

OPERATIONS AND MAINTENANCE PLAN FOR THE 100-KR-4 PUMP AND TREAT SYSTEMS

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management



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OPERATIONS AND MAINTENANCE PLAN FOR THE 100-KR-4 PUMP AND TREAT SYSTEMS

Date Published
July 2018

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

 U.S. DEPARTMENT OF
ENERGY | Richland Operations
Office
P.O. Box 550
Richland, Washington 99352

APPROVED
By Janis D. Aardal at 8:17 am, Jul 18, 2018

Release Approval

Date

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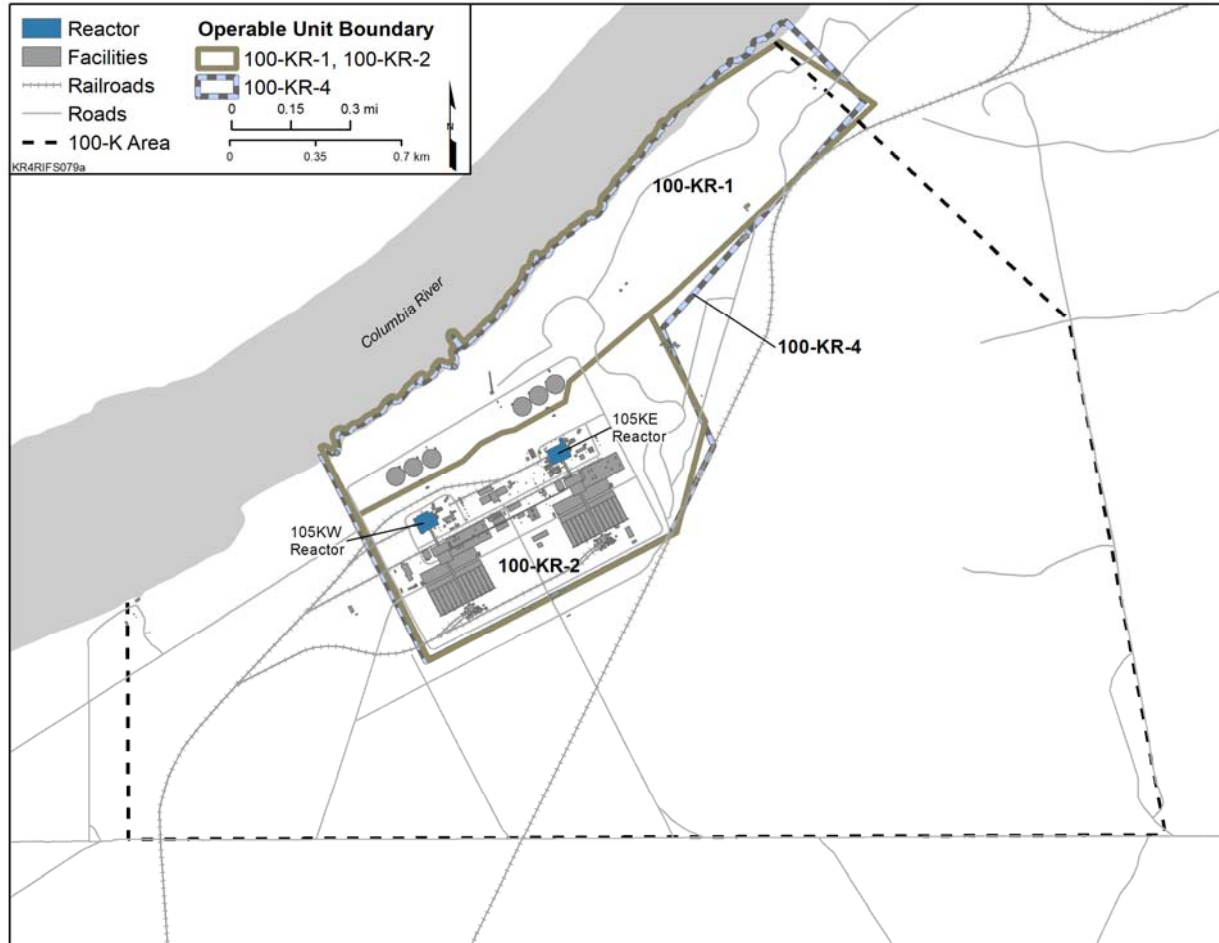
Terms

ALARA	as low as reasonably achievable
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act of 1980</i>
CHPRC	CH2M HILL Plateau Remediation Company
D&D	decontamination and decommissioning
DMCS	document management control system
DOE	U.S. Department of Energy
DOE-RL	DOE Richland Operations Office
DQA	data quality assessment
EPA	U.S. Environmental Protection Agency
ESD	explanation of significant differences
HASP	health and safety plan
HASQARD	<i>Hanford Analytical Services Quality Assurance Requirements Document</i>
IC	institutional control
ISMS	Integrated Safety Management System
ITEM	Integrated Training Electronic Matrix
IX	ion exchange
JCS	job control system
KW	K-West
KX	K-Expansion
O&M	operations and maintenance
OU	operable unit
P&T	pump and treat
PLC	programmable logic controller
PPE	personal protective equipment
PPS	Plateau Remediation Company Procedure System
PRCMSS	Plateau Remediation Contract Material Services System
QA	quality assurance
QAPjP	quality assurance project plan
RAO	remedial action objective
RD/RAWP	remedial design/remedial action work plan
ROD	record of decision

RPO	remedial process optimization
S&GRP	Soil and Groundwater Remediation Project
SAP	sampling and analysis plan
SCADA	Supervisory Control and Data Acquisition
SMR	Sample Management and Reporting
TPA	Tri-Party Agreement
Tri-Party Agreement	<i>Hanford Federal Facility Agreement and Consent Order</i>

1 Introduction

In 1996, an interim action record of decision (ROD) (EPA/ROD/R10-96/134, *Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units Interim Remedial Actions, Hanford Site, Benton County, Washington*) was issued for the 100-HR-3 and 100-KR-4 Groundwater Operable Units (OUs) in the Hanford 100 Area. Pump and treat (P&T) technology for remediation of hexavalent chromium (Cr(VI)) was selected as the interim remedy for the 100-KR-4 OU. The network of 100-KR-4 OU P&T systems is a major component of the interim action ROD. Figure 1-1 shows the location of the 100-K Area and the 100-KR-4 OU on the Hanford Site.



Note: The 100-KR-4 OU comprises the groundwater contaminant plumes that are above drinking water standards, risk-based concentrations, and the state surface water quality standard.

Figure 1-1. 100-K Area and Operable Units

In August 2009, an explanation of significant differences (ESD) was issued to provide notice of revisions to the cost estimate and reinjection locations with the P&T interim action (EPA et al., 2009, *Explanation of Significant Differences for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision: Hanford Site Benton County, Washington*). Expansion of the P&T system to address Cr(VI) groundwater concentrations that continued to exceed the cleanup levels was identified in the future cost estimate. The 2009 ESD also revised the reinjection standards and location requirements for treated water.

This operations and maintenance (O&M) plan supports the remedial design/remedial action work plan (RD/RAWP) for the 100-KR-4 OU (DOE/RL-2013-33, *Remedial Design/Remedial Action Work Plan for the 100-KR-4 Groundwater Operable Unit Interim Action* [hereinafter called the 100-KR-4 RD/RAWP]) and outlines the activities necessary to operate, maintain, and monitor three P&T facilities in the 100-KR-4 OU from operations through decommissioning. The scope includes O&M, performance monitoring and reporting, *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) 5-year remedy reviews, health and safety, and quality assurance (QA). These activities are supported by DOE/RL-2013-29, *Sampling and Analysis Plan for 100-KR-4 Groundwater Operable Unit Monitoring*, and DOE/RL-97-01, *Interim Action Waste Management Plan for the 100-KR-3 and 100-KR-4 Operable Units*.

1.1 Purpose of this Plan

The purpose of this plan is to describe O&M of the 100-KR-4 P&T systems that are designed to meet the interim action ROD (EPA/ROD/R10-96/134) remedial action objectives (RAOs) for the 100-KR-4 OU. Maintaining an adequate and functioning O&M program throughout a remedy's lifecycle is critical for a successful remedy and achievement of the RAOs. The RAOs for the interim remedial action at 100-KR-4 OU are as follows:

- Protect aquatic receptors in the river bottom substrate from contaminants in groundwater entering the Columbia River. To meet this objective, the U.S. Department of Energy (DOE) has implemented a P&T system with the following operational requirements.
 - Groundwater above 20 µg/L Cr(VI) will not be discharged to injection wells that are downgradient of extraction wells.
 - Groundwater above 50 µg/L Cr(VI) will not be discharged.
 - Water treated using ion exchange (IX) to remove Cr(VI) will be injected through wells to hydraulically manage Cr(VI) plumes.
- Protect human health by preventing exposure to contaminants in the groundwater.
 - The interim action is expected to provide adequate protection of human health via institutional controls (ICs), which are implemented through programs not covered by this plan, and the interim remedial action itself will not pose any unacceptable risks to human health.
- Provide information that will lead to the final remedy.
 - Evaluation of the interim action effectiveness will be based on site-specific data. This evaluation should include treatment cost, efficiency, other technologies, hydraulic effects, and effectiveness of contaminant removal from the aquifer.

Figure 1-1 shows the location of the 100-K Area and the 100-KR-1, 100-KR-2, and 100-KR-4 OUs.

1.2 Scope of the Operations and Maintenance Plan

The plan describes O&M for the KR4, K-West (KW), and K-Expansion (KX) P&T systems in the 100-KR-4 OU of the Hanford Site. The O&M plan includes the following information:

- Routine and preventive O&M
- Upset conditions
- Corrective maintenance

- O&M methods and training
- Inspection requirements
- System monitoring
- Reporting
- Decontamination and decommissioning
- Health, safety, and QA

The O&M plan includes information for scheduling maintenance activities to minimize effects to system performance.

This O&M plan presents information based on the system design at the end of calendar year 2017. Information on previous system design, project history, and remedial performance is provided in the annual summary reports for P&T operations. The following reports summarize operations for the KW, KX, and KR4 P&T systems:

- DOE/RL-2011-25, *Calendar Year 2010 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump-and-Treat Operations and 100-NR-2 Groundwater Remediation.*
- DOE/RL-2012-02, *Calendar Year 2011 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump-and-Treat Operations, and 100-NR-2 Groundwater Remediation.*
- DOE/RL-2013-13, *Calendar Year 2012 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump-and-Treat Operations, and 100-NR-2 Groundwater Remediation.*
- DOE/RL-2014-25, *Calendar Year 2013 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump-and-Treat Operations, and 100-NR-2 Groundwater Remediation.*
- DOE/RL-2015-05, *Calendar Year 2014 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations, and 100-NR-2 Groundwater Remediation.*
- DOE/RL-2016-19, *Calendar Year 2015 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations, and 100-NR-2 Groundwater Remediation.*
- DOE/RL-2016-68, *Calendar Year 2016 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations, and 100-NR-2 Groundwater Remediation.*
- DOE/RL-2017-67, *Calendar Year 2017 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations, and 100-NR-2 Groundwater Remediation (pending).*

This plan is updated or revised when relevant or substantive changes are made to the operating system or supporting primary documents that affect the project, as described in the 100-KR-4 RD/RAWP (DOE/RL-2013-33).

1.3 Remedy Description

Removal of Cr(VI) from contaminated groundwater using P&T technology was selected by the interim action ROD as the interim remedy for 100-KR-4 OU groundwater contaminated with Cr(VI). The remedy consists of extraction wells located within the plume, IX systems to remove Cr(VI), and injection wells to return treated water to the aquifer. As the lead agency, DOE implemented these interim remedies within the 100-KR-4 OU. The remedy includes ICs to prevent exposure of human receptors to contaminated groundwater. The following sections provide a brief description of the interim remedies.

1.3.1 Pump and Treat Systems

The three P&T systems operating in the 100-KR-4 OU are similar in their design, construction, and operation. The KR4 system was the first system installed and began operation in 1997. This system was designed to remediate groundwater around the 116-K-2 Trench. The KW system was the second system installed, and it began remediating Cr(VI) in the KW Reactor area in January 2007. The KX system is the third and newest system and began operation in February 2009. The KX system is used primarily to treat Cr(VI) in groundwater that has migrated from the 116-K-2 Trench area toward N Reactor. The KR4 system was originally designed to process up to 1,130 L/min (300 gpm), the KW system was originally designed to process up to 760 L/min (200 gpm), and the KX system was originally designed to process up to 2,300 L/min (600 gpm). At the end of calendar year 2015, modifications to the P&T systems provided facility operating capacities of 1,250 L/min (330 gpm) for the KR4 and KW P&T systems, and 3,400 L/min (900 gpm) for the KX P&T system.

Each P&T system includes an extraction well network, a treatment building, an injection well network, conveyance piping, and support equipment and components. The KR4 and KX systems also include transfer buildings. Water is pumped from the extraction wells to collection tanks in the transfer buildings, then to the treatment building, or directly to collection tanks in the treatment building, depending on system configuration. The extraction well system is operated and managed to remove Cr(VI) mass efficiently while protecting the Columbia River. Figure 1-2 shows the layout of the KR4, KW, and KX P&T systems and the extraction/injection well networks as of the end of 2017.

System modifications are implemented for the KR4, KW, and KX P&T systems based on changes in Cr(VI) concentrations in groundwater and changing contaminant plume configurations. Extraction and injection well configurations and facility equipment are modified when it is determined to be beneficial to the cleanup progress and completion of the remedial action. This may include rebound studies and treatability tests. Current system configurations can be found in the most recent version of the annual pump and treat report. However, the annual reports reflect the system configuration when they were issued and may not contain the most recent system configurations.

Figure 1-3 presents a simple line diagram of the KR4 and KX treatment systems, and Figure 1-4 presents a simple line diagram for the KW treatment system.

Cr(IV) is removed from the extracted groundwater using IX technology. A summary of resin evaluations and process alternatives analysis performed to support resin selection and facility design and a recommended strategy for resin management for 100 Area chromium P&T systems are provided in SGW-46621, *100 Area Groundwater Chromium Resin Management Strategy for Ion Exchange Systems*. A successful test was conducted for ResinTech® SIR-700 conversion of the KW P&T system (SGW-51721, *100-KW Pump and Treat ResinTech SIR-700 Test Results and Recommendations for Use Across 100-KR-4 Operable Unit*). The successful conversion led to selection and use of ResinTech SIR-700 in the KR4, KW, and KX P&T systems.

ResinTech SIR-700 is a weak base anion exchange resin with high selectivity and capacity for chromate and dichromate. Influent pH adjustment is accomplished by the addition of an acid. This adjustment typically takes place within the influent tank in the treatment building. Following influent pH adjustment, the influent is directed to one or more of the IX trains located within the treatment building. Currently, treated water is routed to effluent tanks and then to the injection wells in the KR4, KW, and KX P&T systems.

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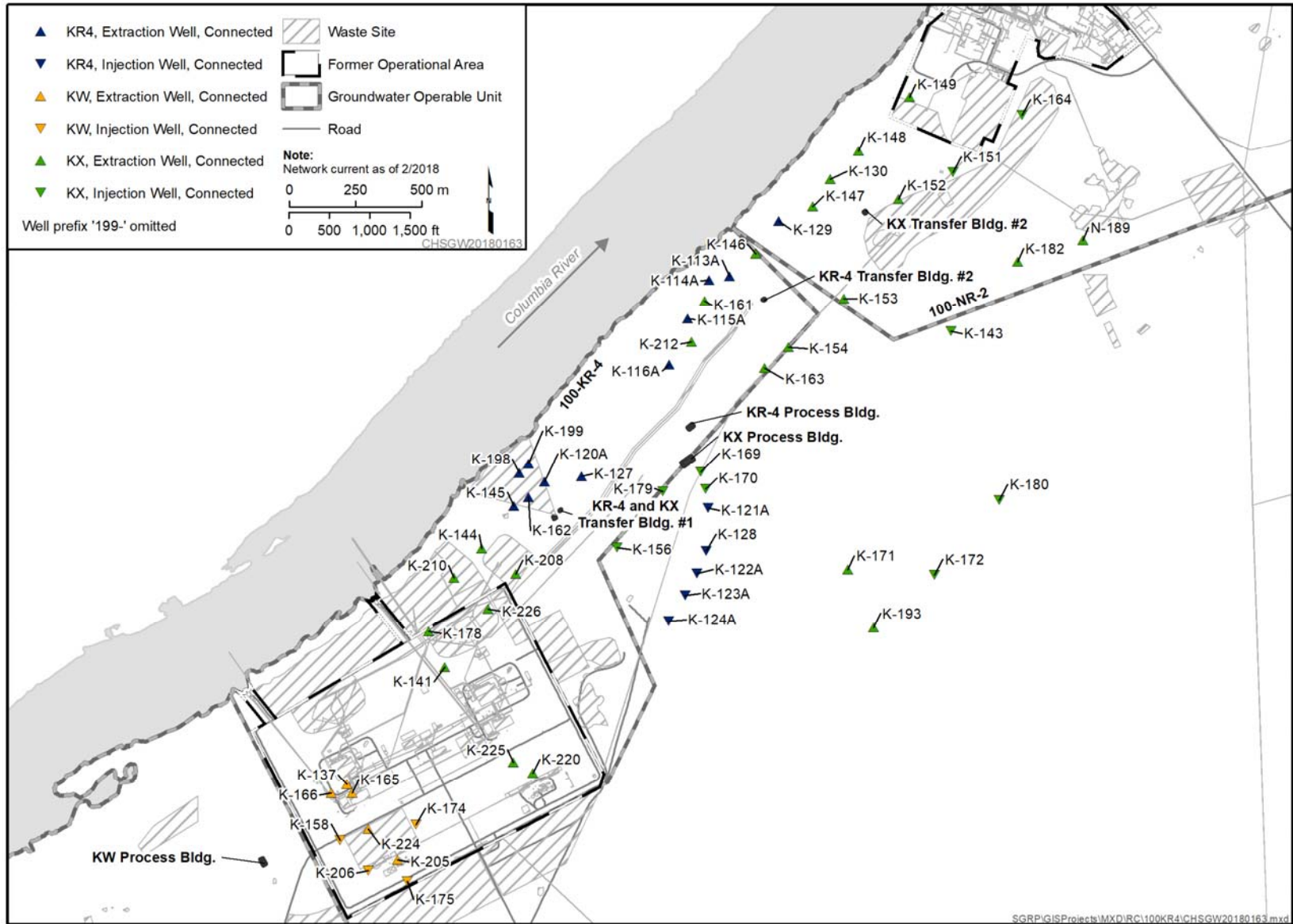
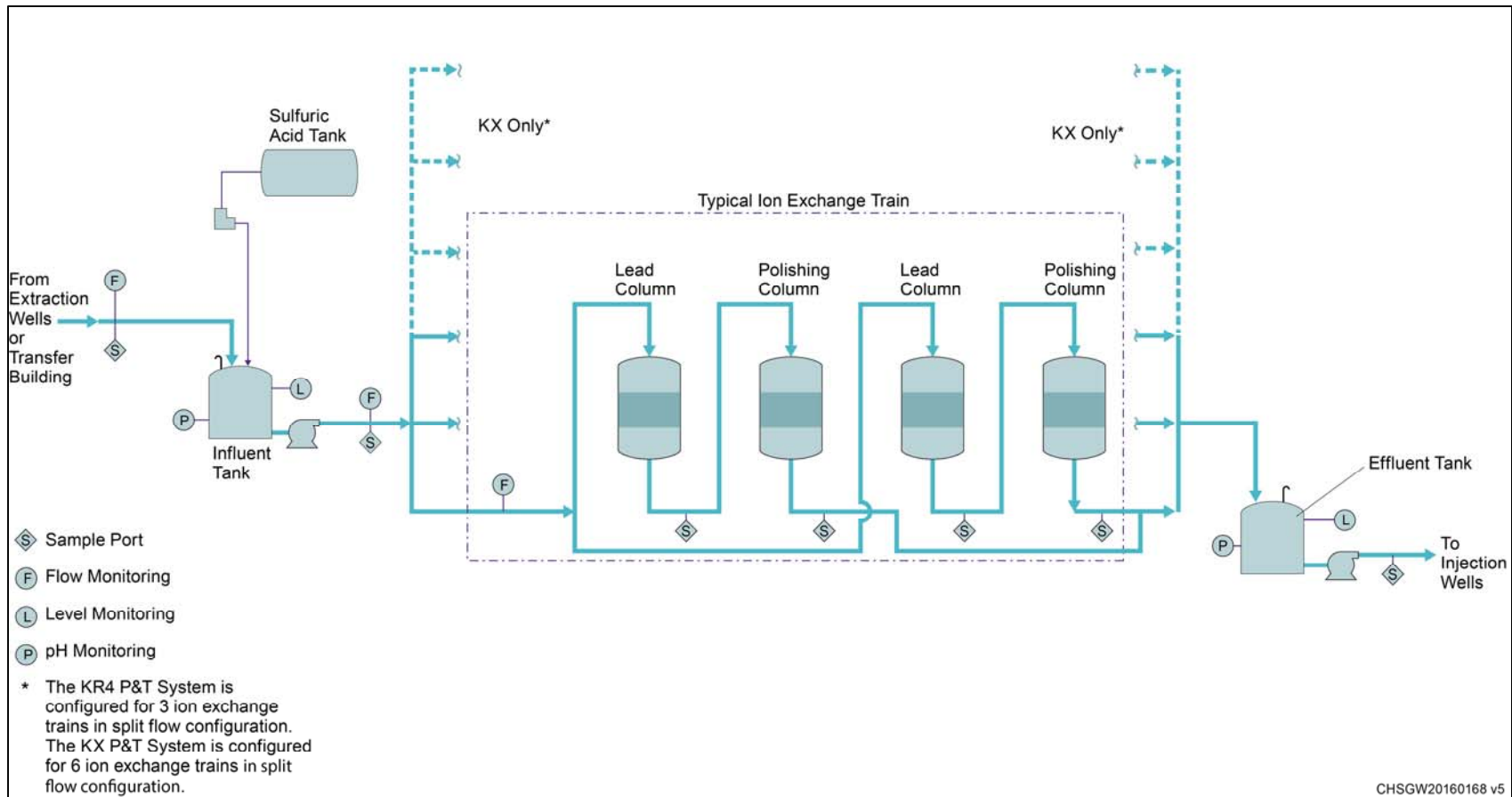
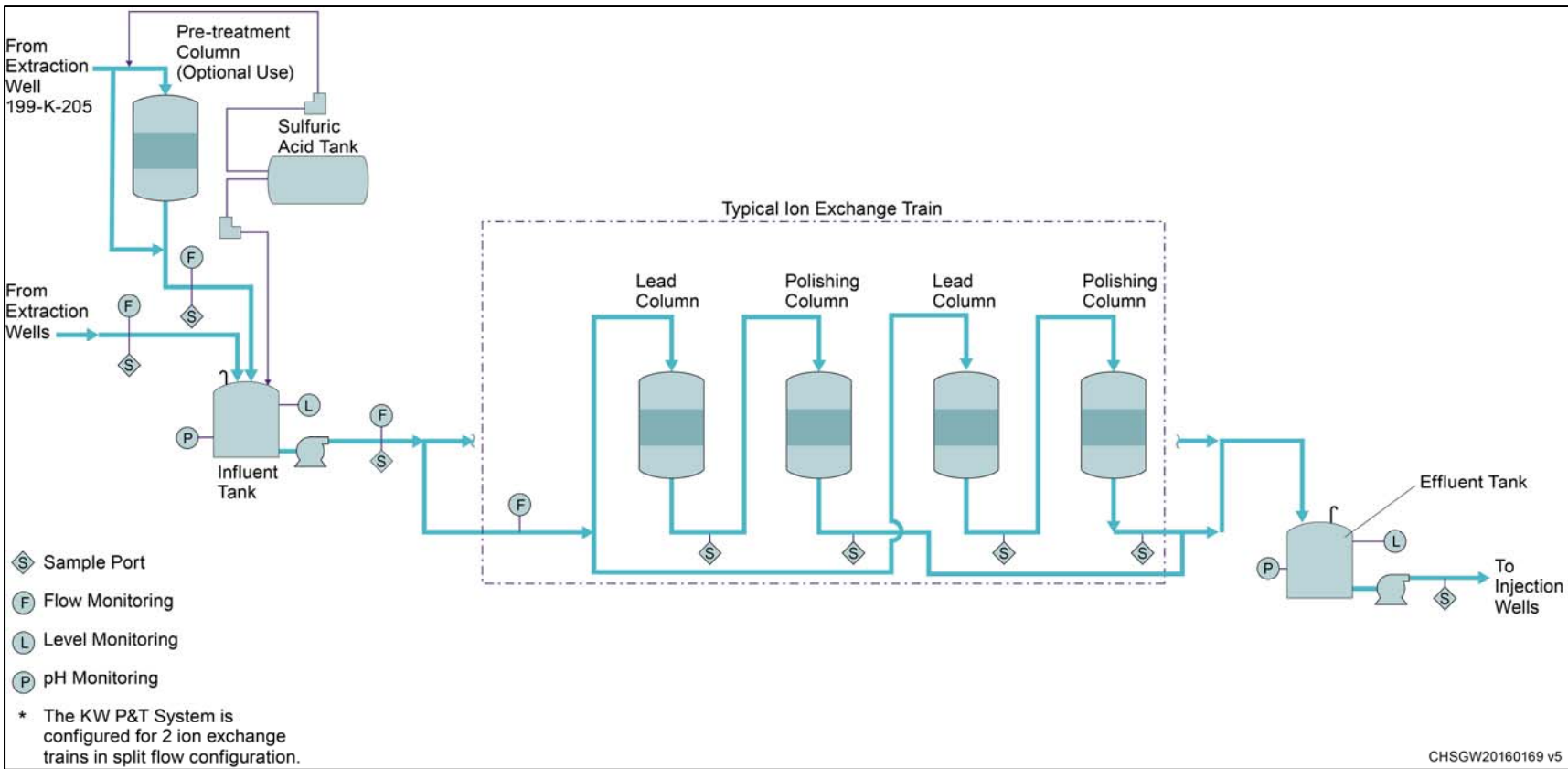


Figure 1-2. 100-KR-4 Operable Unit Pump and Treat System, 2017



Note: Components and locations may vary from those shown.

Figure 1-3. Simple Line Diagram of the KR4 and KX Treatment Systems



Note: Components and locations may vary from those shown.

Figure 1-4. Simple Line Diagram of the KW Treatment System

Table 1-1 summarizes the treatment capabilities and performance of the three P&T systems through December 31, 2017. The extraction well system is operated and managed to remove Cr(VI) mass efficiently while protecting the Columbia River. The interim action ROD amendment requires Cr(VI) removal to the maximum extent practicable, and not to exceed 20 µg/L. The 100-KR-4 P&T systems include the extraction and injection wells shown in Table 1-2 as of the end of 2017.

Table 1-1. 100-KR-4 Pump and Treat Systems Performance Summary (as of 12/31/2017)

System	Current Capacity (gpm/L/min)	Volume Treated (million gal/million L)	Mass Removed Cr(VI) (lb/kg)
KR4	330/1,250	2,378/9,000	836/379
KW	330/1,250	1,120/4,239	563/255
KX	900/3,400	2,735/10,351	594/269

Table 1-2. 100-KR-4 Pump and Treat System Wells (2017)

KR4		KW	KX		
Extraction Wells					
199-K-113A	199-K-162	199-K-137	199-K-130	199-K-154	199-K-210
199-K-114A	199-K-198	199-K-165	199-K-141	199-K-161	199-K-212
199-K-115A	199-K-199	199-K-166	199-K-144	199-K-163	199-K-220
199-K-116A	--	199-K-205	199-K-146	199-K-171	199-K-225
199-K-120A	--	199-K-224	199-K-147	199-K-178	199-K-226
199-K-127	--	--	199-K-148	199-K-182	199-N-189
199-K-129	--	--	199-K-152	199-K-193	--
199-K-145	--	--	199-K-153	199-K-208	--
Injection Wells					
199-K-121A	199-K-128	199-K-158	199-K-143	199-K-164	199-K-180
199-K-122A	--	199-K-174	199-K-149	199-K-170	--
199-K-123A	--	199-K-175	199-K-151	199-K-172	--
199-K-124A	--	199-K-206	199-K-156	199-K-179	--

The influent Cr(VI) concentrations at the KR4 P&T system were below interim action cleanup levels in 2017, and are expected to remain low. Currently, the primary function of the KR4 P&T system is for hydraulic control of contaminant plumes. Because influent Cr(VI) concentrations are below interim action cleanup levels and are expected to remain low, acid use at the KR4 P&T system may be discontinued except for periodic use to remove scale buildup and biofouling in the IX treatment trains. The system is monitored to determine the appropriate amount of acid needed in order to maintain plant operations. Of the three 100-KR-4 OU P&T systems, the KX P&T system is anticipated to remain operational for the longest period.

1.3.2 Other Remedy Components

This subsection describes the components of the groundwater remedy that augment the P&T systems.

1.3.2.1 Flow-Path Control

The 100-KR-4 OU remedial action includes extracting and injecting treated groundwater at strategic locations relative to groundwater contaminant plume(s) distribution and groundwater flow direction. The general pumping strategy includes the following considerations:

- Downgradient extraction wells are located within about 200 m (656 ft) of the Columbia River and operated to provide capture of plume segments that exceed RAOs and have potential to migrate directly to the river.
- Source area extraction wells are located in or near high-concentration plume segments that are generally associated with historical release points and exhibit potential effects of continuing contributions from secondary sources. These wells provide increased mass removal from the aquifer.
- Mid-plume extraction wells provide additional plume capture, minimizing the contaminant mass approaching the river.
- Injection wells for all three systems are generally located inland of and, in the case of three KX P&T system wells, away from the primary plume areas. These injection locations help maintain water balance in the aquifer, influence flow direction by creating recharge mounds, and release untreated co-contaminants at locations to reduce effects at potential exposure points.

Refining extraction and injection locations is used to control plume(s) migration, increase contaminant removal efficiency, direct higher concentration plume segments toward extraction wells, and divert untreated co-contaminants to locations where natural attenuating processes reduce potential exposures.

1.3.2.2 Institutional Controls

The interim action ROD requires ICs during the interim action to prevent human exposure to contaminated groundwater. ICs are instruments (e.g., administrative and/or legal restrictions) designed to control or eliminate exposure to specific contaminants. Groundwater use is restricted until cleanup levels are achieved. Current ICs for the Hanford Site are identified in DOE/RL-2001-41, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Actions*. It also describes how ICs are implemented and maintained, serving as a reference point for selecting future ICs.

The current plan identifies the controls needed to prevent exposure during the restoration period, which include entry restrictions and groundwater use restrictions. These ICs are implemented by programs not covered in this O&M plan. Controls to prevent exposure are achieved by implementing the IC actions throughout the interim action, or until the pathway is eliminated or contaminant concentrations decline below health-based levels.

1.3.2.3 Source Remediation

Although the groundwater remedial action is operated independently of source remedial actions within the 100-K Area, the groundwater remedy is coordinated with source remediation actions. Some source areas at the 100-K Area may continue to release contaminants that contribute to groundwater contamination. The groundwater remedy cannot be completed until continuing sources of contamination are identified and remediated.

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2 Organization, Operations, and Optimization

This chapter describes the 100-KR-4 P&T systems project organization, O&M program, and optimization process.

2.1 Project Organization

The project organization includes the DOE Richland Operations Office (DOE-RL), U.S. Environmental Protection Agency (EPA), and Remediation Contractor organizations that support the 100-KR-4 OU interim remedial actions. Figure 2-1 provides the organizational structure supporting the 100-KR-4 OU interim remedial actions. The organizational structure may be modified as project requirements change. Organizational responsibilities and interrelationships are described in the following subsections.

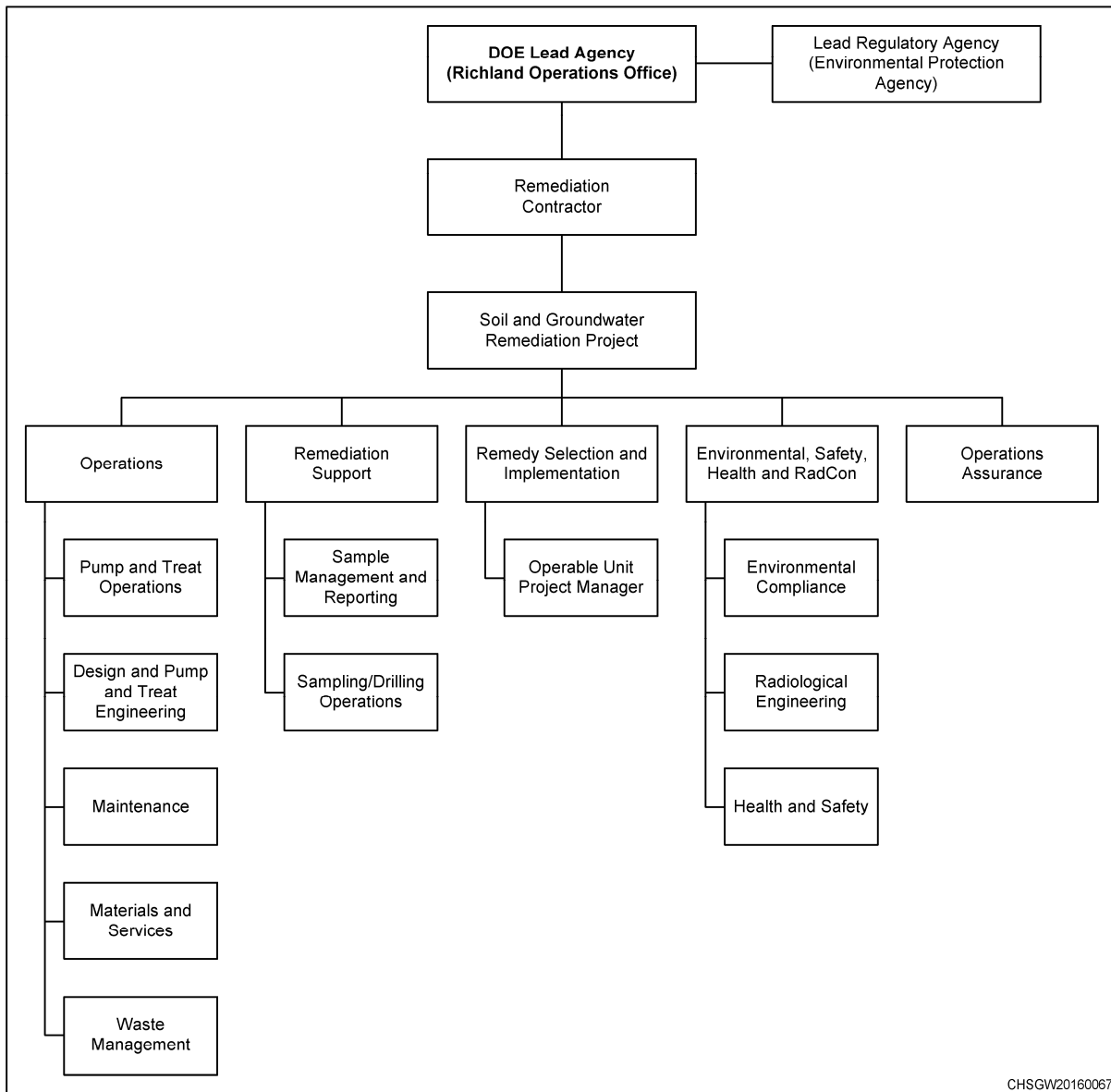


Figure 2-1. Organization Chart for 100-KR-4 OU Pump and Treat Operations and Maintenance

2.1.1 DOE Lead Agency (Richland Operations Office)

DOE is the lead agency under CERCLA (delegated by Executive Order 12580, *Superfund Implementation*, the primary authority under Section 104, “Response Authorities,” and Section 121, “Cleanup Standards”) to conduct removal and remedial actions at DOE facilities. DOE-RL is responsible for the remedial actions throughout the Hanford Site and is responsible for managing the assigned activities including scope, budget, schedule, quality, personnel, communication, risk/safety, contracts, and regulatory interface and works under regulatory oversight in accordance with CERCLA Section 120, “Federal Facilities,” as implemented through the Tri-Party Agreement (TPA), as amended (Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*). DOE obtains Congressional funding for these functions.

2.1.2 Lead Regulatory Agency

EPA is the lead regulatory agency for CERCLA remediation activities at the 100-KR-4 OU, as described in the TPA (Ecology et al., 1989a). The lead regulatory agency is responsible for overseeing activities to verify that applicable regulatory requirements are met. Lead regulatory agency approval will be required on all TPA primary documents.

2.1.3 Remediation Contractor

The prime contractor is responsible for implementing the CERCLA remediation activities at the 100-KR-4 OU. The following organizations within CH2M HILL Plateau Remediation Company (CHPRC) provide functional and operational support for the remediation activities.

2.1.4 Soil and Groundwater Remediation Project

The Soil and Groundwater Remediation Project (S&GRP) is responsible for management and implementation of remediation activities at the 100-KR-4 OU and coordinates with DOE-RL, EPA, and Remediation Contractor personnel. The following organizations within the S&GRP provide functional and operational support for the remediation activities.

2.1.4.1 *Remedy Selection and Implementation*

Remedy Selection and Implementation provides direction and oversight for remediation activities and coordinates with DOE-RL, EPA, and Remediation Contractor personnel. Remedy Selection and Implementation is responsible for coordinating and evaluating remediation data and ensuring compliance with state and federal laws. The group is also responsible for collecting P&T data and tracking trends to show the cleanup performance.

2.1.4.2 *Operable Unit Project Manager*

The OU project manager provides direction and oversight for all activities and coordinates with DOE-RL, regulatory, and contractor personnel to support remediation activities. The OU project manager is responsible for sampling documents and requirements, field activities, and subcontracted tasks. The OU project manager works closely with the Operations, Remediation Support, Health and Safety organization, and Operations Assurance organizations to integrate the disciplines in planning and implementing the work scope.

2.1.4.3 *Remediation Support*

The Remediation Support organization provides field and technical support to the S&GRP. These field activities include groundwater well and investigative borehole drilling, well and borehole decommissioning, environmental sampling, and groundwater well maintenance. The organization also

provides environmental sample planning, sample and data management, sample analytical support, and data quality assessment (DQA) services.

2.1.4.4 Sample Management and Reporting

The Sample Management and Reporting (SMR) organization supports three primary work areas: sample and data planning, sample and data management, and analytical support. Sample and data planning includes assistance in planning, generating, and reviewing data quality objective processes and reports, sampling and analysis plans (SAPs), sampling instructions, and DQA reports. The SMR organization also coordinates laboratory analytical work and ensures that the laboratories conform to DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD) or their equivalent as approved by DOE and the regulatory agencies. SMR receives analytical data from the laboratories, enters the data into the Hanford Environmental Information System database, and arranges for data validation. SMR is responsible for informing the OU project manager of any issues reported by the analytical laboratories.

2.1.4.5 Sampling/Drilling Operations

The Sampling and Drilling Operations organization provides field sampling, well maintenance, drilling and decommissioning, and well planning support to S&GRP. The field sampling group provides trained and certified personnel to conduct sampling in accordance with HASQARD (DOE/RL-96-68). The well maintenance group is responsible for ensuring the wells remain operable during the life of the well. The well planning group is responsible for preparing and coordinating key documents needed to safely execute drilling projects and provide technical support.

2.1.4.6 Environmental, Safety, Health, and RadCon

The Environment, Safety, Health, and RadCon organization supports the S&GRP by providing a safe work environment. The organization is responsible for protection of employees, the public, and the environment and provides assistance in complying with company, DOE, and Occupational Safety and Health Administration standards and requirements. Safe operations are achieved by applying the Integrated Safety Management System (ISMS) and the Voluntary Protection Program.

2.1.4.7 Environmental Compliance

The Environmental Compliance organization reviews plans, methods, and technical documents to ensure that environmental requirements have been addressed; identifies environmental issues that affect operations and develops cost-effective solutions; and responds to environmental/regulatory issues. The Environmental Compliance organization also oversees project implementation for compliance with environmental requirements.

2.1.4.8 Radiological Engineering

The Radiological Engineering organization is responsible for radiological support within S&GRP. Specific responsibilities include conducting as low as reasonably achievable (ALARA) reviews, exposure and release modeling, work planning, and optimizing radiological controls. The Radiological Engineering organization identifies radiological hazards and implements appropriate controls to maintain worker exposures ALARA. The Radiological Control organization plans and directs radiological control technician support for all activities. The Radiological Engineering organization coordinates with the Health and Safety organization to determine personal protective equipment (PPE) requirements.

2.1.4.9 Health and Safety

The Health and Safety organization is responsible for coordinating industrial safety and health support within S&GRP. This is implemented through hazards analysis, job hazard analyses, and other pertinent safety documents. The Health and Safety organization assists project personnel in complying with applicable health and safety standards and requirements and coordinates with the Radiological Engineering organization to determine PPE requirements.

2.1.4.10 Operations Assurance

The Operations Assurance organization provides support to S&GRP to execute project activities in a manner that improves operational efficiency and performance. Operations Assurance responsibilities include training, methods, issues management, emergency preparedness, QA, work control, and shift office.

2.1.4.11 Operations

The Operations organization is responsible for operation and maintenance of the P&T systems. This includes ensuring that appropriate operations support functions (e.g., radiological protection and safety) are available to support operations activities and verifying that O&M methods have been prepared, approved, and implemented.

2.1.4.12 Pump and Treat Operations

The P&T Operations organization is responsible for planning and coordinating field resources and ensuring that workers are appropriately trained and available. The organization is also responsible for day-to-day safe configuration and continued operations of the facility, issue identification, and responding to system maintenance needs. The organization develops operational guides and conducts training and performance evaluations. Additional responsibilities include analyzing operational process control methods, maintaining operational records and reports, and reviewing all plant operating records.

2.1.4.13 Design and Pump and Treat Engineering

The Design and P&T Engineering organization is responsible for the design and operations/maintenance support of the P&T systems. This includes reviewing and approving functional design criteria, design changes, construction submittals, and requests for information; performing engineering inspections for design compliance; and reviewing and approving maintenance and operations methods.

2.1.4.14 Maintenance

The Maintenance organization is responsible for supervising all preventive and corrective maintenance of the P&T facilities. This includes planning, scheduling, and directing maintenance of equipment and buildings, and coordinating and supervising personnel and materials required for the maintenance and repair of facilities.

2.1.4.15 Materials and Services

The Materials and Services organization coordinates storage, inventory, transportation, and delivery of materials to support the P&T systems. The organization provides the carpenters that support the P&T systems.

2.1.4.16 Waste Management

The Waste Management organization is responsible for communicating policies and protocols with the waste generators and ensuring compliance with state and federal requirements for proper storage, transportation, disposal, and tracking of wastes. Other responsibilities include identifying waste

management sampling/characterization requirements, interpreting data to determine waste designations and profiles, and preparing and maintaining waste management documents.

2.2 Operations and Maintenance Program

O&M is managed through a system of established methods and databases. The following bullets briefly describe primary methods and databases:

- **Job Control System (JCS):** JCS is a computerized work control process used to track work packages, maintenance activities, and work scheduling. The JCS database contains component/equipment information, maintenance schedules, and provides a primary implementing interface for work control methods.
- **Document Management Control System (DMCS):** DMCS serves as the primary document issuance and change control database for controlled technical documents (i.e., plans, drawings, engineering document changes, specifications, supporting documents, facility modification packages, and standards).
- **Plateau Remediation Contract Material Services System (PRCMSS):** PRCMSS is the primary implementing database for material control methods. The PRCMSS provides processes to manage purchasing, receiving, issuing, and controlling materials for project use.
- **Integrated Training Electronic Matrix (ITEM):** ITEM is the primary implementing database for training and qualification methods. The ITEM provides processes to manage requirements, scheduling, completion, and records related to training and qualifications.
- **Plateau Remediation Company Procedure System (PPS):** The procedure system provides processes for managing CHPRC procedures creation, access, distribution, and revision.

O&M methods and databases rely on automated electronic information management platforms for creating, storing, and updating components of the system on the Hanford local area network. The information specific to the 100-KR-4 OU P&T systems was uploaded into the electronic platform and vendor information submittals were received during construction. The electronic information residing in this platform references the location of any supporting information not contained within the system (e.g., hard copy vendor submittal information).

The following types of information are contained within the electronic platform:

- System description, including system equipment and treatment processes
- Preventive and corrective maintenance information for monitoring equipment and process operations
- Process liquid stream sampling and reporting requirements
- Vendor equipment information
- System O&M information, including equipment manufacturer and vendor-supplied O&M manuals (specific to individual system components or equipment)
- Spare parts list
- Standard operating methods addressing system operations
- System transient condition response actions and methods

- Alarm and spill response methods
- Training methods

The operator training necessary to operate and maintain the P&T system includes facility-specific training, evaluation, and qualification along with required health and safety training. Training is discussed in Section 3.5.4 of this plan.

2.3 Operations and Remedial Process Optimization

Remedial process optimization (RPO) is an ongoing systematic evaluation that includes a comprehensive examination of all aspects of remedial systems. Results of the individual RPO process element analyses are integrated with the remedial system performance monitoring data, groundwater monitoring data, plume capture analysis, and an overall evaluation of the well network to identify recommendations for changes to the system configuration and/or operation. Successful RPO requires development of a series of related tasks that, when implemented, enable and promote the objective of remedy optimization. These changes provide the opportunity to accelerate achievement of RAOs and reduce incremental and overall project costs. Optimization changes are prioritized to meet the following project objectives:

- Protect the river from discharges of Cr(VI)
- Remove contaminant mass
- Delineate Cr(VI) plumes

The following elements of the 100-KR-4 P&T systems are used to evaluate system performance and support process optimization:

- **Extraction well performance:** This element includes evaluation of individual well performance in addition to well function relative to known plume configuration. Extraction well pump sizing, placement, performance, and configuration of other well components (e.g., well diameter, screen characteristics, and sand pack characteristics) are assessed as part of this element.
- **Extracted water conveyance performance:** This element includes evaluation of conveyance pipe routing, head loss, and transfer station performance.
- **Treatment system performance:** This element includes evaluation of the mechanical and chemical process components of the treatment system. Evaluation includes assessment of contaminant removal efficiency, effluent water quality, hydraulic throughput, material consumption, component service life, and overall cost.
- **Treated water conveyance performance:** This element includes evaluation of conveyance pipe routing, head loss, and transfer station performance.
- **Injection well performance:** This element includes evaluation of individual well performance in addition to well function relative to known plume configuration. Well placement, performance, and configuration of well components are assessed as part of this element.

Extraction well hydraulics and pipeline conveyance capacity, treatment system throughput, and injection conveyance and hydraulic capacity are balanced to achieve optimum performance. Extraction and injection well performance may decline over time, resulting in lower throughput. To assess the need for well maintenance, extraction well pumping and injection rates are correlated with water level measurements at each well to detect changes that potentially could affect well performance. Steadily declining pumping water levels at extraction wells or steadily increasing water levels at injection wells

may indicate the need for well maintenance. An extraction and injection well monitoring and maintenance plan (SGW-58236, *Well Performance Monitoring and Maintenance Process for the 100-HR-3 and 100-KR-4 Groundwater Treatment Facilities*) was developed to support 100-KR-4 P&T operations.

Analysis of contaminant capture and modification of well field pumping rates are important elements of the P&T systems performance evaluation. A pumping rate analysis based on system performance and well capacity fluctuations based on river level is used to derive recommended pumping rates for the upcoming year. If the recommended pumping rates are not achievable, system reconfiguration, maintenance, and modifications can be evaluated. This process is outlined in Figure 2-2. System performance information is summarized in the annual P&T report.

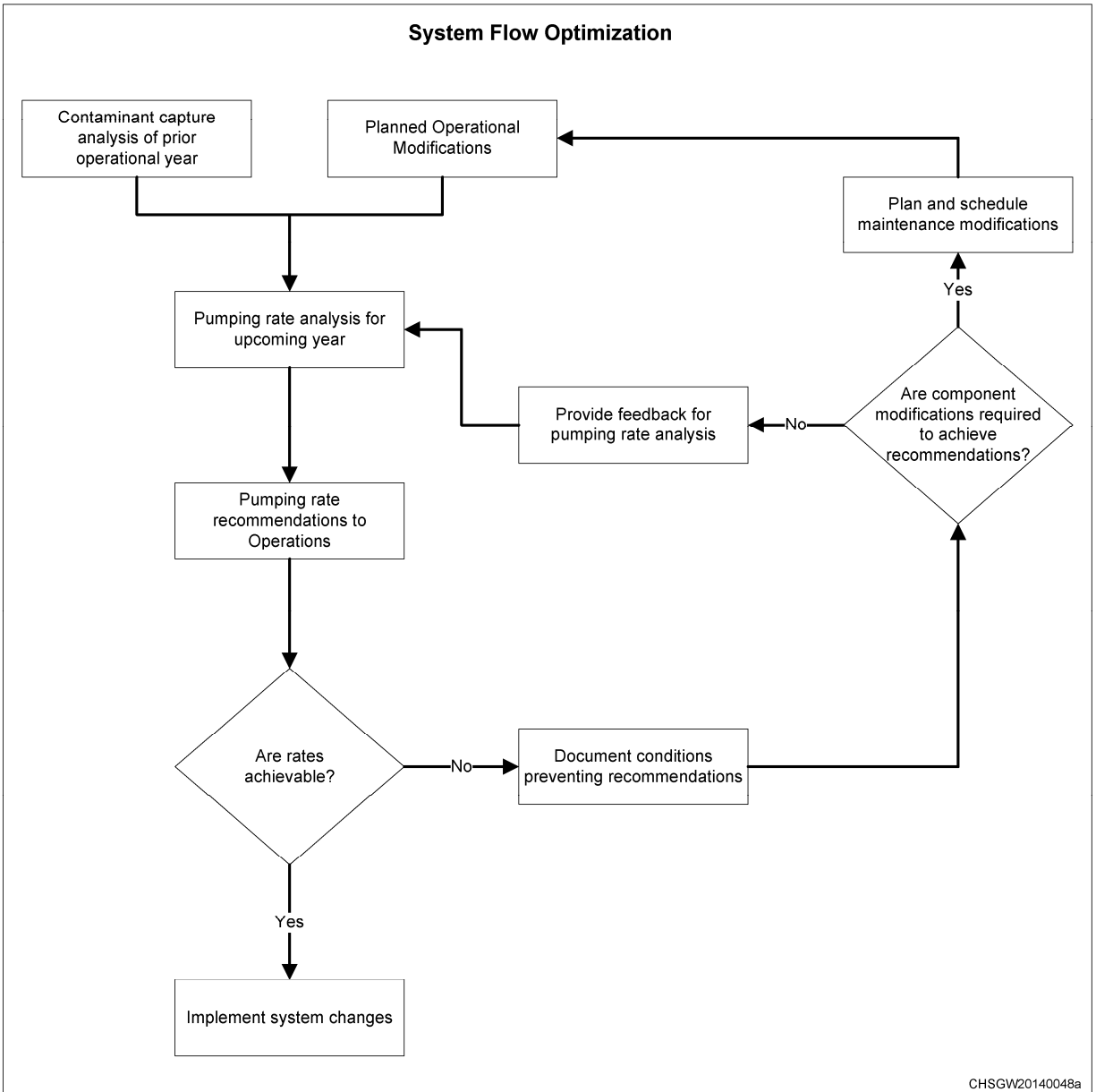


Figure 2-2. System Flow Optimization

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3 Operations and Maintenance

This chapter presents information associated with routine and preventive maintenance, upset conditions, corrective maintenance, training, and inspections related to the 100-KR-4 P&T systems.

3.1 Operations Overview

Routine 100-KR-4 OU P&T operation consists of pumping groundwater from extraction wells and conveying the stream through aboveground pipes to one of three treatment facilities for removing Cr(VI) from the extracted groundwater. The treatment system reduces the Cr(VI) concentrations in the treated effluent to meet the state surface water quality standard of 10 µg/L. The treated water is returned to the aquifer through a series of injection wells. Concentrations of Cr(VI) in the treated water are routinely checked to ensure the pump and system is operating as expected and RAOs are being met.

The treatment systems have the facility capacity to treat 5,900 L/min (1,560 gpm). The treatment system uses a Supervisory Control and Data Acquisition (SCADA) system that provides data acquisition, monitoring, and control capability for the operations and equipment. The SCADA system employs centralized server equipment to communicate with instrumentation and equipment by way of programmable logic controllers (PLCs) located throughout the main process building, transfer buildings, and at the wells. PLCs pick up information directly from process instruments to control devices such as valves. The servers are programmed with software that polls, displays, and records real-time process data as it occurs throughout the facility. Operations personnel are also able to adjust control and alarm set points and operate specific pieces of equipment in manual mode from operator workstations. By using this instrumentation and control system, integrating operational methods, PLCs, and set points and limit alarms, the 100-KR-4 P&T systems have the ability to automatically shut down components that may be affected by upset conditions due to sudden and unavoidable failure of control or process equipment or unintended failure of a process to operate in a normal or usual manner. The automated control systems, including remote notification and alarm capabilities, allow for continuous operation.

Treatment process systems and equipment are operable from SCADA system stations located in the control rooms of each P&T system. Sensors and transmitters are provided to allow control of key process parameters such as flow rates, pump discharge pressure, tank or vessel water level, well water level, temperature, and pH). Water level transmitters are provided for extraction wells, injection wells, influent tanks, and effluent tanks. Flow-indicating transmitters are provided for each extraction well and for each injection well. Flows for each extraction well are independently adjustable with limited interaction between wells. Sampling locations at the treatment facility and at the transfer buildings are provided for influent and effluent streams. Figures 1-3 and 1-4 show the sampling port locations downstream of system components (influent tanks, IX vessels, and effluent tanks).

3.2 Routine and Preventive Maintenance

Routine maintenance activities are necessary to ensure the long-term integrity and success of the P&T systems. The routine and preventive maintenance program ensures properly maintained equipment and provides for early detection of equipment issues. The river stage (e.g., low water as identified in the SAP [DOE/RL-2013-29]) as well as compliance, facility performance, resource constraints, and freezing weather conditions are considered when scheduling maintenance activities.

Equipment-specific inspection forms and a maintenance frequency have been developed using recommendations contained in the manufacturer and vendor-supplied manuals and evaluations by the P&T engineering group. Records from the maintenance and inspection forms are entered into the JCS.

Typical routine and preventive maintenance of P&T system components is performed in accordance with methods approved by the Operations group. Table 3-1 contains a brief description of typical routine and preventive maintenance methods for the P&T systems. Method revision and approval are controlled by the PPS. Current methods are maintained in the PPS.

Table 3-1. Typical Routine and Preventive Maintenance Methods

Component	Description
Air compressor	A safe, uniform method to perform inspections and maintenance on Ingersoll Rand® Model 2545 or equivalent air compressors at P&T buildings. The method includes use of lockout/tagout to take the equipment out of service to perform maintenance.
Backup lights	Safe, uniform methods to perform inspections of backup lights at P&T facilities. Inspections include visual inspection and illumination tests. This method also covers repairs or replaces backup lights that fail inspection.
Backwash and sluice pump	A safe, uniform method for performing inspections of pipe connections and mechanical seals, and conducting periodic maintenance on P&T backwash and sluice pumps. The method includes use of lockout/tagout to take the equipment out of service to perform maintenance.
Chemical pumps	A safe, uniform method for performing visual inspections and lubrication activities on PULSA Series® 680 or equivalent pumps. The method includes use of lockout/tagout to take the equipment out of service to perform visual inspections and maintenance.
Motorized position valve	A safe, uniform method to perform a periodic functional test of motorized position valves at P&T facilities. Each valve is manually cycled open and shut before being returned to its original configuration.
GFCI receptacle/breaker	A safe, uniform method for visually inspecting and performing a trip test at permanently installed GFCI receptacles and GFCI breakers at P&T facilities.
Motors and pumps at groundwater facilities	A safe, uniform method for visually inspecting pump motors and pumps, and performing periodic preventive maintenance.
pH electrode	A safe, uniform method for performing maintenance on pH electrodes that includes periodic checks of spare electrodes and replenishment of pH storage solution. It also includes testing, inspecting, and cleaning of the pH electrodes and meters. The electrodes are calibrated as needed with 4.01, 7.00, and 10.01 buffer solutions.
American Society of Mechanical Engineers pressure relief valve	A safe, uniform method for testing pressure relief valves in P&T facilities.
Safety shower	A safe, uniform method for testing and inspecting safety showers. This method also ensures cleanliness of water.
Fixed ladder	A safe, uniform method for inspecting fixed (installed) ladders.
Overhead door	A safe, uniform method for inspecting overhead doors.
Alarm dialers	A safe, uniform method for setup, testing, and inspecting alarm dialers (auto dialers).
Uninterrupted power supply	A safe, uniform method for replacement of uninterrupted power supply.

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® PULSA Series is a registered trademark of Pulsafeeder Engineered Products, Rochester, New York.

GFCI = ground fault circuit interrupter

The recommended frequency for conducting routine and preventive maintenance is incorporated into the JCS. Table 3-2 provides a summary of typical routine and preventive maintenance activities and the recommended frequency. Work packages are used to schedule, plan, and document the maintenance activities. Frequencies are modified based on equipment performance and evaluation. Frequency

modification requires engineering approval documented in the JCS. Work packages are also entered into the JCS.

Table 3-2. Typical Routine and Preventive Maintenance Activities and Frequency

Equipment/Component	Activity	Recommended Frequency ^a
Backwash and sluice pumps	Inspection and lubrication	Upon engineering request
Pumps	Inspection and lubrication	Quarterly
Treatment system motors	Inspection and lubrication	Quarterly
Motorized valves	Exercise	Monthly
GFCI receptacle/breaker	Test	Monthly
Exhauster fans	Inspection	Annually
Air compressors	Inspection	Annually
Backup lights	Inspection and testing	3 months and annually
Ion exchange train relief valve	Replacement	<10 years
Flow, water level, pressure instrumentation	Inspect and check calibration	1 year, 2 years, 3 years; recalibrate as needed
pH instrumentation	Calibration check	Daily and weekly readings ^b Calibration check every 3 months
Meters and probes	Calibration check	3 months
SIR-700 resin	Resin change-out	As needed; dependent on effluent monitoring and contaminant concentrations

a. As defined by the specific equipment preventive maintenance activity.

b. During the regular work shift (Monday through Thursday).

GFCI = ground fault circuit interrupter

In addition to preventive maintenance for common mechanical components, a routine maintenance program for remedial system wells is implemented in accordance with WAC 173-160-381, “Minimum Standards for Construction and Maintenance of Wells,” “What Are the Standards for Decommissioning a Well?” and WAC 173-160-371, “What Are the Standards for Chemical Conditioning?” Well maintenance consists primarily of well inspection, cleaning, and redevelopment. The program includes extraction, injection, and monitoring wells within the 100-KR-4 OU. SGW-58236 describes the maintenance activities.

3.3 Upset Conditions

An upset condition is a failure of control or process equipment or a failure of a process to operate in a normal or usual manner. Upset conditions may include periods of variation in contaminant removal efficiency or off-normal operation of essential subsystems such as unexpected accumulation of solids in extraction well components, biofouling, formation of insoluble precipitates in system components, or effluent concentrations and pH values outside of targets. Upset conditions are normally indicated to operations personnel by automated alarms or control indications, or through routine examination of operating equipment.

Controls are in place in the P&T system to identify potential upset conditions. The automated control system is designed with a series of interlocks with established set points and limits for safe operation. Parameters that are monitored include tank water levels, pump speeds, well water levels, flow pressures, and pH. In some cases, interlocks trigger warning alarms. In other cases, interlocks may trigger an alarm or shutdown a component, series of components, or facility.

If an upset condition is confirmed, the event is documented in the logbook, along with the following information:

- Location(s) and date(s)
- Description of upset condition
- Corrective actions taken

Periodic resin conditioning may produce a change to the operating system. Resin conditioning is performed when treatment water samples indicate an increasing trend of Cr(VI) in the treated water exiting an IX vessel. Increasing levels of Cr(VI) indicate decreasing removal efficiency of the resin in the IX vessel. Conditioning involves lowering the pH of the water entering the IX vessel and then isolating the vessel from the treatment system. The low pH water is allowed to sit in the IX vessel for typically less than 1 week. After the resin has been conditioned, the IX vessel is valved back into the treatment system. Monitoring of the effluent discharge following resin conditioning is conducted as described in the SAP (DOE/RL-2013-29).

DOE-RL will be notified in instances of significant upset conditions or a discharge or a spill of a reportable quantity of material.

3.4 Corrective Maintenance

Corrective maintenance activities are repairs of system components after failure. Typical examples include worn-out pumps, leaky pipe joints, and failed electronic components. If a failure occurs, the system is evaluated to determine the apparent cause of the failure, actions that should be taken to correct the failure, and the feasibility of an alternative operating configuration to reduce the likelihood of recurrence of the failure. Corrective maintenance activities are then performed in accordance with approved work packages, which are controlled in the JCS.

Maintenance activities are documented in the JCS, and a summary of maintenance activities that result in extended system downtime are provided in the annual P&T report. Depending on the corrective maintenance activities, the routine and preventive maintenance schedule may be reviewed and modified.

3.5 Operations and Maintenance Methods and Training

The following sections give an overview of the treatment facility operating methods and environment, health, and safety methods used for the 100-KR-4 P&T systems. The general training processes used to ensure personnel are trained to the methods and work activities are also described. PPS controls the method revisions and approval and provides current methods.

3.5.1 Typical Treatment Facility Operation Methods

The P&T systems' operating methods provide the necessary information and direction to properly start up, operate, and shut down all system components, including the treatment facilities, transfer buildings, and the extraction and injection wells. The methods include the operational steps needed to put the system into a normal operating lineup and place the system in service. The methods also include the steps for

responding to alarms and performing a routine system shutdown. Table 3-3 contains the activity and a brief description of typical operating methods for the KR4, KW, and KX P&T systems.

Table 3-3. Typical Treatment Facility Operation Methods

Activity	Description
KR4 P&T operation	Operating instructions and guidelines for the KR4 P&T system. The method provides instructions for normal system startup, shutdown, abnormal conditions, alarm, and manual modes for system operations. Normal system startup and shutdown occur via the HMI* computer in the KR4 Process Building. IX manual operations (e.g., resin load, backwash, unload) occur in the KR4 Process Building. Valve, breaker, switch alignments, and manual equipment operation occur throughout the system.
KW P&T operation	Operating instructions and guidelines for the KW P&T system. This method provides instructions for normal system startup, shutdown, abnormal conditions, alarm, and manual modes for system operations. Normal system startup and shutdown occur via the HMI computer in the KW Process Building. IX manual operations (e.g., resin load, backwash, unload) occur in the KW Process Building. Valve, breaker, switch alignments, and manual equipment operation occur throughout the system.
KX P&T operation	Operating instructions and guidelines for the KX P&T system. This method provides instructions for normal system startup, shutdown, abnormal conditions, alarm, and manual modes for system operations. Normal system startup and shutdown occur via the HMI computer in the KX Process Building. IX manual operations (e.g., resin load, backwash, unload) occur in the KX Process Building. Valve, breaker, switch alignments, and manual equipment operation occur throughout the system.
Respond to HMI notifications for 100 Area P&T	This method provides guidance for responding to P&T HMI System Operational Notifications. The notifications, which are indicated on the HMI Monitor Screen, include warnings, alarms, and trips.
KR4 P&T lineup	This method contains the supporting valve, equipment, switch, and electrical lineups for operations use by certified system operators to perform system lineup verification, support system facility operation, and support post-maintenance verification of lineups after major work.
KW P&T lineup	This method contains the supporting valve, equipment, switch, and electrical lineups for operations use. This method is used by certified system operators to perform system lineup verification to support the facility operation of the system and to support post-maintenance verification of lineups after major work.
KX P&T lineup	This method contains the supporting valve, equipment, switch, and electrical lineups for operations use. This method is used by certified system operators to perform system lineup verification to support the facility operation of the system and to support post-maintenance verification of lineups after major work.
KW, KX, or KR4 P&T bulk acids unloading	Instructions for unloading bulk deliveries of concentrated sulfuric acid (H ₂ SO ₄) to the KX, KW, and KR4 P&T facilities exterior acid tanks. The method lists precautions, required tools and protective equipment, and procedural steps for completing the activities. Tanker trucks covered by this method are vendor-supplied bulk chemical tankers.
Well tasks	This method applies to well tasks that involve the installation and/or removal of items from a well. This method is for use by maintenance personnel in support of various installation/removal activities that preserve the ability of the well to meet data quality objectives and support collecting required measurements. It also applies to well services performed to support hydrologic and vadose testing, well construction, remediation, maintenance, and decommissioning activities. As appropriate, personnel performing activities comply with minimum standards for the construction and decommissioning of wells (WAC 173-160).
Replace extraction well pump/motor	This method provides instructions for replacing the pump and motor in an extraction well. The method includes instructions for removing insulation, heat trace, electrical power and mechanically disconnecting the piping at the well head. The method includes removing the equipment from the well and cleaning and configuring the piping and motor/pump assembly before and after installation.

Table 3-3. Typical Treatment Facility Operation Methods

Activity	Description
Setup and operation of alarm dialers	This method provides verification of the setup and operation of alarm dialers in the P&T facilities. An alarm dialer is an electronic device that monitors the P&T systems for alarm signals that indicate a problem. When a problem is detected, it communicates the problem to the correct on-call personnel so it can be rectified. This method provides steps to test the alarm dialers and perform maintenance as needed.
Support equipment operations	This method provides instructions for the operation of support equipment at the P&T facilities. This method identifies the operation of peripheral equipment not captured by facility-specific methods, including the following support equipment and activities: <ul style="list-style-type: none"> • Position valves and operate sluice pumps • Adjust flow rates and back wash IX vessels • Water transfer to sump area • Remove liquids from secondary containment area • Drain filters, isolate filter, and vent filter housings • Vent train vessels • Operate air compressor
Chromium measurement of water samples	This method provides instructions to operate the Hach® DR/4000V, Hach DR/2010, or Hach DR/2800 or equivalent spectrophotometer to determine Cr(VI) concentrations in water samples. Qualified system operators use this method to sample and measure Cr(VI) concentrations in water samples taken from P&T process systems. The method includes requirements for collecting samples, preparing the samples for analysis, verifying operation of the spectrophotometer, performing the measurements, disposing of the samples, and entering the data.
pH and temperature readings	This method provides instructions for taking pH and temperature measurements with Hach HQ40d/HQ30d or equivalent meters and probes. This method applies to activities that require pH and temperature sampling of P&T projects or facilities process water, groundwater, or purge water. The method includes requirements for verifying operation of the meters and probes, performing the measurements, cleaning the equipment, storing the equipment, and recording the data.

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Reference: WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells."

*The HMI is a computer used to access the computer program that controls the P&T system.

HMI = human-machine interface

IX = ion exchange

P&T = pump and treat

3.5.2 Routine Methods

Routine methods are used to complete repetitive tasks such as inspections and calibrations that are performed on a regular frequency. Records from completion of routine methods are maintained in the JCS. Routine methods are followed by operators, support craft, and other support personnel to perform day-to-day activities, such as the following:

- Housekeeping inspections
- Waste storage area inspections
- Instrument calibrations
- Inspections and routine adjustments of facility equipment and machinery
- Inspections of tanks, secondary containment devices, and sumps

Table 3-4 contains the activity and a brief description of typical routine methods for the KR4, KW, and KX P&T systems.

Table 3-4. Typical Routine Methods

Activity/Component	Description
KR4 P&T rounds	A method that provides instructions and data sheets for KR4 P&T system daily rounds. Qualified system operators use it to perform rounds in support of facility operations and routine checks of facility equipment, IX trains, and wells.
KW P&T rounds	A method that provides instructions and data sheets for KW P&T system daily rounds. Qualified system operators use it to perform rounds in support of facility operations and routine checks of facility equipment, IX trains, and wells.
KX P&T rounds	A method that provides instructions and data sheets for KX P&T system daily rounds. Qualified system operators use it to perform rounds in support of facility operations and routine checks of facility equipment, IX trains, and wells.
Portable and fixed ladders; mobile ladder stands; mobile ladder stand platforms	A safe, uniform method for inspection of permanently affixed ladders, portable ladders, mobile ladder stands, and mobile ladder stand platforms to ensure conformance to the requirements of 29 CFR 1910, Subpart D, Articles 1910 25-27 and -29 and the equipment is in safe condition.
P&T safety shower and eyewash	A safe, uniform set of instructions for cleaning/disinfecting, flushing, testing the flow capacity, and refilling the safety shower/eyewash stations located at the P&T facilities.
S&GRP CERCLA waste storage areas	A safe, uniform set of instructions for performing waste management inspection activities of CERCLA waste storage areas. The method includes steps for inspection of S&GRP waste storage areas, response to abnormal conditions, and reporting.
Cold Weather Plan	The Cold Weather Plan provides instructions and checklists to ensure P&T equipment and facilities are protected against the effects of cold weather. The method applies to P&T facilities as well as active pump stations, gauges, heat sensing devices, outdoor storage areas, and mobile office facilities. Facility-specific checklists are attached to this plan for use by the operations manager to document inspections.
Spectrophotometers	A safe, uniform method for calibrating the spectrophotometers for Cr(VI) measurements. The method includes steps for preventive maintenance and replacing lamps.
pH sensors and transmitters	A safe, uniform method for removing, cleaning, calibrating, and reinstalling (or replacing) inline pH sensors. The method includes steps for cleaning the sensors, performing calibration, and verifying system alarm settings.
Data loggers	A safe, uniform method to verify calibration of data loggers. The method includes steps to configure parameters and verify the settings.
Submersible pressure transducers	This method covers the acceptance testing of submersible current-loop pressure transducers used in support of the P&T facilities. The method includes steps to visually inspect, clean, and test the transducers. Each transducer is tested by applying a known pressure, measuring the transducer's response, and calculating the transducer's deviation from the applied pressure.

References: *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*

29 CFR 1910, "Occupational Safety and Health Standards," Subpart D, "Walking-Working Surfaces."

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*

S&GRP = Soil and Groundwater Remediation Project

3.5.3 Environment, Health, and Safety Methods

Specific methods are used to complete the following critical environment, safety, and health activities. The methods are approved by the appropriate manager of the environment, health, or safety organizations.

- **Waste handling:** All waste streams associated with operation of the 100-KR-4 OU P&T systems are managed in accordance with the waste management plan (DOE/RL-97-01), the requirements of which are implemented by methods that address specific waste streams such as drill cuttings, spent resins, and spent filter elements.
- **Safety equipment:** Methods are used to ensure correct use and maintenance of safety equipment within the P&T facilities. This includes portable fire extinguishers, emergency lights, tank alarms, leak detection, spill cleanup, and other protection systems.
- **Alarm and spill response:** Methods are used to ensure the proper response is taken when a process alarm indicator is triggered, an abnormal condition occurs, or a spill occurs. These methods include the operational steps for determining the process upset, isolating it, and shutting down the system (if necessary).

Table 3-5 contains the activity and a brief description of typical environment, health, and safety methods.

Table 3-5. Typical Environment, Health, and Safety Methods

Activity/Component	Description
Portable eyewash	A safe, uniform method to perform monthly visual inspections and periodic maintenance on eyewash stations. Inspections include checking the eyewash for leaks, flow, and pressurization. Maintenance includes draining, cleaning, and flushing the eyewash, replacing the eyewash solution, and pressurizing the eyewash.
P&T facilities emergency and safety equipment	A safe, uniform method to perform weekly and monthly inspections of emergency and safety equipment. The method covers first aid kits, safety showers, permanent eyewashes, fire extinguishers, spill kits, portable eyewashes, and emergency exit checks at the P&T facilities.
Spill or leak response	<p>A safe, uniform method to respond to wet and dry spills of process water, known hazardous substances, dangerous wastes, mixed wastes, oil, or petroleum products within the P&T facilities. This method applies to facility-personnel manageable spills/releases that can be mitigated by facility staff, regardless of the quantity, except for small drips and splatters that can be immediately wiped up.</p> <p>For any spill or leak, the “SWIMS” system is initiated: Stop, Warn, Isolate, Minimize, Secure. The operations supervisor is notified as soon as possible and together the operations supervisor and operator determine if the leak or spill is facility manageable.</p> <p>Events that require additional resources and/or instructions not contained in this method to mitigate a spill/release event are not facility manageable. The operations supervisor contacts the reporting single point of contact to initiate additional response and make all reporting requirements. Such a spill/release may require a response from Emergency Support Services (Hanford Fire Department).</p>
Environmental event	This method defines the process for implementing environmental requirements associated with the minimization, reporting, cleanup, and documentation of environmental events, including those with potential for or involving the release of hazardous substance(s) to the environment. In addition, this method defines the process for reporting and documenting accidental damage to protected natural and cultural resources. This method applies to all nonemergency spills and releases and includes notification and reporting requirements for compliance with regulatory standards.

Table 3-5. Typical Environment, Health, and Safety Methods

Activity/Component	Description
Environmental protection requirements	This method defines the requirements established to protect human health and the environment. The method identifies the regulatory basis for spill prevention and reporting. As outlined in this method, spills or leaks of dangerous wastes or hazardous substances are reported in accordance with 40 CFR 302 and WAC 173-303-070.
Waste packaging and handling	A safe, uniform method for inspecting, preparing, packaging, labeling, transferring, and shipping various types of waste for S&GRP activities. The scope of this work is limited to low-level radioactive waste, material or waste managed as radioactive material, U.S. Department of Transportation-compliant packaging of low-level, low-level mixed, hazardous/dangerous, and nonregulated waste.

References: 40 CFR 302, "Designation, Reportable Quantities, and Notification."

WAC 173-303-070, "Dangerous Waste Regulations," "Designation of Dangerous Waste."

S&GRP = Soil and Groundwater Remediation Project

3.5.4 Training

The responsible manager ensures that their personnel have received the appropriate preparation for their job tasks and work activities, including Hanford Site-specific classroom, computer-based, and on-the-job activity training. The responsible manager also ensures that their personnel are up-to-date on required training.

For P&T facility operators, this training covers facility startup and shutdown, operation adjustments, and specific methods and tasks they perform. The training enables the operators to experience a number of routine and nonroutine events prior to actual hands-on contact with operations and equipment.

3.6 Typical Inspection Requirements

The following subsections describe typical inspections for the 100-KR-4 OU P&T systems.

3.6.1 Extraction and Injection Well Inspection

Facility piping and fittings are visually inspected weekly as part of the operator's rounds method to detect leaks and identify potential maintenance needs. The inspection findings are documented as a part of the operator rounds reports. Items requiring maintenance or repair are identified and communicated to the Remediation Support organization for implementation of corrective action.

3.6.2 Conveyance Line Inspections

Conveyance lines are inspected visually for leaks following construction, repairs, or modifications to lines. Lines are also inspected in response to operational indicators of a conveyance line anomaly. Transfer lines between buildings have a flow differential alarm. Items requiring maintenance or repair are identified and communicated to the Remediation Support organization for implementation of corrective action.

3.6.3 Monitoring Well Inspections

The physical condition of monitoring wells is inspected by the groundwater sampling crew during each sampling event. Conditions requiring maintenance or repair are noted and communicated to the Remediation Support organization.

3.6.4 Typical Periodic Inspections

Observations and inspections are performed for each of the P&T facilities, as specified in the operator's rounds method. The operator's rounds include periodic observations and inspections of tanks, pumps, valves, IX vessels, leak detection equipment, and safety equipment in each P&T facility. The inspection results are documented on operator rounds datasheets. Periodic inspections are also performed for support systems, such as decontamination equipment, spill kits, eyewashes, safety showers, and fire extinguishers.

4 Operational Monitoring

As described in the interim action ROD (EPA/ROD/R10-96/134) and summarized in Chapter 1, the selected remedy combines P&T, ICs, and an evaluation of remedy effectiveness to achieve RAOs. The interim action ROD also stipulates that compliance monitoring will include analysis of results in a timely manner to support modifications to the treatment system in order to meet the RAOs.

Operational monitoring is designed to evaluate how well the treatment process functions and to facilitate operation of the system. Operational monitoring is described in the following two subsections, and includes P&T process monitoring and treatment process water monitoring.

4.1 Pump and Treat Process Monitoring

P&T process monitoring is conducted during operations to ensure system components are operating as expected and alert operators of upset conditions. These operational data are also used in conjunction with the treatment process water monitoring to evaluate IX resin performance, assess aquifer and Cr(VI) plume response, and optimize extraction and injection well pumping rates for system performance.

Operational data are collected throughout the treatment system for a range of parameters on specific system components. Specific parameters monitored continuously by the remedial process control system are summarized in Table 4-1. Figures 1-3 and 1-4 provide schematics of the treatment systems showing the typical location of flow, water level, and pH monitoring sensors.

Table 4-1. Normal Operational System Monitoring

Parameter	Component(s) Monitored
Flow	Extraction/injection wells, IX trains, and influent/effluent tanks
Liquid level	Extraction/injection wells, influent/effluent tanks, and acid/caustic tanks
pH	Influent/effluent tanks and piping
Temperature	Process stream influent and process building/transfer building tanks
Pressure	Extraction wells, feed pumps, IX trains, and booster pumps
Differential water pressure	Extraction/injection filters, and IX vessels
Drive frequency (Hz)	All variable frequency drive motors
Motor-operated valve position	Injection wells
Amperage	Selected electrically controlled components
Voltage	Selected electrically controlled components
Leak detection	Floor sumps in process buildings, and acid/caustic transfer lines; piping between transfer buildings and process buildings (flow differential)

IX = ion exchange

Flow rates are typically measured during operations using inline flow meters in extraction and injection wells and in the treatment plant influent piping. Flow rate information is relayed to the SCADA system, which automatically controls pumps and valves, as needed, to optimize flow rates, with overall flow parameters set and monitored by the system operators. The measured pressures are also recorded, which can be used to identify an unusual drop in system pressure that might indicate a leak.

During P&T system operations, groundwater elevation data are collected from the system well network by water level transducers. Water level data are used to control the extraction rates and injection rates, and assess the need to rebalance flow rates to optimize capture zone boundaries. The water level data are also integrated with the sitewide water level data to construct groundwater elevation contour maps for evaluating groundwater flow directions, hydraulic gradients, and hydraulic capture and flow control.

Water levels are continuously monitored in extraction wells based on height above the pump. Injection wellhead levels are monitored continuously as depth below ground surface. These measurements are relayed to PLCs where the information is used to control pumps and valves in order to maintain efficient system operation. Control limits are set for the PLCs to prevent extraction well pumps from running dry and to prevent injection wells from flooding to the ground surface.

4.2 Treatment Process Water Monitoring

Treatment process water monitoring includes collecting process water samples from the extraction wells, influent tanks, IX resin vessels, and effluent tanks in order to monitor the contaminant concentrations through the treatment process and ensure the system is operating as expected. The data are also used to assess Cr(VI) removal efficiency and the need for IX resin change-out. The data collected from extraction wells and effluent tanks also provide information for performance monitoring and process optimization.

Figures 1-3 and 1-4 present schematics of the treatment system showing typical sampling locations for the influent tanks, IX resin vessels, and effluent tanks. Extraction well samples are collected from a port located “downstream” of the extraction line filter. Cr(VI) concentrations at injection wells are obtained from effluent tank samples.

Treatment process water samples are collected and analyzed by system operators in accordance with the operations method listed in Table 3-3. Table 4-2 summarizes the frequency for treatment process water Cr(VI) monitoring. In addition to the treatment process water monitoring, performance monitoring (as described in the 100-KR-4 SAP [DOE/RL-2013-29]) analyzes groundwater samples at the laboratory using EPA Method 7196 for Cr(VI).

Table 4-2. Treatment Process Water Monitoring for Cr(VI)

Parameter	Location	Data Use	Typical Frequency
Cr(VI)	Extraction wells	Monitor remedy performance and transient conditions	Monthly
	Influent/effluent tanks, resin vessels	Monitor IX resin performance and mass removal; demonstrate achievement of discharge requirements	Weekly

Additional parameters may be measured as determined by the design authority and project scientist, to monitor operational performance and effects.

4.3 Hexavalent Chromium Field Sampling and Analysis

Samples are collected from ports located within the KR4, KW, and KX facilities. The Cr(VI) analyses are conducted using a portable spectrophotometer following manufacturer methods. Samples are analyzed following EPA Method 8023, as adapted from APHA/AWWA/WEF, 2012, *Standard Methods for the Examination of Water and Wastewater* (1,5-Diphenylcarbohydrazide Method). The method provides details for the following:

- Collect Water Sample – identifies PPE, instrument calibration check, chemical reagent check, collection, and recording
- Sample Preparation – identifies test selection, filling and cleaning sample cell, time for reagent reaction and measurement, and recording
- Instrument Calibration and Accuracy Check – identifies references for verifying calibration and methods for standard and confirmatory accuracy check

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5 Reporting

This chapter describes periodic reporting for the 100-KR-4 OU P&T systems while the systems are in operation, as well as final remedial action closure reporting once the 100-KR-4 OU RAOs have been met. The reports discussed in this chapter may be prepared as individual project-specific reports or they may be combined into area-specific (e.g., annual P&T report) or Hanford Site-wide reports.

5.1 System Operations and Remedy Performance Report

System performance reports include information on P&T operations (e.g., average flow rates, monitoring results from the treatment system, hydraulic monitoring well network, and mass removal) and progress toward meeting remedial goals. The system performance information is compiled annually and reported in the annual P&T report.

Once DOE, in consultation with the lead regulatory agency, has determined the RAOs and final cleanup levels have been met, a final close out report will be prepared. The report will provide information as outlined in OSWER Directive 9320.2-22, *Close Out Procedures for National Priorities List Sites*, which identifies site completion as the end of all response actions. The site completion designation generally means that the response actions at the site were completed and it is anticipated that no further response is necessary to protect human health and the environment.

5.2 CERCLA Five-Year Review

In accordance with 40 CFR 300.430(f)(4)(ii), “National Oil and Hazardous Substances Pollution Contingency Plan,” “Remedial Investigation/Feasibility Study and Selection of Remedy,” DOE conducts 5-year reviews for the 100 Area because the selected remedy has not achieved cleanup levels that allow for unlimited use and unrestricted exposure. CERCLA 5-year review of the 100-KR-4 OU remedial actions began in 2001 and continued in 2006, 2011, and 2016. Additional reviews will be conducted every five years until cleanup levels are attained. The reviews are conducted pursuant to CERCLA, Section 121(c) and as provided in EPA 540-R-01-007, *Comprehensive Five-Year Review Guidance*.

5.3 Records Management

Record material that forms the basis for selection of the final action will be managed in accordance with procedures specified in Section 9.4 of the TPA (Ecology et al. 1989a). Materials that form the basis for the final closeout report (Section 6.4 of the 100-KR-4 RD/RAWP [DOE/RL-2013-33]) will be maintained in accordance with OSWER Directive 9320.2-22. The following records are associated with O&M of the 100-KR-4 OU P&T systems:

- Operation logs
 - Field logbooks and laboratory reports
 - Monitoring results
 - Emergency and transient condition events
- Annual reports
- Maintenance records
 - Inspections
 - Calibrations
- Operating costs
- Personnel records

5.4 Change Control

The 100-KR-4 OU project manager is responsible for tracking changes and obtaining appropriate reviews by contractor staff. The 100-KR-4 OU project manager will discuss the change with DOE-RL, who will then discuss significant and fundamental changes with the lead regulatory agency, as described in Sections 9.3 and 12.4 of the TPA Action Plan (Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*). Appropriate documentation will follow, in accordance with the requirements for the type of change. Table 5-1 summarizes the project modifications that may occur, type of change, and the corresponding documentation requirements. Changes that affect the remedial design or remedial action should be managed in accordance with the change management requirements in the 100-KR-4 RD/RAWP (DOE/RL-2013-33).

Table 5-1. Project Modifications and Approval Mechanism for Change Management

Type of Change	Documentation Process	Project Modification
Nonsignificant	Project file (technical memos or calculations)	Re-route injection or extraction conveyance
		Modify ion exchange vessel configuration
		Modify well pumping rates
		Modify instrumentation and control systems
	RL informational notifications to regulator	Temporarily suspend operations due to unplanned circumstances (e.g., power surges or weather extremes)
	Tri-Party Agreement Change Notice or document revision	Add or remove extraction/injection well (well realignment)
		Permanently modify treatment system capacity to less than described in Table 1-1
		Change ion exchange media type
		Permanently modify sampling requirements defined in Table 4-2
		Permanently discontinue pumping at specific wells in response to plume cleanup/achieving remedial action objectives in specific plume segments
Update to the remedial design/remedial action work plan (DOE/RL-2013-33)		
Significant	Explanation of significant differences	Realize cost increase or decrease (> +50% or < -30%)
		Add another contaminant treated with same technology
		Add new/additional hexavalent chromium contaminant plume areas to the remedy
Fundamental	Record of Decision amendment	Remedy change
		Add constituent treatment (additional technology)

6 Decontamination and Decommissioning

Decontamination and decommissioning (D&D) of the 100-KR-4 OU P&T systems will be addressed after DOE, EPA, and the Washington State Department of Ecology determine active remediation is complete or the treatment system is no longer required. Requirements will be addressed in a final D&D plan, which will be developed and submitted prior to the end of the active remediation period. Information on D&D of the 100-KR-4 OU P&T systems is contained in the 100-KR-4 RDR/RAWP (DOE/RL-2013-33).

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7 Health, Safety, and Quality

This chapter describes the health, safety, and quality controls associated with operating the 100-KR-4 OU P&T systems.

7.1 Health and Safety

The hazardous waste operations safety and health program was developed for employees involved in hazardous waste site activities. The program was developed to comply with the requirements of 29 CFR 1910.120, “Occupational Safety and Health Standards,” “Hazardous Waste Operations and Emergency Response,” and 10 CFR 835, “Occupational Radiation Protection,” to ensure the safety and health of workers during hazardous waste operations.

The health and safety program was developed to define the chemical, radiological, and physical hazards and to specify the controls and requirements for day-to-day work activities on the overall Hanford Site. The program incorporates applicable core functions and guiding principles outlined in ISMS and governs the following elements (per 29 CFR 1910.120(b)(4)(ii)):

- A safety and health hazard analysis identifying hazards and their mitigations
- Employee training assignments
- PPE to be used by employees for tasks and operations
- Medical surveillance requirements
- Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques
- Site control measures
- Decontamination methods
- Emergency response plan, including necessary PPE and other equipment
- Confined space entry methods
- Spill containment measures

The objective of ISMS is to integrate working safely into management and work practices at all levels, addressing all types of work and all types of hazards to ensure safety for the workers, the public, and the environment. ISMS integrates working safely into planning and execution of work.

In accordance with SGW-41472, *Soil and Groundwater Remediation Project Site Specific Health and Safety Plan (HASP)*, all S&GRP field activities are conducted either via a work package, method, or statement of work. Each of these processes requires a hazard analysis. S&GRP documents their hazard assessment of industrial hygiene hazards via formal Industrial Hygiene Exposure Assessments. Mitigative controls from these exposure assessments are incorporated into job hazard analyses, work packages, and methods as appropriate.

Project staff are required to comply with the health and safety program and at all times. Field staff potentially exposed to hazardous substances, health hazards, or safety hazards and the site responsible managers receive the requisite training before they are permitted to engage in P&T work activities. Visitors will be briefed on site hazards and controls and must be escorted by a member of the P&T operations organization or designee. Visitors are not allowed into contamination controlled areas or into areas where waste systems are open with the potential for exposure.

7.1.1 Upset Events

Upset events within the P&T system that exhibit emergency conditions require immediate notification and response from the Hanford Fire Department in accordance with the S&GRP Health and Safety Plan (HASP) (SGW-41472). The following are examples of upset events addressed by the S&GRP HASP:

- Life threatening injuries
- Fire
- Radiological/chemical hazard events
- Nonfacility manageable spills or leaks

In accordance with the S&GRP HASP, all upset events require notification of the Shift Office.

Table 3-5 identifies typical environment, health, and safety methods related to the 100-KR-4 OU P&Ts. Events that can be mitigated by facility staff using the instruction in the method are defined as a facility manageable spill or release. An event that requires additional resources and/or instructions outside those contained in the method for mitigation is a nonfacility manageable method. When there is a nonfacility manageable spill or leak of chemicals or unknown constituents, the Hanford Fire Department is contacted for support.

The general instructions for responding to a spill or leak include initiating SWIM:

- S – stop all nonemergency work activities in the area of the spill or leak
- W – warn others in the area of the spill or leak
- I – isolate area if possible and safe to do so
- M – minimize exposure and contamination by safely performing any of the following as needed to mitigate:
 - Shutdown pumps
 - Swap pumps
 - Close valves
 - Reduce flows or pressures
 - Secure subsystems
 - Shutdown facility operations

After notifying the operations supervisor, the operator and supervisor determine if the leak or spill is facility manageable or nonfacility manageable. For facility manageable spills or leaks of water or process water, specific notifications and methods for cleanup and waste disposal are identified within the method. For chemical spills or leaks, specifically sulfuric acid and sodium hydroxide, neutralization options and disposal instructions are included.

7.1.2 General Hazards

Several general hazards have been identified within the S&GRP. These hazards have been evaluated and are considered easily recognized and mitigated by employee's fundamental knowledge and training. General hazards are not typically included in work packages or methods unless particular emphasis is needed. General hazards found with the S&GRP include the following:

- Dust
- Heat stress
- Cold stress

- Contact with untreated or pH adjusted water
- Abrasion, laceration, cut, or puncture hazards to the hands
- Scrapes to the hands
- Foot injury due to falling or rolling objects
- High noise
- Head injury due to falling or flying objects, or electrical shock or burns
- Head bump hazard
- Bomb threat/suspicious object/written threat letter
- Hostage situation/armed intruder
- Range fire

7.1.3 Facility Emergency Response

Requirements for emergency preparedness programs at DOE sites are set forth in DOE O 151.1C, *Comprehensive Emergency Management System*. The S&GRP Operations organization is responsible for the implementing emergency response plans and related documentation, as well as verifying that their employees, including subcontractor employees, receive the required training to ensure that adequate levels of preparedness and response are maintained.

Based on hazards surveys, the 100-KR-4 OU P&T facilities are classified as general purpose facilities. General purpose facilities are defined as office buildings or general purpose facilities that contain no hazardous materials in excess of any regulatory quantities that require emergency preparedness planning. The governing requirement for the P&T facilities is 29 CFR 1910.38, "Emergency Action Plans." For the P&T facilities, personnel are evacuated from the danger area when an emergency occurs, and do not directly assist in handling the emergency.

Emergency response information for the 100-KR-4 OU P&T facilities is posted on facility emergency response information boards, which are located in the control rooms of each P&T system. The boards provide the evacuation routes and location of staging areas as well as emergency contact information.

7.2 Quality Assurance

Remediation contractor CHPRC is responsible for maintaining a QA program that provides the quality requirements applicable to the activities performed. Quality requirements for activities within the scope of environmental cleanup and restoration conducted by CHPRC are included in an Environmental QA Program Plan. Implementation of environmental quality requirements for the S&GRP is included in the S&GRP quality assurance project plan (QAPjP).

The QAPjP defines the processes used by S&GRP to produce quality data and ensure that operations are fully compliant with all applicable quality affecting requirements. The plan provides additional QA requirements for S&GRP such as quality objectives, methods, operational approaches, and goals for performing the work scope.

CHPRC implements QA requirements on a graded approach. The graded approach for environmental activities that involve generating, acquiring, or using environmental data is based on the intended use of the data, analytical protocol selected, and parameters of accuracy, precision, comparability, completeness, representativeness, bias, and sensitivity.

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