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**TREATABILITY STUDY WORK PLAN
FOR THE COLLOID POLISHING FILTER METHOD**

ROCKY FLATS PLANT

**U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado**

ADMIN RECORD

in conjunction with

**U.S. ENVIRONMENTAL PROTECTION AGENCY
Risk Reduction Engineering Laboratory
Cincinnati, Ohio**

ENVIRONMENTAL RESTORATION PROGRAM

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Prepared by

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ABBREVIATION TABLE

| | |
|---------|---|
| AAR | Applications analysis report |
| ARAR | Applicable or relevant and appropriate requirements |
| ASTM | American Society of Testing Materials |
| °C | degrees Centigrade |
| CCV | Continuing calibration verification |
| CDH | Colorado Department of Health |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| CLP | Contract laboratory program |
| CP | Colloid polishing |
| CPFM | Colloid Polishing Filter Method |
| cpm | counts per minute |
| CRE | Contaminant removal efficiency |
| CWQCC | Colorado Water Quality Control Commission |
| DEC | Decontamination procedures |
| DOE | Department of Energy |
| DOT | Department of Transportation |
| EA | Environmental Assessment |
| EIS | Environmental Impact Statement |
| EPA | Environmental Protection Agency |
| °F | degrees Fahrenheit |
| FF 1000 | Filter Flow 1000 |
| FFT | Filter Flow Technologies |
| GC/MS | Gas chromatography and mass spectroscopy |
| gpd | gallons per day |
| gpm | gallons per minute |
| HPLC | High performance liquid chromatography |
| IAG | Interagency Agreement |
| ICP | Inductively Coupled Plasma (shortened form of ICPES) |
| ICPES | Inductively Coupled Plasma Emission Spectroscopy |
| ICV | Initial calibration verification |
| IDL | Instrument detection limit |
| IM/IRA | Interim measure/interim remedial action |
| ITPH | Interceptor trench pump house |
| ITS | Interceptor trench system |
| kg | kilograms |
| LCS | Laboratory control sample |
| MCE | Mean contaminant concentration in the effluent |
| MCI | Mean contaminant concentration in the influent |
| MCL | Maximum contaminant level |
| MDL | Method detection limit |
| mg/L | milligrams per liter |
| MOU | Memorandum of Understanding |
| mR/hr | milliRoentgens per hour |
| MS/MSD | Matrix spike/matrix spike duplicate |
| MSDS | Material safety data sheet |
| NBS | National Bureau of Standards |
| NEPA | National Environmental Policy Act |
| NIOSH | National Institute of Occupational Safety and Health |
| NIST | National Institute of Science and Technology |
| NORM | Naturally occurring radioactive materials |

ABBREVIATION TABLE
(Continued)

| | |
|----------|---|
| NPDES | National Pollutant Discharge Elimination System |
| NPL | National Priorities List |
| NRC | Nuclear Regulatory Commission |
| OFC | Office interview |
| ONS | On-site |
| ORD | Office of Research and Development |
| OSHA | Occupational Safety and Health Administration |
| OSR | Off-site reconnaissance |
| OSWER | Office of Solid Waste and Emergency Response |
| OU | Operable unit |
| pCi/g | picoCuries per gram |
| pCi/L | picoCuries per liter |
| PE | Performance evaluation |
| ppb | parts per billion |
| ppm | parts per million |
| PQL | Practical quantitation limit |
| PRC | PRC Environmental Management, Inc. |
| psi | pounds per square inch |
| psig | pounds per square inch gauge |
| QA/QC | Quality assurance/quality control |
| QAPjP | Quality assurance project plan |
| QCC | Quality Control Coordinator |
| RCRA | Resource Conservation and Recovery Act |
| RFO | Rocky Flats Office |
| RFP | Rocky Flats Plant |
| RPD | Relative percent difference |
| RREL | Risk Reduction Engineering Laboratory |
| RSD | Relative standard deviation |
| SARA | Superfund Amendments and Reauthorization Act |
| SEP | Solar evaporation pond |
| SITE | Superfund Innovative Technology Evaluation |
| SOP | Standard operating procedure |
| SRM | Standard reference material |
| TCLP | Toxicity Characteristics Leaching Procedure |
| TDS | Total dissolved solids |
| TER | Technology evaluation report |
| TLD | Thermoluminescent dosimeter |
| TLV | Threshold limit value |
| TOC | Total organic carbon |
| TS | Treatability study |
| TSS | Total suspended solids |
| UCL | Upper confidence limit |
| umhos/cm | micromhos per centimeter |
| USCG | United States Coast Guard |
| VOC | Volatile organic compound |

EXECUTIVE SUMMARY

This treatability study work plan describes the steps necessary to demonstrate the effectiveness of the Colloid Polishing Filter Method (CPFM) technology in removing radionuclides and metals from ground water at Rocky Flats Plant (RFP). The objective of this treatability study is to evaluate the efficiency of the CPFM system in removing radionuclides and metals from the ground water stream stored in the operable unit 4 (OU4) interim measure/interim remedial action (IM/IRA) storage tanks. This stream flows from the interceptor trench pump house (ITPH) sump which collects underground seepage around the solar evaporation ponds.

This treatability study coincides with the U.S. Environmental Protection Agency (EPA) Risk Reduction Engineering Laboratory (RREL) Superfund Innovative Technology Evaluation (SITE) program demonstration. The technology and its developer, Filter Flow Technology, Inc., (FFT) are currently participating in the SITE program. Through this program, EPA RREL and the developer provide funds and resources to conduct a demonstration, or field treatability study, of the technology. Department of Energy (DOE) and EG&G personnel have agreed to assist with this demonstration. EPA Region 8 and the Colorado Department of Health (CDH) have also been involved and support the project. EPA RREL's contractor, PRC Environmental Management, Inc. (PRC), is responsible for completing all reports and deliverables and arranging the demonstration.

The technology has undergone several bench-scale and field treatability studies prior to this field demonstration. The bench-scale studies were conducted at RFP, Building 881, Laboratory 123. These studies show very favorable results with respect to uranium, gross alpha, plutonium, and americium removal efficiencies. The demonstration will provide the opportunity to test the technology on a larger scale.

Results of the demonstration will be fully documented in a series of reports. EPA RREL will publish two reports, the technology evaluation report and applications analysis report, within 1-year of completion of the demonstration. EG&G will produce a treatability study report also based on the results of the demonstration.

1.0 INTRODUCTION

The final Interagency Agreement (IAG) between the U.S. Environmental Protection Agency (EPA), Colorado Department of Health (CDH), and U.S. Department of Energy (DOE) required DOE to develop a treatability studies plan (TSP) to evaluate candidate remedial technologies for the general types of contamination encountered at the Rocky Flat Plant (RFP). The TSP presented treatment technologies applicable to remediation efforts at two or more operable units (OUs) (DOE, 1991a). The treatability studies are designed to provide information to the individual OU feasibility studies/corrective measure studies (FS/CMS).

In conjunction with EPA Risk Reduction Engineering Laboratory (RREL), DOE has sponsored the Colloid Polishing Filter Method (CPFM) as one of the technologies to be tested under the TSP. This technology was selected for removal of metals and radionuclides in ground water. This work plan describes the project objectives, technology, process description, sampling and analysis procedures, quality assurance/quality control (QA/QC) procedures, and health and safety related issues.

1.1 OBJECTIVES

This demonstration will evaluate the effectiveness of the CPFM system as a potential treatment alternative in reducing the volume, toxicity, or mobility of hazardous substances, pollutants, and contaminants from RFP ground water. Specific testing objectives appear in Section 2.4.

2.0 PROJECT DESCRIPTION

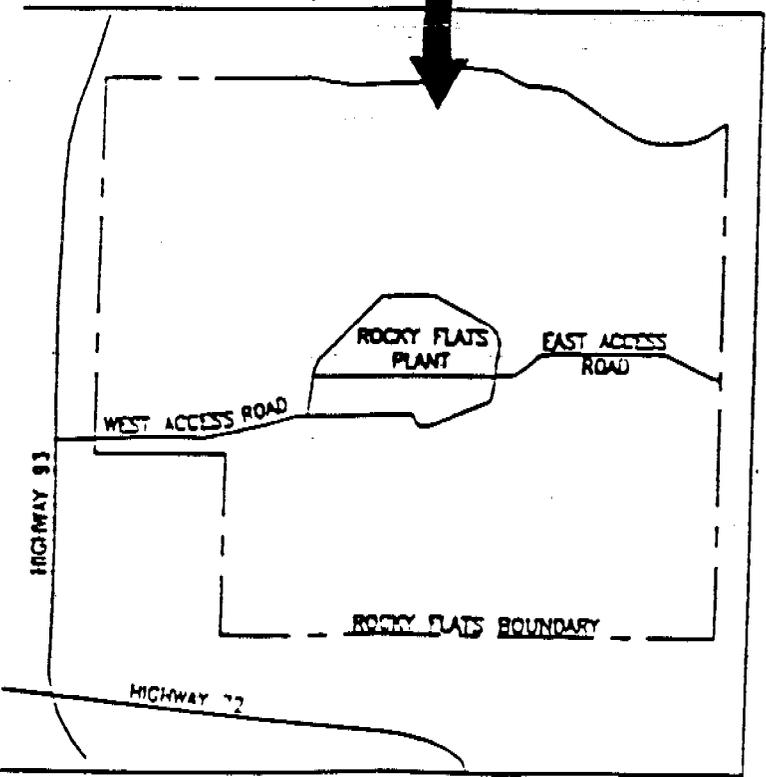
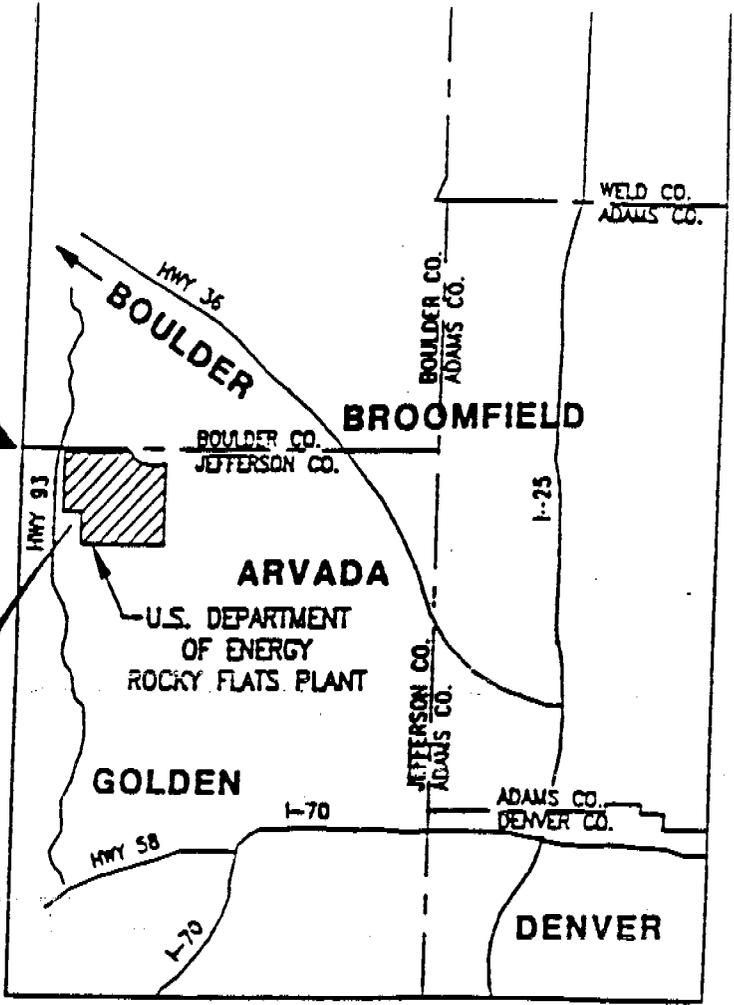
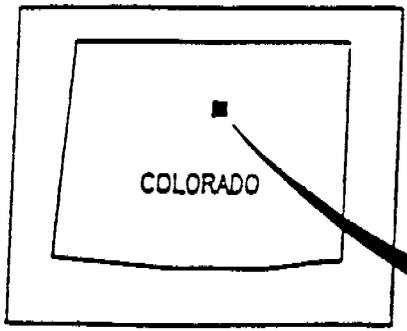
EPA annually solicits proposals from technology developers to demonstrate innovative technologies through the SITE program. Filter Flow Technology, Inc. (FFT) of League City, Texas submitted a proposal under this program for its CPFM technology. This technology was one of several selected for demonstration. Through a cooperative effort between EPA RREL, [a division of the Office of Research and Development (ORD)], DOE Rocky Flats Office (RFO), CDH, and EPA Region 8, the CPFM technology will be demonstrated under the Superfund Innovative Technology Evaluation (SITE) program at RFP. The following sections describe the CPFM technology and RFP.

2.1 BACKGROUND INFORMATION

RFP is a key facility in the federal government's nationwide nuclear weapons research, development, and production complex. It supports the nuclear weapons program and other work related to national defense with unique processing capabilities for fabricating weapons components from plutonium, uranium, beryllium, and stainless steel. The plant also plays a key role in the decommissioning and maintenance of nuclear weapons and would be instrumental in the implementation of any future arms reduction agreement (DOE, 1991a).

Construction of the RFP began in 1951, and initial operations occurred the following year. The plant was operated at that time by Dow Chemical U.S.A., a unit of the Dow Chemical Company, for the U.S. Atomic Energy Commission. When the Energy Reorganization Act of 1974 dissolved the U.S. Atomic Energy Commission, federal government responsibility for the plant was assigned to the Energy Research and Development Administration.

On July 1, 1975, Rockwell International assumed operation of the plant for the Energy Research and Development Administration. Two years later, the Energy Research and Development Administration was changed to the U.S. Department of Energy, the federal agency currently responsible for the plant. EG&G Rocky Flats, Inc. (EG&G) took over the operating contract from Rockwell International on January 1, 1990.



SITE CPFM DEMONSTRATION
 ROCKY FLATS PLANT - GOLDEN, COLORADO

FIGURE 2-1

SITE LOCATION MAP

FRC ENVIRONMENTAL MANAGEMENT, INC.

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SCALE: NOT TO SCALE

Placement of process waste material into the SEPs ceased in 1986 due to changes in RFP waste treatment operations. Ongoing activities at the SEPs include evaporation of the liquids currently held in the ponds, removal and solidification of pond sludge, and site monitoring and characterization activities. Ponds 207-A, B, and C continue to store intercepted seepage water collected by the interceptor trench system (ITS). Between October 1971 and April 1974, interceptor trenches 1 through 5-B were installed to prevent natural seepage and pond leakage from entering North Walnut Creek. This system has been replaced by the current ITS, which was installed in April 1981 (DOE, 1991b). This ITS routes area ground water and seepage to the ITPH.

The water collected in the ITPH is pumped to the RCRA OU4 interim measure/interim remedial action (IM/IRA) storage tanks. Three 500,000-gallon tanks were constructed on the hillside northwest of the ITPH sump. These tanks are designed for temporary storage of the ground water collected in the ITPH sump. One tank is always full, a second tank is half full, and the third tank is an emergency storage tank. Water is pumped from these storage tanks to the evaporation treatment system in RFP Building 910. This activity is permitted by CDH under RCRA.

2.1.1 Location

RFP is located in northern Jefferson County, Colorado, approximately 16 miles northwest of downtown Denver (Figure 2-1). The 400-acre plant site is located within a restricted area of approximately 6,550 acres, which serves as a buffer zone between the plant and surrounding communities. The immediate area around RFP is primarily agricultural or undeveloped land. Population centers within 12 miles of the facility include the cities of Boulder, Broomfield, Golden, and Arvada.

2.1.2 Climatology and Meteorology

The area surrounding RFP has a semiarid climate characteristic of much of the central Rocky Mountain region. Approximately 40 percent of the 15-inch annual precipitation falls during the spring season, much of it as wet snow. Thunderstorms (June to August) account for an additional 30 percent of the annual precipitation. Autumn and winter are drier seasons, accounting for 19 and 11 percent of the annual precipitation, respectively. Snowfall averages 85 inches per year,

RFP materials were defined as hazardous substances, pollutants, and contaminants by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and as hazardous waste and hazardous constituents by the Resource Conservation and Recovery Act (RCRA). These materials have been used, produced, managed, and disposed at the plant since operations began in 1952. Some of these materials have been detected in air, water, or soil at and near the site.

Throughout the plant's history, plant operations have incorporated safety controls to protect workers, the public, and the environment. Nevertheless, some incidents occurred that resulted in on-site and off-site radioactive or hazardous material contamination. Also, like many industries, the plant historically used accepted methods of disposal, such as shallow-land burial of materials, that would not meet today's standards. These areas are currently being remediated or are scheduled for remediation (DOE, 1991a).

Some of the ground water beneath the RFP site has become contaminated with radionuclides and heavy metals. Area contamination and ground-water characteristics are discussed further in Section 2.3. Due to the nature of ground-water contamination and its compatibility with the CPFM treatment technology, EPA RREL and DOE agreed that RFP would provide a good site for this technology demonstration. A memorandum of understanding (MOU), dated December 7, 1989, between DOE and EPA concerning cooperative research and development efforts for the remediation of hazardous waste, facilitates this mutually beneficial project.

The CPFM technology demonstration will treat ground water collected in the interceptor trench pump house (ITPH) from the french drain constructed around the solar evaporation ponds (SEP). The SEPs, located in the central portion of RFP, are currently configured as a series of five evaporation ponds. These ponds were initially placed into service from August 1956 to June 1960. They are identified as OU4. These ponds stored and treated liquid process wastes having less than 100,000 picoCuries per liter (pCi/L) of total long-lived alpha activity (DOE, 1980). These process wastes also contained high concentrations of nitrates as well as treated acidic wastes containing aluminum hydroxide. The ponds are also known to have received other wastes, including sanitary sewer sludge, lithium chloride, lithium metal, sodium nitrate, ferric chloride, sulfuric acid, ammonium persulfates, hydrochloric acid, nitric acid, hexavalent chromium, tritium, and cyanide solutions (Rockwell International, 1988). The SEPs have not received waste since 1986.

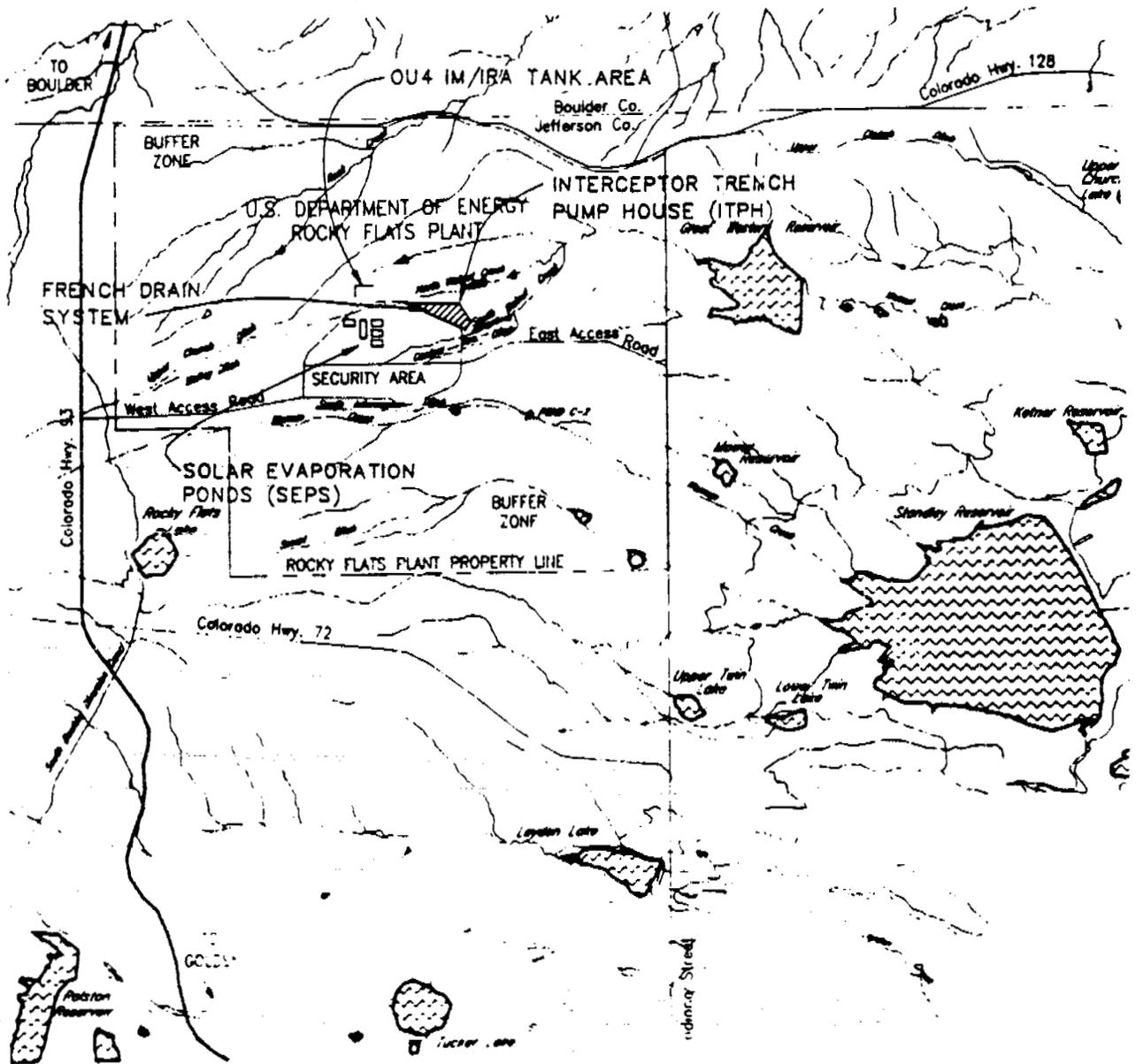
falling from October through May.

Winds, although variable, are predominantly from the west-northwest, with stronger winds occurring during the winter. The area occasionally experiences Chinook winds with gusts over 100 miles per hour. Temperatures at Rocky Flats are moderate. On the average, daily summer maximum temperatures range from 55 to 85 degrees Fahrenheit (°F) and winter minimum temperatures range from 10 to 25°F. Extremely warm or cold weather is usually of short duration (DOE, 1980).

2.1.3 Geology and Hydrogeology

The RFP is located directly upstream from Great Western Reservoir and Standley Lake, two reservoirs used for municipal water supplies. Walnut Creek and Woman Creek are the two intermittent creeks that naturally drain the area from the plant site into Great Western Reservoir and Standley Lake, respectively (Figure 2-2). Walnut Creek drainage currently is diverted around Great Western Reservoir and discharged back into the creek east of the reservoir. Additionally, Woman Creek drainage currently is intercepted by a dam on the plant site and directed by pipeline into Walnut Creek upstream of the diversion around Great Western Reservoir. To the north of the SEPs, a french drain system prevents water seepage from the SEPs from entering Walnut Creek. The intercepted seepage water is collected and returned for storage in the SEPs.

Ground-water flow occurs in the Rocky Flats alluvium, which underlies a large portion of the plant at depths to 100 feet. The alluvium is a broad deposit consisting of a topsoil layer underlain by varying amounts of silt, clay, sand, and gravel. General water movement is from west to east toward the drainages and is generated from precipitation, snowmelt, and water losses from ditches, streams, and ponds. The regional aquifer, known as the Laramie-Fox Hills aquifer, lies 700 feet below the upper contact Laramie claystone formation with the Rocky Flats alluvium. The Laramie-Fox Hills aquifer ranges from 200 to 300 feet in thickness. Due to the low hydraulic conductivity of the claystone, the U.S. Geologic Survey (Hurr, 1976) concluded that RFP operations would not have an impact on any units below the claystone unit of the Laramie formation.



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MODIFIED FROM U.S. DEPARTMENT OF ENERGY
PHASE 1 RFI/RI WORK PLAN, MARCH 1991

SITE CPFM DEMONSTRATION
ROCKY FLATS PLANT - GOLDEN, COLORADO

FIGURE 2-2

SURFACE WATER DRAINAGE

FRC ENVIRONMENTAL MANAGEMENT, INC.

SCALE: NOT TO SCALE

2.2 TREATMENT GOALS/ARARs

On January 22, 1991, RFP, DOE, EPA Region 8, and CDH entered into an IAG for environmental restoration activities. Officially titled a federal facility agreement and compliance order, the IAG clarifies responsibilities and authorities of these agencies, spells out procedures to be followed, and sets timelines for completion of various activities for cleanup of past contamination (Monitor, 1991). The CPFM technology demonstration qualifies as a treatability study under the IAG.

The SEPs are listed as OU4 in the IAG. The SEPs were scheduled for RCRA closure operations beginning in 1992. Although wastes have not been disposed in the ponds since 1986, the wastes are currently regulated under RCRA not CERCLA. Since the SEPs are not a Superfund site, they are not subject to federal jurisdiction under CERCLA. Thus, applicable permits and agency approvals for the field demonstration will be required. These include requirements under the IAG, National Environmental Policy Act (NEPA), and internal RFP guidelines. These requirements are summarized below. In addition to the regulations and guidelines, applicable or relevant and appropriate requirements (ARARs) have been identified for the demonstration at RFP and are summarized in Table 2-1.

IAG

Before treatability studies can commence on the RFP site, DOE must submit a work plan for each activity to EPA Region 8 and CDH for review. The information contained in an IAG work plan is very similar to that in a SITE demonstration plan. A work plan based on information in this demonstration plan will be submitted to EPA Region 8 and CDH to fulfill the IAG requirements.

TABLE 2-1

CPFM TECHNOLOGY DEMONSTRATION
LIST OF FEDERAL AND STATE ARARS AT ROCKY FLATS PLANT

| <u>Process Activity</u> | <u>ARAR</u> | <u>Description</u> | <u>Basis</u> | <u>Response</u> |
|--------------------------------------|--|---|---|---|
| Waste processing | RCRA 40 CFR §264.190 to §264.200 or State equivalent | Standards that apply to the storage or treatment of hazardous wastes in tanks | The treatment process occurs in a series of tanks | Tank integrity will be monitored and maintained to prevent leakage or failure; the tank will be decontaminated when processing is complete. |
| Waste characterization | RCRA 40 CFR §261.24 or State equivalent | Standards that apply to waste characteristics | Need to determine if treated material is RCRA hazardous waste or mixed waste | Testing will be performed prior to disposal. |
| Storage after processing | RCRA 40 CFR §264.190 to §264.199 or State equivalent | Standards that apply to the storage of hazardous wastes in tanks | The treated waste will be placed in the IM/IRA tank | The tanks will be maintained in good condition. The tanks will be operated in accordance with on-site requirements. (The applicable Part B permit). |
| On-site disposal | RCRA 40 CFR §264.300 to §264.317 or State equivalent | Standards that apply to the landfilling of hazardous waste | If left on-site, the treated waste may still be a hazardous waste or mixed waste subject to land disposal requirements | Contact EPA Region 8 for on-site hazardous waste disposal; also, disposal will be in accordance with DOE RFO requirements. |
| | RCRA Subtitle D or State equivalent | Standards that apply to the disposal of solid waste | The treated waste may no longer be a hazardous waste, but only a solid waste | Contact EPA Region 8 for solid waste disposal; also, disposal will be in accordance with DOE RFO requirements. |
| Transportation for off-site disposal | RCRA 40 CFR §262 | Manifest requirements and packaging and labeling requirements prior to transporting | The used health and safety gear must be manifested and managed as a hazardous or mixed waste | Obtain an identification number from EPA. |
| | 40 CFR §263 | Transportation standards | The used health and safety gear must be transported as a hazardous waste (if radioactively contaminated, must remain on-site) | Use a transporter that is licensed by EPA to transport the hazardous waste off-site for disposal. |

NEPA

NEPA requires that federal facilities document potential environmental impacts from all major federal actions at the site. These activities can be environmental restoration or industrial- and manufacturing-related activities. Depending on the project, a full-scale environmental impact statement (EIS), a smaller environmental assessment (EA) report, or a categorical exclusion (CX) justification is required. EG&G NEPA personnel have decided that a CX will be sufficient for this demonstration. PRC, EG&G, and DOE will collaborate on the CPFM NEPA CX; however, DOE will take the lead. This document will be submitted to federal NEPA officials in Washington, DC for review and approval prior to initiating field activities.

Internal RFP Guidelines

All field test activities must comply with standards and guidelines in place at RFP. These include: health and safety protocols; security precautions; the test condition matrix; design, construction, and operation of the CPFM process equipment; sampling and analysis procedures; decontamination protocols; and waste disposal requirements. EG&G and DOE engineering facilities branches have been consulted throughout development of the test plan. Their final approval will be necessary before demonstration activities can begin.

The treated effluent and filter cake must be tested prior to disposal. The effluent will be routed back to the IM/IRA tanks. The filter cake remaining after the demonstration is complete will be tested for hazardous waste and radiation characteristics and appropriately disposed of at an EPA- and DOE-approved facility.

2.3 DESCRIPTION OF CONTAMINANTS

Approximately four times a year, EG&G collects and analyzes samples of ground water at different RFP sites. The samples used to characterize the ITPH contamination were collected from surface water sampling stations 94 and 95. These sampling stations are located inside the ITPH sump on the side wall and bottom of the ITPH. Since the IM/IRA tanks have not yet been completed, analysis of the water sampled directly from the tanks is not available.

Analytical data for samples previously collected from surface water sampling stations 94 and 95 were provided in EG&G data sheets. Radionuclides included high concentrations of uranium-233, 234, 235, and 238, and tritium; moderate concentrations of radium-226 and 228; and lower concentrations of plutonium-239, americium-241, strontium-90, and cesium-137. A list of previously detected radionuclides in surface water sampling stations 94 and 95 appears in Table 2-2. The uranium concentration was generally high throughout the year, while the other radionuclide concentrations were highest in the spring. Also present in the surface water samples were metals. Table 2-3 lists the metals found at stations 94 and 95. The higher concentration metals consisted of antimony, lithium, thallium, tin, and zinc. Organic compounds were also present in the surface water samples. Table 2-4 lists the organic compounds found in the water. It is important to note the low concentrations of organic compounds in these samples because high organic concentrations can potentially interfere with the CPFM treatment technology. Tables 2-2, 2-3, and 2-4 also list the various treatment standards which apply to each compound. The Colorado Water Quality Control Commission's (CWQCC) treatment standards for radionuclides govern the effluent treatment levels for this demonstration.

2.4 TREATABILITY STUDY OVERVIEW

EPA, PRC, DOE, EG&G, and FFT met in EPA's Cincinnati, Ohio office on January 29, 1991 to identify the objectives for the CPFM technology demonstration. Information concerning the process operating parameters and RFP ground-water characterization enabled a determination of preliminary project objectives. Through further discussion and supplemental technical information on the process, the objectives were negotiated, agreed upon, and finalized. The treatability and bench-scale studies refined the testing objectives. For this demonstration, two types of project objectives were identified: primary and secondary. Primary objectives are considered critical for the technology evaluation. The secondary objectives would provide additional information that is useful but not critical. The primary objectives for this project are:

-
- To assess the technology's ability to remove radionuclides listed in Section 4.0.
 - To develop capital and operating costs for this technology that can be readily used in the Superfund decision-making process

TABLE 2-2
CPFM TECHNOLOGY DEMONSTRATION
RADIONUCLIDES DETECTED IN ITPH SAMPLES
AND CORRESPONDING TREATMENT STANDARDS

| Radionuclide | Rocky Flats Plant SW-94 and 95 Maximum Concentration* (pCi/L) | Colorado Water Quality Control Commission (CWQCC) ^b (pCi/L) | Federal Drinking Water Standard (pCi/L) | EPA 10 CFR 20 Appendix B ^c (pCi/L) | Derived Concentration Guideline ^d (pCi/L) |
|-----------------------|---|--|---|---|--|
| Uranium-233, 234, 238 | 206.8 | 5 | 10 | 30,000 | 500 |
| Uranium-235 | 4.2 | 5 | --- | 30,000 | --- |
| Plutonium-239 | 10 | 0.05 | --- | 5,000 | 30 |
| Americium-241 | 2.2 | 0.05 | --- | 4,000 | 30 |
| Radium-226 | 4.4 | 5 | 5 | 30 | --- |
| Radium-228 | 5.3 | 5 | 5 | 30 | --- |
| Strontium-90 | 0.49 | 8 | 300 | --- | --- |
| Cesium-137 | 0.50 | 80 | 200 | 20,000 | --- |
| Tritium | 3,430 | 500 | 20,000 | 3,000,000 | 2,000,000 |
| Gross Alpha | 340 | 7 | 15 | --- | --- |
| Gross Beta and Gamma | 250 | 5 | 50 | --- | --- |

Notes:

- * Data collected from 1986 to 1990
 - ^b Standards adopted through the Rocky Flats Interagency Agreement - the effluent treatment standard (except for tritium) governing the demonstration
 - ^c Allowable concentrations in water above natural background as applicable to the Nuclear Regulatory Commission (NRC) in Title 10 Code of Federal Regulations (CFR) Part 20
 - ^d Based on DOE dose limit of 0.1 rem/year
- pCi/L = picoCuries per liter; "----" = no standard exists

**CPFM TECHNOLOGY DEMONSTRATION
METALS DETECTED IN ITPH SAMPLES
-AND CORRESPONDING TREATMENT STANDARDS**

| Metal | Rocky Flats Plant SW-94 and 95 Range of Concentration ^a (ppm) | Colorado Water Quality Control Commission (CWQCC) ^b (ppm) | EPA MCL ^c (ppm) |
|------------|---|---|----------------------------------|
| Aluminum | 0.107 - 0.500 | 5.0 | 5.0 |
| Arsenic | 0.01 | 0.05 | 0.05 |
| Antimony | 0.04 - 0.15 | --- | 0.06 |
| Barium | 0.2 | 1.0 | 1.0 |
| Beryllium | 0.005 | 0.1 | 0.1 |
| Cadmium | 0.002 - 0.006 | 0.01 | 0.01 |
| Chromium | 0.01 - 0.0303 | 0.05 | 0.05 |
| Cobalt | 0.05 | --- | 0.05 |
| Copper | 0.005 - 0.0308 | 0.2 | 1.0 |
| Cesium | 0.1 - 2.5 | --- | --- |
| Calcium | 396.0 | --- | --- |
| Iron | 0.1 - 0.230 | 0.3 | 1.0 |
| Lead | 0.005 | 0.05 | 0.05 |
| Lithium | 0.3 - 85.2 | 2.5 | .25 |
| Magnesium | 50 - 100 | --- | --- |
| Manganese | 0.015 - 0.03 | 0.05 | 0.05 |
| Mercury | 0.0002 | 0.002 | 0.002 |
| Molybdenum | 0.100 | 0.1 | 0.1 |
| Nickel | 0.04 - 0.308 | 0.2 | 0.32 |
| Potassium | 50 - 128 | --- | --- |
| Silver | 0.01 | 0.05 | 0.05 |
| Selenium | 0.0184 | 0.01 | 0.01 |
| Sodium | 821 | --- | --- |
| Strontium | 3.5 | --- | 0.382 |
| Thallium | 0.1 | --- | 0.01 |
| Tin | 0.155 | --- | 0.1 |
| Vanadium | 0.017 | 0.1 | 0.024 |
| Zinc | 0.373 | 2.0 | 0.05 |

Notes:

- ^a Data collected from 1986 to 1990
- ^b Standards adopted through the Rocky Flats Interagency Agreement - the effluent treatment standard governing the demonstration
- ^c RCRA Subpart F maximum contaminant levels (MCL) (40 CFR 264.94)

ppm = parts per million; "----" = no standard exists

TABLE 2-4

CPFM TECHNOLOGY DEMONSTRATION
 ORGANICS COMPOUNDS DETECTED IN ITPH SAMPLES
 AND CORRESPONDING TREATMENT STANDARDS

| Organic Compounds | Rocky Flats Plant SW-94 and 95 Maximum Concentration ^a (ppb) | RCRA Concentration Limits ^b (ppb) | EPA Water Quality Criteria ^c (ppb) | CDH ^d Drinking Water (ppb) |
|------------------------------|---|---|--|--|
| Acetone | 80 | 50,000 | --- | --- |
| Methylene chloride | 10 | 5,000 | --- | --- |
| Bis (2-ethylhexyl) phthalate | 24 | --- | --- | --- |
| Pentachlorophenol | 50 | --- | 1,010 | --- |
| Carbon tetrachloride | 11 | --- | 0.4 | 5,000 |
| 1,1-Dichloroethane | 5 ^e | 5,000 | --- | --- |
| 1,2-Dichloroethylene | 5 ^e | --- | 0.1 | --- |
| 1,1,2-Trichloroethane | 5 ^e | 600 | 5 | 5,000 |
| Vinyl chloride | 10 ^e | 1 | 2 | --- |

Notes:

^a Data collected from 1986 to 1990

^b RCRA Subpart F (40 CFR 264.94)

^c These adjusted criteria, for drinking water ingestion only, were derived from published EPA Water Quality Criteria (Federal Register 45:79318-79379, November 28, 1980) for combined fish and drinking water ingestion and for fish ingestion alone. The adjusted values are not official EPA Water Quality Criteria but may be appropriate for Superfund sites with contaminated ground water

^d Colorado Department of Health (CDH)

^e ~~Method detection limit (MDL)~~

ppb = parts per billion; "----" = no standard exists

- To determine the system's ability to produce an effluent that meets ARARs; for this project, the CWQCC standards

The secondary objectives for this project are to:

- Evaluate the disposal options and costs for the effluent and filter cake generated from this process
- Document the operating conditions and identify operational needs, such as utility and labor requirements, for the treatment system

3.0 REMEDIAL TECHNOLOGY DESCRIPTION

DRAFT

This section provides a general overview of the CPFM technology.

3.1 CPFM THEORY

The CPFM technology is designed to remove low to moderate levels of nontritium radionuclides (less than 1,000 parts per million [ppm]) and heavy metal pollutants from wastewater, ground water, or pond water using either batch mode or continuous processing. The inorganic pollutants are concentrated into an insoluble, inorganic filter cake containing about 60 percent solids. The developer claims that the system is best operated as a polishing filter unit to meet strict heavy metal and radionuclide maximum contaminant level (MCL) limits for effluent water. The following text provides information concerning the CPFM theory. A detailed process description can be found in Section 3.2.

The CPFM technology can be used with or without chemical pretreatment in combination with a colloid filter unit equipped with specially designed filter plates to facilitate the removal of radionuclides and heavy metals from moderately contaminated water. Removal of the contaminants is achieved through chemical complexing, adsorption, absorption, and physical filtration for pollutants ranging from colloidal (less than 10 microns) to the molecular and ionic range forms. Heavy metal and nontritium radionuclide pollutants in ground water predominantly exist as colloids, colloidal aggregates in association with inorganic ions, or inorganic and organic particles. By optimizing the water pH and chemistry to favor radionuclide and heavy metal insolubility, the pollutant colloids and colloidal aggregates can be formed, then effectively and economically removed by the CPFM system.

The CPFM technology apparently will not remove tritium because of tritium's chemical characteristics. First, tritium's oxidation state is not comparable to other radionuclides. Second, its molecular size is smaller than the reaction mechanisms the CPFM technology can handle. Tritium's oxidation state is +1 (the same as hydrogen), compared to those of uranium, plutonium, and americium which are +3 to +6. Although future testing of this technology may prove differently, preliminary results and theoretical investigations do not indicate potential tritium removal. Also, the

bench-scale study I-results confirm no tritium removal. Therefore, tritium analysis of the treated and untreated water will not be conducted in this demonstration.

The filter bed material, Filter Flow 1000 (FF 1000), is an insoluble, inorganic oxide-based, granular material. The parent compound of FF 1000 is essentially an inorganic, calcium oxide-based sorption and complexing agent. The material safety data sheet (MSDS) for FF 1000 appears in Appendix B. For this demonstration, the filter bed material is contained in a filter pack constructed of a durable, and fibrous polymer material. The filter packs are placed horizontally between filter plates in the colloid filter unit. The contaminated water is first processed to remove bulk solids and if necessary the pH is adjusted to 8. Additional chemical treatment may be necessary depending upon the existing water chemistry of the contaminated stream. The chemically adjusted ground water is then pumped to the colloid filter unit. The fluid is distributed by a filter plate and then flows through the filter pack containing the FF 1000. The contaminants react with the FF 1000, agglomerate, and remain in the filter pack while treated effluent is discharged. Further description concerning the filter pack can be found in Section 3.2. The reaction mechanisms within the filter pack claimed by the developer are described as follows:

Chemical Complexing: Heavy metal and nontritium radionuclide pollutants in water form charge-dependent, stable complexes with certain inorganic agents. The soluble metal ion or radionuclide species associate with an inorganic, oppositely charged entity (FF 1000) to form insoluble colloids, colloidal aggregates, or larger precipitating particles. An estimated 20 percent of the reaction mechanism is attributable to chemical complexing.

Adsorption: Radionuclides readily adsorb to soil particles and bind strongly to minerals to form colloids. The adsorbed colloids and ions electrostatically attach to the surface of the filter bed material. The heavy metals and radionuclides then react with the filter bed material to form insoluble, trapped particles. An estimated 75 percent of the reaction mechanism is attributable to adsorption.

Absorption: It is estimated that less than 1 percent of the reaction mechanism is attributable to absorption.

Physical Filtration: The FF 1000 filter medium forms a compact but porous bed that potentially filters out micro-molecular particles. An estimated 5 percent of the reaction mechanism is attributable to physical filtration.

The strategy employed in this technology is to first remove the bulk solids, then manipulate the water chemistry to shift the equilibrium toward formation of colloids and colloidal aggregates. For example, the pH adjustment with sodium hydroxide creates negatively charged particles which enable reactions with oxides in the filter media. Chemical manipulation (for example, with sodium sulfide or sodium bisulfite) enhances the formation of colloids for some compounds which may not otherwise form colloids.

FFT claims that the CPFM technology offers the following advantages over other small size particle removal methods such as ion exchange, reverse osmosis, and ultrafiltration:

- Reduced chemical costs of aggregate formation using inexpensive and insoluble inorganic sorption and complexing chemicals versus ion exchange resins which may be expensive
- Reduced amount of solids generated due to the small volume, and potentially regenerable, filter bed
- Reduced capital equipment, operational, and maintenance costs by use of simplified equipment treatment train
- Higher throughput capacity per unit cost
- Improved reliability due to few operating variables (reduction of process variables increases process reliability)
- Regeneration equipment for filter bed material is optional
- Improved removal efficiencies for multivalent, chelated, or complexed metals and radionuclides

Although this demonstration is limited to RFP ground water, the developer claims that this treatment technology may be applicable to soils and sludges as a secondary or tertiary water treatment process. Potential applications include remediation of contaminated liquid wastes from industrial operations, oil-drilling production water contaminated with naturally occurring radioactive materials

(NORM), uranium mine ground water, and transuranic and low level radioactive wastes from nuclear-related facilities with contaminated water.

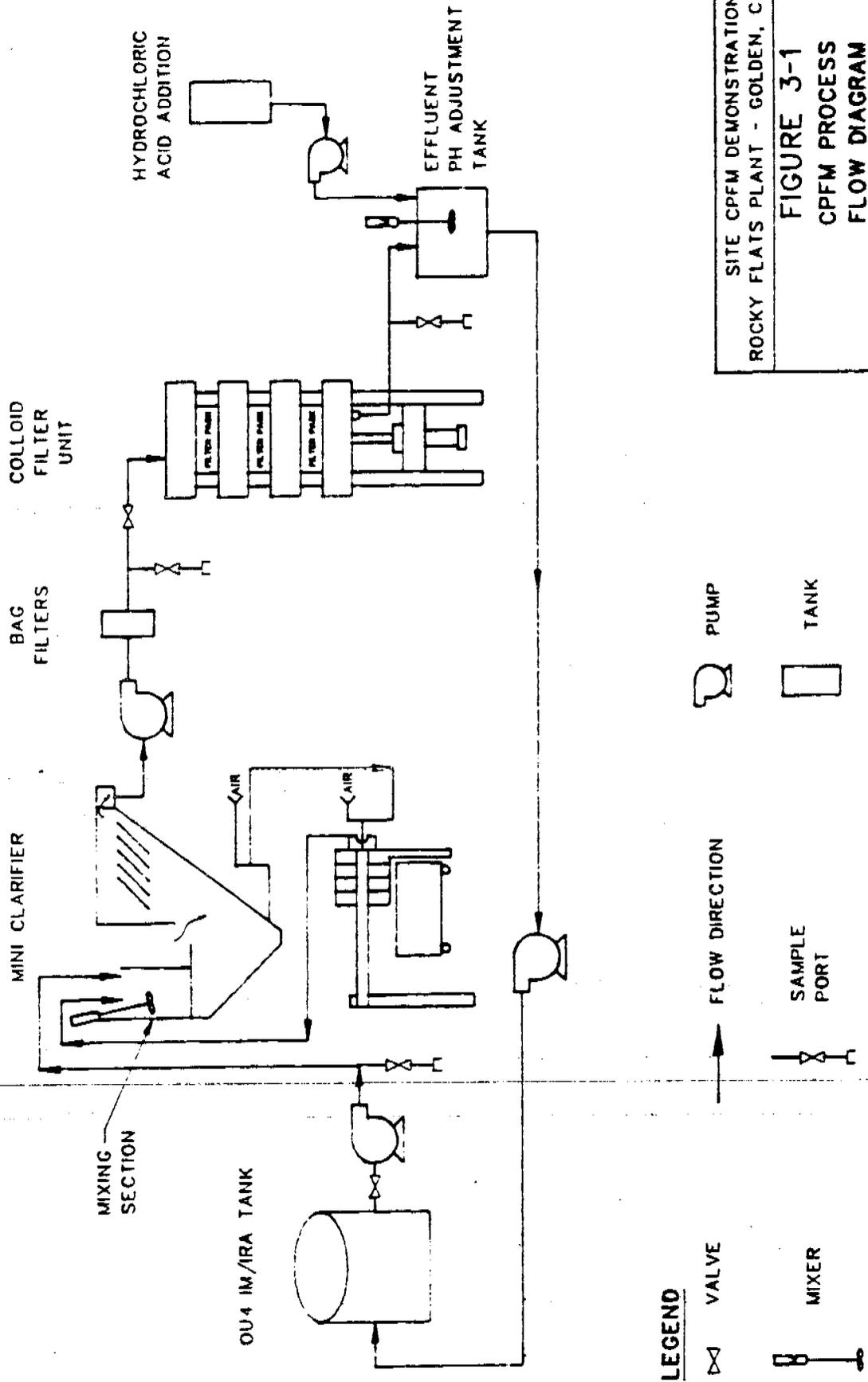
3.2 CPFM PROCESS DESCRIPTION

FFT claims that the underlying principle of the CPFM technology is to form pollutant colloids and colloidal aggregates, then effectively and economically remove them from water by bulk removal of solids followed by sorption in a colloid polishing filter (CP filter). Several CP filters, either in parallel or in series, are installed in a colloid filter unit. CP filters used in series provide filtration redundancy to achieve high decontamination factor (DF) values for contaminant removal. This process description will focus on the system designed for the SITE demonstration. Although other configurations may be employed, the remainder of the discussion will be limited to equipment set-up for the RFP demonstration. The CPFM process flow is described below and the process flow diagram appears in Figure 3-1.

Contaminated ground water is first pumped from the eastern IM/IRA storage tank to a mini clarifier for bulk solids removal. The settled solids stream from the bottom of the clarifier is routed to a small filter press where the solids are removed from the liquid stream. The effluent from the filter press is routed back to the clarifier. The separated solids are removed from the filter press plates, collected in a bin, and placed for final storage in the solids disposal container. This container holds all the process solids generated during the demonstration.

If the raw influent pH is less than 8, a 40 percent sodium hydroxide solution will be added in the clarifier's mixing section to bring the pH closer to 8. This solution will be added as needed to keep the pH around 8. It is not anticipated that pH adjustment will be needed during the demonstration as bench-scale studies indicate the raw influent pH will be between 7.6 and 8.1. However, equipment and solution will be available if pH adjustment is required. A pH probe will be placed in the clarifier to confirm an effluent stream pH close to 8.

The clarifier effluent is then pumped through a series of two in-line bag filters. These bag filters are designed to remove any remaining solids greater than 10 microns in diameter. The solids collected in the bag filters will be removed and placed for final storage in the solids disposal container.



LEGEND

∞ VALVE

⊥ MIXER

→ FLOW DIRECTION

⊥ SAMPLE PORT

⊥ PUMP

□ TANK

SITE CPFM DEMONSTRATION
ROCKY FLATS PLANT - GOLDEN, COLORADO

FIGURE 3-1
CPFM PROCESS
FLOW DIAGRAM

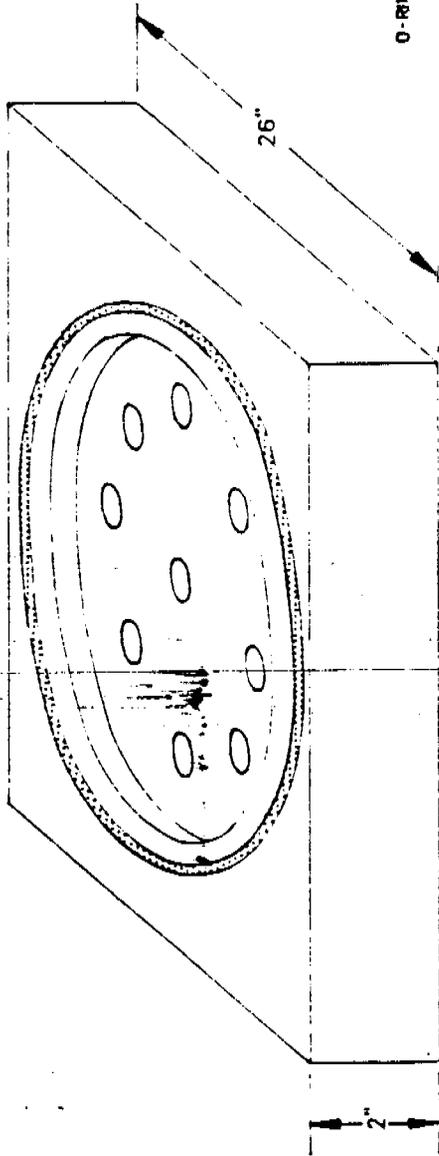
EMC ENVIRONMENTAL MANAGEMENT, INC.

The prefiltered stream is then routed to the colloid filter unit. A colloid filter unit consists of filter plates with a filter pack placed horizontally between them. The number of plates and packs can vary depending upon the application and remediation needs. Unit configurations for the SITE demonstration are further discussed in Section 5.3. Once the filter plates and packs are installed on the unit, approximately 50,000 pounds per square inch gauge (psig) of hydraulic pressure is applied. This promotes a tight seal around each plate and enables the system to dewater the filter packs. Schematics of a typical filter plate and filter pack appear in Figure 3-2. A schematic of the modified filter press appears in Figure 3-3.

Prefiltered influent is evenly dispersed with baffles and distribution ports in the filter plates through each filter pack. The contaminants are then removed by the filter bed material through chemical and physical mechanisms discussed in Section 3.1. The filter cake generated during the process is contained within the filter pack for ease of handling and disposal. The effluent from the colloid filter unit flows to a pH adjustment tank where it will be treated with hydrochloric acid to lower the pH to the same as the influent ground water's pH. The pH-adjusted effluent is then routed back to the original IM/IRA storage tank.

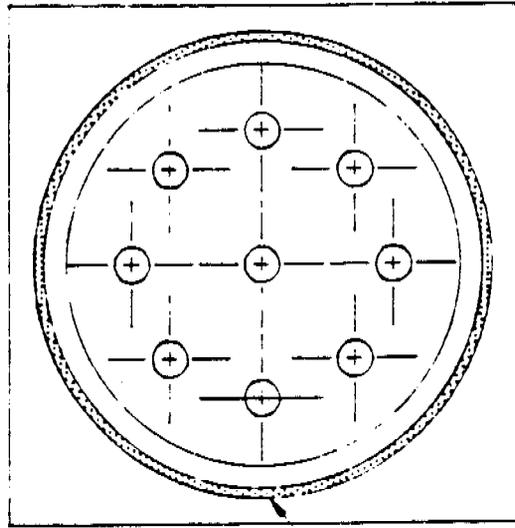
After treatment, the pressure on the system is released and the filter packs are removed from between the plates. Based on the bench-scale and treatability studies results, the filter cake will need to be stabilized in order to meet the toxicity characteristic leaching procedure (TCLP) limits for metals. For this reason, the generated filter cake will be removed from the filter packs and mixed with a stabilizing agent (ChemSorb-500) in 55-gallon drums. It will be stored on the RFP site or at an off-site storage facility approved by DOE and EPA. Samples of the filter cake solids will be analyzed both before and after stabilization. Appendix A discusses analytical parameters for solids. Prefiltered solids collected in the mini clarifier and bag filters from each run will be combined with the composited filter cake and stabilized with ChemSorb-500 for disposal.

SCALE: NOT TO SCALE



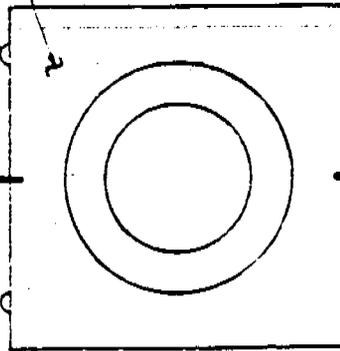
TYPICAL TWO-SIDED FILTER PLATE

TOP VIEW



O-RING SEAL

TAB (TYP.)

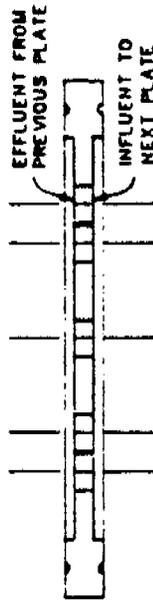


PLAN

TYPICAL FILTER PACK

SECTION A-A

FRONT AND PROFILE VIEW



SCALE: 1 = 10

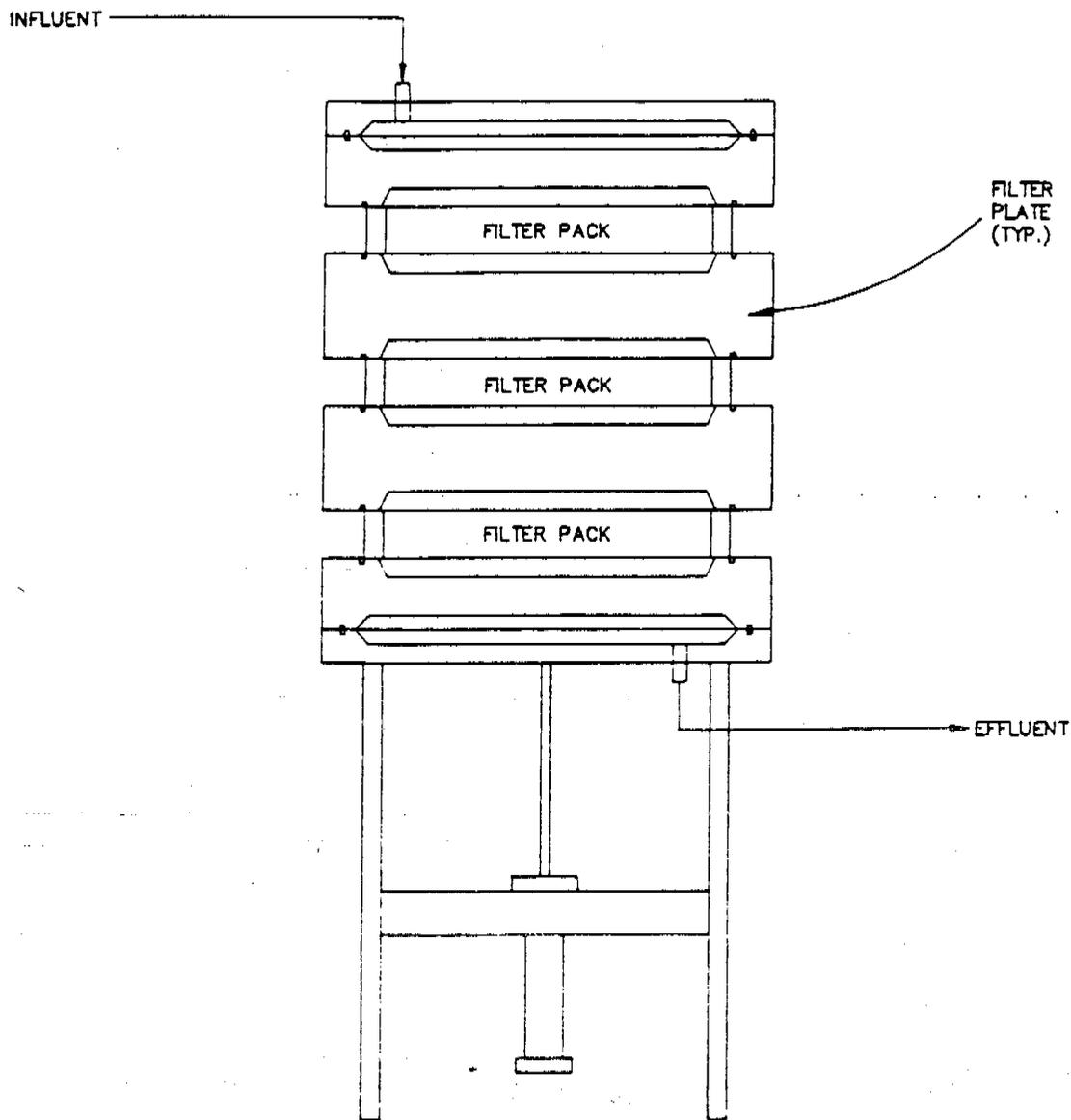
SITE CPM DEMONSTRATION
ROCKY FLATS PLANT - GOLDEN, COLORADO

FIGURE 3-2
SCHEMATIC OF TYPICAL FILTER
PLATE AND FILTER PACK

SCALE: NOT TO SCALE



ENVIRONMENTAL MANAGEMENT, INC.



FILE NAME: D:\7-041\Y12-303.DWG

DATE: 06/28/92 BCM

NOTE:
 THIS CONFIGURATION EMPLOYS THREE
 FILTER BEDS, EACH WITH ONE FILTER
 PACK, OPERATING IN SERIES,
 CONFIGURATION ONE (SEE SECTION
 5.3 FOR FURTHER DISCUSSION
 CONCERNING BED CONFIGURATIONS).

SCALE: NOT TO SCALE

SITE CPM DEMONSTRATION
 ROCKY FLATS PLANT - GOLDEN, COLORADO

FIGURE 3-3
 SCHEMATIC OF COLLOID
 FILTER UNIT

PRC ENVIRONMENTAL MANAGEMENT, INC.

4.0 DATA QUALITY OBJECTIVES

The primary objective of this treatability study is to evaluate the effectiveness of the CPFM technology in removing radionuclides and metals from contaminated ground water. Data quality objectives (DQOs) are developed to produce high quality data that can be used to evaluate the effectiveness of the technology. The DQOs were developed using guidelines presented in EPA's *Preparation Aids for the Development of Category II Quality Assurance Project Plans* (EPA, 1991) document and *Preparing Perfect Plans -- A Pocket Guide for the Preparation of Quality Assurance Project Plans* (EPA, 1989).

The following sections discuss topics directly related to the DQOs. These include data uses; quality assurance objectives; analytical data required; analytical levels; precision, accuracy, representativeness, completeness, and comparability (PARCC) objectives; detection levels; and corrective action.

4.1 DATA USES

The uses for the data collected during the CPFM treatability study include:

- 1) Assessment of the technology's ability to remove radionuclides
- 2) Development of capital and operating costs for this technology
- 3) Determination of the system's ability to produce an effluent that meets ARARs
- 4) Evaluation of the disposal options and costs for the effluent and filter cake generated by this process
- 5) Documentation the operating conditions and identification of operational needs, such as utility and labor requirements, for the treatment system

4.2 QUALITY ASSURANCE OBJECTIVES

Quality assurance objectives include the following:

- Develop appropriate sampling procedures, quality assurance procedures, and documentation procedures for obtaining and evaluating data that can be used to meet the treatability study objectives
- Provide high quality field and laboratory data which are fully documented in terms of data generation, review, approval, and reporting
- Implement a system of project management oversight to verify that the field and laboratory activities will be performed by properly trained and qualified personnel and will conform to the procedures outlined in the project plan

4.3 DATA REQUIRED

Analytical results for radionuclides in water matrices will be reported in pCi/L and in soil matrices will be reported in picoCuries per gram (pCi/g). Other units of measurement will be used as appropriate for inorganic and physical parameters. Analytical methods for critical and noncritical measurements in water and filter cake appear in Tables 4-1, 4-2, 4-3, and 4-4.

Results of water analyses will be compared between influent, intermediate, and effluent streams to calculate the effectiveness of the CPFM technology. Results of filter cake analyses will be reviewed for compliance with ARARs for potential disposal options.

4.4 ANALYTICAL LEVEL

The analytical levels as defined by the EPA are:

- Level I - Field screening or analysis with portable instruments. This level provides an indication of contamination presence and has few QA/QC requirements.
- Level II - Field analyses with more sophisticated portable instruments or a mobile laboratory. The data quality associated with this level depends on the QA/QC steps used. Data concentrations are usually reported in concentration ranges.

TABLE 4-1

**CPFM TECHNOLOGY DEMONSTRATION
QA OBJECTIVES FOR CRITICAL MEASUREMENTS
LIQUID SAMPLES**

| Critical Measurement | Method | Measurement Unit | Practical Quantitation Limits | Precision (RSD) ^a | Accuracy (% Recovery) | Completeness (%) |
|-----------------------------|--|------------------|-------------------------------|------------------------------|-----------------------|------------------|
| Radionuclides | | | | | | |
| Gross Alpha | 900.0 ^b | pCi/L | 2 | 40 | 70-130 | 90 |
| Isotopic Uranium | D3972-80/ ^c HEA-0011-01 ^c | pCi/L | 1 | 30 | 70-130 | 90 |
| Others | | | | | | |
| pH | 150.1 ^d | pH units | 0.01 | ± 0.2 ^e | ± 0.04 ^f | 90 |
| Flow rate ^g | Rotameter | gpm | 0.1 | NA | NA | 90 |
| Pumping Period ^g | Timer | minutes | 0.5 | NA | NA | 90 |
| Pressure Drop ^h | Pressure Gauge | psig | 0.1 | NA | NA | 90 |
| Volume of Water Treated | Calculation | gallons | 0.1 | NA | NA | 90 |
| Electricity Usage | Watt-hour meter | kilowatts-hr | 1 | NA | NA | 90 |

Notes:

- a RSD = Relative standard deviation
- b Prescribed Procedures for Measurement of Radioactivity in Drinking Water, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, EPA-600/4-80-032, 1980.
- c Standard Test Method for Isotopic Uranium in Water by Radiochemistry, American Society of Testing Materials (ASTM), December 31, 1980.
- d Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, U.S. Environmental Protection Agency, 1983, and subsequent EPA-600/4 Technical Additions.
- e For pH, precision is expressed in pH units as range.
- f For pH, accuracy is expressed in pH units as bias.
- g In addition to the influent, intermediate, and effluent streams, flow rate and pumping period measurements include chemical addition rates for hydrochloric acid.
- h Pressure drop is measured across the filter bed.
- i Analysis of Uranium in Water by Anion Exchange, Rocky Flats Plant Health and Safety Laboratories, Golden, Colorado, 1991.
- NA = not applicable
- pCi/L = picoCuries per liter
- gpm = gallons per minute
- psig = pound per square inch gauge

TABLE 4-2

**CPFM TECHNOLOGY DEMONSTRATION
QA OBJECTIVES FOR CRITICAL MEASUREMENTS
SOLID SAMPLES**

| Critical Measurement | Method | Measurement Unit | Practical Quantitation Limits | Precision (RSD) ^a | Accuracy (% Recovery) | Completeness (%) |
|---|--|------------------|-------------------------------|------------------------------|-----------------------|------------------|
| <u>Radionuclides</u> (before stabilization) | | | | | | |
| Gross Alpha | 3050 ^b /900.0 ^c | pCi/g | 2 | 40 | 70-130 | 90 |
| Isotopic Uranium | 3050 ^b /D3972-80 ^d | pCi/g | 0.3 | 30 | 70-130 | 90 |
| <u>TCLP - Extract</u> (after stabilization) | | | | | | |
| Gross Alpha | 900.0 ^c | pCi/L | 2 | 40 | 70-130 | 90 |
| Isotopic Uranium | D3972-80 ^d | pCi/L | 1.0 | 30 | 70-130 | 90 |
| Paint Filter Liquids Test (before and after stabilization) | 9095 ^e | pass/fail | NA | NA | NA | 90 |

Notes:

^a RSD = relative standard deviation

^b Test Methods for Evaluating Solid Waste Volumes IA-IC Laboratory Manual, Physical/Chemical Methods; and Volume II Field Manual, Physical/Chemical Methods, SW-846, Third Edition, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, 1986.

^c Radiochemical Analytical Procedures for Analysis of Environmental Samples, Report No. EMSL-LY-0539-1, U.S. Environmental Protection Agency, 1979.

^d Standard Test Method for Isotopic Uranium in Water by Radiochemistry, American Society of Testing Materials (ASTM), December 31, 1980.

NA = not applicable

pCi/g = picoCuries per gram

pCi/L = picoCuries per liter

TABLE 4-3

**CPFM TECHNOLOGY DEMONSTRATION
QA OBJECTIVES FOR NONCRITICAL MEASUREMENTS
LIQUID SAMPLES**

| Noncritical Measurement | Method | Measurement Unit | Practical Quantitation Limits | Precision (RPD)* | Accuracy (% Recovery) | Completeness (%) |
|---|---|------------------|-------------------------------|------------------|-----------------------|------------------|
| <u>Radionuclides</u> | | | | | | |
| Radium 226 | 903.0 ^d | pCi/L | 1.0 | 30 | 70-130 | 90 |
| Plutonium 239, 240 | EPA-600/7-79-081 ^b /HEA-0018-01 ^c | pCi/L | 0.01 | 30 | 70-130 | 90 |
| Americium 241 | EPA-600/7-79-081 ^b /HEA-0018-01 ^c | pCi/L | 0.01 | 30 | 70-130 | 90 |
| <u>Organic Compounds</u> | | | | | | |
| TOC | 9060 ^e | mg/L | 1.0 | 20 | 75-125 | 90 |
| <u>ICP Metals</u> | | | | | | |
| Aluminum | 3010/6010 ^a | mg/L | 0.2 | 20 | 75-125 | 90 |
| Antimony | 3010/6010 ^a | mg/L | 0.1 | 20 | 75-125 | 90 |
| Arsenic | 3010/6010 ^a | mg/L | 0.3 | 20 | 75-125 | 90 |
| Barium | 3010/6010 ^a | mg/L | 0.01 | 20 | 75-125 | 90 |
| Beryllium | 3010/6010 ^a | mg/L | 0.002 | 20 | 75-125 | 90 |
| Boron | 3010/6010 ^a | mg/L | 0.6 | 20 | 75-125 | 90 |
| Cadmium | 3010/6010 ^a | mg/L | 0.005 | 20 | 75-125 | 90 |
| Calcium | 3010/6010 ^a | mg/L | 1.0 | 20 | 75-125 | 90 |
| Chromium | 3010/6010 ^a | mg/L | 0.01 | 20 | 75-125 | 90 |
| Cobalt | 3010/6010 ^a | mg/L | 0.01 | 20 | 75-125 | 90 |
| Copper | 3010/6010 ^a | mg/L | 0.02 | 20 | 75-125 | 90 |
| Iron | 3010/6010 ^a | mg/L | 0.04 | 20 | 75-125 | 90 |
| Lead | 3020/6010 ^a | mg/L | 0.05 | 20 | 75-125 | 90 |
| Magnesium | 3010/6010 ^a | mg/L | 1.0 | 20 | 75-125 | 90 |
| Manganese | 3010/6010 ^a | mg/L | 0.01 | 20 | 75-125 | 90 |
| Molybdenum | 3010/6010 ^a | mg/L | 0.05 | 20 | 75-125 | 90 |
| Nickel | 3010/6010 ^a | mg/L | 0.02 | 20 | 75-125 | 90 |
| Potassium | 3010/6010 ^a | mg/L | 3.0 | 20 | 75-125 | 90 |
| Selenium | 3010/6010 ^a | mg/L | 0.3 | 20 | 75-125 | 90 |
| Silicon | 3010/6010 ^a | mg/L | 1.0 | 20 | 75-125 | 90 |
| Silver | 3010/6010 ^a | mg/L | 0.01 | 20 | 75-125 | 90 |
| Sodium | 3010/6010 ^a | mg/L | 1.0 | 20 | 75-125 | 90 |
| Strontium | 3010/6010 ^a | mg/L | 0.003 | 20 | 75-125 | 90 |
| Thallium | 3010/6010 ^a | mg/L | 0.1 | 20 | 75-125 | 90 |
| Vanadium | 3010/6010 ^a | mg/L | 0.02 | 20 | 75-125 | 90 |
| Zinc | 3010/6010 ^a | mg/L | 0.02 | 20 | 75-125 | 90 |
| <u>Anions</u> | | | | | | |
| Fluoride (F) | 300.0 ^f | mg/L | 0.1 | 15 | 90-110 | 90 |
| Chloride (Cl) | 300.0 ^f | mg/L | 0.026 | 15 | 90-110 | 90 |
| Nitrite/Nitrate (NO ₂ /NO ₃) | 353.1 ^f | mg/L | 0.020 | 20 | 85-115 | 90 |
| Sulfate (SO ₄) | 300.0 ^f | mg/L | 1.0 | 15 | 90-110 | 90 |
| Phosphate (PO ₄) | 365.2 ^f | mg/L | | 20 | 85-115 | 90 |
| Carbonate (CO ₃ - Alkalinity) | 310.1 ^f | mg/L | | 20 | 80-120 | 90 |
| Ammonia (NH ₃) | 350.1 ^f | mg/L | | 20 | 85-115 | 90 |

TABLE 4-3

**CPFM TECHNOLOGY DEMONSTRATION
QA OBJECTIVES FOR NONCRITICAL MEASUREMENTS
LIQUID SAMPLES
(Continued)**

| Noncritical Measurement | Method | Measurement Unit | Practical Quantitation Limits | Precision (RPD) ^a | Accuracy (% Recovery) | Completeness (%) |
|---------------------------------|--------------------|------------------|-------------------------------|------------------------------|-----------------------|------------------|
| Physical Characteristics | | | | | | |
| Total Dissolved Solids | 160.1 ^a | mg/L | 10 | 30 | NA | 90 |
| Total Suspended Solids | 160.2 ^a | mg/L | 5 | 30 | NA | 90 |
| Electrical Conductivity | 2510 ^b | μmhos/cm | 0.10 | NA | NA | 90 |
| Temperature | 2550 ^b | degree Celsius | 0.1 | NA | NA | 90 |

Notes:

- ^a RPD = relative percent difference
- ^b Acid Dissolution Method for Analysis of Plutonium in Soils, U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, 1979.
- ^c Maximum Sensitivity Procedures for Isolation of Plutonium and Americium in composited Water Samples, Rocky Flats Plant Health and Safety Laboratories, Golden, Colorado, 1990.
- ^d Prescribed Procedures for Measurement of Radioactivity in Drinking Water, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, EPA-600/4-80-032, 1980.
- ^e Test Methods for Evaluating Solid Waste, Volumes IA-IC: Laboratory Manual, Physical/Chemical Methods; and Volume II Field Manual, Physical/Chemical Methods, SW-846, Third Edition, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, 1986.
- ^f ICP = inductively coupled plasma
- ^g Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, U.S. Environmental Protection Agency, 1983, and subsequent EPA-600/4 Technical Additions.
- ^h Standard Methods for the Examination of Water and Wastewater, 17th Edition, APHA, AWWA, and WPCF, 1989.

NA = not applicable
 pCi/L = picoCuries per liter
 mg/L = milligrams per liter
 μmhos/cm = micromhos per centimeter

TABLE 4-4

**CPFM TECHNOLOGY DEMONSTRATION
QA OBJECTIVES FOR NONCRITICAL MEASUREMENTS
SOLID SAMPLES**

| Noncritical Measurement | Method | Measurement Unit | Practical Quantitation Limits | Precision (RPD) ^a | Accuracy (% Recovery) | Completeness (%) |
|-------------------------------|---|------------------|-------------------------------|------------------------------|-----------------------|------------------|
| Radionuclides | | | | | | |
| (before stabilization) | | | | | | |
| Radium 226 | 3050/903.0 ^b | pCi/g | 0.5 | 30 | 70-130 | 90 |
| Plutonium 239, 240 | EPA-600/7-79-081 ^b /HEA-0018-01 ^c | pCi/g | 0.03 | 30 | 70-130 | 90 |
| Americium 241 | EPA-600/7-79-081 ^b /HEA-0018-01 ^c | pCi/g | 0.02 | 30 | 70-130 | 90 |
| | | | | | | 90 |
| TOC | | | | | | |
| (before stabilization) | | | | | | |
| | Radian SOP ^b | mg/kg | 0.12% | 20 | 75-125 | |
| ICP Metals | | | | | | |
| (before stabilization) | | | | | | |
| Aluminum | 3050/6010 ^d | mg/kg | 20 | 20 | 75-125 | 90 |
| Antimony | 3050/6010 ^d | mg/kg | 10 | 20 | 75-125 | 90 |
| Arsenic | 3050/6010 ^d | mg/kg | 30 | 20 | 75-125 | 90 |
| Berium | 3050/6010 ^d | mg/kg | 1 | 20 | 75-125 | 90 |
| Beryllium | 3050/6010 ^d | mg/kg | 0.2 | 20 | 75-125 | 90 |
| Boron | 3050/6010 ^d | mg/kg | 6.0 | 20 | 75-125 | 90 |
| Cadmium | 3050/6010 ^d | mg/kg | 0.5 | 20 | 75-125 | 90 |
| Calcium | 3050/6010 ^d | mg/kg | 100 | 20 | 75-125 | 90 |
| Chromium | 3050/6010 ^d | mg/kg | 1 | 20 | 75-125 | 90 |
| Cobalt | 3050/6010 ^d | mg/kg | 1 | 20 | 75-125 | 90 |
| Copper | 3050/6010 ^d | mg/kg | 2 | 20 | 75-125 | 90 |
| Iron | 3050/6010 ^d | mg/kg | 4 | 20 | 75-125 | 90 |
| Lead | 3050/6010 ^d | mg/kg | 5 | 20 | 75-125 | 90 |
| Magnesium | 3050/6010 ^d | mg/kg | 100 | 20 | 75-125 | 90 |
| Manganese | 3050/6010 ^d | mg/kg | 1 | 20 | 75-125 | 90 |
| Molybdenum | 3050/6010 ^d | mg/kg | 2 | 20 | 75-125 | 90 |
| Nickel | 3050/6010 ^d | mg/kg | 300 | 20 | 75-125 | 90 |
| Potassium | 3050/6010 ^d | mg/kg | 30 | 20 | 75-125 | 90 |
| Selenium | 3050/6010 ^d | mg/kg | 100 | 20 | 75-125 | 90 |
| Silicon | 3050/6010 ^d | mg/kg | 1 | 20 | 75-125 | 90 |
| Silver | 3050/6010 ^d | mg/kg | 100 | 20 | 75-125 | 90 |
| Sodium | 3050/6010 ^d | mg/kg | 0.3 | 20 | 75-125 | 90 |
| Strontium | 3050/6010 ^d | mg/kg | 10 | 20 | 75-125 | 90 |
| Tballium | 3050/6010 ^d | mg/kg | 2 | 20 | 75-125 | 90 |
| Vanadium | 3050/6010 ^d | mg/kg | 2 | 20 | 75-125 | 90 |
| Zinc | 3050/6010 ^d | mg/kg | | 20 | 75-125 | 90 |

TABLE 4-4

**CPFM TECHNOLOGY DEMONSTRATION
QA OBJECTIVES FOR NONCRITICAL MEASUREMENTS
SOLID SAMPLES
(Continued)**

| Noncritical Measurement | Method | Measurement Unit | Practical Quantitation Limits | Precision (RPD) ^a | Accuracy (% Recovery) | Completeness (%) |
|---|--------------------------|------------------|-------------------------------|------------------------------|-----------------------|------------------|
| <u>Physical Characteristics</u> (before stabilization) | | | | | | |
| Filter cake mass | scale | kg | 0.0001 | NA | NA | 90 |
| Filter cake volume | estimated | cm ³ | 1 | NA | NA | 90 |
| <u>TCLP - Radionuclides</u> (after stabilization) | | | | | | |
| Radium 226 | 903.0 ^a | pCi/L | 1 | 30 | 70-130 | 90 |
| Plutonium 239, 240 | HEA-0018-01 ^c | pCi/L | 0.01 | 30 | 70-130 | 90 |
| Americium 241 | HEA-0018-01 ^c | pCi/L | 0.01 | 30 | 70-130 | 90 |
| <u>TCLP - VOC</u> (after stabilization) | | | | | | |
| Methylene chloride | 1311/8240 ^d | µg/L | 5 | 20 | 50-150 | 90 |
| Carbon tetrachloride | 1311/8240 ^d | µg/L | 5 | 20 | 50-150 | 90 |
| 1,2-Dichloroethane | 1311/8240 ^d | µg/L | 5 | 20 | 50-150 | 90 |
| 1,1-Dichloroethylene | 1311/8240 ^d | µg/L | 5 | 20 | 50-150 | 90 |
| Vinyl chloride | 1311/8240 ^d | µg/L | 10 | 20 | 50-150 | 90 |
| <u>TCLP - ICP^e Metals</u> (after stabilization) | | | | | | |
| Aluminum | 6010 ^d | mg/L | 0.2 | 20 | 75-125 | 90 |
| Antimony | 6010 ^d | mg/L | 0.1 | 20 | 75-125 | 90 |
| Arsenic | 6010 ^d | mg/L | 0.3 | 20 | 75-125 | 90 |
| Barium | 6010 ^d | mg/L | 0.01 | 20 | 75-125 | 90 |
| Beryllium | 6010 ^d | mg/L | 0.002 | 20 | 75-125 | 90 |
| Boron | 6010 ^d | mg/L | 0.6 | 20 | 75-125 | 90 |
| Cadmium | 6010 ^d | mg/L | 0.005 | 20 | 75-125 | 90 |
| Calcium | 6010 ^d | mg/L | 1.0 | 20 | 75-125 | 90 |
| Chromium | 6010 ^d | mg/L | 0.01 | 20 | 75-125 | 90 |
| Cobalt | 6010 ^d | mg/L | 0.01 | 20 | 75-125 | 90 |
| Copper | 6010 ^d | mg/L | 0.02 | 20 | 75-125 | 90 |
| Iron | 6010 ^d | mg/L | 0.04 | 20 | 75-125 | 90 |
| Lead | 6010 ^d | mg/L | 0.05 | 20 | 75-125 | 90 |
| Magnesium | 6010 ^d | mg/L | 1.0 | 20 | 75-125 | 90 |
| Manganese | 6010 ^d | mg/L | 0.01 | 20 | 75-125 | 90 |
| Molybdenum | 6010 ^d | mg/L | 0.05 | 20 | 75-125 | 90 |
| Nickel | 6010 ^d | mg/L | 0.02 | 20 | 75-125 | 90 |
| Potassium | 6010 ^d | mg/L | 3.0 | 20 | 75-125 | 90 |
| Selenium | 6010 ^d | mg/L | 0.3 | 20 | 75-125 | 90 |
| Silicon | 6010 ^d | mg/L | 1.0 | 20 | 75-125 | 90 |
| Silver | 6010 ^d | mg/L | 0.01 | 20 | 75-125 | 90 |
| Sodium | 6010 ^d | mg/L | 1.0 | 20 | 75-125 | 90 |
| Strontium | 6010 ^d | mg/L | 0.003 | 20 | 75-125 | 90 |
| Thallium | 6010 ^d | mg/L | 0.1 | 20 | 75-125 | 90 |
| Vanadium | 6010 ^d | mg/L | 0.02 | 20 | 75-125 | 90 |
| Zinc | 6010 ^d | mg/L | 0.02 | 20 | 75-125 | 90 |

TABLE 4-4

**CPFM TECHNOLOGY DEMONSTRATION
QA OBJECTIVES FOR NONCRITICAL MEASUREMENTS
SOLID SAMPLES
(Continued)**

| Noncritical Measurement | Method | Measurement Unit | Practical Quantitation Limits | Precision (RPD) ^a | Accuracy (% Recovery) | Completeness (%) |
|---|-----------------------|--------------------|-------------------------------|------------------------------|-----------------------|------------------|
| <u>Physical Characteristics (after stabilization)</u> | | | | | | |
| Moisture Content | D2216 ^f | percent | 1 | NA | NA | 90 |
| Bulk Density | D2937-83 ^g | mg/cm ³ | 0.1 | NA | NA | 90 |
| Stabilized Mixture Mass | Scale | kg | 0.0001 | NA | NA | 90 |
| Stabilized Mixture Volume | Estimated | cm ³ | 1 | NA | NA | 90 |

Notes:

- ^a RPD = relative percent difference.
- ^b Acid Dissolution Method for Analysis of Plutonium in Soils, U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, 1979.
- ^c Maximum Sensitivity Procedures for Isolation of Plutonium and Americium in Compositated Water Samples, Rocky Flats Plant Health and Safety Laboratories, Golden, Colorado, 1990.
- ^d Test Methods for Evaluating Solid Waste, Volumes IA-IC: Laboratory Manual, Physical/Chemical Methods; and Volume II Field Manual, Physical/Chemical Methods, SW-846, Third Edition, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, 1986.
- ^e Radiochemical Analytical Procedures for Analysis of Environmental Samples, Report No. EMSL-LY-0539-1, U.S. Environmental Protection Agency, 1979.
- ^f ICP = inductively coupled plasma.
- ^g American Society of Testing Materials, 1983
- ^h Radian standard operating procedure for TOC using a Perkin Elmer 240C Elemental Analyzer

NA = not applicable

Specs = accuracy based on manufacturer specifications

µg/L = micrograms per liter

mg/L = milligrams per cubic centimeter

kg = kilograms

mg/kg = milligrams per kilograms

- Level III - Analyses for organic and inorganic constituents are performed in an off-site analytical laboratory that may or may not involve contract laboratory program (CLP) procedures. The detection limits will be similar to those specified by the CLP. Level III uses rigorous QA/QC.
- Level IV - Analyses encompass the hazardous substance list (HSL) organic and inorganic parameters by sophisticated laboratory instrumentation such as gas chromatography/mass spectroscopy (GC/MS), atomic absorption (AA), and inductively coupled plasma (ICP). Detection limits reach low parts-per-billion (ppb) levels. This analytical level also provides tentative identification of non-HSL parameters. Data require validation to evaluate compliance with rigorous QA/QC requirements. Level IV procedures are appropriate to develop data of known quality.
- Level V - Analyses using nonstandard analytical methods. Method development or method modification may be required for specific constituents or detection limits.

For this treatability study, analytical Level II will be used for all field measurements, analytical Level IV will be used for metals, anions, and organic analyses, and analytical Level V will be used for radionuclide analyses.

4.5 PARCC CRITERIA

PARCC criteria are indicators of project data quality. Objectives for these indicator parameters were developed for this project based on past experience in bench-scale and treatability studies and on the objectives of the project. Field procedures, analytical methods, and the project QA program were selected and developed to meet these objectives.

QC samples are collected in addition to the field samples and are used in conjunction with laboratory QC samples to evaluate the quality of the data produced from the field sampling program. QC samples serve DQOs by meeting CLP and the laboratory's established acceptance criteria. QC samples that do not meet the criteria may serve as indicators of unacceptable data resulting in the laboratory implementing corrective action procedures or in the data being qualified. PARCC parameter goals appear in Tables 4-1, 4-2, 4-3, and 4-4 and are discussed in the following sections.

4.5.1 Precision

Precision is the degree of mutual agreement between individual measurements of the same property under similar prescribed conditions. Data precision is a function of field sampling precision and laboratory analytical precision. It is evaluated by collecting and analyzing field replicates, laboratory control samples (LCSs), and matrix spike/matrix spike duplicates (MS/MSDs).

For the critical measurements (see Tables 4-1 and 4-2) of gross alpha and uranium, precision is determined by taking three replicate samples at each sampling location and calculating the relative standard deviation (RSD) values between these analyte levels. The RSD will be calculated using Equation 4-1 (EPA, 1991):

$$\% RSD = (s/x) \times 100 \quad (4-1)$$

where:

% RSD = percent relative standard deviation
s = standard deviation
x = mean of replicate analyses

Precision for the critical parameter of pH will be estimated by calculating the range for duplicate aliquots of a field sample, using Equation 4-2:

$$D(pH) = |pH_1 - pH_2| \quad (4-2)$$

where:

D(pH) = Range for pH
pH₁, pH₂ = Observed values for duplicate aliquots of a sample

The remainder of the critical measurements (flow rate, pumping period, pressure drop, volume, electricity usage and paint filter liquids test) are variable or qualitative tests. RSD values cannot be determined for these tests. However, three replicate sample measurements will be taken for

each of these tests. If the results for the replicate samples do not agree with each other, one additional sample will be analyzed to determine whether there is a variance.

For the noncritical measurements (see Tables 4-3 and 4-4) of radium, plutonium, americium, carbonate, total dissolved solids (TDS), and total suspended solids (TSS), precision is determined by using LCSs or QC replicates as replicate samples and calculating relative percent difference (RPD). RPD is calculated using Equation 4-3:

$$\% RPD = \frac{|A - B|}{(A + B)/2} \times 100\% \quad (4-3)$$

where:

- %RPD = percent relative difference
- A = first replicate concentration
- B = second replicate concentration

Precision will be estimated by analyzing duplicate matrix spiked samples for organic compounds, metals, and the anions of fluoride, chloride, nitrite/nitrate, sulfate, phosphate, and ammonia. The RPD between the analyte levels measured in the MS and MSD sample will be calculated using Equation 4-4 (EPA, 1991):

$$\% RPD = \frac{|MS - MSD|}{0.5(MS + MSD)} \times 100\% \quad (4-4)$$

where:

- %RPD = percent relative difference
- MS = matrix spike concentration
- MSD = matrix spike duplicate concentration

The remaining noncritical parameters of electrical conductivity, temperature, mass, volume, moisture content, and bulk density will not be quantified for precision due to the variable nature of these measurements.

4.5.2 Accuracy

Accuracy is the degree of agreement between an analytical measurement and a reference accepted as true value. The accuracy of a measurement system is impacted by errors introduced through the sampling process, field contamination, preservation, handling sample matrix, sample preparation, and analytical techniques. Accuracy is evaluated through the use of standard reference materials (SRMs), MS/MSD, QC check samples, calibration standards, sampling equipment rinsate blanks, and bottle rinsate samples.

Accuracy for radionuclide critical and noncritical parameters will be estimated as percent recovery of the true analyte level from an SRM. Accuracy will be calculated using Equation 4-5 (EPA, 1991):

$$\% R = (C_m / C_{SRM}) \times 100\% \quad (4-5)$$

where:

- $\% R$ = percent recovery
- C_m = measured concentration of SRM
- C_{SRM} = actual concentration of SRM

Accuracy for radionuclides will also be monitored using EPA performance evaluation (PE) samples. These are samples provided to the laboratory by EPA containing radionuclides of interest in quantities unknown to the laboratory. PE results are analyzed and results returned to the EPA for evaluation. Additionally, the laboratory will use standards derived from EPA and National Bureau of Standards (NBS) supplied vials for QC.

Accuracy for organic compounds and metal analyses will be estimated as percent recovery of the true analyte level from a matrix sample using equation 4-5. Accuracy for anion analyses will be estimated as percent recovery of the true analyte level from a QC check sample using equation 4-5.

For pH, accuracy will be estimated as bias from the true value. Standard reference materials, such as EPA QC check samples, will be used to estimate bias in pH measurements.

No accuracy values will be obtained for flow rate, pumping period, pressure drop, volume of water treated, electricity usage, paint filter liquids test, TDS, TSS, electrical conductivity, temperature, mass, volume of filter cake, moisture content, and bulk density.

4.5.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, parameter variations at a sampling point, or an environmental condition they are intended to represent. For this project, representative data will be obtained through sample size (see Appendix A), and careful selection of sampling sites and analytical parameters. They will also be obtained through the proper collection and handling of samples to avoid interferences and minimize contamination and loss.

4.5.4 Completeness

Completeness is a measure of the percentage of project-specified data that are valid. Valid data are obtained when (1) samples are collected and analyzed in accordance with the QC procedures outlined in the QAPjP; and (2) none of the QC criteria that affect data quality are exceeded. The project completeness value will be calculated by dividing the number of valid sample results by the total number of sample analyses completed for this treatability study (see Equation 4-6).

$$\% C = (V/T) \times 100\% \quad (4-6)$$

where:

% C = Percent completeness
V = Number of measurements judged valid
T = Total number of measurements

4.5.5 Comparability

The comparability objective determines whether analytical conditions are sufficiently uniform for each analytical run to verify that all of the reported data will be consistent. This requires

adherence to the specified analytical methodology and to the laboratory and field procedures. Additionally, comparability is verified through the use of standard units of measurement and tabular format in reporting of the analytical data. These techniques and units are reported in the data management section and Tables 4-1, 4-2, 4-3, and 4-4.

4.6 DETECTION LIMITS

The method detection limit (MDL) expresses the lowest concentration of a substance that can be determined within the accuracy and precision limits established for the analytical method. This value is based on the instrument detection limit (IDL) with allowance for the relative instrument error inherent in the analytical method. This is the lowest concentration that can be accurately determined. The practical quantitation limit (PQL) is the lowest level that can be reliably reported based upon the QC limits for a particular analyte in a given matrix. Concentrations lower than the PQL but greater than the MDL are reported as estimated values only. They may or may not meet the QC acceptance criteria for the method.

The IDL is a measure of the sensitivity of the detection device for the component of interest. It is the primary factor influencing the relative values established for more meaningful limits of detection for substances prepared and analyzed in a common manner. The most accurate method of expressing the IDL is in terms of an absolute mass of the analyte, rather than in units of concentration.

MDLs are determined in accordance with the EPA CLP protocols. Radian Corporation (Radian), the analytical laboratory used for inorganic analysis, determines MDLs once a year. The most recent determination was in March 1992. Radian's standard operating procedure (SOP) for determining MDLs is described below:

For inorganic analyses, a sample containing all analytes in reagent water is prepared at a concentration of approximately five times the IDL and analyzed five to seven times. The average concentration and the standard deviation are calculated. The MDL is calculated as three times the standard deviation for each analyte.

Since MDLs are determined by the analyses of spiked samples of reagent water, the actual values obtainable for environmental samples are subject to matrix effects and moisture content of solid samples. For this project, using data from the MDL study and the analytical experience with the bench-scale and treatability study samples, Radian has estimated the PQLs for this project. The PQLs for the critical parameters of this study are given in Tables 4-1, 4-2, 4-3, and 4-4.

4.7 CORRECTIVE ACTION

As stated earlier, the primary objective of this study is to estimate the CPFM treatment system's ability to remove radionuclides listed in Table 4-1 from the OU4 IM/IRA water. To achieve this, all precision, accuracy, and completeness goals must be achieved. Should the analytical data fail to meet these QA objectives, the following corrective actions may be taken: (1) verify that the analytical measurement system was in control; (2) make a thorough check of all calculations; (3) use data qualifiers (flags); or (4) reanalyze the affected samples, if authorized by the EPA project manager and if a sufficient quantity of sample is available and holding times can be met.

5.0 EXPERIMENT DESIGN AND PROCEDURES

This section describes the approach and procedures to be followed in conducting the demonstration.

5.1 GENERAL OBJECTIVES

The overall objective of this project is to evaluate the CPFM technology and develop information to evaluate the suitability of this technology to remediate hazardous waste sites. For this project, the critical parameters include:

- Concentration of uranium and gross alpha in:
 - storage tank water (influent)
 - untreated water after prefiltration (intermediate)
 - treated water (effluent)
 - filter cake solids (prior to stabilization)
 - stabilized mixture's (filter cake and prefiltered solids) TCLP extract

- Free liquids (as measured by the paint filter liquids test) before stabilization (in the filter cake solids) and after stabilization (in the stabilized mixture)

- pH of the:
 - influent
 - intermediate
 - effluent

- Flow rate and pumping periods of the:
 - influent
 - intermediate
 - effluent (flow rate only)

TABLE 5-1

CPFM TECHNOLOGY DEMONSTRATION
BENCH-SCALE STUDY II RESULTS

| Radiochemistry* (pCi/L) ^b | Run 1 (pH = 7.6, no pretreatment) | | Run 2 (pH = 8.0 w/Sodium Sulfide) | | Run 3 (pH = 9.0 w/Sodium Sulfide and Sodium Bisulfite) | | Run 4 (pH = 9.0 w/Sodium Sulfide) | | Run 5 (pH = 8.0 w/Sodium Sulfide & Sodium Bisulfite) ^c | | Run 6 (pH = 9.0 w/Sodium Sulfide & Sodium Bisulfite) | | | | Run 7 (Overnight Equilibrium with Minerals, pH = 9.0 w/Sodium Sulfide and Sodium Bisulfite) | | Run 8 (Overnight Equilibrium with Fiber Flow Plus Sodium Sulfide) | |
|---|--------------------------------------|------------|--------------------------------------|------------|---|------------|--------------------------------------|------------|--|------------|---|---------------|--------------------|--------------------|--|-----------|--|----------|
| | Influent | Effluent | Inter-mediate | Effluent | Inter-mediate | Effluent | Inter-mediate | Effluent | Inter-mediate | Effluent | Influent | Lower-mediate | Fast Flow Effluent | Slow Flow Effluent | Inter-mediate | Effluent | Inter-mediate | Effluent |
| Gross Alpha | 166 ± 15 | 23 ± 6 | 46 ± 5 | 17 ± 5 | 133 ± 13 | 18 ± 6 | 89 ± 11 | 21 ± 5 | 34 ± 4 | 82 ± 8 | 42 ± 4 | 24 ± 5 | 13 ± 4 | 85 ± 9 | 19 ± 5 | 46 ± 8 | 14 ± 3 | |
| Gross Beta | 124 ± 8 | 57 ± 7 | 34 ± 5 | 54 ± 9 | 99 ± 12 | 63 ± 8 | 62 ± 8 | 55 ± 9 | 73 ± 8 | 44 ± 8 | 20 ± 7 | 31 ± 6 | 24 ± 7 | 42 ± 6 | 34 ± 7 | 35 ± 8 | 31 ± 5 | |
| Radium-226 ^d | 13 ± 7 | 7.4 ± 7.0 | 9.2 ± 7 | 11 ± 7 | 12 ± 7 | 11 ± 7 | 15 ± 7 | 13 ± 7 | 13 ± 7 | NS | NS | NS | NS | NS | NS | NS | NS | |
| Uranium-234 | 56.0 ± 10.0 | -0.3 ± .03 | 49.0 ± 8.2 | .02 ± .04 | 50.0 ± 9.0 | .04 ± .06 | 51.0 ± 7.1 | -.02 ± .03 | -.01 ± .04 | 18.0 ± 3.3 | 12.0 ± 2.0 | .01 ± .03 | .01 ± .03 | 17.0 ± 3.1 | -.01 ± .04 | 5.1 ± 1.1 | -.01 ± .03 | |
| Uranium-238 | 35.0 ± 6.5 | -.01 ± .03 | 31.0 ± 5.4 | -.01 ± .03 | 32.0 ± 6.0 | .03 ± .05 | 31.0 ± 4.5 | -.01 ± .03 | -.01 ± .03 | 12.0 ± 2.2 | 7.5 ± 1.2 | .01 ± .03 | .02 ± .03 | 11.0 ± 2.1 | -.01 ± .03 | 3.3 ± .8 | -.01 ± .03 | |
| Plutonium | 6.8 ± 1.2 | -.01 ± .02 | 3.8 ± .8 | -.02 ± .02 | 8.1 ± 1.4 | -.02 ± .01 | 4.9 ± .8 | -.03 ± .01 | .02 ± .02 | 22.0 ± 3.5 | 9.0 ± 1.3 | -.01 ± .02 | -.01 ± .02 | 14.0 ± 2.3 | .01 ± .02 | 6.1 ± 1.0 | -.01 ± .02 | |
| Americium-241 | 22.0 ± 3.8 | -.01 ± .01 | 1.2 ± .4 | .04 ± .03 | 4.3 ± .8 | .01 ± .02 | 3.4 ± 1.1 | -.01 ± .02 | -.01 ± .01 | 26.0 ± 3.8 | 6.0 ± 1.2 | .015 ± .02 | .03 ± .03 | 17 ± 6 | -.059 ± .052 | 9.2 ± 2.4 | .05 ± .04 | |

All analyses were completed by EG&G staff, REP Building 123 laboratory, except for radium.

Analyte concentrations are from one sample.

pCi/L = PicoCuries per liter. Only liquids were analyzed in this study.

Radian Corp. in Austin, Texas conducted the radium analyses.

Intermediate results for this run from Radian include: radium-226 = 15.5 ± 7.0, uranium-234 = 50.8 ± 2.1, uranium-238 = 32.5 ± 1.0. EG&G did not conduct analyses for the intermediate stream from this run.

NS = Not Sampled

- hydrochloric acid stream (and sodium hydroxide stream if needed for influent pH adjustment)
- **Pressure loss across the colloid filter unit as a function of operating time (as measured by the differential pressure across each filter bed)**
- Volume of water treated
- Electricity usage

Noncritical parameters for this project include:

- Concentrations in the influent, intermediate, and effluent of:
 - plutonium, americium, and radium
 - anions
 - total organic carbon (TOC)
 - ICP metals
 - TSS and TDS
 - electrical conductivity
 - temperature
- Individual measurements of the prefiltered solids and filter cake prior to stabilization for:
 - total mass
 - estimated volume
- Individual concentrations in the prefiltered solids and filter cake prior to stabilization for:
 - plutonium, americium, and radium
 - anions
 - ICP metals
 - TOC

- Measurements of the stabilized mixture for:

- moisture content
- bulk density
- total mass
- estimated volume

- Concentrations in the TCLP extract from the stabilized mixture of:

- plutonium, americium, and radium
- anions
- ICP metals
- volatile organic compounds (VOCs)

5.2 KEY ASSUMPTIONS

The selection of the demonstration's critical and noncritical parameters was based on the demonstration goals for the technology and the contamination levels in the ITPH water. The first approach was to name all radionuclides (other than tritium) and metals five times greater than their respective drinking water standards as critical analytes. These concentration levels would have been sufficient to effectively illustrate removal by the treatment system. This list, based on historical data, would have included plutonium, americium, radium, uranium, gross alpha, and gross beta. As mentioned earlier, the bench-scale studies' ITPH water analyses indicated levels of plutonium, americium, and radium at or below 1 pCi/L. Since the levels of these compounds, in addition to the concentrations of gross beta and metals, are either at or below their respective treatment standards, they are not sufficient to assess the technology's removal ability. Thus, plutonium, americium, radium, gross beta, and metals are noncritical analytical parameters for this demonstration. Uranium and gross alpha will remain critical analytical parameters for the demonstration.

The anion analysis includes the following compounds:

- Fluoride

- Chloride
- Sulfate
- Nitrite/nitrate
- Phosphate
- Carbonate
- Ammonia

These analyses will determine any potential radionuclide complexing. Some anions result in different complexed radionuclide states. Quantifying these anion concentrations will enable a more in depth examination of the demonstration's analytical results.

Aqueous phase organic compounds at concentrations in excess of 5 percent are known to affect the CPFM treatment system's ability to remove metals and radionuclides. The concentrations of organic compounds in the ITPH listed in Table 2-4 are well below this level; therefore, interference due to organic compounds is not anticipated during the demonstration. However, the TOC analysis will verify that the concentration of organic compounds has not increased (since the date of the last analyses) sufficiently to cause removal process interference.

TCLP analyses of the prefiltered solids and filter cake prior to stabilization will not be conducted; however, analyses for several compounds will be conducted. Concentrations prior to stabilization can be compared to the concentration in the TCLP extract divided by a factor of 20. The reasoning behind this comparison is as follows. The TCLP includes a dilution factor of 20 times the sample volume. A compound's concentration in a straight (non-TCLP) sample reduced by a factor of 20 is a conservative estimate of that compound's maximum concentration in the TCLP prepared sample. Since the TCLP results for metals and VOCs are noncritical parameters and no TCLP limits for radionuclides currently exist, this general rule-of-thumb approach should be sufficient.

Bench-scale studies conducted at RFP on ITPH water have assisted in determining the optimum operating conditions for the full-scale treatment unit for the SITE demonstration. A field treatability study conducted at an in-situ uranium mine located in Texas provided further information on the process equipment. The results from the waste characterization study and the bench-scale and treatability studies refined the testing objectives and test conditions for the CPFM demonstration;

specifically, the level of pH-adjustment, chemical addition, and the appropriate flow rates and corresponding filter bed residence times. The following summarizes the second bench-scale study which provided the most conclusive results.

FFT conducted two bench-scale studies in a laboratory at RFP using ITPH water: one in late June and another late September and early October 1991. The purpose of these studies was to optimize operating pH, sodium sulfide and sodium bisulfite addition, flow rates, filter bed residence times for the full-scale demonstration, and to prove the remediation capability of the technology. Due to Department of Transportation (DOT) shipping restrictions, sufficient volume for bench-scale testing of RFP ITPH water could not be sent off-site. As a result, FFT's bench-scale equipment was brought to the RFP site. The bench-scale equipment was downsized from the full-scale treatability study (mobile unit) equipment and was operated in batch mode. The unit used in the bench-scale studies was a crude, flanged version of the CPFM mobile unit. FF 1000 was slurried onto a polypropylene filter mesh within a flanged, vertical, filtering vessel to emulate filter beds.

The second bench-scale study occurred between September 30 and October 2, 1991 at RFP. The equipment for this study included a single-flanged filtering vessel representing one filter bed. Approximately 40 gallons of ground water were used for this study. Flow rates during this bench-scale study approached 0.05 gpm. This study used ITPH water spiked with up to 30 pCi/L of plutonium-239, americium-241, and radium-226. The water was spiked to more easily determine removal efficiencies for plutonium, americium, and radium since their concentrations were relatively low in the ITPH water during the previous bench-scale study. Eight test runs were conducted to treat the spiked ITPH water. Run 1 did not use chemical pretreatment, only contaminated influent passing through the filter media. This provided a baseline data set. Runs 2 and 3 were performed at a pH of 8. Run 2 included addition of sodium sulfide while Run 3 included addition of both sodium sulfide and sodium bisulfite. Runs 4 and 5 essentially mimicked Runs 2 and 3, but at a pH of 9.

EG&G and FFT staff conducted the three remaining runs. Run 6 was performed with the same chemical conditions as Run 3, but two flow rates were used, a fast flow rate (460 milliliters per minute [ml/min]), and a slow flow rate (75 ml/min). For comparison, all the other runs were performed with flow rates between 150 and 200 ml/min.

In Run 7, minerals were added to the spiked water stream and allowed to soak overnight. The pH was adjusted to 9, and sodium sulfide and sodium bisulfite were added. This solution was then pumped through the flanged unit containing FF 1000 as filter bed material.

In Run 8, minerals and FF 1000 were added to the spiked water stream and allowed to soak overnight. The mixture of minerals and FF 1000 was termed Filter Flow Plus. Sodium sulfide was the only chemical added. This solution was pumped through the flanged unit without any filter bed material pre-slurried onto the filter mesh.

PRC collected influent, intermediate, and effluent water samples during this bench-scale study. Uranium, radium, and ICP metals samples were sent to PRC's SITE team member laboratory, Radian, for analysis. Samples for plutonium and americium were sent to S-Cubed laboratories in San Diego. The results from S-Cubed were suspect due to the use of an incorrect analytical method which caused radionuclide complexing in the sample. These results are not reported in the summary table. EG&G also analyzed of the samples. Additional analyses from EG&G had a lower detection limit enabling a determination of more accurate removal efficiency. Filter cake samples were not analyzed in this study because there was not enough filter cake generated to provide a sample. The goal of the study was to determine radionuclide removal from the water by the CPFM treatment system. The analytical results appear in Table 5-1.

The operating equipment worked very well during the bench-scale study II experiment; no leaks were detected and no filter bed material was observed in the effluent.

The results from this study reconfirm that uranium can be effectively removed from the waste. However, it went a step further and illustrated effective removal with no chemical pretreatment. These test runs still showed only marginal removal efficiency for radium. The plutonium and americium results indicated excellent removal efficiencies. The main result drawn from the bench-scale study II is that uranium can be essentially eliminated from the ITPH water under any conditions posed by this bench-scale study.

1

5.3 TASK DESCRIPTIONS

For purposes of this demonstration, there will be no pH adjustment or chemical addition as determined from the bench-scale and treatability studies. The desired pH will be approximately 8 and sodium hydroxide will only be added if the raw influent's pH is not close to 8. Conducting the demonstration without any chemical addition greatly simplifies the process while providing the opportunity for acceptable removal efficiencies.

The CPFM field unit will be used for the RFP SITE demonstration. During the demonstration, the flow rate of the influent and the filter bed configuration will be varied to evaluate the CPFM technology. The experiments are divided into two groups: group one (Runs 1 through 4) designed to prove the technology (proof of principle); and group two (Run 5) designed to determine the saturation rate of the filter media (breakthrough). Group one addresses reproducibility of performance. A summary of the test runs appears in Table 5-2.

Two preruns will be conducted at 5 and 10 gpm using clean water (process water) only. These preruns will test the fittings, piping, and overall system integrity. The filter bed configuration used in test Runs 1 through 4 will be employed during the preruns. Pressure gauges, flow meters, mixer speeds, and other equipment specifics will be checked at this time. The same set of three filter packs will be used throughout both preruns.

At the start of each test run, clean water will be flushed through the system for 30 minutes. This will allow the filter media within the filter pack to become thoroughly wet. Moreover, it seems that trace amounts of certain elements, such as barium and potassium, leach from the filter media during this flushing. A sample of the influent and effluent water will be taken 15 minutes after flushing starts, as the majority of leaching from the filter media will occur within this time.

After flushing is complete, untreated influent will be pumped to the mini clarifier. Caustic will be pumped into this vessel to obtain a pH of 8 only if the raw influent's pH is not close to 8. After approximately 30 minutes of settling time in the mini clarifier, the effluent will be pumped through the bag filters (which remove particles larger than 10 microns). The contaminants of

TABLE 5-2**SUMMARY OF TEST RUNS FOR THE
CPFM TECHNOLOGY DEMONSTRATION**

| Run No. | Flow Rate (gpm) ^a | Length of Run (hours) | Special Operation Conditions ^b |
|-----------------|------------------------------|-----------------------|---|
| P1 ^c | 5 | 2 | Clean water only, bed configuration one |
| P2 ^c | 10 | 2 | Clean water only, bed configuration one |
| 1 | 5 | 4 | Bed configuration one |
| 2 | 5 | 4 | Bed configuration one |
| 3 | 5 | 4 | Bed configuration one |
| 4 | 10 | 4 | Bed configuration one |
| 5 | 5 (10) ^d | 24 | Bed configuration one |

Notes:

- ^a gpm = gallons per minute
- ^b This column indicates any special conditions for the test run and identifies which filter bed configuration, one or two, will be employed. Filter bed configurations are described in Section 3.1.3. Also, contaminated influent will be used for all test runs unless indicated otherwise.
- ^c "P" denotes prerun.
- ^d Five gpm represents the flow rate to each colloid filter unit. Since there will be two colloid filter units in parallel, a total volumetric flow rate of 10 gpm will be required for Run 5.

concern, nontritium radionuclides and metals, should remain in their colloid forms and pass through the bag filters enroute to the colloid filter unit.

There are two configurations of filter plates for the RFP demonstration. The group one configuration will employ a single colloid filter unit with three filter packs; this will require two end plates and two inside plates. This configuration will allow the three filter packs to operate in series providing redundancy in removal capacity. There will be only one effluent stream for this configuration. A composite sample of filter cake from all three filter packs will be sampled and analyzed to determine the level of contamination in the packs. Three runs at 5 gpm will provide reproducibility of performance data and one run at 15 gpm will provide removal efficiency data at a higher flow rate. Each run will last 4 hours. Fresh filter packs will be used for each run.

The group two configuration will employ two separate colloid filter units each unit with one filter pack; this will require two end plates for each unit. This configuration will allow the filter units to operate in parallel, provide two separate sets of data, and minimize the volume of water and time required to approach breakthrough of the filter bed material. There will be two separate effluent streams for this configuration. The filter cake from each filter pack will be sampled prior to stabilization. Fresh filter packs will be used for the breakthrough run. This run should last approximately 24 hours. Breakthrough may not be reached within this period, but the trend analyses from the demonstration should provide a good indication of when it might occur. The length of this run may also be reduced if it can be determined that breakthrough will occur before 24 hours have expired.

The effluent from each run will be routed to the effluent pH adjustment tank. Here, hydrochloric acid will be added to the vessel to lower the pH to the original level, approximately 8. After 20 to 30 minutes, the material is continuously pumped to the IM/IRA storage tank.

After each run, the processing equipment (without filter packs in place) will be purged for 10 minutes with clean water at 5 gpm. This purge water will also be discharged to the IM/IRA tanks.

The field equipment will be designed to process up to 50 gpm of water, but the demonstration will only be run at 5 and 10 gpm. Between 1,200 gallons and 15,000 gallons of storage tank water

will be required per operating day. Between 200 and 1,200 gallons of clean water will be required per day for preruns and flushing between runs. Table 5-3 summarizes the water needs for the field demonstration. Clean water will be kept in a portable storage tank and refilled by tanker truck when needed. The storage tank water will be pumped directly to the mini clarifier rather than to an influent holding tank. Due to the nature of the water contamination, the PRC SITE team and EG&G staff decided that equipment exposure to the untreated influent should be minimized and an influent holding tank should be eliminated. The capacity of the IM/IRA tank is 500,000 gallons. EG&G officials stated that one of the storage tanks should be full and another should be half-full during normal operations. Thus, a shortage of influent is not expected.

Preliminary calculations estimate 10 gallons (approximately 50 pounds) of filter cake would be produced for a 1-week testing period. Potential characteristics of the filter cake are based on bench-scale and treatability study results. Due to the presence of TCLP metals, the filter cake produced in the demonstration will probably be low-level mixed waste. The organic concentration of the influent water treated is at or below detection limits. Thus, it is unlikely the filter cake will contain organic concentrations above TCLP levels. The filter cake will be sampled prior to stabilization to gather qualitative information concerning the removal efficiency of the treatment system and the effectiveness of the stabilizing agent. All filter cake and prefiltered solids will be composited, stabilized, and sampled to facilitate storage.

The PRC SITE team plans to complete one test run per day. The schedule is summarized below:

| <u>WEEK</u> | <u>DAY</u> | <u>ACTIVITY</u> |
|-------------|------------|--|
| 1 | 1-4 | Set up, area preparation, and equipment assembly |
| | 5 | Preruns 1 and 2 |
| <u>WEEK</u> | <u>DAY</u> | <u>ACTIVITY</u> |
| 2 | 1 | Runs 1 and 2 |
| | 2 | Runs 3 and 4 |
| | 3-4 | Run 5 |
| | 5 | Free day |
| 3 | 1-5 | Decontamination, equipment disassembly, and demobilization |

**TABLE 5-3
SUMMARY OF WATER NEEDS FOR THE CPFPM TECHNOLOGY DEMONSTRATION***

| | RUNS | | | | | | |
|--------------------------------------|------|-------|-----|-----|-----|-----|--------|
| | P1 | P2 | 1 | 2 | 3 | 4 | 5 |
| Clean (Process) Water | * | | | | | | |
| gpm ^b | 5 | 10 | 5 | 5 | 5 | 10 | 5 (10) |
| Flush time ^c (minutes) | 120 | 120 | 30 | 30 | 30 | 30 | 30 |
| Purge time ^d (minutes) | -- | -- | 10 | 10 | 10 | 10 | 10 |
| Total (gallons) | 600 | 1,200 | 200 | 200 | 200 | 400 | 400 |

Total clean water = 3,200 gallons

| | | | | | | | |
|----------------------------|----|----|-------|-------|-------|-------|---------------------|
| Influent Water | | | | | | | |
| gpm ^b | -- | -- | 5 | 5 | 5 | 10 | 5 (10) ^e |
| Length of run (minutes) | | | 240 | 240 | 240 | 240 | 1,440 |
| Total (gallons) | | | 1,200 | 1,200 | 1,200 | 2,400 | 14,400 |

Total influent water = 20,400 gallons

Notes:

- * This summary does not include water for decontamination purposes.
- ^b gpm = gallons per minute
- ^c Flush time includes processing clean water during the preruns and the first 30 minutes of each run when clean water is sent through the system to wet the filter packs.
- ^d Purge time includes the 10 minutes after a run is complete when the spent filter packs are removed and the system is purged at 5 gpm with clean water.
- ^e Five gpm represents the flow rate to each filter bed. Since there will be two colloid units in parallel, a total volumetric flow rate of 10 gpm will be required for Run 5.

The schedule offers some flexibility because the preruns can be performed in the later half of week 1, and Runs 1 through 5 can be performed in week 2 (with 1 day free for problem solving). Work is not scheduled for the weekends but can be scheduled to make up lost time.

5.4 OPERATING PLAN

Site Preparation, Equipment Set-up, and Waste Collection

Site preparation, equipment set-up, and waste collection include the following activities:

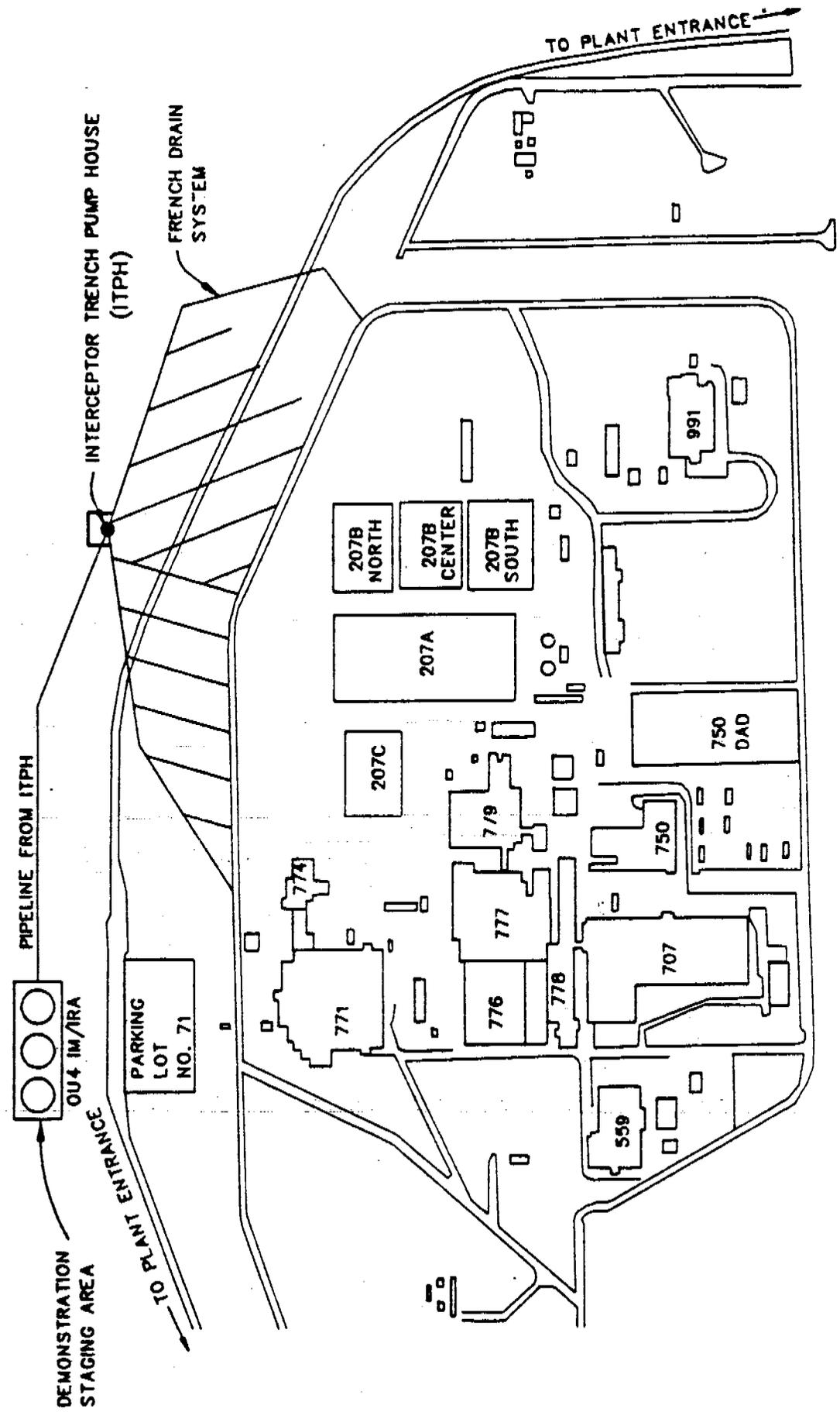
- Providing site improvements
- Providing health and safety equipment
- Transporting and assembling the CPFM system equipment
- Connecting utilities
- Collecting wastes for treatment

Providing Site Improvements

The demonstration area will be located adjacent to the IM/IRA tanks in the tank pad area (see Figure 5-1). Minimal site preparation will be required because the system will be mounted for transportation and operated on a flat-bed trailer. The trailer will be parked in a bermed area.

An area (approximately 10 feet by 10 feet) adjacent to and west of the CPFM staging area will be reserved for storing drums containing potentially hazardous waste. This area will be lined with polyethylene sheeting (at least 30 millimeters thick) and surrounded by a berm constructed of either wood or sand bags.

Earth work will not be required at the site, as maintained and dirt roads lead to the test area and a well graded area exists for placement of the process system. Fencing of the demonstration area will not be required because this area is within the RFP secured area.



SITE CPFM DEMONSTRATION
 ROCKY FLATS PLANT - GOLDEN, COLORADO

FIGURE 5-1
 SOLAR EVAPORATION
 PONDS LOCATIONS

FMC ENVIRONMENTAL MANAGEMENT, INC.

SCALE: NOT TO SCALE

PRC will install an office and laboratory trailer or rent a small recreational vehicle. This trailer is expected to be located in the parking lot downhill of the demonstration area. The trailer will serve as a field office and on-site laboratory and will store small equipment (for example, sampling, monitoring, and health and safety equipment). The trailer will also serve as an area where daily meetings may be held with on-site personnel involved in the demonstration. PRC will also install two portable toilets near the office and laboratory trailer. Folding tables, with an overhead tarp, will be set up adjacent to the CPFM trailer. These tables will be used for sample preservation and shipping preparation.

Providing Health and Safety Equipment

The PRC SITE team will supply all health and safety equipment for its field personnel and for EPA personnel. Health and safety equipment will be delivered to the site and stored in the office and laboratory trailer. FFT will be responsible for supplying health and safety equipment for its field personnel. The PRC SITE team's detailed health and safety plan for the demonstration appears in Appendix B.

Transporting and Assembling CPFM System Equipment

FFT will be responsible for supplying all equipment necessary for transporting and assembling the process equipment at RFP. The CPFM system equipment is to be transported to the site on a flat-bed trailer. EG&G will install all piping and appurtenances necessary for transporting the IM/IRA tank water to the treatment system. In addition, EG&G will be responsible for installing equipment to transport treated water from the treatment unit (on the flat-bed trailer) back to the IM/IRA tank (see Section 2.2.4). FFT will be responsible for connecting influent and effluent lines to the CPFM system.

Connecting Utilities

PRC will coordinate with EG&G to provide electricity required at process system locations specified by FFT. PRC will arrange for the installation of metering devices for measuring the electricity used by the CPFM system. EG&G will connect power lines to the demonstration

equipment and the office and laboratory trailer, if needed. In addition, electricity will be supplied to flood lamps to be used while operating the system at night.

PRC will obtain high performance liquid chromatography (HPLC) grade distilled water from PRC's equipment warehouse for measurement instrumentation decontamination. PRC will purchase distilled water for sampling equipment decontamination from a local grocery store. All distilled water will be stored in the on-site office laboratory trailer.

PRC will procure a 1,000-gallon storage tank for storing process water. PRC will coordinate with EG&G to determine where water may be accessed for this purpose, and to determine possible methods for filling the 1,000-gallon storage tank. If necessary, a tanker truck may be rented for supplying process water at the site.

Telephone communication will be through two cellular phones.

Collecting Waste for Treatment

The CPFM technology will be demonstrated using water stored in the IM/IRA tanks. Three 500,000-gallon tanks will be used to store ground water collected in the ITPH sump from the interceptor trench system (french drain) surrounding the solar evaporation ponds. EG&G staff stated that one tank should always be full, another tank may be half-full, and the third tank is an emergency storage tank. The easternmost tank is the tank that will always be full. This tank will supply the influent stream for the process. It will also receive the treated effluent from the treatment system. Due to the large volume of water in the tank, it is highly unlikely that dilution of the influent stream will result from the effluent stream being pumped back to the tank.

System Startup and Demonstration

FFT will conduct startup testing of its demonstration equipment after site preparations are completed, demonstration equipment and support facilities are installed and connected to utilities, and monitoring equipment has been calibrated (the developer is responsible for calibrating all monitoring equipment associated with the CPFM system). During startup, two preruns using clean water will be

conducted at flow rates of 5 and 10 gpm, respectively. Each prerun will last for a period of 2 hours. During each prerun, piping will be checked for leaks and all monitoring and process equipment will be inspected for proper operation. Any problems or deficiencies identified during the startup phase will be corrected before the demonstration begins.

After startup procedures are completed, the demonstration program will begin. During the demonstration, five test runs will be performed in 1 week. Process monitors, meters, and instruments will be calibrated prior to each prerun and test run.

Only one operating parameter, water flow rate, and one equipment set-up parameter, bed configuration, will be varied during the demonstration. Other process parameters, such as operating pressure and FF 1000 volume, will be constant. The first three runs will be at a constant flowrate of 5 gpm and will determine the system's ability to consistently produce treated water meeting effluent goals. The fourth run will be performed at 10 gpm. This run will provide data indicating the effect of increasing process flowrate on effluent quality. The CPFM system will be operated for 4 hours during the first four runs. In order to induce high removal efficiencies within the system and minimize the volume of water required, all four runs will be conducted using three filter packs in series.

The final run will determine the time required to reach breakthrough in the filter packs. For the purpose of this demonstration, breakthrough will be defined as the point at which effluent goals for radionuclides are no longer achieved. Run 5 will be performed using two colloid filter units with one pack each in parallel and a flowrate of 5 gpm. This run will be approximately 24 hours. Less time may be allotted to determine breakthrough of the filter packs. In the event that an insufficient amount of ITPH water is available to reach breakthrough, or breakthrough is not actually reached in 24 hours, the data will be analyzed to estimate the predicted time required for breakthrough.

All filter cake will be removed from the filter packs and sampled before and after stabilization. The packs will be opened, sampled, and disposed in accordance with procedures outlined in Appendix A.

During each test run, liquid and solid samples will be collected. Liquid samples include untreated water; prefiltered water (the intermediate stream); and effluent water. Solid samples include prefiltered solids, filter cake removed from the filter packs before stabilization, and the stabilized mixture (filter cake and prefiltered solids). The majority of the samples will be sent to Radian's laboratory in Austin, Texas for analyses. Plutonium and americium analysis will be conducted at Accu-labs in Golden, Colorado. Some samples will be collected for field measurements. The number of samples to be collected at each location, the frequency of sampling, and the rationale for sampling and analysis parameters are presented in Appendix A. The parameters to be analyzed on-site versus off-site are also discussed in Appendix A.

Due to the lack of homogeneity of the filter cake in the pack, a mass balance across the system (including liquid and solid material) may not prove worthwhile. A mass balance across the system will not provide good quality data because the CPFM treatment system is not a perfectly closed-loop system. Potential interferences, both chemical (unpredicted chemical complexing) and physical (adsorption of contaminants onto the process equipment), make an accurate mass balance difficult. The level of filter cake contamination will be determined for disposal purposes.

After each demonstration run, the CPFM system equipment will be flushed with clean (process) water.

Decontamination and Demobilization

Decontamination will be necessary for the CPFM demonstration equipment, support equipment, and sampling equipment. FFT will be responsible for decontaminating the demonstration unit. EG&G will be responsible for decontaminating support equipment (such as piping to and from the demonstration unit). PRC will be responsible for decontaminating all sampling equipment.

Disposable sampling equipment will be used as much as possible, thereby removing the need for decontamination after each run. Disposable protective clothing, such as coveralls and gloves, will be collected in 55-gallon drums and disposed of as directed by EG&G.

Stainless steel scoops will be used to sample filter cake solids and will require decontamination during the technology demonstration. Decontamination procedures for the sampling equipment are described in Appendix A.

CPFM equipment will be decontaminated before being transported to the site and after the demonstration. Any process equipment which has been potentially exposed to the contaminated water or other hazardous materials and is readily accessible will be decontaminated using high pressure steam. Decontamination of the process equipment may take place at a separate decontamination area at RFP. EG&G will dictate the specific decontamination procedures required. Decontamination water (decon water) will be collected in drums and routed to the IM/IRA tank. Process equipment (such as piping and pumps) will be decontaminated by flushing the system with process water for a 30-minute period. This decon water will also be routed to the IM/IRA tank.

After the demonstration program is completed and on-site equipment is disassembled and decontaminated, demobilization activities will begin. Demobilization of the CPFM process equipment will be the responsibility of FFT. Equipment demobilization will include disconnecting utilities (EG&G's responsibility), transporting the trailer-mounted equipment off-site, and returning support equipment rented by the PRC SITE team. EG&G will make final disposal arrangements for wastes generated from decontamination activities. After the demobilization is completed, PRC, EPA, DOE, and EG&G will perform a final inspection of the site and confirm that the site is restored to its original condition.

Soil samples will be collected for analysis in the event that soils may have been exposed to contaminated water or other hazardous materials as a result of spills. The number and location of samples will depend on the suspected extent of contamination. Samples will be placed in appropriate containers, labeled with the required data, field logged, immediately placed on ice in portable chests (if necessary), and sent to the laboratory for analysis. If contamination above acceptable levels is detected, the soil will be excavated, drummed, and disposed in accordance with federal and state requirements under the guidance of EG&G and the financial support of Superfund.

6.0 EQUIPMENT AND MATERIALS

The following main components make up the CPFM system: (1) mini clarifier with filter press, (2) bag filters, (3) transfer pumps, (4) colloid filter units, (5) an effluent pH adjustment tank, and (6) filter cake stabilizing equipment.

The mini clarifier has a nominal volume of 500 gallons. It is designed to allow bulk solids to settle out of the influent prior to treatment in the CPFM system. It is also equipped with a mixer in the mixing section if chemical addition is required.

The bag filters are made of heavy-duty filter cloth which acts as in-line screens to remove particles larger than 10 microns. The separated particles are removed from the bag filters and placed in the solids disposal container for stabilization with ChemSorb-500. They will be disposed with any collected prefiltered solids. Fresh bag filters will be used for each run.

Transfer pumps are required for pumping the water between the filter press and mini clarifier, to the colloid filter unit, to the effluent holding tank, and to the IM/IRA storage tank. These diaphragm pumps have a rated capacity of 25 gpm. The transfer pump to the colloid filter unit is controlled with an air pressure gauge which operates between 5 and 100 psig. The other pumps will be equipped with a rotameter downstream of the discharge side. The CPFM system also includes two 20-gallon buckets, each equipped with a small, less than 5 gpm, transfer pump to store and pump the sodium hydroxide and hydrochloric acid solutions.

The colloid filter unit is approximately 7 feet high and 3 feet square. It is skid mounted, preassembled, and has few moving parts. It is equipped with influent and effluent polyvinyl chloride (PVC) piping and valves. The filter plates are positioned on vertical supporting bars and pressed together using a hand controlled hydraulic pump to approximately 50,000 psig of pressure. Filter plates are 26 inches square, have a 2-inch width, and are constructed of very strong plastic. Each filter pack is constructed of a durable, fibrous, polymer material. They each contain a premeasured amount (approximately 0.364 cubic feet) of the complexing agent FF 1000. The filter packs are placed horizontally between facing plates. Each pack is equipped with edge tabs for handling.

The effluent pH adjustment tank uses a hydrochloric acid solution to adjust the pH to approximately 8. The tank is constructed of polyethylene, has a capacity of 200 gallons, and is equipped with a mixer.

The filter cake stabilizing equipment consists of two 55-gallon drums, one 30-gallon solids mixing vessel, and a solids mixing device. The ChemSorb-500 will be added directly to the solids mixing vessel with pour spouts from the storage bags.

All the components of the CPFM system that come in direct contact with the contaminated water and filter cake are made of stainless steel, Teflon®, or plastic to minimize contamination of the process stream by the construction materials.

All process equipment will be mounted and operated on the bed of a trailer truck. The developer claims that once on-site, the unit can be operational within a week if all the necessary facilities, equipment, utilities, and supplies are available. On-site assembly and maintenance requirements are expected to be minimal. After the demonstration is completed, the unit should be demobilized within 1 week.

6.1 SITE PREPARATION AND TECHNOLOGY SUPPORT REQUIREMENTS

Before the CPFM system can be mobilized onto RFP, an area must be prepared to meet the needs of the technology demonstration. Minimal site preparation is expected because the system can be mounted, operated, and tested on a flat-bed trailer. Also, the demonstration staging area is already level and covered with loose gravel so excavation and compacting will not be needed.

Approximately 1,000 square feet (approximately 45 by 22 feet) of relatively flat ground surface is needed for the trailer and demonstration support equipment such as folding tables, chemical drum storage, and potentially hazardous waste storage containers. The office and field laboratory trailer will be parked in a nearby parking lot to minimize potential contamination of the trailer and avoid congestion at the demonstration staging area. After the demonstration, all equipment will be decontaminated and removed off-site if it meets DOE and EG&G requirements for off-site removal. If it does not, the equipment will be stored on RFP and become the property of DOE.

Technology Support Requirements

Technology support requirements, including utilities, facilities, equipment, services, and supplies, are described below.

Utilities

Utilities required for the demonstration include the following:

Water: Clean (process) water is required for system operation and process equipment and personnel decontamination. During operation, the system will require process water for the preruns and for wetting the filter packs and flushing between the test runs. Decontamination needs are estimated to be 50 gpd. A 60 psi hose connection will be needed for decontamination. Final decontamination will require about 1,000 gallons of water. Water usage will be recorded for each run. Drinking water (bottled water) needs are estimated to be 5 to 10 gpd.

Electricity: Electricity is needed for the process equipment and field laboratory equipment. The equipment requires 120 volt, 30 amperes electrical service. Additional electrical outlets will be needed mainly for operating the field and laboratory equipment. A diesel powered electric generator will be procured. A backup generator will also be available during the demonstration, should the initial generator fail. A separate, smaller generator may be needed to operate a field trailer (unless a recreational vehicle is rented). Electrical power usage will be measured by a standard watt meter.

Compressed Air: An air compressor and related equipment for generating compressed air at a minimum of 100 psi are required for operating the process equipment. An air compressor will be brought on-site and hooked up to the electric generator.

Telephone: Telephone service is required mainly for ordering equipment, parts, chemical supplies, scheduling deliveries, and emergency communications. Two cellular telephones are preferred.

Facilities

Support facilities needed for the demonstration include an office trailer measuring 10 feet by 20 feet with furniture and filing cabinets to file data collection reports and store small equipment and supplies. A small recreational vehicle may be rented instead of an office trailer. EG&G staff stated it is sometimes difficult to get a trailer to particular locations on the plant site.

One portable chemical toilet will be required near the office trailer, unless a recreational vehicle is rented and equipped with a restroom.

Equipment

Support equipment includes storage tanks for equipment washdown and decontamination rinse waters, equipment for filter cake disposal, a dumpster, a forklift with operator, pumps, sampling equipment, health and safety-related gear, and a van. Specific items include:

- One 500-gallon, polyethylene storage tank to contain the equipment washdown and decontamination rinse waters
- Two 55-gallon stainless steel drums with lids for filter cake disposal, and two 55-gallon open head plastic lined drums to store used disposable health and safety and sampling gear prior to disposal
- One 55-gallon open head plastic lined drum to use as a solid waste dumpster to store nonhazardous wastes prior to disposal
- Decontamination appurtenances as required by RFP standard operating procedures.
- A forklift with operator for equipment set-up and for moving drummed wastes
- Sampling equipment to sample aqueous media and contain the filter cake, described in Appendix A
- Analytical equipment for measuring parameters at the demonstration site, described in Appendix A
- Health and safety-related equipment, such as a first-aid kit and protective coveralls, latex or similar inner gloves, nitrile outer gloves, steel-toed boots, disposable overboots, safety glasses, air purifying respirators, and hard hats

- Equipment to stabilize the filter cake including, at a minimum, long handled plastic paddles for mixing composite cake
- A van to transport oversight personnel and supplies

Services and Supplies

Supplies required for the demonstration include various reagents, chemicals, office supplies, and sampling supplies. Specific supplies include the following:

- Laboratory reagents, chemicals, and deionized or distilled water for conducting field analyses and rinsing sampling equipment.
- Office supplies such as folding tables, chairs, filing cabinets, lamps, paper and writing supplies, and a tarp to place over the field folding tables.
- Sampling supplies, such as sampling bottles and containers, ice, labels, forms, and shipping containers. The quantities and types of sampling supplies will be based on the analyses to be performed as described in Appendix A.

Services for this demonstration, including area security, will be provided by EG&G.

7.0 ANALYTICAL PROCEDURES AND DATA MANAGEMENT

The samples collected during the CPFM treatability study will be analyzed using approved methods. These methods will yield scientifically valid, defensible, and comparable data through proper data management. These analytical procedures and data management are discussed in the following sections.

7.1 ANALYTICAL PROCEDURES AND CALIBRATION

The methods and procedures used to prepare and analyze samples are discussed below.

7.1.1 Selection of Analytical Methods

In selecting appropriate methods to analyze the samples from the CPFM treatment system, the PRC SITE team has taken into account the specific analytes of interest, the sample matrix, and the minimum detectable concentrations needed for the project. The selection process involved the following hierarchy:

- (1) EPA-approved methods described in the following references:
 - (a) *Test Methods for Evaluating Solid Waste, Volumes IA-IC: Laboratory Manual, Physical/Chemical Methods; and Volume II: Field Manual, Physical/Chemical Methods*, SW-846, Third Edition, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, 1986.
 - (b) *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, Revised March 1983, Environmental Monitoring and Support Laboratory, Cincinnati, OH, U.S. Environmental Protection Agency, and subsequent EPA-600/4 Technical Additions.
 - (c) *Prescribed Procedures for Measurement of Radioactivity in Drinking Water*, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, EPA-600/4-80-032, 1980.
- (2) Approved standard methods such as *Standard Methods for the Examination of Water and Wastewater*, 17th Edition, APHA, AWWA, and WPCF, 1989.
- (3) Other standard methods, such as those published by the American Society of Testing Materials (ASTM).

- (4) Published methods with pertinent method validation data, if available.

Table 7-1 summarizes the analytical methods chosen. Table 7-2 summarizes the calibration requirements for each method. Additionally, the calibration procedures are described in more detail in Section 7.1.2. The radionuclides will be analyzed using EPA- or ASTM-approved methods where applicable.

7.1.2 Calibration Procedures and Frequency for Analytical Equipment

This section describes the calibration procedures and frequency of calibration for each analytical system. Specific calibration procedures for standard, EPA-approved methods are described in the published method protocols that are referenced. A summary of calibration procedures appears in Table 7-2, including frequency of calibration checks, acceptance criteria, and corrective action.

Calibration standards are prepared from standard reference materials obtained from EPA or commercial sources. Calibration check samples are prepared independently or from sources other than that used for calibration. Calibration data will be recorded in the instrument log book and referenced to the standards preparation log to identify the source and method of preparation of the standard solutions used. All the field analytical equipment will be calibrated prior to shipment to the field. The following sections describe calibration procedures.

7.1.2.1 Analysis for Extremely Low Levels of Plutonium and Americium in Water

Methods for the analysis of extremely low levels of plutonium and americium in water, less than 0.5 pCi/L, are often developed independently at various nuclear facilities. The method selected for this situation is that developed at RFP *Maximum Sensitivity Procedures for Isolation of Plutonium and Americium in Compositing Water Samples*, RFP Procedure Number HEA-0018. This procedure has been used by RFP personnel to analyze hundreds of samples annually and has been validated by RFP. Because the method is not widely published, a brief summary is included below.

TABLE 7-1

CPFM TECHNOLOGY DEMONSTRATION
SUMMARY OF ANALYTICAL METHODS

| Parameter | Sample Type | Method Number | Method Title | Method Type |
|----------------------|------------------|---|---|--|
| RADIONUCLIDES | | | | |
| Isotopic uranium | Solid and liquid | D3972-80/HEA-0011-01 ¹ | Isotopic uranium in water by radiochemistry | Alpha spectrometry |
| Gross alpha | Solid and liquid | 3050 ⁰ /900 ⁰ | Gross alpha and beta | Alpha and beta gas flow proportional counter |
| Radium - 226 | Solid and liquid | 3050 ⁰ /903 ⁰ | Alpha emitting radium, isotopes in drinking water | Alpha scintillation counter |
| Plutonium - 239, 240 | Solid and liquid | EPA-600/7-79-081/HEA-0018-01 ¹ | Plutonium-239, -240 | Ion exchange, alpha spectrometry |
| Americium - 241 | Solid and liquid | EPA-600/7-79-081/HEA-0018-01 ¹ | Americium - 241 | Ion exchange, alpha spectrometry |
| ANIONS | | | | |
| Fluoride | Liquid | 300 ⁰ | Ion chromatography determination: chloride, fluoride, nitrate, nitrite, and sulfate | Ion chromatography |
| Chloride | Liquid | 300 ⁰ | Ion chromatography determination: chloride, fluoride, nitrate, nitrite, and sulfate | Ion chromatography |
| Nitrite/nitrate | Liquid | 353.1 ¹ | Nitrate-nitrite nitrogen | Colorimetric determination |
| Sulfate | Liquid | 300 ⁰ | Ion chromatograph determination: chloride, fluoride, nitrate, nitrite, and sulfate | Ion chromatography |
| Phosphate | Liquid | 365.2 ¹ | Phosphorus (all forms) | Colorimetric determination |
| Carbonate | Liquid | 310.1 ¹ | Alkalinity | Titration |
| Ammonia | Liquid | 350.1 ¹ | Ammonia | Colorimetric determination |

TABLE 7-1

CPFM TECHNOLOGY DEMONSTRATION
SUMMARY OF ANALYTICAL METHODS
(Continued)

| Parameter | Sample Type | Method Number | Method Title | Method Type |
|----------------------------|------------------|-------------------|---|--------------------|
| ICP METALS | | | | |
| Aluminum | Solid and liquid | 30507/30107/60107 | Acid digestion of aqueous samples and extracts for total metals analysis by Inductively Coupled Plasma (ICP) spectroscopy | Digestion/ICP |
| Antimony | | | | |
| Arsenic | | | | |
| Barium | | | | |
| Beryllium | | | | |
| Boron | | | | |
| Cadmium | | | | |
| Calcium | | | | |
| Chromium | | | | |
| Cobalt | | | | |
| Copper | | | | |
| Iron | | | | |
| Lead | | | | |
| Magnesium | | | | |
| Manganese | | | | |
| Molybdenum | | | | |
| Nickel | | | | |
| Potassium | | | | |
| Selenium | | | | |
| Silicon | | | | |
| Silver | | | | |
| Sodium | | | | |
| Strontium | | | | |
| Thallium | | | | |
| Vandium | | | | |
| Zinc | | | | |
| ORGANIC COMPOUNDS | | | | |
| Total Organic Carbon (TOC) | Liquid | 90607 | Total organic carbon | Infrared |
| Total Organic Carbon (TOC) | Solids | Radinn SOP | Total organic carbon | Elemental analyzer |

TABLE 7-1

CPFM TECHNOLOGY DEMONSTRATION
SUMMARY OF ANALYTICAL METHODS
(Continued)

| Parameter | Sample Type | Method Number | Method Title | Method Type |
|---|------------------|---------------|--|----------------------------|
| Volatle Organic Compounds (VOC) | Liquid | 8240* | Gas chromatography and mass spectroscopy (GC/MS) for volatile organics | GC/MS |
| LEACHING TESTS | | | | |
| Toxicity Characteristic Leaching Procedure (TCLP) | Solid | 1311* | Toxicity characteristic leaching procedure | Extraction procedure |
| ON-SITE MONITORING | | | | |
| pH | Liquid | 150.1† | pH | Electrochemical |
| Flow rate | Liquid | NA | NA | Rotameter |
| Pressure | Liquid | NA | NA | Pressure gauge |
| Electrical conductivity | Liquid | 2510* | Specific conductance | Electrical resistivity |
| Temperature | Liquid | 2550* | Temperature | Thermocouple |
| Filter cake mass | Solid | NA | Gravimetric | Gravimetric |
| Free liquids | Semi-solid | 9095* | Paint Filter Liquids Test (PFLT) | Filtration/volumetric |
| PHYSICAL CHARACTERISTICS | | | | |
| Moisture content | Solid/semi-solid | D2216* | Moisture content | Gravimetric |
| Bulk Density | Solid/semi-solid | D2937-83* | Bulk density | Gravimetric and volumetric |
| OTHERS | | | | |
| Total suspended solids | Liquid | 160.2† | Total suspended solids | Gravimetric and volumetric |
| Total dissolved solids | Liquid | 160.1† | Total suspended solids | Gravimetric and volumetric |

TABLE 7-1

**CPFM TECHNOLOGY DEMONSTRATION
SUMMARY OF ANALYTICAL METHODS
(Continued)**

NOTES:

- Acid Dissolution Method for Analysis of Plutonium in Soils, U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, 1979.
- Maximum Sensitivity Procedures for Isolation of Plutonium and Americium in Compositied Water Samples, Rocky Flats Plant Health and Safety Laboratories, Golden, Colorado, 1990.
- Test Methods for Evaluating Solid Waste, Volumes IA-IC: Laboratory Manual, Physical/Chemical methods; and Volume II Field Manual, Physical/Chemical Methods, SW-846, Third Edition, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, 1986.
- Prescribed Procedures for Measurement of Radioactivity in Drinking Water, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, EPA-600/4-80-032, 1980.
- American Society of Testing Materials (ASTM), 1980, 1983.
- Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, U.S. Environmental Protection Agency, 1983, and subsequent EPA-600/4 Technical Additions.
- Standard Methods for the Examination of Water and Wastewater, 17th Edition, APHA, AWWA, and WPCF, 1989.
- Radian standard operating procedure for TOC using a Perkin Elmer 240C Elemental Analyzer.
- Analysis of Uranium in Water by Anion Exchange, Rocky Flats Plant Health and Safety Laboratories, Golden, Colorado, 1991.

TABLE 7-2
CPFM TECHNOLOGY DEMONSTRATION
SUMMARY OF CALIBRATION REQUIREMENTS

| Parameter | Analytical Method | Calibration | Frequency | Acceptance Criteria | Corrective Action |
|----------------------|---------------------------------|------------------------|----------------------------|--|-----------------------------|
| RADIONUCLIDES | | | | | |
| Isotopic uranium | 3050/D3972-82 ^c | Multipoint calibration | NA | Refer to method | Internal sample calibration |
| Gross alpha | 900.0 ^b | Multipoint calibration | As required by lab manager | Refer to method | Recalibrate |
| Radium - 226 | 903.0 ^b | Multipoint calibration | As required by lab manager | Refer to method | Recalibrate |
| Plutonium - 239,240 | Alpha Spectrometry ^a | Multipoint calibration | NA | Refer to method | Internal sample calibration |
| Americium-241 | Alpha Spectrometry ^a | Multipoint calibration | NA | Refer to method | Internal sample calibration |
| ANIONS | | | | | |
| Fluoride | 300.0 ^f | Multipoint calibration | Daily | Correlation coefficient \geq 0.995 | Recalibrate |
| Chloride | 300.0 ^f | Multipoint calibration | Daily | Correlation coefficient \geq 0.995 | Recalibrate |
| Nitrite/nitrate | 353.1 ^f | Multipoint calibration | Daily | Correlation coefficient \geq 0.995 | Recalibrate |
| Sulfate | 300.0 ^f | Multipoint calibration | Daily | Correlation coefficient \geq 0.995 | Recalibrate |
| Phosphate | 365.2 ^f | Multipoint calibration | Daily | Correlation coefficient \geq 0.995 | Recalibrate |
| Carbonate | 310.1 ^f | Multipoint calibration | Daily | Duplicate analyses within \pm 5% of each other | Recalibrate |
| Ammonia | 350.1 ^f | Multipoint calibration | Daily | Correlation coefficient \geq 0.995 | Recalibrate |

TABLE 7-2
 CPFM TECHNOLOGY DEMONSTRATION
 SUMMARY OF CALIBRATION REQUIREMENTS
 (continued)

| Parameter | Analytical Method | Calibration | Frequency | Acceptance Criteria | Corrective Action |
|--------------------------------------|------------------------------|--|--|---|---|
| METALS (ICP)^d | | | | | |
| Aluminum | 3050, 3010/6010 ^e | Mixed standard calibration | Daily, prior to analysis | Daily initial calibration and comparison to an outside reference standard within ± 10 percent of expected value | Repeat calibration |
| Antimony | | | | | |
| Arsenic | | Calibration check | 10 percent | $\pm 10\%$ | (1) repeat twice (2) evaluate system (3) recalibrate (4) reanalyze last 10 samples |
| Barium | | | | | |
| Beryllium | | | | | |
| Boron | | | | | |
| Cadmium | | | | | |
| Calcium | | | | | |
| Chromium | | | | | |
| Cobalt | | | | | |
| Copper | Calibration check | 10 percent | Measured value within 10 percent of expected value | (1) evaluate system (2) recalibrate | |
| Iron | | | | | |
| Lead | | | | | |
| Magnesium | | | | | |
| Manganese | | | | | |
| Molybdenum | | | | | |
| Nickel | | | | | |
| Potassium | | | | | |
| Selenium | | | | | |
| Silicon | | | | | |
| Silver | | | | | |
| Sodium | | | | | |
| Strontium | | | | | |
| Thallium | | | | | |
| Vanadium | | | | | |
| Zinc | | | | | |
| ORGANIC COMPOUNDS | | | | | |
| Total organic carbon (TOC) (liquids) | 9060 ^e | Multipoint calibration (3-level minimum) | Daily | Correlation coefficient > 0.995 | Repeat calibration |

TABLE 7-2

**CPFM TECHNOLOGY DEMONSTRATION
SUMMARY OF CALIBRATION REQUIREMENTS**
(continued)

| Parameter | Analytical Method | Calibration | Frequency | Acceptance Criteria | Corrective Action |
|--|--------------------------------------|---|--|---|---|
| ORGANIC COMPOUNDS (continued) | | | | | |
| Total organic carbon (TOC) (solids) | Radian SOP ^a | Multipoint calibration | Daily | ±5 of K factor | Recalibrate |
| | | Calibration check sample | Daily prior to analysis and at a frequency of 1 in 10 during the run | ±10% of true value | (1) Evaluate system (2) Rerun CCS (3) Recalibrate |
| | | QC check sample | 5% of the total number of samples | ±20% of true value | (1) Evaluate system (2) Rerun QC (3) Run CCS |
| Volatile organic compounds (VOC) | 8240 ^a | Tune GC/MS using bromofluorobenzene | Daily prior to analyses | Refer to method | Rerun |
| | | System performance check compounds | Every 12 hours | Minimum response factor (FR) is 0.300 | Evaluate system |
| LEACHING TESTS | | | | | |
| Toxicity characteristic leaching procedure | 1311 ^a /8240 ^a | Balance calibration (2 points minimum) | Daily | ±0.01 gram | Service balance |
| | | pH probe and meter calibration (2 points minimum) | Daily and before and after measurement sequence | Reading with 0.05 pH units of buffer solution | Recalibrate or replace |
| | | pH probe and meter calibration (2 points minimum) | Daily and before and after measurement sequence | Reading with 0.05 pH units of buffer solution | Recalibrate or replace |
| ON-SITE MONITORING | | | | | |
| pH | 150.1 ^a | pH probe and meter calibration (2 points minimum) | Daily and before and after measurement sequence | Reading with 0.05 pH units of buffer solution | Recalibrate or replace |

TABLE 7-2

**CPFM TECHNOLOGY DEMONSTRATION
SUMMARY OF CALIBRATION REQUIREMENTS
(continued)**

| Parameter | Analytical Method | Calibration | Frequency | Acceptance Criteria | Corrective Action |
|---|-----------------------|---|---------------------------|--|--|
| Flow rate | NA | Check flow rate by recording time required to fill up 1,000 mL graduated cylinder (3 times and average results) | Daily | Flow rate within 0.1 gallons per minute | Record difference and adjust flow rate readings |
| <u>ON-SITE MONITORING</u> (continued) | | | | | |
| Pressure | NA | Pressurize system without filter packs, record pressure upstream and downstream of filter press | Prior to Run Nos. 1 and 3 | ±2.0 pounds per square inch gauge (psig) | Record difference and adjust pressure loss readings accordingly Replace gauges |
| Electrical conductivity | 2150 ^c | Check conductivity meter and probe with standard reference solution | Daily | 2.0 psig difference ±0.1 μmhos/cm | Correct readings in accordance with manufacturers instructions Calibrate or replace |
| Temperature | MC 170.1 | Single point calibration and zero with certified thermometer | Daily | ±0.5°C | |
| Filter cake mass | Balance | Two points calibration with NIST traceable weights | Daily | ±0.01 gram | Service or replace balance |
| Free liquids | 9095 ^c | NA | NA | NA | NA |
| <u>PHYSICAL CHARACTERISTICS</u> | | | | | |
| Moisture content | D2216 ^c | Two point calibration of balance | Daily | ±0.01 gram | Service or replace balance |
| Bulk density | D2937-83 ^c | Two point calibration of balance | Daily | ±0.01 gram | Service or replace balance |

TABLE 7-2

**CPFM TECHNOLOGY DEMONSTRATION
SUMMARY OF CALIBRATION REQUIREMENTS**
(continued)

| Parameter | Analytical Method | Calibration | Frequency | Acceptance Criteria | Corrective Action |
|------------------------|--------------------|----------------------------------|-----------|---------------------|--------------------|
| OTHERS | | | | | |
| Total suspended solids | 160.2 ^f | Two point calibration of balance | Daily | ±0.01 gram | Service or balance |
| Total dissolved solids | 160.2 ^f | Two point calibration of balance | Daily | ±0.01 gram | Service or balance |

NOTES:

- ^a Acid Dissolution Method for Analysis of Plutonium in Soils, U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, 1979. Maximum Sensitivity Procedures for Isolation of Plutonium and Americium in Compositied Water Samples, Rocky Flats Plant Health and Safety Laboratories, Golden, Colorado, 1990.
- ^b Prescribed Procedures for Measurement of radioactivity in Drinking Water, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, EPA-600/4-80-032, 1980.
- ^c American Society of Testing Materials (ASTM)
- ^d Method 3010/6010 and the three calibration techniques apply to all metals (ICP)
- ^e Test Methods for Evaluating Solid Waste, Volumes IA-IC: Laboratory Manual, Physical/Chemical methods; and Volume II Field Manual, Physical/Chemical methods, SW-846, Third Edition, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, 1986.
- ^f Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, U.S. Environmental Protection Agency, 1983, and subsequent EPA-600/4 Technical Additions.
- ^g Standard Methods for the Examination of Water and Wastewater, 17th Edition, APHA, AWWA, and WPCF, 1989.
- ^h Radian standard operating procedure for TOC using a Perkin Elmer 240C Elemental Analyzer.

Liquid samples are aliquoted, spiked with plutonium-236 and curium-244, and evaporated to near dryness. Nitric and hydrofluoric acid are then added to destroy organic components and silicates. Once dissolution is complete, the sample is evaporated to dryness. Solid samples are weighed, spiked, dissolved in nitric and hydrofluoric acid, and dried. The sample is then redissolved in nitric acid. The nitric acid solution is added to the anion exchange column. Americium, with its curium-244 spike tracer, passes through the column while the plutonium, with the plutonium-236 spike tracer, is held by the column resin until it is eluted from the column by washing with nitric and hydrofluoric acid. The americium is sequentially extracted from the solution that passed through the column using dibutyl-N,N-diethylcarbamyphosphonate (DDCP) and hydrochloric acid. The americium bearing hydrochloric acid solution is added to a cation exchange column and the americium, with the curium-244 spike tracer, is eluted from the column with more concentrated hydrochloric acid. The plutonium and americium containing solutions are acidified to destroy any organic compounds from the resin and evaporated to dryness. The plutonium and the americium plus curium are then electrodeposited onto stainless steel planchets and counted by alpha spectrometry.

This method has the advantage over EPA Method 907.0 in that the addition of the spike tracers allows an accurate assessment of the plutonium and americium recovery to be made for every sample. Additionally, the procedure of separating plutonium and americium from the matrix using anion and cation exchange columns rather than a sequence of coprecipitation and solvent extraction steps appears to be less subject to matrix interferences than 907.0.

7.1.2.2 Alpha Beta Gas Proportional Counter

The alpha beta gas-proportional counter is calibrated when the laboratory manager decides that repeated instances of failure to meet acceptance criteria is attributable to a nonrepresentative calibration curve. The calibration curve consists of at least 10 points. Three solid check standards are run daily to check instrument operation. An internal standard and blank are run with every set of 10 samples.

7.1.2.3 Alpha Scintillation Counter

The alpha scintillation counter is calibrated when the laboratory manager decides that repeated instances of failure to meet acceptance criteria is attributable to a nonrepresentative calibration curve. The calibration curve consists of at least 10 points. The counter is regularly run without samples to establish that the counter has not been contaminated. A solid check standard is run daily to check instrument operation. An internal standard and blank are run with every set of 10 samples.

7.1.2.4 Alpha Spectrometer

The alpha spectrometer is calibrated for energy and counting data. The energy calibration is performed monthly using a standard source containing uranium-238, uranium-235, uranium-234, plutonium-238, and curium-244. Energy calibration is performed more frequently if there is a significant shift in the calibration as determined by the Accu-lab Radiochemistry Group Supervisor. The counting calibration is performed weekly using the same standard source containing uranium-238, uranium-235, uranium-234, plutonium-238, and curium-244. The calibration is also performed on a daily basis per sample by counting a marker for 30 seconds to demonstrate the correct instrument operation.

To determine instrument background, a clean stainless steel disk is counted in each detector chamber on a monthly basis. Instrument background is performed more frequently if there is a significant increase in background as determined by the Accu-lab Radiochemistry Group Supervisor.

An LCS and a reagent blank sample are analyzed with every set of 10 samples; a sample replicate is analyzed with every set of 10 samples as the sample volume is available. Acceptance criteria are: $\pm 20\%$ of the true value for the LCS; ± 3 sigma of the running mean of the last 30 results or less than 5% of the actual sample result for the reagent blank; and at the 99% confidence level for the sample replicate.

7.1.2.5 Anions

The analysis for anions consist of five methods: ion chromatography for chloride, fluoride, and sulfate; a nitrite/nitrate method; a phosphate method; an alkalinity method for carbonate; and an ammonia method.

7.1.2.5.1 Ion Chromatography

The ion chromatograph is calibrated daily by analyzing standard solutions containing the anions of interest (chloride, fluoride, and sulfate). The calibration uses a minimum of five points. The correlation coefficient of the resulting calibration curve must be greater than 0.995 or the calibration is repeated. The calibration curve is verified by analyzing QC check samples. The results for the check samples must agree within 10 percent of the expected value or the instrument is recalibrated.

7.1.2.5.2 Colorimetric Determination of Nitrite/Nitrate

A calibration curve is constructed using a blank plus five standards. The correlation coefficient for the calibration curve must exceed 0.995. QC samples from an independent source are checked at a frequency of 10 percent. The acceptable recovery of the check sample is ± 15 percent.

7.1.2.5.3 Colorimetric Determination of Phosphate

A calibration curve consisting of a blank and five standards is constructed daily. The correlation coefficient for the linear equation must be greater than or equal to 0.995. A QC check sample is analyzed at a frequency of 10 percent. The acceptable recovery error for the check sample is ± 15 percent.

7.1.2.5.4 Alkalinity Method for Carbonate

Calibration consists of a three-point calibration using 10.0, 7.0, and 4.0 pH buffers. The acid titrant is standardized each time against reagent sodium carbonate standard solution. Duplicate

determinations should agree within 5 percent. One check sample from an independent source is analyzed per batch at a frequency of 10 percent. Acceptable error is ± 20 percent.

7.1.2.5.5 Colorimetric Determination of Ammonia

A calibration curve is constructed using a reagent blank and five standards on a daily basis. The correlation coefficient must exceed 0.995 or the calibration is repeated. Samples are duplicated and spiked at a frequency of 10 percent. A QC check sample is analyzed for every 10 samples; recovery must be within ± 15 percent of the expected value.

7.1.2.6 Inductively Coupled Plasma Emission Spectroscopy (ICPES)

The ICPES instrument is calibrated daily by analyzing a calibration standard and a calibration blank. The calibration blank and standard are prepared daily from commercially available standards and deionized water. The respective response factors resulting from the calibration analyses are calculated and stored in the ICPES computer.

Following calibration, the initial calibration verification (ICV) standard solutions are reanalyzed as samples. The measured values must agree within 10 percent of the values for the ICV standard solutions. At the beginning of the analytical run, and as the analyses proceed, the calibration of the instrument is checked by analyzing ICV standard solutions as in the initial calibration verification. Additionally, a continuing calibration verification standard (CCV) is analyzed at a frequency of 10 percent. The values measured for the CCV must agree within 10 percent of the expected values. If the recoveries for the ICV and CCVs are not acceptable, the instrument is recalibrated and the samples affected are reanalyzed. The sources of the ICV, CCV, and all other QC standards are independent from those for the calibration standards.

A calibration blank is analyzed at a frequency of 10 percent as the analyses proceed. The values for the calibration blank must be within 10 percent of the mean value for prior calibration blanks. If the data for the blank do not meet these criteria, the problem is corrected, the instrument is recalibrated, and the previous 10 samples are reanalyzed.

A reagent blank, containing all the reagents and diluted to the same volume as the samples involved, is prepared alongside the samples and analyzed at a frequency of 5 percent or once per analytical batch. The reagent blank should contain each analyte at concentrations less than the quantitation limits.

An interference check standard is analyzed at the beginning, end, and at intervals during the analyses of a batch of samples. This standard contains the analytes of interest at minimal concentrations in the presence of known concentrations of interfering elements. If the results do not agree within 20 percent of the expected values, the instrument is recalibrated before analyses continue.

7.1.2.7 Total Organic Carbon - Liquids

The TOC instrument is calibrated daily using a calibration blank and several calibration standards covering the working range of the instrument. The correlation coefficient of the resulting calibration curve must be greater than 0.995 or the calibration is repeated. The calibration of the TOC instrument is verified initially after calibration and subsequently as analyses proceed by analysis of a check standard. The results for the check sample must agree within 20 percent of expected value or the instrument is recalibrated.

An analytical blank is analyzed once per sample batch. The data for the blank are used to assess contamination and should be less than five times the detection limit.

7.1.2.8 Total Organic Carbon - Solids

The Perkin Elmer 240C elemental analyzer is calibrated daily using at least five calibration standards over the working range of the instrument. The K factor resulting from this calibration must be 20 ± 5 for C, or the calibration is repeated. The calibration of the elemental analyzer is verified by analyzing a calibration check sample initially after calibration and subsequently at a frequency of 10 percent as analyses proceed. The results for the check sample must agree within 10 percent of the expected values or the instrument is recalibrated.

A QC check sample is prepared with the samples. This QC check sample is analyzed prior to analyses and after every five samples. The results for the QC check sample must agree within 20 percent of the expected value for analyses to proceed.

7.1.2.9 Total Dissolved Solids and Total Suspended Solids

The analytical balance used to perform these gravimetric analyses is calibrated daily with National Institute of Science and Technology (NIST)-traceable weights. The balance is recalibrated if the acceptance criteria are not met.

7.1.2.10 Moisture Content of Solids

The moisture content of solid samples will be determined using ASTM-D2216. The balance used for the determination will be calibrated daily before use. Duplicate determinations of moisture content will be performed at a frequency of 10 percent.

7.1.2.11 pH Meter

The meter used in the field for measuring pH of an aqueous solution is calibrated by use of commercially obtained standard buffer solutions at a minimum of two values (for example, pH 4 and pH 7). The meter is calibrated daily and checked for continuing calibration accuracy at the beginning and end of each sequence of measurements. The recorded pH value will be compensated for temperature variations.

7.1.2.12 Temperature

Temperature will be measured using a YSI specific conductivity meter (SCM) with a thermocouple. The thermocouple will have been calibrated using a NIST-traceable and -certified thermometer according to MC Method 170.1. The thermocouple will be checked daily with a NIST traceable thermometer.

7.1.2.13 Electrical Conductivity

The electrical conductivity meter used in the field will be calibrated daily using a standard reference solution.

7.1.2.14 Balance

The balances used in the field and the Radian laboratory in Austin, Texas will be checked for accuracy with certified weights. The balances will be calibrated daily. The radiochemistry balance uses an internal calibration mass on a daily basis. This value is recorded in the laboratory book.

7.1.2.15 Flow Rate Rotameters

Water flow rates will be measured by rotameters. These rotameters will be field calibrated at the beginning and end of the demonstration. The time it takes to fill a premeasured container will be measured for three flow rates. A stopwatch will be used and each measurement will be taken at least three times.

7.1.2.16 Watt-hour Meter

Electrical power usage will be measured by a standard watt-hour meter. The date of factory calibration will be noted along with any other certification information.

7.1.2.17 Pressure Drop

Pressure drop will be measured by a standard pressure gauge. The date of factory calibration will be noted along with any other certification information.

7.2 DATA MANAGEMENT

For laboratory data to be scientifically valid, defensible, and comparable, the correct equations and procedures must be used to prepare those data. The following sections describe the

PRC SITE team's data management including data reduction, validation, and reporting procedures to be used in this treatability study. In addition, performance and system audits and corrective action are discussed.

7.2.1 Data Reduction

Each analytical method contains detailed instructions and equations for calculating the respective compound or parameter concentrations. The PRC SITE team will use those procedures to calculate the analytes' concentrations and report the results as follows. For liquid sample analyses (for example, untreated water, treated effluent), calculated results will be reported as micrograms per liter ($\mu\text{g/L}$) VOCs, for TOC, TSS, TDS, anions; mg/L for metals; and pCi/L for radionuclides. For solid sample analyses (filter cake), calculated results will be reported as milligrams per kilogram (mg/kg) for metals and pCi/g for radionuclides. Aqueous sample pH results will be reported as is, since they are direct-read, temperature-compensated measurements. Temperature measurements will be reported in degrees Celsius. The reporting units for the remaining parameters are specified as follows:

| <u>Parameter</u> | <u>Units</u> |
|-----------------------------|---------------------------------|
| Moisture content (S) | Percent |
| Bulk density (S) | Milligrams per cubic centimeter |
| Flow rate (L) | Gallons per minute |
| Pumping period | Minute |
| Pressure drop | Pounds per square inch gauge |
| Volume | Gallons |
| Mass (S) | Pounds |
| Electrical conductivity (L) | Micromhos per centimeter |

Note: (L) = Liquid sample
(S) = Solid sample

The analysts responsible for the measurements will enter raw data into log books or on data sheets. In accordance with standard document control procedures, the laboratory will maintain on file the original copy of all data sheets and log books containing raw data and instrument calibration data, signed and dated by the responsible analyst. Separate instrument use logs will also be maintained by the laboratory to enable a reconstruction of the run sequences for individual instruments. Radian will

maintain all data on file until the end of the project. At that time, the data files will be submitted first to PRC and ultimately to EPA.

7.2.2 Data Validation

Individual analysts will verify the completion of the appropriate data forms and the completeness and correctness of data acquisition and reduction. The laboratory supervisor will review calculations and inspect laboratory notebooks and data sheets to verify accuracy, completeness, and adherence to the specified analytical method protocols. Calibration and QC data will be examined daily by the individual analysts and the laboratory supervisor. The Radian or Accu-lab project managers and QA managers will verify that all instrument systems are functioning properly and that QA objectives for precision, accuracy, completeness, and PQLs are being met.

Analytical outlier data are defined as those QC data lying outside a specific QC objective window for precision or accuracy of a given analytical method. If QC data are outside of control limits, the laboratory supervisor will investigate the problem's cause. The data will be flagged with a data qualifier or, if Radian's or Accu-lab's QA manager determines reanalysis is required, the sample will be reanalyzed. If reanalysis corrects the problem, then only the reanalysis results will be reported. If both initial analysis and reanalysis results indicate a matrix problem, both results will be reported, and the results will be qualified in the final report. If reanalysis is not feasible, the initial analysis results will be reported and qualified in the final report.

Project outlier data are defined as sample data outside acceptance limits established around the central tendency estimator (the arithmetic mean) of the project's entire data set. For data that are known or assumed to be normally distributed, the specified acceptance limits will be the 95 percent confidence limits defined by the student's two-tailed, t-distribution. Project outlier data will be identified and reported in the final project report, but they will not be used to determine other overall project results.

PRC will evaluate all analytical data generated by the Radian and Accu-lab laboratories.

7.2.3 Reporting

A flowchart depicting the overall data handling and reporting scheme appears in Figure 7-1. Data will be reported in standard units, as described above.

Computer-generated report forms similar to those shown in Figure 7-2 for metals analyses will be used to report sample results; forms similar to those shown in Figure 7-3 for metals analyses will be used to report QC data. Similar forms will also be used to record and report analytical data for other parameters, such as TOC, pH, and radionuclides. In addition to presenting the analytical results and QC data, the final analytical data report will provide details regarding the corrective actions taken and discuss any necessary deviations from the protocols established in the referenced methods. The completed final report will be approved by the Radian and PRC project managers before it is submitted to EPA for review.

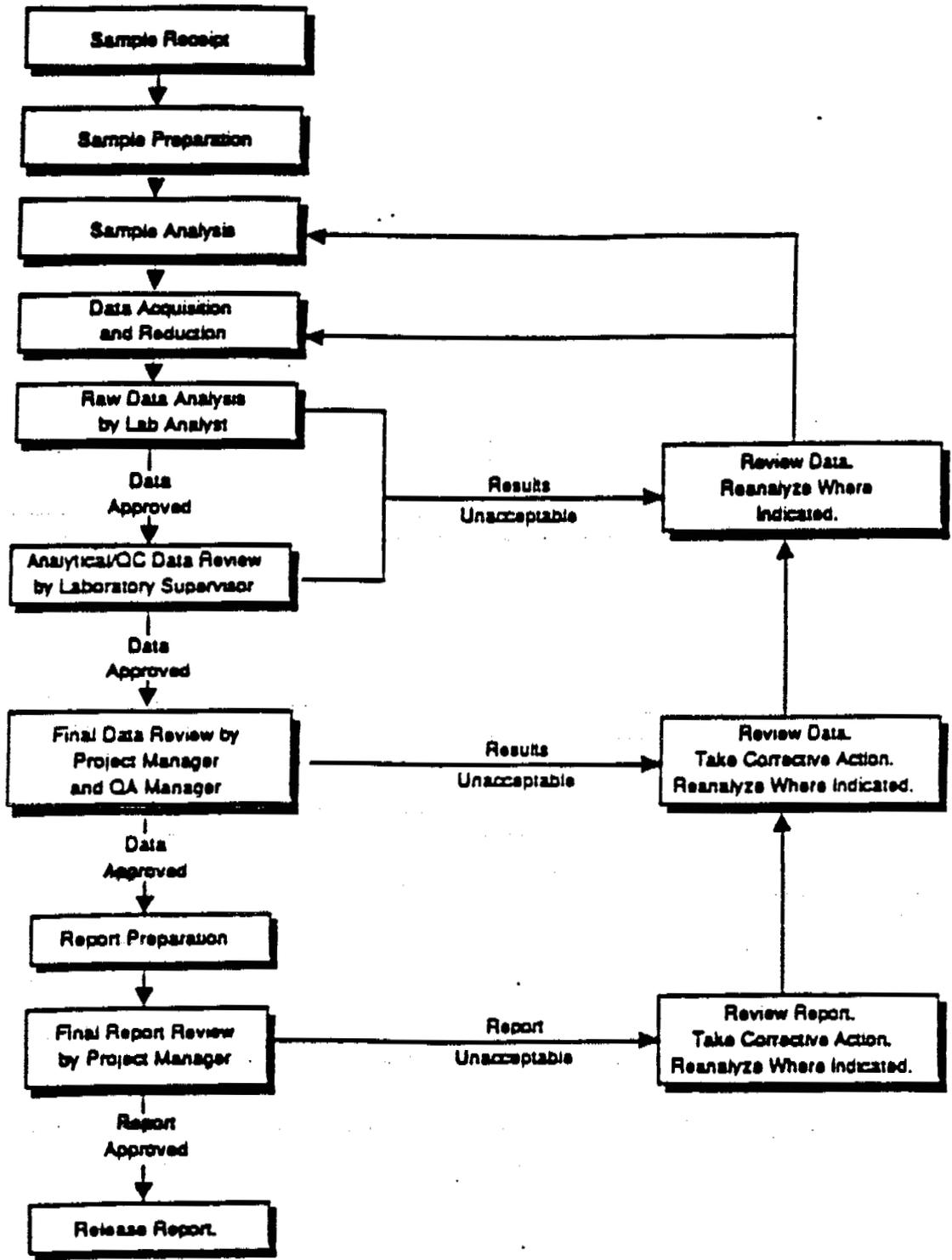
Documentation and reporting requirements include:

- Treatability study work plan
- Quality assurance project plan
- Interim sampling and analysis report
- Final report

The Radian and Accu-lab QA managers will prepare a summary of QA activities for the interim report. The Radian and Accu-lab project managers will then prepare the final analytical data report, which will include a summary of all QA data, with estimates of measurement uncertainty.

7.2.4 Performance and Systems Audits

A quality assurance audit is an independent assessment of a measurement system. QA audits may be internal or external audits and performance or systems audits. Internal audits are conducted by the PRC SITE QA manager and may be functionally independent of the sampling and analytical teams. External audits are those conducted by an independent organization, such as the EPA.



DATE: 06/21/92 9CM FILE NAME: 007-0713V10-313.DWG

SITE CPFM DEMONSTRATION
ROCKY FLATS PLANT - GOLDEN, COLORADO

FIGURE 7-1
DATA REDUCTION, VALIDATION,
AND REPORTING SCHEME

FAC ENVIRONMENTAL MANAGEMENT, INC.



Analytical Data Summary

EPR1 Waste Use
 Radian Work Order: 91-11-039

Method: ICP 39 element scan, SW6010 (1)
 List: Special list

| Sample ID: | K103SP | K104SP | K105SP | K106SP |
|-------------|-------------|-------------|-------------|-------------|
| Factor: | 1.0 | 1.0 | 1.0 | 1.0 |
| Results in: | mg/L 05A | mg/L 06A | mg/L 07A | mg/L 08A |
| Matrix: | water | water | water | water |

| | Result | Det. Limit | Result | Det. Limit | Result | Det. Limit | Result | Det. Limit |
|------------|-----------|------------|-----------|------------|----------|------------|----------|------------|
| Aluminum | 0.059 a | 0.20 | 0.078 a | 0.20 | 0.051 a | 0.20 | 1.5 | 0.20 |
| Antimony | ND | 3.0 | 0.019 a | 3.0 | 0.0044 a | 3.0 | ND | 3.0 |
| Barium | 0.061 | 0.010 | 0.042 a | 0.010 | 0.056 | 0.010 | 0.097 | 0.010 |
| Beryllium | ND | 0.0020 | ND | 0.0020 | ND | 0.0020 | 0.000080 | 0.0020 |
| Boron | 0.15 a | 0.60 | 0.18 a | 0.60 | 0.11 a | 0.60 | 7.7 | 0.60 |
| Cadmium | ND | 0.0050 | 0.00042 a | 0.0050 | 0.0016 a | 0.0050 | ND | 0.0050 |
| Calcium | 32 | 1.0 | 16 | 1.0 | 30 | 1.0 | 190 | 1.0 |
| Chromium | 0.00015 a | 0.010 | 0.0052 a | 0.010 | 0.0031 a | 0.010 | 0.12 | 0.010 |
| Cobalt | ND | 0.010 | 0.0029 a | 0.010 | ND | 0.010 | 0.027 a | 0.010 |
| Copper | 0.0071 a | 0.020 | 0.012 a | 0.020 | 0.0041 a | 0.020 | 0.054 a | 0.020 |
| Iron | 0.024 a | 0.040 | 0.056 a | 0.040 | 0.16 a | 0.040 | 0.0092 a | 0.040 |
| Lithium | 0.0026 a | 0.020 | 0.0030 a | 0.020 | 0.0081 a | 0.020 | 0.022 a | 0.020 |
| Magnesium | 10 | 1.0 | 5.0 | 1.0 | 9.0 | 1.0 | 0.74 a | 1.0 |
| Manganese | 0.0038 a | 0.010 | 0.0024 a | 0.010 | 0.0029 a | 0.010 | 0.0017 a | 0.010 |
| Molybdenum | 0.00016 a | 0.050 | ND | 0.050 | ND | 0.050 | 0.40 | 0.050 |
| Nickel | ND | 0.020 | ND | 0.020 | ND | 0.020 | 0.0056 a | 0.020 |
| Phosphorus | ND | 0.30 | ND | 0.30 | ND | 0.30 | ND | 0.30 |
| Potassium | ND | 3.0 | 0.92 a | 3.0 | 0.68 a | 3.0 | 11 a | 3.0 |
| Silicon | 3.5 a | 1.0 | 6.8 a | 1.0 | 3.8 a | 1.0 | 1.7 a | 1.0 |
| Silver | ND | 0.010 | 0.00080 a | 0.010 | ND | 0.010 | ND | 0.010 |
| Sodium | 14 | 1.0 | 7.9 | 1.0 | 9.9 | 1.0 | 710 | 1.0 |
| Strontium | 0.38 | 0.0030 | 0.19 | 0.0030 | 0.39 | 0.0030 | 4.8 | 0.0030 |
| Sulfur | 76 | 1.0 | 13 | 1.0 | 12 | 1.0 | 490 | 1.0 |
| Thallium | 0.00048 a | 0.10 | ND | 0.10 | 0.025 a | 0.10 | ND | 0.10 |
| Tin | 0.0062 a | 0.60 | 0.0077 a | 0.60 | ND | 0.60 | ND | 0.60 |
| Titanium | ND | 0.050 | 0.0059 a | 0.050 | ND | 0.050 | ND | 0.050 |
| Uranium | ND | 0.50 | ND | 0.50 | ND | 0.50 | ND | 0.50 |
| Vanadium | ND | 0.020 | 0.0025 a | 0.020 | 0.0011 a | 0.020 | 0.11 | 0.020 |
| Zinc | 0.017 a | 0.020 | 0.063 a | 0.020 | 0.015 a | 0.020 | 0.011 a | 0.020 |

a Est. result less than 5 times detection limit

ND Not detected at specified detection limit

(1) For a detailed description of flags and technical terms in this report refer to Appendix A in this report.

NOTE:
 THIS IS AN EXAMPLE OF THE SUMMARY SHEET AND IS FOR REFERENCE ONLY.

SITE CPM DEMONSTRATION
 ROCKY FLATS PLANT - GOLDEN, COLORADO

FIGURE 7-2

INORGANIC ANALYSIS
 SAMPLE SUMMARY SHEET

PRC ENVIRONMENTAL MANAGEMENT, INC.

FILE NAME: 047-2723V13-314.DWG

DATE: 08/11/91 RCJ

Time: 01/15/92 14:35:51
 Analysis time: 11/14/91

Sample Detail
 Instrument: JAA1

Page: 3

SPIKE DUPLICATE

Test Class/ Matrix/ Ref Spk
 Seq. Sample ID Code Sub/Dup Sub Seq Seq Dilution Weight Volum REF. Conv. Final
 30 9110226-04A ICPSM00 K M D W 28 29 1.00 1 1
 File ID= JA611114-30 Batch ID= JAA1 111410-001 Cmt. ID= K140W % Moisture
 Source=

| Analytes | Raw Result | Calc. Result | Unspiked Result | Detection Limit | Spike Value | Rec- every | Specs Low | RPD High | Specs Low | RPD High | Refer. Recov. | RPD | V |
|------------|------------|--------------|-----------------|-----------------|-------------|------------|-----------|----------|-----------|----------|---------------|-----|-------|
| Aluminum | 1.766 | 0 | 0 | 0.20 | 2 | 88.3 | 75 | 125 | 20 | 88.6 | 0.339 | | |
| Antimony | 0.8880 | 0 | 0 | 0.20 | 1 | 88.8 | 75 | 125 | 20 | 87.5 | 1.47 | | |
| Arsenic | 0.9885 | 0 | 0 | 0.30 | 1 | 98.8 | 75 | 125 | 20 | 102 | 3.19 | | |
| Barium | 0.9791 | 0.09968 | 0 | 0.010 | 1 | 87.9 | 75 | 125 | 20 | 87.8 | 0.114 | | |
| Beryllium | 0.1787 | 0 | 0 | 0.0020 | 0.2 | 89.4 | 75 | 125 | 20 | 89.4 | 0 | | |
| Boron | 2.361 | 0 | 0 | 0.60 | 2 | 118 | 75 | 125 | 20 | 117 | 0.851 | | |
| Cadmium | 0.03536 | 0 | 0 | 0.0050 | 0.04 | 88.4 | 75 | 125 | 20 | 91.5 | 3.45 | | |
| Calcium | 667.9 | 512.9 | 0 | 1.0 | 400 | 38.8 | 0 | 75 | 125 | 20 | 36.4 | 0 | 6.38 |
| Chromium | 0.03991 | 0 | 0 | 0.010 | 0.04 | 99.8 | 75 | 125 | 20 | 93.0 | 7.05 | | |
| Cobalt | 0.1691 | 0 | 0 | 0.010 | 0.2 | 84.6 | 75 | 125 | 20 | 83.8 | 0.950 | | |
| Copper | 0.1006 | 0 | 0 | 0.020 | 0.1 | 101 | 75 | 125 | 20 | 99.6 | 1.40 | | |
| Iron | 16.94 | 0 | 0 | 0.040 | 20 | 84.7 | 75 | 125 | 20 | 84.4 | 0.355 | | |
| Magnesium | 188.6 | 104.8 | 0 | 1.0 | 200 | 41.9 | 0 | 75 | 125 | 20 | 40.9 | 0 | 2.42 |
| Manganese | 0.9090 | 0.05813 | 0 | 0.010 | 1 | 85.1 | 75 | 125 | 20 | 84.9 | 0.235 | | |
| Molybdenum | 0.5637 | 0 | 0 | 0.050 | 0.6 | 94.0 | 75 | 125 | 20 | 93.4 | 0.640 | | |
| Nickel | 0.1784 | 0 | 0 | 0.020 | 0.2 | 89.2 | 75 | 125 | 20 | 90.2 | 1.11 | | |
| Lead | 0.3269 | 0 | 0 | 0.050 | 0.4 | 81.7 | 75 | 125 | 20 | 79.6 | 2.60 | | |
| Potassium | 93.97 | 4.348 | 0 | 3.0 | 200 | 44.8 | 0 | 75 | 125 | 20 | 45.0 | 0 | 0.445 |
| Selenium | 0.5926 | 0 | 0 | 0.30 | 0.4 | 148 | 0 | 75 | 125 | 20 | 136 | 0 | 8.45 |
| Silicon | 14.75 | 2.457 | 0 | 1.0 | 10 | 92.9 | 75 | 125 | 20 | 91.5 | 1.52 | | |
| Silver | 0.1852 | 0 | 0 | 0.010 | 0.2 | 92.6 | 75 | 125 | 20 | 91.3 | 1.41 | | |
| Sodium | 435.4 | 81.95 | 0 | 1.0 | 400 | 88.4 | 75 | 125 | 20 | 89.0 | 0.454 | | |
| Strontium | 10.42 | 2.949 | 0 | 0.0030 | 1 | 57.1 | 0 | 75 | 125 | 20 | 26.1 | 0 | 37.4 |
| Thallium | 0.5143 | 0 | 0 | 0.10 | 0.6 | 85.7 | 75 | 125 | 20 | 86.2 | 0.582 | | |
| Vanadium | 0.1801 | 0 | 0 | 0.020 | 0.2 | 90.0 | 75 | 125 | 20 | 89.6 | 0.445 | | |
| Zinc | 0.4037 | 0.06341 | 0 | 0.020 | 0.4 | 85.1 | 75 | 125 | 20 | 84.5 | 0.708 | | |

FILE NAME: 047-3723V12-315.D#8
 DATE: 08/11/93 09:21

NOTE:
 THIS IS AN EXAMPLE OF THE FORM
 AND IS FOR REFERENCE ONLY.

SITE CPFM DEMONSTRATION
 ROCKY FLATS PLANT - GOLDEN, COLORADO

FIGURE 7-3
 INORGANIC ANALYSIS
 REPORT FORM

PRC ENVIRONMENTAL MANAGEMENT, INC.

Performance and systems audits are described below.

7.2.4.1 Performance Audits

Performance audits of sampling and analysis procedures may be conducted at the discretion of either EPA's project manager and QA officer or the PRC SITE QA manager. The audits may consist of the following, as appropriate:

- Conduct a field audit during the demonstration to verify that QAPJP-specified sampling and monitoring procedures and frequencies are being followed
- Issue blind QC samples to the analytical laboratory for analysis of specified critical parameters
- Prepare a QA report that will include the results of the blind QC samples and the associated calibration and control charts (if appropriate). (All reports will be sent to the PRC project manager and to the EPA RREL project manager and QA officer)

The Radian laboratory routinely participates in SITE program performance audits. Radian will be audited prior to the demonstration for, at a minimum, adherence to analytical protocols for uranium, gross alpha, and radium. Accu-lab will also be audited prior to the demonstration. It will be audited for adherence to analytical protocols for plutonium and americium.

7.2.4.2 Systems Audits

System audits include a thorough evaluation of both field and laboratory QC procedures and are normally performed before data collection systems are operational. These audits will be conducted at the direction of the EPA project manager or PRC SITE QA manager. The audits will, where appropriate, include:

- Reviewing actual practices versus the protocols and reporting deviations from protocols
- Verifying whether SOPs are available and are implemented properly
- Assessing traceability of samples and data

- Validating that appropriate QC checks are made and that appropriate documentation is maintained
- Determining if the specified equipment is available, calibrated, and in proper working condition
- Assuring that recordkeeping procedures, including notebooks, logsheets, bench sheets, and tracking forms, are properly maintained and durations are recorded
- Preparing and submitting a report to the PRC program manager

For this project, the PRC SITE team plans to perform internal systems audits for both field and laboratory activities before the demonstration begins. The project managers and QA managers from PRC, Radian, and Accu-lab will be present during the respective audits. The audits may be performed in late 1992, upon approval from the EPA project manager.

7.2.5 Corrective Action

The PRC SITE team will take corrective actions when any problems are identified in the program that affect product quality. The PRC, Radian, and Accu-lab project managers and QA managers, or their designees, are responsible for identifying causes of the problems and developing solutions.

The cause of the problem must first be determined so that its effects on the overall program can be identified. The PRC SITE team and, if necessary, the EPA project manager, will then develop a plausible corrective action. The effects of the action will be examined to determine whether the problem is addressed.

If the corrective action is initially successful, the PRC, Radian, and Accu-lab project managers or QA managers, or their designees, will submit a corrective action memorandum describing the corrective action, how and when it was implemented, and the results. The memorandum will be sent to the EPA project manager and QA officer. The PRC project manager, or designee, will be responsible for implementing the corrective measure and assessing its effectiveness.

7.2.5.1 Performance and Systems Audits

If problems are detected during any field or laboratory audit, the following procedures should be followed:

- The PRC project manager will immediately notify the field or laboratory personnel responsible, the PRC SITE QA manager, and all other appropriate personnel of the problem and any action taken.
- Personnel will then correct the problem according to the procedures outlined above.
- The project manager responsible for the problems detected during the audit will prepare and send a corrective action memorandum to the EPA project manager, QA officer, PRC project manager, PRC SITE QA manager, and other appropriate personnel.

7.2.5.2 Data Outside Control Limits

If at any time data fall outside previously designated limits, the following procedures will be instituted:

- If a field or laboratory person observes that instruments are not within calibration limits, the instruments will be recalibrated. The samples analyzed between an unacceptable continuing calibration check and the last acceptable calibration will be reanalyzed once an acceptable calibration has been obtained.
- If a field or laboratory person observes data problems, such as results for specific QC analysis outside the QC limits, that person will immediately notify the field manager or laboratory supervisor, as appropriate.
- If the laboratory managers or supervisors discover data problems or are notified of a problem, they will decide on the severity of the problem and take the appropriate action as follows:

Minimal data problems – The problem and corrective action taken will be documented and a copy of this report will be submitted to PRC's project manager; no further action will be necessary.

Moderate data problems – A problem memorandum will be prepared and sent to the laboratory project manager and the PRC project manager; a collective decision on the appropriate action will then be made, as needed.

Severe data problems – A problem memorandum will be prepared and sent to the PRC SITE QA manager and project manager, and corrective action procedures will be initiated. If necessary, the EPA project manager will also be involved in developing a corrective action.

7.2.5.3 Data Problems

As data problems arise, the PRC SITE team will investigate the problem and perform one or more of the following actions:

- If the problems occurred in the field, an on-site staff member will try to correct the problem. If a major problem is then discovered, the staff member will contact both the laboratories' project managers (if needed) and PRC project manager for additional instructions.
- If the problem is minimal and occurred in-house, the laboratory supervisor will correct the problem and prepare a corrective action memorandum.
- If the problem is limited in scope and easily corrected, the appropriate supervisor, in concert with the laboratories' project managers and PRC project manager, will make the corrections and prepare a corrective action memorandum.
- If the problem is judged by the laboratory supervisor or either project manager to be significant, corrective actions will be initiated as described at the beginning of Section 7.2.5.

8.0 DATA ANALYSIS AND INTERPRETATION

Upon completion of treatability testing, data will be analyzed and interpreted in accordance with Section 7.0 of this treatability study work plan. Data will be summarized and evaluated to determine the validity of measurements and performance of the treatment process. Section 7.0 also describes the requirements for data reduction, validation, usability criteria, and reporting of data. Appendix C, the quality assurance addendum, addresses specific QA requirements for this treatability study.

8.1 MEASUREMENTS OF PERFORMANCE

Data Analysis

The data collected during the demonstration will be used to evaluate the following:

- Removal efficiencies for radionuclides in the system under a given set of operating conditions
- Treated water compliance with the applicable disposal or discharge standards under a given set of conditions

The percent contaminant removal efficiencies will be calculated using Equation 3-1 (EPA, 1991):

$$CRE = \frac{MCI - MCE}{MCI} \times 100 \quad (3-1)$$

Where,

CRE = Contaminant removal efficiency
MCI = Mean contaminant concentration in the influent
MCE = Mean contaminant concentration in the effluent

To determine if the analyte concentrations in the treated water meet the applicable disposal or discharge standard, PRC will perform a one-tailed student's t-test, assuming that the data are normally

distributed. The upper confidence limit (UCL) for the mean contaminant concentration in the treated waste will be calculated at a specified confidence level using Equation 3-2:

$$UCL = \bar{x} + \frac{ts}{n^{1/2}} \quad (3-2)$$

Where,

| | | |
|---|---|--|
| x | = | Sample mean contaminant concentration |
| t | = | Student's t-test statistic value at a specified confidence level |
| s | = | Sample standard deviation |
| n | = | Sample size (number of replicates) |

The UCL will be compared with the regulatory threshold (CWQCC in this case). If the UCL is less than or equal to the regulatory threshold, the treated waste does not exceed the applicable disposal or discharge standard for that contaminant.

Data checking to assess data for precision, accuracy, and completeness will be in accordance with the guidelines set forth in Section 4.0. Qualified personnel not directly associated with the treatability study or laboratory analyses will validate the data validation at the direction of the PRC SITE team. The verified and validated data will be reduced to graphical or tabular form for interpretation. Conclusions concerning the effectiveness of the system will be deduced directly from the treatability data using the equations above. The implementation and cost of a full-scale process will be indirectly deduced from calculations based on this treatability study.

9.0 RESIDUAL MANAGEMENT

Liquid and solid wastes generated during the CPFM technology demonstration will include treated water, filter cake, decontamination water from personnel and equipment decontamination, and used disposable sampling and health and safety equipment.

The water treated in the CPFM system will be discharged to the IM/IRA tank. Treated water should exhibit contaminant concentrations which are lower than the existing influent water. Therefore, net water quality in the process effluent will remain the same or improve.

Approximately 60 gallons of filter cake will be produced during the demonstration. Disposal of the filter cake will involve mixing the removed filter cake and prefiltered solids with a stabilizing agent (ChemSorb-500) and storing the stabilized material in 55-gallon drums. These drums will be stored at an EPA- and DOE-approved storage facility. Final disposal of filter cake will be the responsibility of DOE.

Wash water from decontamination will be collected and stored in a 1,000-gallon storage tank. This water will be routed to the IM/IRA tank.

Drummed disposable sampling and health and safety equipment will be disposed of in accordance with state and federal requirements.

All unused treatability samples and residues will be returned to the RFP under the Treatability Study Exemption Rule. In accordance with 40 CFR 261.4(f), samples and residues will be returned ~~within~~ 90 days from the completion of treatability testing, or within 1 year from the sample shipment date from RFP to the laboratory. All unused samples will be contained separately from sample residues.

The outside contractor laboratory will be responsible for properly disposing of any unused portions of the effluent samples submitted for analyses, and incidental wastes generated during sample preparation and analysis.

DRAFT

10.0 REPORTS

The CPMF treatability study results will be summarized by EG&G in a treatability study report. The report will be prepared upon completion of treatability study testing and will summarize the test results and discuss any improvements or additional testing that may need to be conducted. The report will also describe the technology's effectiveness in removing metals and radionuclides from contaminated water and will identify any additional data needs. The format of the report will follow the format presented in the guidance for conducting treatability studies under CERCLA (EPA, 1989). The format appears in Table 10-1.

PRC will prepare two additional reports; a technology evaluation report and an applications analysis report. These reports will be EPA publications available to the public.

TABLE 10-1
ORGANIZATION OF THE TREATABILITY STUDY REPORT

1. Introduction
 - 1.1 Site description
 - 1.1.1 Site name and location
 - 1.1.2 History of operations
 - 1.1.3 Prior removal and remediation activities
 - 1.2 Waste stream description
 - 1.2.1 Waste matrices
 - 1.2.2 Pollutants/chemical
 - 1.3 Remedial technology description
 - 1.3.1 Treatment process and scale
 - 1.3.2 Operating features
 - 1.4 Previous treatability studies at the site
 2. Conclusions and Recommendations
 - 2.1 Conclusions
 - 2.2 Recommendations
 3. Treatability Study Approach
 - 3.1 Test objectives and rationale
 - 3.2 Experimental design and procedures
 - 3.3 Equipment and material
 - 3.4 Sampling and Analysis
 - 3.4.1 Waste stream
 - 3.4.2 Treatment process
 - 3.5 Data management
 - 3.6 Deviations from the work plan
 4. Results and Discussion
 - 4.1 Data analysis and interpretation
 - 4.1.1 Analysis of waste stream characteristics
 - 4.1.2 Analysis of treatability study data
 - 4.1.3 Comparison to test objectives
 - 4.2 Quality assurance/quality control
 - 4.3 Costs/schedule for performing the treatability study
 - 4.4 Key contacts
- References
- Appendices
- A. Data summaries
 - B. Standard operating procedures
-

Source: EPA, 1989.

11.0 SCHEDULE

The CPFM treatability study shall consist of three phases during a 3-week period: (1) start up, approximately 1 week; (2) testing, 5 days; and (3) demobilization, about 1 week. Site preparation and equipment mobilization for the demonstration are expected to begin in late April 1993, with all field activities completed by May 1993. All remaining demonstration activities, including test data analysis, final technology evaluation report, and applications analysis report, are expected to be completed by May 1994. An approximate project schedule to illustrate the timing, duration, and interrelationship between phases for the CPFM treatability study will be provided in the final draft work plan.

12.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Figure 12-1 presents the project assignments for EPA, PRC, Radian, EG&G, DOE, and FFT staff. A brief description of personnel responsibilities is presented below. The key project personnel locations and telephone numbers are provided at the end of this section.

EPA RREL Project Personnel

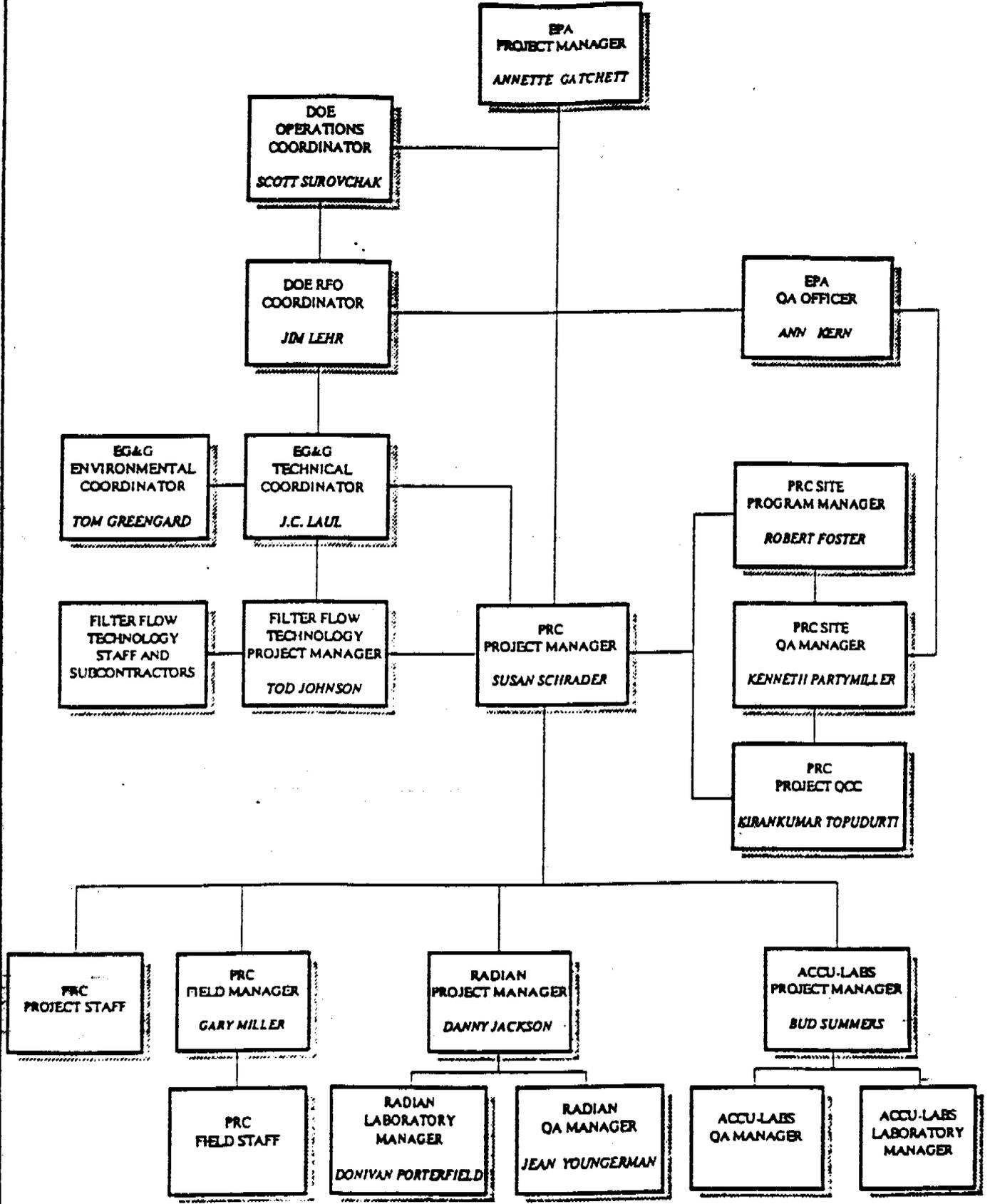
The EPA SITE project manager, Annette Gatchett, is responsible for the overall project. The EPA QA officer, Ann Kern, is responsible for overseeing, reviewing, and approving project QA activities, including laboratory and field audits conducted during the demonstration.

PRC Project Personnel

The PRC SITE team will verify that analytical data are valid and will make routine assessments of measurement systems for precision and accuracy.

PRC's SITE program QA manager, Kenneth Partymiller, will support the PRC project manager; Susan Schrader, and will coordinate QA technical operations among project staff. His specific responsibilities include:

- Providing assistance and guidance in developing and revising specific QA project plans for each discipline area and integrating these into a unified program
- Performing systems audits of work assignment team QA/QC, SOPs and operations manuals to evaluate if the defined practices are appropriate
- Auditing work assignment team operations to evaluate if the defined operations are properly performed
- Providing guidance and coordination to promote rapid resolution of any QA/QC problems
- Maintaining all QA records and QA data for inspection by program management and EPA
- Providing QA of the program data and document control and security system that provides chain of custody and confidentiality protection for program data and documentation



SITE CPFM DEMONSTRATION
 ROCKY FLATS PLANT - GOLDEN, COLORADO
FIGURE 12-1
 PROJECT ORGANIZATION CHART
PRC ENVIRONMENTAL MANAGEMENT, INC.

FILE NAME: 047-2723VF12-1.0880
 DATE: 8/31/93 BCW

- Reviewing the quality of all documentation or outputs to EPA, including all progress reports and work assignment reports

The PRC project manager, Susan Schrader, is responsible for effective day-to-day management of the total project staff as well as direct communication with EPA. She is also responsible for verifying that all PRC SITE team personnel understand and comply with the QA/QC plans. In addition, Ms. Schrader and the PRC SITE team will review sampling and analytical data obtained during the demonstration. Kirankumar Topudurti, the quality control coordinator (QCC) for this project, will provide technical guidance and conduct reviews of all reports. PRC's SITE program manager, Robert Foster, will provide general oversight of PRC's activities.

The PRC field manager, Gary Miller, is responsible for directing day-to-day field operations and reporting to the PRC project manager. He will monitor sampling procedures and verify that the sampling crew follows the procedures set forth in the project's health and safety plan. Mr. Miller or his designee will also verify that chain-of-custody procedures and appropriate shipping regulations are followed. His specific responsibilities include:

- Supervising staffing and mobilization activities
- Overseeing sample collection and field measurements
- Overseeing the activities of all project personnel in the field
- Providing required planning, cost and schedule control, records documentation, and data management for field activities

PRC field staff will assist Mr. Miller in day-to-day field activities, such as taking field measurements.

PRC has planned one trip to Radian's laboratory in Austin, Texas to review the laboratory SOPs and monitor the QA/QC programs. PRC has already conducted a site visit, tour, and QA/QC program review of the Accu-labs facility in Golden, Colorado. EG&G staff, J.C. Laul and Iggy Littor, participated with PRC on the tour. Additionally, the PRC project manager or QA manager, or her or his designee, plan to participate in EPA's audit of Radian's laboratory.

Radian Project Personnel

Radian will provide the bulk of the analytical services. Radian's project director, Danny Jackson, is responsible for overall planning, scheduling, budgeting, and reporting. All work will be coordinated through Dr. Jackson, who will be the primary contact with PRC's project manager. Dr. Jackson will also provide technical reviews of all Radian reports.

Radian's QA manager, Jean Youngerman, will oversee all Radian's QA/QC activities. Ms. Youngerman will review field sampling procedures and analytical data to ensure that samples were not contaminated in the field, that chain-of-custody procedures were followed both in the field and in the laboratory, and that the analytical data meet the project's QA objectives.

Radian's laboratory manager, Donovan Porterfield, will ensure that the laboratory follows proper chain-of-custody procedures and uses proper analytical methods, and that the data meet the project's QA/QC objectives.

Accu-Labs Project Personnel

Accu-labs will provide analytical services for plutonium and americium samples. Accu-labs project director, Bud Summers, is responsible for overall planning, scheduling, budgeting, and reporting. All work will be coordinated through Mr. Summers, who will be the primary contact with PRC's project manager and project staff. Mr. Summers will also provide technical reviews of all Accu-labs reports.

Accu-labs QA manager will oversee all Accu-labs QA/QC activities. The QA manager will review field sampling procedures and analytical data to ensure that samples were not contaminated in the field, that chain-of-custody procedures were followed both in the field and in the laboratory, and that the analytical data meet the project's QA objectives.

Accu-labs laboratory manager will ensure that the laboratory follows proper chain-of-custody procedures and uses proper analytical methods, and that all procedures follow the project's QA/QC program.

FFT Project Personnel

FFT will be responsible for providing and operating all demonstration equipment proposed for the SITE demonstration program.

FFT's project manager, Tod Johnson, will be responsible for all CPFM project activities. FFT staff will assist Dr. Johnson with day-to-day activities at the site.

DOE RFO Project Personnel

DOE RFO will provide oversight throughout the field demonstration activities. The points of contact for the DOE RFO, Jim Lehr and Scott Surovchak, will be responsible for coordinating the field teams access to the site and providing the necessary security escorts. Mr. Lehr is an employee of EPA Region 8 detailed as a liaison to the RFO. He is responsible for the communication between PRC, FFT, EG&G, and DOE RFO. Mr. Surovchak is the OU4 area manager and is ultimately responsible for activities in the area.

EG&G Rocky Flats Project Personnel

EG&G will also provide oversight throughout the field demonstration. The EG&G environmental point of contact, Tom Greengard, will be responsible for procuring all necessary EG&G division approvals for all activities surrounding the demonstration. J. C. Laul is the technical coordinator and was responsible for coordinating the bench-scale studies at RFP site.

Project Personnel Locations and Telephone Numbers

The locations and telephone numbers of the key project personnel are given below.

| <u>Name</u> | <u>Location</u> | <u>Telephone Number</u> |
|----------------------|---|-------------------------|
| Annette Gatchett | EPA, Cincinnati, Ohio | (513) 569-7697 |
| Ann Kern | EPA, Cincinnati, Ohio | (513) 569-7635 |
| Tod Johnson | FFT, League City, Texas | (713) 334-6080 |
| Robert Foster | PRC, Chicago, Illinois | (312) 856-8700 |
| Kirankumar Topudurti | PRC, Chicago, Illinois | (312) 856-8700 |
| Kenneth Partymiller | PRC, Houston, Texas | (713) 364-7137 |
| Susan Schrader | PRC, Denver, Colorado | (303) 295-1101 |
| Gary Miller | PRC, Denver, Colorado | (303) 295-1101 |
| Danny Jackson | Radian, Austin, Texas | (512) 454-4797 |
| Jean Youngerman | Radian, Austin, Texas | (512) 454-4797 |
| Donivan Porterfield | Radian, Austin, Texas | (512) 454-4797 |
| Bud Summers | Accu-labs, Golden, Colorado | (303) 277-9514 |
| Tom Greengard | EG&G, Golden, Colorado | (303) 273-6073 |
| J. C. Laul | EG&G, Golden, Colorado | (303) 966-3254 |
| Jim Lehr | EPA Region 8, DOE RFO Golden, Colorado | (303) 966-4543 |
| Scott Surovchak | DOE RFO, Golden, Colorado | (303) 966-3551 |

Contractor Interaction

The PRC SITE team subcontractor, Radian, is responsible for providing a monthly summary of its activities to PRC the first of every month. In addition, communication between Radian and PRC will be made on an as-needed basis (sometimes daily). Accu-labs will also be required to provide a monthly summary of activities to PRC. PRC, in turn, is responsible for providing a monthly status report to the EPA RREL project manager. This report will outline all activities surrounding the project, including progress to date and anticipated activities. Communication between the PRC and EPA RREL project managers is also on an as-needed basis (usually semiweekly).

13.0 REFERENCES

DRAFT

- DOE, 1980, U.S. Department of Energy, *Rocky Flats Plant, Final Environmental Impact Statement*, DOE/EI5-0064. Golden, CO.
- DOE, 1991a, U.S. Department of Energy, Rocky Flats Plant, *Draft Rocky Flats Plant Community Relations Plan*. January, Golden, CO.
- DOE, 1991b, U.S. Department of Energy, Rocky Flats Plant, *National Environmental Policy Act Draft Environmental Assessment, Dewatering and RCRA Closure of Solar Evaporation Ponds*, DOE/EA-0487. Golden, CO.
- EPA, 1988, U.S. Environmental Protection Agency, *Protocol for a Chemical Treatment Demonstration Plan*, Hazardous Waste Engineering Research Laboratory. April, Cincinnati, Ohio.
- EPA 1989, U.S. Environmental Protection Agency, *Preparing Perfect Project Plans*, Risk Reduction Engineering Laboratory, October 1989, Cincinnati, Ohio.
- EPA, 1991, U.S. Environmental Protection Agency, *Preparation Aids for the Development of Category II Quality Assurance Project Plans*, Office of Research and Development, February 1991, Cincinnati, Ohio.
- Evans, G., 1990, *Estimating Innovative Technology Costs for the SITE Program*, Journal of Air and Waste Management Association, 40:7:1047-1051.
- Hurr, R. T., 1976, *Hydrology of a Nuclear Processing Plant Site, Rocky Flats, Jefferson County, Colorado*, U.S. Geological Survey Open-File Report 76-268.
- Monitor, 1991, *Rocky Flats Environmental Monitoring Council Monitor*. February, Golden, CO.
- Rockwell International, 1988, *Rockwell International Corporation, Resource Conservation and Recovery Act, Post Closure Care Permit Application, Appendix 1-2, Solar Evaporation Ponds*. July, Golden, CO.

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APPENDIX A
SAMPLING AND ANALYSIS PLAN

SAMPLING AND ANALYSIS PLAN

The selection of sampling locations is based on the CPFM treatment system's configuration and is designed to determine its removal efficiency of the radionuclides listed in Tables 4-1 and 4-2 of the treatability studies work plan. Sample collection procedures have been established based on the treatability and bench-scale studies and the assumption that the concentration of the critical parameters and the chemical characteristics of the ground water in the 500,000-gallon OU4 IM/IRA Tank will be relatively uniform during the course of each test run.

A.1 Sampling Objectives and Locations

This section describes the sampling objectives and identifies specific sampling locations and sampling frequencies for critical and noncritical analyses and measurements.

A.1.1 Sampling Objectives

Specific sampling objectives for the CPFM demonstration include the following:

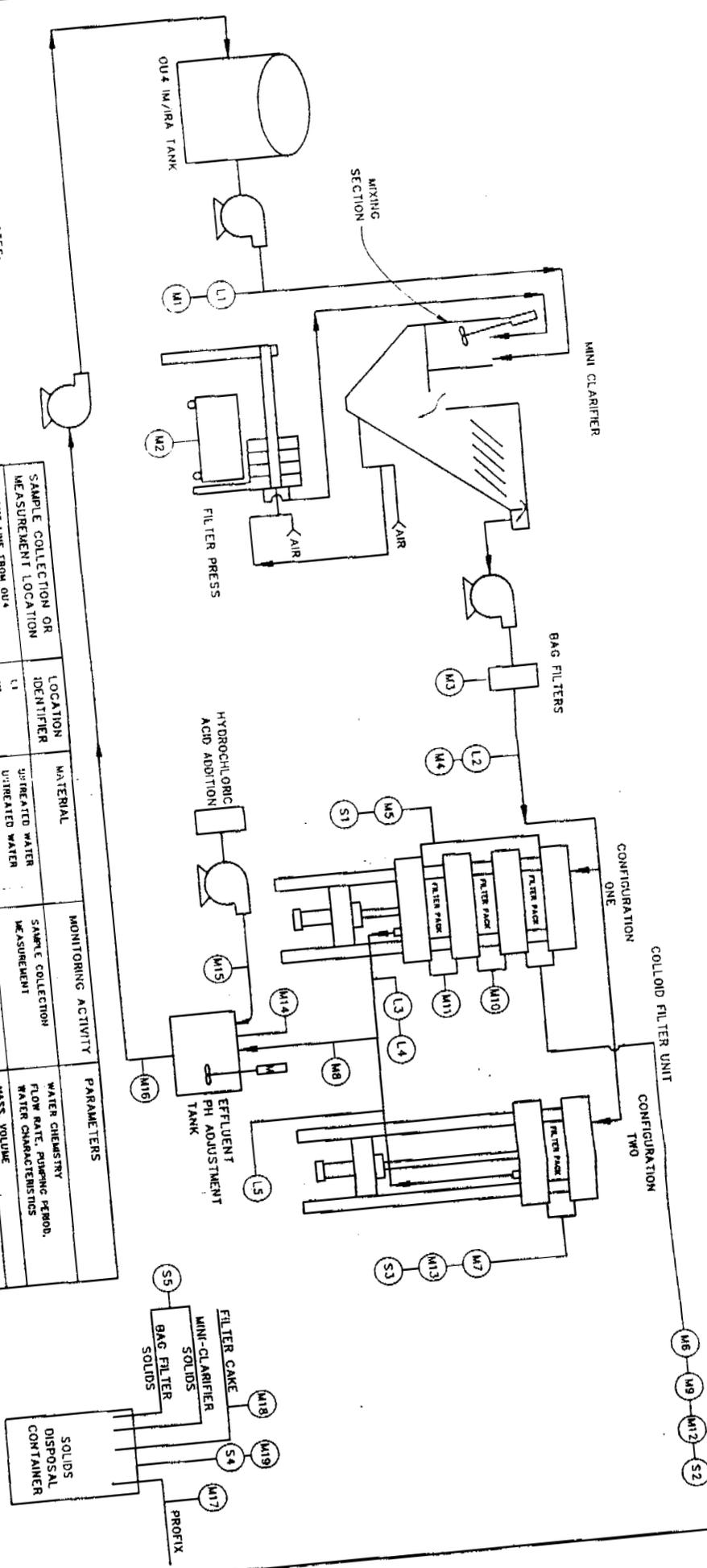
- Collect representative samples. The PRC SITE team will collect samples in a manner and frequency which promotes representative analytical results for the critical parameters.
- Conduct physical and chemical characterizations of the representative samples. The PRC SITE team will analyze the samples collected for critical and noncritical parameters in accordance with the methods and QA objectives listed in Tables 4-1 through 4-4 of the treatability studies work plan. The objectives of the analyses and measurements of critical parameters are to determine the removal efficiency of the treatment system, the suitability of the treated effluent, filter cake solids, and ~~stabilized~~ stabilized mixture for discharge and disposal, and to obtain operational data for economic analyses. The objectives of the analyses and measurements of noncritical parameters are to identify any physical or chemical interferences that might affect the removal efficiency of the treatment system and obtain supplemental operational and analytical data.

A.1.2 Sampling and Measurement Locations

Figure A-1 shows the sampling and measurement locations for liquids and solids. There are five liquid sampling locations (L1 through L5) planned for the demonstration. The following water chemistry analyses will be performed on L1 through L4 samples: radionuclides, anions, ICP metals, TDS, TSS, and TOC. Chemical analyses at L5 will include only uranium and gross alpha. Samples collected at locations L1 through L5 will be analyzed in an off-site laboratory. The analytical results for the critical parameters from these locations will be used to evaluate the treatment system's effectiveness.

There are five solid sampling locations (S1 through S5) planned for the demonstration. The following solids chemistry and characteristics analyses will be performed on the filter cake and pre-filtered solids (S1, S2, S3 and S5): radionuclides, ICP metals, TOC, and paint filter liquids test. The following solids chemistry and solids characteristics analyses will be performed on the stabilized filter cake (S4) mixture: TCLP radionuclides, TCLP ICP metals, and TCLP VOCs from the TCLP extract; paint filter liquids test; bulk density; and moisture content. All of these analyses will be at an off-site laboratory, except for the paint filter liquids test for the filter cake which will be performed on-site in the field. The analytical results from these tests will determine the appropriate disposal option for the stabilized mixture. The results for the critical parameters from these locations will offer a qualitative indication as to the treatment system's effectiveness.

There are 19 measurement locations (M1 through M19) planned for the demonstration. The following water characteristic measurements will be made on samples from locations M1, M4, M8, and M16: electrical conductivity, temperature, and pH. Flow rate and pumping period will be recorded for measurement location M15, M1 and M4, and flow rate only for M8. The differential pressure across the filter beds will be measured at locations M5, M6, and M7. Samples for mass and volume (estimated) measurements of the solids material will be obtained at locations M2, M3, M9 through M13, M17, M18, and M19. The electricity usage, although not represented in Figure A-1, will be recorded at the beginning and end of each run. All measurements will be obtained in the field during the demonstration and will be logged in the field logbook.



LEGEND

- FLOW DIRECTION
- [M] MIXER
- 1. LIQUID SAMPLE COLLECTION
- 5. SOLID SAMPLE COLLECTION
- 34. MEASUREMENT LOCATION

NOTES:

WATER CHEMISTRY INCLUDES: RADIONUCLIDES, ANIONS, METALS, TOTAL DISSOLVED SOLIDS (TDS), TOTAL SUSPENDED SOLIDS (TSS), AND TOTAL ORGANIC CARBON (TOC); THESE ARE FIELD MEASUREMENTS. L5 WILL BE SAMPLED FOR URANIUM AND GROSS ALPHA ONLY.

WATER CHARACTERISTICS INCLUDE: ELECTRICAL CONDUCTIVITY, TEMPERATURE, AND PH (THESE ARE FIELD MEASUREMENTS).

SOLIDS CHEMISTRY INCLUDES: RADIONUCLIDES, METALS, AND TCLP (S4 ONLY).

SOLIDS CHARACTERISTICS INCLUDE: PAINT FILTER LOSS TEST (S1 THROUGH S3), MOISTURE CONTENT (S4 ONLY), AND BULK DENSITY (S4 ONLY).

| SAMPLE COLLECTION OR MEASUREMENT LOCATION | LOCATION IDENTIFIER | MATERIAL | MONITORING ACTIVITY | PARAMETERS |
|--|---------------------|---------------------------------------|-------------------------------|--|
| INFLUENT LINE FROM OU4 IN/IRA TANK | L1 | UNTREATED WATER | SAMPLE COLLECTION MEASUREMENT | WATER CHEMISTRY FLOW RATE, PUMPING PERIOD, WATER CHARACTERISTICS |
| MINI CLARIFIER | M1 | MINI-CLARIFIER SOLIDS | MEASUREMENT | MASS, VOLUME |
| BAG FILTERS | M2 | BAG FILTER SOLIDS | MEASUREMENT | WATER CHEMISTRY FLOW RATE, PUMPING PERIOD WATER CHARACTERISTICS |
| INFLUENT TO THE COLLOID FILTER PRESS (INTERMEDIATE STREAM) | L2 | PREFILTERED WATER | SAMPLE COLLECTION | SOLIDS CHEMISTRY AND CHARACTERISTICS DIFFERENTIAL PRESSURE ACROSS EACH FILTER BED FLOW RATE, WATER CHARACTERISTICS |
| COLLOID FILTER UNIT | M3 | FILTER CAKE | MEASUREMENT | MASS, VOLUME |
| EFFLUENT PH ADJUSTMENT TANK | M4 | TREATED EFFLUENT | MEASUREMENT | PH (PROBE) FLOW RATE, PUMPING PERIOD WATER CHARACTERISTICS |
| HYDROCHLORIC ACID ADDITION | M5 | PH-ADJUSTED EFFLUENT | MEASUREMENT | WATER CHARACTERISTICS |
| EFFLUENT TO OU4 IN/IRA TANK | M6 | PROFIX FILTER CAKE STABILIZED MIXTURE | MEASUREMENT | MASS, VOLUME |
| SOLIDS DISPOSAL CONTAINER | M7 | | MEASUREMENT | MASS, VOLUME |
| | M8 | | MEASUREMENT | MASS, VOLUME |
| | M9 | | MEASUREMENT | SOLIDS CHEMISTRY AND CHARACTERISTICS |
| | M10 | | MEASUREMENT | |
| | M11 | | MEASUREMENT | |
| | M12 | | MEASUREMENT | |
| | M13 | | MEASUREMENT | |
| | M14 | | MEASUREMENT | |
| | M15 | | MEASUREMENT | |
| | M16 | | MEASUREMENT | |
| | M17 | | MEASUREMENT | |
| | M18 | | MEASUREMENT | |
| | M19 | | MEASUREMENT | |
| | S1 | | MEASUREMENT | |
| | S2 | | MEASUREMENT | |
| | S3 | | MEASUREMENT | |
| | S4 | | MEASUREMENT | |

FIGURE A-1
SITE OF PM DEMONSTRATION
ROCKY FLATS PLANT - GOLDEN, COLORADO
SAMPLING AND MEASUREMENT LOCATIONS
P/MC ENVIRONMENTAL MANAGEMENT, INC.

A.2 Sample Size, Sampling Frequency, and Analytical Parameters

EPA does not have a specific method to determine the minimum sample size required for estimating mean values. However, based on EPA's method for determining adequate sample size for regulatory threshold values (EPA, 1986), PRC proposes the following approach.

The sample size required to estimate the mean value of an analyte concentration depends on the allowable error (L) at a specified confidence level. The confidence interval (CI) for the mean (\bar{x}) is estimated using the following equation (Steel and Torrie, 1980; Winer, 1971; Snedecor and Cochran, 1967):

$$CI = \bar{x} \pm \frac{t\sigma}{n^{1/2}} \quad (A-1)$$

where,

- x = sample mean
- σ = population standard deviation
- t = student's t-test statistic value
- n = sample size

The term $t\sigma/n^{1/2}$ is the allowable error (L) equal to one-half the width of the confidence interval. The test-statistic value (t) depends on the sample's degrees of freedom and the desired confidence level. The values for the allowable error and confidence level are usually based on judgement. Once the allowable error and confidence level are selected, the average sample size can be calculated using the following relationships:

$$L = \frac{t\sigma}{n^{1/2}} \quad (A-2)$$

$$n = \frac{t^2\sigma^2}{L^2} \quad (A-3)$$

To determine the number of samples required for this demonstration, the population standard deviation from Bench-Scale Study I, a two-tailed t-test, and allowable error set at various levels (7 to 20 percent of the mean) is used. Based on these calculations, a 20 percent allowable error (which is

within the required precision for analytical parameters) is chosen. Thus, using equation A-3 and results from Bench-Scale Study 1, the number of samples can be determined for a confidence interval of 95 percent with an allowable error of 20 percent of the mean. Using data for influent, intermediate, and effluent streams and solids, the number of samples is determined to be two for the influent and/or intermediate, three for the effluent, and three for the solids. These numbers of samples will be used for critical parameters listed in Tables 4-1 and 4-2. One sample (plus QA/QC samples at a frequency of at least one per 20 samples) for the noncritical parameters listed in Tables 4-3 and 4-4 will be taken. This sample size is believed to be reasonable based on the intended use of the data and the reliability of the analytical methods.

Table A-1 lists sample collection locations, the analytical parameters or measurements, and the rationale for their selection. Tables A-2 and A-3 summarize the number and frequency of samples to be collected and the type of measurements that will be taken at each location.

A.3 Sampling Method

The following sections describe the sample collection methods for solid and liquid sample media.

A.3.1 Solids (Filter Cake) Sampling

Filter cake solids will be removed from the filter packs and sampled during the demonstration. These samples are considered important indicators of the treatment system's removal efficiency for the radionuclides listed in Tables 4-1 and 4-2 for identifying disposal options for the filter cake.

The FF 1000 media will be enclosed between two sheets of fibrous material (Pulplus®). The filter packs measure 26 inches by 26 inches and are about 2-inches thick. The FF 1000 medium will be a mixture of fine and medium coarse powder prior to the run and will have the consistency of moldable putty at the end of a run. During preparation of the filter packs the fibrous material will be weighed on an analytical balance before and after addition of the FF 1000. The initial weights will be recorded in a field logbook and each filter pack will be assigned a unique identification number. This

TABLE A-1

CPFM TECHNOLOGY DEMONSTRATION
RATIONALE FOR SAMPLING AND FIELD MEASUREMENTS

| Sampling and Measurement Locations | Parameter | Measurement Type | Sampling Frequency | Rationale for Selection |
|--|--|------------------|---|--|
| Influent line from the OU4 IM/IRA tank (L1), intermediate line to filter press (L2), and effluent from filter press at sampling ports L3, L4, and L5 | Uranium and gross alpha | Critical | <p>Runs 1-4: Influent at L1, intermediate at L2 and effluent at L3 will be sampled as a composite during the run.</p> <p>Run 5: Influent at L1, intermediate at L2, effluent at L4, and effluent at L5 will be sampled at specific time intervals during the run.</p> | These are the critical analytical parameters for the demonstration. The main objective of the demonstration is to determine the efficiency with which the CPFM treatment system removes uranium and reduces gross alpha contamination. Sampling at influent, intermediate, and effluent points is necessary to establish these concentrations before, during, and after treatment. |
| Influent line (M1), intermediate line (M4), and the effluent line from the filter press (M8) | pH | Critical | Each time a sample is collected from L1 (for M1), L2 (for M4), or M8 an additional sample will be collected and measured three times for the pH. | The formation of colloids and the solubility of metals and radionuclides is pH dependant. The pH is to be monitored throughout the demonstration. The pH measurements are necessary to document that the pH maintained during each run and the pH change due to the reaction of the water in the filter press. |
| Influent line from the OU4 IM/IRA Tank (M1), intermediate line to the filter press (M4), effluent from the filter press (M8-flow rate only) | Flow rate, pumping period, and volume of water treated | Critical | The flow rate will be recorded at 1-hour intervals during all runs. The pump start and finish times will be recorded for each run. | The flow rate and the pumping period is necessary to calculate the volume of water treated. |
| Influent and effluent to the filter press (M5-M7) | Differential pressure | Critical | The pressure differential between the influent and effluent lines of the filter press will be recorded at 1-hour intervals during each run. | The pressure loss across the filter press is necessary to evaluate the operational requirements of the CPFM treatment system. |

TABLE A-1

CPFM TECHNOLOGY DEMONSTRATION
 RATIONALE FOR SAMPLING AND FIELD MEASUREMENTS
 (Continued)

| Sampling and Measurement Locations | Parameter | Measurement Type | Sampling Frequency | Rationale for Selection |
|---|---|------------------|--|--|
| Filter cake prior to stabilization (S1, S2, and S3) and stabilized mixture (S4) | Uranium and gross alpha in the filter cake solids and the stabilized mixture's TCLP extract | Critical | The filter cake solids will be collected and composited at the completion of each run. The stabilized mixture (filter cake and pre-filtered solids, S4) will be sampled at the completion of each run. | Determination of these concentrations in the filter cake solids and the TCLP extract is necessary to verify removal by the FF 1000 media and to characterize the filter cake solids and stabilized mixture for disposal. |
| Pre-filtered solids (from mini clarifier and bag filters, S5) prior to stabilization | Uranium and gross alpha in the pre-filtered solids | Critical | The pre-filtered solids will be collected and composited at the completion of each run. | Determination of these concentrations in the pre-filtered solids is necessary to characterize removal of contaminants by the CPFM treatment system. |
| The filter cake and pre-filtered solids prior to stabilization (S1, S2, S3, and S5) and stabilized mixture (S4) | Paint filter liquids test | Critical | The filter cake solids will be collected and composited at the completion of each run. The stabilized mixture (filter cake and pre-filtered solids, S4) will be sampled at the completion of each run. | The paint filter liquids test is necessary to determine whether the filter cake and stabilized mixture contain free liquids, thereby determining if the solids can be land disposed. |
| Watt meter | Electricity (kilowatt-hr) | Critical | The reading from the watt meter will be recorded at the beginning and end of each run. | The electricity usage will evaluate electricity costs and requirements for the treatment system. |

TABLE A-1
CPFM TECHNOLOGY DEMONSTRATION
RATIONALE FOR SAMPLING AND FIELD MEASUREMENTS
(Continued)

| Sampling and Measurement Locations | Parameter | Measurement Type | Sampling Frequency | Rationale for Selection |
|---|--|------------------|---|---|
| Influent line from the OU4 IM/IRA tank (L1), intermediate line to the filter press (L2), and the effluent from the filter press at sampling ports L3 and L4 | Radium, plutonium, americium, anions, and ICP metals | Noncritical | Runs 1-4: Influent at L1, intermediate at L2, effluent at L3 will be sampled as composites of collections taken throughout the run. Run 5: Intermediate at L2 and effluent at L4 will be sampled at specific time intervals during Run 5. | The CPFM treatment system is capable of removing metals and radionuclides, but the concentrations of metals and certain radionuclides in the OU4 IM/IRA tank water are expected to be too low to be considered critical. However, the determination of these concentrations are necessary to verify this assumption and to document any removal that might occur. |
| Influent from the OU4 IM/IRA tank (L1), intermediate line to the filter press (L2), and effluent line from the filter press at sampling ports L3 and L4 | TOC | Noncritical | Runs 1-4: Influent at L1, intermediate at L2, and effluent at L3 will be sampled as composites of collections taken throughout the run. Run 5: Intermediate at L2 and effluent at L4 will be sampled at specific time intervals during Run 5. | The removal efficiency of the CPFM treatment system can be adversely affected by high concentrations of organic compounds. The concentration of organics in the OU4 IM/IRA tank is expected to be too low to cause any interference; however, sampling for TOC is necessary to verify this assumption. |
| Influent from the OU4 IM/IRA tank (L1), intermediate line to the filter press (L2), and effluent line from the filter press at sampling ports L3 and L4 | TDS and TSS | Noncritical | Runs 1-4: Influent at L1, intermediate at L2, and effluent at L3 will be sampled as composites of collections taken throughout the run. Run 5: Intermediate effluent at L2 and effluent at L4 will be sampled at specific time intervals during Run 5. | The removal efficiency of the CPFM treatment system can be adversely affected by high concentrations of TDS and TSS. The concentration of TDS and TSS in the OU4 IM/IRA tank is expected to be too low to cause any interference; however, it is necessary to verify this assumption. In addition, TSS concentration in the effluent will provide a measurement of the system's filtration ability. |

TABLE A-1
CPFM TECHNOLOGY DEMONSTRATION
RATIONALE FOR SAMPLING AND FIELD MEASUREMENTS
(Continued)

| Sampling and Measurement Locations | Parameter | Measurement Type | Sampling Frequency | Rationale for Selection |
|--|---|------------------|---|---|
| Influent from the OU4 IM/IRA tank (M1), intermediate line to filter press (M4), effluent from filter press (M8), and the effluent line from holding tank (M16) | Electrical conductivity and temperature | Noncritical | Each time a sample is collected from L1 through L4, an additional sample will be collected from M1, M4, and M8 and measured for these parameters. Samples will be collected from M16 at the end of each run prior to discharge. | Electrical conductivity is a general water quality measurement indicative of the concentration of dissolved ions. This parameter will be used as a qualitative indication of gross changes in the chemical characteristics of both the influent and effluent. Temperature readings must be taken to qualify these data. |
| Filter cake solids (S1, S2, and S3) and prefiltered solids (from mini clarifier and bag filter, S5) prior to stabilization | Radium, plutonium, americium, ICP metals, and TOC | Noncritical | The filter cake and prefiltered solids will be collected at the completion of each run. | Analyses of these compounds will identify contaminant concentrations and determine the necessity for stabilization. |
| Stabilized mixture: combined prefiltered solids and filter cake solids (S4) | Moisture content, bulk density, and TCLP extracts for radium, plutonium, americium, ICP metals, and VOCs. | Noncritical | Stabilized mixture will be generated and sampled at the end of each run. | The determination of the physical characteristics of the filter cake solids is necessary for evaluating the treatment residual for economic comparison with other technologies. The TCLP analysis from the stabilized mixture is necessary to determine disposal options. |
| Prefiltered solids (M2 and M3), filter cake (M9-M13, M18), Prefix stabilizing agent (M17), and stabilized mixture (M19) | Mass and volume | Noncritical | Prefiltered solids, filter cake, and stabilizing agent will be weighed at the completion of each run. The mixture for stabilization will be weighed before and after stabilization. | The amount of solids generated during treatment is needed to determine amount of stabilizing agent required and the volume of waste for disposal. |

TABLE A-1

**CPFM TECHNOLOGY DEMONSTRATION
RATIONALE FOR SAMPLING AND FIELD MEASUREMENTS**
(Continued)

| Sampling and Measurement Locations | Parameter | Measurement Type | Sampling Frequency | Rationale for Selection |
|------------------------------------|-------------------------|------------------|---|--|
| Hydrochloric acid addition (M15) | Flow and pumping period | Noncritical | The flow rate will be recorded at 1-hr intervals during all runs. The pump start and finish times will be recorded for each run. | The flow rate and pumping period is necessary to calculate the volume of hydrochloric acid added. |
| Treated effluent (M14 and M16) | pH | Noncritical | The effluent will be collected and pH-adjusted at the completion of each run. Samples from M16 will be collected at the end of each run prior to discharge. These samples will be measured for pH. The pH for M14 is continuously measured using a pH probe. The readings from the probe will be recorded at regular intervals. | This sampling will be used to establish the following: at M14, if sufficient amount of HCl has been added and at M16, that the pH was lowered to 7.5 to meet discharge requirements. |

TABLE A-2

SUMMARY OF SAMPLE COLLECTION PROGRAM FOR THE CPFM TECHNOLOGY DEMONSTRATION
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| Location | Run No. | Parameter | Replicate* samples | MS/MSD | Process* Equipment Blank | Sampling Equipment Rinsate Blank | QC Replicate | Total No. of Samples |
|----------|---------|--|--------------------|--------|--------------------------|----------------------------------|--------------|----------------------|
| L1 | 1-4 | Uranium | 2 | NA | 0 | NA | 0 | 8 |
| | | Gross alpha | 2 | NA | 0 | NA | 0 | 8 |
| | | Radium | 1 | NA | 0 | NA | 0 | 4 |
| | | Plutonium | 1 | NA | 0 | NA | 0 | 4 |
| | | Americium | 1 | NA | 0 | NA | 0 | 4 |
| | | F, Cl, SO ₄ , CO ₂ | 1 | 1 | 0 | NA | 0 | 8 |
| | | NO ₂ /NO ₃ , PO ₄ , NH ₄ | 1 | 1 | 0 | NA | 0 | 8 |
| | | ICP metals | 1 | 0 | 0 | NA | 1 | 8 |
| | | TDS | 1 | 0 | 0 | NA | 1 | 8 |
| | | TSS | 1 | 0 | 0 | NA | 0 | 8 |
| 5 | | TOC | 1 | 1 | 0 | NA | 0 | 8 |
| | | Uranium | 6 | NA | 0 | NA | 0 | 6 |
| | | Gross alpha | 6 | NA | 0 | NA | 0 | 6 |
| | | Radium | 0 | NA | 0 | NA | 0 | 0 |
| | | Plutonium | 0 | NA | 0 | NA | 0 | 0 |
| | | Americium | 0 | NA | 0 | NA | 0 | 0 |
| | | F, Cl, SO ₄ , CO ₂ | 0 | NA | 0 | NA | 0 | 0 |
| | | NO ₂ /NO ₃ , PO ₄ , NH ₄ | 0 | 0 | 0 | NA | 0 | 0 |
| | | ICP metals | 0 | 0 | 0 | NA | 0 | 0 |
| | | TDS | 0 | 0 | 0 | NA | 0 | 0 |
| TSS | 0 | 0 | 0 | NA | 0 | 0 | | |
| TOC | 0 | 0 | 0 | NA | 0 | 0 | | |

TABLE A-2
SUMMARY OF SAMPLE COLLECTION PROGRAM FOR THE CPFM TECHNOLOGY DEMONSTRATION
(Page 2 of 9)

| Location | Run No. | Parameter | Replicate samples | MS/MSD | Process Equipment Blank | Sampling Equipment Rinse/Blank | QC Replicate | Total No. of Samples |
|----------|---------|--|-------------------|--------|-------------------------|--------------------------------|--------------|----------------------|
| L2 | 1-4 | Uranium | 2 | NA | 1 | NA | 0 | 12 |
| | | Gross alpha | 2 | NA | 1 | NA | 0 | 12 |
| | | Radium | 1 | NA | 1 | NA | 0 | 8 |
| | | Plutonium | 1 | NA | 1 | NA | 0 | 8 |
| | | Americium | 1 | NA | 1 | NA | 0 | 8 |
| | | F, Cl, SO ₄ , CO ₃ | 1 | 1 | 1 | NA | 0 | 12 |
| | | NO ₂ /NO ₃ , PO ₄ , NH ₄ | 1 | 1 | 1 | NA | 0 | 12 |
| | | ICP Metals | 1 | 1 | 1 | NA | 0 | 12 |
| | | TDS | 1 | 0 | 1 | NA | 1 | 12 |
| | | TSS | 1 | 0 | 1 | NA | 1 | 12 |
| | TOC | 1 | 1 | 1 | NA | 0 | 12 | |
| | 5 | Uranium | 4 | NA | 1 | NA | 0 | 5 |
| | | Gross alpha | 4 | NA | 1 | NA | 0 | 5 |
| | | Radium | 2 | NA | 1 | NA | 0 | 3 |
| | | Plutonium | 2 | NA | 1 | NA | 0 | 3 |
| | | Americium | 2 | NA | 1 | NA | 0 | 3 |
| | | F, Cl, SO ₄ , CO ₃ | 2 | 1 | 1 | NA | 0 | 4 |
| | | NO ₂ /NO ₃ , PO ₄ , NH ₄ | 2 | 1 | 1 | NA | 0 | 4 |
| | | ICP metals | 2 | 1 | 1 | NA | 0 | 4 |
| | | TDS | 2 | 0 | 1 | NA | 1 | 4 |
| | | TSS | 2 | 0 | 1 | NA | 1 | 4 |
| | TOC | 2 | 1 | 1 | NA | 0 | 4 | |

TABLE A-2
 SUMMARY OF SAMPLE COLLECTION PROGRAM FOR THE CPM TECHNOLOGY DEMONSTRATION
 (Page 3 of 9)

| Location | Run No. | Parameter | Replicate ^a samples | MS/MSD | Process ^b Equipment Blank | Sampling Equipment Rinse ^c Blank | QC Replicate | Total No. of Samples |
|----------|----------------|--|--------------------------------|--------|--------------------------------------|---|--------------|----------------------|
| L3 | 1-4 | Uranium | 3 | NA | 1 | NA | 0 | 16 |
| | | Gross alpha | 3 | NA | 1 | NA | 0 | 16 |
| | | Radium | 1 | NA | 1 | NA | 0 | 8 |
| | | Plutonium | 1 | NA | 1 | NA | 0 | 8 |
| | | Americium | 1 | NA | 1 | NA | 0 | 8 |
| | | F, Cl, SO ₂ , CO ₂ | 1 | 1 | 1 | NA | 0 | 12 |
| | | NO ₂ /NO ₃ , PO ₄ , NH ₃ | 1 | 1 | 1 | NA | 0 | 12 |
| | | ICP metals | 1 | 1 | 1 | NA | 0 | 12 |
| | | TDS | 1 | 0 | 1 | NA | 1 | 12 |
| | | TSS | 1 | 0 | 1 | NA | 1 | 12 |
| TOC | 1 | 1 | 1 | NA | 0 | 12 | | |
| | 5 | NA | | | | | | |
| L4 | 1-4 | Uranium | 27 | NA | 1 | NA | 0 | 28 |
| | | Gross alpha | 27 | NA | 1 | NA | 0 | 28 |
| | | Radium | 4 ^d | NA | 1 | NA | 0 | 5 |
| | | Plutonium | 4 ^d | NA | 1 | NA | 0 | 5 |
| | | Americium | 4 ^d | NA | 1 | NA | 0 | 5 |
| | | F, Cl, SO ₂ , CO ₂ | 4 ^d | 1 | 1 | NA | 0 | 6 |
| | | NO ₂ /NO ₃ , PO ₄ , NH ₃ | 4 ^d | 1 | 1 | NA | 0 | 6 |
| | | ICP metals | 4 ^d | 1 | 1 | NA | 0 | 6 |
| | | TDS | 4 ^d | 0 | 1 | NA | 1 | 6 |
| | | TSS | 4 ^d | 0 | 1 | NA | 1 | 6 |
| TOC | 4 ^d | 1 | 1 | NA | 0 | 6 | | |

TABLE A-2
 SUMMARY OF SAMPLE COLLECTION PROGRAM FOR THE CPFM TECHNOLOGY DEMONSTRATION
 (Page 4 of 9)

| Location | Run No. | Parameter | Replicate samples | MS/MSD | Process ^a Equipment Blank | Sampling Equipment Rinseate Blank | QC Replicate | Total No. of Samples |
|----------------------|---------|--|-------------------|--------|--------------------------------------|-----------------------------------|--------------|----------------------|
| L5 | 1-4 | NA | | | | | | |
| | 5 | Uranium | 9 | NA | 1 | NA | 0 | 10 |
| | | Gross alpha | 9 | NA | 1 | NA | 0 | 10 |
| | | Radium | 0 | NA | 0 | NA | 0 | 0 |
| | | Plutonium | 0 | NA | 0 | NA | 0 | 0 |
| | | Americium | 0 | NA | 0 | NA | 0 | 0 |
| | | F, Cl, SO ₄ , CO ₃ | 0 | 0 | 0 | NA | 0 | 0 |
| | | NO ₂ /NO ₃ , PO ₄ , NH ₄ | 0 | 0 | 0 | NA | 0 | 0 |
| | | ICP metals | 0 | 0 | 0 | NA | 0 | 0 |
| | | TDS | 0 | 0 | 0 | NA | 0 | 0 |
| | | TSS | 0 | 0 | 0 | NA | 0 | 0 |
| | | TOC | 0 | 0 | 0 | NA | 0 | 0 |
| Total Liquid Samples | | | | | | | | 50 ^d |

TABLE A-2
SUMMARY OF SAMPLE COLLECTION PROGRAM FOR THE CPFM TECHNOLOGY DEMONSTRATION
(Page 5 of 9)

| Location | Run No. | Parameter | Replicate samples | MS/MSD | Process ^a Equipment Blank | Sampling Equipment Rinse ^a Blank | QC Replicate | Total No. of Samples |
|----------|---------|----------------------|-------------------|--------|--------------------------------------|---|--------------|----------------------|
| S1 | 1-4 | Uranium | 3 | NA | NA | 0 | 0 | 12 |
| | | Gross alpha | 3 | NA | NA | 0 | 0 | 12 |
| | | Radium | 1 | NA | NA | 0 | 0 | 4 |
| | | Plutonium | 1 | NA | NA | 0 | 0 | 4 |
| | | Americium | 1 | NA | NA | 0 | 0 | 4 |
| | | ICP metals | 1 | 0 | NA | 0 | 0 | 4 |
| | | TDS | NA | NA | NA | 0 | NA | 0 |
| | | TSS | NA | NA | NA | 0 | NA | 0 |
| | | TOC | 1 | 0 | NA | 0 | 0 | 4 |
| | | Paint filter liquids | 3 | NA | NA | NA | 0 | 12 |
| | | Bulk density | 0 | NA | NA | NA | 0 | 0 |
| | | Moisture content | 0 | NA | NA | NA | 0 | 0 |
| | | 5 | NA | | | | | |
| S2 | 1-4 | NA | | | | | | |
| | | Uranium | 3 | NA | NA | 0 | 0 | 3 |
| | | Gross alpha | 3 | NA | NA | 0 | 0 | 3 |
| | | Radium | 1 | NA | NA | 0 | 0 | 1 |
| | | Plutonium | 1 | NA | NA | 0 | 0 | 1 |
| | | Americium | 1 | NA | NA | 0 | 0 | 1 |
| | | ICP metals | 1 | 0 | NA | 0 | 0 | 1 |
| | | TDS | NA | NA | NA | 0 | NA | 0 |
| | | TSS | NA | NA | NA | 0 | NA | 0 |
| | | TOC | 1 | 0 | NA | 0 | 0 | 1 |
| | | Paint filter liquids | 3 | NA | NA | NA | 0 | 3 |
| | | Bulk density | 0 | NA | NA | NA | 0 | 0 |
| | | Moisture content | 0 | NA | NA | NA | 0 | 0 |

TABLE A-2
 SUMMARY OF SAMPLE COLLECTION PROGRAM FOR THE CPFM TECHNOLOGY DEMONSTRATION
 (Page 6 of 9)

| Location | Run No. | Parameter | Replicate* samples | MS/MSD | Process* Equipment Blank | Sampling Equipment Rinsate Blank | QC Replicate | Total No. of Samples |
|----------|---------|----------------------|--------------------|--------|--------------------------|----------------------------------|--------------|----------------------|
| SJ | 1-4 | NA | | | | | | |
| | 5 | Uranium | 3 | NA | NA | 0 | 0 | 3 |
| | | Gross alpha | 3 | NA | NA | 0 | 0 | 3 |
| | | Radium | 1 | NA | NA | 0 | 0 | 1 |
| | | Plutonium | 1 | NA | NA | 0 | 0 | 1 |
| | | Americium | 1 | NA | NA | 0 | 0 | 1 |
| | | ICP metals | 1 | 0 | NA | 0 | 0 | 1 |
| | | TDS | NA | NA | NA | 0 | NA | 0 |
| | | TSS | NA | NA | NA | 0 | NA | 0 |
| | | TOC | 1 | 0 | NA | 0 | 0 | 1 |
| | | Paint filter liquids | 3 | NA | NA | NA | 0 | 3 |
| | | Bulk density | 0 | NA | NA | NA | 0 | 0 |
| | | Moisture content | 0 | NA | NA | NA | 0 | 0 |

TABLE A-2
 SUMMARY OF SAMPLE COLLECTION PROGRAM FOR THE CPFM TECHNOLOGY DEMONSTRATION
 (Page 7 of 9)

| Location | Run No. | Parameter | Replicate samples | MS/MSD | Process Equipment Blank | Sampling Equipment Rinsate Blank | QC Replicate | Total No. of Samplers | |
|-----------|---------|----------------------|-------------------|--------|-------------------------|----------------------------------|--------------|-----------------------|---|
| S4 (TCLP) | 1-4 | Uranium | 3 | NA | NA | 1 | 0 | 16 | |
| | | Gross Alpha | 3 | NA | NA | 1 | 0 | 16 | |
| | | Radium | 1 | NA | NA | 1 | 0 | 8 | |
| | | Plutonium | 1 | NA | NA | 1 | 0 | 8 | |
| | | Americium | 1 | NA | NA | 1 | 0 | 8 | |
| | | ICP metals | 1 | 1 | NA | 1 | 0 | 12 | |
| | | TDS | 0 | 0 | NA | 0 | 0 | 0 | |
| | | TSS | 0 | 0 | NA | 0 | 0 | 0 | |
| | | TOC | 1 | 1 | NA | 1 | 0 | 12 | |
| | | Paint filter Liquids | 3 | NA | NA | 0 | 0 | 12 | |
| | | Bulk density | 1 | NA | NA | 0 | 0 | 4 | |
| | | Moisture content | 1 | NA | NA | 0 | 0 | 4 | |
| | 5 | | Uranium | 3 | NA | NA | 1 | 0 | 4 |
| | | | Gross alpha | 3 | NA | NA | 1 | 0 | 4 |
| | | | Radium | 1 | NA | NA | 1 | 0 | 2 |
| | | | Plutonium | 1 | NA | NA | 1 | 0 | 2 |
| | | Americium | 1 | NA | NA | 1 | 0 | 2 | |
| | | Metals | 1 | 1 | NA | 1 | 0 | 3 | |
| | | TDS | 0 | 0 | NA | 0 | 0 | 0 | |
| | | TSS | 0 | 0 | NA | 0 | 0 | 0 | |
| | | TOC | 1 | 1 | NA | 1 | 0 | 3 | |
| | | Paint filter liquids | 3 | NA | NA | 0 | 0 | 3 | |
| | | Bulk density | 1 | NA | NA | 0 | 0 | 1 | |
| | | Moisture content | 1 | NA | NA | 0 | 0 | 1 | |

TABLE A-2
SUMMARY OF SAMPLE COLLECTION PROGRAM FOR THE CPFM TECHNOLOGY DEMONSTRATION
(Page 8 of 9)

| Location | Run No. | Parameter | Replicate samples | MS/MSD | Process Equipment Blank | Sampling Equipment Rinse Blank | QC Replicate | Total No. of Samples | |
|----------------------|---------|----------------------|-------------------|--------|-------------------------|--------------------------------|--------------|----------------------|---|
| S5 | 1-4 | Uranium | 3 | NA | NA | 0 | 0 | 12 | |
| | | Gross alpha | 3 | NA | NA | 0 | 0 | 12 | |
| | | Radium | 1 | NA | NA | 0 | 0 | 4 | |
| | | Plutonium | 1 | NA | NA | 0 | 0 | 4 | |
| | | Americium | 1 | NA | NA | 0 | 0 | 4 | |
| | | ICP metals | 1 | 0 | NA | 0 | 0 | 4 | |
| | | TDS | NA | NA | NA | 0 | 0 | 0 | |
| | | TSS | NA | NA | NA | 0 | 0 | 0 | |
| | | TOC | 1 | 0 | NA | 0 | 0 | 4 | |
| | | Paint filter liquids | 3 | NA | NA | 0 | 0 | 12 | |
| | | Bulk density | 0 | NA | NA | 0 | 0 | 0 | |
| | | Moisture content | 0 | NA | NA | 0 | 0 | 0 | |
| | S5 | | Uranium | 3 | NA | NA | 0 | 0 | 3 |
| | | | Gross alpha | 3 | NA | NA | 0 | 0 | 3 |
| | | Radium | 1 | NA | NA | 0 | 0 | 1 | |
| | | Plutonium | 1 | NA | NA | 0 | 0 | 1 | |
| | | Americium | 1 | NA | NA | 0 | 0 | 1 | |
| | | Metals | 1 | 0 | NA | 0 | 0 | 1 | |
| | | TDS | NA | NA | NA | 0 | 0 | 0 | |
| | | TSS | NA | NA | NA | 0 | 0 | 0 | |
| | | TOC | 1 | 0 | NA | 0 | 0 | 1 | |
| | | Paint filter liquids | 3 | NA | NA | 0 | 0 | 3 | |
| | | Bulk density | 0 | NA | NA | 0 | 0 | 0 | |
| | | Moisture content | 0 | NA | NA | 0 | 0 | 0 | |
| Total Solid Samples | | | | | | | | 279 | |
| Total of All Samples | | | | | | | | 783* | |

TABLE A-2
SUMMARY OF SAMPLE COLLECTION PROGRAM FOR THE CPFM TECHNOLOGY DEMONSTRATION
(Page 9 of 9)

NOTES:

- a. Replicate samples for Runs 1-4 are taken from a 23-L container filled with a composite of water sampled at seven time intervals.
- b. Process equipment blanks will be collected during the 30 minute clean water flushing before each run.
- c. Samples are to be collected at time = 2.5, 7.5, 15, and 21.5 hours for Run 5.
- d. This total includes eight bottle rinse samples for critical parameters.

THE SAMPLE FREQUENCIES ARE TO BE AS FOLLOWS:

- Runs 1-4 Samples are to be collected from L1, L2, and L3 at seven equal time intervals during the run and composited into three 20-L containers, respectively.
- Run 5 Samples are to be collected from L1 at time = 0, 11 and 21.5 hours. Samples from L2 are to be collected at time = 11 and 21.5 hours. Samples from L4 and L5 are to be collected at time = 2.5, 5.0, 7.5, 10, 12.5, 15, 17.5, 20, and 21.5 hours.

TABLE A-3

SUMMARY OF FIELD MEASUREMENT PROGRAM FOR THE CPFM TECHNOLOGY DEMONSTRATION

| Measurement Locations | MEASUREMENT PARAMETERS | | | | | | | | | |
|-----------------------|------------------------|----|-------------------------|-----------|----------------|------|--------|-----------------------|---|--|
| | Temperature | pH | Electrical Conductivity | Flow Rate | Pumping Period | Mass | Volume | Differential Pressure | | |
| M1 | 1 | 3 | 1 | 3 | 3 | | | | | |
| M2 | | | | | | 1 | 1 | | | |
| M3 | | | | | | 1 | 1 | | | |
| M4 | 1 | 3 | 1 | 3 | 3 | | | | | |
| M5 | | | | | | | | | 3 | |
| M6 | | | | | | | | | 3 | |
| M7 | | | | | | | | | 3 | |
| M8 | 1 | 3 | 1 | 3 | | | | | | |
| M9 | | | | | | 1 | 1 | | | |
| M10 | | | | | | 1 | 1 | | | |
| M11 | | | | | | 1 | 1 | | | |
| M12 | | | | | | 1 | 1 | | | |
| M13 | 1 | | | | | 1 | 1 | | | |
| M14 | | 1 | | | | | | | | |
| M15 | | | | 1 | 1 | | | | | |
| M16 | 1 | 1 | 1 | | | | | | | |
| M17 | | | | | | 1 | 1 | | | |
| M18 | | | | | | 1 | 1 | | | |
| M19 | | | | | | 1 | 1 | | | |

NOTES: All measurements are to be taken during sample collection for each run.

activity will take place at FFT's fabrication facilities in Conroe, Texas prior to the demonstration. A PRC representative will oversee the construction of the filter packs and participate in the weighing of the filter packs and the FF 1000 material. Each filter pack will be reweighed in the field on an analytical balance immediately before placement in the modified filter press. The purpose of these measurements will be to establish the weight of the filter packs prior to use.

At the completion of each run, the filter packs will be weighed. In Runs 1 through 4 after weighing the packs, an incision will be made into the Pulplus® and the filter cake from all three packs will be removed with a stainless steel spoon, composited, and placed in a stainless steel bowl. The composite filter cake will be thoroughly mixed in the stainless steel bowl using a stainless steel spoon. After mixing, the filter cake will be split into 14 samples. Nine samples will be analyzed for the critical parameters listed in Table 4-2, and the other five samples will be used for analyzing the noncritical parameters listed in Table 4-4. In addition, if there are enough prefiltered solids from the mini clarifier and bag filters, samples will be collected for analysis according to Table A-2. After filter cake samples are collected, the pre-filtered solids will be added to the remaining filter cake. Then, a weighed amount of ProFix will be added to the mixture and thoroughly mixed using a stainless steel spoon. Eighteen samples of the stabilized mixture will be collected for TCLP analyses. The TCLP extract will be analyzed for radionuclides, ICP metals, VOCs, and solid characteristics.

In Run 5, both filter packs will be sampled prior to stabilization. After the filter cake sample has been obtained, the filter cake from the two packs will be combined, along with any prefiltered solids, for stabilization and sampling.

A.3.2 Liquid Sampling

All liquid samples will be collected directly from sample ports at the locations shown in Figure A-1. The PRC SITE team will collect composite grab samples from the sampling ports L1 through L5 in the following manner. The sampling port will be flushed out prior to sample collection by opening the sampling port and allowing the water to flow into a 5-gallon bucket for a minimum of 30 seconds. Waters from the influent sampling port (L1), the intermediate sampling port (L2), and the effluent sampling port (L3), will be collected at seven time intervals in three separate containers during Runs 1, 2, 3, and 4. From these composites, samples will be taken for each of the analyses.

The sample containers for the critical parameters will be filled first, followed by the sample containers for the noncritical parameters. During Run 5, samples of L1 will be collected by grab sample at three time intervals. At L2, two time interval grab samples will be collected. At L4 and L5, nine time interval grab samples will be collected. The time intervals for Run 5 are stated in Table A-2. The starting time and completion time for each sampling interval will be recorded in the field logbook.

A.3.3 Sampling Equipment Decontamination

All sampling equipment that comes into direct contact with sample media will be decontaminated before use. For this project, the sampling equipment requiring decontamination consists of the stainless steel spoons and bowls used for the collection and compositing of the filter cake solids. The decontamination procedures to be used are as follows:

- Wash with Alconox® water solution to remove solids
- Rinse with dilute solution of hydrochloric acid
- Rinse with deionized water and allow to dry
- Wrap with aluminum foil until needed

All equipment decontamination fluids will be treated with the CPFM treatment system prior to discharge into the OU4 IM/IRA tank.

A.4 Quality Assurance/Quality Control Sampling

The PRC SITE team will use three types of field QA/QC samples for the critical parameters listed in Tables 4-1 and 4-2: (1) replicate samples, (2) process equipment blanks, and (3) sampling equipment rinsate blanks. In addition, MS/MSD samples will be collected for anions, ICP metals, and organic compound analyses (noncritical parameters). Field measurements will be replicated for pH, flow rate, pumping period, and free liquids. Field equipment will be calibrated according to procedures described in Section 7.0 of the treatability studies work plan. QA/QC sampling procedures are discussed in the following subsections for aqueous and filter cake solids samples.

A.4.1 Filter Cake Solids Sampling

QA/QC samples for filter cake solids sampling will consist of replicate samples and sampling equipment rinsate blanks to determine analytical precision and accuracy. Field QA/QC samples will be collected as described below.

Replicate Samples

The PRC SITE team will collect three replicate samples for each critical parameter listed in Table 4-2. The replicate samples will be collected as individual samples from the composited filter cake from the filter packs; the prefiltered solids for runs 1, 2, 3, and 4; and each of the two filter packs and prefiltered solids during run 5 for the prestabilized solids.

Sampling Equipment Rinsate Blanks

The PRC SITE team will collect sampling equipment rinsate blanks at a frequency of one per run. The rinsate blank will be collected by pouring HPLC water over the decontaminated stainless steel bowl and spoon used for mixing and collecting the filter cake solids. The rinsate will be recovered into the sample containers specified for each analysis in Table A-4. The sampling equipment will be decontaminated using the procedure defined in Section A.3.3 prior to the collection of the rinsate blank.

A.4.2 Aqueous Sampling

QA/QC samples for aqueous sampling will include replicate samples, process equipment blanks, and MS/MSD samples. These samples will determine analytical precision and accuracy. QA/QC samples will be collected as described below.

TABLE A-4

**CPFM TECHNOLOGY DEMONSTRATION
SAMPLE CONTAINERIZATION AND PRESERVATION**

| <u>Parameter</u> | <u>Media</u> | <u>Minimum Sample Quantity</u> | <u>Container</u> | <u>Preservation</u> | <u>Maximum Holding Time</u> |
|--|--------------|--|------------------|---|-----------------------------|
| ICP metals | L | 1 L | P | HNO ₃ to pH < 2 Cool to 4°C | 6 months |
| Plutonium Americium | L | 5 L | P | HNO ₃ to pH < 2 | Indefinite |
| Radium | L | 1 L | P | HNO ₃ to pH < 2 | Indefinite |
| Isotopic uranium | L | 1 L | P | HCl to pH < 1 | Indefinite |
| Gross Alpha | L | 1 L | P | HNO ₃ to pH < 2 | Indefinite |
| TOC | L | 2 X 40 mL | G (TLS) | HCl to pH < 2 Cool to 4°C | 28 days |
| Anions: | | | | | |
| Fluoride (F) | L | 1 L | P | Cool to 4°C | 28 days |
| Chloride (CL) | L | Aliquot from F | P | Cool to 4°C | 28 days |
| Nitrite/nitrate (NO ₂ /NO ₃) | L | 1 L | P | H ₂ SO ₄ to pH < 2 Cool to 4°C | 28 days |
| Sulfate (SO ₄) | L | Aliquot from F | P | Cool to 4°C | 28 days |
| Phosphate (PO ₄) | L | Aliquot from NO ₂ /NO ₃ | P | H ₂ SO ₄ to pH < 2 Cool to 4°C | 28 days |
| Carbonate (CO ₃ - alkalinity) | L | Aliquot from F | P | Cool to 4°C | 14 days |
| Ammonia (NH ₃) | L | Aliquot from NO ₂ /NO ₃ | P | H ₂ SO ₄ to pH < 2 Cool to 4°C | 28 days |
| pH | L | 500 mL beaker | P | Not required | Analyze Immediately |
| Temperature | L | 500 mL beaker | P | Not required | Analyze Immediately |
| Electrical conductivity | L | 500 mL beaker | P | Not required | Analyze Immediately |
| TDS and TSS | L | 1 L | P | Cool to 4°C | 7 days |
| ICP metals | S | 8 Oz | G | Cool to 4°C | 6 months |
| TOC | S | 10 g | G | Cool to 4°C | 28 days |
| Radionuclides | S | 8 Oz | G | Cool to 4°C | Indefinite |

TABLE A-4

**CPFM TECHNOLOGY DEMONSTRATION
SAMPLE CONTAINERIZATION AND PRESERVATION
(Continued)**

| <u>Parameter</u> | <u>Media</u> | <u>Minimum Sample Quantity^a</u> | <u>Container</u> | <u>Preservation</u> | <u>Maximum Holding Time</u> |
|------------------|--------------|--|------------------|---------------------|---|
| TCLP | S | 8 Oz | G | Cool to 4°C | 28 days for extraction; 6 months for metals analyses; 14 days for VOCs |
| Free Liquids | S | 8 Oz | G | Not required | Analyze Immediately |
| Bulk density | S | 8 Oz | G | Not required | Not Applicable |
| Moisture content | S | 8 Oz | G | Not required | Not Applicable |

Notes: For media and container abbreviations:

L = Liquid
 S = Solids
 P = Plastic
 G = Glass
 G (TLS) = Glass with Teflon[®] lined septum

^a Minimum sample quantity as defined in this QAPjP applies to all samples including replicates and QA/QC samples. Units are as follows:
 L = liter, ml = milliliter, oz = ounce, g = gram.

Replicate Samples

The PRC SITE team will collect two or three replicate samples (as specified in Table 4-2) for each critical parameter listed in Table 4-1 of the treatability studies work plan. The replicate samples will be collected from the composite.

Process Equipment Blanks

The PRC SITE team will collect one process equipment blank at the intermediate line to the filter press and the effluent line from the filter press prior to the startup of each test run. The process equipment blank will be analyzed for the critical and noncritical parameters listed in Table 4-1 and Table 4-3 of the treatability studies work plan. Prior to the collection of the process equipment blank, FFT will pump clean water through the filter press for about 30 minutes at a rate of 5 gpm. At the end of 15 minutes, the PRC SITE team will collect one process equipment blank at the influent and effluent line of the filter press. The vendor claims the majority of leachable compounds from the filter cake will leach within the first 15 minutes of wetting the filter bed.

Matrix Spike and Matrix Spike Duplicates

The PRC SITE team will collect MS/MSD samples at a frequency of one sample per 20 samples analyzed for anions, metals, TOC, TCLP metals, and TCLP VOCs (noncritical parameters). The MS/MSD samples will be collected from the composite. Radian will divide the sample into equal amounts (subsamples) and spike each of them separately. Each of the two subsamples will be spiked with the same volume of spiking solution. The spiking solutions will contain all analytes listed in Table 4-3 of the treatability studies work plan. The two subsamples will be the MS/MSD.

A.5 Sample Containerization, Preservation, Handling, and Shipment

The following sample handling considerations, containerization and preservation requirements, and shipment procedures were developed in accordance with RREL guidance (EPA, 1987) and SW-846 criteria (EPA, 1986).

A.5.1 Containerization, Preservation, and Holding Times

Table A-4 presents the container and preservation requirements for each parameter to be analyzed. All containers will be obtained from Radian and will be cleaned before shipment. Preservatives will be added to samples as soon as possible after they are collected. Samples will be placed in ice-filled coolers upon collection. Table A-4 also presents holding times for analytical parameters. These holding times were obtained from the analytical methods or other reference literature.

A.5.2 Sample Custody and Transport

The PRC SITE team will maintain standard chain of custody for each sample as it is collected. Samples will be retained at all times in the field crew's custody. Samples will be kept on ice and protected from direct sunlight. Samples will be shipped by overnight courier to Radian and Accu-lab at the end of each day.

Each sample will be labeled with the following information: unique sample identification number, the sample location, date and time of collection, and analyses to be performed. Figure A-2 shows a typical sample label. Sample custody seals will be placed on each sample container and on the front and back of each ice chest or cooler lid to detect unauthorized tampering after collection and before analysis. Figure A-3 shows a sample tamper-proof custody seal. The sampling crew chief or designee will affix seals at the time of sample packaging. Each seal will include the following information:

- Name or initials of sampler
- Date of sampling

Sample custody will begin at the time of sample collection. The sample will be placed into an iced cooler, or other appropriate container, in the possession of the designated field sample custodian. The field chain-of-custody form (Figure A-4) will immediately be filled out and initialed by the field sample custodian. The following describe the procedures to complete the chain-of-custody form:

Field Number _____
Sample Type: _____
Client: _____
Location: _____
Preservative: _____
Sampler: _____
Date: _____
Comment: _____

6-89-31426

FILE NAME: 0013-10112-300-0000

DATE: 02/17/92

NOTE:
THIS IS AN EXAMPLE OF THE LABEL
AND IS FOR REFERENCE ONLY.

SITE CPM DEMONSTRATION
ROCKY FLATS PLANT - GOLDEN, COLORADO

FIGURE A-2
SAMPLE LABEL AND
CUSTODY TAG

PMC ENVIRONMENTAL MANAGEMENT, INC.

ATTENTION:
BEFORE OPENING
NOTE IF CONTAINER
WAS TAMPERED WITH

I.D. # _____

ATTENTION:
BEFORE OPENING
NOTE IF CONTAINER
WAS TAMPERED WITH

6 88-31426

FILE NAME: 0413-14-712-110 DMC

DATE: 06/17/93 JEM

NOTE:
THIS IS AN EXAMPLE OF THE SEAL
AND IS FOR REFERENCE ONLY.

SITE CPFM DEMONSTRATION
ROCKY FLATS PLANT - GOLDEN, COLORADO

FIGURE A-3

TAMPERPROOF CUSTODY SEAL

PRC ENVIRONMENTAL MANAGEMENT, INC.

| | |
|--|--|
| <u>Project Name</u> | Enter the project name -- SITE CPM Demonstration. |
| <u>Site</u> | Enter the site location -- RFP. |
| <u>Samplers</u> | Enter the signatures and print names of people who participated in collecting the samples listed and who should be contacted if questions arise during sample log in. If the field sample custodian is not listed as a sampler, receipt documentation should be indicated. |
| <u>Field Sample Identification (ID) Number</u> | Enter the PRC-assigned sample identification number. |
| <u>Sample Matrix</u> | Enter the sample matrix: solid or liquid. |
| <u>Date/Time</u> | Enter date and time of sample collection. If sample is a composite, indicate both start and finish date and time. |
| <u>Number of Containers</u> | Enter the total number of sample containers for a given sample identification number. |
| <u>Analyses</u> | List parameters to be analyzed; if abbreviation or parameter categories (such as ICP metals) are used, provide further details when logging in samples. |
| <u>Remarks</u> | Enter either composite or grab and add any other comments such as the lot number of the sample containers. |

When all line items on the field chain-of-custody form are completed or when the samples are picked up, the custodian will sign and date the form, list the time, and confirm the completeness of all descriptive information contained on the form. Each individual who subsequently assumes responsibility for the sample will sign the chain-of-custody form and provide the reason for assuming custody. The field chain-of-custody form will terminate when the laboratory receives the samples. The field sample custodian should obtain the pink copy of the chain-of-custody form for program files.

A field tracking report will also be completed in the field (Figure A-5). This report will assist in doublechecking all samples that were taken during the sampling effort. It can be tailored to insure that all required samples were obtained.

All samples will be packaged, labeled for shipment, and shipped in compliance with Title 40 of the Code of Federal Regulations (CFR) Part 173, Subpart I (Radioactive Materials) 173.421, current U.S. Department of Transportation (DOT) (49 CFR Part 172), and International Air Transport Association (IATA) (Dangerous Goods Regulations, 31st Edition, January 1, 1991) regulations. Based on the concentrations of radionuclides in the OU4 IM/IRA tank water listed in Table 2-1 of the treatability studies work plan, the liquid and solid samples will not exceed the radiation limits specified in 40 CFR Part 173.423 and can be shipped as a limited quantity of excepted radioactive material in accordance with 40 CFR Part 173.421. However, the radiation level on the external surface of the shipping container will be measured by the PRC SITE team with a radiation detector to evaluate whether the radiation level is below 0.5 millirem per hour. RFP personnel will also perform a wipe test on the external surface of each shipping container prior to authorizing its removal from the RFP site.

Sample shipping containers will be marked in accordance with 40 CFR Part 173.241. A label will be placed inside each cooler that states the following:

This package conforms to the conditions and limitations specified in 49 CFR Part 173.241 for limited quantities of excepted radioactive materials.

In addition, the coolers will be marked with a sticker containing the originator's complete mailing addresses and "this end up" arrows on all four sides.

When possible, all samples from a single sampling location will be kept together. Styrofoam, bubble wrap, or equivalent material will be used to absorb shock. When more than one set of samples can fit in a cooler, one of the sets will be placed in a separate plastic bag to prevent cross contamination if the containers break.

Sample chain-of-custody forms and any other shipping and sample documentation will accompany the shipment. These documents will be enclosed in a waterproof plastic bag and taped to the underside of the cooler lid.

Only metal or plastic ice chests will be used for shipping hazardous waste samples. The outside container must be able to withstand a 4-foot drop on solid concrete in the position most likely to cause damage. Each ice chest prepared for shipment will be securely taped shut. Reinforced or other suitable tape will be wrapped at least twice around the ice chest near each end where the hinges are located. Custody seals will be affixed across the joint between the top and bottom (in front and in the back) of each ice chest prepared for shipment. The seals will then be covered with clear plastic tape.

When selecting sample shipment modes, field personnel will verify whether the sample will not exceed allowable holding times for individual analytes. When commercial common carriers are used to ship samples, all samples will be shipped "priority one/overnight." If necessary, samples can be shipped through a reliable commercial carrier, such as Federal Express, Emery, or DHL. If commercial carriers are used, airbills will be completed and attached to the exterior lids of the containers. Multiple shipment labels will be used when shipping more than one container.

The Radian and Accu-lab sample custodians or designated alternates will receive and assume custody of samples until they have been properly logged into the laboratory and stored in a secure area.

Upon receipt of a sample shipment, the shipping container will be inspected for warning labels and security seals before it is opened. The sample custodian will open the container and check the contents for evidence of breakage or leakage. The temperature of the water in the ice chest will be measured and the presence of ice noted. The contents of the container will be inspected for chain-of-custody forms and other information or instructions. The temperature will be noted on the chain-of-custody form with the date and signature of the person making the entry. The sample custodian will verify that all information on the sample bottle labels is correct, in accordance with the chain-of-custody forms, and will sign for the receipt. The pH of the liquid samples will be determined. The chain-of-custody form will be retained in the project file, and a copy will be returned to the client or project manager to verify receipt. A copy of the chain-of-custody form will be permanently attached to a bound and dated log book.

Any discrepancy between the samples and the chain-of-custody information, any broken or leaking sample bottles, or any other abnormal situation will be reported to the Radian and Accu-lab project directors. PRC and, if required, EPA, will be informed of the problem and corrective action options will be discussed and implemented. Notations of the problem and resolution will be made on the chain-of-custody form, initialed, and dated by the sample custodian. Identifying information will be recorded in a bound sample log book. The information required includes:

- Date of receipt
- Client name
- Client identifying number or description
- Project number
- Analyses required

The Radian and Accu-lab computerized laboratory sample tracking system will be used for logging samples into the laboratory, tracking the progress of the analyses, and preparing the analytical report. All information pertinent to the identification of the sample and analyses to be performed will be entered into the sample tracking system. Each sample will be assigned a unique laboratory number. Samples provided in multiple containers for different tests will be identified by the same laboratory number followed by a hyphenated numeral identifying each fraction. A laboratory sample label will be attached to each bottle. A work order will be prepared and provided to the laboratory supervisor for scheduling tests in accordance with method-required maximum holding times. A bench sheet will be printed to inform the analysts of the tests to be performed for each sample. This sheet will serve as the instrument of information transmittal throughout the sample preparation, analysis, and report preparation sequence.

Samples will be stored in designated refrigerated areas according to the analyses to be performed. A log book will be maintained for each refrigerator in which the temperature is recorded each working day.

A sample storage log book will be used to document the removal and replacement of a sample from the secure storage area.

A.6 Field Notes and Logbook

Field personnel will record all information pertinent to the sampling and measurement program in a consecutively numbered field logbook. Each page will be dated and signed by the person making the entries. Logbooks are accountable field documents and serve as a chronological representation of the sampling and measurement program. Sufficient detail will be included in the logbook to provide a summary of the sampling and measurement activities without relying on the recorder's memory. At a minimum, the logbook will contain the following:

Background

- Purpose of sampling (program support, contract number)
- Name and address of facility or site where sampling is performed
- Description of treatment technology
- Brief description of wastes (untreated solids, treated solids)
- Known or suspected waste composition

Chronology of Sampling

- Description of sampling points and sampling methodology
- Number and volume of samples taken
- Date and time of collection
- Sample identification number
- Field measurements -- record date and times
- Field observations -- any problems encountered and deviations from the sampling and analysis plan

Sample Distribution

- Sample distribution and method of transport (number and distribution of duplicates, name of laboratory where samples were sent, overnight courier service used, airbill number, and other such information)
- Signature of samplers or crew chief

A.7 Preventive Maintenance

Preventive maintenance (PM) of analytical and process equipment is necessary to minimize interruptions or delays in the demonstration project. Radian and Accu-lab will follow PM procedures for laboratory analytical equipment. FFT will follow its own PM procedures for the treatment system and ancillary equipment. Prior to the demonstration, the PRC SITE team will develop a comprehensive, itemized checklist to monitor PM. PRC's field manager will maintain a photocopy file of completed PM checklists or certifications performed by both Radian, the other selected laboratory, and FFT. When possible, PRC's field manager or his designate will oversee PM procedures.

A.8 References

- Snedecor, G.W. and W.G. Cochran, 1967. Statistical Methods, The Iowa State University Press, Ames, Iowa.
- Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics, McGraw-Hill Book Company, New York, New York.
- U.S. EPA, 1986. Test Method for Evaluating Solid Waste, Volumes IA-IC: Laboratory Manual, Physical/Chemical Methods; and Volume II: Field Manual, Physical/Chemical Methods, SW-846, Third Edition. Office of Solid Waste and Emergency Response, Washington, D C.
- Winer, B.J., 1971. Statistical Principles in Experimental Design, 2nd Edition, McGraw-Hill Book Company, New York, New York.

DRAFT

APPENDIX C
QUALITY ASSURANCE ADDENDUM

C. QUALITY ASSURANCE ADDENDUM

This quality assurance addendum (QAA) establishes the specific QA controls applicable to the investigation activities described in the *Treatability Study Work Plan for the Superfund Innovative Technology Evaluation (SITE) Colloid Polishing Filter Method Demonstration at Rocky Flats* (referred to as the treatability studies work plan).

The objective of the treatability studies work plan is to evaluate the effectiveness and the cost of this process for reducing the concentration of metals and radionuclides in ground water at RFP. The field testing is described in Section 5.0 of the treatability studies work plan. Successful bench-scale studies of the CPFM process have already been completed.

C.1 ORGANIZATION AND RESPONSIBILITIES

The overall organization for EPA, PRC, Radian, EG&G, DOE and FFT involved in the treatability studies work plan appears in Figure 12-1 of Section 12.0 in the treatability studies work plan.

C.2 QUALITY ASSURANCE PROGRAM

This QAA contains QA requirements that may not have been addressed within the treatability studies work plan. Most of the QA requirements of the treatability study are addressed in the treatability studies work plan and are referenced in this QAA.

C.2.1 Training

All personnel involved in performing field activities at RFP will have completed an Occupational Safety and Health Administration (OSHA) 40-hour safety training course, an 8-hour supervisor training course, an 8-hour refresher training course, a respirator fit-test, cardiopulmonary resuscitation (CPR) training and first aid training. The qualification requirements for the treatability study project team are addressed in Section 12.0 of the treatability studies work plan and in Appendix B (Health and Safety Plan).

C.2.2 Quality Assurance Reports to Management

Effective management of environmental measurement efforts requires timely assessment and review of measurement activities. This requires effective interaction between the team members. Periodic internal reports are necessary to provide ongoing evaluation of measurement data quality. Such reports may include:

- A summary of project activities and general QA program status
- A summary of any procedure changes
- A summary of unscheduled maintenance activities
- A summary of corrective action activities
- Monthly reports indicating the status of unresolved problems
- Audit results

The results of inspections, summaries of problems, and corrective action requests to program management will be reported. The laboratories' project managers will discuss unresolved requests for corrective action with the PRC project manager, PRC program manager, and PRC SITE QA manager, who will then take measures to resolve problems. The appropriate project manager will then reinspect the problem area to verify that appropriate corrective actions were implemented.

The final laboratory report for this project will include a separate QA section documenting QA/QC activities that lend support to the credibility of the data and the validity of the conclusions. The QA section will include the following items, as appropriate:

- Changes to the project procedures
- Limitations or constraints on the applicability of the data
- The status of QA/QC programs, accomplishments, and corrective actions
- Results of technical systems and performance evaluation QC audits
- Assessment of data quality in terms of precision, accuracy, completeness, method detection limits, representativeness, and comparability
- Quality assurance-related training

C.3 DESIGN CONTROL AND CONTROL OF SCIENTIFIC INVESTIGATIONS

C.3.1 Design Control

The treatability studies work plan describes the field sampling, sample preparation and handling, treatment testing, sample analysis, data management, and data analysis and interpretation activities that will be implemented as part of the treatability study. As such, the treatability studies work plan is considered the investigation control plan for the CPFM treatability study.

C.3.2 Data Quality Objectives

DQOs quantitatively and qualitatively describe the uncertainty that decision makers are willing to accept in results derived from environmental data. This uncertainty specifies the quality of the data required to meet the objectives of the investigations. The process for developing DQOs for remedial investigations is given in EPA guidance (EPA, 1991). The DQOs for the treatability study were established in accordance with this guidance.

The specific objectives of the CPFM treatability study are discussed in Section 2.4 of the treatability studies work plan. The data to be collected from the treatability testing were selected to address those objectives. The quality of these data depends on the analytical level of the measurement data which dictates the type of sampling and analytical or measurement quality controls that should be adhered to in collecting the data. The EPA has defined five levels of analytical data (levels I-V). These analytical levels for treatability studies are defined in Section 4.4 of the treatability studies work plan.

The intended use of the data determines which analytical level is required for the treatability testing data to be collected. The type of data to be generated and the analytical level of the data determine the sampling and analytical or measurement options. The data use, data needs, and analytical level for the CPFM treatability testing are discussed in Section 4.0 of the treatability studies work plan.

Analytical levels II, IV, and V have been determined to be appropriate for analytical data collected from the CPFM treatability testing. Typically, analytical levels II to IV data are appropriate for pilot scale treatability tests. However, due to the inclusion of radionuclides as critical parameters, quantitative analytical level V data will be needed to determine if the CPFM treatment was effective in reducing contaminant concentrations. Qualitative measurements (such as analytical level II data) will be appropriate for all field measurements; analytical level IV will be used for metals, anions, and organic analyses; and analytical level V will be used for radionuclide analyses.

Data quality can be measured in terms of precision, accuracy, representativeness, comparability, and completeness (also referred to as PARCC parameters). These parameters are defined in Section 4.5 of the treatability studies work plan. PARCC parameter goals are established prior to initiating investigations. They assist in determining if DQOs for measurement data have been met. Goals set for the PARCC parameters for the CPFM treatability testing are specified in Section 4.5 of the treatability studies work plan.

C.3.3 Field Sampling Program and Sampling Procedures

Untreated and treated ground water and unstabilized and stabilized filter cake will be collected during the treatability tests. Appendix A describes sampling procedures for both media, field measurements, and preparation of stabilized filter cake.

C.3.4 Analytical Procedures

The chemicals and elements of interest for the CPFM treatability study are listed in Tables 4-1 through 4-4 of Section 4.0 of the treatability studies work plan. Laboratory analysis will adhere to EPA CLP analytical methods where applicable. Modified EPA-approved methods will be used for radionuclides. In addition to the laboratory analysis of water and filter cake, measurements of pH, flow rate, temperature, and electrical conductivity will also be obtained according to the analytical methods described in Section 4.0.

C.3.5 Equipment Decontamination

Field sampling equipment will be decontaminated between sample collection in accordance with procedures outlined in Section A.1.3.3 of Appendix A of the treatability studies work plan. Decontamination water will be handled according to procedures discussed in Section 6.1 of the treatability studies work plan.

C.3.6 Quality Control Checks

To promote quality in field sample collection, QC samples will be incorporated into the sampling scheme. QC samples and collection frequencies for field samples are discussed in Section A.1.4 of Appendix A.

Analytical laboratory QC procedures provide measures of internal consistency of analytical and storage procedures. The analytical laboratory QC requirements are specified in Section 7.1.

C.3.7 Data Reduction, Validation, and Reporting

Reduction of laboratory measurements shall be in accordance with the methods specified for each analytical method. Analytical data will be compiled into sample data packages by the analytical laboratory contractor. A sample data package will be developed for each sample delivery group or sample batch, with separate data packages for each type of analysis. The sample data package will consist of a cover letter, a case narrative, data summary forms, and data checklists. The reduced data will be used in the data validation process to verify that the laboratory control and the overall system DQOs have been met.

Data validation activities consist of reviewing and verifying field and laboratory data and evaluating these verified data for data quality. The field and laboratory data validation activities are discussed in Section 4.0 of the treatability studies work plan.

Data management of the treatability test results is discussed in Section 7.0 of the treatability studies work plan. Data analysis and interpretation of analytical and treatability testing are described in Section 8.0.

C.4 PROCUREMENT DOCUMENT CONTROL

Procurement documents for items and services, including services for performing the treatability testing and laboratory analyses will be prepared, handled, and controlled in accordance with the requirements and methods specified by EPA as part of the SITE program.

C.5 INSTRUCTIONS, PROCEDURES, AND DRAWINGS

The treatability studies work plan describes the sampling, treatability testing, sample analyses, and data management to be performed. The treatability studies work plan will be reviewed and approved by the EPA before the field sampling begins. Changes and variances to the approved treatability studies work plan will be documented and approved by the EPA.

C.6 DOCUMENT CONTROL

The following documents will be controlled in accordance with RFP's procedures.

- *Treatability Study Work Plan for the Superfund Innovative Technology Evaluation (SITE) Colloid Polishing Filter Method Demonstration at Rocky Flats*
- *Quality Assurance Addendum to the Treatability Study Work Plan for the Superfund Innovative Technology Evaluation (SITE) Colloid Polishing Filter Method Demonstration at Rocky Flats*

C.7 CONTROL OF PURCHASED ITEMS AND SERVICES

Contractors selected for the laboratory analysis of water and filter cake samples will be required to implement all requirements contained in the treatability studies work plan and this QAA.

Contractor performance will be evaluated through inspection and audits as described in Section 7.2.4 of the treatability studies work plan.

C.8 IDENTIFICATION AND CONTROL OF ITEMS, SAMPLES, AND DATA

C.8.1 Sample containers

Sample volumes, containers, preservation requirements, and holding times for treatability study samples to be sent to the laboratory are specified in Appendix A, Section A.1.5.

C.8.2 Sample Identification

Sample identification and labeling instructions are specified in Appendix A, Section A.1.5.

C.8.3 Chain of Custody

Sample chain of custody will be maintained by following directions provided in Appendix A, Section A.1.5.2.

C.9 CONTROL OF PROCESSES

The CPFM testing process is described in Section 5.0 of the treatability studies work plan.

C.10 INSPECTIONS

Inspections of field sampling, treatability testing, and laboratory analytical activities will be scheduled and implemented by the PRC QA manager and PRC staff. These inspections will note compliance, or noncompliance, with sampling and analytical procedure specifications in the treatability studies work plan.

C.11 TEST CONTROLS

The treatability tests will be controlled according to the individual testing procedures described in the task descriptions presented in Section 5.3 of the treatability studies work plan.

C.12 CONTROL OF MEASURING AND TESTING EQUIPMENT (M&TE)

Water measuring and test equipment used for field measurements during sample collection will adhere to the equipment requirements specified in Section 6.0 of the treatability studies work plan. Calibration and maintenance requirements of field instruments appear in Section 7.1 of the treatability studies work plan.

C.13 HANDLING, STORAGE, AND SHIPPING

Samples will be packaged, transported, and stored in accordance with the requirements specified in Appendix A, Section A.1.5.2. All liquid wastes generated during treatability testing will be handled according to the specifications addressed in Section 9.0 of the treatability studies work plan.

C.14 STATUS OF INSPECTION, TEST, AND OPERATIONS

PRC will maintain and report the status of the process operations to EPA and EG&G.

C.15 CONTROL OF NONCONFORMANCES

The requirements for the identification, control, evaluation, and disposition of nonconforming activities, items, samples, and data will be implemented as specified in Section 7.2.5 of the treatability studies work plan. Nonconformances shall be processed as outlined in this section.

C.16 CORRECTIVE ACTION

The requirements for the identification, documentation, and verification of corrective actions for conditions adverse to quality will be implemented as outlined in Section 7.2.5 of the treatability studies work plan. Conditions adverse to quality identified by PRC will be documented according to this section.

C.17 QUALITY ASSURANCE RECORDS

Field sampling data records will be controlled and considered QA records. Laboratory analytical data packages will also be considered QA records. Other records associated with this activity that will be considered QA records include, but are not necessarily limited to, the following:

- Chain-of-custody records
- Raw data results
- Calculations and data analysis results
- Audit/surveillance reports
- Nonconformance reports
- Corrective action reports
- Data validation results
- Procurement/contracting documentation
- Treatability testing logbook

All QA records generated during the planning and implementation of this activity will be maintained by PRC.

C.18 QUALITY VERIFICATION

The requirements for the verification of quality will be implemented as specified in Section 4.9 of the treatability studies work plan. The PRC QA project manager will develop a surveillance schedule as deemed appropriate for this treatability study, which will include some of the test runs

described in Section 5.3 of the treatability studies work plan. A surveillance of the laboratory analysis will be conducted at the discretion of PRC and EPA.

C.19 SOFTWARE VERIFICATION

The use of computer software programming during the conduct of this activity is not anticipated.

C.20 REFERENCES

U.S. EPA, 1991, Preparation Aid for the Development of Category II Quality Assurance Project Plans, EPA/600/8-91/004, Risk Reduction Engineering Laboratory, Office of Research and Development, Cincinnati, Ohio, U.S. Environmental Protection Agency.