DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES
Natural Resource Damage Program
(406) 443-6103

MEMORANDUM

TO: Libraries

FROM: Dick Pedersen, Manager Dick Pedersen

DATE: April 22, 1992

SUBJECT: Notice of Assessment Plan Part II

Enclosed are four (4) copies of Part II of the Assessment Plan for the Clark Fork River Basin NPL Sites, Montana. The Natural Resource Damage Program will be releasing this plan shortly by select mailings and issuance of a news release. Your library will be able to assist the general public by having this plan available for viewing and commenting.

DJP/asw
Enc.

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES

STAN STEPHENS, GOVERNOR

COGSWELL BUILDING

STATE OF MONTANA

FAX # (406) 444-2606

HELENA, MONTANA 59620

APRIL, 1992

NOTICE OF ASSESSMENT PLAN PART II
and
Public Comment Period until June 1, 1992

The State of Montana, acting on behalf of the people of Montana, as trustee of the natural resources in the state, hereby provides notice pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA"), 42 U.S.C. §§ 9601-9675, the U.S. Department of the Interior ("DOI") Natural Resource Damage Assessments ("NRDA") Regulations, 43 C.F.R. Part 11, and the Montana Comprehensive Environmental Cleanup and Responsibility Act ("CECRA"), Mont. Code Ann. §§ 75-10-701 to 75-10-724.

1. The Atlantic Richfield Company ("ARCO") has been identified by the State of Montana as the primary responsible party for facilities located at the Clark Fork River Basin National Priorities List ("NPL") sites, including the Silver Bow Creek/Butte Area site, the Anaconda Smelter site, the Montana Pole site, and the Milltown Reservoir site. There have been multiple and continuing releases of hazardous substances, including but not limited to arsenic, beryllium, cadmium, copper, creosote, lead, pentachlorophenol ("PCP"), polycyclic aromatic hydrocarbons, selenium, silver, volatile organic compounds, and zinc, from these facilities. Potential injuries to natural resources, including surface water, fish, sediments, ground water, air, soils, vegetation and wildlife, have resulted from these releases.

2. On October 10, 1991, the State of Montana issued its Notice of Intent to Perform an Assessment ("Notice") and released its Preassessment Screen: Clark Fork River Basin NPL Sites, Montana ("Preassessment Screen"). The Notice and Preassessment Screen were provided to ARCO, other interested parties, and members of the public. In accordance with the DOI NRDA regulations, Montana invited ARCO to participate in the development of a natural resource damage assessment and in the performance of the assessment. ARCO was requested to provide to the State of Montana a damage assessment plan pursuant to the DOI NRDA regulations, if ARCO wished to participate in the assessment. ARCO subsequently submitted written comments to the State of Montana regarding the Preassessment Screen and the State's decision to perform a natural resource damage assessment. ARCO did not submit an assessment plan, nor did it indicate any intention to do so in the future. The State reviewed and considered the comments provided by ARCO in its preparation of Part II of the Assessment Plan.

3. On January 27, 1992, the State of Montana issued its Assessment Plan, Part I, Clark Fork River Basin NPL Sites, Montana. Part I identified the methodologies for conducting injury determination and quantification for the surface water, fisheries, sediments, and ground water resources. Comments on Part I were received from several interested parties including ARCO. All comments have been reviewed by the State of Montana.

4. The State of Montana hereby releases its Assessment Plan, Part II, Clark Fork River Basin NPL Sites, Montana ("Part II of the Assessment Plan"). This assessment plan identifies the methodologies for conducting injury determination and quantification for the air, soils, vegetation and wildlife resources. Part II also contains methodologies to be used for assessing economic damages. In addition, a description of field sampling of surface and ground water is contained as a supplement to methods defined in Part I of the plan. Part II of the Assessment Plan is being made available for review and comment by ARCO, other natural resource trustees, other affected federal or state agencies or Indian Tribes, and any other interested members of the public. Comments concerning the assessment plan should be made in writing and mailed by June 1, 1992 to:

Dick Pedersen
Natural Resource Damage Program Manager
Environmental Sciences Division
Department of Health & Environmental Sciences
Cogswell Building
Helena, MT 59620

The State of Montana may modify Part II of the Assessment Plan following its review of submitted comments. Any modifications, which in the judgment of the State of Montana are significant, will be made available for subsequent review and comment.

5. At the conclusion of the Natural Resource Damage Assessment, the State of Montana will prepare and make available a Report of the Assessment. The report will include a summary of the comments received to Parts I and II of the Assessment Plan and the State's responses to those comments.

STATE OF MONTANA

By Dick Pedersen
Dick Pedersen
Natural Resource Damage Program Manager
Environmental Sciences Division
Department of Health and Environmental Sciences
Cogswell Building
Helena, MT 59620

w/plan

ASSESSMENT PLAN: PART II CLARK FORK RIVER BASIN NPL SITES, MONTANA

STATE OF MONTANA
NATURAL RESOURCE DAMAGE PROGRAM

APRIL 1992

EXECUTIVE SUMMARY

The State of Montana ("the State") has commenced an action against the Atlantic Richfield Company ("ARCO") in the United States District Court for the District of Montana (Civil Action No. CV 83-317-HLN-CCL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA"), 42 U.S.C. §§ 9601-9675, and the Montana Comprehensive Environmental Cleanup and Responsibility Act ("CECRA"), Mont. Code Ann. §§ 75-10-701 to 75-10-724. In this action, Montana seeks to recover damages for injuries to natural resources resulting from releases of hazardous and/or deleterious substances[1] from facilities for which ARCO is the primary responsible party. The State of Montana has begun to assess the natural resource damages in accordance with the regulations of the U.S. Department of the Interior (U.S. DOI) as set forth in 43 CFR Part 11 and as modified by Ohio v. U.S.DOI 880 F.2nd 432 (D.C. Cir. 1989).

In January 1992, the State released for public review and comment Part I of its Assessment Plan. Part I of the Plan addressed activities associated with injury determination and quantification phases for four potentially injured natural resources: surface water resources, fisheries resources, sediment resources, and groundwater resources. In addition, Part I of the Assessment Plan contained information on coordination with ongoing remedial investigation/feasibility studies (RI/FS) at the four NPL sites in the Clark Fork River Basin, procedures for sharing data and duplicate or split samples with ARCO and other natural resource trustees, confirmation of exposure to hazardous substances, and a Quality Assurance Project Plan. ARCO and other interested parties submitted comments on Part I of the Plan. The State has reviewed all of the comments.

Part II of the Assessment Plan contains methodologies for conducting injury determination and quantification for air resources, soil resources, vegetation resources, and wildlife resources. In addition, a description of field sampling of surface and groundwater is contained as a supplement to the methods described in Part I of the Plan. Part II of the Plan also contains a preliminary determination of recovery periods for potentially injured resources, as well as methodologies for assessing economic damages.

[1] Hereafter, references to "hazardous substances" include "hazardous and/or deleterious substances."

Public Review and Comment

In accordance with the U.S. DOI regulations, Part II of the Assessment Plan is being made available for review and comment by ARCO, other natural resource trustees, other affected Federal or State agencies or Indian Tribes, and any other interested members of the public for a period of 30 days. Comments may be submitted in writing to:

Mr. Dick Pedersen
Natural Resource Damage Program Manager
Department of Health and Environmental Sciences
Cogswell Building
Capitol Station
Helena, MT 59620.

The State may modify this Assessment Plan following its review of submitted comments. Any modifications which in the judgement of the State are significant will be made available for subsequent review and comment. At the conclusion of the assessment, the State will prepare and make available a Report of the Assessment. The report will contain a summary of the comments received on Parts I and II of the Assessment Plan and the State's responses to those comments.

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF ACRONYMS

ARCO	Atlantic Richfield Company
ASTM	American Society for Testing and Materials
CECRA	Comprehensive Environmental Cleanup and Responsibility Act
CERCLA ("Superfund")	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CFRSSISOP	Clark Fork River Superfund Site Investigations Standard Operating Procedures
CWA	Clean Water Act
CVM	Contingent Valuation Model
DHES	Montana Department of Health and Environmental Sciences
DOI	United States Department of the Interior
FPM	Field Procedures Manual
GFAA	Graphite Furnace Atomic Absorption Spectrometry
GPS	Global Positioning System
HEP	Habitat Evaluation Procedure
ICP	Inductively Coupled Plasma Emission Spectrometry
IFIM	Instream Flow Incremental Methodology
MCAWW	Methods for the Chemical Analysis of Water and Wastewater
NPL	National Priority List
NRDA	Natural Resource Damage Assessment
NRDP	Montana Natural Resource Damage Program
ppb	parts per billion
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
PRP	Potentially Responsible Party
RCDP	Restoration and Compensation Determination Plan
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
TCM	Travel Cost Methodology
U.S. EPA	United States Environmental Protection Agency
USFWS	Unites States Fish & Wildlife Service
USGS	United States Geological Survey
WTP	Willingness to Pay

1.0 INTRODUCTION

1.1 CASE HISTORY AND DESCRIPTION OF ASSESSMENT PLAN CONTENT

The State of Montana ("the State") has commenced an action against the Atlantic Richfield Company ("ARCO") in the United States District Court for the District of Montana (Civil Action No. CV 83-317-HLN-CCL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA"), 42 U.S.C. §§ 9601-9675, and the Montana Comprehensive Environmental Cleanup and Responsibility Act ("CECRA"), Mont. Code Ann. §§ 75-10-701 to 75-10-724. In this action, Montana seeks to recover damages for injuries to natural resources resulting from releases of hazardous and/or deleterious substances from facilities for which ARCO is the primary responsible party. The State of Montana has begun to assess the natural resource damages in accordance with the regulations of the U.S. Department of the Interior (U.S. DOI) as set forth in 43 CFR Part 11 and as modified by Ohio v. U.S.DOI 880 F.2nd 432 (D.C. Cir. 1989).

The purpose of the Assessment Plan is to ensure that the assessment is performed in a planned and systematic manner. The Assessment Plan identifies those scientific and economic methodologies that are expected to be performed in the assessment.

In January 1992, the State released for public review and comment Part I of its Assessment Plan. Part I of the Plan addressed activities associated with injury determination and quantification phases for four potentially injured natural resources: surface water resources, fisheries resources, sediment resources, and groundwater resources. In addition, Part I of the Assessment Plan contained information on coordination with ongoing remedial investigation/feasibility studies (RI/FS) at the four NPL sites in the Clark Fork River Basin, procedures for sharing data and duplicate or split samples with ARCO and other natural resource trustees, confirmation of exposure to hazardous substances, and a Quality Assurance Project Plan. ARCO and other interested parties submitted comments on Part I of the Plan. The State has reviewed all of the comments.

Part II of the Assessment Plan contains methodologies for conducting injury determination and quantification for air resources, soil resources, vegetation resources, and wildlife resources. In addition, a description of field sampling of surface and groundwater is contained as a supplement to the methods described in Part I of the Plan. Part II of the Plan also contains a preliminary determination of recovery periods for potentially injured resources, as well as methodologies for assessing economic damages.

Public Review and Comment

In accordance with the U.S. DOI regulations, Part II of the Assessment Plan is being made available for review and comment by ARCO, other natural resource trustees, other affected Federal or State agencies or Indian Tribes, and any other interested members of the public for a period of 30 days. Comments may be submitted in writing to:

Mr. Dick Pedersen
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The State may modify this Assessment Plan following its review of submitted comments. Any modifications which in the judgement of the State are significant will be made available for subsequent review and comment. At the conclusion of the assessment, the State will prepare and make available a Report of the Assessment. The report will contain a summary of the comments received on Parts I and II of the Assessment Plan and the State's responses to those comments.

This Assessment Plan was prepared by RCG/Hagler, Bailly, Inc. under contract to the State of Montana.

1.2 ORGANIZATION OF ASSESSMENT PLAN

Part II of the Assessment Plan is organized as follows: Section 2.0 contains research plans for air, terrestrial resources (soils, vegetation, wildlife), and supplemental research plans for surface and groundwater. Section 3.0 contains a preliminary estimate of recovery periods for potentially injured resources. Section 4.0 contains economic methodologies for quantification of damages.

2.0 RESEARCH PLANS

This section describes research that will be conducted during the injury determination and quantification phases of the State of Montana's assessment.

Although not specifically discussed further in the individual research plans, significant existing data relevant to the State's assessment have been collected by various Federal and State Agencies and their contractors, as well as by academic institutions and private parties. Much of these data have been collected as part of the RI/FS process at the four NPL sites. Existing data will be evaluated by the State for use in the Assessment.

The geographic focus of the State's injury assessment for soils, vegetation, and wildlife will include riparian areas associated with Silver Bow Creek from Butte to Warm Springs Ponds, the Warm Springs Ponds complex, the Opportunity and Anaconda Ponds areas, and the Clark Fork River from Warm Springs Ponds to Missoula. Upland areas to be addressed will include upland soils, vegetation, and wildlife in areas within and near the cities of Anaconda and Butte. The geographic focus of the air assessment will include the entire Silver Bow Creek/Clark Fork River Basin, from Butte to Missoula, including the Anaconda area.

All research protocols have been designed to meet quality assurance/quality control (QA/QC) project goals -- including the use of instrument calibration standards, blanks, spikes, duplicates, and chain-of-custody -- as described in the Quality Assurance Project Plan (QAPP) contained in Appendix A of the Assessment Plan: Part I.

2.1 SOURCE IDENTIFICATION

As described in Part I of the Assessment Plan, sources of hazardous substances released into the Clark Fork River Basin include, but are not limited to, numerous tailings deposits, tailings ponds, waste piles, flue dust piles, and smelters located throughout the Basin. Sources of hazardous substances to which air, soils, vegetation, and wildlife have been exposed will be identified as a part of the assessment. This is to include:

- Identifying sources of hazardous substances and the nature and extent of releases and re-releases.

- Confirming releases and re-releases of hazardous substances from smelter emissions and tailings.

2.2 PATHWAY DETERMINATION

As indicated in Part I of the Assessment Plan, the purpose of pathway determination is to identify pathways by which natural resources have been exposed to hazardous substances [43 CFR § 11.63 (a)(1)]. Pathways may be determined by demonstrating the presence of hazardous substances in pathway resources or by using models to demonstrate that the exposure route served as a pathway [43 CFR § 11.63 (a)(2)].

Relevant pathways to potentially injured soil, vegetation, wildlife, and air resources of the Clark Fork River Basin include:

- Direct contact with hazardous substances;
- Surface water pathways;
- Groundwater pathways;
- Air pathways;
- Geologic pathways, including both soils and bed, bank, and floodplain sediments; and
- Biological pathways, including vegetation, terrestrial and aquatic invertebrates, birds, mammals, and fish.

Pathway determination will include:

- Demonstration that hazardous substances are present in "sufficient concentrations" in pathway resources, including surface water, groundwater, soils, sediment, sediment pore-water, air, and terrestrial and aquatic biota [43 CFR § 11.63 (a)(2)];
- Demonstration that surface water resources downstream of the sources of releases of hazardous substances constitute an exposure pathway in accordance with 43 CFR § 11.63 (b)(2);
- Demonstration that groundwater beneath or downgradient of the sources of releases of hazardous substances constitute an exposure pathway in accordance with 43 CFR § 11.63 (c)(2);
- Demonstration that air resources constitute an exposure pathway in accordance with 43 CFR § 11.63 (d)(2);

- Demonstration that soils and sediments (including bed, bank, and floodplain) constitute an exposure pathway in accordance with 43 CFR § 11.63 (e)(2); and

- Identification of direct exposure from physical contact and/or indirect exposure from food chain processes involving biological pathways [43 CFR § 11.63 (f)(2)].

2.3 AIR RESOURCES

2.3.1 Definitions of Injury

Relevant definitions of injury to air include:

- Concentrations of emissions in excess of standards for hazardous air pollutants established by section 112 of the Clean Air Act, 42 U.S.C. 7412, or by other Federal or State air standards established for the protection of public welfare or natural resources [43 CFR § 11.62 (d)(1)];

- Concentrations and duration of emissions sufficient to have caused injury...to surface water, groundwater, geologic, or biologic resources when exposed to the emissions [43 CFR § 11.62 (d)(2)].

2.3.2 Description of Air Resources to be Assessed

As described in section 6.6 of Part I of the Assessment Plan, smelter emissions from the Butte and Anaconda Smelter facilities contained elevated concentrations of hazardous substances. The widespread distribution of unconfined tailings and waste piles currently allows re-release of hazardous substances as windblown fugitive dust (McVehil-Monnett Associates 1986). Areas affected include, but are not limited to, Smelter Hill and adjacent uplands in the vicinity of Anaconda, the Deer Lodge Valley, areas downwind of the Yankee Doodle Tailings near Butte, the Colorado Tailings, the Opportunity Ponds, and in the vicinity of tailings deposits along Silver Bow Creek and the Clark Fork River.

The State will focus on areas affected by hazardous substances released from facilities near Anaconda and Butte during periods of operation and continuing through demolition to the present. Injury assessment will also include that resulting from transport via windblown fugitive dust from unconfined waste piles and fluvially deposited slickens containing hazardous substances.

2.3.3 Objectives of the Research Plan

The objective of the air research plan is to (1) determine whether air has served as a critical, and injurious, exposure pathway to terrestrial natural resources (soils, vegetation, wildlife) of the upper Clark Fork Basin, (2) determine whether air resources have been injured based on appropriate definitions of injury, and (3) determine the temporal and spatial extent of injury to air resources of the upper Clark Fork Basin based on differences from baseline concentrations of hazardous substances.

2.3.4 Research Plan

No additional analytical sampling is anticipated for air quality studies. Absent the discovery of additional facts not now known, injury determination and quantification most likely will be based on existing data.

Injury Determination

The injury determination phase may include the following steps:

- Identify suitable control sites in order to determine baseline concentrations of hazardous substances. Selection criteria may include, as appropriate, land use characteristics, climatic factors, and valley configuration.
- Determine baseline concentrations of hazardous substances at control sites.
- Characterize air quality in exposed areas of the Clark Fork River Basin.
- Determine injury in exposed areas based on evaluations of exceedences of standards, and on effects on resident biota.

Injury Quantification

The injury quantification phase will quantify the areal and temporal extent of injured air resources in exposed areas of the upper Clark Fork Basin, relative to control areas.

2.4 TERRESTRIAL RESOURCES: SOILS, VEGETATION, AND WILDLIFE

The State's assessment of injury to terrestrial resources will comprise determination and quantification of injuries to the terrestrial ecosystem, including soils, vegetation, and wildlife. These three resources are being treated collectively because of the relationship between soils, vegetation, and wildlife habitat. Sampling at field sites (both impacted and control) will include examination of each of these three elements: soil samples will be taken to identify and quantify concentrations of hazardous substances; phytotoxicology protocols will be followed to demonstrate the adverse effects of hazardous substances on plants; vegetation field measurements will be used to demonstrate changes in variables such as species abundance, diversity, and cover; habitat evaluation models will be applied at field sites to quantify reductions in wildlife habitat.

2.4.1 Definitions of Injury

2.4.1.1 Soils

Relevant definitions of injury to soils in the upper Clark Fork Basin include:

- Concentrations of substances sufficient for the materials in the geologic resource to exhibit characteristics identified under or listed pursuant to section 3001 of the Solid Waste Disposal Act, 42 U.S.C. 6921 [43 CFR § 11.62 (e)(1)];

- Concentrations of substances sufficient to raise the negative logarithm of the hydrogen ion concentration of the soil (pH) to above 8.5...or to reduce it below 4.0 [43 CFR § 11.62 (e)(2)];

- Concentrations of substances sufficient to decrease the water holding capacity such that plant, microbial or invertebrate populations are affected [43 CFR § 11.62 (e)(4)];

- Concentrations of substances (in the soil) sufficient to impede soil microbial respiration to an extent that plant and microbial growth have been inhibited [43 CFR § 11.62 (e)(5)];

- Concentrations in the soil of substances sufficient to inhibit carbon mineralization resulting from a reduction in soil microbial populations [43 CFR § 11.62 (e)(6)];

- Concentrations of substances sufficient to have caused injury to groundwater... from physical or chemical changes in gases or water from the unsaturated zone [43 CFR § 11.62 (e)(8)];

- Concentrations in the soil of substances sufficient to cause a toxic response to soil invertebrates [43 CFR § 11.62 (e)(9)];

- Concentrations in the soil of substances sufficient to cause a phytotoxic response such as retardation of plant growth [43 CFR § 11.62 (e)(10)]; and

- Concentrations of substances sufficient to have caused injury ... to surface water, groundwater, air or biological resources when exposed to the substances [43 CFR § 11.62 (e)(11)].

2.4.1.2 Vegetation

Relevant definitions of injury to vegetation in the Clark Fork Basin, including riparian and upland vegetation, include:

- Concentrations of substances (in the soil) sufficient to decrease the water holding capacity such that plant ... populations are affected [43 CFR § 11.62 (e)(4)];

- Concentrations of substances (in the soil) sufficient to impede soil microbial respiration to an extent that plant ... growth (has) been inhibited [43 CFR § 11.62 (e)(5)];

- Concentrations in the soil of substances sufficient to cause a phytotoxic response such as retardation of plant growth [43 CFR § 11.62 (e)(10)];

- Concentrations of substances sufficient to cause the biological resource or its offspring to have undergone at least one of the following adverse changes in viability: death, disease,..., genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations [43 CFR § 11.62 (f)(1)(i)].

2.4.1.3 Wildlife

Relevant definitions of injury to wildlife and wildlife habitat include:

- Concentrations of hazardous substances sufficient to cause the biological resource or its offspring to have undergone at least one of the following adverse changes in viability: death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations [43 CFR § 11.62 (f)(1)(i)];

- Reductions in habitat quantity and quality for selected indicator species [43 CFR § 11.63 (f)(4)(ii)(A)], relative to uncontaminated control areas [43 CFR § 11.72 (d)(1)];

- Altered population densities, relative to uncontaminated control areas [43 CFR § 11.71 (l)(1)], among species ... that represent broad components of the ecosystem, or that are especially sensitive to the hazardous substances, or that provide especially significant services [43 CFR § 11.71 (l)(2)].

2.4.2 Description of Resources to be Assessed

2.4.2.1 Soils

As described in section 6.3 of Part I of the Assessment Plan, soils throughout the upper Clark Fork Basin contain elevated levels of metals relative to background concentrations. Many areas contain hazardous substances in concentrations known to be phytotoxic. This has occurred through: surface disposal of contaminated tailings; aerial transport and re-deposition of contaminated dust; aerial transport and deposition of smelter emissions; deposition and subsequent re-release and re-deposition of contaminated materials in the river floodplains; and the use of contaminated river water to irrigate agricultural land.

The State's assessment of injury to soils will concentrate on those areas of greatest injury to riparian and upland soils attributable to releases of hazardous substances. Injured riparian areas include Silver Bow Creek, the Warm Springs Ponds, the upper Clark Fork River from approximately Warm Springs Ponds to Garrison, and the Opportunity Ponds and adjacent lands. Injured upland areas include Smelter Hill and adjacent uplands, and Yankee Doodle Tailings and adjacent mine dumps and leach pads in the Butte area.

2.4.2.2 Vegetation

Floodplain soils and bank sediments on Silver Bow Creek from Butte to Warm Springs Ponds, the Warm Springs Ponds, and the Clark Fork River from Warm Springs Ponds to Garrison, the Anaconda and Opportunity Ponds, and the Yankee Doodle Tailings contain significantly elevated concentrations of hazardous substances relative to control areas (see section 6.3 of the Assessment Plan Part I). Upland soils surrounding Smelter Hill contain elevated concentrations of hazardous substances resulting from the deposition of smelter emissions and fugitive dust containing hazardous substances (see also section 5.0 of the Assessment Plan Part I). Vegetation in these areas is either absent, dead, or exhibits phytotoxic responses to the elevated concentrations of hazardous substances in the soils and sediments (Hydrometrics 1983; Taskey 1972; Munshower 1972).

MultiTech (1986) mapped vegetation communities along Silver Bow Creek and the upper Clark Fork River between Butte and the Kohrs Bridge in Deer Lodge and identified 1,133 acres of bare tailings. No estimates of the areal extent of sparsely vegetated tailings were made. Section 6.5 of the Assessment Plan Part I identifies studies which have confirmed concentrations of hazardous substances in plants grown on contaminated soils on Smelter Hill and in the Deer Lodge Valley. The State's assessment of injury to vegetation resources will concentrate on upland areas near the cities of Anaconda and Butte, and riparian areas along Silver Bow Creek from approximately Butte to Warm Springs Ponds, the upper Clark Fork River from approximately Warm Springs Ponds to Garrison, and the Opportunity lowlands.

2.4.2.3 Wildlife

Wildlife resources in the upper Clark Fork Basin are directly and indirectly exposed to and injured by hazardous substances released from the Silver Bow Creek/Butte Area, Anaconda Smelter, and Clark Fork River/Milltown Reservoir NPL sites. Direct exposure to hazardous substances occurs through the consumption of prey organisms or forage containing the hazardous substances. Food chain transfer and biomagnification of hazardous substances may induce injury at higher trophic levels. Indirect exposure and injury may occur when ambient levels of hazardous substances are sufficient to reduce the suitability or availability of wildlife habitat or prey organisms.

Releases of hazardous substances have resulted in exposure of wildlife to hazardous substances in the upper Clark Fork River. Several mammalian and avian species inhabiting the upper Clark Fork drainage are potentially exposed to elevated levels of hazardous substances through their diet of aquatic organisms. The mammalian species include river otter (*Lutra canadensis*) and mink (*Mustela vison*), which rely heavily or entirely on a diet of fish and aquatic invertebrates, raccoons (*Procyon lotor*) that feed primarily on aquatic invertebrates, and muskrats (*Ondatra zibethicus*) that feed on aquatic vegetation. Among avian species found in the Clark Fork drainage, those likely to be exposed to hazardous substances through their diets include bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), great blue heron (*Ardea herodias*) and belted kingfisher (*Megaceryle alcyon*).

Releases of hazardous substances from the NPL sites listed above also have potentially injured wildlife resources in the upper Clark Fork River Basin by injuring terrestrial habitat. Examples include:

- Wildlife, e.g. white-tailed deer (*Odocoileus virginianus*), associated with riparian plant communities, including those along Silver Bow Creek and the Clark Fork River; and

- Wildlife associated with the upland forest and forest-edge plant communities surrounding Smelter Hill such as elk (*Cervus elaphus*), blue grouse (*Dendragapus obcurus*), mule deer (*Odocoileus hemionus*), and pine marten (*Martes americana*).

2.4.3 Objectives of Research Plans

2.4.3.1 Soils

The overall objective of the soil sampling plan is to determine injury and quantify the spatial and temporal extent to which the soils of the upper Clark Fork Basin have been injured by the release of hazardous substances from the NPL sites in the Basin. Specific objectives include:

Injury Determination

- Determine baseline concentrations of hazardous substances in soils using control sites;

- Determine soil concentrations of hazardous substances in impacted upland and riparian areas;

- Determine injury by comparing concentrations of hazardous substances in the impact area soils to concentrations in control area soils, using the criteria identified above (section 2.4.1); and

Injury Quantification

- Quantify the spatial and temporal extent of injury to soils. This will include mapping the areal extent of injured soils at the present and, when feasible, in the past.

2.4.3.2 Vegetation

The overall objective of the vegetation plan is to determine injury and quantify the spatial and temporal extent of injuries to vegetation in the Clark Fork River Basin. Specific objectives include the following:

Injury Determination

Phytotoxicity studies will be conducted to:

- Determine that vegetation resources of the Clark Fork Basin have been injured as a result of exposure to hazardous substances released from the NPL sites using protocols for germination and growth in controlled environment laboratory conditions.

In addition, plant studies will be conducted to:

- Characterize baseline vegetation community composition and structure at control sites, including species diversity, dominance relationships, percent cover, and number of vertical layers;
- Characterize concentrations of hazardous substances in plant tissues at impacted and control sites.
- Characterize vegetation community composition and structure in areas grossly impacted by the deposition of hazardous substances; and
- Determine injury to plant communities by comparing vegetation measurements from control and impact sites.

Injury Quantification

- Estimate the spatial and temporal extent of grossly injured vegetation communities in the upper Clark Fork Basin using existing maps, aerial photographs, ground truthing, and measurements of soil phytotoxicity.

2.4.3.3 Wildlife

The objectives of the wildlife research plans are to determine the degree to which the wildlife resources in section 2.4.2.3 have been injured by releases of hazardous substances, and to quantify the spatial and temporal extent of injury. Specific objectives include:

Wildlife -- Habitat Injury

Determination Phase

- Determine the suitability of baseline wildlife habitat at control sites;
- Determine the suitability of wildlife habitat at impacted sites exposed to hazardous substances; and
- Determine injury by comparing the suitability of wildlife habitat in impacted and control sites.

Quantification Phase

- Quantify injury to wildlife habitat by estimating the spatial and temporal extent of injury.

Wildlife -- Injury to Consumers of Aquatic Biota

Determination Phase

- Determine background population densities, or indices of the population densities, of wildlife at control sites;
- Determine population densities, or indices of the population densities, of wildlife in Silver Bow Creek and the upper Clark Fork River;
- Determine tissue levels of hazardous substances in wildlife and their prey in control and impacted sites in order to measure exposure;
- Determine injury by comparing population densities and tissue concentrations of hazardous substances in impact areas with those in control areas, and with known toxic levels derived from the wildlife toxicology literature.

Quantification Phase

- Quantify injury based on reductions in populations of wildlife at impacted versus control sites.

2.4.4 Sampling Approaches

2.4.4.1 Site Selection for Terrestrial Resources

Upland and riparian control and impact area sampling sites will be identified using a combination of aerial photographs, ground truthing and maps. Impact area sampling sites will comprise areas of gross injury to plant communities. In the riparian zone these will be unvegetated slickens, while in the uplands they will be areas which have lost plant cover, or where the natural plant community has been highly modified.

The control sampling sites will match the impact sites in relevant environmental variables. Control sites will be chosen so that the topographic and climatic features conform to those of the impact area sampling sites. Variables for selecting riparian control sites will include, as appropriate, geomorphology, elevation, slope, stream order, discharge and aspect. In the upland areas, relevant environmental variables will include elevation, aspect, slope and local topography.

2.4.5 Methodologies

2.4.5.1 Soils

Existing data (e.g., see Table 2 of Part I of the Assessment Plan) will be used in conjunction with data to be gathered to characterize soil concentrations of hazardous substances in control and impacted riparian and upland areas in the present and recent past.

Injury Determination

The sampling protocol will include the following discrete steps:

- Identify appropriate upland and riparian control area sampling sites;
- Determine baseline concentrations of hazardous substances at control sites;
- Identify upland and riparian impact area sampling sites;
- Determine concentrations of hazardous substances at impacted sites;
- Perform controlled laboratory protocols (see section 2.4.5.2) to compare the phytotoxic responses of plants exposed to hazardous substances at concentrations characteristic of impacted sites in the Clark Fork River Basin; and

- Determine injury to soils in the impact areas due to hazardous substances based on the criteria listed above in section 2.4.1.

Injury Quantification - Uplands

Impacted Areas

Soil samples will be collected along a fixed grid pattern. Coordinates for the grid will be established from a random start position. The grid will consist of four to six parallel transects and intersecting grid points. The nominal spacing of transects and intersecting grid points is estimated to be 1 kilometer. The grid size will be adjusted to insure that approximately 24 grid intersect points fall within the impact area.

Locating transects and sampling points in the field will be assisted by Global Positioning System (GPS) instruments. The starting coordinates for each transect and grid point will be pre-determined from maps. Two daily checks of instrument performance will be recorded to describe the precision and accuracy of all measurements.

Composite samples will be collected from approximately 100 meter (m) intervals[2] along each transect. The composite sample will be mixed thoroughly. Split samples will be placed in shipping bags designated for 1) analytical chemistry, 2) phytotoxicity tests, and 3) archives.

Control Areas - Uplands

Approximately 12 points to be sampled in the upland impact area will be characterized as to elevation, slope, aspect, and other relevant physiographic features from topographic maps, geological maps, and aerial photographs. For each sample point a matched site located in an unimpacted control area will be identified. In addition to the characterization criteria listed above, site access will be considered in determining candidate control areas.

Vertical Distribution and Supplemental Measures

Erosional forces operating on the impacted area are likely to have introduced greater spatial variability in metals concentration than if erosion were minimal. Therefore, as a supplement to the systematic sampling described above, additional sampling will be conducted to provide insight into metal concentrations in erosional and depositional zones. Composite samples will be collected from approximately one to three depth strata within each zone.

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[2] Adjustment of the grid size may dictate adjustment of the sampling interval. The purpose of taking composite samples from intervals along the transect is to obtain representative samples over substantially larger areas than can be achieved from simple point sampling. The composite sample diminishes the likelihood of anomalous "hot spot" samples.

Injury Quantification - Riparian Zones

Impacted Areas

Four reaches of Silver Bow Creek and the Clark Fork River previously delineated according to valley floor morphology (see Assessment Plan Part I) will be sampled.

A belt transect (extending approximately 50 m on each side of the stream and conforming to the general orientation of the stream) will be positioned on maps delineating each stream reach. Linear distances measured along the center line of the belt transect will be recorded separately for 1) the slickens intervals and 2) the non-slickens intervals. The upstream end of the belt transect of each reach type (slickens and non-slickens) will be the zero (0) distance measure. A random start between 0 and 100 m will be chosen for each type[3]. This random start and each 100 m distance thereafter will serve as the intersect point for a transect oriented perpendicular to stream. Actual location of the transect intersect point will be achieved from consultation of maps, aerial photos, and/or GPS.

Collection points will be at regular intervals along the transect from a random start point between 0-10 m from the water's edge. In those locations where soil deposits are obviously distinguished as both slickens and non-slickens, post classification will be determined in the field and the collections will be pooled into two or more composite samples.

Control Areas

Matched-pair reaches along reference streams not impacted by large-scale mining have been identified for each of the impacted reaches (see Table 2-1). The sampling methodology will be similar to that described for the impacted area, except that the entire reach will be treated as continuous riparian vegetation.

Analytical Procedures

All soil samples will be collected from within the upper 6 inches. Ancillary soil parameters, (including, but not limited to, organic matter, pH, N:P:K, and texture) will be measured to aid in interpretation of phytotoxicity and vegetative growth potential. Samples will be analyzed for total metals and metalloids, soluble fraction (for As), and exchangeable fraction (for Cd, Cu, Zn, and Pb).

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[3] The linear distance of the slickens and non-slickens portion of the stream will be determined from maps. The length of the sampling intervals will be determined by dividing the total length of each so that 10 sampling transects will be regularly placed. For example, if the cumulative length of slickens is 1,000 m, the interval length would be 100 m. Similarly, if the non-slickens cumulative length is 2,000 m, the sampling interval would be 200 m.

2.4.5.2 Vegetation

Plant Residue Analysis

Woody and herbaceous plants growing within impact and control areas will be sampled to determine concentrations of target metals incorporated in tissues. The data will contribute to an overall understanding of 1) the bioavailability of target metals, and 2) effects related to chronic exposure. Much of the literature on phytotoxicity includes tissue concentration as a measurement endpoint. Thus, the resident plant metal residue data will provide an important linkage between site specific exposure, controlled laboratory exposures, and published phytotoxicity values.

Tissues from individual plants will be collected and composited according to species at each sampling point. Where possible, organs (leaves, stems, reproductive structures) will be divided into year class samples (i.e., 1992 growth, 1991 growth, 1990 growth). Vegetation will be sampled within a 100 m radius of the sample points and as close to the sample point as possible. Approximately equal quantities of plant material will be taken from each 90° arc centered between the cardinal directions. If there is no vegetation near the sample point, successive 10 m wide arcs will be examined until 100 to 500 grams wet weight plant mass is collected. Tree and tall shrub samples will be clipped from branches within arms' reach (i.e., < 2.5 m height) from each side of the tree.

Vegetation found within a 100 m radius of each grid sampling location will be photo-documented and evaluated qualitatively for indications of suppressed vigor and overt symptoms of metal toxicity. Observations will include both aerial (leaves, stems, reproductive structures if present) and below ground plant structures (roots and rhizomes). Quantitative measures of recent growth (past one to three years) will also be measured as further indications of plant performance.

Shallow (i.e., within top 15 cm depth), fibrous roots of major species will be examined to note color and general morphology. Samples will be photo-documented. Roots that display symptoms of metal toxicity will be collected and sent to the lab for further documentation of condition.

Phytotoxicity Studies

Phytotoxicity studies will be used to establish injury using criteria listed at 43 CFR § 11.62 (e)(10) (Phytotoxic response and plant growth). Standard protocols (for plant responses listed at 43 CFR § 11.64 (e)(6)) for the determination of hazard to the environment posed by a chemical substance, based on the toxicity of the substance to terrestrial plants, will be modified to target the specific objectives of this assessment. These protocols may include, but may not be limited to:

- Seed Germination/Root Elongation Toxicity Tests [40 CFR § 797.2750] which examine the inhibition of germination and initial growth at a range of test concentrations, and provide data to generate concentration response curves per chemical and plant species; and

- Early Seedling Growth Toxicity Tests,[4] which address seedling growth rate and biomass reductions at a range of test concentrations, and provide data to generate concentration response curves per chemical and plant species.

Initial Evaluation Tests

The Initial Evaluation test protocol permits the evaluation of a large number and a wide range of soil samples collected from the impacted and control areas. The main objective of the initial evaluation is to facilitate comparison with the large body of existing phytotoxicity literature. The key features of the test will be:

- Only 100% site soils will be tested (i.e., no dilution series will run);

- Exposure will be for 14 days (approximately 7-days post emergence);

- Test species will be restricted to lettuce and wheat (standard species with extensive toxicity data in literature that will allow detailed comparisons from other test systems); and

- Measurement endpoints will include survival and growth.

Extended Tests

Soil samples collected from impacted and control sites will be subjected to an extended protocol for the purposes of identifying phytotoxicity thresholds for native species. The essential features will be:

Upland Sites

- A dilution series consisting of soils mixed as 1) 100% site soil, 2) 2/3 site soil: 1/3 reference soil, 3) 1/3 site soil: 2/3 reference soil, and 4) 100% reference soil will be used;

- Exposure period will vary for different test species between 4- and 8-weeks;

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[4] The pending ASTM protocol will be used as a template for this assessment.

- Test species will include Douglas fir *Pseudotsuga menziesii* seedlings, alfalfa, *Medicago sativa* (with *Rhizobium inoculum*), and a grass; and

- In addition to the standard measurement endpoints of survival and growth, nodulation in alfalfa will be scored.

Riparian Sites

Phytotoxicity testing of riparian plants will follow the procedures described for the upland species, with two modifications:

- Poplar, *Populus* sp., cuttings may be used as a surrogate for cottonwood, *Populus* sp., and willow, *Salix* sp.; and

- Two exposure conditions (waterlogged vs. non-waterlogged) will be tested.

If the initial evaluation tests reveal similar results among replicates, the soil samples will be composited further to yield a single sample for each designated reach.

Vegetation Community Evaluation

The objective of the vegetation community level studies is to determine the spatial extent to which vegetation community structure and composition has been altered by elevated concentrations of hazardous substances. This will be accomplished by comparing impacted and control sites.

The selection criteria for control sites will ensure conformity with important topographic and geologic features of the treatment sites, including: geomorphology, elevation, aspect, slope, stream order, discharge, and gradient. Community structure and composition will be quantified at impact and control sites. At each site, the following data may be recorded: cover type, percent bare ground, canopy cover of species with >5% canopy cover, species diversity, vertical stratification, height of each stratum, and land surface height.

2.4.5.3 Wildlife

Injury Determination - Wildlife Habitat

The sampling protocol will include the following:

- **Determination of wildlife habitat suitability**. Habitat suitability for selected wildlife indicator species will be determined at the upland and riparian impact and control sites by recording key habitat variables for each of the indicator species and by using Habitat Evaluation Procedure (HEP) models [43 CFR 11.71 (l)(8)]. Species selected for HEP evaluation in the upland areas may include: marten, blue grouse, elk, and mule deer. Riparian area species may include: white-tailed deer and mink.

- Loss of biodiversity in impacted areas. HEP models have been developed by the U.S. Fish and Wildlife Service which establish relationships between habitats and their use by wildlife communities. These models will be used to assess the loss of species in impact areas caused by habitat loss.

Injury Quantification - Wildlife Habitat

Injury to riparian and upland wildlife habitats will be quantified by mapping areas of habitat loss relative to control sites (see section 2.4.5.2). The loss of wildlife habitat and wildlife in the impacted areas will be quantified using HEP models (see section 2.4.4.5) and existing survey data.

Injury Determination - Consumers of Aquatic Biota

Sampling protocols will include two distinct tasks: (1) assessment of injury to birds, and (2) assessment of injury to furbearers.

Task 1: Injury to Birds

- Determine the relative abundance of birds -- including great blue herons, belted kingfishers, bald eagles, and osprey -- in impacted and control sites. Relative abundance will be quantified using canoe surveys during nesting seasons, as well as using existing data on population densities, nest density, and fledgling success.

- Determine residues of hazardous substances (e.g. arsenic, cadmium, copper, lead, zinc) in great blue heron nestlings collected from heron rookeries located in impacted and control sites.

- Evaluate the presence of gross physiological abnormalities in heron nestlings collected from impact and control sites.

- Determine residues of hazardous substances (e.g. arsenic, cadmium, copper, lead, zinc) in prey fish collected from impact and control sites.

- Determine injury based on differences in abundance in fish-eating birds between impacted and control sites and by using appropriate biological injury criteria.

Task 2: Injury to Furbearers

- Identify principal food items used by aquatic and semi-aquatic furbearers (e.g., mink, otter, beaver (*Castor canadensis*), muskrat).
- Determine residues of hazardous substances (e.g. arsenic, cadmium, copper, lead, zinc) in principal food items in impacted and control sites.
- Determine residues of hazardous substances (e.g. arsenic, cadmium, copper, lead, zinc) in tissues of furbearers trapped in impacted and control sites.
- Determine the relative abundance of furbearers in impacted and control sites using scent stations and/or sign survey transects.

Injury Quantification - Consumers of Aquatic Biota

- Injury to wildlife will be quantified by estimating the magnitude of population reductions between impacted and control areas, and by estimating the spatial and temporal extent of injury.

2.5 SURFACE WATER

The general components of the surface water resource assessment were described in Part I of the Assessment Plan. These include Definition of Injury (section 7.3.1); Description of Surface Water Resources to be Assessed (section 7.3.2); and Objectives of Research Plan (section 7.3.3). The Research Plan (section 7.3.4) identified specific steps which would be addressed in the injury determination and injury quantification phases of the surface water assessment. However, Part I of the Plan indicated that additional new data might not be collected.

In order to support the State's assessment of injury to surface water and fishery resources, additional surface water sampling will be conducted at fisheries population/habitat sites -- both on Silver Bow Creek/Clark Fork River and corresponding control sites. In addition, time-integrated sampling will be conducted at impacted sites to provide data on exceedences of water quality criteria. A description of the surface water sampling plan follows.

2.5.1 Objectives of Research Plan

The objectives of additional field sampling include:

- Characterizing concentrations of hazardous substances at impacted fisheries population sites in the upper Clark Fork Basin and at control sites on reference streams;

- Characterizing concentrations of hazardous substances in Boulder Batholith-type streams; and

- Conducting time-integrated sampling to document exceedences of ambient aquatic life criteria and other relevant surface water criteria

These objectives will be pursued in three tasks:

Task 1: Surface water sampling at fisheries population Instream Flow Incremental Methodology (IFIM) sites in the upper Clark Fork Basin and at control sites on reference streams during spring runoff and during summer low flows. Samples will be analyzed for field pH, temperature, specific conductance, total suspended solids, hardness, total recoverable metals and dissolved metals (metals include cadmium, copper, lead and zinc). Stream discharge will also be determined.

Task 2: Surface water sampling of Silver Bow Creek headwater streams (Blacktail Creek, Yankee Doodle Creek, Silver Bow Creek) above areas of impact to provide baseline data on Boulder Batholith-type streams in the Butte area. Analyses will include the same variables as under Task 1.

Task 3: Time-integrated sampling at sites on Silver Bow Creek, the Clark Fork River, and Warm Springs Ponds. These samples will provide data for evaluating the duration and magnitude of exceedences of acute and chronic aquatic life criteria, as well as other relevant surface water criteria. Samples will be analyzed for hardness and metals.

2.5.2 Sampling Approaches

Task 1

Fisheries population (IFIM) sites will be sampled approximately six times during spring runoff, and approximately six times at summer low flows, to characterize water quality under a range of flow conditions. Six sites will be sampled in the Clark Fork Basin (Silver Bow

Creek near Ramsay; Clark Fork River at Deer Lodge, Gold Creek, Bearmouth, Bonita, and Turah). Eight sites will be sampled on reference streams. The eight reference sites include the control site for the Clark Fork Basin impact site. In addition, a second IFIM site will be sampled on reference streams where more than one IFIM site exists, so that spatial variability in water quality can be characterized. Table 2-1 contains a list of sampling sites.

Table 2-1
Locations of Surface Water Sampling Sites

1. Silver Bow Creek near Ramsay (SBC 1)
2. Clark Fork River at Deer Lodge (CFR 1)
3. Clark Fork River at Gold Creek (CFR 2)
4. Clark Fork River at Bearmouth (CFR 3)
5. Clark Fork River at Beavertail Hill (CFR 4)
6. Clark Fork River at Turah (CFR 5)
7. Bison Creek (BC 1) - match site for SBC 1
8. Ruby River (RR 1) - match site for CFR 1 and downstream Ruby River IFIM site
9. Ruby River (RR 2) - upstream Ruby River IFIM site
10. Big Hole River (BH 1) - match site for CFR 2 and furthest upstream Big Hole River IFIM site
11. Big Hole River (BH 2) - downstream Big Hole River IFIM site
12. Rock Creek (RC 1) - match site for CFR 3 and upstream Rock Creek IFIM site
13. Rock Creek (RC 2) - match site for CFR 4 and CFR 5, and downstream Rock Creek IFIM site
14. Flint Creek (FC 1)

Samples will be collected as width-integrated and depth-integrated composites at one transect across each IFIM site (NRDP SOP 2.0). Width-integrated composites will be collected when flow conditions permit (generally low flow and lower high flows). At very high flows, composites will be collected as far into the stream channel as is safely practicable (NRDP SOP 3.0). Method validation and data validation sampling will be conducted at one randomly selected IFIM site each sampling trip. Validation sampling will include composite sampling of multiple cross-sections; collection and analysis of composite samples versus grab samples; and collection and analysis of field QA/QC (quality assurance/quality control) samples.

Stream discharge will be determined using U.S. Geological Survey stage-discharge tables, where appropriate and available. Otherwise, stream discharge will be measured using a Marsh-McBirney Model 2100 Portable Current Meter (FPM 5.1.1). Water temperature and field pH will be measured (FPM 5.2.1 and FPM 5.2.2, respectively).

Task 2

Collection and analysis of samples from Silver Bow Creek headwaters streams will follow protocols and SOPs identified in Task 1. Samples will be collected approximately three times during spring runoff and three times during summer low flow. Sample collection procedures may be modified due to the small size of these streams. Where channel width and depth preclude width-integrated and depth-integrated sampling, grab samples will be collected. Validation sampling may include collection and analysis of duplicate grab samples at one sampling location in each sampling run. Field QA/QC samples collected under Task 1 will satisfy QA/QC for this task.

Task 3

Samples will be collected using an automatic sampler at various sites on the Clark Fork River, Silver Bow Creek and Warm Springs Ponds to characterize the magnitude of aquatic life criteria exceedences. Samples will be collected over four days at a pre-determined sampling interval, and will be composited manually in the laboratory. Composited samples will be analyzed for hardness and U.S. EPA total recoverable metals to characterize the duration and magnitude of metals concentrations relative to U.S. EPA aquatic life criteria. Validation sampling will include comparative grab sampling, rinseate blanks, and split samples for documenting subsampling techniques.

2.5.3 Sampling Methodologies and Sample Analysis

Surface water samples will be collected following guidance provided in 43 CFR § 11.64 (b) (1-5). In general, sampling will follow U.S. EPA and U.S. Geological Survey sampling protocols, when applicable. Sample analyses will follow standard U.S. EPA and State of Montana methodologies. Samples will be analyzed for specific conductance, hardness, total suspended sediment, and metals (cadmium, copper, lead and zinc). Methods for metals determination will include dissolved, U.S. EPA total recoverable, and State of Montana total recoverable (Montana total recoverable metals are determined by analyzing a field preserved sample after settling has occurred). "Suspended, recoverable" metals will be determined by difference between the total recoverable concentration and the dissolved concentration (USGS 1985). Metals will be analyzed using Graphite Furnace Atomic Absorption Spectrometry (GFAA) and Inductively Coupled Plasma Emission Spectroscopy (ICP).

2.6 GROUNDWATER

The research plan for groundwater presented in Part I of the Assessment Plan is being amended as follows:

2.6.1 Control Site Selection

The Thompson Park area south of Butte will not be used as the control area for the Butte Hill study; however, the surface water sampling in this area will proceed as set forth in Part I of the Plan. Existing data from the Butte Hill area will be used to characterize baseline groundwater quality. In addition, samples will be collected from existing bedrock wells located in the orebody near Montana Resources, Inc. Sampling locations will include one mine shaft north of Butte ("Margaret Ann"), five existing bedrock wells which are east of Berkeley Pit (A, B, C, D1, D2, E), and one municipal well ("Hebgen").

3.0 PRELIMINARY ESTIMATES OF NATURAL RECOVERY PERIODS

This section provides a preliminary estimate of recovery period for the exposed natural resources of the upper Clark Fork Basin [43 CFR § 11.31 (l)(2)]. Recovery period is defined as the "time needed for each injured resource to recover to the state that...services are restored to baseline levels" [43 CFR § 11.73 (a)]. The following factors will be considered in estimating recovery times:

- Ecological succession patterns;
- Growth or reproductive patterns, life cycles, and ecological requirements of biological species involved, including their reaction or tolerance to the...hazardous substance(s) involved;
- Bioaccumulation and extent of...hazardous substances in the food chain; or
- Chemical, physical, and biological removal rates of the...hazardous substances from the media involved [43 CFR § 11.73 (c)(2)].

Recovery of natural resources to baseline levels requires recovery of currently contaminated *media* (i.e., biotic resources will continue to be injured as long as environmental media -- soils, sediments, water -- remain contaminated and continue to operate as exposure pathways). As shown in section 6.3 of the Assessment Plan Part I, soils and sediments of extensive areas of the upper Clark Fork Basin have been exposed to hazardous substances. The contaminated soils and sediments subsequently contaminate groundwater and surface water through leaching processes and through physical transport during runoff. Contaminated soils and water necessarily expose all biota of the upper Clark Fork Basin to the hazardous substances. Therefore, all sources of hazardous substances in the Basin must be controlled before natural resources can return to baseline conditions.

Current estimates of recovery periods for the contaminated resources of the upper Clark Fork Basin are extremely long. With recovery periods possibly on the order of thousands of years, RI/FS documents will not even estimate recovery periods for no-action remedies. U.S. EPA (1992) states that "the [natural] recovery period has virtually been eliminated for this (upper Clark Fork Basin) ecosystem." An unmeasurable recovery period for the soils near Anaconda also has been predicted, with Munshower (1972) stating that many centuries will be required before soil cadmium levels would be reduced to acceptable background levels, and Tetra Tech (1987) claiming that "soil contamination by heavy metals is virtually permanent because metals accumulated in soils are depleted very slowly by plant uptake, leaching, or erosion."

Limited attempts have been made to predict recovery periods in certain areas after remediation. Tetra Tech (1987) attempted to model the migration of the oxidizing layer of metals in the Anaconda and Opportunity Ponds, and the subsequent time needed for groundwater to return to baseline metals concentrations. Their models suggest that migration time for the oxidized layer of metals at the surface to the saturated area below the tailings would be 10,000-20,000 years in the Opportunity Ponds, and greater than 50,000 years in the Anaconda Ponds. The subsequent time for the metals to migrate out of the saturated zone ranged from 1,000-22,000 years for arsenic, 4,000-18,000 years for cadmium, 7,000-35,000 years for copper, 40,000-300,000 years for lead, and 7,000-40,000 years for zinc (Tetra Tech 1987).

The Tetra Tech (1987) tailings and groundwater recovery period estimates were based on the assumption that future remediation at Anaconda and Opportunity Ponds would effectively prevent further oxidation of metals in the Ponds. Currently, Records of Decision (RODs) for remediation have not been signed at most of the operable units within the four Clark Fork NPL Sites. RODs have been signed on only three of over 20 operable units within the Clark Fork Complex. RODs are not scheduled to be in place at all operable units until the early 21st century (U.S. EPA and MDHES 1990, U.S. EPA 1992).

In conclusion, it is preliminarily estimated that natural recovery periods for injured resources of the Clark Fork River Basin may be on the order of centuries, if not millennia. Remedies selected in the RI/FS process will not be complete for at least another decade, with post-remedy recovery likely to be on the order of decades, if not centuries.

4.0 ECONOMIC DAMAGE DETERMINATION

This section describes damage assessment work that has been and will be conducted during the damage determination phase of the State of Montana's NRDA.

Although not specifically discussed further in the individual research plans, significant amounts of data relevant to the State's assessment have been collected by various Federal and State Agencies and their contractors, as well as by academic institutions and private parties. The State intends to review and use, as appropriate, such existing data.

The 1986 Type B damage assessment regulations were challenged by numerous Petitioners and resulted in a Federal Court ruling (D.C. Cir., July 14, 1989) that remanded to the U.S. DOI certain sections of the regulations for changes and clarifications. As a result, the U.S. DOI published a Notice of Proposed Rulemaking (U.S. DOI, April 29, 1991 and hereafter cited Proposed 43 CFR and the section) stating proposed revisions to the regulations for conducting damage assessments. However, these proposed regulations are not yet final and, based upon public comments, may be revised. This Damage Determination Plan follows the existing U.S. DOI regulations where they were unaffected by the federal Court ruling, plus guidance in the ruling and in the proposed revised regulation.

4.1 OVERALL DESIGN OF THE DAMAGE ASSESSMENT

A "damage determination" is intended to " estimate the amount of money to be sought for compensation for injury to natural resources resulting from a discharge of oil or release of a hazardous substance" [43 CFR § 11.80 (b)]. Damages are defined to include two components:

> "The costs of restoration, rehabilitation, replacement, and/or acquisition of the equivalent of the injured natural resources and the services those resources provide, <u>plus</u> the compensable value of the services lost to the public for the time period from the discharge or release until the attainment of the restoration, rehabilitation, replacement, and/or acquisition of equivalent of the resources and their services to baseline" [Proposed 43 CFR § 11.80 (b)] (emphasis added).

Compensable values are defined to include "the value of lost public uses of the services provided by the injured resources, plus lost nonuse values such as option, existence, and bequest values" [Proposed 43 CFR § 11.83 (c)(1)]. Estimates of compensable values are used to measure damages prior to, during and following "restoration", if restoration is not complete.

Research plans to address methods and costs to restore, rehabilitate, replace, and/or acquire[5] the equivalent resources and services are addressed in section 4.2.

Three work elements are planned to estimate compensable values in addition to restoration damages. These include:

1. Recreation studies. Compensable use values will be estimated for past, present and future impacts to recreation in the Clark Fork Basin. These plans utilize non-market valuation literature and techniques, including travel cost modeling. These plans are discussed in sections 4.3 and 4.4.

2. Total compensable values. The contingent valuation method (CVM) will be applied to estimate the total of use and nonuse compensable values for natural resource injuries due to the release of hazardous substances in the Clark Fork Basin, and is discussed in section 4.5.

3. Market prices. Market price methodologies will be used, where applicable, to measure damages related to injuries to groundwater, surface water, and other resources where market prices may exist. These plans are discussed in section 4.6.

The relationship between natural resource injuries and damage assessment methods is summarized in Table 4-1.

The U.S. DOI regulations [43 CFR § 11.84 (c)] state that "Double counting of damages should be avoided." Compensable damage estimates will be computed in a manner that will provide past and present damages, plus future damages that may be residual of restoration of the resources and resource service flow. Therefore, there will be no double counting of future restoration costs and future compensable damages. Contingent valuation studies will be used to estimate total compensable values. The recreational use value and market value studies will be conducted to isolate and independently estimate the use values component for specific resource injuries, and to substantiate the use value component of the total value study. Any overlap in the use component of the damage determination will be explicitly addressed in the Damage Assessment report so that no double counting occurs.

Uncertainty will be addressed through analysis of how the damages vary in response to key analytic variables and assumptions [43 CFR § 11.84 (d)].

[5] Hereafter, the terms restore or restoration are used to refer to restoration, rehabilitation, replacement and/or acquire equivalent resources.

Table 4-1
Primary Damage Assessment Methods to Value Natural Resource Injuries

Natural Resource Injury/Damage Category	Damage Assessment Methods				
	Restoration Costing	CVM Total Valuation	Recreation Travel Cost Modeling	Recreation CVM and Unit Value Methods	Market Prices
Fisheries					
- Use damages	X	X	X	X	
- Nonuse damages	X	X			
Wildlife					
- Use damages	X	X		X	
- Nonuse damages	X	X			
Surface Water					
- Use damages	X	X		X	X
- Nonuse damages	X	X			
Sediments and Soils					
- Use damages	X	X		X	
- Nonuse damages	X	X			
Groundwater					
- Use damages	X	X			X
- Nonuse damages	X	X			
Vegetation					
- Use damages	X	X		X	
- Nonuse damages	X	X			
Air					
- Use and Nonuse	X	X			

Other aspects of the damage assessment regulations will also be followed, including the use of the discount rate for determining the present value of damages [43 CFR § 11.35 (d)(ii)(5)], and consideration of the services that natural resources provide to affected individuals [43 CFR § 11.71-11.72].

4.2 RESTORATION DETERMINATION

4.2.1 Introduction

The 1986 U.S. DOI Type B regulations called for an analysis of the costs to restore or replace injured resources [43 CFR § 11.81]. If restoration was to be selected, a Restoration Methodology Plan was to be developed after the injury and damage quantification [43 CFR § 11.81 and § 11.82]. The District Court ruling identified that "... restoration is the basic measure of damages, but damages can exceed restoration costs in some cases." (D.C. Cir. 1989, page 450). As a result, the U.S. DOI's April, 1991 proposed regulations adds a Restoration and Compensation Determination Plan (RCDP) [Proposed 43 CFR § 11.81 (d)].

4.2.2 Objectives of the Research Plan

Restoration determination is required to evaluate the developing RI/FS and remediation efforts, to evaluate the potential for injuries and damages that are residual to the remediation, and to define damages that are residual to the remedial and restoration actions.

Research Plan

Restoration determination will involve a screening of resources, operable units, and remediation alternatives and the development of an estimate of anticipated costs and timing for additional restoration efforts beyond the site remediation efforts. The work will rely primarily on existing data, studies, and modeling efforts, and on the efforts to be undertaken in the injury determination and quantification work.

The screening will be based on site-specific literature, the Clark Fork RI/FS documents and RODs issued to date, the Clark Fork Master Plan, RI/FS documents for other mining sites, the professional literature, and interviews with state and federal personnel and experts. This information will be used to:

a. Outline the likely range of RI/FS remediation actions for the major waste sources at the Clark Fork sites;

b. Characterize the unremediated, or residual, natural resource injuries; and

c. Identify and evaluate additional restoration actions required to fully restore (replace or acquire) the site resources and services.

Each of the major waste sources will be linked to groups of injured natural resources, including at least: surface water and fisheries, soils and sediments, vegetation, terrestrial habitat, groundwater, and air. Impacts to resources will be evaluated by regional impact areas. For example, for groundwater, waste sources will be linked to impacts to groundwater in the vicinity of areas such as Butte Hill, Montana Pole, Anaconda/Opportunity Ponds, and Milltown Reservoir. For surface water and fisheries, waste sources will be linked to impacts in regional areas such as Silver Bow Creek, Warm Springs Pond Complex, and the Clark Fork River from Warm Springs Ponds to Milltown Reservoir.

Additional restoration alternatives for waste sources impacting each resource group and area will cover the following range of alternatives [Proposed 43 CFR § 11.32 (c), § 11.73, § 11.82]:

a. Complete intensive restoration and, as may be feasible, intermediate levels of restoration;
b. Replacement or acquisition of like resources and resource services; and
c. No action natural recovery, including how long such natural recovery can be expected to occur, if ever.

The restoration determination analysis will provide information to the State of Montana for evaluation and selection of restoration alternatives. This information will cover factors such as [Proposed 43 CFR § 11.82 (c)(2)]:

a. Technical feasibility;
b. Relationship of costs to expected benefits;
c. Cost effectiveness;
d. Results of actual or planned response actions;
e. Potential of additional injury from proposed actions;
f. Natural recovery period;
g. Ability of resource to recover with or without alternative actions;
h. Potential effects of the action on human health and safety;
i. Consistency with Federal and State policies; and
j. Potential acquisition of equivalent land or resources for State management.

Restoration, replacement or acquisition of the full resources and resource service flows is the basic measure of damages for injuries to natural resources, hence estimates of restoration costs to implement the alternatives will be required. The cost methodologies to be utilized are consistent with the proposed revised regulations [Proposed 43 CFR § 11.83], with emphasis on comparison and unit methods [Proposed 43 CFR § 11.83 (b)(2)(i) and (ii)]. The cost estimates will be "order-of-magnitude" costs. Areal units of cost estimates may vary. For example, wetlands restoration may be estimated on costs per acre, while river bed restoration may be based on cost per mile or costs per cubic yard per mile of sediment dredged and hauled. The cost estimates will use discount rates consistent with 43 CFR § 11.84 (e).

The results of this assessment will be included in the Final Report of the Assessment [Proposed 43 CFR § 11.35 (d)(3)].

4.3 RECREATIONAL FISHING DAMAGE ASSESSMENT

4.3.1 Service Flows

The release of hazardous substances into Silver Bow Creek, the upper Clark Fork River and adjoining water bodies may injure fisheries and/or alter the species diversity. Change in the quantity, quality and diversity of fish species can be expected to impair the amount and enjoyment of recreational fishing use (services) associated with aquatic resources, and thus result in compensable use value damages.

Previous studies of river-related recreational participation that include the upper Clark Fork Basin (Hagmann 1979; McFarland 1989) show that the upper Clark Fork is a recreational resource for anglers, boaters, and shoreline users. Two studies that include this recreational fishery (Duffield *et al.* 1987; Duffield and Allen 1988) developed statewide estimates of the value of Montana recreational stream fisheries using the travel cost and contingent valuation methodologies. The travel cost data are based on surveys of angler use during the 1985 fishing season. These studies show that the use and value for the mainstem upper Clark Fork fishery is well below that of the other major trout streams in the basin.

Silver Bow Creek has also been heavily impacted by mining: McFarland's (1989) angler surveys show zero angler use on this stream for 1982, 1984 and 1985. In four years of sampling, only one angler trip to this stream was reported (in 1983). By contrast, the above studies indicate that there is measurable use on many other small streams in the basin, including Warm Springs Creek.

4.3.2 Objectives of the Research Plan

The injury determination and quantification assessment will address the fisheries injuries due to releases of hazardous substances into the upper Clark Fork River, Silver Bow Creek and Warm Springs Ponds by the PRP (see Assessment Plan Part I). The objective of the damage determination work is to relate changes in the fish stock in affected water bodies to changes in recreational fishing participation and valuation. This can then be used to estimate compensable recreation fishing use value damages. A further objective will be to develop a valuation approach that can account for potential variability of the injury through time, variability in site characteristics, and the availability and characteristics of substitute sites.

4.3.3 Research Plan

The recreational fisheries use value research plan will generate multiple fishing use value damage estimates through three valuation approaches:

1. Use of existing data and literature on the affected and comparable sites;
2. Development, data collection, and analysis of recreational fishing demand models (also referred to as travel cost models); and
3. Development of a contingent valuation of changes in fishery injuries at the impacted sites.

4.3.3.1 Existing Data and Literature Approach

Existing research on recreational fishing in Montana and the Rocky Mountain West will be reviewed. Studies which address impacts on angler use and values resulting from changes in fishing site characteristics (i.e. change in expected catch rate, species availability, size of catch, etc.) will be evaluated to aid in identification of comparable sites and natural resource injuries. Studies identified may be used to estimate the likely magnitude of past, present and residual future changes. New damage assessment efforts will be undertaken, as discussed below; and existing data and literature will be used to support these new efforts.

4.3.3.2 Travel Cost Models

(a) Approach

A travel cost model (TCM), to be constructed, will serve as a component of the recreational fishing damage assessment. Both the current and proposed regulations recognize the method as a best available procedure to estimate compensable use value damages [43 CFR § 11.83 (d)(3); and Proposed 43 CFR § 11.83 (c)(2)(ii)(B)]. Recreational demand models (including TCM) are used to estimate values of a site's recreational services by estimating the money and time costs incurred in traveling to and from the site, and while at the recreational site (U.S. DOI 1987). For example, if individuals will travel further to fish at sites with higher expected catch rates, the added travel time and expenses reveal an economic value for the option to have higher expected catch rates.

A number of variations of recreational demand models have been developed (Bockstael, *et al.* 1991). The approach to be developed and applied in this assessment will involve variations on random utility model multi-site logit and nested-logit models of individual choice (Morey *et al.* 1991; Morey and Shaw 1990; Bockstael *et al.* 1987; Brownstone and Small 1989; and Parsons and Kealy 1992). These models examine characteristics and substitution across multiple sites.

Based upon observed angler activity, the approach models the following choices:

1. The expected number of trips an individual angler takes in a season, and
2. The expected distribution of trips between the affected site and other competing sites.

These observed choices are modeled as a function of characteristics of the individual angler (age, type of species sought, in-state vs. out-of-state residence, etc.) and characteristics of alternative fishing sites. Fishing site characteristics include variables such as travel distance and other costs associated with each site, incurred by each individual angler, and expected fishery stock characteristics. Important stock characteristics may include species, fish size, stock size and/or catch per hour at each of the study sites.

The model allows variation of fishing site characteristics to determine how expected choices of the number of trips and sites selected are altered. For example, one would expect that an increase of the catch rates at a nearby fishing site would increase the expected number of trips to that site. This would be due to substitution of trips away from other sites and/or an increase in the total number of trips taken. Changes in trip taking behavior can be related to the change in expected annual consumer's surplus and is the appropriate measure of use value damages for recreational fishing.

The use of a multiple-site recreation demand model facilitates substitution to other recreation sites; failure to do so, in theory and practice, could bias the damage estimates (Caulkins *et al.* 1985; and U.S. DOI 1987). The current and proposed regulations specifically identify the need to address substitutability of uses (or sites) for those of the injured resource services [43 CFR § 11.84 (f) and Proposed CFR 43 § 11.84 (f)]. The models to be employed meet this requirement. The approach uses a sample of substitute sites, just as it uses a representative sample of anglers, in order to model how changes in fishing stock characteristics impact individual fishing choices.

In summary, a recreation demand model will be developed and implemented that will:

- Directly address, and specifically isolate, the affect of stock/catch rates upon activity level, site choice and damages to anglers. This will require data on stock/catch characteristics and visitation at the affected and other modeled sites;

- Explicitly address other fishing sites. This addresses substitutability and provides use data for "comparable" sites; and

- Specifically address and isolate other important site characteristics that may influence site choice and economic damages.

(b) Implementation

The TCM recreational fishing damage assessment will be conducted in three phases: (1) methods development, (2) data collection, and (3) analysis and reports.

Phase 1: Methods Development. This subtask includes: development of the mathematical recreational demand models consistent with the literature, design of the data collection instruments, design of the data collection protocols, pretesting of the data collection instruments and protocols, and staff training. The content of the data collection instruments is discussed under Phase 2. The draft instruments and data collection protocols will be in-field pretested prior to implementation.

Phase 2: Data Collection. Data will be collected in-field and through follow-up surveys. In-field work will involve an intercept creel survey at selected fishing sites during the summer of 1992. This creel survey will allow a cost effective, consistent measurement of fish stock/catch rate characteristics across the study sites, the relation of these measurements to the stock measurements in the fisheries injury determinations assessment, and inclusion of resident and non-resident analysis.

Approximately 24 to 30 sites will be included in the analysis. These sites will be selected based upon criteria that include:

1. Sampling of locations on each of multiple reaches of Silver Bow Creek, Warm Springs Ponds, and the Clark Fork River between Warm Springs Ponds and Milltown Reservoir;

2. Overlap with sites used in the fisheries injury determination and quantification assessment; and

3. Sampling of substitute and comparable sites, and capturing a significant share of use. Selected sites will exhibit a variability in distance, site and stock characteristics to model the way in which variations in site characteristics affect recreational fishing decisions. This allows the model to be applied to the valuation of fishery resources changes in the upper Clark Fork Basin under a

range of scenarios, from no past and present injuries through various levels of expected future residual injuries.

Table 4-2 presents a preliminary listing of sites for use in the recreation analysis. The site list will be finalized in the Phase I work.

Visits to each site will be made at varying times of the day and varying times of the week based on a randomized procedure. Each visit to each site will take two to four hours, depending upon site size and other characteristics, and will entail both a counting of anglers at the sites and a random selection of anglers for the creel interview. The visits to each site will be spaced throughout the sampling season and will be designed to obtain a minimum of 45 to 90 creel observations at each site, depending upon the site. The creel survey will obtain data concerning on-site catch characteristics (number, type and size, species caught and returned), angler characteristics (number of trips taken, trip origin, etc.); and name, address and phone number for a follow-up survey.

The follow-up survey will be conducted through mail and phone procedures following the protocols in Dillman (1978). The follow-up survey will obtain additional data desirable to estimate the TCM model which would not be available at the time of the on-site survey, such as the total number trips during the season, or which may interfere with the effectiveness of the on-site creel survey. The follow-up mail survey will address general perceptions, awareness and attitudes about fishery management in Montana, reasons for site choice and other background data; trip taking behavior, including total number of trips taken, destinations and catch characteristics at recent fishing sites; contingent valuation of changes of fishing quality (See section 4.3.3.3 below); and information about the angler. The follow-up survey will be implemented during the summer through fall of 1992.

Phase 3: Data Analysis and Report. The data received will be coded, entered and verified (double entry). The statistical analysis will follow, with reports provided in the final assessment report.

4.3.3.3 Contingent Valuation Method in the Recreation Survey

"The contingent valuation methodology includes all techniques that set up hypothetical markets to elicit an individual's economic valuation of a natural resource." [43 CFR § 11.83 (d)(5)(i)], and is recognized as a "best available procedure" for estimating use value damages. The contingent valuation method (CVM) is discussed further in section 4.6 below. One of the most frequent applications of the CVM method is to estimate values for changes in the characteristics of recreational fishing experiences such as catch rates and species availability (e.g. USFWS 1988).

Table 4-2
Preliminary Listing of Sites for the Recreational Fishing Intercept Survey

State	Length/miles
Missoula Area	
Upper Clark Fork #1 - Bonner to Rock Cr.	17
Upper Clark Fork #2 - Rock Cr. to Flint Cr.	35.8
Upper Clark Fork #3 - Flint Cr. to L. Blackfoot	28.1
Md. Clark Fork - Spurgin Rd. to Huson	21
Rock Cr. - 1 Mile up to Harry's Flat	16
Flint Cr. - Maxville to Black Pine Rd.	9
Bitterroot #1 - McClay Br. to Chief Looking Glass	19.5
Bitterroot #2 - Angler's Roost to Hannon Mem.	20
Lolo Cr. - Mormon Cr. to Lolo Hot Springs	27.1
Blackfoot - Bonner to Whitaker Br.	16
L. Blackfoot - Cutoff Rd. to Elliston	23
Butte Area	
Upper Clark Fork #4 - L. Blackfoot to Perkins Lane	24
Upper Clark Fork #5 - Perkins Lane to Pond 2 Outfall	3
Silver Bow Cr. - Ponds to Butte	20
Warm Springs Cr. - Fish Hatchery to Meyer's Dam	5
Warm Springs Ponds	N/A
Big Hole #1 - Pennington Bridge to Brown's Bridge	20.7
Big Hole #2 - Melrose to Divide	13.2
Jefferson #2 - Waterloo to Twin Bridges	22
Beaverhead - Barretts to Clark Canyon	16
Helena Area	
Missouri #1 - Ulm to Cascade	25
Missouri #2 - Dearborn R. to Holter Dam	14
Bozeman Area	
L. Yellowstone - Springdale to Livingstone	20
Gallatin - Shedd Br. to Spanish Cr.	13
E. Gallatin - Spain L. Br. to Griffen Dr.	15
Madison #1 - Cobblestone to Beartrap	18
Madison #2 - Varney to Lyons	26
Jefferson #1 - Willow Cr. to Cardwell	18

CVM will be considered for inclusion in the recreational fishing follow-up mail survey instrument. The CVM questions in the survey would estimate angler willingness to pay (WTP) for changes in the characteristics of the recreational fishery, particularly catch characteristics, resulting from the fishery injuries at the affected sites.

The design of the CVM scenarios of natural resource injuries would be coordinated with the fisheries natural resource injury determination and quantification work. The CVM questions would be developed utilizing the extensive applied literature on fishery CVM applications, and would be in-field pretested. The remainder of the implementation, analysis and reporting would follow the procedures and schedules in the travel cost model follow-up survey research plan.

4.4 OTHER RECREATION DAMAGE DETERMINATION

4.4.1 Service Flows

The release of hazardous substances and subsequent natural resource injuries, may also impact the quality and quantity of non-fishing recreation in the Clark Fork Basin. For example, injured water quality, injured fisheries and other aquatic life, and contaminated streamside soils and sediments may all lead to resource service flow impacts of reductions in the amount and quality of river corridor recreation, and thus result in compensable use value damages.

Non-fishing recreational activities may include swimming, boating, hiking, photography, picnicking and camping. Impacts to non-fishing recreation may have occurred in the upper reaches of the river where there are obvious visual cues to soils, sediments and water quality degradation, and elsewhere where recreational fishing is impacted. Hagmann (1979) found that almost half (48.6 percent) of all river-related recreational use in the upper Clark Fork Basin was general shoreline use (including hiking, floating, wildlife viewing, etc.). In an extensive literature review of the economics of outdoor recreation, Walsh *et al.* (1988) found significant value for shoreline use.

Injuries to wildlife, either directly or indirectly through injury to water supplies, vegetation, habitat or soils, may reduce the abundance and condition of wildlife. Injuries to wildlife may impair wildlife resource service flows of consumptive use such as hunting, and non-consumptive use such as viewing. The economic value of deer and elk hunting in Montana has been the subject of a series of economic studies (Loomis *et al.* 1988; Brooks 1988; and Duffield 1988). The upper Clark Fork Basin is included in several of the specific elk and deer hunting districts covered by these studies. There has also been a study completed of the economic value of waterfowl hunting in Montana (Duffield and Neher 1991). Hagmann (1979) estimated that on an annual basis, five percent of the river-related recreational use in the upper Clark Fork Basin is hunting. During the winter season, this use is 23 percent of total use. Nonconsumptive use of wildlife in the basin has not been specifically studied, but USFWS (1988) estimates indicate that participation in wildlife viewing activities in Montana exceeds participation in either fishing or hunting. These findings generally suggest that wildlife are a resource that provides significant recreational services in the upper Clark Fork Basin.

4.4.2 Objectives of the Research Plan

The injury determination and quantification assessment will address the fisheries, surface water quality, vegetation, wildlife and other natural resource injuries that result from the release of hazardous substances into the Clark Fork Basin (see Assessment Plan Part I, and section 2.0 of this document) that may affect non-fishing recreation use and enjoyment. The objective of the damage determination is to relate changes in natural resource injuries to changes in river corridor recreation use levels and use values, and to wildlife use levels and use values.

4.4.3 Research Plan

(a) Non-Fishing River Corridor Recreation

The approach will be (1) to estimate changes in general non-fishing recreation rates due to natural resource injuries in the Silver Bow Creek and upper Clark Fork River corridors, and (2) to apply literature values for non-fishing recreation to obtain an estimate of annual compensable use values. Past and future residual damages will be determined by scaling current annual damages by population, the levels of natural resource injuries, and other key factors that change through time and that influence recreation activity and values.

The estimates of the impacts of natural resource injuries will be addressed through:

1. Existing literature and data. Studies, such as Hagmann (1979) have examined use rates for non-fishing recreation along the Clark Fork River and other water bodies. These estimates provide one basis for determining current use at the Clark Fork River and selected comparable sites;

2. In-field observation of non-fishing activity types and numbers of participants at Silver Bow Creek, the upper Clark Fork River, and at a set of comparison sites. This observation work will be completed in tandem with the in-field recreational fishing observation and creel survey work described in section 4.3.3.2. The comparison sites for this analysis will be comprised of a subset of the sites used

in the recreational fishing analysis. Comparisons of the non-fishing recreation between the Silver Bow Creek and upper Clark Fork River sites versus the comparison sites provides a measure of the impacts of varying levels of natural resource quality upon recreation use patterns; and

3. A limited sample of individuals participating in non-fishing recreation will be randomly intercepted concurrent with the in-field creel sampling effort. It is expected that on the order of 100 to 150 individuals will be included in this sample. Respondents will be surveyed through either a mail-back survey provided to intercepted individuals, or through a follow-up phone or mail survey. The survey will address non-fishing recreation along the river corridor, factors that influence site selection for non-fishing recreation, and how changes in site characteristics resulting from restoration of natural resources at the site would impact their non-fishing recreation decisions. These data will be used to address whether, and how, natural resource injuries at the site influence the level and enjoyment of non-fishing participation.

The valuation of use impacts will rely upon the considerable literature on non-fishing recreation use values. Walsh *et al.* (1988) summarizes many of the studies which provide the basis for utilization of a unit value methodology. Such a methodology may be used under both the current [43 CFR § 11.83 (d)(6)] and proposed revised regulations: "Unit values are preassigned dollar values for various types of nonmarketed recreational or other experiences by the public. Where feasible, unit values in the region of the affected resource and unit values that closely resemble the recreational or other experience lost with the affected resource may be used" [Proposed 43 CFR § 11.83 (c)(2)(ii)(E); 43 CFR § 11.83 (d)(6) provides similar guidance].

(b) Consumptive and Non-consumptive Wildlife Recreation

Wildlife injuries that may impact recreation away from the river corridor will be addressed through review of existing literature and data. Existing data will be evaluated to determine relationships between wildlife stocks and consumptive and non-consumptive wildlife use rates. Existing economic studies (including Walsh *et al.* 1988) will be used to assign unit values to any losses in estimated recreational use levels.

4.5 TOTAL COMPENSABLE VALUES USING CONTINGENT VALUATION

4.5.1 Service Flows

The recreation demand assessments (section 4.4 above) and market price assessments measure use value compensable damages for a subset of the potentially injured natural resources. Based upon the injury determination and quantification, other resources may be injured that have impacted service flows related to use values. These may include impacts to vegetation, wildlife, biologic life, and other impacts for which there are no market prices or other readily available valuation methods. These use values can be measured by the contingent valuation method.

Natural resource injuries may result in nonuse compensable damages. Nonuse compensable damages include protection of the resource for use by oneself or others now and in the future (option and bequest values related to potential recreational and other uses), protection of resources with minimal impairment, even if the individual does not expect to use the resource (existence values), and for other nonuse services impacted by natural resource injuries. Nonuse values are to be included in natural resource damage assessments. The U.S. DOI proposed regulations define nonuse values as the difference between total compensable value and use values [Proposed 43 CFR § 11.83 (c)(1)(ii)].

4.5.2 Objectives of the Research Plan

"The contingent valuation methodology includes all techniques that set up hypothetical markets to elicit an individual's economic valuation of a natural resource." [43 CFR § 11.83 (d)(5)(i)].

The objectives of this research are to use the contingent valuation method (CVM) to:

- Derive estimates of total compensable damages covering all resource injuries and use and nonuse service flows; and
- Examine the sensitivity of the valuation to changes in key parameters of the CVM design.

4.5.3 Research Plan

The research plan will be conducted in three phases, as discussed below.

Phase I: Design: The CVM design will be directed toward estimating willingness to pay (WTP) measures for resource enhancement and protection that reflect the natural resource injuries in the upper Clark Fork Basin resulting from the release of hazardous substances. Substantial literature exists concerning the methods and issues in the design and testing of CVM (Cummings *et al.* 1986 and Mitchell and Carson 1989; U.S. DOI 1987). These methods and general design issues will be addressed in the conduct of the CVM research.

The first steps in the design of the CVM survey instrument involve determining characteristics of the natural resource injuries, including the types and geographic extent of injuries, the likely magnitude of injuries, the biologic and human significance of the impacts (service flows impacted), the general nature of restoration options that may occur, and other characteristics of the site. This work will be coordinated with the injury determination and quantification assessment, and with the restoration assessment.

Next, preliminary CVM survey designs will be designed to address the basic natural resource injury issues. Several alternative designs will be considered, including, but not limited to, valuing multiple hazardous waste sites in the state and separating out the values for just the Clark Fork Basin sites; valuing natural resource impacts at the Clark Fork Basin sites singly; and valuing specific natural resource injuries, alone or in combinations, that occur at the sites. Further, various levels of enhancement and preservation of natural resources will be evaluated as part of the survey designs. Other approaches may evolve during the survey design and pretest process.

General CVM design issues, variations in the level of potential injury to be addressed, and the presentation of the injury will be resolved/determined through the pretesting and implementation of multiple survey versions. Pretesting multiple survey presentations will isolate aspects of the design that be can used effectively and neutrally to reveal values for the natural resources injuries of concern. In the final survey, multiple versions will be used to reveal the significance of variations in the CVM design and variations in the level and types of injuries considered.

Several stages of pretesting will be conducted to develop the CVM survey instruments. It is likely that multiple methods of pretesting will be used, and that iterations of these pretesting approaches may be used in conjunction with a continuing process to formulate and refine the CVM survey instruments. Stages of pretesting may include:

1. Focus Groups. Focus groups are used to discuss the basic perceptions about the natural resource injuries of concern, and to test preliminary survey wording and other issues that arise in the preliminary stages of the survey design;

2. Verbal Protocols. Verbal protocols are a process whereby individuals are given a survey instrument, a tape recorder, and instructions to continually talk about the survey as they are completing it. Based upon the participant comments during the pretests, refinements to the survey are made; and

3. One-on-one interviews. After, or concurrent with, other pretesting efforts, one or more rounds of interviewing may be conducted. In these interviews, respondents complete the draft survey instruments alone, and are then debriefed by a research team member. The last stage is a formal pretest.

After the initial designs and pretesting work, a random survey sample is drawn from potentially affected households. The sample households are coded with identification numbers, and the identification code and household list are separated to preserve anonymity. Respondent names and addresses will be protected. Concurrent with the final survey design and implementation, a statistical codebook and statistical analysis plan are developed. Finally, the survey is produced and implemented.

Phase II: Implementation. The final survey instrument will be implemented through a modified Dillman mail survey approach (Dillman 1978) to achieve response rates between 65 and 75 percent (net of bad addresses). This generally includes steps such as those outlined in Figure 4-1, Task 2. Alternative implementation approaches will be considered and weighed against the merits of conducting additional survey versions in the mail survey implementation.

Phase III: Data Preparation, Analysis and Report. All data received will be coded, entered and verified (double entry) to insure accuracy. Appropriate quality assurance procedures will be followed (Dillman 1978). The statistical analysis plan will be implemented and the draft and final reports prepared for inclusion in the final report of the assessment.

4.6 MARKET PRICE ANALYSES

4.6.1 Service Flows

Natural resource injuries to surface water, groundwater, and other resources may impact the actual and potential use of these resources for recreation, municipal, irrigation, commercial and other uses. For example, injured groundwater precludes, limits or reduces the quality of the use of the resource for agricultural, municipal and industrial consumption, surface water recharge to maintain in-stream flows, and other purposes. Injured surface water precludes, limits or reduces the quality of the use of the resource for irrigation, and municipal and industrial consumption.

4.6.2 Objectives of the Research Plan

The damage assessment will use a market price approach to quantify past, present and residual future compensable use value damages for surface water, groundwater, and other injured natural resources, if deemed appropriate and where there are market prices or implicit factor prices. Market price valuation methodology is cited in the current and proposed regulations: "This methodology may be used if the natural resource is traded in the market.... If reasonably competitive, the diminution in the market price of the injured

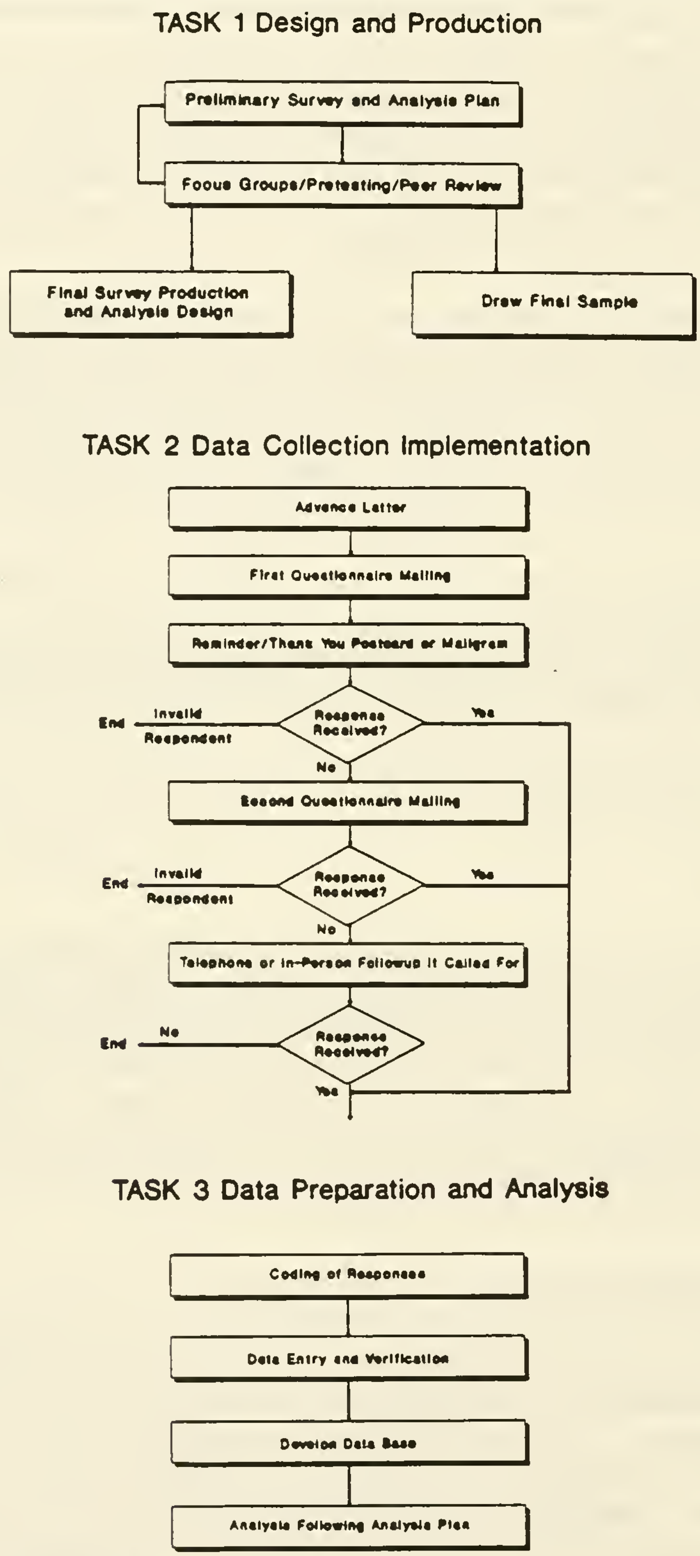

Figure 4-1. Strategy Guide

resource, or lost services, may be used to determine the compensable value of the injured resource" [43 CFR § 11.83 (c)(1); Proposed 43 CFR § 11.83 (c)(2)(i)(A)].

4.6.3 Research Plan

A three-step procedure will be followed to estimate damages with the market prices. First, the past, present, and expected future designated uses or service flows (or absence of limitation on use) will be identified that potentially have market prices. Available information will be gathered on past and present actual use to demonstrate that the resource has provided (or will provide) the use or service flow. Second, based upon the injury determination and quantification, an assessment of the reduced service flows of the resource will be made. Third, market prices will be evaluated and applied to the reduced past, present and expected future uses of the resource.

For example, for groundwater and surface water, potential and actual uses will be evaluated. Next, past, present and expected future use of the resource, and the sustainable annual yields of the resource for the designated uses, will be evaluated. Finally, alternative market price based approaches will be evaluated and applied, including market prices for water rights and delivery for comparable sustainable yields of uncontaminated water, market prices for treating the contaminated water resources for the impacted uses, and the reduced value of contaminated water in the various uses (factor price method).

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