Remedy Decision #3 (RD #3) for the Former BP Casper Refinery Soda Lake Area

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A REMEDY DECISION FOR THE FORMER BP CASPER REFINERY

SODA LAKE AREA

Wyoming Department of Environmental Quality

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1 ACRONYMS AND GLOSSARY

1.1 Acronyms

amsl - above mean sea level
ARAR- Applicable or Relevant and Appropriate Requirement
bgs - below ground surface
BTEX - benzene, toluene, ethylbenzene, and xylene
CAMU- corrective action management unit
CDA - Caustic Disposal Area
CLI - cleanup level index
COC - constituent of concern
COI - constituent of interest
CMS - corrective measures study
CSM - conceptual site model
CWA - Clean Water Act
DQO - data quality objective
DRO - diesel-range organics
DWEL - drinking water equivalent level
gpd - gallons per day
HI - hazard index
HQ - hazard quotient
H_2O - water
H_2S - hydrogen sulfide
IC - institutional controls
JPB - Amoco Reuse Agreement Joint Powers Board
LOAEC - lowest observable adverse effect concentration
log K_{ow} - water/octanol partition coefficient
LTU - land treatment unit
MCL - maximum contaminant level
MNA - monitored natural attenuation
mph - miles per hour
MTBE - methyl-tertiary butyl-ether
MWS - master work plan and schedule
NAPL - nonaqueous-phase liquid
NOAA - National Oceanic and Atmospheric Administration
NOAEC - no observable adverse effect concentration
OM&M - operation, maintenance, and monitoring
PAH - polycyclic aromatic hydrocarbon
PPBV - parts per billion by volume
PPE - personal protective equipment
ppm - parts per million
POC - point of compliance
POTW - publically-owned treatment works
PQL - practical quantitation limit
RA - remedial alternative
RBC - risk-based concentration
RBRG - risk-based remediation goal
RD - remedy decision
RCRA - Resource Conservation and Recovery Act, 42 U.S.C. §6901 *et seq.*
RFA - RCRA facility assessment

RFI - RCRA facility investigation
RM - remedy mechanism
ROEMS - Remedial Option Evaluation and Management Scheme
SQL - sample quantitation limit
SSL - soil screening level
SVOC - semivolatile organic compound
SWMU - solid waste management unit
TDS - total dissolved solids
TOC - total organic carbon
tPAH - total PAH
TPH - total petroleum hydrocarbons
TSD - Technical Support Document
UCA - Use Control Area as defined at Article 16 of the WEQA
UCL - upper confidence limit
UTL - upper threshold limit
µg/L - micrograms per liter (parts per billion)
U.S. EPA - United States Environmental Protection Agency
VOC - volatile organic compound
WEQA - Wyoming Environmental Quality Act; W.S. Title 35, Chapter 11
WVRP - Wyoming Voluntary Remediation Program (or "Voluntary Remediation of Contaminated Sites," Article 16 of the WEQA)
WDEQ - Wyoming Department of Environmental Quality
W.S. - Wyoming Statutes

1.2 Glossary of Environmental and Relevant Terms

Amoco Reuse Agreement Joint Powers Board (JPB) - a statutory joint powers board formed by the City of Casper and Natrona County, Wyoming.

Appendix IX - the list of hazardous waste constituents found in Appendix IX, Chapter 40, Part 264 of the Code of Federal Regulations, equivalent to Appendix H, Chapter 2, of the Wyoming Hazardous Waste Rules and Regulations.

Caustic Disposal Area (CDA) - the Caustic Disposal Area is part of the Soda Lake Area and is a bermed, earthen impoundment of approximately 1,000 square feet located northeast of the Main Lake. The CDA was originally a source of soil for construction of the dike that separates the Main Lake from the Inlet Basin. From 1960 to 1970, the CDA received spent caustic soda from the former refinery caustic sweetening process unit and alkylation unit.

Collaborative Process - the process under the Consent Decree "whereby [BP], WDEQ, and the City/County shall use best efforts to jointly develop technical approaches for the Work to be performed...through discussion, meetings, and technical workshops."

Consent Decree - the Consent Decree between WDEQ and BP and formally entered on September 29, 1998, by the United States District Court for the District of Wyoming in Wilson, *et al.* v. Amoco Corp., *et al.*, Case No. 96-CV-0124B.

Corrective Action Management Unit (CAMU) - means an area within a facility that is designated

by the Director under Chapter 10, Section 18 of the WDEQ Hazardous Waste Rules and Regulations, for the purpose of implementing corrective action requirements under Chapter 10, Section 6(l) and Chapter 11, Section 8(f) of the WDEQ Hazardous Waste Rules and Regulations, W.S. 35-11-503(d), and RCRA Section 3008(h). A CAMU shall only be used for the management of remediation wastes pursuant to implementing such corrective action requirements at the facility.

East Pond - the East Pond is part of the Inlet Basin and is a small (approximately 1.5 acre) pond located on the east side of the Inlet Basin. The East Pond is hydraulically connected to the Inlet Basin. The East Pond is shown on Figure 1-1.

Exposure Area(s) - areas for risk evaluation of human and ecological receptors, considering site Reuse areas (Figure 4-8) and the home range of ecological receptors.

Imminent and Substantial Endangerment - See Chapter 1, Section 1(k) of the Wyoming Hazardous Waste Rules and Regulations.

Inlet Basin - the Inlet Basin is part of the Soda Lake Area and is an approximately 45-acre retention pond that received process water from the former refinery between 1957 and 1990. The Inlet Basin served as a settling pond before clarified water entered the Main Lake through an underflow weir system in a dike separating the Inlet Basin from the Main Lake. The Inlet Basin includes the East Pond and the West Pond, and is shown on Figure 1-1.

Institutional Controls - restrictions on the use of a site, including deed notices, voluntary deed restrictions or other conditions, covenants or restrictions imposed by the property owner and filed with the county clerk, use control areas, and zoning regulations or restrictions.

Main Lake - the Main Lake is part of the Soda Lake Area and is an isolated, intrastate water body of approximately 667 acres into which clarified water from the Inlet Basin is discharged through an underflow weir system in a dike separating the Inlet Basin from the Main Lake. The Main Lake is shown on Figure 1-1.

Media - media for the RD#3 area includes surface water, ground water, porewater, soils, sediment and air.

North Platte River - the North Platte River forms the main tributary for surface water collection in the southern half of Natrona County, and has a Class 2 state use designation. A reach of the North Platte River bounds the South Properties Area (RD#1) on its west and north side and is included in the North Properties Area (RD#2) (Figure 1-2).

North Properties Area - the North Properties Area is generally comprised of the property investigated by BP north of the North Platte River and is bounded on the south and southeast by the North Platte River, on the north, by Revenue Boulevard and generally lying east of Salt Creek Highway and west of two industrial parks - the Interstate Industrial Park and the Wyoming Industrial Park (Figure 1-2).

Northwest Drainage Area - The northernmost inlet stream drainage located on the northwest side of the Main Lake. The drainage feeds into the Main Lake from a small playa located off-site to

the northwest (Figure 1-1).

Refinery Property - the Refinery Property is bounded on the north and west by the North Platte River, on the south by 13th Street and by the north property line of business and industrial properties lying north of Collins Drive, and on the east by Poplar Street. The Refinery Property (former refinery property, Figure 1-2) is comprised of approximately 309 acres, is owned by BP, and is also known as the Platte River Commons (Planned Unit Development). The Refinery Property includes the parcel formerly known as the South Tank Farm and a railroad right of way that separated the former South Tank Farm from the refinery process area. BP constructed a barrier wall on the Refinery Property south and east of the North Platte River, and west of Poplar Street. The portion of the Refinery Property lying south of the barrier wall is referred to as RD#1-Refinery Property.

Reuse - property use plans developed by BP and the JPB for use of the South Properties, North Properties, North Platte River, and Soda Lake Area (excluding the Soda Lake Pipeline) consisting of recreational, commercial, and industrial uses and specifically excluding residential use.

Soda Lake Area - the Soda Lake Area is located 2 to 3 miles northeast of the Refinery Property and is comprised of parcels referred to as the Main Lake, Inlet Basin, East Pond, West Pond, Caustic Disposal Area, and the Soda Lake Pipeline and the contiguous area around Soda Lake that is owned by BP (Figure 1-1). The CAMU is located within the Soda Lake Area and requirements for that facility are addressed under the *Corrective Action Management Unit (CAMU) Application* dated October 16, 2000, and amended December 15, 2000, and approved by WDEQ on February 15, 2001.

Soda Lake Pipeline - the Soda Lake Pipeline is part of the Soda Lake Area and is a 12-inch-diameter steel pipe that runs for 4.7 miles between the Refinery Property and the Inlet Basin, generally buried about 4 feet below ground surface. From 1957 to 1990, the pipeline carried separator effluent, sanitary sewage, and softener sludge to the Inlet Basin. The Soda Lake Pipeline is shown on Figure 1-2. Since 1991, the pipeline has carried North Platte River water to the Inlet Basin to maintain the Main Lake and Inlet Basin as a wildlife habitat.

Solid Waste Management Unit (SWMU) - Any discernable unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which solid wastes have been routinely and systematically released (55 FR 30798, July 27, 1990, EPA's proposed Subpart S rule).

South Properties Area - the South Properties Area is comprised of parcels referred to as the Refinery Property, Off-Site Area A, Off-Site Area B, Off-Site Area H, and the Off-Site South Boundary Area (see Figure 1-1 in RD#1).

Technical Support Document 3 (TSD#3, 2001b) - the comprehensive presentation and technical discussion of the RCRA Facilities Investigation, Risk Assessment, and Corrective Measures Study for the Soda Lake Area.

West Pond - the West Pond is part of the Inlet Basin and is a small pond (approximately 1.8 acres) located on the west side of the Inlet Basin. The West Pond was an arm of the Inlet Basin,

until approximately the early 1990s when it was separated by the construction of a road. The West Pond is shown on Figure 1-1.

2 INTRODUCTION

2.1 Parties

The parties subject to this Remedy Decision #3 (RD#3) are BP Corporation North America, Inc., an Indiana Corporation; BP Products North America Inc., formerly known as, Amoco Oil Company, a Maryland Corporation; and the Wyoming Department of Environmental Quality (WDEQ). Standard Oil Company of Indiana was formed in 1889 and became Amoco Corporation in 1985. As a result of a series of corporate transactions and name changes relating to the 1998 merger of BP Products North America Inc., formerly known as, Amoco Corporation and British Petroleum, Amoco Corporation is now called BP Corporation North America, Inc. In this RD#3, BP Corporation North America, Inc. and its corporate predecessors, Amoco Corporation and Standard Oil Company, and its wholly owned subsidiary, BP North America Inc., formerly Amoco Oil Company, a Maryland Corporation (the record owner of the properties owned by BP in Natrona County, Wyoming) will be referred to as BP. BP is responsible for corrective action activities on the Soda Lake Area due to releases of hazardous constituents at or from the Soda Lake Area. In October 1995, U.S. EPA authorized the State hazardous waste program to serve in lieu of the federal hazardous waste program in Wyoming under Resource Conservation and Recovery Act (RCRA) Subtitle C. Therefore, WDEQ is responsible for overseeing the implementation of corrective action activities outlined in this RD#3.

2.2 Property Description

The property that is subject to the RD#3 is the Soda Lake Area. A number of individually defined parcels make up the Soda Lake Area. (Please refer to these specific definitions in the Glossary of Environmental and Relevant Terms.) These additional location definitions describe specific areas subject to specific corrective actions and Institutional Controls.

The Soda Lake Area is located approximately two to three miles northeast of BP's former refinery in Casper, Wyoming. The Inlet Basin received process water from the former refinery from 1957 through September 1990 as an industrial wastewater treatment system. The Soda Lake Area includes two primary bodies of water, the Inlet Basin (45 acres) and the Main Lake (667 acres) (Figure 1-1), connected by an underflow weir. Two secondary ponds, the East Pond (approximately 1.5 acre in size) and West Pond (1.8 acre), are also a part of the Soda Lake Area and are positioned to the east and west of the Inlet Basin, respectively.

The elevation of the Main Lake water surface averages approximately 5,175 feet above mean sea level (amsl), with an annual flux of ± 0.5 feet. The Inlet Basin water surface elevation is relatively constant at 5,178 feet amsl.

The Soda Lake Area is primarily used as a wildlife habitat and is zoned agricultural (A). BP discontinued discharge of process water to the Inlet Basin in September 1990. BP started pumping water directly from the North Platte River to the Inlet Basin via the Soda Lake Pipeline, which had been in place for more than 30 years.

2.3 Corrective Action Background

The Soda Lake Area is subject to corrective action under the State of Wyoming's hazardous waste program. Currently, the corrective action activities, including the Collaborative Process, are governed by the Consent Decree. In the Collaborative Process the parties, as well as the JPB, use best efforts to jointly develop technical approaches for, and consensus on, the work to be performed under the Consent Decree through discussion, meetings, and technical workshops. The parties have strived throughout the Collaborative Process to ensure full and meaningful public involvement. In addition to corrective action under the Consent Decree, WDEQ determined BP is eligible for participation in the Wyoming Voluntary Remediation Program (WVRP).

2.4 Scope and Objectives of Remedy Decision #3

This RD#3 for the Soda Lake Area has been developed to meet the requirements under W.S. §35-11-1607(b)(i) of the Wyoming Environmental Quality Act (WEQA). The RD#3 identifies the selected remedy and establishes the approaches for implementation, operation, performance, and monitoring of the selected remedy. Specifically, the RD#3: 1) describes past operational activities; 2) provides background on past and current regulatory activities; 3) summarizes current site conditions and risks; 4) describes the proposed remedial alternatives and identifies the selected remedy (including engineering and Institutional Controls); 5) identifies cleanup standards for contaminated media and the performance criteria for the selected remedy; 6) describes the approaches for operating, monitoring, and maintaining the effectiveness of the selected remedy; and 7) contains a schedule for the development and submittal of any documents necessary for implementation of the selected remedy.

In addition, the RD#3 provides references to where more detailed information on the Soda Lake Area and the corrective action activities can be found.

2.5 Document Organization

The RD#3 first provides relevant, summary background information on the Soda Lake Area and on corrective action activities, including investigation, risk assessment, and remedial measures evaluation. The RD#3 then describes the selected remedy for the Inlet Basin, Main Lake, the Soda Lake Pipe Line and Caustic Disposal Area (CDA), and the provisions to ensure the effective implementation of the selected remedy.

2.6 Remedy Decision #3 Process

This RD#3 is the third of three remedy decisions, with the other two being the Remedy Decision for the South Properties Area (RD#1) and the Remedy Decision for the North Properties Area/North Platte River (RD#2). Each RD will be separately submitted for public comment. After the public comment period on each RD has closed, WDEQ and BP will work together and cooperatively to complete each RD. These three completed RDs will comprise one "WDEQ Decision Document" when all three RDs are signed by WDEQ.

After final approval of the WDEQ Decision Document, BP shall have the right to appeal any or all of its terms, including the selected remedies in RD#1, RD#2 and RD#3, pursuant to the

dispute resolution provisions of the Consent Decree.

Following expiration of BP's right to appeal, or resolution of an appeal of, the WDEQ Decision Document, BP shall be required to implement the requirements of the WDEQ Decision Document only after WDEQ has issued an RM, which may be a post-closure permit or another comparable mechanism, including an administrative order on consent or unilateral order, which requires BP to implement the WDEQ Decision Document. BP's right to appeal the corrective action requirements of the RM, the post-closure permit or unilateral order is waived if such requirements are identical to those contained in the WDEQ Decision Document. BP retains the right to appeal the terms of the RM, post-closure permit, or unilateral order, other than the corrective action requirements.

Once the RM has been executed by the parties or otherwise becomes final through the dispute resolution provisions of the Consent Decree, the parties will petition the U.S. District Court to terminate the Consent Decree.

2.7 Reopener and Termination

Reopener and termination clauses consistent with W.S. §35-11-1610 will be addressed in the RM.

3 WYOMING VOLUNTARY REMEDIATION PROGRAM (WVRP)

3.1 Eligibility and Public Participation

In accordance with W.S. §35-11-1603 of the WEQA, BP submitted an application, dated April 28, 2000, to WDEQ for participation in the WVRP. In correspondence dated June 8, 2000, WDEQ determined that the BP Casper former refinery was eligible for participation in the WVRP.

WDEQ's June 8, 2000, eligibility determination for WVRP participation required BP to begin the public notice process as provided under W.S. §35-11-1604 of the WEQA. Correspondence, dated October 19, 2000, from Williams, Porter, Day and Neville (representing BP) documented BP's activities to comply with W.S. §35-11-1604 of the WEQA. WDEQ determined that BP's notice activities satisfied the requirements of the WVRP.

As a result of the public notice, WDEQ received requests from interested stakeholders for preparation and implementation of a public participation plan. It was anticipated that this public participation plan should enhance the existing public participation plan required as part of the Collaborative Process under the terms of the Consent Decree. Based on the WVRP stakeholder requests, WDEQ asked in a September 7, 2000, letter that BP schedule a public session to review the effectiveness of the Collaborative Process in involving the public, and make recommendations for improvements as needed or desirable. A public meeting was held on November 28, 2000, to seek input on how the public participation process could be improved. That meeting resulted in a number of suggested changes to improve public participation that were incorporated into the Collaborative Process. In January 29, 2001, correspondence, WDEQ agreed that the modifications to the Collaborative Process would satisfy the public involvement provisions of W.S. §35-11-1604(b) of the WEQA.

3.2 Preliminary Remediation Agreement

A preliminary remediation agreement was developed to address the requirements of W.S. §35-11-1606 of the WEQA. The preliminary remediation agreement states that the requirements of W.S. §35-11-1606 are satisfied by the Consent Decree, and that compliance with the Consent Decree constitutes compliance with the preliminary remediation agreement. On February 21, 2001, WDEQ gave final approval to the preliminary remediation agreement, and it was signed by the WDEQ director on March 9, 2001, and BP representatives on March 21, 2001.

A draft of the preliminary remediation agreement was released for public comment during the January 17–18, 2001, Collaborative Process meeting. WDEQ did not receive any comments on the draft agreement.

3.3 Remedy Decision

WDEQ and BP have developed this RD#3 to meet the requirements for remedy agreements found at W.S. §35-11-1607. RD#3 was made available for public comment beginning on October 29, 2001, and ending on December 19, 2001, (four weekly public notices plus an additional 30-day public comment period). This remedy decision becomes effective as described in Section 2.6.

4 SITE BACKGROUND

4.1 Operational History

Historically, a portion of the Main Lake was a pond in a naturally enclosed basin where surface water accumulated and evaporated, leaving clay and evaporative mineral deposits. Prior to 1957, the basin contained an intermittent saline basin lake. The sources of recharge to the lake were from precipitation and from groundwater.

From 1913 to 1956, process waste water from the former refinery was discharged directly to the North Platte River. In 1956, as part of a program intended to clean up the North Platte River, the State of Wyoming issued BP a permit to discharge process waste water to Soda Lake. BP constructed a pipeline through which process waste water from the former refinery was pumped to the settling basin ("Inlet Basin") where it was retained for approximately 25 days, before water entered the larger evaporative pond ("Main Lake") through an underflow weir system in a dike separating the Inlet Basin from the Main Lake. Process residuals contained in the water settled to the bottom of the Inlet Basin.

Former refinery process waste water that was pumped to the Inlet Basin included API separator effluent water, sanitary sewage, and softener sludge (SAIC, 1991). The Inlet Basin acted as both a catchment basin and stabilization pond for these wastes, where stabilization occurred through a combination of aerobic and anaerobic processes.

BP discharged process water to the Inlet Basin at an approximate average rate of 1.75 to 2.0 million gallons per day (gpd) from approximately 1956 through September 1990, during which time the Inlet Basin grew to approximately 45 acres and the Main Lake grew to over 650 acres. During this period, the Inlet Basin and Main Lake developed into attractive habitat that provided sanctuary for and habitat wildlife and migratory birds.

After September 1990, BP pre-treated refinery process waste water with an air stripper and discharged the treated water to the City of Casper's publicly-owned treatment works (POTW). Since that time, BP has voluntarily pumped water from the North Platte River to the Inlet Basin in order to maintain the migratory bird habitat.

The CDA, which is located just northeast of the Main Lake, is a bermed, earthen impoundment of approximately 1,000 square feet. It was originally a source of soil for construction of the dike that separates the Main Lake from the Inlet Basin. From 1960 to 1970, the CDA received spent caustic soda from the former refinery caustic sweetening process unit and alkylation unit.

The East Pond and West Pond are part of the Inlet Basin and are small (approximately 1 - 2 acre) ponds located on the east and west sides (respectively) of the Inlet Basin. The East Pond is hydraulically connected to the Inlet Basin. The West Pond was an arm of the Inlet Basin, until approximately the early 1990s when it was separated by the construction of a road.

4.2 Regulatory History

On November 18, 1980, BP filed a RCRA Part A permit application (#WYD00712463) for the Inlet Basin and Main Lake. BP submitted revised RCRA Part A and Part B applications on November 4, 1985. On June 10, 1987, U.S. EPA determined that the Inlet Basin and Main Lake were not a hazardous waste management unit. Instead, U.S. EPA classified the Inlet Basin and Main Lake as a Solid Waste Management Unit (SWMU). The CDA is also considered a SWMU.

Based on a finding that BP had operated a hazardous waste drum storage area (certified closed on December 29, 1989), U.S. EPA entered into negotiations with BP on an administrative order on consent for corrective action at the Refinery Property and the Soda Lake Area under Section 3008(h) of RCRA, 42 U.S.C. §6928(h). The parties, including WDEQ, attempted to negotiate an administrative order on consent in 1994. An initial, unilateral administrative order was issued by U.S. EPA and WDEQ in November 1994; BP requested a federal administrative hearing pursuant to both 40 C.F.R. Part 24 and W.S. §35-11-701 to contest the order. The state proceeding was stayed pending the outcome of the federal administrative proceeding. The U.S. EPA Regional Judicial Officer, as presiding officer, made a recommended decision on December 15, 1995, and U.S. EPA Region VIII issued a final decision on the order on February 23, 1996. U.S. EPA issued a final administrative order (FAO) on April 1, 1996. During this process, in October 1995, U.S. EPA authorized the state hazardous waste program to operate in lieu of the federal hazardous waste program in Wyoming under RCRA Subtitle C.

BP appealed the FAO in the United States District Court for the District of Colorado on April 30, 1996. The district court dismissed the appeal, finding that there was no pre-enforcement review of corrective action orders issued by U.S. EPA pursuant to Section 3008(h) of RCRA. BP appealed this ruling to the Tenth Circuit Court of Appeals. The Tenth Circuit agreed with both parties that the matter was mooted when EPA withdrew its order (after finding that the Consent Decree was equivalent), and remanded the matter to the district court for a decision on BP's motion for vacatur of the original district court ruling. BP appealed that ruling, and the Tenth Circuit Court denied that appeal.

On June 10, 1996, while BP's appeal of the FAO was pending, a separate legal action (the

"Citizen Suit") was brought against BP in the United States District Court for the District of Wyoming. The Citizen Suit, which was filed as both a class action and a citizen suit under RCRA and the federal Clean Water Act (CWA), alleged that the refinery posed an "imminent and substantial endangerment" to human health and the environment. On January 5, 1998, the court entered an order finding an imminent and substantial endangerment and issued a preliminary injunction ordering BP to undertake certain investigations and corrective actions. On April 10, 1998, WDEQ filed a motion to intervene in the Citizen Suit, which the court ultimately granted. BP and WDEQ thereafter negotiated a Consent Decree and submitted it to the court for approval.

On or about September 29, 1998, the Consent Decree was formally entered by the United States District Court in Cheyenne, Wyoming. The Consent Decree was to become effective immediately upon U.S. EPA formally vacating the previously filed FAO. U.S. EPA withdrew the FAO on October 13, 1998, based upon its determination that the terms of the Consent Decree were consistent with and equivalent to the requirements of the FAO. The Consent Decree specifically addressed and sought to resolve, through identification and implementation of certain investigations, any remaining issues regarding any "imminent and substantial endangerment". An April 28, 1998, U.S. EPA directive to remove the Inlet Basin sludges was also integrated into the Consent Decree as an item to be evaluated in the Collaborative Process. The Consent Decree superseded the Court's prior order and established a framework for BP to meet the requirements of RCRA and the WEQA.

4.3 Development of Relevant Standards

This section describes the analysis of Soda Lake Area soil, groundwater, surface water, sediment and porewater. The purposes of this section are to: 1) describe the list of constituents analyzed and evaluated in soil, groundwater, surface water, sediment, and porewater for the Soda Lake Area; 2) outline the process for eliminating constituents from this list that are not of concern from a standpoint of protecting human health and the environment; and 3) outline the process used to define standards, or concentrations of a given constituent, that are protective of human health and the environment, given basic assumptions about the Soda Lake Area.

4.3.1 Process for Developing Constituents of Interest (COIs)

The RFI for the Soda Lake Area was conducted in two phases: 1) the RFI; and 2) the RFI Addendum. BP had previously conducted a voluntary investigation which was summarized in the Soda Lake Technical Memorandum (ThermoRetec, 1999). By comparing the data collected during the Voluntary Investigation to various standards and criteria agreed upon in the Collaborative Process, a subset of constituents was developed for use during the RFI. This section describes the list of constituents analyzed during the voluntary investigation and the process used to develop the list of COIs for further investigation. The process for developing the list of constituents analyzed is described in more detail in Section 4 of Volume I of the TSD#3.

For the Soda Lake Area RFI, the majority of the sediment, surface water, and groundwater samples collected during the voluntary investigation were analyzed for the list of hazardous waste constituents found in Appendix IX Chapter 40, Part 264 of the Code of Federal Regulations (equivalent to Appendix H, Chapter 2, of the Wyoming Hazardous Waste Rules and Regulations). Based upon those data, the RFI Analyte List was generated. Included in Table 4-1 is a site-specific list of constituents including:

- Skinner List analytes (i.e., those typically found at petroleum refineries), as described in National Technology Information Services (1993);
- PAH compounds;
- Refinery-related compounds, as identified through evaluation of the former refinery's processes, interviews, and site inspections with former employees, and input from the WDEQ, JPB, and U.S. EPA;
- Constituents for which data are needed to evaluate the feasibility of various cleanup options;
- All constituents detected in previous investigations;
- Additional constituents in Appendix IX that were detected through analyzing select sediment, surface water, and groundwater samples for the entire Appendix IX list; and
- Additional Appendix IX constituents selected through the Collaborative Process for sampling in specific areas where historical use of a chemical was suspected, such as dioxins, PCBs, and pesticides.

The RFI Analyte List concentrations were compared to conservative screening levels to define compounds with exceedances. Compounds with exceedances and compounds where ½ the detection limits exceeded screening levels were determined to be COIs. The nature and extent of contamination across the Soda Lake Area was defined based upon the presence of COIs. The COIs were then used to develop COCs for risk assessment purposes, as described below.

4.3.2 Process for Developing Constituents of Concern (COCs)

COCs are identified through a process that compares or screens concentrations of each COI analyzed to screening levels. Screening levels are concentrations that are published by federal and state agencies, and are developed to be protective so that concentrations below the levels are considered safe for that receptor and pathway. The screening process eliminates constituents that do not exceed safe levels, thereby focusing the evaluation of protection of human health and the environment (risk assessment) on an appropriate list of constituents. A detailed description of the development of COCs is provided in Section 4 of Volume II of the TSD#3.

The process for identifying COCs for the Soda Lake Area has two components: human health and ecological protection. These are briefly described in the following sections.

4.3.2.1 Human Health COCs

The selection process for determining human health COCs is presented on Figure 4-2. The following steps of U.S. EPA Region VIII's Guidance for Evaluating and Identifying Contaminants of Concern for Human Health (U.S. EPA, 1994c) are incorporated: 1) determination of essential nutrient status; 2) comparison of data to background data; 3) comparison of data to ARARs and relevant screening levels; 4) determination of historical presence; and 5) determination of detection frequency and magnitude of exceedance by non-detects.

As illustrated on Figure 4-2, with regard to sediments and soils, the COC selection process for human health consists of both numerical criteria and relevant screening levels. Numerical criteria are based on federal and state environmental and public health laws, requirements, or regulations for the protection of human health from exposure to constituents (U.S. EPA, 1994c). Relevant screening levels include ARARs and U.S. EPA-approved screening criteria such as U.S. EPA Region III risk-based concentrations (RBCs) (U.S. EPA, 2000). These screening levels are considered conservative because they assume upper-bound levels of exposure protective of any land use. The resulting COCs related to protection of human health are listed in Table 4-2.

A similar process (Figure 4-3) was conducted for groundwater and surface water. The numerical criteria and relevant screening levels for groundwater are based on the following hierarchy: 1) MCLs; 2) DWELs; 3) Wyoming Water Quality Standards; 4) U.S. EPA Region III RBCs for residential ingestion of water; and 5) laboratory practical quantitation limits (PQLs).

If no screening levels exist for a particular constituent or if the screening levels are all below the PQL, then the PQL becomes the screening level.

The groundwater and surface water COCs relating to human health are listed in Table 4-2. Detailed information regarding the development of COCs are provided in Section 4 of Volume II of the TSD.

4.3.2.2 Ecological COCs

Similar to the human health screening process, the ecological screening process (Figures 4-4 and 4-5) incorporates an additional step to narrow the list of COIs for further site investigation to COCs for risk assessment. This step includes:

- Detected COIs that exceeded either high screen level or a low screen level, if a high screen level is not available, are automatically retained as COCs for the ecological risk assessment;

- Non-detected COIs are retained as COCs if their one-half maximum SQL exceeds 10 times the low screen level or if the frequency of exceedance is greater than 10 percent;

- Detected COIs with no available high or low screen levels and a log K_{ow} greater than 3.8 are retained as COCs if their detection frequency is greater than 10 percent; and

- Detected COIs with no available high or low screen levels and a log K_{ow} less than 3.8 were evaluated qualitatively in the Volume II of TSD#3.

The resulting COCs related to the protection of ecological receptors are listed in Table 4-3.

4.3.3 RBRGs for COCs

This section describes the process for defining RBRGs for COCs. RBRGs are site-specific concentrations of COCs in a particular medium that will not result in significant health effects to

receptors based on the site-specific exposure and toxicological assumptions made in the risk assessment. RBRGs are not cleanup goals, rather they represent one of many factors that risk managers consider in selecting an appropriate remedy. Another factor that must be considered for metals is background concentrations.

The procedure for developing RBRGs involves calculating a concentration for an individual COC in a particular medium that would lead to an acceptable target risk level. RBRGs take into account the human health and ecological screening levels described in Section 4.3.2. The human health RBRGs address the known potential carcinogenic and non-carcinogenic effects of each constituent. For the carcinogenic effects, the RBRGs represent the concentrations at which exposure to that constituent increases the chance of causing cancer by one in one million, based on site-specific exposure assumptions. For the non-carcinogenic effects, the RBRGs represent an equivalency to a hazard quotient of 1.0, based on site-specific exposure assumptions. Detailed information regarding the development of human health RBRGs is provided in Section 5.2 of Volume II of the TSD#3.

Ecological RBRGs address the known toxicological effects to potential ecological receptors. These RBRGs utilize criteria that represent an equivalency to a hazard quotient of 1.0, based on site-specific assumptions and data regarding potential receptors and exposure. Detailed information regarding the development of ecological RBRGs is provided in Section 6 of Volume II of the TSD#3.

4.4 Environmental Conditions

This section provides a summary of current Soda Lake Area conditions including climate, topography, geology, hydrogeology, site hazards, sources of contamination, and nature and extent of constituents in soil, groundwater, surface water, sediment, air, and biota. This section summarizes the environmental investigation history, existing and proposed interim measures, potential sources of contamination, and data adequacy.

4.4.1 Environmental Setting

This section provides a description of the environmental setting of the Soda Lake Area, including climate, topography, hydrology, geology, hydrogeology, and physical hazards.

4.4.1.1 Climate

The City of Casper is located in central Wyoming in the North Platte River valley. The climate in this area is semi-arid, with an average annual precipitation of 11 to 12 inches. The wettest months are April, May, and June, with May having an average of 2.1 inches of precipitation. December and January are the driest months with an average of 0.5 inch of precipitation. The greatest average daily temperature is 71 degrees Fahrenheit and occurs in July, while the lowest average daily temperature is 22 degrees Fahrenheit and occurs in January.

The average monthly wind speed measured at the Casper airport is 13 mph with occasional gusts greater than 50 mph (NOAA, 1991). Predominant wind directions are from the southwest and west. Based on wind data collected on the Refinery Property during air quality monitoring, the average wind speed is stronger during the winter months (13.8 mph) than the summer months (7.2 mph) (Radian, 1999).

4.4.1.2 Topography

The Soda Lake Area, except for a portion of the Soda Lake Pipeline, is situated in an enclosed depression and is located approximately two to three miles northeast of the BP former refinery in Casper, Wyoming. The surface and bedrock topography correspond and form a bowl-shaped basin with no outlets. Based on this topographic configuration, surface runoff and groundwater are funneled to the center of the basin with no topological drainage.

4.4.1.3 Physiographic Setting of the Main Lake and the Inlet Basin

The Main Lake and its associated water bodies are situated in a historical playa basin. The extent of the playa basin before North Platte River waters were introduced is shown on Figure 8-1 (5156 foot contour) also with the current lake shoreline. Historically, the Main Lake was a small pond in the playa basin where surface water accumulated and evaporated, leaving evaporative mineral deposits. The natural retention of the broad, shallow basin is further enhanced by the relatively impervious layer of Cody Shale underlying much of the area. Prior to 1957, the basin contained an intermittent, small, saline lake with over 50,000 ppm TDS (Dern, 1970). There was a channel between the Inlet Basin and East Pond, but most flow to the pond appears to be through groundwater. The West Pond is a saline intermittent pond that dries out during the summer.

4.4.1.4 Geology

The Soda Lake Area is believed to be a deflation basin scoured into soft upper Cretaceous (140 to 65 million years old) bedrock by wind erosion (eolian) processes (Woodward-Clyde, 1986). Structure contours of the bedrock surface obtained from boring logs and geophysical work indicate that the basin is closed and bowl-shaped without any topographical drainages beneath the veneer of unconsolidated deposits.

The Soda Lake Area straddles two geologic formations: the Cody Shale and the lowermost Mesaverde Group (Figure 4-1). The contact between the formations strikes northwest-southeast roughly bisecting the Main Lake. The regional dip of the bedrock is five to eight degrees to the northeast and uniformly six degrees northeast at Soda Lake Area. The geologic map subdivides the lowermost member of the Mesaverde Group, the Parkman Sandstone, into three distinct sub-members: the lower, middle, and upper Parkman. Bedrock exposure at the Soda Lake Area is sparse, as Cody Shale and Parkman member rocks form low outcrops at best. Unconsolidated deposits, predominantly in the form of northeast-southwest longitudinal and parabolic eolian (wind-derived) sand dunes cover the southern portion of the Soda Lake Area. These dunes are largely inactive and stabilized by vegetation.

4.4.1.5 Hydrogeology

Surface Water

Four surface water bodies currently exist within the Soda Lake Area. These include: 1) the Main Lake (667 acres); 2) the Inlet Basin (45 acres); 3) the East Pond (1.5 acre); and 4) the West Pond (1.8 acre). Recharge to the Soda Lake Area basin is primarily artificial via a BP pipeline that pumps North Platte River water to the Inlet Basin. In turn, water from the Inlet

Basin (pool elevation of approximately 5,177 feet amsl) passes through an underflow weir to the Main Lake, where a pool elevation of approximately 5,175 feet amsl is maintained.

The Inlet Basin and Main Lake are maintained through the addition of 1.7 million gallons per day (gpd) of fresh water pumped from the North Platte River to preserve the current elevation of the Inlet Basin and Main Lake, and to support the wildlife habitat that has resulted from increasing the size of the lake. Natural recharge is contributed to the lake by direct precipitation, surface runoff from precipitation, four ephemeral streams located on the western side of the Main Lake, and groundwater recharge. The East Pond retains a static water level between the Inlet Basin and the Main Lake. The water level in the West Pond drops during the summer months and does not appear to be in hydraulic connection to the Inlet Basin.

A water mass balance conducted as part of the RFI demonstrated that evaporation accounts for the sum of water inflows (runoff, groundwater, pipeline input). During the summer months, evaporation outpaces recharge (natural and artificial), lowering the Main Lake by more than a foot. Based on the water balance, groundwater outflow from the Soda Lake Area basin does not occur.

Surface Water Quality

The general water quality parameters (pH, salinity, conductivity) of the Inlet Basin are comparable to that of the North Platte River from which it is directly recharged (pumped by BP since 1990). Evaporation concentrates solutes in the Main Lake resulting in elevated total dissolved solids, salinity, and pH. Main Lake total dissolved solids (TDS) and salinity levels are over an order of magnitude higher than that of the Inlet Basin, and the Main Lake has a pH of about 9.

The most recent surface water quality monitoring indicates that the Main Lake TDS level (as of December 2000) now range from 13,000 to 14,000 ppm. Based on TDS and salinity levels, the Main Lake is a brackish water while the Inlet Basin is a freshwater environment. In addition, the Inlet Basin salinity of 390 to 400 ppm (as of December 2000) represents a strictly freshwater environment.

Water quality in the East Pond is similar to that of the Inlet Basin in terms of salinity, conductivity, and TDS. The East Pond is ephemeral and dries out in the summer. General water quality in the West Pond is similar to the Main Lake; brackish with high conductivity and TDS.

Groundwater

On a regional scale, groundwater flows in a southeasterly direction toward the North Platte River. Regional hydrogeologic formations include the Cody and Mesaverde formations. The bedrock that underlies the Inlet Basin are fine-grained shales (Cody) and siltstones (Lower Parkman) of low permeability.

Locally, groundwater flow follows closely to the site topography and consists of a shallow flow component with radial flow toward the Inlet Basin and Main Lake (Figure 4-6). A deeper regional flow component (within bedrock) has a flow somewhat affected by topography, but within permeable bedrock exhibits a southeasterly flow (Figure 4-7). The regional flow shows a dampened effect from topography, which in tandem with water-balance results indicates that the

Inlet Basin and Main Lake are considered a "discharge lake" whereby shallow groundwater discharges to the lake and the deeper groundwater bypasses below. The mechanics of the discharge lake preclude migration of identified contaminants in the Inlet Basin from migrating off site. The nature and extent of impacts to groundwater are discussed in Section 4.4.4.

4.4.1.6 Physical Hazards

There are no known overhead hazards at the Inlet Basin and Main Lake. Underground hazards include a natural gas transmission line along the southern site boundary and the Soda Lake Pipeline which runs from the former refinery to the Inlet Basin. A series of abandoned crude transmission lines transect the northwest portion of the property.

4.4.2 Summary of Environmental Investigations

This section provides the general history and scope of RCRA-related investigations at the Soda Lake Area. Detailed descriptions and timing of the investigations conducted at the Soda Lake Area can be found in Volume I of the TSD#3. The Risk Assessment (RA) and Corrective Measures Study (CMS) for the Soda Lake Area are provided in Volumes II and III, respectively, of the TSD#3.

RCRA Facility Assessment

U.S. EPA contractor, Science Applications International Corporation (SAIC), conducted a preliminary review of regulatory and corporate archives, and submitted the review to U.S. EPA on November 28, 1990. A visual site inspection relating to the former refinery was conducted by U.S. EPA and SAIC on December 17 to 19, 1990. The draft RFA Report dated July 1991 (SAIC, 1991) was sent to BP by U.S. EPA on December 20, 1993. The RFA began the corrective action process. The RFA identified two Solid Waste Management Units at the Inlet Basin and Main Lake: the Caustic Disposal Area and the Inlet Basin. The operational and maintenance history of the Soda Lake Pipeline is provided in the Current Conditions/Release Assessment Report (TriTechnics, 1996).

Soda Lake Area Interim Measures

Section XXXI of the Consent Decree required BP to submit a Draft Interim Measures Work Plan describing stabilization of Inlet Basin process residuals (by removal or by alternative stabilization proposals) no later than July 17, 1998. The work plan was submitted on July 17, 1998 and was considered along with all other existing information in developing the RFI and Risk Assessment work plans for the Soda Lake Area.

Soda Lake Area Voluntary Investigation

The Soda Lake Technical Memorandum (ThermoRetec, 1999) summarized the voluntary investigative activities conducted under the original Draft Soda Lake RFI Work Plan (RETEC, 1998), and data collected under the Draft Interim Measures Work Plan. The Soda Lake Technical Memorandum documented the nature and partial extent of impacts to sediment in the Inlet Basin, characterized levels of chemical constituents in bird and fish tissues and evaluated air quality at the Soda Lake Area. The Soda Lake Technical Memorandum also summarized surface water (Inlet Basin, Main Lake, and inlet streams) and groundwater data collected during the

November 1997 and March, June, and September/October 1998 sampling events. The Soda Lake Technical Memorandum also included wetland delineation and a bird-nest-and-brood survey. Finally, the Soda Lake Technical Memorandum reported the results of physical-, chemical-, and dredging-specific studies designed to support remedial design.

RCRA Facility Investigation (RFI)

The subsequent Soda Lake Area RFI Work Plan (ThermoRetec, 2000a) focused on identifying the extent and nature of impacts in soil, groundwater, surface water, and sediment not fully defined during the previous investigations. Other objectives of the Soda Lake Area RFI Work Plan were to obtain data necessary to perform human health and ecological risk assessments and to evaluate remedial alternatives. Several probable conditions were established for the Soda Lake Area and media as well as DQOs to help focus the investigation activities. The Soda Lake Area RFI Work Plan was approved by WDEQ in December 2000. More detailed information on the RFI can be found in Volume I of the TSD#3.

RFI Sampling and Analysis Plan (SAP) Addendum 2 (as modified)

Because of inclement late autumn/early winter weather, the Soda Lake Area RFI was not completed on the schedule originally planned. In April 2001, historical and available RFI data were evaluated against the DQOs to determine if the proposed, but not completed, work should proceed or be modified. The evaluation determined that certain work to be performed according to the Soda Lake Area RFI Work Plan was no longer necessary. However, specific areas were identified where further data collection was warranted. These investigation activities were conducted in accordance with the RFI Sampling and Analysis Plan, Addendum 2 of the RFI Work Plan, as modified (ThermoRetec, 2001a).

4.4.3 Sources of Contamination

The following sites within the Soda Lake Area are potential sources of contamination:

- The Inlet Basin, which contains sediment impacted by VOCs, SVOCs, and inorganics. Process waste waters were transported from the former refinery via the Soda Lake Pipeline from 1956 to 1990 and is the primary source of contamination at the Soda Lake Area, including the Main Lake, which contains sediment impacted by PAHs, primarily near the underflow weir where water from the Inlet Basin flows into the Main Lake.

- The CDA, which contained solid waste in a shallow bermed pit.

- The Soda Lake Pipeline, which is the conduit to the Inlet Basin.

- The Northwest Drainage Area, which is an area where a 1973 pipeline leak funneled down to the Main Lake.

Sampling activities during various investigations at the Soda Lake Area included characterization of these potential sources and are described below.

4.4.3.1 Inlet Basin

Sediments within the Inlet Basin represent the most significant source of contamination at the Soda Lake Area. Results of voluntary investigations prior to the RFI determined a suite of VOCs, SVOCs, and inorganic compounds related to the former refinery exist in the underlying sediments. The contaminant compounds present in the sediments were at levels sufficient to warrant a remedial action without a formal risk assessment. That determination led to a demonstration pilot capping project during the summer of 2000. While the chemical characterization of the Inlet Basin sediments was largely defined, the overall lateral extent was the focus of the RFI. The nature and extent of Inlet Basin sediment impacts is discussed in Section 4.4.4.

4.4.3.2 Caustic Disposal Area (CDA)

The CDA was used between 1960 and 1970 for the storage of waste materials from the caustic sweetening and alkylation processes. Approximately 18.7 tons of CDA soil were taken to the LTU located in the North Property Area in 1995. Due to the relatively unknown chemical nature of CDA residuals, the RFI Analyte List was applied to the RFI soil investigation along with pH to identify if highly alkaline soil impacts exist.

4.4.3.3 Soda Lake Pipeline

The Soda Lake Pipeline was installed and put into service in 1956. The pipeline is a 12-inch-diameter steel pipe that runs for 4.7 miles between the former refinery and the Inlet Basin. The last 3,000 feet of the pipeline, near the Inlet Basin, is 10-inch-diameter steel pipe. From 1956 to 1990, the pipeline carried separator effluent, sanitary sewage, and softener sludge. Since 1990, the pipeline has transported river water to the Inlet Basin. Typically, flow rates are 1.7 to 2.0 million gallons a day. The pump operates at a pressure of 280 pounds per square inch. The RFA conducted in 1991 did not identify the pipeline as a SWMU or an Area of Concern (SAIC, 1991). Although, not formally identified as a SWMU or Area of Concern, the RFI considered the pipeline to be a potential source of soil and groundwater impact as no formal investigation to test the overall pipeline integrity had been conducted. The testing results of the pipeline, as well as the groundwater and soil chemical data, are provided in Volume I of TSD#3.

4.4.3.4 Northwest Drainage Area

In April 1973, a pipeline failure northwest of the Main Lake was discovered. BP reported that about 500 barrels of oil migrated to the Main Lake where it was burned on the water followed by shoreline treatment (i.e., application of an emulsifier to disperse oil). The RFI soil investigation was designed to determine the nature and extent of impacts remaining in the Northwest Drainage Area (Figure 1-1). Results of the Northwest Drainage Area investigation are provided in detail in Section 8 of Volume I of the TSD#3.

4.4.4 Nature and Extent of Contamination

4.4.4.1 Groundwater

The investigation objectives for groundwater relate to determining the groundwater flow conditions at the site and to determining the nature and extent of contamination in groundwater. The key findings of the RFI investigations are as follows:

- The Main Lake and Inlet Basin are a discharge lake system. The weight of evidence collected during the RFI suggests that the conditions at Soda Lake Area fit the groundwater discharge lake model as proposed in the probable conditions and DQOs. The primary lines of evidence for a discharge lake are:

  - Water balance modeling that indicates that water loss from the lake is solely attributable to evaporation;

  - Hydrogeologic conditions that show net inflow of groundwater; and

  - Natural water chemistry, which demonstrates that surface water characteristic of the Inlet Basin and Main Lake are not evident in groundwater.

- Contaminants from source areas, such as the Inlet Basin, do not migrate in groundwater to off-site locations. The lines of evidence supporting this include:

  - Groundwater discharges into the Main Lake and Inlet Basin;

  - COIs present in the Inlet Basin sediments are not present in groundwater above human health screening levels (MCLs) or background levels; and

  - Similarly, impacts in groundwater have not been observed next to the Soda Lake Pipeline in the area where pipeline integrity has been compromised, or near the CDA, which contains residual wastes characterized by highly alkaline pH levels and TPH-DRO.

In summary, the Inlet Basin and Main Lake are considered a groundwater discharge lake. Although seasonal inflow and outflow occur from a small area on the east side of the Main Lake, an analysis of natural water chemistry indicates that surface water is not degrading groundwater quality in either the shallow flow system or the regional flow system. Although VOCs , SVOCs, dioxins and inorganic compounds have been detected in groundwater, these constituents were below screening levels or were eliminated through the COC screening process. As such, the groundwater media is not subject to corrective action and is not carried forward into the CMS.

4.4.4.2 Soil

Below is a summary of the soil investigation results. All data are provided in Volume I of TSD#3.

Inlet Basin

Authoritative sampling of the soils surrounding the impacted sediment in the Inlet Basin was conducted to characterize the extent of the source material distribution.

- Organic compounds detected in the Inlet Basin perimeter in excess of human health and/or ecological screening criteria include benzo(g,h,i)perylene and TPH-DRO. The extent of impact is defined for benzo(g,h,i)perylene and TPH-DRO.

- Inorganic compounds detected in Inlet Basin perimeter soil samples in excess of human health and/or ecological screening criteria include arsenic, chromium, thallium, and vanadium. For each of these compounds, extent is defined by adjacent samples with concentrations below the relevant criteria. However, several lines of evidence suggest that the inorganic compounds detected in Inlet Basin soils are naturally occurring:

  - Concentrations fall within naturally occurring ranges for similar lithology types;

  - The compounds occur individually, without the presence of organic compounds associated with former refinery related wastes.

East Pond and West Pond

Inorganic COIs including arsenic, thallium and mercury were detected on the west edge of the West Pond in one soil sampling location. No organic COIs have been identified in soils on the perimeter of the East Pond or West Pond.

Caustic Disposal Area

Because the boundaries of the CDA were apparent, authoritative sampling was conducted within the CDA to evaluate the nature of contamination, and to provide sufficient information to design a remedial alternative for the CDA. The primary findings of the identification of the CDA as a source are as follows:

- Within the CDA, compounds that exceed human health or ecological screening criteria include 3,4-methylphenol, TPH-DRO, arsenic, lead, 2-methylnaphthalene, 4,4-DDD, 4,4-DDT, alpha-chlordane, endrin aldehyde, heptachlor epoxide, naphthalene, sec-butyl-benzene, and total xylenes.

- Groundwater below the CDA does not contain COIs. Impacts from soil leaching to groundwater are not indicated.

Northwest Drainage Area

The Northwest Drainage Area was evaluated as part of the RFI soil investigation to determine the nature and extent of impacts from a 1973 pipeline release that flowed overland to the Main Lake. In accordance with the DQOs, the results are summarized as follows:

- Soil samples collected along the Northwest Drainage Area did not show any visible effects of the historic oil spill.

- Organic compounds were not detected in soils above the human health or

ecological screening criteria.

- Inorganic compounds that exceeded the human health and/or ecological screening criteria included arsenic, thallium, and vanadium. However, these compounds do not exceed background.

Soda Lake Pipeline

The Soda Lake Pipeline was evaluated to determine if historical leaks or breaks in the line during former refinery operations might have contributed contaminants to the surrounding soils or groundwater. In accordance with the DQOs, the primary findings for the pipeline as a source are as follows:

- Review of historical operation, maintenance records and groundwater data, followed by flow and hydrostatic testing, indicate the pipeline has not impacted soil or groundwater. Results of the RFI activities concluded that the pipeline integrity has held to date. The last 800 feet above the Inlet Basin outfall was not hydrostatically tested because of concerns for causing a pipe failure. This portion of the line was constructed below the water table and has experienced considerable external corrosion.

- Visual soil impacts were not indicated in the area adjacent to the last 800 feet of pipeline above the Inlet Basin outfall during test pit excavation. No analytical samples were collected from this section of the pipeline.

- The remainder of the pipeline underwent a 17-hour pressure test. The pressure test results and corresponding flow meter measurements indicate the pipeline does not leak.

- Review of operational records and discussions with pipeline personnel indicate that standard practices, including draining of the pipeline, would have occurred for maintenance or abandonment. Therefore, abandoned pipeline, such as the inaccessible 2,700 feet near the I-25/US Hwy20-26 interchange, are not expected to contain liquid residuals.

4.4.4.3 Surface Water

The RFI assessed surface water conditions of the Inlet Basin and the Main Lake. In addition, water quality was measured from four intermittent streams along the west side of the Main Lake to assess background of metals from these sources of surface water. Below is a summary of the surface water investigation results:

- The major source of water is from the North Platte River, with other contributions from surface streams, groundwater, and precipitation. Water mass balance has demonstrated that the water inputs equal the volume of water lost to evaporation.

- Organic compounds attributable to the former refinery were not detected above human health or ecological screening criteria in any surface water sampling event between 1997 and 2001 in any water body of the Soda Lake Area.

- Site-wide surface water COIs (excluding the inlet streams) are restricted to the following metals: antimony, cadmium, selenium, and silver. Selenium is ubiquitous in distribution through all water bodies. Silver, antimony, and cadmium are found at low detection frequencies primarily in the Main Lake.

- Surface water acute and chronic bioassays conducted on water collected in the Inlet Basin showed no significant difference from control bioassays.

- Total antimony, acetone and bis(2-ethylhexyl)pthalate were the only detected COIs in the West Pond. Acetone and bis(2-ethylhexyl)pthalate were detected in surface water in the East Pond.

4.4.4.4 Sediment and Porewater

The purpose of the sediment and porewater investigations was to define the nature and extent of former refinery-related COIs in the Inlet Basin and Main Lake. These areas are discussed separately, below.

Inlet Basin

The sediment porewater investigations at the Inlet Basin focused on defining the extent and nature of contamination within the source area. The investigation results are summarized as follows:

- The nature and extent of COIs in Inlet Basin sediments were defined based on both sediment thickness and chemical analyses; i.e., the COIs are principally found in the sediment and not in the underlying native soil, and are within the Inlet Basin boundary or highwater mark of approximately 5178 amsl.

- COIs that exceeded human health and ecological screening criteria within the Inlet Basin sediments included VOCs, SVOCs, metals, and dioxins (see Section 10.2.1 of Volume I, TSD#3).

- Of all COIs measured, chromium and xylene were found to have the highest concentrations that exceeded the human health and the ecological screening criteria at all depths in the impacted sediment.

- The COIs in the native soils underlying the impacted sediment are chromium, nickel, and PAHs.

- Porewater concentrations of VOCs, SVOCs, and metals were found to be elevated above the screening water quality criteria. BTEX, the soluble PAHs (naphthalene, methylnaphthalene), chromium, lead, and zinc were all elevated in porewater.

- COIs in the East Pond and West Pond are similar to those found in the Inlet Basin. PAH compounds present in the East Pond and West Pond at concentrations above the screening level include anthracene, chrysene, pyrene, benzo(a)pyrene, naphthalene, benzo(g,h,i)perylene, phenanthrene, benzo(a)anthracene,

fluoranthene, and acenaphthene. VOCs in the East Pond and West Pond that exceed the sediment screening criteria include benzene and total xylenes. Phenol was also present in East Pond and West Pond sediments. Metal COIs detected include manganese, chromium, and cadmium.

The majority of the contamination is limited to the impacted sediments in the Inlet Basin. A subset of the COIs found in the impacted sediments were detected in the underlying native soils but at lower concentrations.

Main Lake

The Main Lake is connected hydraulically to the Inlet Basin by the underflow weir. The purpose of the sediment and porewater investigation in the Main Lake was to document the extent of former refinery related COIs introduced into the Main Lake. A comprehensive sampling program was conducted in all portions of the Main Lake. A summary of the RFI findings includes:

- Organic COIs that were detected in surface and subsurface sediments included pyrene, benzene, chrysene, phenanthrene, benzo(a)anthracene, fluoranthene, naphthalene, total xylenes, and phenol. Phenol was the only organic compound present that exceeded benthic ecological high screening criteria. All other detected organic COIs exceeded the benthic low screening criteria only, and the stations that exhibited these compounds were further tested using solid-phase bioassay tests.

- The areal extent of impacted sediments is mostly limited to the area defined in Volume I of TSD#3 as "potentially impacted."

- Metal COIs detected in Main Lake sediment include arsenic, cadmium, chromium, mercury, nickel, and zinc. Cadmium, chromium, nickel, and zinc concentrations exceeded the benthic ecological low screening criteria. Metals that exceed the ecological low screening criteria are ubiquitous throughout the Main Lake indicating these metals are of natural origin. Further discussion on the natural origin of metals in Soda Lake is found in Appendix A of Volume II of TSD#3.

- COIs present in porewater include acetone, phenol, carbon disulfide, arsenic, antimony, manganese, selenium, silver, and vanadium. Acetone is believed to be a laboratory artifact. As discussed above, the metal distribution was ubiquitous throughout the lake; metals are of natural origin.

- Solid-phase bioassay testing was conducted to measure acute and subchronic toxicity of surface sediments. In addition, porewater chemical testing was conducted on those stations that underwent bioassay testing. Low level toxicity and nonrecurring toxicity in some samples were observed and could be related to lab artifacts and procedures (see Volume II of TSD#3).

These data show that COIs are present in the Main Lake sediments and porewaters. The results of the toxicity testing of Main Lake sediments suggest that there is negligible to no acute or subchronic toxicity of the Main Lake sediments to the test organisms.

4.4.4.5 Ambient Air

Air monitoring was conducted at the Soda Lake Area in August 1998 at four sampling locations. Samples collected at one location upwind of the Inlet Basin and Main Lake and three locations downwind were analyzed for VOCs and H_2S. Air monitoring detected eight VOCs at concentrations above one part per billion by volume (ppbV). The highest measured concentrations were 63 ppbV for acetone and 30 ppbV for acetaldehyde, both of which are common contaminants of canisters. The levels upwind of the lake were comparable to the downwind levels, indicating that the lake was not the source of all of the VOCs present in the air. The VOCs were all far below the applicable occupational exposure limits and, generally, were well below the applicable odor detection thresholds. Based on the available data, VOCs at the Soda Lake Area do not appear to contribute to local odors or threaten human health.

The H_2S measurements indicate that the Main Lake is not a source of H_2S odors. The Inlet Basin, however, may contribute to odors in the area, particularly on calm mornings. The measurements made 100 feet downwind of the Inlet Basin indicated few odors, as did the readings later in the day. Therefore, it appears that the H_2S odors are localized to a small area and are transitory (intermittent). Although workers are not present at the site full-time (eight hours per day, five days per week), the maximum concentration of H_2S (150 ppbV) was far below the applicable occupational exposure limit, indicating that H_2S at the Soda Lake Area is not of concern and does not threaten human health. Results of this investigation provided adequate data on air quality for the Soda Lake Area.

4.4.4.6 Biota

Tissue sampling of birds (American coots) and fish (carp) from the Inlet Basin was conducted under voluntary investigations. Results of these investigations indicate:

- PAH metabolites in Inlet Basin bird tissue are higher than that of reference station birds.
- Organic compounds were not detected in the whole body tissue analysis of Inlet Basin fish.
- Inorganic compounds, with the exception of zinc, were within background concentrations for fish as reported by See and others (1992).

4.4.5 Summary of Data Adequacy

To evaluate a site in accordance with RCRA, sufficient data and information must be available to define the nature and extent of contamination, evaluate the risks posed by the contaminants and select a cleanup option where risks are unacceptable. This section describes the adequacy of groundwater, soil, surface water, and sediment data to meet DQOs for the RFI, Risk Assessment, and CMS.

To verify that the Soda Lake Area investigative data are of adequate quality and quantity, a DQO process was developed based on the U.S. EPA Guidance for Data Quality Objectives Process (U.S. EPA, 1994b). The process asks pertinent questions about the data. Once the data

are measured against these questions, called decision rules, a decision can be made as to whether the data are adequate to: 1) characterize the site; 2) conduct a risk assessment; and 3) prepare a CMS.

To ensure full characterization, the following data sets were used: 1) voluntary investigation (pre-RFI) data, and 2) Soda Lake Area RFI (Phase I and Addendum).

The data are adequate to achieve the DQOs. DQOs for groundwater, soil, surface water and sediment are provided in Tables 4-4, 4-5, 4-6 and 4-7 respectively. More detailed information on the DQO process and data adequacy conclusions can be found in Volume I of the TSD#3.

5 SUMMARY OF SITE RISKS

This section provides a summary of the risk assessment (Volume II of the TSD#3) performed for the Soda Lake Area. The purpose of the risk assessment was to determine potential risks to human and ecological receptors, both at the present time and in the future, from constituents in soil, groundwater, surface water, sediment, and air. Data from the Soda Lake Area were used to evaluate risk.

The risk assessment was divided into two sections: human health evaluation and ecological evaluation. The human health risk assessment evaluated both children and adults while the ecological risk assessment evaluated both plants and animals. The overall goal of the risk assessment was to develop a set of constituents and, based on their associated concentrations in soil, groundwater, surface water, sediment, and air, identify areas that should be targeted for cleanup. More information on the human health and ecological risk assessments can be found in Volume II of the TSD#3.

The objectives of the risk assessment were to:

- Provide data that will allow risk managers to define remedy decisions for the site.
- Evaluate site data to determine the potential for adverse effects to human health, wildlife receptors, and aquatic communities following exposure to site contaminants. Included are an evaluation of COCs by sample and by exposure area, spatial definition of potential risks, cumulative risk, and identification of risk drivers for the CMS.
- Ensure protection of human and ecological receptors identified for the Soda Lake Area using the process presented in Risk Assessment Guidance for Superfund (RAGS) (U.S. EPA, 1989), Region VIII Superfund Technical Guidance (1994a), and Supplemental Ecological Risk Assessment Guidance for Superfund (U.S. EPA, 1997b).

BP agreed to remove contaminated sediments impacted by refinery operations within the Inlet Basin, and soils at the CDA. Therefore, the risk assessment focused on those potential risks associated with the Main Lake to determine the need for corrective action and the residual risks (i.e., following waste removal) in the Inlet Basin (using the native soil data) and the CDA (using nearby soil data).

This section provides a summary of the results of the risk assessment presented in Volume II of the TSD #3.

Ecological risks from exposure to selenium, which is considered to be primarily of natural origin, is a constituent of special concern that is evaluated in a separate selenium special studies report (ThermoRetec, 2001b). A summary of the results of this evaluation is presented in Section 5.3.

5.1 Human Health Risk Assessment Summary

The human health risk assessment involved five steps:

- **Identification of COCs.** These include constituents present in and around the Soda Lake Area that could potentially contribute to a risk to humans.
- **Exposure Pathways.** These are processes by which humans come in contact with constituents in the environment.
- **Potential Receptors.** Receptors are humans that could potentially contact the COCs.
- **Toxicity.** The potential adverse health effects of COCs to humans were determined from published literature sources.
- **Determination of Risk.** The concentrations of COCs were compared to safe levels to determine areas where potential risks could occur. In other words, where a concentration of a COC was above the safe level, a potential risk was present.

A detailed description of the human health risk assessment process is provided in Sections 4 and 5 of Volume II of the TSD#3.

5.1.1 Development of COCs

COCs are identified through a process that compares or screens concentrations of each constituent analyzed to screening levels. A description of the process for determining COCs was presented in Section 4.3.2.

5.1.2 Exposure Pathways

The risk assessment evaluated the potential risk to receptors associated with the current and potential land use and also with unrestricted land use. The first step of the exposure assessment was to identify possible pathways by which site-related COCs could migrate in the environment and next to determine which pathways could lead to human contact. This information is summarized in the CSM, which provides a graphical picture of site conditions and tracks constituent migration from potential sources to receptors. Figure 5-1 is the CSM for the residential exposure. Figure 5-2 is the CSM for all of the potential receptors associated with the current and potential future use of the Soda Lake Area. Details on the development of exposure pathways and the CSMs are located in Section 5 of Volume II of the TSD#3.

5.1.3 Potential Receptors

The potential receptors for the Soda Lake Area include: 1) hypothetical on-site resident; 2) off-site resident; 3) on-site and off-site commercial/industrial worker; 4) on-site and off-site construction worker; and 5) recreational user.

Figures 5-1 and 5-2 show the pathways from various site media to the receptors listed above. The media through which migration of constituents could occur included surface soil, subsurface soil, surface water, sediment, porewater, groundwater, air particulates, and air vapors. Site data and risk evaluation provided evidence that certain exposure pathways did not contribute to site risk and, therefore, were not retained for quantitative risk assessment. The exposure assumptions that define a receptor's exposure to media are provided in Section 5 of Volume II of the TSD#3.

5.1.4 Toxicity

The toxicity data provide an estimate of the relationship between the extent of exposure to a constituent and the increased likelihood and/or severity of adverse health effects (U.S. EPA, 1989). Toxicity data for COCs were based on the most recent U.S. EPA-approved data available regarding the potential for a constituent to cause adverse effects in exposed individuals (see Section 5, Volume II of the TSD#3). For the COCs where chemical toxicity data were not available, an uncertainty analysis was conducted. Section 5.5 of Volume II of the TSD#3 describes the uncertainty analysis and the total list of chemicals lacking toxicity data.

5.1.5 Determination and Summary of Site Risks

The results of the exposure and toxicity assessment for COCs were used to determine potential risks to receptors through calculation of RBRGs and cleanup level indices (CLIs). RBRGs are the concentrations of COCs in a particular medium above which risks to receptors could result, and were calculated using site-specific exposure assumptions, toxicity data, and target risk levels.

A numerical toxicity value for lead was not available because there is no demonstrable threshold dose (i.e., a dose below which adverse health effects are not observed). Therefore, RBRGs for lead were derived using U.S. EPA's lead exposure models for children and adults that predict blood lead concentrations and calculate acceptable RBRGs.

Once RBRGs were calculated for both carcinogenic and non-cancer COCs, a CLI was calculated by comparing the concentration of the COCs to the RBRGs. A CLI of one or less than one indicated low potential risk, while a CLI of greater than one indicated that a potential risk could exist because the constituent concentration exceeded the RBRG at a target risk level of 1×10^{-6} for carcinogens or an HI of one for noncarcinogens.

The primary objective of the risk assessment was to identify areas of the Soda Lake Area where potential risks existed that should be targeted for cleanup based on potential future land use and exposure pathways. Four exposure areas, identified based on previous land use, were defined for the Soda Lake Area (see Figure 5-3 of Volume II of the TSD#3). For the purposes of the risk assessment, the exposure areas were defined to correspond with the potentially contaminated areas that were the subject of investigation. The CLIs for these exposure areas were calculated

based on the 95% UCL for each area. In addition, maximum detected values in impacted areas were also considered. Refer to Volume II of the TSD#3 for more detail.

5.1.5.1 Soil

The risk characterization was organized in the context of the remedial objectives. There are three remedial objectives for soil:

- **Remedial Objective 1 (Unrestricted Use).** Allows unrestricted land use including residential and commercial structures with basements and utility excavations not to exceed 12 feet or the top of the water table.

- **Remedial Objective 2 (Reuse Plan with Restriction).** The land use is consistent with the Reuse agreement, including parks, commercial and industrial structures without basements (slab on grade construction) and excavations not to exceed eight feet in depth. Similarly, foundation excavations would be limited to four feet and utility excavations would be limited to eight feet with the use of institutional controls.

- **Remedial Objective 3 (Open Space).** This is similar to Remedial Objective 2 except that land use is consistent with the current uses, including grazing and limited bird viewing. Institutional controls would be used to restrict excavations deeper than four feet and would require management of excavated soils to prevent human and ecological risks.

For residential receptors only thallium was identified as a COC with a CLI exceeding one in one sample for the 0.5- to 4-foot soil interval (CLI = 1.25), and no samples exceeding a CLI of one in the 0 - 0.5 foot or 4- to 12-foot soil depth intervals. The thallium exceedance was not co-located with any other COC indicating it is likely naturally occurring, and therefore it was not carried forward into the CMS.

Two Reuse receptors (industrial worker and adult recreational user) were also evaluated in the risk assessment. Results indicate no cancer or non-cancer risk driver CLI exceeding one. See Table 5-20 in Volume II of the TSD#3.

The construction worker was evaluated on a site-wide basis. Site-wide average concentrations for each soil COC were compared to the construction worker RBRG. Results indicated no cancer or non-cancer risk driver CLI exceeding one. For more detailed information regarding soil risks, refer to Volume II of the TSD#3.

In addition, in the residual risk evaluation of soil in the area near the CDA, one sample at the 0 - 0.5 foot depth interval exceeds the background value of 14.5 mg/kg (also the RBRG) and the CLI of one for arsenic. However, no other metal exceedances were co-located with the arsenic, indicating it is likely naturally occurring.

5.1.5.2 Groundwater

The groundwater evaluation was a CLI evaluation of the groundwater data set on the Soda Lake Area for the time period of 1997–2001. The groundwater risks were based on evaluations of all potential receptors exposed to unrestricted use of groundwater (on-site and off-site).

Exposure to groundwater included the following potential migration pathways related to human receptors:

- **Residents:** Direct contact (ingestion and dermal contact) and inhalation of groundwater VOCs while showering and via indoor air;
- **Construction Workers:** Exposure to groundwater included dermal contact only; and
- **Industrial Workers:** Potable use of groundwater, including ingestion and dermal contact.

The exposure pathway associated with indoor air (i.e., inhalation of VOCs from groundwater via vapor intrusion) is considered an incomplete pathway for Soda Lake Area as there are no volatile COCs.

The remedial objective for groundwater allows unrestricted use of the groundwater through achievement of MCL or RBRGs. The time frame to achieve unrestricted use and the specific area of the site (at the source or a downgradient unit or property boundary) defines the remedial alternative for groundwater.

The COCs identified in the risk assessment where the 95% UCL exceed the MCL (or state or federal DWELs) or RBRGs include:

- Chloride (State MCL is 250,000 µg/L),
- Sulfate (State MCL of 250,000 µg/L),
- Nitrate/Nitrite (MCL of 10,000 µg/L),
- Ammonia (RBRG of 21 µg/L),
- Iron (RBC of 60,450 µg/L
- Lead (MCL of 15 µg/L, and
- Nitrate (MCL is 10,000 µg/L).

Table 5-23 of Volume II of the TSD#3 provides the site data, RBRG, and CLI.

There are also limited areal exceedances via comparison of the maximum concentration to the RBRG, yielding a CLI greater than one for the following COCs:

- Acetone,
- Aluminum,
- Arsenic,
- Barium,

- Beryllium,
- Bis (2-ethylhexyl)phthalate,
- Cadmium,
- Nickel, and
- Vanadium.

Acetone and bis(2-ethylhexyl)phthalate are known (acetone) or suspected ((bis2-ethylhexyl)phthalate) laboratory contaminants and were also detected in upgradient wells. The metals are considered naturally occurring and unlikely to be attributable to the refinery operations. Therefore, they will not be addressed further in RD#3.

5.1.5.3 Sediment

Sediments in the Main Lake, East Pond, and West Pond of the Soda Lake Area (see Figure 5-3, Volume II of the TSD#3) were evaluated for potential human health risk. Sediment data from 1998–2001 were evaluated for potential risk to residents, industrial workers, and recreational users scenarios to be consistent with the remedy objectives. There were CLI exceedances in all exposure areas, at all depth intervals, based on the recreational child cancer RBRG due to arsenic (CLI of 1.2 to 3.3, denoted in Table 5-26, Volume II of the TSD #3). No other sediment COCs exceeded the recreational user RBRGs.

There were no CLI exceedances of sediment residential RBRGs (Table 5-27, Volume II of the TSD#3). The sediment residential RBRGs account for limited sediment contact as shown on Figure 5-1. This scenario is included as required by the Risk Assessment Work Plan and is separate from the evaluation of sediments as soil.

In addition to evaluating a hypothetical resident exposure to sediment, possible exposure to sediment as soil in the case of a dry lake was considered. In the hypothetical future land use scenario, it is possible that the Inlet Basin and Main Lake could dry out and the sediment located therein would turn into soil, thus creating a soil exposure pathway to potential receptors. In consideration of this hypothetical scenario, sediment data was compared to soil RBRGs on a point-by-point and exposure area analysis. The results of the sediment to soil RBRG comparison is discussed in the following paragraphs.

Sediment data was compared to the lowest soil residential RBRGs. When the exposure point concentration was compared to the lowest soil residential RBRG, an exceedance of the CLI of one is seen for arsenic (CLI of 5.5 to 15) in all areas at all depths and thallium (CLI of 1.24 in surface sediment in the East Pond). Table 5-28, Volume II of the TSD#3 presents the results of the sediment COC exposure point concentrations compared to soil residential RBRGs.

Sediment COCs were also compared to soil industrial worker RBRGs in order to evaluate whether an institutional control over the site would be more appropriate. There were no sediment COC exceedances of the soil industrial worker RBRGs (see Table 5-29, Volume II of the TSD#3).

The sediment risk evaluation indicates that sediment is not impacted by refinery operations in concentrations exceeding the target risk-based standards for a recreational user and a construction worker (addressed as Remedial Objective 1).

Native sediment data were compared to the soil and sediment RBRGs for human health receptors. When the exposure point concentration was compared to the lowest soil residential and recreational RBRG, no exceedances are seen for arsenic. Table 5-30, Volume II of the TSD#3 presents the results of the native sediment COC exposure point concentrations compared to RBRGs.

5.1.5.4 Surface Water

The risk assessment identified the COCs where the 95% UCL and the MDC exceed the MCL (or state or federal DWELs) or RBRGs. Surface water data were compared to the groundwater drinking water standards because it was assumed the surface water was being used as a drinking water source. The COCs include:

- Chloride (State MCL is 250,000 µg/L) in the Main Lake and West Pond,
- Sulfate (State MCL of 250,000 µg/L) in the East Pond and West Pond,
- Ammonia (RBRG of 21 µg/L) in the Main Lake,
- Antimony (MCL of 6 µg/L) in the Main Lake and West Pond, and
- Manganese (Wyoming Water Quality Standard of 50 µg/L) in the Main Lake, East Pond, and West Pond.

Tables 5-24 and 5-25 of Volume II of the TSD#3 provides the site data, RBRG, and CLI for residential and non-residential receptors. It is unlikely these chemicals are from the former refinery, therefore, they will not be addressed further in the CMS or RD#3 document.

5.1.5.5 Fish Tissue Evaluation

The risk assessment evaluated potential human health risks resulting from consumption of fish taken from the Inlet Basin and Main Lake. Evaluation of analytes found in fish tissue in the COC selection process identified four COCs; arsenic, mercury, selenium, and zinc. The only fish exceedance was due to arsenic.

5.1.5.6 Waterfowl Evaluation

The risk assessment evaluated potential human health risks resulting from consumption of waterfowl taken from the Soda Lake Area. The waterfowl ingestion evaluation compared the maximum detected concentration for each COC to the residential RBRGs. There are no non-cancer exceedances. Arsenic, gamma-BHC, and TCDF exceed the CLI of 1 in the carcinogenic evaluation. The arsenic is likely related to naturally occurring levels. In addition, gamma-BHC, and TCDF exceedances occur in only one bird (one out of 10) at very low levels.

5.1.5.7 Air Evaluation

In August 1998, air samples were collected from eight monitoring locations across the Soda Lake Area and analyzed for VOCs and hydrogen sulfide, as described in Section 4.1.1 of Volume II of the TSD#3. All of the VOCs were present at concentrations below the applicable

occupational exposure limit, and most VOCs (with the exception of acetaldehyde) were well below the applicable odor detection thresholds. All of the VOCs, except acetaldehyde were also below applicable residential screening levels. Based on the available data, most VOCs do not appear to contribute to local odors nor threaten human health. While acetaldehyde was above residential screening levels, it is below occupational limits and the site is currently not used for residential purposes. The H_2S data indicate that the Main Lake is not a source of H_2S odors, but that the Inlet Basin did contribute some odors in the area immediately adjacent to the basin. H_2S levels were also above the applicable residential screening levels. However, based on current site use, hydrogen sulfide is not of concern and does not pose a risk to human health.

5.2 Ecological Risk Evaluation Result

The ecological risk assessment for the Main Lake, the East Pond and the West Pond was based on U.S. EPA guidance (1997, 1998), including development of an ecological food web (Figure 5-3). Because initial evaluation found ecologic impacts as a result of historic discharges to the Inlet Basin, the risk evaluation was conceived as a tiered baseline evaluation. A formal screening level risk assessment was not indicated, and a number of baseline steps to address specific ecological concerns identified in the Collaborative Process were envisioned from the beginning. Consequently, the evaluation was tiered and applied a "weight-of-evidence" approach to assess ecological risk.

In the tier 1 evaluation, the lines of evidence utilized for the evaluation included screening media concentrations against conservative surface water, sediment, pore water and phytotoxicity screening levels. In the tier 2 evaluation, the lines of evidence included modeling of PAHs and mercury bioaccumulation, total PAH toxicity using narcotic toxicity and organic carbon normalization, and evaluation of sediment bioassays. Other site observations conducted as part of the investigations provide additional lines of evidence.

Nine key assessment endpoints were defined for the aquatic habitats. The assessment endpoints, jointly, provide a snapshot of ecological risk to valued resources. Each of the assessment endpoints was evaluated through the tier 1 comparisons to appropriate screening levels, and for selected assessment endpoints, through tier 2 measurement endpoints. Each measurement endpoint constitutes a line of evidence. The tier 1 and tier 2 lines of evidence, taken together, provide a weight of evidence risk evaluation for each assessment endpoint. The absence of risk for any assessment endpoint suggests that no ecological risk is present.

The risk evaluation assumes that the Main Lake will remain a lake ecosystem. However, a future dry lake scenario was also considered. To assess ecological risk under the dry lake scenario, an alternative specific risk assessment was conducted where terrestrial animals were assumed to be exposed to the sediment under terrestrial conditions (See Section 6.7, Volume II, TSD#3).

The following summary presents the conclusions from the lines of evidence as they apply to each of the assessment endpoints.

5.2.1 Main Lake Weight-of-Evidence Evaluations

5.2.1.1 Aquatic Invertebrate Population (surface water exposure)

No detected organic COC exceedances were identified in the tier 1 screening. The apparent lack of risk to aquatic invertebrates is supported by the presence of a number of species, including sensitive species such as *Daphnia pulex*, callenoid copepods, and *Hyalella azteca*. Additional indirect evidence comes from surface water bioassays conducted in the Inlet Basin, where acute and chronic bioassays showed no evidence of toxicity. Also, there is no significant risk from exposure to COC with screening levels below the detection limit, based on modeling of maximum pore water concentrations from observed sediment concentrations. The pore water concentrations are below the screening level for these analytes, and overlying surface water is expected to have lower concentrations than the pore water.

The lines of evidence indicate there is no significant risk to aquatic invertebrates based on tier 1 screening, supported by additional observations.

5.2.1.2 Benthic and Epibenthic Organisms (exposed to sediment and sediment pore water)

With the exception of phenol, there were no exceedances of the high ("probable effect") screening level for detected COCs. The tier 1 sediment screening evaluation identified eight sediment sampling stations where there were exceedances of the low ("possible effect") screening levels, including six individual PAHs at six locations, with the maximum observed at two locations near the underflow weir. In addition there was one exceedance for benzene. The phenol exceedance was located away from the underflow weir. Three metals (cadmium, nickel and zinc) exceeded low but not high screening criteria. Metals distributions did not appear correlated with refinery sources.

The tier 1 pore water screening evaluation identified three organics exceeding screening levels; carbon disulfide (minimal exceedance in one location), acetone and phenol. Acetone is widespread and thought to be a laboratory contaminant. Phenol is localized and may be a biproduct of plant decomposition. Metals exceedances did not show a pattern consistent with a refinery source.

In addition to bioaccumulation modeling, bioassays were conducted on these surface sediment stations, as well as other stations, to further evaluate risk to benthic and epibenthic organisms. There was no consistency between the stations where chemical data exceeded screening levels and where the bioassays showed potential effects. Low level toxicity and non-recurring toxicity were observed in some samples and could be related to laboratory artifacts and procedures (see Section 6.4.2.1, Volume II, TSD#3). Although there were differences between the control bioassays when compared to bioassays from site sediments, the bioassay data indicate there are no acute risks and negligible sub-chronic risk to benthic and epibenthic organisms near the underflow weir. Chronic risks were not evaluated. Organisms were evaluated for growth in the site sediments compared to control sediments and the comparison was indeterminate. However, growth was observed in the area of potential impact indicating population growth and survival.

Total PAHs were also evaluated in the tier 2 assessment. No location exceeded organic carbon normalized total PAH threshold effect criteria (Schwartz,1999). Probability modeling

shows there were negligible risks to benthic invertebrates from sediment PAH in the Main Lake, based on a 'worst case' analysis.

In the tier 2 evaluation, total and alkyl PAHs were considered (HydroQual, 2001). No location exceeded the narcotic toxicity criteria, when a conservative estimate (factor of 16) of unmeasured, alkyl PAHs were included. One location exceeded the toxicity criteria, based on non-detected data with an elevated detection limit.

Finally, there are both diverse and abundant epibenthic invertebrates identified in the Main Lake. Benthic invertebrates are less diverse, but are locally abundant. Low diversity is believed to be attributed to poor quality habitat (low oxygen, high ammonia, and sulfide content of sediment).

The lines of evidence indicate there is negligible to no risk to aquatic invertebrates based on tier 1 and tier 2 risk evaluations, which is also supported by the presence of epibenthic and benthic invertebrates.

5.2.1.3 Submerged or Emergent Aquatic Vegetation (exposed to sediment)

The only sediment COCs which exceeded terrestrial phytotoxicity screening levels (used in the absence of aquatic vegetation levels) were metals: antimony, barium, chromium, manganese, thallium, and vanadium. Although it appears metals are a potential risk to aquatic vegetation, metals are ubiquitous throughout the Main Lake and appear to be primarily of natural origin.

The tier 1 screening indicates no risk to aquatic vegetation from refinery sources.

5.2.1.4 Benthic Fish (exposed to sediment and surface water)

The tier 1 screening indicates no risk is estimated from sediment and surface water contaminant concentrations from exposure to non-bioaccumulative COCs.

The potential for bioaccumulation of total PAHs and mercury in benthic fish (carp) was evaluated in the tier 2. The maximum detected total PAH in sediments does not exceed the NOAA fish sublethal value of 1,000 ppb (i.e., HQ<1). PAHs were also not detected in whole body carp in the Inlet Basin, where PAHs are known to be elevated.

Mercury (considered as organic mercury) bioaccumulation modeling demonstrated HQs < 1 for both the NOAEC and the LOAEC.

Finally, the Main Lake supports a carp population.

The lines of evidence indicate no risk to benthic fish based on tier 1 screening, tier 2 evaluations and observations of carp in the Main Lake.

5.2.1.5 Amphibians (exposed through the food web and directly to sediment and surface water)

Tier 1 screening indicates sediment and surface water are protective for direct contact (direct ingestion and dermal contact) for upper trophic level biota for non-bioaccumulative COCs.

In the absence of toxicity reference values for amphibian, endpoints defined for insectivorous birds were considered adequate surrogates.

Review of the lines of evidence for amphibian assessment endpoints defined for the Main Lake did not result in unacceptable risk.

5.2.1.6 Herbivorous Birds (exposed through the food web and directly to sediment and surface water)

Sediment and surface water are assumed to be protective for direct contact (direct ingestion and dermal contact) for upper trophic level biota.

Potential bioaccumulation of PAH and mercury was evaluated. It was assumed the representative species (mallards) consume water, sediment, epibenthic invertebrates and aquatic macrophytes. For modeled PAH exposure, the HQs were <0.01 for the NOAEC and LOAEC. For mercury, the modeled exposure HQs are <0.1 for the NOAEC and LOAEC.

5.2.1.7 Insectivorous Birds (exposed through the food web and directly to sediment and surface water)

Sediment and surface water are assumed to be protective for direct contact (direct ingestion and dermal contact) for upper trophic level biota.

Potential bioaccumulation of tPAH (defined as the sum of measured PAHs) and mercury was evaluated. It was assumed the representative species (American avocets) consume water, sediment and epibenthic invertebrates. For modeled tPAH exposure the HQs were <0.01 for the NOAEC and LOAEC. For mercury (considered as organic mercury), the modeled exposure HQs are < 1 for the NOAEC and LOAEC.

Review of the lines of evidence for insectivorous bird assessment endpoints defined for the Main Lake did not result in unacceptable risk.

5.2.1.8 Piscivorous Birds

Sediment and surface water are assumed to be protective for direct contact (direct ingestion and dermal contact) for upper trophic level biota.

Potential bioaccumulation of tPAH (defined as the sum of measured PAHs) and mercury was evaluated. It was assumed the representative species (osprey) consume water and fish. For modeled tPAH exposure the HQs were <0.01 for the NOAEC and LOAEC. For mercury (considered as organic mercury), the modeled exposure HQs are <1 for the NOAEC and LOAEC.

Review of the lines of evidence for piscivorous bird assessment endpoints defined for the Main Lake did not result in unacceptable risk.

5.2.1.9 Piscivorous Mammals

Sediment and surface water are assumed to be protective for direct contact (direct ingestion and dermal contact) for upper trophic level biota.

Potential bioaccumulation of tPAH (defined as the sum of measured PAHs) and mercury was also evaluated. It was assumed the representative species (mink) consume water, sediment and fish. For both modeled tPAH and mercury exposure, the HQs were <1 for the NOAEC and LOAEC.

Review of the lines of evidence for piscivorous mammal assessment endpoints defined for the Main Lake did not result in unacceptable risk.

5.3 Baseline and Long-term Risks Associated with Selenium

A separate investigation of the present and potential future risks of selenium to aquatic receptors was undertaken for the Main Lake (ThermoRetec, 2001b). Seleniferous soils are derived from marine Cretaceous shale formation which are widely distributed in Natrona County. Elevated levels of selenium occur in the North Platte River, thus entering the Soda Lake Area, as a result of drainage of seleniferous soils in the county. Seasonal inlet streams also contribute selenium to the Main Lake and Inlet Basin. Without any natural outlets, the majority of the selenium entering the topographic basin remains within the Main Lake. The investigation was undertaken to determine if selenium was at levels posing risks to fish, birds and mammals, and if over time, selenium could accumulate and rise to toxic levels.

A study of the Main Lake was undertaken to determine 1) the sources and flux of selenium in the Main Lake; 2) the potential risks to wildlife resources from those selenium sources today; and 3) to develop and calibrate a predictive fate model that could be used to project future selenium levels and risks.

Sources and flux of selenium to the Main Lake were evaluated by the collection and analysis of surface water (Main Lake, North Platte River, and inlet streams), groundwater, and sediments, including core profiles and redox measurements. Using these data, along with long-term pumping rates and site-specific evaporation data, a mass balance was estimated for the site. Results indicated that over 97% of the selenium mass is sequestered in the sediment compartment, with a large percentage of the selenium buried below the biologically active zone. The mass balance, along with sediment coring data, demonstrated that the deposition and burial of selenium in sediment is slightly greater than the annual inputs. Thus, selenium input is equal to selenium loss due to burial.

Potential wildlife risks were evaluated by the collection and analysis of selenium in receptor species at the Main Lake. Selenium was measured in chironomids, amphipods, emergent aquatic insects, phytoplankton, zooplankton, pondweed, carp, and American avocet eggs. Current risks were estimated by comparing point-measured values in surface water, sediments, and biota to the appropriate toxicity reference values derived through the scientific literature. Based on these point estimates, wildlife at the Main Lake were found to either have no risk, or potential risk (HQs < 10). A probabilistic risk assessment, based upon dietary uptake for American avocet, mallard, eared grebe, and osprey of selenium-laden prey, found that in all cases, the central tendency was well below the toxic threshold of 3000 ug/kg-body weight/day, dry

weight.

Approximately 20% of American avocet eggs contained selenium in concentrations below the toxicity reference value of 6 ppm and 80% were below the 16 ppm toxicity reference value for chick mortality in bird eggs.

A predictive fate model was developed and calibrated using the mass balance and biological body burden data. Model predictions indicate that the average selenium concentration in the Main Lake water column will most likely remain in the 3 to 4 ug/L range over the long term. This is consistent with the water column data, which show that for at least the 23 years of available data, water column concentrations have been constant (Volume I of TSD#3). Consistent with the flux estimates, the model predicts continued removal of selenium from the Main Lake (i.e., water column and bioactive sediment layer) by sediment burial. In addition ongoing selenium mitigation efforts on the Kendrick Irrigation Project should result in lower selenium levels in the North Platte River in the future. As a result, selenium concentrations in biota are predicted to stay constant over the next 100 years.

5.4 Alternative-specific Residual Risks

Residual risks associated with the recommended remedy were examined for the Inlet Basin. The residual risks for the Inlet Basin were determined by evaluating the COCs within the underlying native soils. The COCs were compared to RBRGs for both aquatic receptors (assuming that the Inlet Basin is re-flooded post-removal), and to RBRGs for upland terrestrial receptors (assuming the Inlet Basin is left dry, post-removal).

The residual risk evaluation has determined there are no exceedances of an RBRG HQ = 1 for any terrestrial receptor. For aquatic receptors, 2-methylnapthalene is the only constituent that exceeds the RBRG HQ = 1 (high sediment screening value). For aquatic receptors, individual PAHs (2-methylnapthalene, acenaphthene, chrysene, fluorene, naphthalene, phenenthrene, and pyrene), nickel and chromium exceeded the HQ = 1 but were less than HQ = 10 for the low sediment screening value. Dibenz(a,h)anthracene, anthracene and acenaphthylene were not detected but the detection limits were within the HQ =1 to HQ=10 range.

6 REMEDY EVALUATION CRITERIA

6.1 Threshold Criteria

The Consent Decree and W.S. §35-11-1605(a) of the WEQA require that all remedies comply with four threshold criteria before being further evaluated relative to the remedy selection balancing criteria. Acceptable remedies must:

1. Be protective of human health and the environment;
2. Comply with applicable standards;
3. Control the source(s) of release so as to reduce or eliminate, to the extent practicable, further releases of contaminants; and
4. Comply with applicable standards for waste management.

WDEQ's Remedial Option Evaluation and Management Scheme (ROEMS) (Waterstone, 2001) contains a detailed description of WDEQ's approach to evaluate proposed RAs relative to the threshold criteria. The following is a summary of the approaches found in ROEMS.

6.1.1 Protection of Human Health and the Environment

All remedies must, first and foremost, be protective of human health and the environment. Protection of human health and the environment can be further defined as the requirement that a proposed remedy, if implemented, results in clean-up such that an area, site, or unit is not (or does not have the potential to be) 1) immediately dangerous, 2) acutely hazardous, or 3) chronically hazardous to human or ecological receptors. Each of these must be considered for a proposed remedy.

Immediately dangerous and acute hazards to human and ecological receptors must be eliminated by removal or treatment of the hazard. If removal or treatment of the hazard results in contamination levels adequate to meet all remediation goals, then no further remedial action is necessary at the area, site or unit. However, if any residual contamination above remedial standards remains at the area, site, or unit, a remedy must be proposed and evaluated relative to the threshold criteria.

To determine whether compounds or conditions found in an area, site, or unit pose an immediate danger or acute hazard to human health, five attributes must be considered: 1) acute toxicity; 2) ignitability; 3) corrosivity; 4) reactivity; and 5) explosivity.

To determine whether compounds or conditions found in an area, site, or unit pose an immediate danger and/or acute hazard to ecological receptors, the following factors and considerations must be addressed:

- Physical hazards that can directly impact the numbers and variety of species, as well as their immediate physical condition. Immediately dangerous situations may include: 1) the presence of corrosive, ignitable, or reactive conditions or substances; 2) the presence of pits, piles or similar features that may engulf, wet, or oil a receptor; and 3) field observations of physical or toxic impacts to receptors (e.g., direct evidence of mortality, such as fish or bird kills).

- Acute effects based on an evaluation of the data against appropriate short-term criteria for aquatic and terrestrial receptors. ROEMS establishes screening levels for this evaluation. Acutely toxic conditions must be confirmed by determining whether: 1) concentrations exceed background; 2) exposure pathways are complete and receptors are present; 3) screening levels used to determine acute effects are appropriate; and 4) media concentrations represent site conditions.

Chronic risks were evaluated through the risk assessment process. The risk assessment process has resulted in the development of RBRGs to determine whether chronic risks to human health and the environment exist. In addition, the RBRGs have been used to define the level of protectiveness goal for any proposed remedy. The approach to addressing chronic risk to human health and the environment is consistent with that implemented by U.S. EPA.

6.1.2 Comply with Applicable Standards

The second remedy selection threshold criterion is that all remedies must comply with applicable standards, as defined in the Consent Decree. Final, media-specific applicable standards have been developed and selected by WDEQ through the Collaborative Process in consideration

of the menu of applicable standards contained in the Consent Decree. Any proposed remedy must ensure that contaminated media meet applicable standards. The applicable standards have been developed to protect human health and the environment (both short- and long-term risk to human and ecological receptors) in consideration of contaminant transfer from one medium to another.

6.1.3 Control Sources

The third threshold criterion is that all remedies must control source(s) of release so as to reduce or eliminate, to the extent practicable, further releases of contaminants. Sources of contamination on or off-site may present a threat to human health and the environment. Any proposed remedy must be demonstrated to prevent or mitigate the continuing migration of contaminant sources and/or future releases of contaminants.

6.1.4 Comply with Applicable Standards for Waste Management

The final threshold criterion is that all remedies must comply with the standards applicable to waste management. Waste generated during corrective action must be managed (i.e., treated, stored, or disposed of) in accordance with applicable local, state, and federal standards. Because it is the waste generator's (BP's) responsibility to understand and have knowledge of the applicable waste management requirements, specific waste management criteria are not described here.

6.2 Remedial Objectives

Through the Collaborative Process, WDEQ and BP have developed a set of remedial objectives and remedial standards that can be used to attain the threshold criteria for the Soda Lake Area. The remedial objectives consider a range of current and potential future land and water uses that range from unrestricted use of the area to the current restricted use. There are three remedial objectives for soil and two remedial objectives for sediment. Each of the remedial objectives include the development of applicable standards that are protective of human health and the environment and control sources.

The risk assessment (Volume II of the TSD#3) applies these remedial standards to the Soda Lake Area data, to identify the primary constituents that exceed these standards within applicable media. Tables 6-1 through 6-5 presents the remedial objectives tables and associated remedial standards that must be achieved by the selected remedy.

The CMS (Volume III of the TSD#3) presents and evaluates the selected remedy using the remedial standards presented in the remedial objective tables. The selected remedy will achieve each of the remedial standards and meet the threshold criteria for the protection of human health and the environment, compliance with applicable standards, and source control.

6.3 Balancing Criteria

Because WDEQ has determined that the selected remedy constitutes a waste unit removal action, comparison to other remedies using the balancing criteria is not relevant because no remedies, other than waste unit removal, were considered. The selected remedy was evaluated in Volume III of TSD#3, using the balancing criteria to analyze costs and benefits of implementing this remedy. A general explanation of each of the balancing criteria is given below.

6.3.1 Long-Term Effectiveness and Reliability

This criterion evaluates a remedy's effectiveness in meeting long-term objectives and standards. This includes determining the degree of uncertainty in achieving standards, remedy permanence (i.e., does the remedy have the inherent 'longevity' necessary to achieve standards), and what is the level of residual risk posed by any remaining contaminants.

For any remedy that includes engineering or institutional controls, the reliability of the controls needs to be determined. Therefore, the remedy should be evaluated for its degree of reliance on engineering and institutional controls, the reliability and potential for failure of the controls, the OM&M burden imposed by the controls, the ability to detect control failures, the consequence of failures, and the ability to correct control failures.

Remedies are favored that are more likely to achieve long-term standards and objectives, that rely less on engineering and institutional controls, and that have lower OM&M burdens.

6.3.2 Reduction in the Toxicity, Mobility or Volume of Contaminants

This criterion considers the degree to which a remedy incorporates treatment or removal of contaminants to lower the long-term risk to human health and the environment. Therefore, remedies should be evaluated, and will be favored, based on the extent to which the toxicity, mobility or volume of contaminants is reduced by treatment or removal.

6.3.3 Short-Term Effectiveness

This criterion considers the time required to attain standards, including the ability to achieve standards in a reasonable time period over most or all of the site. In addition, consideration should be given to the time necessary to substantially reduce contaminant concentrations and risks. Proposed remedies that achieve standards more quickly and that result in rapid reductions in contaminant concentrations during the early phases of remediation will be favored.

6.3.4 Impacts Due to Remedy Implementation

This criterion considers the adverse impacts associated with remedy implementation, and evaluates the gravity of any projected impacts, as well as the cost and availability of measures to mitigate the impacts. Evaluation of this criterion should consider the risks to workers and the community posed by the remedy during implementation, including the length, extent and significance of the risks, measures to mitigate the risks, and the cost of risk mitigation. Other adverse impacts during implementation should be considered, including short- and long-term disruptions to site land use, traffic disruptions, and visual, noise, and odor impacts.

Remedies will be favored that reduce risks to workers, neighbors, and the community during implementation. In general, remedies that minimize long-term disruption to land use will also be favored.

6.3.5 Practicable Capabilities

This balancing criterion considers the extent and nature of contamination and the practicable capabilities of a remedy to address the contamination, including whether it is technically practicable to attain cleanup standards and objectives. An evaluation of a remedy's capability to attain long-term standards and objectives is necessary. This may include an evaluation of demonstrated capabilities at other sites. While this criterion may generally favor demonstrated technologies, the practicable capabilities of potentially innovative technologies and their ability to achieve standards should be considered.

In evaluating a proposed remedy relative to this criterion, consideration should be given to whether remedy effectiveness is impacted by the extent and nature of contamination. The location, area and volume of contamination should be addressed as potential impacts on the intrinsic effectiveness and implementation of the remedy. In addition, the nature of contamination can also impact the effectiveness and implementation of a remedy. Ultimately, the nature of contamination and site conditions (e.g., hydrogeology) may place limitations on the effectiveness of a remedy in attaining final, long-term cleanup standards and objectives, resulting in a determination of technical impracticability.

Finally, consideration should also be given to the practicable capabilities of engineering and institutional controls over the time period they will be required.

Remedies with greater practicable capabilities to achieve final standards, considering the nature and extent of contamination, will be favored.

6.3.6 Future Land Use/Use Restrictions

This criterion addresses whether a proposed remedy is consistent with reasonably anticipated future land uses or the use restrictions contained in a UCA. In the absence of a UCA, the long-term remedial objective is to attain standards protective for any land use, including any potential future use. However, remedies must be capable of meeting remedial standards consistent with the current and any reasonably anticipated future land use.

If a UCA has been designated, remedies for soils should be evaluated relative to the use restrictions contained in the UCA. However, WDEQ's selection of alternate cleanup standards for a use control area is discretionary [W.S. §35-11-1605(c)].

In the absence of a UCA, remedies that are protective in the short-term for current and reasonably anticipated future land use, while progressing to attainment of long-term standards and objectives, will be preferred.

6.3.7 Nature and Complexity of Contaminant Releases

This criterion considers whether a remedy is consistent with the nature and complexity of releases of contaminants. A proposed remedy should be consistent with the contaminants and phases of contaminants present, including mobile, residual, dissolved and vapor phases. A proposed remedy should be consistent with the complexity of releases, including, among others, the type and number of releases, the locations/sources of releases, factors associated with release migration and transport, the hydrogeologic setting, and whether the releases are commingled.

Remedies are favored that are more suited to address petroleum hydrocarbon releases given hydrogeologic conditions. In addition, remedies are favored that address the location and depths of contamination and the variety of contaminant types.

6.3.8 Cost of Remedy

This criterion considers whether the remedy presents a substantial and disproportionately high cost for implementation and completion. Costs of remedies shall be compared considering the degree of risk reduction afforded by each remedy. Costs shall include capital, OM&M, engineering and institutional control costs and monitoring costs for the anticipated life of the remedy.

Possible factors to consider include the total net present value of the remedy, how much remedy cost is incurred by short-term versus long-term annual costs, what is the degree of uncertainty associated with cost estimates, and what are the costs of contingencies if the remedy is not effective.

Remedies are favored that result in the greatest reduction in risk without substantial and disproportionately high costs of implementation and completion relative to other remedies.

7 REMEDIAL ALTERNATIVES

The CMS (Volume III of the TSD#3) recommends the No Further Action alternative for all media at the Main Lake, the Northwest Drainage Area, and the Soda Lake Pipeline. Waste Unit Removal is the recommended remedial alternative for sediments or soil impacted by refinery operations within the Inlet Basin and the Caustic Disposal Area. The WDEQ accepts these recommendations as further discussed below.

The WDEQ has also determined a No Further Action decision is appropriate for site wide groundwater.

7.1 Main Lake and Northwest Drainage Area

Human health and ecological risk assessments were performed for the Main Lake and the Northwest Drainage Area. The human health risk assessment determined that there are no refinery related risks to humans at the Main Lake and Northwest Drainage Area. Constituents exceeding human health RBRGs are naturally occurring.

The ecological risk assessment determined there are no refinery related risks to ecological receptors from exposure to surface water or sediment porewater. The constituents that were detected at the Main Lake in surface water or sediment porewater are below acceptable screening levels, believed to be a laboratory artifact, or naturally occurring. The ecological risk assessment determined there are negligible to no risks to ecological receptors from impacted sediments near the underflow weir. This determination is based on a weight of evidence approach which included bioassays and bioaccumulation modeling. The WDEQ believes these risks are acceptable given that potential risk is limited to benthic or epibenthic organisms (higher trophic levels are not at risk); the risk is associated with a confined area of the Main Lake near the underflow weir; the refinery related risk drivers are PAHs which will naturally attenuate and finally, the source of the contamination (Inlet Basin sediments) will be removed as part of the waste unit removal action.

The Northwest Drainage was evaluated as part of the RFI soil investigation to determine the nature and extent of impacts from a 1973 crude oil pipeline release that flowed overland to the Main Lake. Soil samples collected along the Northwest Drainage did not show any visible effects of the historic oil spill. Organic compounds were not detected in soils above the human health or ecological screening criteria. Inorganic compounds that exceeded the human health and/or ecological screening criteria included arsenic, thallium, and vanadium. However, these compounds do not exceed background.

7.2 Soda Lake Pipeline

The RFI (Volume I of the TSD#3) presented the results of the Soda Lake Pipeline maintenance and testing. The maintenance records indicate that minor corrosion and scaling was observed in the pipeline during inspections. According to the RFI, when the pipeline condition was found unacceptable for continued operation, repairs were made. In 1990, repairs were made in a corroded section of the pipeline located south of Amoco Road.

Flow tests and hydrostatic tests, coupled with visual inspections, interviews with operations personnel and groundwater sampling results indicate that there have not been any releases of refinery waste water or North Platte River water. The last 800 feet above the Inlet Basin outfall was not hydrostatically tested because of concerns for causing pipe failure. This portion of the line was constructed below the water table and has experienced considerable external corrosion. Visual soil impacts were not indicated in the area adjacent to the last 800 feet of pipeline above the Inlet Basin outfall during test pit excavation. No analytical samples were collected from this section of the pipeline.

7.3 Site Wide Groundwater

The RFI (Volume I of the TSD#3) evaluated the potential for groundwater impacts from the Soda Lake Area. Hydrogeologic conditions and groundwater water quality were included in the evaluation. The hydrogeologic evaluation determined that there were two groundwater systems in the Soda Lake Area; a shallow system and a deeper regional system. All of the data suggest these two groundwater systems are not connected to each other in the Soda Lake Area. For the majority of the year, the shallow system is flowing into (i.e. recharging) and toward the Main Lake groundwater system. There is a short period of time during the year when the shallow system is not flowing toward the Main Lake on the east side. During this time, the gradient between the groundwater and the Main Lake is generally flat. Occasionally, the shallow groundwater in this area will migrate away from the Main Lake. However, the hydro-geologic conditions do not allow for off-site migration. The shallow groundwater system has been analyzed for quality. Both organic and inorganic constituents have been detected in groundwater along the east side of the Main Lake. The organic constituents are below screening levels (drinking water standards) or were not detected frequently enough to qualify as a COC in the selection process. Inorganic constituents are above drinking water standards, however, are not above background levels for the Soda Lake Area.

7.4 Inlet Basin Waste Unit Removal Action

The CMS (Volume III of the TSD#3) recommends implementation of a remedy for the excavation and removal of sediments that are impacted by refinery operations in the Inlet Basin. The sediments are uniformly impacted and distinct from the underlying native soils, making

removal a practicable alternative. The CMS recommends dewatering the Inlet Basin so that the sediments can be removed by dry excavation techniques, thereby facilitating visual identification of impacted sediments, and avoiding the complications and high costs of wet dredging. The CMS recommends dewatering the Inlet Basin by shutting off flow to the Inlet Basin from the North Platte River, blocking the underflow weir between the Main Lake and the Inlet Basin, and allowing evaporation to lower the levels of both bodies of water. Inflow of groundwater from surrounding land and through the weir from the Main Lake may have to be controlled by dewatering and/or seepage barriers along the dike. Further evaluation of the evaporation and dewatering processes will be conducted through work plan development.

According to the recommended remedy, the refinery impacted sediment will be removed by dry excavation techniques once the water levels in the Inlet Basin are sufficiently lowered. If possible and beneficial, the sediment will be removed in at least two stages to limit the time that dry sediment is exposed to the atmosphere, as well as the overall time of the remedy. Some reworking or tilling of the sediment during removal operations may be necessary to enhance drying of the sediment. All impacted sediment will be transported to the CAMU for disposal and must meet CAMU operating requirements.

Confirmation sampling is also part of the recommended remedy. Remaining native soils must meet remedial standards for either terrestrial or aquatic conditions, depending on whether or not the Inlet Basin and Main Lake are reflooded. If the Inlet Basin is not reflooded, the recommended remedy requires contouring and seeding of the final excavated grade.

7.5 Caustic Disposal Area

The CMS (Volume III of the TSD#3) recommends implementation of a remedy for the CDA soils impacted by refinery operations, consisting of removal of impacted soils and disposal in the CAMU. The excavation will be conducted within the bermed area that visually defines the CDA. Soils will be excavated down to the bedrock surface. WDEQ will require confirmation sampling as part of the selected remedy.

8 SELECTED REMEDY

This section contains WDEQ's selected remedy for sediments and soils on and beneath the Soda Lake Area.

8.1 Corrective Action Management Unit

In February 15, 2001, correspondence, WDEQ gave conditional approval to BP for the construction and operation of a CAMU (ThermoRetec, 2000b) at the Soda Lake Area. The CAMU is an engineered unit used for the management (i.e., treatment and disposal) of remediation waste generated during cleanup of the former refinery, including the Soda Lake Area. As such, the CAMU is being identified as a component of the selected remedy. If the CAMU cannot be used to manage remediation wastes generated as part of the Soda Lake Area cleanup, BP must propose, for WDEQ written approval, appropriate alternatives to manage wastes that would have been destined for the CAMU.

8.2 Inlet Basin Sediment Removal Action

This section describes the selected remedy for the Inlet Basin sediments impacted by refinery operations. For the purposes of this section, the term Inlet Basin sediments includes impacted sediments in the Inlet Basin, cap material, and recently deposited river sediments. Performance criteria for the selected remedy are found in Section 10. The selected remedy will be designed and implemented in accordance with sediment removal work plans that are submitted for WDEQ's written approval to meet the schedule requirements of Section 12.

Within six months of the effective date of the RM, BP shall submit for WDEQ approval a Phase 1 Inlet Basin Sediment Removal Work Plan that describes: 1) any dewatering or water management activities related to reducing water levels in the Inlet Basin and Main Lake; 2) measures to control dust and odor during dewatering of the Inlet Basin and Main Lake; 3) a program of air monitoring for worker safety in the area of the Inlet Basin and for off-site receptors and odors at the BP property boundary during Inlet Basin and Main Lake dewatering and; 4) a program to monitor impacts to the Soda Lake Area habitat during dewatering of the Inlet Basin and Main Lake. The Phase 1 Inlet Basin Sediment Removal Work Plan will be amended and modified as necessary in the Phase 2 Inlet Basin Sediment Removal Work Plan.

The Phase 2 Inlet Basin Sediment Removal Work Plan shall be submitted for WDEQ review and approval within two years of the effective date of the RM, and shall contain the information as described in this section.

The selected remedy for the Inlet Basin is a waste unit removal action through excavation of all sediments impacted by refinery operations. Impacted sediments can be differentiated from underlying native soils by color, consistency, and density (i.e., the Inlet Basin sediments are dark colored, fine-grained, and soft compared to the tan colored, dense, sandy native soils). The Inlet Basin sediments are currently covered by approximately14 feet of water. While it would be feasible to remove the submerged sediments by mechanical or hydraulic dredging techniques, it would be difficult to ensure that all impacted sediments were removed. Further, without significant additional measures, dredging would cause some resuspension and redistribution of impacted sediments within the basin, potentially re-contaminating areas of the basin that were already dredged. Therefore, this waste unit removal action allows dewatering of the Inlet Basin to facilitate removal of the sediment. This approach will allow more precise and complete removal of sediment based on its visible extent and avoid the potential re-suspension problems associated with wet dredging.

If an acceptable covenant not to sue, or other comparable mechanism, with agencies having jurisdiction and a habitat management partnership is established, and BP (or a member of the habitat management partnership) retains the necessary water rights, BP will continue to pump water to the Inlet Basin or the Main Lake until or unless any agency having jurisdiction or the habitat management partnership decides pumping should be discontinued. If these conditions are not met, dewatering of the Inlet Basin and the Main Lake will be a permanent condition (i.e., pumping is not resumed). Section 8.2.1 provides removal action requirements under the temporary dewatering scenario (i.e. pumping resumes) and under the permanent dewatering scenario (i.e. pumping is not resumed).

WDEQ has concluded that continued pumping of North Platte River water to the Main Lake and Inlet Basin following implementation of the selected remedy does not constitute a

violation of the WEQA.

8.2.1 Description of Removal Action
8.2.1.1 Temporary Dewatering - Pumping Resumes

During the first phase of the waste unit removal action, BP will cease pumping of North Platte River water to the Inlet Basin and Main Lake. As a result, water levels in the Inlet Basin and Main Lake will begin to lower by natural evaporation, gradually exposing the Inlet Basin sediment. At its greatest thickness and depth, the surface of the Inlet Basin sediment is at an elevation of approximately 5162 feet amsl. Because the Inlet Basin and the Main Lake are hydraulically connected, reducing water levels to this extent would remove all free water from the Inlet Basin and substantially shrink the footprint of the Main Lake (Figure 8-1), drying out approximately 70% of the current Main Lake surface water area. Drawdown of the Main Lake would have the following short-term impacts:

- reduction in aquatic vegetation and insects due to increased TDS;
- connection of nesting islands to main land, making them accessible to predators; thus eliminating nesting;
- elimination of nesting habitat in existing shallow water areas;
- reduction in the amount of habitat available and resulting in a reduction in the amount of bird use; and
- evaporative concentration of inorganic constituents (see Volume 1 of TSD#3) in the Main Lake surface water may have additional impacts.

BP and WDEQ recognize that the benefits of the removal of sediments impacted by refinery operations in the Inlet Basin outweigh these short-term impacts. Drawdown of the Main Lake provides the opportunity to enhance aquatic bird habitat in the long-term.

BP will evaluate the potential, to the extent practicable, for minimizing the extent of water level drawdown in the Main Lake required for dry removal of the Inlet Basin sediments. This evaluation will examine the localized dewatering options (e.g., dewatering points, wells, or drains in active excavation areas) and methods for temporarily reducing seepage through the dike between the Main Lake and Inlet Basin (e.g., temporary upstream barriers, such as low permeability soil, bentonite, or membranes). A plan for evaluating dewatering (Phase 1 Inlet Basin Sediment Removal Work Plan) and seepage control options (Phase 2 Inlet Basin Sediment Removal Work Plan) will be required (see Section 12).

Based on water balance modeling presented in Volume III of TSD#3, natural evaporation would reduce water levels in the Main Lake by 14 feet in five to eight years. Even if sediment removal can be conducted at higher water levels, several years of evaporation will still be required to lower the Main Lake water level. As part of this removal action, BP will evaluate the potential benefits (to wildlife that rely on the Soda Lake Area habitat) of accelerating the rate of evaporation and minimizing the time that lake levels are lowered. It should be noted that lowering the water level too quickly may result in adverse impacts by not allowing migratory birds sufficient time to adjust to the smaller water areas. However, if the evaluation shows that more

rapid lowering of the Main Lake and Inlet Basin water level would be beneficial to wildlife and practicable, BP will present plans for accelerating the evaporation process for WDEQ approval.

Treatability test results (see Appendix A, Volume III, TSD#3) indicate that the Inlet Basin sediments should drain by gravity fairly rapidly, and that normal excavation and handling processes should reduce water contents sufficiently to meet CAMU material acceptance criteria. If normal excavation and handling processes are not sufficient to meet CAMU water content requirements, BP may use the earth moving equipment to work and spread the sediment in the basin to promote drying. If working and temporary spreading of the material within the basin are still insufficient to adequately dry the sediment, BP will propose other methods to accelerate sediment dewatering, such as french drain systems installed prior to excavation or drying beds, for WDEQ review and approval.

The Inlet Basin sediment impacted by refinery operations should be removed in at least two stages, as portions of the Inlet Basin become dewatered. For example, when drawdown of the water level is 50% complete, sediment from contiguous and accessible areas of the Inlet Basin that are shallower than this water level (based on the bottom elevation of the Inlet Basin sediment) will be removed. This will 1) minimize the amount of time that sediments are exposed; 2) allow contractors to optimize removal and dewatering techniques before attempting to excavate sediments in deeper and more challenging areas; and 3) reduce the overall time period for remediation. WDEQ's final decision on staged removal will be based on information further refined in the Phase 2 Inlet Basin Sediment Removal Work Plan. In addition, WDEQ will consider potential odor issues when determining whether to conduct sediment removal in stages.

Sediments removed from the Inlet Basin will be placed in the CAMU. Sediments must meet placement requirements of the CAMU approval (February 15, 2001), or a WDEQ approved waiver will be required. There are an estimated 260,000 cy in-place volume of impacted sediments and cap material to be removed under current saturation and inundation conditions. As the water surface recedes and the material dries, this volume is estimated to decrease to approximately 200,000 cy.

Soil sample data reported in Volume 1 of the TSD#3 indicate that COC concentrations in native soils underlying the Inlet Basin sediments (which can be differentiated based on color, texture, and consistency) exceed screening levels for aquatic life but are below RBRGs for terrestrial wildlife. Aquatic life exceedances are less than an HQ of 10 for the low screening levels, except for 2-methylnaphthalene. Therefore, removal of all visibly impacted sediments (i.e., so that native soils are exposed throughout the basin) is expected to result in residual COC concentrations consistent with those reported in Volume 1, TSD#3. While soil sampling and analyses should not be necessary to guide the extent of sediment removal (because of the obvious visual difference between the sediment and native soil), this removal action includes collection of soil samples (Phase 2 Inlet Basin Sediment Removal Work Plan) from within the Inlet Basin after sediment removal is complete to confirm that residual risks are not higher than expected based on this excavation procedure and meet the remedial objectives based on future land use (i.e. aquatic). More details are provided in Section 10.

The waste unit removal action requires dust and odor control during dewatering of the Inlet Basin and the Main Lake, and excavation of the Inlet Basin. Therefore, the selected remedy includes staged hydroseeding of dewatered sediments in the Inlet Basin, and in the area near the underflow weir in the Main Lake.

Following the waste unit removal and confirmation that impacted sediment removal is complete, the underflow weir will be restored and the Inlet Basin and Main Lake will be reflooded.

8.2.1.2 Permanent Dewatering - Pumping Not Resumed

During the first phase of the waste unit removal action, BP will cease pumping of North Platte River water to the Inlet Basin and Main Lake. As a result, water levels in the Inlet Basin and Main Lake will begin to lower by natural evaporation, gradually exposing the Inlet Basin sediment. At its greatest thickness and depth, the base of the Inlet Basin sediment extends approximately 14 feet below current Inlet Basin water levels.

Based on water balance modeling presented in Volume I of TSD#3, natural evaporation would reduce water levels in the Main Lake by 14 feet in five to eight years. Even if sediment removal can be conducted at higher water levels, several years of evaporation will still be required to lower the lake water levels. As part of this removal action, BP will evaluate the potential benefits (to wildlife that rely on the Soda Lake Area habitat) of accelerating the rate of evaporation. It should be noted that lowering the water level too quickly may result in adverse impacts by not allowing migratory birds sufficient time to adjust to the smaller water areas. However, if the evaluation shows that more rapid lowering of the Main Lake and Inlet Basin water level would be beneficial to wildlife and practicable, BP will present plans for accelerating the evaporation process for WDEQ approval.

Treatability test results (see Appendix A, Volume III, TSD#3) indicate that the Inlet Basin sediments should drain by gravity fairly rapidly, and that normal excavation and handling processes should reduce water contents sufficiently to meet CAMU material acceptance criteria. If normal excavation and handling processes are not sufficient to meet CAMU water content requirements, BP may use the earth moving equipment to work and spread the sediment in the basin to promote drying. If working and temporary spreading of the material within the basin are still insufficient to adequately dry the sediment, BP will propose other methods to accelerate sediment dewatering, such as french drain systems installed prior to excavation or drying beds, for WDEQ review and approval.

The Inlet Basin sediment impacted by refinery operations should be removed in at least two stages, as portions of the Inlet Basin become dewatered. For example, when drawdown of the water level is 50% complete, sediment from contiguous and accessible areas of the Inlet Basin that are shallower than this water level (based on the bottom elevation of the Inlet Basin sediment) will be removed. This will 1) minimize the amount of time that sediments are exposed; 2) allow contractors to optimize removal and dewatering techniques before attempting to excavate sediments in deeper and more challenging areas; and 3) reduce the overall time period for remediation. WDEQ's final decision on staged removal will be based on information further refined in the Phase 2 Inlet Basin Sediment Removal Work Plan. In addition, WDEQ will consider potential odor issues when determining whether to conduct sediment removal in stages.

Sediments removed from the Inlet Basin will be placed in the CAMU. Sediments must meet placement requirements of the CAMU approval (February 15, 2001), or a WDEQ approved waiver will be required. There are an estimated 260,000 cy in-place volume of impacted sediments and cap material to be removed under current saturation and inundation conditions. As the water surface recedes and the material dries, this volume is estimated to decrease to

approximately 200,000 cy.

Soil sample data reported in Volume 1 of the TSD#3 indicate that COC concentrations in native soils underlying the Inlet Basin sediments (which can be differentiated based on color, texture, and consistency) exceed screening levels for aquatic life but are below RBRGs for terrestrial wildlife. Aquatic life exceedances are less than an HQ of 10 for the low screening levels, except for 2-methylnaphthalene. Therefore, removal of all visibly impacted sediments (i.e., so that native soils are exposed throughout the basin) is expected to result in residual COC concentrations consistent with those reported in Volume 1, TSD#3. While soil sampling and analyses should not be necessary to guide the extent of sediment removal (because of the obvious visual difference between the sediment and native soil), this removal action includes collection of soil samples (Phase 2 Inlet Basin Sediment Removal Work Plan) from within the Inlet Basin after sediment removal is complete to confirm that residual risks are not higher than expected based on this excavation procedure and meet the remedial objectives based on future land use (i.e. terrestrial). More details are provided in Section 10.

The waste unit removal action requires dust and odor control during dewatering of the Inlet Basin and the Main Lake, and excavation of the Inlet Basin. Therefore, the selected remedy includes staged hydroseeding of dewatered sediments in the Inlet Basin, and in the area near the underflow weir in the Main Lake.

Following the waste unit removal and confirmation that impacted sediment removal is complete, the Inlet Basin will be regraded and seeded, as necessary, to ensure that remedial objectives are met.

8.2.2 Evaluation of the Selected Remedy

The selected remedy for the Inlet Basin is designed to be consistent with unrestricted land use defined in Soil RO#1 in an unflooded state, and with unrestricted recreational use in a flooded state as defined Sediment RO#1. These remedial objectives were presented and evaluated in Volume II of the TSD#3.

The selected remedy for the Inlet Basin is generally consistent with the remedy presented in Volume III of the TSD#3. WDEQ has determined that the selected remedy meets the threshold criteria. Because WDEQ has determined that the selected remedy for the Inlet Basin constitutes a waste unit removal action, evaluation of the remedy relative to the balancing criteria is not relevant because no remedies, other than waste unit removal, were considered.

8.2.3 Contingencies

If the results of confirmation sampling indicate that performance criteria in Section 10 cannot be attained through excavation, then BP may petition WDEQ for implementation of alternative remedies including engineering or institutional controls.

The Phase 1 and Phase 2 Inlet Basin Sediment Removal Work Plans will include contingencies to address impacts to the Main Lake, if any, caused by drainage of Inlet Basin water during dewatering, and dust and odors that exceed performance criteria.

8.2.4 Required Work Plans

The following work plans will be prepared prior to implementation of the Inlet Basin removal action:

Inlet Basin Sediment Removal Work Plans (Phase 1 and Phase 2)

These plans will include the design details for implementation of the selected remedy. Specific elements of the Phase 1 Inlet Basin Sediment Removal Work Plan will include dewatering, surface water management, dust and odor control, air monitoring, and monitor habitat impacts. Specific elements of the Phase 2 Inlet Basin Sediment Removal Work Plan will include additional or modified dewatering or surface water management, seepage control, excavation techniques, modification of the air monitoring program based on excavation techniques and previously collected air monitoring data and information, waste removal confirmation sampling, transportation, and performance specifications required for Inlet Basin sediments to be placed in the CAMU. Additional work plan provisions may be included by agreement of WDEQ and BP.

As-Built Report

A final as-built report will be developed to demonstrate that refinery impacted sediments were removed to the specified lines and grades, that all visible refinery-impacted sediments were removed, that the results of confirmation sampling met performance criteria, and that materials placed in the CAMU met requirements of the approved Materials Management Plan. The as-built report will describe post-removal conditions and show final grades.

8.3 Caustic Disposal Area Removal Action

8.3.1 Description of Removal Action

The selected remedy for the CDA includes removal of refinery impacted soils to meet the performance criteria specified in Section 10. The horizontal extent of soils to be removed is the bermed area of the CDA, and the vertical extent is to bedrock, approximately three feet bgs (Figure 8-2). Excavated soils will be placed in the CAMU. Confirmation sampling will be required to demonstrate that soils exceeding performance criteria have been removed. The excavated area will be backfilled with native soils, graded to blend with the natural topography, and reseeded.

8.3.2 Evaluation of the Selected Remedy

The selected remedy for the CDA is designed to be consistent with unrestricted land use defined in Soil Remedial Objective #1. These remedial objectives were presented and evaluated in Volume II of the TSD#3.

The selected remedy for the CDA is generally consistent with the remedy for CDA soils presented in Volume III of the TSD#3. WDEQ has determined that the selected remedy meets the threshold criteria. Because WDEQ has determined that the selected remedy for the CDA constitutes a waste unit removal action, evaluation of the remedy relative to the balancing criteria is not relevant because no remedies, other than waste unit removal, were considered.

8.3.3 Required Work Plans

The following work plans will be prepared prior to implementation of the CDA waste unit removal action:

CDA Soil Removal Plan

This plan will include the design details for removing the soils impacted by refinery operations from the CDA. Specific elements of this plan will include: impacted soil removal, dust monitoring and control, grading and seeding, confirmation sampling, and management of soils to meet CAMU disposal requirements.

As-Built Report

A final as-built report will be developed to demonstrate that soils exceeding remedial standards were removed, that the results of confirmation sampling met performance criteria, and that materials placed in the CAMU met requirements of the approved Materials Management Plan. The as-built report will also describe post-removal conditions and show final grades for the CDA.

8.4 Other Units within the RD#3 Area

No Further Action is the selected remedy for all other areas and media within the Soda Lake Area including the Main Lake, the Soda Lake Pipeline, the Northwest Drainage Area, and site-wide groundwater, as described in Section 7. Based on existing and predicted future conditions, it is WDEQ's judgement that continued pumping of North Platte River water to the Main Lake and Inlet Basin (following removal of Inlet Basin sediment impacted by refinery operations) will not result in adverse impacts to human health and the environment and does not constitute a violation of the WEQA. The No Further Action determination does not cover impacts to the Soda Lake Area due to unanticipated future conditions.

8.5 Removal/Remedial Standards and Objectives

Contaminants in soils, sediments and sources may present risks to human and ecological receptors. This section identifies the remedial standards for COCs in soils that exceed terrestrial use and aquatic use criteria.

8.5.1 Terrestrial Use Criteria

This section identifies the remedial standards for COCs in soils (in the table below) that exceed the following criteria:

Ecological health COC with an HQ between 1 and 10 using the lowest RBRG identified for terrestrial receptors in Volume II of TSD#3.

8.5.2 Aquatic Use Criteria

This section identifies the remedial standards for COCs in soils (in the table below) that exceed the following criteria:

Ecological health COC with an HQ between 1 and 10 using benthic low screen value, as identified in Volume II of TSD#3.

The residual risk evaluation has determined that for aquatic receptors, the only constituent that exceeded a benthic ecological high screen HQ = 1 was 2-methylnaphthalene. Also, for aquatic receptors, individual PAHs (2-methylnaphthalene, acenaphthene, chrysene, fluorene, naphthalene, phenenthrene, and pyrene), nickel, and chromium exceeded an HQ = 1, but were less than HQ = 10 for the low sediment screening value. Dibenz(a,h)anthracene, anthracene and acenaphthylene were not detected, but the detection limits were within the HQ =1 to HQ=10 range.

In addition, chromium (HQ = 1.1) and nickel (HQ = 1.5) slightly exceeded low screening values but no high screen values. However, these metals are unlikely to be a risk-based concern due to minimal exceedances and lower bioavailability.

Remedial Standards for Aquatic Sediments or Soils					
Soil Standards and Objectives (mg/kg)					
Constituents of Concern	Waste Unit	Ecological Terrestrial Long-Term Remedial Objective (HQ=1)	Ecological Terrestrial Remedial Standards (HQ=10)	Ecological Aquatic Long-Term Remedial Objective (HQ=1)	Ecological Aquatic Remedial Standards (HQ = 10)
2-methylnaphthalene	Inlet Basin	964	9640	0.02	~~0.02~~ 0.2
acenaphthene	Inlet Basin	2830	28300	0.0059	0.059
chrysene	Inlet Basin	839	8390	0.027	0.27
fluorene	Inlet Basin	2490	24900	0.01	0.1
naphthalene	Inlet Basin	1125	11250	0.015	0.15
phenenthrene	Inlet Basin	2427	24270	0.019	0.19
pyrene	Inlet Basin	371	3710	0.044	0.44
lead	CDA	33	330	NA	NA
3,4 - methylphenol	CDA	53	530	NA	NA

Note 1: Detection limits in routine analysis of environmental samples approved for CERCLA Contract Laboratories is 0.33 mg/kg for individual PAHs in a low moisture sample. Most laboratories cannot meet detection limits commensurate with the aquatic long-term remedial objective or even the HQ=10 remedial standards without special method development.

8.6 Points of Compliance

Implementation of the selected remedy for soils on the Soda Lake Area must ensure that remedial standards, which are protective of ecologic receptors, are met at relevant POCs upon completion of the selected remedy. If the Inlet Basin is permanently dewatered, the relevant POC for ecological terrestrial receptors is the upper two feet. If the Inlet Basin is reflooded, the

relevant POC for aquatic receptors is the top 10 cm (four inches) of the sediment surface. The POC for the CDA is the top of bedrock or two feet, whichever is shallower.

8.7 Annual Reporting

On an annual basis, BP shall report activities related to implementation of the selected remedy. The annual report is due to WDEQ no later than April 1st of each year.

The annual report shall provide a summary of remedy implementation activities occurring in the previous year including: 1) for each component of the selected remedy, a description and estimate of the percentage of the component that has been implemented, as well as a description and estimate of the percentage of the component expected to be implemented in the coming year; 2) for each component of the selected remedy that is subject to design study, benchscale testing, or pilot testing, a description of the status and the results of study or testing; 3) a description of activities related to implementation and monitoring of institutional controls; 4) an identification of any activity or requirement of the remedy decision not completed in a timely manner, and problem areas or anticipated problem areas affecting compliance with the remedy decision; 5) a description and summary of remedy monitoring activities; 6) a description and summary of remedy performance; 7) a description of actions taken to address and rectify problems related to implementation of the selected remedy, including institutional controls and Reuse problems; and 8) a description of other corrective action and Reuse activities, including progress and status, undertaken pursuant to this remedy decision.

The annual review should also document modifications or upgrades that have been implemented in the previous year or that would enhance or optimize system performance.

8.8 Five Year Review

The five year review was intended to evaluate the progress of long-term remedial actions. The RD#3 remedy should be complete in less than 10 years, therefore, the requirement for a five year review is tentatively waived. However, any evaluation or actions that would normally occur during a five year review must be addressed adequately by the annual review process, described above. General requirements of the five year review are outlined in Section 8 of RD#1 and RD#2. WDEQ may re-activate the five year review process if the as-built reports are not submitted by BP and approved by WDEQ within 10 years, beginning with the April 1, 2013 report, or as long as a UCA is required for any areas within the Soda Lake Area.

9 INSTITUTIONAL CONTROLS

9.1 CAMU

BP submitted the Corrective Action Management Unit (CAMU) Application dated October 16, 2000 (as amended on December 15, 2000), which was approved by WDEQ on February 15, 2001. Section 8.1 of the approved application requires that, at closure of the facility, BP file for record in Natrona County, Wyoming, a deed notice instrument that restricts any potential activity that would disturb the containment or cover system or functioning of the monitoring systems. BP is not required to establish or implement any additional institutional controls on the CAMU under this RD#3.

9.2 Soda Lake Area (Excluding the CAMU)

9.2.1 No Institutional Controls Required

It is anticipated that after the selected remedy is implemented under RD#3, all of the Soda Lake Area (excluding the CAMU) will meet unrestricted standards. BP is not required to establish or implement institutional controls on the Soda Lake Area.

9.2.2 Contingent Institutional Controls

If unrestricted standards are not attained, BP will establish and maintain the following institutional controls in the Soda Lake Area (excluding the CAMU):

- a Use Control Area (UCA) approved by Natrona County and filed for record in the office of the Natrona County Clerk; and
- a Notice of Use Restrictions and Environmental Conditions that contains use restrictions consistent with the UCA filed for record in the office of the Natrona County Clerk.

9.3 Alternate Institutional Controls

If WDEQ determines that any proposed ICs would not be effective in protecting against human exposure to contamination, BP shall then propose, for WDEQ approval, alternate institutional controls or other actions to correct these deficiencies. In the event an approvable IC or other action is not identified, WDEQ may require this RD#3 to be reopened.

10 PERFORMANCE CRITERIA AND PERFORMANCE MONITORING OF THE SELECTED REMEDY

This section of the RD#3 presents performance objectives, performance criteria, and minimum monitoring requirements for the waste unit removals for the Inlet Basin impacted sediments and CDA soils.

10.1 Performance Criteria and Performance Monitoring Goals

The performance criteria and monitoring requirements described herein are intended to measure the success of the remedy at meeting performance objectives, with the following general goals (in any cases of conflicts or inconsistencies between the general goals and the specific performance criteria, the specific performance criteria shall take precedence):

10.1.1 Verifying Location

Some of the performance monitoring requirements and criteria have been established to ensure that the remedial actions are implemented in all the necessary areas, as well as ensuring that remedial actions are not conducted where they are not necessary or will not be effective.

10.1.2 Confirmation of Design Parameters

The waste unit removal actions are based on assumed: subsurface conditions, evaporation and sediment dewatering rates, material handling characteristics, removal performance, and consistency with CAMU approval requirements. Therefore, some of the performance monitoring requirements and criteria were established to verify that actual conditions are consistent with those assumed in design.

10.1.3 Extent of Removal

Some of the performance objectives are intended to ensure that sediments and soils are removed to the extent required to meet remedial standards and performance objectives. Incomplete removal will trigger additional removal, if practicable, or institutional controls.

10.1.4 Remediation Time Period

The actual progress of remediation will be monitored to ensure that the remedy is likely to achieve the intended remediation standards in a reasonable time period. The remediation time period is defined in the Volume III, TSD#3. Some of the performance criteria may trigger additional actions to ensure that the remedy is completed in a timely manner.

10.2 Dewatering of Inlet Basin Sediments

10.2.1 Temporary Dewatering Option

10.2.1.1 Performance Objectives

a. Dewater Inlet Basin sediments to the extent necessary to allow removal by dry excavation methods, to minimize mixing of sediments and underlying native soils by excavation equipment, and to allow visual identification of the sediment/native soil interface by equipment operators.

b. Minimize the time period that Main Lake sediments are temporarily exposed due to dewatering, to the extent practicable and beneficial to ecological receptors, and control dust and odor impacts.

c. Prevent or minimize impacts to the Main Lake due to drainage of Inlet Basin water into the Main Lake during dewatering (e.g., due to consolidation drainage of Inlet Basin sediments).

10.2.1.2 Performance Criteria and Monitoring

a. BP shall monitor water levels in the Main Lake and Inlet Basin on a quarterly basis after pumping of river water to the Main Lake ceases. Based on an annual evaluation and using at least two years of measurements, if the time to achieve the predicted water level decline is more than 25% longer than the time estimated to achieve that water level in the approved Phase 1 Inlet Basin Sediment Removal Work Plan, BP shall evaluate the cause of the slower drawdown rates. The evaluation shall consider the time predicted to achieve the minimum drawdown necessary to complete dry removal of the sediments, any adverse impacts that might result from the slower drawdown rates and, if necessary, potential

methods to accelerate the rate of drawdown. BP shall submit the results of the evaluation in the next annual report. The 25% criteria may be revised with WDEQ approval.

b. When water levels have drawn down sufficiently to allow access (estimated to be at an Inlet Basin surface water elevation of 5168 feet amsl), BP shall install piezometers in the Inlet Basin sediments at representative locations as identified in the approved Phase 1 Inlet Basin Sediment Removal Work Plan and monitor water levels on a quarterly basis. The purpose of this component of the monitoring is to verify predicted dewatering rates within the sediments and to determine whether groundwater inflow or seepage is impeding dewatering of the Inlet Basin. If, after one year of measurements dewatering rates are 25% slower than predicted rates in the approved Phase 1 Inlet Basin Sediment Removal Work Plan, BP shall conduct the evaluation stipulated in paragraph a. above. BP shall submit the results of the evaluation in the next annual report. The 25% criteria may be revised with WDEQ approval.

c. If the results of quarterly water level measurements in the sediment piezometers indicate that water in the sediments is draining toward the Main Lake, BP shall evaluate the cause of the gradient reversal from the Inlet Basin to the Main Lake and report to WDEQ the results of such evaluation. If the reversal is confirmed, BP shall propose a surface water monitoring program in the Main Lake for WDEQ approval. Alternately BP could propose enhanced dewatering actions in the sediment designed to reverse gradients. Other actions may be required by WDEQ, depending on the extent and nature of any impacts to the Main Lake.

d. The Phase 1 Inlet Basin Sediment Removal Work Plan will propose performance criteria and monitoring requirements for dust and odor control.

10.2.2 Permanent Dewatering Option

10.2.2.1 Performance Objectives

a. Dewater Inlet Basin sediments to the extent necessary to allow removal by dry excavation methods, to minimize mixing of sediments and underlying native soils by excavation equipment, and to allow visual identification of the sediment/native soil interface by equipment operators.

b. Minimize impacts to the Main Lake due to drainage of Inlet Basin water into the Main Lake during dewatering (e.g., due to consolidation drainage of Inlet Basin sediments), and control dust and odor impacts.

10.2.2.2 Performance Criteria and Monitoring

a. BP shall monitor water levels in the Main Lake and Inlet Basin on a quarterly basis after pumping of river water to the Main Lake ceases. Based on an annual evaluation and using at least two years of measurements, if the time to achieve the predicted water level decline is more than 25% longer than the time estimated to achieve that water level in the approved Phase 1 Inlet Basin Sediment Removal Work Plan, BP shall evaluate the cause of the slower drawdown rates. The evaluation shall consider the time predicted to achieve the minimum drawdown necessary to complete dry removal of the sediments, any adverse impacts that might result from the slower drawdown rates and, if necessary, potential

methods to accelerate the rate of drawdown. BP shall submit the results of the evaluation in the next annual report. The 25% criteria may be revised with WDEQ approval.

b. If, after most of the standing water has been drained from the Inlet Basin, impacted sediments are not capable of being handled by dry excavation equipment (e.g. bull dozers, excavators, scrapers), BP shall evaluate alternatives to enhance or accelerate dewatering.

c. If, as a result of quarterly surface water elevation monitoring, the difference between the Main Lake and the Inlet Basin is four feet or greater, BP shall propose for WDEQ approval a water management strategy to reduce the differential to less than four feet. Other actions may be required by WDEQ, depending on the extent and nature of any impacts to the Main Lake.

d. The Phase 1 Inlet Basin Sediment Removal Work Plan will propose performance criteria and monitoring requirements for dust and odor control.

10.3 Sediment Remedy for the Inlet Basin Sediments

10.3.1 Performance Objectives

a. Remove refinery impacted sediments from Inlet Basin (excluding East Pond and West Pond) and confirm that COC concentrations in the remaining native soils meet remedial objectives and standards.

b. Manage or dewater sediments as necessary to meet acceptance criteria for placement in the CAMU, and control dust and odor impacts.

c. Remove refinery impacted sediments from the East Pond and West Pond based on line and grade shown in Figure 8-1.

10.3.2 Performance Criteria and Monitoring

a. Remove impacted sediments from the Inlet Basin according to the lines and grades shown in Figure 8-1 using the procedures presented in the WDEQ approved Phase 2 Inlet Basin Sediment Removal Work Plan. Excavate until all visible refinery impacted sediments are removed. Survey the final grade to demonstrate compliance with the lines and grades as shown in Figure 8-1. Provide adequate photographic and/or videographic evidence that all visible refinery impacted sediment has been removed, unless other documentation methods are approved in writing by WDEQ.

b. The sediments must be sufficiently dewatered at the time of excavation to allow the use of dry excavation equipment (e.g., bulldozers, scrapers, backhoes), so that the interface between the refinery-impacted sediments and the underlying native soils can be observed by equipment operators and WDEQ representatives. It is anticipated that local areas within the Inlet Basin may not be fully dewatered and that wet excavation in those areas may be appropriate. Such wet excavation approaches shall be described in the Phase 2 Inlet Basin Sediment Removal Work Plan.

c. The sediments must meet CAMU requirements, or a WDEQ approved waiver, prior to transport to and disposal in the CAMU. If the excavation and handling procedures

described in the WDEQ approved Phase 2 Inlet Basin Sediment Removal Work Plan are not sufficient to meet these criteria, BP shall cease transport of material to the CAMU, evaluate and submit alternatives for sufficiently managing or treating the sediments to meet this criterion, and implement the WDEQ approved alternative.

d. Following removal of sediments from the Inlet Basin, collect at least 10 confirmation samples of the underlying native soils at random locations within the Inlet Basin excluding the East Pond and West Pond. Composite samples over a depth of two feet, if the area will not be flooded again (i.e., terrestrial remedial standards apply), or over a depth of four inches if the area will be flooded and aquatic remedial objectives apply, and analyze for the PAHs listed in Section 8.5. No further action is required if the 95% UCL of the means for the PAHs are within an HQ of 1 to 10 of the low benthic screening values (Section 8.5) and none of the individual samples is more than twice the HQ of 10 concentration.

e. If the 95% UCL for any of the PAHs listed in Section 8.5 exceeds the HQ of 100 of the low benthic screen, conduct additional sampling and excavation at the location of each sample that exceeds an HQ of 100. The extent of soil exceeding the HQ of 100 shall be determined by the following procedure: collect a minimum of four samples at randomly selected locations within a 50 by 50 foot area, centered over each sample location where the sample concentration was greater than the HQ of 100. For aquatic uses collect the sample over a depth of 0-4 inches. For terrestrial uses, collect the sample over a depth of zero to two feet following regrading. Composite the four samples and analyze the composite for the COCs exceeding the HQ of 100. If the results of the composite analysis exceed the HQ of 100, excavate soils in the corresponding interval of the sampling sector. Continue sampling adjacent sectors until clean sectors (below HQ of 100) are found in all directions. Repeat confirmation sampling over newly exposed surfaces in excavated sectors. BP may elect to sample smaller sectors to reduce the volume of required excavation.

f. As an alternative to paragraph (e), above, if the 95% UCL for any of the PAHs listed in Section 8.5 exceeds the HQ of 100 of the low benthic screen, conduct additional sampling and excavation at the location of each sample that exceeds an HQ of 100. The extent of soil exceeding the HQ of 100 shall be determined by the following procedure: collect a single grab sample at a randomly selected location within a 50 by 50 foot area, centered over each sample location where the sample concentration was greater than the HQ of 100. For aquatic uses collect the sample over a depth of 0-4 inches. For terrestrial uses, collect the sample over a depth of 0-2 feet following regrading. Analyze the sample for the COCs exceeding the HQ of 100. If the results of the analysis exceeds two times the HQ of 100, excavate soils in the corresponding interval of the sampling sector. Continue sampling adjacent sectors until clean sectors (below two times the HQ of 100) are found in all directions. Repeat confirmation sampling over newly exposed surfaces in excavated sectors. BP may elect to sample smaller sectors to reduce the volume of required excavation.

g. If the 95% UCL for any of the PAHs listed in Section 8.5 exceeds the HQ of 10 of the low benthic screen value, but is less than the HQ of 100 of the low benthic screen value, such PAH impacted sediment will be remediated by natural attenuation.

h. If the results of confirmation sampling according to paragraph (e) or (f), above, indicate

that substantial quantities of native soils would require removal to achieve performance criteria, or if additional dewatering would be required to conduct further excavation, BP may petition WDEQ to designate the site a UCA in lieu of further removal. Institutional controls associated with the UCA must be sufficient to meet remedial objectives associated with the terrestrial or flooded land use, as applicable.

i. The Phase 2 Inlet Basin Sediment Removal Work Plan will propose modifications to the Phase 1 Inlet Basin Sediment Removal Work Plan performance criteria and monitoring requirements for dust and odor control.

10.4 Caustic Disposal Area

10.4.1 Performance Objectives

a. Prevent human contact with soils containing, within exposure areas based on Reuse agreement land use, average concentrations of COCs above the long-term remedial objectives listed in Section 8.5.

10.4.2 Performance Criteria and Monitoring

a. Remove soils from the CDA according to the lines and grades shown on Figure 8-2 using the procedures presented in the approved Soil Removal Work Plan.

b. Following removal of impacted soils from the CDA, collect at least five confirmation grab samples at the following locations: one from the base of the excavation and the other four from each of the respective sides near the base of the excavation, and analyze for the COCs listed in Section 8.5. No further action is required if none of the individual samples is more than two times the remedial standard.

c. If any of the grab samples exceed two times the remedial standard, re-excavate the area of the exceedance and collect a new confirmation grab sample. Repeat confirmation sampling over newly exposed surfaces in excavated sectors until two times the remedial standard is achieved.

11 OPERATION, MAINTENANCE AND MONITORING OF THE SELECTED REMEDY

The selected remedy for refinery impacted sediments in the Inlet Basin and refinery impacted soils in the CDA is excavation and placement in the CAMU. An OM&M manual is not necessary for these excavations as long as they are being conducted in accordance with WDEQ approved work plans as described in Section 12 and the performance criteria in Section 10. CAMU OM&M activities are addressed in the CAMU Material Management Plan.

12 WORK PLANS AND SCHEDULE

All work plans required by this section must be approved in writing before implementation of the remedy.

12.1 Master Work Plan and Schedule

BP shall submit a Master Work plan and Schedule (MWS) to WDEQ for review and approval within six months of the effective date of the RM. The MWS shall present an integrated conceptual design for the selected remedy, including a narrative description, conceptual layout drawings, and a conceptual monitoring plan and a general description of the reuse development plans and schedule. The MWS shall also include a proposed schedule for submittal of individual design work plans and schedules, as listed in Section 12.2.

12.2 Work Plans

1. Phase 1 and Phase 2 Inlet Basin Sediment Removal Work Plans as required by Section 8.2.
2. CDA Soil Removal Work Plan as required by Section 8.3.

12.3 Reporting Schedule

1. Master Work Plan and Schedule (Section 12.1) - Within six months of the effective date of the RM.
2. Phase 1 Inlet Basin Sediment Removal Work Plan (Section 8.2) – Within six months of the effective date of the RM.
3. Phase 2 Inlet Basin Sediment Removal Work Plan (Section 8.2) – Within two years of the effective date of the RM.
4. CDA Soil Removal Work Plan (Section 8.3) – Within two years of the effective date of the RM (this work plan may be combined with Phase 2 Inlet Basin Sediment Removal Work Plan).
5. Annual Report (Section 8.7) – April 1, 2003, and annually thereafter.
6. Five Year Review Report (Section 8.8) – Tentatively waived, pending submittal and approval of the as-built reports for RD#3 before April 1, 2013.

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The parties have signed this Remedy Decision #3 on the dates set forth below.

FOR BP PRODUCTS NORTH AMERICA, INC.
a Maryland Corporation

By: _____ 1/10/02

Gregory J. Wurtz — Date

FOR BP CORPORATION NORTH AMERICA, INC.

By: _____ 1-10-02

Janice McLain — Date

FOR WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

By: _____ 1-10-02

Dennis Hemmer, WDEQ Director — Date

By: _____ 1-10-02

David A. Finley, SHWD Administrator — Date

By: _____ 1/10/02

Carl Anderson, Program Manager — Date

By: _____ 1/10/02

Vickie Meredith, Project Supervisor — Date

ATTORNEY GENERAL'S OFFICE APPROVAL AS TO FORM:

By: _____ 1-10-02

Maxine R. Weaver, Senior Assistant Attorney General — Date

Tables

Table 4-1 Soda Lake RFI Analyte List and Reporting Limits

Constituent	Method of Analysis	Practical Quantitation Limit			Threshold Criteria						
		Water[a]	Sediment	Soil	Groundwater	Surface Water			Sediment		Soil
						HH fresh	freshwater	saltwater	Low Screen	High Screen	
					Human Health		Ecological				
Volatile Organic Compounds		***µg/L***	***µg/kg***	***µg/kg***	***µg/L***	***µg/L***	***µg/L***	***µg/L***	***mg/kg per 1%OC***	***mg/kg per 1%OC***	***mg/kg***
1,1-Dichloroethene	8260	1.0	1.0	1.0		7	25		NA	NA	
1,1,2,2-Tetrachloroethane	8260	1.0	1.0	1.0		NA	420		0.94	NA	
1,1,1-Trichloroethane	8260	1.0	1.0	1.0	200	200	62		0.17	NA	0.125
1,1,2-Trichlorotrifluoroethane	8260	2.0	1.0	1.0							
1,2,3-Trichloropropane	8260	3.0	3.0	3.0							
1,2,4-Trimethylbenzene	8260	1.0	1.0	1.0	1.2	1.2	NA		NA	NA	390
1,3,5-Trimethylbenzene	8260	1.0	1.0	1.0	1.2	1.2	NA		NA	NA	390
2-Butanone	8260	5.0	5.0	5.0							
2-Hexanone	8260	5.0	5.0	5.0	150	150	99		NA	NA	310
4-Isopropyltoluene	8260	1.0	1.0	1.0	1	NA	NA		NA	NA	0.005
Acetone	8260	5.0	5.0	5.0	3,200	3,200	1,500	NA	NA	NA	0.63
Benzene	8260	1.0	1.0	1.0	5	5	46		0.057	NA	0.005
Bromodichloromethane	8260	1.0	1.0	1.0	100	100	NA		NA	NA	0.04
Carbon Disulfide	8260	1.0	1.0	1.0	3,200	3,200	0.92		NA	NA	1.35
Chloroform	8260	1.0	1.0	1.0	100	100	28		NA	NA	0.04
Dibromochloromethane	8260	1.0	1.0	1.0	100	100	NA		NA	NA	0.045
Ethylbenzene	8260	1.0	1.0	1.0	700	700	290		3.6	NA	0.66
Isopropylbenzene	8260	1.0	1.0	1.0	1	NA	NA		NA	NA	0.0051
m,p-Xylene	8260	1.0	1.0	1.0							
Methyltert-Butylether	8260	3.0	3.0	3.0	200	200	51,000		NA	NA	0.043
Methylene Chloride	8260	2.0	1.0	1.0	5	5	2,200		NA	NA	0.005
n-Butylbenzene	8260	1.0	2.0	2.0	24	24	NA		NA	NA	310
n-Propylbenzene	8260	1.0	1.0	1.0	24	24	NA		NA	NA	0.122
o-Xylene	8260	1.0	1.0	1.0							
sec-Butylbenzene	8260	1.0	1.0	1.0	24	24	NA		NA	NA	0.159
Tetrachloroethene	8260	1.0	1.0	1.0		5	98		0.53	NA	
Toluene	8260	1.0	1.0	1.0	1,000	1,000	130		0.67	NA	0.86
Vinyl Chloride	8260	1.0	1.0	1.0	2	2	NA		NA	NA	0.01

Table 4-1 Soda Lake RFI Analyte List and Reporting Limits (Continued)

Constituent	Method of Analysis	Practical Quantitation Limit			Threshold Criteria						
		Water[a]	Sediment	Soil	Groundwater	Surface Water			Sediment		Soil
						HH fresh	freshwater	saltwater	Low Screen	High Screen	
					Human Health		Ecological				
Xylenes (total)	8260	1.0	1.0	1.0	10,000	10,000	13		0.025	NA	4.16
Semivolatile Organic Compounds		***µg/L***	***µg/kg***	***µg/kg***	***µg/L***	***µg/L***	***µg/L***	***µg/L***	***mg/kg per 1%OC***	***mg/kg per 1%OC***	***mg/kg***
2-Methylnaphthalene	8270	1.0	20	67	12	12	2.1		0.0202	0.201	0.37
2-Methylphenol (o-cresol)	8270	1.0	20	67	1,600	1,600	13		0.063	NA	0.62
3-Methylphenol (m-cresol) *	8270	2.0	40	130	1,600	1,600	NA		NA	NA	0.58
4-Methylphenol (p-cresol) *	8270	1.0	20	67	200	200	NA		NA	NA	0.33
Acenaphthene	8270	1.0	20	67	1,900	1,900	23		0.0067	0.0889	48.8
Acenaphthylene	8270	1.0	20	67	10	0.0028	NA		0.0059	0.128	0.33
Acetophenone	8270	1.0	20	67	10	0.0042	NA		NA	NA	0.33
Anthracene	8270	1.0	20	67	9,700	9,700	0.73		0.01	0.17	822.3
Benzo(a)anthracene	8270	1.0	20	67	10	0.1	0.027		0.016	0.28	0.87
Benzo(a)pyrene	8270	1.0	20	67	10	0.2	0.014		0.032	0.32	0.33
Benzo(b)fluoranthene	8270	1.0	20	67	10	0.1	NA		0.0272	0.16	0.87
Benzo(g,h,i)perylene	8270	1.0	20	67	10	0.0028	NA		0.016	0.25	0.33
Benzo(k)fluoranthene	8270	1.0	20	67	10	1	NA		0.027	0.16	8.7
bis(2-Ethylhexyl)phthalate	8270	1.0	20	67	10	6	32		0.182	2.647	0.91
Butylbenzylphthalate	8270	1.0	20	67	7,000	7,000	19		11	NA	347.8
Carbazole	8270	1.0	20	67							
Chrysene	8270	1.0	20	67	10	0.0028	NA		0.027	0.41	14.3
Dibenz(a,h)anthracene	8270	1.0	20	67	10	0.01	NA		0.01	0.0282	0.33
Dibenzofuran	8270	1.0	20	67	10	2.4	3.7		NA	5.1	0.36
Dimethylphthalate	8270	1.0	20	67	320,000	320,000	3		NA	NA	97.53
Di-n-Butylphthalate	8270	1.0	20	67	4,000	4,000	33		NA	0.11	0.33
Fluoranthene	8270	1.0	20	67	1,300	1,300	6.1		0.031	0.32	230
Fluorene	8270	1.0	20	67	1,300	1,300	3.9		0.01	0.15	36.32
Indeno(1,2,3-cd)pyrene	8270	1.0	20	67	10	0.1	NA		0.017	0.24	0.87
Naphthalene	8270	1.0	20	67	100	100	24		0.015	0.14	0.45
Phenanthrene	8270	1.0	20	67	10	0.0028	6.3		0.019	0.41	1.12

Table 4-1 Soda Lake RFI Analyte List and Reporting Limits (Continued)

Constituent	Method of Analysis	Practical Quantitation Limit			Threshold Criteria						
		Water[a]	Sediment	Soil	Groundwater	Surface Water			Sediment		Soil
						HH fresh	freshwater	saltwater	Low Screen	High Screen	
					Human Health		Ecological				
Phenol	8270	2.0	40	130	19,000	19,000	110		NA	0.048	5.65
Pyrene	8270	1.0	20	67	30	30	NA		0.044	0.49	7.35
TPH	8015-Dx	10 mg/L	5 mg/kg	5 mg/kg							
Metals		***µg/L***	***µg/kg***	***µg/kg***	***µg/L***	***µg/L***	***µg/L***	***µg/L***	***mg/kg per 1%OC***	***mg/kg per 1%OC***	***mg/kg***
Aluminum	6010	20	5,000	5,000				NA			
Antimony	6010	50	5,000	5,000	6	6	30	500	NA	64	0.248
Arsenic	6010	50	5,000	5,000	50	50	150	36	10.8	48	1
Barium	6010	3.0	500	500	2,000	2,000	114	NA	NA	NA	17.2
Beryllium	6010	1.0	100	100	4	4	5.1		NA	NA	2.42
Boron	6010	6.0	2,000	2,000				NA			
Cadmium	6010	2.0	200	200	5	5	1.6	9.3	0.58	3.2	1.2
Calcium[b]	6010	50	5,000	5,000				NA			
Chromium (total)	6010	5.0	500	500	100	100	127		36.2	120	1.00
Cobalt	6010	3.0	500	500	50	220	3		NA	NA	470
Copper	6010	2.0	200	200	1,300	1,300	13.9	3.1	28	100	28.9
Iron	6010	20	5,000	5,000				NA			
Lead	6010	20	2,000	2,000	15	15	5.8	8	37	82	0.94
Magnesium[b]	6010	20	5,000	5,000	200	NA	NA	NA	NA	NA	20
Manganese	6010	1.0	500	500	50	50	80	NA	630	1,200	7.43
Mercury	7470/1	0.1	50	50	2	0.77	0.012		0.2	2	0.033
Nickel	6010	10	1,000	1,000	100	100	78		19.5	33	64.08
Potassium[b]	6010	500	50,000	50,000				NA			
Selenium	6010	50	5,000	5,000	50	50	5	71	NA	NA	0.5
Silver	6010	3.0	500	500	200	200	0.36	1.9	NA	4.5	22.04
Sodium[b]	6010	50	10,000	10,000	20,000	20,000	NA	NA	NA	NA	500
Thallium	6010	50	5,000	5,000	10	2	12		NA	NA	1
Tin	6010	10	1,000	1,000	19,000	19,000	73	NA	NA	NA	10
Vanadium	6010	3.0	500	500	200	200	19	NA	NA	NA	1

Table 4-1 Soda Lake RFI Analyte List and Reporting Limits (Continued)

Constituent	Method of Analysis	Practical Quantitation Limit			Threshold Criteria						
		Water[a]	Sediment	Soil	Groundwater	Surface Water			Sediment		Soil
						HH fresh	freshwater	saltwater	Low Screen	High Screen	
					Human Health		Ecological				
Zinc	6010	6.0	1,000	1,000	10,000	10,000	178	81	98	540	12
Dioxins and Furans		***pg/L***	***pg/g***	***pg/g***	***ug/L***	***ug/L***	***ug/L***	***ug/L***	***mg/kg***	***mg/kg***	***mg/kg***
1,2,3,4,6,7,8-HpCDD	1613B	25	2.5	2.5							
1,2,3,4,6,7,8-HpCDF	1613B	25	2.5	2.5							
1,2,3,4,7,8,9-HpCDF	1613B	25	2.5	2.5							
1,2,3,4,7,8-HxCDD	1613B	25	2.5	2.5							
1,2,3,4,7,8-HxCDF	1613B	25	2.5	2.5							
1,2,3,6,7,8-HxCDD	1613B	25	2.5	2.5							
1,2,3,6,7,8-HxCDF	1613B	25	2.5	2.5							
1,2,3,7,8,9-HxCDD	1613B	25	2.5	2.5							
1,2,3,7,8-PeCDD	1613B	25	2.5	2.5							
2,3,4,6,7,8-HxCDF	1613B	25	2.5	2.5							
2,3,4,7,8-PeCDF	1613B	25	2.5	2.5							
2,3,7,8-TCDD	1613B	5	0.5	0.5	0.00003	0.00003	0.00001		NA	NA	0.0000037
2,3,7,8-TCDF	1613B	5	0.5	0.5							
OCDD	1613B	25	5.0	5.0							
OCDF	1613B	25	5.0	5.0							
Total HpCDD	1613B	25	2.5	2.5							
Total HpCDF	1613B	25	2.5	2.5							
Total HxCDD	1613B	25	2.5	2.5	0.000025	0.000025	NA		NA	NA	0.0001
Total HxCDF	1613B	25	2.5	2.5	0.0003	0.0003	NA		NA	NA	0.00059
Total PeCDD	1613B	25	2.5	2.5	0.00006	0.00006	NA		NA	NA	0.0000074
Total PeCDF	1613B	25	2.5	2.5	0.00006	0.00006	NA		NA	NA	0.00059
Total TCDD	1613B	5	0.5	0.5	0.00003	0.00003	NA		NA	8.8	0.0000037
Total TCDF	1613B	5	0.5	0.5	0.0003	0.0003	NA		NA	NA	0.0000008
Pesticides, Herbicides, and PCBs		***µg/L***	***µg/kg***	***µg/kg***	***µg/L***	***µg/L***	***µg/L***	***µg/L***	***mg/kg per 1%OC***	***mg/kg per 1%OC***	***mg/kg***
2,4,5-T	8150	0.6	17	17	350						78
(2,4,5-TP (Silvex)	8150	0.3	8.5	8.5	50						63

Table 4-1 Soda Lake RFI Analyte List and Reporting Limits (Continued)

Constituent	Method of Analysis	Practical Quantitation Limit			Threshold Criteria						
		Water[a]	Sediment	Soil	Groundwater	Surface Water			Sediment		Soil
						HH fresh	freshwater	saltwater	Low Screen	High Screen	
					Human Health		Ecological				
4,4'-DDD	8081	0.1	3.3	3.3	0.28						0.0017
4,4'-DDT	8081	0.1	3.3	3.3	0.2						0.0017
Aldrin	8081	0.05	1.7	1.7	1						0.038
alpha Chlordane	8081	0.05	1.7	1.7							
Aroclor 1016	8081	1.0	33	33							
Aroclor 1221	8081	2.0	67	67							
Aroclor 1232	8081	1.0	33	33							
Aroclor 1242	8081	1.0	33	33							
Aroclor 1248	8081	1.0	33	33							
Aroclor 1254	8081	1.0	33	33							
Aroclor 1260	8081	1.0	33	33							
Total PCB					1	0.5	0.014		0.03162	0.24	0.32
beta-BHC	8081	0.05	1.7	1.7	0.05						0.0017
delta-BHC	8081	0.05	1.7	1.7	0.05						0.1
Endosulfan I	8081	0.05	1.7	1.7	22						0.55
Endrin Aldehyde	8081	0.1	3.3	3.3							
gamma-BHC (Lindane)	8081	0.05	1.7	1.7	0.2	0.2	0.08		0.94	1.38	0.077
Heptachlor	8081	0.05	1.7	1.7	0.4						0.14
Heptachlor Epoxide	8081	0.05	1.7	1.7	0.2						0.06
Methoxychlor	8081	0.5	17	17	40						14.08
General Water Quality Parameters		*(mg/L)*	*(mg/kg)*	*(mg/kg)*	*ug/L*	*mg/L*	*mg/L*	*mg/L*	*mg/kg per 1%OC*	*mg/kg per 1%OC*	*mg/kg*
Alkalinity	310.1	1.0	NA	NA			20				
Bicarbonate (Alkalinity)	310.1	1.0	NA	NA			20				
Bromide	320.1	1.0	1.0	1.0							
Carbonate (Alkalinity)	310.1	1.0	NA	NA			20				
Chloride [c]	325.2	1.0	10.0	10.0			230				
Dissolved Organic Carbon	415.1	1.5	200.0	200.0							
Fluoride	340.2	0.1	1.0	1.0							

Table 4-1 Soda Lake RFI Analyte List and Reporting Limits (Continued)

Constituent	Method of Analysis	Practical Quantitation Limit			Threshold Criteria						
		Water[a]	Sediment	Soil	Groundwater	Surface Water			Sediment		Soil
						HH fresh	freshwater	saltwater	Low Screen	High Screen	
					Human Health		Ecological				
Nitrate [c]	353.2	0.01	0.3	0.3	10,000						13,000
pH	150.1	0.1	0.1	0.1							
Preserved Total Solids	150.1	10.0	0.1	0.1							
Sulfate [c]	375.2	2.5	25.0	25.0							
Sulfide	376.2	0.5	5.0	5.0	50						5
TDS	160.1	10.0	NA	NA							
Conductivity	120.1	1.0 µS	1.0 µS	1.0 µS							
Cyanide (total)	335.2	0.01	0.1	0.1	200		0.0052	0.001		NA	160
Total Dissolved Solids	160.1	10.0	NA	NA							
Total Organic Carbon	415.1	1.5	200.0	200.0	1,000						2,000
Total Solids	160.3	10.0	0.1	0.1							
Total Suspended Solids	160.2	1.0	NA	NA							
Total Volatile Solids	160.4	10.0	5.0	5.0							

Notes:

NV – No value

* - Analytes co-elute, reported as 3,4-Methylphenol

[a] The PQLs are the same for groundwater and surface water.

[b] Natural chemistry constituents - cations.

[c] Natural chemistry constituents - anions.

Dioxins and furans to be sampled where appropriate.

Pesticides and herbicides to be sampled where appropriate.

Amendments 1/5/01: added 2-Methylphenol; 3,4-Methylphenol changed to 3-Methylphenol; m,p- and o-Xylene changed to Xylenes (total)

Remedy Decision 3
Table 4-2 Summary of Human Health COC

Chemical	Human Health COC by Media			
	Groundwater	Soil	Surface Water	Sediment
3,4-Methylphenol				
4,4-DDD				
4,4-DDT				
Aluminum		X		X
Antimony		X	X (T,D)	X
Arsenic		X		X
Benzo(ghi)perylene		X		
Diesel Range Organics		X		
Hepthachlor Epoxide				
Mercury		X		X
p-Isopropyltoluene				
Sodium		X	X (T,D)	X
Thallium		X		X
Aldrin				
Aroclor 1254				
Aroclor 1260				
delta-BHC				
Heptachlor				
Chromium				X
Iron				X
Magnesium			X (T,D)	X
Manganese				X
Sulfide				X
Vanadium				X
HxCDFs (total)				
TCDFs (total)				
Cadmium				
Chloride	X (T)		X (T)	
Total Organic Carbon	X (T)		X (T)	
Nitrate/Nitrite	X (T)			
Sulfate	X (T)		X (T)	
Acetonitrile				
Dioxane				
Isobutyl alcohol				
Isodrin	X (T)		X (T)	
trans-1,4-Dichloro-2-butene				

Notes:
T = total analyte
D = dissolved analyte
Groundwater COC denoted as "X (T)" were not retained for quantitative risk assessment per the Geostatistic Work Group decision based on data quality.

Remedy Decision 3
Table 4-3 Summary of Ecological COC

Chemical	Ecological COC by Media			
	Soil	Surface Water	Sediment	Pore Water
1,1,2-Trichloro-1,2,2-trifluoroethane			X	
1,2,3,4,6,7,8-HpCDD			X	
1,2,4-Trimethylbenzene			X	
2-Butanone			X	
2-Methylnaphthalene				
2-Methylphenol				
3,4-Methypphenol				
4,4-DDD				
4,4-DDT				
Acenaphthylene			X	
Acetone			X	X
Aluminum			X	
Ammonia (as N)			X	
Anthracene				
Antimony		X (T,D)	X	X
Arsenic				X
Barium			X	
Beryllium			X	
Benzene			X	
Benzo(a)anthracene		X (T)	X	X
Benzo(a)pyrene		X (T)		X
Benzo(ghi)perylene				
Bis (2-ethyl hexyl)phthalate			X	
Boron			X	
Bromide			X	
Calcium			X	
Cadmium			X	
Carbon disulfide			X	X
Chloride			X	
Chromium	X		X	
Chrysene			X	
Cobalt			X	
Copper	X			
Cyanide (total)			X	
Dibenzofuran				
Diesel Range Organics				
Dimethylphthalate				
Di-n-butyl phthalate			X	
Di-n-octyl phthalate				
Fluoranthene				
Fluorene				
Fluoride			X	
Hepthachlor Epoxide				
HpCDDs (total)			X	
Iron			X	

Lead				
Magnesium			X	
Manganese		X (T,D)		X
Mercury	X			X
Methylene Chloride			X	
Naphthalene			X	
Nitrate			X	
Nitrate/Nitrite			X	
Nickel			X	
OCDD			X	
Pentachlorophenol				
Phenanthrene			X	
Phenol				X
p-Isopropyltoluene				
Potassium			X	
Pyrene			X	
Selenium	X	X (T,D)	X	X
Silver		X (T,D)	X	X
Sodium			X	
Sulfate			X	
Sulfide			X	
Thallium	X		X	
Tin			X	
Vanadium	X		X	X
Xylenes (total)				
Zinc			X	

Notes:
T = total analyte
D = dissolved analyte
Sediment COI selection process will be completed when sediment data are final.

Remedy Decision 3
Table 4-4 Data Quality Objectives for Groundwater

State Problem	Further characterization of the groundwater hydrogeological condition is necessary to evaluate the nature and extent of potential impacts, assess human health risks and to evaluate potential remedies, if necessary.	
Define Study Boundaries	The Soda Lake area, the pipeline corridor between Soda Lake and the Former Refinery, and any off-site media affected by this area.	
Identify the Decision	**Input**	**Decision Rule**
1. What are the nature and extent of COIs in groundwater originating from Soda Lake?	• Completed investigations/documents: â *Draft Soda Lake Technical Memorandum* (ThermoRetec, May 1999); *Current Conditions/Release Assessment Report* (TriTechnics, 1996); *Soda Lake Area Water Quality Monitoring Report* (RETEC, February 1998); *Soda Lake Area Water Quality Monitoring Report* (RETEC, June 1998); *Soda Lake Area Water Quality Monitoring Report* (RETEC, September 1998); *Final Voluntary Sampling Report* (ThermoRetec, December 1999); *Draft Soda Lake Technical Memorandum* (ThermoRetec, May 1999); *Soda Lake Area Water Quality Monitoring Report* (ThermoRetec July 1999); *Soda Lake Area Final Voluntary Monitoring Report* (ThermoRetec December 1999); and *Wetlands Delineation Report for the Proposed Soda Lake Inlet Basin Demonstration Project* (Smayda, January 2000). • Ongoing/upcoming investigations/documents: â Soda Lake Inlet Basin Demonstration Capping Project (ThermoRetec March to May 2000); and â Soda Lake RFI Work Plan. • Relevant screening levels for groundwater.[2] • Comments and responses from regulatory agencies.	• If existing and/or additional data meet the requirements of adequacy as defined below, then the data will be used to evaluate further decision rules: â The suite of analytes are comprised of COIs that represent the potential site contaminants; â Sufficient data exists to evaluate each potential exposure pathway identified in the CSM; â An adequate background or reference site data set exists to compare against site levels; â Detection limits are sufficient for comparison to screening level criteria;[2] â An adequate number of samples are collected to spatially and temporally define risk; and â Adequate data are collected to meet DQOs. • If the concentration of the COI is below background levels[3] or relevant screening levels,[2] then the nature and extent of the COI is considered adequately characterized, the COI is considered not to present a risk, and the COI is eliminated from further study. • If concentration of a COI is above background[3] or relevant screening levels,[2] then the nature and extent of the COI will be delineated in groundwater.

Remedy Decision 3
Table 4-4 Data Quality Objectives for Groundwater

State Problem	Further characterization of the groundwater hydrogeological condition is necessary to evaluate the nature and extent of potential impacts, assess human health risks and to evaluate potential remedies, if necessary.	
Define Study Boundaries	The Soda Lake area, the pipeline corridor between Soda Lake and the Former Refinery, and any off-site media affected by this area.	
Identify the Decision	**Input**	**Decision Rule**
2. Is the hydrogeological relationship between surface waters and groundwater such that Soda Lake is a groundwater discharge lake?	• Same input as for Decision Identification #1, above.	• If the hydrogeological data needs presented below are met, then the hydraulic interaction between surface water and groundwater can be considered adequately characterized: â The site geology is adequately characterized to determine the hydrostratigraphic units at the site; â Flow components within and between hydrostratigraphic units are determined; â The spatial relationships between hydrostratigraphic units and surface water are mapped; and â Mass balance analysis of water inflow versus outflow is conducted within the Soda Lake basin to assess potential of surface water recharge to groundwater. • If the hydrogeological data needs presented above are not met, then additional data will be collected (i.e., seeps).

Remedy Decision 3
Table 4-4 Data Quality Objectives for Groundwater

State Problem	Further characterization of the groundwater hydrogeological condition is necessary to evaluate the nature and extent of potential impacts, assess human health risks and to evaluate potential remedies, if necessary.	
Define Study Boundaries	The Soda Lake area, the pipeline corridor between Soda Lake and the Former Refinery, and any off-site media affected by this area.	
Identify the Decision	**Input**	**Decision Rule**
3. If COIs exist, are they present at levels that could impact human health?	• Same input as for Decision Identification #1, above. • Relevant screening levels for groundwater.[2]	• Data adequacy requirements per Decision Identification #1, above. • If COI concentration at a site is below relevant screening criteria[2] or background,[3] then the COI is considered adequately characterized and is dropped from further consideration. • If COI concentration at the site is above background levels and above relevant screening levels,[2] then the COI will be retained for human health risk assessment. • If, for non-detected analytes, the PQL is above the relevant screening levels, then the PQL shall be considered the screening level and the contaminant is considered adequately characterized, provided the most appropriate analytical technique was used. • If non-detected analytes occur in a data set containing at least one detected value above the PQL, then the non-detects will be carried through the risk assessment at half the detection limit.
4. If COIs are present in groundwater, can they migrate off site?	• Same input as for Decision Identification #1, #2, and #3, above. • Relevant screening levels for groundwater.[2]	• If COIs are above relevant screening levels[2] and background levels at the site boundary, further investigative work will be conducted to determine their extent. • If COIs are not above background levels or relevant screening levels,[2] then no further investigation is required.

Remedy Decision 3
Table 4-4 Data Quality Objectives for Groundwater

State Problem	Further characterization of the groundwater hydrogeological condition is necessary to evaluate the nature and extent of potential impacts, assess human health risks and to evaluate potential remedies, if necessary.	
Define Study Boundaries	The Soda Lake area, the pipeline corridor between Soda Lake and the Former Refinery, and any off-site media affected by this area.	
Identify the Decision	**Input**	**Decision Rule**
5. What data should be collected in order to evaluate potential remedial alternatives?	• Potential remediation data requirements for the Soda Lake RFI.	• If sufficient data are collected to evaluate remedial alternatives according to Soda Lake RFI requirements, then the data set is complete. • If sufficient data are not collected to evaluate remedial alternatives according to the Soda Lake RFI requirements, then additional data will be collected or standard engineering assumptions will be made in the context of the collaborative process.
Specify Limits on Decision Errors	Acceptable decision error goals will be described in the QAPP.	
Optimize Design for Obtaining Data	The existing sampling data will be reviewed and complemented with additional sampling, as necessary, to adequately characterize contamination in Soda Lake groundwater. Review and additional sampling strategy will be provided in the Work Plan.	

Notes:

1. *Guidance for Data Quality Objectives Process*, U.S. EPA, 1994.
2. Relevant screening level hierarchy by media:
   Groundwater
   Relevant screening levels for COIs in groundwater for human health protection will be based on the following hierarchy:
   a. U.S. EPA Maximum Contaminant Levels (MCL);
   b. U.S. EPA Drinking Water Equivalent Levels (DWEL);
   c. Wyoming Water Quality Standards – Chapter 8;
   d. U.S. EPA Region III Risk-Based Concentrations (RBC), adjusted to 0.1 HI for non-carcinogens, based on a residential ingestion assumption; and
   e. Practical quantitation limits (PQLs).
3. Reference or background levels for COIs in groundwater are defined as the concentration of the COI in samples collected from areas not affected by the Soda Lake site or Former Refinery.

The statistical adequacy for comparing reference and on-site data will follow U.S. EPA Interim Final Guidance (EPA G-89-0018)-*Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities.*

Remedy Decision 3
Table 4-5 Data Quality Objectives for Soil

State Problem	The nature and extent of soil contamination along the underground pipe from the North Tank Farm to the Soda Lake site and the Caustic Disposal Area needs to be fully characterized in order to understand impacts to soil, groundwater, human health risk, and to be able to evaluate remedial alternatives.	
Define Study Boundaries	The Soda Lake area, the pipeline corridors used to convey process wastewater from the Former Refinery to Soda Lake, and any off-site media affected by this area.	
Identify the Decision	**Input to the Decision**	**Decision Rule**
1. What is the nature and extent of COIs in soil?	• Completed investigations/documents: â *Draft Soda Lake Technical Memorandum* (ThermoRetec, May 1999); *Current Conditions/Release Assessment Report* (TriTechnics, 1996); *Soda Lake Area Water Quality Monitoring Report* (RETEC, February 1998); *Soda Lake Area Water Quality Monitoring Report* (RETEC, June 1998); *Soda Lake Area Water Quality Monitoring Report* (RETEC, September 1998); *Final Voluntary Sampling Report* (ThermoRetec, December 1999); *Draft Soda Lake Technical Memorandum* (ThermoRetec, May 1999); *Soda Lake Area Water Quality Monitoring Report* (ThermoRetec, July 1999); *Soda Lake Area Final Voluntary Monitoring Report* (ThermoRetec, December 1999); and *Wetlands Delineation Report for the Proposed Soda Lake Inlet Basin Demonstration Project* (Smayda, January 2000). • Ongoing/upcoming investigations/documents: â Soda Lake Inlet Basin Demonstration Capping Project (ThermoRetec March to May 2000); and â Soda Lake RFI Work Plan. • Relevant screening levels for soil and groundwater.[2] • Comments and responses from regulatory agencies.	• If data meet the requirements of data adequacy as defined below, then the data will be used to evaluate further decision rules: â The suite of analytes are comprised of COIs that represent the potential site contaminants; â Sufficient data exists to evaluate each potential exposure pathway identified in the CSM; â Detection limits are sufficient for comparison to relevant screening level criteria,[2] â An adequate number of samples are collected to spatially and temporally define the nature and extent of risk; and â Background data are available for comparison to the historic and future data sets. • If COI concentration is below relevant background levels[3] and relevant screening levels,[2] then the nature and extent of the COI in soil is considered adequately characterized, the COI is considered not to present a risk, and the COI is eliminated from further soil study. • If COI concentration is above relevant background levels[3] or relevant screening levels,[2] then the COI will be retained for further study, as necessary, and considered in the risk assessment.
2. If COIs exist in soil, are they present at levels that could impact groundwater such that concentrations of the COIs in groundwater would be above the relevant standards?	• Completed, ongoing, and planned investigations per Decision Identification #1, above. • Relevant screening levels for groundwater.[2]	

Remedy Decision 3
Table 4-5 Data Quality Objectives for Soil

State Problem	The nature and extent of soil contamination along the underground pipe from the North Tank Farm to the Soda Lake site and the Caustic Disposal Area needs to be fully characterized in order to understand impacts to soil, groundwater, human health risk, and to be able to evaluate remedial alternatives.	
Define Study Boundaries	The Soda Lake area, the pipeline corridors used to convey process wastewater from the Former Refinery to Soda Lake, and any off-site media affected by this area.	
Identify the Decision	**Input to the Decision**	**Decision Rule**
3. If COIs exist, are they present at levels that could impact human health and/or the environment?	• Completed, ongoing, and planned investigations per Decision Identification #1, above. • Relevant screening levels for groundwater.[2]	• Data adequacy requirements per Decision Identification #1, above. • If COI concentration at the site is above background levels and above relevant screening levels,[2] then the COI will be retained for human health risk assessment. • If non-detected analytes occur in a data set containing at least one detected value above the PQL, then the non-detects will be carried through the risk assessment at half the detection limit.
4. What data should be collected in order to evaluate potential remedial alternatives?	• Completed, ongoing, and planned investigations per Decision Identification #1, above. • Potential remediation data requirements for the Soda Lake.	• If sufficient data are collected to evaluate remedial alternatives according to the Soda Lake RFI requirements, then the data set is complete. • If sufficient data are not collected to evaluate remedial alternatives according to the Soda Lake RFI requirements, then additional data will be collected or standard engineering assumptions will be made.

Remedy Decision 3
Table 4-5 Data Quality Objectives for Soil

State Problem	The nature and extent of soil contamination along the underground pipe from the North Tank Farm to the Soda Lake site and the Caustic Disposal Area needs to be fully characterized in order to understand impacts to soil, groundwater, human health risk, and to be able to evaluate remedial alternatives.	
Define Study Boundaries	The Soda Lake area, the pipeline corridors used to convey process wastewater from the Former Refinery to Soda Lake, and any off-site media affected by this area.	
Identify the Decision	**Input to the Decision**	**Decision Rule**
Specify Limits on Decision Errors	Acceptable decision error goals will be described in the QAPP.	
Optimize Design for Obtaining Data	The existing sampling data will be reviewed and complemented with necessary sampling to adequately characterize contamination in soil, existing sampling data will be reviewed and complemented with necessary sampling to adequately characterize contamination in Soda Lake area soil.	

Notes:

1. *Guidance for Data Quality Objectives Process*, U.S. EPA, 1994
2. Relevant screening level hierarchy by media:
   Soil
   Relevant screening criteria for soil if above the PQL:
   a. Concentrations for residential exposure; (RBCs adjusted to a 0.1HI for non-carcinogens); or
   b. Concentration which ensures protection of groundwater (as defined below);
   c. Concentration which ensures protection to ecological receptors;
   Groundwater
   d. Maximum Contaminant Levels (MCLs);
   e. U.S. EPA or Wyoming Drinking Water Equivalent (DWEL);
   f. Wyoming Water Quality Standards – Chapter 8;
   g. PQLs;
   h. EPA Region III Risk-Based Concentrations (RBC). The RBCs to be adjusted to a 0.1HI for non-carcinogens based on the residential ingestion of groundwater.
3. "Background" refers to the background soil data collected as part of the Soda Lake RFI.

Remedy Decision 3
Table 4-6 Data Quality Objectives for Surface Water

State Problem	Impacts to Soda Lake surface waters potentially exist as a result of process water discharges to the inlet basin from the Soda Lake pipeline between 1957 and 1990 and pumping of North Platte River water from 1990 to present. Further characterization of surface water quality may be necessary to evaluate nature and extent of impact, assess ecological risk, test the site groundwater model, and to evaluate potential remedies, if necessary.	
Define Site Boundaries	The Soda Lake area, the pipeline corridor between Soda Lake and the North Properties, and any off-site media affected by this area.	
Identify the Decision	**Input**	**Decision Rule**
1. Are COIs present in Soda Lake surface waters that are attributable to the Former Refinery and its operations?	• Completed investigations/documents: â *Draft Soda Lake Technical Memorandum* (ThermoRetec, May 1999); *Current Conditions/Release Assessment Report* (TriTechnics, 1996); *Soda Lake Area Water Quality Monitoring Report* (RETEC, February 1998); *Soda Lake Area Water Quality Monitoring Report* (RETEC, June 1998); *Soda Lake Area Water Quality Monitoring Report* (RETEC, September 1998); *Final Voluntary Sampling Report* (ThermoRetec, December 1999); *Draft Soda Lake Technical Memorandum* (ThermoRetec, May 1999); *Soda Lake Area Water Quality Monitoring Report* (ThermoRetec, July 1999); *Soda Lake Area Final Voluntary Monitoring Report* (ThermoRetec, December 1999); and *Wetlands Delineation Report for the Proposed Soda Lake Inlet Basin Demonstration Project* (Smayda, January 2000). • Ongoing/upcoming investigations/documents: â Soda Lake Inlet Basin Demonstration Capping Project (ThermoRetec March to May 2000); and â Soda Lake RFI Work Plan. • Relevant screening levels for surface water.[2] • Comments and responses from regulatory agencies.	• If existing and/or additional data meet the requirements of adequacy as defined below, then the data will be used to evaluate further decision rules: â The suite of analytes are comprised of constituents of interest (COIs) that represent the potential site contaminants; â Sufficient data exists to evaluate each potential exposure pathway identified in the CSM; â An adequate background[3] or reference site data set exists to compare against site levels; â Detection limits are sufficient for comparison to screening level criteria;[2] â An adequate number of samples are collected to spatially and temporally define risk; and â Adequate data are collected to meet DQOs. • If site surface water COI concentrations are not higher than background concentrations, then Soda Lake sediments (i.e., refinery-related source media) are not considered to be a source to surface water. The COI is not considered to present a risk to surface water and is eliminated. • If site surface water COI concentrations are higher than background concentrations, then Soda Lake sediments may be considered to be a source to surface water. The COI potentially presents risk to surface water and is retained for further consideration.

Remedy Decision 3
Table 4-6 Data Quality Objectives for Surface Water

State Problem	Impacts to Soda Lake surface waters potentially exist as a result of process water discharges to the inlet basin from the Soda Lake pipeline between 1957 and 1990 and pumping of North Platte River water from 1990 to present. Further characterization of surface water quality may be necessary to evaluate nature and extent of impact, assess ecological risk, test the site groundwater model, and to evaluate potential remedies, if necessary.	
Define Site Boundaries	The Soda Lake area, the pipeline corridor between Soda Lake and the North Properties, and any off-site media affected by this area.	
Identify the Decision	**Input**	**Decision Rule**
2. Are COIs associated with the site (as retained from Decision Identification #1 above) present in surface water at levels above relevant screening criteria?	• Completed, ongoing, and planned investigations as detailed in Decision Identification #1, above. • Relevant ecological screening levels for surface water.[2] • Background or reference location[4] data.	• Data adequacy requirements per Decision Identification #1 above, and: â Sufficient data exist to evaluate each potential exposure pathway identified in the SCM; â Detection limits are sufficient for comparison to screening level criteria;[2] and â An adequate number of samples are collected to spatially and temporally define risk. • If COI concentration at a site is below relevant screening criteria,[2] then the COI is considered adequately characterized and is dropped from further consideration. • If COI concentration at the site is above background levels and above screening levels,[2] then the COI will be retained for: â Tier II Analysis or CMS/remedial action. • If, for non-detected analytes, the PQL is above the relevant screening levels, then the PQL shall be considered the screening level and the contaminant is considered adequately characterized provided the most appropriate analytical technique was used. • If non-detected analytes occur in a data set containing at least one detected value above the PQL, then the non-detects will be carried through the risk assessment at half the detection limit.
3. What data should be collected in order to evaluate potential remedial alternatives and any residual risk?	• Completed, ongoing and planned investigations as detailed in Decision Identification #1, above. • Potential remediation data requirements for the Soda Lake RFI.	• If sufficient data are collected to evaluate remedial alternatives according to Soda Lake RFI requirements, then the data set is complete. • If sufficient data are not collected to evaluate remedial alternatives according to the Soda Lake RFI requirements, then additional data will be collected or standard engineering assumptions will be made in the context of the Collaborative Process.

Remedy Decision 3
Table 4-6 Data Quality Objectives for Surface Water

State Problem	Impacts to Soda Lake surface waters potentially exist as a result of process water discharges to the inlet basin from the Soda Lake pipeline between 1957 and 1990 and pumping of North Platte River water from 1990 to present. Further characterization of surface water quality may be necessary to evaluate nature and extent of impact, assess ecological risk, test the site groundwater model, and to evaluate potential remedies, if necessary.	
Define Site Boundaries	The Soda Lake area, the pipeline corridor between Soda Lake and the North Properties, and any off-site media affected by this area.	
Identify the Decision	**Input**	**Decision Rule**
Specify Limits on Decision Errors	Sample number will be selected with a goal of 50% MDRD against background, at $p = 0.20$, and at an estimated power of 0.8*. If the sample Relative Standard Error is such that a power of 0.8 cannot be achieved, then the data set will be considered inadequate and additional data may be necessary.	
Optimize Design for Obtaining Data	The existing sampling data will be reviewed and complemented with additional sampling, as necessary, to adequately characterize contamination in Soda Lake surface water. Review and additional sampling strategy will be provided in the Work Plan.	

Notes:

1. *Guidance for Data Quality Objectives Process*, U.S. EPA, 1994.
2. Relevant screening level hierarchy by media:
   Surface Water
   Relevant screening levels for COIs in surface water for human health protection will be based on the following hierarchy:
   a. U.S. EPA Maximum Contaminant Levels (MCL);
   b. U.S. EPA Drinking Water Equivalent Levels (DWEL);
   c. Wyoming Water Quality Standards – Chapter 1;
   d. Practical quantitation limits (PQLs); and
   e. U.S. EPA Region III Risk-Based Concentrations (RBC), adjusted to 0.1 HI for non-carcinogens, based on a residential ingestion assumption.

   Relevant screening benchmarks for COIs in surface water for ecological protection are based on the following hierarchy (as proposed in December 1999 Collaborative Process and presented in "Table A: Proposed Screening Benchmarks for the North Platte River"):
   a. Lowest of National Ambient Water Quality Criteria – Acute or Chronic (NAWQC-CCC) (adjusted for hardness as appropriate) and Wyoming Water Quality Criteria – Acute or Chronic (WWQC) (adjusted for hardness as appropriate);
   b. OSWER Ecotox Thresholds;
   c. Screening Ecological Benchmarks (ORNL) from Suter & Tsao, 1996; and
   d. PQLs.

   Note: if screening criteria are not available, PQL will be the screening criteria.
3. For diluted sample analysis resolution, see "Detection Limit Screening Process Table" (defined in November 1999 Collaborative Process).
4. Background data will be collected from a setting under similar hydrologic conditions as Soda Lake unaffected by Former Refinery operations. Inlet basin waters on the east and west ponds will be compared against NPR background surface water quality. The main lake will be compared against background surface water quality from nearby enclosed playa basins (e.g., Pratt's Soda Lake or Suicide Soda Lake).

Remedy Decision 3
Table 4-7 Data Quality Objectives for Sediment

State Problem	The nature and extent of sediment contamination of the Soda Lake site as a result of discharges from the BP Amoco operations need to be fully characterized in order to understand impacts to groundwater, human health and ecological risks, and to evaluate remedial alternatives.	
Define Study Boundaries	The Soda Lake area, the pipeline corridor between Soda Lake and the Former Refinery, and any off-site media affected by this area.	
Identify the Decision	**Input**	**Decision Rule**
1. What is the nature and extent of COIs in sediment at the Soda Lake site?	• Completed investigations/documents: â *Draft Soda Lake Technical Memorandum* (ThermoRetec, May 1999); *Current Conditions/Release Assessment Report* (TriTechnics, 1996); *Soda Lake Area Water Quality Monitoring Report* (RETEC, February 1998); *Soda Lake Area Water Quality Monitoring Report* (RETEC, June 1998); *Soda Lake Area Water Quality Monitoring Report* (RETEC, September 1998); *Final Voluntary Sampling Report* (ThermoRetec, December 1999); *Draft Soda Lake Technical Memorandum* (ThermoRetec, May 1999); *Soda Lake Area Water Quality Monitoring Report* (ThermoRetec, July 1999); *Soda Lake Area Final Voluntary Monitoring Report* (ThermoRetec, December 1999); and *Wetlands Delineation Report for the Proposed Soda Lake Inlet Basin Demonstration Project* (Smayda, January 2000). • Ongoing/upcoming investigations/documents: â Soda Lake Inlet Basin Demonstration Capping Project (ThermoRetec March to May 2000); and â Soda Lake RFI Work Plan. • Comments and responses from regulatory agencies.	• If data meet the requirements of data adequacy as defined below, then they will be used to evaluate further decision rules: â The suite of analytes are comprised of COIs that represent the potential site contaminants; â Sufficient data exists to evaluate each potential exposure pathway identified in the SCM; â Detection limits are sufficient for comparison to relevant screening level criteria;[2] â An adequate number of samples are collected from available depositional areas to spatially define the nature/extent of risk. The nature and extent of sediment impacts will be defined from the weir outfall (source area) outward to the COI plume margins and to the high water mark for the inlet basin, main lake, and the east and west ponds; and â Adequate background data[3] are available for comparison to the historic and future data sets.

Remedy Decision 3
Table 4-7 Data Quality Objectives for Sediment

State Problem	The nature and extent of sediment contamination of the Soda Lake site as a result of discharges from the BP Amoco operations need to be fully characterized in order to understand impacts to groundwater, human health and ecological risks, and to evaluate remedial alternatives.	
Define Study Boundaries	The Soda Lake area, the pipeline corridor between Soda Lake and the Former Refinery, and any off-site media affected by this area.	
Identify the Decision	**Input**	**Decision Rule**
2. Is there evidence that COIs associated with the site occur in sediment or pore water at levels above background concentration and screening criteria?	• Completed, ongoing, and planned investigations per Decision Identification #1, above. • Relevant ecological screening levels for sediment[2] and/or pore water.[5]	• Data adequacy requirements per Decision Identification #1, above. • If the COI concentration retained per Decision Identification #1 above is statistically below relevant background levels[4] in bulk sediment or pore water, then the nature and extent of the COI in the sediment is considered adequately characterized, the COI is considered not to present a risk, and the COI is eliminated from further consideration. • If, for non-detected analytes, the PQL is above the relevant screening levels, then the PQL shall be considered the screening level and the contaminant is considered adequately characterized, provided the most appropriate analytical technique was used. • If non-detected analytes occur in a data set containing at least one sample above the PQL, then the non-detects will be carried through risk assessment at half the sample quantitation. • If the COI concentration is statistically above relevant background levels,[4] then the COI will be retained for further study. • If the COI concentration in sediment retained per Decision Identification #1 above is below low screening levels, then the contaminant is considered to be adequately characterized, the risk from the COI is considered not to be significant, and the COI is eliminated from further consideration. • If the COI concentration of sediment is above the low screening level and the COI does not have a high screening level, then the contaminant will be retained. • If COI concentration exceeds low screening criteria, but not the high screening criteria, the COI will be evaluated qualitatively or quantitatively (i.e., sediment bioassays) to determine if it will be retained. Inclusion or exclusion of a COI will be agreed to by WDEQ. • If the COI concentration exceeds the high screening level, the COI will be retained for evaluation for: â Sediment bioassays; â Simple bioaccumulation modeling; and â Remedial action. • If the COI concentration in pore water retained per Decision Identification #1 above is below surface water or pore water specific screening levels, then the contaminant is considered adequately characterized, the risk from the COI is considered not to be significant, and the COI is eliminated from further consideration.
3. If COIs exist, are they present at levels that could impact human health?	• Completed, ongoing, and planned investigations per Decision Identification #1, above. • Relevant screening levels for human health assessment of sediment.[2]	• Data adequacy requirements per Decision Identification #1, above. • If a COI is eliminated after evaluation according to Figure 1 "Selection Process for COCs" prepared by U.S. EPA Region VIII, then the contaminant is considered adequately characterized, the risk from the COI is considered not to be significant, and the COI is eliminated from further consideration. • If a COI is retained after evaluation according to Figure 1 "Selection Process for COCs" prepared by U.S. EPA Region VIII, then the contaminant will be retained for quantitative risk evaluation in the Human Health Risk Assessment.

Remedy Decision 3
Table 4-7 Data Quality Objectives for Sediment

State Problem	The nature and extent of sediment contamination of the Soda Lake site as a result of discharges from the BP Amoco operations need to be fully characterized in order to understand impacts to groundwater, human health and ecological risks, and to evaluate remedial alternatives.	
Define Study Boundaries	The Soda Lake area, the pipeline corridor between Soda Lake and the Former Refinery, and any off-site media affected by this area.	
Identify the Decision	**Input**	**Decision Rule**
4. What data should be collected in order to evaluate potential remedial alternatives?	• Potential remediation data requirements for Soda Lake.	• If sufficient data are collected to evaluate remedial alternatives according to the data needs defined for the Soda Lake RFI Work Plan, then the data set is complete. • If sufficient data are not collected to evaluate remedial alternatives according to the data needs defined for the Soda Lake RFI Work Plan, then additional data will be collected or standard engineering assumptions will be made in the context of the Collaborative Process.
Specify Limits on Decision Errors	Sample number will be selected with a goal of 50% MDRD against background, at $p = 0.20$, and at an estimated power of 0.8*. If the sample Relative Standard Error is such that a power of 0.8 cannot be achieved, then the data set will be considered inadequate and additional data may be necessary.	
Optimize Design for Obtaining Data	The existing sampling data will be reviewed and complemented with necessary sampling to adequately characterize contamination in Soda Lake sediment.	

Notes:

1. *Guidance for Data Quality Objectives Process*, U.S. EPA, 1994.
2. Relevant screening levels for COI in sediment.
   Screening levels for human health protection will be based on the following criteria, adapted from human health criteria applicable to soils:
   a. U.S. EPA Region III Risk-Based Concentrations (RBC), adjusted to 0.1 HI for non-carcinogens;
   b. Practical quantitation limits (PQLs);
   Screening benchmarks for COI in sediment for ecological protection are based on the following hierarchy, as proposed in the Collaborative Process meeting in December 1999 and revised in June 2000:
   c. *Low Screen:* 1) Swartz (1999) Lowest Effect Level (LEL); 2) Lowest of ARCS (Assessment and Remediation of Contaminated Sediments) *Hyalella azteca* Threshold Effect Level (TEL) as presented in Ingersoll *et al.* (1996); 3) Ontario, Canada Ministry of Environment Lower Effect Level (LEL); 4) FDEP (Florida Department of Environmental Protection) TEL; 5) Washington proposed FSQV (Freshwater Sediment Quality Values); 6) OSWER SQB; and 7) Proposed EPA SQC (Sediment Quality Criteria);
   d. *High Screen:* 1) Swartz (1999) Median Effect Level (MEL); 2) Lowest of ARCS *Hyalella azteca* Probable Effect Level (PEL) as presented in Ingersoll *et al.* (1996); 3) FDEP PEL; 4) Washington LAET (Lowest Apparent Threshold Effect), if the benchmark was developed with *Hyalella* bioassays; and 5) Ontario, Canada Ministry of Environment Severe Effect Level (SEL);
   e. If the benchmarks are lower than the PQL, the PQL becomes the screening benchmark; and
   f. For some specific chemicals, benchmarks exist from other sources than those described above, as detailed in Table 3-9 of this Work Plan.
3. For diluted sample analysis resolution, see "Detection Limit Screening Process Table" (defined in November 1999 Collaborative Process).
4. Background levels for COI in sediment are defined as the concentration of the COI observed in samples from areas not affected by the refinery. Background sediment samples may be collected from areas within Soda Lake (the old playa salt footprint and the flooded terrestrial soils that are not influenced by the weir outfall) or from nearby enclosed playa basins with similar geologic settings to the Soda Lake Basin (e.g., Pratt's Soda Lake, Suicide Soda Lake, or Bar None Lake).
5. Appropriate criteria for screening and utilizing pore water data to be determined in Collaborative Process. Likely, screening benchmarks for pore water will be based on the surface water screening benchmarks specified in the DQOs for surface water. Specific values for pore water screening are under U.S. EPA development.

Table 6-1 Evaluation of Remedial Objectives for Sediment Alternative Remedial Objective 1: Unrestricted Recreational Uses

EVALUATION OF REMEDIAL OBJECTIVES FOR SEDIMENTS	
BP SODA LAKE	
Alternative Remedial Objective #1: Unrestricted Recreational Uses – allows unrestricted water access and adjacent recreational land use. Protects surface water from leaching contaminants from sediments and prevents the resuspension of contaminated sediments that would exceed the AWQC and federal or state drinking water standards. Protects ecological receptors. Sediments potentially drying out upon cessation of pumping will meet the lower of sediment or residential soil standards.	
Remedial Objectives	**Remedial Standards**
0 - 4 in. (10cm) Surficial Sediment Depth	
1.a. Remediate (treat or remove) sediments to 4 inches to:	1a. Remedial standards for sediments should be the lowest of the following standards:
i. **Minimize the potential for direct contact with contaminated sediments or other sources, including process residuals,.** This objective is intended to prevent any harmful effects to workers, users, or occupants of the site assuming any potential future surface uses of the site.	i. For carcinogenic constituents, a "point of departure" risk of one in one million (10-06) and for chronic non-carcinogenic constituents a hazard index less than 1.0, using residential exposure assumptions giving consideration to exposures to children and the elderly [W.S. 35-11-1605(a)(ii)(B)];
ii. **Prevent ongoing surface water contamination**, such as leaching from residual sediment contamination;	ii. For residual sediment contamination, [as defined in ROEMS] capable of leaching or resuspending contaminants into surface water, concentrations that prevent exceedances of surface water standards(AWQCs or MCLs, whichever is lower);
iii. **Ensure there are no unacceptable risks to ecological receptors** in the biologically active zone, including porewater; and	iii. A. Concentrations that meet the immediate and long-term hazard criteria for ecological receptors [ROEMS] for receptors for which habitats have been identified on or near the site, and for receptors likely to be observed at the site; OR B. Concentrations that will lead to an exceedance of AWQC in porewater; OR C. Conditions shown by a Tier II analysis to be protective of ecological receptors; and
iv. **Ensure that unsafe conditions are not present.**	iv. Concentrations and conditions that prevent immediate hazards to humans [ROEMS].

Notes:
ROEMS = Remedial Option Evaluation and Management Scheme
AWQC = Aquatic Water Quality Concentrations
MCLs = Maximum Concentration Levels
NAPL = Non-aqueous phase liquids

Table 6-2 Evaluation of Remedial Objectives for Sediment Alternative Remedial Objective 2: Restricted Use–Unlimited Terrestrial and Restricted Recreational Access

EVALUATION OF REMEDIAL OBJECTIVES FOR SEDIMENTS	
BP SODA LAKE	
Alternative Remedial Objective #2: Restricted Use – Unlimited Terrestrial and Restricted Recreational Access - allows unlimited terrestrial access to shoreline and near shore areas and limited recreational access to Soda Lake. This land use is intended to be strictly for observation of wildlife, with the objective being to maintain Soda Lake as a wildlife habitat. Requires the site to be located wthin a use control area designated under W.S. 35-11-1609. Protects surface water from leaching contaminants from sediments or sources that would exceed AWQC or Federal or state drinking water standards. Protects ecological receptors for which habitats have been identified on or near the site.	
Remedial Objectives	**Remedial Standards**
0 - 4 inches Sediment Depth	
1.a. Remediate (treat or remove) sediments to 4 inches to:	1a. Remedial standards for sediments should be the lowest of the following standards:
i. **Minimize the potential for direct contact with contaminated sediments or other sources, including process residuals** This objective is intended to prevent any harmful effects to recreational users, of the site assuming recreational future surface uses of the site.	i. For carcinogenic constituents, a "point of departure" risk of one in one million (10-06) and for chronic non-carcinogenic constituents a hazard index less than 1.0, using exposure assumptions consistent with the reuse plan. [W.S. 35-11-1605(a)(ii)(B)];
ii. **Prevent ongoing surface water contamination**, such as leaching from residual sediment contamination;	ii. For residual sediment contamination, [as defined in ROEMS] capable of leaching or resuspending contaminants into surface water, concentrations that prevent exceedances of surface water standards (AWQCs or MCLs, whichever is lower);
iii. **Ensure there are no unacceptable risk to ecological receptors** in the biologically active zone, including porewater; and	iii. A. Concentrations that meet the immediate and long-term hazard criteria for ecological receptors [ROEMS] for receptors for which habitats have been identified on or near the site, and for receptors likely to be observed at the site; OR B. Concentrations which will lead to an exceedance of AWQC in porewater; OR C. Conditions shown by a Tier II analysis to be protective of ecological receptors; and
iv. **Ensure that unsafe conditions are not present.**	iv. Concentrations and conditions that prevent immediate hazards to humans [ROEMS].

Notes:
ROEMS = Remedial Option Evaluation and Management Scheme
AWQC = Aquatic Water Quality Concentrations
MCLs = Maximum Concentration Levels
NAPL = Non-aqueous phase liquids

Table 6-3 Evaluation of Remedial Objectives for Soils and Sources Alternative Remedial Objective 1: Unrestricted Use

EVALUATION OF REMEDIAL OBJECTIVES FOR SOILS AND SOURCES	
BP SODA LAKE	
Alternative Remedial Objective #1: Unrestricted Use – allows unrestricted land use, including residential and commercial structures with basements and utility excavations not to exceed 12 ft in depth or the top of the water table. Institutional controls would be used to restrict foundation excavations deeper than 12 ft. or the top of the water table. Vapor intrusion controls may be required depending on the groundwater remedial alternative selected. Protects groundwater from leaching contaminants from soils and sources that would result in exceedances of the drinking water standards. Protects ecological receptors.	
Remedial Objectives	**Remedial Standards**
0 - 12 ft or top of water table	
1.a. Remediate (treat or remove) soils and sources in the 0-12 ft depth range to:	1a. Remedial standards for this soil interval should be the lowest of the following standards:
i. **Minimize the potential for direct contact with contaminated soils or other sources, including process residuals, during any type of future occupancy.** This objective is intended to prevent any harmful effects to workers, users, or occupants of the site assuming any potential future surface uses of the site, including direct contact with soils or other sources, including any reasonably expected excavation for buildings and utilities, ingestion of vegetables grown at the site, and inhalation of outdoor or indoor air.	i. For carcinogenic constituents, a "point of departure" risk of one in one million (10-06) and for chronic non-carcinogenic constituents a hazard index less than 1.0, using residential exposure assumptions giving consideration to exposures to children and the elderly [W.S. 35-11-1605(a)(ii)(B)];
ii. **Prevent ongoing groundwater contamination**, such as leaching from residual soil contamination and other sources,	ii. For residual soil contamination, and for sources [as defined in ROEMS] capable of leaching contaminants to groundwater, concentrations that prevent exceedances of groundwater standards assuming a soil attenuation factor based on site specific conditions with no dilution in groundwater [ROEMS]. Interim standards can be established based on groundwater remedial standards;
iii. **Prevent surface water contamination**, such as leaching from residual soil contamination and other sources	iii. For residual soil contamination, and for sources [as defined in ROEMS] capable of leaching contaminants to surface water, concentrations that prevent exceedances of AWQC or MCLs assuming a soil attenuation factor based on site specific conditions with no dilution in surface water [ROEMS];
iv. **Ensure there are no unacceptable risk to ecological receptors**, including throughout the burrowing zone; and	iv. A. Concentrations that meet the immediate and long-term hazard criteria for ecological receptors [ROEMS] for receptors for which habitats have been identified on or near the site, and for receptors likely to be observed at the site; OR B. Conditions shown by a Tier II analysis to be protective of ecological receptors; and
v. **Ensure that unsafe conditions are not present.**	v. Concentrations and conditions that prevent immediate hazards to humans [ROEMS].
vi. **Ensure that runoff does not impact surface waters.**	vi. For surface runoff soil contamination, prevent concentrations that exceed AWQC or MCLs;

Notes:
ROEMS = Remedial Option Evaluation and Management Scheme
AWQC = Aquatic Water Quality Concentrations
MCLs = Maximum Concentration Levels
NAPL = Non-aqueous phase liquids

Table 6-4 Evaluation of Remedial Objectives for Soils and Sources Alternative Remedial Objective 2: Reuse Plan with Restrictions

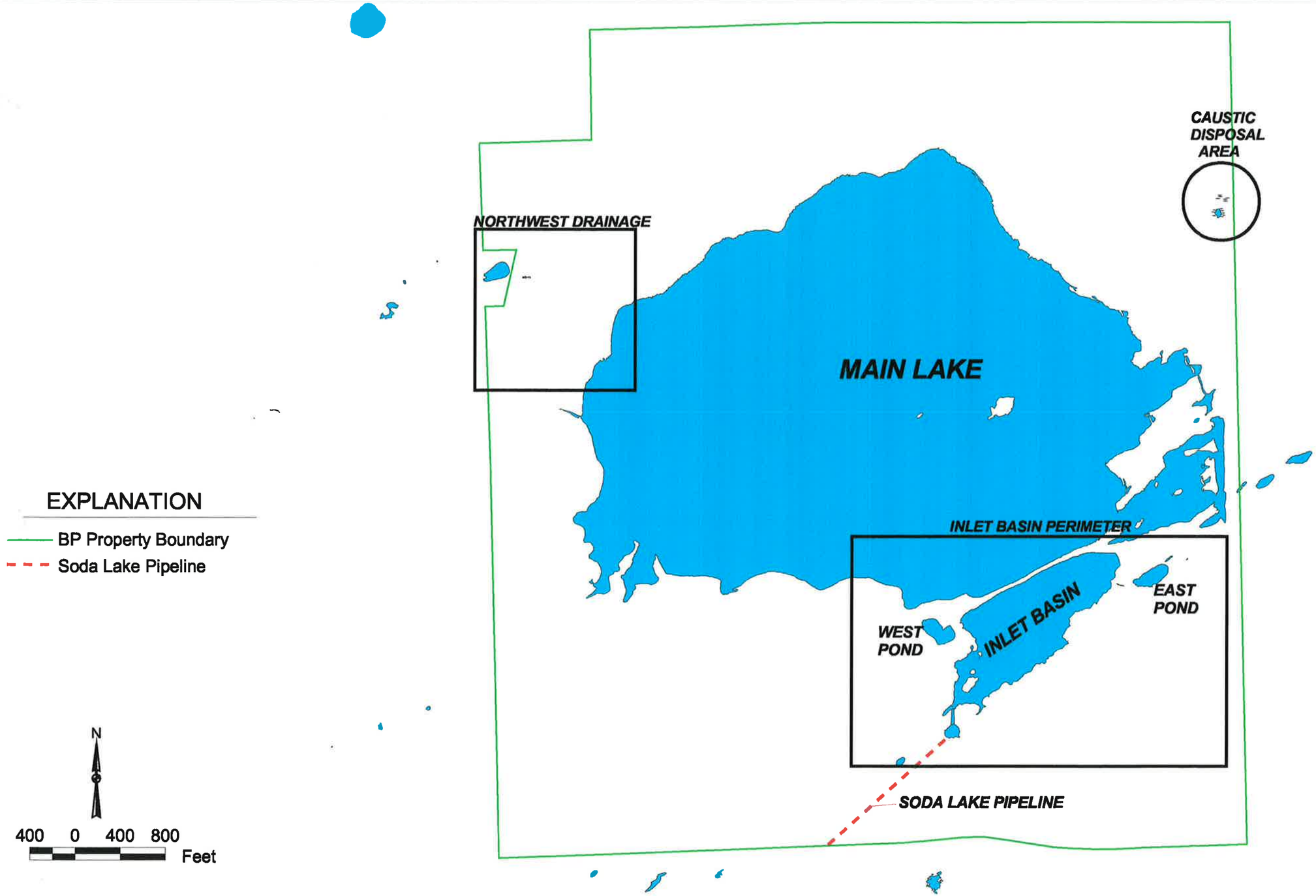
EVALUATION OF REMEDIAL OBJECTIVES FOR SOILS AND SOURCES	
BP SODA LAKE	
Alternative Remedial Objective #2: Reuse Plan with Restrictions – allows land use consistent with reuse agreement, including parks, commercial and industrial structures without basements (slab on grade construction), and excavations not to exceed 8 ft in depth. Requires the site to be located within a use control area designated under W.S. 35-11-1609. Institutional controls would be used to restrict excavations deeper than 4 feet and would require management of excavated soils to prevent public and ecological risks caused by exposure to contaminated materials exceeding reuse remedial standards. Institutional controls would also limit utility excavations below 8 ft. Vapor intrusion controls may be required depending on the groundwater remedial alternative selected. Protects groundwater from leaching contaminants from soils or sources that would results in exceedances of drinking water standards. Protects ecological receptors for which habitats have been identified on or near the site.	
Remedial Objectives	**Remedial Standards**
0 - 4 ft Soil Depth[1]	
1.a. Remediate (treat, remove or contain) soils and sources in the 0-4 ft depth range to:	1a. Remedial standards for this soil interval should be the lowest of the following standards:
i. **Minimize the potential for direct contact with contaminated soils or other sources, including process residuals, during any type of future occupancy.** This objective is intended to prevent any harmful effects to workers, users, or occupants of the site assuming any potential future surface uses of the site, including direct contact with soils or other sources, including any reasonably expected excavation for buildings and utilities, and inhalation of outdoor or indoor air.	i. For carcinogenic constituents, a "point of departure" risk of one in a million (10-06) and for chronic non-carcinogenic constituents a hazard index less than 1.0, using exposure assumptions consistent with the reuse plan [W.S. 35-11-1605 (c)];
ii. **Prevent ongoing groundwater contamination,** such as leaching from residual soil contamination and other sources;	ii. For residual soil contamination, and for sources [as defined in ROEMS] capable of leaching contaminants to groundwater, concentrations that prevent exceedances of groundwater standards assuming a soil attenuation factor based on site specific conditions with no dilution in groundwater [ROEMS]. Interim standards can be established based on groundwater remedial standards;
iii. **Prevent surface water contamination**, such as leaching from residual soil contamination and other sources	iii. For residual soil contamination, and for sources [as defined in ROEMS] capable of leaching contaminants to surface water, concentrations that prevent exceedances of AWQC or MCLs assuming a soil attenuation factor based on site specific conditions with no dilution in surface water [ROEMS];
iv. **Ensure there are no unacceptable risk to ecological receptors**, including throughout the burrowing zone; and	iv. A. Concentrations that meet the immediate and long-term hazard criteria for ecologic receptors [ROEMS] for receptors for which habitats have been identified on or near the site, and for receptors likely to be observed at the site; OR B. Conditions shown by a Tier II analysis to be protective of ecologic receptors; and
v. **Ensure that unsafe conditions are not present.**	v. Concentrations and conditions that prevent immediate hazards to humans [ROEMS].

[1] During remedial alternative evaluation a depth to six feet will be considered.

Table 6-5 Evaluation of Remedial Objectives for Soils and Sources Alternative Remedial Objective 3: Open Space Use

EVALUATION OF REMEDIAL OBJECTIVES FOR SOILS AND SOURCES	
BP SODA LAKE	
Alternative Remedial Objective #3: Open Space Use - allows land use consistent with current uses, including grazing and limited bird viewing. Requires the site to be located within a use control area designated under W.S. 35-11-1609. Institutional controls would be used to restrict excavations deeper than 4 feet and would require management of excavated soils to prevent public and ecological risks caused by exposure to contaminated materials exceeding ecological or industrial use remedial standards. Institutional controls would also limit utility excavations below 8 ft. and protects construction workers. Vapor intrusion controls may be required depending on the groundwater remedial alternative selected. Protects groundwater from leaching contaminants from soils or sources that would result in exceedances of drinking water standards. Protects ecological receptors for which habitats have been identified on or near the site.	
Remedial Objectives	**Remedial Standards**
0 - 4 ft Soil Depth	
1.a. Remediate (treat, remove or contain) soils and sources in the 0-4 ft depth range to:	1a. Remedial standards for this soil interval should be the lowest of the following standards:
i. **Minimize the potential for direct contact with contaminated soils or other sources, including process residuals, during any type of future occupancy.** This objective is intended to prevent any harmful effects to current users, including direct contact with soils or other sources, including any reasonably expected excavation for buildings and utilities.	i. For carcinogenic constituents, a "point of departure" risk of one in a million (10-06) and for chronic non-carcinogenic constituents a hazard index less than 1.0, using exposure assumptions for current users of the site[W.S. 35-11-1605 (c)];
ii. **Prevent ongoing groundwater contamination**; such as leaching from residual soil contamination and other sources,	ii. For sources [as defined in ROEMS] capable of leaching contaminants to groundwater, concentrations that prevent exceedances of groundwater standards assuming a groundwater dilution factor of 1.0 and considering a soil attenuation factor based on site specific conditions [ROEMS]. An interim remedial standard can be established based on groundwater remedial standards;
iii. **Prevent surface water contamination**, such as leaching from residual soil contamination and other sources	iii. For residual soil contamination, and for sources [as defined in ROEMS] capable of leaching contaminants to surface water, concentrations that prevent exceedances of AWQC or MCLs assuming a soil attenuation factor based on site specific conditions with no dilution in surface water [ROEMS].;
iv. **Ensure there are no unacceptable impacts to ecological receptors**, including throughout the burrowing zone; and	iv. A. Concentrations that meet the immediate and long-term hazard criteria for ecologic receptors [ROEMS] for receptors for which habitats have been identified on or near the site, and for receptors likely to be observed at the site; OR B. Conditions shown by a Tier II analysis to be protective of ecologic receptors; and
v. **Ensure that unsafe conditions are not present.**	v. Concentrations and conditions that prevent immediate hazards to humans [ROEMS].
vi. **Ensure that runoff does not impact surface waters.**	vi. For surface runoff soil contamination, prevent concentrations that exceed AWQC or MCLs

Figures



EXPLANATION

- BP Property Boundary
- Soda Lake Pipeline

N

400 0 400 800

Feet

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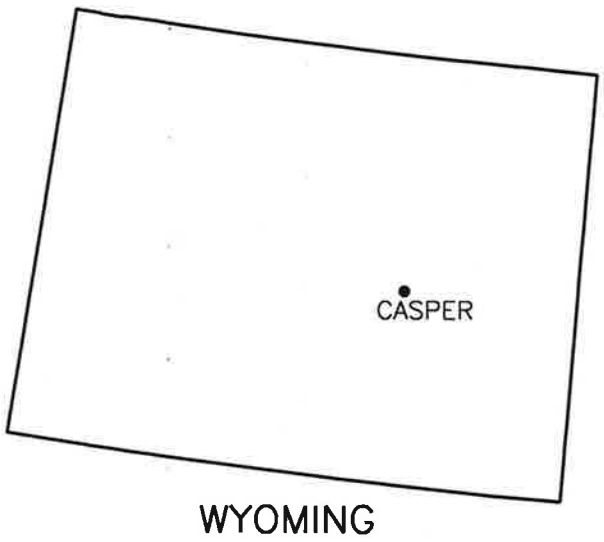
Remedy Decision 3 Technical Support Document Volume I: RCRA Facility Investigation BP Soda Lake, Casper, WY (AMO12-15168-372)			POTENTIAL SOURCE LOCATIONS AT THE SODA LAKE AREA
DATE: 8/20/01	JDH	FILE: w:\amoco\casper\1-4593\soil boring maps.apr(potential source locations)	FIGURE 1-1



LEGEND

- RFI AREA
- BP AMOCO PROPERTY BOUNDARY
- PIPELINE
- ABANDONED PIPELINE

SODA LAKE (MAIN LAKE)
CAUSTIC DISPOSAL AREA
INLET BASIN
WEST POND
EAST POND
CAMU PERMIT BOUNDARY
SODA LAKE PIPELINE
INTERSTATE 25
ABANDONED PIPELINE
NORTH PLATTE RIVER
CASPER CREEK
FORMER REFINERY
CASPER, WY

1000 0 2000
SCALE IN FEET

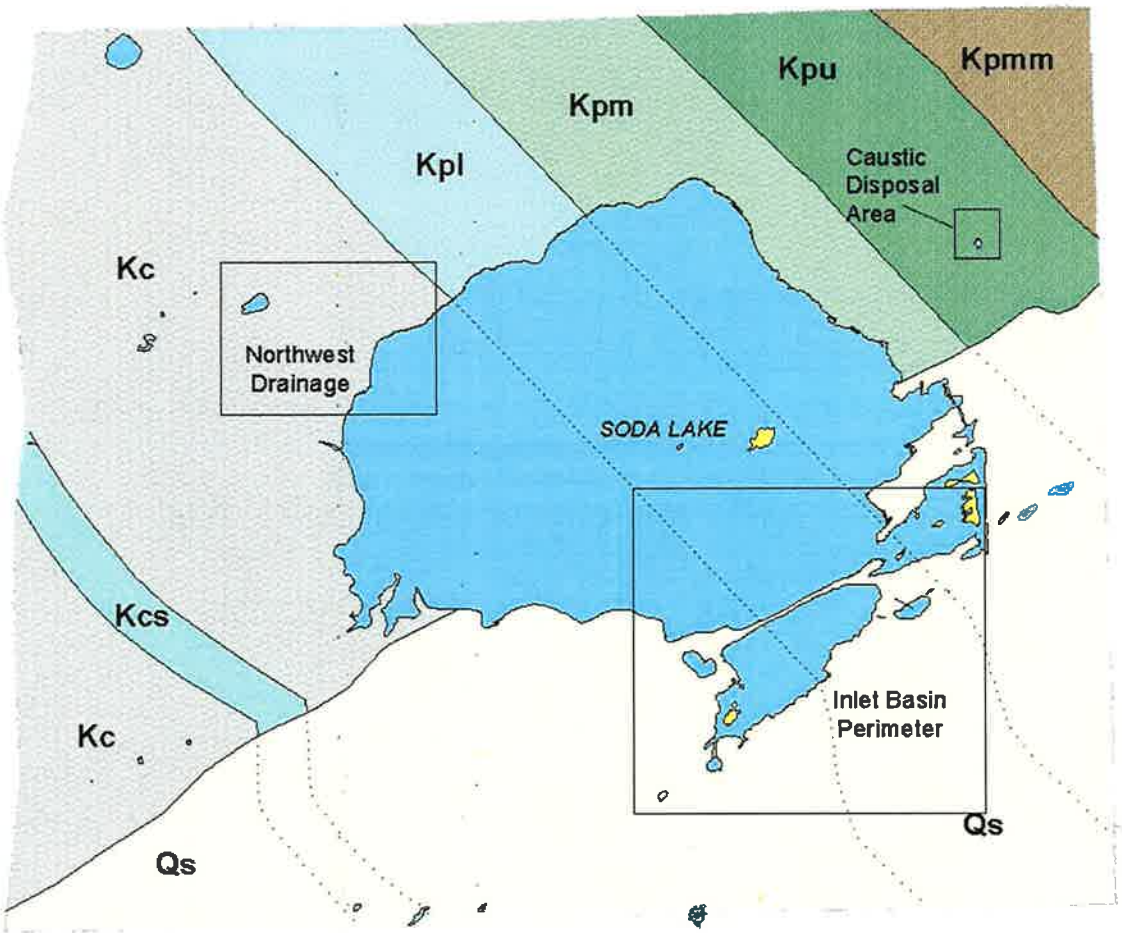
ThermoRetec

REMEDY DECISION 3 TECHNICAL SUPPORT DOCUMENT VOLUME I: RFI
BP SODA LAKE AREA, CASPER, WY (AMO12-15168-372)

CURRENT DATE	10/03/01	CADD FILE	15168s085

SODA LAKE INLET BASIN SITE LOCATION MAP

FIGURE 1-2



Explanation

Qs - Quaternary sand dunes. Consist of fine to medium grained sand. Stabilized by vegetation.

Kpmm - Un-named Middle member of the Mesaverde Fm, interbedded shale and siltstone.

Kpu - Upper Parkman member. Non-marine sandstone, shale and coal near base. The sandstone portion of this unit forms a low ridge and blocky outcrops on the northeastern corner of the site, produces limited quantities of water.

Kpm - Middle Parkman member. Marine sandstone and siltstone, friable, not exposed at the surface, produces abundant groundwater.

Kpl - Lower Parkman member. Marine deposited interbedded shale, siltstone and limestone. Grain size within this unit coarsens upwards. Limestone stringers in this unit form low ridges on the northwestern portion of the site, otherwise, no outcrops are present. Basal portion is very fine-grained. Upper siltstone produces water.

Kc - Cody Shale. Marine shale. Gray-colored, fissile, locally bentonitic, gypsiferous, and calcareous. Upper Cody Shale contains ridge-forming limestone beds which form low outcrops on the western portion of the site.

Kcs - Sussex Sandstone member. 30-60' thick marine siltstone to sandstone, aquiferous.

LEGEND

- Geologic Contact
- Geologic Contact Concealed
- Piezometer
- Monitoring Well
- Contours
- Surface Water
- Strike & Dip of Bedding (6°)

N

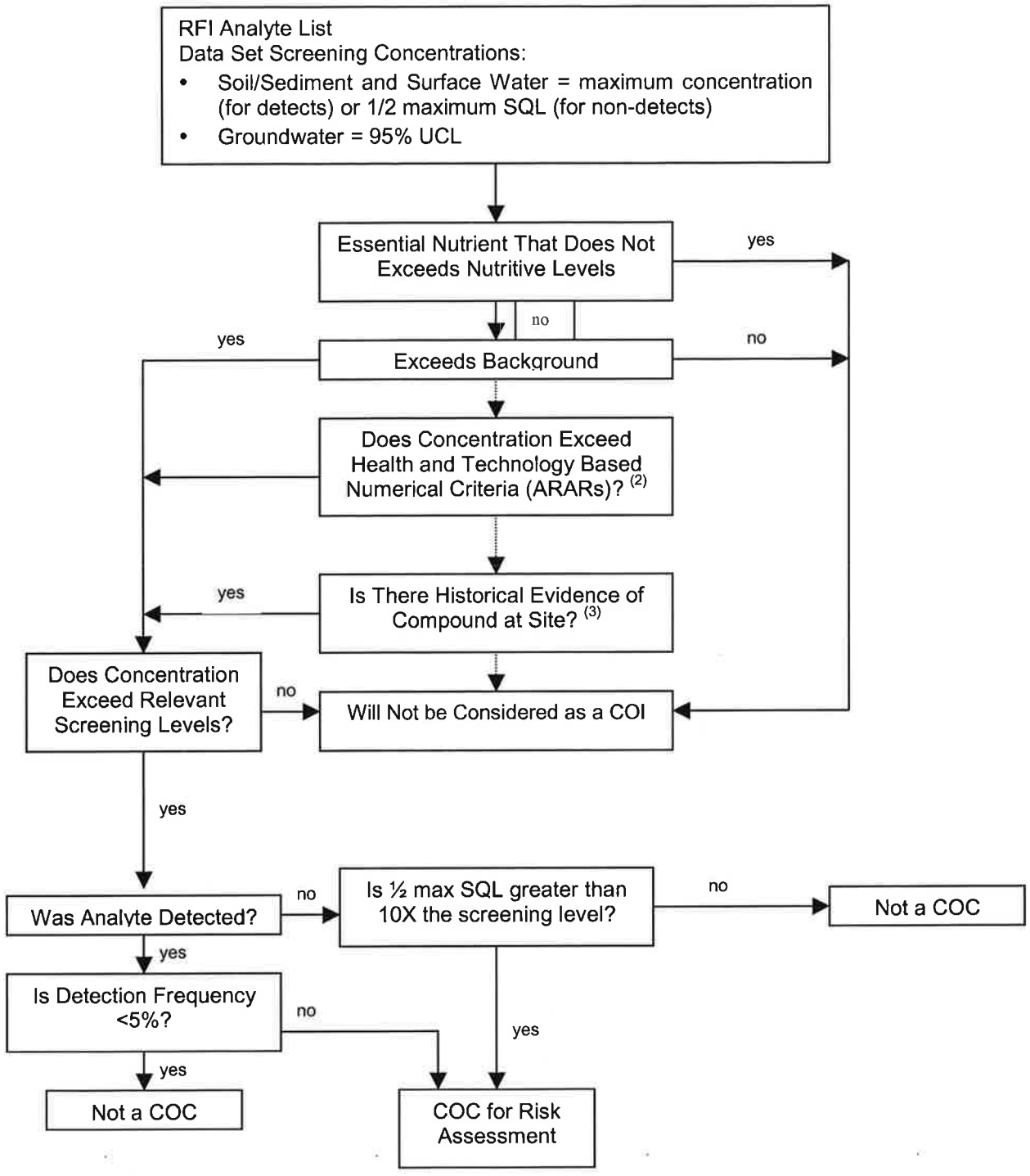
1300 0 1300 2600

ThermoRetec

Remedy Decision 3 for the Former BP Casper Refinery - Soda Lake Area
BP Soda Lake, Casper, WY
(AMO12-16168-372)

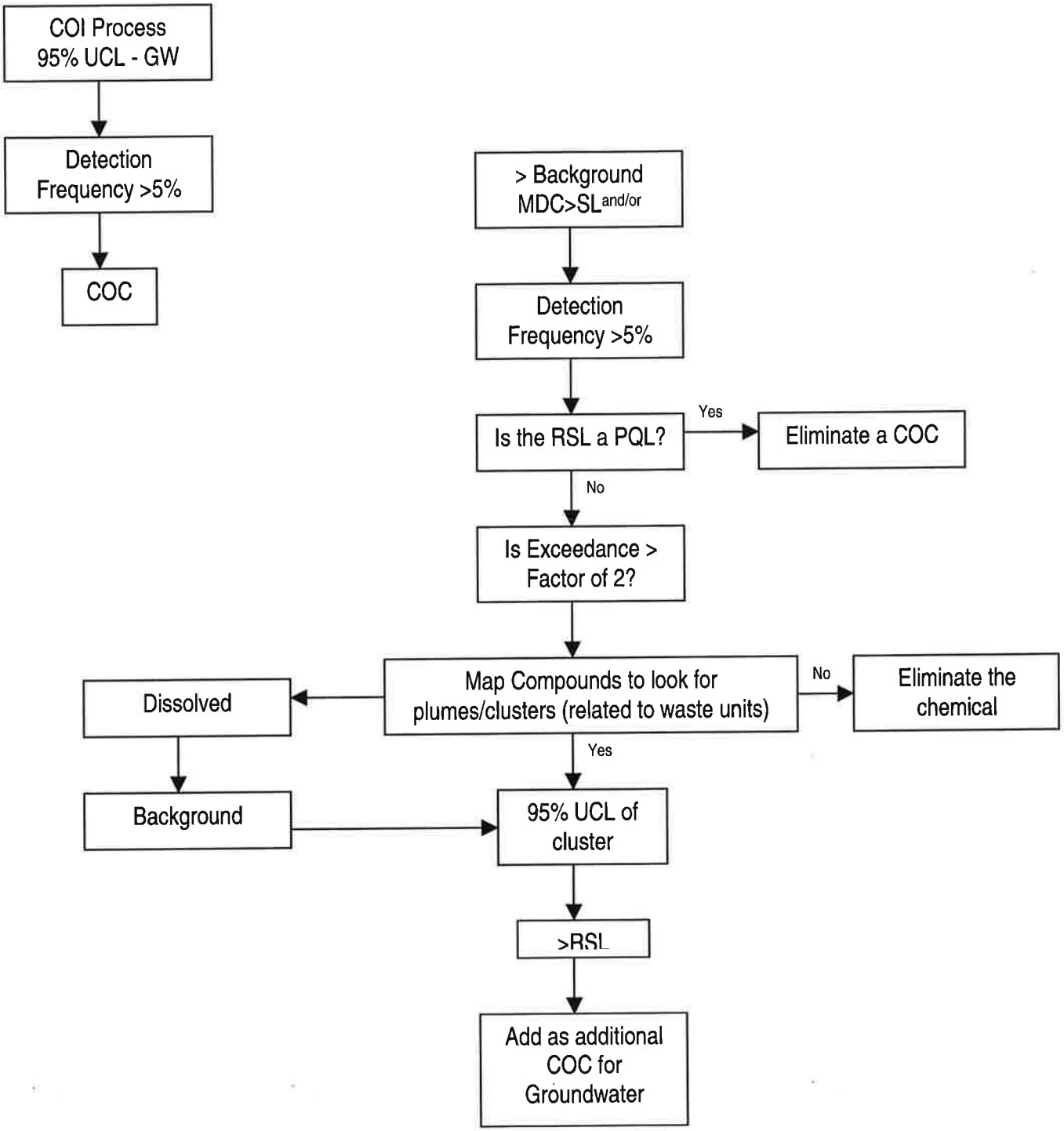
Site Geologic Map and Source Areas

DATE: 7/24/01 | RLB | FILE: w:\amoco\casper\1\5168\hydrochem\GIS Map\Area1 rochem.apr | FIGURE 4-1



(1) Modified EPA Region 8 Guidance (September 1994) for Determining Appropriate Analyte List in Site Investigation/Risk Evaluation.
(2) Included in Relevant Screening Levels.
(3) Considered in defining Analyte List (using authoritative sampling and Appendix IX analyses) .

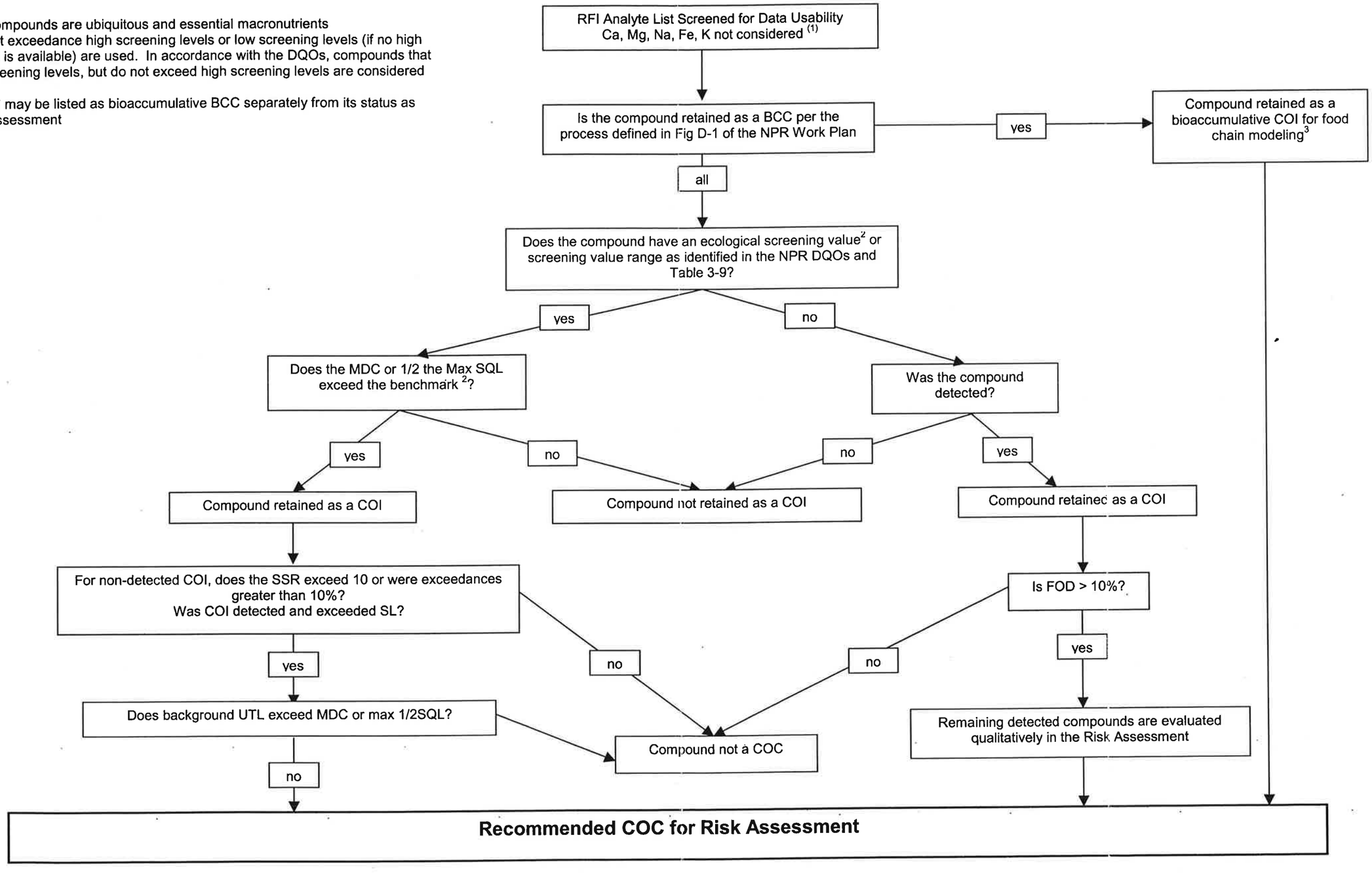
Volume II: Risk Assessment **Remedy Decision 3 Technical Support Document** **BP Soda Lake Area, Casper, WY (AMO12-15168-330)**		**SELECTION PROCESS FOR DETERMINING HUMAN HEALTH COC FOR RISK ASSESSMENT**
DATE: 09/21/2001	M:\\Casper\Soda Lake\RD2\Working\Figures\Section 4\Figure 4-1.doc	**Figure 4-2**



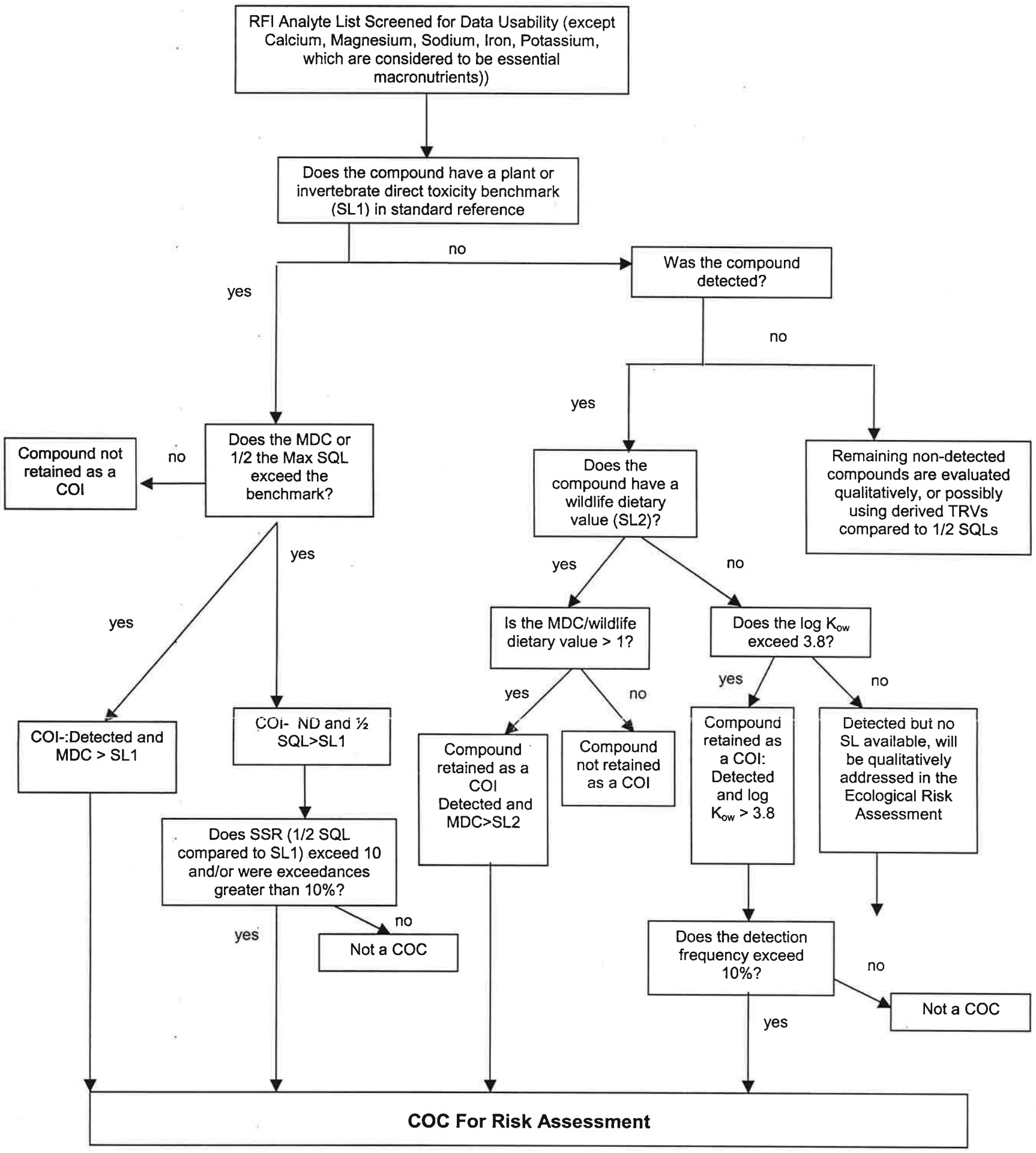
Volume III: Risk Assessment **Remedy Decision 3 - Technical Support Document** **BP North Properties Area, Casper, WY (AMO12-15168-330)**	**Additional COC Evaluation for Groundwater and Surface Water**
DATE: 07/25/2001	M:\\Casper\North Properties\RD2\Final\Figures\Section 4\Figure 4-5.doc
	Figure 4-3

Notes

1. The listed compounds are ubiquitous and essential macronutrients
2. For sediment exceedance high screening levels or low screening levels (if no high screening level is available) are used. In accordance with the DQOs, compounds that exceed low screening levels, but do not exceed high screening levels are considered qualitatively
3. A compound may be listed as bioaccumulative BCC separately from its status as COC for risk assessment



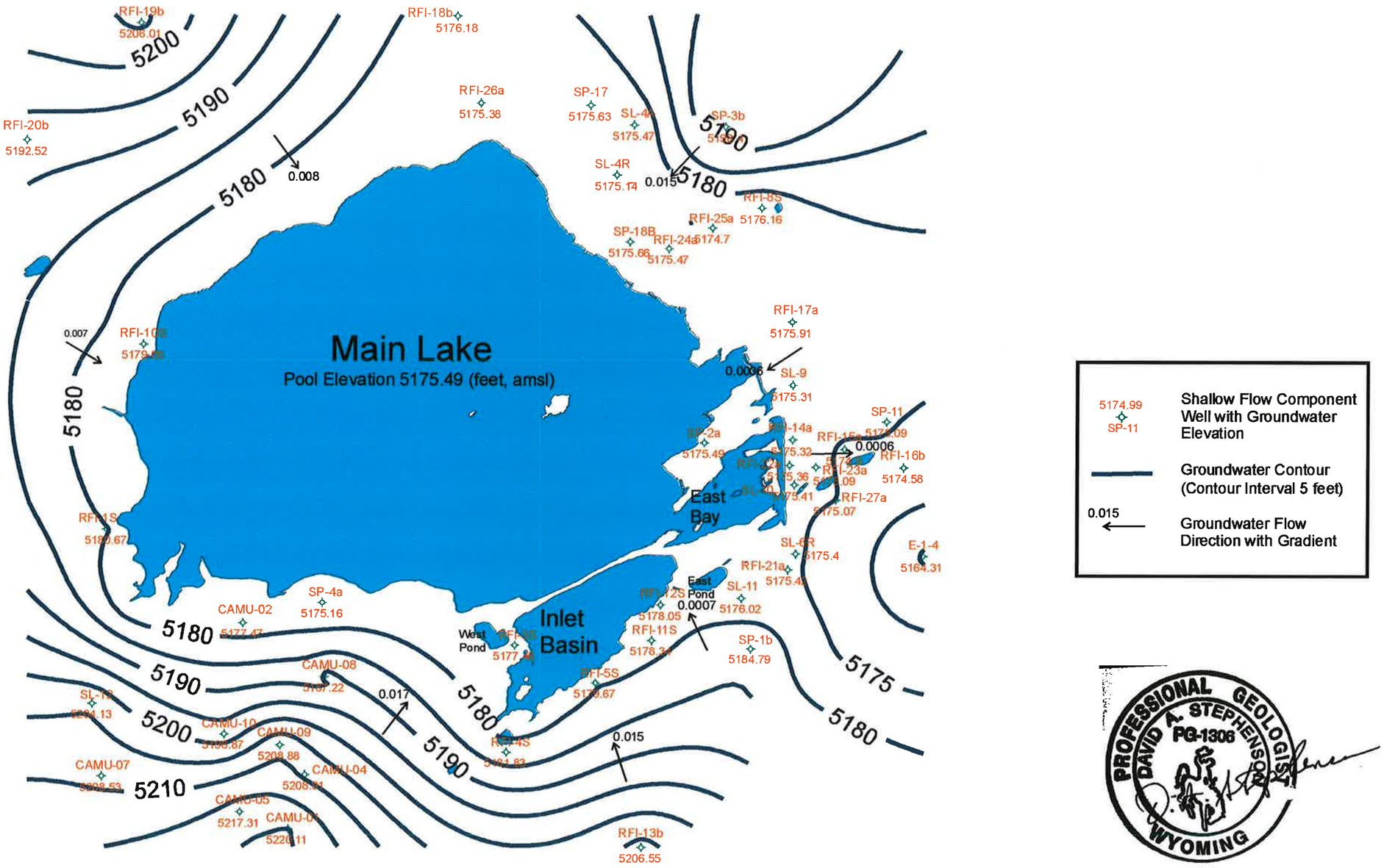
Remedy Decision 3 - Technical Support Document Volume II: Risk Assessment BP Soda Lake Property, Casper, WY (AMO12-15768-330)	**Selection Process for Determining Ecological COC in Surface Water, Sediment, and Pore Water**
DATE: 07/23/2001 — M:\\Casper\North Properties\RD2 RA\Final\Figures\Section 4\Figure 4-6.doc	**Figure 4-4**



Notes:
MDC = Maximum Detected Concentration
SL = Screening Level
ND = Not Detected
SQL = Sample Quantitation Limit
TRV = Toxicity Reference Value
WDV = Wildlife Dietary Values (SL2)
COI = Chemical of Interest
COC = Chemical of Concern

Volume II: Risk Assessment **Remedy Decision 3 Technical Support Document** **BP Soda Lake Area, Casper, WY (AMO12-15168-330)**	**Selection Process for Determining terrestrial Ecological COC for Risk Assessment**
DATE: 07/07/2001	M:\\Casper\North Properties\RD2\Final\Figures\Section 4\Figure 4-2

Figure 4-5



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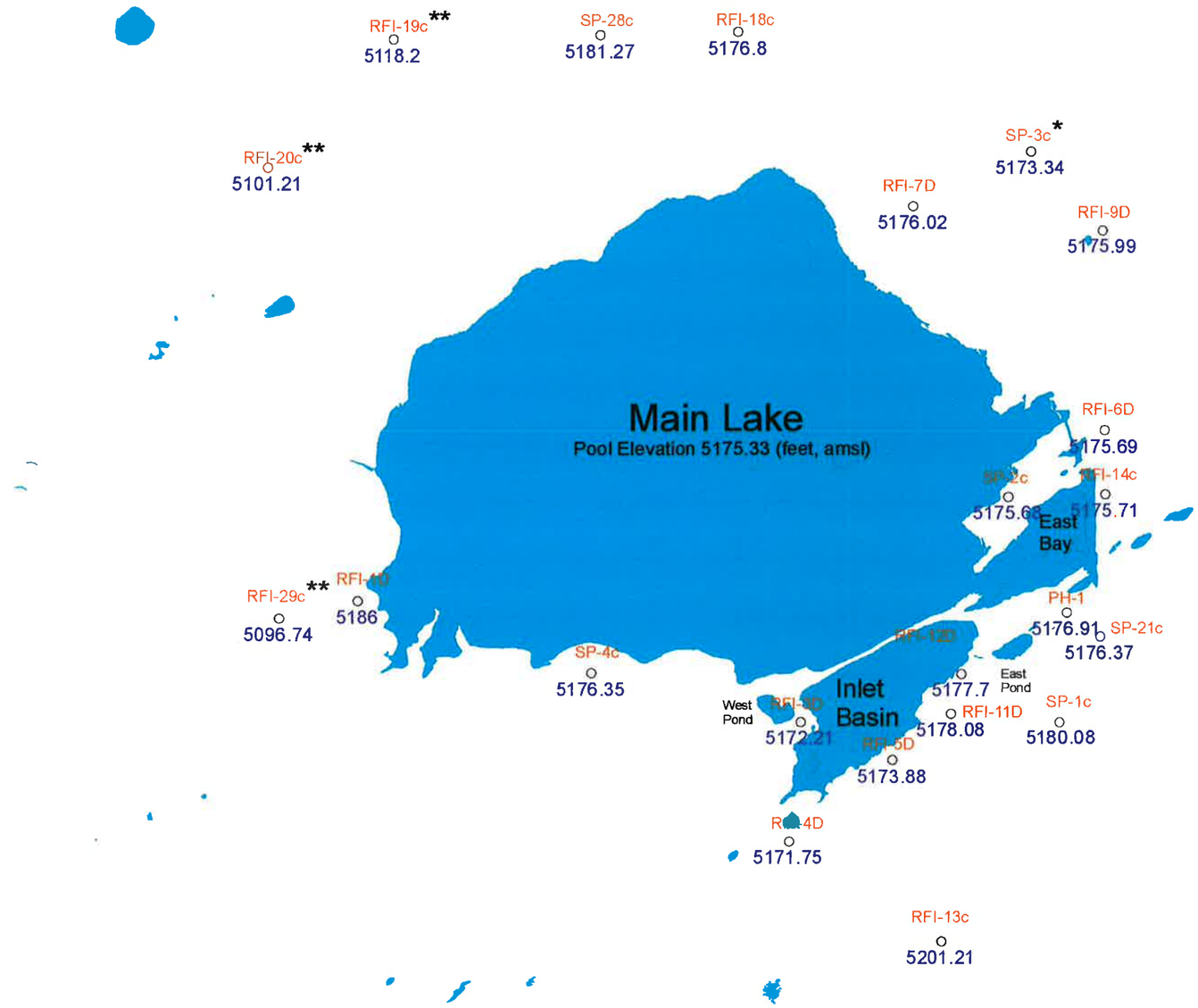
Remedy Decision 3 Technical Support Document Volume1: RCRA Facility Investigation BP Soda Lake Casper, WY (AM012-15168-372)			**Groundwater Contour Map of the Shallow Flow Component April 3, 2001**
DATE: 6/11/01	BTA	FILE: W:\amoco\casper\gis_soda_lake\surfer-7-24-01.cdr (P-6)	FIGURE 4-6



5123.28 ○ E-2-4 — Regional Flow Component Well with Groundwater Elevation

* Denotes well that had not achieved representative static level at time of measurement.

** Denotes well not in hydraulic communication with the flow component.

Groundwater Contour (contour interval 20 feet)

Scale

0 1000 2000 3000

(feet, amsl)

N W E S

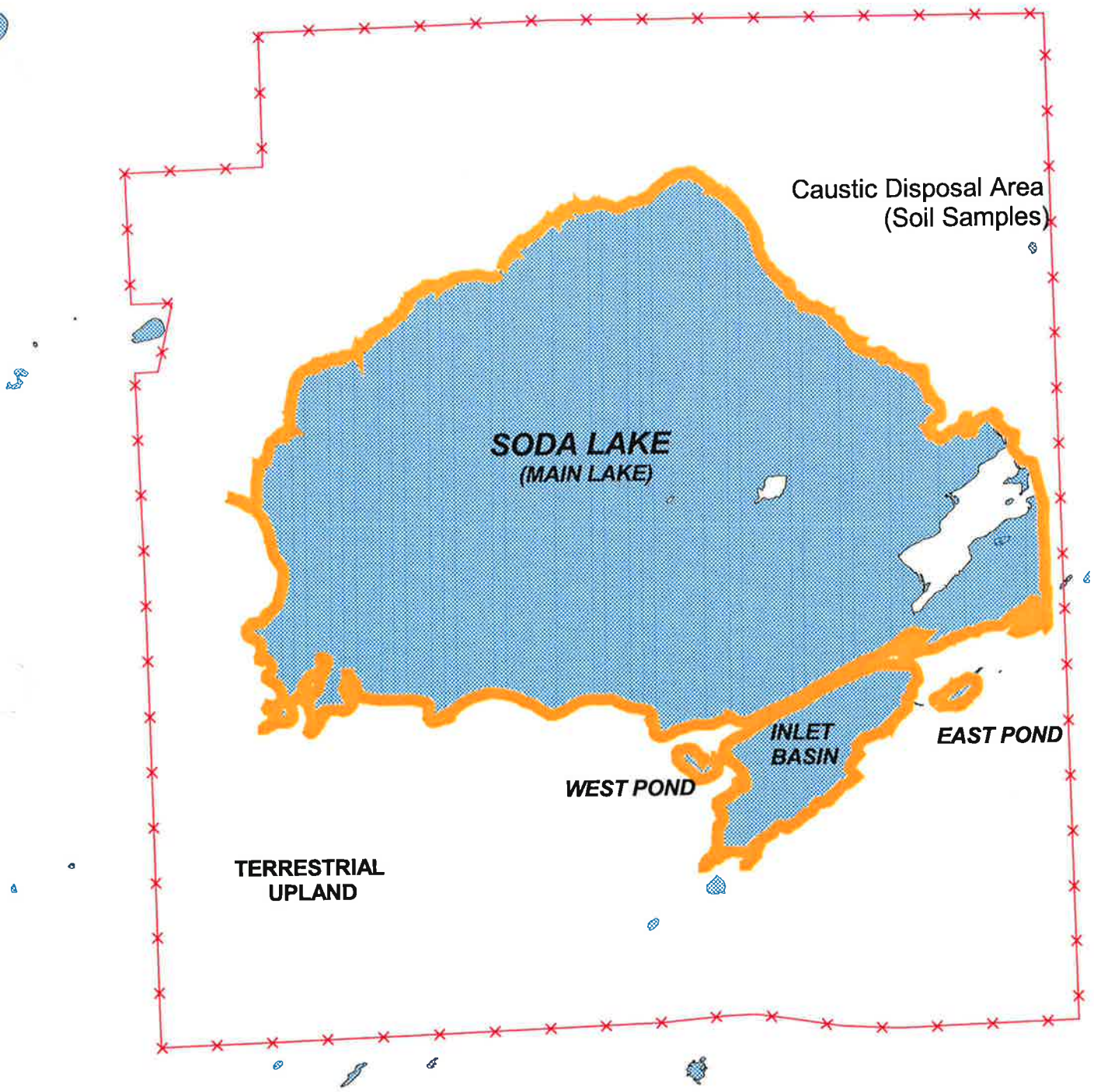
ThermoRetec

Remedy Decision 3 Technical Support Document
Volume1: RCRA Facility Investigation

BP Soda Lake Casper, WY (AM012-15168-372)

Groundwater Elevations of the Regional Flow Component Wells May 23, 2001

DATE: 6/11/01	BTA	FILE: W:\amoco\casper\gis_soda_lake\surfer-7-24-01.cdr (P-2)	FIGURE 4-7



No soil exposure areas (all soils are evaluated collectively).
Sediment exposure areas include East Pond, West Pond and Main Lake.
Native Inlet Basin sediments are evaluated against soil criteria.

Property Boundary/Fence Line

Exposure Area

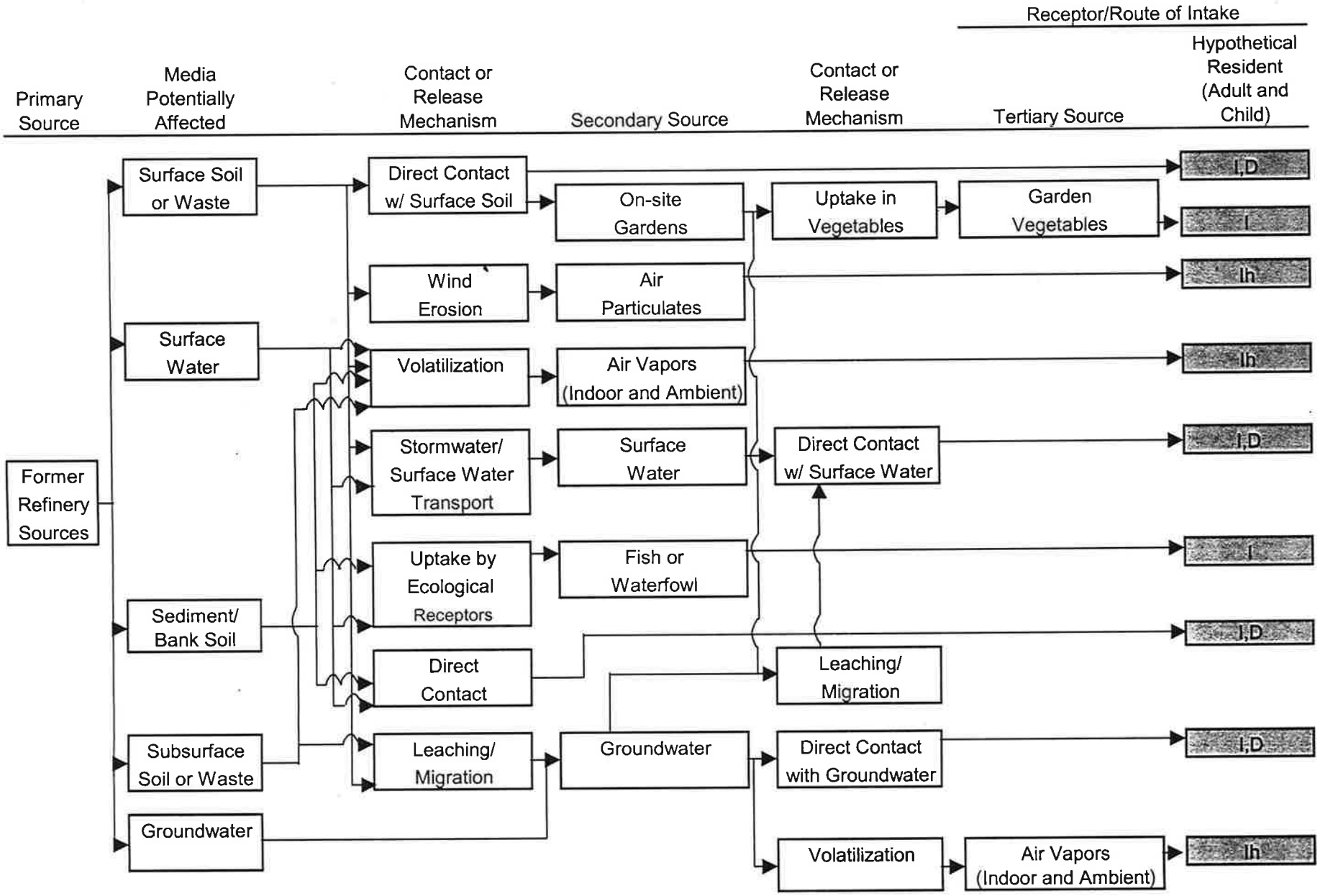
Water

N
W
E
S

1000 0 1000 2000 3000 Feet

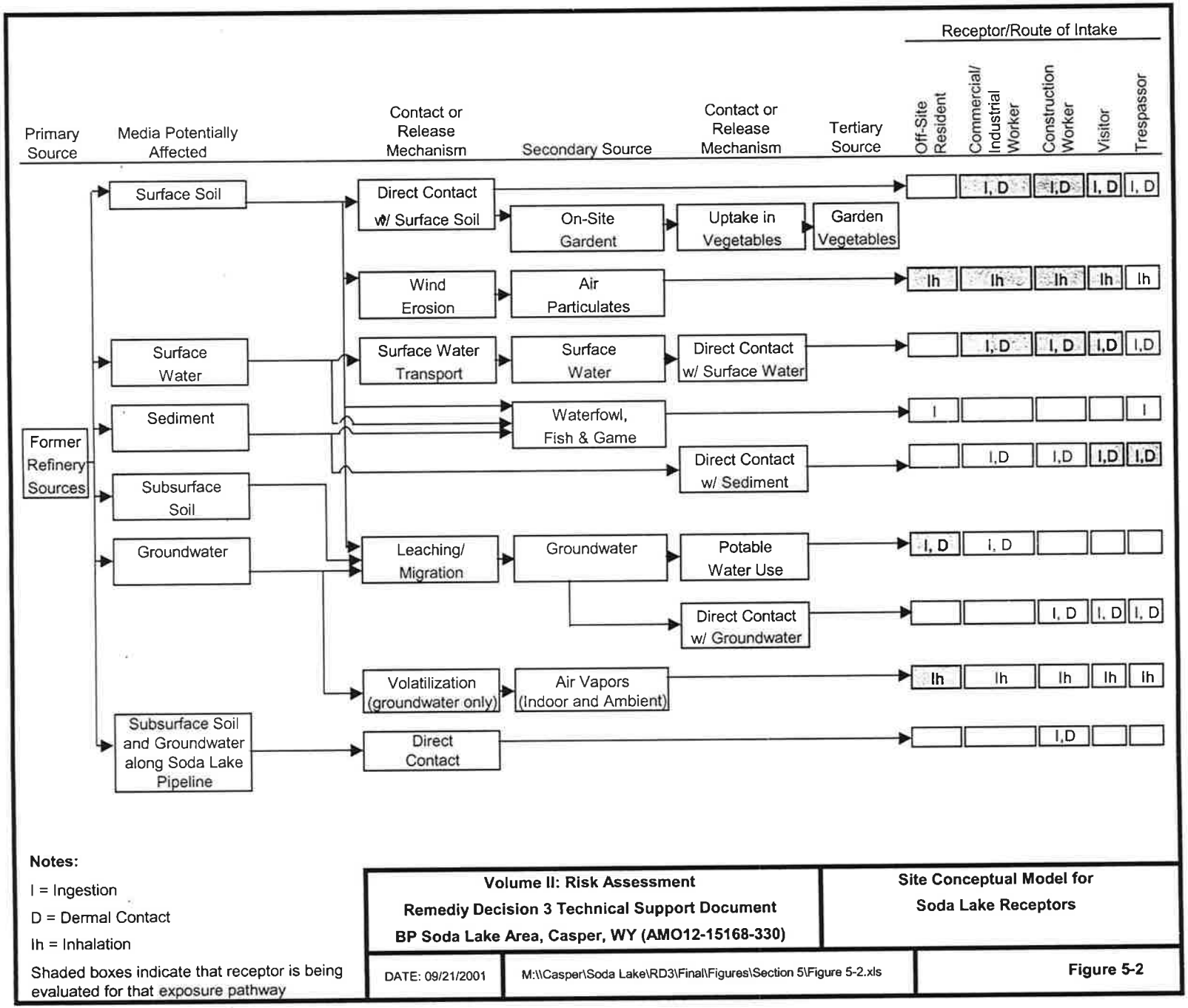
ThermoRetec

Remedy Decision 3 - Technical Support Document Remedy Decision Document BP Soda Lake, Casper, WY (AMO12-15168-330)			**SODA LAKE EXPOSURE AREAS**
DATE: 10/25/01	BTA (KBL)	FILE: E:\PROJECTS\SODA_LAKE\EXPOSURE.APR	FIGURE 4-8



Notes:
Shaded boxes indicate pathways that are quantitatively evaluated in the Risk Assessment
I = ingestion
D = Dermal Contact
Ih = Inhalation

Volume II: Risk Assessment **Remedy Decision 3 Technical Support Document** **BP Soda Lake Area, Casper, WY (AMO12-15168-330)**	**Site Conceptual Model for the Hypothetical Resident**
DATE: 09/21/2001 — M:\\Casper\Soda Lake\RD3\Final\Figures\Section 5\Figure 5-1.doc	**Figure 5-1**



Notes:

I = Ingestion

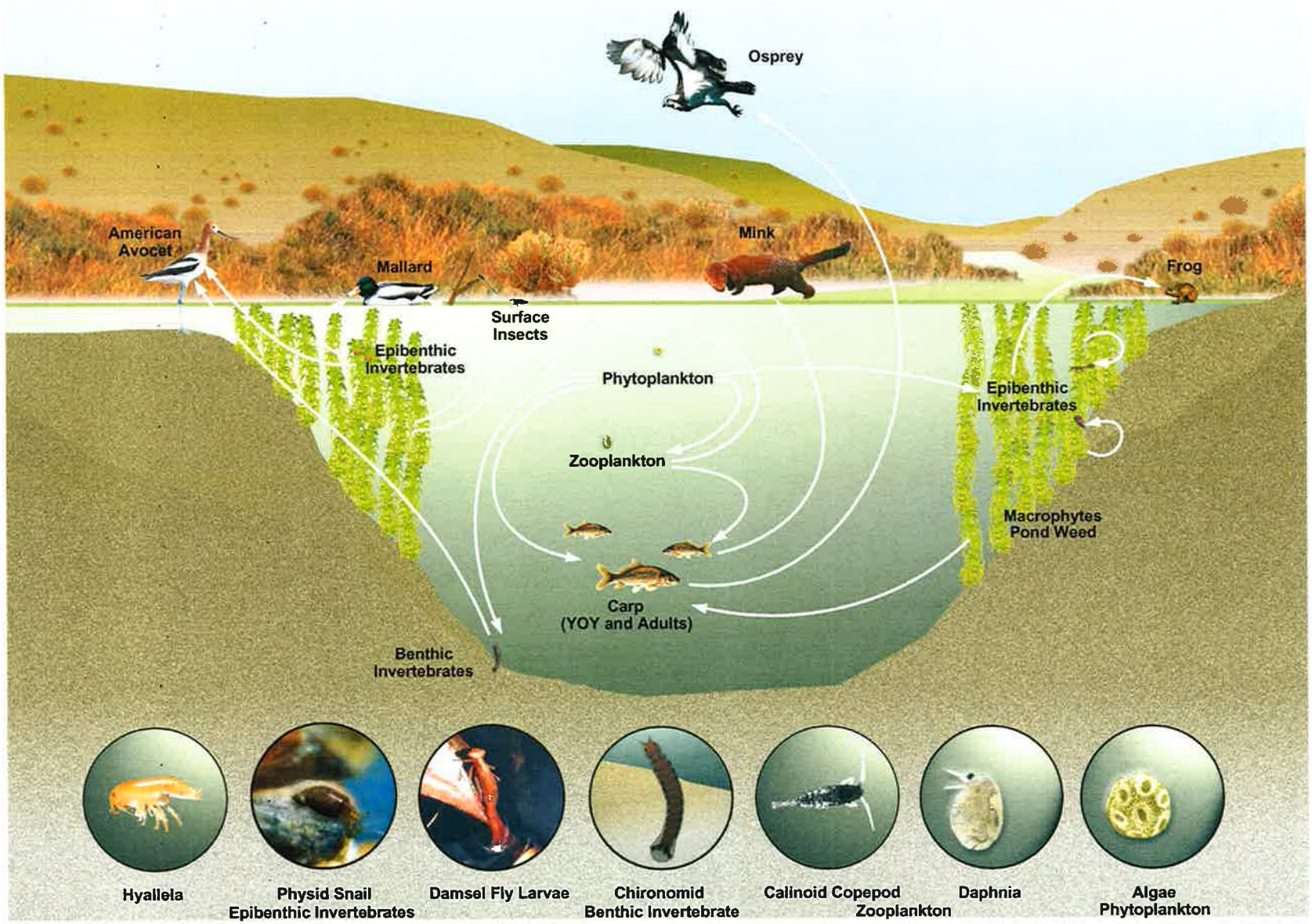
D = Dermal Contact

Ih = Inhalation

Shaded boxes indicate that receptor is being evaluated for that exposure pathway

Volume II: Risk Assessment **Remediy Decision 3 Technical Support Document** **BP Soda Lake Area, Casper, WY (AMO12-15168-330)**	**Site Conceptual Model for Soda Lake Receptors**
DATE: 09/21/2001 — M:\\Casper\Soda Lake\RD3\Final\Figures\Section 5\Figure 5-2.xls	**Figure 5-2**

Figure 5-3 Soda Lake Area Ecological Food Web



BrickTudorStudios/WebProcessCasperJune

Notes: 1. Surface insects include: damsel fly, chironomid after hatch (midge fly)
2. YOY: young-of-the-year

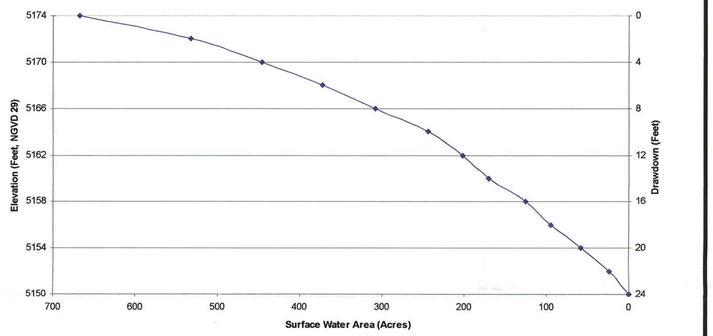
RELATIONSHIP OF SURFACE AREA TO ELEVATION

Elevation (Feet amsl)	Acres of Surface Water in Main Lake (Acres)	Percent of Main Lake Area Below Given Elevation	Inlet Basin Surface Area Where Impacted Sediment is Above Water Table (Acres)	Inlet Basin Percent of Area Where Impacted Sediment is Above Water Table	Time To Achieve Elevation In Main Lake During Natural Drying (Years)
5178	667	100%	0.3	0.6%	NOT CALCULATED
5176	667	100%	7.5	16%	NOT CALCULATED
5174	667	100%	14.9	32%	NOT CALCULATED
5172	533	80%	20.6	44%	1
5170	446	67%	26.4	56%	2
5168	372	56%	33.7	72%	3
5166	308	46%	40.2	85%	4
5164	244	37%	45.1	96%	5
5162	202	30%	46.9	100%	6
5160	171	26%	47.0	100%	7
5158	125	19%	47.0	100%	9
5156	95	14%	47.0	100%	11
5154	58	9%	47.0	100%	NOT CALCULATED
5152	24	4%	47.0	100%	NOT CALCULATED
5150	0	0%	47.0	100%	NOT CALCULATED

NOTES:

1. SEDIMENT CONTOUR INTERVALS = 2 FEET
   –HORIZONTAL STATE PLANE COORD. WYOMING EAST ZONE 4902, NAD 27
   –VERTICAL DATUM – NGVD 29
2. TERRESTRIAL CONTOUR INTERVAL = 2 FEET
3. BATHYMETRY DATA COLLECTED DURING LEAD LINE AND SPI SURVEYS SEPTEMBER 2000
4. MAIN LAKE LEVEL = 5174.2 FEET
5. INLET BASIN LEVEL = 5178.0 FEET
6. THE 5162 FOOT CONTOUR COINCIDES WITH THE MAIN LAKE WATER LEVEL EXTENT THAT WOULD REMAIN AFTER INLET BASIN SEDIMENTS ARE NATURALLY DEWATERED IF THE PUMP REMAINED OFF. THE CMS PROPOSES MAINTAINING A 5165 FOOT LEVEL DURING DEWATERING IF THE PUMP REMAINS ON.
7. GYPSUM PRECIPITATION IS PREDICTED TO OCCUR IF THE MAIN LAKE ELEVATION DROPS BELOW APPROXIMATELY 5,162 FEET (RFI SECTION 14.4.2, VOLUME I)

Relationship of Main Lake Surface Area to Water Elevation and Drawdown



MAIN LAKE

THESE CONTOURS REPRESENT THE SURFACE WATER/SEDIMENT INTERFACE IN THE MAIN LAKE

WEST POND

EAST POND

INLET BASIN

THESE CONTOURS REPRESENT THE IMPACTED SEDIMENT/ NATIVE MATERIAL INTERFACE IN THE INLET BASIN

N

200 0 400

SCALE IN FEET

LEGEND

- GRAVEL ROAD
- UNIMPROVED ROAD
- UNIMPROVED WAY
- 5240 NGVD ELEVATION CONTOUR
- SEASONAL INLET STREAM

5172
5168
5162
Feet amsl

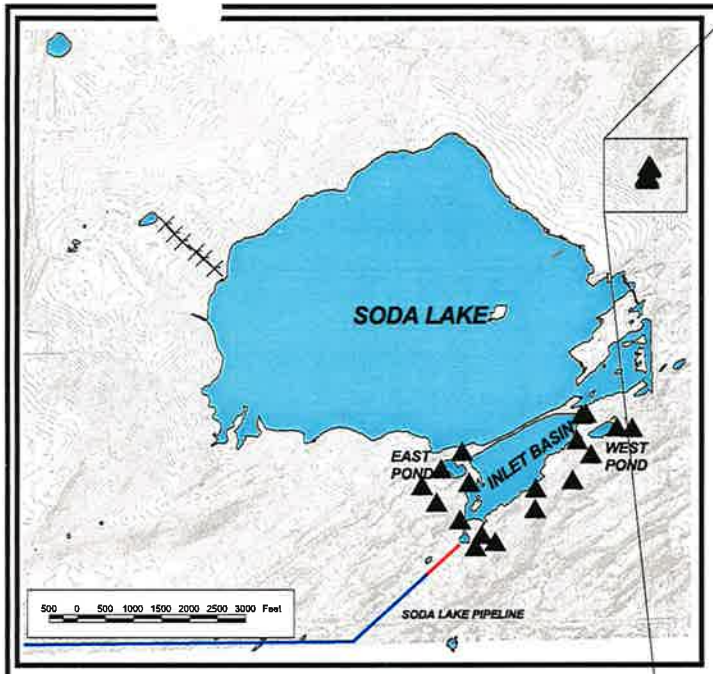
ThermoRetec

REMEDY DECISION 3 TECHNICAL SUPPORT DOCUMENT
VOLUME III: CORRECTIVE MEASURES STUDY/PRESUMPTIVE REMEDY
CASPER, WY (AMO12-15168-445)

CURRENT DATE 10/26/01 | CADD FILE 15168s099

CONTOUR ELEVATIONS OF MAIN LAKE SURFACE WATER/SEDIMENT INTERFACE AND INLET BASIN IMPACTED SEDIMENT/ NATIVE MATERIAL INTERFACE

FIGURE 8-1



SHALLOW CUT INTO BEDROCK WITH BRUSH PILE

CDA2-01
CDA2-05
CDA2-02
CDA2-04
CDA2-06
CDA2-03

CAUSTIC DISPOSAL AREA

CDA-01
CDA-08
CDA-02
CDA-06
CDA-07
CDA-03
CDA-05
CDA-04

10 0 10 20 30 40 Feet

N

LEGEND

- Soda Lake Pipeline Not Hydrostatically Tested
- Soda Lake Pipeline Hydrostatically Tested
- Potential Lateral Extent of Necessary Soil Excavation, to be verified with confirmation sampling(Physically Contained within Berm)
- Soil Sample
- Area of Stressed Vegetation

RETEC

REMEDY DECISION 3 TECHNICAL SUPPORT DOCUMENT
REMEDY DECISION DOCUMENT

CASPER, WY (AMO12-15168-330)

AREA OF SOIL REQUIRING REMEDIATION TO ACHIEVE REMEDIAL OBJECTIVES: CAUSTIC DISPOSAL AREA

DATE: 10/25/01	KBL	FILE: W:\AMOCO\CASPER\1-4593\GIS\COI DETECTS.APR (CAUSTIC-rdd)	FIGURE: 8-2