambient Water Quality Criteria of 11 μg/L may be significantly reduced by this alternative. Reverse osmosis has been shown to obtain rejection efficiencies for chromium (VI) in groundwater between 95 and 99 percent (Huxstep and Sorg 1988). This would correspond to a reduction from 490 μg/L [highest concentration reported in LFI (DOE-RL 1993b)] to between 5 and 25 μg/L. Groundwater modeling results indicate that a seven well extraction system positioned along the Columbia River can remove enough contaminated groundwater to reduce the mass of chromium entering the river relative to the baseline (no action). The risks associated with the substrate of the Columbia River has not been quantified.
Timeframe to achieve acceptable levels?	Based on groundwater modeling results, operation of the pump-and-treat system in the 100 D/DR Area will be required for the duration of the IRM period (year 2001) in order to maintain protection of the Columbia River. However, reductions in chromium contaminated groundwater entering the river will be achieved once pump-and-treat is initiated. It should be noted that the intent of the pump-and-treat system is protection of the river and not aquifer restoration.	Based on groundwater modeling results, operation of the pump-and-treat system in the 100 H Area will be required for the duration of the IRM period (year 2001) in order to maintain protection of the Columbia River. However, reductions in chromium contaminated groundwater entering the river will be achieved once pump-and-treat is initiated. It should be noted that the intent of the pump-and-treat system is protection of the river and not aquifer restoration.

Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 2 of 20)

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
Will additional threats be minimized?	Additional threats posed by chromium removed from groundwater will be insignificant. All treatment residuals will be disposed at ERDF, W-025, or another site. Although concentrate from the reverse osmosis/evaporation treatment may be classified as mixed waste, solidification in cement followed by disposal at an approved facility will minimize potential threats.	Additional threats posed by chromium removed from groundwater will be insignificant. All treatment residuals will be disposed at ERDF, W-025, or another site. Although concentrate from the reverse osmosis/evaporation treatment may be classified as mixed waste, solidification in cement followed by disposal at an approved facility will minimize potential threats.
Will the alternative pose any unacceptable short-term or cross-media impacts?	No. Chromium concentrations in groundwater and in the Columbia River are expected to decline.	Same as D/DR Area
What restoration actions may be necessary?	If the system is removed following remediation, some regrading and revegetation of a may be necessary to restore the a area to its natural state.	If the system is removed following remediation, some regrading and revegetation of a may be necessary to restore the a area to its natural state.
Will residual contamination (following remediation) be a potential problem?	Not applicable for interim action. It is anticipated that final remedial action will address residual contamination.	Not applicable for interim action. It is anticipated that final remedial action will address residual contamination.

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Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 3 of 20)

COMPLIANCE WITH ARAR	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What are the potential ARARs?	See Table 6-6.	See Table 6-6.
Will the potential ARARs be met? How?	See Table 6-6.	See Table 6-6.
Basis for waivers?	This alternative may represent an interim action preceding a final action. The final remedial action will be selected to ensure compliance with applicable ARAR. Reduction of chromium concentrations in groundwater entering the Columbia River to below the EPA Ambient Water Quality Criteria level of 11 μg/L may be technically impractical. Although the purpose of the interim action is not aquifer restoration, contaminant concentrations in the aquifer represent the contaminant concentrations potentially entering the river. Due to the persistence of chromium in the environment, removal would be the only means of ensuring permanent compliance with ARARs. However, conventional pump-and-treat may never result in sufficient chromium reduction in the aquifer to comply with ARAR.	This alternative may represent an interim action preceding a final action. The final remedial action will be selected to ensure compliance with applicable ARAR. Reduction of chromium concentrations in groundwater entering the Columbia River to below the EPA Ambient Water Quality Criteria level of 11 μg/L may be technically impractical. Although the purpose of the interim action is not aquifer restoration, contaminant concentrations in the aquifer represent the contaminant concentrations potentially entering the river. Due to the persistence of chromium in the environment, removal would be the only means of ensuring permanent compliance with ARARs. However, conventional pump-and-treat may never result in sufficient chromium reduction in the aquifer to comply with ARAR.

Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 4 of 20)

COMPLIANCE WITH ARAR	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
Basis for waivers? (continued)	Reverse osmosis is specified as a Best Available Technology (BAT) for chromium treatment within the SDWA, based on the SDWA MCL for chromium (100 μg/L). Previous studies have shown reverse osmosis to remove chromium (VI) in groundwater with 95 to 99 percent efficiency (Huxstep and Sorg 1988). However, the ability of reverse osmosis to satisfy the 11 μg/L EPA Ambient Water Quality Criteria is unknown.	Reverse osmosis is specified as a Best Available Technology (BAT) for chromium treatment within the SDWA, based on the SDWA MCL for chromium (100 μg/L). Previous studies have shown reverse osmosis to remove chromium (VI) in groundwater with 95 to 99 percent efficiency (Huxstep and Sorg 1988). However, the ability of reverse osmosis to satisfy the 11 μg/L EPA Ambient Water Quality Criteria is unknown.
What are the potential TBC?	See Table 6-6.	See Table 6-6.
Is the alternative consistent with TBC listed above?	See Table 6-6.	See Table 6-6.
Will implementation of the alternative comply with ARARs regarding protection, restoration, and enhancement of natural resources and protection of cultural resources?	See Table 6-6.	See Table 6-6.
What difficulties may be associated with compliance to ARARs?	See Table 6-6.	See Table 6-6.

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Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 5 of 20)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What is the magnitude of the remaining risk?	Reduction of chromium concentrations in groundwater extracted from the unconfined aquifer may be significantly reduced by reverse osmosis. Groundwater modeling results indicate the mass of chromium entering the river can be reduced relative to no action. However, groundwater modeling results also indicate pump-and-treat would be required beyond the IRM period of in order to maintain protection of the river.	Reduction of chromium concentrations in groundwater extracted from the unconfined aquifer may be significantly reduced by reverse osmosis. Groundwater modeling results indicate the mass of chromium entering the river can be reduced relative to no action. However, groundwater modeling results also indicate pump-and-treat would be required beyond the IRM period of in order to maintain protection of the river.
What remaining sources of risk can be identified?	Untreated groundwater remaining in the aquifer, treated groundwater discharged to the Columbia River, and untreated groundwater leakage past the extraction system are the remaining sources of risk. However, final remedial action will address risk due to chromium contaminated groundwater remaining in the aquifer after the IRM period.	Untreated groundwater remaining in the aquifer, treated groundwater discharged to the Columbia River, and untreated groundwater leakage past the extraction system are the remaining sources of risk. However, final remedial action will address risk due to chromium contaminated groundwater remaining in the aquifer after the IRM period.
What is the likelihood that the technologies will meet performance needs?	Groundwater modeling results indicate the extraction system can reduce the mass of chromium entering the Columbia River relative to the baseline. Specification of reverse osmosis as a BAT within the SDWA indicates chromium reduction to the 100 μg/L MCL is reasonably achievable. The ability of RO to meet the 11 μg/L Ambient Water Quality Criteria is uncertain.	Groundwater modeling results indicate the extraction system can reduce the mass of chromium entering the Columbia River relative to the baseline. Specification of reverse osmosis as a BAT within the SDWA indicates chromium reduction to the 100 μg/L MCL is reasonably achievable. The ability of RO to meet the 11 μg/L Ambient Water Quality Criteria is uncertain.

Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 6 of 20)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What type and degree of long-term management is required?	Long-term management is required for the duration of the IRM period to maintain operation of the reverse osmosis treatment system and extraction wells, satisfy annual reporting requirements, and conduct periodic groundwater monitoring. Increases in groundwater extraction rate may require replacement or addition of treatment components.	Long-term management is required for the duration of the IRM period to maintain operation of the reverse osmosis treatment system and extraction wells, satisfy annual reporting requirements, and conduct periodic groundwater monitoring. Increases in groundwater extraction rate may require replacement or addition of treatment components.
What are the requirements for long-term monitoring?	The current monitoring program will continue through the IRM period. Evaluations will be made periodically to ensure the effectiveness of the treatment is maintained.	The current monitoring program will continue through the IRM period. Evaluations will be made periodically to ensure the effectiveness of the treatment is maintained.
What O&M functions must be performed?	O&M will be required for the duration of the IRM period to ensure continuous treatment and monitoring.	O&M will be required for the duration of the IRM period to ensure continuous treatment and monitoring.
What difficulties may be associated with long-term O&M?	None foreseeable within the timeframe of the IRM.	None foreseeable within the timeframe of the IRM.
What is the potential need for replacement of technical components?	Periodic replacement of reverse osmosis/evaporation system components (e.g., reverse osmosis membrane, evaporator heat exchanger), extraction wells, monitoring wells, and associated ancillary equipment will be required.	Periodic replacement of reverse osmosis/evaporation system components (e.g., reverse osmosis membrane, evaporator heat exchanger), extraction wells, monitoring wells, and associated ancillary equipment will be required.

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Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 7 of 20)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What is the magnitude of risk should the remedial action need replacement?	The time required to replace components of the treatment system is not considered significant. However, in the event treatment is unavailable for extended periods, untreated chromium contaminated groundwater could enter the river.	The time required to replace components of the treatment system is not considered significant. However, in the event treatment is unavailable for extended periods, untreated chromium contaminated groundwater could enter the river.
What is the degree of confidence that controls can adequately handle potential problems?	Potential problems associated with operation of the treatment system include equipment failure, leaks or spills, and chromium removal inefficiency. Control measures can adequately protect human health and the environment should such problems arise. The treatment system will be equipped with automated shut-down controls, secondary containment measures, and effluent chromium concentration monitoring.	Potential problems associated with operation of the treatment system include equipment failure, leaks or spills, and chromium removal inefficiency. Control measures can adequately protect human health and the environment should such problems arise. The treatment system will be equipped with automated shut-down controls, secondary containment measures, and effluent chromium concentration monitoring.
How is the removed contamination disposed of?	Chromium contaminated sludge discharged from the rotary drum filter will be solidified in cement. These solidified residues will be disposed on the Hanford Site.	Chromium contaminated sludge discharged from the rotary drum filter will be solidified in cement. These solidified residues will be disposed on the Hanford Site.
What are potential final actions?	Potential final actions likely include no action, institutional controls, and pump and treat for mass reduction. The vertical barrier option is not considered for final action because chromium is persistent in the environment and does not readily degrade. The wall will contain the chromium by lengthening the travel time for the contaminants to reach the river; however, the contamination will eventually migrate around the wall.	Same as D/DR Area. The hydraulic barrier is not considered because of the logistics of maintaining the barrier indefinitely due to the persistence of the chromium.

Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 8 of 20)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
Is the alternative for the IRM compatible with potential final actions?	The pump and treat alternative for containment and some mass reduction as proposed in this FFS is consistent with future pump and treat scenarios for mass removal. The IRM system can be expanded to meet changing objective, such as significant mass removal. This situation is similar to that proposed in the 100-HR-3 treatability test where a small pump and treat system will be installed to obtain information about the technology specific to the chromium plume in the operable unit. The proposed plan is to expand the treatability system to an IRM if results are favorable for the technology. However, for reverse osmosis, considerable costs may be incurred should the system require expansion to treat increased flows if the groundwater extraction system is expanded. The IRM system is not very compatible with the no action and institutional controls alternatives because of the expense involved in installing and operating the pumping system during the IRM period only to shut it down for final action.	The pump and treat alternative for containment and some mass reduction as proposed in this FFS is consistent with future pump and treat scenarios for mass removal. The IRM system can be expanded to meet changing objective, such as significant mass removal. This situation is similar to that proposed in the 100-HR-3 treatability test where a small pump and treat system will be installed to obtain information about the technology specific to the chromium plume in the operable unit. The proposed plan is to expand the treatability system to an IRM if results are favorable for the technology. However, for reverse osmosis, considerable costs may be incurred should the system require expansion to treat increased flows if the groundwater extraction system is expanded. The IRM system is not very compatible with the no action and institutional controls alternatives because of the expense involved in installing and operating the pumping system during the IRM period only to shut it down for final action.
What are the uncertainties associated with land disposal of residuals and untreated wastes?	Residuals and wastes will be disposed at existing waste management facilities at Hanford. It is anticipated that the facilities will remain in operation during the IRM period.	Residuals and wastes will be disposed at existing waste management facilities at Hanford. It is anticipated that the facilities will remain in operation during the IRM period.

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Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 9 of 20)

LONG-TERM EFFECTIVENESS AND PERMANENCE	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
Will the alternative provide long-term protection of natural resources?	Yes. Contribution of chromium to the Columbia River will be reduced during the IRM period. Some chromium will be removed from groundwater, but it is anticipated that final action will be required to address residual contamination.	Yes. Contribution of chromium to the Columbia River will be reduced during the IRM period. Some chromium will be removed from groundwater, but it is anticipated that final action will be required to address residual contamination.
Will terrestrial habitats be degraded or enhanced?	There will be some degradation of terrestrial habitat during the construction phase until habitats are restores after remediation is complete.	There will be some degradation of terrestrial habitat during the construction phase until habitats are restored after remediation is complete.
How will the remedial action affect the overall quality of the ecosystem?	This alternative will improve the quality of the ecosystem by reducing the flux of chromium to the Columbia River and enhancing salmon spawning areas.	This alternative will improve the quality of the ecosystem by reducing the flux of chromium to the Columbia River and enhancing salmon spawning areas.

Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 10 of 20)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
Does the treatment process address the principal threats?	Yes. Reverse osmosis has been shown to result in 95 to 99 percent rejection of hexavalent chromium in groundwater (Huxstep and Sorg 1988).	Same as D/DR Area for chromium contamination.
Are there any special requirements for the treatment process?	Pretreatment is required to prevent fouling the reverse osmosis membrane(s) due to high solids content or salts precipitation. Filtration will be used to remove suspended solids. Crystal inhibitors (sodium hexametaphosphate) and pH adjustment will prevent salts from precipitating within the reverse osmosis unit.	Same as D/DR Area for chromium contamination.
What portion of the contaminated material is treated/destroyed?	The volume of chromium contaminated groundwater treated will be equivalent to the design flow rate (100 gal/min) multiplied by the operation time. Assuming continuous operation throughout the duration of the IRM period (1996 to 2001), the volume of treated would be approximately 3.0×10^8 gallons.	The volume of chromium and iron contaminated groundwater treated would be equivalent to the design flow rate (225 gpm) multiplied by the operation time. Assuming continuous operation for the duration of the interim action period (1996 to 2001), the volume treated would be approximately 6.0×10^8 gallons.
To what extent is total mass of toxic contaminants reduced?	Groundwater modeling indicates the effects of the extraction system can reduce the mass of chromium entering the Columbia River relative to the baseline (no action). The concentration of chromium in the treatment effluent may be reduced to the levels achievable by reverse osmosis. The reverse osmosis treatment system is assumed to effectively reduce chromium concentration in extracted groundwater to at least 100 μg/L (based on the SDWA specification of reverse osmosis as BAT for chromium). Previous studies have shown reverse osmosis to reject chromium (VI) in groundwater with 95 to 99 percent efficiency (Huxstep and Sorg 1988).	Same as D/DR Area for chromium contamination.

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Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 11 of 20)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
To what extent is the mobility of toxic contaminants reduced?	The mobility of chromium removed by the reverse osmosis treatment system will be minimized by subsequent solidification in cement followed by disposal at an approved facility. The mobility of untreated groundwater or residual chromium remaining in treated groundwater will not be reduced.	The mobility of chromium removed by the reverse osmosis treatment system will be minimized by subsequent solidification in cement followed by disposal at an approved facility. The mobility of untreated groundwater or residual chromium remaining in treated groundwater will not be reduced.
To what extent is the volume of toxic contaminants reduced?	The reduction in volume of contaminated groundwater is equal to the volume treated, approximately 3.0×10^8 gallons by the end of the interim action period (year 2001).	The reduction in volume of contaminated groundwater is equal to the volume treated, approximately 6.0×10^8 gallons by the end of the interim action period.
To what extent are the effects of the treatment irreversible?	Removal of chromium from the unconfined aquifer is considered irreversible.	Same as D/DR Area for chromium.
What are the quantities of residuals and characteristics of the residual risks?	Reverse osmosis will reduce the volume of Cr contaminated groundwater by approximately 10 to 1. Based on a 100 gal/min flow rate, this volume reduction results in approximately 10 gal/min into the evaporator. The evaporator will result in additional volume reduction based on an approximate 50% solids concentration. Concentrate from the evaporator will be solidified in cement which will result in a subsequent volume increase of approximately 1.5 to 1. Preliminary estimates indicate that 4,160 cu ft of spent filters and 5,141 cu ft of evaporator cake will be generated each year.	Preliminary estimates indicate that 4,160 cu ft of spent filters and 10,293 cu ft of evaporator cake will be generated each year.

Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 12 of 20)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What risks do treatment of residuals pose?	Cement solidification is well developed and used for both radioactive and hazardous wastes. Thus, risk from residuals treatment is considered minimal.	Cement solidification is well developed and used for both radioactive and hazardous wastes. Thus, risk from residuals treatment is considered minimal.
Is treatment used to reduce inherent hazards posed by principal threats at the site?	Yes. Chromium removal from 100 D/DR Area Operable Unit groundwater will reduce the threat posed by Cr migration into the river. Treatment residuals will pose minimal risk to human health and the environment based on cement solidification followed by disposal at ERDF.	Yes. Chromium removal from 100 H Area Operable Unit groundwater will reduce the threat posed by Cr migration into the river. Treatment residuals will pose minimal risk to human health and the environment based on cement solidification followed by disposal at ERDF.
How does the proposed treatment impact natural resources?	Reduction of chromium flux to the Columbia River and removal of chromium from groundwater will reduce potential exposures of aquatic organisms to chromium.	Reduction of chromium flux to the Columbia River and removal of chromium from groundwater will reduce potential exposures of aquatic organisms to chromium.
Does the alternative result in a gain or loss of quality at the site for natural resources?	The reduction of chromium concentrations in groundwater entering the Columbia River will have a positive impact on natural resources. There will be some negative impacts during construction of the removal/treatment system.	The reduction of chromium concentrations in groundwater entering the Columbia River will have a positive impact on natural resources. There will be some negative impacts during construction of the removal/treatment system.

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Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 13 of 20)

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
Will implementation of the alternative result in short-term impacts to natural resources (e.g., exposure of ecological receptors to physical or chemical impacts, noise, intrusion to habitat and special breeding areas, temporary displacement, or seasonal restrictions on habitat use)?	Some minor impacts due to noise and intrusion on terrestrial habitats will occur during construction and implementation. No impacts are likely during system operation.	Some minor impacts due to noise and intrusion on terrestrial habitats will occur during construction and implementation. No impacts are likely during system operation.
Will the natural resource restoration activities associated with this alternative be easily implemented?	Yes. Some revegetation and grading may be necessary to restore riparian or territorial habitat impacted by implementation of the alternative.	Yes. Some revegetation and grading may be necessary to restore riparian or territorial habitat impacted by implementation of the alternative.
Will long-term maintenance and monitoring of mitigation/restoration efforts and activities be necessary?	No.	No.

Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 14 of 20)

SHORT-TERM EFFECTIVENESS	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What are the risks to the community during remedial actions that must be addressed?	None.	None.
How will the risks to the community be addressed and mitigated?	Not applicable.	Not applicable.
What risks remain to the community that cannot be readily controlled?	None.	None.
What are the risks to the workers that need to be addressed?	Risks to workers are associated with handling treatment residuals, operation and maintenance of treatment process equipment, and groundwater monitoring. Worker risks associated with groundwater extraction and handling are considered low.	Risks to workers are associated with handling treatment residuals, operation and maintenance of treatment process equipment, and groundwater monitoring. Worker risks associated with groundwater extraction and handling are considered low.
What risks remain to the workers that cannot be readily controlled?	None.	None.
How will the risks to the workers be addressed and mitigated?	Standard operating procedures will be established to define proper treatment system operating parameters and maintenance requirements. Health and safety plans will establish training requirements, identify personal protection equipment needs, specify treatment residual handling procedures, and define general safe working practices.	Standard operating procedures will be established to define proper treatment system operating parameters and maintenance requirements. Health and safety plans will establish training requirements, identify personal protection equipment needs, specify treatment residual handling procedures, and define general safe working practices.

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Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 15 of 20)

SHORT-TERM EFFECTIVENESS	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What environmental impacts are expected with the construction and implementation of the alternative?	Environmental impacts resulting from treatment system construction are considered minimal. The primary impact to the environment will be associated with installation of extraction wells and construction of the piping system to transport groundwater to and from wells. These activities will likely result in physical disturbances to natural resources, such as habitat potentially inhabited by threatened or endangered species. The treatment process (reverse osmosis/evaporation) will likely reside within the facilities area of the 100 D/DR Area and therefore will not result in additional impacts to the environment. Ecological and cultural evaluations required prior to implementation. Floodplain/wetlands assessment may also be necessary. The installation of extraction, injection, and monitoring wells would have minimal impact on ecological and cultural resources. There is enough flexibility in the placement of wells that sensitive areas and cultural resources could be avoided through prudent location of wells.	Environmental impacts resulting from treatment system construction are considered minimal. The primary impact to the environment will be associated with installation of extraction wells and construction of the piping system to transport groundwater to and from wells. These activities will likely result in physical disturbances to natural resources, such as habitat potentially inhabited by threatened or endangered species. The treatment process (reverse osmosis/evaporation) will likely reside within the facilities area of the 100 H Area and therefore will not result in additional impacts to the environment. Ecological and cultural evaluations required prior to implementation. Floodplain/wetlands assessment may also be necessary. The installation of extraction, injection, and monitoring wells would have minimal impact on ecological and cultural resources. There is enough flexibility in the placement of wells that sensitive areas and cultural resources could be avoided through prudent location of wells.
What are the impacts that cannot be avoided should the alternative be implemented?	Physical disturbances to riparian and aquatic habitat resulting from construction activities will be unavoidable. However, construction activities will be conducted to avoid or minimize such impacts (such as during seasons when endangered species are not present in the area).	Physical disturbances to riparian and aquatic habitat resulting from construction activities will be unavoidable. However, construction activities will be conducted to avoid or minimize such impacts (such as during seasons when endangered species are not present in the area).

Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 16 of 20)

SHORT-TERM EFFECTIVENESS	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
How long until remedial action objectives are achieved?	Since the primary goal of the interim action is protection of the river as opposed to aquifer restoration, pump-and-treat will be required for the duration of the IRM period to maintain protection of the river. Aquifer restoration will be addressed by the final remedial action selected (which may be continued pump-and-treat).	Since the primary goal of the interim action is protection of the river as opposed to aquifer restoration, pump-and-treat will be required for the duration of the IRM period to maintain protection of the river. Aquifer restoration will be addressed by the final remedial action selected (which may be continued pump-and-treat).

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Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 17 of 20)

IMPLEMENTABILITY	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What difficulties and uncertainties are associated with construction?	None. Construction of extraction wells and reverse osmosis treatment systems is well developed technology.	None. Construction of extraction wells and reverse osmosis treatment systems is well developed technology.
What is the likelihood that technical problems will lead to schedule delays?	Because the components of the treatment system (reverse osmosis, evaporation, cement solidification, and pumping wells) are well developed technologies, technical problems are not likely to cause significant delays. One potential problem is that the treatment system could fail to achieve performance objectives (effluent chromium concentrations). This situation could result in schedule delays.	Because the components of the treatment system (reverse osmosis, evaporation, cement solidification, and pumping wells) are well developed technologies, technical problems are not likely to cause significant delays. One potential problem is that the treatment system could fail to achieve performance objectives (effluent chromium concentrations). This situation could result in schedule delays.
What likely future remedial actions are anticipated?	No additional remedial actions are considered necessary during the IRM period. However, final remedial action could be implemented to address other contaminants of concern.	No additional remedial actions are considered necessary during the IRM period. However, final remedial action could be implemented to address other contaminants of concern.
What risks of exposure exist should monitoring be insufficient to detect failure?	Monitoring failure could lead to prematurely ending treatment operations. The resulting risk would depend on the extent of treatment up to that point in time, but would be no greater than the baseline conditions identified in the QRA.	Monitoring failure could lead to prematurely ending treatment operations. The resulting risk would depend on the extent of treatment up to that point in time, but would be no greater than the baseline conditions identified in the QRA.

Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative With Reverse Osmosis Treatment. (Page 18 of 20)

IMPLEMENTABILITY	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
What activities are proposed which require coordination with other agencies?	Mitigation medium should be coordinated with Natural Resource Trustees and other state and federal agencies.	Mitigation medium should be coordinated with Natural Resource Trustees and other state and federal agencies.
Are adequate treatment, storage capacity, and disposal services available?	Reverse osmosis treatment services are commercially available. Storage and disposal services are considered available within the Hanford Site (at ERDF).	Reverse osmosis treatment services are commercially available. Storage and disposal services are considered available within the Hanford Site (at ERDF).
Are the necessary equipment and specialists available?	Yes. Reverse osmosis equipment and specialists are available within DOE and private industry.	Yes. Reverse osmosis equipment and specialists are available within DOE and private industry.
What additional equipment and specialists are required and what are their potential impacts to implementation?	No adverse impacts to implementation are anticipated.	No adverse impacts to implementation are anticipated.

Table 6-5. Detailed Analysis for GW-6, Removal, Treatment, and Disposal Alternative with Reverse Osmosis Treatment. (Page 20 of 20)

COST COMPONENT	ALTERNATIVE GW-6: REMOVAL/TREATMENT/DISPOSAL	
	D/DR Area	H Area
Capital?	$3,500,000	$3,900,000
Operation and Maintenance?	$11,800,000	$12,800,000
Present Worth?	$13,800,000	$15,000,000

Table 6-6. Compliance with ARAR (Page 4 of 6)

ARAR	ALTERNATIVE AFFECTED	REQUIREMENT	HOW ARE REQUIREMENTS MET
RCRA 3020 (b)	GW-5, GW-6	Allows reinjection of hazardous or radioactive waste exceeding drinking water standards pursuant to (1) RCRA or CERCLA corrective action; (2) treatment to substantially reduce hazardous constituents; (3) CERCLA or RCRA effort will protect human health and environment.	Will allow reinjection of groundwater after pump and treat technology.
WAC 232-12-292	All	Requires protection of bald eagle habitat.	All activities will be scheduled to avoid impacts to the eagles during nesting; remedial actions will not result in destruction of eagle nesting habitat.
WAC 232-12-297	All	Prescribes actions to protect wildlife defined as endangered or threatened.	Activities will be scheduled to avoid impacts to eagles. Runoff control will be employed to prevent construction contaminants from impacting river biota; minimal impacts would be attributable to the pump and treat alternative; the vertical barrier would disturb an area near the river for implementation. This area would be restored after implementation.

Table 6-6. Compliance with ARAR (Page 1 of 6)

ARAR	ALTERNATIVE AFFECTED	REQUIREMENT	HOW ARE REQUIREMENTS MET
40 CFR 122	GW-3, GW-5, GW-6	Sets discharge limits to surface waters.	No treated water will be discharged to the river which exceeds drinking water standards or ambient water quality criteria.
40 CFR 110	GW-3, GW-5, GW-6	Prohibits discharge of oil above water quality standards or that causes a sheen on water surface.	Runoff control will be implemented during all activities. All tanks will be bermed.
40 CFR 261	GW-3, GW-5, GW-6	Chromium may be a hazardous waste.	Chromium will be treated as a hazardous waste for disposal purposes.
40 CFR 262.34	GW-3, GW-5, GW-6	Allows accumulation of hazardous waste for 90 days or less without a permit.	
40 CFR 262.11	GW-2, GW-3, GW-5, GW-6	List procedures and methods used to characterize waste generated.	These methods would be pertinent to shipment of hazardous waste.
40 CFR 263.30	All	Action to be taken in the event of a discharge	The appropriate notifications, documentation and clean-ups will be implemented.
40 CFR 268	GW-3, GW-5, GW-6	Prohibits placement of RCRA wastes in landfill unless treated.	All hazardous wastes will be treated prior to disposal or will be disposed in a camu, or a waiver will be sought.
40 CFR 50.6	GW-3, GW-5, GW-6	$\leq$50 $\mu g/m^3$ annual average concentration of particulate emissions or 150 $\mu g/m^3$ per 24-hr period.	Excavation and drilling activities will use dust control measures as required. No other particulate emissions are anticipated from the treatment systems.

Table 6-6. Compliance with ARAR (Page 2 of 6)

ARAR	ALTERNATIVE AFFECTED	REQUIREMENT	HOW ARE REQUIREMENTS MET
40 CFR 144.13 (c)	GW-5, GW-6	Underground Injection Control Program	Injection of treated groundwater into same formation when done pursuant to CERCLA or RCRA authority.
40 CFR 131	GW-3, GW-5, GW-6	Ambient Water Quality Criteria	Establishes the water quality criteria for metals including chromium.
16 U.S.C. 469	GW-3, GW-5, GW-6	Requires recovery or preservation of artifacts.	Only a few sites have been identified in the area of potential action. Consideration of these sites would be given in placing a vertical barrier in this area. Additional testing of these sites may be required. Impacts from extraction wells could be minimized by prudent placement.
50 CFR 17, 222, 225, 226, 227, 402, 424	GW-3, GW-5, GW-6	Actions must not threaten the continued existence of a listed species or destroy critical habitat.	Fish and Wildlife Service will be consulted prior to actions.
16 U.S.C. 461	All	Requirements for preservation of historic sites, buildings, or objects of national significance. Undesirable impacts must be mitigated.	See 16 U.S.C. 469.
16 U.S.C. 470 et seq.	All	Prohibits impacts and requires mitigation for unavoidable impacts on cultural resources.	See 16 U.S. C. 469.

Table 6-6. Compliance with ARAR (Page 3 of 6)

ARAR	ALTERNATIVE AFFECTED	REQUIREMENT	HOW ARE REQUIREMENTS MET
40 CFR 257.3-1	GW-3, GW-5, GW-6	Prohibits facilities or practices from restricting flow of base flood, reducing temporary storage capacity of floodplain, or causing washout of solid waste.	Vertical barrier may have some impact on local ground and surface water flow. However, the wall is relatively short and should not impact the base flood. Other alternatives do not significantly impact floodplain.
40 CFR 257.3-2	GW-3, GW-5, GW-6	Prohibits facilities or practices from causing or contributing to the taking of endangered or threatened species.	Activities will be scheduled to avoid impacts to eagles. Runoff control will be employed to prevent construction contaminants form impacting river biota; minimal impacts would be attributable to the pump and treat alternative; the vertical barrier would disturb an area near the river for implementation. This area would be restored after implementation.
16 U.S.C. 1271	GW-3, GW-5, GW-6	Prohibits federal agencies from recommending authorization of water resource projects that would have a direct and adverse affect on the qualities of the wild and scenic river.	Impacts from the pumping system would be minimal. The vertical barrier would present a short duration impact to visual resources; however, after implementation the site would be restored to provide the visual aesthetics.

Table 6-6. Compliance with ARAR (Page 4 of 6)

ARAR	ALTERNATIVE AFFECTED	REQUIREMENT	HOW ARE REQUIREMENTS MET
RCRA 3020 (b)	GW-5, GW-6	Allows reinjection of hazardous or radioactive waste exceeding drinking water standards pursuant to (1) RCRA or CERCLA corrective action; (2) treatment to substantially reduce hazardous constituents; (3) CERCLA or RCRA effort will protect human health and environment.	Will allow reinjection of groundwater after pump and treat technology.
WAC 232-12-292	All	Requires protection of bald eagle habitat.	All activities will be scheduled to avoid impacts to the eagles during nesting; remedial actions will not result in destruction of eagle nesting habitat.
WAC 232-12-297	All	Prescribes actions to protect wildlife defined as endangered or threatened.	Activities will be scheduled to avoid impacts to eagles. Runoff control will be employed to prevent construction contaminants from impacting river biota; minimal impacts would be attributable to the pump and treat alternative; the vertical barrier would disturb an area near the river for implementation. This area would be restored after implementation.

7.0 QUALITATIVE SENSITIVITY ANALYSIS

The sensitivities associated with the key assumptions for the FFS are presented qualitatively in Table 7-1. This table identifies each key assumption and the impacts that the assumption has on the direction of the FFS and on the associated costs. Additional discussions on uncertainties and sensitivities are included in Section 4.0 and in Appendix C. The details of the cost assumptions used in defining alternative costs are included in the detailed cost model printouts in Appendix D.

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ASSUMPTIONS	IMPACT
The objective of the IRM is to protect the Columbia River.	Because the objective is to protect ecological receptors in and along the Columbia River, the containment and pump and treat alternatives are designed primarily to reduce the movement of chromium into the river. Although the pump and treat alternatives may reduce the mass of chromium in the aquifer, they are not designed to optimize that function.
The alternatives are designed for containment and control of contaminant plumes. (The alternatives are not designed for mass reduction or aquifer cleanup.)	The costs developed in this FFS are based on this assumption. If the objectives were to clean up the aquifer and reduce the mass of chromium then the remedial alternatives would have to be redesigned. In the case of the vertical barrier, the barrier will not perform well in the long term because chromium is a persistent and mobile contaminant. The wall will block the contaminant transport in the short term, but the contamination will eventually travel around the wall to the river. If mass reduction is the objective, then the well number, placement, and pumping rates would have to be adjusted to meet the objective. The costs for pump and treat are influenced by well installation costs and pumping rate. The mass reduction scenario would likely require more wells and higher pumping rates than currently proposed. Pump and treat systems for aquifer cleanup or mass reduction would result in significant increases to the pump and treat options.
The lifecycle for the FFS is assumed to be to 2001.	The present worth calculations are tied to this timeframe. The capital costs, O&M costs, and present worth for each year can be seen on the present worth tables presented in Appendix D. Costs associated with years past 2001 can be extrapolated from the tables.

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Table 7-1 Qualitative Sensitivity Analysis of Key Assumptions (Page 2 of 2)

ASSUMPTIONS	IMPACT
The *100 Areas Feasibility Study Phases 1 & 2* (DOE-RL 1994a) forms the basis for the alternatives evaluated in this FFS. Additional alternatives or deviations from the alternatives are only considered when the defined alternative does not meet the operable unit specifics. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) does, however, allow the flexibility of specifying different process options at any point in the remedial investigation/feasibility study circumstances.	The sensitivities to this assumption are small because most of the emerging technologies are not yet implementable in field applications. Research and development activities are proceeding and could lead to significant cost savings to the remedial actions if these innovative technologies become field ready. The technologies can be integrated into the IRM program as data and new techniques become available.
ERDF has sufficient space for operable unit waste and is available to meet schedule.	The disposal costs for the ion exchange resins are not a major cost factor when using the Boomsnub data on resin capacities. The resin will not be required to be changed over the project life. The reverse osmosis costs for disposal are higher due to dispersal of replacement filters, but this is also not a major cost factor.

8.0 COMPARATIVE ANALYSIS

The comparative analysis is an evaluation of the relative performance of each alternative using ~~the nine~~ CERCLA criteria. This analysis compares five alternatives; No Action (GW-1), Institutional Controls/Continued Current Actions (GW-2), Containment (GW-3), Pump and Treat with Ion Exchange (GW-5), and Pump and Treat with Reverse Osmosis (GW-6). ~~Alternative GW-4 is not included in this analysis because the alternative addresses contaminants in situ that are not COCs for 100-HR-3.~~ Table 8-1 summarizes the comparative analysis.

8.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

~~The current human health risk associated with the 100-HR-3 Operable Unit is low (ICR 10^{-6} to 10^{-4}, HQ < 1) for the occasional use scenario, based on the QRA. However,~~ The purpose of the IRM is to protect aquatic organisms in the Columbia River. A potential ecological risk exists based on hexavalent chromium concentrations in near-river wells that exceed an ecological ARAR ~~level~~ (EPA Ambient Water Quality Criteria of 11 μg/L). ~~and the recommended performance objective of 50 μ/L. Protection of the Columbia River is the primary focus of the IRM. Groundwater modeling results show~~It is evident that the no action and institutional controls/continued current actions alternatives will have little effect on the ~~current~~ concentrations of chromium in the near-river wells during the IRM period. However, the vertical barrier and pump and treat alternatives would ~~were shown to~~ significantly reduce the mass of chromium entering the river, relative to the baseline (no action). The magnitude of the ecological risk is uncertain; in addition, the risk associated with the substrate of the river has not been quantified. ~~Therefore, the overall protectiveness of the alternatives is dependent on the true risk associated with the operable unit. For example, if the risk determined in the QRA is representative, then the pump and treat and vertical barrier options offer greater protectiveness. However, if the risk is exaggerated, then the no action or institutional controls/continued current actions alternatives may be sufficiently protective. This uncertainty would be addressed by the institutional controls/continued current actions alternative, as time would be allowed for additional information to better direct the IRM selection.~~

~~The primary goal of the IRM is the protection of the Columbia River. Groundwater modeling indicates~~It is assumed that the pump and treat alternatives can potentially reduce chromium concentrations in near-river wells during the IRM period. The pump and treat alternatives not only provide protection of the river by formation of a hydraulic barrier, but they also reduce the inherent risk associated with the contaminated groundwater by removing chromium through treatment. The containment alternative may provide protection of the river, but it does not reduce the risk associated with the contaminated groundwater. The no action and institutional controls/continued current actions alternatives essentially result in no change from the existing conditions.

8.2 COMPLIANCE WITH ARAR

It is possible that none of the alternatives will meet the EPA Ambient Water Quality Criteria for hexavalent chromium in the Columbia River (11 μg/L). Compliance with this ARAR may be waived on the following basis.

- Reduction of chromium concentrations in groundwater entering the Columbia River to below the EPA Ambient Water Quality Criteria level of 11 μg/L may be technically impractical. Although effective treatment technologies for chromium-contaminated groundwater exist (ion exchange and reverse osmosis), the ability to remove chromium ~~from~~ in the unconfined aquifer to the 11 μg/L level may not be practical due to uncertainties in the adsorption characteristics of chromium in the unconfined aquifer. ~~As discussed in Section 3, a performance objective of 50 μ/L is recommended for near-river wells.~~

- The preferred alternative selected from this FFS may be an interim action preceding a final remedial action that will ensure compliance with the chromium Ambient Water Quality Criteria ~~level of 11 μg/L for chromium ARAR.~~

Although the purpose of the interim action is not aquifer restoration, contaminant concentrations in the aquifer represent the contaminant concentrations potentially entering the river. Due to the persistence of chromium in the environment, removal may be the only means of ensuring permanent compliance with the EPA Ambient Water Quality Criteria ARAR.

8.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

The lifecycle of the IRM is likely to be set at five years (1996-2001). ~~In this time frame, none of the alternatives meet the 11 μg/L Ambient Water Quality Criteria at the river. However,~~ During this time frame, the barrier and pump and treat alternatives result in a reduction in mass of chromium reaching the river. ~~Concentrations in near-river wells may approach the recommended performance objective of 50 μ/L.~~ Long-term effectiveness beyond the year 2001 will be addressed in the final remedial action for the 100-HR-3 Operable Unit. ~~Long-term effectiveness in this FFS is intended to be through the IRM period. The final FS for the final action will consider this criterion beyond the IRM period.~~

The pump and treat alternatives ~~provide the most~~ are more effective because they actively remove chromium from the groundwater. Also, the location of the extraction system along the Columbia River prevents contaminated groundwater from entering the river. Removal of chromium (by ion exchange or reverse osmosis) from the extracted groundwater reduces potential risk. The pump and treat alternatives, however, will be O&M intensive throughout the IRM period.

~~Based on recent experience at a similar site containing chromium in groundwater, t~~ The reverse osmosis treatment technology is relatively expensive to upgrade should the system require expansion to meet long term performance objectives. ~~may not be capable of meeting~~

~~project performance criteria if groundwater discharge rates are increased (EPA,1995).~~ For this reason, the long-term effectiveness and performance of reverse osmosis is judged to be only fair compared to ion exchange, which has performed well in treatability studies and under field conditions at analogous sites.

Although groundwater modeling results indicate that the containment alternative can provide protection of the river in both the 100-H and 100-D/DR Areas in the short term, chromium is a persistent contaminant in the environment and will continue to migrate around the wall to the river. The containment system proposed for the 100-H Area will be O&M intensive through the IRM period. The hydraulic control system (extraction and injection wells) will require constant operational control to account for changes in the hydraulic conditions near the Columbia River caused by seasonal and daily fluctuations in the river stage. Although the proposed containment system for the 100-D/DR Area involves a sheet pile cutoff wall (which is not O&M intensive), the system also uses hydraulic control wells to prevent leakage at the ends of the cutoff wall.

~~Groundwater modeling results indicate that t~~The no action and institutional controls/continued current actions alternatives will have little effect on the concentrations of chromium in the near-river wells during the IRM period. ~~Essentially, t~~These alternatives ~~result in no~~ will not change the existing ~~conditions~~ groundwater contamination during the IRM period. ~~This result may be significant in the event that current conditions are not considered detrimental to human health and the environment.~~ The institutional controls/continued current actions alternative would allow time to assimilate additional information and select a final remedial action.

Evaluation of the alternatives for use as IRMs requires some forethought into the potential final remedial actions. As an IRM, the institutional controls/continued current actions alternative would allow additional time for conducting treatability studies and defining parameters (adsorption of chromium) required to support selection of a final remedial action. Due to the persistence of chromium in the environment, containment would not reduce the potential risk associated with 100-HR-3 groundwater. Therefore, selection of the containment alternative as an IRM for the 100-HR-3 Operable Unit would require a final remedial action involving removal. The pump and treat alternatives could be used as IRMs to protect the river while also reducing the risk associated with the contaminated groundwater, and acquiring more information on the effectiveness of pump and treat. Depending on the goal of the pump and treat system used during the interim action period (aquifer restoration or protection of the river), continued operation or expansion to capture the entire plume may be required as the final remedial action. Pump and treat may be the only means of ensuring long-term protection of the river and reducing the potential ecological risk associated with 100-HR-3 groundwater.

8.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME

The pump and treat alternatives ~~have the most significant impact on the reduction of toxicity,~~ will reduce the mobility and ~~volume~~ quantity of contaminants in the groundwater. They also satisfy the statutory preference for treatment as a principal element. Pump and treat reduces

mobility by hydraulically controlling contaminated groundwater migration ~~near~~into the river. In addition, the ion exchange and reverse osmosis treatment technology reduces the mass of chromium in the groundwater ~~removed from the~~ aquifer. ~~As discussed in Section 8.3, reverse osmosis may be less effective in removing chromium from groundwater. Although chromium removed from the groundwater will remain in the hexavalent form, d~~Disposal of treatment residues (such as ion exchange resins and solidified treatment effluent) at ERDF ensures isolation from the accessible environment.

The containment alternative reduces the mobility of contaminants, but does not affect volume or toxicity due to the persistence of chromium in the environment. The no action and institutional controls/continued current actions alternatives have no direct effect on these parameters, but they do allow chromium to dissipate by migration into the river. However, ~~groundwater modeling results indicate that~~ continued migration into the river has little effect on chromium concentrations in the unconfined aquifer as long as sources for the chromium continue to exist.

8.5 SHORT-TERM EFFECTIVENESS

None of the alternatives are likely to have an impact on the surrounding communities due to the remoteness of the 100-D/DR and 100-H Areas. Risk to workers is primarily due to physical hazards during construction and well installation activities. Implementation of the containment alternative in the 100-D/DR Area (sheet pile cutoff wall) has the highest potential worker risk due to pile driving activities and excavation to facilitate installation of the cutoff wall (i.e., removing subsurface obstructions and re-contouring the riverbank). Risk to workers from implementation of the containment alternative in the 100-H Area (hydraulic control wells) is due to installation of extraction and injection wells. The short-term risk to workers from implementation of the pump and treat alternatives is ~~also~~ primarily due to well installation. Physical hazards associated with implementation of any of the alternatives can be minimized by adherence to stringent health and safety protocols.

Short-term impacts to the environment are physical disturbances to habitat resulting from construction activities. The no action alternative does not require implementation and, therefore, does not impact the environment. Containment will have the most impact on natural resources. The cutoff wall is directly adjacent to the river. There are few, if any, options as far as placement. Pump and treat wells and treatment facilities can be intentionally placed where they have less impact.

Implementation of the containment alternative in the 100-D/DR Area (sheet pile cutoff wall) has the highest potential environmental impact due to construction of the sheet pile cutoff wall along the bank of the Columbia River. Impacts to the environment from implementation of the containment alternative in the 100-H Area (hydraulic control wells) is considered minimal based on the installation of extraction and injection wells and associated piping. Environmental impacts from implementation of the pump and treat alternatives is also due to well and piping installation. Physical disturbances to habitat from implementation of the containment and pump and treat alternatives is unavoidable. Environmental impacts from construction can be minimized to the extent possible by requiring offsite pre-fabrication of

system components (such as piping and skid mounted treatment systems) ~~whenever possible,~~ by avoiding nesting seasons and ~~or by the revegetation or transplantation of plants in other locations.~~by restricting activities in sensitive habitats. Optimized placement of remedial systems considering ecological factors can minimize impacts.

Although the objective of the pump and treat alternatives during interim action at the 100-HR-3 Operable Unit is not aquifer restoration, the concentrations in the aquifer ~~represent the potential~~pose a risk to the environment. Groundwater modeling ~~results~~ of the pump and treat alternatives ~~do not show~~ indicate no significant reduction in the concentration of chromium will occur in the unconfined aquifer during the interim action period However, long-term and permanent protection of the river will likely require aquifer restoration to be the goal of pump and treat. Uncertainty in the adsorption characteristics of chromium in the unconfined aquifer results in uncertainty in the long-term effectiveness of pump and treat for aquifer cleanup.

8.6 IMPLEMENTABILITY

The no action and institutional controls/continued current actions alternatives are considered to be already in place (i.e., access restrictions and monitoring) and therefore do not involve any implementability concerns. The pump and treat alternatives are also considered easily implementable.~~; however, the effectiveness of these alternatives is uncertain.~~ Although both ion exchange and reverse osmosis are considered Best Available Technologies (BATs) for meeting the Safe Drinking Water Act (SDWA) Maximum Contaminant Level (MCL) of 100 μg/L for total chromium, the ability of these treatment technologies to achieve the EPA Ambient Water Quality Criteria level of 11 μg/L for hexavalent chromium is unknown. The treatability study conducted using ion exchange indicates that this treatment is effective for removing chromium from 100-HR-3 groundwater to less than 20 μg/L (based on 19 μg/L detection limit) (WHC 1993c). Ion exchange technology has also been successfully implemented at an analogous site in Washington State (EPA, 1995). Treatability testing with reverse osmosis would be required to establish accurate performance data. Uncertainty also exists in the ability to remove chromium from the unconfined aquifer. Effective and efficient chromium removal from the unconfined aquifer is dependent on the adsorption characteristics of chromium. The adsorption characteristics of chromium in the unconfined aquifer are uncertain and will require additional site characterization to accurately define. Reverse osmosis also requires the use of high pressure pumps and may be more difficult to implement than ion exchange.

Implementation of a vertical physical barrier (cutoff wall) at 100-H Area is considered impracticable; ~~The proposed alternate containment action is the~~therefore, a hydraulic control alternative is proposed. Although groundwater modeling results indicate this alternative to be effective for controlling the flux of chromium to the river, ~~operability of~~it may be more difficult to operate the hydraulic control system ~~is questionable~~. Operational difficulties are anticipated due to continuously changing hydrologic conditions in the unconfined aquifer near the river. Daily and seasonal fluctuations in the river stage will result in corresponding fluctuations in the water table elevation, hydraulic gradient, and direction of the hydraulic gradient. Containment of a persistent contaminant such as chromium would eventually lead

to additional remedial actions (i.e., pump and treat) or alternate cleanup levels would have to be negotiated. Operation of the extraction/injection of contaminated groundwater may encounter regulatory resistance in the absence of treatment. However, the goal of the alternative is to contain the contaminant plume without incurring the massive treatment costs associated with the pump and treat alternatives.

Implementability of the sheet pile cutoff at 100-D/DR Area is considered difficult due to potential subsurface obstructions and ~~recontouring areas of the river bank~~the necessity to place the wall in sensitive habitat adjacent to the river. ~~Treatability testing~~A field evaluation may be required to establish the implementability of a sheet pile cutoff wall in the 100-D/DR Area. In addition, the containment system proposed for the 100-D/DR Area also involves hydraulic control to prevent leakage near the ends of the cutoff wall. Operation of these hydraulic control wells will involve the same operational difficulties described above for the proposed hydraulic containment system in the 100-H Area.

8.7 COST

Costs for the alternatives are ~~compared~~presented in Tables 8-~~1~~2 and 8-~~2~~3. Additional details and assumptions for the costs are presented in Appendix D. ~~For all alternatives, t~~The cost estimates assume an interim remediation period of 5 years (1996-2001). ~~Costs for alternative GW-5 (groundwater removal and treatment with ion exchange) were also estimated assuming a 5-year IRM period (1996-2001) to support the DOE and EPA planning and review process and to incorporate data from recent experience with ion exchange at an analogous site in Washington State (EPA 1995).~~ The costs developed for this FFS cover only the implementation and operation of the IRM. Consideration of the final action costs is outside the scope of the FFS; however, some general statements are provided for consideration as follows.

- Costs for the continuation of the IRM as a final action can be extrapolated from the FFS costs.

- Costs for combining alternatives (such as a vertical barrier in conjunction with pump and treat) can be assumed to be additive (on an order of magnitude basis).

Table 8-1
Summary of Comparative Analysis
HR-3 Operable Unit

Remedial Action	CERCLA Evaluation Criteria							
	Overall Protection of Human Health and Environment	Compliance with ARARs	Long Term Effectiveness and Permanence	Reduction in Toxicity, Mobility, and Volume	Short Term Effectiveness	Implementability	Cost (Present Worth in millions)	
							H Area	D/DR Area
No Action GW-1	Poor - Ecological risks not quantified and not expected to significantly reduce concentrations of chromium in groundwater.	Poor - Chromium concentrations will exceed ambient water quality criteria in near-river wells and possibly in salmon spawning habitat.	Fair - Potential ecological risks to river will remain, but alternative compatible with potential final actions.	Poor - no significant reduction during IRM period	Fair - no additional adverse impacts, but threat to river not mitigated.	Good - groundwater monitoring technology well established	0	0
Institutional Control/Continue Current Action GW-2	Poor - Ecological risks not quantified and not expected to significantly reduce concentrations of chromium in groundwater	Poor - Chromium concentrations will exceed ambient water quality criteria in near-river wells and possibly in salmon spawning habitat.	Fair - Potential ecological risks to river will remain, but alternative compatible with potential final actions.	Poor - no significant reduction during IRM period	Fair - no additional adverse impacts, but threat to river not mitigated.	Good - groundwater monitoring technology well established.	0.5	0.5
Containment GW-3	Good - immediate reduction in concentrations of chromium entering the river in contained areas.	Fair - Chromium concentrations in the river will decrease and may fall below AWQC. However, chromium mass in groundwater will not be reduced.	Fair - Groundwater may eventually migrate around barrier. Option may require future remedial action to remove chromium.	Fair - mobility reduced, but toxicity and volume not affected	Fair - chromium will immediately be prevented from migrating towards river. However, some environmental impacts due in installation of barrier wall.	Poor - Cannot drive sheet piles in H Area; uncertain in D/DR Area.	2.8	22.6
Removal/Ion Exchange Treatment/Disposal GW-5	Good - immediate reduction in chromium mass in groundwater expected; however, the mass removal rate relative to total inventory will likely become apparent during compliance monitoring. Chromium concentrations entering the river are expected to decline, thus providing protection of aquatic organisms.	Good - IRM system will be designed with intention of meeting AWQC in the river. ARARs must also be met for disposal of removed chromium.	Good - chromium permanently removed from system. IRM system could be expanded to meet changing objectives.	Good - chromium removed from system, mobility limited by groundwater extraction wells	Good - potential risks to environment and to workers are expected to be minimal	Good - technology well established; equipment and specialists are available.	9.5	9.1

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Table 8-1
Summary of Comparative Analysis
HR-3 Operable Unit

	CERCLA Evaluation Criteria							
Remedial Action	**Overall Protection of Human Health and Environment**	**Compliance with ARARs**	**Long Term Effectiveness and Permanence**	**Reduction in Toxicity, Mobility, and Volume**	**Short Term Effectiveness**	**Implementability**	**Cost (Present Worth in millions)**	
Removal/Reverse Osmosis Treatment/Disposal GW-6	Good - immediate reduction in chromium mass in groundwater expected; however, the mass removal rate relative to total inventory will likely become apparent during compliance monitoring. Chromium concentrations entering the river are expected to decline, thus providing protection of aquatic organisms.	Good - IRM system will be designed with intention of meeting AWQC in the river. ARARs must also be met for disposal of removed chromium.	Fair - Reverse osmosis system may not be effective at removing chromium if groundwater discharge rates are increased, and may require updating or replacement.	Good - chromium removed from system, mobility limited by groundwater extraction wells	Fair - potential risks to environment and to workers are expected to be minimal, but more land required for sludge disposal.	Fair - Requires installation of high pressure pumps, more difficult and expensive to implement than ion exchange.	15.0	13.8

Table 8-2. Comparison of Capital, O&M, and Present Worth Costs for the 100-D/DR Area.

IRM Period (years)	Alternative	Capital Costs	O&M Costs	Present Worth
5	GW-1 No Action	$0	$0	$0
5	GW-2 Institutional Controls/Continued Current Actions	$0	$600,000	$500,000
5	GW-3 Containment	$11,400,000	$13,000,000	$22,600,000
5	GW-5 Removal, Treatment, Disposal Using Ion Exchange	$3,300,000	$6,600,000	$9,100,000
5	GW-6 Removal, Treatment, Disposal Using Reverse Osmosis	$3,500,000	$11,800,000	$13,800,000

Note: Cost assumptions are described in Appendix D.

Table 8-3. Comparison of Capital, O&M, and Present Worth Costs for the 100-H Area.

IRM Period (years)	Alternative	Capital Costs	O&M Costs	Present Worth
5	GW-1 No Action	$0	$0	$0
5	GW-2 Institutional Controls/Continued Current Actions	$0	$600,000	$500,000
5	GW-3 Containment	$800,000	$2,300,000	$2,800,000
5	GW-5 Removal, Treatment, Disposal Using Ion Exchange	$3,300,000	$7,100,000	$9,500,000
5	GW-6 Removal, Treatment, Disposal Using Reverse Osmosis	$3,900,000	$12,800,000	$15,000,000

Note: Cost assumptions are described in Appendix D.

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APPENDIX A

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Applicable or relevant and appropriate requirements (ARARs) in federal or state law must be met or waived for remedial actions as required by Section 121 of CERCLA. A component of an action's protectiveness is its ability to comply with ARARs. This appendix consists of a written discussion of major federal and state ARARs, followed by tables listing ARARs that are pertinent to interim remedial activities evaluated in the FFS. Identification of ARARs is directly impacted by characteristics of the site, contaminants present, and Remedial Alternatives developed; therefore, only specific sections of the regulations may be an ARAR.

PRIMARY ARARS

1. EFFLUENT DISCHARGE STANDARDS - REMOVAL, TREATMENT, AND DISPOSAL ALTERNATIVES

The primary issue associated with the removal, treatment, and disposal alternatives would involve the return of treated groundwater to the aquifer. It is anticipated that this effluent may contain constituents above the MCLs (Constituents not being treated could remain above MCL's or constituents that are reduced in concentration through treatment but still not to MCLs).

At CERCLA sites, RCRA Section 3020(b) allows discharge of hazardous or radioactive waste and/or effluent exceeding drinking water standards into injection wells provided that the reinjection: (1) is done pursuant to CERCLA or RCRA corrective action authority; (2) includes treatment of contaminated water to substantially reduce hazardous constituents prior to reinjection; and (3) the CERCLA or RCRA effort will, upon completion, be sufficient to protect human health and the environment. Reinjection of treated effluent would be allowable pursuant to RCRA Section 3020b). In a similar manner, and notwithstanding the general prohibition of 40 CFR 144.13(a), 40 CFR 144.13(c) allows injection of treated groundwater into the same formation from which it was drawn when such actions are done pursuant to CERCLA or RCRA authority.

2. HAZARDOUS/DANGEROUS WASTE MANAGEMENT STANDARDS

The pump-and-treat technologies may generate RCRA hazardous waste. If so, substantive RCRA and WAC 173-303 standards would apply to the generated waste.

The Resource Conservation and Recovery Act (RCRA) regulates the generation, transportation, storage, treatment, and disposal of hazardous waste. This law also provides authority for the cleanup of spills and environmental releases of hazardous waste to the environment as a result of past practices. Hazardous waste management regulations promulgated pursuant to RCRA are codified at 40 CFR 260 through 270. The regulations include chemical-specific standards for the designation of hazardous wastes, as well as standards for treatment of these wastes prior to disposal. Washington State Dangerous Waste Regulations implement the federal hazardous waste regulations and are administered by Ecology. RCRA requirements are applicable to those remediation activities that may generate, treat, store, or dispose of hazardous waste.

Land disposal restrictions (LDRs), outlined in 40 CFR 268, identify hazardous wastes that are restricted from land disposal and prescribes treatment standards for such wastes. Applicable treatment standards would be met unless such wastes were disposed pursuant to the RCRA corrective action management unit regulations or a treatment waiver or variance were obtained.

3. AIR STANDARDS

Under 40 CFR Part 61, Subpart H and WAC 246-247, radionuclide airborne emissions from all combined operations at the Hanford Site may not exceed 10 mrem/year effective dose equivalent to the hypothetical offsite maximally exposed individual. The WAC 173-460 establishes acceptable source impact levels for more than 500 carcinogenic acutely toxic air pollutants.

The radionuclide emission requirements would apply to all fugitive, diffuse, and point source air emissions of radionuclides generated by the pump and treat technologies described in the removal, treatment, and disposal alternatives. If either the pump-and-treat technology or the containment technology alternatives generated an increase of toxic air pollutants to the atmosphere above the small quantity emission rates, implementation of Best Available Control Technology for Toxics (T-BACT) would be required. If radionuclides exist in the groundwater and emissions do not exceed small quantity emissions rates, Reasonably Available Control Technology would be required at a minimum.

MISCELLANEOUS ARARS AND TO-BE-CONSIDERED REQUIREMENTS

The Water Well Construction Act - 18.104 RCW promulgated at WAC 173-160

The Standards for Construction and Maintenance of Wells (WAC 173-160) establishes a minimum standard for design, construction, capping, and sealing of all wells; sets additional requirements including disinfection of equipment, abandonment of wells, and quality of drilling water. All wells in the 100-HR-3 Operable unit will comply with this standard.

The *National Historic Preservation Act of 1966* - 16 USC 470 et seq.

The *National Historic Preservation Act* requires that historically significant properties be protected. The Act requires that impacts posed to property listed on or eligible for inclusion on the National Register of Historic Places must be evaluated. The National Register of Historic Places is a list of sites, buildings, or other resources identified as significant to United States history. If facilities within the operable units are determined to be of historical significance, this Act is applicable to alternatives that may cause ground disturbance.

The *Archeological and Historic Preservation Act* - 16 USC 469a

This Act is similar to the National Historic Preservation Act but differs in that it mandates only protection of historic or archaeologic data and not the actual archaeologic or historical site. If activities in connection with any federal project or federally approved project may cause irreparable loss to significant scientific, prehistorical, or archeological data, the Act requires that the agency responsible for the project preserve the data. This Act requires that actions conducted at a waste site must not cause the loss of any

archeological and historic data. There are known and potential archeological sites in the 100 Area. This Act is, therefore, applicable.

The *Endangered Species Act* - 16 USC 1531

The *Endangered Species Act of 1973* establishes requirements to protect species threatened by extinction and habitats important to their survival. The *Endangered Species Act* is designed as a means for the conservation of flora and fauna that are threatened with extinction. Endangered species are identified under the Act as species that are in danger of extinction throughout all or a significant portion of their range. Threatened species are identified as species that are anticipated to be in danger of extinction within the foreseeable future. The Endangered Species Act provides for the designation of critical habitat, defined as "specific areas within the geographical area occupied by the (endangered or threatened) species ... on which are found those physical or biological features essential to the conservation of the species..." This Act is applicable because some threatened and endangered species are residents or seasonal visitors with the 100 Area.

Floodplain/Wetlands Environmental Review Requirements 10 CFR 1022

This regulation requires DOE and other federal agencies to comply with the requirements of Executive Order 11990 - Protection of Wetlands, and Executive Order 11988 - Floodplain Management. Executive Order 11988 requires DOE procedures to ensure that any action conducted in a floodplain shall consider alternatives to avoid adverse effects in the floodplains. Executive Order 11990 requires protection of wetlands from destruction. This regulation requires federal agencies to implement these considerations through existing federal standards, such as the *National Environmental Policy Act*. The U.S. Army Corp of Engineers has established a nationwide permitting program for actions that impact wetlands. Under CERCLA, onsite actions are not required to comply with administrative permit requirements of federal, state and local regulations; however, CERCLA actions must comply with substantive portions of the regulations. There are wetlands within the 100 Area operable units. The substantive requirements of these Orders are, therefore, relevant and appropriate.

***Department of Game State Environmental Policy Act* Procedures - WAC 232-012**

The regulations include the State of Washington Department of Fish and Wildlife procedures for compliance with the *Washington State Environmental Policy Act* (SEPA). The Act requires that management plans be developed if threatened, endangered, or sensitive wildlife or habitat are affected by remedial actions at the site. Even though the majority of these requirements are administrative in nature, remedial activities are required to meet the substantive aspects of the regulation and to adhere to the goals of protecting and enhancing wildlife resources. Since state-listed threatened and endangered species have been identified in the 100 Area, this Act is applicable. The Washington State Department of Fish and Wildlife will be consulted to determine management policies and any mitigation that may be necessary to minimize ecological impacts.

Hanford Reach Study Act, P.L. 100-605

The Hanford Reach Study Act is a TBC requirement that provides for a comprehensive river conservation study. It prohibits the construction of any dam, channel, or navigation project by a federal agency for 8 years after enactment. New federal and nonfederal projects and activities are required, to the extent practicable, to minimize direct and adverse effects on the values for which the river is under study and to utilize existing structures.

Radiation Protection of the Public and Environment - DOE Order 5400.5

Radiation protection and radioactive waste management requirements issued under the *Atomic Energy Act* are implemented at DOE facilities as DOE Orders. Under CERCLA these standards are TBC for remedial activities because they are not promulgated regulations.

DOE Order 5400.5, "Radiation Protection of the Public and Environment," establishes the standards and requirements for radiation protection of the public and the environment at DOE and DOE contractor facilities. This DOE Order defines members of the public as persons not occupationally associated with the DOE facility or operations. However, this DOE Order is discussed because it presents exposure limits for airborne and liquid effluent that may be useful as comparisons to occupational limits. This DOE policy is to implement all legally applicable radiation protection standards, and to adopt or consider recommendations from authoritative organizations, such as the National Council on Radiation Protection and Measurements and the ICRP. This DOE policy also includes implementation of standards generally consistent with NRC for DOE facilities not subject to NRC regulation.

The DOE Order applies the "As Low As is Reasonably Achievable" (ALARA) process to radiation protection. The ALARA process is not a dose-based limit, but a feasibility limit, in that exposures should be as far below applicable limits as practical. The feasibility limit should account for social, economic, technical, and public policy considerations. As part of the ALARA process, DOE operations monitor routine and non-routine exposure and assess the dose to members of the public. The ALARA process includes procedures for evaluating alternative operations and other factors to reduce radiation exposures.

This DOE Order adopts radiation protection dose standards consistent with the 1977 ICRP guidance that has been adopted and implemented world wide by countries with nuclear programs. Dose limits presented in this DOE Order are expressed both in terms of effective dose equivalents (ICRP guidance) and dose equivalents to specific organs or whole body to be consistent with pre-1977 standards or public dose limits established by EPA for selected exposure pathways or sources.

The DOE primary standard for allowable effective dose equivalent to members of the public in a year is 0.1 rem. The DOE-Headquarters is to be notified if an annual public exposure in excess of 0.01 rem occurs or is anticipated to occur. This dose considers all exposure modes resulting from DOE activities. "Effective Dose Equivalent", developed by the ICRP, is calculated by the weighted summation of doses to various organs of the body. The 0.1 rem effective dose equivalent in a year is the sum of all exposures from external sources plus the committed effective dose equivalent from sources taken into the body during the year. The public dose limit does not include medical exposures, exposure resulting from consumer products, residual fallout from past nuclear accidents and weapons tests, or naturally occurring radiation sources.

The DOE Order 5400.5 identifies circumstances where supplemental limits or exceptions to the standards may be implemented. A temporary public dose limit higher than 0.1 rem, but not to exceed 0.5 rem for the year, may be approved from the DOE Operations office in coordination with its Program Office. Situations identified by DOE that may warrant use of a supplemental standard include situations where remedial action would pose a clear and present risk to workers or members of the public using reasonable measures to reduce or avoid the risk.

The DOE Order presents derived concentration guides (DCG) for conducting radiological environmental monitoring programs at DOE facilities. The DCGs are presented for three exposure modes: ingestion of water, inhalation of air, and immersion in a gaseous cloud. The DCGs are not designed as occupational intake limits. The DCGs for internal exposure are based on a committed effective dose equivalent of 0.1 rem/year for radionuclides taken into the body through ingestion or inhalation. The DCGs may be used for evaluating compliance to the drinking water limit of 0.004 rem/year by using 4% of the DCG for ingestion. The exposure conditions used for development of the ingestion and inhalation DCGs are presented with the DCGs in table format.

The proposed DOE rule, Radiation Protection of the Public and the Environment (10 CFR 834), published in the March 23, 1993 Federal Register (58 FR 16268), promulgates the standards presently found in DOE Order 5400.5. The proposed rule retains the substantive portions of the DOE Order and differs from the existing DOE Order in format, enhanced emphasis on the ALARA process, and changes in the usage of DCGs. The proposed rule identifies DCGs not as "acceptable" discharge limits, but to be used as reference values for estimating potential dose and determining compliance with the requirements of the proposed rule.

Table A-1 Federal Chemical-Specific ARAR

Description	Citation	A/R&A*	Requirements	Remarks	Alternatives Potentially Affected
Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (RCRA)	42 U.S.C. 6901 et. seq		Establishes the basic framework for federal regulation of solid and hazardous waste.		
Groundwater Protection Standards	40 CFR 264.92 (WAC 173-303-6 45)[1]	A	A facility shall not contaminate the uppermost aquifer underlying the waste management area beyond the point of compliance, which is a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated area. The concentration of certain chemicals shall not exceed background levels, certain specified maximum concentrations, or alternate concentration limits, whichever is higher. µg/l Arsenic 50 Chromium 50 Lead 50 Silver 50	Groundwater concentration limits in this section do not exceed 40 CFR 141, except for chromium which has a limit of 50 µg/L.	GW-5, GW-6

*NOTE: A = Applicable R&A = Relevant and Appropriate

[1]These are State of Washington regulatory citations which are equivalent to the Title 40 Code of Federal Regulations, Parts 264 and 268 as stated in Washington Administrative Code 173-303.

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Table A-2 Federal Action-Specific ARAR

Description	Citation	A/R&A*	Requirements	Remarks	Alternatives Potentially Affected
Federal Water Pollution Control Act (FWPCA), as amended by the Clean Water Act of 1977 (CWA)	33 U.S.C. 1251 et seq.		Creates the basic national framework for water pollution control and water quality management in the United States.	Applicable to discharges of pollutants to navigable waters.	
The National Pollutant Discharge Elimination System (NPDES)	40 CFR Part 122	A	Part 122 covers establishing technology-based limitations and standards, control of toxic pollutants, and monitoring of effluent to assure limits are not exceeded.	Applicable if remediation includes wastewater discharge; also applies to storm water runoff associated with industrial activities. Effluent limitations established by EPA and included in NPDES permit.	GW-5, GW-6
NPDES Criteria and Standards	40 CFR 125.104		Best management practices program shall be developed in accordance with good engineering practice.		
Ambient Water Quality Criteria	40 CFR 131	A	Establishes the water quality criteria.	Requirements include ambient water quality criteria for chromium	GW-3, GW-5, GW-6
Discharge of Oil	40 CFR Part 110	A	Prohibits discharge of oil that violates applicable water quality standards or causes a sheen of oil on water surface.	Runoff from site will need control for oily waste discharge to waters of the United States.	GW-3, GW-5, GW-6
Underground Injection Control Program	40 CFR 144.13 (c)	A	Allows injection of treated groundwater into same formation when done pursuant to CERCLA or RCRA authorization.	Applicable for reinjection of groundwater after treatment.	GW-5, GW-6
Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act (RCRA)	Section 3020	A	Allows reinjection of hazardous or radioactive waste exceeding drinking water standards pursuant to (1) RCRA or CERCLA corrective action; (2) treatment to substantially reduce hazardous constituents; (3) CERCLA or RCRA effort will protect human health and environment.	Will allow reinjection of groundwater after pump and treat technology.	GW-5, GW-6
Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act (RCRA)	42 U.S.C. 6901 et seq.		Establishes the basic framework for federal regulation of solid waste. Subpart C of RCRA controls the generation, transportation, treatment, storage, and disposal of hazardous waste through a comprehensive "cradle to grave" system of hazardous waste management techniques and requirements.	Hazardous waste generated by site remediation activities must meet RCRA generator and treatment, storage, or disposal (TSD) requirements.	

Table A-2 Federal Action-Specific ARAR

Description	Citation	A/R&A*	Requirements	Remarks	Alternatives Potentially Affected
Identification and Listing of Hazardous Waste	40 CFR Part 261 (WAC 173-303-016)	A	Identifies by both listing and characterization, those solid wastes subject to regulation as hazardous wastes under Parts 261-265, 268, and 270.	Applicable if remediation techniques result in generation of hazardous wastes.	GW-5, GW-6
Accumulation Time	40 CFR 262.34 (WAC 173-303-200)	A	Allows a generator to accumulate hazardous waste onsite for 90 days or less without a permit, provided that all waste is containerized and labeled.	Hazardous waste removed from the 100 Area operable unites, and waste treatment residues, are subject to the 90-day generator accumulation requirements if the waste is stored onsite for 90 days or less. If hazardous waste is stored for more than 90 days, the full standards for TSD facilities must be met.	GW-5, GW-6
Hazardous Waste Determination	40 CFR 262.11	R&A	Lists procedures and methods used to characterize waste generated.	These methods would be pertinent to shipment of hazardous waste.	GW-2, GW-3, GW-5, GW-6
Hazardous Waste Determination	40 CFR 262.14	R&A	Lists procedures and methods used to characterize waste generated.	These methods would be pertinent to shipment of hazardous waste.	
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR Part 264 (WAC 173-303)		Establishes requirements for operating hazardous waste treatment, storage, and disposal facilities.	Substantive requirements apply if remediation technique results in onsite treatment, storage, or disposal of hazardous waste.	GW-5, GW-6
Land Disposal Restrictions (LDR)	40 CFR Part 268 (WAC 173-303-140 WAC 173-303-141)	A	Establishes treatment standards that must be met prior to land disposal.	Applicable if RCRA hazardous wastes are land disposed.	GW-5, GW-6
Hazardous Waste Discharges	40 CFR 263.30 Subpart C	R&A	Establishes actions to be taken in the event of a hazardous waste discharge.	The appropriate, notification, documentation, and cleanup will be implemented	GW-2, GW-3, GW-5, GW-6
Clean Air Act, as amended	42 U.S.C. 7401 et seq.		A comprehensive environmental law designed to regulate any activities that affect air quality, providing the national framework for controlling air pollution.		
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50		Sets National Ambient Air Quality Standards for ambient pollutants which are regulated within a region.		

Table A-2 Federal Action-Specific ARAR					
Description	Citation	A/R&A*	Requirements	Remarks	Alternatives Potentially Affected
Air Standards for Particulates	40 CFR 50.6	A	Prohibits average concentrations of particulate emissions in excess of 50 micrograms/m^3 annually or 150 micrograms/m^3 per 24-hr period.	A potential for particulate emissions exists during material handling or treatment, including incineration.	GW-5, GW-6
National Emissions Standards for Hazardous Air Pollutants (NESHAP)	40 CFR Part 61		Establishes numerical standards for hazardous air pollutants		

*NOTE: A = Applicable R&A = Relevant and Appropriate

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Table A-3 State Action-Specific ARAR

Description	Citation	A/R&A*	Requirements	Remarks	Alternatives Potentially Affected
Department of Ecology	43.21A RCW		Vests the Washington Department of Ecology with the authority to undertake the state air regulation and management program.		
Air Pollution Regulations	WAC 173-400		Establishes requirements for the control and/or prevention of the emission of air contaminants.	Applicable if emission sources are created during remedial action.	
Standards for Maximum Emissions	WAC 173-400-040	A	Requires best available control technology be used to control fugitive emissions of dust from materials handling, construction, demolition, or any other activities that are sources of fugitive emissions. Restricts emitted particulates from being deposited beyond Hanford. Requires control of odors emitted from the source. Prohibits masking or concealing prohibited emissions. Requires measures to prevent fugitive dust from becoming airborne.	Applicable to dust emissions from cutting of concrete and metal and vehicular traffic during remediation	GW-3, GW-5, GW-6
Emission Limits for Radionuclides	WAC 173-480		Controls air emissions of radionuclides from specific sources.	Applicable to remedial activities that result in air emissions.	
New and Modified Emission Units	WAC 173-480-060	A	Requires the best available radionuclide control technology be utilized in planning, constructing, installing, or establishing a new emission unit.	Applicable to remedial actions that result in air emissions.	GW-3, GW-5, GW-6
Washington Clean Air Act	RCW 70.94				
Controls for New Sources of Toxic Air Pollutants	WAC 173-460		Establishes systematic control of new sources emitting toxic air pollutants.		
Demonstrating Ambient Impact Compliance	WAC 173-460-080	A	Requires the owner or operator of a new source to complete an acceptable source impact level analysis using dispersion modeling to estimate maximum incremental ambient impact of each Class A or B toxic air pollutants. Establishes numerical limits for small quantity emission rates.	Applicable to remedial alternative with the potential to release toxic air pollutants.	GW-3, GW-5, GW-6

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Table A-3 State Action-Specific ARAR

Description	Citation	A/R&A*	Requirements	Remarks	Alternatives Potentially Affected
Hazardous Waste Management Act of 1976 as amended in 1980 and 1983[1]	70.105 RCW		Establishes a statewide framework for the planning, regulation, control, and management of hazardous waste.		
Dangerous Waste Regulations	WAC 173-303		Establishes the design, operation, and monitoring requirements for management of hazardous waste.	Includes requirements for generation of dangerous waste. Dangerous waste includes the full universe of wastes regulated by WAC 173-303 including extremely hazardous waste.	
Solid Waste Management Act	70.59 RCW		Establishes a statewide program for solid waste handling, recovery, and/or recycling.	Applicable if management of solid waste occurs during remediation. Solid waste controlled by this Act includes garbage, industrial waste, construction waste, ashes, and swill.	
Minimum Functional Standards for Solid Waste Handling	WAC 173-304		Establishes requirements to be met statewide for the handling of all solid waste.		
Onsite Containerized Storage, Collection, and Transportation Standards	WAC 173-304-200	R&A	Sets requirements for containers and vehicles to be used onsite; requires monthly inspections and retention of inspection records for at least two years.		GW-3, GW-5, GW-6
Water Well Construction Act	18.104 RCW				
Standards for Construction and Maintenance of Wells	WAC 173-160	A	Establishes minimum standards for design, construction, capping, and sealing of all wells; sets additional requirements including disinfection of equipment, abandonment of wells, and quality of drilling water.	Applicable if water supply wells, monitoring wells, or other wells are utilized during remediation.	GW-2, GW-3, GW-5, GW-6

*NOTE: A = Applicable R&A = Relevant and Appropriate

[1]The Hazardous Waste Management Act and regulations pursuant to the Act provide the statutory and regulatory basis for state authorization to implement RCRA. State of Washington regulations that are equivalent to RCRA regulations are cited in brackets in the federal ARARs. The WAC 173-303 regulations cited in this section are those judged to be more stringent than RCRA regulations.

Table A-4 Federal Location-Specific ARAR

Description	Citation	A/R&A*	Requirements	Remarks	Alternatives Potentially Affected
Archaeological and Historical Preservation Act of 1974	16 U.S.C. 469	A	Requires action to recover and preserve artifacts in areas where activity may cause irreparable harm, loss, or destruction of significant artifacts.	Applicable when remedial action threatens significant scientific, prehistorical, historical, or archeological data.	GW-2, GW-3, GW-5, GW-6
Endangered Species Act of 1973	16 U.S.C. 1531 et seq.		Prohibits federal agencies from jeopardizing threatened or endangered species or adversely modifying habitats essential to their survival.		
Fish and Wildlife Services List of Endangered and Threatened Wildlife and Plants	50 CFR Parts 17, 222, 225, 226, 227, 402, 424	A	Requires identification of activities that may affect listed species. Actions must not threaten the continued existence of a listed species or destroy critical habitat.	Requires consultation with the Fish and Wildlife Service to determine if threatened or endangered species could be impacted by activity.	GW-3, GW-5, GW-6
Historic Sites, Buildings, and Antiques Act	16 U.S.C. 461	A	Establishes requirements for preservation of historic sites, building, or objects of national significance. Undesirable impacts to such resources must be mitigated.		GW-3, GW-5, GW-6
National Historic Preservation Act of 1966, as amended.	16 U.S.C. 470 et seq.	A	Prohibits impacts on cultural resources. Where impacts are unavoidable, requires impact mitigation through design and data recovery.	Applicable to properties listed in the National Register of Historic Places, or eligible for such listing.	GW-3, GW-5, GW-6
Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (RCRA)	42 U.S.C. 6901 et seq.		Establishes the basic framework for federal regulation of solid and hazardous waste.		
Floodplains	40 CFR 257.3-1	A	Prohibits facilities or practices in floodplains from restricting the flow of the base flood, reducing the temporary water storage capacity of the floodplain, or causing washout of solid waste, so as to pose a hazard to human life, wildlife, or land or water resources.		GW-3, GW-5, GW-6
Endangered Species	40 CFR 275.3-2	A	Prohibits facilities or practices from causing or contributing to the taking of any endangered or threatened species of plants, fish, or wildlife. Prohibits destruction or adverse modification of habitat of endangered or threatened species.		GW-3, GW-5, GW-6

Table A-4 Federal Location-Specific ARAR					
Description	Citation	A/R&A*	Requirements	Remarks	Alternatives Potentially Affected
Wild and Scenic Rivers Act	16 U.S.C. 1271	R&A	Prohibits federal agencies from recommending authorization of any water resource project that would have a direct and adverse effect on the values for which a river was designated as a wild and scenic river or included as a study area.	The Hanford Reach of the Columbia River is under study for inclusion as a wild and scenic river.	GW-3, GW-5, GW-6

*NOTE: A = Applicable R&A = Relevant and Appropriate

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Table A-5 State Location-Specific ARAR

Description	Citation	A/R&A*	Requirements	Remarks	Alternatives Potentially Affected
Habitat Buffer Zone for Bald Eagle Rules	RCW 77.12.655				
Bald Eagle Protection Rules	WAC 232-12-292	A	Prescribes action to protect bald eagle habitat, such as nesting or roost sites, through the development of a site management plan.	Applicable if the sites of remedial activities includes bald eagle habitat.	GW-3, GW-5, GW-6
Regulating the Taking or Possessing of Game	RCW 77.12.040				
Endangered, Threatened, or Sensitive Wildlife Species Classification	WAC 232-12-297	A	Prescribes action to protect wildlife classified as endangered, threatened, or sensitive, through development of a site management plan.	Applicable if wildlife classified as endangered, threatened, or sensitive are present in areas impacted by remedial activities.	GW-3, GW-5, GW-6

*NOTE: A = Applicable, R&A = Relevant and Appropriate

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Table A-6 To be Considered (TBC) Requirements

Description	Citation	Requirements	Remarks	Alternatives Potentially Affected
Solid Waste Disposal Act, as amended by RCRA	42 U.S.C. 6901 et seq.			
Corrective Action for Solid Waste Management Units	40 CFR 264 Subpart S, proposed	Establishes requirements for investigation and corrective action for releases of hazardous waste from solid waste management units.		GW-5, GW-6
U.S. Department of Energy Orders				
Radiation Protection of the Public and the Environment	DOE 5400.5	Establishes radiation protection standards for the public and environment.		
Radiation Dose Limit (All Pathways)	DOE 5400.5, Chapter 11, Section 1a	The exposure of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem from all exposure pathways, except under specified circumstances.	Pertinent if remedial activities are "routine DOE activities."	All
U.S. Department of Energy Orders				
Radiation Protection of the Public and the Environment	DOE 5400.5	Establishes standards and requirements for operation of DOE and DOE contractors respecting protection of the public and the environment against undue risk of radiation.		All
Floodplains/Wetlands Environmental Review	10 CFR Part 1022	Requires federal agencies to avoid, to the extent possible, adverse effects associated with the development of a floodplain or the destruction or loss of wetlands.	Pertinent if remedial activities take place in a floodplain or wetlands.	GW-3, GW-5, GW-6
Hanford Reach Study Act	P.L. 100-605	Provides for a comprehensive river conservation study. Prohibits the construction of any dam, channel, or navigation project by a federal agency for 8 years after enactment. New federal and non-federal projects and activities are required, to the extent practicable, to minimize direct and adverse effects on the values for which the river is under study and to utilize existing structures.	This law was enacted November 4, 1988.	GW-3, GW-4, GW-5, GW-6

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APPENDIX B

DETAILED DESCRIPTIONS OF REMEDIAL ALTERNATIVES FROM THE 100 AREAS FEASIBILITY STUDY PHASES 1 AND 2

1.0 GROUNDWATER REMEDIAL ALTERNATIVE DESCRIPTIONS

The alternatives considered for treatment of the 100 Areas groundwater operable unit were developed and screened in the *100 Areas Feasibility Study Phases 1 and 2* (DOE-RL 1994a). This appendix presents detailed descriptions of each groundwater alternative retained from the 100 Areas FS for more detailed analysis. The descriptions for these alternatives (referred as the general alternatives) are expanded from the information presented in the 100 Areas FS and are modified, as needed, to reflect new information gathered since preparation of the FS. These alternative descriptions will be modified, as needed, to reflect site specifics in the individual operable unit FFS.

1.1 ALTERNATIVE GW-1

1.1.1 Description

Alternative GW-1, the no action alternative, is required by the NCP to serve as a baseline for the evaluation of other alternatives. The no action alternative may be selected for sites where contamination does not exceed the level of unacceptable risk, where site contamination is in compliance with ARAR, where short-term risks associated with the remedial action exceed the risk of no action, or where the cost of remediation is excessive compared to the benefit gained in risk reduction. The no action alternative assumes no further action at a site. For example, no action for the groundwater operable unit consists of continued existing groundwater monitoring events. The contamination is allowed to dissipate through natural attenuation processes. For radionuclides, this is mainly natural radioactive decay. The effectiveness of the natural attenuation process is related to the half-life of the radionuclide and the affinity of the radionuclide to sorb to the Hanford soils. For other contaminants, such as chromium, the major attenuation factor is advection/dispersion, which depends on natural groundwater flow and the river flushing action to reduce concentrations.

1.2 ALTERNATIVE GW-2

A single alternative has been developed for the general response action (GRA) of institutional controls (designated Alternative GW-2). The remedial technologies and associated process options specified for this alternative in the 100 Areas FS Phases 1 and 2 (DOE-RL 1994a) have been modified. Based on the requirement to consider only the recreational use scenario, identification of an alternate water supply for residential, industrial, or agricultural use is no longer necessary. Therefore, the institutional controls proposed to prevent access to contaminated groundwater plumes beneath the 100 Areas are as follows:

- Access restrictions
  - Deed restrictions
  - Water rights restrictions

- Monitoring
  - Groundwater monitoring.

1.2.1 Description

The institutional controls alternative for groundwater involves restricting access to contaminated sites within the 100 Areas. The restrictions included in this alternative are unique to groundwater media. Types of restrictions are defined as follows.

- Deed restrictions may be established to place limitations on groundwater use. These limitations could specify restrictions on acceptable groundwater uses and may take the form of covenants that limit activities resulting in human contact. Deed restrictions may include a prohibition on groundwater use or less stringent limitations on use for off-site farming and industrial activities.

- Water rights restrictions limit access to contaminated groundwater. The water rights restrictions could be imposed by deed restrictions, as discussed above, or by designated use, should the title to the 100 Areas remain with the federal government. Water-rights restrictions merely designate the acceptable use of 100 Areas groundwater (if at all) for recreational use, such as temporary drinking water. This action may require an additional change in water rights administration to be effective. At this time, no state water rights restrictions are necessary if consumptive use is less than 5,000 gal/day (Washington Administrative Code [WAC] 173-160-040).

In addition to restricting groundwater use and access to groundwater, the institutional action alternative also includes groundwater and environmental monitoring. Monitoring will be required to determine if and when institutional controls to restrict access to groundwater are no longer necessary.

Institutional controls are assumed to be in place during the period of DOE control. After DOE release of the site, deed and water rights restrictions can be implemented to prevent access.

1.3 ALTERNATIVE GW-3

Alternative GW-3 has been developed as a containment GRA. The objective of Alternative GW-3 is to eliminate source to receptor pathways by preventing migration of contaminated groundwater to environmental resources, such as the Columbia River, and preventing further migration of contaminated groundwater outside the operable unit. In order to achieve this objective, Alternative GW-3 is designed to isolate and contain existing contaminant plumes. Through the use of cutoff walls and extraction/injection wells, contaminant plumes would be contained to prevent migration and isolated to prevent further contamination of the unconfined aquifer. In addition to containment and isolation of contaminant plumes, this remedial action would be implemented to minimize overall effects on the general hydrologic conditions of the unconfined aquifer. The containment alternative objectives must be maintained until natural attenuation reduces concentrations to acceptable levels or until alternate cleanup standards can be negotiated and agreed upon by the parties to the Tri-Party Agreement. Contaminants that are persistent in the environment especially may require additional remedial action or determination of alternate cleanup levels.

1.3.1 Baseline Description

Alternative GW-3 was initially developed in the 100 Areas FS Phases 1 and 2 (DOE-RL 1994a). The alternative initially developed forms the baseline from which modifications are made for application to the 100-HR-3 Operable Unit. The baseline description of this alternative is based on the remedial technologies and associated process options specified in the 100 Areas FS for containment of contaminated groundwater plumes beneath the 100 Areas:

- vertical barriers:
  - cutoff walls

- hydraulic control:
  - extraction wells
  - injection wells (as necessary)

- monitoring:
  - groundwater monitoring.

1.3.1.1 Cutoff Wall Options. The baseline description of this alternative includes several subsurface barrier (cutoff wall) technologies that are potentially applicable in the 100 Areas. A cutoff wall is a subsurface barrier designed to prevent the flow of contaminated groundwater. Several cutoff wall technologies are available that may be applicable in the 100 Areas depending on site-specific conditions and requirements. Each technology has advantages and disadvantages based on the specific applications. Therefore, no one specific cutoff wall technology will be universally applicable in the 100 Areas. The cutoff wall technologies considered potentially applicable in the 100 Areas are:

- slurry wall
- deep soil mixing
- sheet piling
- injection grouting.

The specific cutoff wall technology selected to represent the containment alternative will be determined on an operable unit-specific basis. In this manner, the cutoff wall technology most applicable to operable unit site-specific conditions and requirements can be specified.

In situations where subsurface barriers may not be applicable due to technical limitations such as wall depth requirements, hydraulic control measures may be specified as the method of contaminant plume containment. Hydraulic control provides containment by extraction of contaminated groundwater from the downgradient front of the plume followed by reinjection in the upgradient portion of the plume. Continuous extraction and injection can effectively isolate contaminant plumes, but ~~are~~ is considered operating and maintenance intensive compared to vertical barriers. This method of containment would only be used in situations where the use of a subsurface barrier is not applicable. This alternative does not represent a complete solution for persistent contaminants but is consistent with the IRM approach and with the final remedy.

1.3.1.1.1 Slurry Walls. Typical slurry wall construction involves trench excavation under a slurry. The slurry provides hydraulic shoring to maintain the integrity of the trench while at the same time forming a low permeability filter cake on the trench walls that prevents fluid loss into the surrounding soil. Once a portion of the trench has been excavated to depth, a backfill material is added. In this manner, excavation and backfilling occur simultaneously until the wall is complete. The completed wall is designed to be less permeable than the surrounding native soil and thereby forms a barrier to groundwater flow.

Backfill materials commonly used in slurry wall construction include mixtures of bentonite slurry and soil, or mixtures of cement, bentonite, and water. Slurry walls constructed of soil/bentonite are generally the least permeable, least susceptible to contaminant degradation, and least expensive (Spooner et al. 1985). Slurry walls constructed of cement/bentonite are generally easier to install, provide more strength, and can be installed to greater depths (Spooner et al. 1985).

The depth of a slurry wall is dependent on the depth of the aquitard beneath the contaminant plume. To ensure effective containment of contaminant plumes, slurry walls must be keyed-in to a low permeability or aquitard zone beneath the aquifer. In the case of the 100 Areas, this aquitard may be a silty sand zone that separates the coarse sand and gravel zones in the unconfined aquifer or a paleosol/overbank deposit at the base of the unconfined aquifer. However, if contaminant plumes extend throughout the Ringold aquifers, the clay, silt, and fine sand of the Ringold lower mud unit ("Blue Clay") may be the nearest aquitard. In any case, the required depth of the slurry wall will depend on the nearest aquitard.

Filter cake formation regulates the amount of slurry lost to the surrounding soils. Formation of the filter cake depends on the permeability of the soil, pore size, type of slurry, and any additives used. In gravel beds, which allow groundwater velocities of 1 to 10 cm/sec, the pores are too large to be easily closed. Fines, such as sand, are used in these cases to assist pore space blockage. Slurries are typically mixed with up to 10% fines to assist formation of the filter cake. The Hanford formation is classified as a sandy gravelly unit with a water movement rate of about 0.1 cm/sec (DOE-RL 1993b). Generally, a bentonite/soil slurry would be chosen because of its low permeability; however, sand or other fines may be added to the slurry to increase filter cake formation. Testing must be done on the specific soil conditions to determine the need to add fines.

The equipment used for excavating slurry wall trenches is also dependent on the required wall depth and the former is limited by the maximum digging depth capabilities of the machinery. In general, long-reach type backhoe equipment can provide excavation depth up to approximately 24 m (80 ft) (Spooner et al. 1985). Draglines or clamshell excavation equipment is typically required for depths >24 m (>80 ft) (Spooner et al. 1985). The presence of large rock or boulders can present problems during the implementation phase. The potential for large boulders is reduced by placing the wall as close to the river as possible because the Hanford formation has often been eroded in this area. Most of the large boulders are associated with the Hanford formation; the Ringold Formation generally does not contain these boulders. By placing the barrier close to the river, the effectiveness is increased and the need to excavate through the Hanford formation is minimized.

Slurry preparation and placement generally requires raw material areas, mixing equipment, transport equipment, storage ponds, and cleaning equipment. Raw materials required for a slurry mixture include water, bentonite, cement (if specified), and soil (engineered if necessary). Formation of the slurries can be

accomplished with venturi (flash) mixers or paddle (vortex) mixers (Spooner et al. 1985). Storage ponds provide surge capacity for continuous application of slurry into excavation trenches. Pumps, pipes, valves, hoses, and other associated fitting and tools are required to move the slurry from mixing area to the storage pond or from storage pond to the excavation.

Backfill preparation and placement also requires raw materials storage, mixing, transport, and placement equipment. Backfilling is generally less complicated than slurry preparation and placement. Raw materials include bentonite, soil, and cement (if necessary). Mixing is generally carried out with bucket loaders or bulldozers, but can also be accomplished mechanically with a pugmill. Initial placement of backfill in the trench requires a clamshell to lower the material to the bottom. This prevents segregation of backfill particles and entrapment of slurry pockets with the backfill (Spooner et al. 1985). Thereafter, a bulldozer or bucket loader can simply push backfill into the trench.

Should future removal of the slurry wall be required, the wall can be excavated, drilled and perforated, or broken by blasting in order to allow groundwater movement through the barrier similar to initial conditions (prior to remedial action).

1.3.1.1.2 Deep Soil Mixing. Deep soil mixing is a commercially available technology for construction of vertical barriers with properties similar to slurry walls. The deep soil mixing technique uses a crane-mounted boring/mixing tool containing injection nozzles. The tool is initially driven into the soil formation to the required cutoff wall depth. The tool is then partially withdrawn (approximately half the cutoff wall depth) to begin injection of slurry material. As injection continues the tool is driven back down to the required cutoff wall depth. Injection is continued until the tool is completely withdrawn. The tool mixes the slurry and soil throughout the injection process. The slurry materials selected for injection are typically cement, bentonite, or cement-bentonite mixtures, depending on the required permeability. The cutoff wall is formed by installation of a continuous series of overlapping columns.

The primary advantage of deep soil mixing is that the technique does not require removal of contaminated soil. Mixing occurs in the subsurface without exposing workers and the environment to contaminated soil and groundwater. The technique essentially eliminates disposal requirements, handling contaminated materials, as well as worker and environmental exposures.

The operational depth of deep soil mixing is dependent on the equipment specifications and the geologic formation in which the cutoff wall is to be installed. The deep soil mixing method performs poorly in formations with boulders. The presence of large rock or boulders (>18") in the Hanford formation can present problems during implementation. Large boulders can be removed by pre-excavation or worked around by offsetting the columns. A typical deep soil mixing system requires and area of 130' x 50' to accommodate set up and tear down the crane. Operation of the system also requires an on-site support area and an adjacent equipment decontamination pad. The soil formation must be able to support the system (crane and mixing tool), approximately 15 pounds per square foot.

Removal of the deep soil mixed barrier would be accomplished in the same manner as the slurry wall.

1.3.1.1.3 Sheet Pile. Sheet piling is a commercially available technology that has been widely used for earth retaining structures such as dock walls, bulkheads, river walls, piers, and dry dock walls. The

technology has more recently become used for contaminated groundwater control as seepage cutoff walls. Sheet steel piling consists of hot-rolled steel sections provided with clutches or interlocks for connecting successive piles to one another such that a continuous wall can be formed. The sheet piles are usually driven in pairs using hammers of the double acting type or diesel hammers. The driving of each new sheet is started once the neighbor sheet has been about one-third driven. Since the sheet pile is assumed not to undergo bending moments, the anticipated soil resistance to be overcome during driving will determine the thickness of steel required in the cross section, as well as the quality of steel from which the piles should be manufactured. The interlock (or annulus) between sheet piles is completely soil tight and can be injected with a sealant (such as grout) to ensure an appropriate impermeability.

Characteristics of the geologic formation can impose some limitations in the applicability of the sheet pile technique. Splitting the web during driving is not uncommon, particularly when obstructions or dense granular soils are being penetrated. Driving sheet piles becomes difficult and often times impracticable in formations which contain large boulders. Corrosion is another factor to be taken into consideration when evaluating the use of sheet pile cutoff walls. Groundwater chemistry will have the most significant impact on corrosion of a sheet pile wall, however, a protective coating can be applied if necessary. Depth limitations exist for the sheet pile technology with walls currently extending <30 m (100 ft) in depth.

The sheet pile wall can be removed by pulling the sheets out under vibration. This process is more difficult when the joints are grouted. A sheet pile wall ~~is being~~was designed ~~and tested at~~ N Springs. Information from this application ~~should~~will be useful for the other 100 Areas groundwater operable units. ~~If this information is not available in time to meet the schedules for groundwater IRM, then additional testing of the implementability of the sheet pile wall may be necessary in conjunction with a geotechnical investigation.~~

1.3.1.1.4 Jet Grouting. Grouting technology has wide applications in engineering practice. Grout curtains are typically used as containment barriers to control seepage through dam foundations, protect excavations conducted under groundwater level, and prevent contaminant migration. Injection grouting has also been used for other engineering applications such as soil improvement, pre-stressing of rock and lifting and leveling of structures. Grout injection is a technique used to force grout into voids and fissures of a soil formation to obtain a desired property, such as reduced permeability.

Jet grouting typically involves drilling boreholes into a formation and then injecting grout under pressure until the voids around the injected section are filled to satisfy a specified design condition. The properties of the grout vary with the application, and often times a combination of different grouts are selected based on the specific characteristics of the site. Grouting consists of the following sequence of operations (Nonveiller 1989):

- drilling injection boreholes in a predetermined arrangement and depth
- preparation, proportioning, weighing and mixing of the selected grout suspension
- injecting the prepared suspension into the designated section of the borehole such that soil voids are filled.

The spacing of the injection holes is based on the results obtained from test grouting plots injected at the site. Rotary or percussion rotary drilling rigs are used for drilling the injection holes. Rotary percussion drill rigs can be used for depths up to 180 m (500 ft) with drilling speeds of 20 m/h (66 ft/h) (Nonveiller 1989). Rotary percussion is considered the most suitable drilling method in Hanford formation due to the potential for subsurface boulders.

The appropriate grouting compound for a specific project is dependent upon the characteristics and properties of the geologic formation in which the cutoff wall is to be installed. Thick cement, clay and bentonite suspensions are typically recommended for the grouting compounds used for uniform medium sand and gravel (Nonveiller 1989). Other suspensions such as clay cement, bentonite gel and clay gel are used in similar applications. Treatability studies would be required to determine the optimum grouting compound for use in the geologic formation of the 100 Areas.

The efficiency of injection grouting depends on the maximum pressure at which a grouted section of a borehole will become saturated. Low saturation pressures will permeate only a small volume of the soil whereas high pressures will cause hydrofracturing. The injection pressure must always be higher than the overburden stress at the level of injection. Formulae to calculate injection pressures are provided in literature (Nonveiller 1989).

In granular soils, the discharge of grouting decreases as the injection process takes place (at constant injection pressure). This decrease in permeability is a function of three parameters: the grain size of solids elements of the grout, the percentage of dry materials, and the state of flocculation (Winterkorn and Fang 1975). Laboratory experiments have demonstrated that slightly loaded grouts would more easily penetrate a soil than a highly loaded grout. Therefore, engineering practice shows that the cement quantity should be minimized to obtain the desired resistance into the soil. Stability of the grout can be ensured by low percentages of ultracolloidal clay (i.e., bentonite). Typical cement-bentonite grouts used to form low permeability soils will contain approximately 170 kg (374 lb) of dry materials for 1 m^3 (35 cu ft) grout.

The state of flocculation is also a parameter of concern. A stable suspension penetrates the soil more easily when it contains few grains or when the diameters of the grains is small. This means that slightly loaded grouts without any cement (i.e., clay and bentonite grout) are used for impermeability requirements. Clay or bentonite should be dispersed in the grout as elementary grains and not in flocculated form.

The total grout volume necessary is based on the void volume of the soil. However, the radius of grout flow is typically irregular and usually involves significant losses of grout into unintended areas of the formation. Permeable formations, such as Hanford formation, can result in large losses of grout if the grouting selection has not been carefully planned.

The depth limitation of injection grouting is that of the drilling and pressure unit devices. Depths of up to 200 m (656 ft) have been reported in literature (Nonveiller 1989).

The grout wall is likely the hardest to remove; the method of removal would be the same as the slurry wall and deep soil mixed barrier.

1.3.1.2 Containment System Configuration. The containment response action can be implemented in a number of different ways. The optimum number and location of cutoff walls and extraction/injection wells required to contain contaminant plumes in the 100 Areas will be determined by hydrologic modeling. Cutoff walls can be constructed to completely surround contaminant plumes; to divert uncontaminated groundwater around contaminant plumes; or to prevent migration of contaminant plumes. Extraction wells can be operated to produce an artificial gradient that stagnates movement of contaminant plumes, to intercept uncontaminated groundwater before contacting contaminant plumes, or to intercept contaminated groundwater movement around the barrier. In general, the combination of cutoff walls and extraction/injection wells will be located such that contaminated groundwater plumes are isolated and contained. All the barrier options are assumed to have expected useful lives much greater than the IRM period.

It is assumed for purposes of this FS that the containment alternative is implemented as follows: cutoff walls would be built to prevent migration of contaminant plumes; groundwater extraction wells, if necessary, would be placed to intercept contaminated groundwater at the ends of the wall; and injection wells would be placed to minimize the effects on the overall hydrologic conditions of the unconfined aquifer, if necessary. ~~The baseline concept of Alternative GW-3 is presented graphically in Figure 4-1.~~

1.3.1.3 Disposal Distances and Location. Wastes requiring disposal may result from drilling activities and/or construction of the cutoff walls. Slurry wall construction would result in generation of more significant quantities of waste than the other cutoff wall technologies. During slurry wall construction, the addition of slurry agents results in a net excess of soil. Approximately 33% of the total excavated volume for a soil-bentonite wall and up to 60% for a soil-bentonite-cement wall would require disposal (Spooner et al. 1985). To minimize the volume of contaminated soil produced, materials could be segregated so that the uncontaminated vadose zone soil would make up most of the excess soil.

Radiologically and/or chemically contaminated soils will be transported by truck or rail to the ERDF, W-025, or another site for disposal. It is anticipated that all wastes will meet ERDF waste acceptance criteria only preliminary guidelines for waste acceptance criteria have been identified in the ERDF conceptual design reports.

Liquid waste disposal is not applicable to Alternative GW-3. Although hydraulic control (extraction) wells may be used to remove groundwater to stop contaminant migration around the ends of the wall, this water would be reinjected into the aquifer in a recycle loop.

1.3.1.4 Monitoring. The containment-action alternative also includes groundwater and environmental monitoring. Monitoring will be required to evaluate the long-term effectiveness of slurry walls and provide information to base subsequent decisions regarding the continued need for containment actions.

1.4 ALTERNATIVE GW-4

A single alternative has been developed for the in situ treatment GRA (designated GW-4). The remedial technologies and associated process options selected in the 100 Areas FS Phases 1 and 2 (DOE-RL 1994a) for in situ groundwater treatment are:

- biological treatment:
  - biodenitrification (nitrates)
- physical treatment:
  - air sparging (this may be combined with soil vapor extraction (SVE) to eliminate venting organics to the atmosphere)
- monitoring:
  - groundwater monitoring.

1.4.1 Objective

The objective of Alternative GW-4 is to eliminate source to receptor pathways by in situ remediation of contaminated groundwater plumes. In order to achieve this objective, Alternative GW-4 is designed to eliminate nitrate and organic contaminated groundwater in situ. Biodenitrification and air sparging are the in situ treatment technologies specified to remove nitrate and volatile organic compound (VOC) contamination, respectively. Other in situ treatment technologies such as biodegradation may be required on a case-by-case basis to remove semi- or non-volatile organics that may also be present in contaminated groundwater plumes. It is noted here that the objective of this alternative will not be completely satisfied due to limitations in the current status of in situ remedial technologies. Currently there are no proven or innovative in situ treatment technologies capable of reducing or eliminating the health and environmental risks from metals and radionuclides.

1.4.2 System Configuration

Although nitrates are expected at each of the 100 Areas groundwater operable unit, the location of organic contamination is not as well defined. The LFI for the groundwater operable unit describes the contamination present in 100 Areas groundwater.

Air sparging and biodenitrification systems can be implemented in several different ways. Each system requires an injection well system to ensure treatment encompasses the entire plume. Extraction well systems are generally not necessary since treatment occurs below ground. However, extraction wells can be used to facilitate treatment or satisfy regulatory requirements. In situ air sparging systems can utilize extraction wells (i.e., soil vapor extraction) to prevent VOCs from venting into the atmosphere (potential regulatory requirement) or to facilitate vertical migration of volatilized contaminants. In situ bioremediation systems utilize extraction wells to facilitate effective mixing of nutrients, microbes, and contaminants.

The size and configuration of Alternative GW-4 treatment systems will be determined by the extent of nitrate and organic contamination in 100 Areas groundwater. Optimizing the number and location of treatment systems will be determined by hydrologic modeling. Optimizing operating parameters of the treatment systems will be determined by laboratory and pilot-scale testing as well as treatability studies.

1.4.3 Unit Operations

The concept of in situ treatment technologies specified for Alternative GW-4 are presented graphically in Figure B-1. Process operations, equipment requirements, and design considerations are described below.

1.4.3.1 In Situ Biodenitrification. Development and demonstration of in situ bioremediation of nitrates and carbon tetrachloride by indigenous microbes in Hanford groundwater is currently ongoing (Skeen et al. 1993). The process under development involves stimulating indigenous microorganisms to reduce nitrates to nitrogen gas during metabolization of organic carbon. To facilitate this process for remediation of 100 Areas nitrate plumes, additions of nutrients (e.g. phosphorus) and a carbon source (acetate or methanol) may be required. The denitrification process is chemically represented according to the following simplified reaction:

$$NO_3^{-1} \xrightarrow{\text{Bacterial Metabolic Process}} N_2\uparrow$$

The in situ biodenitrification process proposed involves a combination of extraction and injection wells. Placement of these wells is specified such that a closed pumping circuit is developed between extraction and injection wells. Well-to-well interaction is achieved by using one well for injection and nutrient addition and another well for extraction (Skeen et al. 1993). Extracted groundwater is transferred to a series of nutrient mixing tanks before injection back into the aquifer. The interaction between wells enhances flow and ensures proper mixing between wells (Skeen et al. 1993). Concentrations of additives required are based on pilot tests and continuous monitoring of extracted groundwater.

Equipment required for the in situ bioremediation scheme includes extraction wells, injections wells, nutrient feed tanks, mixing tanks, and associated pumps, piping, valves, monitoring and control systems. Due to the potential for leaks and spills in any hazardous liquid system, secondary containment measures may also be required in the event of an accident. Such measures could include double walled piping, berms around tanks, and overflow collection equipment.

The number and location of injection and extraction wells would be determined on the basis of hydrologic modeling. Design, installation, and operation requirements for the extraction and injection wells will be similar to standard production water wells. The primary design consideration for these wells is locating and sizing the screened area such that only that portion of the aquifer containing nitrate contamination is affected and the interaction between wells facilitates the closed pumping circuit concept described above.

Prior to injecting groundwater and additives back into the aquifer, mixing is required to ensure homogeneity. Nutrient mixing tanks utilizing mechanical agitation by a motor driven internal impeller are specified for this purpose. The specified mixing tanks operate on a continuous basis with the capability of maintaining a design residence time.

Nutrient feed can be made directly into the mixing tanks or the piping leading to the mixing tanks. Nutrient feed tanks are sized according to the required capacity of the system. A small capacity pump or gravity feed system will be required to inject nutrients at the specified location in the system.

1.4.3.2 Air Sparging. Air sparging is proposed for remediation of isolated plumes of VOC contamination in 100 Areas groundwater. This remediation technology is similar to air stripping and involves injecting air into the soil or strata below contaminated groundwater plumes. Volatile organic compounds dissolved in groundwater and adsorbed onto soils are volatilized into the gas phase as air bubbles flow upward through the water column (Hazardous Waste Consultant 1993). A crude air stripping process is developed where the soil in the aquifer acts as tower packing that maximizes water surface area contact with air. Stripped contaminants are either drawn upward and collected with a vapor extraction system or, if permissible, allowed to naturally migrate to the surface and enter the atmosphere. An additional effect of injecting air into the aquifer is that natural aerobic biodegradation may be enhanced.

Air sparging is generally most effective in coarse-grained soils. Fine-grained soils tend to require greater air injection pressures that can result in lateral rather than vertical dispersion of air (Hazardous Waste Consultant 1993). Air movement in heterogeneous soils will follow the path of least resistance and can therefore short circuit the intended area of influence. The potential effects of short circuiting include missing target contamination due to vertical channeling and/or horizontal migration of contamination (Hazardous Waste Consultant 1993).

An additional concern involves the heterogeneity of vadose zone soils which range in particle size from boulders to silt. The heterogeneity of vadose zone soils may prevent effective natural migration of stripped VOC to the surface for venting to the atmosphere. Potential for horizontal channelling may result in contaminant migration without venting to the atmosphere. To eliminate this potential, installation of a soil vapor extraction system is required with well screens located just above the saturated zone. The vapor extraction system will capture volatilized contaminants before lateral migration in the vadose zone can occur.

The number, location, and spacing of injection and extraction wells will be determined on the basis of modeling and pilot tests. Pilot tests are used to determine the radius of influence of injection and extraction wells within the subsurface of the area of contamination. In general, the radius of influence is larger in highly permeable soils and smaller in low permeability soils (Hazardous Waste Consultant 1993). To ensure effective contaminant removal, injection and extraction wells are spaced such that the radius of influence of each system is overlapping.

There are four types of well configurations used for in situ air sparging: spaced wells, nested wells, horizontal wells, and combined horizontal/vertical wells (Hazardous Waste Consultant 1993). The spaced well configuration is most common and involves the use of independent vertical wells to perform extraction and injection. The nested well configuration involves the use of a single vertical borehole to perform both

injection and extraction. The horizontal well configuration utilizes horizontal drilling techniques or trenching to install injection and extraction wells. Combined horizontal/vertical wells uses a combination of both vertical and horizontal wells to perform injection and extraction. The configuration best suited for remediation of 100 Areas sites must be determined on a case-by-case basis.

Equipment requirements for the proposed in situ air sparging system include an extraction/injection well network, vapor abatement system (if necessary), air compressor or blower, vacuum pump, and associated piping, valves, monitoring and control equipment. The compressor or blower size is typically based on a design maximum expected flow rate and pressure. Each injection well requires pressure measurement and regulation controls to maintain the design operating conditions. Typical well construction materials include metal or PVC piping. Injection well screens are generally 0.3 to 1 m (1 to 3 ft) in length and must be properly sealed to prevent air flow into the borehole (Hazardous Waste Consultant 1993). Due to the elevated temperature of air leaving the compressor, steel and/or rubber air hose is recommended for the pressurized air distribution system (Hazardous Waste Consultant 1993). Captured vapor will be released to the atmosphere unless an abatement system using carbon adsorption, thermal treatment, or chemical oxidation is used.

In situ air sparging may artificially elevate the water table. This effect should be considered if floating free product is present or if elevating the water table would impact the direction of plume migration.

1.4.3.3 Groundwater Monitoring System. Post-treatment monitoring of nitrate and organic contaminant plumes will be necessary to ensure that established remediation levels have been satisfied. The number and location of monitoring wells required will be determined based on contaminant distribution. Monitoring well design, equipment requirements, and installation are unique due to periodic use and the necessity to obtain representative groundwater samples.

Monitoring wells are typically operated at low, intermittent pumping rates and therefore require much smaller pumps than production-type extraction wells. Wells will be installed to ensure that samples taken are representative and do not include contaminants resulting from materials used for well installation. Also of concern is potential interactions between construction materials and the groundwater being sampled. The design of monitoring wells therefore must specify construction materials that are inert to the chemistry of groundwater being sampled.

1.4.4 Disposal Distances and Location

Wastes requiring disposal include well drilling and construction wastes and vapor treatment wastes. All other treatment processes are in situ treatment techniques, thereby eliminating any other disposal requirements.

1.5 ALTERNATIVE GW-5

Alternative GW-5 has been developed as a removal, treatment, and disposal GRA. The remedial technologies and associated process options that comprise this alternative were initially specified in the 100

Areas FS Phases 1 and 2 (DOE-RL 1994a). Based on review of additional information (LFI, 100 Areas aggregate studies, treatability testing, and refined RAO), no modifications to this alternative are required. Therefore, the remedial technologies and associated process options are as initially developed:

- removal:
  - extraction wells
- biological treatment:
  - biodenitrification (nitrates)
- chemical treatment:
  - chemical oxidation (organics)
  - precipitation (heavy metals and radionuclides)
  - chemical reduction (hexavalent chromium)
- physical treatment:
  - filtration (remove precipitates and suspended solids)
  - ion exchange (polishing for removal of any remaining ionic contaminants)
- stabilization/solidification:
  - cement-based solidification (secondary waste streams)
- liquid disposal:
  - river discharge or reinjection into an aquifer
- solids disposal:
  - ERDF, W-025, or another site
- monitoring
  - groundwater monitoring.

1.5.1 Objective

The objective of Alternative GW-5 is to contain the contaminant plumes from reaching the river or migrating outside the operable unit and to eliminate source to receptor pathways by removing, treating, and disposing of contaminated groundwater. Alternative GW-5 is designed to remove contaminant plumes from the unconfined aquifer; treat contaminated groundwater to the levels established by remedial action goals; isolate and dispose treatment residuals from the accessible environment; and reinject treated groundwater into the unconfined aquifer or discharge it to the river.

1.5.2 Size and Configuration

Several options are available for implementing groundwater treatment, including a single treatment facility for all contaminated groundwater within the 100 Areas or separate treatment facilities for each groundwater operable unit. Although past practices at the 100 Areas reactor sites may have resulted in the same contaminants being released to the environment, sampling and analysis indicates the concentrations of contaminants in each operable unit are not the same. Therefore, separate treatment facilities at each operable unit are considered to prevent cross-contamination and enable tailoring treatment systems to specific COC at each operable unit.

Pump and treat alternatives have variable life cycles depending on remediation goals and technology performance for specific sites, i.e., the system can run until goals are met or until the technology limitations are met.

1.5.3 Unit Operations

Figure B-2 is a conceptual flow diagram of the unit operations proposed for Alternative GW-5. Each unit operation, equipment requirements and options, and design considerations are described below.

1.5.3.1 Groundwater Extraction System. The belowground portion of the groundwater extraction system will consist of a series of extraction wells. The extraction wells proposed for removing contaminated groundwater from beneath the 100 Areas will be similar to standard production-type water wells used for domestic and industrial applications. The number and location of extraction wells required for each contaminant plume will be determined by hydrologic modeling.

An extraction well consists of vertical borehole tapping the contaminated aquifer. The depth of the well is determined by the vertical extent of contamination and the characteristics of the aquifer. Casing materials would conform to DOE and state requirements for well completion. The casing serves to maintain the borehole integrity and support the pumping mechanism. The well casing is grouted into place so it will not be a conduit for the downward migration of additional contamination.

Extraction wells should be completed using stainless steel, continuous wire-wrapped well screens. The screen prevents sediment uptake and provides support for loose formation material (Driscoll 1986). The screen slot size is specifically designed for the aquifer materials to minimize entrance velocity and prevent the influx of aquifer fines after development. The screened interval of the well must be developed following installation and before it is used for remediation. Development consists of optimizing the flow characteristics of the well screen/aquifer interface by the removal of aquifer fines through surging, over-pumping, or other means.

Any commonly available well pump may be used for extraction of contaminated groundwater. Selection of pump type and power are determined by the response of the aquifer to pumping, the movement of

contaminants and the capacity of the remediation system. Typical systems, in order of decreasing capacity and/or pumping depth capability, include:

- line-shaft turbines
- submersible turbines
- jet
- centrifugal
- positive displacement
- peristaltic.

Centrifugal and peristaltic pumps are generally not applicable for suction (i.e., inlet) lifts exceeding 6 m (20 ft) (Driscoll 1986).

The above-ground portion of the groundwater extraction system will consist of a piping network that connects each extraction well to a manifold. From the manifold a single pipeline will bring contaminated groundwater to a storage tank near the treatment area. The storage tank will allow flow equalization and settling of suspended solids that may interfere with subsequent treatment operations. The piping system will be of double-walled construction to ensure leak protection. A single-walled, above-ground storage tank is specified with secondary containment provided by an engineered berm. Pumps, valves, sampling, and monitoring equipment will be specified as needed for the capacity and requirements of the system.

1.5.3.2 Chemical Oxidation System. Chemical oxidation is the initial unit operation proposed for destruction of organic contamination in 100 Areas groundwater. Groundwater and reagents, such as hydrogen peroxide and ozone, are pumped into a process vessel where organic contaminants are oxidized (the reaction may be enhanced by ultraviolet light). A simplified reaction (for a hydrocarbon) of this process is:

$$C_xH_y + H_2O_2/O_3 \xrightarrow{uv} xCO_2\uparrow + \frac{y}{2}H_2O$$

Groundwater entering the chemical oxidation system is filtered to remove suspended solids. Two cartridge filters arranged in parallel are specified for this application to allow for continuous operation during maintenance or filter replacement. After filtration the oxidizing reagent is combined with the groundwater and passed through a static mixer to ensure the feed into the oxidation reactor is homogeneous. A static mixer is selected for this application for simplicity, as such a unit has no moving parts and requires no maintenance or operating costs.

Once the groundwater and reagents have been combined, the mixture is fed into the oxidation reactor vessel. Inside the reactor this mixture is exposed to ultra violet lamps that catalyze the oxidation process. Organic contaminants are oxidized to form carbon dioxide and water (assuming 100% reaction efficiency).

A hydrochloric acid scrubber is required if chlorinated organics are present[3]. An acid or base may be required to adjust pH before and after the oxidation reactor to optimize the efficiency of oxidizing organic contaminants (EPA 1993).

1.5.3.3 Precipitation System. Following chemical oxidation, chemical precipitation is proposed to remove radionuclides and heavy metals. In general, metal contaminants can be precipitated from solution as hydroxides, sulfides, carbonates, or other insoluble salts (EPA 1987). Common precipitation reagents include lime, caustics such as sodium hydroxide, sulfides such as sodium bisulfide, ferrous sulfide, calcium carbonate, and sodium carbonate (Corbitt 1990). However, because contaminant concentrations are so dilute, most of the precipitating species will consist of common water minerals. Common methods for precipitation involve addition of precipitation reagents or pH adjustment.

Specification of precipitation reagents and pH is contaminant dependent. A precipitation reaction resulting in the formation of an insoluble form of strontium-90 occurs as described by the following simplified reaction:

$$^{90}Sr + CO_3 \rightarrow {}^{90}SrCO_3\downarrow$$

A conceptual chemical precipitation process consists of a mixing tank, a reagent feed system, and a clarifier tank. Associated piping, pumps, valves, and monitoring and control equipment complete the equipment requirements. The process stream and precipitation reagents are combined in a continuously stirred continuous flow (CSCF) reactor vessel. The mixture is then pumped to the clarifier tank where the resulting insoluble salts are separated from the process stream as a concentrate. The process stream or overflow from the clarifier is then pumped to chromium reduction process.

The concentrate from the CSCF reactor is pumped to a rotary drum filter for dewatering. A filtration media such as diatomaceous earth is added to the concentrate to facilitate the filtration process. The resulting filter cake is collected and transported to the solidification system. The liquid effluent from dewatering is combined with the process stream from the clarifier for subsequent treatment in the chromium reduction process.

1.5.3.4 Chromium Reduction System. Following chemical precipitation unit operations, chromium reduction is proposed to reduce hexavalent chromium. Hexavalent chromium can be reduced from the soluble hexavalent state to the less soluble trivalent state (pH ≤ 3) and precipitated under basic conditions (pH of 8 to 9) (Corbitt 1990). Chromium may also be reduced by reaction with reagents such as sulfur dioxide, sulfite salts (such as sodium metabisulfite), and ferrous sulfate (Corbitt 1990). Hexavalent chromium can be reduced by reacting with sulfur dioxide and then precipitated as a hydroxide according to the following reactions:

[3]Hydrochloric acid is a byproduct of oxidation of chlorinated organics.

$$Cr_2O_7^{2-} + 6Fe^{2+} + 6SO_4^{2-} + 14H^+ \rightarrow 2Cr^{3+}(SO_4^{2-})_3 \downarrow + 6Fe^{3+}$$

The chemical reduction process is similar to the chemical precipitation process described previously. Separate process equipment is required to perform chemical reduction because of the conditions and reagents under which the required reaction occurs. The process stream, reducing agent, and precipitation reagent are combined in a CSCF reactor vessel. The mixture is then pumped to the clarifier tank where the resulting insoluble salt is separated from the process stream as a concentrate. The process stream or overflow from the clarifier is then pumped to the biodenitrification system.

The concentrate from the CSCF is pumped to a rotary drum filter for dewatering. A filtration media such as diatomaceous earth is added to the concentrate to facilitate the filtration system. The resulting filter cake is transferred to the solidification process to be prepared for disposal. The liquid effluent from dewatering is combined with the process stream from the clarifier for subsequent treatment in the biodenitrification system.

1.5.3.5 Biodenitrification System. Following chemical reduction, biodenitrification is proposed to reduce nitrates to elemental nitrogen. The growth of microorganisms is dependent on the availability of nutrients and a carbon source (Corbitt 1990). In the denitrification process, bacteria use nitrates as an electron acceptor. Denitrification occurs according to the following simplified reaction:

$$NO_3^{-1} \xrightarrow{\text{Bacterial Metabolic Process}} N_2\uparrow$$

The biodenitrification treatment process requires a feed system, reactor vessel, clarifier, and monitoring and control equipment (Brouns et al. 1991). Piping, pumps, and valves are required as needed for the capacity requirements of the system.

The feed system adds nitrate contaminated groundwater plus a carbon source, such as acetate or methanol, into a reactor vessel. Depending on the type of bioreactor, recycling biomass or growth of the original culture will preclude the need for addition of bacteria. Off-gas chemistry, pressure, temperature, and pH are monitored to control the denitrification process.

Bioreactors are generally classified into two categories: suspended-growth systems and fixed-growth systems (Corbitt 1990). Suspended-growth systems, such as a continuously stirred-tank bioreactors (CSTR), or fixed-growth systems, such as a fluidized-bed bioreactors (FBR), can be used for denitrification applications (Brouns et al. 1991). The CSTR vessel mixes contaminated groundwater with suspended biomass to maximize contact between contaminants and microorganisms. The FBR vessel contains biomass attached to a support media, such as anthracite coal. Contaminated groundwater passes through the support media where nitrate contaminants contact microorganisms.

Effluent from the reactor vessel is sent to a settling tank. In the case of the CSTR, suspended biomass is removed for recovery and recycled back into the reactor. The settling tank clarifies the effluent for subsequent processing in the ion exchange process.

1.5.3.6 Ion Exchange System. Following biodenitrification, ion exchange is proposed to remove radionuclides not readily precipitated (either by pH adjustment or by redox), such as cesium-137 and technetium-99. The ion exchange process is the final unit operation applied to contaminated groundwater prior to reinjection into an aquifer. Both cation and anion exchange resins are proposed to ensure removal of any contaminants that may still remain in trace concentrations. The proposed ion exchange process consists of media filtration followed by separate cation and anion exchange columns, and a resin regeneration loop.

The performance of ion exchange resins will be impaired by the presence of suspended solids, bacteria, colloids, or oily materials in the feed stream (Corbitt 1990, Moghissi et al. 1986). Therefore, the process design specifies that the feed stream is filtered prior to entering the exchange columns. Two cartridge filters arranged in parallel are specified for this application to allow for continuous operation during maintenance or filter replacement. Pressure monitoring equipment is required to identify when replacement is necessary due to particulate loading.

The proposed ion exchange design will utilize a separate-bed system as opposed to a mixed-bed system in order to facilitate resin regeneration. The separate-bed system involves two vessels arranged in series. The first vessel containing the cation exchange resin and the second vessel containing the anion exchange resin. The separate-bed system is preferred for removing specific radionuclides (Moghissi et al. 1986). Similar to the cartridge filter design, two separate-bed systems may be arranged in parallel to allow for continuous operation during maintenance, regeneration, or resin replacement.

Specification of ion exchange resins for this process will depend on the type of contaminants to be removed, the contaminant concentration remediation levels, and the presence of other ions in the feed stream that may interfere with the efficiency of removing contaminants (Corbitt 1990). There are four general types of ion exchange resins that include strong- and weak-acid cation resins and strong- and weak-base anion exchange resins (Corbitt 1990). Ion specific exchange resins are available for isotopes of Cs^{+}, Co^{+2}, Sr^{+2}, and Mn^{+2} (Moghissi et al. 1986). Ion-selective exchange resins can be used to remove any one or more these specific contaminants. Selective resins are typically zeolite and glass-based materials. The primary benefit of ion-selective exchange resins is a reduction in the amount of resin spent on removing ions from the process stream that are not of concern.

Strong-acid cation and strong-base anion exchange resins have a low regeneration efficiency (Moghissi et al. 1986). Therefore, regeneration of these resins can result in large quantities of regenerative waste. Conversely, weak-acid cation and weak-base anion exchange resins can be regenerated with near stoichiometric quantities of regenerants (Moghissi et al. 1986). Another option is a chabazite zeolite cation exchange resin. The zeolite resin is nonregenerable and would be discarded after loading. The benefit from using the zeolite resin is that it is not regenerated and thus no liquid regeneration wastes are generated. The only waste product is the contaminated solid zeolite. These once-through zeolites are economical because the secondary waste is a solid waste rather than a liquid waste which must be further processed (at considerable additional cost).

~~A regeneration loop is included in the ion exchange process to maximize the life of the ion exchange resins. A design variation may avoid regeneration by specifying disposal of spent resins (e.g., chabazite zeolite); however, regeneration is assumed in this application for conservatism. Monitoring the conductivity of the effluent from each ion exchange vessel will identify when the resins will require regeneration. Regeneration is accomplished by stripping contaminant ions from exhausted resin beds with concentrated acid, caustic, or other reagent solutions. In this process, contaminant cations are replaced with innocuous cations, such as hydronium (H^+), and contaminant anions are replaced with innocuous anions, such as hydroxide (OH^-) (Corbitt 1990). The equipment requirements to perform regeneration include acid and caustic storage tanks, regenerative waste storage tank, and any associated piping, pumps, valves, and monitoring equipment.~~

~~The regeneration loop results in secondary liquid waste requiring solidification prior to disposal. Therefore, liquid regenerative wastes will be sent to a cement based solidification process.~~

1.5.3.7 Cement-Based Solidification System. Cement-based solidification is proposed for all liquid-, sludge-, or slurry-type waste streams generated as a result of treating contaminated groundwater prior to disposal. Secondary waste streams such as spent ion exchange resins may or may not require solidification prior to disposal depending on the requirements of the ERDF waste acceptance criteria. The secondary waste streams generated from each treatment process are summarized in Table B-1.

Cement is the most commonly used material for solidification of radioactive wastes (DOE 1988). The types of cement used for waste solidification are Portland cement, masonry cement, and gypsum (DOE 1988). Special additives have been developed to enhance the capabilities of cement-based solidification such as waste loading, contaminant leachability, compressive strength, and setting characteristics.

Filter cake, ion exchange resins, and decontamination solutions are compatible with cement-based solidification (DOE 1988). However, cement-based solidification of each secondary waste stream generated from treatment of 100 Areas groundwater is likely to require development of separate recipes or formulations. Differences in cement formulations may require separate solidification systems for each secondary waste stream or batch processing each secondary waste stream separately. The equipment requirements for cement-based solidification depend on pretreatment requirements, physical form, and waste volume.

Pretreatment such as pH adjustment of liquid wastes may be required. Resin regenerative wastes may require addition of an acid or caustic for pH adjustment prior to solidification. The physical form of secondary wastes will influence equipment specifications for items such as piping, pumps, and storage tanks for liquids. Conveying equipment and storage bins or silos may also be required.

The volume of secondary wastes generated will be used to determine whether solidification can be accomplished directly within containers or whether larger more complex mixing equipment is required. In-container mixing processes are generally applicable to small volume waste streams. These processes involve simply adding cement and waste (in predetermined proportions) directly into the disposal container and mixing. Mixing can be accomplished by placing a mixing weight into the container, sealing the container, and then using a drum tumbler or shaker until the contents are thoroughly mixed. Motor driven

mixing rods are available in which the mixing rod can be either reused or simply left in the container (DOE 1988).

Large volume waste streams require mixing waste and cement in large vessels. This type of system consists of storage tanks for liquid wastes, feed hoppers for solid wastes and dry materials such as cement and additives. Waste, cement, and water (if necessary) are combined in larger mixing vessels. The resulting mixture is then metered and fed into disposal containers. This type of solidification process enables continuous processing or may be used on a batch-type basis.

Secondary waste streams which do not require solidification in cement, such as filter cartridges, will be packaged directly into disposal containers and transported to ERDF.

1.5.4 Disposal Distances and Location

1.5.4.1 Liquid Disposal. Treated groundwater is the only liquid effluent generated by this alternative and it will be discharged to the Columbia River or reinjected to the aquifer. The treatment train described above treats the groundwater for every contaminant except tritium (no practicable treatment is currently available for tritium). The tritium levels in most plumes in the 100 Areas are already below the MCL, thus the water can be discharge directly to the river. However, if tritium levels in the effluent exceed the MCL, then the effluent cannot be discharged to a surface water (i.e., it doesn't meet drinking water standards).

Effluent contaminated by tritium above the MCL will be reinjected into the groundwater. This establishes an extraction/injection loop which allows time for natural radioactive decay of the tritium. The injection point can be chosen such that the travel time to the river is sufficient for the tritium to radioactively decay below the MCL before reaching the river. Both river discharge and reinjection process options are discussed below.

1.5.4.1.1 River Discharge. The treated water will be collected in a surge tank to determine if is below MCL for the contaminants. If so, the treated water will be directed to the river via a buried gravity flow pipeline. It is assumed that the flow would be routed via an existing river outfall (such as 009 in the 100 N Area) or a new outfall. An analysis of the condition of existing pipelines and outfalls would be required prior to implementation.

River discharge may require an National Pollutant Discharge Elimination System (NPDES) permit. Although some outfalls have been operating under existing NPDES permits, additional permitting requirements, if any, have not yet been established for river disposal of treated water. Establishing permitting requirements would require discussions with regulators. In addition, the Tri-Party Agreement Milestone M-17 requiring cessation of liquid effluent discharges by 1995 may affect treated water disposal options.

1.5.4.1.2 Reinjection System. Following treatment, effluent with tritium levels above MCL is to be reinjected into the aquifer beneath the 100 Areas. The number and location of injection wells will be determined on the basis of hydrologic modeling and required flow rates. Design, installation, and equipment requirements for such an injection system will similar to the equipment described previously for

extraction wells. Treated groundwater will be pumped in a single pipeline. At the injection point, a manifold will be used to feed the treated groundwater to each injection well.

The primary design considerations involved with injection wells are efficiency and well life (Driscoll 1986). The efficiency of an injection well is dependent on the selection and location of the screen. The well screen should be located in the area of the aquifer and/or vadose zone that has the greatest hydraulic conductivity. Screen openings should be as large as possible such that treated groundwater can enter the formation without excessive pressure build-up. Material selection can be an important consideration for ensuring adequate well life. However, due to the quality of treated groundwater exiting the ion exchange process, this should not be a major concern.

1.5.4.2 Disposal of Solidified Residues. Solid wastes generated as a result of treating contaminated groundwater are disposed in the ERDF (approximately 9 miles from the 100 Areas). Solidified waste is transported by truck for disposal. Radioactive and mixed secondary waste will meet ERDF acceptance criteria.

1.5.5 Groundwater Monitoring

Post-treatment monitoring of 100 Areas groundwater will be necessary to ensure that established remediation levels have been satisfied and additional sources of contamination are not discovered. The number and location of monitoring wells required will be determined based on contaminant distribution. Monitoring well design, equipment requirements, and installation were described previously under Alternative GW-4.

1.6 ALTERNATIVE GW-6

Alternative GW-6 has been developed as a removal, treatment, and disposal general response action. The remedial technologies and associated process options initially specified for this alternative in the 100 Areas FS Phases 1 and 2 (DOE-RL 1994a) have been significantly modified. The biodenitrification and ion exchange processes initially specified have been determined to be redundant and no longer necessary. This determination is based on the capabilities of reverse osmosis for removing contaminants applicable to biodenitrification and ion exchange treatment. Based on these modifications, Alternative GW-6 now consists of the following remedial technologies and associated process options:

- removal:
  - extraction wells

- physical treatment:
  - air stripping/carbon adsorption (organics)
  - filtration (remove suspended solids)
  - forced evaporation (for volume reduction prior to solidification)
  - reverse osmosis (high molecular weight inorganic contaminants)

- stabilization/solidification:
  - cement-based solidification (secondary waste streams)

- liquid disposal:
  - crib disposal

- solids disposal:
  - ERDF, W-025, or another site

- monitoring
  - groundwater monitoring (100 Areas groundwater).

1.6.1 Objective

The objective of Alternative GW-6 is identical to that described previously for Alternative GW-5. Source to receptor pathways are to be eliminated by complete removal, treatment, and disposal of contaminants in the 100 Areas. Alternative GW-6 satisfies this objective in the same manner as Alternative GW-5 except for the methods of treatment. Alternative GW-6 is designed to remove contaminant plumes from the unconfined aquifer; treat contaminated groundwater to the levels established by remedial action goals; isolate and dispose treatment residuals from the accessible environment; and dispose treated groundwater by reinjection to the unconfined aquifer or to the river.

1.6.2 Size and Configuration

Alternatives GW-6 and GW-5 are similar in that both alternatives are developed as removal, treatment, and disposal general response actions. The primary difference between these alternatives is the treatment technologies specified to achieve RAO. The aspects of alternative GW-6 that are differ from alternative GW-5 are summarized below:

- biological treatment - no biological treatments are specified in GW-6
- chemical treatment - no chemical treatment are specified in GW-6
- physical treatment - only physical treatments are specified in GW-6
- disposal - crib disposal as an option to injection or river disposal.

The primary components of the unit operations required for alternative GW-6 are presented schematically in Figure B-3.

1.6.3 Unit Operations

Figure B-4 is a conceptual flow diagram of the unit operations proposed for Alternative GW-6. As noted previously, the biodenitrification and ion exchange unit operations initially specified for this alternative in the 100 Areas FS Phases 1 and 2 (DOE-RL 1994a) are no longer included. In addition, the location within

the treatment train initially specified for the evaporator has also been changed. Since operable unit-specific treatment processes are being considered as opposed to a single 100 Areas treatment facility, the primary purpose of the evaporator has changed from volume reduction of groundwater entering the treatment system to volume reduction of liquid effluent from the reverse osmosis process. Unit operations, equipment requirements and options, and design considerations are described below.

1.6.3.1 Groundwater Extraction System. The groundwater extraction system proposed for Alternative GW-6 is identical to the system described for Alternative GW-5. Refer to the description presented previously for Alternative GW-5 for details.

1.6.3.2 Air Stripping/Carbon Adsorption. Air stripping followed by carbon adsorption is the initial series of unit operations proposed in this alternative for treating 100 Areas groundwater. This process removes low concentrations of VOC from contaminated groundwater. Due to the extent and type of organic contamination in 100 Areas groundwater, the process would be required only on an as needed basis. Air stripping is generally applicable to dilute aqueous wastes with VOC concentrations less than approximately 100 mg/L (Freeman 1989). The VOC are removed from groundwater by countercurrent gas-liquid desorption. Once removed from the groundwater, VOC can then adsorbed onto activated carbon.

Groundwater entering the process is filtered to remove suspended solids. Two cartridge filters arranged in parallel are specified for this application to allow for continuous operation during maintenance or filter replacement. After filtration, groundwater is pumped to the air stripper.

Several air stripper designs are currently available, however, the most common or conventional air strippers are vertical towers filled with a packing media. In this design contaminated water enters the top of the tower and falls by gravity through the packing media to a collection sump. Simultaneously, uncontaminated air enters from the bottom of the tower and is discharged at the top. The packing media maximizes the liquid surface area exposed to air flowing countercurrent to the liquid. Depending on water quality, packed-tower air strippers can be susceptible to fouling from scaling or solids deposition.

Newer designs involve low-profile air strippers which are essentially diffused aerators that bubble air up through a chamber filled with contaminated water (Reese 1992). Low-profile air strippers offer several advantages over conventional packed-tower designs: reduced potential for fouling; less maintenance requirements; and higher efficiency at lower contaminant concentrations. However, the low-profile design uses higher air/water ratios that require higher horsepower blowers and result in increased off-gas volume requiring treatment.

Liquid effluent from the air stripper is pumped to the reverse osmosis system for inorganic contaminant removal while VOC laden off-gas is treated in carbon adsorption units. Two carbon beds in parallel are placed in series with one polishing carbon bed for removing VOC from the air stripper off-gas. Vapor phase carbon adsorption beds are available in disposable canisters or larger reusable vessels. Large activated carbon beds can be regenerated or disposed once saturated with contaminants. Treated air is discharged to the atmosphere.

1.6.3.3 Reverse Osmosis System. Following the organics treatment system, reverse osmosis is proposed to remove soluble inorganic contaminants, especially those of higher molecular weight. Reverse osmosis is a cross-flow membrane separation process that purifies contaminated water by application of high pressure which forces pure water through a semipermeable membrane, but leaves the contaminants in a concentrated waste stream (EPA 1987). The process is commercially available and highly effective for purifying water containing dissolved ions and radionuclides. However, a chief disadvantage is the generation of a substantial volume of secondary liquid waste that must be volume reduced and solidified prior to disposal.

Reverse osmosis membranes are typically either spiral wound into a cylindrical configuration or are fabricated into hollow fibers. The membranes provide a pore size in the range of one to ten angstroms (0.0001 - 0.001 microns). There are essentially three types of reverse osmosis membranes: cellulose acetate, aromatic polyamides, and thin-film composites (Freeman 1989). The thin-film composite type membranes are generally considered to be the most effective.

An reverse osmosis system may consist of three separate components. The first component in the system provides pretreatment of the feed stream to comply with the reverse osmosis membrane manufactures specifications. The second component is the reverse osmosis treatment vessel which, depending on the final system design, may consist of multiple reverse osmosis vessels. The third component provides post-treatment to the purified effluent to meet reuse standards or to prepare for additional treatment. The third component is not considered applicable to this system as any treatment required for additional unit operations will be considered pretreatment for that particular system.

Pretreatment requirements are based on the type and manufacturer of the reverse osmosis membrane specified and the condition of the feed stream. If necessary, pretreatment will maximize reverse osmosis membrane operating efficiency and reduce the potential for fouling. Pretreatment requirements may include (Porter 1990, Freeman 1989, Moghissi et al. 1986):

- elimination of suspended solids 1 micrometer or larger
- pH adjustment to between 4 and 6
- addition of precipitation inhibitors
- removal of oxidizing compounds
- elimination of organic contaminants
- temperature elevation.

The reverse osmosis portion of the system consists primarily of a high pressure pump, reverse osmosis module (containing the reverse osmosis membrane), piping, valves, and control and monitoring equipment. The high pressure pump pressurizes feed water to above osmotic pressures such that the reverse osmosis phenomenon occurs. The reverse osmosis module contains the membrane packaging and is categorized into four possible designs: plate and frame, spiral-wound, tubular, and hollow fine fiber (Porter 1990). The tubular design reverse osmosis module is least susceptible to fouling, has the highest tolerance to suspended solids, and has the possibility of mechanical membrane cleaning (Porter 1990).

1.6.3.4 Evaporation System. Following the reverse osmosis process, forced evaporation is proposed to reduce the volume of reverse osmosis concentrate requiring cement solidification. Depending on the type of evaporation system specified, concentrations of up to 50% total solids can be achieved (DOE 1988).

Evaporation technology has been used for liquid radioactive waste treatment for several decades (Moghissi et al. 1986). The evaporation process involves the use of heat to vaporize water, thereby leaving a concentrated solution containing nonvolatile contaminants. The resulting concentrated solution requires additional treatment while vaporized water is simply condensed and sent for disposal.

Evaporators generally fall into one of two categories, either natural circulation or forced circulation. Natural or forced refers to the way in which liquid waste is circulated through the heat exchanger and vapor body. Natural circulation evaporators include rising-film and fixed-film types. Forced circulation evaporators include evaporative crystallizer, wiped-film, and extruder types. The evaporative crystallizer is the most commonly used evaporator for radioactive waste applications (DOE 1988).

Forced circulation evaporators have proven to be more effective in concentrating solids than natural circulation evaporators (DOE 1988). In addition, forced circulation evaporators allow separation of the heat transfer, vapor-liquid separation, and crystallization functions (Moghissi et al. 1986), thereby facilitating maintenance operations.

Evaporator energy requirements can be substantially reduced by recycling heated vapor generated by the evaporator back into the heat exchanger to facilitate evaporation of additional feed waste. Not only is the energy stored in the steam reused to heat feed waste, but the need for a condenser is eliminated. This process is commonly referred to as vapor recompression. Vapor recompression can reduce energy consumption by up to 80% (DOE 1988).

The evaporation system specified for application to Hanford 100 Areas groundwater is the forced circulation, evaporative crystallizer with mechanical recompression. Due to the low capacity of typical evaporators, multiple evaporators may be required. Each evaporator system consists of a heat exchanger, vapor body (or flash chamber), recirculation pump, entrainment separator, and condenser (or compressor for recompression). Associated piping, valves, feed and effluent pumps, and control and monitoring equipment will be required as needed.

Concentrate from the evaporator is fed to a rotary vacuum drum filter for dewatering. A filtration media such as diatomaceous earth is added to the concentrate to facilitate the filtration process. The resulting filter cake is collected in a hopper which can be transported with industrial equipment such as a forklift to the solidification system. Liquid effluent from the rotary drum filter is recirculated back into the feed stream entering the reverse osmosis system.

1.6.3.5 Cement-Based Solidification System. As described previously for Alternative GW-5, cement-based solidification is proposed for liquid-, sludge-, or slurry-type waste streams generated as a result of treating contaminated groundwater (see Table B-2). Solidified wastes will be transported to the 200 Area for disposal. The secondary waste streams generated from each treatment system are summarized as follows:

The secondary waste streams generated by the treatment systems proposed for Alternative GW-6 are similar to those generated from the Alternative GW-5 treatment systems. Those secondary waste streams unique to Alternative GW-6 include fouled packing material from the air stripping tower, spent activated carbon beds, and fouled reverse osmosis membranes from the carbon adsorption units. Secondary waste streams in solid

form such as filter cartridges, air stripper packing material, spent carbon, and fouled reverse osmosis membranes, will generally be packaged directly into containers suitable for disposal. However, if solidification is required for any of these materials (based on ERDF requirements), size reduction may be necessary to ensure complete encapsulation in cement.

The cement solidification system and materials described previously for Alternative GW-5 would be identical to the cement solidification system requirements for this alternative. In general, the applicable secondary waste streams will be pretreated (if necessary), mixed with cement, and placed in Department of Transportation (DOT) approved containers. After the appropriate curing time has elapsed, solidified wastes will be transported by truck to the ERDF, W-025, or another site for disposal.

1.6.4 Disposal Distances and Location

1.6.4.1 Liquid Disposal. Disposal of liquid effluents generated by implementation of Alternative GW-6 is nearly identical to the previous discussion for Alternative GW-5. Surface discharge into cribs is specified for Alternative GW-6 as opposed to the reinjection/river discharge technique specified for Alternative GW-5.

1.6.4.2 Disposal of Solidified Residues. Disposal of solidified waste generated by implementation of Alternative GW-6 is identical to the previous discussion for Alternative GW-5.

1.6.5 Groundwater Monitoring

As described previously in Alternative GW-5, post-treatment monitoring of 100 Areas groundwater will be necessary to ensure that established remediation levels have been satisfied and additional sources of contamination are not discovered. The number and location of monitoring wells required will be determined based on contaminant distribution. Monitoring well design, equipment requirements, and installation are the same as described previously in Alternative GW-4.

Figure B-1. Conceptual In Situ Treatment Alternative GW-4.

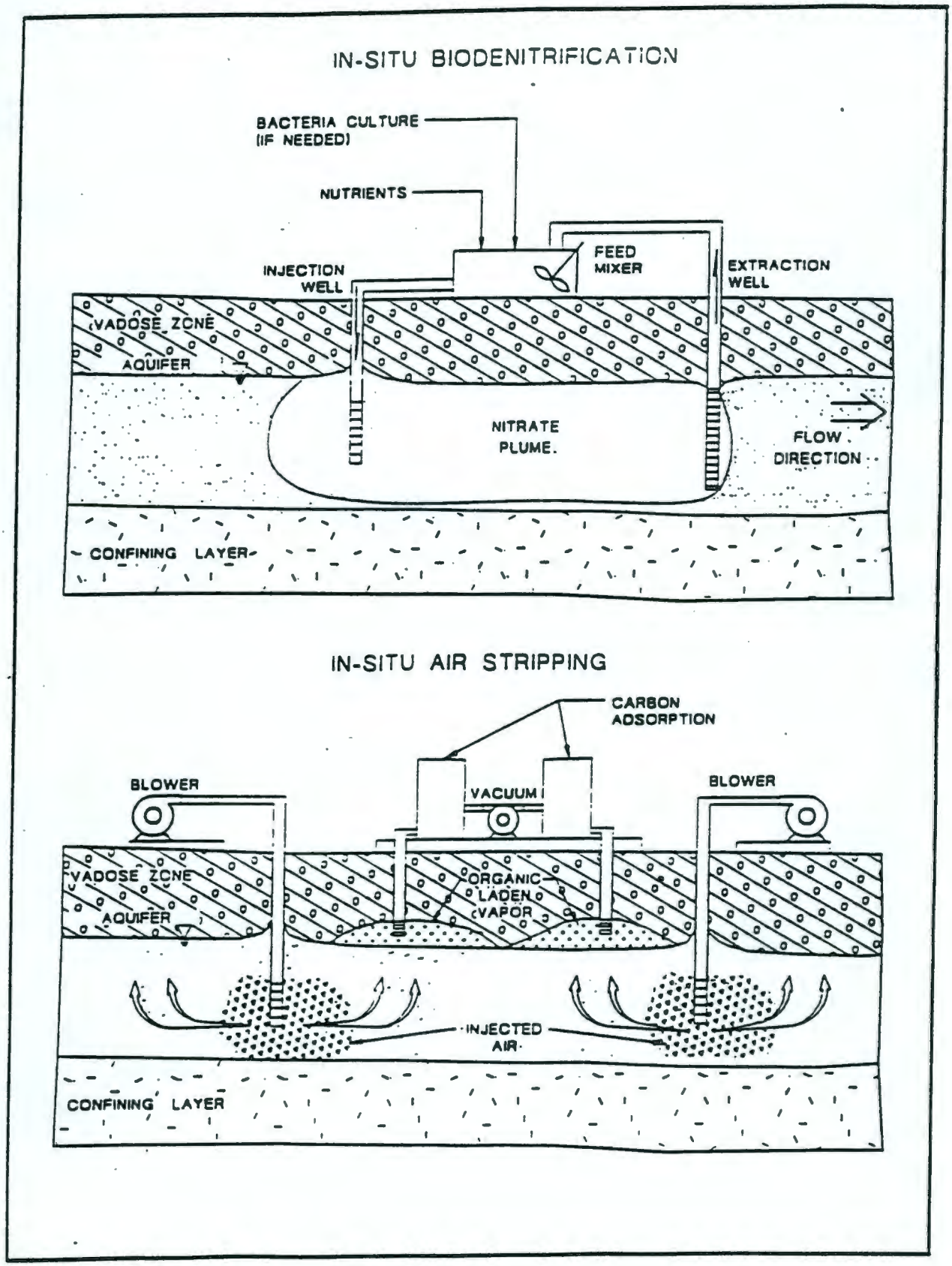

Figure B-2. Conceptual Ion Exchange Treatment System for Alternative GW-5.

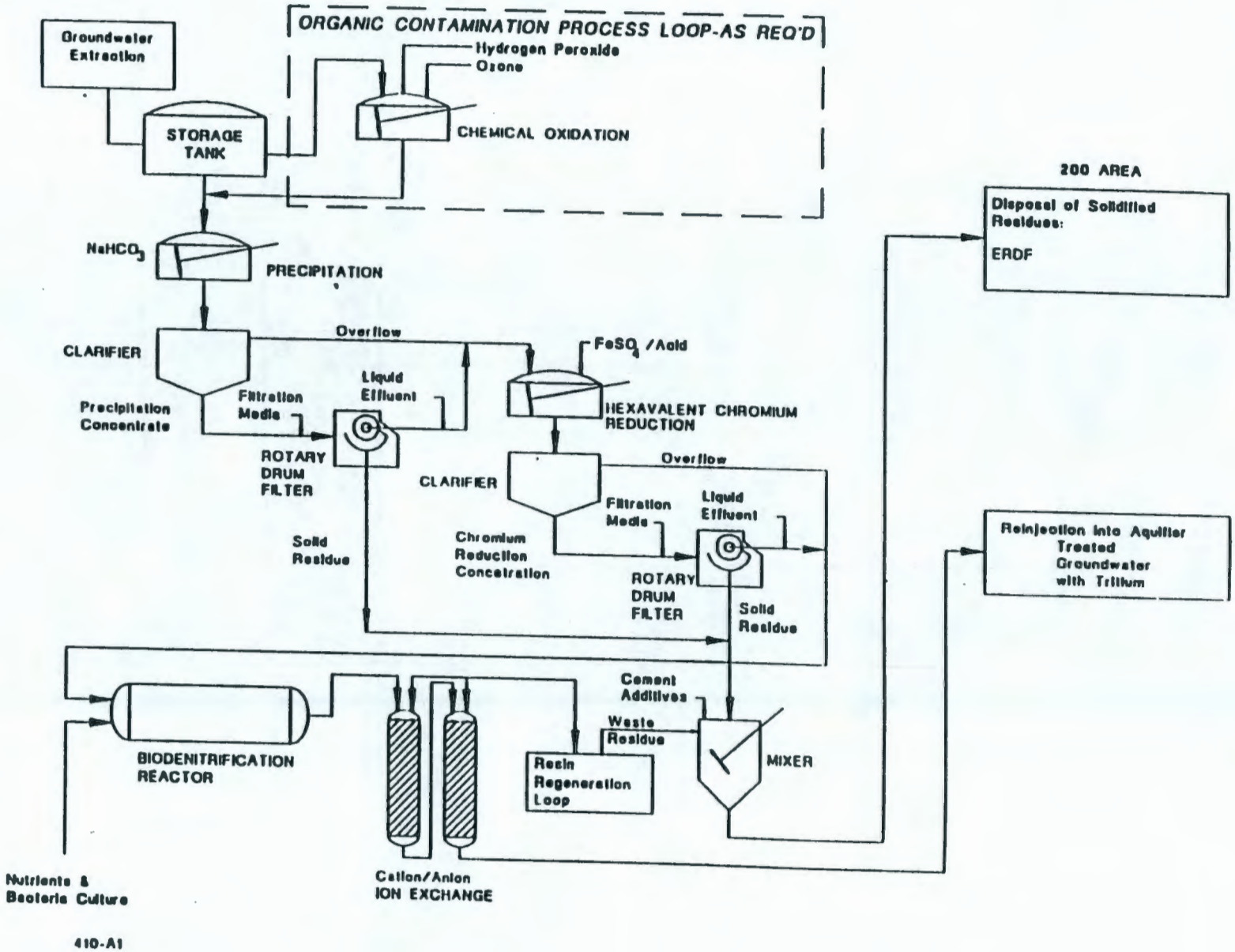

Figure B-3. Conceptual Reverse Osmosis Treatment System for Alternative GW-6.

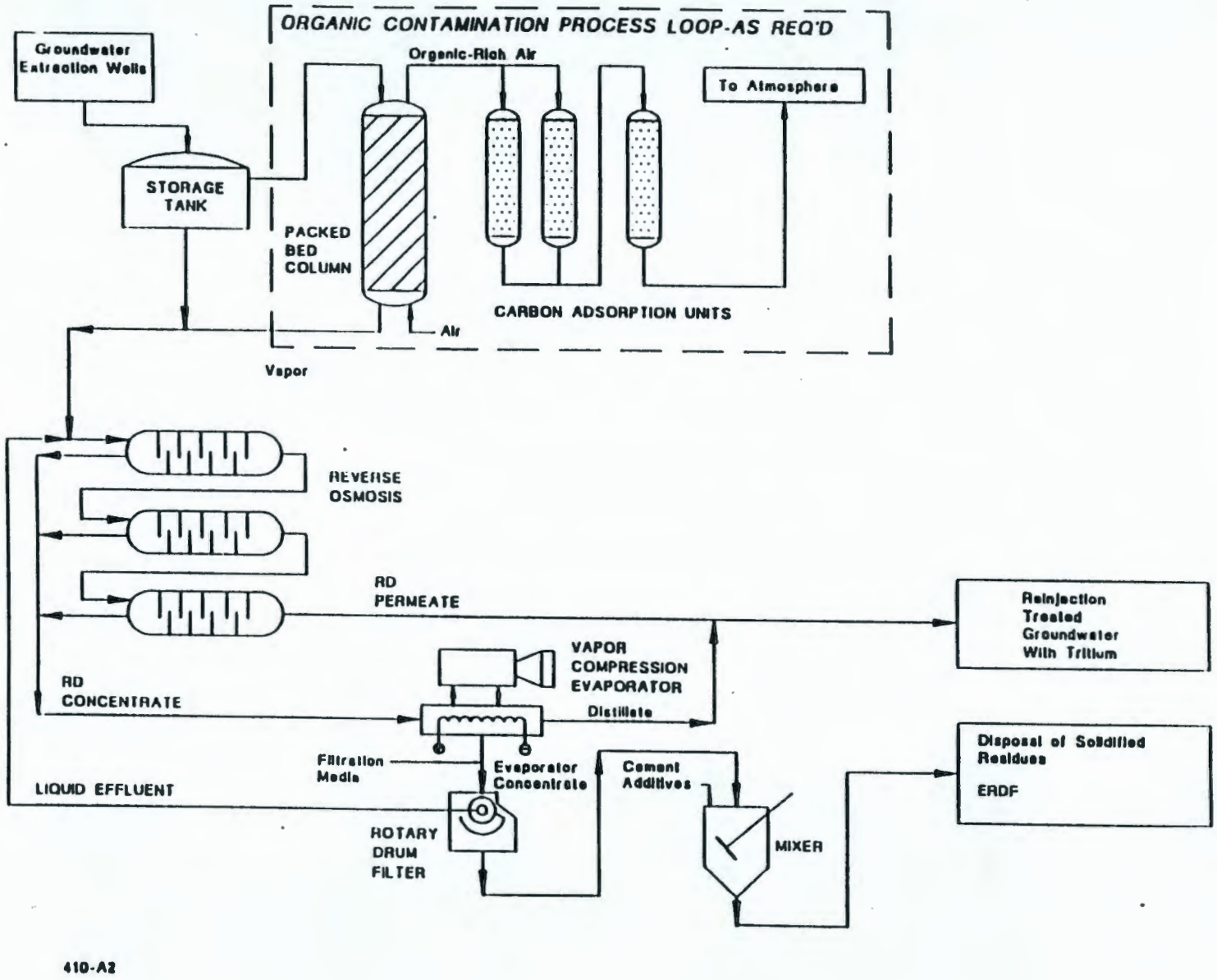

Table B-1. Secondary Waste Streams for Alternative GW-5.

Treatment Process	Description	Physical Form
Equalization storage tank	Tank bottoms	Sludge
Chemical oxidation	Filter cartridges	Solid
Chemical precipitation	Rotary drum filter cake	Filter cake
Chemical reduction	Rotary drum filter cake	Filter cake
Biodenitrification	Clarifier concentrate	Slurry
Ion exchange	Filter cartridges	Solid
	Spent ion exchange resins	Solid

Table B-2. Secondary Waste Stream for Alternative GW-6.

Treatment Process	Description	Physical Form
Equalization storage tank	Tank bottoms	Sludge
Air stripping	Filter cartridges	Solid
	Fouled packing	Solid
	Activated carbon	Solid
Reverse osmosis	Fouled membranes	Solid
Evaporator	Rotary drum filter cake	Filter cake

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APPENDIX C

MODELING DETAILS

1.0 GROUNDWATER FLOW AND SOLUTE TRANSPORT MODEL DESIGN, CALIBRATION, AND SENSITIVITY ANALYSIS

Groundwater flow and solute transport models were developed for both the 100-D/DR and 100-H Areas. A general discussion of the modeling was presented in the text. The purpose of this appendix is to discuss the details of the modeling. The models were developed using ModelCad386™, a computer-aided design program for groundwater modeling developed by Geraghty and Miller (1993). ModelCad386™ has an interactive graphical interface that provides a fast and accurate method for constructing and calibrating complex groundwater flow models.

1.1 GROUNDWATER FLOW MODELS

1.1.1 Groundwater Flow Code

The groundwater flow code used in this evaluation was MODFLOW, a three-dimensional, finite-difference, groundwater flow model code developed by the USGS (McDonald and Harbaugh 1988). The numerical method used in the code to the groundwater flow equation results in a series of equations where the hydraulic head at each node of the model grid is primarily unknown. The equations are then solved for the head at every node using an algebraic procedure for the solution of simultaneous linear equations. The Strongly Implicit Procedure (SIP) solver, which is based on algebraic procedure developed by Weinstein et al. (1969(, was used in the D/DR and H Area models because of its relatively fast execution speed. A complete discussion of the solution method used in the SIP module is provided in the MODFLOW documentation (McDonald and Harbaugh 1988).

1.1.2 Model Setup

The boundary conditions, grid, layering, and model assumptions are discussed in the main document. The base of the model for the D/DR Area was constructed by contouring geologic data for the base of Ringold Unit E using SURFER (Golden Software 1991). The SURFER data were then directly input to MODFLOW using ModelCad386™. For the H Area, the Hanford/Ringold interface was contoured using SURFER and input to MODFLOW as the base of Layer 1 which ranges in elevation from 107 to 114 m (350 to 374 ft). The base of Layer 2 and the base of the model were set to an elevation of 55.5 m (182 ft) which corresponds to the top of the Ringold Lower Mud Unit. For the D/DR Area simulation, water can exit at the Columbia River and at the constant head boundaries (depending on the surrounding heads). For the H Area simulation, water can only exit at the Columbia River.

1.1.3 H Area Leakance between Layers

MODFLOW requires input on the leakance between layers when more than one layer is simulated. The leakance is based in the thickness of the layers and the vertical hydraulic conductivity. For the H Area model, the leakance value at each node was calculated by ModelCad using these parameters.

1.1.4 Flow Model Calibration

For the D/DR Area model, the model was run in the steady-state mode using initial data input. The horizontal hydraulic conductivity was adjusted to obtain the best match between model predicted and observed water level elevations. The head in the vicinity of wells 199-D5-13, 199-D5-20, 199-D8-4, and 199 D8-6 remained too low; therefore the conductivity in this area was decreased to 5 m/d (16 ft/d). This resulted in the heads shown in table B-1. Because this match appeared to be adequate, the recharge and river bed conductance were not changed from the initial inputs.

The H Area model was initially setup as a 2-dimensional model with the Hanford/Ringold contact as the base of the aquifer. This resulted in model-predicted heads which were considerably lower than the observed heads. Therefore, an additional layer was added to the model to represent a portion of the Ringold Formation and allow the upward movement of water to the Hanford formation. The horizontal hydraulic conductivity of the aquifers were adjusted to provide the best match between observed and model predicted water-level elevations (as shown in Table B-2). The model predicted heads do not match the observed heads as well as in the D/DR Area. Because the only way to increase the model heads is to decrease the hydraulic conductivity and because the conductivities were as low as seemed reasonable, the calibration was determined to be adequate.

1.2 SOLUTE TRANSPORT MODEL

1.2.1 Solute Transport Code

The solute transport models were setup using ModelCad^{386}™. The transport code used was MT3D™ (S.S. Papadopulos & Associates 1992), a modular three-dimensional transport code for the simulation of advection, dispersion, and chemical reactions of dissolved constituents in groundwater. MT3D™ uses a mixed Eulerian-Lagrangian approach to the solution of the three-dimensional advective-dispersion-reactive equation. The solution was performed with the Hybrid Method of Characteristics (HMOC). MT3D™ works in conjuction with any block-centered finite difference model, such as MODFLOW.

1.2.2 Initial Conditions

The initial conditions for the D/DR Area were developed using the October through December 1992 contoured chromium concentrations from the LFI (DOE-RL 1993b). The 1992 data set was selected for the initial conditions because there are some uncertainties in more recent metals data (Peterson 1993).

The initial conditions for the H Area were developed by contouring the 1987 chromium data with SURFER. The 1987 data set was selected because it marked the beginning of the RCRA monitoring program and adequate data were available to develop contour maps. The SURFER data were then directly input to MT3D using ModelCad^{386TM}.

1.2.3 D Area Sensitivity Analysis

As mentioned in the main document, a variety of transport parameters were run to evaluate the sensitivity of the model to porosity, dispersivity, and retardation. The results from all of these runs are shown in Table B-3. This table indicates that the model is not very sensitive to porosity or retardation. The model is the most sensitive to dispersivity.

1.2.4 H Area Calibration

The H Area model was calibrated by running the model with the initial conditions for 5 years and attempting to match October/November 1992 chromium data. The calibration was performed by adjusting the dispersivity, retardation, and porosity. A summary of the calibration runs is shown in Table B-4. A summary of the results from these runs is shown in Tables B-5 and B-6. Run 10 was selected to perform the remedial alternative analyses because it has the lowest mean error of the three runs which simulated the river with the river package. The river package is believed to best represent the interaction between the aquifer and the Columbia River; comparing runs 10 and 11 shows that there is very little difference in the contaminant distribution between the two boundary options.

Table C-1 100 D/DR Area Calibrated Groundwater Flow Model Statistics

Well Name	Observed Head (m)	Model Predicted Head (m)	Error (m)
199-D2-6	116.91	116.85	0.06
199-D2-5	117.31	117.34	-0.03
199-D5-19	117.25	117.32	-0.07
199-D5-18	117.13	117.29	-0.16
199-D5-17	117.22	117.25	-0.03
199-D5-12	117.07	117.21	-0.14
199-D5-15	117.03	117.06	-0.03
199-D5-14	116.90	116.96	-0.06
199-D5-16	116.94	117.14	-0.20
199-D5-13	116.83	116.73	0.10
199-D5-20	116.49	116.24	0.25
199-D8-6	116.66	116.43	0.23
199-D8-5	116.27	116.10	0.17
199-D8-55	115.97	115.97	-0.00
199-D8-53	115.96	116.08	-0.12
199-D8-3	115.97	116.32	-0.35
199-D8-54A	115.97	116.03	-0.06

Mean Error = -0.026
Error Standard Deviation = 0.152

Table C-2 100 H Area Calibrated Groundwater Flow Model Statistics

Well Name	Observed Head (m)	Model Predicted Head (m)	Error (m)
199-H4-15A	113.78	113.21	0.57
199-H4-8	113.93	113.51	0.42
199-H4-7	114.04	113.69	0.35
199-H4-4	113.64	113.15	0.49
199-H4-12A	113.72	113.17	0.55
199-H4-10	113.78	113.24	0.54
199-H4-11	113.51	113.14	0.37
199-H4-14	114.19	113.82	0.37
199-H3-2A	114.45	114.14	0.31
199-H3-1	114.59	114.41	0.18
199-H4-45	113.87	113.54	0.33
199-H6-1	113.90	113.64	0.26
199-H5-1	114.58	114.59	-0.01
199-H4-13	113.41	113.12	0.29
199-H4-9	113.83	113.44	0.39

Mean Error = 0.359
Error Standard Deviation = 0.148

C-3. 100 D/DR Area Sensitivity Analysis and Data

Remedial Alternative	Porosity	Retardation Factor	Dispersivity Dl/Dt (m)	Mass Removed at River Nodes (kg)	Mass Removed at Wells (kg)	Comments
No Action	0.20	25	10/1	76.61	na	Base Case
	0.15	25	10/1	81.61	na	Model not sensitive to porosity (n) at R = 25
	0.25	25	10/1	72.44	na	Model not sensitive to n at R = 25
	0.20	1	10/1	78.83	na	No sorption, simulated plume unrealistic
	0.20	10	10/1	88.83	na	
	0.15	10	10/1	90.75	na	Model not sensitive to n at R = 10
	0.25	10	10/1	86.70	na	Model not sensitive to n at R = 10
	0.25	50	10/1	61.38	na	Model not sensitive to R at R > 25
	0.20	25	100/10	88.5	na	
	0.15	25	100/10	90.59	na	Model not sensitive to n at R = 25
	0.25	25	100/10	86.68	na	Model not sensitive to n at R = 25
	0.20	10	100/10	93.84	na	
	0.15	10	100/10	94.66	na	Model not sensitive to n at R = 10
	0.25	10	100/10	92.91	na	Model not sensitive to n at R = 10

Remedial Alternative	Porosity	Retardation Factor	Dispersivity Dl/Dt (m)	Mass Removed at River Nodes (kg)	Mass Removed at Wells (kg)	Comments
No Action	0.25	50	100/10	82.25	na	Model not sensitive to R at R > 25
Barrier Wall	0.20	25	10/1	3.04	na	
	0.20	10	10/1	3.14	na	
	0.20	25	100/10	4.87	na	
	0.20	10	100/10	5.18	na	Barrier Wall can be shortened on north end
Pump and Treat	0.20	25	10/1	1.88	418.2	Better containment than wall
	0.20	10	10/1	1.72	346.5	
	0.20	25	100/10	3.32	377.12	
	0.20	10	100/10			Large mass balance error
Barrier Wall with Pumping Wells	0.20	25	10/1	3.03	1.30	
	0.20	10	10/1	3.16	12.77	
Shortened Barrier Wall and Pumping Wells	0.20	25	100/10	5.01	10.65	
	0.20	10	100/10			Large mass balance error

na = Not Applicable
n = porosity
R = retardation

Table C-4 Summary of H Area Transport Calibration Runs

Run Number	Longitudinal Dispersivity (m)	Transverse Dispersivity (m)	Porosity	Retardation	River Boundary
1	1	0.1	0.20	100	Constant Head
2	10	1	0.20	100	Constant Head
3	10	1	0.20	50	Constant Head
4	10	1	0.20	25	Constant Head
5	100	50	0.30	17	River Boundary
6	100	10	0.20	25	Constant Head
7	10	1	0.20	13	Constant Head
8	30	3	0.20	25	Constant Head
9	5	0.5	0.30	17	River Boundary
10	5	0.5	0.20	25	River Boundary
11[a]	5	0.5	0.20	25	Constant Head

[a] Same as run 10 with the river as a constant head boundary

9513360.2743

Table C-5 Summary of H Area Model Results

Well Number	Oct/Nov 199	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9	Run 10	Run 11
199-H4-15A	120	136.16	129.4	117.45	94.01	128	12.557	62.09	53.734	126.93	126.9	127.76
199-H4-5	80	174.91	158.04	132.44	94.531	158	9.7287	48.301	41.91	154.9	154.98	156.57
199-H4-12	290	217.25	205.4	190.63	166.21	220	22.715	117.57	95.074	219.07	218.8	221.26
199-H4-8	130	116.51	99.761	84.607	63.467	124	4.9609	43.078	21.775	124.3	124.18	122.32
199-H4-7	110	136.94	122.21	110.3	93.736	137	9.3497	71.564	46.294	137.28	137.21	137.32
199-H4-6	110	59.346	56.746	53.6	46.993	57.2	9.306	34.455	31.192	58.272	57.982	57.4
199-H4-9	75	169.44	141.2	117.43	84.397	177	6.7393	49.617	25.414	177.61	177.52	174.91
199-H4-3	44	285.82	231.03	178.23	115.85	265	9.3664	61.282	34.279	261.32	259.51	265.9
199-H4-4	110	275.96	257.75	237.78	203.78	267	25.562	141.33	115.37	268.87	269.03	267.24
199-H3-2A	50	40.153	41.399	39.589	36.37	44.1	14.176	30.952	30.126	42.345	42.401	43.491
199-H4-14	360	NA	239.08	224.32	204.07	242	43.714	165.91	143.41	241.56	242.29	241.8
199-H4-8	210	NA	209.45	169.28	116.25	255	9.3828	59.179	36.008	254.5	255.76	255.74
199-H4-11	110	NA	113.3	109.33	103.65	125	21.075	90.057	70.763	124.69	124.75	125.39
199-H4-13	84	NA	32.59	33.135	32.778	44.2	7.8158	33.617	23.022	40.262	40.171	39.926
199-H4-48	4.5	NA	172.91	164.4	146.65	171	41.179	117.12	107.89	172.35	172.18	170.81
199-H4-49	66	NA	95.773	90.677	80.316	92.6	25.962	64.343	60.951	93.65	93.533	92.839
199-H4-47	4.3	158.55	151.72	142.3	126.86	151	30.06	102.4	89.597	151.91	151.85	150.17
199-H4-46	52.7	99.137	95.478	91.289	83.388	98	22.451	68.449	60.234	98.2	98.165	97.914
199-H5-1	84.4	40.076	41.23	39.812	36.976	42.1	15.724	32.288	31.365	40.478	40.972	42.125
199-H6-1	45.6	19.838	19.103	18.265	16.897	19.7	5.7464	16.759	13.304	19.817	19.83	20.002

Table C-6 Statistics of H Area Model Runs ***

Well Number	Oct/Nov 199	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9	Run 10	Run 11
199-H4-15A	120	16.16	9.4	-2.55	-25.99	8	-107.443	-57.91	-66.266	6.93	6.9	7.76
199-H4-5	80	94.91	78.04	52.44	14.531	78	-70.2713	-31.699	-38.09	74.9	74.98	76.57
199-H4-12	290	-72.75	-84.6	-99.37	-123.79	-70	-267.285	-172.43	-194.926	-70.93	-71.2	-68.74
199-H4-8	130	-13.49	-30.239	-45.393	-66.533	-6	-125.039	-86.922	-108.225	-5.7	-5.82	-7.68
199-H4-7	110	26.94	12.21	0.3	-16.264	27	-100.65	-38.436	-63.706	27.28	27.21	27.32
199-H4-6	110	-50.654	-53.254	-56.4	-63.007	-52.8	-100.694	-75.545	-78.808	-51.728	-52.018	-52.6
199-H4-9	75	94.44	66.2	42.43	9.397	102	-68.2607	-25.383	-49.586	102.61	102.52	99.91
199-H4-3	44	241.82	187.03	134.23	71.85	221	-34.6336	17.282	-9.721	217.32	215.51	221.9
199-H4-4	110	165.96	147.75	127.78	93.78	157	-84.438	31.33	5.37	158.87	159.03	157.24
199-H3-2A	50	-9.847	-8.601	-10.411	-13.63	-5.9	-35.824	-19.048	-19.874	-7.655	-7.599	-6.509
199-H4-14	360	NA	-120.92	-135.68	-155.93	-118	-316.286	-194.09	-216.59	-118.44	-117.71	-118.2
199-H4-8	210	NA	-0.55	-40.72	-93.75	45	-200.617	-150.821	-173.992	44.5	45.76	45.74
199-H4-11	110	NA	3.3	-0.67	-6.35	15	-88.925	-19.943	-39.237	14.69	14.75	15.39
199-H4-13	84	NA	-51.41	-50.865	-51.222	-39.8	-76.1842	-50.383	-60.978	-43.738	-43.829	-44.074
199-H4-48	4.5	NA	168.41	159.9	142.15	166.5	36.679	112.62	103.39	167.85	167.68	166.31
199-H4-49	66	NA	29.773	24.677	14.316	26.6	-40.038	-1.657	-5.049	27.65	27.533	26.839
199-H4-47	4.3	154.25	147.42	138	122.56	146.7	25.76	98.1	85.297	147.61	147.55	145.87
199-H4-46	52.7	46.437	42.778	38.589	30.688	45.3	-30.249	15.749	7.534	45.5	45.465	45.214
199-H5-1	84.4	-44.324	-43.17	-44.588	-47.424	-42.3	-68.676	-52.112	-53.035	-43.922	-43.428	-42.275
199-H6-1	45.6	-25.762	-26.497	-27.335	-28.703	-25.9	-39.8536	-28.841	-32.296	-25.783	-25.77	-25.598
Mean Error		44.58	23.65	10.22	-9.67	33.87	-89.65	-36.51	-50.44	33.39	33.38	33.52

APPENDIX D

COST ESTIMATES

1.0 COST MODEL DETAILS AND ASSUMPTIONS

This appendix presents the details of the cost estivates for the 100-HR-3 OU FFS. Included are assumptions and other criteria used to establish costs of implementing each remedial alternative. Four subsections are provided that include:

1.1 COST MODEL ASSUMPTIONS

1.1.1 EXTRACTION/INJECTION WELL NETWORK

General Assumptions for Extraction/Injection Wells

- The extraction well network will use a combination of existing and new wells to intercept the chromium plume along the shoreline, as defined by the 50 ug/L chromium concentration contour line.

- Existing wells (screened and perforated) are assumed to be usable for extraction and reinjection after an initial refurbishing. New wells will be designed to optimize groundwater extraction or injection rates.

- Capture zones (the portion of the aquifer that contributes water to an extraction well) were estimated using established analytical methods (Keely and Tsang, 1983; Javendel and Tsang, 1986). These estimates provided an optimal well spacing value that was used to determine the number of existing and new extraction wells needed to intercept the plume along the shoreline. Table D-1 presents a summary of well spacing estimates for various pumping rates and time intervals.

- Drill depths for new wells are assumed to be inclusive of the vertical extent of chromium contamination. The estimated drill depths for new wells are based on the installed depths of existing wells.

- Extraction rates are approximations based on experience at the 100-D/DR pilot scale test, and on best professional judgement based on hydrostratigraphic units. Injection wells are assumed to have twice the capacity (gpm) of extraction wells.

Specific Assumptions for the 100-D/DR Area (100-HR-3 Operable Unit)

- The chromium plume is assumed to intercept the river along the northern portion of the 100-D/DR Area shoreline. This shoreline segment is directly downgradient of presumed sources near the reactor buildings, the coolant water retention basins, and the liquid waste disposal trench.

- Injection of treated groundwater will be upgradient of the extraction network, between the coolant water retention basins and the reactor buildings.

Specific Assumptions for the 100-H Area (100-HR-3 Operable Unit)

- The chromium plume intercepts the river in the northern portion of the area, where the groundwater plume from the 183-H Solar Evaporation Basins is centered. The length of the plume front is estimated from the 50 ug/L contour line drawn for December 1994 analytical results for filtered samples.

- All existing wells along the shoreline that are within the plume were used as extraction wells. One new extraction well is added to provide coverage at the northern end of the plume front.

- Reinjection will be in an area upgradient of the extraction well network.

General Assumptions for Estimating Piping Lengths for Well Network

Existing and new extraction wells, along with an assumed treatment system location, were plotted on Hanford Site 1:2000 scale topographic maps. The distance from each well to the treatment system was measured along the most reasonable route, considering existing roads, buildings, etc. A single piping run was measured from the treatment system to the vicinity of the injection wells. The total piping required is the sum of all the individual piping runs.

Table D-1. Summary of Estimates for Optimal Well Spacing.

Contaminated thickness (ft)	Hydraulic conductivity (ft/d)	Discharge capacity (gpm)	Optimal well spacing (ft)	Optimal well spacing (m)
100-D/DR reactor area: Assumes gradient of 0.003 and effective porosity of 0.15				
12	17	5	501	153
12	33	10	516	157
12	60	15	426	130
100-H reactor area: Assumes gradient of 0.003 and effective porosity of 0.15				
13	50	20	628	192
13	75	25	524	160
13	100	30	471	144

Notes: Capture zone dimension and optimal well spacing based on analytical methods described in Keely and Tsang (1983) and Javendal and Tsang (1986).

Table D-1. Capture Zone Size Estimates.

Time Interval (years)	Pumping Rate (gpm)	Capture Zone Radius (feet)	(meters)
100-D/DR Area: Contaminated thickness = 12 feet; specific yield = 0.15			
1	5	249	76
	10	353	107
	20	499	152
5	5	557	170
	10	788	240
	20	1115	340
100-H Area: Contaminated thickness = 13 feet; specific yield = 0.15			
1	5	239	73
	10	339	103
	20	479	146
5	5	535	163
	10	757	231
	20	1071	327

Note: Capture zone radii were estimated from the cylindrical volume associated with withdrawing water at various discharge rates from a screened interval that penetrates the contaminated thickness of the aquifer.

1.2 Present Worth Tables

Capital expenditures and operation and maintenance costs are tabluated by year and linked with the discount factors to arrive at a present worth for that remedial technology. Dollar amounts for capital and operation and maintenance are taken from Cost Summary Sheets provided in Section 1.3.

1.3 Cost Model Assumptions

Included are assumptions for each remedial alternative by task/subtask/sub-subtask. The source for costs associated with the task/subtask/sub-subtask assumption(s) are also provided.

1.4 Cost Summary Sheets

The cost summary tables provide a link between the remedial alternative cost models and their respective present worth. It is here that capital and operation and maintenance costs are summed by year for subsequent entry into the present worth tables.

1.5 Remedial Alternative Cost Models

Cost elements of each remedial alternative are listed by task/subtask/sub-subtask using the MCACES cost model software. Additional details such as linear feet of pipe, pump size, and flow capacity of equipment are also included.

Adders such as tax, project management costs, and contingencies are introduced into the remedial alternative cost at this stage.

Note: This section contains detailed output from cost model analysis. Due to the length of this section, it has not been reproduced for this review. It will be included in the final document and is available upon request.

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SECTION 1.1 PRESENT WORTH TABLES

PRESENT WORTH CALCULATIONS

100 D/DR AREA: INSTITUTIONAL CONTROLS (GW-2)

ANNUAL DISCOUNT RATE = 5%

YEAR	CAPITAL COST	O&M COST	DISCOUNT FACTOR	ANNUAL EXPENDITURE	PRESENT WORTH
0	$0	$0	1.0000	$0	$0
1	$0	$118,726	0.9524	$118,726	$113,075
2	$0	$118,726	0.9070	$118,726	$107,684
3	$0	$118,726	0.8638	$118,726	$102,556
4	$0	$118,726	0.8227	$118,726	$97,676
5	$0	$118,726	0.7835	$118,726	$93,022
TOTALS	$0	$593,630			$514,012

TOTAL COST OF THE ALTERNATIVE: ***$514,012***

PRESENT WORTH CALCULATIONS

100 D/DR AREA: SHEET PILE BARRIER (GW-3)

ANNUAL DISCOUNT RATE = 5%

YEAR	CAPITAL COST	O&M COST	DISCOUNT FACTOR	ANNUAL EXPENDITURE	PRESENT WORTH
0	$11,334,830	$0	1.0000	$11,334,830	$11,334,830
1	$0	$2,609,374	0.9524	$2,609,374	$2,485,168
2	$0	$2,577,004	0.9070	$2,577,004	$2,337,343
3	$0	$2,635,754	0.8638	$2,635,754	$2,276,764
4	$0	$2,577,004	0.8227	$2,577,004	$2,120,101
5	$32,000	$2,577,004	0.7835	$2,609,004	$2,044,155
TOTALS	$11,366,830	$12,976,140			$22,598,361

TOTAL COST OF THE ALTERNATIVE: ***$22,598,361***

PRESENT WORTH CALCULATIONS

100 D/DR AREA: REMOVAL, TREATMENT, AND DISPOSAL ALTERNATIVE WITH ION EXCHANGE (GW-5)

ANNUAL DISCOUNT RATE = 5%

YEAR	CAPITAL COST	O&M COST	DISCOUNT FACTOR	ANNUAL EXPENDITURE	PRESENT WORTH
0	$3,310,360	$0	1.0000	$3,310,360	$3,310,360
1	$0	$1,367,382	0.9524	$1,367,382	$1,302,295
2	$0	$1,261,906	0.9070	$1,261,906	$1,144,549
3	$0	$1,493,536	0.8638	$1,493,536	$1,290,116
4	$0	$1,261,906	0.8227	$1,261,906	$1,038,170
5	$32,240	$1,263,072	0.7835	$1,295,312	$1,014,877
TOTALS	$3,342,600	$6,647,802			$9,100,367

TOTAL COST OF THE ALTERNATIVE: ***$9,100,367***

PRESENT WORTH CALCULATIONS

100 D/DR AREA: REMOVAL, TREATMENT, AND DISPOSAL ALTERNATIVE WITH REVERSE OSMOSIS (GW-6)

ANNUAL DISCOUNT RATE = 5%

YEAR	CAPITAL COST	O&M COST	DISCOUNT FACTOR	ANNUAL EXPENDITURE	PRESENT WORTH
0	$3,479,480	$0	1.0000	$3,479,480	$3,479,480
1	$0	$2,382,894	0.9524	$2,382,894	$2,269,468
2	$0	$2,307,804	0.9070	$2,307,804	$2,093,178
3	$0	$2,539,344	0.8638	$2,539,344	$2,193,485
4	$0	$2,307,804	0.8227	$2,307,804	$1,898,630
5	$32,230	$2,307,804	0.7835	$2,340,034	$1,833,417
TOTALS	$3,511,710	$11,845,650			$13,767,659

TOTAL COST OF THE ALTERNATIVE: ***$13,767,659***

PRESENT WORTH CALCULATIONS

100 H AREA: INSTITUTIONAL CONTROLS (GW-2)

ANNUAL DISCOUNT RATE = 5%

YEAR	CAPITAL COST	O&M COST	DISCOUNT FACTOR	ANNUAL EXPENDITURE	PRESENT WORTH
0	$0	$0	1.0000	$0	$0
1	$0	$118,726	0.9524	$118,726	$113,075
2	$0	$118,726	0.9070	$118,726	$107,684
3	$0	$118,726	0.8638	$118,726	$102,556
4	$0	$118,726	0.8227	$118,726	$97,676
5	$0	$118,726	0.7835	$118,726	$93,022
TOTALS	$0	$593,630			$514,012

TOTAL COST OF THE ALTERNATIVE: ***$514,012***

PRESENT WORTH CALCULATIONS

100 H AREA: HYDRAULIC CONTROL (GW-3)

ANNUAL DISCOUNT RATE = 5%

YEAR	CAPITAL COST	O&M COST	DISCOUNT FACTOR	ANNUAL EXPENDITURE	PRESENT WORTH
0	$770,510	$0	1.0000	$770,510	$770,510
1	$0	$437,358	0.9524	$437,358	$416,540
2	$0	$407,278	0.9070	$407,278	$369,401
3	$0	$597,648	0.8638	$597,648	$516,248
4	$0	$407,278	0.8227	$407,278	$335,068
5	$32,450	$407,278	0.7835	$439,728	$344,527
TOTALS	$802,960	$2,256,840			$2,752,294

TOTAL COST OF THE ALTERNATIVE: ***$2,752,294***

PRESENT WORTH CALCULATIONS

100 H AREA: REMOVAL, TREATMENT, AND DISPOSAL ALTERNATIVE WITH ION EXCHANGE (GW-5)

ANNUAL DISCOUNT RATE = 5%

YEAR	CAPITAL COST	O&M COST	DISCOUNT FACTOR	ANNUAL EXPENDITURE	PRESENT WORTH
0	$3,306,640	$0	1.0000	$3,306,640	$3,306,640
1	$0	$1,548,128	0.9524	$1,548,128	$1,474,437
2	$0	$1,340,254	0.9070	$1,340,254	$1,215,610
3	$0	$1,529,447	0.8638	$1,529,447	$1,321,136
4	$0	$1,340,254	0.8227	$1,340,254	$1,102,627
5	$32,250	$1,343,362	0.7835	$1,375,612	$1,077,792
TOTALS	$3,338,890	$7,101,445			$9,498,243

TOTAL COST OF THE ALTERNATIVE: ***$9,498,243***

PRESENT WORTH CALCULATIONS

100 H AREA: REMOVAL, TREATMENT, AND DISPOSAL ALTERNATIVE WITH REVERSE OSMOSIS (GW-6)

ANNUAL DISCOUNT RATE = 5%

YEAR	CAPITAL COST	O&M COST	DISCOUNT FACTOR	ANNUAL EXPENDITURE	PRESENT WORTH
0	$3,885,810	$0	1.0000	$3,885,810	$3,885,810
1	$0	$2,576,980	0.9524	$2,576,980	$2,454,316
2	$0	$2,501,890	0.9070	$2,501,890	$2,269,214
3	$0	$2,690,880	0.8638	$2,690,880	$2,324,382
4	$0	$2,501,890	0.8227	$2,501,890	$2,058,305
5	$32,220	$2,501,890	0.7835	$2,534,110	$1,985,475
TOTALS	$3,918,030	$12,773,530			$14,977,502

TOTAL COST OF THE ALTERNATIVE: ***$14,977,502***

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SECTION 1.2 COST MODEL ASSUMPTIONS

D/DR INSTITUTIONAL CONTROLS/CURRENT ACTION

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
ANA:02.08.02. Ground Water Analysis (Yrs 1-5)	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr) • All on-site sample analyses performed by mobile lab. • 10% off-site verification analysis of reduced analyte list with CLP protocol. (10% of 14 = 1 ea)	DOE Cost Meeting
WHC:02.08.02. Ground Water Analysis (Yrs 1-5)	• Assume sampling of 7 monitoring well on a semiannual basis for the 5-year lifecycle (14 samples/yr) - Total samples = 14 • 90% of samples for analysis at mobile lab (90% of 14 = 13)	DOE Cost Meeting
WHC:02.08.04. Ground Water Monitor Samples	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr) • Assume 2 field technicians for 6 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)	DOE Cost Meeting
WHC:13.21.11 Prepare Annual Report (Yrs 1-5)	• Assume 2 FTE's for 6 months each year	HR-3 Cost Workshop

D AREA SHEET PILE

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
ANA:02.08.02. Ground Water Analysis Yr 1-5	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples) • Assume monthly performance monitoring of 7 wells for the 5-year lifecycle. (84 Samples) - Total samples = 98 • All on-site sample analyses performed by mobile lab • 10% off-site verification analysis of reduced analyte list with CLP protocol. (10% of 98 = 10 ea)	Best professional judgement Best professional judgement DOE Cost Meeting DOE Cost Meeting
SUB:01.02. Mobilize Trailers	• Includes mobilization of field office, storage, and decontamination trailers	Best professional judgement
SUB:01.04. Setup Trailers	• Includes setup of field office, storage, and decontamination trailers	Best professional judgement
SUB:01.04.02. Construct Decon Area	• Work to be Performed: Construct decontamination area/pad for equipment and vehicles • Crew and Equipment: Fixed Price Contractor: I Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers Equipment: 1 Backhoe, 1 pickup truck Output: Assumed duration for this activity is 3 crew days. • Allowance for Tank Assume 1000 gal plastic tank for water collection	Best professional judgement
SUB:01.04.03. Site Survey	• Survey site for construction	Best professional judgement
SUB:01.05. Construct Temporary Utilities	• Includes connections for temporary electricty, telephone, water, and sewer facilities	Best professional judgement

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TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:01.06 Pre-Construction Submittals	• Includes pre-construction submittals by fixed-price contractor	Best professional judgement
SUB:03.03. Earthwork	• Includes dirtwork to prepare site	Best professional judgement
SUB:03.04. Roads/Parking/ Curbs/Walks	• Access Roads to Wells Assume road length equal to well piping, 10 ft wide, native materials	Wall length and well spacing utilized to estimate road placement, Richardson Cost Estimating Guide
SUB:06.01.01. Well Drilling & Construction	• Drill/Install Extr/Inject Wells Note: 2 new extraction wells and 2 new injection wells, 100 ft deep, 8 in diameter, screened for 50 ft. Unit cost is assumed to include handling and packaging of contaminated well cuttings, transport to the disposal facility and associated disposal fees. • Allowance well Head Covers Assume manhole type cover at each well head • Allowance for Well Pumps-10 gpm • Allowance for Water Level Monitoring Instrumentation Assume 5 piezometers per extraction well using well points • Allowance for Well Testing	Modelling, geological reports, and actual costs from WHC RCRA drilling program Best professional judgement Best professional judgement Best professional judgement Best professional judgement
SUB:06.01.04. Operations and Maintenance year 3	• Allowance for Well Workover Assume 1 every 3 years for each well for the 5-year lifecycle. Workovers in year 3 • Allowance for Well Pump Assume 1 pump replacement per extraction well every three years for the 5-year lifecycle. Pump replacement in year 3.	Best professional judgement Best professional judgement
SUB:06.01.9X. Site Piping	• Allowance for Piping from extraction well to consolidation facility. Assume 1500 lf of double-wall PVC piping per extraction well. 1500 lf/well x 2 wells = 3000 lf • Allowance for Force Main Discharge Piping Assume 1500 lf of double-wall PVC piping per injection well. 1500 lf/well x 2 wells = 3000 lf	Wall length and well spacing used to estimate flowline length, best professional judgement

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:06.03. Sheet Pile	• Construct Sheet Pile Wall Assume 50 ft deep x 4300 lf Includes mob of equipment, excavation, and installation of sheet piles.	Vendor quote
SUB:20.04. Site Restoration	• Includes revegetation at end of project	Best professional judgement
SUB:21.02.02 Demobilize Personnel and Equipment	• Includes demobilization of field office, storage, and decontamination trailers	Best professional judgement
SUB:21.04.02. Demobilize Temp Facilities	• Includes decomobilization of field office, storage, and decontamination trailers • Crew and Equipment: Fixed Price Contractor:1 Group 6 Operator, 3 Group 1 Laborer, and 3 Group 2 Laborers • Equipment: 1 backhoe, 1 pickup truck • Output: Assumed duration for this activity is 1 crew day	Best professional judgement
SUB:21.05 Disconnect Temporary Utilities	• Includes disconnecting electricity, telephone, water, and sewer services	Best professional judgement
SUB:21.04.02. Remove Decon Area	• Crew and Equipment: Fixed Price Contractor:1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers Equipment: 1 backhoe, 1 pickup Output: Assumed duration for this activity is 1 crew day.	Best professional judgement
SUB:21.06. Post-Construction Submittals	• Includes post-construction submittals by fixed-price contractor	Best professional judgement

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TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
WHC:02.08.02. Ground Water Analysis	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples) • Assume monthly performance monitoring of 7 wells for the 5-year lifecycle. (84 samples) - Total samples = 98 • 90% of samples analyzed by mobile lab (90% of 98 = 88) • All on-site samples analyses performed by mobile lab	DOE Cost Meeting Best professional judgement DOE Cost Meeting DOE Cost Meeting
WHC:02.08.03. Take Ground Water Samples	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples) • Assume 2 Field Technicians for 6 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)	DOE Cost Meeting Best professional judgement
WHC:06.03. Vertical Barrier (Sheet Pile Wall), Yr 1	• Assume QA and Safety oversite for the construction project.	Best professional judgement
WHC:06.05. Operation and Maintenance	• WHC Allowance for Electricity Wells: 147 kW-h/d Assume 24 hr/day x 365 days/yr Total = 53,600 kW-h/yr	Vendor catalogs, vendor quotes
WHC:13.21.11 Prepare Annual Report Yr 1	• Assume 2 FTE's for 6 months per year	HR-3 Cost Workshop
WHC: 13.21.11. Prepare Annual Report Yrs 2-5	• Assume 2 FTE's for 4 months per year	HR-3 Cost Workshop

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D AREA ION EXCHANGE

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
ANA:02.08.02. Ground Water Analysis Yr - 1	• Assume shake-down period with following sampling of treatment system: - First 2 days: Sample each day of influent and effluent (4 samples) - Next 4 weeks: 1 sample per week of influent and effluent (8 samples)	Best professional judgement
	• 1 sample every 2 weeks of the influent and effluent for the remainder of year 1 (48 samples/yr)	Best professional judgement
	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr)	Best professional judgement
	• All onsite sample analyses performed by mobile lab	DOE Cost Meeting
	• 10% offsite verification analysis of reduced analyte list with CLP protocol.	DOE Cost Meeting
ANA:02.08.03. Ground Water Analysis Yrs 2-5	• Assume 1 sample every 2 weeks of influent and effluent for the 5-yr lifecycle. (52 samples/yr)	Best professional judgement
	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-yr lifecycle (14 samples/yr)	Best professional judgement
	• All onsite samples analyses performed by mobile lab	DOE Cost Meeting
	• 10% offsite verification analysis of reduced analyte list with CLP protocol	DOE Cost Meeting
SUB:01.02.02 Mobilize Trailers	• Includes mobilization of field office, storage, and decontamination trailers	Best professional judgement
SUB:01.04.01 Setup Trailers	• Includes setup of field office, storage, and decontamination trailers	Best professional judgement

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:01.04.02. Construct Decon Area	• Work to be Performed: Construct decontamination area/pad for equipment and vehicles. • Crew and Equipment Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers Equipment: 1 backhoe, 1 pickup truck • Output: Assumed duration for this activity is 3 crew days • Allowance for Tank Assume 1000 gal plastic tank for water collection	Best professional judgement
SUB:01.04.03 Site Survey	• Survey for artifacts	Best professional judgement
SUB:01.05 Construct Temporary Utilities	• Includes connections for temporary electricity, telephone, water, and sewer facilities	Best professional judgement
SUB:01.06 Pre-Construction Submittals	• Includes pre-construction submittals by fixed-price contractor	Best professional judgement
SUB:03.03 Earthwork	• Includes dirtwork to prepare site	Best professional judgement
SUB:03.04. Roads/Parking/Curbs/ Walks	• Access Roads to Wells Assume 10 ft wide, native materials, road length equal to well piping length • Road length equal to well piping length	Well spacing utilized to estimate road placement, Richardson Cost Estimating Guide
SUB:03.05. Fencing	• Allowance for Permanent Fencing Assume 7 ft high security fence	Industry standard, Best professional judgement

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:06. Groundwater Collection and Control	• Drill/install extraction wells Note: 7 new extraction wells 80 ft deep and 5 new injection wells, 100 ft deep, 8 in. diameter. Unit cost is assumed to include handling and packaging of contaminated well cuttings, transport to the disposal facility, and associated disposal fees. • Allowance for Well Pumps and Installation - 10 GPM • Allowance for Controls and Connections at Well Heads • Allowance for Water Level Monitoring Instrumentation -Assume 5 piezometers per extraction well • Assume refurbishing existing wells. • Allowance for Well Head Covers Assume manhole type cover at each well head • Allowance for Well Testing	Modelling, geological reports, and actual costs from WHC RCRA drilling program Richardson Cost Estimating Guide, Best professional judgement Best professional judgement Best professional judgement Best professional judgement Best professional judgement
SUB:06.01.04. Operations and Maintenance 3	• Allowance for Well Workover Assume 1 workover every 3 years for each well for the 5-year lifecycle. Workovers in year 3 • Allowance for Well Pump Replacement Assume one pump replacement and installation per well every 3 years for the 5-year lifecycle Replacement in year 3	Best professional judgement Best professional judgement
SUB:06.01.9X. Site Piping	• Allowance for Piping from Well Head to Treatment Plant - double-wall PVC piping • Allowance for Leak Detection • Allowance for Force Main Discharge Piping - single wall PCV piping	Well spacing utilized to estimate flow line length, Best professional judgement

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TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:12. Chemical Treatment	• Excavate and prepare site for construction Assume a tent structure complete with frame, doors, and roll-up doors. • Ion Exchange Equipment/Staging Includes 1 x 150 gpm treatment system. Resin included in O&M. • Allowance for Bldg Electrical Includes lighting, fixtures, motor starters, controllers, junction boxes, transformer, chart recorders, annunciators, panels, conduit, and wiring. • Allowance for Bldg Mechanical Includes equipment installation and connections, controls/instrumentation, interior piping (plastic), floor drains and piping.	Vendor quote Vendor quote, results from treatability study Best professional judgement Best professional judgement
SUB:20.04 Site Restoration	• Includes revegetation at end of project	Best professional judgement
SUB:21.04. Demobilze Temp Facilities	• Includes removal of decontamination area • Crew and Equipment: Fixed Price Contractor:1 Group 6 Operator, 3 Group 1 Laborer, and 3 Group 2 Laborers • Equipment: 1 backhoe, 1 pickup truck • Output: Assumed duration for this activity is 1 crew day	Best professional judgement
SUB:21.05 Disconnect Temporary Utilities	• Includes disconnecting electricity, telephone, water, and sewer services	Best professional judgement
SUB:21.06 Post-Construction Submittals	• Includes post-construction submittals by fixed-price contractor	Best professional judgement

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
WHC:02.08.02. Ground Water Analysis Yr - 1	• Assume shake-down period with following sampling of treatment system: - First 2 days: Sample each day of influent and effluent (4 samples) - Next 5 weeks: 1 sample per week of influent and effluent (8 samples) • 1 sample every 2 weeks of influent and effluent for remainder of year (48 samples/yr) • 90% of samples analyzed a mobile lab • HACH kit samples are taken 2 per day for the 5-yr lifecycle plus an additional 48 samples during the shake-down period.	Best professional judgement, cost meeting DOE Cost Meeting DOE Cost Meeting
WHC:02.08.03. Ground Water Analysis Yr 2 - 5	• Assume 1 sample every 2 weeks of the influent and effluent for the 5-yr lifecycle. (104 samples/yr) • Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr) • 90% of samples analyzed at mobile lab • HACH kit samples are taken 2 per day for the 5-yr lifecycle.	Best professional judgement DOE Cost Meeting DOE Cost Meeting DOE Cost Meeting
WHC:02.08.04. Ground Water Monitor Samples	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr) • Assume 2 field technicians for 12 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)	DOE Cost Meeting Best professional judgement
WHC:12.05.06 Personnel Training	• Includes operator time and allowance to attend 40-hour training	Best professional judgement

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TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
WHC:12.05.08 Operations & Maintenance Yrs 1-5	• Treatment facility will be fully staffed with 2 FTE's per shift, 1 shift per day, 7 days per week. (365 days/yr x 8 hrs/day = 2,920 hrs/yr)	Best professional judgement
	• Ion exchange media for chromium treatment	Vendor quote, treatability test report results
	• 2 FTE crew will be composed of the following members: 0.25 ea - supervisor 1.00 ea - operator 0.50 - engineering support 0.25 ea - maintenance engineer	
	• Allowance for electricity Wells: 806 kW-hr/d Ion Exchange Plant: 1902 kW-hr/d Assume 24 hrs/day x 365 days/yr Total = 988,366 kW-hr/yr	Vendor catalogs, vendor quotes
	• Ion Exchange Media will not require replacement during the 5-year lifecycle	Boomsnub data, best professional judgement
	• pH adjustment	Boomsnub data
	• Ion Exchange Media will not be regenerated	
	• Disposal Fee for ion exchange media Assume disposal at ERDF for year 5	HR-3 Cost Workshop
WHC:12.05.11. Prepare Annual Report Yr 1	• Assume 2 FTEs for 6 months each year	HR-3 Cost Workshop
WHC:12.05.12. Prepare Annual Report Yrs 2-5	• Assume 2 FTEs for 4 months each year	HR-3 Cost Workshop

D AREA REVERSE OSMOSIS

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
ANA:02.08.02. Ground Water Analysis (YR 1)	• Assume shake-down period with the following sampling schedule for the treatment system: - First 2 days: Samples every four hours of influent and effluent (24 samples) - Next 5 days: 1 sample per day of influent and effluent (10 samples) - Next 7 weeks: 1 sample per week of influent and effluent (14 samples) • 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle (104 samples/yr) • Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr) - Total samples = 166 • All on-site samples analyses performed by mobile lab • 10% off-site verification analysis of reduced analyte list with CLP protocol. (10% of 166 = 17 ea)	Best professional judgement Best professional judgement Best professional judgement DOE Cost Meeting DOE Cost Meeting
ANA:02.08.03. Ground Water Analysis (YRS 2-5)	• Assume 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle. (104 samples/yr) • Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr) - Total Samples = 118 • All on-site sample analyses performed by mobile lab • 10% off-site verification analysis of reduced analyte list with CLP protocol (10% of 118 = 12)	Best professional judgement Best professional judgement DOE Cost Meeting DOE Cost Meeting
SUB:01.02.02 Mobilize Trailers	• Includes mobilization of field office, storage, and decon trailers	Best professional judgement
SUB:01.04.01. Setup/Construct Temporary Facilities	• Includes setup of field office, storage, and decon trailers	Best professional judgement

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TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:01.04.02. Construct Decon Area	• Work to be performed: Construct decontamination area/pad for equipment and vehicles. • Crew and Equipment • Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, 3 Group 2 Laborers Equipment: 1 backhoe, 1 pickup truck Assumed duration for this activity is 3 crew days. • Allowance for Tank Assume 1000 gal plastic tank for water collection	Best professional judgement
SUB:01.04.03. Site Survey	• Survey site for construction	Best professional judgement
SUB:01.05. Construct Temporary Utilities	• Includes connections for temporary electricity, telephone, water, and sewer services	Best professional judgement
SUB:01.06. Pre-Construction Submittals	• Includes pre-construction submittals by fixed-price contractor	Best professional judgement
SUB:03.03. Earthwork	• Includes dirtwork to prepare site	Best professional judgement
SUB:03.04. Roads/Parking/ Curbs/Walks	• Assume 10 ft wide, native materials • Road length equal to well piping length	Well spacing utilized to estimate road placement, Richardson Cost Estimating Guide
SUB:03.05. Fencing	• Allowance for Permanent Fencing Assume 7 ft high security fence	Industry standard, Best professional judgement
SUB:03.06 Electrical Distribution	• Includes pulling power to site	Best professional judgement

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:13.21.04. Construction of Permanent Plant	• Excavate and Install Building Foundation • Install Butler Building Assume a prefabricated heated building complete with frame, doors, roll up doors, gutters, insulation, and roof vent. • Reverse Osmosis Equipment/Staging Includes 1 - 150 gpm treatment system, 225 psi inlet pressure, 10% reject • Vapor Recompression Evaporator Capacity = 150 gpm x 0.1 = 15 gpm, includes startup boiler, 2% reject • Rotary Drum Filter/Dryer Liquid loading: 150 gpm x 0.1 x 0.02 = 0.30 gpm = 150 lbs/hr Drying area = 25 sf • Steam Generator Evaporate 0.30 gpm = 256,960 BTU • Allowance for Bldg Electrical Includes lighting, fixtures, motor starters, controllers, junction boxes, transformer, chart recorders, annunciators, panels, conduit, and wiring. • Allowance for Bldg Mechanical Includes equipment installation and connections, controls/instrumentation, interior piping (plastic), floor drains and piping.	Best professional judgement Vendor quote Vendor quote Richardson Cost Estimating Guide Vendor catalog Best professional judgement Best professional judgement
SUB: 20.04 Site Restoration	• Includes revegetation at end of project	Best professional judgement
SUB: 21.02.02 Demobilization	• Demobilize field office, storage, and decontamination trailers	Best professional judgement
SUB: 21.04.02. Remove Decon Area-Yr 5	• Includes removal of decontamination area • Crew and Equipment: Fixed Price Contractor:1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers Equipment: 1 backhoe, 1 pickup Output: Assumed duration for this activity is 1 crew day	Best professional judgement
SUB 21.05 Disconnect Temporary Utilities	• Includes disconnecting electricity, telephone, water, and sewer services.	Best professional judgement

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TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:06. Groundwater Collection & Control	• Drill/Install Extr/Inject Wells Note: 7 new extraction wells 80 ft deep and 5 new injection wells, 100 ft deep, 8 in diameter. Unit cost is assumed to include handling and cuttings, transport to the disposal facility, and associated disposal fees. • Allowance for Well Pumps - 10 gpm • Allowance for Water Level Monitoring Instrumentation -Assume 5 piezometers per extraction well • Assume refurbishing existing wells • Allowance for Well Head Covers Assume manhole type cover at each well head • Allowance for Well Testing	Modelling, geological reports, and actual costs from WHC RCRA Drilling Program Richardson Cost Estimating Guide, Best professional judgement Best professional judgement Best professional judgement
SUB:06.01.04 Operations and Maintenance year 3	• Allowance for Well Workover Assume 1 workover for every 3 yrs. for each well; workovers in year 3 • Allowance for Well Pump Replacement. Assume 1 pump replacement per extraction well every 3 years; pump replacements in year 3	Best professional judgement Best professional judgement
SUB:06.01.9X. Site Piping	• Allowance for Piping from Well Head to Treatment Plant Assume double-wall PVC piping for extraction well. • Allowance for Force Main Discharge Piping Assume single-wall PVC for each injection well.	Well spacing utilized to estimate flow line length, Best professional judgement

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB 21.06 Post-Construction Submittals	• Includes post-construction submittals by fixed-price contractor	Best professional judgement
WHC:02.08.02. Ground Water Analysis-Yr I	• Assume shake-down period with the following sampling of treatment system: - First 2 days: Sample every four hours of influent and effluent (24 samples) - Next 5 days: 1 sample per day of influent and effluent (10 samples) - Next 7 weeks: 1 sample per week of influent and effluent (14 samples) • 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle (104 samples/yr) • Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr) - Total samples = 166 • 90% of samples for analysis at mobile lab (90% of 166 = 149) • HACH kit samples are taken 1 per shift for the 5-yr lifecycle plus an additional 48 samples during the shake-down period. (1143 samples) • HACH Kit Replacement Assume 1 per yr	Best professional judgement, cost meeting Best professional judgement Best professional judgement DOE cost meeting DOE cost meeting

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TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
WHC:02.08.03. Ground Water Analysis-Yrs 2-5	• 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle (104 samples/yr) • Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr) - Total samples = 118 • 90% of samples for analysis at mobile lab (90% of 118 = 106) • HACH kit samples are taken 1 per shift for the 5-yr lifecycle (1143 samples) • HACH kit Replacement Assume 1 per yr	Best professional judgement DOE cost meeting DOE cost meeting DOE cost meeting
WHC:02.08.04. Ground Water Monitor Samples	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr) • Assume 2 field technicians for 6 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)	DOE cost meeting Best professional judgement
WHC:13.21.06. Personnel Training	• Note: This account to allow for operator time and an allowance for 40 hour training course	Best professional judgement
WHC:13.21.08. Operation and Maint-Yrs 1-5	• Treatment facility will be fully staffed with 2 FTE's per shift, 3 shifts per day, 7 days per week. (365 days/year x 24 hrs/day = 8760 hrs) • Reverse Osmosis filters will be replaced every week for the 12-year lifecycle. • 2 FTE crew will be composed of the following members: 0.25 ea - supervisor 1.00 ea - operator 0.50 ea - TP tech support 0.25 ea - maintenance supervisor	Best professional judgement Best professional judgement

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
WHC:13.21.08. Operation and Maint-Yrs 1-5 (Continued)	• Allowance for Electricity Wells: 806 kW-hr/d RO System: 593 kW-hr/d Recompr Evap: 1728 kW-hr/d Rotary Filter/Drum: 1806 kW-hr/d Assume 24 hrs/day x 365 days/yr Total = 1,800,545 kW-hr/yr	Vendor catalogs, vendor quotes
	• RO System Chemicals Includes scale inhibitors, $0.29/1000 gal 150 gpm x 1440 m/d x 365 d/y = 78.8 MMgpy	Vendor quote
	• Reverse Osmosis Filter Replacement Assume replacement of 2 filters on a weekly basis for the 5-year lifecycle. (52 wk/yr x 2 filters/wk)	Best professional judgement
	• Disposal Fee for Reverse Osmosis Filters Assume disposal at ERDF for years 1 - 5 of the 5-year lifecycle. Assume each filter to be 40 cu ft.	HR-3 Cost Workshop
	• Disposal Fee - Evaporation Cake 150 gpm x 325 ppm = 9.39 cf/day 9.39 cf/day x 365 days = 3427 cf/year	Best professional judgement
	Assume 50% volume increase to stabilize evaporation cake 1.5 x 3427 cf/yr = 5141 cf/yr	HR-3 Cost Workshop
	• Allowance for Water Usage. Assume 1000 gal per month usage for the 5 year lifecycle	Best professional judgement
WHC:13.21.11. Prepare Annual Report (Yr-1)	• Assume 2 FTE's for 6 months each year	HR-3 Cost Workshop
WHC:13.21.12. Prepare Annual Report (Yrs 2-5)	• Assume 2 FTE's for 4 months each year	HR-3 Cost Workshop

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H AREA HYDRAULIC CONTROL

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
ANA:02.08.02. Ground Water Analysis Yr 1-5	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples) • Assume monthly performance monitoring of 7 wells for the 5-year lifecycle. (84 Samples) - Total samples = 98 • All on-site sample analyses performed by mobile lab • 10% off-site verification analysis of reduced analyte list with CLP protocol. (10% of 98 = 10 ea)	Best professional judgement Best professional judgement DOE Cost Meeting DOE Cost Meeting
SUB:01.02.02 Mobilize Trailers	• Includes mobilization of field office, storage, and decontamination trailers	Best professional judgement
SUB:01.04.01 Setup Trailers	• Includes setup of field office, storage, and decontamination trailers	Best professional judgement
SUB:01.04.02. Construct Decon Area	• Construct decontamination area/pad for equipment and vehicles • Crew and Equipment: Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers Equipment: 1 Backhoe, 1 pickup truck Output: Assumed duration for this activity is 3 crew days. • Allowance for Tank Assume 1000 gal plastic tank for water collection	Best professional judgement
SUB:01.04.03 Site Survey	• Survey site for construction	Best professional judgement
SUB:01.05 Construct Temporary Utilities	• Includes connections for temporary electricity, telephone, water, and sewer facilities	Best professional judgement
SUB:01.06 Pre-Construction Submittals	• Includes pre-construction submittals by fixed-price contractor	Best professional judgement

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:03.03 Earthwork	• Includes dirtwork to prepare site	Best professional judgement
SUB:03.04. Roads/Parking/ Curbs/Walks	• Access Roads to Wells Assume 1500 lf of road per well, 10 ft wide, native materials 1500 lf/well x 14 wells - 21,000 lf	Well spacing utilized to estimate road placement, Richardson Cost Estimating Guide
SUB:06.01.01. Groundwater Collection and Control	• Drill/Install Extr/Inject Wells Note: 1 new extraction well, 45 ft deep and 3 new injection wells, 60 ft deep, 8 in diameter. Unit cost is assumed to include handling and packaging of contaminated well cuttings, transport to the disposal facility and associated disposal fees. • Allowance for well Head Covers Assume manhole type cover at each well head • Allowance for Well Pumps-25 gpm • Allowance for Controls and Connections at Well Heads • Allowance for Water Level Monitoring Instrumentation • Assume 5 piezometers per extraction well using well points • Allowance for well testing • Refurbishing existing wells	Modelling, geological reports, and actual costs from the WHC RCRA drilling program Best professional judgement Richardson Cost Estimating Guide, Best professional judgement Best professional judgement Best professional judgement Best professional judgement
SUB:06.01.04. Operations and Maintenance year 3	• Allowance for Well Workover Assume 1 every 3 years for each well for the 5-year lifecycle. Workovers in year 3 • Allowance for Well Pump Assume 1 pump replacement per extraction well every three years for the 5-year lifecycle. Pump replacement in year 3.	Best professional judgement Best professional judgement
SUB:06.01.9X. Site Piping	• Allowance for Piping from extraction well to consolidation facility. Assume double-wall PVC piping for extraction well. • Allowance for leak detection • Allowance for Force Main Discharge Piping Assume double-wall PVC piping for injection well.	Well spacing utilized to estimate flow line length, Best professional judgement
SUB:20.04 Site Restoration	• Includes revegetation at end of project	Best professional judgement
SUB:21.02.02 Demobilize Trailers	• Demobilize field office, storage, and decontamination trailers	Best professional judgement

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TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:21.04.02. Remove Decon Area	• Work to be performed: Remove decontamination area/pad for equipment and vehicles • Crew and Equipment: Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers Equipment: 1 backhoe, 1 pickup Output: Assumed duration for this activity is 1 crew day.	Best professional judgement
SUB:21.05 Disconnect Temporary Utilities	• Includes disconnecting electricity, telephone, water, and sewer services	Best professional judgement
SUB:21.06 Post-Construction Submittals	• Includes post-construction submittals by fixed-price contractor	Best professional judgement
WHC:02.08.02. Ground Water Analysis	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples) • Assume monthly performance monitoring of 7 wells for the 5-year lifecycle. (84 samples) - Total samples = 98 • 90% of samples analyzed by mobile lab (90% of 98 = 88) • All on-site samples analyses performed by mobile lab	DOE Cost Meeting
WHC:02.08.03. Take Ground Water Samples	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples) • Assume 2 Field Technicians for 6 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)	DOE Cost Meeting Best Professional Judgement
WHC:06.03. Hydraulic Control, Yrs 1-5	• Assume QA and safety oversite for the construction project.	Best professional judgement

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
WHC:06.05. Operation and Maintenance	• Allowance for Electricity Wells: 645 kW-h/d Assume 24 hr/day x 365 days/yr Total = 235,259 kW-h/yr	Vendor catalogs, vendor quotes
WHC: 13.21.11. Prepare Annual Report (Yr 1)	• Assume 2 FTE's for 6 months per year	HR-3 Cost Workshop
WHC: 13.21.12 Prepare Annual Report (Yrs. 2-5)	• Assume 2 FTE's for 4 months per year	HR-3 Cost Workshop

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H AREA INSTITUTIONAL CONTROLS/CURRENT ACTION

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
ANA:02.08.02. Ground Water Analysis (Yrs 1-5)	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr) • All on-site sample analyses performed by mobile lab. • 10% off-site verification analysis of reduced analyte list with CLP protocol. (10% of 14 = 1 ea)	DOE Cost Meeting
WHC:02.08.02. Ground Water Analysis (Yrs 1-5)	• Assume sampling of 7 monitoring well on a semiannual basis for the 5-year lifecycle (14 samples/yr) - Total samples = 14 • 90% of samples for analysis at mobile lab (90% of 14 = 13)	DOE Cost Meeting
WHC:02.08.04. Ground Water Monitor Samples	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr) • Assume 2 field technicians for 6 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)	DOE Cost Meeting
WHC:13.21.11 Prepare Annual Report (Yrs 1-5)	• Assume 2 FTE's for 6 months each year	HR-3 Cost Workshop

H AREA REVERSE OSMOSIS

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
ANA:02.08.02. Ground Water Analysis (YR 1)	• Assume shake-down period with the following sampling schedule for the treatment system: - First 2 days: Samples every four hours of influent and effluent (24 samples) - Next 5 days: 1 sample per day of influent and effluent (10 samples) - Next 7 weeks: 1 sample per week of influent and effluent (14 samples) • 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle (104 samples/yr) • Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr) - Total samples = 166 • All on-site samples analyses performed by mobile lab • 10% off-site verification analysis of reduced analyte list with CLP protocol. (10% of 166 = 17 ea)	Best professional judgement Best professional judgement Best professional judgement DOE Cost Meeting DOE Cost Meeting
ANA:02.08.03. Ground Water Analysis (YRS 2-5)	• Assume 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle. (104 samples/yr) • Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr) - Total Samples = 118 • All on-site sample analyses performed by mobile lab • 10% off-site verification analysis of reduced analyte list with CLP protocol (10% of 118 = 12)	Best professional judgement Best professional judgement DOE Cost Meeting DOE Cost Meeting
SUB:01.02.02 Mobilize Trailers	• Includes mobilization of field office, storage, and decon trailers	Best professional judgement
SUB:01.04.01. Setup/Construct Temporary Facilities	• Includes setup of field office, storage, and decon trailers	Best professional judgement

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TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:01.04.02. Construct Decon Area	• Work to be performed: Construct decontamination area/pad for equipment and vehicles. • Crew and Equipment • Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, 3 Group 2 Laborers Equipment: 1 backhoe, 1 pickup truck Assumed duration for this activity is 3 crew days. • Allowance for Tank Assume 1000 gal plastic tank for water collection	Best professional judgement
SUB:01.04.03. Site Survey	• Survey site for construction	Best professional judgement
SUB:01.05. Construct Temporary Utilities	• Includes connections for temporary electricity, telephone, water, and sewer services	Best professional judgement
SUB:01.06. Pre-Construction Submittals	• Includes pre-construction submittals by fixed-price contractor	Best professional judgement
SUB:03.03. Earthwork	• Includes dirtwork to prepare site	Best professional judgement
SUB:03.04. Roads/Parking/ Curbs/Walks	• Assume 10 ft wide, native materials • Road length equal to well piping length	Well spacing utilized to estimate road placement, Richardson Cost Estimating Guide
SUB:03.05. Fencing	• Allowance for Permanent Fencing Assume 7 ft high security fence	Industry standard, Best professional judgement
SUB:03.06 Electrical Distribution	• Includes pulling power to site	Best professional judgement

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:06. Groundwater Collection & Control	• Drill/Install Extr/Inject Wells Note: 1 new extraction well 45 ft deep and 3 new injection wells, 60 ft deep, 8 in diameter. Unit cost is assumed to include handling and cuttings, transport to the disposal facility, and associated disposal fees. • Allowance for Well Pumps - 25 gpm • Allowance for Water Level Monitoring Instrumentation Assume 5 peizometers per extraction well using well points • Allowance for Well Head Covers Assume manhole type cover at each well head • Allowance for Well Testing • Refurbish existing wells	Modelling, geological reports, and actual costs form WHC RCRA Drilling Program Richardson Cost Estimating Guide, Best professional judgement Best professional judgement Best professional judgement
SUB:06.01.04 Operations and Maintenance year 3	• Allowance for Well Workover Assume 1 workover for every 3 yrs. for each well; workovers in year 3 • Allowance for Well Pump Replacement. Assume 1 pump replacement per extraction well every 3 years; pump replacements in year 3	Best professional judgement Best professional judgement
SUB:06.01.9X. Site Piping	• Allowance for Piping from Well Head to Treatment Plant Assume double-wall PVC piping for extraction well. • Allowance for Force Main Discharge Piping Assume single-wall PVC for each injection well.	Well spacing utilized to estimate flow line length, Best professional judgement

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TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:13.21.04. Construction of Permanent Plant	• Excavate and Install Building Foundation • Install Butler Building Assume a prefabricated heated building complete with frame, doors, roll up doors, gutters, insulation, and roof vent. • Reverse Osmosis Equipment/Staging Includes 1 - 300 gpm treatment system, 225 psi inlet pressure, 10% reject • Vapor Recompression Evaporator Capacity = 300 gpm x 0.1 = 30 gpm, includes startup boiler, 2% reject • Rotary Drum Filter/Dryer Liquid loading: 300 gpm x 0.1 x 0.02 = 0.6 gpm = 300 lbs/hr Drying area = 50 sf • Steam Generator Evaporate 0.6 gpm = 514,000 BTU • Allowance for Bldg Electrical Includes lighting, fixtures, motor starters, controllers, junction boxes, transformer, chart recorders, annunciators, panels, conduit, and wiring. • Allowance for Bldg Mechanical Includes equipment installation and connections, controls/instrumentation, interior piping (plastic), floor drains and piping.	Best professional judgement Vendor quote Vendor quote Richardson Cost Estimating Guide Vendor catalog Best professional judgement Best professional judgement
SUB: 20.04 Site Restoration	• Includes revegetation at end of project	Best professional judgement
SUB: 21.02.02 Demobilization	• Demobilize field office, storage, and decontamination trailers	Best professional judgement
SUB: 21.04.02. Remove Decon Area-Yr 5	• Includes removal of decontamination area • Crew and Equipment: Fixed Price Contractor:1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers Equipment: 1 backhoe, 1 pickup Output: Assumed duration for this activity is 1 crew day	Best professional judgement

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB 21.05 Disconnect Temporary Utilities	• Includes disconnecting electricity, telephone, water, and sewer services.	Best professional judgement
SUB 21.06 Post-Construction Submittals	• Includes post-construction submittals by fixed-price contractor	Best professional judgement
WHC:02.08.02. Ground Water Analysis-Yr 1	• Assume shake-down period with the following sampling of treatment system: - First 2 days: Sample every four hours of influent and effluent (24 samples) - Next 5 days: 1 sample per day of influent and effluent (10 samples) - Next 7 weeks: 1 sample per week of influent and effluent (14 samples) • 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle (104 samples/yr) • Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr) - Total samples = 166 • 90% of samples for analysis at mobile lab (90% of 166 = 149) • HACH kit samples are taken 1 per shift for the 5-yr lifecycle plus an additional 48 samples during the shake-down period. (1143 samples) • HACH Kit Replacement Assume 1 per yr	Best professional judgement, cost meeting Best professional judgement Best professional judgement DOE cost meeting DOE cost meeting

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TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
WHC:02.08.03. Ground Water Analysis-Yrs 2-5	• 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle (104 samples/yr) • Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr) - Total samples = 118 • 90% of samples for analysis at mobile lab (90% of 118 = 106) • HACH kit samples are taken 1 per shift for the 5-yr lifecycle (1143 samples) • HACH kit Replacement Assume 1 per yr	Best professional judgement DOE cost meeting DOE cost meeting DOE cost meeting
WHC:02.08.04. Ground Water Monitor Samples	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr) • Assume 2 field technicians for 6 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)	DOE cost meeting Best professional judgement
WHC:13.21.06. Personnel Training	• Note: This account to allow for operator time and an allowance for 40 hour training course	Best professional judgement
WHC:13.21.08. Operation and Maint-Yrs 1-5	• Treatment facility will be fully staffed with 2 FTE's per shift, 3 shifts per day, 7 days per week. (365 days/year x 24 hrs/day = 8760 hrs) • Reverse Osmosis filters will be replaced every week for the 12-year lifecycle. • 2 FTE crew will be composed of the following members: 0.25 ea - supervisor 1.00 ea - operator 0.50 ea - TP tech support 0.25 ea - maintenance supervisor	Best professional judgement Best professional judgement

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
WHC:13.21.08. Operation and Maint- Yrs 1-5 (Continued)	• Allowance for Electricity Wells: 752 kW-hr/d RO System: 1185 kW-hr/d Recompr Evap: 3456 kW-hr/d Rotary Filter/Drum: 3612 kW-hr/d Assume 24 hrs/day x 365 days/yr Total = 3,286,825 kW-hr/yr	Vendor catalogs, vendor quotes
	• RO System Chemicals Includes scale inhibitors, $0.29/1000 gal 300 gpm x 1440 m/d x 365 d/y = 157.7 MMgpy	Vendor quote
	• Reverse Osmosis Filter Replacement Assume replacement of 2 filters on a weekly basis for the 5-year lifecycle. (52 wk/yr x 2 filters/wk)	Best professional judgement
	• Disposal Fee for Reverse Osmosis Filters Assume disposal at ERDF for years 1 - 5 of the 5-year lifecycle. Assume each filter to be 40 cu ft.	HR-3 cost workshop
	• Disposal Fee - Evaporation Cake 300 gpm x 325 ppm = 18.8 cf/day 18.8 cf/day x 365 days = 6862 cf/year	Best professional judgement
	Assume 50% volume increase to stabilize evaporation cake 1.5 x 6862 cf/yr = 10,293 cf/yr	HR-3 Cost Workshop
	• Allowance for Water Usage. Assume 1000 gal per month usage for the 5 year lifecycle	Best professional judgement
WHC:13.21.11. Prepare Annual Report (Yr-1)	• Assume 2 FTE's for 6 months each year	HR-3 Cost Workshop
WHC:13.21.12. Prepare Annual Report (Yrs 2-5)	• Assume 2 FTE's for 4 months each year	HR-3 Cost Workshop

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H AREA ION EXCHANGE

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
ANA:02.08.02. Ground Water Analysis Yr - 1	• Assume shake-down period with following sampling of treatment system: - First 2 days: Sample each day of influent and effluent (4 samples) - Next 4 weeks: 1 sample per week of influent and effluent (8 samples)	Best professional judgement
	• 1 sample every 2 weeks of the influent and effluent for remainder of year (48 samples/yr)	Best professional judgement
	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr)	Best professional judgement
	• All onsite sample analyses performed by mobile lab	DOE Cost Meeting
	• 10% offsite verification analysis of reduced analyte list with CLP protocol.	DOE Cost Meeting
ANA:02.08.03. Ground Water Analysis Yrs 2-5	• Assume 1 sample every 2 weeks of influent and effluent for the 5-yr lifecycle. (52 samples/yr)	Best professional judgement
	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-yr lifecycle (14 samples/yr)	Best professional judgement
	• All onsite samples analyses performed by mobile lab	DOE Cost Meeting
	• 10% offsite verification analysis of reduced analyte list with CLP protocol	DOE Cost Meeting
SUB:01.02.02 Mobilize Trailers	• Includes mobilization of field office, storage, and decontamination trailers	Best professional judgement
SUB:01.04.01 Setup Trailers	• Includes setup of field office, storage, and decontamination trailers	Best professional judgement

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:01.04.02. Construct Decon Area	• Work to be Performed: Construct decontamination area/pad for equipment and vehicles. • Crew and Equipment Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers • Output: Assumed duration for this activity is 3 crew days • Allowance for Tank Assume 1000 gal plastic tank for water collection	Best professional judgement
SUB:01.04.03 Site Survey	• Survey for artifacts	Best professional judgement
SUB:01.05 Construct Temporary Utilities	• Includes connections for temporary electricity, telephone, water, and sewer facilities	Best professional judgement
SUB:01.06 Pre-Construction Submittals	• Includes pre-construction submittals by fixed-price contractor	Best professional judgement
SUB:03.03 Earthwork	• Includes dirtwork to prepare site	Best professional judgement
SUB:03.04. Roads/Parking/Curbs/ Walks	• Access Roads to Wells Assume 10 ft wide, native materials • Road length equal to well piping length	Well spacing utilized to estimate road placement, Richardson Cost Estimating Guide
SUB:03.05. Fencing	• Allowance for Permanent Fencing Assume 7 ft high security fence	Industry standard, Best professional judgement

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TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:06. Groundwater Collection and Control	• Drill/install extraction wells Note: 1 new extraction well, 45 ft deep, and 3 new injection wells, 60 ft deep, 8 in diameter. Unit cost is assumed to include handling and packaging of contaminated well cuttings, transport to the disposal facility, and associated disposal fees. • Allowance for Well Pumps and Installation - 25 GPM • Allowance for Controls and Connections at Well Heads • Allowance for Water Level Monitoring Instrumentation • Assume 5 peizometers per extraction well • Assume refurbishing existing wells. • Allowance for Well Head Covers Assume manhole type cover at each well head • Allowance for Well Testing	Modelling, geological reports, and actual costs from WHC RCRA drilling program Richardson Cost Estimating Guide, Best professional judgement Best professional judgement Best professional judgement Best professional judgement Best professional judgement
SUB:06.01.04. Operations and Maintenance 3	• Allowance for Well Workover Assume 1 workover every 3 yrs for each well for the 5-year lifecycle. Workovers in year 3 • Allowance for Well Pump Replacement Assume one pump replacement and installation per well every 3 years for the 5-year lifecycle Replacement in year 3	Best professional judgement Best professional judgement
SUB:06.01.9X. Site Piping	• Allowance for Piping from Well Head to Treatment Plant - double-wall PVC piping • Allowance for Leak Detection • Allowance for Force Main Discharge Piping - single-wall PVC piping	Well spacing utilized to estimate flow line length, Best professional judgement

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
SUB:12. Chemical Treatment	• Excavate and prepare site for construction Assume a tent structure complete with frame, doors, and roll-up doors.	Vendor quote
	• Ion Exchange Equipment/Staging Includes 1 x 300 gpm treatment system. Resin included in O&M.	Vendor quote, results from treatability study
	• Allowance for Bldg Electrical Includes lighting, fixtures, motor starters, controllers, junction boxes, transformer, chart recorders, annunciators, panels, conduit, and wiring.	Best professional judgement
	• Allowance for Bldg Mechanical Includes equipment installation and connections, controls/instrumentation, interior piping (plastic), floor drains and piping.	Best professional judgement
SUB:20.04 Site Restoration	• Includes revegetation at end of project	Best professional judgement
SUB:21.04. Demobilze Temp Facilities	• Includes removal of decontamination area • Crew and Equipment: Fixed Price Contractor:1 Group 6 Operator, 3 Group 1 Laborer, and 3 Group 2 Laborers • Equipment: 1 backhoe, 1 pickup truck • Output: Assumed duration for this activity is 1 crew day	Best professional judgement
SUB:21.05 Disconnect Temporary Utilities	• Includes disconnecting electricity, telephone, water, and sewer services	Best professional judgement
SUB:21.06 Post-Construction Submittals	• Includes post-construction submittals by fixed-price contractor	Best professional judgement

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TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
WHC:02.08.02. Ground Water Analysis Yr - 1	• Assume shake-down period with following sampling of treatment system: - First 2 days: Sample each day of influent and effluent (4 samples) - Next 4 weeks: 1 sample per week of influent and effluent (8 samples)	Best professional judgement, cost meeting
	• 1 sample every 2 weeks of influent and effluent for remainder of year (48 samples/yr)	Best professional judgement
	• 90% of samples analyzed a mobile lab	DOE Cost Meeting
	• HACH kit samples are taken 2 per day for the 5-yr lifecycle plus an additional 48 samples during the shake-down period.	DOE Cost Meeting
WHC:02.08.03. Ground Water Analysis Yr 2 - 5	• Assume 1 sample every 2 weeks of the influent and effluent for the 5-yr lifecycle. (52 samples/yr)	Best professional judgement
	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr)	DOE Cost Meeting
	• 90% of samples analyzed at mobile lab	DOE Cost Meeting
	• HACH kit samples are taken 2 per day for the 5-yr lifecycle.	DOE Cost Meeting
WHC:02.08.04. Ground Water Monitor Samples	• Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr)	DOE Cost Meeting
	• Assume 2 field technicians for 6 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)	Best professional judgement
WHC:12.05.06 Personnel Training	• Includes operator time and allowance to attend 40-hour training	Best professional judgement

TASK NUMBER	ASSUMPTIONS	JUSTIFICATION
WHC:12.05.08 Operations & Maintenance Yrs 1-5	• Treatment facility will be fully staffed with 2 FTE's per shift, 1 shift per day, 7 days per week. (365 days/yr x 8 hrs/day = 2,920 hrs/yr)	Best professional judgement
	• Ion exchange media to be regenerated every 7 days for chromium treatment	Vendor quote, treatability test report results
	• 2 FTE crew will be composed of the following members: 0.25 ea - supervisor 1.00 ea - operator 0.50 - engineering support 0.25 ea - maintenance engineer	
	• Allowance for electricity Wells: 483 kW-hr/d Ion Exchange Plant: 2880 kW-hr/d Assume 24 hrs/day x 365 days/yr Total = 1,227,495 kW-hr/yr	Vendor catalogs, vendor quotes
	• Ion Exchange Media will not require replacement during the 5-year lifecycle.	Boomsnub data, best professional judgement
	• pH adjustment	Boomsnub data
	• Disposal Fee for ion exchange media Assume disposal at ERDF for year 5	HR-3 Cost Workshop
WHC:12.05.11. Prepare Annual Report Yr 1	• Assume 2 FTE's for 6 months each year	HR-3 Cost Workshop
WHC:12.05.12. Prepare Annual Report Yrs 2-5	• Assume 2 FTE's for 4 months each year	HR-3 Cost Workshop

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SECTION 1.3 COST SUMMARY TABLES

Cost Summary for D/DR Area			Cost[b]						
Cost Element			Type		Year(s) Applicable	Institutional Controls/ Continued Current Actions	Vertical Barrier (Sheet Pile)	Pump and Treat with Ion Exchange	Pump and Treat with Reverse Osmosis
			CAP	O&M					
ANA: Off-Site Analytical Services									
ANA:02	Monitoring, Sampling, and Analysis	Offsite Yr 1		x	1	4210	42,100	33,680	71,570
		Offsite Yrs 2-5		x	2-5	4210	42,100	29,470	50,520
SUB: Fixed Price Contractor									
SUB:01	Mobilization & Preparatory		x		0	-	37,580	37,860	37,850
SUB:03	Site Work		x		0	-	27,740	77,000	89,830
SUB:06	Groundwater Collection and Control	Drilling	x		0	-	229,900	1,070,630	1,070,240
		O&M 3		x	3	-	58,750	231,630	231,540
		Piping	x		0	-	144,330	439,150	438,990
		Sheet Pile	x		0	-	10,895,280	-	-
SUB:12	Chemical Treatment		x		0	-	-	1,685,720	-
SUB:13	Physical Treatment		x		0	-	-	-	1,842,570
SUB:20	Site Restoration		x		5	-	12,770	12,870	12,860
SUB:21	Demobilization		x		5	-	19,230	19,370	19,370
WHC:Westinghouse Hanford Company									
WHC:02	Monitoring, Sampling, & Analysis	Yr 1		x	1	5200	35,200	28,080	60,270
		Yrs 2-5		x	2-5	5200	35,200	25,230	43,210
		Yrs 1-5		x	1-5	660	660	660	660

Cost Summary for D/DR Area			Cost[b]						
Cost Element			Type		Year(s) Applicable	Institutional Controls/ Continued Current Actions	Vertical Barrier (Sheet Pile)	Pump and Treat with Ion Exchange	Pump and Treat with Reverse Osmosis
			CAP	O&M					
WHC:06	Groundwater Collection and Control	Yr 1		x	1	-	2290	-	-
		Yrs 1-5		x	1-5	-	2140	-	-
WHC:12	Chemical Treatment	Training Yr 1		x	1	-	-	6,900	-
		O&M Yrs 1-5		x	1-5	-	-	323,610	-
		Annual Rpt Yr 1		x	1	-	-	90,150	-
		Annual Rpt Yrs 2-5		x	2-5	-	-	60,070	-
WHC:13	Physical Treatment[a]	Training Yr 1		x	1	-	-	-	6900
		O&M Yrs 1-5		x	1-5	-	-	-	1,074,870
		Annual Rpt Yr 1		x	1	90,150	90,150	-	90,150
		Annual Rpt Yrs 2-12		x	2-5	90,150	60,070	-	60,070
Miscellaneous	Subcontractor MPR			x	1-5	-	160,492	52,184	54,652
	Project Management/Construction Management			x	1-5	2880	359,568	131,096	160,580
	General & Admin/Common Support Pool			x	1-5	5632	702,954	256,292	313,932
	Contingency			x	1-5	9994	1,213,820	445,896	549,310
	Total Miscellaneous					18,506	2,436,834	885,469	1,078,474
SUMMARY									

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Cost Summary for D/DR Area			Cost[b]						
Cost Element			Type		Year(s) Applicable	Institutional Controls/ Continued Current Actions	Vertical Barrier (Sheet Pile)	Pump and Treat with Ion Exchange	Pump and Treat with Reverse Osmosis
			CAP	O&M					
	Capital	Year 0				0	11,334,830	3,310,360	3,479,480
		Year 12				0	32,000	32,240	32,230
	Annual O&M	Year 1				118,726	2,609,374	1,367,382	2,382,894
		Years 2,4				118,726	2,577,004	1,261,906	2,307,804
		Year 3				118,726	2,635,754	1,493,536	2,539,344
		Years 5				118,726	2,577,004	1,263,072	2,307,804
	Present Worth					514,012	22,598,361	9,100,367	13,767,659

(a) For Institutional Controls/Continued Current Actions and Vertical Barrier (Sheet Pile) = Annual Report

(b) Costs for task/subtask/sub-subtask elements are obtained from the Contract Cost column in the Level 5 Project Indirect Summaries (MCACES Cost Model Runs). Yearly Miscellaneous Costs are obtained by taking 1/5 of the individual line-item Miscellaneous Costs from the Total Cost column of the Level 1 Project Direct Summaries (5 years is the project duration).

CAP Capital

O&M Operation & Maintenance

Cost Summary for H Area			Cost[b]						
Cost Element			Type		Year(s) Applicable	Institutional Controls/ Continued Current Actions	Hydraulic Control	Pump and Treat with Ion Exchange	Pump and Treat with Reverse Osmosis
			CAP	O&M					
ANA: Off-Site Analytical Services									
ANA:02	Monitoring, Sampling, and Analysis	Offsite Yr 1		x	1	4210	42,100	33,680	71,570
		Offsite Yrs 2-5		x	2-5	4210	42,100	29,470	50,520
SUB: Fixed Price Contractor									
SUB:01	Mobilization & Preparatory		x		0	-	38,110	37,870	37,830
SUB:03	Site Work		x		0	-	34,720	48,210	61,020
SUB:06	Groundwater Collection and Control	Drilling	x		0	-	425,420	422,790	422,330
		O&M 3		x	3	-	190,370	189,190	188,990
		Piping	x		0	-	272,260	262,340	262,680
SUB:12	Chemical Treatment		x		0	-	-	2,535,430	-
SUB:13	Physical Treatment		x		0	-	-	-	3,101,950
SUB:20	Site Restoration		x		5	-	12,950	12,870	12,860
SUB:21	Demobilization		x		5	-	19,500	19,380	19,360
WHC:Westinghouse Hanford Company									
WHC:02	Monitoring, Sampling, & Analysis	Yr 1		x	1	5200	35,200	28,080	60,270
		Yrs 2-5		x	2-5	5200	35,200	25,230	43,210
		Yrs 1-5		x	1-5	660	660	660	660

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Cost Summary for H Area			Cost[b]						
Cost Element			Type		Year(s) Applicable	Institutional Controls/ Continued Current Actions	Hydraulic Control	Pump and Treat with Ion Exchange	Pump and Treat with Reverse Osmosis
			CAP	O&M					
WHC:06	Groundwater Collection and Control	Yr 1		x	1	-	12,550	-	-
		Yrs 2-5		x	2-5	-	12,550	-	-
WHC:12	Chemical Treatment	Training Yr 1		x	1	-	-	6900	-
		O&M Yrs 1-5		x	1-5	-	-	483,110	-
		Annual Rpt Yr 1		x	1	-	-	90,150	-
		Annual Rpt Yrs 2-5		x	2-5	-	-	60,070	-
WHC:13	Physical Treatment[a]	Training Yr 1		x	1	-	-	-	6900
		O&M Yrs 1-5		x	1-5	-	-	-	1,171,320
		Annual Rpt Yr 1		x	1	90,150	90,150	-	90,150
		Annual Rpt Yrs 2-5		x	2-5	90,150	60,070	-	60,070
Miscellaneous	Subcontractor MPR			x	1-5	-	14,502	51,510	59,962
	Project Management/Construction Management			x	1-5	2880	37,840	134,396	175,182
	General & Admin/Common Support Pool			x	1-5	5632	73,978	262,742	342,480
	Contingency			x	1-5	9994	130,378	457,008	598,486
Total Miscellaneous						18,506	256,698	908,656	1,176,110

Cost Summary for H Area			Cost[b]					
Cost Element			Type		Year(s) Applicable	Institutional Controls/ Continued Current Actions	Hydraulic Control	Pump and Treat with Ion Exchange	Pump and Treat with Reverse Osmosis
			CAP	O&M					
SUMMARY									
	Capital	Year 0				0	770,510	3,306,640	3,885,810
		Year 5				0	32,450	32,250	32,220
	Annual O&M	Year 1				118,726	437,358	1,548,128	2,576,980
		Years 2,4				118,726	407,278	1,340,254	2,501,890
		Year 3				118,726	597,648	1,529,447	2,690,880
		Years 5				118,726	407,278	1,343,362	2,501,890
	Present Worth					514,012	2,952,294	9,498,243	14,977,502

(a) For Institutional Controls/Continued Current Actions and Hydraulic Control = Annual Report

(b) Costs for task/subtask/sub-subtask elements are obtained from the Contract Cost column of the level 5 Project Indirect Summaries (MCACES Cost Model Runs). Yearly Miscellaneous Costs are obtained by taking 1/5 of the individual line-item Miscellaneous Costs from the Total Cost Column of the Level 1 Project Direct Summaries (12 years is the project duration).

CAP Capital

O&M Operation & Maintenance

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SECTION 1.4 REMEDIAL ALTERNATIVE COST MODELS

HANFORD: ER PROGRAM
100 D/DR INSTIT CONTROLS/CONT'D
CURRENT ACTIONS
1.4.10.1.1.10.5.2.4
FOCUSED FEASIBILITY STUDY

Designed By:
Estimated By: CH2M HILL HANFORD, INC.

Prepared By: ERC CONTRACT - RICHLAND, WASH

Preparation Date: 07/21/95
Effective Date of Pricing: 09/14/94

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U.S. Army Corps of Engineers - D.O. 94 - Final
PROJECT DNOACT: HANFORD: ER PROGRAM - 100 D/DR INSTIT CONTROLS/CONT'D
100 D/DR INSTIT CONTROLS/CONT'D CURRENT ACTIONS
** PROJECT OWNER SUMMARY - CNTRCTOR (Rounded to 10's) **

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		4,210	0	0	0	1,470	5,680	
WHC Westinghouse Hanford Company		96,010	0	14,400	28,160	48,500	187,070	
TOTAL HANFORD: ER PROGRAM		100,220	0	14,400	28,160	49,970	192,750	

U.S. Army Corps of Engineers - D.O. 94 - Final
PROJECT DNOACT: HANFORD: ER PROGRAM - 100 D/DR INSTIT CONTROLS/CONT'D
100 D/DR INSTIT CONTROLS/CONT'D CURRENT ACTIONS
** PROJECT OWNER SUMMARY - FEATURE (Rounded to 10's) **

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis		4,210	0	0	0	1,470	5,680	
TOTAL Off-Site Analytical Services		4,210	0	0	0	1,470	5,680	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis		5,860	0	880	1,720	2,960	11,420	
WHC:13 Annual Report (Yrs 1-5)		90,150	0	13,520	26,440	45,540	175,640	
TOTAL Westinghouse Hanford Company		96,010	0	14,400	28,160	48,500	187,070	
TOTAL HANFORD: ER PROGRAM		100,220	0	14,400	28,160	49,970	192,750	

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	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis								
ANA:02.08 Sampling Rad Contaminated Media								
ANA:02.08.02 Ground Water Analysis (Yrs 1-5)	1.00 EA	4,210	0	0	0	1,470	5,680	5683.50
TOTAL Sampling Rad Contaminated Media		4,210	0	0	0	1,470	5,680	
TOTAL Monitoring, Sampling & Analysis		4,210	0	0	0	1,470	5,680	
TOTAL Off-Site Analytical Services		4,210	0	0	0	1,470	5,680	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis								
WHC:02.08 Sampling Rad Contaminated Media								
WHC:02.08.02 Ground Water Analysis-Yrs (1-5)	13.00 EA	5,200	0	780	1,520	2,630	10,130	779.36
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	100	190	330	1,290	53.82
TOTAL Sampling Rad Contaminated Media		5,860	0	880	1,720	2,960	11,420	
TOTAL Monitoring, Sampling & Analysis		5,860	0	880	1,720	2,960	11,420	
WHC:13 Annual Report (Yrs 1-5)								
WHC:13.21 Annual Report								
WHC:13.21.11 Prepare Annual Report	2080.00 HR	90,150	0	13,520	26,440	45,540	175,640	84.44
TOTAL Annual Report		90,150	0	13,520	26,440	45,540	175,640	
TOTAL Annual Report (Yrs 1-5)		90,150	0	13,520	26,440	45,540	175,640	
TOTAL Westinghouse Hanford Company		96,010	0	14,400	28,160	48,500	187,070	
TOTAL HANFORD: ER PROGRAM		100,220	0	14,400	28,160	49,970	192,750	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		4,210	0	0	0	0	0	4,210	
WHC Westinghouse Hanford Company		96,010	0	0	0	0	0	96,010	
HANFORD: ER PROGRAM		100,220	0	0	0	0	0	100,220	
Project Management/Construction Mgnt								14,400	
SUBTOTAL								114,620	
General & Admin/Common Support Pool								28,160	
SUBTOTAL								142,780	
Contingency								49,970	
TOTAL INCL OWNER COSTS								192,750	

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	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis		4,210	0	0	0	0	0	4,210	
TOTAL Off-Site Analytical Services		4,210	0	0	0	0	0	4,210	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis		5,860	0	0	0	0	0	5,860	
WHC:13 Annual Report (Yrs 1-5)		90,150	0	0	0	0	0	90,150	
TOTAL Westinghouse Hanford Company		96,010	0	0	0	0	0	96,010	
TOTAL HANFORD: ER PROGRAM		100,220	0	0	0	0	0	100,220	
Project Management/Construction Mgnt								14,400	
SUBTOTAL								114,620	
General & Admin/Common Support Pool								28,160	
SUBTOTAL								142,780	
Contingency								49,970	
TOTAL INCL OWNER COSTS								192,750	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis									
ANA:02.08 Sampling Rad Contaminated Media									
ANA:02.08.02 Ground Water Analysis (Yrs 1-5	1.00 EA	4,210	0	0	0	0	0	4,210	4210.00
TOTAL Sampling Rad Contaminated Medi		4,210	0	0	0	0	0	4,210	
TOTAL Monitoring, Sampling & Analysi		4,210	0	0	0	0	0	4,210	
TOTAL Off-Site Analytical Services		4,210	0	0	0	0	0	4,210	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis									
WHC:02.08 Sampling Rad Contaminated Media									
WHC:02.08.02 Ground Water Analysis-Yrs (1-5	13.00 EA	5,200	0	0	0	0	0	5,200	400.00
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	0	0	0	0	660	27.62
TOTAL Sampling Rad Contaminated Medi		5,860	0	0	0	0	0	5,860	
TOTAL Monitoring, Sampling & Analysi		5,860	0	0	0	0	0	5,860	
WHC:13 Annual Report (Yrs 1-5)									
WHC:13.21 Annual Report									
WHC:13.21.11 Prepare Annual Report	2080.00 HR	90,150	0	0	0	0	0	90,150	43.34
TOTAL Annual Report		90,150	0	0	0	0	0	90,150	
TOTAL Annual Report (Yrs 1-5)		90,150	0	0	0	0	0	90,150	
TOTAL Westinghouse Hanford Company		96,010	0	0	0	0	0	96,010	
TOTAL HANFORD: ER PROGRAM		100,220	0	0	0	0	0	100,220	
Project Management/Construction Mgnt								14,400	
SUBTOTAL								114,620	
General & Admin/Common Support Pool								28,160	
SUBTOTAL								142,780	
Contingency								49,970	

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	QUANTITY	UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
TOTAL INCL OWNER COSTS									192,750	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		0	0	0	4,210	4,210	
WHC Westinghouse Hanford Company		90,810	0	0	5,200	96,010	
TOTAL HANFORD: ER PROGRAM		90,810	0	0	9,410	100,220	
Project Management/Construction Mgnt						14,400	
SUBTOTAL						114,620	
General & Admin/Common Support Pool						28,160	
SUBTOTAL						142,780	
Contingency						49,970	
TOTAL INCL OWNER COSTS						192,750	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis		0	0	0	4,210	4,210	
TOTAL Off-Site Analytical Services		0	0	0	4,210	4,210	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis		660	0	0	5,200	5,860	
WHC:13 Annual Report (Yrs 1-5)		90,150	0	0	0	90,150	
TOTAL Westinghouse Hanford Company		90,810	0	0	5,200	96,010	
TOTAL HANFORD: ER PROGRAM		90,810	0	0	9,410	100,220	
Project Management/Construction Mgnt						14,400	
SUBTOTAL						114,620	
General & Admin/Common Support Pool						28,160	
SUBTOTAL						142,780	
Contingency						49,970	
TOTAL INCL OWNER COSTS						192,750	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis							
ANA:02.08 Sampling Rad Contaminated Media							
ANA:02.08.02 Ground Water Analysis (Yrs 1-5)	1.00 EA	0	0	0	4,210	4,210	4210.00
TOTAL Sampling Rad Contaminated Media		0	0	0	4,210	4,210	
TOTAL Monitoring, Sampling & Analysis		0	0	0	4,210	4,210	
TOTAL Off-Site Analytical Services		0	0	0	4,210	4,210	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis							
WHC:02.08 Sampling Rad Contaminated Media							
WHC:02.08.02 Ground Water Analysis-Yrs (1-5)	13.00 EA	0	0	0	5,200	5,200	400.00
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	0	0	660	27.62
TOTAL Sampling Rad Contaminated Media		660	0	0	5,200	5,860	
TOTAL Monitoring, Sampling & Analysis		660	0	0	5,200	5,860	
WHC:13 Annual Report (Yrs 1-5)							
WHC:13.21 Annual Report							
WHC:13.21.11 Prepare Annual Report	2080.00 HR	90,150	0	0	0	90,150	43.34
TOTAL Annual Report		90,150	0	0	0	90,150	
TOTAL Annual Report (Yrs 1-5)		90,150	0	0	0	90,150	
TOTAL Westinghouse Hanford Company		90,810	0	0	5,200	96,010	
TOTAL HANFORD: ER PROGRAM		90,810	0	0	9,410	100,220	
Project Management/Construction Mgnt						14,400	
SUBTOTAL						114,620	
General & Admin/Common Support Pool						28,160	
SUBTOTAL						142,780	
Contingency						49,970	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
TOTAL INCL OWNER COSTS						192,750	

ANA:02. Monitoring, Sampling & Analysis	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

ANA. Off-Site Analytical Services
ANA:02. Monitoring, Sampling & Analysis
ANA:02.08. Sampling Rad Contaminated Media
ANA:02.08.02. Ground Water Analysis (Yrs 1-5)

Assumptions:

1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr)

   - Total samples = 14

2. All on-site sample analyses performed by mobile lab.

3. 10% off-site verification analysis of reduced analyte list with CLP protocol. (10% of 14 = 1 ea)

ANA	Analyze LLW Sample - Off-site Lab	1.00	EA	0.00 0	0.00 0	0.00 0	4210.00 4,210	4210.00 4,210	4210.00
TOTAL	Ground Water Analysis (Yrs 1-5)	1.00	EA	0	0	0	4,210	4,210	4210.00
TOTAL	Sampling Rad Contaminated Media			0	0	0	4,210	4,210	
TOTAL	Monitoring, Sampling & Analysis			0	0	0	4,210	4,210	
TOTAL	Off-Site Analytical Services			0	0	0	4,210	4,210	

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WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

WHC. Westinghouse Hanford Company
WHC:02. Monitoring, Sampling & Analysis
WHC:02.08. Sampling Rad Contaminated Media
WHC:02.08.02. Ground Water Analysis-Yrs (1-5)

Assumptions:

1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr)

   - Total samples = 14

2. 90% of samples for analysis at mobile lab (90% of 14 = 13)

WHC	Analyze LLW Sample - Mobile Lab		0.00	0.00	0.00	400.00	400.00
		13.00 EA	0	0	0	5,200	5,200	400.00
TOTAL	Ground Water Analysis-Yrs (1-5)	13.00 EA	0	0	0	5,200	5,200	400.00

WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:02.08.04. Ground Water Monitor Samples							
Work to be Performed:							
Take semiannual groundwater monitoring samples.							
Assumptions:							
1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr)							
2. Assume 2 field Technicians for 6 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)							
WHC Technician, Environmental		27.62	0.00	0.00	0.00	27.62	
Restoration Ops - 2 ea	24.00 HR 85201	663	0	0	0	663	27.62
TOTAL Ground Water Monitor Samples	24.00 HR	663	0	0	0	663	27.62
TOTAL Sampling Rad Contaminated Media		663	0	0	5,200	5,863	
TOTAL Monitoring, Sampling & Analysis		663	0	0	5,200	5,863	

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WHC:13. Annual Report (Yrs 1-5)	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:13. Annual Report (Yrs 1-5)							
WHC:13.21. Annual Report							
WHC:13.21.11. Prepare Annual Report							
Assume 2 FTE's for 6 months each year.							
WHC Engineer, Environmental		43.34	0.00	0.00	0.00	43.34	
Restoration Ops - 1 ea	1040.00 HR 85101	45,074	0	0	0	45,074	43.34
WHC Scientist, Environmental		43.34	0.00	0.00	0.00	43.34	
Restoration Ops - 1 ea	1040.00 HR 85102	45,074	0	0	0	45,074	43.34
TOTAL Prepare Annual Report	2080.00 HR	90,148	0	0	0	90,148	43.34
TOTAL Annual Report		90,148	0	0	0	90,148	
TOTAL Annual Report (Yrs 1-5)		90,148	0	0	0	90,148	
TOTAL Westinghouse Hanford Company		90,811	0	0	5,200	96,011	
TOTAL HANFORD: ER PROGRAM		90,811	0	0	9,410	100,221	

SRC	LABOR ID	DESCRIPTION	BASE	OVERTM	TXS/INS	FRNG	TRVL	RATE	UOM	UPDATE	**** TOTAL **** DEFAULT	HOURS
WHC	85101	Engineer, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	1040
WHC	85102	Scientist, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	1040
WHC	85201	Technician, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	24

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SRC	EQUIP ID	DESCRIPTION	DEPR	CAPT	FUEL	FOG	EQ REP	TR WR	TR REP	TOTAL	UOM	** TOTAL HOURS **

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HANFORD: ER PROGRAM
D AREA SHEET PILE
1.4.10.1.1.10.5.2.4
VERTICAL BARRIER
FOCUSED FEASIBILITY STUDY

Designed By:
Estimated By: CH2M HILL HANFORD, INC.

Prepared By: ERC CONTRACT - RICHLANDM, WASH

Preparation Date: 07/20/95
Effective Date of Pricing: 09/14/94

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U.S. Army Corps of Engineers - D.O. 94 - Final
PROJECT DSHTPL: HANFORD: ER PROGRAM - D AREA SHEET PILE
VERTICAL BARRIER MODEL 100-HR-3 / 100 D AREA
** PROJECT OWNER SUMMARY - CNTRCTOR (Rounded to 10's) **

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		42,100	0	0	0	14,740	56,840	
SUB Fixed Price Contractor		10,992,610	802,460	1,769,260	3,458,900	5,958,130	22,981,370	
WHC Westinghouse Hanford Company		190,520	0	28,580	55,870	96,240	371,200	
TOTAL HANFORD: ER PROGRAM		11,225,220	802,460	1,797,840	3,514,770	6,069,100	23,409,400	

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis		42,100	0	0	0	14,740	56,840	
TOTAL Off-Site Analytical Services		42,100	0	0	0	14,740	56,840	
SUB Fixed Price Contractor								
SUB:01 Mobilization & Preparatory Work		37,580	2,740	6,050	11,830	20,370	78,570	
SUB:03 Site Work		27,740	2,030	4,460	8,730	15,040	58,000	
SUB:06 Groundwater Collection & Control		10,895,280	795,360	1,753,600	3,428,280	5,905,380	22,777,900	
SUB:20 Site Restoration		12,770	930	2,060	4,020	6,920	26,700	
SUB:21 Demobilization		19,230	1,400	3,100	6,050	10,420	40,200	
TOTAL Fixed Price Contractor		10,992,610	802,460	1,769,260	3,458,900	5,958,130	22,981,370	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis		35,860	0	5,380	10,520	18,120	69,870	
WHC:06 Groundwater Collection & Control		4,430	0	670	1,300	2,240	8,640	
WHC:13 Annual Report		150,220	0	22,530	44,050	75,880	292,680	
TOTAL Westinghouse Hanford Company		190,520	0	28,580	55,870	96,240	371,200	
TOTAL HANFORD: ER PROGRAM		11,225,220	802,460	1,797,840	3,514,770	6,069,100	23,409,400	

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	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis								
ANA:02.08 Sampling Rad Contaminated Media								
ANA:02.08.02 Ground Water Analysis Yr 1-5	10.00 EA	42,100	0	0	0	14,740	56,840	5683.50
TOTAL Sampling Rad Contaminated Media		42,100	0	0	0	14,740	56,840	
TOTAL Monitoring, Sampling & Analysis		42,100	0	0	0	14,740	56,840	
TOTAL Off-Site Analytical Services		42,100	0	0	0	14,740	56,840	
SUB Fixed Price Contractor								
SUB:01 Mobilization & Preparatory Work								
SUB:01.02 Mobilize Personnel & Equipment								
SUB:01.02.02 Mobilize Trailers		960	70	150	300	520	2,000	
TOTAL Mobilize Personnel & Equipment		960	70	150	300	520	2,000	
SUB:01.04 Setup/Construct Temp Facilities								
SUB:01.04.01 Establish Facilities								
SUB:01.04.01.02 Setup Trailers		4,860	360	780	1,530	2,640	10,170	
TOTAL Establish Facilities		4,860	360	780	1,530	2,640	10,170	
SUB:01.04.02 Construct Decon Area	24.00 HR	11,740	860	1,890	3,690	6,360	24,540	1022.56
SUB:01.04.03 Site Survey		1,280	90	210	400	690	2,670	
TOTAL Setup/Construct Temp Facilities		17,880	1,310	2,880	5,630	9,690	37,380	
SUB:01.05 Construct Temporary Utilities		5,970	440	960	1,880	3,240	12,480	
SUB:01.06 Pre-Construction Submittals	4.00 EA	12,770	930	2,060	4,020	6,920	26,700	6675.43
TOTAL Mobilization & Preparatory Work		37,580	2,740	6,050	11,830	20,370	78,570	
SUB:03 Site Work								
SUB:03.03 Earthwork		6,390	470	1,030	2,010	3,460	13,350	
SUB:03.04 Roads/Parking/Curbs/Walks		21,360	1,560	3,440	6,720	11,570	44,650	

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
TOTAL Site Work		27,740	2,030	4,460	8,730	15,040	58,000	
SUB:06 Groundwater Collection & Control								
SUB:06.01 Extraction & Injection Wells								
SUB:06.01.01 Well Drilling & Construction	4.00 EA	229,900	16,780	37,000	72,340	124,610	480,630	120157.72
SUB:06.01.04 Operations and Maintenance Yr 3		58,750	4,290	9,460	18,490	31,840	122,830	
SUB:06.01.9X Site Piping		144,330	10,540	23,230	45,410	78,230	301,730	
TOTAL Extraction & Injection Wells		432,980	31,610	69,690	136,240	234,680	905,190	
SUB:06.03 Sheet Pile		10,462,310	763,750	1,683,910	3,292,040	5,670,700	21,872,710	
TOTAL Groundwater Collection & Control		10,895,280	795,360	1,753,600	3,428,280	5,905,380	22,777,900	
SUB:20 Site Restoration								
SUB:20.04 Revegetation and Planting		12,770	930	2,060	4,020	6,920	26,700	
TOTAL Site Restoration		12,770	930	2,060	4,020	6,920	26,700	
SUB:21 Demobilization								
SUB:21.02 Demobilize Personnel & Equipment								
SUB:21.02.02 Demobilize Trailers		960	70	150	300	520	2,000	
TOTAL Demobilize Personnel & Equipment		960	70	150	300	520	2,000	
SUB:21.04 Demobilize Temp Facilities								
SUB:21.04.02 Remove Decon Area	8.00 HR	2,310	170	370	730	1,250	4,820	602.79
TOTAL Demobilize Temp Facilities		2,310	170	370	730	1,250	4,820	
SUB:21.05 Disconnect Temporary Utilities		3,190	230	510	1,000	1,730	6,680	
SUB:21.06 Post-Construction Submittals	4.00 EA	12,770	930	2,060	4,020	6,920	26,700	6675.43
TOTAL Demobilization		19,230	1,400	3,100	6,050	10,420	40,200	
TOTAL Fixed Price Contractor		10,992,610	802,460	1,769,260	3,458,900	5,958,130	22,981,370	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis								

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	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
WHC:02.08 Sampling Rad Cntmntd Media 1-5								
WHC:02.08.02 Ground Water Analysis	88.00 EA	35,200	0	5,280	10,320	17,780	68,580	779.35
WHC:02.08.03 Take Ground Water Samples	24.00 HR	660	0	100	190	330	1,290	53.82
TOTAL Sampling Rad Cntmntd Media 1-5		35,860	0	5,380	10,520	18,120	69,870	
TOTAL Monitoring, Sampling & Analysis		35,860	0	5,380	10,520	18,120	69,870	
WHC:06 Groundwater Collection & Control								
WHC:06.03 Vertical Barrier (Sheet Pile		2,290	0	340	670	1,160	4,460	
WHC:06.05 Operation and Maintenance, 1-5		2,140	0	320	630	1,080	4,180	
TOTAL Groundwater Collection & Control		4,430	0	670	1,300	2,240	8,640	
WHC:13 Annual Report								
WHC:13.21 Annual Report								
WHC:13.21.11 Prepare Annual Report (Yr 1)		90,150	0	13,520	26,440	45,540	175,640	
WHC:13.21.12 Prepare Annual Report (Yrs 2-5)		60,070	0	9,010	17,620	30,340	117,040	
TOTAL Annual Report		150,220	0	22,530	44,050	75,880	292,680	
TOTAL Annual Report		150,220	0	22,530	44,050	75,880	292,680	
TOTAL Westinghouse Hanford Company		190,520	0	28,580	55,870	96,240	371,200	
TOTAL HANFORD: ER PROGRAM		11,225,220	802,460	1,797,840	3,514,770	6,069,100	23,409,400	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		42,100	0	0	0	0	0	42,100	
SUB Fixed Price Contractor		8,606,700	1,635,270	635,000	64,210	51,420	0	10,992,610	
WHC Westinghouse Hanford Company		190,520	0	0	0	0	0	190,520	
HANFORD: ER PROGRAM		8,839,320	1,635,270	635,000	64,210	51,420	0	11,225,220	
Subcontractor MPR								802,460	
SUBTOTAL								12,027,690	
Project Management/Construction Mgnt								1,797,840	
SUBTOTAL								13,825,520	
General & Admin/Common Support Pool								3,514,770	
SUBTOTAL								17,340,300	
Contingency								6,069,100	
TOTAL INCL OWNER COSTS								23,409,400	

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	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis		42,100	0	0	0	0	0	42,100	
TOTAL Off-Site Analytical Services		42,100	0	0	0	0	0	42,100	
SUB Fixed Price Contractor									
SUB:01 Mobilization & Preparatory Work		29,430	5,590	2,170	220	180	0	37,580	
SUB:03 Site Work		21,720	4,130	1,600	160	130	0	27,740	
SUB:06 Groundwater Collection & Control		8,530,500	1,620,800	629,380	63,640	50,970	0	10,895,280	
SUB:20 Site Restoration		10,000	1,900	740	70	60	0	12,770	
SUB:21 Demobilization		15,060	2,860	1,110	110	90	0	19,230	
TOTAL Fixed Price Contractor		8,606,700	1,635,270	635,000	64,210	51,420	0	10,992,610	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis		35,860	0	0	0	0	0	35,860	
WHC:06 Groundwater Collection & Control		4,430	0	0	0	0	0	4,430	
WHC:13 Annual Report		150,220	0	0	0	0	0	150,220	
TOTAL Westinghouse Hanford Company		190,520	0	0	0	0	0	190,520	
TOTAL HANFORD: ER PROGRAM		8,839,320	1,635,270	635,000	64,210	51,420	0	11,225,220	
Subcontractor MPR								802,460	
SUBTOTAL								12,027,690	
Project Management/Construction Mgnt								1,797,840	
SUBTOTAL								13,825,520	
General & Admin/Common Support Pool								3,514,770	
SUBTOTAL								17,340,300	
Contingency								6,069,100	
TOTAL INCL OWNER COSTS								23,409,400	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis									
ANA:02.08 Sampling Rad Contaminated Media									
ANA:02.08.02 Ground Water Analysis Yr 1-5	10.00 EA	42,100	0	0	0	0	0	42,100	4210.00
TOTAL Sampling Rad Contaminated M		42,100	0	0	0	0	0	42,100	
TOTAL Monitoring, Sampling & Anal		42,100	0	0	0	0	0	42,100	
TOTAL Off-Site Analytical Service		42,100	0	0	0	0	0	42,100	
SUB Fixed Price Contractor									
SUB:01 Mobilization & Preparatory Work									
SUB:01.02 Mobilize Personnel & Equipment									
SUB:01.02.02 Mobilize Trailers		750	140	60	10	0	0	960	
TOTAL Mobilize Personnel & Equipm		750	140	60	10	0	0	960	
SUB:01.04 Setup/Construct Temp Facilities									
SUB:01.04.01 Establish Facilities									
SUB:01.04.01.02 Setup Trailers		3,810	720	280	30	20	0	4,860	
TOTAL Establish Facilities		3,810	720	280	30	20	0	4,860	
SUB:01.04.02 Construct Decon Area	24.00 HR	9,190	1,750	680	70	50	0	11,740	489.12
SUB:01.04.03 Site Survey		1,000	190	70	10	10	0	1,280	
TOTAL Setup/Construct Temp Facili		14,000	2,660	1,030	100	80	0	17,880	
SUB:01.05 Construct Temporary Utilities		4,680	890	340	30	30	0	5,970	
SUB:01.06 Pre-Construction Submittals	4.00 EA	10,000	1,900	740	70	60	0	12,770	3193.04
TOTAL Mobilization & Preparatory		29,430	5,590	2,170	220	180	0	37,580	
SUB:03 Site Work									
SUB:03.03 Earthwork		5,000	950	370	40	30	0	6,390	
SUB:03.04 Roads/Parking/Curbs/Walks		16,720	3,180	1,230	120	100	0	21,360	

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	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
TOTAL Site Work		21,720	4,130	1,600	160	130	0	27,740	
SUB:06 Groundwater Collection & Control									
SUB:06.01 Extraction & Injection Wells									
SUB:06.01.01 Well Drilling & Construction	4.00 EA	180,000	34,200	13,280	1,340	1,080	0	229,900	57474.69
SUB:06.01.04 Operations and Maintenance Yr		46,000	8,740	3,390	340	270	0	58,750	
SUB:06.01.9X Site Piping		113,000	21,470	8,340	840	680	0	144,330	
TOTAL Extraction & Injection Well		339,000	64,410	25,010	2,530	2,030	0	432,980	
SUB:06.03 Sheet Pile		8,191,500	1,556,390	604,370	61,110	48,940	0	10,462,310	
TOTAL Groundwater Collection & Co		8,530,500	1,620,800	629,380	63,640	50,970	0	10,895,280	
SUB:20 Site Restoration									
SUB:20.04 Revegetation and Planting		10,000	1,900	740	70	60	0	12,770	
TOTAL Site Restoration		10,000	1,900	740	70	60	0	12,770	
SUB:21 Demobilization									
SUB:21.02 Demobilize Personnel & Equipment									
SUB:21.02.02 Demobilize Trailers		750	140	60	10	0	0	960	
TOTAL Demobilize Personnel & Equi		750	140	60	10	0	0	960	
SUB:21.04 Demobilize Temp Facilities									
SUB:21.04.02 Remove Decon Area	8.00 HR	1,810	340	130	10	10	0	2,310	288.33
TOTAL Demobilize Temp Facilities		1,810	340	130	10	10	0	2,310	
SUB:21.05 Disconnect Temporary Utilities		2,500	480	180	20	10	0	3,190	
SUB:21.06 Post-Construction Submittals	4.00 EA	10,000	1,900	740	70	60	0	12,770	3193.04
TOTAL Demobilization		15,060	2,860	1,110	110	90	0	19,230	
TOTAL Fixed Price Contractor		8,606,700	1,635,270	635,000	64,210	51,420	0	10,992,610	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis									

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
WHC:02.08 Sampling Rad Cntmntd Media 1-5									
WHC:02.08.02 Ground Water Analysis	88.00 EA	35,200	0	0	0	0	0	35,200	400.00
WHC:02.08.03 Take Ground Water Samples	24.00 HR	660	0	0	0	0	0	660	27.62
TOTAL Sampling Rad Cntmntd Media		35,860	0	0	0	0	0	35,860	
TOTAL Monitoring, Sampling & Anal		35,860	0	0	0	0	0	35,860	
WHC:06 Groundwater Collection & Control									
WHC:06.03 Vertical Barrier (Sheet Pile		2,290	0	0	0	0	0	2,290	
WHC:06.05 Operation and Maintenance, 1-5		2,140	0	0	0	0	0	2,140	
TOTAL Groundwater Collection & Co		4,430	0	0	0	0	0	4,430	
WHC:13 Annual Report									
WHC:13.21 Annual Report									
WHC:13.21.11 Prepare Annual Report (Yr 1)		90,150	0	0	0	0	0	90,150	
WHC:13.21.12 Prepare Annual Report (Yrs 2-5		60,070	0	0	0	0	0	60,070	
TOTAL Annual Report		150,220	0	0	0	0	0	150,220	
TOTAL Annual Report		150,220	0	0	0	0	0	150,220	
TOTAL Westinghouse Hanford Compan		190,520	0	0	0	0	0	190,520	
TOTAL HANFORD: ER PROGRAM		8,839,320	1,635,270	635,000	64,210	51,420	0	11,225,220	
Subcontractor MPR								802,460	
SUBTOTAL								12,027,690	
Project Management/Construction Mgnt								1,797,840	
SUBTOTAL								13,825,520	
General & Admin/Common Support Pool								3,514,770	
SUBTOTAL								17,340,300	
Contingency								6,069,100	
TOTAL INCL OWNER COSTS								23,409,400	

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U.S. Army Corps of Engineers - D.O. 94 - Final
PROJECT DSHTPL: HANFORD: ER PROGRAM - D AREA SHEET PILE
VERTICAL BARRIER MODEL 100-HR-3 / 100 D AREA
** PROJECT DIRECT SUMMARY - CNTRCTOR (Rounded to 10's) **

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		0	0	0	42,100	42,100	
SUB Fixed Price Contractor		13,550	2,930	7,010	8,583,220	8,606,700	
WHC Westinghouse Hanford Company		153,170	0	0	37,340	190,520	
TOTAL HANFORD: ER PROGRAM		166,720	2,930	7,010	8,662,660	8,839,320	
Overhead						1,635,270	
SUBTOTAL						10,474,590	
Profit						635,000	
SUBTOTAL						11,109,590	
Bond						64,210	
SUBTOTAL						11,173,800	
B&O Tax						51,420	
TOTAL INCL INDIRECTS						11,225,220	
Subcontractor MPR						802,460	
SUBTOTAL						12,027,690	
Project Management/Construction Mgnt						1,797,840	
SUBTOTAL						13,825,520	
General & Admin/Common Support Pool						3,514,770	
SUBTOTAL						17,340,300	
Contingency						6,069,100	
TOTAL INCL OWNER COSTS						23,409,400	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis		0	0	0	42,100	42,100	
TOTAL Off-Site Analytical Services		0	0	0	42,100	42,100	
SUB Fixed Price Contractor							
SUB:01 Mobilization & Preparatory Work		9,600	1,820	7,010	11,000	29,430	
SUB:03 Site Work		0	0	0	21,720	21,720	
SUB:06 Groundwater Collection & Control		0	0	0	8,530,500	8,530,500	
SUB:20 Site Restoration		0	0	0	10,000	10,000	
SUB:21 Demobilization		3,950	1,110	0	10,000	15,060	
TOTAL Fixed Price Contractor		13,550	2,930	7,010	8,583,220	8,606,700	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis		660	0	0	35,200	35,860	
WHC:06 Groundwater Collection & Control		2,290	0	0	2,140	4,430	
WHC:13 Annual Report		150,220	0	0	0	150,220	
TOTAL Westinghouse Hanford Company		153,170	0	0	37,340	190,520	
TOTAL HANFORD: ER PROGRAM		166,720	2,930	7,010	8,662,660	8,839,320	
Overhead						1,635,270	
SUBTOTAL						10,474,590	
Profit						635,000	
SUBTOTAL						11,109,590	
Bond						64,210	
SUBTOTAL						11,173,800	
B&O Tax						51,420	
TOTAL INCL INDIRECTS						11,225,220	
Subcontractor MPR						802,460	
SUBTOTAL						12,027,690	
Project Management/Construction Mgnt						1,797,840	
SUBTOTAL						13,825,520	
General & Admin/Common Support Pool						3,514,770	
SUBTOTAL						17,340,300	
Contingency						6,069,100	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
TOTAL INCL OWNER COSTS						23,409,400	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis							
ANA:02.08 Sampling Rad Contaminated Media							
ANA:02.08.02 Ground Water Analysis Yr 1-5	10.00 EA	0	0	0	42,100	42,100	4210.00
TOTAL Sampling Rad Contaminated Media		0	0	0	42,100	42,100	
TOTAL Monitoring, Sampling & Analysis		0	0	0	42,100	42,100	
TOTAL Off-Site Analytical Services		0	0	0	42,100	42,100	
SUB Fixed Price Contractor							
SUB:01 Mobilization & Preparatory Work							
SUB:01.02 Mobilize Personnel & Equipment							
SUB:01.02.02 Mobilize Trailers		0	750	0	0	750	
TOTAL Mobilize Personnel & Equipment		0	750	0	0	750	
SUB:01.04 Setup/Construct Temp Facilities							
SUB:01.04.01 Establish Facilities							
SUB:01.04.01.02 Setup Trailers		3,000	0	810	0	3,810	
TOTAL Establish Facilities		3,000	0	810	0	3,810	
SUB:01.04.02 Construct Decon Area	24.00 HR	4,350	1,070	3,770	0	9,190	382.96
SUB:01.04.03 Site Survey		0	0	0	1,000	1,000	
TOTAL Setup/Construct Temp Facilities		7,350	1,070	4,580	1,000	14,000	
SUB:01.05 Construct Temporary Utilities		2,250	0	2,430	0	4,680	
SUB:01.06 Pre-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Mobilization & Preparatory Work		9,600	1,820	7,010	11,000	29,430	
SUB:03 Site Work							
SUB:03.03 Earthwork		0	0	0	5,000	5,000	
SUB:03.04 Roads/Parking/Curbs/Walks		0	0	0	16,720	16,720	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
TOTAL Site Work		0	0	0	21,720	21,720	
SUB:06 Groundwater Collection & Control							
SUB:06.01 Extraction & Injection Wells							
SUB:06.01.01 Well Drilling & Construction	4.00 EA	0	0	0	180,000	180,000	45000.00
SUB:06.01.04 Operations and Maintenance Yr 3		0	0	0	46,000	46,000	
SUB:06.01.9X Site Piping		0	0	0	113,000	113,000	
TOTAL Extraction & Injection Wells		0	0	0	339,000	339,000	
SUB:06.03 Sheet Pile		0	0	0	8,191,500	8,191,500	
TOTAL Groundwater Collection & Control		0	0	0	8,530,500	8,530,500	
SUB:20 Site Restoration							
SUB:20.04 Revegetation and Planting		0	0	0	10,000	10,000	
TOTAL Site Restoration		0	0	0	10,000	10,000	
SUB:21 Demobilization							
SUB:21.02 Demobilize Personnel & Equipment							
SUB:21.02.02 Demobilize Trailers		0	750	0	0	750	
TOTAL Demobilize Personnel & Equipment		0	750	0	0	750	
SUB:21.04 Demobilize Temp Facilities							
SUB:21.04.02 Remove Decon Area	8.00 HR	1,450	360	0	0	1,810	225.75
TOTAL Demobilize Temp Facilities		1,450	360	0	0	1,810	
SUB:21.05 Disconnect Temporary Utilities		2,500	0	0	0	2,500	
SUB:21.06 Post-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Demobilization		3,950	1,110	0	10,000	15,060	
TOTAL Fixed Price Contractor		13,550	2,930	7,010	8,583,220	8,606,700	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis							

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:02.08 Sampling Rad Cntmntd Media 1-5							
WHC:02.08.02 Ground Water Analysis	88.00 EA	0	0	0	35,200	35,200	400.00
WHC:02.08.03 Take Ground Water Samples	24.00 HR	660	0	0	0	660	27.62
TOTAL Sampling Rad Cntmntd Media 1-5		660	0	0	35,200	35,860	
TOTAL Monitoring, Sampling & Analysis		660	0	0	35,200	35,860	
WHC:06 Groundwater Collection & Control							
WHC:06.03 Vertical Barrier (Sheet Pile		2,290	0	0	0	2,290	
WHC:06.05 Operation and Maintenance, 1-5		0	0	0	2,140	2,140	
TOTAL Groundwater Collection & Control		2,290	0	0	2,140	4,430	
WHC:13 Annual Report							
WHC:13.21 Annual Report							
WHC:13.21.11 Prepare Annual Report (Yr 1)		90,150	0	0	0	90,150	
WHC:13.21.12 Prepare Annual Report (Yrs 2-5)		60,070	0	0	0	60,070	
TOTAL Annual Report		150,220	0	0	0	150,220	
TOTAL Annual Report		150,220	0	0	0	150,220	
TOTAL Westinghouse Hanford Company		153,170	0	0	37,340	190,520	
TOTAL HANFORD: ER PROGRAM		166,720	2,930	7,010	8,662,660	8,839,320	
Overhead						1,635,270	
SUBTOTAL						10,474,590	
Profit						635,000	
SUBTOTAL						11,109,590	
Bond						64,210	
SUBTOTAL						11,173,800	
B&O Tax						51,420	
TOTAL INCL INDIRECTS						11,225,220	
Subcontractor MPR						802,460	
SUBTOTAL						12,027,690	
Project Management/Construction Mgnt						1,797,840	
SUBTOTAL						13,825,520	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
General & Admin/Common Support Pool						3,514,770	
SUBTOTAL						17,340,300	
Contingency						6,069,100	
TOTAL INCL OWNER COSTS						23,409,400	

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ANA:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

ANA. Off-Site Analytical Services
ANA:02. Monitoring, Sampling & Analysis
ANA:02.08. Sampling Rad Contaminated Media
ANA:02.08.02. Ground Water Analysis Yr 1-5

Assumptions:

1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle.
   (14 samples)

2. Assume monthly performance monitoring of 7 wells for the 5-year lifecycle.
   (84 samples)

   - Total samples = 98

3. All on-site sample analyses performed by mobile lab

4. 10% off-site verification analysis of reduced analyte list with CLP protocol.
   (10% of 98 = 10 ea)

ANA	Analyze LLW Sample - Off-site Lab	10.00 EA	0.00 0	0.00 0	0.00 0	4210.00 42,100	4210.00 42,100	4210.00
TOTAL	Ground Water Analysis Yr 1-5	10.00 EA	0	0	0	42,100	42,100	4210.00
TOTAL	Sampling Rad Contaminated Media		0	0	0	42,100	42,100	
TOTAL	Monitoring, Sampling & Analysis		0	0	0	42,100	42,100	
TOTAL	Off-Site Analytical Services		0	0	0	42,100	42,100	

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB. Fixed Price Contractor							
SUB:01. Mobilization & Preparatory Work							
SUB:01.02. Mobilize Personnel & Equipment							
SUB:01.02.02. Mobilize Trailers							
FPC S3 Mobilize Field Office Trailer	1.00 EA	0.00 0	250.00 250	0.00 0	0.00 0	250.00 250	250.00
FPC S3 Mobilize Storage Trailer	1.00 EA	0.00 0	250.00 250	0.00 0	0.00 0	250.00 250	250.00
FPC S3 Mobilize Decon Trailer	1.00 EA	0.00 0	250.00 250	0.00 0	0.00 0	250.00 250	250.00
TOTAL Mobilize Trailers		0	750	0	0	750	
TOTAL Mobilize Personnel & Equipment		0	750	0	0	750	

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04. Setup/Construct Temp Facilities							
SUB:01.04.01. Establish Facilities							
SUB:01.04.01.02. Setup Trailers							
M FPC S3 Setup Field Office Trailer		1000.00	0.00	269.50	0.00	1269.50	
	1.00 EA	1,000	0	270	0	1,270	1269.50
M FPC S3 Setup Storage Trailer		1000.00	0.00	269.50	0.00	1269.50	
	1.00 EA	1,000	0	270	0	1,270	1269.50
M FPC S3 Setup Decon Trailer		1000.00	0.00	269.50	0.00	1269.50	
	1.00 EA	1,000	0	270	0	1,270	1269.50
TOTAL Setup Trailers		3,000	0	809	0	3,809	
TOTAL Establish Facilities		3,000	0	809	0	3,809	

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SUB:01. Mobilization & Preparatory Work	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04.02. Construct Decon Area									
Work to be Performed:									
Construct decontamination area/pad for equipment and vehicles.									
Crew and Equipment:									
Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers									
Equipment: 1 backhoe, 1 pickup truck									
Output:									
Assumed duration for this activity is 3 crew days.									
FPC S3 Laborer Group - 1				25.20	0.00	0.00	0.00	25.20	
- 3 ea	72.00	HR	0029	1,814	0	0	0	1,814	25.20
FPC S3 Laborer Group - 2				25.50	0.00	0.00	0.00	25.50	
- 3 ea	72.00	HR	0030	1,836	0	0	0	1,836	25.50
FPC S3 Group-6 Power Equipment Operator				29.10	0.00	0.00	0.00	29.10	
- 1 ea	24.00	HR	0039	698	0	0	0	698	29.10
FPC S3 Small Tools - 2 ea				0.00	1.40	0.00	0.00	1.40	
	48.00	HR	XMIXX020	0	67	0	0	67	1.40
FPC S3 TRK,HWY,4X4,F250,3/4T,8800 GVW				0.00	7.31	0.00	0.00	7.31	
4X4 3/4 TON PICK-UP	24.00	HR	T50FO004	0	175	0	0	175	7.31
- 1 ea									
FPC S3 HYD EXCAV,TRK MTD,.5 CY BKT,6X4				0.00	34.44	0.00	0.00	34.44	
HYDRO-SCOPIC - 1 ea	24.00	HR	H30BA001	0	827	0	0	827	34.44
M FPC S3 Construction Materials/Supplies				0.00	0.00	2156.00	0.00	2156.00	
Allowance	1.00	LS		0	0	2,156	0	2,156	2156.00
M FPC S3 Allowance for Tank				0.00	0.00	1617.00	0.00	1617.00	
Assume 1000 gal plastic tank	1.00	EA		0	0	1,617	0	1,617	1617.00
for water collection									
TOTAL Construct Decon Area	24.00	HR		4,349	1,069	3,773	0	9,191	382.96

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04.03. Site Survey							
FPC S3 Allowance for Site Survey		0.00	0.00	0.00	1000.00	1000.00	
	1.00 LS	0	0	0	1,000	1,000	1000.00
TOTAL Site Survey		0	0	0	1,000	1,000	
TOTAL Setup/Construct Temp Facilities		7,349	1,069	4,582	1,000	14,000	

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SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.05. Construct Temporary Utilities							
M FPC S3 Allowance for Temporary Power		1.00	0.00	1.08	0.00	2.08	
	500.00 LF	500	0	539	0	1,039	2.08
M FPC S3 Allowance for Telephone		0.50	0.00	0.54	0.00	1.04	
	500.00 LF	250	0	270	0	520	1.04
M FPC S3 Allowance for Temporary Water and Sewer Service		3.00	0.00	3.23	0.00	6.23	
	500.00 LF	1,500	0	1,617	0	3,117	6.23
TOTAL Construct Temporary Utilities		2,250	0	2,426	0	4,676	

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.06. Pre-Construction Submittals							
FPC S3 Allowance for Pre-Construction Submittals by Fixed Price Contractor		0.00	0.00	0.00	2500.00	2500.00	
	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Pre-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Mobilization & Preparatory Work		9,599	1,819	7,007	11,000	29,425	

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SUB:03. Site Work	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03. Site Work									
SUB:03.03. Earthwork									
FPC S3 Allowance for Site Preparation				0.00	0.00	0.00	5000.00	5000.00	
	1.00	LS		0	0	0	5,000	5,000	5000.00
TOTAL Earthwork				0	0	0	5,000	5,000	

SUB:03. Site Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.04. Roads/Parking/Curbs/Walks							
FPC S3 Allowance for Access Road		0.00	0.00	0.00	10.00	10.00	
	400.00 SY	0	0	0	4,000	4,000	10.00
FPC S3 Access Roads to Wells		0.00	0.00	0.00	2.12	2.12	
Asume 1500 lf of road per well, 10 ft wide, native materials 1500 lf/well x 4 wells = 6000 lf	6000.00 LF	0	0	0	12,720	12,720	2.12
TOTAL Roads/Parking/Curbs/Walks		0	0	0	16,720	16,720	
TOTAL Site Work		0	0	0	21,720	21,720	

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SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06. Groundwater Collection & Control							
SUB:06.01. Extraction & Injection Wells							
SUB:06.01.01. Well Drilling & Construction							
FPC S3 Drill/Install Extr/Inject Wells		0.00	0.00	0.00	500.00	500.00	
Note: 2 new extraction wells and 2 new injection wells, 50 ft deep, 8 in diameter. Unit cost is assumed to include handling and packaging of contaminated well cuttings, transport to the disposal facility, and associated disposal fees.	200.00 LF	0	0	0	100,000	100,000	500.00
FPC S3 Allowance Well Head Covers		0.00	0.00	0.00	1000.00	1000.00	
Assume manhole type cover at each well head	4.00 EA	0	0	0	4,000	4,000	1000.00
FPC S3 Allowance for Well Pumps, 10 GPM		0.00	0.00	0.00	3000.00	3000.00	
	2.00 EA	0	0	0	6,000	6,000	3000.00
FPC S3 Allowance for Controls and Connections at Well Heads		0.00	0.00	0.00	10000.00	10000.00	
	4.00 EA	0	0	0	40,000	40,000	10000.00
FPC S3 Allowance for Water Level Monitoring Instrumentation Assume 5 piezometers per extraction well using well points		0.00	0.00	0.00	1000.00	1000.00	
	10.00 EA	0	0	0	10,000	10,000	1000.00
FPC S3 Allowance for Well Testing		0.00	0.00	0.00	5000.00	5000.00	
	4.00 EA	0	0	0	20,000	20,000	5000.00
TOTAL Well Drilling & Construction	4.00 EA	0	0	0	180,000	180,000	45000.00

SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06.01.04. Operations and Maintenance Yr 3							
FPC S3 Allowance for Well Workover		0.00	0.00	0.00	10000.00	10000.00	
Assume 1 every 3 yrs for each well for the 5-year lifecycle. Workovers in year 3	4.00 EA	0	0	0	40,000	40,000	10000.00
FPC S3 Allowance for Well Pump Replacement		0.00	0.00	0.00	3000.00	3000.00	
Assume 1 pump replacement per extraction well every three years for the 5-year lifecycle. Pump replacement in year 3	2.00 EA	0	0	0	6,000	6,000	3000.00
TOTAL Operations and Maintenance Yr 3		0	0	0	46,000	46,000	

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SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06.01.9X. Site Piping							
FPC S3 Allowance for Piping From extraction well to treatment plant. Assume 1500 lf of double wall PVC piping per extraction well 1500 lf/well x 2 wells = 3000 lf	3000.00 LF	0.00 0	0.00 0	0.00 0	18.00 54,000	18.00 54,000	18.00
FPC S3 Allowance for Leak Detection	1.00 LS	0.00 0	0.00 0	0.00 0	5000.00 5,000	5000.00 5,000	5000.00
FPC S3 Allowance for Force Main Discharge Piping Assume 1500 lf of double-wall PVC piping per injection well 1500 lf/well x 2 wells = 3000 lf	3000.00 LF	0.00 0	0.00 0	0.00 0	18.00 54,000	18.00 54,000	18.00
TOTAL Site Piping		0	0	0	113,000	113,000	
TOTAL Extraction & Injection Wells		0	0	0	339,000	339,000	

SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06.03. Sheet Pile							
FPC S3 Construct Sheet Pile Wall		0.00	0.00	0.00	38.00	38.00	
Assume 50 ft deep x 4300 lf Includes mob of equipment, excavation, and installation of sheet piles.	215000 SF	0	0	0	8,170,000	8,170,000	38.00
FPC S3 Install Soil Cap over Barrier		0.00	0.00	0.00	5.00	5.00	
	4300.00 LF	0	0	0	21,500	21,500	5.00
TOTAL Sheet Pile		0	0	0	8,191,500	8,191,500	
TOTAL Groundwater Collection & Control		0	0	0	8,530,500	8,530,500	

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SUB:20. Site Restoration	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:20. Site Restoration							
SUB:20.04. Revegetation and Planting							
FPC S3 Allowance for Site Restoration	5000.00 SY	0.00 0	0.00 0	0.00 0	2.00 10,000	2.00 10,000	2.00
TOTAL Revegetation and Planting		0	0	0	10,000	10,000	
TOTAL Site Restoration		0	0	0	10,000	10,000	

SUB:21. Demobilization	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21. Demobilization									
SUB:21.02. Demobilize Personnel & Equipment									
SUB:21.02.02. Demobilize Trailers									
FPC S3 Demob Field Office Trailer				0.00	250.00	0.00	0.00	250.00	
	1.00	EA		0	250	0	0	250	250.00
FPC S3 Demob Storage Trailer				0.00	250.00	0.00	0.00	250.00	
	1.00	EA		0	250	0	0	250	250.00
FPC S3 Demob Decon Trailer				0.00	250.00	0.00	0.00	250.00	
	1.00	EA		0	250	0	0	250	250.00
TOTAL Demobilize Trailers				0	750	0	0	750	
TOTAL Demobilize Personnel & Equipment				0	750	0	0	750	

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SUB:21. Demobilization	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.04. Demobilize Temp Facilities									
SUB:21.04.02. Remove Decon Area									

Work to be Performed:
Remove decontamination area/pad for equipment and vehicles.

Crew and Equipment:
Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers
Equipment: 1 backhoe, 1 pickup truck

Output:
Assumed duration for this activity is 1 crew day.

FPC S3 Group-6 Power Equipment Operator - 1 ea	8.00	HR	0039	29.10 233	0.00 0	0.00 0	0.00 0	29.10 233	29.10
FPC S3 Laborer Group - 1 - 3 ea	24.00	HR	0029	25.20 605	0.00 0	0.00 0	0.00 0	25.20 605	25.20
FPC S3 Laborer Group - 2 - 3 ea	24.00	HR	0030	25.50 612	0.00 0	0.00 0	0.00 0	25.50 612	25.50
FPC S3 HYD EXCAV,TRK MTD,.5 CY BKT,6X4 HYDRO-SCOPIC - 1 ea	8.00	HR	H30BA001	0.00 0	34.44 276	0.00 0	0.00 0	34.44 276	34.44
FPC S3 TRK,HWY,4X4,F250,3/4T,8800 GVW 4X4 3/4 TON PICK-UP - 1 ea	8.00	HR	T50F0004	0.00 0	7.31 58	0.00 0	0.00 0	7.31 58	7.31
FPC S3 Small Tools - 2 ea	16.00	HR	XMIXX020	0.00 0	1.40 22	0.00 0	0.00 0	1.40 22	1.40
TOTAL Remove Decon Area	8.00	HR		1,450	356	0	0	1,806	225.75
TOTAL Demobilize Temp Facilities				1,450	356	0	0	1,806	

SUB:21. Demobilization	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.05. Disconnect Temporary Utilities							
M FPC S3 Remove Temporary Power		1.00	0.00	0.00	0.00	1.00	
	500.00 LF	500	0	0	0	500	1.00
M FPC S3 Remove Telephone		1.00	0.00	0.00	0.00	1.00	
	500.00 LF	500	0	0	0	500	1.00
M FPC S3 Remove Temporary Water and Sewer Service		3.00	0.00	0.00	0.00	3.00	
	500.00 LF	1,500	0	0	0	1,500	3.00
TOTAL Disconnect Temporary Utilities		2,500	0	0	0	2,500	

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SUB:21. Demobilization	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.06. Post-Construction Submittals							
FPC S3 Allowance for Post-Construction Submittals by Fixed Price Contractor	4.00 EA	0.00 0	0.00 0	0.00 0	2500.00 10,000	2500.00 10,000	2500.00
TOTAL Post-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Demobilization		3,950	1,106	0	10,000	15,056	
TOTAL Fixed Price Contractor		13,548	2,926	7,007	8,583,220	8,606,701	

WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

WHC. Westinghouse Hanford Company
WHC:02. Monitoring, Sampling & Analysis
WHC:02.08. Sampling Rad Cntmntd Media 1-5
WHC:02.08.02. Ground Water Analysis

Assumptions:

1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle.
   (14 samples)

2. Assume monthly performance monitoring of 7 wells for the 5-year lifecycle.
   (84 samples)

   - Total samples = 98

3. 90% of samples analyzed by mobile lab
   (90% of 98 = 88)

4. All on-site sample analyses performed by mobile lab

WHC Analyze LLW Sample - Mobile Lab		0.00	0.00	0.00	400.00	400.00	
	88.00 EA	0	0	0	35,200	35,200	400.00
TOTAL Ground Water Analysis	88.00 EA	0	0	0	35,200	35,200	400.00

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WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:02.08.03. Take Ground Water Samples							
Assumptions:							
1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples)							
2. Assume 2 Field Technicians for 6 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)							
WHC Technician, Environmental Restoration Ops - 2 ea	24.00 HR 85201	27.62 663	0.00 0	0.00 0	0.00 0	27.62 663	27.62
TOTAL Take Ground Water Samples	24.00 HR	663	0	0	0	663	27.62
TOTAL Sampling Rad Cntmntd Media 1-5		663	0	0	35,200	35,863	
TOTAL Monitoring, Sampling & Analysis		663	0	0	35,200	35,863	

WHC:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:06. Groundwater Collection & Control							
WHC:06.03. Vertical Barrier (Sheet Pile Wall), Yr 1							
Assume WHC QA and safety oversite for the construction project.							
WHC Technician, Environmental (Yr 1)		28.62	0.00	0.00	0.00	28.62	
Restoration Ops	80.00 HR 85201	2,290	0	0	0	2,290	28.62
TOTAL Vertical Barrier (Sheet Pile		2,290	0	0	0	2,290	

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WHC:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:06.05. Operation and Maintenance, 1-5							
WHC Allowance for Electricity		0.00	0.00	0.00	0.04	0.04	
Wells: 147 kW-hr/d	53600 KWH	0	0	0	2,144	2,144	0.04
Assume 24 hrs/day x 365 days/yr							
Total = 53,600 kW-hr/yr							
TOTAL Operation and Maintenance, 1-5		0	0	0	2,144	2,144	
TOTAL Groundwater Collection & Control		2,290	0	0	2,144	4,434	

WHC:13. Annual Report		QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:13. Annual Report										
WHC:13.21. Annual Report										
WHC:13.21.11. Prepare Annual Report (Yr 1)										
Assume 2 FTE's for 6 months each year										
WHC	Engineer, Environmental				43.34	0.00	0.00	0.00	43.34	
	Restoration Ops	1040.00	HR	85101	45,074	0	0	0	45,074	43.34
WHC	Scientist, Environmental				43.34	0.00	0.00	0.00	43.34	
	Restoration Ops	1040.00	HR	85102	45,074	0	0	0	45,074	43.34
TOTAL	Prepare Annual Report (Yr 1)				90,148	0	0	0	90,148	

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WHC:13. Annual Report	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:13.21.12. Prepare Annual Report (Yrs 2-5) Assume 66% Year 1 Annual Report effort (2 FTE's for 4 months per year)							
WHC Engineer, Environmental		43.34	0.00	0.00	0.00	43.34	
Restoration Ops - 1 ea	693.00 HR 85101	30,035	0	0	0	30,035	43.34
WHC Scientist, Environmental		43.34	0.00	0.00	0.00	43.34	
Restoration Ops - 1 ea	693.00 HR 85102	30,035	0	0	0	30,035	43.34
TOTAL Prepare Annual Report (Yrs 2-5)		60,070	0	0	0	60,070	
TOTAL Annual Report		150,218	0	0	0	150,218	
TOTAL Annual Report		150,218	0	0	0	150,218	
TOTAL Westinghouse Hanford Company		153,171	0	0	37,344	190,515	
TOTAL HANFORD: ER PROGRAM		166,719	2,926	7,007	8,662,664	8,839,316	

SRC	LABOR ID	DESCRIPTION	BASE	OVERTM	TXS/INS	FRNG	TRVL	RATE	UOM	UPDATE	**** TOTAL **** DEFAULT	HOURS
FPC	0029	Laborer Group - 1	15.84	0.0%	28.7%	3.57	1.25	25.20	HR	07/09/93	0.00	96
FPC	0030	Laborer Group - 2	16.09	0.0%	28.5%	3.57	1.25	25.50	HR	07/09/93	0.00	96
FPC	0039	Group-6 Power Equipment Operator	18.02	0.0%	27.4%	4.90	1.25	29.10	HR	07/09/93	0.00	32
WHC	85101	Engineer, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	1733
WHC	85102	Scientist, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	1733
WHC	85201	Technician, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	104

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SRC	EQUIP ID	DESCRIPTION	DEPR	CAPT	FUEL	FOG	EQ REP	TR WR	TR REP	TOTAL UOM	** TOTAL ** HOURS
USR	H30BA001	HYD EXCAV,TRK MTD,.5 CY BKT,6X4			12.07	1.4	19.78	0.98	0.15	34.44 HR	32
USR	T50FO004	TRK,HWY,4X4,F250,3/4T,8800 GVW			2.67	0.7	3.58	0.27	0.04	7.31 HR	32
MIL	XMIXX020	Small Tools	0.47	0.17	0.13	0.0	0.57			1.40 HR	64

HANFORD: ER PROGRAM
D AREA ION EXCHANGE
FOCUSED FEASIBILITY STUDY
ION EXCHANGE REMEDIATION
OU 100-HR-3 / D AREA

Designed By:
Estimated By: CH2M HILL HANFORD,INC.

Prepared By: ERC CONTRACT - RICHLAND, WASH

Preparation Date: 07/26/95
Effective Date of Pricing: 09/14/94

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PROJECT DAREIX: HANFORD: ER PROGRAM - D AREA ION EXCHANGE
ION EXCHANGE REMEDIATION MODEL 100-HR-3/ D AREA
** PROJECT OWNER SUMMARY - CNTRCTOR (Rounded to 10's) **

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		63,150	0	0	0	22,100	85,250	
SUB Fixed Price Contractor		3,574,230	260,920	575,270	1,124,660	1,937,280	7,472,350	
WHC Westinghouse Hanford Company		534,710	0	80,210	156,800	270,100	1,041,820	
TOTAL HANFORD: ER PROGRAM		4,172,080	260,920	655,480	1,281,460	2,229,480	8,599,420	

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis		63,150	0	0	0	22,100	85,250	
TOTAL Off-Site Analytical Services		63,150	0	0	0	22,100	85,250	
SUB Fixed Price Contractor								
SUB:01 Mobilization & Preparatory Work		37,860	2,760	6,090	11,910	20,520	79,160	
SUB:03 Site Work		77,000	5,620	12,390	24,230	41,730	160,970	
SUB:06 Groundwater Collection & Control		1,741,400	127,120	280,280	547,940	943,860	3,640,600	
SUB:12 Chemical Treatment		1,685,720	123,060	271,320	530,430	913,680	3,524,210	
SUB:20 Site Restoration		12,870	940	2,070	4,050	6,970	26,900	
SUB:21 Demobilization		19,370	1,410	3,120	6,100	10,500	40,500	
TOTAL Fixed Price Contractor		3,574,230	260,920	575,270	1,124,660	1,937,280	7,472,350	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis		53,970	0	8,100	15,830	27,260	105,160	
WHC:12 Chemical Treatment		480,740	0	72,110	140,980	242,840	936,660	
TOTAL Westinghouse Hanford Company		534,710	0	80,210	156,800	270,100	1,041,820	
TOTAL HANFORD: ER PROGRAM		4,172,080	260,920	655,480	1,281,460	2,229,480	8,599,420	

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	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis								
ANA:02.08 Sampling Rad Contaminated Media								
ANA:02.08.02 Ground Water Analysis Yr - 1	8.00 EA	33,680	0	0	0	11,790	45,470	5683.50
ANA:02.08.03 Ground Water Analysis Yrs 2-5	7.00 EA	29,470	0	0	0	10,310	39,780	5683.50
TOTAL Sampling Rad Contaminated Media		63,150	0	0	0	22,100	85,250	
TOTAL Monitoring, Sampling & Analysis		63,150	0	0	0	22,100	85,250	
TOTAL Off-Site Analytical Services		63,150	0	0	0	22,100	85,250	
SUB Fixed Price Contractor								
SUB:01 Mobilization & Preparatory Work								
SUB:01.02 Mobilize Personnel & Equipment								
SUB:01.02.02 Mobilize Trailers		970	70	160	300	520	2,020	
TOTAL Mobilize Personnel & Equipment		970	70	160	300	520	2,020	
SUB:01.04 Setup/Construct Temp Facilities								
SUB:01.04.01 Establish Facilities								
SUB:01.04.01.02 Setup Trailers		4,900	360	790	1,540	2,660	10,250	
TOTAL Establish Facilities		4,900	360	790	1,540	2,660	10,250	
SUB:01.04.02 Construct Decon Area	24.00 HR	11,830	860	1,900	3,720	6,410	24,730	1030.25
SUB:01.04.03 Site Survey		1,290	90	210	400	700	2,690	
TOTAL Setup/Construct Temp Facilities		18,010	1,320	2,900	5,670	9,760	37,660	
SUB:01.05 Construct Temporary Utilities		6,020	440	970	1,890	3,260	12,580	
SUB:01.06 Pre-Construction Submittals	4.00 EA	12,870	940	2,070	4,050	6,970	26,900	6725.59
TOTAL Mobilization & Preparatory Work		37,860	2,760	6,090	11,910	20,520	79,160	
SUB:03 Site Work								
SUB:03.03 Earthwork		6,430	470	1,040	2,020	3,490	13,450	
SUB:03.04 Roads/Parking/Curbs/Walks		60,720	4,430	9,770	19,110	32,910	126,940	

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
SUB:03.05 Fencing		9,840	720	1,580	3,100	5,340	20,580	
TOTAL Site Work		77,000	5,620	12,390	24,230	41,730	160,970	
SUB:06 Groundwater Collection & Control								
SUB:06.01 Extraction & Injection Wells								
SUB:06.01.01 Well Drilling & Construction		1,070,630	78,160	172,320	336,880	580,290	2,238,270	
SUB:06.01.04 Operations and Maintenance Yr 3		231,630	16,910	37,280	72,880	125,540	484,240	
SUB:06.01.9X Site Piping		439,150	32,060	70,680	138,180	238,020	918,090	
TOTAL Extraction & Injection Wells		1,741,400	127,120	280,280	547,940	943,860	3,640,600	
TOTAL Groundwater Collection & Control		1,741,400	127,120	280,280	547,940	943,860	3,640,600	
SUB:12 Chemical Treatment								
SUB:12.05 Ion Exchange								
SUB:12.05.04 Construction of Permanent Plant	1.00 EA	1,685,720	123,060	271,320	530,430	913,680	3,524,210	3524206.60
TOTAL Ion Exchange		1,685,720	123,060	271,320	530,430	913,680	3,524,210	
TOTAL Chemical Treatment		1,685,720	123,060	271,320	530,430	913,680	3,524,210	
SUB:20 Site Restoration								
SUB:20.04 Revegetation and Planting		12,870	940	2,070	4,050	6,970	26,900	
TOTAL Site Restoration		12,870	940	2,070	4,050	6,970	26,900	
SUB:21 Demobilization								
SUB:21.02 Demobilize Personnel & Equipment								
SUB:21.02.02 Demobilize Trailers		970	70	160	300	520	2,020	
TOTAL Demobilize Personnel & Equipment		970	70	160	300	520	2,020	
SUB:21.04 Demobilize Temp Facilities								
SUB:21.04.02 Remove Decon Area	8.00 HR	2,320	170	370	730	1,260	4,860	607.32
TOTAL Demobilize Temp Facilities		2,320	170	370	730	1,260	4,860	

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
SUB:21.05 Disconnect Temporary Utilities		3,220	230	520	1,010	1,740	6,730	
SUB:21.06 Post-Construction Submittals	4.00 EA	12,870	940	2,070	4,050	6,970	26,900	6725.59
TOTAL Demobilization		19,370	1,410	3,120	6,100	10,500	40,500	
TOTAL Fixed Price Contractor		3,574,230	260,920	575,270	1,124,660	1,937,280	7,472,350	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis								
WHC:02.08 Sampling Rad Contaminated Media								
WHC:02.08.02 Ground Water Analysis - Yr 1	1.00 EA	28,080	0	4,210	8,230	14,180	54,710	54706.82
WHC:02.08.03 Ground Water Analysis - Yrs 2-5	1.00 EA	25,230	0	3,780	7,400	12,740	49,160	49157.82
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	100	190	330	1,290	53.82
TOTAL Sampling Rad Contaminated Media		53,970	0	8,100	15,830	27,260	105,160	
TOTAL Monitoring, Sampling & Analysis		53,970	0	8,100	15,830	27,260	105,160	
WHC:12 Chemical Treatment								
WHC:12.05 Ion Exchange								
WHC:12.05.06 Personnel Training		6,900	0	1,040	2,020	3,490	13,450	
WHC:12.05.08 Operation & Maintenance Yrs 1-5	1.00 YR	323,610	0	48,540	94,900	163,470	630,520	630523.69
WHC:12.05.11 Prepare Annual Report (Yr 1)	2080.00 HR	90,150	0	13,520	26,440	45,540	175,640	84.44
WHC:12.05.12 Prepare Annual Report (Yrs 2-5)	1386.00 HR	60,070	0	9,010	17,620	30,340	117,040	84.44
TOTAL Ion Exchange		480,740	0	72,110	140,980	242,840	936,660	
TOTAL Chemical Treatment		480,740	0	72,110	140,980	242,840	936,660	
TOTAL Westinghouse Hanford Company		534,710	0	80,210	156,800	270,100	1,041,820	
TOTAL HANFORD: ER PROGRAM		4,172,080	260,920	655,480	1,281,460	2,229,480	8,599,420	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		63,150	0	0	0	0	0	63,150	
SUB Fixed Price Contractor		2,777,580	527,740	225,750	26,430	16,720	0	3,574,230	
WHC Westinghouse Hanford Company		530,530	0	0	0	0	4,180	534,710	
HANFORD: ER PROGRAM		3,371,260	527,740	225,750	26,430	16,720	4,180	4,172,080	
Subcontractor MPR								260,920	
SUBTOTAL								4,433,000	
Project Management/Construction Mgnt								655,480	
SUBTOTAL								5,088,480	
General & Admin/Common Support Pool								1,281,460	
SUBTOTAL								6,369,940	
Contingency								2,229,480	
TOTAL INCL OWNER COSTS								8,599,420	

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U.S. Army Corps of Engineers - D.O. 94 - Final
PROJECT DAREIX: HANFORD: ER PROGRAM - D AREA ION EXCHANGE
ION EXCHANGE REMEDIATION MODEL 100-HR-3/ D AREA
** PROJECT INDIRECT SUMMARY - FEATURE (Rounded to 10's) **

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis		63,150	0	0	0	0	0	63,150	
TOTAL Off-Site Analytical Services		63,150	0	0	0	0	0	63,150	
SUB Fixed Price Contractor									
SUB:01 Mobilization & Preparatory Work		29,430	5,590	2,390	280	180	0	37,860	
SUB:03 Site Work		59,830	11,370	4,860	570	360	0	77,000	
SUB:06 Groundwater Collection & Control		1,353,270	257,120	109,990	12,880	8,150	0	1,741,400	
SUB:12 Chemical Treatment		1,310,000	248,900	106,470	12,460	7,890	0	1,685,720	
SUB:20 Site Restoration		10,000	1,900	810	100	60	0	12,870	
SUB:21 Demobilization		15,060	2,860	1,220	140	90	0	19,370	
TOTAL Fixed Price Contractor		2,777,580	527,740	225,750	26,430	16,720	0	3,574,230	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis		53,970	0	0	0	0	0	53,970	
WHC:12 Chemical Treatment		476,560	0	0	0	0	4,180	480,740	
TOTAL Westinghouse Hanford Company		530,530	0	0	0	0	4,180	534,710	
TOTAL HANFORD: ER PROGRAM		3,371,260	527,740	225,750	26,430	16,720	4,180	4,172,080	
Subcontractor MPR								260,920	
SUBTOTAL								4,433,000	
Project Management/Construction Mgnt								655,480	
SUBTOTAL								5,088,480	
General & Admin/Common Support Pool								1,281,460	
SUBTOTAL								6,369,940	
Contingency								2,229,480	
TOTAL INCL OWNER COSTS								8,599,420	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis									
ANA:02.08 Sampling Rad Contaminated Media									
ANA:02.08.02 Ground Water Analysis Yr - 1	8.00 EA	33,680	0	0	0	0	0	33,680	4210.00
ANA:02.08.03 Ground Water Analysis Yrs 2-5	7.00 EA	29,470	0	0	0	0	0	29,470	4210.00
TOTAL Sampling Rad Contaminated M		63,150	0	0	0	0	0	63,150	
TOTAL Monitoring, Sampling & Anal		63,150	0	0	0	0	0	63,150	
TOTAL Off-Site Analytical Service		63,150	0	0	0	0	0	63,150	
SUB Fixed Price Contractor									
SUB:01 Mobilization & Preparatory Work									
SUB:01.02 Mobilize Personnel & Equipment									
SUB:01.02.02 Mobilize Trailers		750	140	60	10	0	0	970	
TOTAL Mobilize Personnel & Equipm		750	140	60	10	0	0	970	
SUB:01.04 Setup/Construct Temp Facilities									
SUB:01.04.01 Establish Facilities									
SUB:01.04.01.02 Setup Trailers		3,810	720	310	40	20	0	4,900	
TOTAL Establish Facilities		3,810	720	310	40	20	0	4,900	
SUB:01.04.02 Construct Decon Area	24.00 HR	9,190	1,750	750	90	60	0	11,830	492.80
SUB:01.04.03 Site Survey		1,000	190	80	10	10	0	1,290	
TOTAL Setup/Construct Temp Facili		14,000	2,660	1,140	130	80	0	18,010	
SUB:01.05 Construct Temporary Utilities		4,680	890	380	40	30	0	6,020	
SUB:01.06 Pre-Construction Submittals	4.00 EA	10,000	1,900	810	100	60	0	12,870	3217.03
TOTAL Mobilization & Preparatory		29,430	5,590	2,390	280	180	0	37,860	
SUB:03 Site Work									
SUB:03.03 Earthwork		5,000	950	410	50	30	0	6,430	
SUB:03.04 Roads/Parking/Curbs/Walks		47,180	8,970	3,840	450	280	0	60,720	

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	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
SUB:03.05 Fencing		7,650	1,450	620	70	50	0	9,840	
TOTAL Site Work		59,830	11,370	4,860	570	360	0	77,000	
SUB:06 Groundwater Collection & Control									
SUB:06.01 Extraction & Injection Wells									
SUB:06.01.01 Well Drilling & Construction		832,000	158,080	67,620	7,920	5,010	0	1,070,630	
SUB:06.01.04 Operations and Maintenance Yr		180,000	34,200	14,630	1,710	1,080	0	231,630	
SUB:06.01.9X Site Piping		341,270	64,840	27,740	3,250	2,050	0	439,150	
TOTAL Extraction & Injection Well		1,353,270	257,120	109,990	12,880	8,150	0	1,741,400	
TOTAL Groundwater Collection & Co		1,353,270	257,120	109,990	12,880	8,150	0	1,741,400	
SUB:12 Chemical Treatment									
SUB:12.05 Ion Exchange									
SUB:12.05.04 Construction of Permanent Plan	1.00 EA	1,310,000	248,900	106,470	12,460	7,890	0	1,685,720	1685723.35
TOTAL Ion Exchange		1,310,000	248,900	106,470	12,460	7,890	0	1,685,720	
TOTAL Chemical Treatment		1,310,000	248,900	106,470	12,460	7,890	0	1,685,720	
SUB:20 Site Restoration									
SUB:20.04 Revegetation and Planting		10,000	1,900	810	100	60	0	12,870	
TOTAL Site Restoration		10,000	1,900	810	100	60	0	12,870	
SUB:21 Demobilization									
SUB:21.02 Demobilize Personnel & Equipment									
SUB:21.02.02 Demobilize Trailers		750	140	60	10	0	0	970	
TOTAL Demobilize Personnel & Equi		750	140	60	10	0	0	970	
SUB:21.04 Demobilize Temp Facilities									
SUB:21.04.02 Remove Decon Area	8.00 HR	1,810	340	150	20	10	0	2,320	290.50
TOTAL Demobilize Temp Facilities		1,810	340	150	20	10	0	2,320	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
SUB:21.05 Disconnect Temporary Utilities		2,500	480	200	20	20	0	3,220	
SUB:21.06 Post-Construction Submittals	4.00 EA	10,000	1,900	810	100	60	0	12,870	3217.03
TOTAL Demobilization		15,060	2,860	1,220	140	90	0	19,370	
TOTAL Fixed Price Contractor		2,777,580	527,740	225,750	26,430	16,720	0	3,574,230	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis									
WHC:02.08 Sampling Rad Contaminated Media									
WHC:02.08.02 Ground Water Analysis - Yr 1	1.00 EA	28,080	0	0	0	0	0	28,080	28078.00
WHC:02.08.03 Ground Water Analysis - Yrs 2-	1.00 EA	25,230	0	0	0	0	0	25,230	25230.00
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	0	0	0	0	660	27.62
TOTAL Sampling Rad Contaminated M		53,970	0	0	0	0	0	53,970	
TOTAL Monitoring, Sampling & Anal		53,970	0	0	0	0	0	53,970	
WHC:12 Chemical Treatment									
WHC:12.05 Ion Exchange									
WHC:12.05.06 Personnel Training		6,900	0	0	0	0	0	6,900	
WHC:12.05.08 Operation & Maintenance Yrs 1-	1.00 YR	319,430	0	0	0	0	4,180	323,610	323613.08
WHC:12.05.11 Prepare Annual Report (Yr 1)	2080.00 HR	90,150	0	0	0	0	0	90,150	43.34
WHC:12.05.12 Prepare Annual Report (Yrs 2-5	1386.00 HR	60,070	0	0	0	0	0	60,070	43.34
TOTAL Ion Exchange		476,560	0	0	0	0	4,180	480,740	
TOTAL Chemical Treatment		476,560	0	0	0	0	4,180	480,740	
TOTAL Westinghouse Hanford Compan		530,530	0	0	0	0	4,180	534,710	
TOTAL HANFORD: ER PROGRAM		3,371,260	527,740	225,750	26,430	16,720	4,180	4,172,080	
Subcontractor MPR								260,920	
SUBTOTAL								4,433,000	
Project Management/Construction Mgnt								655,480	
SUBTOTAL								5,088,480	
General & Admin/Common Support Pool								1,281,460	
SUBTOTAL								6,369,940	
Contingency								2,229,480	

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	QUANTITY	UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
TOTAL INCL OWNER COSTS									8,599,420	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		0	0	0	63,150	63,150	
SUB Fixed Price Contractor		13,550	2,930	7,010	2,754,100	2,777,580	
WHC Westinghouse Hanford Company		336,990	0	93,730	99,810	530,530	
TOTAL HANFORD: ER PROGRAM		350,530	2,930	100,740	2,917,060	3,371,260	
Overhead						527,740	
SUBTOTAL						3,899,000	
Profit						225,750	
SUBTOTAL						4,124,750	
Bond						26,430	
SUBTOTAL						4,151,180	
B&O Tax						16,720	
SUBTOTAL						4,167,900	
Material/Supply MPR						4,180	
TOTAL INCL INDIRECTS						4,172,080	
Subcontractor MPR						260,920	
SUBTOTAL						4,433,000	
Project Management/Construction Mgnt						655,480	
SUBTOTAL						5,088,480	
General & Admin/Common Support Pool						1,281,460	
SUBTOTAL						6,369,940	
Contingency						2,229,480	
TOTAL INCL OWNER COSTS						8,599,420	

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U.S. Army Corps of Engineers - D.O. 94 - Final
PROJECT DAREIX: HANFORD: ER PROGRAM - D AREA ION EXCHANGE
ION EXCHANGE REMEDIATION MODEL 100-HR-3/ D AREA
** PROJECT DIRECT SUMMARY - FEATURE (Rounded to 10's) **

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis		0	0	0	63,150	63,150	
TOTAL Off-Site Analytical Services		0	0	0	63,150	63,150	
SUB Fixed Price Contractor							
SUB:01 Mobilization & Preparatory Work		9,600	1,820	7,010	11,000	29,430	
SUB:03 Site Work		0	0	0	59,830	59,830	
SUB:06 Groundwater Collection & Control		0	0	0	1,353,270	1,353,270	
SUB:12 Chemical Treatment		0	0	0	1,310,000	1,310,000	
SUB:20 Site Restoration		0	0	0	10,000	10,000	
SUB:21 Demobilization		3,950	1,110	0	10,000	15,060	
TOTAL Fixed Price Contractor		13,550	2,930	7,010	2,754,100	2,777,580	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis		660	0	0	53,310	53,970	
WHC:12 Chemical Treatment		336,320	0	93,730	46,500	476,560	
TOTAL Westinghouse Hanford Company		336,990	0	93,730	99,810	530,530	
TOTAL HANFORD: ER PROGRAM		350,530	2,930	100,740	2,917,060	3,371,260	
Overhead						527,740	
SUBTOTAL						3,899,000	
Profit						225,750	
SUBTOTAL						4,124,750	
Bond						26,430	
SUBTOTAL						4,151,180	
B&O Tax						16,720	
SUBTOTAL						4,167,900	
Material/Supply MPR						4,180	
TOTAL INCL INDIRECTS						4,172,080	
Subcontractor MPR						260,920	
SUBTOTAL						4,433,000	
Project Management/Construction Mgnt						655,480	
SUBTOTAL						5,088,480	
General & Admin/Common Support Pool						1,281,460	

	QUANTITY	UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUBTOTAL							6,369,940	
Contingency							2,229,480	
TOTAL INCL OWNER COSTS							8,599,420	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis							
ANA:02.08 Sampling Rad Contaminated Media							
ANA:02.08.02 Ground Water Analysis Yr - 1	8.00 EA	0	0	0	33,680	33,680	4210.00
ANA:02.08.03 Ground Water Analysis Yrs 2-5	7.00 EA	0	0	0	29,470	29,470	4210.00
TOTAL Sampling Rad Contaminated Media		0	0	0	63,150	63,150	
TOTAL Monitoring, Sampling & Analysis		0	0	0	63,150	63,150	
TOTAL Off-Site Analytical Services		0	0	0	63,150	63,150	
SUB Fixed Price Contractor							
SUB:01 Mobilization & Preparatory Work							
SUB:01.02 Mobilize Personnel & Equipment							
SUB:01.02.02 Mobilize Trailers		0	750	0	0	750	
TOTAL Mobilize Personnel & Equipment		0	750	0	0	750	
SUB:01.04 Setup/Construct Temp Facilities							
SUB:01.04.01 Establish Facilities							
SUB:01.04.01.02 Setup Trailers		3,000	0	810	0	3,810	
TOTAL Establish Facilities		3,000	0	810	0	3,810	
SUB:01.04.02 Construct Decon Area	24.00 HR	4,350	1,070	3,770	0	9,190	382.96
SUB:01.04.03 Site Survey		0	0	0	1,000	1,000	
TOTAL Setup/Construct Temp Facilities		7,350	1,070	4,580	1,000	14,000	
SUB:01.05 Construct Temporary Utilities		2,250	0	2,430	0	4,680	
SUB:01.06 Pre-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Mobilization & Preparatory Work		9,600	1,820	7,010	11,000	29,430	
SUB:03 Site Work							
SUB:03.03 Earthwork		0	0	0	5,000	5,000	
SUB:03.04 Roads/Parking/Curbs/Walks		0	0	0	47,180	47,180	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.05 Fencing		0	0	0	7,650	7,650	
TOTAL Site Work		0	0	0	59,830	59,830	
SUB:06 Groundwater Collection & Control							
SUB:06.01 Extraction & Injection Wells							
SUB:06.01.01 Well Drilling & Construction		0	0	0	832,000	832,000	
SUB:06.01.04 Operations and Maintenance Yr 3		0	0	0	180,000	180,000	
SUB:06.01.9X Site Piping		0	0	0	341,270	341,270	
TOTAL Extraction & Injection Wells		0	0	0	1,353,270	1,353,270	
TOTAL Groundwater Collection & Control		0	0	0	1,353,270	1,353,270	
SUB:12 Chemical Treatment							
SUB:12.05 Ion Exchange							
SUB:12.05.04 Construction of Permanent Plant	1.00 EA	0	0	0	1,310,000	1,310,000	1310000.00
TOTAL Ion Exchange		0	0	0	1,310,000	1,310,000	
TOTAL Chemical Treatment		0	0	0	1,310,000	1,310,000	
SUB:20 Site Restoration							
SUB:20.04 Revegetation and Planting		0	0	0	10,000	10,000	
TOTAL Site Restoration		0	0	0	10,000	10,000	
SUB:21 Demobilization							
SUB:21.02 Demobilize Personnel & Equipment							
SUB:21.02.02 Demobilize Trailers		0	750	0	0	750	
TOTAL Demobilize Personnel & Equipment		0	750	0	0	750	
SUB:21.04 Demobilize Temp Facilities							
SUB:21.04.02 Remove Decon Area	8.00 HR	1,450	360	0	0	1,810	225.75
TOTAL Demobilize Temp Facilities		1,450	360	0	0	1,810	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.05 Disconnect Temporary Utilities		2,500	0	0	0	2,500	
SUB:21.06 Post-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Demobilization		3,950	1,110	0	10,000	15,060	
TOTAL Fixed Price Contractor		13,550	2,930	7,010	2,754,100	2,777,580	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis							
WHC:02.08 Sampling Rad Contaminated Media							
WHC:02.08.02 Ground Water Analysis - Yr 1	1.00 EA	0	0	0	28,080	28,080	28078.00
WHC:02.08.03 Ground Water Analysis - Yrs 2-5	1.00 EA	0	0	0	25,230	25,230	25230.00
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	0	0	660	27.62
TOTAL Sampling Rad Contaminated Media		660	0	0	53,310	53,970	
TOTAL Monitoring, Sampling & Analysis		660	0	0	53,310	53,970	
WHC:12 Chemical Treatment							
WHC:12.05 Ion Exchange							
WHC:12.05.06 Personnel Training		1,100	0	0	5,800	6,900	
WHC:12.05.08 Operation & Maintenance Yrs 1-5	1.00 YR	185,000	0	93,730	40,700	319,430	319433.37
WHC:12.05.11 Prepare Annual Report (Yr 1)	2080.00 HR	90,150	0	0	0	90,150	43.34
WHC:12.05.12 Prepare Annual Report (Yrs 2-5)	1386.00 HR	60,070	0	0	0	60,070	43.34
TOTAL Ion Exchange		336,320	0	93,730	46,500	476,560	
TOTAL Chemical Treatment		336,320	0	93,730	46,500	476,560	
TOTAL Westinghouse Hanford Company		336,990	0	93,730	99,810	530,530	
TOTAL HANFORD: ER PROGRAM		350,530	2,930	100,740	2,917,060	3,371,260	
Overhead						527,740	
SUBTOTAL						3,899,000	
Profit						225,750	
SUBTOTAL						4,124,750	
Bond						26,430	
SUBTOTAL						4,151,180	
B&O Tax						16,720	

	QUANTITY	UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUBTOTAL							4,167,900	
Material/Supply MPR							4,180	
TOTAL INCL INDIRECTS							4,172,080	
Subcontractor MPR							260,920	
SUBTOTAL							4,433,000	
Project Management/Construction Mgnt							655,480	
SUBTOTAL							5,088,480	
General & Admin/Common Support Pool							1,281,460	
SUBTOTAL							6,369,940	
Contingency							2,229,480	
TOTAL INCL OWNER COSTS							8,599,420	

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ANA:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

ANA. Off-Site Analytical Services
ANA:02. Monitoring, Sampling & Analysis
ANA:02.08. Sampling Rad Contaminated Media
ANA:02.08.02. Ground Water Analysis Yr - 1

Assumptions:

1. Assume shake-down period with following sampling of treatment system:
   - First 2 days: 1 sample per day from influent and effluent (4 samples)
   - Next 4 weeks- 1 sample per week from influent and effluent (8 samples)
2. 1 sample every 2 weeks for remainder of year from influent and effluent (48 samples/yr)
3. Assume sampling 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/year)
4. All on-site sample analyses performed by mobile lab.
5. 10% off-site verification analysis of reduced analyte list with CLP protocol. (10% of 74 = 8 ea)

ANA	Analyze LLW Sample - Off-site Lab	8.00 EA	0.00 0	0.00 0	0.00 0	4210.00 33,680	4210.00 33,680	4210.00
TOTAL	Ground Water Analysis Yr - 1	8.00 EA	0	0	0	33,680	33,680	4210.00

ANA:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA:02.08.03. Ground Water Analysis Yrs 2-5							

Assumptions:

1. Assume 1 sample every 2 weeks from influent and effluent years 2 - 5 (52 samples/yr)
2. Assume sampling 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr)
3. All on-site sample analyses performed by mobile lab
4. 10% off-site verification analysis of reduced analyte list with CLP protocol (10% of 66 = 7 ea)
5. Cost developed on this sheet is for one (1) year only

ANA	Analyze LLW Sample - Off-site Lab	7.00 EA	0.00 0	0.00 0	0.00 0	4210.00 29,470	4210.00 29,470	4210.00
TOTAL	Ground Water Analysis Yrs 2-5	7.00 EA	0	0	0	29,470	29,470	4210.00
TOTAL	Sampling Rad Contaminated Media		0	0	0	63,150	63,150	
TOTAL	Monitoring, Sampling & Analysis		0	0	0	63,150	63,150	
TOTAL	Off-Site Analytical Services		0	0	0	63,150	63,150	

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SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB. Fixed Price Contractor							
SUB:01. Mobilization & Preparatory Work							
SUB:01.02. Mobilize Personnel & Equipment							
SUB:01.02.02. Mobilize Trailers							
FPC S3 Mobilize Field Office Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
FPC S3 Mobilize Storage Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
FPC S3 Mobilize Decon Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
TOTAL Mobilize Trailers		0	750	0	0	750	
TOTAL Mobilize Personnel & Equipment		0	750	0	0	750	

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04. Setup/Construct Temp Facilities							
SUB:01.04.01. Establish Facilities							
SUB:01.04.01.02. Setup Trailers							
M FPC S3 Setup Field Office Trailer		1000.00	0.00	269.50	0.00	1269.50	
	1.00 EA	1,000	0	270	0	1,270	1269.50
M FPC S3 Setup Storage Trailer		1000.00	0.00	269.50	0.00	1269.50	
	1.00 EA	1,000	0	270	0	1,270	1269.50
M FPC S3 Setup Decon Trailer		1000.00	0.00	269.50	0.00	1269.50	
	1.00 EA	1,000	0	270	0	1,270	1269.50
TOTAL Setup Trailers		3,000	0	809	0	3,809	
TOTAL Establish Facilities		3,000	0	809	0	3,809	

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SUB:01. Mobilization & Preparatory Work	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04.02. Construct Decon Area									
Work to be Performed:									
Construct decontamination area/pad for equipment and vehicles.									
Crew and Equipment:									
Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers									
Equipment: 1 backhoe, 1 pickup truck									
Output:									
Assumed duration for this activity is 3 crew days.									
FPC S3 Laborer Group - 1				25.20	0.00	0.00	0.00	25.20	
- 3 ea	72.00	HR	0029	1,814	0	0	0	1,814	25.20
FPC S3 Laborer Group - 2				25.50	0.00	0.00	0.00	25.50	
- 3 ea	72.00	HR	0030	1,836	0	0	0	1,836	25.50
FPC S3 Group-6 Power Equipment Operator				29.10	0.00	0.00	0.00	29.10	
- 1 ea	24.00	HR	0039	698	0	0	0	698	29.10
FPC S3 Small Tools - 2 ea				0.00	1.40	0.00	0.00	1.40	
	48.00	HR	XMIXX020	0	67	0	0	67	1.40
L FPC S3 TRK,HWY,4X4,F250,3/4T,8800 GVW				0.00	7.31	0.00	0.00	7.31	
4X4 3/4 TON PICK-UP	24.00	HR	T50F0004	0	175	0	0	175	7.31
- 1 ea									
L FPC S3 HYD EXCAV,TRK MTD,.5 CY BKT,6X4				0.00	34.44	0.00	0.00	34.44	
HYDRO-SCOPIC - 1 ea	24.00	HR	H30BA001	0	827	0	0	827	34.44
M FPC S3 Construction Materials/Supplies				0.00	0.00	2156.00	0.00	2156.00	
Allowance	1.00	LS		0	0	2,156	0	2,156	2156.00
M FPC S3 Allowance for Tank				0.00	0.00	1617.00	0.00	1617.00	
Assume 1000 gal plastic tank	1.00	EA		0	0	1,617	0	1,617	1617.00
for water collection									
TOTAL Construct Decon Area	24.00	HR		4,349	1,069	3,773	0	9,191	382.96

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04.03. Site Survey							
FPC S3 Allowance for Site Survey		0.00	0.00	0.00	1000.00	1000.00	
	1.00 LS	0	0	0	1,000	1,000	1000.00
TOTAL Site Survey		0	0	0	1,000	1,000	
TOTAL Setup/Construct Temp Facilities		7,349	1,069	4,582	1,000	14,000	

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SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.05. Construct Temporary Utilities							
M FPC S3 Allowance for Temporary Power		1.00	0.00	1.08	0.00	2.08	
	500.00 LF	500	0	539	0	1,039	2.08
M FPC S3 Allowance for Telephone		0.50	0.00	0.54	0.00	1.04	
	500.00 LF	250	0	270	0	520	1.04
M FPC S3 Allowance for Temporary Water and Sewer Service		3.00	0.00	3.23	0.00	6.23	
	500.00 LF	1,500	0	1,617	0	3,117	6.23
TOTAL Construct Temporary Utilities		2,250	0	2,426	0	4,676	

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.06. Pre-Construction Submittals							
FPC S3 Allowance for Pre-Construction Submittals by Fixed Price Contractor	4.00 EA	0.00 0	0.00 0	0.00 0	2500.00 10,000	2500.00 10,000	2500.00
TOTAL Pre-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Mobilization & Preparatory Work		9,599	1,819	7,007	11,000	29,425	

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SUB:03. Site Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03. Site Work							
SUB:03.03. Earthwork							
FPC S3 Allowance for Site Preparation		0.00	0.00	0.00	5000.00	5000.00	
	1.00 LS	0	0	0	5,000	5,000	5000.00
TOTAL Earthwork		0	0	0	5,000	5,000	

SUB:03. Site Work	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.04. Roads/Parking/Curbs/Walks									
FPC S3 Allowance for Access Road				0.00	0.00	0.00	10.00	10.00	
	400.00	SY		0	0	0	4,000	4,000	10.00
FPC S3 Allowance Gravel Parking Area				0.00	0.00	0.00	10.00	10.00	
	300.00	SY		0	0	0	3,000	3,000	10.00
FPC S3 Access Roads to Wells				0.00	0.00	0.00	2.12	2.12	
Assume 10 feet wide, native materials	18955	LF		0	0	0	40,185	40,185	2.12
Road length equal to the length of well piping									
TOTAL Roads/Parking/Curbs/Walks				0	0	0	47,185	47,185	

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SUB:03. Site Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.05. Fencing							
FPC S3 Allowance for Permanent Fencing		0.00	0.00	0.00	21.00	21.00	
Assume 7 ft high security fence	350.00 LF	0	0	0	7,350	7,350	21.00
FPC S3 Allowance for Entrance Gate		0.00	0.00	0.00	300.00	300.00	
	1.00 EA	0	0	0	300	300	300.00
TOTAL Fencing		0	0	0	7,650	7,650	
TOTAL Site Work		0	0	0	59,835	59,835	

SUB:06. Groundwater Collection & Control	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06. Groundwater Collection & Control									
SUB:06.01. Extraction & Injection Wells									
SUB:06.01.01. Well Drilling & Construction									
FPC S3 Drill/Install Extr/Inject Wells Note: 7 new extraction wells, 80 feet deep and 5 new injection wells, 100 feet deep, 8" in diameter. Unit cost is assumed to include handling and packaging of contaminated well cuttings, transport to the disposal facility, and associated disposal fees.	1060.00	LF		0.00 0	0.00 0	0.00 0	500.00 530,000	500.00 530,000	500.00
FPC S3 Allowance for Well Pumps- 10 gpm for existing extraction wells that are to be refurbished	10.00	EA		0.00 0	0.00 0	0.00 0	3000.00 30,000	3000.00 30,000	3000.00
FPC S3 Allowance for Controls and Connections at Well Heads	12.00	EA		0.00 0	0.00 0	0.00 0	10000.00 120,000	10000.00 120,000	10000.00
FPC S3 Refurbish Existing Wells	3.00	EA		0.00 0	0.00 0	0.00 0	10000.00 30,000	10000.00 30,000	10000.00
S3 Water Level Monitoring (Wells) Allowance for 5 piezometers per extraction well using well points	50.00			0.00 0	0.00 0	0.00 0	1000.00 50,000	1000.00 50,000	1000.00
FPC S3 Allowance for Well Head Covers Assume manhole type cover at each well head	12.00	EA		0.00 0	0.00 0	0.00 0	1000.00 12,000	1000.00 12,000	1000.00
FPC S3 Allowance for Well Testing	12.00	EA		0.00 0	0.00 0	0.00 0	5000.00 60,000	5000.00 60,000	5000.00
TOTAL Well Drilling & Construction				0	0	0	832,000	832,000	

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SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06.01.04. Operations and Maintenance Yr 3							
FPC S3 Allowance for Well Workover		0.00	0.00	0.00	10000.00	10000.00	
Assume 1 workover every 3 yrs for each well for the 5 year lifecycle (all wells) Workovers occur during year 3	15.00 EA	0	0	0	150,000	150,000	10000.00
FPC S3 Allowance for Well Pump Replacement		0.00	0.00	0.00	3000.00	3000.00	
Assume one pump replacement per extraction well every 3 years for the 5- year lifecycle Replacement in year 3	10.00 EA	0	0	0	30,000	30,000	3000.00
TOTAL Operations and Maintenance Yr 3		0	0	0	180,000	180,000	

SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06.01.9X. Site Piping							
FPC S3 Piping from Well Head to Treatment Plant Allowance Assume double wall PVC pipe for extraction wells	17314 LF	0.00 0	0.00 0	0.00 0	18.00 311,652	18.00 311,652	18.00
FPC S3 Force Main Discharge Piping from process plant to injection wells Assume single wall PVC pipe for injection wells.	1641.00 LF	0.00 0	0.00 0	0.00 0	15.00 24,615	15.00 24,615	15.00
FPC S3 Allowance for Leak Detection	1.00 LS	0.00 0	0.00 0	0.00 0	5000.00 5,000	5000.00 5,000	5000.00
TOTAL Site Piping		0	0	0	341,267	341,267	
TOTAL Extraction & Injection Wells		0	0	0	1,353,267	1,353,267	
TOTAL Groundwater Collection & Control		0	0	0	1,353,267	1,353,267	

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SUB:12. Chemical Treatment	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:12. Chemical Treatment							
SUB:12.05. Ion Exchange							
SUB:12.05.04. Construction of Permanent Plant							
FPC S3 Ion Exchange Treatment Plant - 150 gpm capacity for the removal of chrome.	1.00 EA	0.00 0	0.00 0	0.00 0	1310000.00 1,310,000	1310000.00 1,310,000	1310000.00
TOTAL Construction of Permanent Plant	1.00 EA	0	0	0	1,310,000	1,310,000	1310000.00
TOTAL Ion Exchange		0	0	0	1,310,000	1,310,000	
TOTAL Chemical Treatment		0	0	0	1,310,000	1,310,000	

SUB:20. Site Restoration	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:20. Site Restoration							
SUB:20.04. Revegetation and Planting							
FPC S3 Allowance for Site Restoration		0.00	0.00	0.00	2.00	2.00	
	5000.00 SY	0	0	0	10,000	10,000	2.00
TOTAL Revegetation and Planting		0	0	0	10,000	10,000	
TOTAL Site Restoration		0	0	0	10,000	10,000	

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SUB:21. Demobilization	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21. Demobilization							
SUB:21.02. Demobilize Personnel & Equipment							
SUB:21.02.02. Demobilize Trailers							
FPC S3 Demob Field Office Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
FPC S3 Demob Storage Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
FPC S3 Demob Decon Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
TOTAL Demobilize Trailers		0	750	0	0	750	
TOTAL Demobilize Personnel & Equipment		0	750	0	0	750	

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SUB:21. Demobilization	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.04. Demobilize Temp Facilities									
SUB:21.04.02. Remove Decon Area									
Work to be Performed:									
Remove decontamination area/pad for equipment and vehicles.									
Crew and Equipment:									
Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers									
Equipment: 1 backhoe, 1 pickup truck									
Output:									
Assumed duration for this activity is 1 crew day.									
FPC S3 Group-6 Power Equipment Operator - 1 ea				29.10	0.00	0.00	0.00	29.10	
	8.00	HR	0039	233	0	0	0	233	29.10
FPC S3 Laborer Group - 1 - 3 ea				25.20	0.00	0.00	0.00	25.20	
	24.00	HR	0029	605	0	0	0	605	25.20
FPC S3 Laborer Group - 2 - 3 ea				25.50	0.00	0.00	0.00	25.50	
	24.00	HR	0030	612	0	0	0	612	25.50
L FPC S3 HYD EXCAV,TRK MTD,.5 CY BKT,6X4 HYDRO-SCOPIC - 1 ea				0.00	34.44	0.00	0.00	34.44	
	8.00	HR	H30BA001	0	276	0	0	276	34.44
L FPC S3 TRK,HWY,4X4,F250,3/4T,8800 GVW 4X4 3/4 TON PICK-UP - 1 ea				0.00	7.31	0.00	0.00	7.31	
	8.00	HR	T50F0004	0	58	0	0	58	7.31
FPC S3 Small Tools - 2 ea				0.00	1.40	0.00	0.00	1.40	
	16.00	HR	XMIXX020	0	22	0	0	22	1.40
TOTAL Remove Decon Area	8.00	HR		1,450	356	0	0	1,806	225.75
TOTAL Demobilize Temp Facilities				1,450	356	0	0	1,806	

SUB:21. Demobilization	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.05. Disconnect Temporary Utilities							
M FPC S3 Remove Temporary Power	500.00 LF	1.00 500	0.00 0	0.00 0	0.00 0	1.00 500	1.00
M FPC S3 Remove Telephone	500.00 LF	1.00 500	0.00 0	0.00 0	0.00 0	1.00 500	1.00
M FPC S3 Remove Temporary Water and Sewer Service	500.00 LF	3.00 1,500	0.00 0	0.00 0	0.00 0	3.00 1,500	3.00
TOTAL Disconnect Temporary Utilities		2,500	0	0	0	2,500	

SUB:21. Demobilization	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.06. Post-Construction Submittals							
FPC S3 Allowance for Post-Construction Submittals by Fixed Price Contractor		0.00	0.00	0.00	2500.00	2500.00	
	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Post-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Demobilization		3,950	1,106	0	10,000	15,056	
TOTAL Fixed Price Contractor		13,548	2,926	7,007	2,754,102	2,777,583	

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WHC:02. Monitoring, Sampling & Analysis		QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

WHC. Westinghouse Hanford Company
WHC:02. Monitoring, Sampling & Analysis
WHC:02.08. Sampling Rad Contaminated Media
WHC:02.08.02. Ground Water Analysis - Yr 1

Assumptions:

1. Assume shake-down period with following sampling of treatment system:
   - First 2 days: 1 sample per day from influent and effluent (4 samples)
   - Next 4 weeks: 1 sample per week from influent and effluent (8 samples)
2. 1 sample every 2 weeks from influent and effluent for remainder of Yr 1 (48 samples/yr)
3. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr)
4. 90% of samples analyzed at mobile lab (90% of 74= 67)
5. HACH kit samples are taken 2 per day for the 5-yr lifecycle plus an additional 48 samples during the shake-down period. (Yr 1 = 730 + 48 = 778 samples)

WHC	Analyze LLW Sample - Mobile Lab	67.00 EA	0.00 0	0.00 0	0.00 0	400.00 26,800	400.00 26,800	400.00
WHC	HACH Kit Sampling	778.00 EA	0.00 0	0.00 0	0.00 0	1.00 778	1.00 778	1.00
WHC	HACH Kit Replacement Assume 1 per yr	1.00 EA	0.00 0	0.00 0	0.00 0	500.00 500	500.00 500	500.00
TOTAL	Ground Water Analysis - Yr 1	1.00 EA	0	0	0	28,078	28,078	28078.00

WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

WHC:02.08.03. Ground Water Analysis - Yrs 2-5

Assumptions:

1. Assume 1 sample every 2 weeks from influent and effluent for 5 year lifecycle. (52 samples/yr)

2. Assume sampling 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr)

3. 90% of samples analyzed at mobile lab (90% of 66 = 60 samples)

4. HACH kit samples are taken 2 per day for the 5-yr lifecycle. (730 samples/yr)

5. Cost developed on this sheet is for one (1) year only.

WHC	Analyze LLW Sample - Mobile Lab		0.00	0.00	0.00	400.00	400.00	
		60.00 EA	0	0	0	24,000	24,000	400.00
WHC	HACH Kit Sampling		0.00	0.00	0.00	1.00	1.00	
		730.00 EA	0	0	0	730	730	1.00
WHC	HACH Kit Replacement		0.00	0.00	0.00	500.00	500.00	
	Assume 1 per yr	1.00 EA	0	0	0	500	500	500.00
TOTAL	Ground Water Analysis - Yrs 2-5	1.00 EA	0	0	0	25,230	25,230	25230.00

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WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:02.08.04. Ground Water Monitor Samples							
Work to be Performed:							
Take semiannual groundwater monitoring samples							
Assumptions:							
1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr)							
2. Assume 2 field technicians for 6 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)							
3. Cost developed on this sheet is for one (1) year only.							
WHC Technician, Environmental Restoration Ops - 2 ea	24.00 HR 85201	27.62 663	0.00 0	0.00 0	0.00 0	27.62 663	27.62
TOTAL Ground Water Monitor Samples	24.00 HR	663	0	0	0	663	27.62
TOTAL Sampling Rad Contaminated Media		663	0	0	53,308	53,971	
TOTAL Monitoring, Sampling & Analysis		663	0	0	53,308	53,971	

WHC:12. Chemical Treatment		QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:12. Chemical Treatment										
WHC:12.05. Ion Exchange										
WHC:12.05.06. Personnel Training										
Note: This account to allow for operator time and an allowance for a 40-hour training course.										
WHC	Operator, Environmental				27.62	0.00	0.00	0.00	27.62	
	Restoration Ops	40.00	HR	85302	1,105	0	0	0	1,105	27.62
WHC	Allowance for 40 hr Training				0.00	0.00	0.00	800.00	800.00	
		1.00	LS		0	0	0	800	800	800.00
WHC	Allowance for Maintainence				0.00	0.00	0.00	5000.00	5000.00	
	Manuals	1.00	LS		0	0	0	5,000	5,000	5000.00
TOTAL	Personnel Training				1,105	0	0	5,800	6,905	

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WHC:12. Chemical Treatment		QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

WHC:12.05.08. Operation & Maintenance Yrs 1-5

Assumptions:

1. Treatment facility will be fully staffed with 2 FTE's per shift, 1 shift per day, 7 days per week. (365 days/yr x 8 hrs/day = 2920 hrs/yr)

2. Ion exchange media will not require regeneration during the 5 year life cycle for chromium treatment.

3. 2 FTE crew will be composed of the following members:

   0.25 ea - supervisor
   1.00 ea - operator
   0.50 ea - engineering support
   0.25 ea - maintenance engineer

4. Cost developed on this sheet is for one (1) year only.

L WHC	Technician, Environmental Restoration Ops - Supervisor - 0.25 ea	730.00 HR 85201	28.62 20,895	0.00 0	0.00 0	0.00 0	28.62 20,895	28.62
WHC	Operator, Environmental Restoration Ops - 1 ea	2920.00 HR 85302	27.62 80,661	0.00 0	0.00 0	0.00 0	27.62 80,661	27.62
L WHC	Engineer, Environmental Restoration Ops	1460.00 HR 85101	43.34 63,277	0.00 0	0.00 0	0.00 0	43.34 63,277	43.34
WHC	Skilled Craft, Environmental Restoration Ops - Maintenance - 0.25 ea	730.00 HR 85301	27.62 20,165	0.00 0	0.00 0	0.00 0	27.62 20,165	27.62
WHC	Allowance for Electricity Wells: 806 kW-hr/d Ion exchange plant: 1902 kw-hr/day Assume 24 hrs/day x 365 days/yr Total = 988,366 kW-hr/yr	988366 KWH	0.00 0	0.00 0	0.00 0	0.04 39,535	0.04 39,535	0.04
M WHC	Chemicals for pH Adjustment Chemical cost calculated at $0.60 per 1000 gallons treated per year. (100 gpm x 60 min/hr x 24 hr/day x 365 day/Yr = 52.6 million gal)	1.00 EA	0.00 0	0.00 0	36477.50 36,478	0.00 0	36477.50 36,478	36477.50
M WHC S2	Ion Exchange Media (resin) Cost for initial resin required for Ion Exchange vessels (3	450.00 CF	0.00 0	0.00 0	127.24 57,256	0.00 0	127.24 57,256	127.24

WHC:12. Chemical Treatment		QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
	Vessels x 150 cf/vessel = 450 cf). Replacement of resin not required during 5 year lifecycle.							
WHC	Disposal Fee for resin		0.00	0.00	0.00	2.59	2.59	
	Media	450.00 CF	0	0	0	1,166	1,166	2.59
	Assume disposal at ERDF for in year 5 of lifecycle							
TOTAL	Operation & Maintenance Yrs 1-5	1.00 YR	184,999	0	93,734	40,700	319,433	319433.37

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WHC:12. Chemical Treatment		QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:12.05.11. Prepare Annual Report (Yr 1) Assume 2 FTE's for 6 months each year.										
WHC	Engineer, Environmental Restoration Ops - 1 ea	1040.00	HR	85101	43.34 45,074	0.00 0	0.00 0	0.00 0	43.34 45,074	43.34
WHC	Scientist, Environmental Restoration Ops - 1 ea	1040.00	HR	85102	43.34 45,074	0.00 0	0.00 0	0.00 0	43.34 45,074	43.34
TOTAL	Prepare Annual Report (Yr 1)	2080.00	HR		90,148	0	0	0	90,148	43.34

WHC:12. Chemical Treatment	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:12.05.12. Prepare Annual Report (Yrs 2-5) Assume 66% of a Year 1 Annual Report effort (2 FTE's for 4 months each year)									
Cost developed on this sheet is for one (1) year only.									
WHC Engineer, Environmental				43.34	0.00	0.00	0.00	43.34	
Restoration Ops - 1 ea	693.00	HR	85101	30,035	0	0	0	30,035	43.34
WHC Scientist, Environmental				43.34	0.00	0.00	0.00	43.34	
Restoration Ops - 1 ea	693.00	HR	85102	30,035	0	0	0	30,035	43.34
TOTAL Prepare Annual Report (Yrs 2-5)	1386.00	HR		60,070	0	0	0	60,070	43.34
TOTAL Ion Exchange				336,322	0	93,734	46,500	476,556	
TOTAL Chemical Treatment				336,322	0	93,734	46,500	476,556	
TOTAL Westinghouse Hanford Company				336,985	0	93,734	99,808	530,527	
TOTAL HANFORD: ER PROGRAM				350,534	2,926	100,741	2,917,060	3,371,260	

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SRC	LABOR ID	DESCRIPTION	BASE	OVERTM	TXS/INS	FRNG	TRVL	RATE	UOM	UPDATE	**** TOTAL **** DEFAULT	HOURS
FPC	0029	Laborer Group - 1	15.84	0.0%	28.7%	3.57	1.25	25.20	HR	07/09/93	0.00	96
FPC	0030	Laborer Group - 2	16.09	0.0%	28.5%	3.57	1.25	25.50	HR	07/09/93	0.00	96
FPC	0039	Group-6 Power Equipment Operator	18.02	0.0%	27.4%	4.90	1.25	29.10	HR	07/09/93	0.00	32
WHC	85101	Engineer, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	3193
WHC	85102	Scientist, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	1733
WHC	85201	Technician, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	754
WHC	85301	Skilled Craft, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	730
WHC	85302	Operator, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	2960

SRC	EQUIP ID	DESCRIPTION	DEPR	CAPT	FUEL	FOG	EQ REP	TR WR	TR REP	TOTAL	UOM	** TOTAL ** HOURS
USR	H30BA001	HYD EXCAV,TRK MTD,.5 CY BKT,6X4			12.07	1.4	19.78	0.98	0.15	34.44	HR	32
USR	T50FO004	TRK,HWY,4X4,F250,3/4T,8800 GVW			2.67	0.7	3.58	0.27	0.04	7.31	HR	32
MIL	XMIXX020	Small Tools	0.47	0.17	0.13	0.0	0.57			1.40	HR	64

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SRC	LABOR ID	DESCRIPTION	BASE	OVERTM	TXS/INS	FRNG	TRVL	RATE	UOM	UPDATE	**** TOTAL **** DEFAULT	HOURS
FPC	0029	Laborer Group - 1	15.84	0.0%	28.7%	3.57	1.25	25.20	HR	07/09/93	0.00	96
FPC	0030	Laborer Group - 2	16.09	0.0%	28.5%	3.57	1.25	25.50	HR	07/09/93	0.00	96
FPC	0039	Group-6 Power Equipment Operator	18.02	0.0%	27.4%	4.90	1.25	29.10	HR	07/09/93	0.00	32
WHC	33201	Technician, Health Physics	28.78	0.0%	38.0%	0.00	0.00	39.72	HR	01/07/94	0.00	4380
WHC	85101	Engineer, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	1733
WHC	85102	Scientist, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	1733
WHC	85201	Technician, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	2214
WHC	85301	Skilled Craft, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	2190
WHC	85302	Operator, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	8800

WHC:13. Physical Treatment		QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:13.21.12. Prepare Annual Report (Yrs 2-5) Assume 66% effort of Year 1 Annual Report (2 FTE's for 4 months each year)								
WHC	Engineer, Environmental Restoration Ops	693.00 HR 85101	43.34 30,035	0.00 0	0.00 0	0.00 0	43.34 30,035	43.34
WHC	Scientist, Environmental Restoration Ops	693.00 HR 85102	43.34 30,035	0.00 0	0.00 0	0.00 0	43.34 30,035	43.34
TOTAL	Prepare Annual Report (Yrs 2-5)	1.00 YR	60,070	0	0	0	60,070	60069.93
TOTAL	Reverse Osmosis		690,448	0	360,889	222,250	1,273,586	
TOTAL	Physical Treatment		690,448	0	360,889	222,250	1,273,586	
TOTAL	Westinghouse Hanford Company		691,111	0	360,889	325,726	1,377,725	
TOTAL	HANFORD: ER PROGRAM		704,659	2,926	367,896	3,618,901	4,694,382	

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WHC:13. Physical Treatment	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:13.21.11. Prepare Annual Report (Yr 1) Assume 2 FTE's for 6 months each year.							
WHC Engineer, Environmental Restoration Ops - 1 ea	1040.00 HR 85101	43.34 45,074	0.00 0	0.00 0	0.00 0	43.34 45,074	43.34
WHC Scientist, Environmental Restoration Ops - 1 ea	1040.00 HR 85102	43.34 45,074	0.00 0	0.00 0	0.00 0	43.34 45,074	43.34
TOTAL Prepare Annual Report (Yr 1)	2080.00 HR	90,148	0	0	0	90,148	43.34

WHC:13. Physical Treatment		QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC	Disposal Fee for Reverse Osmosis Filters Assume disposal at ERDF for years 1-5 of the 5-year lifecycle Assume each filter to be 40 cf	4160.00 CF	0.00 0	0.00 0	0.00 0	2.59 10,774	2.59 10,774	2.59
WHC	Disposal Fee - Evaporation Cake Assume disposal at ERDF for years 1-5 of the 5-year lifecycle 300 gpm x 325 ppm = 18.8 cf/day 18.8 cf x 365 days = 6862 cf/year Assume 50% volume increase to stabilize evaporation cake 1.5 x 6862 cf/yr = 10,293 cf/yr	10293 CF	0.00 0	0.00 0	0.00 0	2.59 26,659	2.59 26,659	2.59
M WHC S2	Reverse Osmosis Filter Replacement Assume replacement of 2 filters on a weekly basis (52 wk/yr x 2 filters/wk)	104.00 EA	0.00 0	0.00 0	3470.08 360,889	0.00 0	3470.08 360,889	3470.08
TOTAL	Operation and Maint (Yrs 1-5)	1.00 YR	539,125	0	360,889	216,450	1,116,463	1116463.36

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WHC:13. Physical Treatment		QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:13.21.08. Operation and Maint (Yrs 1-5)										
	Assumptions: 1. Treatment facility will be fully staffed with 2 FTE's per shift, 3 shifts per day, 7 days per week. (365 days/yr x 24 hrs/day = 8760 hrs) 2. Reverse Osmosis filters will be replaced every week for the 5-year lifecycle. 3. 2 FTE crew will be composed of the following members: 0.25 ea - supervisor 1.00 ea - operator 0.50 ea - TP tech support 0.25 ea - maintenance engineer									
WHC	Technician, Environmental Restoration Ops - Supervisor - 0.25 ea	2190.00	HR	85201	28.62 62,686	0.00 0	0.00 0	0.00 0	28.62 62,686	28.62
WHC	Operator, Environmental Restoration Ops - 1 ea	8760.00	HR	85302	27.62 241,984	0.00 0	0.00 0	0.00 0	27.62 241,984	27.62
WHC	Technician, Health Physics - 0.50 ea	4380.00	HR	33201	39.72 173,958	0.00 0	0.00 0	0.00 0	39.72 173,958	39.72
WHC	Skilled Craft, Environmental Restoration Ops - Maintenance - 0.25 ea	2190.00	HR	85301	27.62 60,496	0.00 0	0.00 0	0.00 0	27.62 60,496	27.62
WHC	Allowance for Electricity Wells: 752 kW-hr/d RO System: 1185 kW-hr/d Recompr Evap: 3456 kW-hr/d (80 kW-hr/1000 gal) Rotary Filter/Drum: 3612 kW-hr/d Assume 24 hrs/day x 365 days/yr Total = 3,286,825 kW-hr/yr	3286825	KWH		0.00 0	0.00 0	0.00 0	0.04 131,473	0.04 131,473	0.04
WHC	Allowance for Water Usage Assume 1000 gal per month usage for the 5 year lifecycle	12000	GAL		0.00 0	0.00 0	0.00 0	0.02 240	0.02 240	0.02
WHC	RO System Chemicals Includes scale inhibitors, $0.29/1000 gal 300 gpm x 1440 m/d x 365 d/y = 157,680,000 gal/yr	********	GAL		0.00 0	0.00 0	0.00 0	0.00 47,304	0.00 47,304	0.00

WHC:13. Physical Treatment		QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:13. Physical Treatment								
WHC:13.21. Reverse Osmosis								
WHC:13.21.06. Personnel Training								
Note: This account to allow for operator time and an allowance for a 40 hour training course.								
WHC	Operator, Environmental		27.62	0.00	0.00	0.00	27.62	
	Restoration Ops	40.00 HR 85302	1,105	0	0	0	1,105	27.62
WHC	Allowance for 40 hr Training		0.00	0.00	0.00	800.00	800.00	
		1.00 LS	0	0	0	800	800	800.00
WHC	Allowance for Maintainence		0.00	0.00	0.00	5000.00	5000.00	
	Manuals	1.00 LS	0	0	0	5,000	5,000	5000.00
TOTAL	Personnel Training		1,105	0	0	5,800	6,905	

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WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:02.08.04. Ground Water Monitor Samples							
Work to be Performed:							
Take semiannual groundwater monitoring samples.							
Assumptions:							
1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr)							
2. Assume 2 field Technicians for 6 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)							
WHC Technician, Environmental Restoration Ops - 2 ea	24.00 HR 85201	27.62 663	0.00 0	0.00 0	0.00 0	27.62 663	27.62
TOTAL Ground Water Monitor Samples	24.00 HR	663	0	0	0	663	27.62
TOTAL Sampling Rad Contaminated Media		663	0	0	103,476	104,139	
TOTAL Monitoring, Sampling & Analysis		663	0	0	103,476	104,139	

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WHC:02. Monitoring, Sampling & Analysis		QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:02.08.03. Ground Water Analysis-Yr 2-5								

Assumptions:

1. 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle (104 samples/yr)

2. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr)

   - Total samples = 118

4. 90% of samples for analysis at mobile lab (90% of 118 = 106)

5. HACH kit samples are taken 1 per shift for the 5-yr lifecycle (1143 samples)

WHC	Analyze LLW Sample - Mobile Lab		0.00	0.00	0.00	400.00	400.00	
		106.00 EA	0	0	0	42,400	42,400	400.00
WHC	HACH Kit Sampling		0.00	0.00	0.00	0.50	0.50	
		1143.00 EA	0	0	0	572	572	0.50
WHC	HACH Kit Replacement		0.00	0.00	0.00	235.00	235.00	
	Assume 1 per yr	1.00 EA	0	0	0	235	235	235.00
TOTAL	Ground Water Analysis-Yr 2-5	106.00 EA	0	0	0	43,207	43,207	407.61

WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

WHC. Westinghouse Hanford Company
WHC:02. Monitoring, Sampling & Analysis
WHC:02.08. Sampling Rad Contaminated Media
WHC:02.08.02. Ground Water Analysis-Yr 1

Assumptions:

1. Assume shake-down period with following sampling of treatment system:
   - First 2 days: Sample every four hours of influent anf effluent (24 samples)
   - Next 5 days: 1 sample per day of influent and effluent (10 samples)
   - Next 7 weeks: 1 sample per week of influent and effluent (14 samples)
2. 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle (104 samples/yr)
3. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr)

   - Total samples = 166
4. 90% of samples for analysis at mobile lab (90% of 166 = 149)
5. HACH kit samples are taken 1 per shift for the 5-yr lifecycle plus an additional 48 samples during the shake-down period. (1143 samples)

WHC	Analyze LLW Sample - Mobile Lab	149.00 EA	0.00 0	0.00 0	0.00 0	400.00 59,600	400.00 59,600	400.00
WHC	HACH Kit Sampling	1143.00 EA	0.00 0	0.00 0	0.00 0	0.50 572	0.50 572	0.50
WHC	HACH Kit Replacement Assume 1 per yr	0.42 EA	0.00 0	0.00 0	0.00 0	235.00 98	235.00 98	235.00
TOTAL	Ground Water Analysis-Yr 1	149.00 EA	0	0	0	60,269	60,269	404.49

SUB:21. Demobilization	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.06. Post-Construction Submittals Yr 5									
FPC S3 Allowance for Post-Construction Submittals by Fixed Price Contractor	4.00	EA		0.00 0	0.00 0	0.00 0	2500.00 10,000	2500.00 10,000	2500.00
TOTAL Post-Construction Submittals	4.00	EA		0	0	0	10,000	10,000	2500.00
TOTAL Demobilization				3,950	1,106	0	10,000	15,056	
TOTAL Fixed Price Contractor				13,548	2,926	7,007	3,171,085	3,194,566	

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SUB:21. Demobilization	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.05. Disconnect Temporary Utilities Yr 5							
M FPC S3 Remove Temporary Power	500.00 LF	1.00 500	0.00 0	0.00 0	0.00 0	1.00 500	1.00
M FPC S3 Remove Telephone	500.00 LF	1.00 500	0.00 0	0.00 0	0.00 0	1.00 500	1.00
M FPC S3 Remove Temporary Water and Sewer Service	500.00 LF	3.00 1,500	0.00 0	0.00 0	0.00 0	3.00 1,500	3.00
TOTAL Disconnect Temporary Utilities		2,500	0	0	0	2,500	

SUB:21. Demobilization	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.04. Demobilize Temp Facilities									
SUB:21.04.02. Remove Decon Area-Yr 5									
Work to be Performed:									
Remove decontamination area/pad for equipment and vehicles.									
Crew and Equipment:									
Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers									
Equipment: 1 backhoe, 1 pickup truck									
Output:									
Assumed duration for this activity is 1 crew day.									
FPC S3 Group-6 Power Equipment Operator				29.10	0.00	0.00	0.00	29.10	
- 1 ea	8.00	HR	0039	233	0	0	0	233	29.10
FPC S3 Laborer Group - 1				25.20	0.00	0.00	0.00	25.20	
- 3 ea	24.00	HR	0029	605	0	0	0	605	25.20
FPC S3 Laborer Group - 2				25.50	0.00	0.00	0.00	25.50	
- 3 ea	24.00	HR	0030	612	0	0	0	612	25.50
FPC S3 HYD EXCAV,TRK MTD,.5 CY BKT,6X4				0.00	34.44	0.00	0.00	34.44	
HYDRO-SCOPIC - 1 ea	8.00	HR	H30BA001	0	276	0	0	276	34.44
FPC S3 TRK,HWY,4X4,F250,3/4T,8800 GVW				0.00	7.31	0.00	0.00	7.31	
4X4 3/4 TON PICK-UP - 1 ea	8.00	HR	T50F0004	0	58	0	0	58	7.31
FPC S3 Small Tools - 2 ea				0.00	1.40	0.00	0.00	1.40	
	16.00	HR	XMIXX020	0	22	0	0	22	1.40
TOTAL Remove Decon Area-Yr 5	8.00	HR		1,450	356	0	0	1,806	225.75
TOTAL Demobilize Temp Facilities				1,450	356	0	0	1,806	

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SUB:21. Demobilization	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21. Demobilization							
SUB:21.02. Demobilize Personnel & Equipment							
SUB:21.02.02. Demobilize Trailers-Yr 5							
FPC S3 Demob Field Office Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
FPC S3 Demob Storage Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
FPC S3 Demob Decon Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
TOTAL Demobilize Trailers-Yr 5		0	750	0	0	750	
TOTAL Demobilize Personnel & Equipment		0	750	0	0	750	

SUB:20. Site Restoration	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:20. Site Restoration							
SUB:20.04. Revegetation and Planting Yr 5							
FPC S3 Allowance for Site Restoration		0.00	0.00	0.00	2.00	2.00	
	5000.00 SY	0	0	0	10,000	10,000	2.00
TOTAL Revegetation and Planting Yr 5		0	0	0	10,000	10,000	
TOTAL Site Restoration		0	0	0	10,000	10,000	

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SUB:13. Physical Treatment	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
TOTAL Physical Treatment				0	0	0	2,412,800	2,412,800	

SUB:13. Physical Treatment	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:13. Physical Treatment									
SUB:13.21. Reverse Osmosis									
SUB:13.21.04. Construction of Permanent Plant									
FPC S3 Excavate and Install Building Foundation	800.00	SF		0.00 0	0.00 0	0.00 0	20.00 16,000	20.00 16,000	20.00
FPC S3 Install Butler Building Assume a prefabricated heated building complete with frame, doors, roll up doors, gutters, insulation, and roof vent.	800.00	SF		0.00 0	0.00 0	0.00 0	20.00 16,000	20.00 16,000	20.00
FPC S3 Reverse Osmosis Equipment/Staging Includes 1 x 300 gpm treatment system, 225 psi inlet pressure, 10% reject	1.00	LS		0.00 0	0.00 0	0.00 0	432000.00 432,000	432000.00 432,000	432000.00
FPC S3 Vapor Recompression Evaporator 300 gpm x 0.1 = 30 gpm, includes startup boiler, 2% reject	1.00	LS		0.00 0	0.00 0	0.00 0	700000.00 700,000	700000.00 700,000	700000.00
FPC S3 Rotary Drum Filter/Dryer Liquid loading: 300 gpm x 0.1 x 0.02 = 0.6 gpm (300 lbs/hr), 35 sf/unit drying area	2.00	EA		0.00 0	0.00 0	0.00 0	585000.00 1,170,000	585000.00 1,170,000	585000.00
FPC S3 Steam Generator Load = 300 lbs/hr, 514,000 BTU	1.00	LS		0.00 0	0.00 0	0.00 0	6800.00 6,800	6800.00 6,800	6800.00
FPC S3 Allowance for Bldg Electrical Includes lighting, fixtures, motor starters, controllers, junction boxes, transformer, chart recorders, annunciators, panels, conduit, and wiring.	800.00	SF		0.00 0	0.00 0	0.00 0	40.00 32,000	40.00 32,000	40.00
FPC S3 Allowance for Bldg Mechanical Includes equipment installation and connections, controls/instrumentation, interior piping (plastic), floor drains and piping.	800.00	SF		0.00 0	0.00 0	0.00 0	50.00 40,000	50.00 40,000	50.00
TOTAL Construction of Permanent Plant	800.00	SF		0	0	0	2,412,800	2,412,800	3016.00
TOTAL Reverse Osmosis				0	0	0	2,412,800	2,412,800	

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SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06.01.9X. Site Piping							
FPC S3 Piping from Well Head to Treatment Plant Allowance Assume double-wall PVC piping for extraction wells.	9296.00 LF	0.00 0	0.00 0	0.00 0	18.00 167,328	18.00 167,328	18.00
FPC S3 Allowance for Leak Detection	1.00 LS	0.00 0	0.00 0	0.00 0	5000.00 5,000	5000.00 5,000	5000.00
FPC S3 Force Main Discharge Piping Allowance Assume single-wall PVC for injection wells.	2133.00 LF	0.00 0	0.00 0	0.00 0	15.00 31,995	15.00 31,995	15.00
TOTAL Site Piping		0	0	0	204,323	204,323	
TOTAL Extraction & Injection Wells		0	0	0	679,823	679,823	
TOTAL Groundwater Collection & Control		0	0	0	679,823	679,823	

SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06.01.04. Operations and Maintenance Yr 3							
FPC S3 Allowance for Well Workover		0.00	0.00	0.00	10000.00	10000.00	
Assume 1 workover every 3 yrs for each well Workovers in year 3	12.00 EA	0	0	0	120,000	120,000	10000.00
FPC S3 Allowance for Well Pump Replacement		0.00	0.00	0.00	3000.00	3000.00	
Assume 1 pump replacement per extraction well every 3 years Pump replacements in year 3	9.00 EA	0	0	0	27,000	27,000	3000.00
TOTAL Operations and Maintenance Yr 3		0	0	0	147,000	147,000	

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SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06. Groundwater Collection & Control							
SUB:06.01. Extraction & Injection Wells							
SUB:06.01.01. Well Drilling & Construction							
FPC S3 Drill/Install Extr/Inject Wells Note: 1 new extraction well, 45 feet deep and 3 new injection wells, 60 ft deep, 8 in diameter. Unit cost is assumed to include handling and packaging of contaminated well cuttings, transport to the disposal facility, and associated disposal fees.	225.00 LF	0.00 0	0.00 0	0.00 0	500.00 112,500	500.00 112,500	500.00
FPC S3 Allowance for Well Pumps-25 gpm	9.00 EA	0.00 0	0.00 0	0.00 0	3000.00 27,000	3000.00 27,000	3000.00
FPC S3 Allowance for Controls and Connections at Well Heads	4.00 EA	0.00 0	0.00 0	0.00 0	10000.00 40,000	10000.00 40,000	10000.00
FPC S3 Refurbish Existing Wells	8.00 EA	0.00 0	0.00 0	0.00 0	10000.00 80,000	10000.00 80,000	10000.00
S3 Water Level Monitoring (Wells) Allowance for 5 piezometers per extraction well using well points	45.00	0.00 0	0.00 0	0.00 0	1000.00 45,000	1000.00 45,000	1000.00
FPC S3 Allowance for Well Head Covers Assume manhole type cover at each well head	4.00 EA	0.00 0	0.00 0	0.00 0	1000.00 4,000	1000.00 4,000	1000.00
FPC S3 Allowance for Well Testing	4.00 EA	0.00 0	0.00 0	0.00 0	5000.00 20,000	5000.00 20,000	5000.00
TOTAL Well Drilling & Construction		0	0	0	328,500	328,500	

SUB:03. Site Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.06. Electrical Distribution							
FPC S3 Allowance for Site Electrical		0.00	0.00	0.00	10000.00	10000.00	
	1.00 LS	0	0	0	10,000	10,000	10000.00
TOTAL Electrical Distribution		0	0	0	10,000	10,000	
TOTAL Site Work		0	0	0	47,462	47,462	

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SUB:03. Site Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.05. Fencing							
FPC S3 Allowance for Permanent Fencing		0.00	0.00	0.00	21.00	21.00	
Assume 7 ft high security fence	350.00 LF	0	0	0	7,350	7,350	21.00
FPC S3 Allowance for Entrance Gate		0.00	0.00	0.00	300.00	300.00	
	1.00 EA	0	0	0	300	300	300.00
TOTAL Fencing		0	0	0	7,650	7,650	

SUB:03. Site Work	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.04. Roads/Parking/Curbs/Walks									
FPC S3 Allowance for Access Road				0.00	0.00	0.00	10.00	10.00	
	400.00	SY		0	0	0	4,000	4,000	10.00
FPC S3 Allowance Gravel Parking Area				0.00	0.00	0.00	10.00	10.00	
	300.00	SY		0	0	0	3,000	3,000	10.00
FPC S3 Access Roads to Wells				0.00	0.00	0.00	2.12	2.12	
Assume 10 ft wide, native materials	8402.00	LF		0	0	0	17,812	17,812	2.12
Road length equal to the length of well piping									
TOTAL Roads/Parking/Curbs/Walks				0	0	0	24,812	24,812	

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SUB:03. Site Work	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03. Site Work									
SUB:03.03. Earthwork									
FPC S3 Allowance for Site Preparation				0.00	0.00	0.00	5000.00	5000.00	
	1.00	LS		0	0	0	5,000	5,000	5000.00
TOTAL Earthwork				0	0	0	5,000	5,000	

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.06. Pre-Construction Submittals							
FPC S3 Allowance for Pre-Construction Submittals by Fixed Price Contractor	4.00 EA	0.00 0	0.00 0	0.00 0	2500.00 10,000	2500.00 10,000	2500.00
TOTAL Pre-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Mobilization & Preparatory Work		9,599	1,819	7,007	11,000	29,425	

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SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.05. Construct Temporary Utilities							
M FPC S3 Allowance for Temporary Power	500.00 LF	1.00 500	0.00 0	1.08 539	0.00 0	2.08 1,039	2.08
M FPC S3 Allowance for Telephone	500.00 LF	0.50 250	0.00 0	0.54 270	0.00 0	1.04 520	1.04
M FPC S3 Allowance for Temporary Water and Sewer Service	500.00 LF	3.00 1,500	0.00 0	3.23 1,617	0.00 0	6.23 3,117	6.23
TOTAL Construct Temporary Utilities		2,250	0	2,426	0	4,676	

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04.03. Site Survey							
FPC S3 Allowance for Site Survey		0.00	0.00	0.00	1000.00	1000.00	
	1.00 LS	0	0	0	1,000	1,000	1000.00
TOTAL Site Survey		0	0	0	1,000	1,000	
TOTAL Setup/Construct Temp Facilities		7,349	1,069	4,582	1,000	14,000	

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SUB:01. Mobilization & Preparatory Work	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04.02. Construct Decon Area Work to be Performed: Construct decontamination area/pad for equipment and vehicles. Crew and Equipment: Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers Equipment: 1 backhoe, 1 pickup truck Output: Assumed duration for this activity is 3 crew days.									
FPC S3 Laborer Group - 1 - 3 ea	72.00	HR	0029	25.20 1,814	0.00 0	0.00 0	0.00 0	25.20 1,814	25.20
FPC S3 Laborer Group - 2 - 3 ea	72.00	HR	0030	25.50 1,836	0.00 0	0.00 0	0.00 0	25.50 1,836	25.50
FPC S3 Group-6 Power Equipment Operator - 1 ea	24.00	HR	0039	29.10 698	0.00 0	0.00 0	0.00 0	29.10 698	29.10
FPC S3 Small Tools - 2 ea	48.00	HR	XMIXX020	0.00 0	1.40 67	0.00 0	0.00 0	1.40 67	1.40
FPC S3 TRK,HWY,4X4,F250,3/4T,8800 GVW 4X4 3/4 TON PICK-UP - 1 ea	24.00	HR	T50F0004	0.00 0	7.31 175	0.00 0	0.00 0	7.31 175	7.31
FPC S3 HYD EXCAV,TRK MTD,.5 CY BKT,6X4 HYDRO-SCOPIC - 1 ea	24.00	HR	H30BA001	0.00 0	34.44 827	0.00 0	0.00 0	34.44 827	34.44
M FPC S3 Construction Materials/Supplies Allowance	1.00	LS		0.00 0	0.00 0	2156.00 2,156	0.00 0	2156.00 2,156	2156.00
M FPC S3 Allowance for Tank Assume 1000 gal plastic tank for water collection	1.00	EA		0.00 0	0.00 0	1617.00 1,617	0.00 0	1617.00 1,617	1617.00
TOTAL Construct Decon Area	24.00	HR		4,349	1,069	3,773	0	9,191	382.96

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04. Setup/Construct Temp Facilities							
SUB:01.04.01. Establish Facilities							
SUB:01.04.01.02. Setup Trailers							
M FPC S3 Setup Field Office Trailer		1000.00	0.00	269.50	0.00	1269.50	
	1.00 EA	1,000	0	270	0	1,270	1269.50
M FPC S3 Setup Storage Trailer		1000.00	0.00	269.50	0.00	1269.50	
	1.00 EA	1,000	0	270	0	1,270	1269.50
M FPC S3 Setup Decon Trailer		1000.00	0.00	269.50	0.00	1269.50	
	1.00 EA	1,000	0	270	0	1,270	1269.50
TOTAL Setup Trailers		3,000	0	809	0	3,809	
TOTAL Establish Facilities		3,000	0	809	0	3,809	

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SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB. Fixed Price Contractor							
SUB:01. Mobilization & Preparatory Work							
SUB:01.02. Mobilize Personnel & Equipment							
SUB:01.02.02. Mobilize Trailers							
FPC S3 Mobilize Field Office Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
FPC S3 Mobilize Storage Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
FPC S3 Mobilize Decon Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
TOTAL Mobilize Trailers		0	750	0	0	750	
TOTAL Mobilize Personnel & Equipment		0	750	0	0	750	

ANA:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA:02.08.03. Ground Water Analysis (YRS 2-5)							
Assumptions:							
1. Assume 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle (104 samples/yr)							
2. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr)							
- Total Samples = 118							
3. All on-site sample analyses performed by mobile lab							
4. 10% off-site verification analysis of reduced analyte list with CLP protocol (10% of 118 = 12)							
ANA Analyze LLW Sample - Off-site		0.00	0.00	0.00	4210.00	4210.00	
Lab	12.00 EA	0	0	0	50,520	50,520	4210.00
TOTAL Ground Water Analysis (YRS 2-5)	12.00 EA	0	0	0	50,520	50,520	4210.00
TOTAL Sampling Rad Contaminated Media		0	0	0	122,090	122,090	
TOTAL Monitoring, Sampling & Analysis		0	0	0	122,090	122,090	
TOTAL Off-Site Analytical Services		0	0	0	122,090	122,090	

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ANA:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

ANA. Off-Site Analytical Services
ANA:02. Monitoring, Sampling & Analysis
ANA:02.08. Sampling Rad Contaminated Media
ANA:02.08.02. Ground Water Analysis (YR 1)

Assumptions:

1. Assume shake-down period with following sampling of treatment system:
   - First 2 days: Sample every four hours of influent and effluent (24 samples)
   - Next 5 days: 1 sample per day of influent and effluent (10 samples)
   - Next 7 weeks: 1 sample per week of influent and effluent (14 samples)

2. 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle (104 samples/yr)

3. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr)

   - Total samples = 166

4. All on-site sample analyses performed by mobile lab

5. 10% off-site verification analysis of reduced analyte list with CLP protocol. (10% of 166 = 17 ea)

ANA	Analyze LLW Sample - Off-site Lab	17.00 EA	0.00 0	0.00 0	0.00 0	4210.00 71,570	4210.00 71,570	4210.00
TOTAL	Ground Water Analysis (YR 1)	17.00 EA	0	0	0	71,570	71,570	4210.00

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUBTOTAL						5,606,820	
Material/Supply MPR						54,860	
TOTAL INCL INDIRECTS						5,661,670	
Subcontractor MPR						299,810	
SUBTOTAL						5,961,480	
Project Management/Construction Mgnt						875,910	
SUBTOTAL						6,837,390	
General & Admin/Common Support Pool						1,712,400	
SUBTOTAL						8,549,790	
Contingency						2,992,430	
TOTAL INCL OWNER COSTS						11,542,220	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.05 Disconnect Temporary Utilities		2,500	0	0	0	2,500	
SUB:21.06 Post-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Demobilization		3,950	1,110	0	10,000	15,060	
TOTAL Fixed Price Contractor		13,550	2,930	7,010	3,171,090	3,194,570	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis							
WHC:02.08 Sampling Rad Contaminated Media							
WHC:02.08.02 Ground Water Analysis-Yr 1	149.00 EA	0	0	0	60,270	60,270	404.49
WHC:02.08.03 Ground Water Analysis-Yr 2-5	106.00 EA	0	0	0	43,210	43,210	407.61
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	0	0	660	27.62
TOTAL Sampling Rad Contaminated Media		660	0	0	103,480	104,140	
TOTAL Monitoring, Sampling & Analysis		660	0	0	103,480	104,140	
WHC:13 Physical Treatment							
WHC:13.21 Reverse Osmosis							
WHC:13.21.06 Personnel Training		1,100	0	0	5,800	6,900	
WHC:13.21.08 Operation and Maint (Yrs 1-5)	1.00 YR	539,120	0	360,890	216,450	1,116,460	1116463.36
WHC:13.21.11 Prepare Annual Report (Yr 1)	2080.00 HR	90,150	0	0	0	90,150	43.34
WHC:13.21.12 Prepare Annual Report (Yrs 2-5)	1.00 YR	60,070	0	0	0	60,070	60069.93
TOTAL Reverse Osmosis		690,450	0	360,890	222,250	1,273,590	
TOTAL Physical Treatment		690,450	0	360,890	222,250	1,273,590	
TOTAL Westinghouse Hanford Company		691,110	0	360,890	325,730	1,377,730	
TOTAL HANFORD: ER PROGRAM		704,660	2,930	367,900	3,618,900	4,694,380	
Overhead						606,970	
SUBTOTAL						5,301,350	
Profit						256,790	
SUBTOTAL						5,558,140	
Bond						29,460	
SUBTOTAL						5,587,600	
B&O Tax						19,210	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.05 Fencing		0	0	0	7,650	7,650	
SUB:03.06 Electrical Distribution		0	0	0	10,000	10,000	
TOTAL Site Work		0	0	0	47,460	47,460	
SUB:06 Groundwater Collection & Control							
SUB:06.01 Extraction & Injection Wells							
SUB:06.01.01 Well Drilling & Construction		0	0	0	328,500	328,500	
SUB:06.01.04 Operations and Maintenance Yr 3		0	0	0	147,000	147,000	
SUB:06.01.9X Site Piping		0	0	0	204,320	204,320	
TOTAL Extraction & Injection Wells		0	0	0	679,820	679,820	
TOTAL Groundwater Collection & Control		0	0	0	679,820	679,820	
SUB:13 Physical Treatment							
SUB:13.21 Reverse Osmosis							
SUB:13.21.04 Construction of Permanent Plant	800.00 SF	0	0	0	2,412,800	2,412,800	3016.00
TOTAL Reverse Osmosis		0	0	0	2,412,800	2,412,800	
TOTAL Physical Treatment		0	0	0	2,412,800	2,412,800	
SUB:20 Site Restoration							
SUB:20.04 Revegetation and Planting Yr 5		0	0	0	10,000	10,000	
TOTAL Site Restoration		0	0	0	10,000	10,000	
SUB:21 Demobilization							
SUB:21.02 Demobilize Personnel & Equipment							
SUB:21.02.02 Demobilize Trailers-Yr 5		0	750	0	0	750	
TOTAL Demobilize Personnel & Equipment		0	750	0	0	750	
SUB:21.04 Demobilize Temp Facilities							
SUB:21.04.02 Remove Decon Area-Yr 5	8.00 HR	1,450	360	0	0	1,810	225.75
TOTAL Demobilize Temp Facilities		1,450	360	0	0	1,810	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis							
ANA:02.08 Sampling Rad Contaminated Media							
ANA:02.08.02 Ground Water Analysis (YR 1)	17.00 EA	0	0	0	71,570	71,570	4210.00
ANA:02.08.03 Ground Water Analysis (YRS 2-5)	12.00 EA	0	0	0	50,520	50,520	4210.00
TOTAL Sampling Rad Contaminated Media		0	0	0	122,090	122,090	
TOTAL Monitoring, Sampling & Analysis		0	0	0	122,090	122,090	
TOTAL Off-Site Analytical Services		0	0	0	122,090	122,090	
SUB Fixed Price Contractor							
SUB:01 Mobilization & Preparatory Work							
SUB:01.02 Mobilize Personnel & Equipment							
SUB:01.02.02 Mobilize Trailers		0	750	0	0	750	
TOTAL Mobilize Personnel & Equipment		0	750	0	0	750	
SUB:01.04 Setup/Construct Temp Facilities							
SUB:01.04.01 Establish Facilities							
SUB:01.04.01.02 Setup Trailers		3,000	0	810	0	3,810	
TOTAL Establish Facilities		3,000	0	810	0	3,810	
SUB:01.04.02 Construct Decon Area	24.00 HR	4,350	1,070	3,770	0	9,190	382.96
SUB:01.04.03 Site Survey		0	0	0	1,000	1,000	
TOTAL Setup/Construct Temp Facilities		7,350	1,070	4,580	1,000	14,000	
SUB:01.05 Construct Temporary Utilities		2,250	0	2,430	0	4,680	
SUB:01.06 Pre-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Mobilization & Preparatory Work		9,600	1,820	7,010	11,000	29,430	
SUB:03 Site Work							
SUB:03.03 Earthwork		0	0	0	5,000	5,000	
SUB:03.04 Roads/Parking/Curbs/Walks		0	0	0	24,810	24,810	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUBTOTAL						8,549,790	
Contingency						2,992,430	
TOTAL INCL OWNER COSTS						11,542,220	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis		0	0	0	122,090	122,090	
TOTAL Off-Site Analytical Services		0	0	0	122,090	122,090	
SUB Fixed Price Contractor							
SUB:01 Mobilization & Preparatory Work		9,600	1,820	7,010	11,000	29,430	
SUB:03 Site Work		0	0	0	47,460	47,460	
SUB:06 Groundwater Collection & Control		0	0	0	679,820	679,820	
SUB:13 Physical Treatment		0	0	0	2,412,800	2,412,800	
SUB:20 Site Restoration		0	0	0	10,000	10,000	
SUB:21 Demobilization		3,950	1,110	0	10,000	15,060	
TOTAL Fixed Price Contractor		13,550	2,930	7,010	3,171,090	3,194,570	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis		660	0	0	103,480	104,140	
WHC:13 Physical Treatment		690,450	0	360,890	222,250	1,273,590	
TOTAL Westinghouse Hanford Company		691,110	0	360,890	325,730	1,377,730	
TOTAL HANFORD: ER PROGRAM		704,660	2,930	367,900	3,618,900	4,694,380	
Overhead						606,970	
SUBTOTAL						5,301,350	
Profit						256,790	
SUBTOTAL						5,558,140	
Bond						29,460	
SUBTOTAL						5,587,600	
B&O Tax						19,210	
SUBTOTAL						5,606,820	
Material/Supply MPR						54,860	
TOTAL INCL INDIRECTS						5,661,670	
Subcontractor MPR						299,810	
SUBTOTAL						5,961,480	
Project Management/Construction Mgnt						875,910	
SUBTOTAL						6,837,390	
General & Admin/Common Support Pool						1,712,400	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		0	0	0	122,090	122,090	
SUB Fixed Price Contractor		13,550	2,930	7,010	3,171,090	3,194,570	
WHC Westinghouse Hanford Company		691,110	0	360,890	325,730	1,377,730	
TOTAL HANFORD: ER PROGRAM		704,660	2,930	367,900	3,618,900	4,694,380	
Overhead						606,970	
SUBTOTAL						5,301,350	
Profit						256,790	
SUBTOTAL						5,558,140	
Bond						29,460	
SUBTOTAL						5,587,600	
B&O Tax						19,210	
SUBTOTAL						5,606,820	
Material/Supply MPR						54,860	
TOTAL INCL INDIRECTS						5,661,670	
Subcontractor MPR						299,810	
SUBTOTAL						5,961,480	
Project Management/Construction Mgnt						875,910	
SUBTOTAL						6,837,390	
General & Admin/Common Support Pool						1,712,400	
SUBTOTAL						8,549,790	
Contingency						2,992,430	
TOTAL INCL OWNER COSTS						11,542,220	

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	QUANTITY	UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
TOTAL INCL OWNER COSTS									11,542,220	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
SUB:21.05 Disconnect Temporary Utilities		2,500	480	200	20	20	0	3,210	
SUB:21.06 Post-Construction Submittals	4.00 EA	10,000	1,900	800	90	60	0	12,860	3214.05
TOTAL Demobilization		15,060	2,860	1,210	140	90	0	19,360	
TOTAL Fixed Price Contractor		3,194,570	606,970	256,790	29,460	19,210	0	4,107,000	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis									
WHC:02.08 Sampling Rad Contaminated Media									
WHC:02.08.02 Ground Water Analysis-Yr 1	149.00 EA	60,270	0	0	0	0	0	60,270	404.49
WHC:02.08.03 Ground Water Analysis-Yr 2-5	106.00 EA	43,210	0	0	0	0	0	43,210	407.61
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	0	0	0	0	660	27.62
TOTAL Sampling Rad Contaminated M		104,140	0	0	0	0	0	104,140	
TOTAL Monitoring, Sampling & Anal		104,140	0	0	0	0	0	104,140	
WHC:13 Physical Treatment									
WHC:13.21 Reverse Osmosis									
WHC:13.21.06 Personnel Training		6,900	0	0	0	0	0	6,900	
WHC:13.21.08 Operation and Maint (Yrs 1-5)	1.00 YR	1,116,460	0	0	0	0	54,860	1,171,320	1171318.42
WHC:13.21.11 Prepare Annual Report (Yr 1)	2080.00 HR	90,150	0	0	0	0	0	90,150	43.34
WHC:13.21.12 Prepare Annual Report (Yrs 2-5	1.00 YR	60,070	0	0	0	0	0	60,070	60069.93
TOTAL Reverse Osmosis		1,273,590	0	0	0	0	54,860	1,328,440	
TOTAL Physical Treatment		1,273,590	0	0	0	0	54,860	1,328,440	
TOTAL Westinghouse Hanford Compan		1,377,730	0	0	0	0	54,860	1,432,580	
TOTAL HANFORD: ER PROGRAM		4,694,380	606,970	256,790	29,460	19,210	54,860	5,661,670	
Subcontractor MPR								299,810	
SUBTOTAL								5,961,480	
Project Management/Construction Mgnt								875,910	
SUBTOTAL								6,837,390	
General & Admin/Common Support Pool								1,712,400	
SUBTOTAL								8,549,790	
Contingency								2,992,430	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
SUB:03.05 Fencing		7,650	1,450	610	70	50	0	9,830	
SUB:03.06 Electrical Distribution		10,000	1,900	800	90	60	0	12,860	
TOTAL Site Work		47,460	9,020	3,820	440	290	0	61,020	
SUB:06 Groundwater Collection & Control									
SUB:06.01 Extraction & Injection Wells									
SUB:06.01.01 Well Drilling & Construction		328,500	62,420	26,410	3,030	1,980	0	422,330	
SUB:06.01.04 Operations and Maintenance Yr		147,000	27,930	11,820	1,360	880	0	188,990	
SUB:06.01.9X Site Piping		204,320	38,820	16,420	1,880	1,230	0	262,680	
TOTAL Extraction & Injection Well		679,820	129,170	54,650	6,270	4,090	0	873,990	
TOTAL Groundwater Collection & Co		679,820	129,170	54,650	6,270	4,090	0	873,990	
SUB:13 Physical Treatment									
SUB:13.21 Reverse Osmosis									
SUB:13.21.04 Construction of Permanent Plan	800.00 SF	2,412,800	458,430	193,950	22,250	14,510	0	3,101,950	3877.43
TOTAL Reverse Osmosis		2,412,800	458,430	193,950	22,250	14,510	0	3,101,950	
TOTAL Physical Treatment		2,412,800	458,430	193,950	22,250	14,510	0	3,101,950	
SUB:20 Site Restoration									
SUB:20.04 Revegetation and Planting Yr 5		10,000	1,900	800	90	60	0	12,860	
TOTAL Site Restoration		10,000	1,900	800	90	60	0	12,860	
SUB:21 Demobilization									
SUB:21.02 Demobilize Personnel & Equipment									
SUB:21.02.02 Demobilize Trailers-Yr 5		750	140	60	10	0	0	960	
TOTAL Demobilize Personnel & Equi		750	140	60	10	0	0	960	
SUB:21.04 Demobilize Temp Facilities									
SUB:21.04.02 Remove Decon Area-Yr 5	8.00 HR	1,810	340	150	20	10	0	2,320	290.23
TOTAL Demobilize Temp Facilities		1,810	340	150	20	10	0	2,320	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis									
ANA:02.08 Sampling Rad Contaminated Media									
ANA:02.08.02 Ground Water Analysis (YR 1)	17.00 EA	71,570	0	0	0	0	0	71,570	4210.00
ANA:02.08.03 Ground Water Analysis (YRS 2-5	12.00 EA	50,520	0	0	0	0	0	50,520	4210.00
TOTAL Sampling Rad Contaminated M		122,090	0	0	0	0	0	122,090	
TOTAL Monitoring, Sampling & Anal		122,090	0	0	0	0	0	122,090	
TOTAL Off-Site Analytical Service		122,090	0	0	0	0	0	122,090	
SUB Fixed Price Contractor									
SUB:01 Mobilization & Preparatory Work									
SUB:01.02 Mobilize Personnel & Equipment									
SUB:01.02.02 Mobilize Trailers		750	140	60	10	0	0	960	
TOTAL Mobilize Personnel & Equipm		750	140	60	10	0	0	960	
SUB:01.04 Setup/Construct Temp Facilities									
SUB:01.04.01 Establish Facilities									
SUB:01.04.01.02 Setup Trailers		3,810	720	310	40	20	0	4,900	
TOTAL Establish Facilities		3,810	720	310	40	20	0	4,900	
SUB:01.04.02 Construct Decon Area	24.00 HR	9,190	1,750	740	80	60	0	11,820	492.34
SUB:01.04.03 Site Survey		1,000	190	80	10	10	0	1,290	
TOTAL Setup/Construct Temp Facili		14,000	2,660	1,130	130	80	0	18,000	
SUB:01.05 Construct Temporary Utilities		4,680	890	380	40	30	0	6,010	
SUB:01.06 Pre-Construction Submittals	4.00 EA	10,000	1,900	800	90	60	0	12,860	3214.05
TOTAL Mobilization & Preparatory		29,430	5,590	2,370	270	180	0	37,830	
SUB:03 Site Work									
SUB:03.03 Earthwork		5,000	950	400	50	30	0	6,430	
SUB:03.04 Roads/Parking/Curbs/Walks		24,810	4,710	1,990	230	150	0	31,900	

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U.S. Army Corps of Engineers - D.O. 94 - Final
PROJECT HARERO: HANFORD: ER PROGRAM - H AREA REVERSE OSMOSIS
REVERSE OSMOSIS REMEDIATION MODEL 100 H AREA
** PROJECT INDIRECT SUMMARY - FEATURE (Rounded to 10's) **

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis		122,090	0	0	0	0	0	122,090	
TOTAL Off-Site Analytical Services		122,090	0	0	0	0	0	122,090	
SUB Fixed Price Contractor									
SUB:01 Mobilization & Preparatory Work		29,430	5,590	2,370	270	180	0	37,830	
SUB:03 Site Work		47,460	9,020	3,820	440	290	0	61,020	
SUB:06 Groundwater Collection & Control		679,820	129,170	54,650	6,270	4,090	0	873,990	
SUB:13 Physical Treatment		2,412,800	458,430	193,950	22,250	14,510	0	3,101,950	
SUB:20 Site Restoration		10,000	1,900	800	90	60	0	12,860	
SUB:21 Demobilization		15,060	2,860	1,210	140	90	0	19,360	
TOTAL Fixed Price Contractor		3,194,570	606,970	256,790	29,460	19,210	0	4,107,000	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis		104,140	0	0	0	0	0	104,140	
WHC:13 Physical Treatment		1,273,590	0	0	0	0	54,860	1,328,440	
TOTAL Westinghouse Hanford Company		1,377,730	0	0	0	0	54,860	1,432,580	
TOTAL HANFORD: ER PROGRAM		4,694,380	606,970	256,790	29,460	19,210	54,860	5,661,670	
Subcontractor MPR								299,810	
SUBTOTAL								5,961,480	
Project Management/Construction Mgnt								875,910	
SUBTOTAL								6,837,390	
General & Admin/Common Support Pool								1,712,400	
SUBTOTAL								8,549,790	
Contingency								2,992,430	
TOTAL INCL OWNER COSTS								11,542,220	

		QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA	Off-Site Analytical Services		122,090	0	0	0	0	0	122,090	
SUB	Fixed Price Contractor		3,194,570	606,970	256,790	29,460	19,210	0	4,107,000	
WHC	Westinghouse Hanford Company		1,377,730	0	0	0	0	54,860	1,432,580	
	HANFORD: ER PROGRAM		4,694,380	606,970	256,790	29,460	19,210	54,860	5,661,670	
	Subcontractor MPR								299,810	
	SUBTOTAL								5,961,480	
	Project Management/Construction Mgnt								875,910	
	SUBTOTAL								6,837,390	
	General & Admin/Common Support Pool								1,712,400	
	SUBTOTAL								8,549,790	
	Contingency								2,992,430	
	TOTAL INCL OWNER COSTS								11,542,220	

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	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
SUB:21.05 Disconnect Temporary Utilities		3,210	230	520	1,010	1,740	6,720	
SUB:21.06 Post-Construction Submittals	4.00 EA	12,860	940	2,070	4,050	6,970	26,880	6719.36
TOTAL Demobilization		19,360	1,410	3,120	6,090	10,490	40,470	
TOTAL Fixed Price Contractor		4,107,000	299,810	661,020	1,292,300	2,226,050	8,586,180	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis								
WHC:02.08 Sampling Rad Contaminated Media								
WHC:02.08.02 Ground Water Analysis-Yr 1	149.00 EA	60,270	0	9,040	17,670	30,440	117,430	788.11
WHC:02.08.03 Ground Water Analysis-Yr 2-5	106.00 EA	43,210	0	6,480	12,670	21,830	84,180	794.18
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	100	190	330	1,290	53.82
TOTAL Sampling Rad Contaminated Media		104,140	0	15,620	30,540	52,600	202,900	
TOTAL Monitoring, Sampling & Analysis		104,140	0	15,620	30,540	52,600	202,900	
WHC:13 Physical Treatment								
WHC:13.21 Reverse Osmosis								
WHC:13.21.06 Personnel Training		6,900	0	1,040	2,020	3,490	13,450	
WHC:13.21.08 Operation and Maint (Yrs 1-5)	1.00 YR	1,171,320	0	175,700	343,490	591,680	2,282,180	2282182.16
WHC:13.21.11 Prepare Annual Report (Yr 1)	2080.00 HR	90,150	0	13,520	26,440	45,540	175,640	84.44
WHC:13.21.12 Prepare Annual Report (Yrs 2-5)	1.00 YR	60,070	0	9,010	17,620	30,340	117,040	117039.51
TOTAL Reverse Osmosis		1,328,440	0	199,270	389,570	671,050	2,588,320	
TOTAL Physical Treatment		1,328,440	0	199,270	389,570	671,050	2,588,320	
TOTAL Westinghouse Hanford Company		1,432,580	0	214,890	420,100	723,650	2,791,220	
TOTAL HANFORD: ER PROGRAM		5,661,670	299,810	875,910	1,712,400	2,992,430	11,542,220	

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
SUB:03.05 Fencing		9,830	720	1,580	3,090	5,330	20,560	
SUB:03.06 Electrical Distribution		12,860	940	2,070	4,050	6,970	26,880	
TOTAL Site Work		61,020	4,450	9,820	19,200	33,070	127,570	
SUB:06 Groundwater Collection & Control								
SUB:06.01 Extraction & Injection Wells								
SUB:06.01.01 Well Drilling & Construction		422,330	30,830	67,970	132,890	228,910	882,920	
SUB:06.01.04 Operations and Maintenance Yr 3		188,990	13,800	30,420	59,470	102,430	395,100	
SUB:06.01.9X Site Piping		262,680	19,180	42,280	82,650	142,380	549,170	
TOTAL Extraction & Injection Wells		873,990	63,800	140,670	275,010	473,720	1,827,190	
TOTAL Groundwater Collection & Control		873,990	63,800	140,670	275,010	473,720	1,827,190	
SUB:13 Physical Treatment								
SUB:13.21 Reverse Osmosis								
SUB:13.21.04 Construction of Permanent Plant	800.00 SF	3,101,950	226,440	499,260	976,050	1,681,290	6,484,990	8106.24
TOTAL Reverse Osmosis		3,101,950	226,440	499,260	976,050	1,681,290	6,484,990	
TOTAL Physical Treatment		3,101,950	226,440	499,260	976,050	1,681,290	6,484,990	
SUB:20 Site Restoration								
SUB:20.04 Revegetation and Planting Yr 5		12,860	940	2,070	4,050	6,970	26,880	
TOTAL Site Restoration		12,860	940	2,070	4,050	6,970	26,880	
SUB:21 Demobilization								
SUB:21.02 Demobilize Personnel & Equipment								
SUB:21.02.02 Demobilize Trailers-Yr 5		960	70	160	300	520	2,020	
TOTAL Demobilize Personnel & Equipment		960	70	160	300	520	2,020	
SUB:21.04 Demobilize Temp Facilities								
SUB:21.04.02 Remove Decon Area-Yr 5	8.00 HR	2,320	170	370	730	1,260	4,850	606.76
TOTAL Demobilize Temp Facilities		2,320	170	370	730	1,260	4,850	

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	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis								
ANA:02.08 Sampling Rad Contaminated Media								
ANA:02.08.02 Ground Water Analysis (YR 1)	17.00 EA	71,570	0	0	0	25,050	96,620	5683.50
ANA:02.08.03 Ground Water Analysis (YRS 2-5)	12.00 EA	50,520	0	0	0	17,680	68,200	5683.50
TOTAL Sampling Rad Contaminated Media		122,090	0	0	0	42,730	164,820	
TOTAL Monitoring, Sampling & Analysis		122,090	0	0	0	42,730	164,820	
TOTAL Off-Site Analytical Services		122,090	0	0	0	42,730	164,820	
SUB Fixed Price Contractor								
SUB:01 Mobilization & Preparatory Work								
SUB:01.02 Mobilize Personnel & Equipment								
SUB:01.02.02 Mobilize Trailers		960	70	160	300	520	2,020	
TOTAL Mobilize Personnel & Equipment		960	70	160	300	520	2,020	
SUB:01.04 Setup/Construct Temp Facilities								
SUB:01.04.01 Establish Facilities								
SUB:01.04.01.02 Setup Trailers		4,900	360	790	1,540	2,650	10,240	
TOTAL Establish Facilities		4,900	360	790	1,540	2,650	10,240	
SUB:01.04.02 Construct Decon Area	24.00 HR	11,820	860	1,900	3,720	6,400	24,700	1029.29
SUB:01.04.03 Site Survey		1,290	90	210	400	700	2,690	
TOTAL Setup/Construct Temp Facilities		18,000	1,310	2,900	5,660	9,760	37,630	
SUB:01.05 Construct Temporary Utilities		6,010	440	970	1,890	3,260	12,570	
SUB:01.06 Pre-Construction Submittals	4.00 EA	12,860	940	2,070	4,050	6,970	26,880	6719.36
TOTAL Mobilization & Preparatory Work		37,830	2,760	6,090	11,900	20,500	79,090	
SUB:03 Site Work								
SUB:03.03 Earthwork		6,430	470	1,030	2,020	3,480	13,440	
SUB:03.04 Roads/Parking/Curbs/Walks		31,900	2,330	5,130	10,040	17,290	66,690	

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis		122,090	0	0	0	42,730	164,820	
TOTAL Off-Site Analytical Services		122,090	0	0	0	42,730	164,820	
SUB Fixed Price Contractor								
SUB:01 Mobilization & Preparatory Work		37,830	2,760	6,090	11,900	20,500	79,090	
SUB:03 Site Work		61,020	4,450	9,820	19,200	33,070	127,570	
SUB:06 Groundwater Collection & Control		873,990	63,800	140,670	275,010	473,720	1,827,190	
SUB:13 Physical Treatment		3,101,950	226,440	499,260	976,050	1,681,290	6,484,990	
SUB:20 Site Restoration		12,860	940	2,070	4,050	6,970	26,880	
SUB:21 Demobilization		19,360	1,410	3,120	6,090	10,490	40,470	
TOTAL Fixed Price Contractor		4,107,000	299,810	661,020	1,292,300	2,226,050	8,586,180	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis		104,140	0	15,620	30,540	52,600	202,900	
WHC:13 Physical Treatment		1,328,440	0	199,270	389,570	671,050	2,588,320	
TOTAL Westinghouse Hanford Company		1,432,580	0	214,890	420,100	723,650	2,791,220	
TOTAL HANFORD: ER PROGRAM		5,661,670	299,810	875,910	1,712,400	2,992,430	11,542,220	

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Wed 26 Jul 1995
Eff. Date 09/14/94

U.S. Army Corps of Engineers - D.O. 94 - Final
PROJECT HARERO: HANFORD: ER PROGRAM - H AREA REVERSE OSMOSIS
REVERSE OSMOSIS REMEDIATION MODEL 100 H AREA
** PROJECT OWNER SUMMARY - CNTRCTOR (Rounded to 10's) **

TIME 13:12:34

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		122,090	0	0	0	42,730	164,820	
SUB Fixed Price Contractor		4,107,000	299,810	661,020	1,292,300	2,226,050	8,586,180	
WHC Westinghouse Hanford Company		1,432,580	0	214,890	420,100	723,650	2,791,220	
TOTAL HANFORD: ER PROGRAM		5,661,670	299,810	875,910	1,712,400	2,992,430	11,542,220	

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HANFORD: ER PROGRAM
H AREA REVERSE OSMOSIS
1.4.10.1.1.10.5.2.4
REVERSE OSMOSIS REMEDIATION
FOCUSED FEASIBILITY STUDY

Designed By:
Estimated By: CH2M HILL HANFORD, INC.

Prepared By: ERC CONTRACT - RICHLAND, WASH

Preparation Date: 07/26/95
Effective Date of Pricing: 09/14/94

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SRC	EQUIP ID	DESCRIPTION	DEPR	CAPT	FUEL	FOG	EQ REP	TR WR	TR REP	TOTAL	UOM	** TOTAL ** HOURS
USR	H30BA001	HYD EXCAV,TRK MTD,.5 CY BKT,6X4			12.07	1.4	19.78	0.98	0.15	34.44	HR	32
USR	T50F0004	TRK,HWY,4X4,F250,3/4T,8800 GVW			2.67	0.7	3.58	0.27	0.04	7.31	HR	32
MIL	XMIXX020	Small Tools	0.47	0.17	0.13	0.0	0.57			1.40	HR	64

SRC	LABOR ID	DESCRIPTION	BASE	OVERTM	TXS/INS	FRNG	TRVL	RATE	UOM	UPDATE	**** TOTAL **** DEFAULT	HOURS
FPC	0029	Laborer Group - 1	15.84	0.0%	28.7%	3.57	1.25	25.20	HR	07/09/93	0.00	96
FPC	0030	Laborer Group - 2	16.09	0.0%	28.5%	3.57	1.25	25.50	HR	07/09/93	0.00	96
FPC	0039	Group-6 Power Equipment Operator	18.02	0.0%	27.4%	4.90	1.25	29.10	HR	07/09/93	0.00	32
WHC	85101	Engineer, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	3193
WHC	85102	Scientist, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	1733
WHC	85201	Technician, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	754
WHC	85301	Skilled Craft, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	730
WHC	85302	Operator, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	2960

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WHC:12. Chemical Treatment	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:12.05.12. Prepare Annual Report (Yrs 2-5) Assume 66% of a Year 1 Annual Report effort (2 FTE's for 4 months each year)							
Cost developed on this sheet is for one (1) year only							
WHC Engineer, Environmental Restoration Ops - 1 ea	693.00 HR 85101	43.34 30,035	0.00 0	0.00 0	0.00 0	43.34 30,035	43.34
WHC Scientist, Environmental Restoration Ops - 1 ea	693.00 HR 85102	43.34 30,035	0.00 0	0.00 0	0.00 0	43.34 30,035	43.34
TOTAL Prepare Annual Report (Yrs 2-5)	1386.00 HR	60,070	0	0	0	60,070	43.34
TOTAL Ion Exchange		336,322	0	234,758	58,008	629,088	
TOTAL Chemical Treatment		336,322	0	234,758	58,008	629,088	
TOTAL Westinghouse Hanford Company		336,985	0	234,758	111,316	683,059	
TOTAL HANFORD: ER PROGRAM		350,534	2,926	241,765	2,892,265	3,487,489	

WHC:12. Chemical Treatment		QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:12.05.11. Prepare Annual Report (Yr 1) Assume 2 FTE's for 6 months each year.										
WHC	Engineer, Environmental				43.34	0.00	0.00	0.00	43.34	
	Restoration Ops - 1 ea	1040.00	HR	85101	45,074	0	0	0	45,074	43.34
WHC	Scientist, Environmental				43.34	0.00	0.00	0.00	43.34	
	Restoration Ops - 1 ea	1040.00	HR	85102	45,074	0	0	0	45,074	43.34
TOTAL	Prepare Annual Report (Yr 1)	2080.00	HR		90,148	0	0	0	90,148	43.34

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WHC:12. Chemical Treatment		QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
	Vessels x 400 cf/vessel = 1200 cf). Replacement of resin not required during 5 year lifecycle.									
WHC	Disposal Fee for resin Media Assume disposal at ERDF for in year 5 of lifecycle	1200.00	CF		0.00 0	0.00 0	0.00 0	2.59 3,108	2.59 3,108	2.59
TOTAL	Operation & Maintenance Yrs 1-5	1.00	YR		184,999	0	234,758	52,208	471,965	471965.16

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WHC:12. Chemical Treatment		QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:12.05.08. Operation & Maintenance Yrs 1-5										
	Assumptions: 1. Treatment facility will be fully staffed with 2 FTE's per shift, 1 shift per day, 7 days per week. (365 days/yr x 8 hrs/day = 2920 hrs/yr) 2. Ion exchange media will not require regeneration during the 5 year life cycle for chromium treatment. 3. 2 FTE crew will be composed of the following members: 0.25 ea - supervisor 1.00 ea - operator 0.50 ea - engineering support 0.25 ea - maintenance engineer 4. Cost developed on this sheet is for one (1) year only									
L WHC	Technician, Environmental Restoration Ops - Supervisor - 0.25 ea	730.00	HR	85201	28.62 20,895	0.00 0	0.00 0	0.00 0	28.62 20,895	28.62
WHC	Operator, Environmental Restoration Ops - 1 ea	2920.00	HR	85302	27.62 80,661	0.00 0	0.00 0	0.00 0	27.62 80,661	27.62
L WHC	Engineer, Environmental Restoration Ops	1460.00	HR	85101	43.34 63,277	0.00 0	0.00 0	0.00 0	43.34 63,277	43.34
WHC	Skilled Craft, Environmental Restoration Ops - Maintenance - 0.25 ea	730.00	HR	85301	27.62 20,165	0.00 0	0.00 0	0.00 0	27.62 20,165	27.62
WHC	Allowance for Electricity Wells: 483 kW-hr/d Ion exchange plant: 2880 kw-hr/day Assume 24 hrs/day x 365 days/yr Total = 1,227,495 kW-hr/yr	1227495	KWH		0.00 0	0.00 0	0.00 0	0.04 49,100	0.04 49,100	0.04
M WHC	Chemicals for pH Adjustment Chemical cost calculated at $0.60 per 1000 gallons treated per year. (225 gpm x 60 min/hr x 24 hr/day x 365 day/Yr = 118.3 million gal)	1.00	EA		0.00 0	0.00 0	82074.38 82,074	0.00 0	82074.38 82,074	82074.38
M WHC S2	Ion Exchange Media (resin) Cost for initial resin required for Ion Exchange vessels (3	1200.00	CF		0.00 0	0.00 0	127.24 152,684	0.00 0	127.24 152,684	127.24

WHC:12. Chemical Treatment		QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:12. Chemical Treatment								
WHC:12.05. Ion Exchange								
WHC:12.05.06. Personnel Training								
Note: This account to allow for operator time and an allowance for a 40-hour training course.								
WHC	Operator, Environmental Restoration Ops	40.00 HR 85302	27.62 1,105	0.00 0	0.00 0	0.00 0	27.62 1,105	27.62
WHC	Allowance for 40 hr Training	1.00 LS	0.00 0	0.00 0	0.00 0	800.00 800	800.00 800	800.00
WHC	Allowance for Maintainence Manuals	1.00 LS	0.00 0	0.00 0	0.00 0	5000.00 5,000	5000.00 5,000	5000.00
TOTAL Personnel Training			1,105	0	0	5,800	6,905	

WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:02.08.04. Ground Water Monitor Samples							
Work to be Performed:							
Take semiannual groundwater monitoring samples							
Assumptions:							
1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr)							
2. Assume 2 field technicians for 6 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)							
3. Cost developed on this sheet is for one (1) year only							
WHC Technician, Environmental		27.62	0.00	0.00	0.00	27.62	
Restoration Ops - 2 ea	24.00 HR 85201	663	0	0	0	663	27.62
TOTAL Ground Water Monitor Samples	24.00 HR	663	0	0	0	663	27.62
TOTAL Sampling Rad Contaminated Media		663	0	0	53,308	53,971	
TOTAL Monitoring, Sampling & Analysis		663	0	0	53,308	53,971	

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WHC:02. Monitoring, Sampling & Analysis		QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:02.08.03. Ground Water Analysis - Yrs 2-5								

Assumptions:

1. Assume 1 sample every 2 weeks from influent and effluent for 5-year lifecycle. (52 samples/yr)

2. Assume sampling 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr)

3. 90% of samples analyzed at mobile lab (90% of 66 = 60 samples)

4. HACH kit samples are taken 2 per day for the 5-yr lifecycle. (730 samples/yr)

5. Cost developed on this sheet is for one (1) year only

WHC	Analyze LLW Sample - Mobile Lab	60.00 EA	0.00 0	0.00 0	0.00 0	400.00 24,000	400.00 24,000	400.00
WHC	HACH Kit Sampling	730.00 EA	0.00 0	0.00 0	0.00 0	1.00 730	1.00 730	1.00
WHC	HACH Kit Replacement Assume 1 per yr	1.00 EA	0.00 0	0.00 0	0.00 0	500.00 500	500.00 500	500.00
TOTAL	Ground Water Analysis - Yrs 2-5	1.00 EA	0	0	0	25,230	25,230	25230.00

WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

WHC. Westinghouse Hanford Company
WHC:02. Monitoring, Sampling & Analysis
WHC:02.08. Sampling Rad Contaminated Media
WHC:02.08.02. Ground Water Analysis - Yr 1

Assumptions:

1. Assume shake-down period with following sampling of treatment system:
   - First 2 days: 1 sample per day from influent and effluent (4 samples)
   - Next 4 weeks: 1 sample per week from influent and effluent (8 samples)

2. 1 sample every 2 weeks from influent and effluent for remainder of Yr 1 (48 samples/yr)

3. Assume sampling 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr)

4. 90% of samples analyzed at mobile lab (90% of 74= 67)

5. HACH kit samples are taken 2 per day for the 5-yr lifecycle plus an additional 48 samples during the shake-down period. (Yr 1 = 730 + 48 = 778 samples)

WHC	Analyze LLW Sample - Mobile Lab		0.00	0.00	0.00	400.00	400.00	
		67.00 EA	0	0	0	26,800	26,800	400.00
WHC	HACH Kit Sampling		0.00	0.00	0.00	1.00	1.00	
		778.00 EA	0	0	0	778	778	1.00
WHC	HACH Kit Replacement		0.00	0.00	0.00	500.00	500.00	
	Assume 1 per yr	1.00 EA	0	0	0	500	500	500.00
TOTAL	Ground Water Analysis - Yr 1	1.00 EA	0	0	0	28,078	28,078	28078.00

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SUB:21. Demobilization	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.06. Post-Construction Submittals							
FPC S3 Allowance for Post-Construction Submittals by Fixed Price Contractor	4.00 EA	0.00 0	0.00 0	0.00 0	2500.00 10,000	2500.00 10,000	2500.00
TOTAL Post-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Demobilization		3,950	1,106	0	10,000	15,056	
TOTAL Fixed Price Contractor		13,548	2,926	7,007	2,717,799	2,741,280	

SUB:21. Demobilization	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.05. Disconnect Temporary Utilities									
M FPC S3 Remove Temporary Power				1.00	0.00	0.00	0.00	1.00	
	500.00	LF		500	0	0	0	500	1.00
M FPC S3 Remove Telephone				1.00	0.00	0.00	0.00	1.00	
	500.00	LF		500	0	0	0	500	1.00
M FPC S3 Remove Temporary Water and Sewer Service				3.00	0.00	0.00	0.00	3.00	
	500.00	LF		1,500	0	0	0	1,500	3.00
TOTAL Disconnect Temporary Utilities				2,500	0	0	0	2,500	

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SUB:21. Demobilization	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.04. Demobilize Temp Facilities									
SUB:21.04.02. Remove Decon Area									
Work to be Performed: Remove decontamination area/pad for equipment and vehicles.									
Crew and Equipment: Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers; Equipment: 1 backhoe, 1 pickup truck									
Output: Assumed duration for this activity is 1 crew day.									
FPC S3 Group-6 Power Equipment Operator - 1 ea	8.00	HR	0039	29.10 233	0.00 0	0.00 0	0.00 0	29.10 233	29.10
FPC S3 Laborer Group - 1 - 3 ea	24.00	HR	0029	25.20 605	0.00 0	0.00 0	0.00 0	25.20 605	25.20
FPC S3 Laborer Group - 2 - 3 ea	24.00	HR	0030	25.50 612	0.00 0	0.00 0	0.00 0	25.50 612	25.50
L FPC S3 HYD EXCAV,TRK MTD,.5 CY BKT,6X4 HYDRO-SCOPIC - 1 ea	8.00	HR	H30BA001	0.00 0	34.44 276	0.00 0	0.00 0	34.44 276	34.44
L FPC S3 TRK,HWY,4X4,F250,3/4T,8800 GVW 4X4 3/4 TON PICK-UP - 1 ea	8.00	HR	T50F0004	0.00 0	7.31 58	0.00 0	0.00 0	7.31 58	7.31
FPC S3 Small Tools - 2 ea	16.00	HR	XMIXX020	0.00 0	1.40 22	0.00 0	0.00 0	1.40 22	1.40
TOTAL Remove Decon Area	8.00	HR		1,450	356	0	0	1,806	225.75
TOTAL Demobilize Temp Facilities				1,450	356	0	0	1,806	

SUB:21. Demobilization	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21. Demobilization									
SUB:21.02. Demobilize Personnel & Equipment									
SUB:21.02.02. Demobilize Trailers									
FPC S3 Demob Field Office Trailer				0.00	250.00	0.00	0.00	250.00	
	1.00	EA		0	250	0	0	250	250.00
FPC S3 Demob Storage Trailer				0.00	250.00	0.00	0.00	250.00	
	1.00	EA		0	250	0	0	250	250.00
FPC S3 Demob Decon Trailer				0.00	250.00	0.00	0.00	250.00	
	1.00	EA		0	250	0	0	250	250.00
TOTAL Demobilize Trailers				0	750	0	0	750	
TOTAL Demobilize Personnel & Equipment				0	750	0	0	750	

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SUB:20. Site Restoration	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:20. Site Restoration							
SUB:20.04. Revegetation and Planting							
FPC S3 Allowance for Site Restoration		0.00	0.00	0.00	2.00	2.00	
	5000.00 SY	0	0	0	10,000	10,000	2.00
TOTAL Revegetation and Planting		0	0	0	10,000	10,000	
TOTAL Site Restoration		0	0	0	10,000	10,000	

SUB:12. Chemical Treatment	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:12. Chemical Treatment							
SUB:12.05. Ion Exchange							
SUB:12.05.04. Construction of Permanent Plant							
FPC S3 Ion Exchange Treatment Plant -		0.00	0.00	0.00	1970000.00	1970000.00	
300 gpm capacity for the removal of chrome.	1.00 EA	0	0	0	1,970,000	1,970,000	1970000.00
TOTAL Construction of Permanent Plant	1.00 EA	0	0	0	1,970,000	1,970,000	1970000.00
TOTAL Ion Exchange		0	0	0	1,970,000	1,970,000	
TOTAL Chemical Treatment		0	0	0	1,970,000	1,970,000	

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SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06.01.9X. Site Piping							
FPC S3 Allowance for Piping from Well Head to Treatment Plant Assume double wall PVC pipe for extraction wells.	9269.00 LF	0.00 0	0.00 0	0.00 0	18.00 166,842	18.00 166,842	18.00
FPC S3 Allowance for Force Main Discharge Piping from process plant to injection wells Assume single wall PVC pipe for injection wells.	2133.00 LF	0.00 0	0.00 0	0.00 0	15.00 31,995	15.00 31,995	15.00
FPC S3 Allowance for Leak Detection	1.00 LS	0.00 0	0.00 0	0.00 0	5000.00 5,000	5000.00 5,000	5000.00
TOTAL Site Piping		0	0	0	203,837	203,837	
TOTAL Extraction & Injection Wells		0	0	0	679,337	679,337	
TOTAL Groundwater Collection & Control		0	0	0	679,337	679,337	

SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06.01.04. Operations and Maintenance Yr 3							
FPC S3 Allowance for Well Workover		0.00	0.00	0.00	10000.00	10000.00	
Assume 1 workover every 3 yrs for each well for the 5 year lifecycle (all wells) Workovers in year 3	12.00 EA	0	0	0	120,000	120,000	10000.00
FPC S3 Allowance for Well Pump Replacement		0.00	0.00	0.00	3000.00	3000.00	
Assume one pump replacement per extraction well every 3 years for the 5- year lifecycle Replacement in year 3	9.00 EA	0	0	0	27,000	27,000	3000.00
TOTAL Operations and Maintenance Yr 3		0	0	0	147,000	147,000	

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SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06. Groundwater Collection & Control							
SUB:06.01. Extraction & Injection Wells							
SUB:06.01.01. Well Drilling & Construction							
FPC S3 Drill/Install Extr/Inject Wells		0.00	0.00	0.00	500.00	500.00	
Note: 1 new extraction well, 45 feet deep and 3 new injection wells, 60 ft deep, 8 in diameter. Unit cost is assumed to include handling and packaging of contaminated well cuttings, transport to the disposal facility, and associated disposal fees.	225.00 LF	0	0	0	112,500	112,500	500.00
FPC S3 Allowance for Well Pumps- 25 gpm		0.00	0.00	0.00	3000.00	3000.00	
for the one new and existing extraction wells that are to be refurbished	9.00 EA	0	0	0	27,000	27,000	3000.00
FPC S3 Allowance for Controls and		0.00	0.00	0.00	10000.00	10000.00	
Connections at Well Heads	4.00 EA	0	0	0	40,000	40,000	10000.00
FPC S3 Refurbish Existing Wells		0.00	0.00	0.00	10000.00	10000.00	
	8.00 EA	0	0	0	80,000	80,000	10000.00
M S3 Water Level Monitoring (Wells)		0.00	0.00	0.00	1000.00	1000.00	
Allowance for 5 piezometers per extraction well using well points.	45.00 EA	0	0	0	45,000	45,000	1000.00
FPC S3 Allowance for Well Head Covers		0.00	0.00	0.00	1000.00	1000.00	
Assume manhole type cover at each well head	4.00 EA	0	0	0	4,000	4,000	1000.00
FPC S3 Allowance for Well Testing		0.00	0.00	0.00	5000.00	5000.00	
	4.00 EA	0	0	0	20,000	20,000	5000.00
TOTAL Well Drilling & Construction		0	0	0	328,500	328,500	

SUB:03. Site Work	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.05. Fencing									
FPC S3 Allowance for Permanent Fencing				0.00	0.00	0.00	21.00	21.00	
Assume 7 ft high security fence	350.00	LF		0	0	0	7,350	7,350	21.00
FPC S3 Allowance for Entrance Gate				0.00	0.00	0.00	300.00	300.00	
	1.00	EA		0	0	0	300	300	300.00
TOTAL Fencing				0	0	0	7,650	7,650	
TOTAL Site Work				0	0	0	37,462	37,462	

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SUB:03. Site Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.04. Roads/Parking/Curbs/Walks							
FPC S3 Allowance for Access Road		0.00	0.00	0.00	10.00	10.00	
	400.00 SY	0	0	0	4,000	4,000	10.00
FPC S3 Allowance Gravel Parking Area		0.00	0.00	0.00	10.00	10.00	
	300.00 SY	0	0	0	3,000	3,000	10.00
FPC S3 Access Roads to Wells		0.00	0.00	0.00	2.12	2.12	
Assume 10 feet wide, native materials	8402.00 LF	0	0	0	17,812	17,812	2.12
Road length equal to the length of well piping							
TOTAL Roads/Parking/Curbs/Walks		0	0	0	24,812	24,812	

SUB:03. Site Work	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03. Site Work									
SUB:03.03. Earthwork									
FPC S3 Allowance for Site Preparation				0.00	0.00	0.00	5000.00	5000.00	
	1.00	LS		0	0	0	5,000	5,000	5000.00
TOTAL Earthwork				0	0	0	5,000	5,000	

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SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.06. Pre-Construction Submittals							
FPC S3 Allowance for Pre-Construction Submittals by Fixed Price Contractor	4.00 EA	0.00 0	0.00 0	0.00 0	2500.00 10,000	2500.00 10,000	2500.00
TOTAL Pre-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Mobilization & Preparatory Work		9,599	1,819	7,007	11,000	29,425	

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.05. Construct Temporary Utilities							
M FPC S3 Allowance for Temporary Power		1.00	0.00	1.08	0.00	2.08	
	500.00 LF	500	0	539	0	1,039	2.08
M FPC S3 Allowance for Telephone		0.50	0.00	0.54	0.00	1.04	
	500.00 LF	250	0	270	0	520	1.04
M FPC S3 Allowance for Temporary Water and Sewer Service		3.00	0.00	3.23	0.00	6.23	
	500.00 LF	1,500	0	1,617	0	3,117	6.23
TOTAL Construct Temporary Utilities		2,250	0	2,426	0	4,676	

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SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04.03. Site Survey							
FPC S3 Allowance for Site Survey		0.00	0.00	0.00	1000.00	1000.00	
	1.00 LS	0	0	0	1,000	1,000	1000.00
TOTAL Site Survey		0	0	0	1,000	1,000	
TOTAL Setup/Construct Temp Facilities		7,349	1,069	4,582	1,000	14,000	

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SUB:01. Mobilization & Preparatory Work	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04.02. Construct Decon Area									
Work to be Performed:									
Construct decontamination area/pad for equipment and vehicles.									
Crew and Equipment:									
Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers									
Equipment: 1 backhoe, 1 pickup truck									
Output:									
Assumed duration for this activity is 3 crew days.									
FPC S3 Laborer Group - 1				25.20	0.00	0.00	0.00	25.20	
- 3 ea	72.00	HR	0029	1,814	0	0	0	1,814	25.20
FPC S3 Laborer Group - 2				25.50	0.00	0.00	0.00	25.50	
- 3 ea	72.00	HR	0030	1,836	0	0	0	1,836	25.50
FPC S3 Group-6 Power Equipment Operator				29.10	0.00	0.00	0.00	29.10	
- 1 ea	24.00	HR	0039	698	0	0	0	698	29.10
FPC S3 Small Tools - 2 ea				0.00	1.40	0.00	0.00	1.40	
	48.00	HR	XMIXX020	0	67	0	0	67	1.40
L FPC S3 TRK,HWY,4X4,F250,3/4T,8800 GVW				0.00	7.31	0.00	0.00	7.31	
4X4 3/4 TON PICK-UP	24.00	HR	T50F0004	0	175	0	0	175	7.31
- 1 ea									
L FPC S3 HYD EXCAV,TRK MTD,.5 CY BKT,6X4				0.00	34.44	0.00	0.00	34.44	
HYDRO-SCOPIC - 1 ea	24.00	HR	H30BA001	0	827	0	0	827	34.44
M FPC S3 Construction Materials/Supplies				0.00	0.00	2156.00	0.00	2156.00	
Allowance	1.00	LS		0	0	2,156	0	2,156	2156.00
M FPC S3 Allowance for Tank				0.00	0.00	1617.00	0.00	1617.00	
Assume 1000 gal plastic tank	1.00	EA		0	0	1,617	0	1,617	1617.00
for water collection									
TOTAL Construct Decon Area	24.00	HR		4,349	1,069	3,773	0	9,191	382.96

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04. Setup/Construct Temp Facilities							
SUB:01.04.01. Establish Facilities							
SUB:01.04.01.02. Setup Trailers							
M FPC S3 Setup Field Office Trailer		1000.00	0.00	269.50	0.00	1269.50	
	1.00 EA	1,000	0	270	0	1,270	1269.50
M FPC S3 Setup Storage Trailer		1000.00	0.00	269.50	0.00	1269.50	
	1.00 EA	1,000	0	270	0	1,270	1269.50
M FPC S3 Setup Decon Trailer		1000.00	0.00	269.50	0.00	1269.50	
	1.00 EA	1,000	0	270	0	1,270	1269.50
TOTAL Setup Trailers		3,000	0	809	0	3,809	
TOTAL Establish Facilities		3,000	0	809	0	3,809	

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB. Fixed Price Contractor							
SUB:01. Mobilization & Preparatory Work							
SUB:01.02. Mobilize Personnel & Equipment							
SUB:01.02.02. Mobilize Trailers							
FPC S3 Mobilize Field Office Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
FPC S3 Mobilize Storage Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
FPC S3 Mobilize Decon Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
TOTAL Mobilize Trailers		0	750	0	0	750	
TOTAL Mobilize Personnel & Equipment		0	750	0	0	750	

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ANA:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

ANA:02.08.03. Ground Water Analysis Yrs 2-5

Assumptions:

1. Assume 1 sample every 2 weeks from influent and effluent years 2 - 5 (52 samples/yr)
2. Assume sampling 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr)
3. All on-site sample analyses performed by mobile lab
4. 10% off-site verification analysis of reduced analyte list with CLP protocol (10% of 66 = 7 ea)
5. Cost developed on this sheet is for one (1) year only

ANA	Analyze LLW Sample - Off-site Lab	7.00 EA	0.00 0	0.00 0	0.00 0	4210.00 29,470	4210.00 29,470	4210.00
TOTAL	Ground Water Analysis Yrs 2-5	7.00 EA	0	0	0	29,470	29,470	4210.00
TOTAL	Sampling Rad Contaminated Media		0	0	0	63,150	63,150	
TOTAL	Monitoring, Sampling & Analysis		0	0	0	63,150	63,150	
TOTAL	Off-Site Analytical Services		0	0	0	63,150	63,150	

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ANA:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

ANA. Off-Site Analytical Services
ANA:02. Monitoring, Sampling & Analysis
ANA:02.08. Sampling Rad Contaminated Media
ANA:02.08.02. Ground Water Analysis Yr - 1

Assumptions:

1. Assume shake-down period with following sampling of treatment system:
   - First 2 days: 1 sample per day from influent and effluent (4 samples)
   - Next 4 weeks- 1 sample per week from influent and effluent (8 samples)

2. 1 sample every 2 weeks for remainder of year from influent and effluent (48 samples/yr)
3. Assume sampling 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr)

4. All on-site sample analyses performed by mobile lab

5. 10% off-site verification analysis of reduced analyte list with CLP protocol.
   (10% of 74 = 8 ea)

ANA	Analyze LLW Sample - Off-site Lab	8.00 EA	0.00 0	0.00 0	0.00 0	4210.00 33,680	4210.00 33,680	4210.00
TOTAL	Ground Water Analysis Yr - 1	8.00 EA	0	0	0	33,680	33,680	4210.00

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUBTOTAL						4,274,300	
Material/Supply MPR						11,150	
TOTAL INCL INDIRECTS						4,285,440	
Subcontractor MPR						257,550	
SUBTOTAL						4,542,990	
Project Management/Construction Mgnt						671,980	
SUBTOTAL						5,214,970	
General & Admin/Common Support Pool						1,313,710	
SUBTOTAL						6,528,680	
Contingency						2,285,040	
TOTAL INCL OWNER COSTS						8,813,720	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.05 Disconnect Temporary Utilities		2,500	0	0	0	2,500	
SUB:21.06 Post-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Demobilization		3,950	1,110	0	10,000	15,060	
TOTAL Fixed Price Contractor		13,550	2,930	7,010	2,717,800	2,741,280	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis							
WHC:02.08 Sampling Rad Contaminated Media							
WHC:02.08.02 Ground Water Analysis - Yr 1	1.00 EA	0	0	0	28,080	28,080	28078.00
WHC:02.08.03 Ground Water Analysis - Yrs 2-5	1.00 EA	0	0	0	25,230	25,230	25230.00
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	0	0	660	27.62
TOTAL Sampling Rad Contaminated Media		660	0	0	53,310	53,970	
TOTAL Monitoring, Sampling & Analysis		660	0	0	53,310	53,970	
WHC:12 Chemical Treatment							
WHC:12.05 Ion Exchange							
WHC:12.05.06 Personnel Training		1,100	0	0	5,800	6,900	
WHC:12.05.08 Operation & Maintenance Yrs 1-5	1.00 YR	185,000	0	234,760	52,210	471,970	471965.16
WHC:12.05.11 Prepare Annual Report (Yr 1)	2080.00 HR	90,150	0	0	0	90,150	43.34
WHC:12.05.12 Prepare Annual Report (Yrs 2-5)	1386.00 HR	60,070	0	0	0	60,070	43.34
TOTAL Ion Exchange		336,320	0	234,760	58,010	629,090	
TOTAL Chemical Treatment		336,320	0	234,760	58,010	629,090	
TOTAL Westinghouse Hanford Company		336,990	0	234,760	111,320	683,060	
TOTAL HANFORD: ER PROGRAM		350,530	2,930	241,760	2,892,270	3,487,490	
Overhead						520,840	
SUBTOTAL						4,008,330	
Profit						223,290	
SUBTOTAL						4,231,630	
Bond						26,170	
SUBTOTAL						4,257,790	
B&O Tax						16,500	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.05 Fencing		0	0	0	7,650	7,650	
TOTAL Site Work		0	0	0	37,460	37,460	
SUB:06 Groundwater Collection & Control							
SUB:06.01 Extraction & Injection Wells							
SUB:06.01.01 Well Drilling & Construction		0	0	0	328,500	328,500	
SUB:06.01.04 Operations and Maintenance Yr 3		0	0	0	147,000	147,000	
SUB:06.01.9X Site Piping		0	0	0	203,840	203,840	
TOTAL Extraction & Injection Wells		0	0	0	679,340	679,340	
TOTAL Groundwater Collection & Control		0	0	0	679,340	679,340	
SUB:12 Chemical Treatment							
SUB:12.05 Ion Exchange							
SUB:12.05.04 Construction of Permanent Plant	1.00 EA	0	0	0	1,970,000	1,970,000	1970000.00
TOTAL Ion Exchange		0	0	0	1,970,000	1,970,000	
TOTAL Chemical Treatment		0	0	0	1,970,000	1,970,000	
SUB:20 Site Restoration							
SUB:20.04 Revegetation and Planting		0	0	0	10,000	10,000	
TOTAL Site Restoration		0	0	0	10,000	10,000	
SUB:21 Demobilization							
SUB:21.02 Demobilize Personnel & Equipment							
SUB:21.02.02 Demobilize Trailers		0	750	0	0	750	
TOTAL Demobilize Personnel & Equipment		0	750	0	0	750	
SUB:21.04 Demobilize Temp Facilities							
SUB:21.04.02 Remove Decon Area	8.00 HR	1,450	360	0	0	1,810	225.75
TOTAL Demobilize Temp Facilities		1,450	360	0	0	1,810	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis							
ANA:02.08 Sampling Rad Contaminated Media							
ANA:02.08.02 Ground Water Analysis Yr - 1	8.00 EA	0	0	0	33,680	33,680	4210.00
ANA:02.08.03 Ground Water Analysis Yrs 2-5	7.00 EA	0	0	0	29,470	29,470	4210.00
TOTAL Sampling Rad Contaminated Media		0	0	0	63,150	63,150	
TOTAL Monitoring, Sampling & Analysis		0	0	0	63,150	63,150	
TOTAL Off-Site Analytical Services		0	0	0	63,150	63,150	
SUB Fixed Price Contractor							
SUB:01 Mobilization & Preparatory Work							
SUB:01.02 Mobilize Personnel & Equipment							
SUB:01.02.02 Mobilize Trailers		0	750	0	0	750	
TOTAL Mobilize Personnel & Equipment		0	750	0	0	750	
SUB:01.04 Setup/Construct Temp Facilities							
SUB:01.04.01 Establish Facilities							
SUB:01.04.01.02 Setup Trailers		3,000	0	810	0	3,810	
TOTAL Establish Facilities		3,000	0	810	0	3,810	
SUB:01.04.02 Construct Decon Area	24.00 HR	4,350	1,070	3,770	0	9,190	382.96
SUB:01.04.03 Site Survey		0	0	0	1,000	1,000	
TOTAL Setup/Construct Temp Facilities		7,350	1,070	4,580	1,000	14,000	
SUB:01.05 Construct Temporary Utilities		2,250	0	2,430	0	4,680	
SUB:01.06 Pre-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Mobilization & Preparatory Work		9,600	1,820	7,010	11,000	29,430	
SUB:03 Site Work							
SUB:03.03 Earthwork		0	0	0	5,000	5,000	
SUB:03.04 Roads/Parking/Curbs/Walks		0	0	0	24,810	24,810	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUBTOTAL						6,528,680	
Contingency						2,285,040	
TOTAL INCL OWNER COSTS						8,813,720	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis		0	0	0	63,150	63,150	
TOTAL Off-Site Analytical Services		0	0	0	63,150	63,150	
SUB Fixed Price Contractor							
SUB:01 Mobilization & Preparatory Work		9,600	1,820	7,010	11,000	29,430	
SUB:03 Site Work		0	0	0	37,460	37,460	
SUB:06 Groundwater Collection & Control		0	0	0	679,340	679,340	
SUB:12 Chemical Treatment		0	0	0	1,970,000	1,970,000	
SUB:20 Site Restoration		0	0	0	10,000	10,000	
SUB:21 Demobilization		3,950	1,110	0	10,000	15,060	
TOTAL Fixed Price Contractor		13,550	2,930	7,010	2,717,800	2,741,280	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis		660	0	0	53,310	53,970	
WHC:12 Chemical Treatment		336,320	0	234,760	58,010	629,090	
TOTAL Westinghouse Hanford Company		336,990	0	234,760	111,320	683,060	
TOTAL HANFORD: ER PROGRAM		350,530	2,930	241,760	2,892,270	3,487,490	
Overhead						520,840	
SUBTOTAL						4,008,330	
Profit						223,290	
SUBTOTAL						4,231,630	
Bond						26,170	
SUBTOTAL						4,257,790	
B&O Tax						16,500	
SUBTOTAL						4,274,300	
Material/Supply MPR						11,150	
TOTAL INCL INDIRECTS						4,285,440	
Subcontractor MPR						257,550	
SUBTOTAL						4,542,990	
Project Management/Construction Mgnt						671,980	
SUBTOTAL						5,214,970	
General & Admin/Common Support Pool						1,313,710	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		0	0	0	63,150	63,150	
SUB Fixed Price Contractor		13,550	2,930	7,010	2,717,800	2,741,280	
WHC Westinghouse Hanford Company		336,990	0	234,760	111,320	683,060	
TOTAL HANFORD: ER PROGRAM		350,530	2,930	241,760	2,892,270	3,487,490	
Overhead						520,840	
SUBTOTAL						4,008,330	
Profit						223,290	
SUBTOTAL						4,231,630	
Bond						26,170	
SUBTOTAL						4,257,790	
B&O Tax						16,500	
SUBTOTAL						4,274,300	
Material/Supply MPR						11,150	
TOTAL INCL INDIRECTS						4,285,440	
Subcontractor MPR						257,550	
SUBTOTAL						4,542,990	
Project Management/Construction Mgnt						671,980	
SUBTOTAL						5,214,970	
General & Admin/Common Support Pool						1,313,710	
SUBTOTAL						6,528,680	
Contingency						2,285,040	
TOTAL INCL OWNER COSTS						8,813,720	

	QUANTITY	UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
TOTAL INCL OWNER COSTS									8,813,720	

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	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
SUB:21.05 Disconnect Temporary Utilities		2,500	480	200	20	20	0	3,220	
SUB:21.06 Post-Construction Submittals	4.00 EA	10,000	1,900	810	100	60	0	12,870	3217.55
TOTAL Demobilization		15,060	2,860	1,230	140	90	0	19,380	
TOTAL Fixed Price Contractor		2,741,280	520,840	223,290	26,170	16,500	0	3,528,090	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis									
WHC:02.08 Sampling Rad Contaminated Media									
WHC:02.08.02 Ground Water Analysis - Yr 1	1.00 EA	28,080	0	0	0	0	0	28,080	28078.00
WHC:02.08.03 Ground Water Analysis - Yrs 2-	1.00 EA	25,230	0	0	0	0	0	25,230	25230.00
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	0	0	0	0	660	27.62
TOTAL Sampling Rad Contaminated M		53,970	0	0	0	0	0	53,970	
TOTAL Monitoring, Sampling & Anal		53,970	0	0	0	0	0	53,970	
WHC:12 Chemical Treatment									
WHC:12.05 Ion Exchange									
WHC:12.05.06 Personnel Training		6,900	0	0	0	0	0	6,900	
WHC:12.05.08 Operation & Maintenance Yrs 1-	1.00 YR	471,970	0	0	0	0	11,150	483,110	483111.06
WHC:12.05.11 Prepare Annual Report (Yr 1)	2080.00 HR	90,150	0	0	0	0	0	90,150	43.34
WHC:12.05.12 Prepare Annual Report (Yrs 2-5	1386.00 HR	60,070	0	0	0	0	0	60,070	43.34
TOTAL Ion Exchange		629,090	0	0	0	0	11,150	640,230	
TOTAL Chemical Treatment		629,090	0	0	0	0	11,150	640,230	
TOTAL Westinghouse Hanford Compan		683,060	0	0	0	0	11,150	694,210	
TOTAL HANFORD: ER PROGRAM		3,487,490	520,840	223,290	26,170	16,500	11,150	4,285,440	
Subcontractor MPR								257,550	
SUBTOTAL								4,542,990	
Project Management/Construction Mgnt								671,980	
SUBTOTAL								5,214,970	
General & Admin/Common Support Pool								1,313,710	
SUBTOTAL								6,528,680	
Contingency								2,285,040	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
SUB:03.05 Fencing		7,650	1,450	620	70	50	0	9,850	
TOTAL Site Work		37,460	7,120	3,050	360	230	0	48,210	
SUB:06 Groundwater Collection & Control									
SUB:06.01 Extraction & Injection Wells									
SUB:06.01.01 Well Drilling & Construction		328,500	62,420	26,760	3,140	1,980	0	422,790	
SUB:06.01.04 Operations and Maintenance Yr		147,000	27,930	11,970	1,400	890	0	189,190	
SUB:06.01.9X Site Piping		203,840	38,730	16,600	1,950	1,230	0	262,340	
TOTAL Extraction & Injection Well		679,340	129,070	55,340	6,480	4,090	0	874,320	
TOTAL Groundwater Collection & Co		679,340	129,070	55,340	6,480	4,090	0	874,320	
SUB:12 Chemical Treatment									
SUB:12.05 Ion Exchange									
SUB:12.05.04 Construction of Permanent Plan	1.00 EA	1,970,000	374,300	160,470	18,800	11,860	0	2,535,430	2535432.22
TOTAL Ion Exchange		1,970,000	374,300	160,470	18,800	11,860	0	2,535,430	
TOTAL Chemical Treatment		1,970,000	374,300	160,470	18,800	11,860	0	2,535,430	
SUB:20 Site Restoration									
SUB:20.04 Revegetation and Planting		10,000	1,900	810	100	60	0	12,870	
TOTAL Site Restoration		10,000	1,900	810	100	60	0	12,870	
SUB:21 Demobilization									
SUB:21.02 Demobilize Personnel & Equipment									
SUB:21.02.02 Demobilize Trailers		750	140	60	10	0	0	970	
TOTAL Demobilize Personnel & Equi		750	140	60	10	0	0	970	
SUB:21.04 Demobilize Temp Facilities									
SUB:21.04.02 Remove Decon Area	8.00 HR	1,810	340	150	20	10	0	2,320	290.55
TOTAL Demobilize Temp Facilities		1,810	340	150	20	10	0	2,320	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis									
ANA:02.08 Sampling Rad Contaminated Media									
ANA:02.08.02 Ground Water Analysis Yr - 1	8.00 EA	33,680	0	0	0	0	0	33,680	4210.00
ANA:02.08.03 Ground Water Analysis Yrs 2-5	7.00 EA	29,470	0	0	0	0	0	29,470	4210.00
TOTAL Sampling Rad Contaminated M		63,150	0	0	0	0	0	63,150	
TOTAL Monitoring, Sampling & Anal		63,150	0	0	0	0	0	63,150	
TOTAL Off-Site Analytical Service		63,150	0	0	0	0	0	63,150	
SUB Fixed Price Contractor									
SUB:01 Mobilization & Preparatory Work									
SUB:01.02 Mobilize Personnel & Equipment									
SUB:01.02.02 Mobilize Trailers		750	140	60	10	0	0	970	
TOTAL Mobilize Personnel & Equipm		750	140	60	10	0	0	970	
SUB:01.04 Setup/Construct Temp Facilities									
SUB:01.04.01 Establish Facilities									
SUB:01.04.01.02 Setup Trailers		3,810	720	310	40	20	0	4,900	
TOTAL Establish Facilities		3,810	720	310	40	20	0	4,900	
SUB:01.04.02 Construct Decon Area	24.00 HR	9,190	1,750	750	90	60	0	11,830	492.88
SUB:01.04.03 Site Survey		1,000	190	80	10	10	0	1,290	
TOTAL Setup/Construct Temp Facili		14,000	2,660	1,140	130	80	0	18,020	
SUB:01.05 Construct Temporary Utilities		4,680	890	380	40	30	0	6,020	
SUB:01.06 Pre-Construction Submittals	4.00 EA	10,000	1,900	810	100	60	0	12,870	3217.55
TOTAL Mobilization & Preparatory		29,430	5,590	2,400	280	180	0	37,870	
SUB:03 Site Work									
SUB:03.03 Earthwork		5,000	950	410	50	30	0	6,440	
SUB:03.04 Roads/Parking/Curbs/Walks		24,810	4,710	2,020	240	150	0	31,930	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis		63,150	0	0	0	0	0	63,150	
TOTAL Off-Site Analytical Services		63,150	0	0	0	0	0	63,150	
SUB Fixed Price Contractor									
SUB:01 Mobilization & Preparatory Work		29,430	5,590	2,400	280	180	0	37,870	
SUB:03 Site Work		37,460	7,120	3,050	360	230	0	48,210	
SUB:06 Groundwater Collection & Control		679,340	129,070	55,340	6,480	4,090	0	874,320	
SUB:12 Chemical Treatment		1,970,000	374,300	160,470	18,800	11,860	0	2,535,430	
SUB:20 Site Restoration		10,000	1,900	810	100	60	0	12,870	
SUB:21 Demobilization		15,060	2,860	1,230	140	90	0	19,380	
TOTAL Fixed Price Contractor		2,741,280	520,840	223,290	26,170	16,500	0	3,528,090	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis		53,970	0	0	0	0	0	53,970	
WHC:12 Chemical Treatment		629,090	0	0	0	0	11,150	640,230	
TOTAL Westinghouse Hanford Company		683,060	0	0	0	0	11,150	694,210	
TOTAL HANFORD: ER PROGRAM		3,487,490	520,840	223,290	26,170	16,500	11,150	4,285,440	
Subcontractor MPR								257,550	
SUBTOTAL								4,542,990	
Project Management/Construction Mgnt								671,980	
SUBTOTAL								5,214,970	
General & Admin/Common Support Pool								1,313,710	
SUBTOTAL								6,528,680	
Contingency								2,285,040	
TOTAL INCL OWNER COSTS								8,813,720	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		63,150	0	0	0	0	0	63,150	
SUB Fixed Price Contractor		2,741,280	520,840	223,290	26,170	16,500	0	3,528,090	
WHC Westinghouse Hanford Company		683,060	0	0	0	0	11,150	694,210	
HANFORD: ER PROGRAM		3,487,490	520,840	223,290	26,170	16,500	11,150	4,285,440	
Subcontractor MPR								257,550	
SUBTOTAL								4,542,990	
Project Management/Construction Mgnt								671,980	
SUBTOTAL								5,214,970	
General & Admin/Common Support Pool								1,313,710	
SUBTOTAL								6,528,680	
Contingency								2,285,040	
TOTAL INCL OWNER COSTS								8,813,720	

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
SUB:21.05 Disconnect Temporary Utilities		3,220	230	520	1,010	1,740	6,730	
SUB:21.06 Post-Construction Submittals	4.00 EA	12,870	940	2,070	4,050	6,980	26,910	6726.68
TOTAL Demobilization		19,380	1,410	3,120	6,100	10,500	40,510	
TOTAL Fixed Price Contractor		3,528,090	257,550	567,850	1,110,140	1,912,270	7,375,890	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis								
WHC:02.08 Sampling Rad Contaminated Media								
WHC:02.08.02 Ground Water Analysis - Yr 1	1.00 EA	28,080	0	4,210	8,230	14,180	54,710	54706.82
WHC:02.08.03 Ground Water Analysis - Yrs 2-5	1.00 EA	25,230	0	3,780	7,400	12,740	49,160	49157.82
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	100	190	330	1,290	53.82
TOTAL Sampling Rad Contaminated Media		53,970	0	8,100	15,830	27,260	105,160	
TOTAL Monitoring, Sampling & Analysis		53,970	0	8,100	15,830	27,260	105,160	
WHC:12 Chemical Treatment								
WHC:12.05 Ion Exchange								
WHC:12.05.06 Personnel Training		6,900	0	1,040	2,020	3,490	13,450	
WHC:12.05.08 Operation & Maintenance Yrs 1-5	1.00 YR	483,110	0	72,470	141,670	244,040	941,290	941287.56
WHC:12.05.11 Prepare Annual Report (Yr 1)	2080.00 HR	90,150	0	13,520	26,440	45,540	175,640	84.44
WHC:12.05.12 Prepare Annual Report (Yrs 2-5)	1386.00 HR	60,070	0	9,010	17,620	30,340	117,040	84.44
TOTAL Ion Exchange		640,230	0	96,040	187,750	323,410	1,247,420	
TOTAL Chemical Treatment		640,230	0	96,040	187,750	323,410	1,247,420	
TOTAL Westinghouse Hanford Company		694,210	0	104,130	203,580	350,670	1,352,580	
TOTAL HANFORD: ER PROGRAM		4,285,440	257,550	671,980	1,313,710	2,285,040	8,813,720	

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	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
SUB:03.05 Fencing		9,850	720	1,580	3,100	5,340	20,580	
TOTAL Site Work		48,210	3,520	7,760	15,170	26,130	100,800	
SUB:06 Groundwater Collection & Control								
SUB:06.01 Extraction & Injection Wells								
SUB:06.01.01 Well Drilling & Construction		422,790	30,860	68,050	133,030	229,160	883,890	
SUB:06.01.04 Operations and Maintenance Yr 3		189,190	13,810	30,450	59,530	102,540	395,530	
SUB:06.01.9X Site Piping		262,340	19,150	42,220	82,550	142,190	548,460	
TOTAL Extraction & Injection Wells		874,320	63,830	140,720	275,110	473,890	1,827,870	
TOTAL Groundwater Collection & Control		874,320	63,830	140,720	275,110	473,890	1,827,870	
SUB:12 Chemical Treatment								
SUB:12.05 Ion Exchange								
SUB:12.05.04 Construction of Permanent Plant	1.00 EA	2,535,430	185,090	408,080	797,790	1,374,240	5,300,620	5300624.76
TOTAL Ion Exchange		2,535,430	185,090	408,080	797,790	1,374,240	5,300,620	
TOTAL Chemical Treatment		2,535,430	185,090	408,080	797,790	1,374,240	5,300,620	
SUB:20 Site Restoration								
SUB:20.04 Revegetation and Planting		12,870	940	2,070	4,050	6,980	26,910	
TOTAL Site Restoration		12,870	940	2,070	4,050	6,980	26,910	
SUB:21 Demobilization								
SUB:21.02 Demobilize Personnel & Equipment								
SUB:21.02.02 Demobilize Trailers		970	70	160	300	520	2,020	
TOTAL Demobilize Personnel & Equipment		970	70	160	300	520	2,020	
SUB:21.04 Demobilize Temp Facilities								
SUB:21.04.02 Remove Decon Area	8.00 HR	2,320	170	370	730	1,260	4,860	607.42
TOTAL Demobilize Temp Facilities		2,320	170	370	730	1,260	4,860	

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis								
ANA:02.08 Sampling Rad Contaminated Media								
ANA:02.08.02 Ground Water Analysis Yr - 1	8.00 EA	33,680	0	0	0	11,790	45,470	5683.50
ANA:02.08.03 Ground Water Analysis Yrs 2-5	7.00 EA	29,470	0	0	0	10,310	39,780	5683.50
TOTAL Sampling Rad Contaminated Media		63,150	0	0	0	22,100	85,250	
TOTAL Monitoring, Sampling & Analysis		63,150	0	0	0	22,100	85,250	
TOTAL Off-Site Analytical Services		63,150	0	0	0	22,100	85,250	
SUB Fixed Price Contractor								
SUB:01 Mobilization & Preparatory Work								
SUB:01.02 Mobilize Personnel & Equipment								
SUB:01.02.02 Mobilize Trailers		970	70	160	300	520	2,020	
TOTAL Mobilize Personnel & Equipment		970	70	160	300	520	2,020	
SUB:01.04 Setup/Construct Temp Facilities								
SUB:01.04.01 Establish Facilities								
SUB:01.04.01.02 Setup Trailers		4,900	360	790	1,540	2,660	10,250	
TOTAL Establish Facilities		4,900	360	790	1,540	2,660	10,250	
SUB:01.04.02 Construct Decon Area	24.00 HR	11,830	860	1,900	3,720	6,410	24,730	1030.42
SUB:01.04.03 Site Survey		1,290	90	210	400	700	2,690	
TOTAL Setup/Construct Temp Facilities		18,020	1,320	2,900	5,670	9,770	37,670	
SUB:01.05 Construct Temporary Utilities		6,020	440	970	1,890	3,260	12,580	
SUB:01.06 Pre-Construction Submittals	4.00 EA	12,870	940	2,070	4,050	6,980	26,910	6726.68
TOTAL Mobilization & Preparatory Work		37,870	2,760	6,100	11,920	20,530	79,170	
SUB:03 Site Work								
SUB:03.03 Earthwork		6,440	470	1,040	2,020	3,490	13,450	
SUB:03.04 Roads/Parking/Curbs/Walks		31,930	2,330	5,140	10,050	17,310	66,760	

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PROJECT HAREIX: HANFORD: ER PROGRAM - H AREA ION EXCHANGE
ION EXCHANGE REMEDIATION MODEL 100-HR-3/ H AREA
** PROJECT OWNER SUMMARY - FEATURE (Rounded to 10's) **

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis		63,150	0	0	0	22,100	85,250	
TOTAL Off-Site Analytical Services		63,150	0	0	0	22,100	85,250	
SUB Fixed Price Contractor								
SUB:01 Mobilization & Preparatory Work		37,870	2,760	6,100	11,920	20,530	79,170	
SUB:03 Site Work		48,210	3,520	7,760	15,170	26,130	100,800	
SUB:06 Groundwater Collection & Control		874,320	63,830	140,720	275,110	473,890	1,827,870	
SUB:12 Chemical Treatment		2,535,430	185,090	408,080	797,790	1,374,240	5,300,620	
SUB:20 Site Restoration		12,870	940	2,070	4,050	6,980	26,910	
SUB:21 Demobilization		19,380	1,410	3,120	6,100	10,500	40,510	
TOTAL Fixed Price Contractor		3,528,090	257,550	567,850	1,110,140	1,912,270	7,375,890	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis		53,970	0	8,100	15,830	27,260	105,160	
WHC:12 Chemical Treatment		640,230	0	96,040	187,750	323,410	1,247,420	
TOTAL Westinghouse Hanford Company		694,210	0	104,130	203,580	350,670	1,352,580	
TOTAL HANFORD: ER PROGRAM		4,285,440	257,550	671,980	1,313,710	2,285,040	8,813,720	

U.S. Army Corps of Engineers - D.O. 94 - Final
PROJECT HAREIX: HANFORD: ER PROGRAM - H AREA ION EXCHANGE
ION EXCHANGE REMEDIATION MODEL 100-HR-3/ H AREA
** PROJECT OWNER SUMMARY - CNTRCTOR (Rounded to 10's) **

		QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA	Off-Site Analytical Services		63,150	0	0	0	22,100	85,250	
SUB	Fixed Price Contractor		3,528,090	257,550	567,850	1,110,140	1,912,270	7,375,890	
WHC	Westinghouse Hanford Company		694,210	0	104,130	203,580	350,670	1,352,580	
TOTAL HANFORD: ER PROGRAM			4,285,440	257,550	671,980	1,313,710	2,285,040	8,813,720	

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HANFORD: ER PROGRAM
H AREA ION EXCHANGE
FOCUSED FEASIBILITY STUDY
ION EXCHANGE REMEDIATION
OU 100-HR-3 / H AREA

Designed By:
Estimated By: CH2M HILL HANFORD,INC.

Prepared By: ERC CONTRACT - RICHLAND, WASH

Preparation Date: 07/26/95
Effective Date of Pricing: 09/14/94

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SRC	EQUIP ID	DESCRIPTION	DEPR	CAPT	FUEL	FOG	EQ REP	TR WR	TR REP	TOTAL	UOM	** TOTAL ** HOURS
USR	H30BA001	HYD EXCAV,TRK MTD,.5 CY BKT,6X4			12.07	1.4	19.78	0.98	0.15	34.44	HR	32
USR	T50F0004	TRK,HWY,4X4,F250,3/4T,8800 GVW			2.67	0.7	3.58	0.27	0.04	7.31	HR	32
MIL	XMIXX020	Small Tools	0.47	0.17	0.13	0.0	0.57			1.40	HR	64

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SRC LABOR ID	DESCRIPTION	BASE	OVERTM	TXS/INS	FRNG	TRVL	RATE	UOM	UPDATE	**** TOTAL **** DEFAULT	HOURS
FPC 0029	Laborer Group - 1	15.84	0.0%	28.7%	3.57	1.25	25.20	HR	07/09/93	0.00	96
FPC 0030	Laborer Group - 2	16.09	0.0%	28.5%	3.57	1.25	25.50	HR	07/09/93	0.00	96
FPC 0039	Group-6 Power Equipment Operator	18.02	0.0%	27.4%	4.90	1.25	29.10	HR	07/09/93	0.00	32
WHC 85101	Engineer, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	1733
WHC 85102	Scientist, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	1733
WHC 85201	Technician, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	24

WHC:13. Annual Report	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:13.21.12. Prepare Annual Report (Yrs 2-5) Assume 66% Year 1 Annual Report effort (2 FTE's for 4 months each year)									
WHC Engineer, Environmental				43.34	0.00	0.00	0.00	43.34	
Restoration Ops - 1 ea	693.00	HR	85101	30,035	0	0	0	30,035	43.34
WHC Scientist, Environmental				43.34	0.00	0.00	0.00	43.34	
Restoration Ops - 1 ea	693.00	HR	85102	30,035	0	0	0	30,035	43.34
TOTAL Prepare Annual Report (Yrs 2-5)				60,070	0	0	0	60,070	
TOTAL Annual Report				150,218	0	0	0	150,218	
TOTAL Annual Report				150,218	0	0	0	150,218	
TOTAL Westinghouse Hanford Company				150,881	0	0	44,610	195,492	
TOTAL HANFORD: ER PROGRAM				164,430	2,926	7,007	830,259	1,004,621	

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WHC:13. Annual Report		QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:13. Annual Report										
WHC:13.21. Annual Report										
WHC:13.21.11. Prepare Annual Report (Yr 1)										
Assume 2 FTE's for 6 months per year										
WHC	Engineer, Environmental				43.34	0.00	0.00	0.00	43.34	
	Restoration Ops	1040.00	HR	85101	45,074	0	0	0	45,074	43.34
WHC	Scientist, Environmental				43.34	0.00	0.00	0.00	43.34	
	Restoration Ops	1040.00	HR	85102	45,074	0	0	0	45,074	43.34
TOTAL Prepare Annual Report (Yr 1)					90,148	0	0	0	90,148	

WHC:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:06. Groundwater Collection & Control							
WHC:06.05. Operation and Maintenance							
WHC Allowance for Electricity		0.00	0.00	0.00	0.04	0.04	
Wells: 645 kW-hr/d	235259 KWH	0	0	0	9,410	9,410	0.04
Assume 24 hr/day x 365 days/yr							
Total = 235,259 kW-hr/yr							
TOTAL Operation and Maintenance		0	0	0	9,410	9,410	
TOTAL Groundwater Collection & Control		0	0	0	9,410	9,410	

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WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:02.08.03. Take Ground Water Samples							
Assumptions:							
1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples)							
2. Assume 2 Field Technicians for 6 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)							
		27.62	0.00	0.00	0.00	27.62	
WHC Technician, Environmental Restoration Ops - 2 ea	24.00 HR 85201	663	0	0	0	663	27.62
TOTAL Take Ground Water Samples	24.00 HR	663	0	0	0	663	27.62
TOTAL Sampling Rad Cntmntd Media 1-5		663	0	0	35,200	35,863	
TOTAL Monitoring, Sampling & Analysis		663	0	0	35,200	35,863	

WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

WHC. Westinghouse Hanford Company
WHC:02. Monitoring, Sampling & Analysis
WHC:02.08. Sampling Rad Cntmntd Media 1-5
WHC:02.08.02. Ground Water Analysis

Assumptions:

1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle.
   (14 samples)

2. Assume monthly performance monitoring of 7 wells for the 5-year lifecycle.
   (84 samples)

   - Total samples = 98

3. 90% of samples analyzed by mobile lab
   (90% of 98 = 88)

4. All on-site sample analyses performed by mobile lab

WHC	Analyze LLW Sample - Mobile Lab		0.00	0.00	0.00	400.00	400.00	
		88.00 EA	0	0	0	35,200	35,200	400.00
TOTAL	Ground Water Analysis	88.00 EA	0	0	0	35,200	35,200	400.00

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SUB:21. Demobilization	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.06. Post-Construction Submittals									
FPC S3 Allowance for Post-Construction Submittals by Fixed Price Contractor	4.00	EA		0.00 0	0.00 0	0.00 0	2500.00 10,000	2500.00 10,000	2500.00
TOTAL Post-Construction Submittals	4.00	EA		0	0	0	10,000	10,000	2500.00
TOTAL Demobilization				3,950	1,106	0	10,000	15,056	
TOTAL Fixed Price Contractor				13,548	2,926	7,007	743,548	767,029	

SUB:21. Demobilization	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.05. Disconnect Temporary Utilities							
M FPC S3 Remove Temporary Power		1.00	0.00	0.00	0.00	1.00	
	500.00 LF	500	0	0	0	500	1.00
M FPC S3 Remove Telephone		1.00	0.00	0.00	0.00	1.00	
	500.00 LF	500	0	0	0	500	1.00
M FPC S3 Remove Temporary Water and Sewer Service		3.00	0.00	0.00	0.00	3.00	
	500.00 LF	1,500	0	0	0	1,500	3.00
TOTAL Disconnect Temporary Utilities		2,500	0	0	0	2,500	

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SUB:21. Demobilization	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.04. Demobilize Temp Facilities									
SUB:21.04.02. Remove Decon Area									
Work to be Performed: Remove decontamination area/pad for equipment and vehicles.									
Crew and Equipment: Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers									
Equipment: 1 backhoe, 1 pickup truck									
Output: Assumed duration for this activity is 1 crew day.									
FPC S3 Group-6 Power Equipment Operator - 1 ea	8.00	HR	0039	29.10 233	0.00 0	0.00 0	0.00 0	29.10 233	29.10
FPC S3 Laborer Group - 1 - 3 ea	24.00	HR	0029	25.20 605	0.00 0	0.00 0	0.00 0	25.20 605	25.20
FPC S3 Laborer Group - 2 - 3 ea	24.00	HR	0030	25.50 612	0.00 0	0.00 0	0.00 0	25.50 612	25.50
FPC S3 HYD EXCAV,TRK MTD,.5 CY BKT,6X4 HYDRO-SCOPIC - 1 ea	8.00	HR	H30BA001	0.00 0	34.44 276	0.00 0	0.00 0	34.44 276	34.44
FPC S3 TRK,HWY,4X4,F250,3/4T,8800 GVW 4X4 3/4 TON PICK-UP - 1 ea	8.00	HR	T50F0004	0.00 0	7.31 58	0.00 0	0.00 0	7.31 58	7.31
FPC S3 Small Tools - 2 ea	16.00	HR	XMIXX020	0.00 0	1.40 22	0.00 0	0.00 0	1.40 22	1.40
TOTAL Remove Decon Area	8.00	HR		1,450	356	0	0	1,806	225.75
TOTAL Demobilize Temp Facilities				1,450	356	0	0	1,806	

SUB:21. Demobilization	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21. Demobilization									
SUB:21.02. Demobilize Personnel & Equipment									
SUB:21.02.02. Demobilize Trailers									
FPC S3 Demob Field Office Trailer				0.00	250.00	0.00	0.00	250.00	
	1.00	EA		0	250	0	0	250	250.00
FPC S3 Demob Storage Trailer				0.00	250.00	0.00	0.00	250.00	
	1.00	EA		0	250	0	0	250	250.00
FPC S3 Demob Decon Trailer				0.00	250.00	0.00	0.00	250.00	
	1.00	EA		0	250	0	0	250	250.00
TOTAL Demobilize Trailers				0	750	0	0	750	
TOTAL Demobilize Personnel & Equipment				0	750	0	0	750	

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SUB:20. Site Restoration	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:20. Site Restoration							
SUB:20.04. Revegetation and Planting							
FPC S3 Allowance for Site Restoration	5000.00 SY	0.00 0	0.00 0	0.00 0	2.00 10,000	2.00 10,000	2.00
TOTAL Revegetation and Planting		0	0	0	10,000	10,000	
TOTAL Site Restoration		0	0	0	10,000	10,000	

SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06.01.9X. Site Piping							
FPC S3 Allowance for Piping From extraction well to consolidation facility. Assume double wall PVC piping for extraction wells	9269.00 LF	0.00 0	0.00 0	0.00 0	18.00 166,842	18.00 166,842	18.00
FPC S3 Allowance for Leak Detection	1.00 LS	0.00 0	0.00 0	0.00 0	5000.00 5,000	5000.00 5,000	5000.00
FPC S3 Allowance for Force Main Discharge Piping Assume double-wall PVC piping for injection wells.	2133.00 LF	0.00 0	0.00 0	0.00 0	18.00 38,394	18.00 38,394	18.00
TOTAL Site Piping		0	0	0	210,236	210,236	
TOTAL Extraction & Injection Wells		0	0	0	685,736	685,736	
TOTAL Groundwater Collection & Control		0	0	0	685,736	685,736	

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SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06.01.04. Operations and Maintenance Yr 3							
FPC S3 Allowance for Well Workover		0.00	0.00	0.00	10000.00	10000.00	
Assume 1 every 3 yrs for each well for the 5-year lifecycle Workovers in year 3	12.00 EA	0	0	0	120,000	120,000	10000.00
FPC S3 Allowance for Well Pump		0.00	0.00	0.00	3000.00	3000.00	
Assume 1 pump replacement per extraction well every three years for the 5-year lifecycle. Pump replacement in year 3	9.00 EA	0	0	0	27,000	27,000	3000.00
TOTAL Operations and Maintenance Yr 3		0	0	0	147,000	147,000	

SUB:06. Groundwater Collection & Control	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06. Groundwater Collection & Control									
SUB:06.01. Extraction & Injection Wells									
SUB:06.01.01. Well Drilling & Construction									
FPC S3 Drill/Install Extr/Inject Wells NOTE:1 new extraction well, 45 feet deep and 3 new injection wells, 60 ft deep, 8 in diameter. Unit cost is assumed to include handling and packaging of contaminated well cuttings, transport to the disposal facility, and associated disposal fees.	225.00	LF		0.00 0	0.00 0	0.00 0	500.00 112,500	500.00 112,500	500.00
FPC S3 Allowance Well Head Covers Assume manhole type cover at each well head	4.00	EA		0.00 0	0.00 0	0.00 0	1000.00 4,000	1000.00 4,000	1000.00
FPC S3 Allowance for Well Pumps -25 gpm	9.00	EA		0.00 0	0.00 0	0.00 0	3000.00 27,000	3000.00 27,000	3000.00
FPC S3 Allowance for Controls and Connections at Well Heads	4.00	EA		0.00 0	0.00 0	0.00 0	10000.00 40,000	10000.00 40,000	10000.00
FPC S3 Refurbish Existing Wells	8.00	EA		0.00 0	0.00 0	0.00 0	10000.00 80,000	10000.00 80,000	10000.00
FPC S3 Allowance for Well Testing	4.00	EA		0.00 0	0.00 0	0.00 0	5000.00 20,000	5000.00 20,000	5000.00
M S3 Water Level Monitoring (Wells) Allowance for 5 piezometers per extraction well using well points	45.00			0.00 0	0.00 0	0.00 0	1000.00 45,000	1000.00 45,000	1000.00
TOTAL Well Drilling & Construction				0	0	0	328,500	328,500	

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SUB:03. Site Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.04. Roads/Parking/Curbs/Walks							
FPC S3 Allowance for Access Road		0.00	0.00	0.00	10.00	10.00	
	400.00 SY	0	0	0	4,000	4,000	10.00
FPC S3 Access Roads to Wells		0.00	0.00	0.00	2.12	2.12	
Assume 10 ft wide, native materials	8402.00 LF	0	0	0	17,812	17,812	2.12
Road length equal to the length of well piping							
TOTAL Roads/Parking/Curbs/Walks		0	0	0	21,812	21,812	
TOTAL Site Work		0	0	0	26,812	26,812	

SUB:03. Site Work	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03. Site Work									
SUB:03.03. Earthwork									
FPC S3 Allowance for Site Preparation				0.00	0.00	0.00	5000.00	5000.00	
	1.00	LS		0	0	0	5,000	5,000	5000.00
TOTAL Earthwork				0	0	0	5,000	5,000	

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SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.06. Pre-Construction Submittals							
FPC S3 Allowance for Pre-Construction Submittals by Fixed Price Contractor	4.00 EA	0.00 0	0.00 0	0.00 0	2500.00 10,000	2500.00 10,000	2500.00
TOTAL Pre-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Mobilization & Preparatory Work		9,599	1,819	7,007	11,000	29,425	

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.05. Construct Temporary Utilities							
M FPC S3 Allowance for Temporary Power		1.00	0.00	1.08	0.00	2.08	
	500.00 LF	500	0	539	0	1,039	2.08
M FPC S3 Allowance for Telephone		0.50	0.00	0.54	0.00	1.04	
	500.00 LF	250	0	270	0	520	1.04
M FPC S3 Allowance for Temporary Water and Sewer Service		3.00	0.00	3.23	0.00	6.23	
	500.00 LF	1,500	0	1,617	0	3,117	6.23
TOTAL Construct Temporary Utilities		2,250	0	2,426	0	4,676	

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SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04.03. Site Survey							
FPC S3 Allowance for Site Survey		0.00	0.00	0.00	1000.00	1000.00	
	1.00 LS	0	0	0	1,000	1,000	1000.00
TOTAL Site Survey		0	0	0	1,000	1,000	
TOTAL Setup/Construct Temp Facilities		7,349	1,069	4,582	1,000	14,000	

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SUB:01. Mobilization & Preparatory Work	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04.02. Construct Decon Area Work to be Performed: Construct decontamination area/pad for equipment and vehicles. Crew and Equipment: Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers Equipment: 1 backhoe, 1 pickup truck Output: Assumed duration for this activity is 3 crew days.									
FPC S3 Laborer Group - 1				25.20	0.00	0.00	0.00	25.20	
- 3 ea	72.00	HR	0029	1,814	0	0	0	1,814	25.20
FPC S3 Laborer Group - 2				25.50	0.00	0.00	0.00	25.50	
- 3 ea	72.00	HR	0030	1,836	0	0	0	1,836	25.50
FPC S3 Group-6 Power Equipment Operator				29.10	0.00	0.00	0.00	29.10	
- 1 ea	24.00	HR	0039	698	0	0	0	698	29.10
FPC S3 Small Tools - 2 ea				0.00	1.40	0.00	0.00	1.40	
	48.00	HR	XMIXX020	0	67	0	0	67	1.40
FPC S3 TRK,HWY,4X4,F250,3/4T,8800 GVW				0.00	7.31	0.00	0.00	7.31	
4X4 3/4 TON PICK-UP - 1 ea	24.00	HR	T50F0004	0	175	0	0	175	7.31
FPC S3 HYD EXCAV,TRK MTD,.5 CY BKT,6X4				0.00	34.44	0.00	0.00	34.44	
HYDRO-SCOPIC - 1 ea	24.00	HR	H30BA001	0	827	0	0	827	34.44
M FPC S3 Construction Materials/Supplies				0.00	0.00	2156.00	0.00	2156.00	
Allowance	1.00	LS		0	0	2,156	0	2,156	2156.00
M FPC S3 Allowance for Tank				0.00	0.00	1617.00	0.00	1617.00	
Assume 1000 gal plastic tank for water collection	1.00	EA		0	0	1,617	0	1,617	1617.00
TOTAL Construct Decon Area	24.00	HR		4,349	1,069	3,773	0	9,191	382.96

SUB:01. Mobilization & Preparatory Work	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04. Setup/Construct Temp Facilities									
SUB:01.04.01. Establish Facilities									
SUB:01.04.01.02. Setup Trailers									
M FPC S3 Setup Field Office Trailer				1000.00	0.00	269.50	0.00	1269.50	
	1.00	EA		1,000	0	270	0	1,270	1269.50
M FPC S3 Setup Storage Trailer				1000.00	0.00	269.50	0.00	1269.50	
	1.00	EA		1,000	0	270	0	1,270	1269.50
M FPC S3 Setup Decon Trailer				1000.00	0.00	269.50	0.00	1269.50	
	1.00	EA		1,000	0	270	0	1,270	1269.50
TOTAL Setup Trailers				3,000	0	809	0	3,809	
TOTAL Establish Facilities				3,000	0	809	0	3,809	

SUB:01. Mobilization & Preparatory Work	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB. Fixed Price Contractor									
SUB:01. Mobilization & Preparatory Work									
SUB:01.02. Mobilize Personnel & Equipment									
SUB:01.02.02. Mobilize Trailers									
FPC S3 Mobilize Field Office Trailer				0.00	250.00	0.00	0.00	250.00	
	1.00	EA		0	250	0	0	250	250.00
FPC S3 Mobilize Storage Trailer				0.00	250.00	0.00	0.00	250.00	
	1.00	EA		0	250	0	0	250	250.00
FPC S3 Mobilize Decon Trailer				0.00	250.00	0.00	0.00	250.00	
	1.00	EA		0	250	0	0	250	250.00
TOTAL Mobilize Trailers				0	750	0	0	750	
TOTAL Mobilize Personnel & Equipment				0	750	0	0	750	

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ANA:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

ANA. Off-Site Analytical Services
ANA:02. Monitoring, Sampling & Analysis
ANA:02.08. Sampling Rad Contaminated Media
ANA:02.08.02. Ground Water Analysis Yr 1-5

Assumptions:
1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle.
(14 samples)

2. Assume monthly performance monitoring of 7 wells for the 5-year lifecycle.
(84 samples)

- Total samples = 98

3. All on-site sample analyses performed by mobile lab

4. 10% off-site verification analysis of reduced analyte list with CLP protocol.
(10% of 98 = 10 ea)

ANA	Analyze LLW Sample - Off-site Lab	10.00 EA	0.00 0	0.00 0	0.00 0	4210.00 42,100	4210.00 42,100	4210.00
TOTAL	Ground Water Analysis Yr 1-5	10.00 EA	0	0	0	42,100	42,100	4210.00
TOTAL	Sampling Rad Contaminated Media		0	0	0	42,100	42,100	
TOTAL	Monitoring, Sampling & Analysis		0	0	0	42,100	42,100	
TOTAL	Off-Site Analytical Services		0	0	0	42,100	42,100	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
Contingency						651,890	
TOTAL INCL OWNER COSTS						2,514,410	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:02.08.02 Ground Water Analysis	88.00 EA	0	0	0	35,200	35,200	400.00
WHC:02.08.03 Take Ground Water Samples	24.00 HR	660	0	0	0	660	27.62
TOTAL Sampling Rad Cntmntd Media 1-5		660	0	0	35,200	35,860	
TOTAL Monitoring, Sampling & Analysis		660	0	0	35,200	35,860	
WHC:06 Groundwater Collection & Control							
WHC:06.05 Operation and Maintenance		0	0	0	9,410	9,410	
TOTAL Groundwater Collection & Control		0	0	0	9,410	9,410	
WHC:13 Annual Report							
WHC:13.21 Annual Report							
WHC:13.21.11 Prepare Annual Report (Yr 1)		90,150	0	0	0	90,150	
WHC:13.21.12 Prepare Annual Report (Yrs 2-5)		60,070	0	0	0	60,070	
TOTAL Annual Report		150,220	0	0	0	150,220	
TOTAL Annual Report		150,220	0	0	0	150,220	
TOTAL Westinghouse Hanford Company		150,880	0	0	44,610	195,490	
TOTAL HANFORD: ER PROGRAM		164,430	2,930	7,010	830,260	1,004,620	
Overhead						145,740	
SUBTOTAL						1,150,360	
Profit						66,450	
SUBTOTAL						1,216,810	
Bond						9,470	
SUBTOTAL						1,226,280	
B&O Tax						4,650	
TOTAL INCL INDIRECTS						1,230,930	
Subcontractor MPR						72,510	
SUBTOTAL						1,303,440	
Project Management/Construction Mgnt						189,200	
SUBTOTAL						1,492,640	
General & Admin/Common Support Pool						369,890	
SUBTOTAL						1,862,530	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
TOTAL Site Work		0	0	0	26,810	26,810	
SUB:06 Groundwater Collection & Control							
SUB:06.01 Extraction & Injection Wells							
SUB:06.01.01 Well Drilling & Construction		0	0	0	328,500	328,500	
SUB:06.01.04 Operations and Maintenance Yr 3		0	0	0	147,000	147,000	
SUB:06.01.9X Site Piping		0	0	0	210,240	210,240	
TOTAL Extraction & Injection Wells		0	0	0	685,740	685,740	
TOTAL Groundwater Collection & Control		0	0	0	685,740	685,740	
SUB:20 Site Restoration							
SUB:20.04 Revegetation and Planting		0	0	0	10,000	10,000	
TOTAL Site Restoration		0	0	0	10,000	10,000	
SUB:21 Demobilization							
SUB:21.02 Demobilize Personnel & Equipment							
SUB:21.02.02 Demobilize Trailers		0	750	0	0	750	
TOTAL Demobilize Personnel & Equipment		0	750	0	0	750	
SUB:21.04 Demobilize Temp Facilities							
SUB:21.04.02 Remove Decon Area	8.00 HR	1,450	360	0	0	1,810	225.75
TOTAL Demobilize Temp Facilities		1,450	360	0	0	1,810	
SUB:21.05 Disconnect Temporary Utilities		2,500	0	0	0	2,500	
SUB:21.06 Post-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Demobilization		3,950	1,110	0	10,000	15,060	
TOTAL Fixed Price Contractor		13,550	2,930	7,010	743,550	767,030	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis							
WHC:02.08 Sampling Rad Cntmntd Media 1-5							

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis							
ANA:02.08 Sampling Rad Contaminated Media							
ANA:02.08.02 Ground Water Analysis Yr 1-5	10.00 EA	0	0	0	42,100	42,100	4210.00
TOTAL Sampling Rad Contaminated Media		0	0	0	42,100	42,100	
TOTAL Monitoring, Sampling & Analysis		0	0	0	42,100	42,100	
TOTAL Off-Site Analytical Services		0	0	0	42,100	42,100	
SUB Fixed Price Contractor							
SUB:01 Mobilization & Preparatory Work							
SUB:01.02 Mobilize Personnel & Equipment							
SUB:01.02.02 Mobilize Trailers		0	750	0	0	750	
TOTAL Mobilize Personnel & Equipment		0	750	0	0	750	
SUB:01.04 Setup/Construct Temp Facilities							
SUB:01.04.01 Establish Facilities							
SUB:01.04.01.02 Setup Trailers		3,000	0	810	0	3,810	
TOTAL Establish Facilities		3,000	0	810	0	3,810	
SUB:01.04.02 Construct Decon Area	24.00 HR	4,350	1,070	3,770	0	9,190	382.96
SUB:01.04.03 Site Survey		0	0	0	1,000	1,000	
TOTAL Setup/Construct Temp Facilities		7,350	1,070	4,580	1,000	14,000	
SUB:01.05 Construct Temporary Utilities		2,250	0	2,430	0	4,680	
SUB:01.06 Pre-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Mobilization & Preparatory Work		9,600	1,820	7,010	11,000	29,430	
SUB:03 Site Work							
SUB:03.03 Earthwork		0	0	0	5,000	5,000	
SUB:03.04 Roads/Parking/Curbs/Walks		0	0	0	21,810	21,810	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
TOTAL INCL OWNER COSTS						2,514,410	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis		0	0	0	42,100	42,100	
TOTAL Off-Site Analytical Services		0	0	0	42,100	42,100	
SUB Fixed Price Contractor							
SUB:01 Mobilization & Preparatory Work		9,600	1,820	7,010	11,000	29,430	
SUB:03 Site Work		0	0	0	26,810	26,810	
SUB:06 Groundwater Collection & Control		0	0	0	685,740	685,740	
SUB:20 Site Restoration		0	0	0	10,000	10,000	
SUB:21 Demobilization		3,950	1,110	0	10,000	15,060	
TOTAL Fixed Price Contractor		13,550	2,930	7,010	743,550	767,030	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis		660	0	0	35,200	35,860	
WHC:06 Groundwater Collection & Control		0	0	0	9,410	9,410	
WHC:13 Annual Report		150,220	0	0	0	150,220	
TOTAL Westinghouse Hanford Company		150,880	0	0	44,610	195,490	
TOTAL HANFORD: ER PROGRAM		164,430	2,930	7,010	830,260	1,004,620	
Overhead						145,740	
SUBTOTAL						1,150,360	
Profit						66,450	
SUBTOTAL						1,216,810	
Bond						9,470	
SUBTOTAL						1,226,280	
B&O Tax						4,650	
TOTAL INCL INDIRECTS						1,230,930	
Subcontractor MPR						72,510	
SUBTOTAL						1,303,440	
Project Management/Construction Mgnt						189,200	
SUBTOTAL						1,492,640	
General & Admin/Common Support Pool						369,890	
SUBTOTAL						1,862,530	
Contingency						651,890	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		0	0	0	42,100	42,100	
SUB Fixed Price Contractor		13,550	2,930	7,010	743,550	767,030	
WHC Westinghouse Hanford Company		150,880	0	0	44,610	195,490	
TOTAL HANFORD: ER PROGRAM		164,430	2,930	7,010	830,260	1,004,620	
Overhead						145,740	
SUBTOTAL						1,150,360	
Profit						66,450	
SUBTOTAL						1,216,810	
Bond						9,470	
SUBTOTAL						1,226,280	
B&O Tax						4,650	
TOTAL INCL INDIRECTS						1,230,930	
Subcontractor MPR						72,510	
SUBTOTAL						1,303,440	
Project Management/Construction Mgnt						189,200	
SUBTOTAL						1,492,640	
General & Admin/Common Support Pool						369,890	
SUBTOTAL						1,862,530	
Contingency						651,890	
TOTAL INCL OWNER COSTS						2,514,410	

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	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
WHC:02.08.02 Ground Water Analysis	88.00 EA	35,200	0	0	0	0	0	35,200	400.00
WHC:02.08.03 Take Ground Water Samples	24.00 HR	660	0	0	0	0	0	660	27.62
TOTAL Sampling Rad Cntmntd Media		35,860	0	0	0	0	0	35,860	
TOTAL Monitoring, Sampling & Anal		35,860	0	0	0	0	0	35,860	
WHC:06 Groundwater Collection & Control									
WHC:06.05 Operation and Maintenance		9,410	0	0	0	0	0	9,410	
TOTAL Groundwater Collection & Co		9,410	0	0	0	0	0	9,410	
WHC:13 Annual Report									
WHC:13.21 Annual Report									
WHC:13.21.11 Prepare Annual Report (Yr 1)		90,150	0	0	0	0	0	90,150	
WHC:13.21.12 Prepare Annual Report (Yrs 2-5		60,070	0	0	0	0	0	60,070	
TOTAL Annual Report		150,220	0	0	0	0	0	150,220	
TOTAL Annual Report		150,220	0	0	0	0	0	150,220	
TOTAL Westinghouse Hanford Compan		195,490	0	0	0	0	0	195,490	
TOTAL HANFORD: ER PROGRAM		1,004,620	145,740	66,450	9,470	4,650	0	1,230,930	
Subcontractor MPR								72,510	
SUBTOTAL								1,303,440	
Project Management/Construction Mgnt								189,200	
SUBTOTAL								1,492,640	
General & Admin/Common Support Pool								369,890	
SUBTOTAL								1,862,530	
Contingency								651,890	
TOTAL INCL OWNER COSTS								2,514,410	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
TOTAL Site Work		26,810	5,090	2,320	330	160	0	34,720	
SUB:06 Groundwater Collection & Control									
SUB:06.01 Extraction & Injection Wells									
SUB:06.01.01 Well Drilling & Construction		328,500	62,420	28,460	4,060	1,990	0	425,420	
SUB:06.01.04 Operations and Maintenance Yr		147,000	27,930	12,730	1,820	890	0	190,370	
SUB:06.01.9X Site Piping		210,240	39,940	18,210	2,600	1,270	0	272,260	
TOTAL Extraction & Injection Well		685,740	130,290	59,410	8,470	4,150	0	888,060	
TOTAL Groundwater Collection & Co		685,740	130,290	59,410	8,470	4,150	0	888,060	
SUB:20 Site Restoration									
SUB:20.04 Revegetation and Planting		10,000	1,900	870	120	60	0	12,950	
TOTAL Site Restoration		10,000	1,900	870	120	60	0	12,950	
SUB:21 Demobilization									
SUB:21.02 Demobilize Personnel & Equipment									
SUB:21.02.02 Demobilize Trailers		750	140	60	10	0	0	970	
TOTAL Demobilize Personnel & Equi		750	140	60	10	0	0	970	
SUB:21.04 Demobilize Temp Facilities									
SUB:21.04.02 Remove Decon Area	8.00 HR	1,810	340	160	20	10	0	2,340	292.36
TOTAL Demobilize Temp Facilities		1,810	340	160	20	10	0	2,340	
SUB:21.05 Disconnect Temporary Utilities		2,500	480	220	30	20	0	3,240	
SUB:21.06 Post-Construction Submittals	4.00 EA	10,000	1,900	870	120	60	0	12,950	3237.61
TOTAL Demobilization		15,060	2,860	1,300	190	90	0	19,500	
TOTAL Fixed Price Contractor		767,030	145,740	66,450	9,470	4,650	0	993,340	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis									
WHC:02.08 Sampling Rad Cntmntd Media 1-5									

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	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis									
ANA:02.08 Sampling Rad Contaminated Media									
ANA:02.08.02 Ground Water Analysis Yr 1-5	10.00 EA	42,100	0	0	0	0	0	42,100	4210.00
TOTAL Sampling Rad Contaminated M		42,100	0	0	0	0	0	42,100	
TOTAL Monitoring, Sampling & Anal		42,100	0	0	0	0	0	42,100	
TOTAL Off-Site Analytical Service		42,100	0	0	0	0	0	42,100	
SUB Fixed Price Contractor									
SUB:01 Mobilization & Preparatory Work									
SUB:01.02 Mobilize Personnel & Equipment									
SUB:01.02.02 Mobilize Trailers		750	140	60	10	0	0	970	
TOTAL Mobilize Personnel & Equipm		750	140	60	10	0	0	970	
SUB:01.04 Setup/Construct Temp Facilities									
SUB:01.04.01 Establish Facilities									
SUB:01.04.01.02 Setup Trailers		3,810	720	330	50	20	0	4,930	
TOTAL Establish Facilities		3,810	720	330	50	20	0	4,930	
SUB:01.04.02 Construct Decon Area	24.00 HR	9,190	1,750	800	110	60	0	11,900	495.95
SUB:01.04.03 Site Survey		1,000	190	90	10	10	0	1,300	
TOTAL Setup/Construct Temp Facili		14,000	2,660	1,210	170	80	0	18,130	
SUB:01.05 Construct Temporary Utilities		4,680	890	410	60	30	0	6,050	
SUB:01.06 Pre-Construction Submittals	4.00 EA	10,000	1,900	870	120	60	0	12,950	3237.61
TOTAL Mobilization & Preparatory		29,430	5,590	2,550	360	180	0	38,110	
SUB:03 Site Work									
SUB:03.03 Earthwork		5,000	950	430	60	30	0	6,480	
SUB:03.04 Roads/Parking/Curbs/Walks		21,810	4,140	1,890	270	130	0	28,250	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis		42,100	0	0	0	0	0	42,100	
TOTAL Off-Site Analytical Services		42,100	0	0	0	0	0	42,100	
SUB Fixed Price Contractor									
SUB:01 Mobilization & Preparatory Work		29,430	5,590	2,550	360	180	0	38,110	
SUB:03 Site Work		26,810	5,090	2,320	330	160	0	34,720	
SUB:06 Groundwater Collection & Control		685,740	130,290	59,410	8,470	4,150	0	888,060	
SUB:20 Site Restoration		10,000	1,900	870	120	60	0	12,950	
SUB:21 Demobilization		15,060	2,860	1,300	190	90	0	19,500	
TOTAL Fixed Price Contractor		767,030	145,740	66,450	9,470	4,650	0	993,340	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis		35,860	0	0	0	0	0	35,860	
WHC:06 Groundwater Collection & Control		9,410	0	0	0	0	0	9,410	
WHC:13 Annual Report		150,220	0	0	0	0	0	150,220	
TOTAL Westinghouse Hanford Company		195,490	0	0	0	0	0	195,490	
TOTAL HANFORD: ER PROGRAM		1,004,620	145,740	66,450	9,470	4,650	0	1,230,930	
Subcontractor MPR								72,510	
SUBTOTAL								1,303,440	
Project Management/Construction Mgnt								189,200	
SUBTOTAL								1,492,640	
General & Admin/Common Support Pool								369,890	
SUBTOTAL								1,862,530	
Contingency								651,890	
TOTAL INCL OWNER COSTS								2,514,410	

U.S. Army Corps of Engineers - D.O. 94 - Final
PROJECT HHYDCL: HANFORD: ER PROGRAM - H AREA HYDRAULIC CONTROL
HYDRAULIC CONTROL 100-HR-3 / 100 H AREA
** PROJECT INDIRECT SUMMARY - CNTRCTOR (Rounded to 10's) **

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		42,100	0	0	0	0	0	42,100	
SUB Fixed Price Contractor		767,030	145,740	66,450	9,470	4,650	0	993,340	
WHC Westinghouse Hanford Company		195,490	0	0	0	0	0	195,490	
HANFORD: ER PROGRAM		1,004,620	145,740	66,450	9,470	4,650	0	1,230,930	
Subcontractor MPR								72,510	
SUBTOTAL								1,303,440	
Project Management/Construction Mgnt								189,200	
SUBTOTAL								1,492,640	
General & Admin/Common Support Pool								369,890	
SUBTOTAL								1,862,530	
Contingency								651,890	
TOTAL INCL OWNER COSTS								2,514,410	

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis								
ANA:02.08 Sampling Rad Contaminated Media								
ANA:02.08.02 Ground Water Analysis Yr 1-5	10.00 EA	42,100	0	0	0	14,740	56,840	5683.50
TOTAL Sampling Rad Contaminated Media		42,100	0	0	0	14,740	56,840	
TOTAL Monitoring, Sampling & Analysis		42,100	0	0	0	14,740	56,840	
TOTAL Off-Site Analytical Services		42,100	0	0	0	14,740	56,840	
SUB Fixed Price Contractor								
SUB:01 Mobilization & Preparatory Work								
SUB:01.02 Mobilize Personnel & Equipment								
SUB:01.02.02 Mobilize Trailers		970	70	160	310	530	2,030	
TOTAL Mobilize Personnel & Equipment		970	70	160	310	530	2,030	
SUB:01.04 Setup/Construct Temp Facilities								
SUB:01.04.01 Establish Facilities								
SUB:01.04.01.02 Setup Trailers		4,930	360	790	1,550	2,670	10,310	
TOTAL Establish Facilities		4,930	360	790	1,550	2,670	10,310	
SUB:01.04.02 Construct Decon Area	24.00 HR	11,900	870	1,920	3,750	6,450	24,880	1036.84
SUB:01.04.03 Site Survey		1,300	90	210	410	700	2,710	
TOTAL Setup/Construct Temp Facilities		18,130	1,320	2,920	5,700	9,830	37,900	
SUB:01.05 Construct Temporary Utilities		6,050	440	970	1,910	3,280	12,660	
SUB:01.06 Pre-Construction Submittals	4.00 EA	12,950	950	2,080	4,070	7,020	27,070	6768.60
TOTAL Mobilization & Preparatory Work		38,110	2,780	6,130	11,990	20,650	79,670	
SUB:03 Site Work								
SUB:03.03 Earthwork		6,480	470	1,040	2,040	3,510	13,540	
SUB:03.04 Roads/Parking/Curbs/Walks		28,250	2,060	4,550	8,890	15,310	59,060	

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U.S. Army Corps of Engineers - D.O. 94 - Final
PROJECT HHYDCL: HANFORD: ER PROGRAM - H AREA HYDRAULIC CONTROL
HYDRAULIC CONTROL 100-HR-3 / 100 H AREA
** PROJECT OWNER SUMMARY - FEATURE (Rounded to 10's) **

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis		42,100	0	0	0	14,740	56,840	
TOTAL Off-Site Analytical Services		42,100	0	0	0	14,740	56,840	
SUB Fixed Price Contractor								
SUB:01 Mobilization & Preparatory Work		38,110	2,780	6,130	11,990	20,650	79,670	
SUB:03 Site Work		34,720	2,530	5,590	10,930	18,820	72,590	
SUB:06 Groundwater Collection & Control		888,060	64,830	142,930	279,430	481,340	1,856,590	
SUB:20 Site Restoration		12,950	950	2,080	4,070	7,020	27,070	
SUB:21 Demobilization		19,500	1,420	3,140	6,140	10,570	40,760	
TOTAL Fixed Price Contractor		993,340	72,510	159,880	312,560	538,400	2,076,690	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis		35,860	0	5,380	10,520	18,120	69,870	
WHC:06 Groundwater Collection & Control		9,410	0	1,410	2,760	4,750	18,340	
WHC:13 Annual Report		150,220	0	22,530	44,050	75,880	292,680	
TOTAL Westinghouse Hanford Company		195,490	0	29,320	57,330	98,750	380,890	
TOTAL HANFORD: ER PROGRAM		1,230,930	72,510	189,200	369,890	651,890	2,514,410	

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
WHC:02.08.02 Ground Water Analysis	88.00 EA	35,200	0	5,280	10,320	17,780	68,580	779.35
WHC:02.08.03 Take Ground Water Samples	24.00 HR	660	0	100	190	330	1,290	53.82
TOTAL Sampling Rad Cntmntd Media 1-5		35,860	0	5,380	10,520	18,120	69,870	
TOTAL Monitoring, Sampling & Analysis		35,860	0	5,380	10,520	18,120	69,870	
WHC:06 Groundwater Collection & Control								
WHC:06.05 Operation and Maintenance		9,410	0	1,410	2,760	4,750	18,340	
TOTAL Groundwater Collection & Control		9,410	0	1,410	2,760	4,750	18,340	
WHC:13 Annual Report								
WHC:13.21 Annual Report								
WHC:13.21.11 Prepare Annual Report (Yr 1)		90,150	0	13,520	26,440	45,540	175,640	
WHC:13.21.12 Prepare Annual Report (Yrs 2-5)		60,070	0	9,010	17,620	30,340	117,040	
TOTAL Annual Report		150,220	0	22,530	44,050	75,880	292,680	
TOTAL Annual Report		150,220	0	22,530	44,050	75,880	292,680	
TOTAL Westinghouse Hanford Company		195,490	0	29,320	57,330	98,750	380,890	
TOTAL HANFORD: ER PROGRAM		1,230,930	72,510	189,200	369,890	651,890	2,514,410	

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	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
TOTAL Site Work		34,720	2,530	5,590	10,930	18,820	72,590	
SUB:06 Groundwater Collection & Control								
SUB:06.01 Extraction & Injection Wells								
SUB:06.01.01 Well Drilling & Construction		425,420	31,060	68,470	133,860	230,580	889,390	
SUB:06.01.04 Operations and Maintenance Yr 3		190,370	13,900	30,640	59,900	103,180	397,990	
SUB:06.01.9X Site Piping		272,260	19,880	43,820	85,670	147,570	569,200	
TOTAL Extraction & Injection Wells		888,060	64,830	142,930	279,430	481,340	1,856,590	
TOTAL Groundwater Collection & Control		888,060	64,830	142,930	279,430	481,340	1,856,590	
SUB:20 Site Restoration								
SUB:20.04 Revegetation and Planting		12,950	950	2,080	4,070	7,020	27,070	
TOTAL Site Restoration		12,950	950	2,080	4,070	7,020	27,070	
SUB:21 Demobilization								
SUB:21.02 Demobilize Personnel & Equipment								
SUB:21.02.02 Demobilize Trailers		970	70	160	310	530	2,030	
TOTAL Demobilize Personnel & Equipment		970	70	160	310	530	2,030	
SUB:21.04 Demobilize Temp Facilities								
SUB:21.04.02 Remove Decon Area	8.00 HR	2,340	170	380	740	1,270	4,890	611.20
TOTAL Demobilize Temp Facilities		2,340	170	380	740	1,270	4,890	
SUB:21.05 Disconnect Temporary Utilities		3,240	240	520	1,020	1,750	6,770	
SUB:21.06 Post-Construction Submittals	4.00 EA	12,950	950	2,080	4,070	7,020	27,070	6768.60
TOTAL Demobilization		19,500	1,420	3,140	6,140	10,570	40,760	
TOTAL Fixed Price Contractor		993,340	72,510	159,880	312,560	538,400	2,076,690	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis								
WHC:02.08 Sampling Rad Cntmntd Media 1-5								

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		42,100	0	0	0	14,740	56,840	
SUB Fixed Price Contractor		993,340	72,510	159,880	312,560	538,400	2,076,690	
WHC Westinghouse Hanford Company		195,490	0	29,320	57,330	98,750	380,890	
TOTAL HANFORD: ER PROGRAM		1,230,930	72,510	189,200	369,890	651,890	2,514,410	

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HANFORD: ER PROGRAM
H AREA HYDRAULIC CONTROL
1.4.10.1.1.10.5.2.4
HYDRAULIC CONTROL REMEDIATION
FOCUSED FEASIBILITY STUDY

Designed By:
Estimated By: CH2M HILL HANFORD, INC.

Prepared By: ERC CONTRACT - RICHLAND, WASH

Preparation Date: 07/26/95
Effective Date of Pricing: 09/14/94

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SRC	EQUIP ID	DESCRIPTION	DEPR	CAPT	FUEL	FOG	EQ REP	TR WR	TR REP	TOTAL UOM	** TOTAL ** HOURS

9513360.2908

SRC	LABOR ID	DESCRIPTION	BASE	OVERTM	TXS/INS	FRNG	TRVL	RATE	UOM	UPDATE	**** TOTAL **** DEFAULT	HOURS
WHC	85101	Engineer, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	1040
WHC	85102	Scientist, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	1040
WHC	85201	Technician, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	24

WHC:13. Annual Report	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:13. Annual Report									
WHC:13.21. Annual Report									
WHC:13.21.11. Prepare Annual Report (Yrs 1-5)									
Assume 2 FTE's for 6 months each year.									
WHC Engineer, Environmental				43.34	0.00	0.00	0.00	43.34	
Restoration Ops - 1 ea	1040.00	HR	85101	45,074	0	0	0	45,074	43.34
WHC Scientist, Environmental				43.34	0.00	0.00	0.00	43.34	
Restoration Ops - 1 ea	1040.00	HR	85102	45,074	0	0	0	45,074	43.34
TOTAL Prepare Annual Report (Yrs 1-5)	2080.00	HR		90,148	0	0	0	90,148	43.34
TOTAL Annual Report				90,148	0	0	0	90,148	
TOTAL Annual Report				90,148	0	0	0	90,148	
TOTAL Westinghouse Hanford Company				90,811	0	0	5,200	96,011	
TOTAL HANFORD: ER PROGRAM				90,811	0	0	9,410	100,221	

9513360.2909

WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:02.08.04. Ground Water Monitor Samples							
Work to be Performed:							
Take semiannual groundwater monitoring samples.							
Assumptions:							
1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr)							
2. Assume 2 field Technicians for 6 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)							
WHC Technician, Environmental Restoration Ops - 2 ea	24.00 HR 85201	27.62 663	0.00 0	0.00 0	0.00 0	27.62 663	27.62
TOTAL Ground Water Monitor Samples	24.00 HR	663	0	0	0	663	27.62
TOTAL Sampling Rad Contaminated Media		663	0	0	5,200	5,863	
TOTAL Monitoring, Sampling & Analysis		663	0	0	5,200	5,863	

WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

WHC. Westinghouse Hanford Company
WHC:02. Monitoring, Sampling & Analysis
WHC:02.08. Sampling Rad Contaminated Media
WHC:02.08.02. Ground Water Analysis (Yrs 1-5)

Assumptions:

1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr)

   - Total samples = 14

2. 90% of samples for analysis at mobile lab (90% of 14 = 13)

WHC	Analyze LLW Sample - Mobile Lab		0.00	0.00	0.00	400.00	400.00	
		13.00 EA	0	0	0	5,200	5,200	400.00
TOTAL	Ground Water Analysis (Yrs 1-5)	13.00 EA	0	0	0	5,200	5,200	400.00

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ANA:02. Monitoring, Sampling & Analysis	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

ANA. Off-Site Analytical Services
ANA:02. Monitoring, Sampling & Analysis
ANA:02.08. Sampling Rad Contaminated Media
ANA:02.08.02. Ground Water Analysis (Yrs 1-5)

Assumptions:

1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle
(14 samples/yr)

- Total samples = 14

2. All on-site sample analyses performed by mobile lab.

3. 10% off-site verification analysis of reduced analyte list with CLP protocol.
(10% of 14 = 1 ea)

ANA	Analyze LLW Sample - Off-site Lab	1.00	EA	0.00 0	0.00 0	0.00 0	4210.00 4,210	4210.00 4,210	4210.00
TOTAL	Ground Water Analysis (Yrs 1-5)	1.00	EA	0	0	0	4,210	4,210	4210.00
TOTAL	Sampling Rad Contaminated Media			0	0	0	4,210	4,210	
TOTAL	Monitoring, Sampling & Analysis			0	0	0	4,210	4,210	
TOTAL	Off-Site Analytical Services			0	0	0	4,210	4,210	

	QUANTITY	UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
TOTAL INCL OWNER COSTS							192,750	

9513360.2911

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis							
ANA:02.08 Sampling Rad Contaminated Media							
ANA:02.08.02 Ground Water Analysis (Yrs 1-5)	1.00 EA	0	0	0	4,210	4,210	4210.00
TOTAL Sampling Rad Contaminated Media		0	0	0	4,210	4,210	
TOTAL Monitoring, Sampling & Analysis		0	0	0	4,210	4,210	
TOTAL Off-Site Analytical Services		0	0	0	4,210	4,210	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis							
WHC:02.08 Sampling Rad Contaminated Media							
WHC:02.08.02 Ground Water Analysis (Yrs 1-5)	13.00 EA	0	0	0	5,200	5,200	400.00
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	0	0	660	27.62
TOTAL Sampling Rad Contaminated Media		660	0	0	5,200	5,860	
TOTAL Monitoring, Sampling & Analysis		660	0	0	5,200	5,860	
WHC:13 Annual Report							
WHC:13.21 Annual Report							
WHC:13.21.11 Prepare Annual Report (Yrs 1-5)	2080.00 HR	90,150	0	0	0	90,150	43.34
TOTAL Annual Report		90,150	0	0	0	90,150	
TOTAL Annual Report		90,150	0	0	0	90,150	
TOTAL Westinghouse Hanford Company		90,810	0	0	5,200	96,010	
TOTAL HANFORD: ER PROGRAM		90,810	0	0	9,410	100,220	
Project Management/Construction Mgnt						14,400	
SUBTOTAL						114,620	
General & Admin/Common Support Pool						28,160	
SUBTOTAL						142,780	
Contingency						49,970	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis		0	0	0	4,210	4,210	
TOTAL Off-Site Analytical Services		0	0	0	4,210	4,210	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis		660	0	0	5,200	5,860	
WHC:13 Annual Report		90,150	0	0	0	90,150	
TOTAL Westinghouse Hanford Company		90,810	0	0	5,200	96,010	
TOTAL HANFORD: ER PROGRAM		90,810	0	0	9,410	100,220	
Project Management/Construction Mgnt						14,400	
SUBTOTAL						114,620	
General & Admin/Common Support Pool						28,160	
SUBTOTAL						142,780	
Contingency						49,970	
TOTAL INCL OWNER COSTS						192,750	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		0	0	0	4,210	4,210	
WHC Westinghouse Hanford Company		90,810	0	0	5,200	96,010	
TOTAL HANFORD: ER PROGRAM		90,810	0	0	9,410	100,220	
Project Management/Construction Mgnt						14,400	
SUBTOTAL						114,620	
General & Admin/Common Support Pool						28,160	
SUBTOTAL						142,780	
Contingency						49,970	
TOTAL INCL OWNER COSTS						192,750	

	QUANTITY	UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
TOTAL INCL OWNER COSTS									192,750	

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	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis									
ANA:02.08 Sampling Rad Contaminated Media									
ANA:02.08.02 Ground Water Analysis (Yrs 1-5	1.00 EA	4,210	0	0	0	0	0	4,210	4210.00
TOTAL Sampling Rad Contaminated Medi		4,210	0	0	0	0	0	4,210	
TOTAL Monitoring, Sampling & Analysi		4,210	0	0	0	0	0	4,210	
TOTAL Off-Site Analytical Services		4,210	0	0	0	0	0	4,210	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis									
WHC:02.08 Sampling Rad Contaminated Media									
WHC:02.08.02 Ground Water Analysis (Yrs 1-5	13.00 EA	5,200	0	0	0	0	0	5,200	400.00
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	0	0	0	0	660	27.62
TOTAL Sampling Rad Contaminated Medi		5,860	0	0	0	0	0	5,860	
TOTAL Monitoring, Sampling & Analysi		5,860	0	0	0	0	0	5,860	
WHC:13 Annual Report									
WHC:13.21 Annual Report									
WHC:13.21.11 Prepare Annual Report (Yrs 1-5	2080.00 HR	90,150	0	0	0	0	0	90,150	43.34
TOTAL Annual Report		90,150	0	0	0	0	0	90,150	
TOTAL Annual Report		90,150	0	0	0	0	0	90,150	
TOTAL Westinghouse Hanford Company		96,010	0	0	0	0	0	96,010	
TOTAL HANFORD: ER PROGRAM		100,220	0	0	0	0	0	100,220	
Project Management/Construction Mgnt								14,400	
SUBTOTAL								114,620	
General & Admin/Common Support Pool								28,160	
SUBTOTAL								142,780	
Contingency								49,970	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis		4,210	0	0	0	0	0	4,210	
TOTAL Off-Site Analytical Services		4,210	0	0	0	0	0	4,210	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis		5,860	0	0	0	0	0	5,860	
WHC:13 Annual Report		90,150	0	0	0	0	0	90,150	
TOTAL Westinghouse Hanford Company		96,010	0	0	0	0	0	96,010	
TOTAL HANFORD: ER PROGRAM		100,220	0	0	0	0	0	100,220	
Project Management/Construction Mgnt								14,400	
SUBTOTAL								114,620	
General & Admin/Common Support Pool								28,160	
SUBTOTAL								142,780	
Contingency								49,970	
TOTAL INCL OWNER COSTS								192,750	

U.S. Army Corps of Engineers - D.O. 94 - Final
PROJECT HNOACT: HANFORD: ER PROGRAM - 100 H AREA INSTIT CONTROLS/
H AREA INSTIT CONTROLS/CONT'D CURRENT ACTIONS
** PROJECT INDIRECT SUMMARY - CNTRCTOR (Rounded to 10's) **

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		4,210	0	0	0	0	0	4,210	
WHC Westinghouse Hanford Company		96,010	0	0	0	0	0	96,010	
HANFORD: ER PROGRAM		100,220	0	0	0	0	0	100,220	
Project Management/Construction Mgnt								14,400	
SUBTOTAL								114,620	
General & Admin/Common Support Pool								28,160	
SUBTOTAL								142,780	
Contingency								49,970	
TOTAL INCL OWNER COSTS								192,750	

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis								
ANA:02.08 Sampling Rad Contaminated Media								
ANA:02.08.02 Ground Water Analysis (Yrs 1-5)	1.00 EA	4,210	0	0	0	1,470	5,680	5683.50
TOTAL Sampling Rad Contaminated Media		4,210	0	0	0	1,470	5,680	
TOTAL Monitoring, Sampling & Analysis		4,210	0	0	0	1,470	5,680	
TOTAL Off-Site Analytical Services		4,210	0	0	0	1,470	5,680	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis								
WHC:02.08 Sampling Rad Contaminated Media								
WHC:02.08.02 Ground Water Analysis (Yrs 1-5)	13.00 EA	5,200	0	780	1,520	2,630	10,130	779.36
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	100	190	330	1,290	53.82
TOTAL Sampling Rad Contaminated Media		5,860	0	880	1,720	2,960	11,420	
TOTAL Monitoring, Sampling & Analysis		5,860	0	880	1,720	2,960	11,420	
WHC:13 Annual Report								
WHC:13.21 Annual Report								
WHC:13.21.11 Prepare Annual Report (Yrs 1-5)	2080.00 HR	90,150	0	13,520	26,440	45,540	175,640	84.44
TOTAL Annual Report		90,150	0	13,520	26,440	45,540	175,640	
TOTAL Annual Report		90,150	0	13,520	26,440	45,540	175,640	
TOTAL Westinghouse Hanford Company		96,010	0	14,400	28,160	48,500	187,070	
TOTAL HANFORD: ER PROGRAM		100,220	0	14,400	28,160	49,970	192,750	

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	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis		4,210	0	0	0	1,470	5,680	
TOTAL Off-Site Analytical Services		4,210	0	0	0	1,470	5,680	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis		5,860	0	880	1,720	2,960	11,420	
WHC:13 Annual Report		90,150	0	13,520	26,440	45,540	175,640	
TOTAL Westinghouse Hanford Company		96,010	0	14,400	28,160	48,500	187,070	
TOTAL HANFORD: ER PROGRAM		100,220	0	14,400	28,160	49,970	192,750	

U.S. Army Corps of Engineers - D.O. 94 - Final
PROJECT HNOACT: HANFORD: ER PROGRAM - 100 H AREA INSTIT CONTROLS/
H AREA INSTIT CONTROLS/CONT'D CURRENT ACTIONS
** PROJECT OWNER SUMMARY - CNTRCTOR (Rounded to 10's) **

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		4,210	0	0	0	1,470	5,680	
WHC Westinghouse Hanford Company		96,010	0	14,400	28,160	48,500	187,070	
TOTAL HANFORD: ER PROGRAM		100,220	0	14,400	28,160	49,970	192,750	

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HANFORD: ER PROGRAM
100 H AREA INSTIT CONTROLS/
CONTINUED CURRENT ACTIONS
1.4.10.1.1.10.5.2.4
FOCUSED FEASIBILITY STUDY

Designed By:
Estimated By: CH2M HILL HANFORD, INC.

Prepared By: ERC CONTRACT - RICHLAND, WASH

Preparation Date: 07/21/95
Effective Date of Pricing: 09/22/94

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Release 5.27

SRC	EQUIP ID	DESCRIPTION	DEPR	CAPT	FUEL	FOG	EQ REP	TR WR	TR REP	TOTAL UOM	** TOTAL ** HOURS
USR	H30BA001	HYD EXCAV,TRK MTD,.5 CY BKT,6X4			12.07	1.4	19.78	0.98	0.15	34.44 HR	32
USR	T50FO004	TRK,HWY,4X4,F250,3/4T,8800 GVW			2.67	0.7	3.58	0.27	0.04	7.31 HR	32
MIL	XMIXX020	Small Tools	0.47	0.17	0.13	0.0	0.57			1.40 HR	64

SRC	LABOR ID	DESCRIPTION	BASE	OVERTM	TXS/INS	FRNG	TRVL	RATE	UOM	UPDATE	**** TOTAL **** DEFAULT	HOURS
FPC	0029	Laborer Group - 1	15.84	0.0%	28.7%	3.57	1.25	25.20	HR	07/09/93	0.00	96
FPC	0030	Laborer Group - 2	16.09	0.0%	28.5%	3.57	1.25	25.50	HR	07/09/93	0.00	96
FPC	0039	Group-6 Power Equipment Operator	18.02	0.0%	27.4%	4.90	1.25	29.10	HR	07/09/93	0.00	32
WHC	33201	Technician, Health Physics	28.78	0.0%	38.0%	0.00	0.00	39.72	HR	01/07/94	0.00	4380
WHC	85101	Engineer, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	1733
WHC	85102	Scientist, Environmental	35.38	0.0%	22.5%	0.00	0.00	43.34	HR	01/07/94	0.00	1733
WHC	85201	Technician, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	2214
WHC	85301	Skilled Craft, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	2190
WHC	85302	Operator, Environmental	22.55	0.0%	22.5%	0.00	0.00	27.62	HR	01/07/94	0.00	8800

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WHC:13. Physical Treatment		QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:13.21.12. Prepare Annual Report (Yrs 2-5) Assume a 66% effort level of the year 1 report (2 FTE's for 4 months each year)								
WHC	Engineer, Environmental Restoration Ops - 1 ea	693.00 HR 85101	43.34 30,035	0.00 0	0.00 0	0.00 0	43.34 30,035	43.34
WHC	Scientist, Environmental Restoration Ops - 1 ea	693.00 HR 85102	43.34 30,035	0.00 0	0.00 0	0.00 0	43.34 30,035	43.34
TOTAL Prepare Annual Report (Yrs 2-5)			60,070	0	0	0	60,070	
TOTAL Reverse Osmosis			690,448	0	360,889	125,803	1,177,140	
TOTAL Physical Treatment			690,448	0	360,889	125,803	1,177,140	
TOTAL Westinghouse Hanford Company			691,111	0	360,889	229,279	1,281,279	
TOTAL HANFORD: ER PROGRAM			704,659	2,926	367,896	3,237,871	4,313,351	

WHC:13. Physical Treatment		QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:13.21.11. Prepare Annual Report (Yr 1) Assume 2 FTE's for 6 months each year										
WHC	Engineer, Environmental Restoration Ops - 1 ea	1040.00	HR	85101	43.34 45,074	0.00 0	0.00 0	0.00 0	43.34 45,074	43.34
WHC	Scientist, Environmental Restoration Ops - 1 ea	1040.00	HR	85102	43.34 45,074	0.00 0	0.00 0	0.00 0	43.34 45,074	43.34
TOTAL	Prepare Annual Report (Yr 1)	2080.00	HR		90,148	0	0	0	90,148	43.34

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WHC:13. Physical Treatment		QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
	(52 wk/yr x 2 filters/wk)							
WHC	Disposal Fee for Reverse Osmosis Filters Assume disposal at ERDF for years 1-5 of the 5-year lifecycle. Assume each filter to be 40 cf	4160.00 CF	0.00 0	0.00 0	0.00 0	2.59 10,774	2.59 10,774	2.59
WHC	Disposal Fee - Evaporation Cake Assume disposal at ERDF for years 1-5 of the 5-year lifecycle. 150 gpm x 325 ppm = 9.39 cf/day, 9.39 cf/day x 365 days = 3427 cf/yr Assume 50% volume increase to stabilize evaporation cake 1.5 x 3427 cf/yr = 5141 cf/yr	5141.00 CF	0.00 0	0.00 0	0.00 0	2.59 13,315	2.59 13,315	2.59
WHC	Allowance for Water Usage Assume 1000 gal per month usage for the 5-year lifecycle	12000 GAL	0.00 0	0.00 0	0.00 0	0.02 240	0.02 240	0.02
TOTAL	Operation and Maint (Yrs 1-5)	1.00 YR	539,125	0	360,889	120,003	1,020,016	1020016.48

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WHC:13. Physical Treatment		QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:13.21.08. Operation and Maint (Yrs 1-5)										
	Assumptions: 1. Treatment facility will be fully staffed with 2 FTE's per shift, 3 shifts per day, 7 days per week. (365 days/yr x 24 hrs/day = 8760 hrs) 2. Reverse Osmosis filters will be replaced every week for the 5-year lifecycle. 3. 2 FTE crew will be composed of the following members: 0.25 ea - supervisor 1.00 ea - operator 0.50 ea - TP tech support 0.25 ea - maintenance engineer									
WHC	Technician, Environmental Restoration Ops - Supervisor - 0.25 ea	2190.00	HR	85201	28.62 62,686	0.00 0	0.00 0	0.00 0	28.62 62,686	28.62
WHC	Operator, Environmental Restoration Ops - 1 ea	8760.00	HR	85302	27.62 241,984	0.00 0	0.00 0	0.00 0	27.62 241,984	27.62
WHC	Technician, Health Physics - 0.50 ea	4380.00	HR	33201	39.72 173,958	0.00 0	0.00 0	0.00 0	39.72 173,958	39.72
WHC	Skilled Craft, Environmental Restoration Ops - Maintenance - 0.25 ea	2190.00	HR	85301	27.62 60,496	0.00 0	0.00 0	0.00 0	27.62 60,496	27.62
WHC	Allowance for Electricity Wells: 806 kW-hr/d RO System: 593 kW-hr/d Recompr Evap: 1728 kW-hr/d Rotary Filter: 1806 kW-hr/d (80 kW-hr/1000 gal) Assume 24 hrs/day x 365 days/yr Total = 1,800,545 kW-hr/yr	1800545	KWH		0.00 0	0.00 0	0.00 0	0.04 72,022	0.04 72,022	0.04
WHC	RO System Chemicals Includes scale inhibitors $ 0.29/1000 gal, 150 gpm x 1440 m/d x 365 d/y = 78.8 MMgpy	78840000	GAL		0.00 0	0.00 0	0.00 0	0.00 23,652	0.00 23,652	0.00
M WHC S2	Reverse Osmosis Filter Replacement Assume replacement of 2 filters on a weekly basis for the 5-year lifecycle.	104.00	EA		0.00 0	0.00 0	3470.08 360,889	0.00 0	3470.08 360,889	3470.08

WHC:13. Physical Treatment		QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:13. Physical Treatment								
WHC:13.21. Reverse Osmosis								
WHC:13.21.06. Personnel Training								
Note: This account to allow for operator time and an allowance for a 40-hour training course.								
WHC	Operator, Environmental Restoration Ops	40.00 HR 85302	27.62 1,105	0.00 0	0.00 0	0.00 0	27.62 1,105	27.62
WHC	Allowance for 40 hr Training	1.00 LS	0.00 0	0.00 0	0.00 0	800.00 800	800.00 800	800.00
WHC	Allowance for Maintainence Manuals	1.00 LS	0.00 0	0.00 0	0.00 0	5000.00 5,000	5000.00 5,000	5000.00
TOTAL Personnel Training			1,105	0	0	5,800	6,905	

WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
WHC:02.08.04. Ground Water Monitor Samples							
Work to be Performed:							
Take semiannual groundwater monitoring samples.							
Assumptions:							
1. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle. (14 samples/yr)							
2. Assume 2 field Technicians for 6 hours on a semiannual basis for the 5-year lifecycle. (24 hrs/yr)							
WHC Technician, Environmental		27.62	0.00	0.00	0.00	27.62	
Restoration Ops - 2 ea	24.00 HR 85201	663	0	0	0	663	27.62
TOTAL Ground Water Monitor Samples	24.00 HR	663	0	0	0	663	27.62
TOTAL Sampling Rad Contaminated Media		663	0	0	103,476	104,139	
TOTAL Monitoring, Sampling & Analysis		663	0	0	103,476	104,139	

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WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

WHC:02.08.03. Ground Water Analysis-Yr 2-5

Assumptions:

1. 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle (104 samples/yr)

2. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr)

- Total samples = 118

4. 90% of samples for analysis at mobile lab (90% of 118 = 106)

5. HACH kit samples are taken 1 per shift for the 5-yr lifecycle (1143 samples)

WHC	Analyze LLW Sample - Mobile Lab	106.00 EA	0.00 0	0.00 0	0.00 0	400.00 42,400	400.00 42,400	400.00
WHC	HACH Kit Sampling	1143.00 EA	0.00 0	0.00 0	0.00 0	0.50 572	0.50 572	0.50
WHC	HACH Kit Replacement Assume 1 per yr	1.00 EA	0.00 0	0.00 0	0.00 0	235.00 235	235.00 235	235.00
TOTAL	Ground Water Analysis-Yr 2-5	106.00 EA	0	0	0	43,207	43,207	407.61

9513360.2972

WHC:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

WHC. Westinghouse Hanford Company
WHC:02. Monitoring, Sampling & Analysis
WHC:02.08. Sampling Rad Contaminated Media
WHC:02.08.02. Ground Water Analysis-Yr 1

Assumptions:

1. Assume shake-down period with following sampling of treatment system:
   - First 2 days: Sample every four hours of influent anf effluent (24 samples)
   - Next 5 days: 1 sample per day of influent and effluent (10 samples)
   - Next 7 weeks: 1 sample per week of influent and effluent (14 samples)

2. 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle (104 samples/yr)

3. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr)

   - Total samples = 166

4. 90% of samples for analysis at mobile lab (90% of 166 = 149)

5. HACH kit samples are taken 1 per shift for the 5-yr lifecycle plus an additional 48 samples during the shake-down period. (1143 samples)

WHC	Analyze LLW Sample - Mobile Lab		0.00	0.00	0.00	400.00	400.00	
		149.00 EA	0	0	0	59,600	59,600	400.00
WHC	HACH Kit Sampling		0.00	0.00	0.00	0.50	0.50	
		1143.00 EA	0	0	0	572	572	0.50
WHC	HACH Kit Replacement		0.00	0.00	0.00	235.00	235.00	
	Assume 1 per yr	0.42 EA	0	0	0	98	98	235.00
TOTAL	Ground Water Analysis-Yr 1	149.00 EA	0	0	0	60,269	60,269	404.49

SUB:21. Demobilization	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.06. Post-Construction Submittals Yr 5									
FPC S3 Allowance for Post-Construction Submittals by Fixed Price Contractor	4.00	EA		0.00 0	0.00 0	0.00 0	2500.00 10,000	2500.00 10,000	2500.00
TOTAL Post-Construction Submittals	4.00	EA		0	0	0	10,000	10,000	2500.00
TOTAL Demobilization				3,950	1,106	0	10,000	15,056	
TOTAL Fixed Price Contractor				13,548	2,926	7,007	2,886,502	2,909,983	

SUB:21. Demobilization	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.05. Disconnect Temporary Utilities Yr 5									
M FPC S3 Remove Temporary Power				1.00	0.00	0.00	0.00	1.00	
	500.00	LF		500	0	0	0	500	1.00
M FPC S3 Remove Telephone				1.00	0.00	0.00	0.00	1.00	
	500.00	LF		500	0	0	0	500	1.00
M FPC S3 Remove Temporary Water and Sewer Service	500.00	LF		3.00	0.00	0.00	0.00	3.00	
				1,500	0	0	0	1,500	3.00
TOTAL Disconnect Temporary Utilities				2,500	0	0	0	2,500	

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SUB:21. Demobilization	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

SUB:21.04. Demobilize Temp Facilities
SUB:21.04.02. Remove Decon Area-Yr 5

Work to be Performed:
Remove decontamination area/pad for equipment and vehicles.

Crew and Equipment:
Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers
Equipment: 1 backhoe, 1 pickup truck

Output:
Assumed duration for this activity is 1 crew day.

FPC S3 Group-6 Power Equipment Operator - 1 ea	8.00	HR	0039	29.10 233	0.00 0	0.00 0	0.00 0	29.10 233	29.10
FPC S3 Laborer Group - 1 - 3 ea	24.00	HR	0029	25.20 605	0.00 0	0.00 0	0.00 0	25.20 605	25.20
FPC S3 Laborer Group - 2 - 3 ea	24.00	HR	0030	25.50 612	0.00 0	0.00 0	0.00 0	25.50 612	25.50
FPC S3 HYD EXCAV,TRK MTD,.5 CY BKT,6X4 HYDRO-SCOPIC - 1 ea	8.00	HR	H30BA001	0.00 0	34.44 276	0.00 0	0.00 0	34.44 276	34.44
FPC S3 TRK,HWY,4X4,F250,3/4T,8800 GVW 4X4 3/4 TON PICK-UP - 1 ea	8.00	HR	T50F0004	0.00 0	7.31 58	0.00 0	0.00 0	7.31 58	7.31
FPC S3 Small Tools - 2 ea	16.00	HR	XMIXX020	0.00 0	1.40 22	0.00 0	0.00 0	1.40 22	1.40
TOTAL Remove Decon Area-Yr 5	8.00	HR		1,450	356	0	0	1,806	225.75
TOTAL Demobilize Temp Facilities				1,450	356	0	0	1,806	

SUB:21. Demobilization	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21. Demobilization									
SUB:21.02. Demobilize Personnel & Equipment									
SUB:21.02.02. Demobilize Trailers-Yr 5									
FPC S3 Demob Field Office Trailer				0.00	250.00	0.00	0.00	250.00	
	1.00	EA		0	250	0	0	250	250.00
FPC S3 Demob Storage Trailer				0.00	250.00	0.00	0.00	250.00	
	1.00	EA		0	250	0	0	250	250.00
FPC S3 Demob Decon Trailer				0.00	250.00	0.00	0.00	250.00	
	1.00	EA		0	250	0	0	250	250.00
TOTAL Demobilize Trailers-Yr 5				0	750	0	0	750	
TOTAL Demobilize Personnel & Equipment				0	750	0	0	750	

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SUB:20. Site Restoration	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:20. Site Restoration							
SUB:20.04. Revegetation and Planting Yr 5							
FPC S3 Allowance for Site Restoration	5000.00 SY	0.00 0	0.00 0	0.00 0	2.00 10,000	2.00 10,000	2.00
TOTAL Revegetation and Planting Yr 5		0	0	0	10,000	10,000	
TOTAL Site Restoration		0	0	0	10,000	10,000	

SUB:13. Physical Treatment	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
TOTAL Reverse Osmosis		0	0	0	1,432,400	1,432,400	
TOTAL Physical Treatment		0	0	0	1,432,400	1,432,400	

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SUB:13. Physical Treatment	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:13. Physical Treatment							
SUB:13.21. Reverse Osmosis							
SUB:13.21.04. Construction of Permanent Plant							
FPC S3 Excavate and Install Building Foundation	600.00 SF	0.00 0	0.00 0	0.00 0	20.00 12,000	20.00 12,000	20.00
FPC S3 Install Butler Building Assume a prefabricated heated building complete with frame, doors, roll up doors, gutters, insulation, and roof vent.	600.00 SF	0.00 0	0.00 0	0.00 0	20.00 12,000	20.00 12,000	20.00
FPC S3 Reverse Osmosis Equipment/Staging Includes 1 - 150 gpm treatment system, 225-psi inlet pressure, 10% reject	1.00 LS	0.00 0	0.00 0	0.00 0	216000.00 216,000	216000.00 216,000	216000.00
FPC S3 Vapor Recompression Evaporator Capacity =150 gpm x 0.1= 15 gpm, includes startup boiler, 2% reject	1.00 LS	0.00 0	0.00 0	0.00 0	550000.00 550,000	550000.00 550,000	550000.00
FPC S3 Rotary Drum Filter/Dryer Liquid loading= 150 gpm x 0.1 x 0.02 = 0.30 gpm = 150 lbs/hr, Drying area = 25 sf	1.00 LS	0.00 0	0.00 0	0.00 0	585000.00 585,000	585000.00 585,000	585000.00
FPC S3 Steam Generator Evaporate 0.30 gpm =150 lbs/hr 257000 BTU	1.00 LS	0.00 0	0.00 0	0.00 0	3400.00 3,400	3400.00 3,400	3400.00
FPC S3 Allowance for Bldg Electrical Includes lighting, fixtures, motor starters, controllers, junction boxes, transformer, chart recorders, annunciators, panels, conduit, and wiring.	600.00 SF	0.00 0	0.00 0	0.00 0	40.00 24,000	40.00 24,000	40.00
FPC S3 Allowance for Bldg Mechanical Includes equipment installation and connections, controls/instrumentation, interior piping (plastic), floor drains and piping.	600.00 SF	0.00 0	0.00 0	0.00 0	50.00 30,000	50.00 30,000	50.00
TOTAL Construction of Permanent Plant	600.00 SF	0	0	0	1,432,400	1,432,400	2387.33

SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06.01.9X. Site Piping							
FPC S3 Allowance for Piping from Well Head to Treatment Plant Assume double wall PVC piping for extraction wells.		0.00	0.00	0.00	18.00	18.00	
	17314 LF	0	0	0	311,652	311,652	18.00
FPC S3 Allowance for Leak Detection		0.00	0.00	0.00	5000.00	5000.00	
	1.00 LS	0	0	0	5,000	5,000	5000.00
FPC S3 Allowance for Force Main Discharge Piping Assume single-wall PVC piping for injection wells.		0.00	0.00	0.00	15.00	15.00	
	1641.00 LF	0	0	0	24,615	24,615	15.00
TOTAL Site Piping		0	0	0	341,267	341,267	
TOTAL Extraction & Injection Wells		0	0	0	1,353,267	1,353,267	
TOTAL Groundwater Collection & Control		0	0	0	1,353,267	1,353,267	

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SUB:06. Groundwater Collection & Control	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06.01.04. Operations and Maintenance Yr 3							
FPC S3 Allowance for Well Workover		0.00	0.00	0.00	10000.00	10000.00	
Assume 1 every 3 yrs for each well for the 5-year lifecycle. Workovers performed in year 3	15.00 EA	0	0	0	150,000	150,000	10000.00
FPC S3 Allowance for Well Pump Replacement		0.00	0.00	0.00	3000.00	3000.00	
Assume 1 pump replacement per production well every 3 years for the 5-year lifecycle. Pumps replaced in year 3	10.00 EA	0	0	0	30,000	30,000	3000.00
TOTAL Operations and Maintenance Yr 3		0	0	0	180,000	180,000	

SUB:06. Groundwater Collection & Control	QUANTY	UOM	CREW	ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:06. Groundwater Collection & Control										
SUB:06.01. Extraction & Injection Wells										
SUB:06.01.01. Well Drilling & Construction										
FPC S3 Drill/Install Extr/Inject Wells					0.00	0.00	0.00	500.00	500.00	
Note: 7 new extraction wells 80 feet deep and 5 new injection wells, 100 ft deep, 8 in diameter. Unit cost is assumed to include handling and packaging of contaminated well cuttings, transport to the disposal facility, and associated disposal fees.	1060.00	LF			0	0	0	530,000	530,000	500.00
FPC S3 Allowance for Well Pumps- 10 gpm					0.00	0.00	0.00	3000.00	3000.00	
	10.00	EA			0	0	0	30,000	30,000	3000.00
FPC S3 Allowance for Controls and Connections at Well Heads					0.00	0.00	0.00	10000.00	10000.00	
	12.00	EA			0	0	0	120,000	120,000	10000.00
FPC S3 Refurbish Existing Wells					0.00	0.00	0.00	10000.00	10000.00	
	3.00	EA			0	0	0	30,000	30,000	10000.00
S3 Water Level Monitoring (Wells)					0.00	0.00	0.00	1000.00	1000.00	
Allowance for 5 piezometers per extraction well using well points	50.00				0	0	0	50,000	50,000	1000.00
FPC S3 Allowance for Well Head Covers					0.00	0.00	0.00	1000.00	1000.00	
Assume manhole type cover at each well head	12.00	EA			0	0	0	12,000	12,000	1000.00
FPC S3 Allowance for Well Testing					0.00	0.00	0.00	5000.00	5000.00	
	12.00	EA			0	0	0	60,000	60,000	5000.00
TOTAL Well Drilling & Construction	12.00	EA			0	0	0	832,000	832,000	69333.33

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SUB:03. Site Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.06. Electrical Distribution							
FPC S3 Allowance for Site Electrical	1.00 LS	0.00 0	0.00 0	0.00 0	10000.00 10,000	10000.00 10,000	10000.00
TOTAL Electrical Distribution		0	0	0	10,000	10,000	
TOTAL Site Work		0	0	0	69,835	69,835	

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SUB:03. Site Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.05. Fencing							
FPC S3 Allowance for Permanent Fencing		0.00	0.00	0.00	21.00	21.00	
Assume 7 ft high security fence	350.00 LF	0	0	0	7,350	7,350	21.00
FPC S3 Allowance for Entrance Gate		0.00	0.00	0.00	300.00	300.00	
	1.00 EA	0	0	0	300	300	300.00
TOTAL Fencing		0	0	0	7,650	7,650	

SUB:03. Site Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.04. Roads/Parking/Curbs/Walks							
FPC S3 Allowance for Access Road		0.00	0.00	0.00	10.00	10.00	
	400.00 SY	0	0	0	4,000	4,000	10.00
FPC S3 Allowance Gravel Parking Area		0.00	0.00	0.00	10.00	10.00	
	300.00 SY	0	0	0	3,000	3,000	10.00
FPC S3 Access Roads to Wells		0.00	0.00	0.00	2.12	2.12	
Assume 10 ft wide, native materials	18955 LF	0	0	0	40,185	40,185	2.12
Road length equal to the length of well piping							
TOTAL Roads/Parking/Curbs/Walks		0	0	0	47,185	47,185	

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SUB:03. Site Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03. Site Work							
SUB:03.03. Earthwork							
FPC S3 Allowance for Site Preparation	1.00 LS	0.00 0	0.00 0	0.00 0	5000.00 5,000	5000.00 5,000	5000.00
TOTAL Earthwork		0	0	0	5,000	5,000	

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.06. Pre-Construction Submittals							
FPC S3 Allowance for Pre-Construction Submittals by Fixed Price Contractor	4.00 EA	0.00 0	0.00 0	0.00 0	2500.00 10,000	2500.00 10,000	2500.00
TOTAL Pre-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Mobilization & Preparatory Work		9,599	1,819	7,007	11,000	29,425	

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SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.05. Construct Temporary Utilities							
M FPC S3 Allowance for Temporary Power		1.00	0.00	1.08	0.00	2.08	
	500.00 LF	500	0	539	0	1,039	2.08
M FPC S3 Allowance for Telephone		0.50	0.00	0.54	0.00	1.04	
	500.00 LF	250	0	270	0	520	1.04
M FPC S3 Allowance for Temporary Water and Sewer Service		3.00	0.00	3.23	0.00	6.23	
	500.00 LF	1,500	0	1,617	0	3,117	6.23
TOTAL Construct Temporary Utilities		2,250	0	2,426	0	4,676	

SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04.03. Site Survey							
FPC S3 Allowance for Site Survey		0.00	0.00	0.00	1000.00	1000.00	
	1.00 LS	0	0	0	1,000	1,000	1000.00
TOTAL Site Survey		0	0	0	1,000	1,000	
TOTAL Setup/Construct Temp Facilities		7,349	1,069	4,582	1,000	14,000	

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SUB:01. Mobilization & Preparatory Work

SUB:01.04.02. Construct Decon Area

Work to be Performed:
Construct decontamination area/pad for equipment and vehicles.

Crew and Equipment:
Fixed Price Contractor: 1 Group 6 Operator, 3 Group 1 Laborers, and 3 Group 2 Laborers
Equipment: 1 backhoe, 1 pickup truck

Output:
Assumed duration for this activity is 3 crew days.

	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
FPC S3 Laborer Group - 1 - 3 ea	72.00	HR	0029	25.20 1,814	0.00 0	0.00 0	0.00 0	25.20 1,814	25.20
FPC S3 Laborer Group - 2 - 3 ea	72.00	HR	0030	25.50 1,836	0.00 0	0.00 0	0.00 0	25.50 1,836	25.50
FPC S3 Group-6 Power Equipment Operator - 1 ea	24.00	HR	0039	29.10 698	0.00 0	0.00 0	0.00 0	29.10 698	29.10
FPC S3 Small Tools - 2 ea	48.00	HR	XMIXX020	0.00 0	1.40 67	0.00 0	0.00 0	1.40 67	1.40
FPC S3 TRK,HWY,4X4,F250,3/4T,8800 GVW 4X4 3/4 TON PICK-UP - 1 ea	24.00	HR	T50F0004	0.00 0	7.31 175	0.00 0	0.00 0	7.31 175	7.31
FPC S3 HYD EXCAV,TRK MTD,.5 CY BKT,6X4 HYDRO-SCOPIC - 1 ea	24.00	HR	H30BA001	0.00 0	34.44 827	0.00 0	0.00 0	34.44 827	34.44
M FPC S3 Construction Materials/Supplies Allowance	1.00	LS		0.00 0	0.00 0	2156.00 2,156	0.00 0	2156.00 2,156	2156.00
M FPC S3 Allowance for Tank Assume 1000 gal plastic tank for water collection	1.00	EA		0.00 0	0.00 0	1617.00 1,617	0.00 0	1617.00 1,617	1617.00
TOTAL Construct Decon Area	24.00	HR		4,349	1,069	3,773	0	9,191	382.96

SUB:01. Mobilization & Preparatory Work	QUANTY	UOM	CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:01.04. Setup/Construct Temp Facilities									
SUB:01.04.01. Establish Facilities									
SUB:01.04.01.02. Setup Trailers									
M FPC S3 Setup Field Office Trailer				1000.00	0.00	269.50	0.00	1269.50	
	1.00	EA		1,000	0	270	0	1,270	1269.50
M FPC S3 Setup Storage Trailer				1000.00	0.00	269.50	0.00	1269.50	
	1.00	EA		1,000	0	270	0	1,270	1269.50
M FPC S3 Setup Decon Trailer				1000.00	0.00	269.50	0.00	1269.50	
	1.00	EA		1,000	0	270	0	1,270	1269.50
TOTAL Setup Trailers				3,000	0	809	0	3,809	
TOTAL Establish Facilities				3,000	0	809	0	3,809	

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SUB:01. Mobilization & Preparatory Work	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB. Fixed Price Contractor							
SUB:01. Mobilization & Preparatory Work							
SUB:01.02. Mobilize Personnel & Equipment							
SUB:01.02.02. Mobilize Trailers							
FPC S3 Mobilize Field Office Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
FPC S3 Mobilize Storage Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
FPC S3 Mobilize Decon Trailer		0.00	250.00	0.00	0.00	250.00	
	1.00 EA	0	250	0	0	250	250.00
TOTAL Mobilize Trailers		0	750	0	0	750	
TOTAL Mobilize Personnel & Equipment		0	750	0	0	750	

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ANA:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA:02.08.03. Ground Water Analysis (YRS 2-5)							
Assumptions:							
1. Assume 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle (104 samples/yr)							
2. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr)							
- Total Samples = 118							
3. All on-site sample analysis performed by mobile lab							
4. 10% off-site verification analysis of reduced analyte list with CLP protocol (10% of 118 = 12)							
ANA Analyze LLW Sample - Off-site Lab		0.00	0.00	0.00	4210.00	4210.00	
	12.00 EA	0	0	0	50,520	50,520	4210.00
TOTAL Ground Water Analysis (YRS 2-5)	12.00 EA	0	0	0	50,520	50,520	4210.00
TOTAL Sampling Rad Contaminated Media		0	0	0	122,090	122,090	
TOTAL Monitoring, Sampling & Analysis		0	0	0	122,090	122,090	
TOTAL Off-Site Analytical Services		0	0	0	122,090	122,090	

ANA:02. Monitoring, Sampling & Analysis	QUANTY UOM CREW ID	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST

ANA. Off-Site Analytical Services
ANA:02. Monitoring, Sampling & Analysis
ANA:02.08. Sampling Rad Contaminated Media
ANA:02.08.02. Ground Water Analysis (YR 1)

Assumptions:

1. Assume shake-down period with following sampling of treatment system:
   - First 2 days: Sample every four hours of influent and effluent (24 samples)
   - Next 5 days: 1 sample per day of influent and effluent (10 samples)
   - Next 7 weeks: 1 sample per week of influent and effluent (14 samples)

2. 1 sample per filter change out (1 week) of the influent and effluent for the 5-yr lifecycle (104 samples/yr)

3. Assume sampling of 7 monitoring wells on a semiannual basis for the 5-year lifecycle (14 samples/yr)

   - Total samples = 166

4. All on-site sample analyses performed by mobile lab

5. 10% off-site verification analysis of reduced analyte list with CLP protocol. (10% of 166 = 17 ea)

ANA	Analyze LLW Sample - Off-site Lab	17.00 EA	0.00 0	0.00 0	0.00 0	4210.00 71,570	4210.00 71,570	4210.00
TOTAL	Ground Water Analysis (YR 1)	17.00 EA	0	0	0	71,570	71,570	4210.00

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUBTOTAL						5,146,630	
Material/Supply MPR						54,860	
TOTAL INCL INDIRECTS						5,201,480	
Subcontractor MPR						273,260	
SUBTOTAL						5,474,740	
Project Management/Construction Mgnt						802,900	
SUBTOTAL						6,277,640	
General & Admin/Common Support Pool						1,569,660	
SUBTOTAL						7,847,300	
Contingency						2,746,550	
TOTAL INCL OWNER COSTS						10,593,850	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:21.05 Disconnect Temporary Utilities		2,500	0	0	0	2,500	
SUB:21.06 Post-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Demobilization		3,950	1,110	0	10,000	15,060	
TOTAL Fixed Price Contractor		13,550	2,930	7,010	2,886,500	2,909,980	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis							
WHC:02.08 Sampling Rad Contaminated Media							
WHC:02.08.02 Ground Water Analysis-Yr 1	149.00 EA	0	0	0	60,270	60,270	404.49
WHC:02.08.03 Ground Water Analysis-Yr 2-5	106.00 EA	0	0	0	43,210	43,210	407.61
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	0	0	660	27.62
TOTAL Sampling Rad Contaminated Media		660	0	0	103,480	104,140	
TOTAL Monitoring, Sampling & Analysis		660	0	0	103,480	104,140	
WHC:13 Physical Treatment							
WHC:13.21 Reverse Osmosis							
WHC:13.21.06 Personnel Training		1,100	0	0	5,800	6,900	
WHC:13.21.08 Operation and Maint (Yrs 1-5)	1.00 YR	539,120	0	360,890	120,000	1,020,020	1020016.48
WHC:13.21.11 Prepare Annual Report (Yr 1)	2080.00 HR	90,150	0	0	0	90,150	43.34
WHC:13.21.12 Prepare Annual Report (Yrs 2-5)		60,070	0	0	0	60,070	
TOTAL Reverse Osmosis		690,450	0	360,890	125,800	1,177,140	
TOTAL Physical Treatment		690,450	0	360,890	125,800	1,177,140	
TOTAL Westinghouse Hanford Company		691,110	0	360,890	229,280	1,281,280	
TOTAL HANFORD: ER PROGRAM		704,660	2,930	367,900	3,237,870	4,313,350	
Overhead						552,900	
SUBTOTAL						4,866,250	
Profit						235,480	
SUBTOTAL						5,101,720	
Bond						27,390	
SUBTOTAL						5,129,110	
B&O Tax						17,510	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUB:03.05 Fencing		0	0	0	7,650	7,650	
SUB:03.06 Electrical Distribution		0	0	0	10,000	10,000	
TOTAL Site Work		0	0	0	69,830	69,830	
SUB:06 Groundwater Collection & Control							
SUB:06.01 Extraction & Injection Wells							
SUB:06.01.01 Well Drilling & Construction	12.00 EA	0	0	0	832,000	832,000	69333.33
SUB:06.01.04 Operations and Maintenance Yr 3		0	0	0	180,000	180,000	
SUB:06.01.9X Site Piping		0	0	0	341,270	341,270	
TOTAL Extraction & Injection Wells		0	0	0	1,353,270	1,353,270	
TOTAL Groundwater Collection & Control		0	0	0	1,353,270	1,353,270	
SUB:13 Physical Treatment							
SUB:13.21 Reverse Osmosis							
SUB:13.21.04 Construction of Permanent Plant	600.00 SF	0	0	0	1,432,400	1,432,400	2387.33
TOTAL Reverse Osmosis		0	0	0	1,432,400	1,432,400	
TOTAL Physical Treatment		0	0	0	1,432,400	1,432,400	
SUB:20 Site Restoration							
SUB:20.04 Revegetation and Planting Yr 5		0	0	0	10,000	10,000	
TOTAL Site Restoration		0	0	0	10,000	10,000	
SUB:21 Demobilization							
SUB:21.02 Demobilize Personnel & Equipment							
SUB:21.02.02 Demobilize Trailers-Yr 5		0	750	0	0	750	
TOTAL Demobilize Personnel & Equipment		0	750	0	0	750	
SUB:21.04 Demobilize Temp Facilities							
SUB:21.04.02 Remove Decon Area-Yr 5	8.00 HR	1,450	360	0	0	1,810	225.75
TOTAL Demobilize Temp Facilities		1,450	360	0	0	1,810	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis							
ANA:02.08 Sampling Rad Contaminated Media							
ANA:02.08.02 Ground Water Analysis (YR 1)	17.00 EA	0	0	0	71,570	71,570	4210.00
ANA:02.08.03 Ground Water Analysis (YRS 2-5)	12.00 EA	0	0	0	50,520	50,520	4210.00
TOTAL Sampling Rad Contaminated Media		0	0	0	122,090	122,090	
TOTAL Monitoring, Sampling & Analysis		0	0	0	122,090	122,090	
TOTAL Off-Site Analytical Services		0	0	0	122,090	122,090	
SUB Fixed Price Contractor							
SUB:01 Mobilization & Preparatory Work							
SUB:01.02 Mobilize Personnel & Equipment							
SUB:01.02.02 Mobilize Trailers		0	750	0	0	750	
TOTAL Mobilize Personnel & Equipment		0	750	0	0	750	
SUB:01.04 Setup/Construct Temp Facilities							
SUB:01.04.01 Establish Facilities							
SUB:01.04.01.02 Setup Trailers		3,000	0	810	0	3,810	
TOTAL Establish Facilities		3,000	0	810	0	3,810	
SUB:01.04.02 Construct Decon Area	24.00 HR	4,350	1,070	3,770	0	9,190	382.96
SUB:01.04.03 Site Survey		0	0	0	1,000	1,000	
TOTAL Setup/Construct Temp Facilities		7,350	1,070	4,580	1,000	14,000	
SUB:01.05 Construct Temporary Utilities		2,250	0	2,430	0	4,680	
SUB:01.06 Pre-Construction Submittals	4.00 EA	0	0	0	10,000	10,000	2500.00
TOTAL Mobilization & Preparatory Work		9,600	1,820	7,010	11,000	29,430	
SUB:03 Site Work							
SUB:03.03 Earthwork		0	0	0	5,000	5,000	
SUB:03.04 Roads/Parking/Curbs/Walks		0	0	0	47,180	47,180	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
SUBTOTAL						7,847,300	
Contingency						2,746,550	
TOTAL INCL OWNER COSTS						10,593,850	

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	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services							
ANA:02 Monitoring, Sampling & Analysis		0	0	0	122,090	122,090	
TOTAL Off-Site Analytical Services		0	0	0	122,090	122,090	
SUB Fixed Price Contractor							
SUB:01 Mobilization & Preparatory Work		9,600	1,820	7,010	11,000	29,430	
SUB:03 Site Work		0	0	0	69,830	69,830	
SUB:06 Groundwater Collection & Control		0	0	0	1,353,270	1,353,270	
SUB:13 Physical Treatment		0	0	0	1,432,400	1,432,400	
SUB:20 Site Restoration		0	0	0	10,000	10,000	
SUB:21 Demobilization		3,950	1,110	0	10,000	15,060	
TOTAL Fixed Price Contractor		13,550	2,930	7,010	2,886,500	2,909,980	
WHC Westinghouse Hanford Company							
WHC:02 Monitoring, Sampling & Analysis		660	0	0	103,480	104,140	
WHC:13 Physical Treatment		690,450	0	360,890	125,800	1,177,140	
TOTAL Westinghouse Hanford Company		691,110	0	360,890	229,280	1,281,280	
TOTAL HANFORD: ER PROGRAM		704,660	2,930	367,900	3,237,870	4,313,350	
Overhead						552,900	
SUBTOTAL						4,866,250	
Profit						235,480	
SUBTOTAL						5,101,720	
Bond						27,390	
SUBTOTAL						5,129,110	
B&O Tax						17,510	
SUBTOTAL						5,146,630	
Material/Supply MPR						54,860	
TOTAL INCL INDIRECTS						5,201,480	
Subcontractor MPR						273,260	
SUBTOTAL						5,474,740	
Project Management/Construction Mgnt						802,900	
SUBTOTAL						6,277,640	
General & Admin/Common Support Pool						1,569,660	

	QUANTITY UOM	LABOR	EQUIPMNT	MAT/SUPP	UNIT CST	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		0	0	0	122,090	122,090	
SUB Fixed Price Contractor		13,550	2,930	7,010	2,886,500	2,909,980	
WHC Westinghouse Hanford Company		691,110	0	360,890	229,280	1,281,280	
TOTAL HANFORD: ER PROGRAM		704,660	2,930	367,900	3,237,870	4,313,350	
Overhead						552,900	
SUBTOTAL						4,866,250	
Profit						235,480	
SUBTOTAL						5,101,720	
Bond						27,390	
SUBTOTAL						5,129,110	
B&O Tax						17,510	
SUBTOTAL						5,146,630	
Material/Supply MPR						54,860	
TOTAL INCL INDIRECTS						5,201,480	
Subcontractor MPR						273,260	
SUBTOTAL						5,474,740	
Project Management/Construction Mgnt						802,900	
SUBTOTAL						6,277,640	
General & Admin/Common Support Pool						1,569,660	
SUBTOTAL						7,847,300	
Contingency						2,746,550	
TOTAL INCL OWNER COSTS						10,593,850	

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	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
TOTAL INCL OWNER COSTS								10,593,850	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
SUB:21.05 Disconnect Temporary Utilities		2,500	480	200	20	20	0	3,220	
SUB:21.06 Post-Construction Submittals	4.00 EA	10,000	1,900	810	90	60	0	12,860	3215.88
TOTAL Demobilization		15,060	2,860	1,220	140	90	0	19,370	
TOTAL Fixed Price Contractor		2,909,980	552,900	235,480	27,390	17,510	0	3,743,260	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis									
WHC:02.08 Sampling Rad Contaminated Media									
WHC:02.08.02 Ground Water Analysis-Yr 1	149.00 EA	60,270	0	0	0	0	0	60,270	404.49
WHC:02.08.03 Ground Water Analysis-Yr 2-5	106.00 EA	43,210	0	0	0	0	0	43,210	407.61
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	0	0	0	0	660	27.62
TOTAL Sampling Rad Contaminated M		104,140	0	0	0	0	0	104,140	
TOTAL Monitoring, Sampling & Anal		104,140	0	0	0	0	0	104,140	
WHC:13 Physical Treatment									
WHC:13.21 Reverse Osmosis									
WHC:13.21.06 Personnel Training		6,900	0	0	0	0	0	6,900	
WHC:13.21.08 Operation and Maint (Yrs 1-5)	1.00 YR	1,020,020	0	0	0	0	54,860	1,074,870	1074871.54
WHC:13.21.11 Prepare Annual Report (Yr 1)	2080.00 HR	90,150	0	0	0	0	0	90,150	43.34
WHC:13.21.12 Prepare Annual Report (Yrs 2-5		60,070	0	0	0	0	0	60,070	
TOTAL Reverse Osmosis		1,177,140	0	0	0	0	54,860	1,231,990	
TOTAL Physical Treatment		1,177,140	0	0	0	0	54,860	1,231,990	
TOTAL Westinghouse Hanford Compan		1,281,280	0	0	0	0	54,860	1,336,130	
TOTAL HANFORD: ER PROGRAM		4,313,350	552,900	235,480	27,390	17,510	54,860	5,201,480	
Subcontractor MPR								273,260	
SUBTOTAL								5,474,740	
Project Management/Construction Mgnt								802,900	
SUBTOTAL								6,277,640	
General & Admin/Common Support Pool								1,569,660	
SUBTOTAL								7,847,300	
Contingency								2,746,550	

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	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
SUB:03.05 Fencing		7,650	1,450	620	70	50	0	9,840	
SUB:03.06 Electrical Distribution		10,000	1,900	810	90	60	0	12,860	
TOTAL Site Work		69,830	13,270	5,650	660	420	0	89,830	
SUB:06 Groundwater Collection & Control									
SUB:06.01 Extraction & Injection Wells									
SUB:06.01.01 Well Drilling & Construction	12.00 EA	832,000	158,080	67,330	7,830	5,010	0	1,070,240	89186.95
SUB:06.01.04 Operations and Maintenance Yr		180,000	34,200	14,570	1,690	1,080	0	231,540	
SUB:06.01.9X Site Piping		341,270	64,840	27,620	3,210	2,050	0	438,990	
TOTAL Extraction & Injection Well		1,353,270	257,120	109,510	12,740	8,140	0	1,740,780	
TOTAL Groundwater Collection & Co		1,353,270	257,120	109,510	12,740	8,140	0	1,740,780	
SUB:13 Physical Treatment									
SUB:13.21 Reverse Osmosis									
SUB:13.21.04 Construction of Permanent Plan	600.00 SF	1,432,400	272,160	115,910	13,480	8,620	0	1,842,570	3070.95
TOTAL Reverse Osmosis		1,432,400	272,160	115,910	13,480	8,620	0	1,842,570	
TOTAL Physical Treatment		1,432,400	272,160	115,910	13,480	8,620	0	1,842,570	
SUB:20 Site Restoration									
SUB:20.04 Revegetation and Planting Yr 5		10,000	1,900	810	90	60	0	12,860	
TOTAL Site Restoration		10,000	1,900	810	90	60	0	12,860	
SUB:21 Demobilization									
SUB:21.02 Demobilize Personnel & Equipment									
SUB:21.02.02 Demobilize Trailers-Yr 5		750	140	60	10	0	0	960	
TOTAL Demobilize Personnel & Equi		750	140	60	10	0	0	960	
SUB:21.04 Demobilize Temp Facilities									
SUB:21.04.02 Remove Decon Area-Yr 5	8.00 HR	1,810	340	150	20	10	0	2,320	290.39
TOTAL Demobilize Temp Facilities		1,810	340	150	20	10	0	2,320	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis									
ANA:02.08 Sampling Rad Contaminated Media									
ANA:02.08.02 Ground Water Analysis (YR 1)	17.00 EA	71,570	0	0	0	0	0	71,570	4210.00
ANA:02.08.03 Ground Water Analysis (YRS 2-5	12.00 EA	50,520	0	0	0	0	0	50,520	4210.00
TOTAL Sampling Rad Contaminated M		122,090	0	0	0	0	0	122,090	
TOTAL Monitoring, Sampling & Anal		122,090	0	0	0	0	0	122,090	
TOTAL Off-Site Analytical Service		122,090	0	0	0	0	0	122,090	
SUB Fixed Price Contractor									
SUB:01 Mobilization & Preparatory Work									
SUB:01.02 Mobilize Personnel & Equipment									
SUB:01.02.02 Mobilize Trailers		750	140	60	10	0	0	960	
TOTAL Mobilize Personnel & Equipm		750	140	60	10	0	0	960	
SUB:01.04 Setup/Construct Temp Facilities									
SUB:01.04.01 Establish Facilities									
SUB:01.04.01.02 Setup Trailers		3,810	720	310	40	20	0	4,900	
TOTAL Establish Facilities		3,810	720	310	40	20	0	4,900	
SUB:01.04.02 Construct Decon Area	24.00 HR	9,190	1,750	740	90	60	0	11,820	492.62
SUB:01.04.03 Site Survey		1,000	190	80	10	10	0	1,290	
TOTAL Setup/Construct Temp Facili		14,000	2,660	1,130	130	80	0	18,010	
SUB:01.05 Construct Temporary Utilities		4,680	890	380	40	30	0	6,010	
SUB:01.06 Pre-Construction Submittals	4.00 EA	10,000	1,900	810	90	60	0	12,860	3215.88
TOTAL Mobilization & Preparatory		29,430	5,590	2,380	280	180	0	37,850	
SUB:03 Site Work									
SUB:03.03 Earthwork		5,000	950	400	50	30	0	6,430	
SUB:03.04 Roads/Parking/Curbs/Walks		47,180	8,970	3,820	440	280	0	60,700	

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	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services									
ANA:02 Monitoring, Sampling & Analysis		122,090	0	0	0	0	0	122,090	
TOTAL Off-Site Analytical Services		122,090	0	0	0	0	0	122,090	
SUB Fixed Price Contractor									
SUB:01 Mobilization & Preparatory Work		29,430	5,590	2,380	280	180	0	37,850	
SUB:03 Site Work		69,830	13,270	5,650	660	420	0	89,830	
SUB:06 Groundwater Collection & Control		1,353,270	257,120	109,510	12,740	8,140	0	1,740,780	
SUB:13 Physical Treatment		1,432,400	272,160	115,910	13,480	8,620	0	1,842,570	
SUB:20 Site Restoration		10,000	1,900	810	90	60	0	12,860	
SUB:21 Demobilization		15,060	2,860	1,220	140	90	0	19,370	
TOTAL Fixed Price Contractor		2,909,980	552,900	235,480	27,390	17,510	0	3,743,260	
WHC Westinghouse Hanford Company									
WHC:02 Monitoring, Sampling & Analysis		104,140	0	0	0	0	0	104,140	
WHC:13 Physical Treatment		1,177,140	0	0	0	0	54,860	1,231,990	
TOTAL Westinghouse Hanford Company		1,281,280	0	0	0	0	54,860	1,336,130	
TOTAL HANFORD: ER PROGRAM		4,313,350	552,900	235,480	27,390	17,510	54,860	5,201,480	
Subcontractor MPR								273,260	
SUBTOTAL								5,474,740	
Project Management/Construction Mgnt								802,900	
SUBTOTAL								6,277,640	
General & Admin/Common Support Pool								1,569,660	
SUBTOTAL								7,847,300	
Contingency								2,746,550	
TOTAL INCL OWNER COSTS								10,593,850	

	QUANTITY UOM	TOTAL DIRECT	OVERHEAD	PROFIT	BOND	B&O TAX	MAT MPR	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		122,090	0	0	0	0	0	122,090	
SUB Fixed Price Contractor		2,909,980	552,900	235,480	27,390	17,510	0	3,743,260	
WHC Westinghouse Hanford Company		1,281,280	0	0	0	0	54,860	1,336,130	
HANFORD: ER PROGRAM		4,313,350	552,900	235,480	27,390	17,510	54,860	5,201,480	
Subcontractor MPR								273,260	
SUBTOTAL								5,474,740	
Project Management/Construction Mgnt								802,900	
SUBTOTAL								6,277,640	
General & Admin/Common Support Pool								1,569,660	
SUBTOTAL								7,847,300	
Contingency								2,746,550	
TOTAL INCL OWNER COSTS								10,593,850	

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	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
SUB:21.05 Disconnect Temporary Utilities		3,220	230	520	1,010	1,740	6,720	
SUB:21.06 Post-Construction Submittals	4.00 EA	12,860	940	2,070	4,050	6,970	26,890	6723.17
TOTAL Demobilization		19,370	1,410	3,120	6,090	10,500	40,490	
TOTAL Fixed Price Contractor		3,743,260	273,260	602,480	1,177,840	2,028,890	7,825,730	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis								
WHC:02.08 Sampling Rad Contaminated Media								
WHC:02.08.02 Ground Water Analysis-Yr 1	149.00 EA	60,270	0	9,040	17,670	30,440	117,430	788.11
WHC:02.08.03 Ground Water Analysis-Yr 2-5	106.00 EA	43,210	0	6,480	12,670	21,830	84,180	794.18
WHC:02.08.04 Ground Water Monitor Samples	24.00 HR	660	0	100	190	330	1,290	53.82
TOTAL Sampling Rad Contaminated Media		104,140	0	15,620	30,540	52,600	202,900	
TOTAL Monitoring, Sampling & Analysis		104,140	0	15,620	30,540	52,600	202,900	
WHC:13 Physical Treatment								
WHC:13.21 Reverse Osmosis								
WHC:13.21.06 Personnel Training		6,900	0	1,040	2,020	3,490	13,450	
WHC:13.21.08 Operation and Maint (Yrs 1-5)	1.00 YR	1,074,870	0	161,230	315,210	542,960	2,094,270	2094266.27
WHC:13.21.11 Prepare Annual Report (Yr 1)	2080.00 HR	90,150	0	13,520	26,440	45,540	175,640	84.44
WHC:13.21.12 Prepare Annual Report (Yrs 2-5)		60,070	0	9,010	17,620	30,340	117,040	
TOTAL Reverse Osmosis		1,231,990	0	184,800	361,280	622,330	2,400,400	
TOTAL Physical Treatment		1,231,990	0	184,800	361,280	622,330	2,400,400	
TOTAL Westinghouse Hanford Company		1,336,130	0	200,420	391,820	674,930	2,603,310	
TOTAL HANFORD: ER PROGRAM		5,201,480	273,260	802,900	1,569,660	2,746,550	10,593,850	

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
SUB:03.05 Fencing		9,840	720	1,580	3,100	5,330	20,570	
SUB:03.06 Electrical Distribution		12,860	940	2,070	4,050	6,970	26,890	
TOTAL Site Work		89,830	6,560	14,460	28,270	48,690	187,800	
SUB:06 Groundwater Collection & Control								
SUB:06.01 Extraction & Injection Wells								
SUB:06.01.01 Well Drilling & Construction	12.00 EA	1,070,240	78,130	172,260	336,760	580,090	2,237,470	186455.99
SUB:06.01.04 Operations and Maintenance Yr 3		231,540	16,900	37,270	72,860	125,500	484,070	
SUB:06.01.9X Site Piping		438,990	32,050	70,660	138,130	237,940	917,760	
TOTAL Extraction & Injection Wells		1,740,780	127,080	280,180	547,750	943,520	3,639,300	
TOTAL Groundwater Collection & Control		1,740,780	127,080	280,180	547,750	943,520	3,639,300	
SUB:13 Physical Treatment								
SUB:13.21 Reverse Osmosis								
SUB:13.21.04 Construction of Permanent Plant	600.00 SF	1,842,570	134,510	296,560	579,780	998,690	3,852,110	6420.18
TOTAL Reverse Osmosis		1,842,570	134,510	296,560	579,780	998,690	3,852,110	
TOTAL Physical Treatment		1,842,570	134,510	296,560	579,780	998,690	3,852,110	
SUB:20 Site Restoration								
SUB:20.04 Revegetation and Planting Yr 5		12,860	940	2,070	4,050	6,970	26,890	
TOTAL Site Restoration		12,860	940	2,070	4,050	6,970	26,890	
SUB:21 Demobilization								
SUB:21.02 Demobilize Personnel & Equipment								
SUB:21.02.02 Demobilize Trailers-Yr 5		960	70	160	300	520	2,020	
TOTAL Demobilize Personnel & Equipment		960	70	160	300	520	2,020	
SUB:21.04 Demobilize Temp Facilities								
SUB:21.04.02 Remove Decon Area-Yr 5	8.00 HR	2,320	170	370	730	1,260	4,860	607.10
TOTAL Demobilize Temp Facilities		2,320	170	370	730	1,260	4,860	

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	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis								
ANA:02.08 Sampling Rad Contaminated Media								
ANA:02.08.02 Ground Water Analysis (YR 1)	17.00 EA	71,570	0	0	0	25,050	96,620	5683.50
ANA:02.08.03 Ground Water Analysis (YRS 2-5)	12.00 EA	50,520	0	0	0	17,680	68,200	5683.50
TOTAL Sampling Rad Contaminated Media		122,090	0	0	0	42,730	164,820	
TOTAL Monitoring, Sampling & Analysis		122,090	0	0	0	42,730	164,820	
TOTAL Off-Site Analytical Services		122,090	0	0	0	42,730	164,820	
SUB Fixed Price Contractor								
SUB:01 Mobilization & Preparatory Work								
SUB:01.02 Mobilize Personnel & Equipment								
SUB:01.02.02 Mobilize Trailers		960	70	160	300	520	2,020	
TOTAL Mobilize Personnel & Equipment		960	70	160	300	520	2,020	
SUB:01.04 Setup/Construct Temp Facilities								
SUB:01.04.01 Establish Facilities								
SUB:01.04.01.02 Setup Trailers		4,900	360	790	1,540	2,660	10,240	
TOTAL Establish Facilities		4,900	360	790	1,540	2,660	10,240	
SUB:01.04.02 Construct Decon Area	24.00 HR	11,820	860	1,900	3,720	6,410	24,720	1029.88
SUB:01.04.03 Site Survey		1,290	90	210	400	700	2,690	
TOTAL Setup/Construct Temp Facilities		18,010	1,310	2,900	5,670	9,760	37,650	
SUB:01.05 Construct Temporary Utilities		6,010	440	970	1,890	3,260	12,570	
SUB:01.06 Pre-Construction Submittals	4.00 EA	12,860	940	2,070	4,050	6,970	26,890	6723.17
TOTAL Mobilization & Preparatory Work		37,850	2,760	6,090	11,910	20,520	79,130	
SUB:03 Site Work								
SUB:03.03 Earthwork		6,430	470	1,040	2,020	3,490	13,450	
SUB:03.04 Roads/Parking/Curbs/Walks		60,700	4,430	9,770	19,100	32,900	126,890	

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services								
ANA:02 Monitoring, Sampling & Analysis		122,090	0	0	0	42,730	164,820	
TOTAL Off-Site Analytical Services		122,090	0	0	0	42,730	164,820	
SUB Fixed Price Contractor								
SUB:01 Mobilization & Preparatory Work		37,850	2,760	6,090	11,910	20,520	79,130	
SUB:03 Site Work		89,830	6,560	14,460	28,270	48,690	187,800	
SUB:06 Groundwater Collection & Control		1,740,780	127,080	280,180	547,750	943,520	3,639,300	
SUB:13 Physical Treatment		1,842,570	134,510	296,560	579,780	998,690	3,852,110	
SUB:20 Site Restoration		12,860	940	2,070	4,050	6,970	26,890	
SUB:21 Demobilization		19,370	1,410	3,120	6,090	10,500	40,490	
TOTAL Fixed Price Contractor		3,743,260	273,260	602,480	1,177,840	2,028,890	7,825,730	
WHC Westinghouse Hanford Company								
WHC:02 Monitoring, Sampling & Analysis		104,140	0	15,620	30,540	52,600	202,900	
WHC:13 Physical Treatment		1,231,990	0	184,800	361,280	622,330	2,400,400	
TOTAL Westinghouse Hanford Company		1,336,130	0	200,420	391,820	674,930	2,603,310	
TOTAL HANFORD: ER PROGRAM		5,201,480	273,260	802,900	1,569,660	2,746,550	10,593,850	

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PROJECT DARERO: HANFORD: ER PROGRAM - D AREA REVERSE OSMOSIS
REVERSE OSMOSIS 100-HR-3 / 100 D AREA
** PROJECT OWNER SUMMARY - CNTRCTOR (Rounded to 10's) **

	QUANTITY UOM	CONTRACT COST	SUB MPR	PM/CM	G&A/CSP	CONTINGN	TOTAL COST	UNIT COST
ANA Off-Site Analytical Services		122,090	0	0	0	42,730	164,820	
SUB Fixed Price Contractor		3,743,260	273,260	602,480	1,177,840	2,028,890	7,825,730	
WHC Westinghouse Hanford Company		1,336,130	0	200,420	391,820	674,930	2,603,310	
TOTAL HANFORD: ER PROGRAM		5,201,480	273,260	802,900	1,569,660	2,746,550	10,593,850	

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HANFORD: ER PROGRAM
D AREA REVERSE OSMOSIS
1.4.10.1.1.10.5.2.4
REVERSE OSMOSIS REMEDIATION
FOCUSED FEASIBILITY STUDY

Designed By:
Estimated By: CH2M HILL HANFORD, INC.

Prepared By: ERC CONTRACT - RICHLAND, WASH

Preparation Date: 07/26/95
Effective Date of Pricing: 09/14/94

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SRC	EQUIP ID	DESCRIPTION	DEPR	CAPT	FUEL	FOG	EQ REP	TR WR	TR REP	TOTAL UOM	** TOTAL ** HOURS
USR	H30BA001	HYD EXCAV,TRK MTD,.5 CY BKT,6X4			12.07	1.4	19.78	0.98	0.15	34.44 HR	32
USR	T50FO004	TRK,HWY,4X4,F250,3/4T,8800 GVW			2.67	0.7	3.58	0.27	0.04	7.31 HR	32
MIL	XMIXX020	Small Tools	0.47	0.17	0.13	0.0	0.57			1.40 HR	64

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