SEDIMENT CHARACTERIZATION PLAN

ENVIRONMENTAL RESTORATION PROGRAM

OCTOBER 5, 1990

DRAFT FINAL

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EXECUTIVE SUMMARY

Potential chemical releases from the Rocky Flats Plant (RFP) to surface water could result in transport of contaminants to off-site surface water and municipal drinking water supplies. The movement of contaminants in stream channels may be accelerated and compounded by adsorption of some chemical species (e.g., radionuclides and metals) to sediment components and subsequent transport of the sediments off-site. It is hypothesized that peak sediment transport occurs during the rising stages of storm and snowmelt runoff and pond discharge events. Contaminated sediments can also serve as a reservoir for continuous release of toxic substances into surface water.

The overall goal of the Sediment Characterization Study for the RFP Environmental Restoration (ER) Program is to characterize sediment and adsorbed contaminant transport in major stream channels at RFP during the rising stage of storm and snowmelt runoff and pond discharge events. The information obtained from reaching this goal will be incorporated into the CERCLA Remedial Investigation/Feasibility Study (RI/FS) process or the RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) process for each of the 16 Operable Units (OUs) within the RFP site. It will also provide ER Program management the ability to make sound decisions based on quantitative and scientifically defensible data and investigation protocols. The specific objectives of the study are as follows:

(1) Determine suspended sediment concentrations in major stream channels during the rising stage of storm and snowmelt runoff and pond discharge events.
(2) Determine bedload concentrations in major stream channels under these conditions.
(3) Determine concentrations of chemical constituents adsorbed to suspended sediment and bedload.
(4) Estimate total loadings of sediment and adsorbed constituents transported through and exiting RFP.

Sampling of suspended sediment and bedload will be concentrated during these types of flow events. Sediment sampling will be performed in the three major stream channels at RFP: Woman Creek, Walnut Creek and Rock Creek. Sediment sampling locations will coincide with 11 permanent stream gaging stations used in the RFP ER Program site-wide Surface Water and Sediment Monitoring Program. Flow data will be measured continuously

using Parshall flumes and an automatic flow indicator/totalizer/recorder at each station. U.S. Series U-59 Single-Stage Suspended-Sediment Samplers will be used to "automatically" collect representative suspended sediment samples at several stages on the rising limb of the hydrograph during storm and snowmelt runoff and pond discharge events. Pump samplers will be used in conjunction with the U-59 samplers to collect adequate volumes of suspended sediment samples for complete chemical analyses. Composite bedload samples will also be collected during the same events with a USGS-approved bedload sampler.

All sediment samples will be analyzed for sediment concentration, grain size distribution, and organic material content. A subset of samples will be analyzed for metals, radionuclides, semi-volatile organics, pesticides/PCBs, indicator parameters, and some additional ions.

Once data are validated, they will be incorporated into a centralized environmental data base for the ER Program. The computerized data base is the core of the data management system, and provides an organized, systematic and consistent framework within which all technical data pertaining to this study can be stored, accessed, manipulated, and tracked. The specific objectives of the data management system are to provide a structured, accurate, and verifiable method to track all samples from field collection, through laboratory analysis, to final disposition; record all field data generated during sample collection; record all results of laboratory analyses performed on samples and overall laboratory performance; allow all recorded data to be accessed and manipulated for data analysis and/or report preparation; and comply with the Technical Data Management Plan for the ER Program.

Regression analysis will be used to assess the correlation between (1) sediment concentration and water discharge for each flow event sampled at every station, (2) bedload concentration and discharge for multiple flow events at each station, and (3) adsorbed contaminant concentrations and grain size distribution and organic material content. Suspended sediment, bedload, and adsorbed contaminant mass fluxes will be estimated based on this infomation. Flow-wieghted mean sediment and adsorbed contaminant loads will also be estimated. In addition, multivariate analysis incorporating additional environmental parameters will be used to estimate conditions under which the greatest sediment loads and associated contamiannt loads can be expected. This information will be used to generate predictive models for estimating sediment and adsorbed constituent loads during future events.

If the results of this study indicate that the transport of adsorbed contaminants may be a

significant problem at the RFP downstream boundaries, monitoring of sediment may be warranted in the future. Potential remedial technologies and engineering alternatives to address these problems will also be evaluated.

A Sediment Characterization Report will be generated that will provide all of the following information:

- A summary of all significant findings
- All field and laboratory analytical results, laboratory performance data, and data validation information in appendices
- All streamflow data in appendices
- Results of statistical and quantitative analyses
- Interpretation of data and results of analyses
- Characterization of potential adsorbed contaminant transport problems and recommendations for future investigation, monitoring, or remediation

The total estimated cost for implementation of the Sediment Characterization Study is approximately $1,750,000. A proposed schedule for implementation of the study is presented in the plan. This schedule includes a time frame for equipment procurement, construction and installation, testing and calibration, sampling, laboratory analysis, data compilation, data analysis, and report preparation.

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1.0 INTRODUCTION

The Sediment Characterization Plan developed for the Rocky Flats Plant (RFP) Environmental Restoration (ER) Program documents the overall goals, specific objectives, and a general protocol for implementation of a site-wide Sediment Characterization Study for the RFP. The plan describes the study from initial design through general field sampling procedures and equipment, laboratory and analytical requirements, data validation, data management, statistical and quantitative data analyses, and information reporting requirements. The protocol is consistent with the following ER Program documents that have been developed for a variety of ER programs:

- Standard Procedures for the Design of Environmental Monitoring Systems (Rockwell, 1988a)
- Background Hydrogeochemical Characterization and Monitoring Plan (Rockwell, 1989a)
- Standard Operating Procedures (SOPs) (EG&G, 1990a)
- RFP Site-Wide Quality Assurance Project Plan (QAPP) for CERCLA Remedial Investigations/Feasibility Studies and RCRA Facility Investigations/ Corrective Measures Studies Activities (EG&G, 1990b)
- ER Health and Safety Program Plan (HSSP) and Workbook (EG&G, 1990c)
- Technical Data Management Plan (TDMP) (Rockwell, 1989b)

1.1 Study Goals

The primary goal of the Sediment Characterization Study for the RFP ER Program is to characterize sediment and adsorbed contaminant transport in major stream channels at RFP during the rising stage of storm and snowmelt runoff and pond discharge events. The information obtained from the completed study will be incorporated into the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation/Feasibility Study (RI/FS) process or the Resource Conservation and Recovery Act (RCRA) Facility Investigation/Corrective Measures Study (RFI/CMS) process for each of the 16 Operable Units (OUs) within the RFP site. It will also provide ER Program management the ability to make sound decisions based on quantitative and scientifically defensible data and investigation protocols.

1.2 Study Objectives

The specific objectives of the Sediment Characterization Study that have been developed to reach the study goals are as follows:

(1) Determine suspended sediment concentrations in major stream channels during the rising stage of storm and snowmelt runoff and pond discharge events.

(2) Determine bedload concentrations in major stream channels under these conditions.

(3) Determine concentrations of chemical constituents adsorbed to suspended sediment and bedload.

(4) The results of objectives (1), (2), and (3) will be used to estimate total loadings of sediment and adsorbed contaminants transported through and exiting RFP.

2.0 SITE DESCRIPTION

2.1 Rocky Flats Plant Description

The Rocky Flats Plant is located approximately 16 miles northwest of downtown Denver, in Sections 1 through 4 and 9 through 15 of R70W T2S of Jefferson County, Colorado (Figure 2.1). RFP encompasses approximately 6,550 acres of federally owned land and is a government-owned and contractor-operated (GOCO) facility that has been operational since 1951. The plant is a U.S. Department of Energy (DOE) facility that manufactures metal components for nuclear weapons from plutonium, uranium, beryllium, and stainless steel. Other production activities include chemical recovery and purification of recyclable transuranic radionuclides, metal fabrication and assembly, and related quality control functions. The plant also conducts research and development in metallurgy, machining, nondestructive testing, coatings, remote engineering, chemistry and physics. Parts manufactured at the plant are shipped off-site for final assembly. Primary plant structures and all production buildings are located within a 400-acre secure plant complex area. A 6150-acre buffer zone surrounds the perimeter of the main plant complex.

Solid and liquid nonhazardous, hazardous, radioactive, and mixed radioactive wastes are generated in the RFP manufacturing process and operations. Current waste handling and disposal practices include on-site treatment and both on-site and off-site recycling of hazardous and mixed radioactive wastes, on-site storage, or shipment off-site for disposal of hazardous and solid radioactive materials at another DOE facility. However, disposal of hazardous, mixed, and solid radioactive wastes has occurred on the RFP site in the past. Nonhazardous wastes, such as office trash, are disposed in an on-site landfill.

Preliminary assessments performed by the ER Program identified some of the past on-site storage and disposal locations as potential sources of environmental contamination. A comprehensive list of all known and suspected hazardous, radioactive, and mixed waste sources at RFP has been compiled. This list includes descriptions and all known release

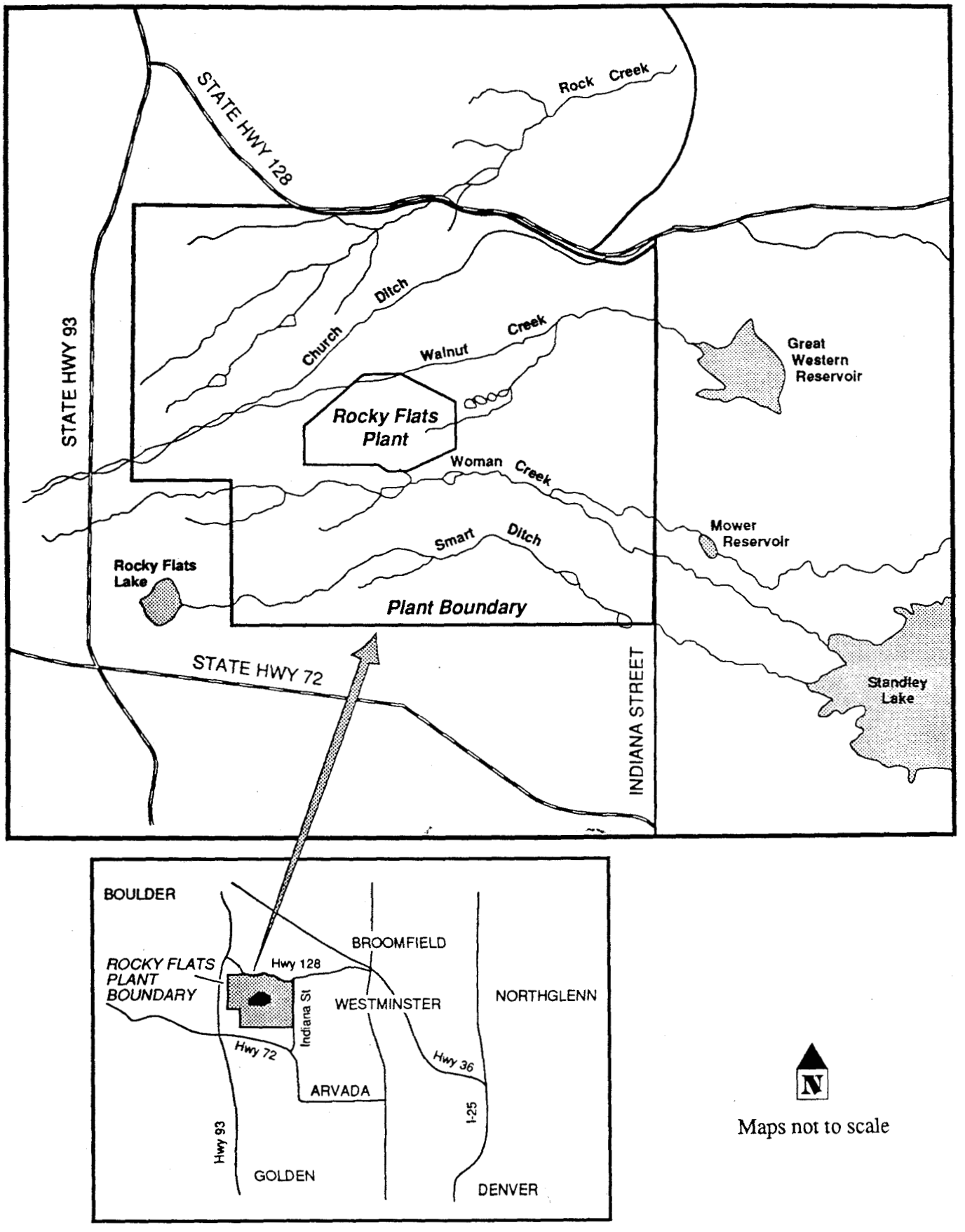


FIGURE 2.1 Location Map of Rocky Flats Plant

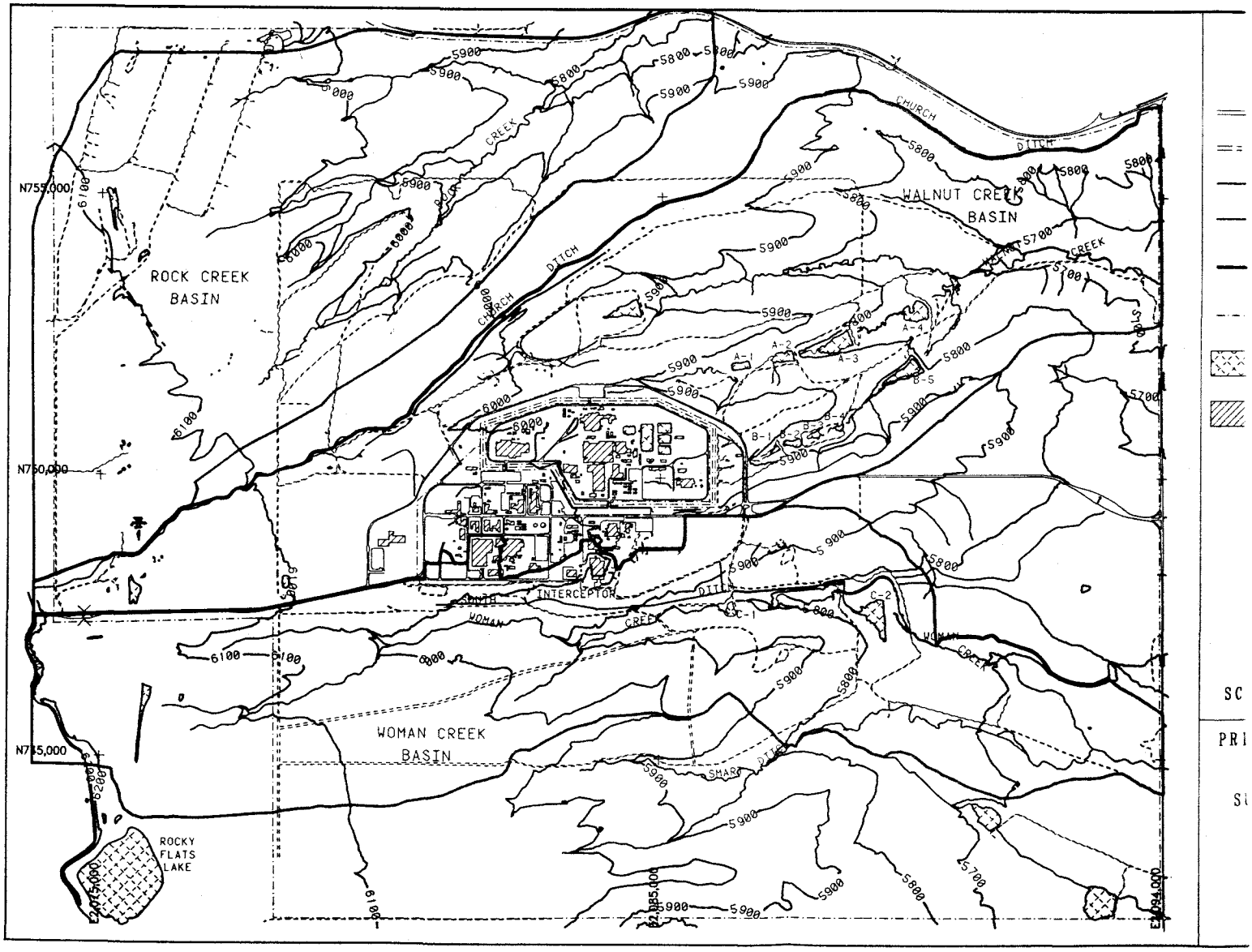
information for all identified RCRA-regulated units and CERCLA Individual Hazardous Substance Sites (IHHSs, previously known as Solid Waste Management Units or SWMUs). The regulated and waste management units at RFP have been categorized for further environmental investigation and remediation into 16 Operable Units based on potential threats to human health and the environment, as well as geographic location. Waste management units that received hazardous waste after November 19, 1980, require RCRA closure plans. Land disposal units that received hazardous wastes after July 26, 1982, (regulated units) are also subject to RCRA interim status groundwater monitoring requirements prior to closure and post-closure care requirements subsequent to closure. The RFP regulated units are described in detail in the RCRA, Post-Closure Care Permit Application (Rockwell, 1988b).

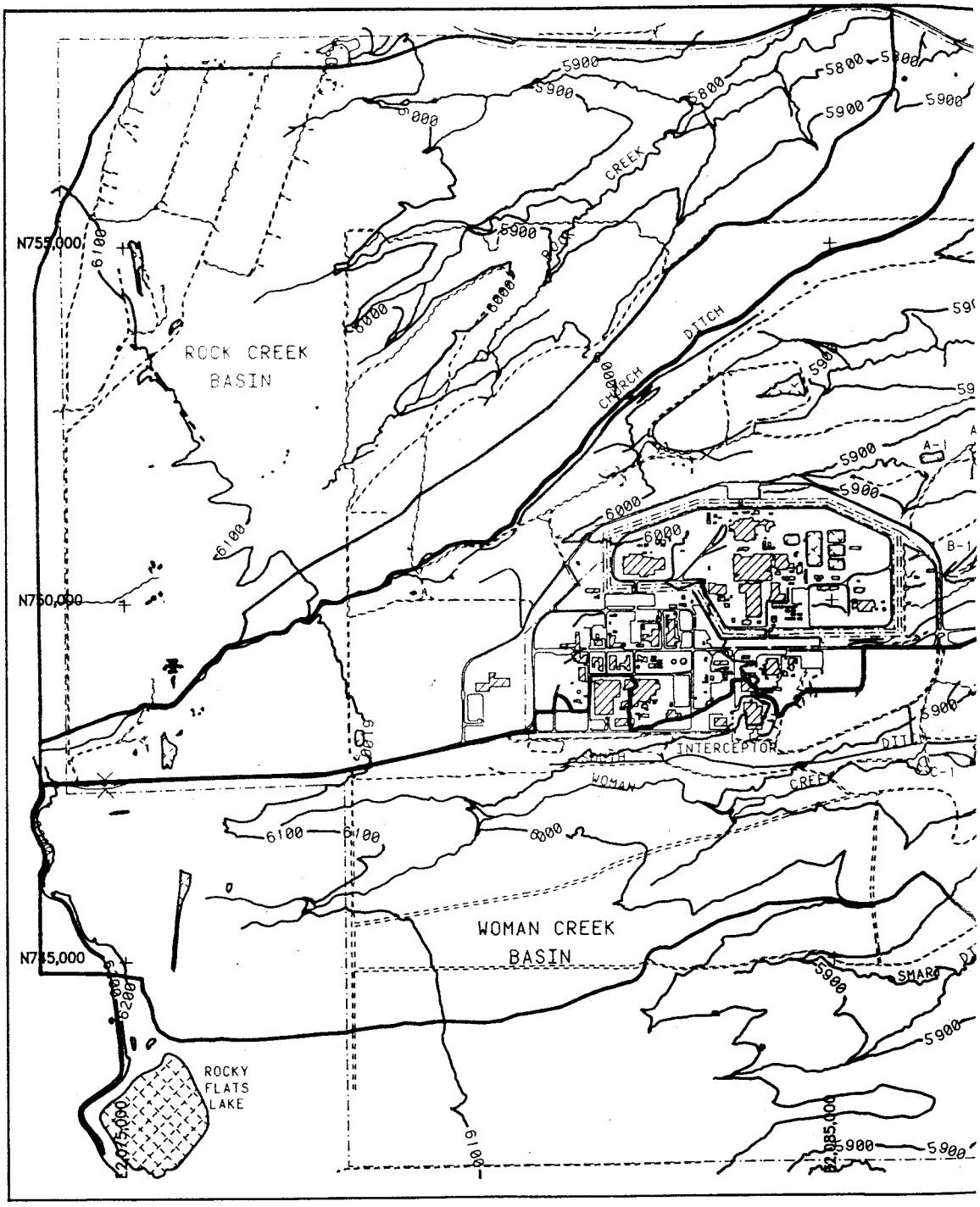
Under a Compliance Agreement between DOE, the U.S. Environmental Protection Agency (EPA), and the State of Colorado Department of Health (CDH), the ER Program has responsibility for complying with CERCLA, RCRA 3004u, and RCRA closure requirements. As an integral component of compliance with these regulations, as well as of the comprehensive goals of the ER Program in general, environmental monitoring is necessary for site characterization and for performing effective RI/FS and RFI/CMS activities to assess potential contamination problems and to evaluate alternative remedial actions where problems do exist. Surface water and sediment characterization is an important part of this overall site investigation effort.

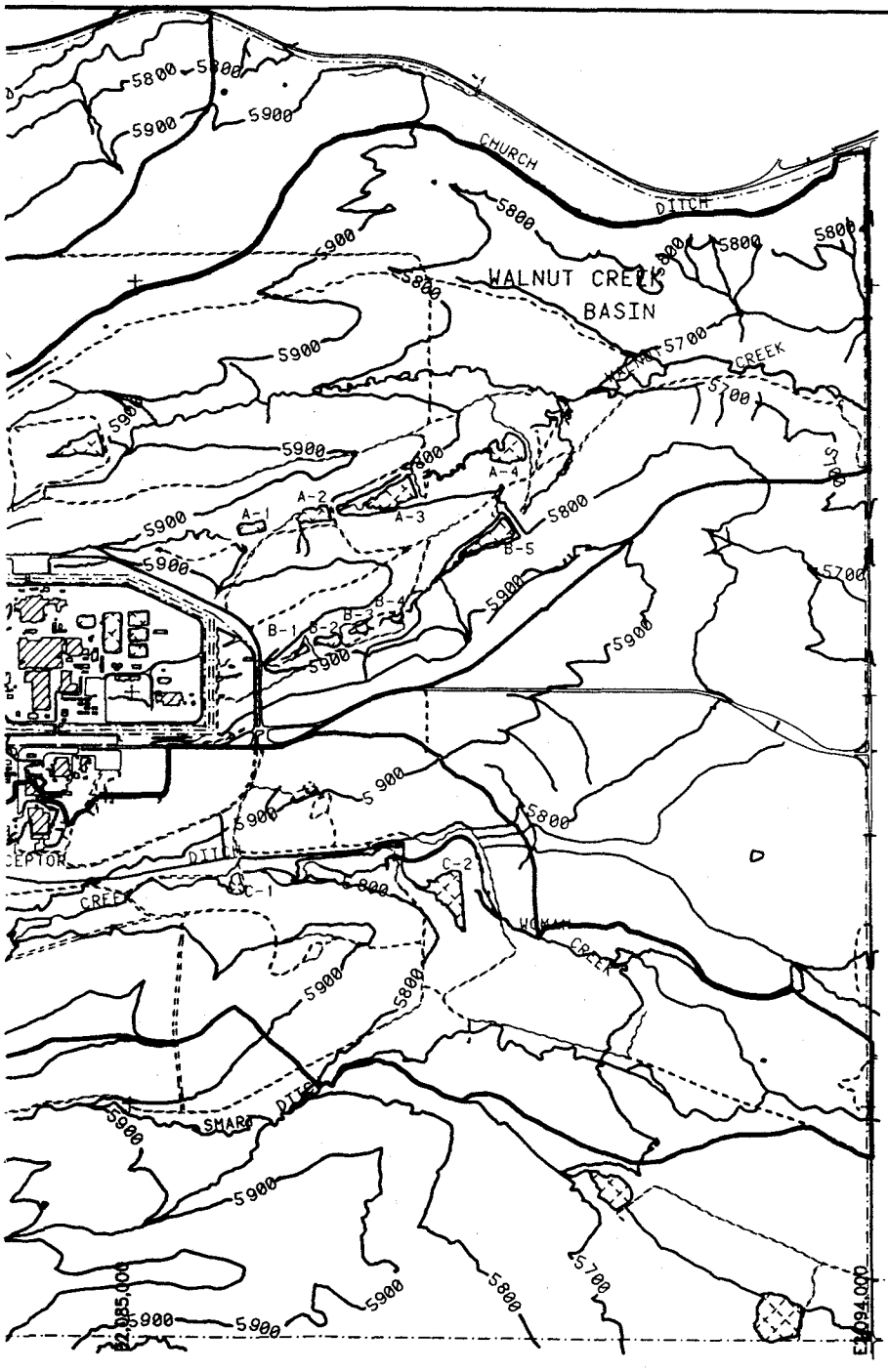
2.2 Surface Water Hydrology

2.2.1 Natural Drainages

Figure 2.2 presents a generalized map of the principal drainage basins and surface water features on the RFP site. Three drainage basins and natural ephemeral streams traverse the RFP, and surface water flow across the site is generally from west to east. A


ROCK CREEK BASIN
WALNUT CREEK BASIN
WOMAN CREEK BASIN
ROCKY FLATS LAKE
CHURCH DITCH
WOMAN CREEK
SMART DITCH
INTERCEPTOR DITCH
N755,000
N750,000
N745,000
E2,075,000
E2,085,000
E2,094,000
A-1
A-2
A-3
A-4
B-1
B-5
C-1
C-2


ROCK CREEK
BASIN
WOMAN CREEK
BASIN
ROCKY
FLATS
LAKE
N755,000
N750,000
N745,000
E2,085,000
INTERCEPTOR
DITCH
SMART
5900
6000
6100
5800



MAP LEGEND

- PAVED ROADS
- DIRT ROADS
- 100 FOOT CONTOUR LINES
- STREAMS, DITCHES, DRAINAGE FEATURES
- DRAINAGE BASIN BOUNDARIES
- SECURITY FENCE
- SURFACE WATER IMPOUNDMENTS
- BUILDINGS

N

0 feet 1800 3600

SCALE: 1 INCH = 1800 FEET

CONTOUR INTERVAL = 100 FEET

PRINCIPAL DRAINAGE BASINS
AND
SURFACE WATER FEATURES
ON
ROCKY FLATS PLANT

FIGURE 2.2

topographic divide bisects the site that trends east-west and lies slightly south of Central Avenue (the approximate centerline of the site). The Rock Creek drainage basin traverses and drains the northwestern portion of the plant site and is located in the buffer zone entirely separate from the operational plant complex. This drainage is therefore generally unimpacted by plant operations and potential contaminant releases to surface water. Rock Creek flows to the northeast to its off-site confluence with Coal Creek. Preliminary surface water modeling of the Rock Creek basin using the Colorado Urban Hydrograph Procedure (CUHP) (Urban Drainage and Flood Control District [UDFCD], 1985) indicates that the 2-year, 2-hour storm would result in a flood peak of approximately 55 cubic feet per second (cfs) at the outlet of the basin. To date, the largest flow observed at the outlet (SW004) from monthly monitoring was less than 1 cfs.

The Woman Creek drainage basin traverses and drains the southern portion of the site. Although this basin is located primarily in the buffer zone, it does extend into the extreme southern boundary of the operational plant complex. An interceptor ditch known as the South Interceptor Ditch (SID) is located between and parallel to Woman Creek and the southern boundary of the operational plant complex. The relatively small quantity of surface runoff that flows from the southern boundary of the plant complex toward Woman Creek is intercepted by this ditch. This intercepted flow eventually rejoins Woman Creek downstream of a retention pond. Surface runoff downstream of the SID is tributary to Woman Creek, which flows to the east and eventually off-site to Standley Lake, a water supply for the City of Westminster and for portions of the cities of Northglenn and Thornton. Woman Creek also delivers some water off-site to Mower Reservoir. Preliminary modeling of the Woman Creek basin using CUHP shows that the 2-year, 2-hour storm would result in a flood peak of approximately 35 cfs at the basin outlet. Another modeling effort using the Soil Conservation Service TR-20 hydrologic model indicates that the 25-year, 2-hour storm results in a flood peak of about 595 cfs at the outlet (RFP, 1987). To date, the largest flow observed at the outlet (SW001) from monthly monitoring was 8 cfs during the month of May.

The Walnut Creek drainage basin traverses the western, northern, and northeastern portion of the RFP site and receives runoff from the majority of the operational plant complex. Three ephemeral streams are actually tributary to Walnut Creek: Dry Creek, North Walnut Creek, and South Walnut Creek (which receives most of the runoff from the operational plant complex). These three forks of Walnut Creek join in the buffer zone (about 0.7 mile west of the eastern perimeter of RFP) and flow to the east and off-site to Great Western Reservoir, a water supply for a portion of the City of Broomfield, approximately one mile east of this confluence. Preliminary modeling of this basin using CUHP indicates that the 2-year, 2-hour storm would result in a flood peak of approximately 50 cfs at the outlet of the basin. Modeling using TR-20 indicates that the 25-year, 2-hour storm results in a flood peak of about 1660 cfs at the outlet. To date, the largest flow observed at the outlet (SW003) from monthly monitoring was 2 cfs during the month of September.

2.2.2 Ditches and Diversions

In addition to natural flows and the South Interceptor Ditch, there are seven ditches or diversion canals in the general vicinity of the RFP. The Church, Mckay, Kinnear, and Reservoir Company Ditches (diversions of Coal Creek) cross the site. Church Ditch delivers water to Upper Church Lake and Great Western Reservoir. Mckay Ditch also supplies water to Great Western Reservoir. Kinnear Ditch and Reservoir Company Ditch divert water from Coal Creek and deliver it to Woman Creek and eventually to Standley Lake. Last Chance Ditch flows south of the RFP and supplies water to Rocky Flats Lake and Twin Lakes. Smart Ditch diverts water from Rocky Flats Lake and transports it off-site to the east. The South Boulder Diversion Canal is located immediately west of the western boundary of RFP, diverts water from South Boulder Creek, and delivers water to Ralston Reservoir, a water supply for the City of Denver.

2.2.3 Retention Ponds and RFP Discharges

A series of dams, retention ponds, diversion structures, and ditches has been constructed at RFP to control the release of plant discharges and surface (stormwater) runoff that may not consistently meet water quality standards developed by EPA and CDH. The ponds located downstream of the plant complex on North Walnut Creek are designated A-1 through A-4. Ponds on South Walnut Creek are designated B-1 through B-5. These A- and B-series ponds receive runoff from the plant complex. Pond B-3 also receives treated effluent from the Sanitary Treatment Plant (STP). Pond C-1 is located on Woman Creek and receives natural flows, and Pond C-2 is located immediately south of Woman Creek (the creek is diverted to the north around the pond) and receives diverted flow from the SID as well as some natural flows from its immediate drainage basin. Another retention pond (Landfill Pond) is located at the upper end of Dry Creek and immediately downstream of the Present Landfill. Following water quality monitoring, water from the Landfill Pond is spray irrigated.

Any discharges from the downstream ponds on Walnut or Woman creeks (A-4, B-5, or C-2) to downstream surface water are regularly monitored according to the requirements of the RFP National Pollutant Discharge Elimination System (NPDES) permit under the Clean Water Act (CWA). This NPDES monitoring and compliance is the responsibility of the RFP Clean Water Act Division. The NPDES permit currently requires monitoring of specific parameters at seven discharge points. Discharges at these points are normally in compliance with the NPDES permit. In addition to the specific NPDES monitoring requirements, all discharges to Walnut and Woman creeks are monitored for plutonium, americium, uranium, and tritium concentrations. The seven permitted discharge points are as follows:

Discharge Point	Location
001	Pond B-3
002	Pond A-3
003	Reverse Osmosis Pilot Plant (not operational)
004	Reverse Osmosis Plant (not operational)
005	Pond A-4
006	Pond B-5
007	Pond C-2

2.2.4 Sediment

In this document, suspended sediment is defined as sediment that is carried in suspension by the turbulent components of water that consists primarily of fine-grained particles such as clays and silts (ASCE, 1975, and USGS, 1977). Bedload is defined as sediment that moves on or near the channel bed by rolling, sliding, and sometimes making brief excursions into the flow a few diameters above the bed, and that consists primarily of silts, sands, and even some gravels. Bed material is defined as the sediment mixture composing the channel bed which may include clays, silts, sands, and gravel. In alluvial streams, bed material particles are likely to be moved at any moment or during some future flow condition.

The ER Program monitors bed material composition and adsorbed constituent chemistry on a quarterly basis at 38 sediment stations throughout the RFP site. In addition, total suspended solids (TSS) are analyzed in water samples on a monthly basis at 107 surface water stations throughout the site. These monitoring efforts are part of the site-wide Surface Water and Sediment Monitoring Program for the ER Program, details of which are provided in the Draft Final Surface Water and Sediment Monitoring Plan (EG&G, 1990d). However, bed material is not in motion when it is sampled, and TSS contains constituents in addition to sediment such as living organisms and other organic components. Also, these data have not been collected specifically during storm or snowmelt runoff or pond discharge events, when the potential for sediment transport may be highest. Consequently, the

magnitude of moving sediment and adsorbed constituent concentrations, loadings, and transport off-site are not well characterized.

The movement of contaminants in stream channels may be accelerated and compounded by adsorption of some chemical species (e.g., metals and radionuclides) to sediment components and subsequent transport of the sediments off-site. Peak sediment transport rates generally occur during the rising stages of flow events and may be proportional to the rate of stream discharge increase during these events (ASCE, 1975, and USGS, 1977). It is hypothesized that contaminant transport resulting from adsorption to and movement of fluvial sediment could potentially account for significant off-site releases. Contaminated sediments can also serve as a reservoir for continuous release of toxic substances into surface water. Therefore, the characterization of sediment-borne contaminant transport will depend on an adequate knowledge of sediment movement as well as the chemical nature of contaminants and sediment.

3.0 CHARACTERIZATION METHODOLOGY

3.1 Data Quality Objectives

Data Quality Objectives (DQOs) are qualitative and quantitative statements of the quality of data needed to support specific decisions or actions. One measure of the success of the Sediment Characterization Study is the extent to which the DQOs are achieved. Establishing useful and attainable DQOs depends on identifying the data users, data uses, types of data needed, sampling and analysis options, and parameters related to precision, accuracy, representativeness, comparability, and completeness of the data.

The data users consist of decision-makers and program management staff and technical personnel. The decision-makers include the DOE Albuquerque Operations Office's Environment, Safety, and Health Division Director and ER Program Manager as well as the DOE Rocky Flats Area Office's Manager and Environment, Safety and Health Branch Chief. The program management staff are the prime contractor personnel responsible for the ER Program. The program management technical personnel are the contractor technical specialists (ER Program and other contractors) responsible for supervising, coordinating, and performing the ER Program activities. Based on an evaluation of the results of the Sediment Characterization Study, additional data users may be identified in the future.

The data uses include the determination of overall surface water and sediment quality and compliance with relevant regulations, the determination of the nature and extent of contamination as part of the Remedial Investigation (RI) process and the RCRA Facility Investigation (RFI) process, the evaluation of the potential risks of identified contaminants to human health and the environment, and the evaluation of remedial alternatives as part of the Feasibility Study (FS) and Corrective Measures Study (CMS) processes.

The data types include the following six classes of surface water/sediment measurement data:

(1) Hydrology
(2) Sedimentology
(3) Organic Chemistry
(4) Metal Chemistry
(5) Ion and Indicator Parameter Chemistry
(6) Radiochemistry

The data collected must conform to the following criteria:

- Data must be of known and documented quality.

- Data must be obtained in accordance with rigorous, documented, QA criteria.

- Data obtained from analyses are characterized by low detection limits and method-specific detection limits. Where available, EPA Contract Laboratory Program (CLP) methods and protocols are used. Methods and associated detection limits are selected such that data may be compared with federal and state Applicable or Relevant and Appropriate Requirements (ARARs) and/or RFP background concentration values.

- Data are reviewed and validated according to validation procedures prescribed by EPA and DOE. Review and validation activities are documented. Data are not used until they have been reviewed and their validity determined. Data validity has three classifications: (1) Valid, (2) Acceptable for Use with Qualification(s), and (3) Rejected (Unacceptable).

Precision and accuracy are generally dependent on the analytical methods used and the results of duplicate, blank, and spike analyses. Generally, only data that meet the validation

criteria of (1) valid or (2) acceptable will achieve the necessary level of precision and accuracy required to reach the study objectives. However, some data from data sets validated as rejected (unacceptable) may be used in rare instances such as storm samples collected under unique occurrences. Such data must be flagged as rejected whenever they are cited.

3.2 Analytical Parameters

Suspended sediment concentration, bedload concentration, grain size distribution, and organic material content will be analyzed by an approved laboratory. The adsorbed chemical parameters for which laboratory analyses will be performed include metals, radionuclides, semi-volatiles, pesticides/PCBs, and some additional ions and indicator parameters. Analysis of semi-volatile organics and pesticides/PCBs will be performed for the compounds on the CLP Target Compound List (Table 3.1). The CLP-required quantitation limits are the current practical minimum detection limits.

Metals analyses will be performed for the compounds on the CLP Target Analyte List (TAL) and are listed in Table 3.2 along with their corresponding required detection limits. In addition, analyses will be performed for the following metals:

- Cesium
- Lithium
- Molybdenum
- Strontium
- Tin

These metals have been added to the TAL because existing surface water or groundwater data indicate possibly anamolous concentrations. Table 3.3 lists these metals with their corresponding required detection limits.

Table 3.1 CLP Target Compound List (TCL) of Semi-Volatile Organics

	Semivolatiles	CAS Number	Quantitation Limits Water ug/L	Low Soil/Sediment ug/Kg
35.	Phenol	108-95-2	10	330
36.	bis(2-Chloroethyl)ether	111-44-4	10	330
37.	2-Chlorophenol	95-57-8	10	330
38.	1,3-Dichlorobenzene	541-73-1	10	330
39.	1,4-Dichlorobenzene	106-46-7	10	330
40.	Benzyl alcohol	100-51-6	10	330
41.	1,2-Dichlorobenzene	95-50-1	10	330
42.	2-Methylphenol	95-48-7	10	330
43.	bis(2-Chloroisopropyl)ether	108-60-1	10	330
44.	4-Methylphenol	106-44-5	10	330
45.	N-Nitroso-di-n-dipropylamine	621-64-7	10	330
46.	Hexachloroethane	67-72-1	10	330
47.	Nitrobenzene	98-95-3	10	330
48.	Isophorone	78-59-1	10	330
49.	2-Nitrophenol	88-75-5	10	330
50.	2,4-Dimethylphenol	105-67-9	10	330
51.	Benzoic acid	65-85-0	50	1600
52.	bis(2-Chloroethoxy)methane	111-91-1	10	330
53.	2,4-Dichlorophenol	120-83-2	10	330
54.	1,2,4-Trichlorobenzene	120-82-1	10	330
55.	Naphthalene	91-20-3	10	330
56.	4-Chloroaniline	106-47-3	10	330
57.	Hexachlorobutadiene	87-68-3	10	330
58.	4-Chloro-3-methylphenol (para-chloro-meta-cresol)	59-50-7	10	330
59.	2-Methylnaphthalene	91-57-6	10	330
60.	Hexachlorocyclopentadiene	77-47-4	10	330
61.	2,4,6-Trichlorophenol	88-06-2	10	330
62.	2,4,5-Trichlorophenol	95-95-4	50	1600
63.	2-Chloronaphthalene	91-58-7	10	330
64.	2-Nitroaniline	88-74-4	50	1600
65.	Dimethylphthalate	131-11-3	10	330
66.	Acenaphthylene	208-96-8	10	330
67.	2,6-Dinitrotoluene	606-20-2	10	330
68.	3-Nitroaniline	99-09-2	50	1600
69.	Acenaphthene	83-32-9	10	330

Table 3.1 CLP Target Compound List (TCL) of Semi-Volatile Organics (continued)

	Semivolatiles	CAS Number	Quantitation Limits Water ug/L	Low Soil/Sediment ug/Kg
70.	2,4-Dinitrophenol	51-28-5	50	1600
71.	4-Nitrophenol	100-02-7	50	1600
72.	Dibenzofuran	132-64-9	10	330
73.	2,4-Dinitrotoluene	121-14-2	10	330
74.	Diethylphthalate	84-66-2	10	330
75.	4-Chlorophenyl-phenyl ether	7005-72-3	10	330
76.	Fluorene	86-73-7	10	330
77.	4-Nitroaniline	100-01-6	50	1600
78.	4,6-Dinitro-2-methylphenol	534-52-1	50	1600
79.	N-nitrosodiphenylamine	86-30-6	10	330
80.	4-Bromophenyl-phenylether	101-55-3	10	330
81.	Hexachlorobenzene	118-74-1	10	330
82.	Pentachlorophenol	87-86-5	50	1600
83.	Phenanthrene	85-01-8	10	330
84.	Anthracene	120-12-7	10	330
85.	Di-n-butylphthalate	84-74-2	10	330
86.	Fluoranthene	206-44-0	10	330
87.	Pyrene	129-00-0	10	330
88.	Butylbenzylphthalate	85-68-7	10	330
89.	3,3'-Dichlorobenzidine	91-94-1	20	660
90.	Benzo(a)anthracene	56-55-3	10	330
91.	Chrysene	218-01-9	10	330
92.	bis(2-Ethylhexyl)phthalate	117-81-7	10	330
93.	Di-n-octylphthalate	117-84-0	10	330
94.	Benzo(b)fluoranthene	205-99-2	10	330
95.	Benzo(k)fluoranthene	207-08-9	10	330
96.	Benzo(a)pyrene	50-32-8	10	330
97.	Indeno(1,2,3-cd)pyrene	193-39-5	10	330
98.	Dibenz(a,h)anthracene	53-70-3	10	330
99.	Benzo(g,h,i)perylene	191-24-2	10	330

Table 3.1 CLP Target Compound List (TCL) of Pesticides/PCBs

Pesticides/PCBs	CAS Number	Quantitation Limits** Water ug/L	Low Soil/Sediment[c] ug/Kg
100. alpha-BHC	319-84-6	0.05	8.0
101. beta-BHC	319-85-7	0.05	8.0
102. delta-BHC	319-86-8	0.05	8.0
103. gamma-BHC (Lindane)	58-89-9	0.05	8.0
104. Heptachlor	76-44-8	0.05	8.0
105. Aldrin	309-00-2	0.05	8.0
106. Heptachlor epoxide	1024-57-3	0.05	8.0
107. Endosulfan I	959-98-8	0.05	8.0
108. Dieldrin	60-57-1	0.10	16.0
109. 4,4'-DDE	72-55-9	0.10	16.0
110. Endrin	72-20-8	0.10	16.0
111. Endosulfan II	33213-65-9	0.10	16.0
112. 4,4'-DDD	72-54-8	0.10	16.0
113. Endosulfan sulfate	1031-07-8	0.10	16.0
114. 4,4'-DDT	50-29-3	0.10	16.0
115. Methoxychlor	72-43-5	0.5	80.0
116. Endrin ketone	53494-70-5	0.10	16.0
117. alpha-Chlordane	5103-71-9	0.5	80.0
118. gamma-Chlordane	5103-74-2	0.5	80.0
119. Toxaphene	8001-35-2	1.0	160.0
120. Aroclor-1016	12674-11-2	0.5	80.0
121. Aroclor-1221	11104-28-2	0.5	80.0
122. Aroclor-1232	11141-16-5	0.5	80.0
123. Aroclor-1242	53469-21-9	0.5	80.0
124. Aroclor-1248	12672-29-6	0.5	80.0
125. Aroclor-1254	11097-69-1	1.0	160.0
126. Aroclor-1260	11096-82-5	1.0	160.0

Note: Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

**Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

[c]Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Pesticide/PCB TCL compounds are 15 times the individual Low Soil/Sediment CRQL.

Table 3.2 CLP Target Analyte List (TAL) of Metals

Element	Nominal Detection Limit Water (ug/L)	Soil (mg/kg)
Aluminum	200	40
Antimony	60	12
Arsenic	10	2
Barium	200	40
Beryllium	5	1.0
Cadmium	5	1.0
Calcium	5000	2000
Chromium	10	2.0
Cobalt	50	10
Copper	25	5.0
Cyanide	10	10
Iron	100	20
Lead	5	1.0
Magnesium	5000	2000
Manganese	15	3.0
Mercury	0.2	0.2
Nickel	40	8.0
Potassium	5000	2000
Selenium	5	1.0
Silver	10	2.0
Sodium	5000	2000
Thallium	10	2.0
Vanadium	50	10.0
Zinc	20	4.0

Table 3.3 Non-CLP Target Analyte List (TAL) of Metals

Analyte	Required Detection Limits Water (mg/L)	Soil (mg/kg)
Cesium	1000	200
Lithium	100	20
Molybdenum	200	40
Strontium	200	40
Tin	200	40

Analyses for some additional ions and indicator parameters will also be performed. Cations for which analyses will be performed and their corresponding detection limits are presented in Table 3.2 and 3.3 with the metals. Anions and indicator parameters are presented in Table 3.4 along with their corresponding detection limits.

Radionuclides for which analyses will be performed are presented in Table 3.5. Also presented in this table are the corresponding minimum detectable activities for each parameter. In addition, some samples will be analyzed for gross alpha and gross beta.

It should be noted that not all of the parameters discussed above will be sampled or analyzed for at every sampling location at the same frequency. In addition to the sediment physical and chemical parameters discussed above, surface water stage and flowrate (rating curves exist for flumes for computation of flowrate) will also be monitored during every collection of a sediment sample at the gaging stations. Flow will be monitored continuously at each of these stations using an automated flowrate indicator/totalizer/recorder.

3.3 Sampling Locations

The major stream channels of interest in this investigation are Woman Creek, Walnut Creek, and Rock Creek. Permanent stream gaging and sampling stations are or will be installed at 13 locations along these streams, including several stations at the downstream RFP boundaries. These gaging stations, along with all of the surface water and sediment monitoring stations included in the site-wide Surface Water and Sediment Monitoring Program, are presented in Plate 3.1 of Appendix A. The sediment sampling stations for this investigation will be located at 11 of these gaging stations as follows:

1. Walnut Creek Station at Indiana Street and the eastern downstream plant boundary on Walnut Creek (SW003 and SED003)
2. Pond A-4 Station immediately downstream of Pond A-4 on North Walnut Creek (SED008)

Table 3.4 Anions and Indicator Parameters

PARAMETER	DETECTION LIMITS Water (mg/l)	Sediment (μg/g)
Anions		
Chloride	5	60
Nitrate as N	5	60
Sulfate	5	60
Sulfide	N/A	4
Indicator Parameters		
pH	0.1 pH units	0.1 pH units

Table 3.5 Radiochemical Parameters

Parameter	Required Detection Limit (MDA) Water (pCi/L)	Soil (pCi/g)
Gross Alpha	2	4 (dry)
Gross Beta	4	10 (dry)
Tritium	400	400 (pCi/ml)
$Pu^{239,240}$	0.01	0.03 (dry)
$U^{233,234}$	0.6	0.3 (dry)
U^{235}	0.6	0.3 (dry)
U^{238}	0.6	0.3 (dry)
$Americium^{241}$	0.01	0.02 (dry)
$Strontium^{89+90}$	1	1 (dry)
$Cesium^{137}$	1	0.1 (dry)
$Radium^{226}$	0.5	0.5 (dry)
$Radium^{228}$	1	0.5 (dry)
$Curium^{244}$	1	0.5 (dry)
$Neptunium^{237}$	1	0.5 (dry)
$Thorium^{230+232}$	1	0.5 (dry)

3. Pond A-3 Station immediately downstream of Pond A-3 on North Walnut Creek

4. Upper A-Series Ponds Station immediately upstream of Pond A-1 on North Walnut Creek (SW092 and SED092)

5. Woman Creek Station at Indiana Street and the eastern downstream plant boundary on Woman Creek (SW001 and SED001)

6. Diversion Canal Station at Indiana Street and the eastern downstream plant boundary on a diversion canal immediately north of SW001 (SW002 and SED002)

7. Rock Creek Station at State Highway 128 and the northern downstream plant boundary on Rock Creek (SW004 and SED022)

8. Upper Woman Creek Station at the western upstream plant boundary on Woman Creek (SW107 and SED016)

9. Tributary Woman Creek Station at the western upstream plant boundary on a tributary to Woman Creek and immediately south of SW107 (SW127 and SED127)

10. Upper B-Series Ponds Station immediately upstream of Pond B-1 on South Walnut Creek (SW023 and SED012)

11. Pond C-1 Station immediately downstream of Pond C-1 on Woman Creek (SW029 and SED027)

The Woman Creek, Diversion Canal, and Walnut Creek stations will be used to sample sediment exiting the RFP site at three points on its eastern downstream boundary. These stations are designed to provide information on the significance and impacts of potential contaminant releases from plant operations to downstream surface water.

The Rock Creek Station will serve as a "control" or background station because it is generally unimpacted by plant activities and no RFP manufacturing operations have occurred in the drainage. No disposal operations have occurred within this basin except for very infrequent destruction of glass vessels containing various inorganic, nonradioactive gases at the site of the Rock Creek Ranch. Rock Creek is considered a reliable source of background data because it has similar characteristics to Walnut and Woman creeks. Specifically, Rock Creek drains similar terrain and flows over similar geologic material. The Upper Woman Creek and Tributary Woman Creek stations will also serve as background stations because they will sample sediment entering the site at its western upstream boundary. Although geologic materials that are somewhat different from those characteristic of the locations of the other permanent monitoring stations may influence the water quality at the Upper Woman Creek and Tributary Woman Creek stations, these upstream locations are unimpacted by plant operations and may be useful for comparison purposes. They will also provide information on the concentrations and loadings of constituents entering the RFP site at its western upstream boundary.

The other stations (Pond A-4, Pond A-3, Upper A-Series Ponds, Upper B-Series Ponds, and Pond C-1) are all located immediately upstream, in between, or downstream of the A-, B-, and C-series ponds. These stations, therefore, are intended to sample sediment entering and exiting (especially during pond discharge events) specific ponds of interest. These data will provide information on potential upgradient contaminant source areas, contaminant loadings to and retention efficiencies of ponds, and loadings to downstream ponds or streams.

3.4 Sampling Frequency

The greatest mobilization and transport of sediment and adsorbed constituents may occur during ephemeral rising and peak flows caused by storm and snowmelt runoff events and, in the case of RFP, pond discharge events. Therefore, sediment sampling efforts for this study will be designed to assess sediment transport during these events. Because of the stochastic nature of meteorological events, regular sampling intervals will not be adequate.

Consequently, "automatic" mechanisms designed to sample sediment as the events occur will be employed (see Section 3.5).

3.4.1 Snowmelt Runoff

Suspended sediment and bedload will be sampled automatically during all flows exceeding a predetermined threshold resulting from snowmelt runoff events. All samples will be temporarily frozen and stored for later analysis. At the end of the sampling season, all samples will be analyzed for sediment concentration, grain size distribution, and organic material content. A subset of these samples will be selected using a protocol that results in an unbiased data set for which complete chemical analyses will be performed.

3.4.2 Storm Runoff

Suspended sediment and bedload will be sampled automatically during all flows exceeding a predetermined threshold resulting from storm runoff events. All samples will be temporarily frozen and stored for later analysis. At the end of the sampling season, sediment concentration and grain size distribution will be analyzed for all samples and complete chemical analyses will be performed for a subset of these samples. This subset will be selected using a protocol that will result in an unbiased data set.

3.4.3 Pond Discharges

Suspended sediment and bedload will be sampled during all flows resulting from pond discharge events, and complete physical and chemical analyses will be performed on all sediment samples from each event.

3.5 Field Sampling Protocol and Equipment

The pertinent protocol in ER Program SOP No. 1.0 for all field operations will be adhered to as follows:

SOP No.	SOP Title
1.3	General Equipment Decontamination
1.6	Handling of Personal Protective Equipment
1.7	Handling of Decontamination Water and Wash Water
1.9	Handling of Residual Samples
1.10	Receiving, Labeling, and Handling Waste Containers
1.11	Field Communications
1.12	Rocky Flats Plant Access and Control
1.13	Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
1.14	Data Base Management
1.15	Use of PIDs and FIDs
1.16	Field Radiological Measurements

Health and safety requirements for field personnel will be consistent with those described in the ER HSPP (EG&G, 1990c). Field operations quality assurance (QA) procedures will be adhered to as documented in the individual SOPs and the QAPP (EG&G, 1990b) for the ER Program.

The Workplan for Automated Surface Water Stations to be generated in November of 1990 will discuss in some detail the field sampling protocol and equipment to be used in this investigation. An SOP will also be developed for suspended sediment and bedload sampling at the gaging stations that will discuss specific details of the sampling procedures and equipment. This SOP is also due in November of 1990. Consequently, the discussion of field protocol and equipment in this plan is limited to general procedures.

U.S. Single-Stage Suspended-Sediment Samplers (U.S. series U-59) will be used for obtaining representative suspended sediment samples for analysis of concentration, grain size distribution, and organic material content. A generalized form of this sampler is illustrated in Figure 3.1. At each sampling station, multiple samplers will be securely fastened to a vertical post (fence post, 4"x4", or equal) at successive heights. The post will be secured (either in the channel bottom or from another post above the channel) near the middle of the channel cross section and positioned so as to minimize interference with other posts (if more than one post is used), streamflow, or flow measurement at the gaging station. The samplers will be positioned at incremental heights on each post so that the channel cross-sectional areas below each sampler intake tube will be equal. This will provide for suspended sediment samples collected successively during the rising stage of the flow event at approximately equal flow intervals. It is anticipated that up to five samplers at five successive stages may be required at each station to meet this criterion. However, the actual number of samplers (stages) and the specific flow intervals sampled will be dependent on the depth and area of each stream channel. The Single-Stage Sampler will be tested and calibrated using a U.S. series depth- or point-integrating suspended sediment sampler. Initial sampling efforts will also include an assessment of the adequacy and variability associated with this sampling technique.

The sample volumes collected with the U.S. Single-Stage Sampler will likely be insufficient to analyze for the entire suite of analytes discussed in Section 3.2. Therefore, an automatic pump sampler will be used in conjunction with the Single-Stage Sampler to collect adequate volumes of water and associated suspended sediment samples to perform adsorbed chemical analyses for the parameters of interest. The pump sampler will be programmed to automatically collect a composite sample over the rising stage of the flow event to be sampled.

Bedload will be sampled at each of the stations using a USGS-approved bedload sampler. This sampler will be securely positioned in the channel bottom to collect one composite sample for each event at each station.

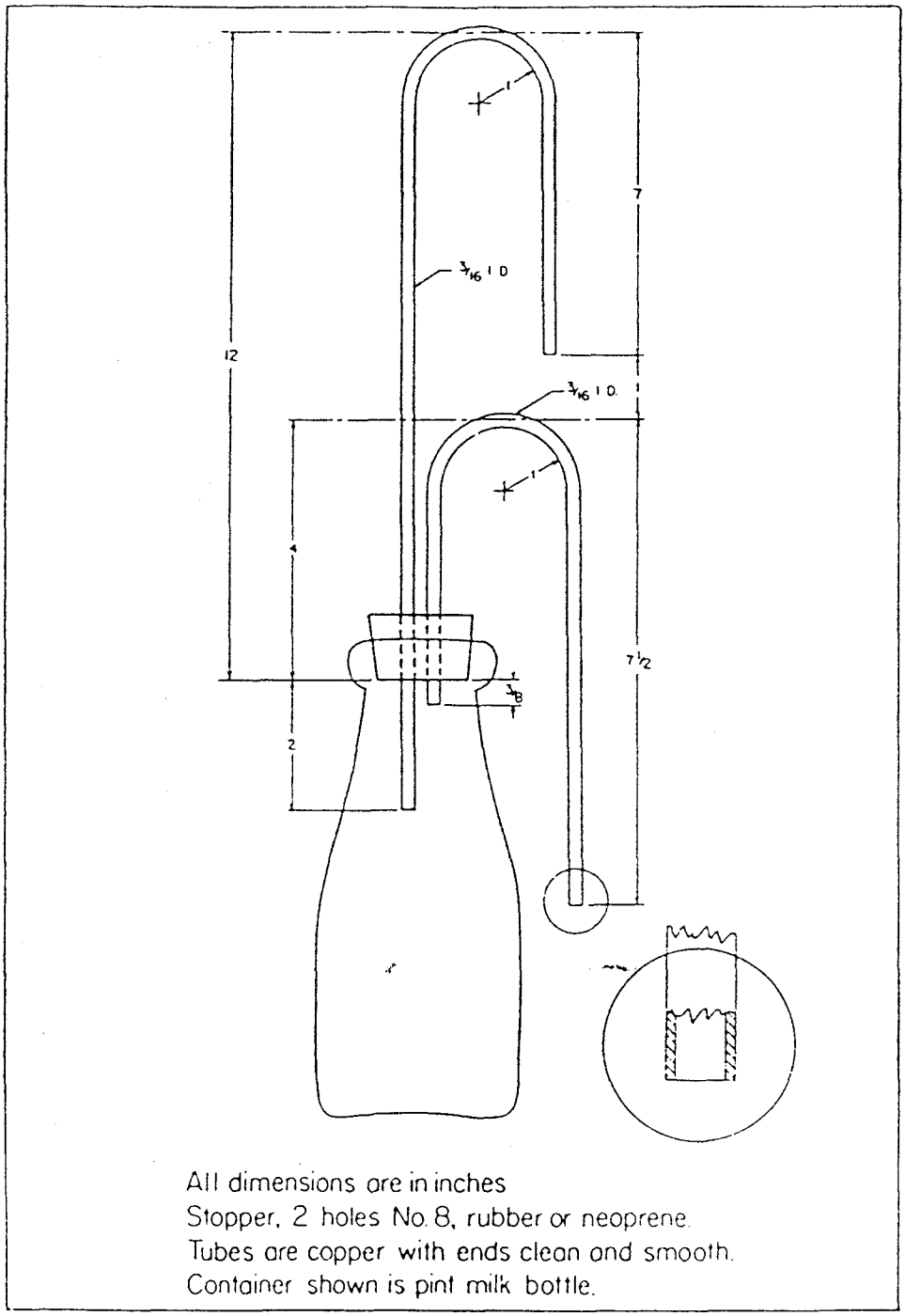


Figure 3.1. Schematic drawing of the U.S. Series U-59 Single-Stage Suspended-Sediment Sampler (U.S. Interagency Report, 1961).

Flow monitoring at each of the gaging and sediment sampling stations will be accomplished using Parshall flumes coupled with automatic water level measurement and recording instrumentation. Flowrate will be measured on a continuous basis as part of the site-wide Surface Water and Sediment Monitoring Program and as described in the Draft Final Surface Water and Sediment Monitoring Plan (EG&G, 1990d). A double-throated Parshall flume is currently in use at the Walnut Creek Station (SW003) to more accurately measure both low and high flows. This station has two steel Parshall flumes in parallel: the first is 6-inches wide at the throat and 42-inches deep to accurately measure low flows, and the second is 36-inches wide and 36-inches deep to accurately monitor higher flows. Each flume has a Drexelbrook Radio-Frequency (RF) level measurement sensor coupled with a flow totalizer housed in an insulated and heated storage building. Engineering drawings and specifications for the gaging station at SW003 are available. An automated composite sampler is also currently used at this station. However, the sensors, totalizers, and sampler do not meet the requirements of this investigation protocol. Consequently, the Walnut Creek Station will be upgraded with a new sensor and continuous flow indicator/totalizer/recorder for each of the flumes as well as telemetry equipment for remote readout and control of flow measurement and automatic sampling equipment at a centralized location.

The Pond A-4 Station has an existing single 24-inch Parshall flume, Pond A-3 Station has an existing 36-inch flume, and the Upper A-Series Ponds Station has an existing 6-inch flume. With the exception of the Upper A-Series Ponds Station flume, each flume has a Drexelbrook RF level measurement sensor coupled with a flow totalizer as well as an automated composite sampler. These sensors, totalizers, and samplers do not meet the requirements of this investigation protocol. Consequently, each of these stations will be upgraded with a new sensor and a continuous flowrate indicator/totalizer/recorder, telemetry equipment for remote readout and centralized control of flow measurement and automatic sampling equipment, and an insulated and heated equipment storage building.

Seven new gaging stations will be equipped with double-throated flumes. The Rock Creek Station (SW004) will consist of one 36-inch Parshall flume (capacity of approximately 50 cfs) and one 6-inch flume. The Woman Creek (SW001), Diversion Canal (SW002), Upper B-Series Ponds (SW023), and Pond C-1 (SW029) stations will probably each have one 24-inch Parshall flume (capacity of about 30 cfs) and one 6-inch flume. The Upper Woman Creek and Tributary Woman Creek stations (SW107 and SW127, respectively) will probably each have one 18-inch Parshall flume (capacity of about 25 cfs) and one 6-inch flume. Each flume will have one flow indicator/totalizer/recorder. The flow instrumentation at each station will be housed in an insulated and heated storage building to ensure continuous flow monitoring during freezing weather. Telemetry equipment will also be installed at each of the stations for remote readout and control at a centralized location. Electricity will be provided to each of the new storage buildings from the nearest existing power lines.

3.6 Laboratory Analysis

The parameters for which analyses will be performed are discussed in Section 3.2 of this plan. The specific analytical methods, analytical detection limits, sample container and volume requirements, preservation techniques, and sample holding times for all parameters are documented in the ER Program QAPP (EG&G, 1990b).

3.7 Data Validation

Analytical data from the laboratory will be reviewed and validated by the ER Program QA staff. The data and laboratory performance will be carefully evaluated to determine whether they achieve the DQOs discussed in Section 3.1 of this plan. EPA data validation guidelines will be used for validating data for organic and inorganic (metals) compounds. Data validation methods and documentation requirements have been developed by the ER Program QA staff for radionuclides and additional ions. These procedures will be followed because EPA has not established any protocol for these compounds. Details of these data validation procedures are documented in the QAPP for the ER Program. The results of

data review and validation procedures will be documented in data validation reports, as discussed in the QAPP.

3.8 Data Management

After data are validated, they will be incorporated into a centralized environmental data base for the RFP ER Program. The computerized data base is the core of the data management system and provides an organized, systematic, and consistent framework within which all technical data pertaining to this investigation can be stored, accessed, manipulated, and tracked. The specific objectives of the data management system are to provide a structured, accurate, and verifiable method to accomplish the following:

- Track all samples from field collection, through laboratory analysis, to final disposition
- Record all field data generated during sample collection
- Record all results of laboratory analyses performed on samples and overall laboratory performance
- Allow all recorded data to be accessed and manipulated for data analysis and/or report preparation
- Comply with the Technical Data Management Plan (Rockwell, 1989b) for the ER Program

The Environmental Monitoring and Assessment Division (EMAD) of the ER Program has instituted a new relational environmental data base system to handle all geologic, geochemical, hydrologic, hydrogeologic, and air quality data collected at the site. This system is driven by the ORACLE commercial data base software package, which has been

customized to the specific needs of ER Program users. All past, present, and future sediment data will be incorporated into this data base. The system initially resides on a dedicated IBM PC but will have data access to the unclassified VAX mainframe system at the RFP. The system is maintained and updated on a continuous basis and allows for upload/download of data for other internal applications required by ER Program users.

3.9 Quantitative and Statistical Analysis

3.9.1 Suspended Sediment

Regression analysis will be used to assess the correlation between suspended sediment concentration and water discharge for each flow event sampled at every station. Suspended sediment loads will be estimated by assuming that sediment concentration is uniform for a given channel cross section and multiplying sediment concentration and discharge. Regression analysis will then be used to assess the correlation between sediment load and discharge. The flow-weighted mean sediment load for each event will also be estimated.

3.9.2 Bedload

Regression analysis will be used to assess the correlation between bedload concentration and discharge for multiple flow events at each station. Bedload mass flux will be computed by estimating the fraction of the total flow contributing to bedload movement and by multiplying this flow and sediment concentration.

3.9.3 Adsorbed Constituents

Regression analysis will be used to assess the correlation between adsorbed contaminant concentrations and grain size distribution and organic material content. Adsorbed constituent loadings will be estimated by multiplying chemical concentrations and sediment

loadings for a given event at each station. The flow-weighted mean constituent load for each event will also be estimated.

3.9.4 Additional Analyses

Multivariate analysis incorporating discharge, discharge rate of increase, season, and other environmental parameters such as antecedent moisture conditions, vegetation cover, basin area, and soil types may be used to estimate conditions under which the greatest sediment loads and associated contaminant loads can be expected.

The correlation between sediment concentrations and loads with flows will be used to generate predictive models for estimating sediment loads during future events. In addition, the correlation between adsorbed constituent concentrations and loads with sediment loads will be used to generate predictive models for estimating adsorbed contaminant loads during future events.

If the results of this characterization study indicate that the transport of contaminants adsorbed to sediment may be a significant problem at the downstream boundaries of the RFP, periodic and/or permanent (continuous) monitoring of sediment may be warranted in the future as part of the ER Program's comprehensive site-wide Surface Water and Sediment Monitoring Program. Potential remedial technologies and engineering alternatives to address the adsorbed constituent transport problems will also be evaluated, if deemed appropriate.

3.10 Information Reporting

The data and/or information collected from the investigation will be incorporated into the RI/FS and RFI/CMS processes for the RFP as well as for individual OUs within the site. A Sediment Characterization Report will be generated for internal ER Program review that incorporates the following:

- A summary of all significant findings
- All field and laboratory analytical results, laboratory performance data, and data validation information in appendices
- All streamflow data in appendices
- Results of statistical and quantitative analyses
- Interpretation of data and results of analyses
- Characterization of potential adsorbed contaminant transport problems and recommendations for future investigation, monitoring, or remediation

4.0 BUDGET

A summary of the estimated costs for implementation of the Sediment Characterization Study is presented in Table 4.1. All costs are to the nearest one hundred dollars.

Table 4.1 Estimated Costs for Implementation of the Sediment Characterization Study

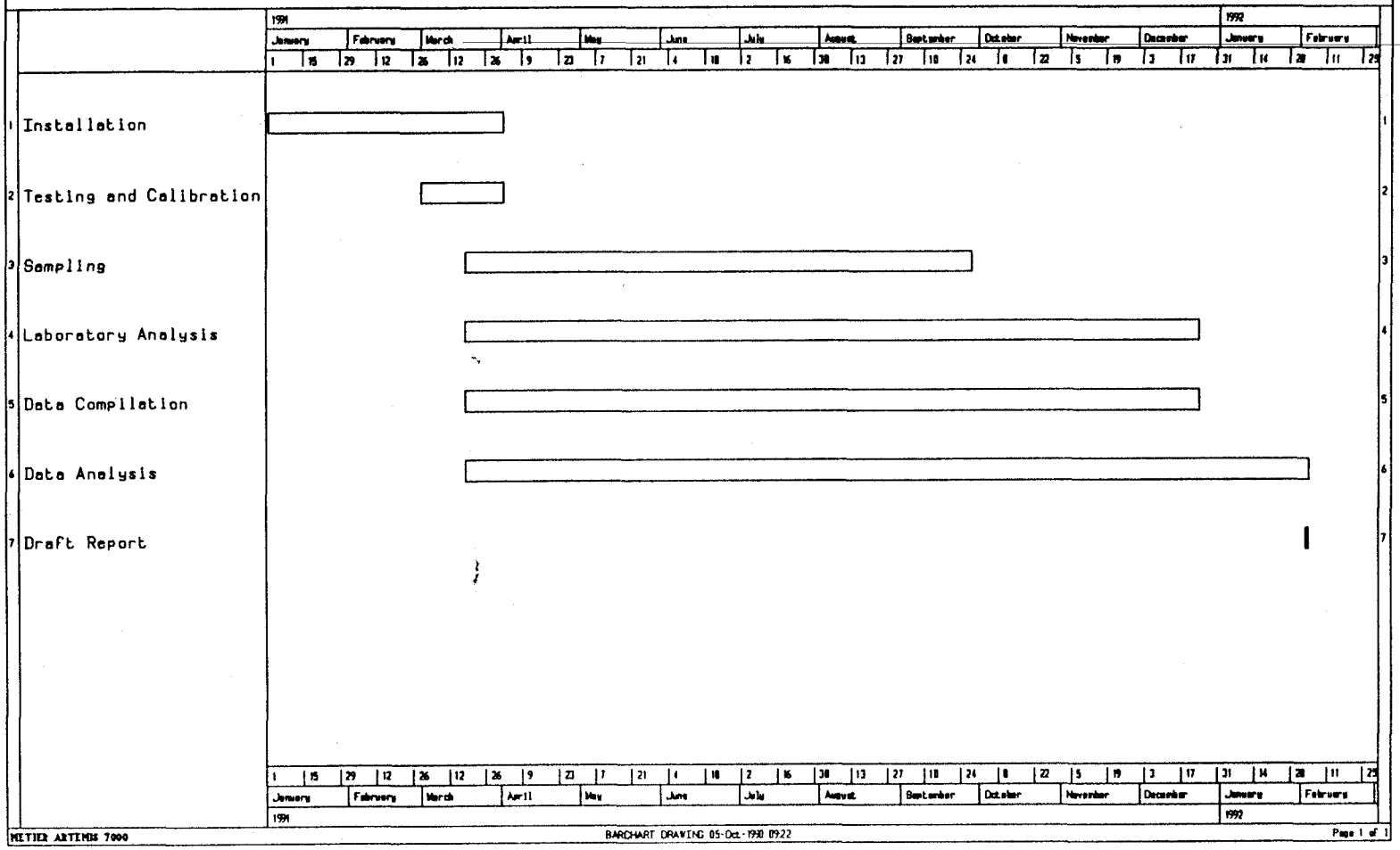
ITEM	UNIT COST	QUANTITY	TOTAL COST*
DIRECT LABOR:	(hour)		
Mobilization	$50	400	$20,000
QAPP/SOP/HSPP Preparation	$55	250	$13,800
Workplan Preparation	$60	175	$10,500
Field Activity Coordination	$55	200	$11,000
Sediment Sampling	$50	2200	$110,000
Health and Safety	$55	100	$5,500
Report Preparation	$60	1000	$60,000
Project Management	$75	260	$19,500
SUBTOTAL:			$250,300
EQIPMENT, MATERIALS AND OTHER DIRECT COSTS:			
Mobilization			$10,000
Suspended Sediment Samplers			$8,500
Bed Material Samplers			$11,000
Shipping			$15,000
Report Preparation			$4,000
Project Management			$500
SUBTOTAL:			$49,000
ANALYTICAL:	(sample)		
Sediment (total chemical)	$4,300	130	$559,000
Sediment (metals, alpha/beta rad)	$750	750	$562,500
Sediment (physical)	$15	2200	$33,000
SUBTOTAL:			$1,154,500
CONTINGENCY: (25%)			$288,625
TOTAL:			$1,742,425

*Rounded to nearest $100

5.0 SCHEDULE

A schematic diagram of the proposed schedule for implementation of the Sediment Characterization Study is presented in Figure 5.1. This schedule includes a time frame for equipment procurement, construction and installation, testing and calibration, sampling, laboratory analysis, data analysis, and report preparation.

FIGURE 5.1 : SCHEDULE FOR IMPLEMENTATION OF THE SEDIMENT CHARACTERIZATION STUDY.



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