Mortandad Canyon Work Plan Presentation and Field Trip - September 29, 1997
Meeting Schedule

8:00 - 9:30 am

Presentation of Mortandad Canyon Work Plan Highlights

1.0 Introduction (10 minutes) (P. Longmire)

2.0 Background (15 minutes) (P. Longmire)
- 2.1 History of Mortandad Canyon
- 2.2 Environmental Monitoring and Regulatory Compliance
- 2.3 Sources of Potential Contamination within Mortandad Canyon
- 2.4 Mesa-Top Sources of Potential Contamination

3.0 Environmental Setting and Conceptual Model (30 Minutes)
- 3.1 Location , Topography, Surface Drainage
- 3.2 Climate
- 3.3 Geology (D. Broxton)
- 3.4 Surface Sediments (R. Koch)
- 3.5 Subsurface Sediment and Bedrock Core Sampling and Analysis (P. Longmire)
- 3.6 Surface Water Hydrology (R. Koch)
- 3.7 Hydrogeology (R. Koch)
- 3.8 Geochemistry of Surface Water and Groundwater in Mortandad Canyon (P. Longmire)
- 3.9 Biological Setting

4.0 Conceptual Model (10 minutes) (A. Stoker)

5.0 Technical Approach - See Canyons Core Document

6.0 Risk Assessment - See Canyon Core Document

7.0 Sampling and Analyses Plan for the Mortandad Canyon System (25 minutes)
- 7.1 Introduction (P. Longmire)
- 7.2 Sediment Sampling and Analysis Plan (S. Reneau)
- 7.3 Surface Water and Groundwater Sampling and Analysis Plan
- 7.4 Air Particulate Sampling and Analysis Plan
- 7.5 Biological Sampling and Analysis Plan

Appendix A Maps
Appendix B List and Status of PRSs
Appendix C Analytical Results for PRS No. 50-006(d) Sediment Samples
Appendix D Data for Wells, Boreholes, and Moisture Access Tubes in Mortandad Canyon
Appendix E List of Contributors.

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9:30 am - 3:00 pm Field trip to Mortandad Canyon including lunch stop

The field trip is scheduled to begin about 9:30 am and last until about 3:00 p.m., depending on the length and breadth of discussion at each stop. Participants are requested to bring drinking water, sturdy boots, and to be prepared to provide interaction at each stop. Lunch will be served to the invited participants at an overlook of Mortandad Canyon at planned stop no. 5.

Mortandad Canyon Field Trip Road Log
September 29, 1997
by
Richard Koch and Pat Longmire

Road Log in miles beginning at the main TA-48 parking lot.

0.0 **Start of Field Trip.** Begin at the parking area in front of building TA-48-1. TA-48 is located on an unnamed mesa on the south rim of Mortandad Canyon. Effluent Canyon heads at the east side of TA-48, and Twomile Canyon, a tributary of Pajarito Canyon is located south of TA-48.

Field trip participants should form a small caravan in as few vehicles as possible, for limited parking space is available at several of the stops. Please keep track of all participants in each vehicle so no one is accidentally left at a stop.

Proceed from TA-48 westward toward TA-3.

0.2 (distance in miles between log points)

0.2 Intersection with Pajarito Road. Turn Right

0.4

0.6 TA-59 on the Left, home of the Hydrology Section of ESH-18, and other Environmental Science and Health (ESH) groups.

0.2

0.8 Intersection with Diamond Drive. Turn Right and Proceed to the 1st stop light on Diamond Drive at Sigma Street.

0.1

0.9 Stop Light at intersection of Diamond Drive and Sigma Street. Turn right at the stop light and immediately make another right turn into the large parking lot near this intersection.

0.1

1.0 **Stop No. 1 The Head of Mortandad Canyon** (20 minutes)
Park in the parking lot on Diamond Drive east of the CMR building (TA-3-29) and south of the Material Science Lab (TA-3-1698). This stop will provide an understanding of the area at the head of the canyon and the sources of surface water into the canyon at this location, and some discussion of historical spills and releases.

The major contributor to flow into Mortandad Canyon is probably stormwater runoff. Discharges from NPDES outfalls provide a smaller volume of water, but a more regular water supply that support small riparian habitats and wetlands. On September 18, 1997, the outfall from the CMR building was flowing approximately 2 gpm and the outfall from the Sigma Building (TA-3-66) was flowing about 5 gpm.

About 0.4 miles down the canyon is an old breached earthen dam (about 20 to 25 ft high) that was probably built by early settlers in an attempt to catch runoff for livestock use. About 0.7 mile down canyon and north of TA-48, is a slight decrease in channel gradient where some alluvium is

present and where former outfalls from TA-48 discharged into Mortandad Canyon. A small wetland may still be present in the canyon north of TA-48. No significant levels of contamination is known to be present in the upper part of the canyon.

After stop no. 1, retrace route to TA-48 for stop no. 2

1.0 Stop light at the intersection of Sigma Street and Diamond Drive. Turn left at light onto Diamond Drive.

0.1

1.1 Intersection of Diamond Drive and Pajarito Road. Turn Left onto Pajarito Road.

0.6

1.7 Stop Light at intersection of Pajarito Road and TA-48. Turn left into TA-48. Continue on main road past the entrance to TA-48-1.

0.3

2.0 Intersection with road to building TA-48-45 at the southeast corner of the fence around TA-48-1. Turn left on the paved road, and drive to small parking lot at east side of TA-48.

The main road continues to the east to the west entrance to TA-55, near where seismic hazard borehole SHB-1 was drilled to 700 ft in 1991. This borehole encountered 140 ft of Cerro Toledo interval sediments (thickest section yet reported) between the Tshirege and Otowi Members of the Bandelier Tuff, drilled through the Guaje Pumice Bed, and bottomed in intermediate volcanic rocks. This hole was drilled with mud rotary tools and experienced a low percentage of core recovery. No saturated zones were reported.

0.1

2.1 **Stop No. 2 The Head of Effluent Canyon.** (20 minutes)

Park in the east parking lot south of building TA-48-45. Stormwater runoff and cooling water from TA-48 discharge to a wetland and then into the head of Effluent Canyon. Most of the flow from the NPDES outfalls has been rerouted to the sanitary sewer system, therefore, most flow into this wetland area has been or is scheduled to be curtailed. An RFI has been performed for three PRSs at this wetland area, two outfalls (PRS Nos. 48-007[a and d]) and the wetland (PRS No. 48-010).

The RFI for these PRSs is currently ongoing, some metals (primarily chromium) have been observed in concentrations above UTLs in the head of Effluent Canyon below the wetland. An expedited cleanup was performed at a mercury spill, PRS No. 48-002(a and b), at the south side of building TA-48-1 in 1996. Sampling of the area down gradient of the spill and of the wetland has shown that mercury was not transported off site of the PRS area, and elevated concentrations of mercury have not been observed in the wetland.

Other NPDES outfalls from TA-48 cooling towers discharged northward directly into Mortandad Canyon. Flow from these outfalls is also being rerouted to the sanitary sewer system. A shallow monitor well (MCO-0.6) is planned in Mortandad Canyon at the northeast side of TA-48, approximately due north from this stop. This monitor well will be installed in the alluvium and will be designed to sample alluvial groundwater in upper Mortandad Canyon, above the Effluent Canyon Confluence and below the TA-3 and TA-48 outfalls that discharge into upper Mortandad Canyon.

To continue the field trip return to Pajarito Road and proceed eastward to TA-35.

0.3

2.4 Stop light at TA-48 road and Pajarito Road. Turn left onto Pajarito Road. TA-55, with the security fence and security cameras, is on the left side of the road.

0.6

3.0 Stop Light at Pajarito Road and Pecos Drive and TA-35. Turn left onto Pecos Drive. The entrance to TA-55, the Plutonium Processing Facility, is on the left, stay on the main road and curve around to the east.

0.2

3.2 On the left a new white metal building is located north of TA-55 at the former site of TA-42, which was an incinerator facility that operated for a short time in the early 1950s. The incinerator was designed to burn radionuclide-contaminated wastes generated at the Laboratory. The facility was completed in 1951 and operated for a short time in 1951 and 1952. Because of the poor performance of the incinerator and due to operational problems, very little waste was actually incinerated at the site. From 1957 until 1969, the Incinerator Site facility was used for storage and decontamination of contaminated equipment (e.g., dry boxes and vehicles). The RFI of PRSs at former TA-42 is ongoing based on NODs received for the RFI report.

An NPDES cooling water outfall discharges at the north fence of TA-55 west of the parking lots at the northeast side of the facility. The water flows in an open channel from the fence northward into Effluent Canyon.

TA-50 is located on the right

0.1

3.3 Entrance to TA-35 through the open Security Gate.

The entrance to TA-50, the Radioactive Liquid Waste Treatment Facility (RLWTF) is located on the right. This plant began operation in 1963, and receives radioactive liquid wastes for processing from TA-55, TA-3, TA-48, and TA-21 via buried pipelines. In 1996 the facility removed 99.56% of the activity from the waste. The resulting solid waste is mixed with concrete and removed to TA-54, and the resulting low level liquid effluent is discharged to Effluent Canyon via a buried pipeline. The waste water effluent is released in batches of 20,885 gallons each time a release is performed. The effluent is released at an average flow rate of 720 gallons per minute, which takes approximately 30 minutes to discharge a batch. See Chapter 2 of the Mortandad Canyon Work Plan for more information about the effluent discharges.

Building TA-35-213 is the first building on the left, which is behind a security fence.

0.1

3.4 Turn left turn onto a small gravel road at the east end of the security fence around building TA-35-213. This is the access road into Effluent Canyon. The TA-50 outfall pipeline is buried under or adjacent to this road. Before building TA-35-213 was built in the 1970s, the outfall pipeline extended straight from TA-50 to the outfall area. When the building was constructed, the outfall

pipeline was rerouted around the east side of building 35-213 and this access road was constructed.

0.2

3.6 **Stop No. 3 Effluent Canyon - Mortandad Canyon confluence and the TA-50 outfall.** (50 minutes) Park in lower Effluent Canyon near the TA-50 outfall. Space is limited, so plan your turnaround. This stop will include a short hike down Effluent Canyon past monitor wells MCO-2, MCM-2.2, MCM-2.8, the famous (or infamous) TA-50 outfall, gaging station GS-1, and with a little more hiking, perhaps MCO-3 and the planned location for R-13.

About 200 yd. up Effluent Canyon from the TA-50 outfall is the NPDES outfall from TA-55. On September 18, 1997 this outfall was flowing about 8-10 gpm.

Low-level effluent has been released since 1963 at the TA-50 outfall. Future plans for treatment of the radioactive liquid wastes at TA-50 will be discussed (Dave Moss). FU-5 conducted preliminary RFI sampling at the TA-50 outfall (PRS No. 50-006[d]) in 1993, and the results are summarized in chapter 3 of the Mortandad Canyon work plan.

GS-1 is located in Mortandad Canyon downstream from the confluence with Effluent Canyon. Gaging station measurements are discussed in Chapter 3 of the work plan. Note the local geology and stratigraphy at the confluence of Mortandad Canyon. The top of Unit 2 of the Tshirege Member of the Bandelier Tuff is present on the bench area near the TA-50 outfall, where the vehicles will be parked. The stream channel at the confluence and at gaging station GS-1 is incised into Unit 2.

A new gaging station, GS-1.3 is tentatively planned to be installed in Mortandad Canyon below monitor well MCO-3 to determine the amount of seepage into the bedrock between GS-1 and GS-1.3. This gaging station will need to be installed directly onto bedrock in a part of the canyon that is nearly inaccessible, and may not be practical to install.

A test hole to the regional aquifer, R-13, is planned to be drilled at the end of the road/trail near well MCO-3. This borehole will be drilled from the Unit 2 bench south of the Mortandad channel to assess possible impacts to the bedrock and to the regional aquifer from the TA-50 outfall.

Continue the field trip by returning to Pecos Drive at TA-35 and turning left (east) on Pecos Drive to the east end of TA-35.

0.3

3.9 Intersection of Effluent Canyon Road and Pecos Drive. Turn left (east) and drive east on Pecos Drive to the front of building TA-35-2.

0.3

4.2 Building TA-35-2. Turn right at the building and drive around the west end of the building, turn left and proceed along the south side of building TA-35-2 toward the east. The new asphalt and curb from the center of the building eastward were recently installed after removal of underground waste lines that connected from building TA-35-2 to the former phase separator pit, TA-35-3, which was removed in 1996.

0.1

4.3 East side of building TA-35-2. This is the former location of the phase separator pit (TA-35-3) and the air filter building (TA-35-7). These former structures date back to 1951 and were removed, decommissioned and decontaminated (D&D) in 1996. The new asphalt and gravel areas east of building TA-35-2 are the former locations of these structures.

0.1

4.4 **Stop 4. The Head of Pratt Canyon and Ten Site Canyon at the east end of TA-35**. (20 minutes) The former TA-35 waste water treatment plant and outfall site are located at the head of Pratt Canyon. Elevated activity in the soil is still present below the location of the former outfall. Geomorphic mapping and sampling of this waste receiving canyon (PRS No. 35-003[r]) is currently being performed for the RFI by FU-4 personnel.

Borehole 35-2028 is located in Pratt Canyon near this stop. This hole was drilled in 1994 to a depth of 299 ft. Elevated beta/gamma radiation measurements were found to a depth of about 11 ft in the weathered tuff from the historic discharges into the canyon. The Cerro Toledo interval was 78 ft thick at this location, and contained two zones of elevated moisture content, one of which was in an andesitic boulder conglomerate (Tshicoma Formation?). The hole bottomed at the top of the Otowi Member. Elevated activities of tritium were not observed in the Cerro Toledo interval in this borehole

Upper Ten Site Canyon heads at the east side of TA-50 near this stop, where accidental releases occurred in the 1970s. The spills were cleaned up in the 1970s and the outfall sources were D&D in the 1980s. FU-5 conducted the RFI and performed an Interim Action(IA) in the area near the head of Ten Site Canyon (PRS No. 50-006(a).

Borehole EGH-LA-1 is located on Sigma Mesa, north across Mortandad Canyon from of this stop. This borehole was drilled in 1979 as a geothermal test hole to a total depth of 2292 ft into Santa Fe Group sediments. This hole did not encounter the intermediate volcanic rocks beneath the Guaje Pumice Bed that were found in borehole SHB-1, but instead, 185 ft of Puye Formation fanglomerate sediments above basalts of the Cerros del Rio volcanics. Two casing strings were set: 36-in. diameter to 85 ft, and 30-in. diameter to 1627 ft. This hole was plagued by lost circulation and large volumes of water, drilling mud, lost circulation materials, and cement were pumped into the hole, usually without return circulation to the surface. The hole was abandoned after loosing an unknown length of drill stem, drill collars, and the bit in the bottom of the hole. The hole was cemented up to about 1425 ft, but cement would not circulate to the surface.

Continue the field trip by returning to Pajarito Road and turn left at the stop light onto Pajarito Road.

0.9

5.3 Stop Light at intersection of Pecos Drive and Pajarito Road. Turn Left. After turning, notice the south side of TA-50 on the left where large storage holding tanks are located. The fenced area on the left is MDA-C, and old landfill site and the subject of an RFI by FU-5.

0.3

5.6 Intersection with Pajarito Road and Puye Drive, the turn to TA-63, TA-52, and Mortandad Canyon. Turn Left and proceed eastward on Puye Road past TA-63 and TA-52.

0.3

5.9 Stop sign at TA-52. Continue eastward. Ten Site Canyon is present along the north side of this mesa. Canada del Buey heads in a canyon at the south side of TA-52, however east of TA-52, near well PM-5, drainage to the south side of this mesa is into an unnamed tributary canyon to Mortandad Canyon.

0.2

6.1 End of pavement.

0.1

6.2 Intersection with a small trail on the left at an old fence line. Turn left into Ten Site Canyon.

0.2

6.4 Hairpin curve to the right. The old TA-35 sewage lagoons are located across the Ten Site Canyon Channel. The confluence of Pratt Canyon and Ten Site Canyon is opposite of the hairpin curve at the southwest corner of the sewage lagoons. Proceed to the east and cross the Ten Site Canyon channel at the southeast side of the sewage lagoons.

0.1

6.5 Quarry east of the sewage lagoons. Turn toward the east and proceed along the trail through the quarry. The quarry is in Unit 3 of the Tshirege Member. The material was probably used for constructing the sewage lagoons.

Sand filter beds are located south of the quarry and along the north side of the Ten Site Canyon channel. These filter beds were constructed to provide clarification of the sewage effluent and are composed of four beds that contain layers of different sizes of quartzite cobbles, pebbles, and silica sand. During operation, the filter beds had to be cleaned out regularly to prevent buildup of algae, and used filter bed material is scattered around the area. Some of the used and unused filter bed materials are present in the floor of the quarry along the trail.

This sewage treatment system operated from 1975 through 1992. Operational records show that an average of 40,000 gallons per day were discharged into Ten Site Canyon. This flow never reached Mortandad Canyon, a distance of about 3500 ft downstream.

0.3

6.8 Crossing under power lines. The planned location of well R-14 is in the relatively flat area to the north just before the power lines. Mortandad Canyon is on the left (north) of this mesa, and Ten Site Canyon is on the right (south).

0.4

7.2 **Stop 5. Mortandad Canyon Overlook at the East end of Ten Site Mesa. Lunch Stop.** (50 minutes) An excellent view of the Mortandad Canyon - Ten Site Canyon confluence is afforded from this vantage point. Numerous monitor wells in Mortandad Canyon can be seen, including the MCO-6 series wells to the north, and the MCWB wells with the white instrument cabinets in the confluence area. The clean-out piles near the sediment traps can be seen down the canyon.

The stratigraphy of the area will be discussed as it relates to the conceptual model of alluvial groundwater and contaminant migration. Boreholes MCM-5.1 and MCM-5.9A were drilled near this location, and the results of the analyses of core from these and other holes will be discussed.

The geochemistry of the alluvial groundwater observed between wells MCO-6 and MCO-7 suggests the possibility of mixing with water from unknown sources may occur near the confluence. Recent Low-level activity measurements of the groundwater using TIMS also suggest this possibility.

Regional aquifer well R-14 is planned to be drilled on the mesa about 0.4 mile west of this location. This location is approximately 350 ft due south of monitor well MCO-4. This well is designed to supplement TW-8 for monitoring the regional aquifer, and is located upgradient to production well PM-5 to provide early warning of possible contamination in the regional aquifer. Analysis of core samples from this hole will also provide an indication of the extent of lateral movement of contaminants away from Mortandad Canyon.

Regional aquifer well R-15 is planned to be drilled in lower Mortandad Canyon east of the sediment traps. This well will be drilled near the south side of the canyon floor so as to not intersect the contaminated alluvial groundwater, to prevent accidental contamination of the regional aquifer. This well is located at the approximate center of the paleotopographic low in the Guaje Pumice Bed that extends from north to south. Saturation observed in the Guaje Pumice Bed beneath Los Alamos Canyon may flow along this paleotopographic low and may be present beneath Mortandad Canyon. This borehole will be continuously cored and will provide information about the hydrologic characteristics of the bedrock units, and about contaminant migration beneath Mortandad Canyon.

Lunch will be served a la discussions of aqueous geochemistry.

After the stop, return to Puye Road to continue the field trip.

0.9

8.1 Intersection of Ten Site Canyon Road with Puye Road. Turn left.

0.3

8.4 Crushed tuff storage area on the left. This was an early firing site at TA-4 during the 1940s.

0.2

8.6 Municipal and Industrial Well PM-5 is on the right side of the road. This well was drilled in 1982 to a depth of 3110 ft. The water level of the regional aquifer was originally 1208 ft. In 1993 the non-pumping water level was 1224 ft, and the pumping water level was 1321 ft. The well pumps at about 1230 gpm and has a specific capacity around 12.6 gpm/ft.

From this point eastward the south side of this mesa drains into the unnamed tributary canyon to Mortandad Canyon. Ten Site Canyon is on the left (north) for the next 1500 ft, after which Mortandad Canyon is on the left (north) side of this mesa.

0.5

9.1 Two early firing sites at TA-5 were present on the north side of the road in the open weedy areas. These firing sites were where the first implosion tests were performed. The RFI for these PRSs is ongoing.

0.1

9.2 Intersection with trail to the right. Keep left on the main road into Mortandad Canyon. The trail on the right leads to a firing site that was used one time for a large shot. The firing sites at TA-5 were not used extensively because the shots rattled glassware in analytical laboratories at TA-21, causing a potentially dangerous situation.

1.2

10.4 Intersection with road in Mortandad Canyon. Keep to the left to drive westward into Mortandad Canyon. The field trip will proceed to the next stop at the upper (western) end of road accessibility in middle Mortandad Canyon and will then continue down-canyon. The "NO TRESPASSING" signs have recently been installed to prevent casual and recreational use of Mortandad Canyon as a result of radioactive contamination that is present in the sediments further up the canyon. Dose assessments associated with the sediments in Mortandad Canyon have been reported in recent Environmental Surveillance Reports.

0.4

10.8 An old settlers homestead site is located on the left (south) side of the road. Most of what is left is some scattered timbers, corrugated metal roofing, a fence enclosure, and an open underground cistern. The cistern is 7 ft diameter and about 15 ft deep; it apparently collected rain water from the corrugated roofing. No evidence has been found to indicate that alluvial groundwater in Mortandad Canyon was ever used for domestic or agricultural purposes.

0.1

10.9 Monitoring well MCO-9 is located to the right (north) of the road. This well has never contained alluvial groundwater, but is probably too shallow to effectively monitor alluvial/Cerro Toledo interval groundwater. Since the sediment traps were installed, this is the approximate easternmost extent of continuous surface water flow in the canyon. Recently installed water balance wells MCWB-9A and MCWB-9B are located north of MCO-9. The 23 water balance wells in the canyon all have white equipment cabinets installed over the well casing.

0.3

11.2 The three MCWB wells to the right (north) are MCWB-8.1-A, -B, and -C. This area is approximately the easternmost extent where alluvial/Cerro Toledo interval groundwater has been observed.

0.3

11.5 The fenced area on the right (north) is the former Mortandad Canyon garden plot where studies were conducted in the 70s to determine the amount of radionuclide uptake in vegetables. The fence was constructed to keep deer out of the garden. No residual contamination associated with this garden plot has been detected. Water balance well MCWB-7.2 is located nearby, and Sediment Trap No. 3 is located on the north side of the canyon bottom. The solar panels supply power for one of the evapotranspiration (ET) monitoring towers that is the strange looking metal tree-like structure located nearby.

0.1

11.6 Monitor wells MCO-7 and MCO-7A are located to the right (north) side of the road adjacent to sediment trap no. 1. Sediment trap no. 1 was cleaned-out in 1991. The large pile near the road is the clean-out material.

0.1

11.7 The canyon to the left is Ten Site Canyon. The small dip in the road may be the main channel from Ten Site Canyon, although surface water flow from Ten Site Canyon into Mortandad Canyon is apparently very infrequent, and has not been documented. Two gaging stations were established in lower Ten Site Canyon in the 1960s, but no flow was recorded at either station. The lunch stop was on the point overlooking this confluence.

0.1

11.8 Monitor wells MCO-6, MCO-6A, MCO-6B, MCWB-6.2A, -B, and -C are located to the right (northeast) of the road. The road through this part of the canyon is lower than the surrounding alluvium, and was probably the main flow conduit during a 1987 storm event. The stream channel was diverted to the north side of the canyon floor after this flood to prevent the road and the monitor wells from washing out.

0.2

12.0 Old gaging station GS-3 is in the channel adjacent to the road. No published records of stream flow data from this gaging station have been located. The road crosses the Mortandad Canyon stream channel upstream from this old gaging station. Core hole MCM-5.1 is located on the right (north) after crossing the stream channel.

0.1

12.1 **Stop 6. Middle Mortandad Canyon at TW-8 and MCO-5.** (40 minutes)
Park the vehicles at TW-8, which is located within the fenced enclosure. This well was drilled with cable tools in 1960 to a depth of 1065 ft, which is about 100 ft into the regional aquifer. The construction of TW-8 and the recent monitoring data with regard to possible contaminant pathways will be discussed. Notice the berm along the stream channel in this area to prevent flooding of the area around TW-8. Also note the vapor phase notch on the north wall of the canyon about 6 ft above the canyon floor. This alteration/weathering affect in the tuff is the contact between units Qbt 1g below and Qbt 1v above the notch. Water balance well MCWB-5 is located near TW-8.

Monitor well MCO-5 is located a short distance upstream (west) from TW-8. Here the canyon narrows considerably, and the seasonal fluctuations in the level of the alluvial groundwater are the greatest.

With some walking upstream (west), MCO-4 and old gaging station GS-2 can be seen, where down-cutting and erosion of the stream channel within the last decade can be observed. Both the well and the gaging station were eroded by flood waters in 1987. Since about 1991 well MCO-4B has been sampled as a substitute for MCO-4 for the environmental surveillance sampling.

Water balance well MCWB-4 is located at the present-day end of the road. This well has been peculiarly dry at most times when the water level has been checked. It has been postulated that this well may have been installed in a large boulder within the alluvium, and therefore the well does not respond to normal alluvial groundwater fluctuations.

Bandelier Tuff characterization well MCBT-4.4 is planned to be located as far up-canyon as possible. This borehole is planned to be drilled through the alluvium, the Bandelier Tuff and the Guaje Pumice Bed to determine the hydrologic characteristics of the tuff and the vertical extent of contaminants.

Borehole MCM-5.1 is located east of TW-8 near the stream crossing. Core samples from this hole and from holes MCM-59A, MCC-8.2, and SIMO, were analyzed for hydrologic properties, radionuclides, and RCRA constituents. A comprehensive discussion of the results is presented in Section 3.5.3 of the Mortandad Canyon Work Plan. The results show that tritium has migrated to at least 180 to 200 ft depth beneath Mortandad Canyon, but because this was the maximum depth drilled, the extent of the tritium migration was not determined. The Bandelier Tuff characterization wells are planned to further obtain hydrologic properties of the tuff and Cerro Toledo interval, and to determine the extent of tritium and other contaminant migration.

After this stop, retrace the route down-canyon (eastward) for more stops in the lower canyon.

0.2

12.3 Water Balance Wells MCWB-6.2-A, -B, and -C are on the left (northeast) side of the road. Across the bottom of the canyon is where the stream channel diversion discharges to the flat canyon floor. A recent thunderstorm event (1.3 inches of rainfall) caused surface flow from the upper and middle part of the canyon to extend as far as the end of the diversion channel. The flow infiltrated within about 100 ft from the end of the diversion channel. Local rainfall from the area of the confluence with Ten Site Canyon gathered in the stream channel below the confluence and created a small amount of flow through gaging station E999, located above the sediment traps. A small amount of this locally derived flow entered sediment trap no. 1, but infiltrated before ponding in the trap.

0.2

12.5 **Stop 7. Mortandad Canyon Sediment Traps** (20 minutes)

The first sediment traps installed in 1974 were 24-in. diameter shafts drilled 20 ft deep in the stream channel. The sediment shafts were filled with gravel to maintain the stability of the shaft. These quickly filled with sediment, and in 1976, two pond-like sediment traps were dug adjacent to the stream channel to catch contaminated sediments and to promote infiltration of surface water and to prevent migration of contaminated sediments down stream. These too soon filled with sediment, and in 1986, three larger sediment traps were constructed. These new sediment traps were cleaned out and enlarged in 1991. Two clean-out piles and present near sediment trap no. 1. Characterization of the sediment traps (PRS No. 00-001) is planned in the Mortandad Canyon Work Plan, which includes the old shafts, old traps, new traps, the berms around the traps, and the clean-out piles.

The preliminary RFI sampling of the modern sediment traps showed that the activities of the plutonium isotopes in the samples from the surface of the sediment traps averaged over 100 times higher than the activities at 2-3 ft depth. The activities of the plutonium isotopes in the samples from 2-3 ft depth were 5 to 10 times elevated with respect to background activities (see Section 3.4.4.2.4). However, the highest activity of radionuclides were found in the old sediment traps at all depths samples.

The alluvial groundwater beneath the sediment traps is at approximately 50 ft below ground level. In November 1996 groundwater elevation measurements were obtained that showed a 30 ft drop in the water level in the area between sediment trap nos. 1 and 3. This has been postulated to be the area where perching of the alluvial groundwater on the Tshirege Member may end as a result of erosion of the perching unit. The Cerro Toledo interval is beneath the Tshirege Member, and is composed of tuffaceous beds and alluvial sediments, similar to the alluvium. The alluvial groundwater may recharge the Cerro Toledo interval at this location, and perching may be present about 30 ft lower in the Cerro Toledo interval (see Section 3.7.2 of the Mortandad Canyon Work Plan). Perching in the Cerro Toledo interval may be due to the presence of low-permeability, clay-rich soil horizons.

It has, however, been observed that higher perching layers are present within the alluvium east of the sediment traps. When monitor wells MT-1, -2, and -3 wells were drilled in 1988, perched alluvial groundwater was present much higher in the alluvium than was previously observed in the area at monitor wells MCO-7.5, MCO-8 and MCO-8.2. The MT wells were drilled after the sediment traps filled with water in 1987, after which water that infiltrated into the alluvium may have been perched within the alluvium for a time. The sediment traps did not contain water in 1996 due to low precipitation conditions, and therefore the groundwater measurements obtained in November 1996 may represent low-water conditions.

Two new characterization/monitor wells are planned in the sediment trap area to investigate the alluvium and the Cerro Toledo interval and any hydraulic connection between these units. Well MCO-6.8 will be drilled west of the sediment traps, and well MCO-7.2 will be drilled east of the sediment traps. Field Unit 4 personnel will carefully document the alluvium/bedrock contact and any perching layers present, and document the presence of groundwater in the alluvium and Cerro Toledo interval.

0.3

12.8 Stop 8. MCO-8 line of monitoring wells (15 minutes)

This line of monitor wells includes six moisture access tubes (MCM-8A to -8F), MCO-8 and -8A wells and MT-2, MT-3, MT-4. Additionally, wells MCO-8.2, MCC-8.2, MCWB-7.4A and -B, and MCWB-7.7-A and -B are located nearby. This is the easternmost extent of where alluvial/Cerro Toledo interval groundwater has been observed. Monitor well MCO-8.2 was the easternmost monitor well that contained perched groundwater. Water levels were recorded in this well for about 6 years during the 1960s until the well silted in and apparently went dry. The water levels in this well never fluctuated more than about 1 ft, unlike other monitor wells up-canyon, suggesting the possibility of a separate saturated hydrogeologic unit within the Cerro Toledo interval.

When monitor well MCO-8 was drilled in 1960, the water level in the hole rose a few feet after penetrating a confining layer, indicating slightly artesian conditions at this location. The number of borehole penetrations in this area has probably reduced the effectiveness of any confining layer present.

Water balance wells MCWB-8.1A, -B, and -C were installed in late 1995. These wells are 72.5 to 80 ft deep and have always been dry (or trace of water). It is possible that these wells are not deep enough to encounter perched water in the Cerro Toledo interval. Monitor wells MCO-9 and MCO-9.5, located about 2000 ft and 3000 ft east of MCO-8, respectively, were probably installed too shallow in the alluvium/Cerro Toledo interval to encounter the perched groundwater, if indeed the perched shallow groundwater continues eastward. If the water is perched in the Cerro Toledo interval east of this area, whatever gradient is present in the Cerro Toledo interval will control the movement and direction of the shallow groundwater.

Core hole MCC-8.2 was drilled to a depth of 184 ft into the Otowi Member and samples of the core were analyzed for hydrologic properties, radionuclides and RCRA constituents. This well encountered shallow perched groundwater from about 73 to 76 ft, probably in the Cerro Toledo interval. The pore water exhibits water quality characteristics similar to the alluvial groundwater present in monitor wells up-canyon. The core samples obtained from the Otowi Member below the saturated zone were dry, but contained tritiated moisture at activity levels higher than those observed in the Otowi Member in core hole MCM-5.9A, possibly indicating higher rates of seepage into the bedrock units in this location.

Bandelier Tuff characterization hole MCBT-8.5 is planned to be drilled in the area east of core hole MCC-8.2 and monitor well MCO-8.2. This hole will characterize the Bandelier tuff through the

Otowi and the Guaje Pumice Bed and will investigate the presence of possible shallow or intermediate perched groundwater in this area.

0.5

13.3 Monitor wells MCO-9 and MCWB-9A and -9B on the left (north) side of the road, the settlers homestead is on the right. This part of lower Mortandad Canyon was cleared and used for farming. The farm fields are evident on areal photographs of the canyon obtained in 1935.

After the original sediment traps were installed in the 1970s, and before the modern sediment traps were installed in 1986, the furthest eastward extent of surface water flow documented in the Canyon was in the vicinity of monitor well MCO-9 (see section 3.6.1 of the Mortandad Canyon Work Plan).

0.4

13.7 Intersection with Mortandad Canyon access road. Keep to the left to visit sites in lower Mortandad Canyon. Monitor wells MCO-11 and MCO-12 are located in the center of the canyon near this road intersection. Since monitoring of the canyon began in 1960, and before the sediment traps were installed in the mid 1970s, surface flow from the upper canyon had extended as far downstream as about MCO-11 on July 31, 1968. Since the modern sediment traps were installed, surface flow has not extended more than about 600 ft east of the sediment traps. Between the sediment traps and the Laboratory boundary no well developed stream channel is present in the canyon (see Section 3.6.1 of the Mortandad Canyon Work Plan).

0.1

13.8 Intersection of trails, turn left.

Monitor well MCO-13 is located in the middle of canyon near this location. This well was found to contain water at a depth of about 105 ft in November 1996. The Cerro Toledo interval is probably present at this depth in this area. The water was sampled in early 1997, and the results are quite peculiar. The water contains 27 mg/L NO_3 (as N), similar to alluvial groundwater further up-canyon, but a concentration of SO_4 of 319 mg/L, about 3 time higher than Mortandad Canyon alluvial groundwater, and anomalous concentrations of Cd (0.23 mg/L) and Zn (2.6 mg/L). The tritium was less than detection limit (<370 pCi/L), indicating that the water does not appear to be associated with the alluvial groundwater further upstream in Mortandad Canyon, which typically contains over 10,000 pCi/L tritium.

When the water level was measured and a sample was collected from well MCO-13, the well had no cap or surface casing and was open to the atmosphere. Since the discovery of water in the well, Laboratory personnel have installed surface casing and a locking cap over the well.

Two alluvial/Cerro Toledo interval monitor wells are planned to be drilled in the area near well MCO-13. These wells will be drilled through the alluvium and the Cerro Toledo interval to document the stratigraphy present in the area and to investigate the possibility of shallow or intermediate perched groundwater in this area near the Laboratory boundary.

0.3

14.1 Cave Kiva and numerous cave dwelling are along the north wall of lower Mortandad Canyon.

0.1

14.2 **Stop 9. Gaging Station and monitor wells SIMO and SIMO-1 at the Laboratory boundary.** (15 minutes)

Gaging station E8313204 was installed on Laboratory property at the boundary in October 1993 and has never recorded flow.

In 1991 Monitor well SIMO was drilled on San Ildefonso land to a depth of 104 ft. (This well was originally called SIMO-1, but when the second well drilled on San Ildefonso land was also called SIMO-1, this well name was changed to SIMO.) This well has two screened intervals: one from 50-60 ft and another from 80-90 ft. When the well was drilled it was thought that the screened intervals were in the Tsankawi Pumice Bed and the Otowi Member, respectively. However, it is likely, based on the reinterpretation of the stratigraphy of the area, that both screen intervals are in the Cerro Toledo interval. Water has never been observed in the well, and is probably too shallow to intersect perched groundwater, if present in this area.

In 1992 monitor well SIMO-1 was drilled to a depth of 163 ft on San Ildefonso land. This well probably encountered the Otowi Member at about 118 ft depth; the alluvium/Cerro Toledo interval contact has not been determined in this area, but may be around 50 ft depth. The well was drilled by the BIA on behalf of the San Ildefonso Pueblo and was dry when drilled. The well is screened over multiple intervals, but the screen intervals were not reported.

In 1994 seven channel sediment samples were collected in lower Mortandad Canyon at sediment sampling sites A-5, A-6 (at the Laboratory boundary), A-7, A-8, A-9, A-10, and A-11 (at the Rio Grande) (see Figure A-2 in Mortandad Canyon Work Plan). The samples were analyzed by thermal ionization mass spectrometry (TIMS) to accurately determine the plutonium and uranium activity levels and atom ratios (see Section 3.4.4.2.1 of the Mortandad Canyon Work Plan).

The results of the analyses showed that combined $^{239+240+241}$Pu activity levels in sediments range from 0.06 pCi/g to about 0.0006 pCi/g. the $^{239+240}$Pu activity levels at all of the sediment sampling locations were within the range of regional background levels (0.023 pCi/g, Purtymun et al. 1987). Uranium activity levels ranged from 0.6 to 1.7 pCi/g, and ^{236}U was observed at two locations, A-6 and A-7, in concentrations slightly above detection limits (Gallaher et al. 1997).

The ^{240}Pu/^{239}Pu ratios at locations A-5, A-9, and A-10 were not discernible due to the ^{240}Pu activity levels near or below detection limits. The ^{240}Pu/^{239}Pu ratios at stations A-6, A-8, and A-11 indicated a possible Laboratory component of plutonium. The data indicate possible off-site migration of plutonium from Laboratory sources as far as State Route 4 in Mortandad Canyon. Because only trace levels of global fallout plutonium were observed from State Route 4 downstream to the Rio Grande, the Laboratory component of the plutonium at the Rio Grande sample location (A-11), is attributed to a source upstream from Mortandad Canyon, and is probably from Los Alamos Canyon (Gallaher et al. 1997).

End of the Field Trip