DOE–LM/GJ652–2004

Office of Legacy Management

Remedial Action Report for the Interim Remedial Action Record of Decision Operable Unit III, Surface Water and Ground Water Monticello Mill Tailings (USDOE) Site, Monticello, Utah

EPA CERCLIS Identification Number UT 3890090035

September 2004

U.S. Department of Energy

Office of Legacy Management

Work Performed Under DOE Contract No. DE–AC01–02GJ79491
for the U.S. Department of Energy Office of Legacy Management.

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Approval and Concurrence

Approved by: [signature] 9/28/04

Terry L. Anderson, Director
Federal Facilities Program
U.S. Environmental Protection Agency

Date

Concurrence by: [signature] 9/28/04

Brent H. Everett, CERCLA Branch Manager
Utah Department of Environmental Quality

Date

Certification of Interim Remedial Action Completion for Operable Unit III, Surface and Ground Water, of the Monticello Mill Tailings (USDOE) Site

The interim remedial actions conducted for Operable Unit III, surface and ground water, of the Monticello Mill Tailings (USDOE) Site, were implemented in accordance with approved project plans and procedures and are complete. Contaminated surface and ground water remaining in Operable Unit III following completion of the interim actions is the subject of the ~~May~~ June 2004 Record of Decision for Operable Unit III.

PSM DGB

Interim remedial action completion certified by:

Michael K Tucker / for	Sept 9, 2004

Donna Bergman-Tabbert	Date
Director LM-50
U.S. Department of Energy
Office of Legacy Management

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Acronyms

AIMTech	Advanced Infrastructure Management Technologies
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDR	Covenant Deferral Request
CFR	U.S. Code of Federal Regulations
cm	centimeter(s)
CS	Commercial Simple (property identification number suffix)
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Difference
FFA	Federal Facility Agreement
ft	foot (feet)
ft^2	square foot (feet)
FUSRAP	Formerly Utilized Sites Remedial Action Program
GJO	Grand Junction Office
HOG	highest outdoor gamma
IC	institutional control
IVC	independent verification contractor
IWMA	Interim Waste Management Area
LAV	Large Area Verification
m^2	square meter(s)
µg/L	micrograms per liter
mg	milligram(s)
mg/L	milligram(s) per liter
MG	Monticello Ground Water (property identification number prefix)
MMTS	Monticello Mill Tailings (USDOE) Site
MP	Monticello Peripheral (property identification number prefix)
MRAP	Monticello Remedial Action Project
MS	Monticello Site (property identification number prefix)
NPL	National Priorities List
OCS	Opposed Crystal System
OLM	Office of Legacy Management
ORNL	Oak Ridge National Laboratory
OSWER	Office of Solid Waste and Emergency Response
OT	Other (property identification number suffix)
OU	Operable Unit
pCi/g	picocurie(s) per gram
PCB	polychlorinated biphenyl
PCR	Property Completion Report
PRB	Permeable Reactive Barrier
Ra-226	radium-226
RAA	Remedial Action Agreement
RAD	Remedial Action Design
RAR	Remedial Action Report
RCRA	Resource Conservation and Recovery Act
RDC	radon decay-product concentration
RD/RA	Remedial Design/Remedial Action
RI	Remedial Investigation

ROD	Record of Decision
SFMP	Surplus Facilities Management Program
SHS	suspect hazardous substance(s)
SWMP	Special Waste Management Plan
Th-230	thorium-230
TSCA	Toxic Substances Control Act
UAC	Utah Administrative Code
UDEQ	Utah Department of Environmental Quality
UDOT	Utah Department of Transportation
UMTRA	Uranium Mill Tailings Remedial Action
UST	underground storage tank
VL	Vacant Lot (property identification number suffix)
WL	working level
yd^3	cubic yard(s)
ZVI	zero valent iron
μR/h	microroentgens per hour

Executive Summary

The Interim Remedial Action (IRA) Record of Decision (ROD) for Operable Unit (OU) III of the Monticello Mill Tailings [USDOE] Site (MMTS) is the subject of this remedial action report (RAR). The purpose of this report is to document and summarize the successful implementation and completion of all OU III IRA activities. OU III is one of three OUs comprising the MMTS. The ROD for OU I and OU II (MMTS ROD), signed in September 1990, stipulated that contaminated mill tailings, soil, sediment, and debris from OUs I and II would be excavated and placed in a permanent on-site repository. OU III was designated by the MMTS ROD to address contaminated surface water and ground water at MMTS. OU III remedial investigations began in 1992 leading to the preparation of a Remedial Investigation report and a draft Feasibility Study in 1998. Selection of a final remedy for OU III was deferred at that time however because the full effects of ongoing OU I and II remediation on the ground water system and associated potential risk were unknown.

A ROD for an IRA for OU III was therefore prepared and signed in September 1998, stipulating long-term risk-reduction measures and specific data collection activities until selection of a final remedy could be justified. Remedial actions under OU I and II were completed by August 2001. The components of the IRA for OU III were:

- Obtain essential data to characterize ground water and surface water conditions as affected by OU I and II remediation.
- Implement institutional controls (IC) to prevent human exposure to contaminated ground water.
- Conduct a treatability study of in-situ permeable reactive barrier technology.
- Continue ground water extraction and treatment during excavation and dewatering of the Millsite (OU I), thereby removing soluble contaminants from the aquifer and improving water quality.

Completion of each of these work elements to fulfill the requirements of the IRA ROD for OU III culminated in the selection of the final remedy for OU III in June 2004, thus concluding the IRA.

End of current text

1.0 Introduction

The Interim Remedial Action (IRA) Record of Decision (ROD) for Operable Unit (OU) III of the Monticello Mill Tailings [USDOE] Site (MMTS) is the subject of this Remedial Action Report (RAR). The MMTS is a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) Superfund Site (CERCLIS ID Number UT3890090035), located in and near the City of Monticello (City), San Juan County, Utah (Figure 1). The site includes a 78-acre tract within the City limits where a former uranium and vanadium mill was located (Millsite), and 34 surrounding peripheral properties covering approximately 1,700 additional acres. The mill area occupied approximately 10 acres of the Millsite. Properties comprising the MMTS are variously owned by the City, the U.S. Department of Energy (DOE), and private parties.

The former mill, operated by and for the U.S. Government, processed approximately one million tons of vanadium and uranium ore between 1942 and 1960. By-products of the milling process and other wastes containing radioactive and non-radioactive constituents, primarily trace metals, remained on the site. Mill tailings, the primary waste form at MMTS, were impounded as slurries at four locations referred to as the Carbonate, Vanadium, Acid, and East Tailings Piles. The individual piles reflected the various generations of processing methods and ore-types at the mill. As a result of mill operations, the Millsite and adjoining properties became contaminated by dispersed mill tailings and fluids, residues from ore stockpiles, and milling process-related by-product materials. Dispersal of tailings to peripheral properties was mainly by wind. Tailings also were transported to downstream properties via Montezuma Creek, a small perennial stream that flows through the center of the project area. Several properties adjacent the Millsite were used for stockpiling ore, while by-product materials generated during former Millsite operations, including trash, building materials, fuel oils, and laboratory materials, were disposed of as waste on certain properties. In addition to MMTS soils and sediments, surface water and ground water at some location within the MMTS became contaminated with tailings-related constituents.

The MMTS includes OUs I, II, and III. The MMTS ROD (DOE 1990) stipulated that radioactively contaminated soil, sediment, and debris from OU I (the former Millsite) and OU II (peripheral properties) would be excavated and placed in a permanent on-site repository. OU III was designated by the MMTS ROD to address contaminated surface water and ground water, and contaminated soil and sediment in the floodplain of certain peripheral properties along Montezuma Creek. However, an Explanation of Significant Difference to the MMTS ROD was prepared to include the OU III peripheral property soil and sediment contamination into the selected remedy for OU II. Remedial actions under OU I and OU II were completed by August 2001. MMTS site features, including the boundary of OU III, are depicted in Figure 2.

The area encompassing OU III is sparsely populated and is used primarily for ranching and dry-land farming. The northwestern portion of OU III lies within the city limits of Monticello (population about 1,900 in 2000). The regional setting comprises the broad, nearly flat surface of the Great Sage Plain, which is about 7,000 feet (ft) in elevation. Average annual precipitation is 15 inches and occurs mainly during late summer and early fall storms.

Montezuma Creek is the main surface water feature in OU III, flowing west to east through the center of the study area. It is a small perennial stream with headwaters in the Abajo Mountains, which rise to nearly 11,000 ft approximately 5 miles west of Monticello. Typical base flow in the creek ranges up to about 0.5 cubic feet per second (225 gallons per minute). Montezuma Creek is

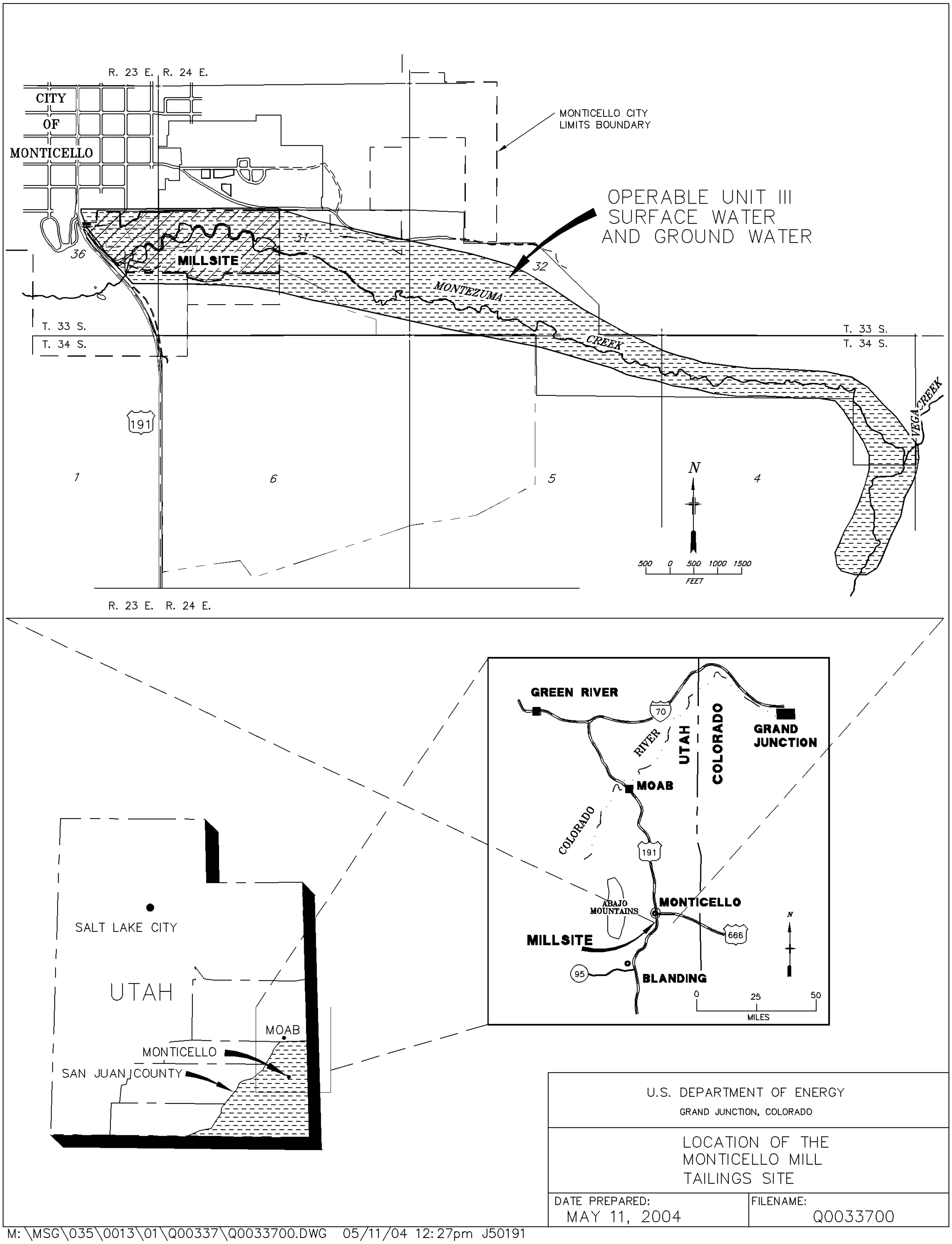

Figure 1. Monticello Mill Tailings Site, San Juan County, Utah

used for irrigation and livestock watering. A municipal reservoir and water treatment plant interrupt natural flow in the creek. Montezuma Creek and its tributaries have incised a canyon network into the local bedrock formations in the east portion of the study area.

The hydrostratigraphic units associated with OU III are the alluvial aquifer, the underlying Dakota Sandstone formation that acts as an aquitard, and the Burro Canyon sandstone aquifer. The alluvial aquifer comprises sand and gravel channel-fill deposits within the valley of Montezuma Creek. The alluvial channel is about 450 ft wide (north to south) at the eastern boundary of the Millsite and narrows to less than 200 ft about 1 mile east, where the valley becomes a steep-walled canyon. The bedrock erosional surface at the base of the alluvial aquifer is relatively flat across the width of the aquifer. Depth to bedrock is generally less than 15 ft below ground surface in the valley floor, and the typical saturated thickness of the aquifer is about 5 ft.

On the Millsite, the alluvial aquifer discharges to Montezuma Creek and to three adjoining wetlands constructed during site restoration. Montezuma Creek loses water to the alluvial aquifer between the eastern boundary of the Millsite and approximately 1 mile downstream. Farther east, a strong gaining stream condition results due to pinching out of the alluvial aquifer because of bedrock control and from ground water discharge from the Burro Canyon Formation. Ground water seepage from sources above the valley along the northern margin of the Millsite is an important source of recharge to the alluvial aquifer.

Ground water contamination is limited to the alluvial aquifer. The Burro Canyon aquifer is not contaminated. Surface water contamination extends throughout most of OU III below the former Millsite. Ground water and surface water contaminants of concern (COCs) for OU III include arsenic, manganese, molybdenum, nitrate, selenium, uranium, and vanadium. The horizontal limit of the alluvial aquifer and the extent of ground water contamination are illustrated in Figure 2. The alluvial aquifer is currently not used for drinking water, irrigation, or livestock watering. The potential to develop the alluvial aquifer as a domestic source is low because the saturated zone is very thin and generally unproductive. The city of Monticello has historically distributed Burro Canyon Formation ground water only for non-domestic purposes (municipal and residential irrigation) but it can be used to augment the culinary water supply.

2.0 Operable Unit III Background

A remedial investigation (RI) for OU III began with site characterization activities in the fall of 1992. The OU III RI report (DOE 1998a) and a draft Feasibility Study (FS) preceded completion of MMTS OU I and II remedial actions. During preparation of the draft FS in 1997, DOE, EPA, and UDEQ recognized that ongoing remedial actions under OU I and II, which started in June 1997, would likely have a major impact on the extent of contamination and flow dynamics of the ground water system. It was determined at that time that potential risks associated with ground water and surface water could not be accurately assessed, and therefore that a final remedy for OU III could not be selected until the complete effects of OUs I and II remediation were known.

A ROD for an IRA for OU III was therefore prepared and signed in September 1998 (DOE 1998b) to stipulate the implementation of long-term risk-reduction measures and specific data collection activities through and following the completion of OU I and II remedial actions.

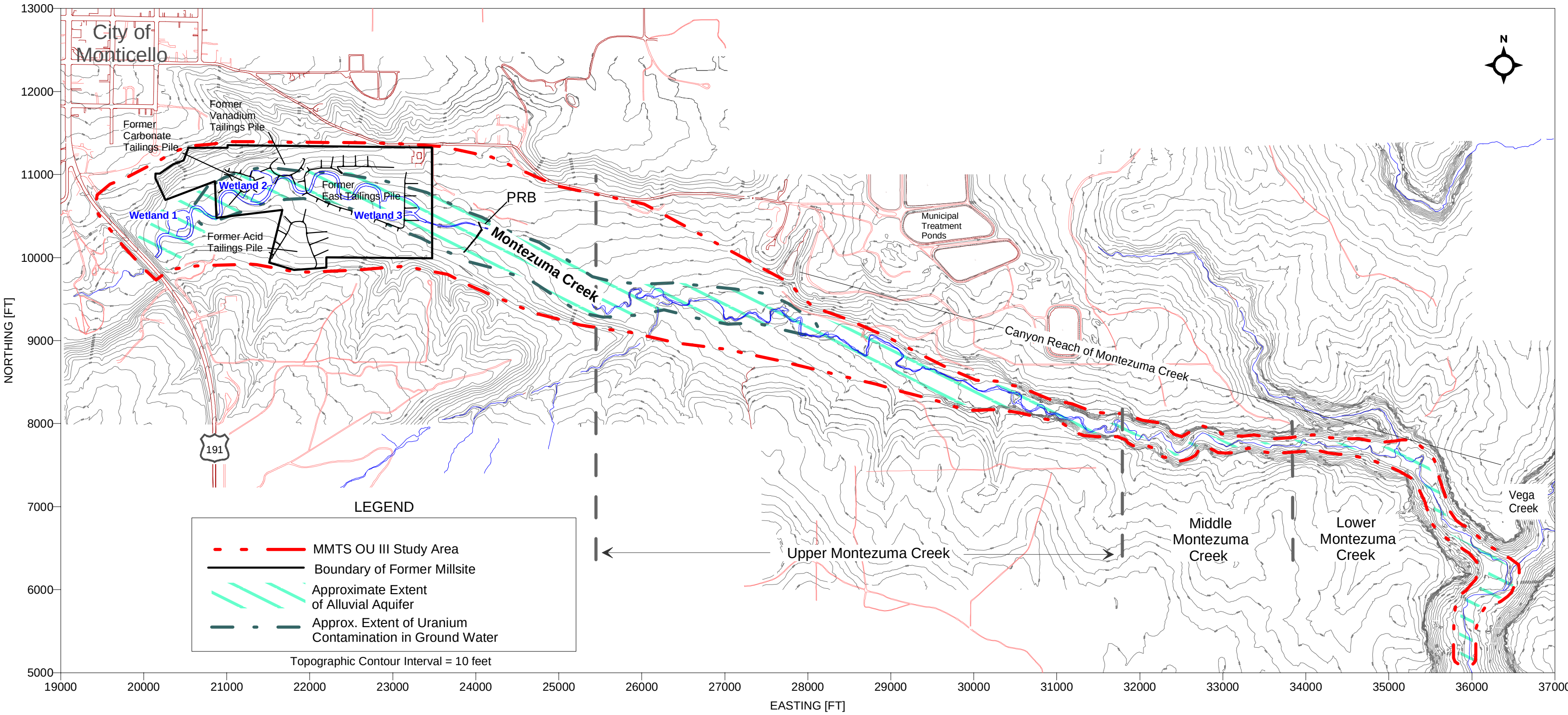

Figure 2. MMTS OU III Site Features

The components of the IRA for OU III were:

- Obtain essential data to characterize ground water and surface water conditions as affected by OU I and II remediation.
- Implement institutional controls (IC) to prevent human exposure to contaminated ground water.
- Conduct a treatability study of in-situ permeable reactive barrier technology.
- Continue ground water extraction and treatment during excavation and dewatering of the Millsite (OU I), thereby removing soluble contaminants from the aquifer and improving water quality.

The work scope associated with the interim ROD was defined in the *Interim Remedial Design/Remedial Action (RD/RA) Work Plan for Operable Unit III–Surface Water and Ground Water* (DOE 1999a) and specified in greater detail in the *Interim Remedial Action Work Plan for Operable Unit III–Surface Water and Ground Water* (DOE 2000a). Results of the activities completed under these plans, as well as other MMTS activities relevant to OU III, were documented in stipulated annual IRA progress reports, a Remedial Investigation Addendum, and a Focused Feasibility Study report, completed in January 2004 (DOE 2004a).

Based on site conditions following remediation of OUs I and II, DOE (2004a) revised the site conceptual model for ground water and surface water, revised the numeric model of ground water flow and contaminant transport, updated the human health and ecological risk assessments, and evaluated detailed alternatives for a final ground water and surface water remedy. As a result, the final ROD for OU III (DOE 2004b) was signed in June 2004, thus concluding the IRA. This RAR was prepared in accordance with the EPA's Close Out Procedures for National Priorities List Sites (EPA 2000) to document fulfillment by DOE of the IRA ROD for OU III. There are no amendments, explanation of significant differences, or technical impracticability waivers associated with the IRA ROD for OU III.

3.0 Design, Construction, and Implementation Activities

Design and scope of the individual IRA components are outlined in the Remedial Design/Remedial Action (RD/RA) Work Plan for the OU III IRA (DOE 1999a) and described in detail in the *Interim Remedial Action Work Plan for Operable Unit III–Surface Water and Ground Water* (DOE 2000a). Among those elements, OU III construction activities are associated only with data collection activities (installation of new wells) and the reactive barrier treatability study (installation of the full scale reactive barrier system). The following sections summarize the main aspects of each IRA task from conception through implementation and completion.

3.1 IRA Monitoring and Data Acquisition

The scope of the IRA monitoring was dependent on the continuing changes to surface and ground water brought about by OU I excavation, source removal, and restoration. These activities were anticipated to significantly reduce the extent of ground water and surface water contamination, particularly on the Millsite. Large areas of the Millsite were excavated to bedrock, removing both mill tailings and the sediments comprising the alluvial aquifer. Flow conditions would therefore likely change due to subsequent reconstruction of the alluvial aquifer and Montezuma Creek into a narrow channel.

Ground water and surface water monitoring was an ongoing activity prior to the IRA but the program was revised for the IRA to account for the changing site conditions. IRA monitoring included quarterly collection and analysis of surface and ground water samples to characterize the extent of contamination. The IRA monitoring task was designed to include installing new wells to replace those abandoned during OU I remedial actions. Ground water levels and surface water flows were also measured quarterly to evaluate site water budget and flow conditions. Sampling and analysis plans were updated throughout the IRA to accommodate the various stages of Millsite remediation and monitoring locations.

IRA monitoring tasks designed to characterize surface and ground water following remedial action and restoration for OU I and OU II included:

- Ground water and surface water monitoring for water quality analysis, ground water levels, and surface water flow. Monitoring was conducted semiannually in 1998 and quarterly in 1999, 2000, 2001, 2002, and 2003. IRA monitoring was again conducted in January and April of 2004, preceding the signing of the OU III ROD. Performance of the permeable reactive barrier was monitored throughout this period through water quality and water level analysis. Additional performance assessments not specified in the IRA were implemented in an ongoing effort to evaluate reactive barrier technology (see Section 3.3).
- Installation of monitoring wells. Because many wells were decommissioned during remediation of the Millsite, numerous new wells were installed on the Millsite, in phases as site restoration proceeded, to re-characterize ground water flow conditions and the extent of ground water and surface water contamination in response to major alterations from remedial actions. Numerous wells were also added to the existing network at the permeable reactive barrier to more closely monitor performance of that system. Additional other new wells were installed farther downgradient to refine the hydrogeologic conceptual model.

The IRA work plan also directed the collection of additional data to evaluate vadose soil of the Millsite as a potential long-term source of ground water contamination, and to evaluate mobility characteristics of COCs in the alluvial aquifer. These data collection activities were designed to provide input to the ground water model that was developed to support the OU III human health risk assessment and evaluate remedial alternatives in the feasibility study. In summary, these tasks consisted of:

- Characterizing the distribution and mobility of COCs in soil beneath former waste areas. As Millsite remediation proceeded, soil samples were collected below the verified depth of radiological contamination to determine the content of OU III ground water and surface water COCs.
- Evaluating the mobility of COCs in vadose zone soil using column leach tests for selected vadose zone soil samples. Multiple pore volumes of water were passed through the samples and analyzed to determine COC concentrations of the effleunt. Test results were

used as input to the ground water model and to direct the removal of secondary source material in conjunction with OU I removal actions, as described in Section 3.5.

- Characterizing mobility of COCs in the saturated zone by column leach testing and sorption batch testing. Results of these activities were used to develop site-specific inputs to the OU III ground water model.

Progress reports that detail the scope, results, interpretation, and use of the IRA data were prepared by DOE in 1999, 2000, and 2001. Subsequent ground water and surface water monitoring results through October 2002 are addressed in the RI Addendum/FFS, which also documents the conceptual and numeric ground water models for OU III that were updated using data collected during the IRA. The most recent IRA monitoring results (January 2003 through April 2004) are documented in DOE (2004c).

3.2 OU III Institutional Controls

Institutional controls have been applied at OU III to prohibit use of contaminated alluvial ground water and to restrict land use on peripheral properties along Montezuma Creek where supplemental standards for soil and sediment remediation were applied. This section describes these institutional controls.

3.2.1 Alluvial Aquifer Institutional Controls

On October 21, 1998, the Utah State Engineer’s office assumed responsibility for preparation and administration of a ground water management policy for the contaminated alluvial ground water system. The State Engineer's office held a public meeting on April 7, 1999, at the San Juan County Courthouse, to inform affected property owners of a proposal to prohibit drilling of shallow alluvial wells in the contaminated areas along Montezuma Creek. A draft ground water management policy was available to the public. The *Ground Water Management Policy for the Monticello Mill Tailings Site and Adjacent Areas* became effective May 21, 1999, at the close of the 30-day public comment period. The policy states that new applications to appropriate water for domestic use from the shallow alluvial aquifer within the boundaries of the Monticello Ground Water Restricted Area (Figure 3) will not be approved until it is determined that the potential risk to human health is eliminated or reduced to acceptable levels; existing water rights are not affected. Also, change applications proposing to divert and use water from the shallow aquifer for domestic purposes will not be approved. The policy also states that applications to drill wells into the deeper Burro Canyon sandstone aquifer would be approved only if demonstrated that the construction would not allow alluvial water to flow to the sandstone aquifer. DOE purchased the sole water right for domestic use (Water Right 09–0130) within the Monticello Ground Water Restricted Area in 2001. The second ground water use restriction for OU III was incorporated with the quitclaim deed that transferred ownership of the Millsite to the city of Monticello for use as a public park (in perpetuity). The deed prohibits the use of any ground water within the boundary of the former Millsite for the purpose of human consumption.

DOE assumes responsibility through its Long Term Stewardship and Maintenance (LTSM) program for ensuring that the Ground Water Management Policy remains effective. DOE conducts annual inspections of the affected properties for any evidence of well installations or ground water use. Inspections conducted to date revealed no evidence of attempted domestic use of alluvial ground water in the OU III restricted area. The effectiveness of the IC was demonstrated in 2003 when a landowner attempt to file a water right for the Burro Canyon sandstone aquifer was initially denied by the State Engineer based on insufficient well construction information.

Before the institutional controls were implemented, the alluvial aquifer was not used for any purpose, and future domestic use, in the absence of the institutional controls, is not likely because the alluvial aquifer is not a reliable or prolific source of ground water. Alternate domestic water supplies (municipal water and ground water from underlying bedrock formations) are also available to current and future residences in the Ground Water Management Area. Predominantly agricultural land use in the Ground Water Management Area, both current and planned, provides additional support that the likelihood of exposure to contaminated ground water will be minimal.

3.2.2 Restrictive Easements

Restrictive easements were applied to properties within OU III where supplemental standards for soil and sediment remediation were applied (see Section 3.5). The restrictive easement prohibits the building of a habitable structure and the removal of soils from within the easement area. By June 2001, the U.S. Army Corps of Engineers had negotiated settlement with all affected property owners regarding compensation for the restrictive easements. The restrictive easements have been recorded on the property deeds. The restrictive easement area extends east of the Millsite approximately 2 miles to the confluence of Montezuma and Vega Creeks. Along this portion of the creek, the restrictive easement area is generally defined as the area within 50 feet of the centerline of the creek. The restrictive easement area is depicted in Figure 3. DOE conducts quarterly compliance inspections of the subject properties.

3.3 Permeable Reactive Barrier Treatability Study

The draft FS concluded that permeable reactive barrier technology for in situ ground water treatment was a potentially viable alternative for OU III but the design parameters and long-term performance were uncertain. EPA and UDEQ therefore recommended that the IRA include site-specific testing of permeable reactive barrier technology at OU III. After a period of bench and field-scale pilot testing, construction of the full-scale permeable reactive barrier at the location shown in Figure 2 was completed on June 30, 1999. The Monticello permeable reactive barrier consists of an initial zone of pebble gravel with approximately 13 percent by volume of zero valent iron (ZVI), a second zone of 100 percent ZVI, and a third zone of 100 percent pebble gravel (Figure 4). As ground water flows through ZVI-containing zones, dissolved ground water contaminants, including arsenic, molybdenum, nitrate, selenium, uranium, and vanadium are immobilized by the reactive media, by reductive precipitation or adsorption onto iron corrosion products (DOE 1998c, 1998d).

3.3.1 Laboratory and Field Treatability Studies

Pre-construction activities included laboratory and field studies. The laboratory treatability study evaluated a variety of reactive materials for the ability to remove contaminants from ground water. Eighteen materials (mostly sorbents) were evaluated using batch tests and twelve zero valent iron (ZVI) products were evaluated using column tests using ground water from the site. Batch testing closely followed ASTM procedure D4646–87. None of the tested sorbents were

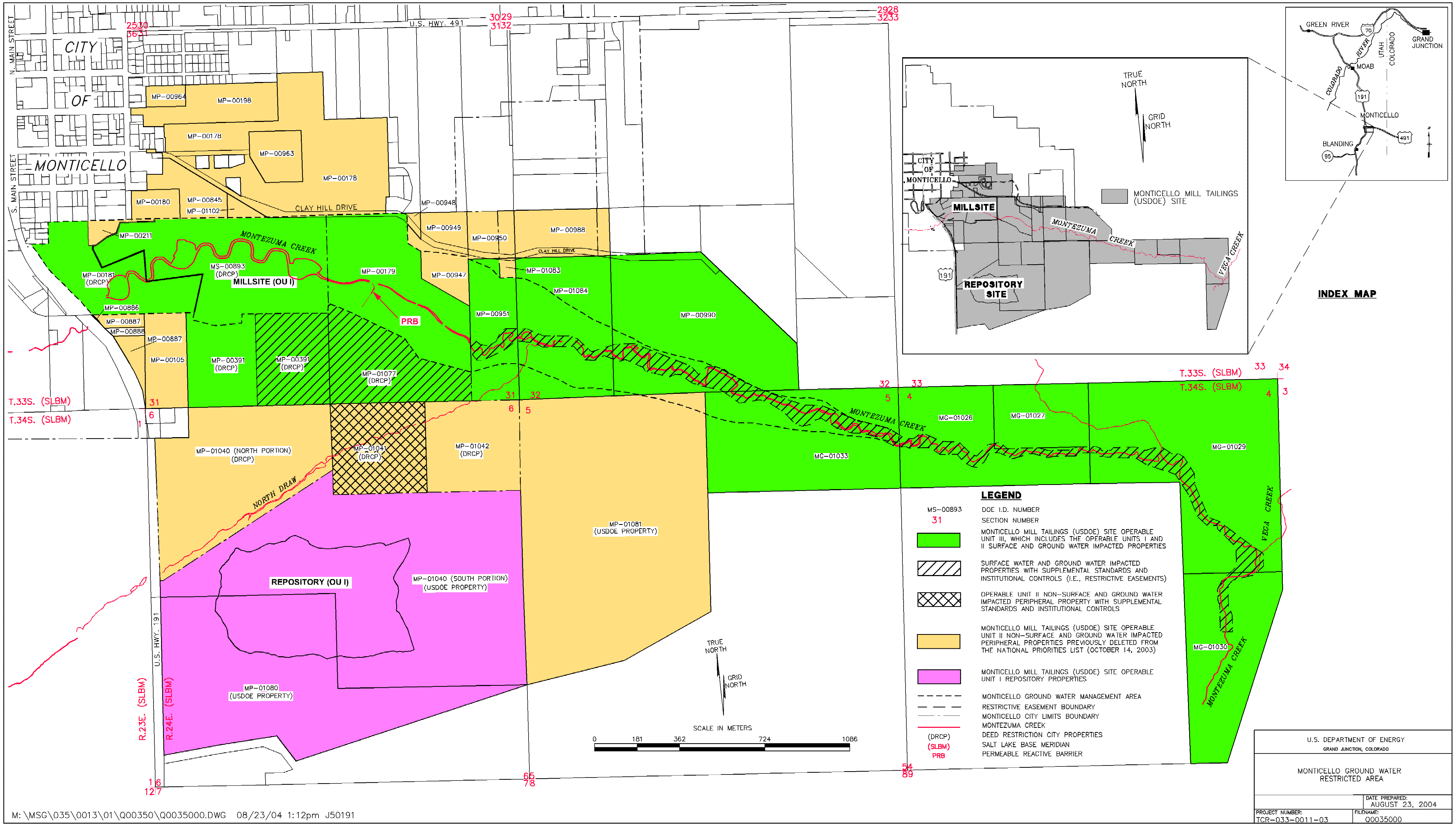

Figure 3. Monticello Ground Water Restricted Area

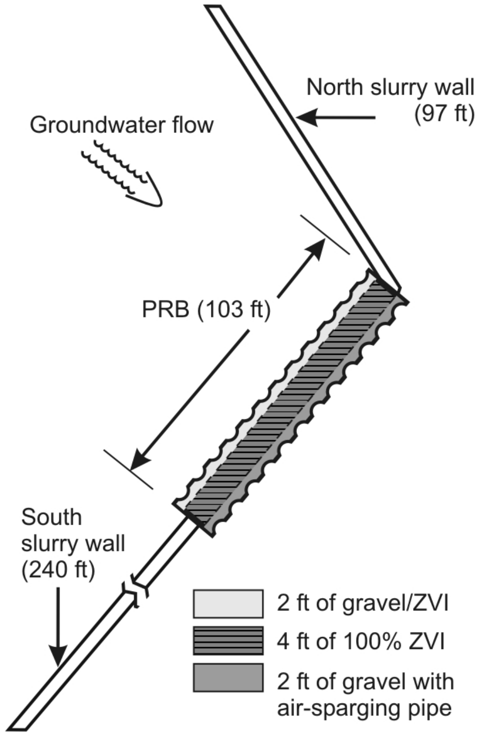

Figure 4. Schematic of PRB

satisfactory for use as the PRB reactive media because they were not able to meet performance requirements (OU III remediation goals) for all contaminants of concern. The ZVI products were found to be very effective (effluent concentrations typically less than 1 micrograms per liter [µg/L]). In addition, ZVI is inexpensive and readily available. Six types were recommended for further evaluation in the field treatability study. Results of the laboratory treatability study are reported in *Permeable Reactive Treatment (PeRT) Wall, Results of Laboratory Treatability Testing for the Monticello, Utah, PeRT Wall* (DOE 1998c).

The purpose of the field treatability study was to provide supplemental data to better predict the effects of emplacing the reactive media. Experiments were conducted in 4-foot high, 4-inch (inside) diameter clear acrylic columns in a field trailer using ground water from a nearby monitoring well completed within the contaminant plume. Five types of ZVI supplied by four manufacturers were used in the study. The following specific objectives were evaluated (1) removal of contaminants, (2) chemical transport in the alluvial aquifer by effluent from a ZVI-containing column, (3) iron and manganese mobilization from ZVI, (4) changes in hydraulic conductivity, (5) mobilization of priority pollutant metals from ZVI, (6) rates of contaminant uptake and mineral precipitation, and (7) geochemical modeling. The results showed that all the ZVI products were effective in removing the contaminants of concern, but some products released lower amounts of iron and manganese and had higher hydraulic conductivity. Results of the field treatability studies are reported in *Permeable Reactive Treatment (PeRT) Wall, Results of Field Treatability Studies for the Monticello, Utah, PeRT Wall* (DOE 1998d).

3.3.2 Site Characterization

During preparation of the draft FS, discussions began with EPA and UDEQ about the location of the PRB. Millsite locations were considered, including the eastern boundary of the Millsite, but because of ongoing remediation, the difficulty in coordinating activities with either the remediation or restoration contractor, and the uncertainties associated with restored surface-water/ground-water systems (contaminant concentrations and flow dynamics) an offsite location was preferred. The selected location is on private property downgradient of the area where most contaminants (except uranium) exceed remediation goals, and therefore, could eliminate plume migration. A 40-year lease was negotiated with the property owner in April 1999.

A field investigation was conducted in January and February 1999 to characterize the hydrogeology and uranium distribution in ground water in detail in the proposed area of the PRB. Results of that investigation, documented in *Field Characterization Summary, March 1999—Monticello PeRT Wall Project* (DOE 1999b) were instrumental in developing the final design of the PRB.

3.3.3 Design

Ground water modeling was conducted with MODFLOW (McDonald and Harbaugh, 1988) and MODPATH (Pollock 1989) to predict (1) the extent of ground water mounding upgradient of the PRB, (2) capture efficiency of the PRB relative to its orientation in the plume, and (3) flow velocity through the PRB. The model predicted steady-state water-table configurations for various PRB and slurry wall designs. Modeled ground-water flux at the proposed location of the PRB was 50 gallons per minute (gal/min). Variables tested in the predictive models were the length, orientation, and position of the slurry walls and the hydraulic conductivity, thickness, and position of the PRB. The model that best represented the installed system predicted a 2- to 3-feet (ft) water-table rise in a small area hydraulically upgradient of the PRB, assuming full capture of ground water by the slurry walls. The steady-state ground-water model developed for the OU III remedial investigation was used as the baseline model in the PRB design phase. Documentation of the baseline model is included in *Monticello Mill Tailings Site, Operable Unit III, Remedial Investigation* (DOE 1998a).

Using a ground-water flux of 50 gal/min, a saturated thickness of 10 ft, cross-sectional area of 1,000 square feet (ft^2), and a porosity for ZVI of 0.5 (an approximate value from the field column tests), the 6-minute residence time for U (determined in column tests) would require the PRB to be only 2.5 cm wide. Although some of the other contaminants required slightly longer residence times, it was apparent that a thin PRB would be acceptable if residence time were the only factor that needed to be considered. Because residence time in the PRB decreases with ZVI dissolution, a thicker PRB is required than is predicted by residence time only. The effect of ZVI loss was estimated based on the average effluent iron concentration (30 milligrams per liter [mg/L]) in the field column tests. Some of the iron (perhaps most) would reprecipitate within the PRB; however, it was assumed that these secondary iron minerals would not further reduce contaminant concentrations in the ground water. On the basis of the ground-water flux rate (50 gal/min) and the length of time required for all of the ZVI to dissolve (if the concentration of iron in ground water is 30 mg/L as estimated from laboratory work [DOE 1999c]), a 4-ft width of ZVI would be depleted in 117 years. Permeability reduction caused by mineral precipitation and loss of reactivity from passivation of ZVI surfaces will also decrease longevity, but no reliable methods were available during design to evaluate these processes.

The PRB was designed with 4 ft of 100 percent ZVI to accommodate ZVI loss for 117 years and because this width was amenable to standard construction practices. Gravel zones (2 ft wide) were designed upgradient and downgradient of the 100 percent ZVI zone to help distribute ground-water flow through the system (Figure 4). The upgradient zone design included 13 percent (by volume) coarse ZVI to initiate oxygen and mineral removal with the intent of extending the life of the PRB by providing additional pore space to accommodate mineral precipitates such as calcite.

The downgradient gravel zone, composed solely of washed pea gravel, was designed to include an air-sparging system constructed of a 2-inch inside diameter perforated (3/16-inch holes) polyvinyl-chloride (PVC) placed 1 ft above bedrock. This pipe would connect to a vertical pipe to the ground surface for air injection. Three 2-inch PVC air-sparging vents were connected to a perforated pipe 2 ft below the top of the wall to provide a path for the air to escape. Data from field column tests indicated that iron and manganese may be released from the PRB and may become mobile in the ground water, but concentrations can be decreased significantly by air sparging. The air-sparging system was designed as an option to precipitate iron and manganese by increasing the concentration of dissolved oxygen.

Additional design details were summarized in *Design Specifications for the MMTS PeRT Wall Ground Water Treatment System* (DOE 1999c) and *Accelerated Site Technology Deployment, Deployment Plan for the Permeable Reactive Treatment Wall for Radionuclides and Metals* (DOE 1997).

3.3.4 Installation

After the site was leveled and equipment was mobilized, the first activity was to construct the northern and southern slurry walls. The next step was to construct the permeable or reactive portion of the PRB. A complete description of construction activities and as-built details is included in *Permeable Reactive Treatment (PeRT) Wall for Radionuclides and Metals, Performance Summary Report for the PeRT Wall at Monticello, Utah* (DOE 1999d). The construction of the PRB took approximately 6 weeks; it was completed on June 30, 1999.

3.3.4.1 Slurry Walls

Slurry walls direct contaminated ground water to the PRB. The south slurry wall is 240-ft long and the north slurry wall is 97-ft long. The landowner requested that the north slurry wall end short of the intended design length to avoid destroying a grove of trees. The north slurry wall is therefore about 50 to 70 ft from the northern extent of the aquifer. Construction on the south slurry wall was stopped when no more alluvial materials were observed in the excavation.
To construct the slurry walls a trench was excavated and spoils were placed in a mixing area. In the mixing area, bentonite powder was added to make a soil/bentonite mixture. As excavation proceeded, a water/bentonite slurry was pumped into the trench to maintain trench stability, to create a seal or skin on the trench walls, and to fill voids between the trench walls and the backfill mix. As the soil/bentonite mix was progressively placed in the trench, excess displaced water/bentonite slurry was transferred to the mixing area to generate additional soil/bentonite mix. A bulldozer mixed the materials until homogeneous. The bentonite content of the soil/bentonite mix was 4 percent by volume. The slurry walls are keyed about 1 to 5 ft into bedrock and range in height above the bedrock from 10- to 16-ft. Laboratory permeability tests

(ASTM 2001) conducted on slurry wall materials indicate an average hydraulic conductivity of 1×10^{-8} cm/sec.

3.3.4.2 Permeable Reactive Gate

The PRB was constructed by driving steel sheet piling through alluvium and into competent bedrock, forming a rectangular box 103-ft long by 8-ft wide. The sheet pile box was constructed of Z-shaped steel sheet piling with an interlocking single jaw and was driven with a 127-ton crane and a 140-ton hydraulic vibratory hammer until it would no longer penetrate. Once in place, the sheet piles were cut near the ground surface, and structural beams and cross bracing were installed. Native soils inside the box were excavated to about 1 ft into the competent bedrock. A trackhoe was used to scrape and remove loose material from the excavation. Workers also entered the excavation to completely remove all remaining loose material and remove soils adhering to the sheet piles. The depth from the top of the sheet pile to the bottom of the excavation was 11 to 13 ft.

The next step was to fill the excavation with the ZVI and the two gravel zones. Compartmentalized steel boxes were placed on the bedrock to keep the gravel zones and 100 percent ZVI zone separate during placement. The 4-ft high boxes were constructed from a steel plate cut in various lengths and welded together to fit the length of the excavated sheet-pile box. As the ZVI and gravel were added, the sheet steel boxes were incrementally hoisted and then removed when the excavation was filled. The upgradient gravel zone is 2-ft wide and is composed of 13 percent by volume –4 to +20 mesh ZVI mixed uniformly with 0.5-inch gravel. The 4-ft-wide middle section of the PRB contains 100 percent –8 to +20 mesh ZVI; approximately 4,480 ft^3 of ZVI with a loose-filled weight density of 115 lb/ft was used. ZVI was placed in the excavation from super sacks (1984 lb canvas bags with a drawstring release at the bottom) suspended from a 127-ton crane. The downgradient gravel zone is 2-ft wide, composed of 0.5-inch sieved gravel and includes the air-sparging system. After the reactive gate was filled to final grade, a geotextile material was placed on top before several ft of native soil was replaced to match the original grade. After the reactive materials and gravel were placed, the Z-shaped sheet pilings perpendicular to the ground-water flow (two 103-ft sections) were removed to allow ground water to flow through the PRB. A cross-sectional view showing the PRB, slurry walls and surrounding alluvium and bedrock is shown in Figure 5.

3.3.5 Performance Monitoring and Testing

More than 70 monitoring wells were installed in or near the PRB to measure water-table elevations and to collect samples for water quality analysis. Since its installation, the Monticello permeable reactive barrier has effectively reduced the concentrations of all COCs except manganese to levels that are much less than site remediation goals. Table 1 compares average COC concentrations at the permeable reactive barrier in October 2002 with those goals. The results shown in the table are typical among the 10 comprehensive sampling events conducted through July 2001 involving 60 monitoring wells (see Figure 6, ground water flow is from northwest to southeast), and 10 reduced-scope sampling events conducted through January 2004. The release of manganese during dissolution of ZVI results in concentrations slightly less than its remediation goal. Permeable reactive barrier performance monitoring data are discussed in detail in IRA Progress Reports (DOE 2000b and 2001), the treatability study report (DOE 2002a), and the RI Addendum report (DOE 2004a).

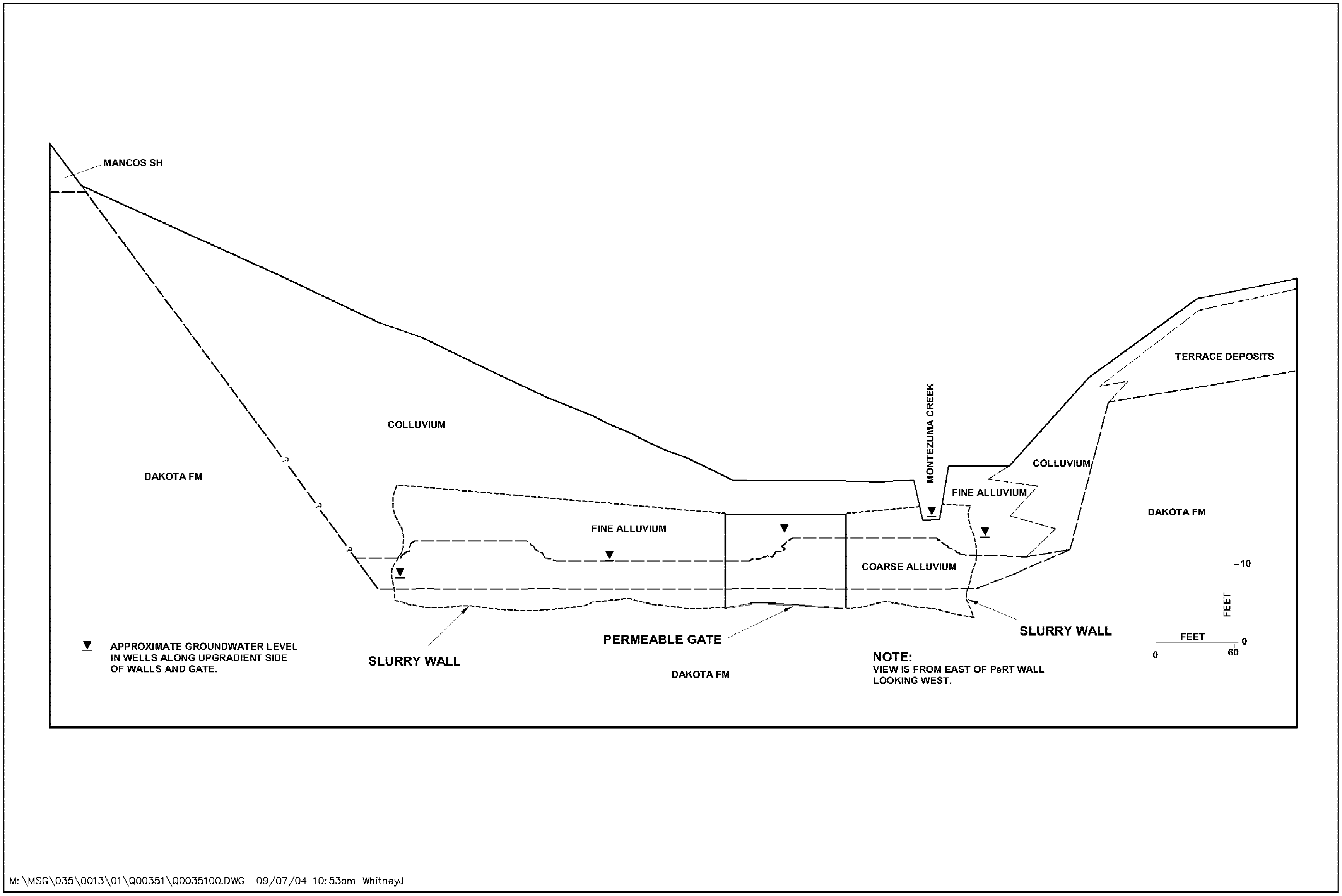

Figure 5. Cross-Sectional View Through Reactive Barrier

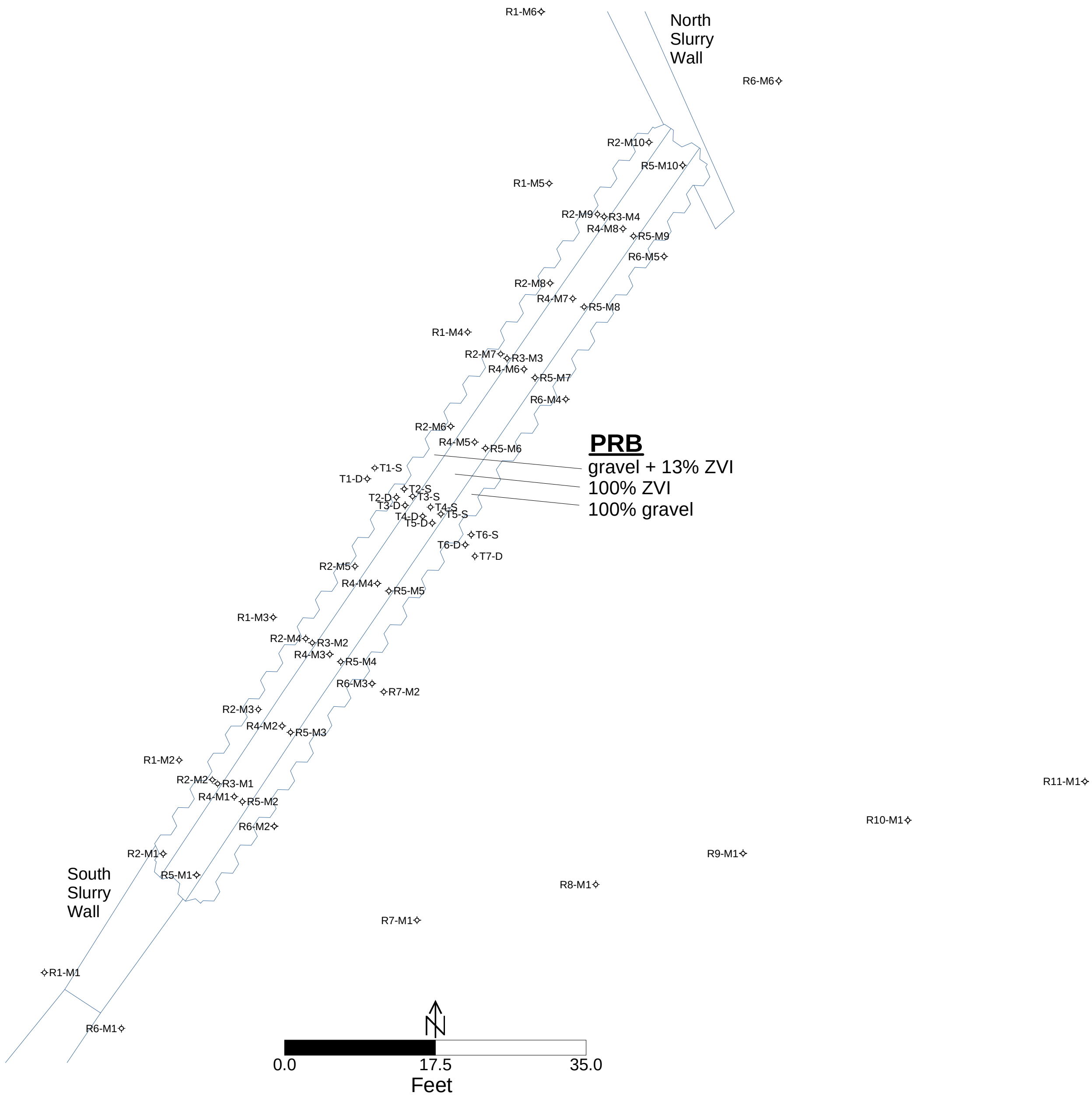

Figure 6. Permeable Reactive Barrier Ground Water Monitoring Well Locations

Additional activities undertaken to evaluate the treatment and hydraulic performance of the permeable reactive barrier included:

- Hydraulic testing
- Colloid tracking
- Multispecies tracer test
- Borehole dilution tests
- Geochemical analysis of permeable reactive barrier core samples.

These separate studies were conducted with technical assistance from OU III as part of ongoing development of reactive barrier technology. Results of these studies are also reported in annual IRA progress reports, in the remedial investigation addendum, and in:

- *Permeable Reactive Treatment (PeRT) Wall for Radionuclides and Metals, Performance Summary Report for the PeRT Wall at Monticello, Utah* (DOE 1999d).
- *Chemical Mechanism of Uranium Uptake by Zero-Valent Iron: Results of a Column Experiment, Permeable Reactive Barrier Project, Monticello, Utah* (DOE 2000c).
- *Performance Evaluation of Zero-Valent Iron-Based Permeable Reactive Barriers and Potential for Rejuvenation by Chemical Flushing* (DOE 2002b).
- *Performance Evaluation of a Permeable Reactive Barrier Using Reaction Products as Tracers* (Morrison 2003).
- *Phase II: Performance Evaluation of Permeable Reactive Barriers and Potential Rejuvenation by Chemical Flushing* (DOE 2004d).

3.3.6 Performance Summary

The mass of uranium and vanadium deposited in the permeable reactive barrier during the first 2.7 years of operation (through February 2002), determined by core sample analysis, were 25 and 16.5 lbs (11.4 and 7.5 kg), respectively (DOE 2004a). Subsequent core analysis (DOE 2004d) determined that the total mass of uranium deposited in the permeable reactive barrier as of August 2003 was about 50 pounds. Based on the solid-phase increases of uranium, vanadium, and calcium in the permeable reactive barrier, in conjunction with dissolved-phase concentration gradients, the calculated rate of ground water flow through the permeable reactive barrier through each of the respective periods of observation ranged between 2 and 10 gallons per minute (gpm). The average flow rate for both periods was about 5 gpm (DOE 2004d). A pumping test determined the rate of flow through the permeable reactive barrier to be 9 gpm in December 2001 (DOE 2002a). Because iron and manganese concentrations in samples of ground water exiting the PRB have remained low, the air-sparging system has never been activated..

Table 1. Contaminant Concentrations at Permeable Reactive Barrier and Remediation Goals

Analyte	Upgradient Concentration[a] (µg/L)	Concentration within the Permeable Reactive Barrier (µg/L)	Downgradient Concentration (µg/L)	Remediation Goal (µg/L)
Arsenic	10.7	<0.1	1.7	10
Manganese	171	338	767	880
Molybdenum	104	<1.7	<1.7	100
NO_3+NO_2 as N	2,080	27	32.5	10,000
Selenium	103	<0.13	<0.1	50
Uranium	535	<0.1	1.5	30
Vanadium	392	<0.3	0.5	330

[a]These contaminant concentrations are from the October 2002 sampling event. The upgradient concentrations are the mean values from the Row 1 wells (R1–M3 and R1–M4), the concentrations within the wall are the mean values from the Row 4 wells (R4–M3 and R4–M6), and the downgradient concentrations are the mean values from Row 6 wells (R6–M2 to R6–M5 and T6–D).

Water level data indicate that contaminated ground water flows around the outer ends of each slurry wall because the full width of the aquifer is not spanned by the system. The north slurry wall was intentionally not extended to the margin of the aquifer, whereas the south slurry wall terminated where alluvial material was no longer observed in the trench during construction. Estimates provided in DOE 2002a indicate that the quantity of ground water that bypasses the permeable reactive barrier is about equal to that which is treated. The monitoring data suggest that slurry walls are otherwise impermeable and that flow beneath the walls and permeable reactive barrier is insignificant. The water table within the ZVI is essentially flat, however, steep hydraulic gradients (up to about 0.5 ft/ft) have characterized the up- and downgradient interfaces of the permeable reactive barrier throughout most of the treatability study, possibly indicating that an intervening zone of disturbed, lower conductivity alluvium may separate undisturbed alluvium from the permeable reactive barrier (DOE 2002a). Flow restriction through this zone may be a contributing factor to the bypass flow. The ground water mounding at the influent boundary of the PRB has since stabilized.

Currently there is no reliable method to predict longevity of permeable reactive barriers because specific physical and chemical mechanisms acting within the reactive media are not well understood. In general however, two possibly interrelated processes can limit the longevity of permeable reactive barriers: reduction of reactivity and reduction of porosity. Deposition of carbonate minerals on ZVI surfaces could affect both processes, and the loss of reactivity could in turn decrease the rate of porosity loss. Thus far, reactivity loss in the Monticello permeable reactive barrier is confined to the gravel/ZVI zone; the ZVI zone still reduces contaminant concentrations to the limits of detection. In the initial 2.7 years of operation, precipitation of approximately 9 metric tons of calcite in the permeable reactive barrier reduced the porosity of the gravel/ZVI zone from 42 to 33 percent, and from 70 to 67 percent in the ZVI zone. Discrete zones of cementation within any portion of the permeable reactive barrier were not evident. Rising-head slug tests using gas displacement (DOE 2004d) indicate a possible reduction of hydraulic conductivity over time in the permeable reactive barrier.

Ground water modeling (DOE 2004a) estimated that the uranium plume will move downgradient of the permeable reactive barrier by about year 2015; consequently, the permeable reactive barrier would provide no further benefit although potentially retaining treatment capacity through that time. Supported by the water-quality monitoring and core sample data obtained through February 2002, coupled analytical models of reactivity and porosity loss (DOE 2004a; Morrison 2003) predict that porosity occlusion alone is unlikely to limit permeable reactive barrier performance at any future time. Instead, reactivity loss was predicted to reduce effective treatment of uranium in the gravel/ZVI zone within 1 year of installation and by about 2006 to 2008 in the ZVI zone due to carbonate mineral coating of ZVI grains. The prediction holds true for the gravel/ZVI zone, which presently reduces influent uranium concentrations, averaging about 0.5 mg/L, by 25 percent. However, the ZVI zone shows no evidence of reactivity loss. As of this writing, uranium concentrations remain at or below the limits of detection. Based on this observation, and contrary to the model prediction of failure within 6 to 8 years of installation, the reactive capacity of the permeable reactive barrier may reasonably extend to 2015.

The ROD for OU III does not include the permeable reactive barrier as a component of the final remedy. Although completion of the IRA concludes the permeable reactive barrier treatability study, DOE and EPA will continue to monitor the effectiveness of the permeable reactive barrier and facilitate continued research of its performance. When the permeable reactive barrier is no longer effective or needed, as directed by the ROD for OU III, it will be excavated, and radioactive components will be disposed in an appropriate facility as defined in 40 CFR 192.01[a].

3.4 Millsite Dewatering and Ground Water Treatment

The primary objectives of Millsite dewatering and treatment were to facilitate excavation and removal of mill tailings and contaminated soil that extended below the water table and to ensure that contaminated surface water and ground water was not released to Montezuma Creek during remediation activities. In treating contaminated ground water and surface water, contaminants of concern were permanently removed from the ground water system, thereby positively affecting ground water and surface water quality.

Prior to remediation of the Millsite, surface water run-off was directed through a series of runoff control ditches to a lined pond located just east of the Millsite on private property. The pond which was constructed in 1994 had a capacity of approximately five million gallons. Water collected in the pond was initially used for dust control; however, in 1995 DOE installed a wastewater treatment plant (WWTP) at the Millsite to treat surface water run-off and excavation water prior to its release back to Montezuma Creek. In 1998 during remediation of the Millsite and the relocation of the tailings to the on-site repository, excavation water was pumped to the pond for utilization in dust control activities or for treatment prior to being released back to Montezuma Creek. Alternatively, depending on water management requirements, water was also pumped temporarily to Pond 4, located just east of the repository, via a pipeline that was installed during September and October 1997.

The WWTP operated intermittently from March 1998 until May 1999.The WWTP was designed to remove heavy metals, radionuclides, and total dissolved solids (TDS) from contaminated ground water and surface water. Considerable treatment process development was required before achieving compliance with applicable Utah Pollutant Discharge Elimination System (UPDES) standards. Originally, the treatment process was conducted in two 48-ft trailers. Precipitation in Trailer 1 removed certain heavy metals and radionuclides. Adjustments to the pH were made in Trailer 2, which also contained a membrane filtration system for filtering out particulate matter to meet the TDS standard. This treatment system was first operated in May 1995 to determine removal efficiencies and a substantial volume of water was treated in 1995 and 1996. However, difficulty in achieving selenium standards was encountered with this system, so a final polishing step using activated alumina was added in 1996. In 1997, installation of Trailer 3, which housed the activated alumina, was completed and treatment resumed. Difficulty in attaining treatment standards was again encountered because elevated concentrations of sulfates were produced. An attempt to precipitate sulfates with barium chloride was unsuccessful because the treated water then failed barium standards established by the State on April 28, 1997.

In 1998 a reverse osmosis treatment system was added to the treatment configuration primarily to remove selenium and TDS. The reverse osmosis unit effectively removed all contaminants of concern. The reverse osmosis system could be used in combination with the precipitation/filtering system or the two systems could be used separately. Processed water from the reverse osmosis unit was blended with water from the trailers. This treatment configuration proved to be effective in meeting treatment standards. The brine generated from the waste stream was eventually disposed in the on-site repository.

Approximately 54 million gallons of water were treated during WWTP operation. The WWTP was decommissioned in May 1999. During its operation an estimated 50 to 100 kg of uranium were permanently removed from the aquifer (DOE 2001). Uranium is the single greatest contributor to potential risk among ground water COCs The mass of uranium removed is equivalent to 15 to 30 percent of the mass of dissolved uranium (340 kg) estimated to have comprised the ground water plume before dewatering and treatment (DOE 2000a).

During Millsite dewatering and ground water treatment activities, the Monticello Program and Project management was committed to establishing, implementing, and maintaining an effective quality assurance (QA) program that achieved quality in all activities through planning, performing, assessing, and continually improving the process. The work performed complied with the requirements of the Grand Junction Office QA Program, which was documented in the GJO Quality Assurance Manual. The GJO Quality Assurance Manual was frequently reviewed and updated during the Monticello dewatering and ground water treatment activities. The most recent update of the Quality Assurance Manual was in 2004 (Stoller 2004). Additionally, the GJO QA Program was designed to adopt and implement the requirements of ANSI/ASQC E4-1994, Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs (ANSI/ASQC 1995).

3.5 Ancillary Source Removal Construction Activities

This section briefly summarizes the remedial actions completed for OUs I and II concurrent with the IRA that benefited OU III ground water and surface water restoration objectives. These activities are relevant to this RAR because they describe the larger context in which the IRA was designed and implemented.

3.5.1 Removal of Primary Contaminant Sources

The primary sources of ground water contamination were removed pursuant to the remedy selected for OU I when approximately 2.5 million cubic yards (yd^3) of contaminated material was excavated from the former mill area, the tailings impoundment area, and an alluvial aquifer floodplain on a private property immediately east of the former Millsite that had been contaminated with windblown and waterborne tailings. These tailings and contaminated materials were placed in a permanent on-site repository. Cleanup under this remedial action was to the 5/15 picocuries per gram (pCi/g) Ra-226 standard. To achieve this standard, excavation and removal of contaminated tailings and alluvium extended beneath the water table to competent bedrock over large areas of the former Millsite. In conjunction with on-site treatment of ground water, source removal significantly reduced the extent of ground water contamination on and immediately downgradient of the former Millsite and significantly eliminated further leaching potential of contaminants to the ground water.

3.5.2 Removal of Secondary Sources of Contamination

An additional 75,000 yd^3 of residual source material from the vadose zone beneath the former tailings piles was removed from the former Millsite. These areas where additional soil was removed were designated the Residual Vadose Zone (RVZ). Although not contaminated to the Ra-226 standard, laboratory experiments indicated that uranium and vanadium in this material had the potential to be a continuing source of ground water contamination (DOE 2000b). On the basis of the study results, a decision was made to excavate below the depth of radiological contamination in numerous areas where uranium exceeded 12 mg/kg and/or vanadium exceeded

70 mg/kg so as to reduce the potential for these areas to be long-term sources of contamination to ground water.

3.5.3 Soil and Sediment Remediation along Montezuma Creek

In 1998, DOE implemented a non-time-critical removal action (DOE 1998e) for the contaminated soil and sediment along Montezuma Creek within OU III. The affected portion of Montezuma Creek was divided into three segments (Upper, Middle, and Lower; see Figure 2) based on topographic features and current and expected future land use/exposure scenarios. Prior to the removal action, potential remedies for the contaminated soil and sediment which applied risk-based criteria were evaluated in the *Monticello Mill Tailings Site, Operable Unit III, Alternatives Analysis for Soil and Sediment* (DOE 1998f).

During 1998 and 1999, under the auspices of OU III, 20,935 yd^3 of contaminated soil and sediment were removed from the floodplain of Upper and Lower Montezuma Creek. In Upper Montezuma Creek, the extent of remediation was determined by excavating soil and sediment in hot-spot areas defined by surface gamma exposure rates exceeding 35 microroentgens per hour (μR/h). Excavation continued at depth in these areas until Ra-226 concentrations did not exceed the 40 CFR 192 cleanup standard or until the excavation intersected the water table. A total of 20,800 yd^3 were removed from Upper Montezuma Creek. Soil or sediment removal from Middle Montezuma Creek was determined unnecessary on the basis of risk assessment. In Lower Montezuma Creek, a surface gamma exposure rate of 80 μR/h was used to delineate four hot-spot areas for cleanup. Excavation of 135 yd^3 of contaminated soil and sediment was completed in July 1999.

Supplemental standards applications were prepared for those areas adjacent to Montezuma Creek where contamination above the standards in 40 CFR 192 Subpart C was left in place; EPA and UDEQ approval of the supplemental standards applications documented their acceptance of the removal actions as part of the final remedy. Restrictive easements (see Section 3.2) were implemented to prohibit construction of a habitable structure and removal of soils for use outside of the supplemental standards area. An Explanation of Significant Difference to the MMTS ROD was prepared to include the OU III peripheral properties (the soil and sediment area along Montezuma Creek) into the selected remedy for OU II.

4.0 Chronology of Events

The following timeline summarizes the sequence of past events relevant to the Interim Remedial Action Record of Decision for OU III. Significant activities from the identification of OU III to the signature of the final ROD for OU III are documented.

1990 (September)	Record of Decision for OU's I and II and identification of OU III
1992	Begin site characterization for OU III RI/FS
1997 (June)	Begin excavation of mill tailings from Millsite
1998 (January)	Alternatives Analysis for OU III Soil and Sediment (OU III supplemental standards properties)
1998 (March)	Start interim ground water extraction and treatment
1998 (June)	Final RI and draft FS for OU III
1998 (June)	Action Memorandum for OU III soil and sediment removal action

1998 (June)	OU III supplemental standards properties removal actions begin
1998 (September)	Interim Remedial Action ROD for OU III signed
1999 (January)	Draft Final Application for Supplemental Standards for Upper, Middle, and Lower Montezuma Creek soil and sediment
1999 (March)	Remedial design/remedial action work plan for OU III IRA finalized
1999 (May)	Final design of permeable reactive barrier
1999 (May)	Ground Water Management Area Implemented (ground water use restriction)
1999 (June)	Permeable reactive barrier installed
1999 (July)	OU III supplemental standards properties removal actions completed
1999 (August)	OU III IRA Annual Status Report
1999 (September)	Complete excavation of tailings from Millsite
2000 (January)	Final Covenant Deferral Request for Transfer of Federal Property
2000 (May)	Transfer of Former Millsite to City of Monticello
2000 (September)	IRA Progress Report (July 1999 – July 2000)
2001 (August)	IRA Progress Report (July 2000 - July 2001)
2001 (June)	Restrictive Easements on OU III supplemental standards properties finalized
2002 (September)	Permeable Reactive Treatment Wall Treatability Study Report
2003 (March)	Draft Remedial Investigation Addendum/Focused Feasibility Study
2003 (December)	Public Meeting and Presentation of Proposed Plan for OU III
2004 (January)	Submit draft final RIA/FFS for OU III
2004 (June)	ROD for OU III signed (Monitored Natural Attenuation with Institutional Controls)
2007	CERCLA 5-yr review for OU III; scheduled through attainment of OU III remediation goals
2045	Expected attainment of OU III remediation goals by natural attenuation

5.0 Performance Standards and Construction Quality Control

Formal performance standards were not established in the ROD for the IRA. Individual components of the IRA were implemented to meet task-specific standards however. For example, ground water and surface water monitoring were conducted to meet quality assurance/quality control measures for field and laboratory methods as identified in the project work plans, sampling and analysis plans, and quality assurance plans. Also, construction of the permeable reactive barrier was completed to design specifications as documented in DOE (1999d). Subsequent performance of the permeable reactive barrier in treating contaminated ground water has been thoroughly monitored and evaluated as summarized in Section 3.2. Through annual inspections, DOE ensured that the institutional controls implemented to reduce risk to human health remained effective throughout the IRA. Remediation of OU III supplemental standards properties, which was not an explicit component of the IRA for OU III, will be documented in a separate RAR by DOE.

6.0 Final Inspection and Certification

Numerous project reports referenced in this RAR provide documentation of the satisfactory completion of each component of the IRA for OU III. Of particular importance is the remedial investigation addendum and focused feasibility study (DOE 2004a) and the permeable reactive barrier treatability study evaluation (DOE 2002a). The final ROD for OU III (DOE 2004b), which selects monitored natural attenuation with institutional controls as the remedy for surface water and ground water, signifies the conclusion of the IRA for OU III. Final close out of OU III is contingent upon conditions established in the ROD for OU III in attaining ground water and surface water remediation goals.

7.0 Operation and Maintenance

Completion of the IRA for OU III involves no continued operation and maintenance activities not required and addressed by the final ROD for OU III. Radioactive contaminants (including radium 226) remain on several OU II properties and hazardous substances are also present in OU III Surface Water and Ground Water. Consequently, pursuant to CERCLA Section 121 (c), as provided in OSWER Directive 9355.7-02 Structure and Components of Five-Year Reviews (May 23, 1991), OSWER Directive 9355.7-02A Superfund Five-Year Review Guidance (July 26, 1994), the Monticello Site FFA (December 1988), and Executive Order 12580, DOE must conduct a statutory CERCLA Five-Year Review. CERCLA Five-Year Reviews were conducted in 1997 and 2002. The next CERCLA Five-Year Review report for the Monticello Mill Tailings (USDOE) Site will be completed prior to September 2007.

8.0 Summary of Project Costs

- Total direct construction cost of the permeable reactive barrier: $986,600. Detailed cost information in constructing the permeable reactive barrier is included in DOE (1999d).
- Direct costs to perform IRA ground water and surface water monitoring: approximately $120,000 per annum.
- No direct OU III costs for ground water treatment or implementing the ground water use restriction. Total actual cost to the Monticello project for ground water treatment was approximately 4.6 million dollars.

9.0 Contact Information

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