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1991 Annual Prelicensing Inspection of the Tuba City, Arizona, UMTRA Project Disposal Site

September 1992

U. S. Department of Energy
Albuquerque Field Office
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Grand Junction, Colorado

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1.0 Introduction

1.1 Purpose

The purpose of this report is to present the results of the U.S. Department of Energy's (DOE's) Uranium Mill Tailings Remedial Action (UMTRA) Project Office poststabilization, Annual Prelicensing Inspection of the Tuba City, Arizona, disposal site. This inspection was conducted on July 17 and 18, 1991, by C. A. Jones, Chief Inspector, and M. P. Pleasinger and C. S. Goodknight, Assistant Inspectors, of Chem-Nuclear Geotech, Inc., operating contractor at the DOE Grand Junction Projects Office (GJPO). Also present in oversight and consulting capacities were R. Edge and C. H. Persson-Reeves of the Jacobs/Weston Technical Assistance Contractor (TAC) at the DOE UMTRA Project Office. D. Lucero, representative of the Hopi Tribe, was present during the site inspection. R. Charlic, representative of the Navajo Nation, observed part of the inspection on July 18, 1991.

This inspection was the first poststabilization Annual Prelicensing Inspection (API) at the Tuba City disposal site. The inspection also fulfilled DOE requirements for the Verification and Orientation (V&O) Inspection. Requirements of the V&O Inspection are to (1) verify as-built and other features shown on inspection drawing(s) by visual comparison with features at the site and (2) orient the GJPO inspectors to the layout of the site and the location of the site's long-term surveillance and maintenance features. Both objectives of the V&O inspection were met during this API.

The procedures and specifications for this API are based on guidance provided in *Guidance for UMTRA Project Surveillance and Maintenance* (DOE, 1986a) and the draft *Surveillance and Maintenance Plan, Tuba City, Arizona,* (DOE, 1986b). The results of recent poststabilization groundwater quality sampling will be provided by the UMTRA Project Office in a separate annual report.

1.2 Site Description

The Tuba City site (Figure 1–1) is located in northeastern Arizona, approximately 5 miles northeast of Tuba City in Coconino County, Arizona. The site is located in Sections 17 and 20, Township 32 North, Range 12 East, Gila and Salt River Meridian, and is within the Bennett Freeze Order Area on the Navajo Indian Reservation. Land development and remedial actions within the Bennett Freeze Order Area, including such actions at the Tuba City disposal site, require the joint approval of the Navajo Nation and Hopi Tribe.

The site lies at an elevation of approximately 5,100 feet (Figure 1–2), on a gently sloping terrace approximately 6,000 feet northwest of Moenkopi Wash. Moenkopi Wash is an intermittent stream that drains southwest into the Little Colorado River. Surface drainage at the site is south and southeast toward Moenkopi Wash. The site occupies an area of 145.7 acres. The top of the tailings embankment is approximately 31 acres.

The terrain north and west of the site is gently rolling. The topography is controlled by active and partially stabilized windblown sand deposits and occasional outcrops of Navajo Sandstone. To the east and south, the terrain is more dissected because of erosion along the flank of Moenkopi Wash. South of the site, two broad alluvial terraces cut into the Navajo Sandstone. These terraces are modified by arroyos and capped by active and arrested

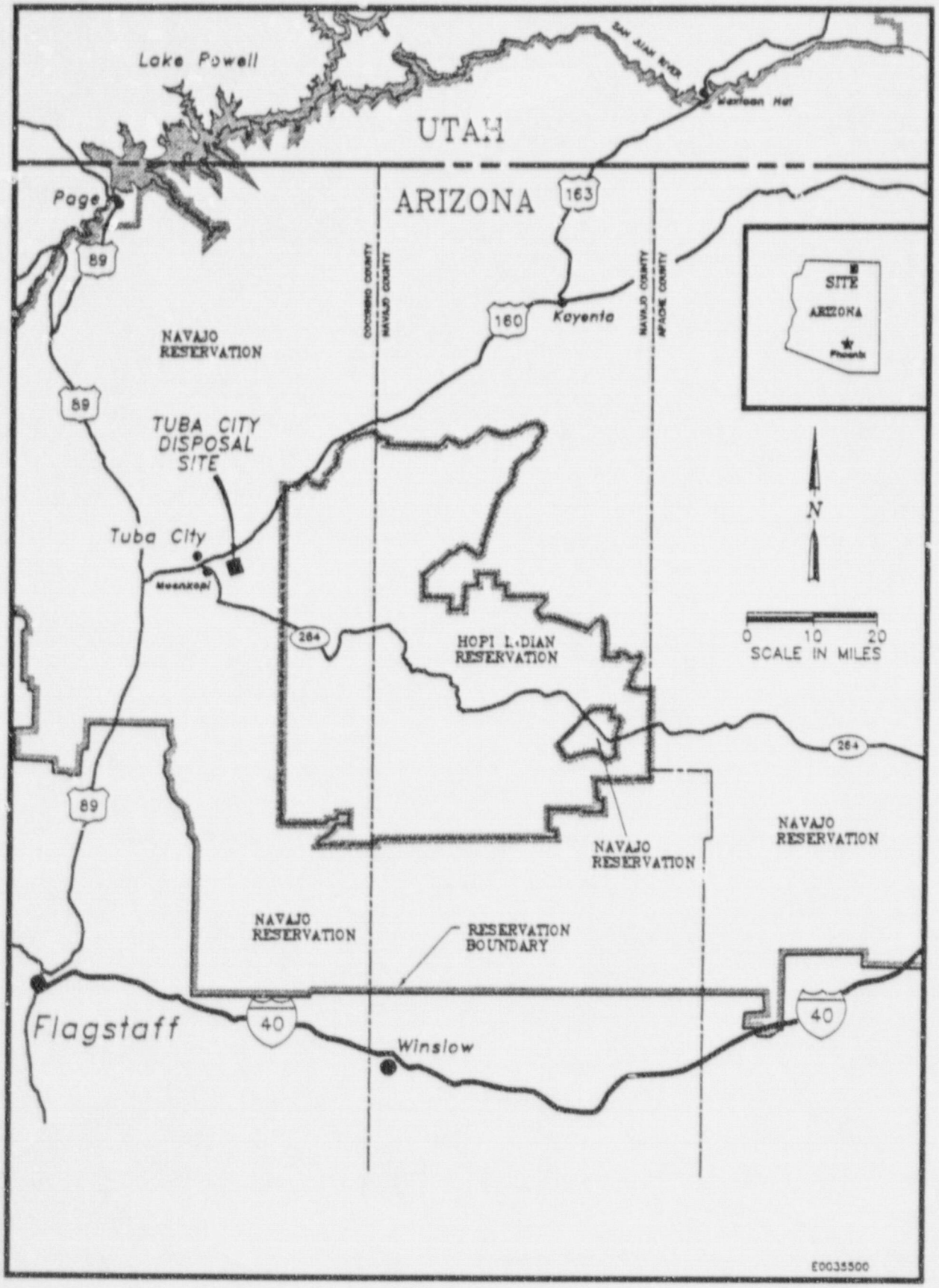


Figure 1–1. Location of Tuba City, Arizona, Disposal Site

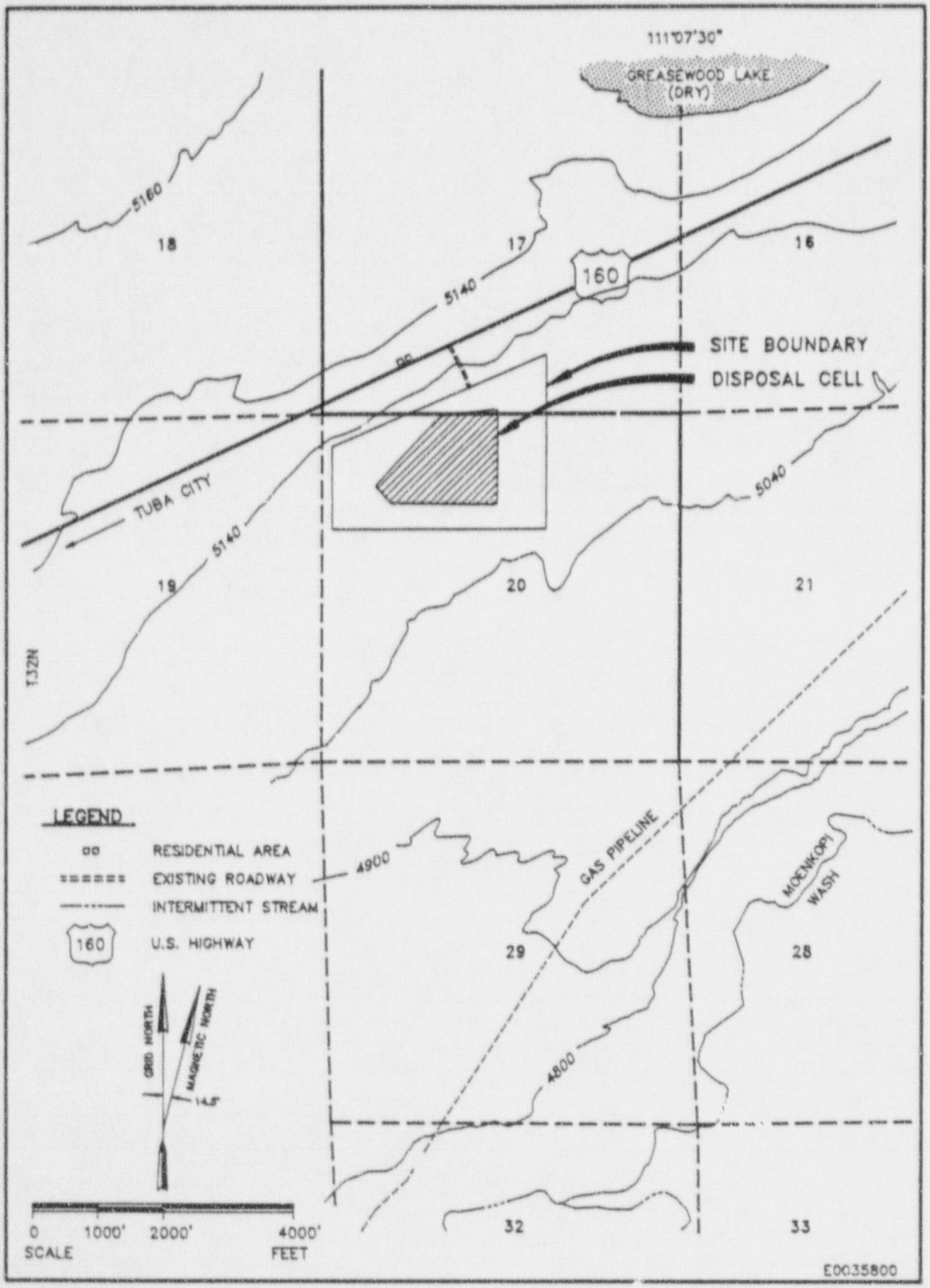


Figure 1–2. Selected Cultural and Topographic Features of Tuba City, Arizona, Disposal Site

windblown sand (dune) deposits. Although mostly covered by dune deposits, the Navajo Sandstone appears to be close to the surface throughout the area.

The area in the vicinity of the disposal site is semiarid and desert-like. Vegetation is sparse and land use is limited to grazing. A few, widely scattered, traditional Navajo hogans and camps exist near the site, but the area is generally sparsely populated.

1.3 Site History

Residual radioactive materials (tailings) from uranium milling operations are stabilized in a disposal cell constructed on the site of the old Tuba City uranium mill. Surface remedial actions under the direction of the UMTRA Project Office began in 1988 and were completed in 1990.

The Tuba City site is currently in poststabilization, prelicensing status. The site is expected to remain in this status until licensed by the U.S. Nuclear Regulatory Commission under provisions of U.S. Code of Federal Regulations, 10 CFR 40, for long-term surveillance and maintenance.

1.4 Site Access

The Tuba City disposal site is about 5 miles northeast of Tuba City, Arizona, on U.S. Highway 160 (Figure 1–1). The turnoff road is unmarked but easily recognized by the gate in the highway fence just north of the disposal cell. The disposal cell is about 600 feet south of U.S. Highway 160 and is accessible by a graded, unpaved road that runs directly to the gate in the site security fence. The site is easily recognized by the prominent mound of tailings covered with black rock. It is a local landmark.

There are two fences with locked gates between Highway 160 and the disposal site. The first gate is in the highway fence. The second gate is in the security fence that surrounds the disposal site. Keys to locks on both gates are held by the Hopi Tribe and the Navajo Nation. Protocol(s) for access and entry will be explained in the Long-Term Surveillance Plan being prepared by the UMTRA Project Office.

2.0 Annual Prelicensing Inspection

Methods used during the inspection and the results of the inspection are described under appropriate headings that follow. Supporting information is provided in Appendix A, Photo Log and Photographs; and Plate 1, Inspection Drawing of Tuba City Disposal Site.

2.1 Methods

The inspectors conducted the inspection by walking several transects across the site and one transect around the perimeter just outside the security fence. Outlying groundwater monitoring wells were also inspected. Monuments, site markers, monitoring wells, security fence and perimeter signs, settlement plate casings, as well as other features of the site were inspected. The location of specific features discussed below are shown on the Inspection Drawing (Plate 1). Specific site surveillance features are listed in Table 2–1; transects are illustrated in Figure 2–1.

Table 2–1. Specific Site Surveillance Features at the Tuba City Disposal Site

Identifier	Feature	Photo Location
---	Entrance Sign	PL–1
SMK–1	Site Marker 1	PL–2
SMK–2	Site Marker 2	PL–3
---	Perimeter Signs, 30 total	---
SM–1/BM–1	Survey Monument/Boundary Monument	PL–5
SM–2/BM–2	Survey Monument/Boundary Monument	PL–6
SM–3/BM–3	Survey Monument/Boundary Monument	PL–7
BM–4	Boundary Monument 4	PL–8
SP–1	Settlement Plate 1	PL–9
SP–2	Settlement Plate 2	PL–10
SP–3	Settlement Plate 3	PL–11
SP–4	Settlement Plate 4	PL–12
MW–906	Monitoring well, on site	PL–13
MW–914	Monitoring well, southeast cluster	PL–14
MW–915	Monitoring well, southeast cluster	PL–15
MW–916	Monitoring well, southeast cluster	PL–16
MW–909	Monitoring well, near-south location	PL–17
MW–908	Monitoring well, near-southwest cluster	PL–18
MW–912	Monitoring well, near-southwest cluster	PL–19
MW–913	Monitoring well, near-southwest cluster	PL–20
MW–903	Monitoring well, south cluster	PL–21
MW–920	Monitoring well, south cluster	PL–22
MW–921	Monitoring well, south cluster	PL–23
MW–904	Monitoring well, distant downgradient well	PL–24
MW–902	Monitoring well, distant downgradient well	PL–25
MW–917	Monitoring well, southwest cluster	PL–26
MW–918	Monitoring well, southwest cluster	PL–27
MW–919	Monitoring well, southwest cluster	PL–28
MW–901	Monitoring well, upgradient cluster	PL–30
MW–910	Monitoring well, upgradient cluster	PL–31
MW–911	Monitoring well, upgradient cluster	PL–32
MW–905	Monitoring well, east of site	PL–34

Equipment used during the inspection include a 35-mm camera, 2-foot scale with north arrow for showing scale and orientation of photographs, measuring tapes, Brunton compass, and notebook and forms for recording observations and photographs. Photographs were taken without filtration on color-negative film (Kodacolor ISO 100). Photographs are identified in the text of this report, in Appendix A, and on Plate 1 by photograph location (PL) number. Photo location numbers for all monitoring wells are shown in Figure 2–2.

2.2 Transects

To ensure a thorough and efficient inspection, the site was divided into small manageable units referred to as transects. Transects are areas of various size and shape. Within each transect, inspectors examined all as-built features, as well as other features of note or interest. Normally, the inspection of one transect is completed before proceeding to the next. Transects used during the inspection of the Tuba City disposal site are listed in Table 2–2 and shown in Figure 2–1.

Table 2–2. Transects Used During the Inspection of the Tuba City Disposal Site

Transect	Explanation
Top	The flat top surface of the disposal cell.
Northwest Side Slope	
North Side Slope	
East Side Slope	
South Side Slope	Includes a short southwest side slope segment.
Inner Diversion Channel	Flanks the disposal cell on the northwest and north sides. Includes two outlets, one at the lower west end of the inner diversion channel, the other at the northeast end of the channel.
Outer Diversion Channel	Upslope from the disposal cell and the inner diversion channel. Includes outlets at the lower west end and at the northeast end.
Graded and Reseeded Areas	Areas around the disposal cell and inner and outer diversion channels; graded to direct runoff to the south and southeast toward Moenkopi Wash; extend a short distance beyond site boundaries on the north, east, and south sides.
Security Fence	Essentially a site perimeter transect because the site boundary and security fence are coincident at the Tuba City site.
Monitoring Wells	Not considered a transect, per se, because the wells are scattered over a large area. However, areas around individual wells and well clusters were treated like transects in that the areas in the vicinity of the wells were examined at the same time the wells were inspected.

Twenty monitoring wells were included in this inspection. All but one are located outside the security fence. Some are a considerable distance, as much as 1 to 2 miles, from the site. These wells were not included in a separate transect but constituted small transects of their own. The area around each well, or cluster of wells, was inspected along with the monitoring wells.

2.3 Results

Results of the 1991 inspection are reported under two main headings: specific site surveillance features and transects. Although most specific features are within a transect, they are reported separately, by category, because (1) they are an important focus of the inspection

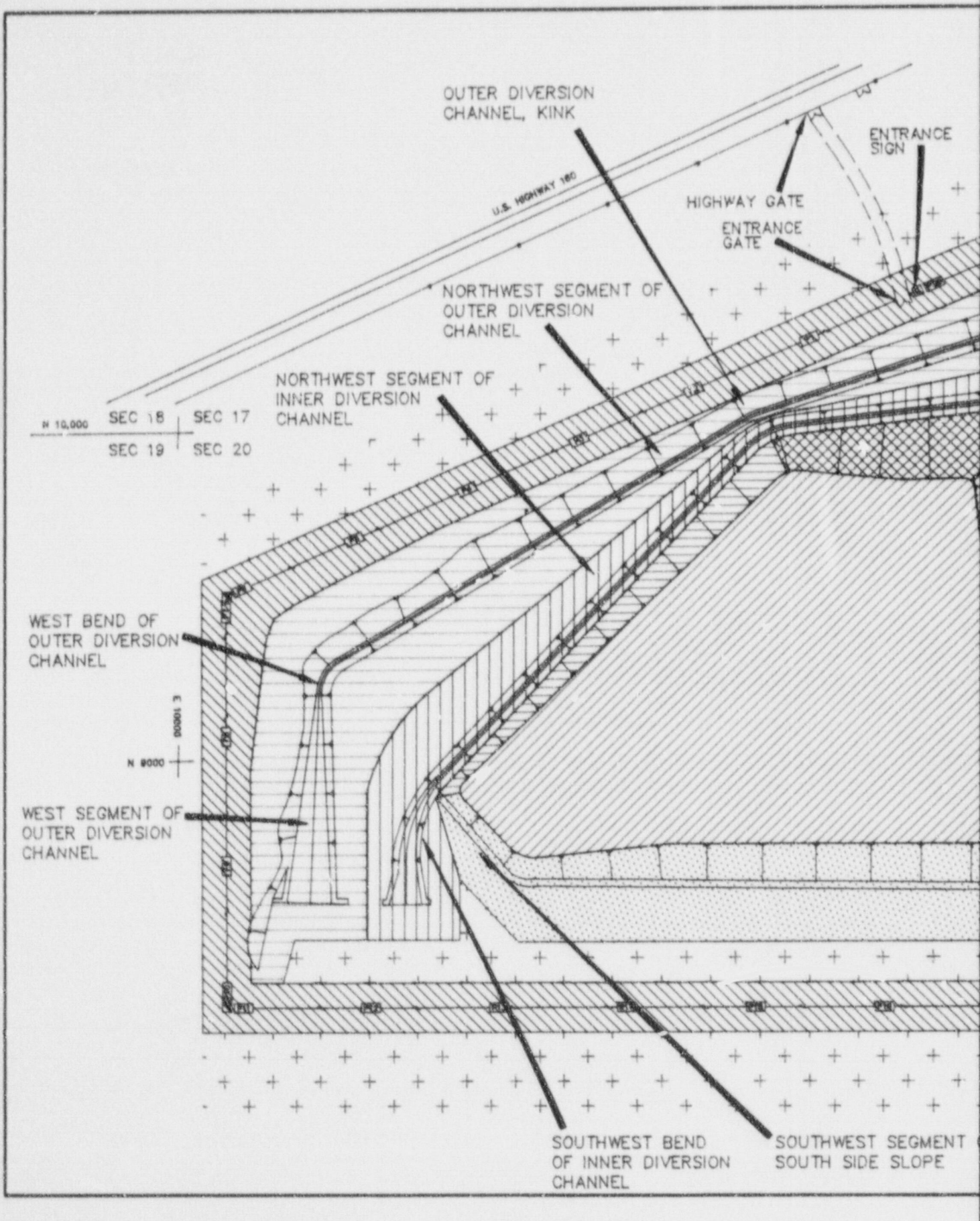
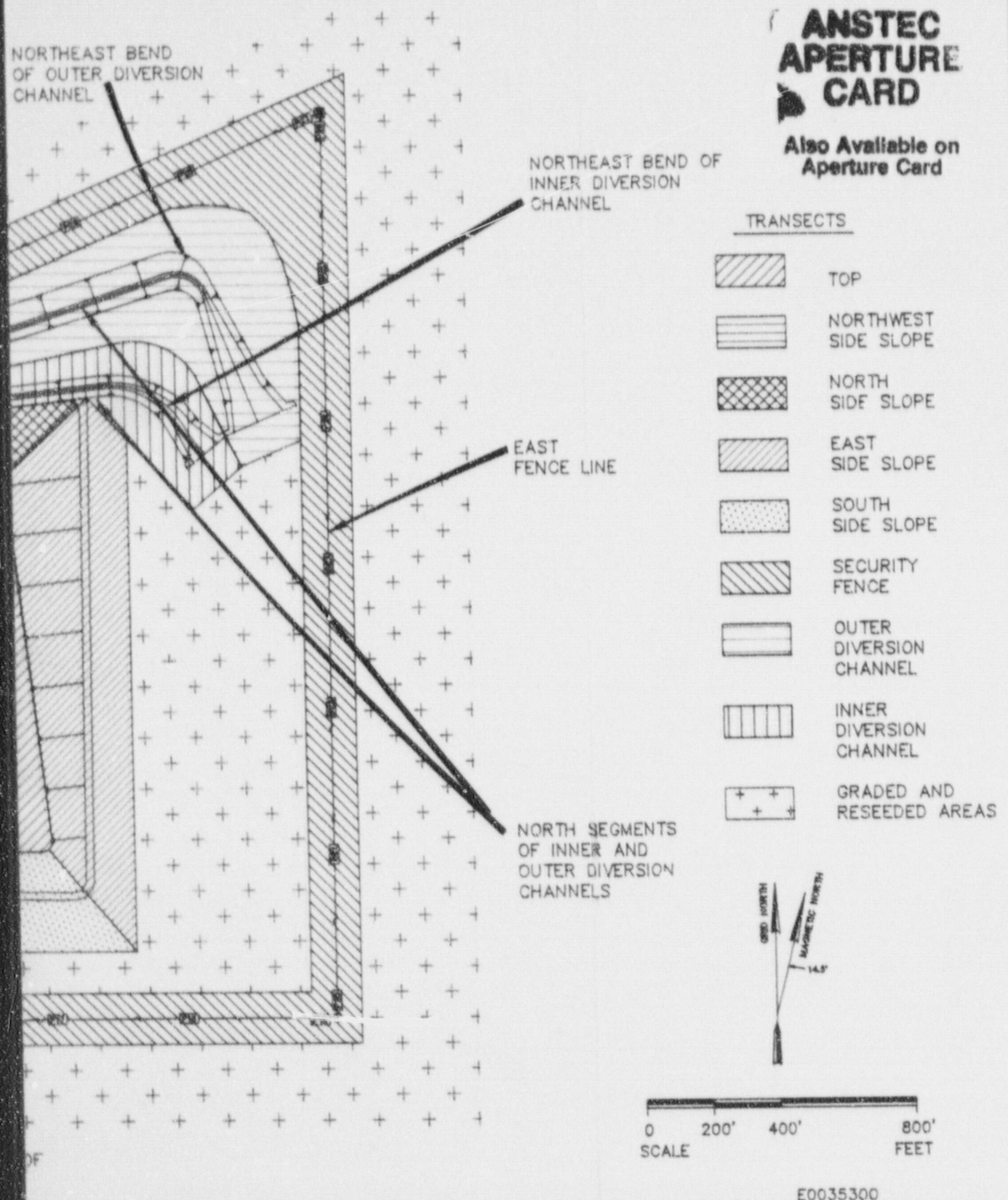


Figure 2–1. Map of Transects of T



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and (2) because reporting by category allows the performance of each type of specific feature to be evaluated separately as a group. The access road and specific surveillance features are discussed first, followed by a description of the condition of each transect.

Report of observations made during the inspection may include reference to specific photographs provided in Appendix A. Photographs are identified in the text, on Figure 2–2, in Appendix A, and on Plate 1 by a photographic location (PL) number. When more than one photograph was taken at a specific photograph location, photographs are identified by a letter suffix (e.g., 3A, 3B).

2.3.1 Access Road and Specific As-Builts

Following a description of the access road, specific surveillance features are discussed in the order presented in Table 2–1.

Access Road

The access road that leads to the site from U.S. Highway 160 is graded, graveled, and hard packed. It is in good condition.

Entrance and Perimeter Signs

There is one entrance to the site and one entrance sign (PL–1). The entrance sign is in place and undamaged.

Ms. Lucero, representative of the Hopi Tribe, called the inspection party's attention to the wording on the entrance sign. The sign includes the words "U.S. Government Property." She asked that the wording be changed to reflect tribal ownership of the site, which is on tribal land.

There are 30 perimeter signs in addition to the entrance sign at this site. All signs are set back 5 feet inside the security fence with information on the sign clearly readable from outside of the fence. Perimeter signs are shown by the symbol P on the inspection drawing (Plate 1). All signs are in place and undamaged.

Site Markers

There are two site markers at the Tuba City disposal site: SMK–1 and SMK–2. SMK–1 is located just inside the entrance gate (PL–2); SMK–2 is centrally located on the flat surface on top of the disposal cell (PL–3A). Both site markers are in excellent condition and show no sign of deterioration.

Site Marker SMK–1 is located at the entrance to the site and is oriented with the incised (engraved) face facing south. A visitor to the site cannot easily read the engraving from outside the fence because the engraving will appear upside down to the visitor. (This problem is not evident in the photograph [PL–2] of SMK–1.)

Survey Monuments and Boundary Monuments

Three survey monuments at the site also serve as boundary monuments: SM–1/BM–1, SM–2/BM–2, and SM–3/BM–3. These monuments are offset inside the security fence at the southwest, northwest, and northeast corners of the fence, respectively (PL–4, PL–5, PL–6A, and PL–6B). A fourth boundary monument, BM–4, is offset inside the fence at the southeast corner (PL– 7A). All are undisturbed and in good condition.

The inspection party experienced difficulty locating SM–3/BM–3 and BM–4 because of tumbleweeds trapped in the northeast and southeast corners of the fence line (PL–6C and PL–7B). The weeds had to be cleared before these monuments could be found and photographed. These monuments are in the downwind corners of the site where tumbleweed accumulation can be expected to be a continuing problem. Not only do these tumbleweeds hide survey and boundary markers, they are also unsightly and constitute a range fire hazard. These weeds should be periodically removed.

Because of the difficulty of finding survey and boundary monuments once they are buried by blown sand or hidden by tumbleweeds, measurements were taken at each corner to aid in locating these monuments during future inspections. Measurements are based on azimuth and distance from the corner posts or one or more of the adjacent fence posts in each corner. These measurements are shown on Plate 1.

Settlement Plates

There are four settlement plates at the site: SP–1, SP–2, SP–3, and SP–4. All are identified by orange-painted casings with hinged lids that enclose the settlement plates. All lids are secured with padlocks. All four settlement plates are on top of the disposal cell (top transect); SP–1 is located in the northeast corner of the top transect (PL–8); SP–2, SP–3, and SP–4 are located along the southern edge of the top transect (PL–9, PL–10, and PL–11).

Casings, hinged lids, padlocks, and concrete collars at the base of the casings are all in good condition. Because the hinged lids were locked, the interior of the casings and the settlement plates were not examined.

Monitoring Wells

Twenty monitoring wells were inspected (PL–12 through PL–31). Location of these wells is shown in Figure 2–2.

One monitoring well, MW–906, is within the disposal site (PL–12). The other wells are outside the site (Figure 2–2). Some of these wells are a considerable distance from the site. One well, MW–904, is approximately 1 mile from the site (PL–24); another well, MW–902, is approximately 2 miles away (PL–25). Some of the outlying wells are difficult to locate. A number of roads and tracks were used to reach the outlying wells. Some of these roads are steep where they cross arroyos and old terrace escarpments. Soft, loose sand is present on most, if not all, of the roads. A high-clearance, four-wheel drive vehicle is an advantage, if not a necessity, in reaching these wells. (An attempt will be made during the 1992 inspection to map the various roads and tracks used to reach the monitoring wells.)

The area surrounding each well was inspected for signs of erosion, human activity, or other phenomena that might jeopardize the well. Nothing was seen at any of the wells to cause

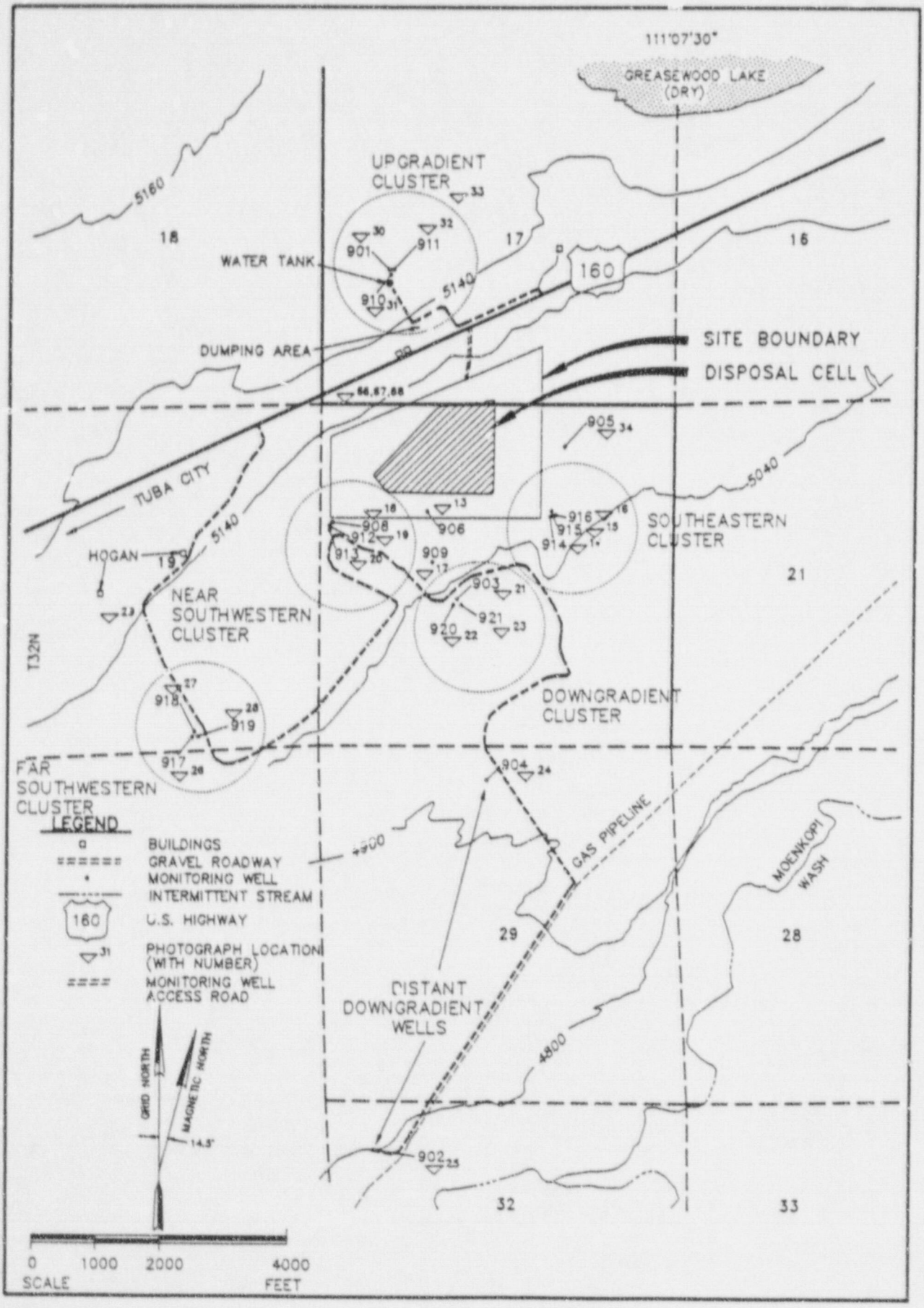


Figure 2–2. Groundwater Monitoring Wells for the Tuba City, Arizona, Disposal Site.

concern. The only wells that appear to be in an area of noticeable or frequent human activity are the upgradient wells MW-901, MW-910, and MW-911. These wells appear to be in an area frequented by livestock (PL-29, PL-30, and PL-31), but there was no indication that the presence of livestock or their owners had an adverse affect on the wells.

All wells were secured by a threaded cap or cap-and-pin system. All wells with cap-and-pin security had two padlocks, one on either end of the pin (e.g., MW-917 at PL-26). Three wells with threaded caps were secured by a single padlock (Table 2-3). Only the external conditions of the wells were examined. This examination included the condition of the steel casing, the cement collar at the base of the casing, the cap, and the padlock and pin, if present. All wells were in excellent condition.

Table 2-3. Inventory of Monitoring Wells by Type of Security.

Cap and Pin	Lock No.	Threaded Cap Without Padlock	Threaded Cap With Padlock	Lock No.
MW-910	3359	MW-901	MW-902	276
MW-911	3359	MW-903	MW-906	Not recorded
MW-912	3359	MW-904	MW-909	No lock number
MW-913	3345	MW-905		
MW-914	3359	MW-908		
MW-915	3359			
MW-916	3359			
MW-917	3359			
MW-918	3359			
MW-919	3359			
MW-920	3359			
MW-921	3359			

Two monitoring wells, MW-902 and MW-919, were found with open padlocks (PL-25 and PL-28). Both locks were operable. The inspection party closed the locks before leaving the wells.

2.3.2 Transects

Transects are listed in Table 2-2 and shown in Figure 2-1.

Disposal Cell Cover and Diversion Channel Transects

The disposal cell is covered with crushed basalt. Small-diameter material is used on top of the disposal cell, coarser material on the side slopes, and large diameter material in the diversion channels that protect the disposal cell on the west, northwest, and north (upslope) sides (Plate 1). Condition of the disposal cell cover is described by five transects; the inner and outer diversion channels by one transect each.

Top Transect. The top of the disposal cell (Plate 1) comprises approximately 31 acres. It was inspected by a series of north-south traverses, each spaced approximately 20 yards apart.

A panorama of the site taken from the location of SMK-2 is included in Appendix A, PL-3B through PL-3I. This panorama is a series of eight photographs, taken clockwise at 45-degree azimuth intervals. The panorama shows the expanse of the top of the disposal cell, its generally vegetation-free condition, and the nature of the topography and environment that surround the disposal site.

The top of the disposal cell is mostly free of vegetation. One solitary Russian thistle plant was noted in the southeast corner (PL-32). More plants may be present; but if so, they are too few, small, and far between to be of concern at this time.

At Tuba City, as at several other sites with rip-rap covers, small patches of fine-grained, typically sandy, material are occasionally seen in the riprap cover (PL-33 and PL-34). These patches of fine material consist of smaller diameter crushed rock, patches of sand and soil, or a mixture of small-diameter rock and sandy soil. These patches vary in area from a few square inches to a few square feet and are usually irregular in shape. The initial impression is that either an underlying layer of fine-grained material is showing through a thin spot in the riprap cover, or that the riprap was not properly sized when installed and contains fine-grained material that is out of specification.

All attempts to dig down through the finer material were thwarted by well-packed, coarser material of the proper size immediately beneath the finer material. The conclusion is therefore that the riprap is not significantly out of specification. These irregular patches are interpreted as nothing more than the presence of small accumulations of fine-grained material that almost always end up in the bed of the truck and slide from the bed as the last of a load is dumped. With proper-sized riprap immediately beneath the fine material, the small amounts of fine-grained material that appear at the surface of the riprap are not interpreted as significant deviations from material specifications.

These patches are, however, a matter of potential concern because they may hold moisture and provide rooting for plants propagated by airborne seeds. This was not observed on top of the Tuba City disposal cell, but it has been observed at other disposal sites. (The one Russian thistle plant observed on the top was not rooted in fine-grained material.)

These patches of fine-grained material will be monitored during future inspections for evidence of change. If plants, such as grasses and other shallow-rooted varieties, take hold in these patches, the problem may still not be great. However, if deep-rooted phreatophytes or other species colonize these patches, their removal or control may be necessary.

There were no other observations on the top of the disposal cell. Potentially significant phenomena, such as settling, slumping, or erosion, were not observed.

Northwest Side Slope Transect. All side slope transects were inspected by three parallel traverses: one along the top, one along the bottom, and one approximately in the middle of the side slope.

The general nature and condition of the northwest side slope is shown in photographs PL-35, PL-36A, PL-36B, and PL-37A. The condition of the side slope is excellent. No evidence of subsidence, slumping, or erosion was seen.

North Side Slope Transect. The north side slope is also in excellent condition (PL-37B and PL-38A).

East Side Slope Transect. The east side slope is generally in excellent condition (PL-38B, PL-39A, PL-39B, and PL-41A); however, a shallow depression was found at PL-40. The depression is roughly circular, about 2 feet in diameter and perhaps 6 inches deep. Consensus of

the inspectors was that the depression was an artifact of cover installation. There was no evidence to suggest that the depression was due to settling or subsidence. The area around this depression will be inspected again during the FY 1992 inspection.

South Side Slope Transect. The south side slope includes the short section of side slope that faces southwest at the west end of the south side slope (Figure 2-1). The south side slope is generally in excellent condition (PL-41B, PL-43A, PL-43B, PL-44A, PL-44B, and PL-45). At both the southeast corner (PL-42A and PL-42B) and southwest corner (PL-44C), windblown sand is beginning to encroach across the toe of the side slopes. At present, this encroachment is minor; but in this region of frequent high winds and sand storms, development of larger dunes is possible. Accumulations of windblown sand will be monitored during future site inspections.

Diversion Channels. Two large diversion channels at this site protect the disposal cell from erosion on the west, northwest, and north (upslope) sides (Figure 2-1). The outer diversion channel is upslope from the disposal cell; the inner diversion channel borders the disposal cell at the base of the cell's northwest and north side slopes. Both diversion channels protect the disposal cell from channel and sheet-flood erosion. The inner diversion channel also protects the disposal cell by diverting water that may flow off the side slopes of the cell. Outflows of both diversion channels divert floodwaters to the south on the west end of the site and to the southeast on the east end (Plate 1).

The inner diversion channel was, for the purpose of the inspection, divided into two segments: (1) a north segment with outlet toward the southeast and (2) a northwest segment with outlet toward the south (Figure 2-1).

Both segments of the inner diversion channel are generally in excellent condition (PL-46A, PL-46B, PL-47A, PL-47B, PL-49A, PL-49B, PL-50A, and PL- 50B). However, both segments of the transect, especially the northwest segment, are susceptible to becoming filled with windblown sand. Sand accumulation is not a problem at the present time but will be monitored in the future.

Patches of fine-grained material (sand and pebble-sized material) were noted in the riprap of the inner diversion channel. A small area of sandy material was noted near the northeast end of the northwest segment of the inner diversion channel (PL-48). Presence of the fine-grained materials was not considered important. (See discussion of fine material under Top Transect.)

The outer diversion channel is generally in excellent condition (PL-51, PL-53A, PL-53B, PL-55A, PL-55B, PL-56A, and PL-56B) with one possible exception. At places, but particularly at PL-54, windblown sand is encroaching on the outer diversion channel. At PL-54, plants have begun to colonize the sand. With time, more windblown sand may enter the diversion channels, eventually filling or partially filling these channels. Plants may stabilize the sand. Sand encroachment, and the permanence of these encroachments, will be monitored during future inspections.

At PL-52, a small solitary Russian thistle was rooted in fine sandy material.

A depression, possibly due to deflation, was noted just beyond the end of the western outflow (PL-59). It was not clear whether the depression was due primarily to erosion by running water or by wind. Most surface features in the area are influenced to some extent by wind. Both agents may have been involved. The feature is shallow and not considered important at this time. It will be monitored during future site inspections.

Graded and Reseeded Areas

The area around the disposal cell and the diversion channels and between the diversion channels is graded to the south so that runoff will flow toward Moenkopi Wash (Figure 1–2). This grading also extends a short distance beyond site boundaries on the north, east, and south sides. Rolling dune topography, for the most part undisturbed, borders the site on the west.

Graded areas were reseeded with grass and perhaps other drought-tolerant plants in the fall of 1990. The health of the plants and, therefore, success of the reseeding, were hard to evaluate. Some areas were rather bare where only scattered seeds appear to have germinated. Except for tumbleweeds growing at widely scattered locations, vegetation seemed to be healthiest near the east fence line on both sides of the fence (PL–58 and PL–62). It was not clear whether these plants were seeded or naturally sown.

It is recognized that 1991 was the first growing season after reseeding and that some areas of the southwestern United States, perhaps including the Tuba City area, experienced higher than normal rainfall. Success of the reseeding will depend upon how well the vegetation propagates during the coming years, some of which may be drier than normal. Success of the reseeding will be monitored during future inspections.

Two large piles of unused riprap (PL–60) are located on the graded area southwest of the disposal site. They appear to have no function other than as a stockpile of riprap should additional riprap be needed. Their presence is noted here for the record.

Security Fence

The disposal site is enclosed by a security fence. The security fence is reportedly exactly on the site boundary line at this site.

Wire mesh, barbed wire, gate, fence posts, and hardware are all in excellent condition with one exception. Sections of pipe at the top of the galvanized mesh fencing are joined by couplings. Couplings are crimped in the middle to limit the length of pipe that can be inserted from either end. One of these couplings is broken through at the crimp. The broken coupling is 55 feet east of perimeter sign 12 (PL–61).

The cause of the break in the coupling is unknown. It could be due to shear or fatigue. The coupling may have been defective or damaged (weakened) when the fence was installed. Other parts of the fence at this location are undamaged. There was no evidence of attempted forced entry.

The GJPO recommends that the broken coupling be replaced. The strength of the fence is weakened by the broken coupling.

Couplings will be examined during future site inspections to see if the break is a singular occurrence or a recurring problem due to defective or poorly designed hardware that is prone to break.

Three additional observations, all somewhat related, were made during the inspection of the security fence transect. None compromise the site at this time, but all warrant monitoring during future inspections.

The first observation is that there are occasional gaps along the bottom of the fence. Some are 8 to 10 inches high. In this region of blowing sand, this problem may be difficult and impractical to correct. Filling along the bottom of the fence with sand or dirt may not be

permanent. If filling is ever deemed necessary, rock may be required. One large jackrabbit was seen inside the fence, but there was no indication that animals are entering the site to burrow. The site and the area around the site is so extremely dry and bereft of vegetation that it probably cannot support a large population of such animals.

Second, sand is accumulating at numerous places along the fence line. At places, this probably offsets the previous problem of gaps at the bottom of the fence. Sand accumulation is greatest and most continuous along the east (downwind) fence line, where a long, low dune is forming (PL–57 and PL–58). There is potential for this dune eventually to bury the fence and defeat the security provided by the fence. It is also possible that an equilibrium may be reached in which, because of a limited supply of sand, the dune does not grow much larger. This dune is considered a significant potential problem for further monitoring.

Third, tumbleweeds are also accumulating at places along the fence line. Tumbleweeds were especially noticeable along the southern part of the east fence line (PL–62) and, as discussed under Survey and Boundary Monuments, in the northeast and southeast corners of the east (downwind) fence line (PL–6C and PL–7B). It seems that in the wind shadow of the disposal cell (northern portion of the east fence line), sand predominates over tumbleweeds and a dune is forming at the bottom of the fence. To the south along the east fence line, tumbleweeds predominate over windblown sand. Both are present, however, all along the east fence line.

At the present time, only the large accumulation of tumbleweeds in the corners of the east fence line are serious enough to warrant removal. Smaller amounts of tumbleweeds, sand accumulations, and gaps at the bottom of the fence will be monitored during future inspections.

2.3.3 Area Surrounding the Site

The area around the site was examined for signs of erosion, development, or other disturbance that may affect the site. The primary land use around the site is for grazing. So far, this seems to be a low-impact activity as far as site security and integrity are concerned. No adjacent off-site activity (such as road building, construction, mining, or excavation) or other activity that might affect the site were observed.

An attempt was made to locate the project survey control point northwest of the site. The attempt was unsuccessful. No pin, monument, or flag was found. Much of the area where the pin might have been has been bladed. The rest of this area was covered by loose sand.

3.0 Conclusions and Recommendations

3.1 Conclusion

The Tuba City disposal site was in excellent condition at the time of the inspection. The FY 1991 inspection is the first Annual Prelicensing Inspection of this site, so there were no observations from previous inspections to be reinspected and evaluated. This report of the 1991 inspection provides baseline information on site conditions for future inspections.

3.2 Observations and Recommendations

Observations and recommendations from the 1991 inspection are

1. Wording on the entrance sign (PL-3) contains the words, U.S. Government Property. This wording seems to be at variance with 10 CFR 40, which states:

   > Where the disposal site is on Indian tribal lands, the tribes retain ownership. (10 CFR 40, Section 40.27)

   The representative of the Hopi Nation, who participated in the FY 1991 inspection of the site, requested the sign be corrected.

   Recommendation: Wording on the sign should be corrected.

2. A coupling at the top of the fence along the south fence line is broken, weakening the strength of the fence.

   Recommendation: Replace the broken coupling.

3. Thin accumulations of windblown sand are encroaching at places along the bottom of the disposal cell and along the edges of the diversion channels. Sand is also being deposited along the bottom of the eastern fence line and intermittently at other places along the fence line.

   The amount of sand encroaching on the lower side slopes of the disposal cell and in the diversion channels will probably increase with time. Topography of the entire area surrounding the site is clearly modified by dune sand, although the supply of sand is not great. There is little reason, at present, to suspect that large dunes will eventually climb the side slopes of the disposal cell or cover large portions of the cell. This could happen, but it does not seem likely under current climatic conditions.

   More likely is that dune sand may fill significant portions of the outer and inner diversion channels. This still may not be a significant problem if the dune sand remains unconsolidated so as to erode easily if the diversion channels fill with running water.

   The long, continuous dune forming at the base of the eastern fence line could eventually bury the fence and compromise site security. This is not an imminent problem because the supply of windblown sand is not great and because equilibrium may be reached before the dune grows much larger. If the dune continues to grow, sand removal from both sides of the fence may be required.

   Recommendation: No action is recommended at this time. The amount of sand on the lower part of the side slopes and along the edges of the diversion channels and eastern fence line is currently too small to be significant. Sand accumulations should be monitored during future inspections.

4. Tumbleweeds are packed in the northeast and southeast corners of the security fence at the site. They are an inconvenience during site inspections because they make it difficult to locate survey and boundary markers. More significantly, these accumulations of tumbleweeds are a potential range fire hazard, they are unsightly, and they may act as baffles, causing wind to deposit sand. If dunes form in fence corners, they may bury survey and boundary monuments. If large enough, the dunes may bury the fence and compromise site security.

   Recommendation: The tumbleweeds should be removed. Experience will dictate how frequently the weeds need to be removed. Removal for the first time in the spring of 1992 would be appropriate. Removal at that time will permit removal of the existing weeds as well as the fall 1991 crop in time for the 1992 Annual Prelicensing Inspection. Removal every 2 to 3 years thereafter may be sufficient.

3.3 Site Maintenance

The following site maintenance is recommended before the 1992 Annual Prelicensing Inspection:

1. Reletter the entrance sign to show correct information on site ownership.
2. Remove the tumbleweeds from northeast and southeast corners of the security fence.
3. Repair the broken coupling on the south fence line.

3.4 Contingency Plans

As indicated in the draft SMP, working relationships have been established by the Uranium Mill Tailings Remedial Action Project Office with the U.S. Geological Survey Earthquake Information Center; U.S. Bureau of Reclamation; and the Division of Public Safety, Navajo Tribe. These agencies will contact the DOE should any unusual event come to their attention that might affect the security or integrity of the Tuba City site.

4.0 References

DOE (U.S. Department of Energy), 1986a. *Guidance for UMTRA Project Surveillance and Maintenance*, UMTRA-DOE/AL-350124.0000, DOE UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

DOE (U. S. Department of Energy), 1986b. *Surveillance and Maintenance Plan, Tuba City, Arizona*, draft, UMTRA-DOE/AL-350201,V200/800-R, DOE UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

10 CFR 40.27. "Custody and Long-Term Care of Uranium and Thorium Mill Tailings Disposal Sites," October 30, 1990.

Appendix A
Photo Log and Photographs

Inspection Photo Log

Site: Tuba City, Arizona **Date:** July 17 and 18, 1991

Explanation

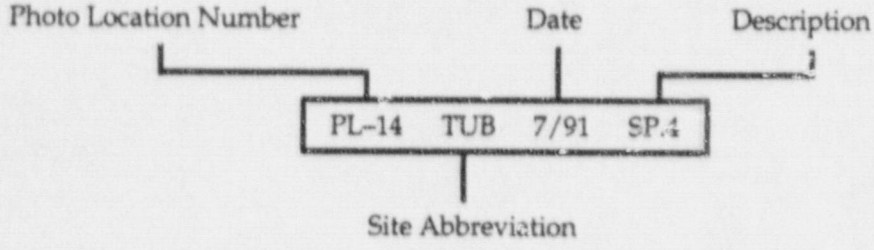
Photographs referred to in the text of this report, as well as a list of these photographs, are included in this appendix (Appendix A). Photographs are identified by photograph location (PL) number. PL numbers also appear on the Inspection Drawing (Plate 1).

Specifications

All photographs were taken on Kodacolor 135 film, ISO 100, with a variable focal length (zoom) lens. Focal lengths vary between 35 mm and 105 mm. All photographs were exposed with daylight illumination and without filtration.

Photograph Labels

Photographs in Appendix A are labelled as follows:



When more that one photograph was taken at a given photograph location, different photographs are identified by a letter suffix (e.g., 3A, 3B)

Abbreviations

The following abbreviations are used in the photograph log:

N	North	NW	Northwest
E	East	SE	Southeast
SSE	South southeast	S	South
SSW	South southwest	SW	Southwest
WSW	West southwest	W	West
SW	Southwest	SP	Settling plate
MW	Monitoring well	SM	Survey monument
BM	Boundary monument	SMK	Site marker
in.	inches	ft	feet
IDC	Inner diversion channel	ODC	Outer diversion channel

Inspection Photo Log

Site: Tuba City, Arizona

Date: July 17, 1991
July 18, 1991

Time of Day: From 0745 to 1830,
From 0720 to 1100

Weather Conditions: Clear to cloudy. Low 70s to mid 90s °F both days

Photographer's Location No.[a]	Azimuth[b]	Photo Description/Remarks
1	170	Entrance sign
2	000	Site marker, SMK–1, near entrance
3A	010	Site marker, SMK–2, top transect
3B	000	Panorama from location of SMK–2, view N
3C	045	Panorama from location of SMK–2, view NE
3D	090	Panorama from location of SMK–2, view E
3E	135	Panorama from location of SMK–2, view SE
3F	180	Panorama from location of SMK–2, view S
3G	215	Panorama from location of SMK–2, view SW
3H	270	Panorama from location of SMK–2, view W
3I	315	Panorama from location of SMK–2, view NW
4	215	Survey monument/boundary monument, SM–1/BM–1
5	215	Survey monument/boundary monument, SM–2/BM–2
6A	030	Survey monument/boundary monument, SM–3/BM–3
6B	010	Same as PL–6A, detail
6C	045	Tumbleweeds, E fence line, NE corner, before SM–3/BM–3 was found
7A	315	Boundary monument, BM–4
7B	110	Tumbleweeds, E fence line, SE corner, before BM–4 was found
8	000	Settling plate, SP–1. Padlock key No. 2357.
9	350	Settling plate, SP–2. Padlock key No. 2357.
10	000	Settling plate, SP–3, Padlock key No. 2357
11	000	Settling plate, SP–4. No key No. on padlock.
12	340	Monitoring well, MW–906, on site. Padloc key No. not recorded.
13	000	Monitoring well, MW–905, E of site. Threaded cap.
14	000	Monitoring well, MW–914, SE cluster. Padlock key No. 3359.
15	000	Monitoring well, MW–915, SE cluster. Two padlocks, both key No. 3359.
16	000	Monitoring well, MW–916, SE cluster. Two padlocks, both key No. 3359.
17	000	Monitoring well, MW–909, S of site. One padlock, no key No.
18	000	Monitoring well, MW–908, near SW cluster. Threaded cap.
19	000	Monitoring well, MW–912, near SW cluster. Two padlocks, both key No. 3359.
20	000	Monitoring well, MW–913, near SW cluster. Two padlocks, both key No. 3359.
21	000	Monitoring well, MW–903 , S (downgradient) cluster. Threaded cap.
22	000	Monitoring well, MW–920, S (downgradient) cluster. Two padlocks, both key No. 3359.
23	000	Monitoring well, MW–921 , S (downgradient) cluster. Two padlocks, both key No. 3359.

[a] See Plate 1 for photo location and Figure 2–1 for nomenclature.
[b] Declination angle: 14.5° E.

Inspection Photo Log

Site: Tuba City, Arizona

Date: July 17, 1991 **Time of Day:** From 0745 to 1830,

July 18, 1991 From 0720 to 1100

Weather Conditions: Clear to cloudy. Low 70s to mid 90s °F both days

Photographer's Location No.[a]	Azimuth[b]	Photo Description/Remarks
24	000	Monitoring well, MW–904, approx. 1 mile S of site. Threaded cap.
25	000	Monitoring well, MW–902, approx. 2 miles S of site. Threaded cap with padlock, key No. 276. Padlock found open.
26[c]	000	Monitoring well, MW–917, far SW cluster. Two padlocks, both key No. 3359.
27[c]	000	Monitoring well, MW–918, far SW cluster. Two padlocks, both key No. 3359.
28[c]	000	Monitoring well, MW–919, far SW cluster. Two padlocks, both key No. 3359; one padlock found open.
29[c]	000	Monitoring well, MW–901, N (upgradient) cluster. Threaded cap.
30[c]	000	Monitoring well, MW–910, N (upgradient) cluster; Two padlocks, both No. 3359.
31[c]	000	Monitoring well, MW–911, N (upgradient) cluster. Two padlocks, both key No. 3359.
32	345	Small plant (Russian thistle), top transect. SMK–2 bears 330°.
33	290	Fine material in riprap, top transect. SMK–2 bears 285°, 38 ft.
34A	180	Fine material in riprap, top transect.
34B	---	Same as PL–34A, detail.
35	045	NW side slope, SW end, view NE
36A	225	NW side slope, middle, view SW
36B	045	NW side slope, middle, view NE
37A	225	NW side slope, NE end, view SW
37B	090	N side slope, W end, view E
38A	270	N side slope, E end, view W
38B	185	E side slope, N end, view S
39A	000	E side slope, middle, view N
39B	180	E side slope, middle, view S
40	095	E side slope, small depression in riprap just below berm. Depression is approx. 6 in. deep, 2 ft in diameter. SMK–2 bears 280°.
41A	000	E side slope, S end, view N
41B	270	S side slope, E end, view W
42A	350	Bottom of side slope, SE corner, view N, windblown sand
42B	290	Bottom of side slope, SE corner, view W, windblown sand
43A	090	S side slope, middle, view E
43B	270	S side slope, middle, view W
44A	090	S side slope, W end, view E
44B	315	S side slope, W end, view NW of SW segment
44C	250	S side slope, W end, view WSW toward toe of side slope, with windblown sand

[a] See Plate 1 for photo location and Figure 2-1 for nomenclature.
[b] Declination angle: 14.5° E.
[c] Two-foot scale with north arrow not available. Broken pieces of lath are used to indicate the north direction in these photographs.

Inspection Photo Log

Site: Tuba City, Arizona

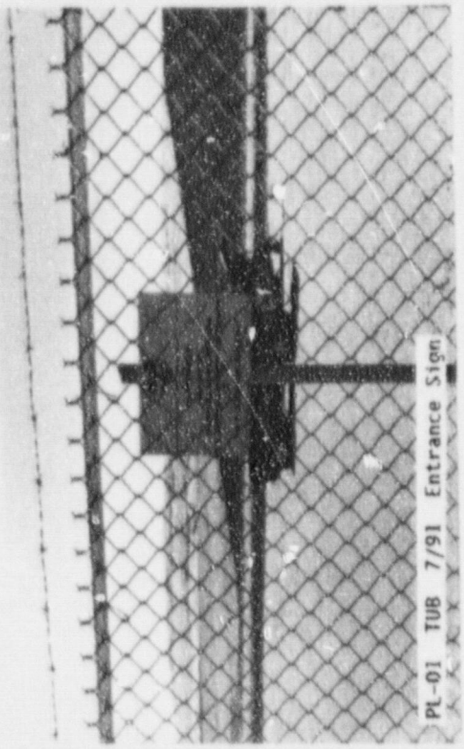
Date: July 17, 1991
July 18, 1991

Time of Day: From 0745 to 1630,
from 0720 to 1100

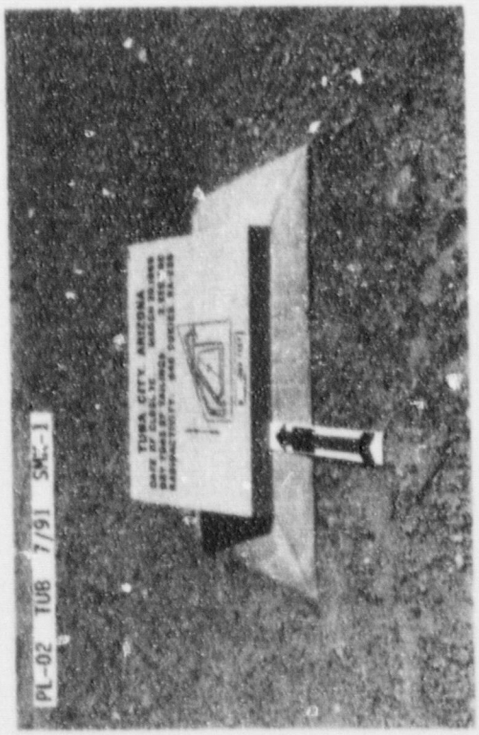
Weather Conditions: Clear to cloudy. Low 70s to mid 90s °F both days

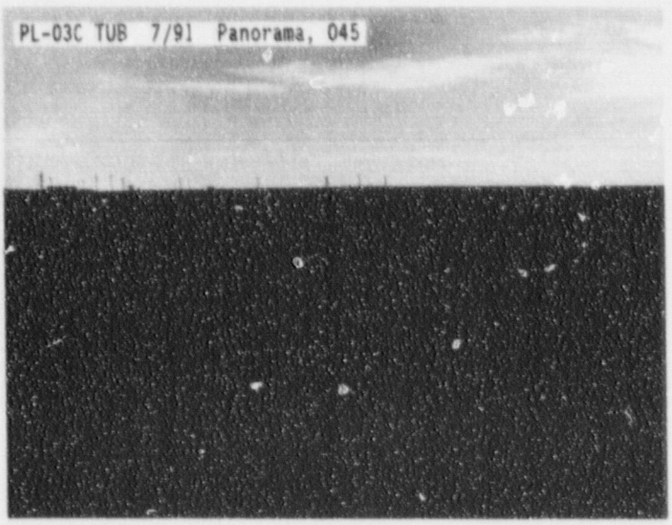
Photographer's Location No.[a]	Azimuth[b]	Photo Description/Remarks
45	150	S side slope, NW end of SW segment, view SE. (Near PI-35)
46A	185	Inner diversion channel, SW bend, view S toward outflow
46B	035	Inner diversion channel, SW bend, view NE
47A	225	Inner diversion channel, NW segment, middle, view SW
47B	045	Inner diversion channel, NW segment, middle, view NE
48	180	Inner diversion channel, NW segment, fine material in riprap
49A	225	Inner diversion channel, NW segment, NE end, view SW
49B	090	Inner diversion channel, N segment, W end, view E
50A	270	Inner diversion channel, NE bend, view W
50B	130	Inner diversion channel, NE bend, view SE toward outflow
51	005	Outer diversion channel, W outflow, view N
52	020	Outer diversion channel, W segment, Russian thistle growing in fine material
53A	195	Outer diversion channel, [illegible] bend, view SSW
53B	060	Outer diversion channel, W bend, view NE
54	160	Outer diversion channel, NW segment, encroachment of windblown sand and small plants
55A	240	Outer diversion channel, NW segment, NE end (at kink), view SW
55B	070	Outer diversion channel, N segment, W end (at kink), view ENE
56A	250	Outer diversion channel, NE bend, view WSW
56B	155	Outer diversion channel, NE bend, view SSE toward outflow
57	045	Sand accumulation along E fence line near sign 24
58	180	Sand accumulation along (outside) E fence line
59	040	Depression, possibly due to deflation, S of W outflow of outer diversion channel
60	040	Two piles of unused riprap on southern part of site
61	140	Broken coupling, S fence line, 55 feet E of sign 12
62	010	Tumbleweeds along southern part of E fence line

[a]See Plate 1 for photo location and Figure 2-1 for nomenclature.
[b]Declination angle: 14.5° E.



PL-03B TUB 7/91 Panorama, 000

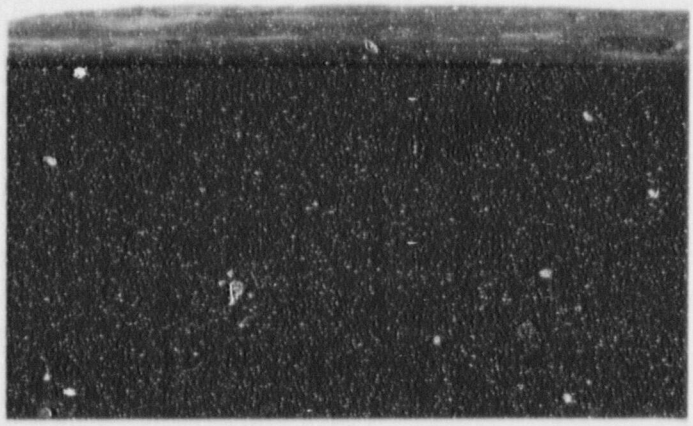




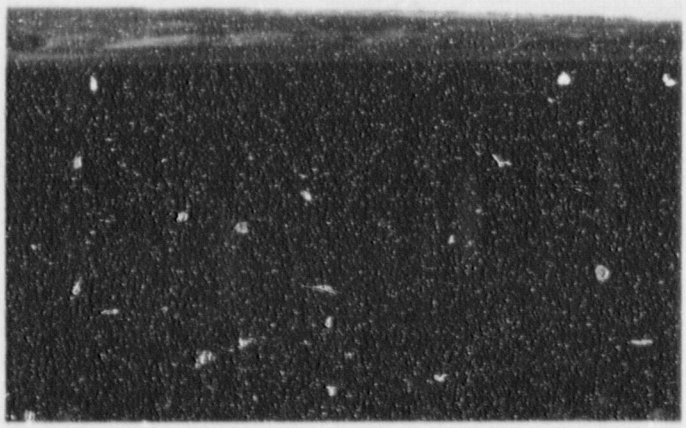
PL-03D TUB 7/91 Panorama, 090

PL-03E TUB 7/91 Panorama, 135

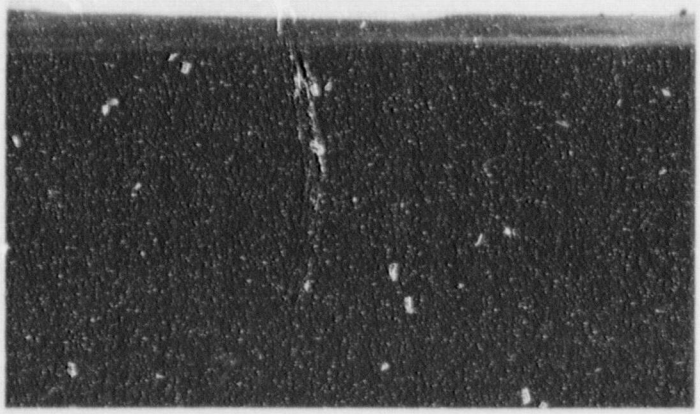
PL-03F TUB 7/91 Panorama, 180



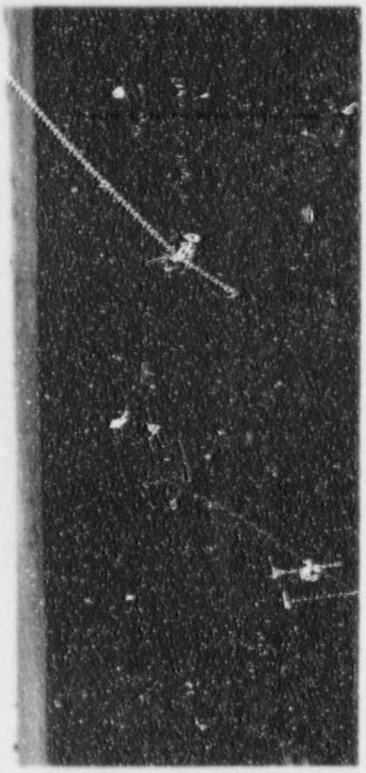
PL-03G TUB 7/91 Panorama, 225



PL-03H TUB 7/91 Panorama, 270



PL-031 TUB 7/91 Panorama, 315

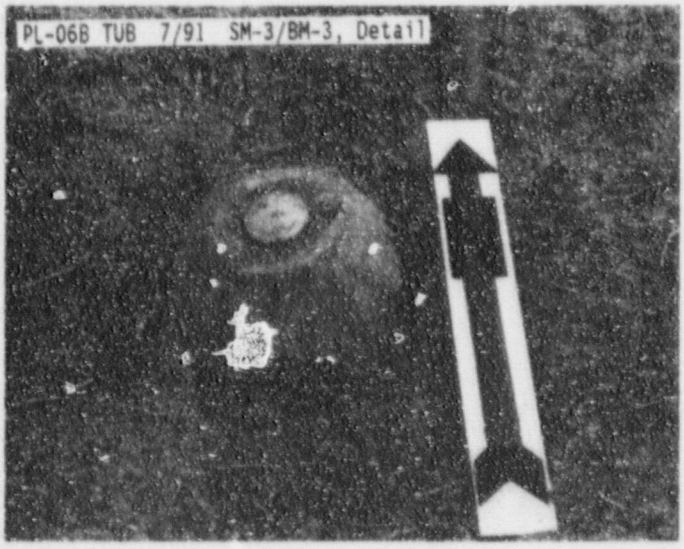


PL-05 TUB 7/91 SM-2/BM-2

PL-06A TUB 7/91 SM-3/BM-3

PL-04 TUB 7/91 SM-1/BM-1

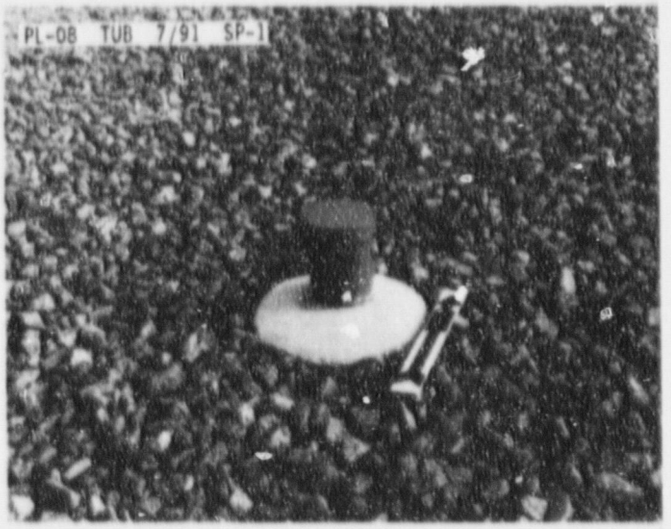
PL-06B TUB 7/91 SM-3/BM-3, Detail




PL-06C TUB 7/91 Tumbleweeds at Fence


PL-07B TUB 7/91 Tumbleweeds at Fence


PL-07A TUB 7/91 BM-4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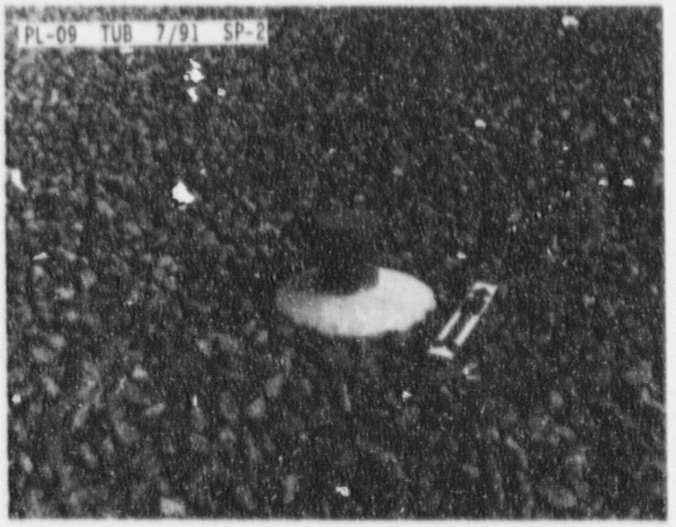
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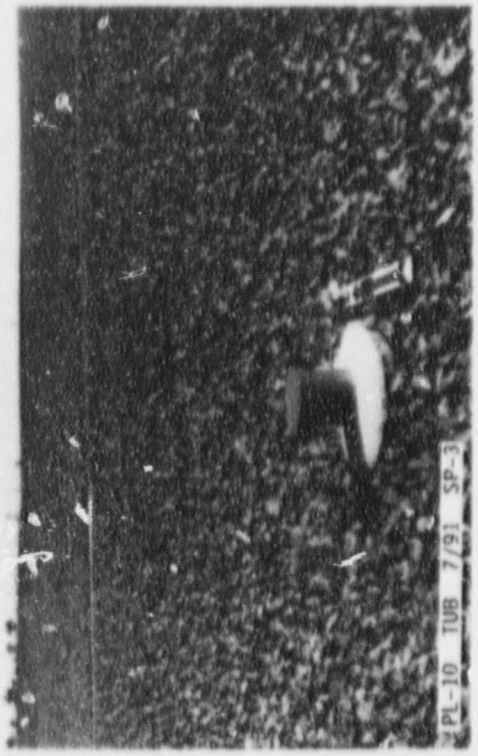
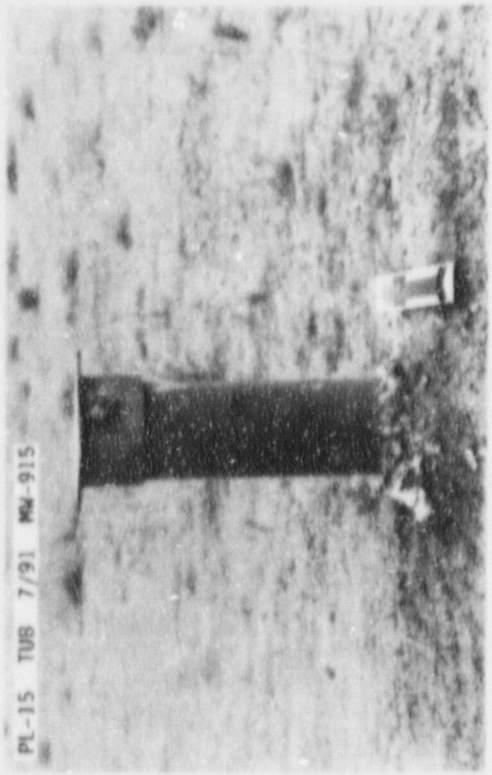

PL-10 TUB 7/91 SP-3


PL-12 TUB 7/91 MW-906


PL-13 TUB 7/91 MW-905


PL-11 TUB 7/91 SP-4


PL-14 TUB 7/91 MW-914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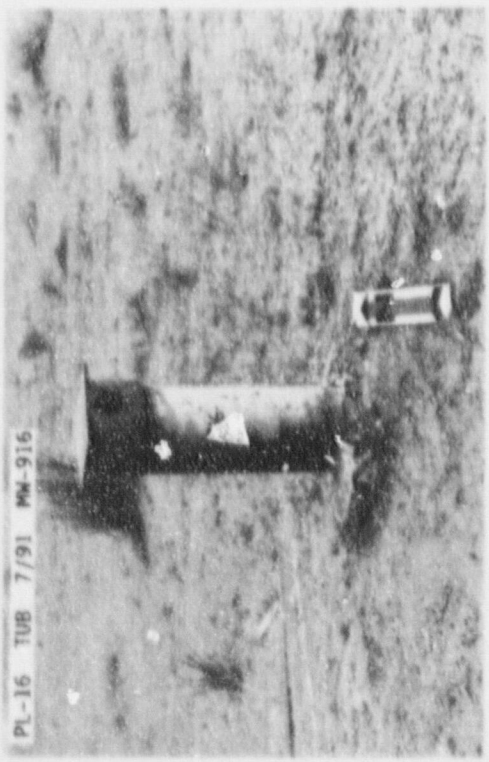
PL-17 TUB 7/91 MW-909


PL-18 TUB 7/91 MW-908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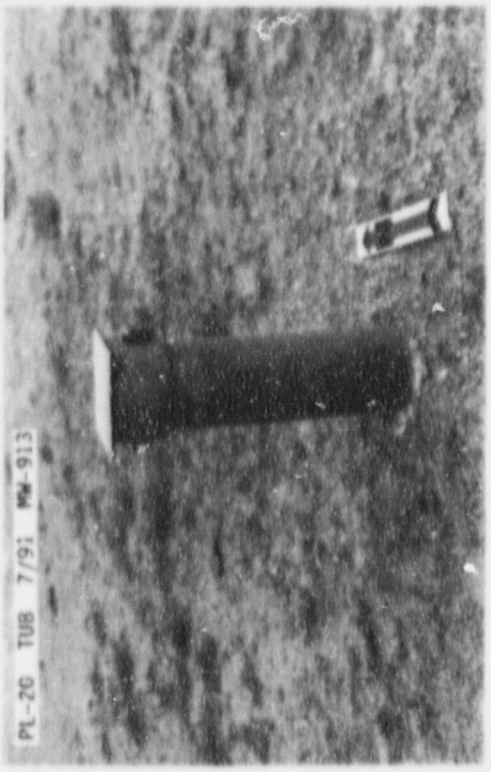
PL-19 TUB 7/91 MW-912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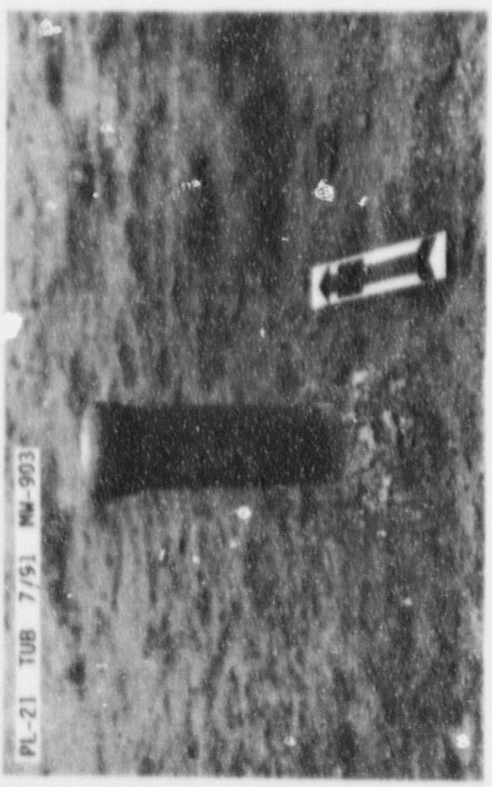
PL-22 TUB 7/91 MW-920


PL-23 TUB 7/91 MW-921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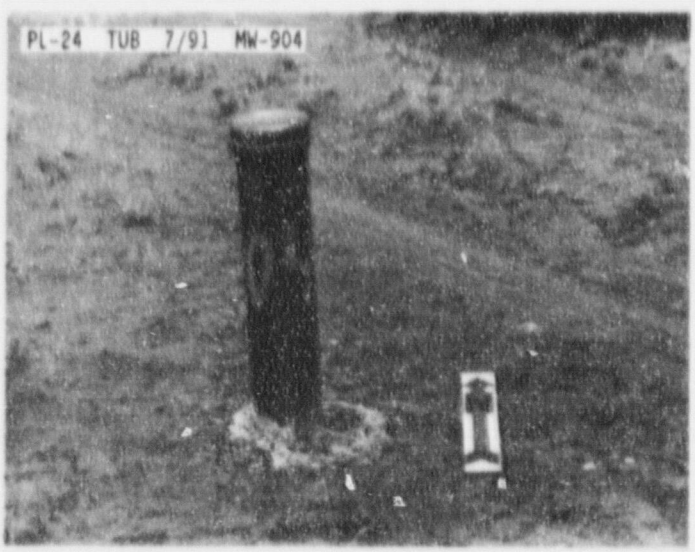
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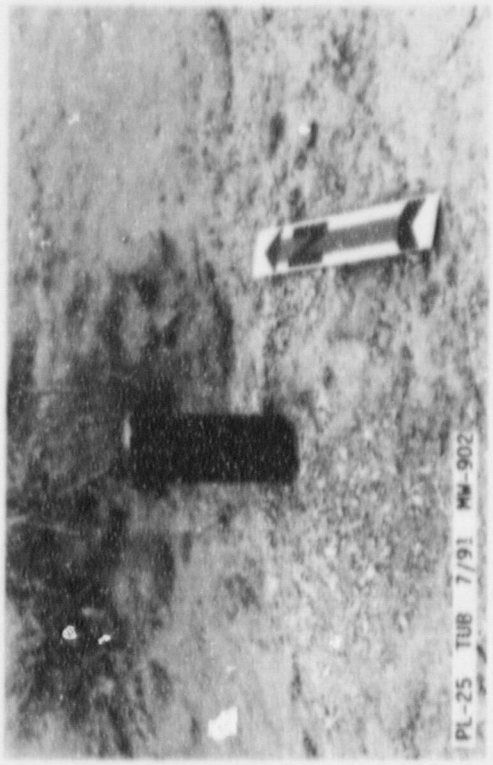
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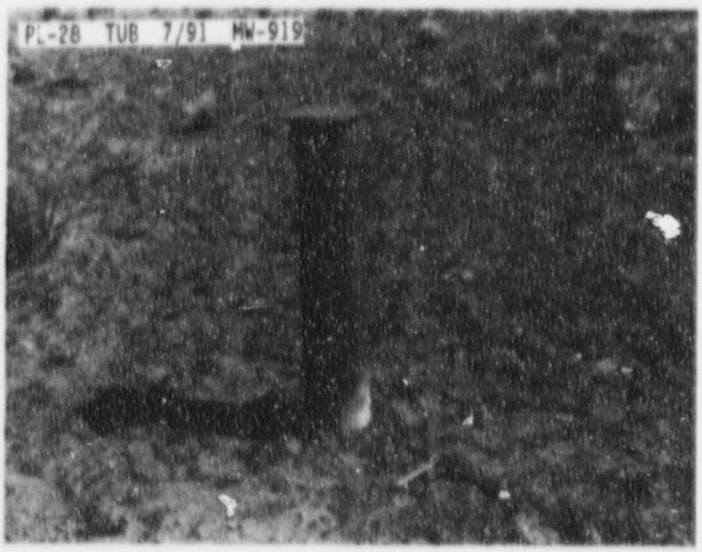
PL-27 TUB 7/91 MW-918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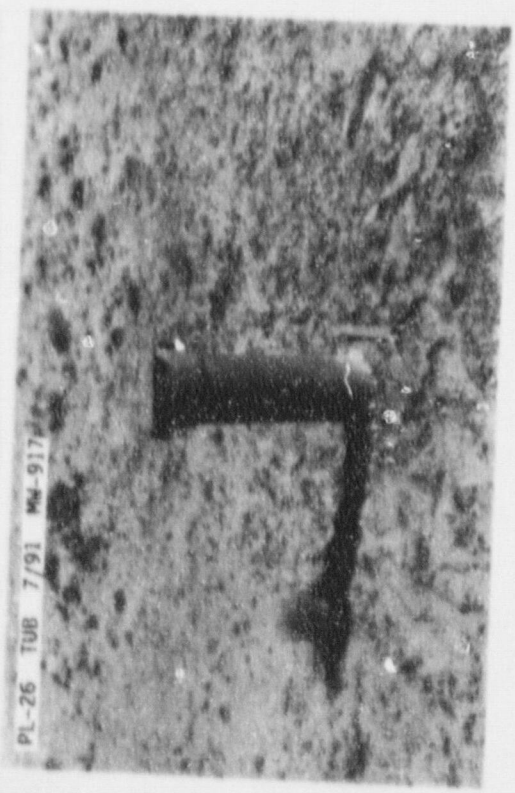
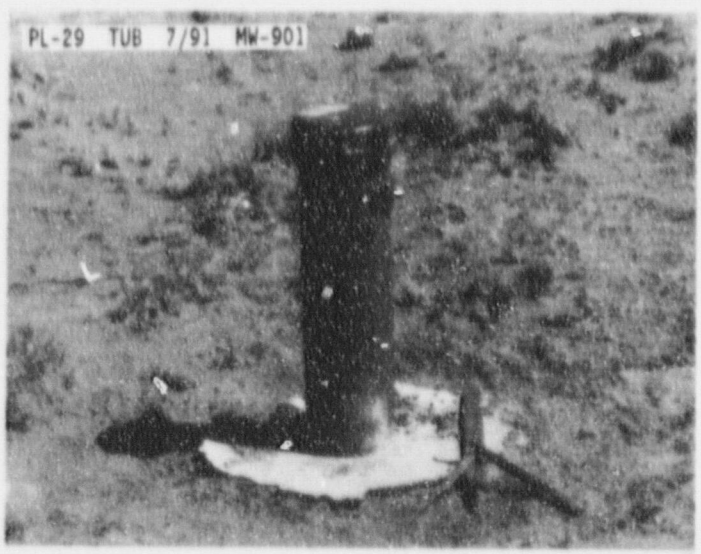

PL-26 TUB 7/91 MW-917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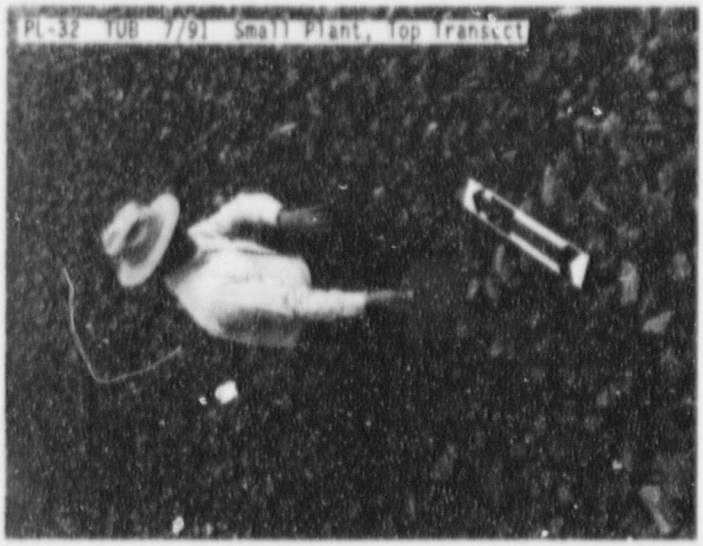
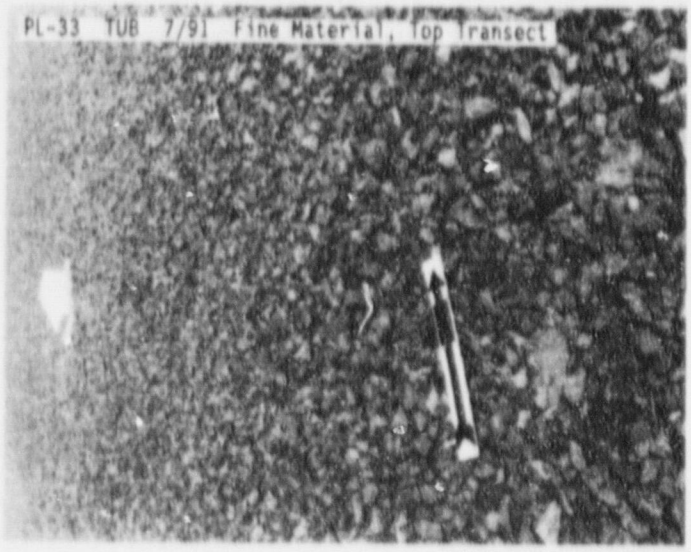
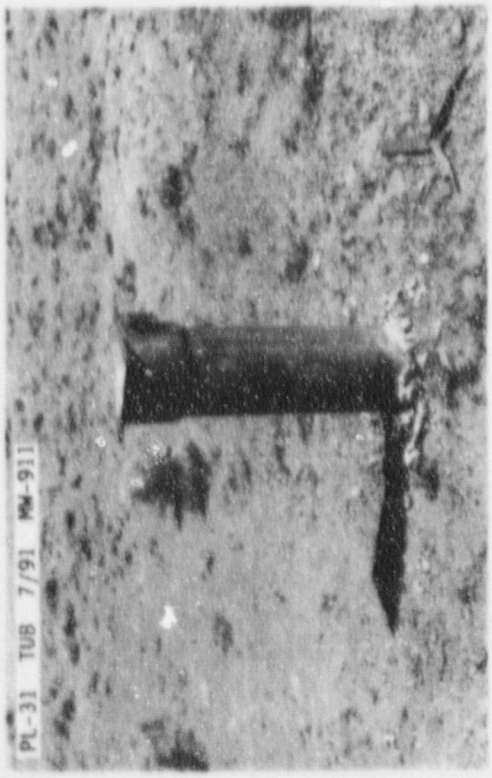
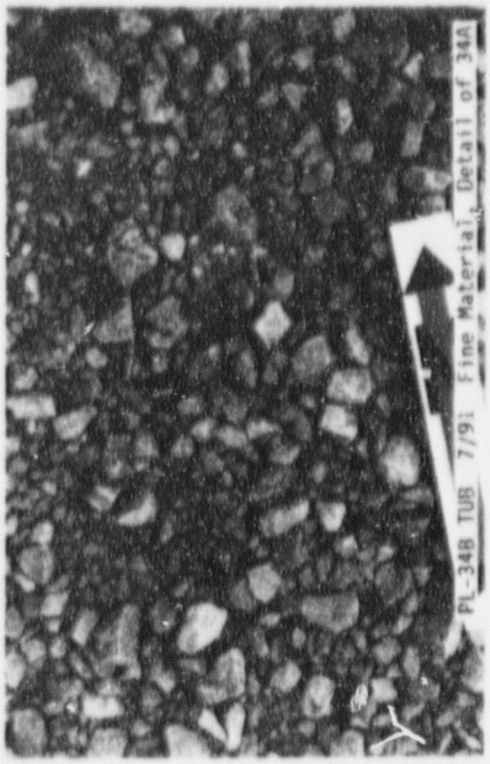
PL-30 TUB 7/91 MW-910


PL-32 TUB 7/91 Small Plant, Top Transect


PL-33 TUB 7/91 Fine Material, Top Transect

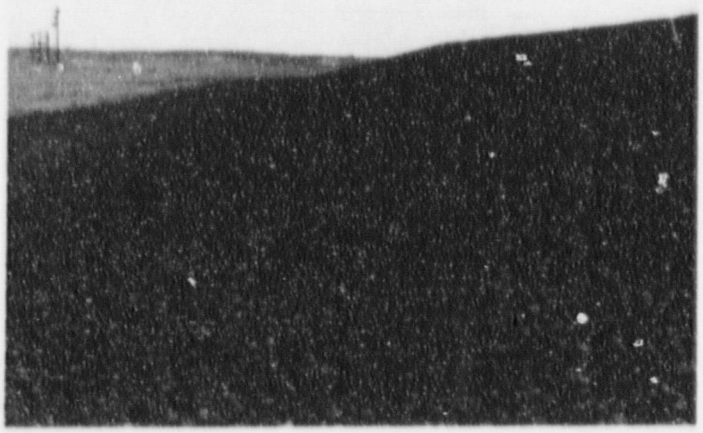

PL-31 TUB 7/91 MW-911


PL-34A TUB 7/91 Fine Material, Top Transect

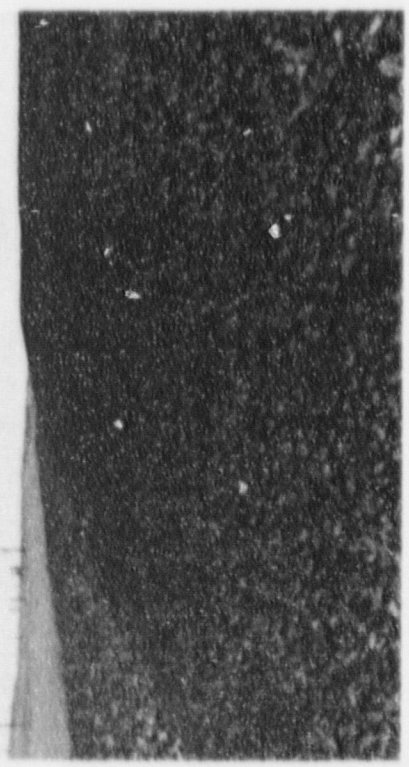


PL-34B TUB 7/91 Fine Material, Detail of 34A

PL-36A TUB 7/91 NW Side Slope, Middle, View SW



PL-36B TUB 7/91 NW Side Slope, Middle, View NE

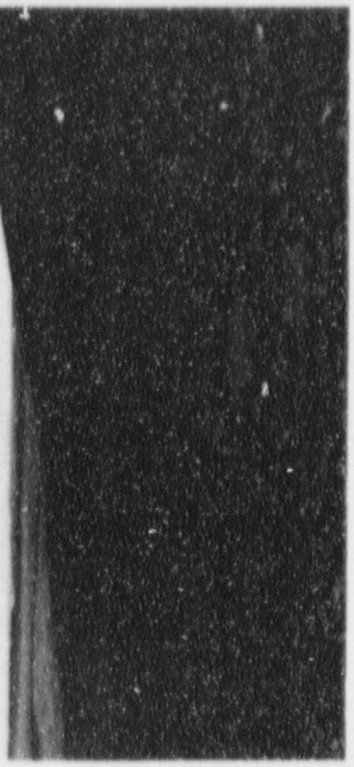


PL-35 TUB 7/91 NW Side Slope, SW End, View NE

PL-37A TUB 7/91 NW Side Slope, NE End, View SW

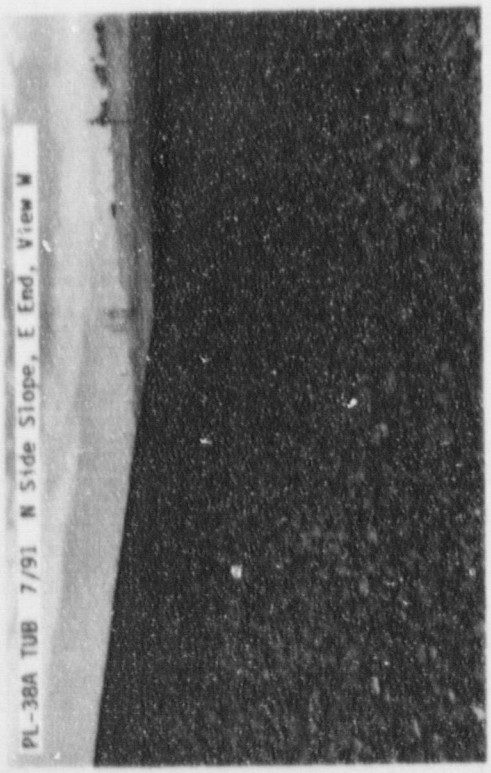
PL-38B TUB 7/91 E Side Slope, N End, View S

PL-37B TUB 7/91 N Side Slope, W End, View E

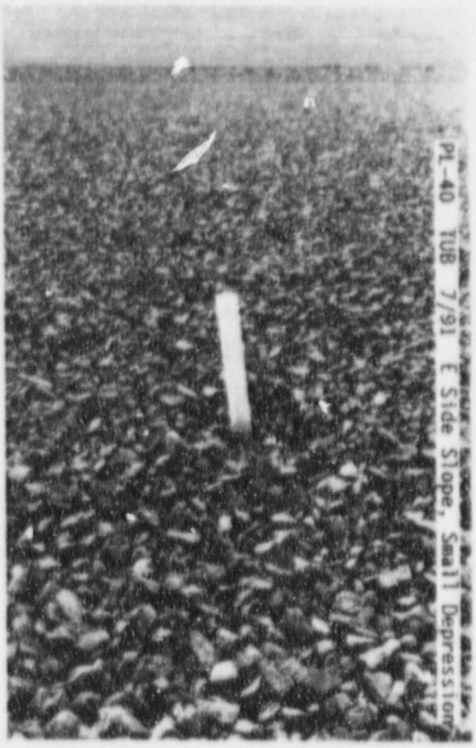


PL-39A TUB 7/91 E Side Slope, Middle, View N

PL-38A TUB 7/91 N Side Slope, E End, View W

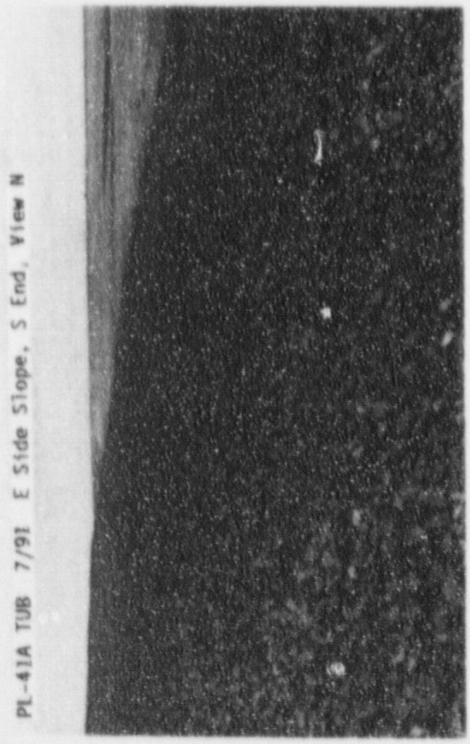


PL-39B TUB 7/91 E Side Slope, Middle, View S

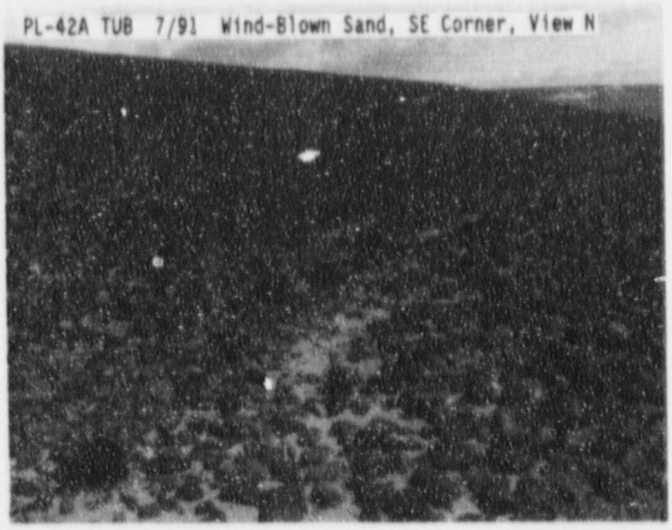


PL-40 TUB 7/91 E Side Slope, Small Depression

PL-41B TUB 7/91 S Side Slope, E End, View W



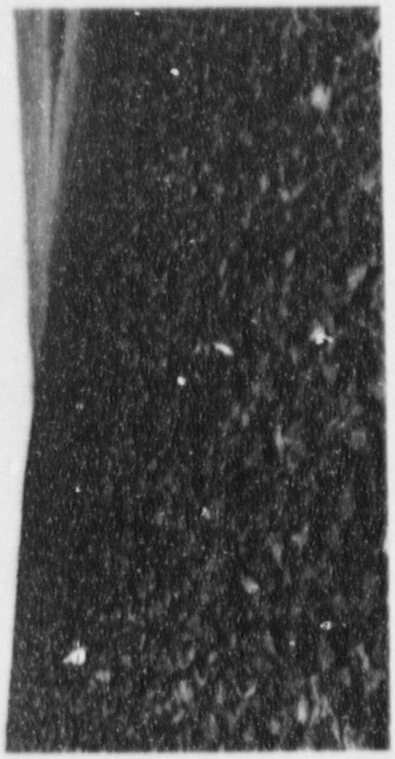
PL-41A TUB 7/91 E Side Slope, S End, View N



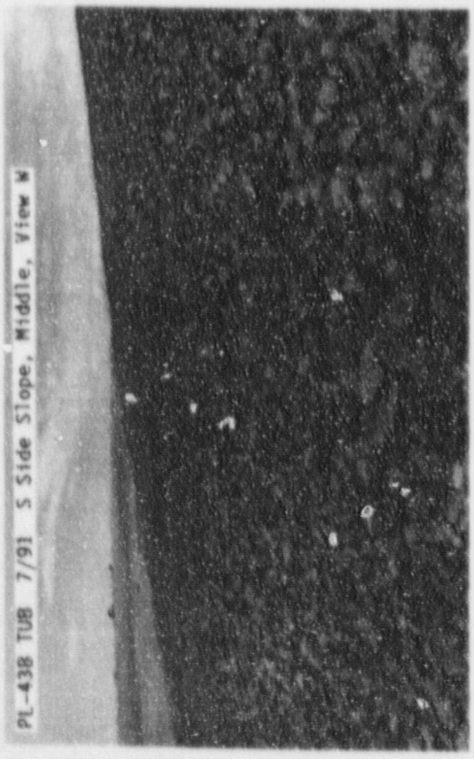
PL-42A TUB 7/91 Wind-Blown Sand, SE Corner, View N

PL-42B TUB 7/91 Wind-blown Sand, SE Corner, View W

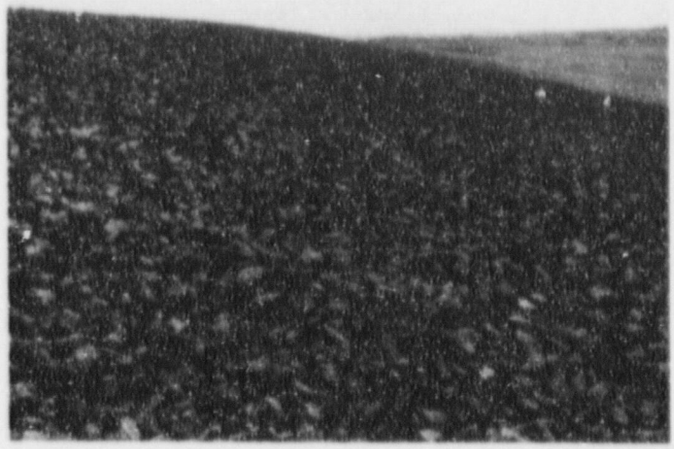
PL-43A TUB 7/91 S Side Slope, Middle, View E



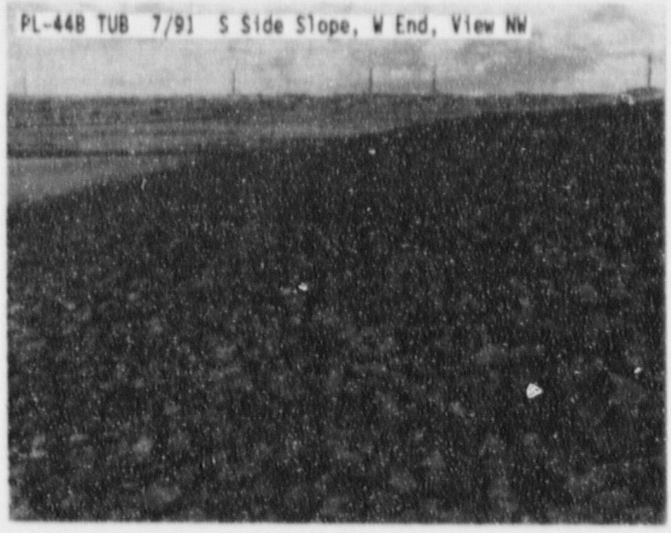
PL-43B TUB 7/91 S Side Slope, Middle, View W

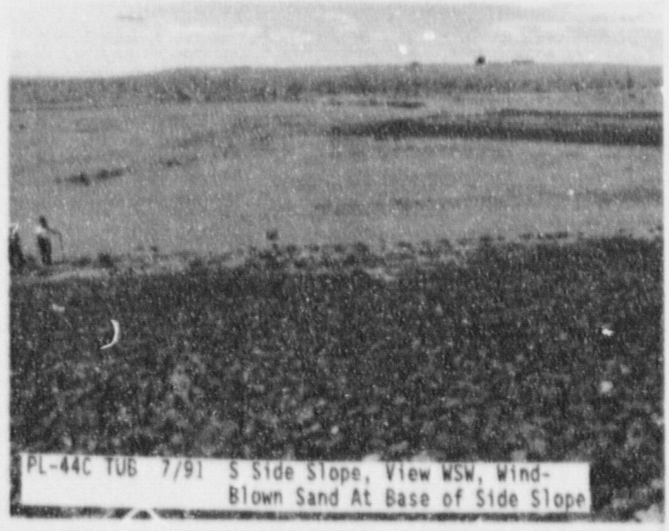


PL-44A TUB 7/91 S Side Slope, W End, View E



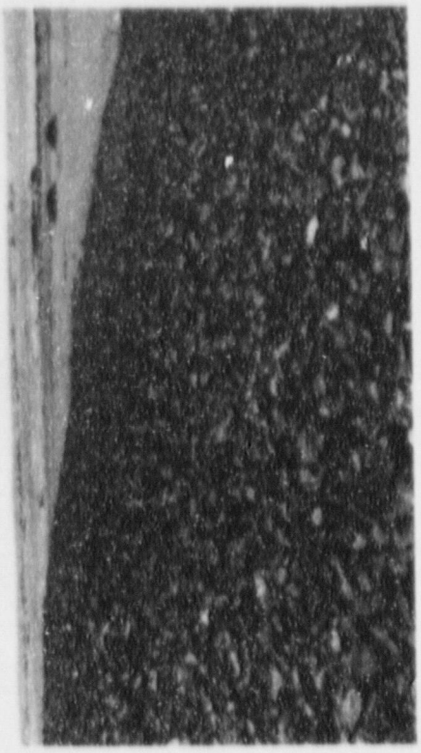
PL-44B TUB 7/91 S Side Slope, W End, View NW



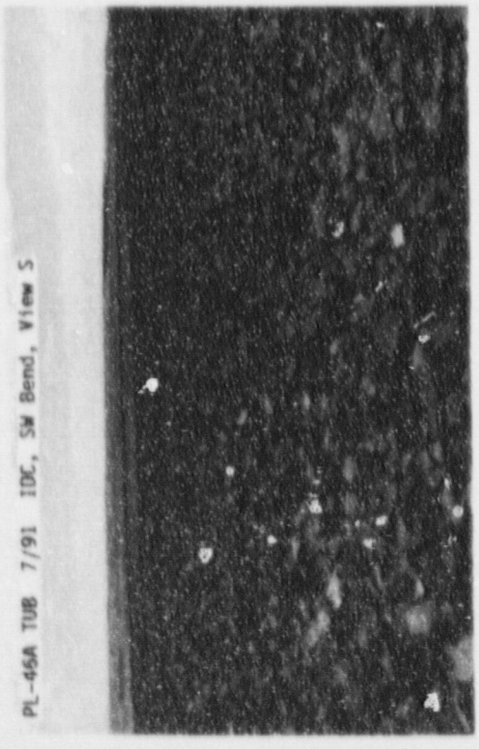


PL-44C TUB 7/91 S Side Slope, View WSW, Wind-Blown Sand At Base of Side Slope

PL-45 TUB 7/91 S Side Slope, NW End, View SE



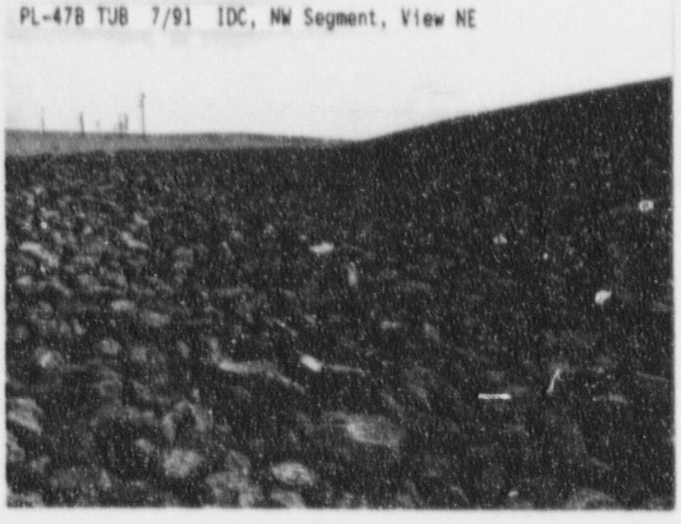
PL-46A TUB 7/91 IDC, SW Bend, View S



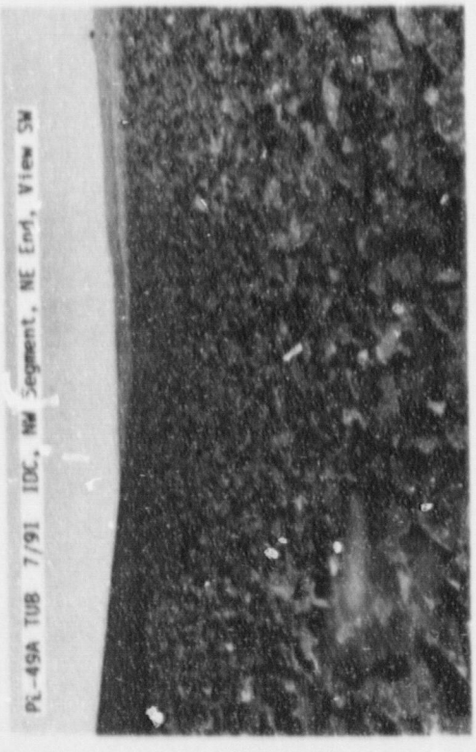
PL-46B TUB 7/91 IDC, SW Bend, View NE

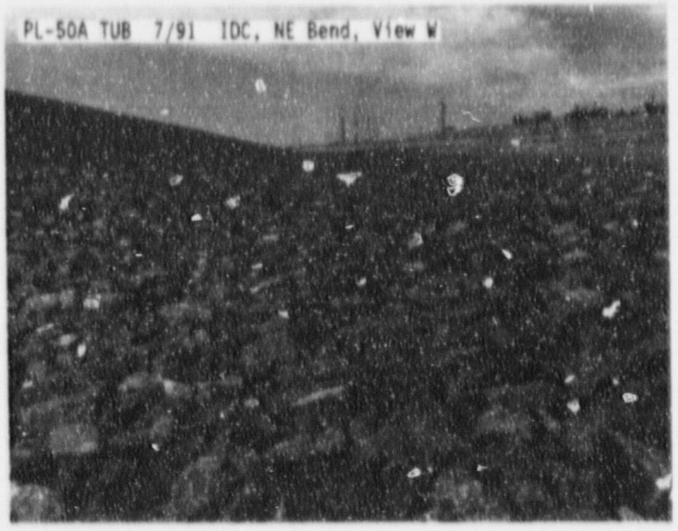
PL-47A TUB 7/91 IDC, NW Segment, View SW

PL-47B TUB 7/91 IDC, NW Segment, View NE

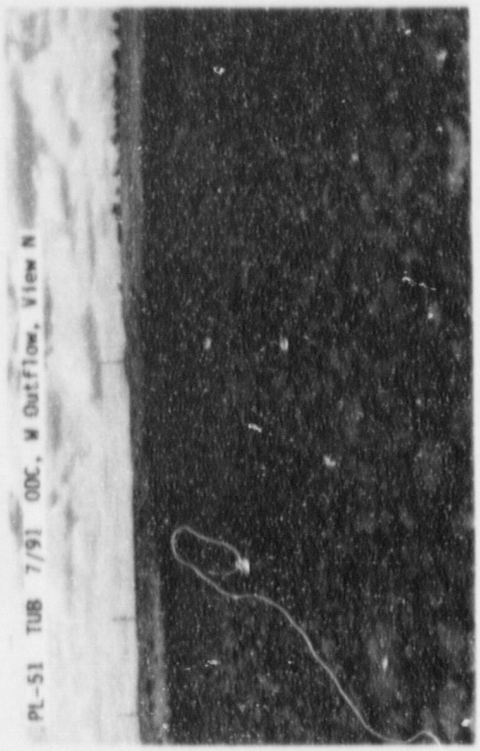


PL-49B TUB 7/91 IDC, N Segment, W End, View E

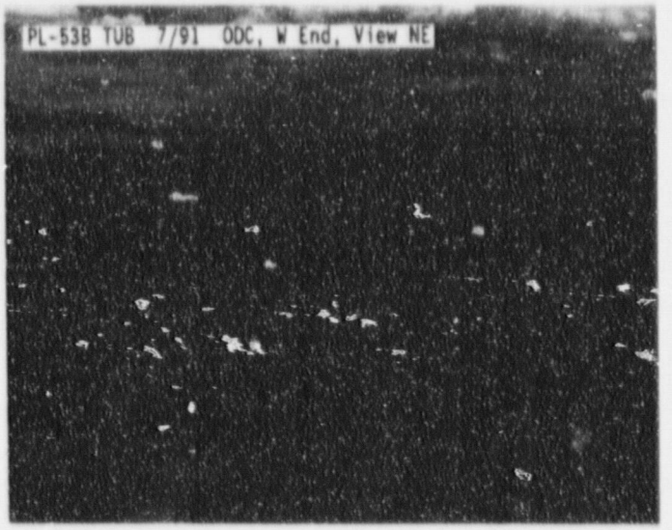


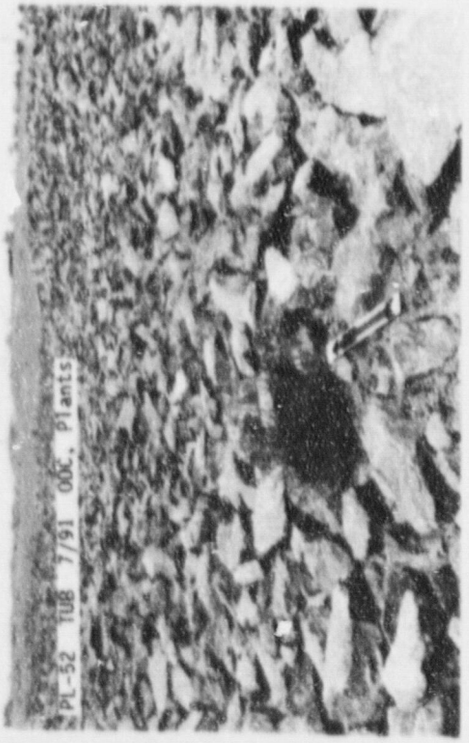


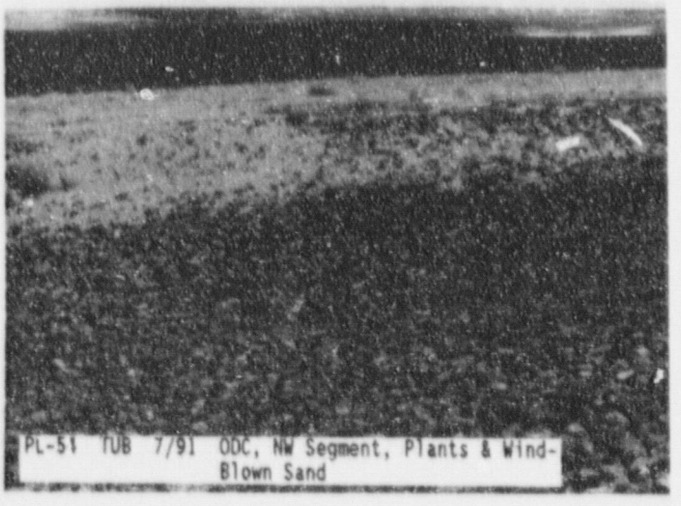
PL-50B TUB 7/91 IDC, NE Bend, View SE


PL-51 TUB 7/91 ODC, W Outflow, View N


PL-53A TUB 7/91 ODC, W End, View SSW

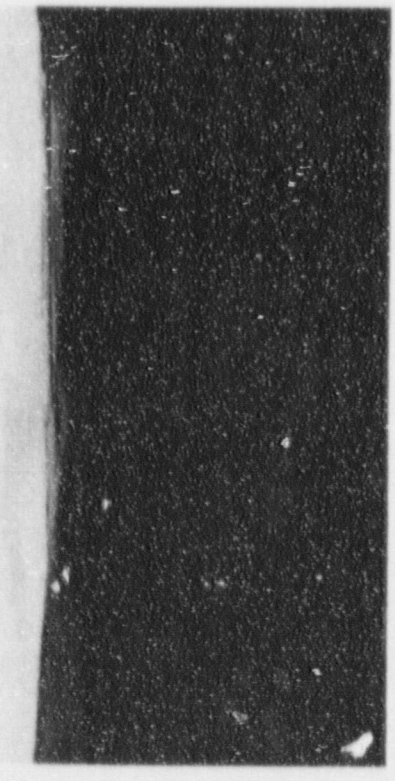

PL-53B TUB 7/91 ODC, W End, View NE


PL-52 TUB 7/91 ODC, Plants


PL-51 TUB 7/91 ODC, NW Segment, Plants & Wind-Blown Sand

PL-55A TUB 7/91 ODC, NW Segment, NE End, View S

PL-55B TUB 7/91 ODC, N Segment, W End, View ENE



PL-56A TUB 7/91 ODC, NE Bend, View WSW

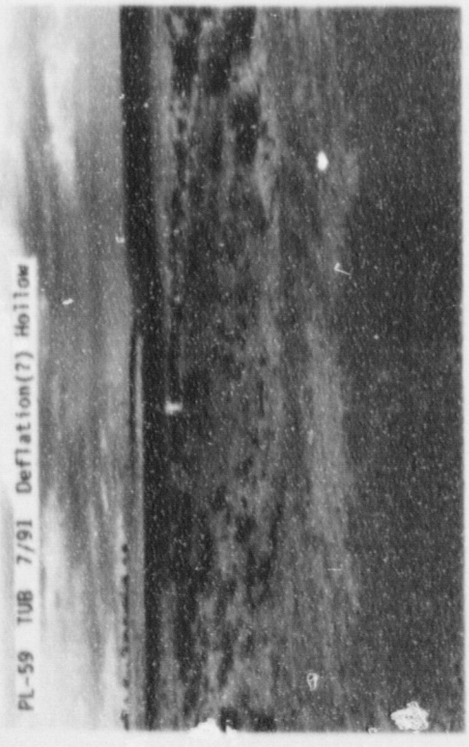
PL-56B TUB 7/91 ODC, NE Bend, View SSE

PL-57 TUB 7/91 Wind-Blown Sand, E Fence Line

PL-58 TUB 7/91 Wind-Blown Sand, E Fence Line

PL-60 TUB 7/91 Piles of Unused Riprap

PL-61 TUB 7/91 Broken Coupling, S Fence Line



PL-59 TUB 7/91 Deflation(?) Hollow

PL-62 TUB 7/91 Tumbleweeds, E Fence Line

Appendix B
Résumés of Inspectors

Charles A. Jones

Fields of Competence

Geologic site characterization; Environmental impact analysis; Regulatory compliance; Mineral resource assessment; and National Environmental Policy Act (NEPA)

Experience Summary

Five years experience in uranium exploration and uranium resource evaluation. Nine years experience in management of site characterization studies at proposed high-level waste disposal sites.

Two years experience in implementation and management of surveillance and maintenance activities at DOE disposal sites.

Credentials

B.A., Geology, University of California, Berkeley, California

Ph.D., Geology, University of Oregon, Eugene, Oregon

Geological Society of America

Society of Economic Paleontologists and Mineralogists

Sigma Xi

Employment History

1972–75	Assistant Professor, Chadron State College, Chadron, Nebraska
1975–86	Geologist and Program/Project Manager, Bendix Field Engineering Corporation
1986–90	Program/Project Manager, UNC Geotech
1990–Present	Program Manager, Chem-Nuclear Geotech, Inc.

Key Projects

DOE National Uranium Resource Evaluation (NURE) program: uranium resource evaluation in Texas and Utah; publications in uranium resource evaluation; managed field operations at five district offices.

DOE Office of Nuclear Waste Isolation (ONWI): managed geochemical and mineralogical research projects, isotopic dating of host rock and formation waters, and established sample archival system in support of site characterization projects in Texas and Washington.

DOE Long-Term Surveillance and Maintenance (LTSM) Program: responsible for implementation and management of new surveillance and maintenance program for long-term custody of remote DOE disposal sites, primarily those decontaminated and stabilized by DOE remedial action programs and projects.

Mark P. Pleesinger

Fields of Competence

Hazardous waste site remediation technologies; feasibility studies under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); underground storage tank site remediation; environmental regulatory considerations; nuclear engineering and radioactive waste handling; heat transfer/fluid mechanics experimental research.

Experience Summary

Nine years of varied professional experience including 3 years of CERCLA remedial investigation/feasibility study-related work. Underground storage tank site remedial actions, transuranic radioactive and mixed-waste handling studies, management of design group performing feasibility studies and site remedial action designs. Also experienced with nuclear reactor operations and experimental research in nuclear reactor thermal hydraulics.

Credentials

B.S., Mechanical Engineering, Colorado State University, Fort Collins, Colorado

M.S., Mechanical Engineering, University of Idaho, Moscow, Idaho

Registered Professional Engineer, Colorado and Idaho

Member, American Society of Mechanical Engineers

Member, American Nuclear Society

Author or co-author of six technical publications.

Employment History

1981–1989	EG&G Idaho, Inc., Idaho National Engineering Laboratory, Idaho Falls, Idaho
1989–Present	Chem-Nuclear Geotech, Inc.

Key Projects

Managerial responsibility for a feasibility study under CERCLA for a U. S. Air Force base in Illinois. The site had a variety of hazardous waste problems.

Primary author of a feasibility study under CERCLA for a U. S. Air Force base in Massachusetts. The site had a variety of hazardous waste problems, including groundwater contamination, fuel spill areas, and landfills.

Design oversight for a number of underground storage tank removals at Federal facilities in Colorado and Hawaii.

Conducted studies for the characterization of transuranic (TRU) and mixed radioactive wastes to determine waste volumes and packaging requirements to enable final waste disposal.

Numerous experiments and several publications related to nuclear reactor thermal hydraulics and associated instrumentation.

Craig S. Goodknight

Fields of Competence

Mineral resource assessment; Geologic mapping; Geologic and geohydrologic characterization of hazardous and/or radiologic sites; Project management; Environmental Assessment/Environmental Impact Statement process; and CERCLA RI/FS process

Experience Summary

Eighteen years of varied professional experience including 7 years in uranium exploration and uranium resource evaluation, 2 years of supervision and planning for conducting UMTRA assessment and verification surveys, 3 years of evaluation and management of geologic and mineral resources on Federal lands, and 6 years of radiologic and hazardous waste site (CERCLA RI/FS-related) investigations and geologic feasibility and characterization studies.

Credentials

B.S., Geology, University of Tulsa, Oklahoma

M.S., Geology, University of New Mexico, Albuquerque, New Mexico

Member, Geological Society of America

Member, Association of Engineering Geologists

Member, Rocky Mountain Association of Geologists

Employment History

1974–77	District Geologist, U.S. Bureau of Land Management, Utah and Colorado
1977–86	Geologist and Department Supervisor, Bendix Field Engineering Corp.
1986–90	Principal Scientist and Project Manager, UNC Geotech
1990–Present	Principal Scientist/Geologist, Chem-Nuclear Geotech, Inc.

Key Projects

Project Manager for characterization of two Operable Units of the Denver Radium (Superfund) site that contained radium and thorium contamination commingled with base metals.

Principal Investigator for evaluation of areas favorable for uranium deposits in Colorado, New Mexico, Wyoming, and Nevada for the DOE Uranium Resource Evaluation (NURE) Program; numerous (NURE) publications resulted from this work.

Conducted a study that identified areas that have potential for high indoor radon concentrations based on screening of NURE data and geologic characteristics for the U.S. Environmental Protection Agency (EPA) Regions III and IV.

Supervisor of the Bendix Field Engineering Radiologic Support Department that assessed or characterized uranium mill tailings contamination at properties in Grand Junction, Colorado; Edgemont, South Dakota; and Monticello, Utah. Department responsibilities also included verification surveys that confirmed the tailings-related contamination had been removed to EPA standards.

Conducted geologic investigations/characterizations for hazardous waste sites in Colorado, Texas, and Ohio and for support in geophysical detection of tunnels constructed by the North Koreans along the Demilitarized Zone in South Korea.

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