PRELIMINARY ASSESSMENT
GAY MINE
FORT HALL INDIAN RESERVATION
FORT HALL, IDAHO

APRIL 2, 2003

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0.2 DEFINITIONS

A-12 Pit, C Pit, HH Pit, JD Pit, Z Pit	Gay Mine naming convention: letters indicate mine area, numbers refer to chronological mining sequence
ANFO	ammonium nitrate and fuel oil, a bulk explosive
aquitard	geological layer that resists water movement
BIA	US Department of Interior Bureau of Indian Affairs
bioaccumulator	plant that concentrates chemicals
BLM	US Department of Interior Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR	Code of Federal Regulations
COPC	contaminant of potential concern
COPEC	contaminant of potential ecological concern
DEQ	Idaho Department of Environmental Quality
DRI	Desert Research Institute, University of Nevada
EA	NEPA Environmental Assessment
EE/CA	CERCLA Engineering Evaluation / Cost Analysis
EIS	NEPA Environmental Impact Statement
EPA	US Environmental Protection Agency
ephemeral	flowing only part of the year
FMC	Food Machinery and Chemical Corporation, later FMC Corporation, Chicago, IL
GPM	gallons per minute
hazardous substance	Under CERCLA § 101(14) a " hazardous substance" is any substance that EPA has designated for special consideration under the Clean Air Act, the Clean Water Act, or the Toxic Substance Control Act, and any hazardous waste defined under RCRA. In addition, EPA may designate additional substances as hazardous substances under CERCLA. EPA maintains and updates a list of hazardous substances in 40 CFR Part 302.
macroinvertibtate	large (vs microscopic) animal having no backbone

MMS	US Department of Interior Minerals Management Service
NCP	The National Oil and Hazardous Substance Pollution Contingency Plan. The NCP establishes the major framework that guides the Superfund effort for response to release of hazardous substances.
NEPA	National Environmental Policy Act of 1969
NOAA	US Department of Commerce National Oceanic and Atmospheric Administration
PA	CERCLA Preliminary Assessment
PCB	polychlorinated bi-phenyl
potentiometric	groundwater surface
prill	pellet, e.g., fertilizer
RCRA	Resource Conservation and Recovery Act of 1976
SI	CERCLA Site Investigation
syncline	u-shaped fold in geologic strata
teratogen	substance causing developmental malformations
teratogenesis	production of monstrous growths or fetuses
USFWS	US Department of Interior Fish and Wildlife Service
USDA	US Department of Agriculture
USGS	US Department of Interior Geological Survey

0.3 EXECUTIVE SUMMARY

Overview The Gay Mine is an inactive surface phosphate mine that is located on the Fort Hall Reservation, approximately 25 miles northeast of Pocatello, Idaho, and 16 miles east of Fort Hall (**Figure 1**). Within an area approximately six miles by six miles, the mine encompasses four work areas (Headquarters, North Limb, East Limb, and South Forty), each containing multiple pits, overburden placement areas and waste shale piles. The Gay Mine is the largest mine development in the Southeast Idaho regional phosphate formation (USGS, 2001). It operated between 1946 and 1993 at a peak ore production rate of approximately 2 million tons per year. **Figure 6** depicts the areas mined as a function of time. Ore was hauled by truck, and later by unit train on a dedicated track (Simplot, 1948) to Fort Hall, and from there onward to processing plants near Pocatello.

Based on the review of available documents that was made in this Preliminary Assessment, it appears that releases of hazardous substances to the environment have occurred, and continue to occur, at the Gay Mine. Significant data gaps exist in many disciplines that do not allow development of a conceptual model to understand how these releases affect human health and the environment, or to quantify the level of risk they represent. Although various areas of the mine have been characterized for limited time periods in certain disciplines as permitting requirements dictated and as resources allowed, none of the Gay Mine work areas has been adequately delineated to support CERCLA risk analyses. A CERCLA Site Investigation is recommended to fill these data gaps.

Records Review A file search was performed of available written records, reports, and data possessed by federal, state, local and Tribal entities that pertain to the Gay Mine and its operational history. Records located at the Bureau of Indian Affairs Fort Hall Agency and the Bureau of Land Management Pocatello Regional Office were found to encompass the key issues that are required for CERCLA decision-making. The BIA files include copies of mining and business leases, as well as technical data. The BLM archives include originals and photocopies of leases and royalty calculations, as well as mine plan approvals, inspection reports, operating summaries and mineral and environmental studies that pertain to Gay Mine. **Figure 9** summarizes archived mine and drilling plans as a function of time, and **Figure 10** summarizes archived Gay Mine environmental studies as a function of time. Prior to 1970, although lease and royalty records appear to be complete, mine plans and environmental documentation is fragmentary. No search of the operating companies' corporate records was performed in this PA. A bibliographic reference list is provided in Section 8.0.

Current Land Use The mine area is relatively remote from population, and no permanent residents live in the mine area; however in addition to land held by the Tribes much of the leased mine area land is privately-held ["allotted land"], and has no restrictions on future (e.g., residential) land use. Cattle grazing dominates the current land uses, which also include hunting, fishing, and other outdoor activities, including collecting, gathering, and use of traditional plants.

Owners and Operators The J. R. Simplot Company (Boise, Idaho) leased lands beginning in 1946 to support opening of the mine. In 1956, additional mine leases were initiated by the WestVaco Chemical Products Company (a division of Westvaco that was later purchased by FMC Corporation, Chicago, Illinois). Lands for the mine and facilities were leased from the BIA (on behalf of individual landowners and the Shoshone-Bannock Tribes), and royalties were paid to the beneficiaries. Mining leases were issued by BIA. BLM provided operational oversight for mineral extraction. Business leases supporting the mine were used for road building, ore storage locations, and structures. **Figure 5** provides a typical and representative summary of lease holdings during the middle operating life of the Gay Mine. Boundaries for these leases are presented in **Figure 15.** During the latter term of the mine, leases were jointly held by Simplot and FMC. For all leases, the J. R. Simplot Company performed mining operations throughout the life of the mine, at some times subcontracting the overburden removal to others. A chronological history of mine operations is provided in the PA.

<u>Mine Geology</u> A geologic map of the Gay Mine area is presented in **Figure 3**. All near-surface geologic resources in the Gay Mine area are sedimentary in origin, of Mississippian through Tertiary age. As noted by Schmitt (1967), the mine is located on the southwestern edge of the Idaho-Wyoming fold and thrust belt, a compressional geologic feature of the Laramide (post-Cretaceous) age. The basis for the Gay Mine reserves is a north-trending, south plunging syncline in which phosphate reserves are exposed on both the east and west flanks. The syncline is heavily deformed by normal faults having displacements of 600 feet or more.

Figure 4 presents a typical stratigraphic section for the Gay Mine. "Acid-grade" ore was mined from relatively thin deposits that occurred as much as 150 feet below original grade, and was converted to fertilizer by Simplot. "Furnace-Grade" phosphatic shales and mudstones occurred in two separated, more extensive, sets of strata and were processed to elemental phosphorus by FMC. Extensive blending and stockpiling of ores occurred at the north side of the Headquarters Area of the mine. Ore with marginal phosphate content, generally comprising inter burden between the richer production horizons, was stockpiled for potential future beneficiation and use. These materials are relatively rich in mining-related metals and metalloids, notably selenium, cadmium, and vanadium, which can be oxidized and mobilized after exposure and storage at the surface. Relatively good records exist for the locations, volume, and content of these stockpiled "mill shale wastes" (BLM, 1996, Hagius, 1988). Because the majority of these piles have been reclaimed with cover vegetation, they are a preferred grazing location and source of forage for cattle that graze at the mine. Because of bioaccumulation, these preferred forage areas constitute a dominant risk pathway for grazing livestock and wildlife.

<u>Reclamation Status</u> Mine reclamation has been inconsistent, with some pits well restored and others continuing to present significant hazards (Koehler and Hernandez, 1997). BLM and the BIA documentation regarding Gay Mine reclamation activities that have been undertaken or planned are summarized in *Status* of *Reclamation Compliance at* Gay *Mine, Fort Hall Agency, Idaho,* 1996-1997, (Koehler and Hernandez, 1997), a joint-agency document. This summary notes that "... In general, most of the existing spoils dumps on the lease have been reclaimed to high standards...[but] Much greater deficiencies were found in mining pit sites... Although there are… exceptional examples of exemplary mining reclamation of pits, there are many others that received no post- mining treatment at all." The report makes specific recommendations for all of the Gay Mine Areas, taking account of accepted mine engineering practices.

During the life of the mine, ore with marginal phosphate content was stockpiled for potential future beneficiation and use. Over 27 million tons (BLM, 1996, Hagius, 1988) of these stockpiled "mill shale wastes" remain at the mine. In multiple cases, overburden or waste shale has been placed outside the geographical bounds of the mine leases (EMI, 2002g).

Selenium Selenium is present at elevated levels in Gay Mine ores and mill shale (Section 4, **Tables 1 and 2**). Selenium easily enters metabolic pathways and therefore is highly bioaccumulative (DOI, 1998). At least eleven incidents of fish or wildlife poisoning by selenium, studied in the field, have been documented in the technical literature (DOI, 1998). Selenium poisoning occurs through bioaccumulation by plants of selenium that is brought to the surface and oxidized as part of the mining process. EMI reviewed studies and reports prepared by the Idaho Mining Association relating to selenium contamination from mining activities in Southeastern Idaho, and interviewed task force personnel. Noteworthy is a final report titled *Evaluation* of *Selenium Status In Gay Mine Reclamation Project, Fort Hall, Idaho* produced by Alabama A&M University and the USDA Agricultural Research Service (2000).

Local Selenium Hot Spots Suspected Selenium in its oxidized forms can be highly toxic to animals, and has been the subject of a long-term interagency study in the Southeast Idaho phosphate area. (DEQ, 2002). Almost all plants used for mine land reclamation are selenium bioaccumulators (DEQ, 2002). Available Gay Mine sampling data for selenium in plants and associated soils is summarized in **Table 2**. Horses are susceptible to selenium poisoning (hoof effects, death), as well as sheep (motor functions, reproductive effects, death), and cattle (motor functions, reproductive effects, death). Selenium toxicosis has been documented in sheep and horses in southeast Idaho relating to mine sites (DEQ, 2002). Reproductive effects are suspected, but have not been documented near Gay Mine. On an area-wide basis, the studies to date have concluded a minimal human health risk from selenium, but a strong ecological concern -- significant selenium hot spots in individual mine areas exist, but that have not yet been well characterized (DEQ, 2002). The definition of these hot spots, their potential exposure pathways and their affected populations is important at Gay Mine, where individual parcel land ownership occurs within the mine area, and therefore potential future residential land use is more relevant than at other mines in Southeast Idaho.

Ore Releases Outside Mine Boundary Several instances of train derailments that released ore to the environment were identified. Known derailment locations are depicted in **Figure 7.** In each of these cases, ore was recovered from the site of the mishap, and efforts were made to restore the site to its pre-accident condition. Derailments occurred at multiple locations immediately west of the Headquarters area, frequently as a result of runaway cars during the makeup of unit trains. Additional multiple derailments occurred at the two locations shown further west. At least two of these events involved loss of ore material into the adjacent stream (Broncho, 2002, Hagius, 2003) .

Although no documents were found that identified trucking accidents in the 1946 – 1948 period that may have released ore outside the mine area, or of derailments on the Union Pacific main line between Fort Hall and the processing plant in Pocatello, it is possible that hazardous substances were used in the construction or maintenance of portions of the access road and of the spur line railroad grade outside the mine boundary. Both the access road and the rail grade were primarily built from material that was borrowed from pits along the respective right-of-ways (USDA, 1956). BIA arranged with Simplot to maintain (regrade and surface) the unpaved portion of the road between the end of the pavement on the western side of Danielson Basin to the mine tipple. Red chert was used for this maintenance (Hernandez, 2003).

Mine operating personnel (Broncho, 2002) noted instances in which bottom gates on ore-carrying hopper-cars would not close completely, opening the possibility that (in addition to fugitive losses by wind erosion of the open cars) some ore may have been lost during the rail transit to processing.

Past and Ongoing Releases Available written records have been used to assess past and ongoing releases of potentially harmful substances to the environment. Contaminates Of Potential Ecological Concern (COPECs) are dominated by mining-related metals and metalloids arising from open and reclaimed mill shale piles (selenium and cadmium), but also include hydrocarbons and solvents in limited areas (e.g., Headquarters Area equipment maintenance locations), and the potential for explosives residues (two powder magazines, now empty, remain at the mine). Based on these records, releases have occurred, and appear to be continuing.

Dewatering Effluent Discharges During the final phase of mining, some pits were temporarily dewatered to allow excavation of an additional lift of ore from below the local water table (Hagius, 2002). In such cases, pump output was released nearby onto disturbed areas. A reference in the mine documents (Drilling and Water Test Summary, Sept 13, 1972, Lease 197, Grid B) that such pump output was released to Queedup Spring has been clarified by operations personnel (Hernandez, 2002; Hagius, 2002; Galloway, 2002) to refer to the Queedup Springs *area,* not to the watercourse.

Mining-related Metal Contaminates in Surface Water Mine-related metals and metalloids have been detected in surface water features near Gay Mine. Only limited sampling has been undertaken in the ponds within on-site open pits (all of which are available to grazing cattle and wildlife). However, most of the available samples reveal levels of selenium (e.g., A-12 -Pit lake, Fall, 1997, at 100 ppb; Z-Pit lake, Sept 1998, at 6.2 ppb; JD-Pit lake, Sept 1998, at 5.9 ppb) that exceed the Cold Water Biota Criterion of 5 ppb. The drinking water standard for selenium is 50 ppb. EMI reviewed the Administrative Record for the current Area-Wide Investigation being conducted by the Idaho Department of Environmental Quality. Surface water sampling data that are derived from the Area- Wide Investigation are reported in the PA.

All available Gay Mine stream sample selenium data are summarized in **Table 3,** and the locations where surface water monitoring has been performed are shown in **Figure 13.** A comparison of the original data sources show that most of these samples are for stream flow and bulk physical parameters -- only a very few of these locations were sampled and analyzed for contaminants. Analytical detection limits for selenium have improved with the passage of time so that more recent samples show significant figures in the parts-per-trillion range in contrast to detection limits in the 1-2 ppb range for earlier samples. One stream sample that showed selenium in excess of the Cold Water Biota Criterion of 5 ppb appears to have occurred in Lower Ross Fork Creek, Fall 1984, (6 ppb). Baker Creek below East Limb showed 4.8 ppb in September 1999. Not all mine areas have been characterized; in fact upstream-downstream sample pairs for any mine- related disturbance do not yet exist.

Ephemeral Streams, Springs and Local Snowmelt **Figure 12** compares the monthly water equivalent precipitation at a rain gage near the Gay Mine (Mt. Putnam, 7750ft MSL vs Gay Mine Headquarters 5600 ft MSL) with similar equipment at Fort Hall and a site further upwind on the Snake River Plain. Mt. Putnam gage precipitation is significant, totaling almost twice the amount received in these agricultural areas. Much of this precipitation falls as snow, and is released as snowmelt during the spring and early summer. Sediment sampling in the area's larger streams is summarized in **Table 4**, and reveals sediment selenium concentrations in the 2000 -5000 ppb range. No sampling has been performed to date to characterize mine-related contamination in ephemeral surface water features that may be strongly affected by Gay Mine's disturbed areas or waste storage piles.

<u>Mining-related Metal Contaminates in Groundwater</u> The effect of the Gay Mine on groundwater resources has not been determined. Disturbed areas at Gay Mine occur at both the east and west ends of a north-south oriented syncline approximately 2.5 miles wide, having edges that dip at 15 -30 degrees. Major folding occurs in the North Limb area. The mine area is highly faulted, with several major and numerous minor transverse faults. Although perched water has been found throughout the mined area, the Phosphoria formation is classified as an aquatard, with best water-conducting strata located below, in the Wells formation (Dames and Moore, 1981). The size of the mine and the wide variation in geology and surface topography suggest that separate groundwater studies in each of the Gay Mine working areas are appropriate.

The locations of wells that have been used for groundwater data collection are presented in **Figure 11.** No groundwater wells are known in the East Limb or North limb areas. The South Forty area has been most heavily monitored for water levels, although not for contamination. Groundwater data collection there has consisted of monitoring water levels in wells, and performing slug tests in which the rate of movement of injected water out of wells was measured. These studies have concluded that a wide variability in hydraulic conductivity of the same formation and at different test sites exists, and that the range is large enough that attempts to assign hydraulic coefficients to the formation, based on slug test data, are not valid. Without these baseline parameters, groundwater flow and contaminant transport simulation modeling cannot be undertaken. Although no potentiometric map of the mine area can be completed based on available data, both Dames and Moore (1981) and Brown and Caldwell (1993) made preliminary hypotheses that groundwater flow in the upper aquifers of the Gay Mine may be in a westerly direction. Much work remains to be done to define groundwater flow and contaminant transport in each of the four work areas of the Gay Mine to enable specification of groundwater contamination and development of a cleanup remedy in a Remedial Action Work Plan. Specification of the characterization work that may be needed will be part of the CERCLA Site Investigation (SI) and CERCLA Engineering Evaluation / Cost Analysis (EE/CA) activities that may follow this PA. This observation is consistent with the requirement of the Interagency Selenium Working Group that as a next step in locating selenium hot spots and their impacts, local mine-level groundwater resources need to be defined at each of the Southeast Idaho phosphate mines (DEQ, 2002).

Groundwater from three wells in the Headquarters area was analyzed for selenium and other contaminants by Brown and Caldwell (1993). The wells were not cased nor designed as monitoring wells. Although selenium was detected in all three wells between 5 and 10 ppb, no regional background concentration was established, and efforts to define relationships between the wells and Gay Mine activities were inconclusive. Groundwater that appears as ponds in the mine's excavated pits contains mining-related metals and metalloids, and sampling data for those locations are presented in **Table 5** of Section 4. All available analysis results for Gay Mine groundwater are presented in **Table 6** of Section 4. Sampling to support a comprehensive groundwater characterization is recommended.

The Shoshone-Bannock Tribes have taken drinking water samples at the nearest residential locations on Ross Fork Creek, several miles potentially down-gradient from the mine, with metals concentrations near the detection limit for selenium. Levels were found to be below the 50 ppb drinking water standard (Hernandez, 2002).

<u>Selenium Concentrating Vegetation</u> Selenium easily enters metabolic pathways and therefore is highly bioaccumulative (DOI, 1998). The high propensity for biotic uptake of selenium is at least partially explained by its biochemical similarity to sulfur. Different plant species have widely varying abilities to take selenium from the soil, accumulate it, and tolerate it. Common types of selenium concentrating vegetation include *Astragalus* (loco weed and milkvetch, 24 species) *Machaeranthera* (hoary aster) *Haplopappus* (goldenweed), and *Stanleya* (mustard). These plant species have an extraordinary ability to accumulate selenium and can achieve selenium concentrations of hundreds or even thousands of milligrams per kilogram, dry weight. On seleniforous soils, non-accumulator plants may contain 1-200 mg Se/kg, and selenium accumulator plants contain even higher concentrations (Girling, 1984)

Based on the known margins of safety between normal and toxic dietary exposures, selenium is more poisonous than either arsenic or mercury (Sorensen, 1991). Both deficiency and toxicity cause similar effects: e.g., reproductive depression, anemia, weight loss, and immune dysfunction (Koller and Exon, 1986).

On an area-wide basis, the studies to date have concluded a minimal human health risk from selenium (DEQ, 2002, HHS 2001a, HHS 2001b). Among vertebrates, reproductive toxicity is one of the most sensitive endpoints; however, egg-laying vertebrates such as fish and birds seem to have substantially lower thresholds for reproductive toxicity than placental mammals (DOI, 1998). This may be a special consideration for migratory waterfowl. The quality of habitat for fish and wildlife is closely linked to particular plant communities. Therefore, selenium contamination could impact fish and wildlife populations indirectly if plant communities are altered by its toxic effects.

Selenium is present at elevated levels in Gay Mine ores and mill shale (Section 4, **Tables 1 and 2**). Data from field cases (DOI, 1998) reveal that selenium exposures in the range of 30-50 times normal levels are almost certain to cause widespread *severe* adverse biological effects. Levels in this range have been encountered in the limited Gay Mine mill shale sampling and soil sampling that has been performed to date. At Gay Mine, bioaccumulation processes are likely to increase these concentrations beyond the concentrations found in soils.

<u>Air Pathway</u> Wind erosion of exposed ore piles ("mill shale") and of remaining open pits has not been quantified, but appears to be a less important release mechanism for hazardous substances, given the comparative efficiency of metals bioaccumulation in reclamation vegetation. During the site reconnaissance, wind erosion of exposed ore in the C Pit resulted in visible blowing dust. BLM mine inspection reports and interviews with former mine operating personnel (EMI 2002a, 2002b) both refer to airborne dust from active haul roads and material transfer operations during the time the mine operated. No site-specific air dispersion modeling has been performed that would identify the impact area for wind-blown particulate. Such modeling is recommended to quantify the area and magnitude of airborne transport of hazardous substances. Wind roses for regional sites near Gay Mine are presented in the PA.

Airborne Radioactivity   Although radioactive substances are commonly found as components of phosphate ores (EPA, 1975), and have been detected in Gay Mine ores, no monitoring for airborne radioisotope concentrations at Gay Mine has been performed. Although some gamma data are available, no alpha activity monitoring has been performed at Gay Mine. Monitoring (e.g., gross alpha and gross beta for Radium 226, Radium 228, Radon 222, Uranium, Lead 210, Polonium 210) is recommended to allow quantifying the presence and impacts of these radiological COPECs.

Local Impacts from Hazardous Substances   Multiple instances of limited, local-scale releases of other hazardous substances were identified in the document review, interviews, and site reconnaissance. These releases may constitute local hazards at the mine.

Petroleum   Oil staining was observed in the Headquarters Area in locations near former above-ground oil storage tanks; however, no petroleum staining was observed outside the Headquarters Area. The shop and fuel tank areas, which were known to be sites where significant releases of oils and solvents occurred, have been excavated, followed by landfarming of the petroleum-contaminated soil. Landfarming was declared successful by EPA based on decreased petroleum-in-soil concentrations (Brown and Caldwell, 2000) in June 2000.

The mine used the A-12 pit as a landfill. Although no rigorous characterization or closure under RCRA Subtitle D was undertaken, documentation of closure for that landfill is available. Several drums of what appeared to be used oil remain in the Headquarters Area. Discarded tires are visible in the waste material dumped over the highwall of the open HH pit in the East Limb, and indicate a probability of disposal of additional refuse there.

The use of PCB-containing oil in electrical equipment was investigated by EPA Region 10, who concluded on September 3, 1998, that no PCB-containing oils remained in Gay Mine's electrical facilities. Many fluorescent light fixtures remain in the Headquarters Area buildings and may include PCB-containing ballasts.

Two explosive magazines exist, one in the Headquarters Area and another in the East Limb Area. These structures were emptied of dangerous substances during the development of the PA. Ammonium nitrate and fuel oil (ANFO) was used as a bulk explosive at the mine. A 30-ton capacity bulk ammonium nitrate tank ("prill tower") and a 1000-gallon diesel tank were located in the East Limb area, approximately 2 miles east of the Headquarters area. Soil sampling below the prill tower revealed total petroleum hydrocarbon values as high as 0.884% (8840 mg/kg) within an area of approximately 200 square feet (Brown and Caldwell, 1993). Based on samples taken by Brown and Caldwell, (1993), nitrate-nitrogen values of 4.2 to 175 mg/kg existed in an area approximately 30 feet east of the tank. No cleanup and closure documentation for these areas was found during the development of the PA.

Site Reconnaissance   A site reconnaissance was performed by EMI on May 6, 2002 (EMI 2002c, 2002d). Surface photographs taken during the on-site reconnaissance (EMI 2002d) are provided in the references. Aerial photographs of the various pits within the mine (EM I 2002e) help show the current status and the spatial relationships of the mine components.

Recommended CERCLA Site Boundary Consistent with evidence regarding releases and threats of releases from the Gay Mine within the Fort Hall Reservation, the recommended CERCLA site boundary for the Gay Mine is presented in **Figure 15.** The recommended *Site Boundary* encompasses all Gay Mine leased areas, with their interconnecting roads, as a contiguous parcel. It includes the Gay Mine Headquarters Area, the North Limb and East Limb areas, and the South 40. Reclaimed areas, and areas containing "mill shale" piles are included within the boundary. If the proposed Site Boundary is located downhill from a mine-disturbed area, its placement has been extended at least one-quarter mile downhill from the disturbance to account for potential near-site impacts. The rail spur from the mine tipple to the intersection of the main Union Pacific line rail at Fort Hall is included, with a recommended width of 100 feet on both sides of the centerline. The Gay Mine access road, formerly used as a haul road, from the mine tipple to the former materials loading area on the main Union Pacific line rail at Fort Hall is included, with a recommended width of 100 feet on both sides of the centerline. The entire Union Pacific rail track on reservation lands from Fort Hall town site to the processing plants is also included, with a width of 100 feet on both sides of the centerline. Surface water features that cross mine disturbed areas are extended to a distance of 2 miles downstream of the site boundary. The stream segment study area boundaries that are shown on the map follow stream centerlines, and are not to scale. The designated stream segments include all areas of riparian vegetation that are associated with the stream segment. The 2 mile distance criteria is a current best estimate of the downstream range of detectable contamination in sediment or aquatic vegetation, and is subject to modification when sampling data become available.

All analytical data that report or relate to releases or threats of releases of hazardous substances at the Gay Mine are summarized in the data tables in Section 4.0 of the PA. Data that describe potential migration pathways for these substances and potential receptors (human and ecological) impacted by these substances have been included.

Interviews EMI interviewed individuals who, by working experience at the mine or their involvement in natural resource agencies, were in a position to provide helpful information for the development of the PA. These parties included employees of the BIA Fort Hall Agency, the BLM Pocatello Regional office, the Shoshone-Bannock Tribes Land Use Commission, and the Idaho Department of Environmental Quality's project manager for the area- wide investigation, as well as former mine employees. Summaries of these interviews are included as references.

Soils A soils survey of the Fort Hall Reservation (McDole et al. 1977) was performed by US Soil Conservation Service and the Bureau of Indian Affairs. It included a general description of soils in the Gay Mine area. Dames and Moore (1981) completed a comprehensive study and definition of soils in the South Forty area to support planned mine expansion. No soils data have been identified that characterize for CERCLA purposes the in-place soils that exist in Gay Mine disturbed areas, with or without reclamation. Such data are likely to be a required component of vegetation studies that address the soil-plant-grazing animal pathway for exposure to hazardous substances. Characterization of Gay Mine soils, undisturbed and re-claimed, with respect to run-off and leaching is recommended.

Vegetation A general vegetation survey was performed at Gay Mine (Dames and Moore, 1981) that defined general vegetation communities, noxious weeds, and threatened and endangered plant species. A separate Threatened and Endangered Plant survey specifically for the Gay Mine Expansion [South Forty] area was performed by Mariah

Associates, Inc. (1980), following a 1978 botanical survey of the Group II Expansion leases (west-central East Limb) that was performed by D. Terrance Booth (cited: Dames and Moore, 1981). At that time, none of the surveys found evidence of listed or proposed plant species; however, new plants have been added to the endangered species listings since that time. No vegetation surveys have been identified that address riparian vegetation or vegetation that exists in Gay Mine disturbed areas, with or without reclamation. Such data are likely to be required to address the soil, plant, animal, and human pathways for exposure to hazardous substances.

Wildlife Based on literature and knowledge of the available habitats, Dames and Moore, (1981) speculated that 60 species of mammals, 166 species of birds, 10 species of reptiles, and 5 species of amphibians may utilize habitat in the Gay Mine area at some time during the year. To the Shoshone-Bannock Tribes and to tribal members, these resources have a value that reflects their cultural, spiritual, medicinal and subsistence usage. Tribal members have noted that all animals possess significant cultural and natural values. Wildlife occurring in the Gay Mine area were surveyed in 1978 by Mariah Associates (1978) and by Dames and Moore (1981). A threatened and endangered bird survey was performed by Mariah Associates (1978) for the 400 square mile Gay Mine regional area. Mariah Associates also included an assessment of fisheries and wildlife in each of four monitoring reports for the Gay Mine Expansion [South Forty] area (Mariah Associates, 1989, 1990, 1991, 1992). Each of these short-duration studies was designed to document numbers of wild animals within or crossing a limited area of the mine. The fisheries studies documented a decrease in fish populations in Ross Fork Creek. No wildlife studies have been identified that focus on potential affects to wildlife that may result from releases of hazardous substances. Exposures and pathways pertaining to wildlife need to be identified. The area-wide selenium study concludes that (with one possible exception) no population-wide impacts in wildlife due to selenium have been noted, although local, site specific impacts are likely, especially when viewed in the short term (DEQ, 2002). Defining such impacts to wildlife is required to understand Gay Mine impacts to the total ecosystem.

Recommendations for CERCLA Site Investigation Based on the review of available documents that was made in this Preliminary Assessment, it appears that releases of hazardous substances to the environment have occurred, and continue to occur, at the Gay Mine. Significant data gaps exist in many disciplines that do not allow development of a conceptual model to understand how these releases affect human health and the environment, or to quantify the level of risk they represent. Although various areas of the mine have been characterized for limited time periods in certain disciplines as permitting requirements dictated and as resources allowed, none of the Gay Mine work areas has been adequately delineated to support CERCLA risk analyses. A CERCLA Site Investigation is recommended to fill these data gaps.

The Gay Mine's potential future land uses will include cattle and sheep grazing, hunting, fishing, and gathering, collecting, and use of traditional plants. In contrast to other Southeast Idaho mines, the possibility exists for residential land use in the Gay Mine area, given individual land ownership there. Therefore, all elements of the Site Investigation should be performed in the context of long-term individual land ownership that exists within the mine area.

Available data demonstrate that mill shales, relatively rich in selenium, were brought to the surface as part of the mining process and are stored in surface piles (many reclaimed with vegetation) in large volumes at Gay Mine. There, selenium is oxidized by exposure to air and water, becoming both toxic and mobile. Precipitation and significant snowmelt may act to transport the material to surrounding waters and soils.

Vegetation planted during the mined-land reclamation process has become a magnet to grazing cattle and wildlife. These plants are known to be effective bioaccumulators of selenium, concentrating it for any animals that use the vegetation for forage, with resulting risks to wildlife and the environment.

The Site Investigation should address, but is not limited to, the following issues:

- Action Levels The SI should develop and define action levels, consistent with other area-wide studies, for hazardous substances in each of the environmental media. Special consideration should be given for cultural significance.

- Sources The chemical forms (i.e., speciation, oxidation state) of Contaminates of Potential Ecological Concern need to be defined and related to sources at the Gay Mine.

- Surface Water A comprehensive characterization of all Gay Mine surface waters is needed to identify hot spots for selenium and other hazardous substances in individual stream segments and ponds. Surface water impacts to sediments, and sediment and water impacts to vegetation need to be quantified. Monitoring needs to be correlated (e.g., upstream and downstream) to mine features that are determined to be potential sources of selenium, cadmium, nickel, or other hazardous substances.

- Groundwater Groundwater resources need to be characterized for each of the four Gay Mine working areas. The groundwater gradient needs to be defined to support the development of groundwater flow and contaminant transport modeling. Because of the high cost of monitoring well development, groundwater resources that are currently used or planned for use should be identified and used to guide the prioritization of resources. As part of this effort, water quality should be determined for seeps, springs, and areas of snowmelt, in areas related to the Gay Mine, as well as in the mine pit lakes.

- Soils Soils that exist in the Gay Mine areas (undisturbed, reclaimed, and near the CERCLA site boundary) need to be defined and characterized as a required prerequisite for vegetation studies that address the soil, plant, animal, and human pathways for exposure to hazardous substances.

- Air Additional air dispersion modeling and ambient air studies should be performed to determine the extent of mine dust distribution, and its relationship to bioaccumulation. These studies should include an assessment of alpha radioactivity dose from mine-related particulate dispersion.

- Vegetation Vegetation studies to define damage to resources and to define bioaccumulation and food-chain effects should be performed on aquatic and terrestrial biota on mined-land reclamation areas, as well as on naturally- reclaimed mine areas. Such studies should address the use of traditional plants by tribal members for cultural and medicinal purposes. The scope of the vegetation study should include the area of wind-blown dust distribution, as determined by the air dispersion study.

- Livestock Grazing The SI should include studies of cattle, horses, and sheep grazing. Controlled studies of grazing female cattle should be included to evaluate the effects of selenium on reproduction.

- Wildlife Uses The SI should include studies of Gay Mine-related wildlife use by Fort Hall Indians, and of most commonly used wildlife harvest scenarios. Impacts of COPECs on wildlife and migratory waterfowl should be defined.

- Cultural Uses An assessment of cultural uses of the Gay Mine area, as well as the risks associated with such use, supported by interviews, should be included in the SI.

Date: April 2, 2003

Prepared by: EMI Services
Norman R. Ricks, Project Manager

Site: GAY MINE
FORT HALL INDIAN RESERVATION
FORT HALL, IDAHO

EPA ID No. n/a
TDD No. n/a

1.0 INTRODUCTION and PURPOSE

Based on the review of available documents that was made in this Preliminary Assessment, it appears that releases of hazardous substances to the environment have occurred, and continue to occur, at the Gay Mine. Significant data gaps exist in many disciplines that do not allow development of a conceptual model to understand how these releases affect human health and the environment, or to quantify the level of risk they represent. Although various areas of the mine have been characterized for limited time periods in certain disciplines as permitting requirements dictated and as resources allowed, none of the Gay Mine work areas has been adequately delineated to support CERCLA risk analyses. A CERCLA Site Investigation is recommended to fill these data gaps.

This Preliminary Assessment (PA) was performed at the request of the Bureau of Indian Affairs (BIA) Office of Trust Responsibilities. Its purpose is to provide an evaluation of the Gay Mine with respect to past, present, and on-going release or threats of release of substances harmful to the environment. The evaluation methods used were:

1. A review of documentation associated with the mine
2. Discussions and interviews with individuals who have specific knowledge of mining operations
3. A site reconnaissance

This PA was performed using the *EPA Guidance for Performing Preliminary Assessments Under CERCLA* (EPA, 1991). Specific actions performed as part of the PA included:

1. Available written records, reports, and data were searched to assess what is known about the Gay Mine and its operational history. Corporations and individuals who were directly involved with ownership and operation of the mine are named. A chronological history (Section 2.2.2) of the mine is provided.
2. A review of the Administrative Record for the Area Wide Assessment of Phosphate Mines in Southeast Idaho was conducted, and all data pertinent to the Gay Mine are summarized.
3. Maps (EMI, 2002f), diagrams, and photographs (EMI, 2002d, 2002e) are included to show the geographic setting of the mine and conditions there.
4. A suggestion for a site boundary is included (Section 5.0, Figure 15).
5. Analytical data from samples taken on the Gay Mine site are cited and summarized (Section 4.0).

6. A summary of reclamation at the site is presented (Section 2.2.4).
7. A Hazard Ranking Score was not developed for this site because CERCLA remediation is being negotiated without an NPL listing; therefore data collection and presentation are not formatted for NPL scoring.
8. A recommendation for further action is provided (Section 6.0).

The site was visited for familiarization purposes on April 8, 2002 with officials of the BIA. The Site Reconnaissance (EMI, 2002d) was conducted on May 6, 2002. A set of aerial photographs (EMI, 2002e) were obtained on June 20, 2002. References include the field logbook (EMI, 2002c) used for the PA.

Ore from Gay Mine was processed by Simplot and FMC into fertilizer and elemental phosphorus, respectively, at adjacent processing facilities near Pocatello. The processing sites constitute a portion of the Eastern Michaud Flats Superfund site, for which a large amount of characterization work has been performed, and for which a remedial strategy is being approved. The reader is referred to the Michaud Flats CERCLA documents (e.g., EPA, 1998a) for comprehensive summaries of phosphate-related Contaminants of Potential Ecological Concern (COPECs) and risk assessments that are applicable to Gay Mine materials during processing.

2.0 BACKGROUND

2.1 Gay Mine Location, Physical and Geological Description

2.1.1 Location

The Gay Mine is an inactive surface phosphate mine that is located on the Fort Hall Indian Reservation (Fort Hall Reservation), approximately 25 miles northeast of Pocatello, and 16 miles east of Fort Hall, Idaho (**Figure 1**). The mine is located in parts of Townships 4 and 5 South, Ranges 37 and 38 East, Boise Meridian, on the north end of the Portneuf Mountain Range, and the east edge of the Upper Snake River Plain. The Gay Mine is depicted on the *Lincoln Peak, Idaho* and the *Yandell Springs, Idaho* USGS 7.5 minute Quadrangle maps.

2.1.2 Physical Description

The mine's setting is moderately steep sloping hills descending into long, gently sloping ridges and draws which trend in a general east west direction, usually normal to the strike of the strata. Elevations within the mine lease area range from 5400 feet to 6200 feet above sea level. The physical setting of the mine is exemplified in **Figure 2**, an aerial photo of the central mine area viewed to the south. Additional aerial photos of all areas of the mine are available in the reference material (EMI 2002e).

Source: EMI 6-20-02 Roll 2, Frame 22 File 5

Figure 2
Perspective View to 5 of Gay Mine

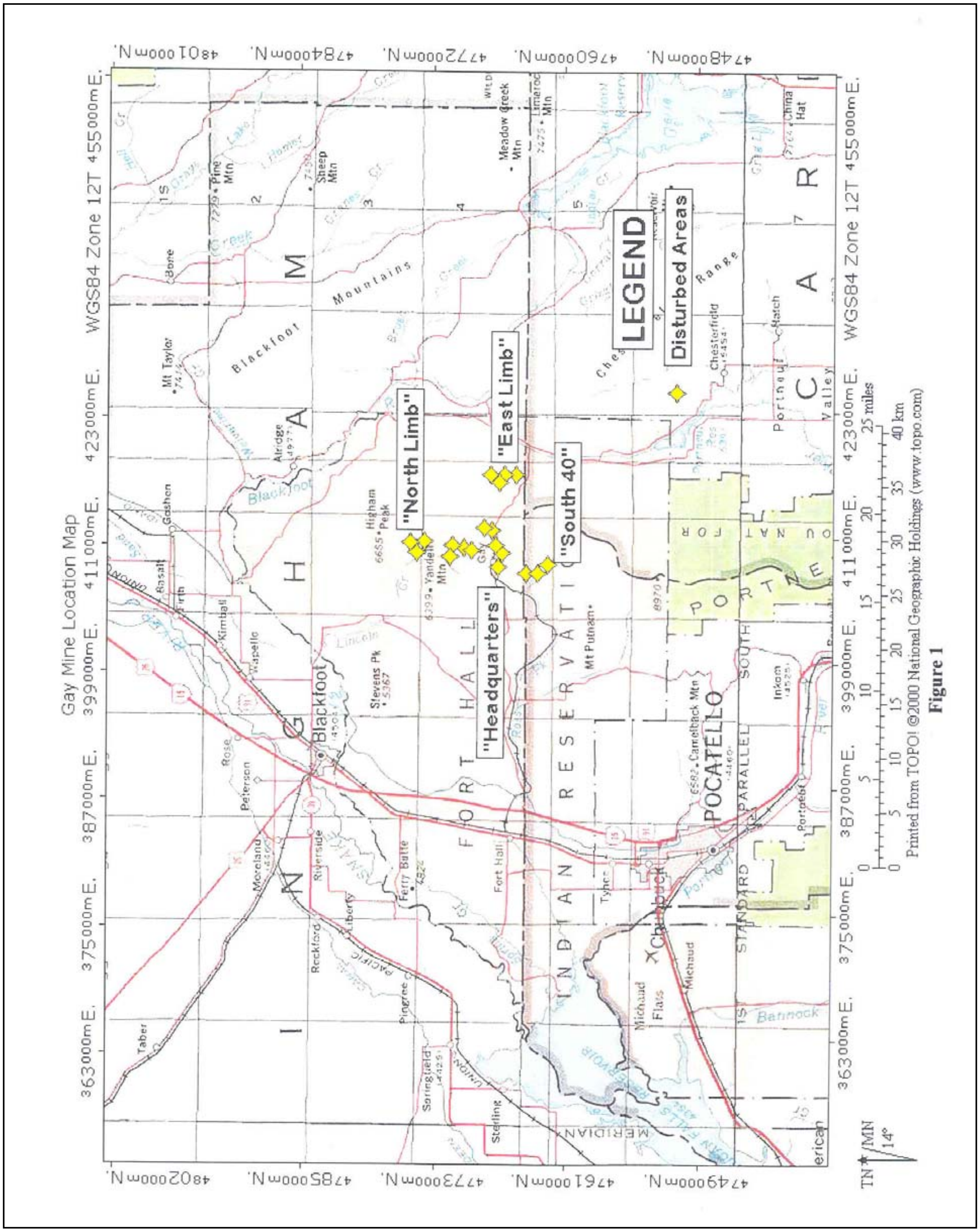


Figure 1
Gay Mine Location Map

The Gay Mine is the largest mine development in the Southeast Idaho regional phosphate formation (USGS, 2001) and is also the longest (47 years) operating. 4694 acres are disturbed at Gay Mine, versus the next largest mine (Conda Mine) at about 1490 acres (USGS, 2001). Within an area approximately six miles by six miles, the mine encompasses four work areas (Headquarters, North Limb, East Limb, and South Forty), each containing multiple pits, overburden placement areas and waste shale piles. Mine pit sizes ranged from 15 to 20 acres to as large as 50 acres, with depths of 250 to 300 feet below local grade.

2.1.3 Current Land Use

The mine area is in a rural mountain setting, and no permanent residents live in the mine area; however much of the mine area land is privately-held, and has no restrictions on future (e.g., residential) land use. Cattle grazing dominates the current land uses, which also include sheep grazing, hunting, fishing, and gathering, collecting, and use of traditional plants, and other outdoor activities.

2.1.4 Climate

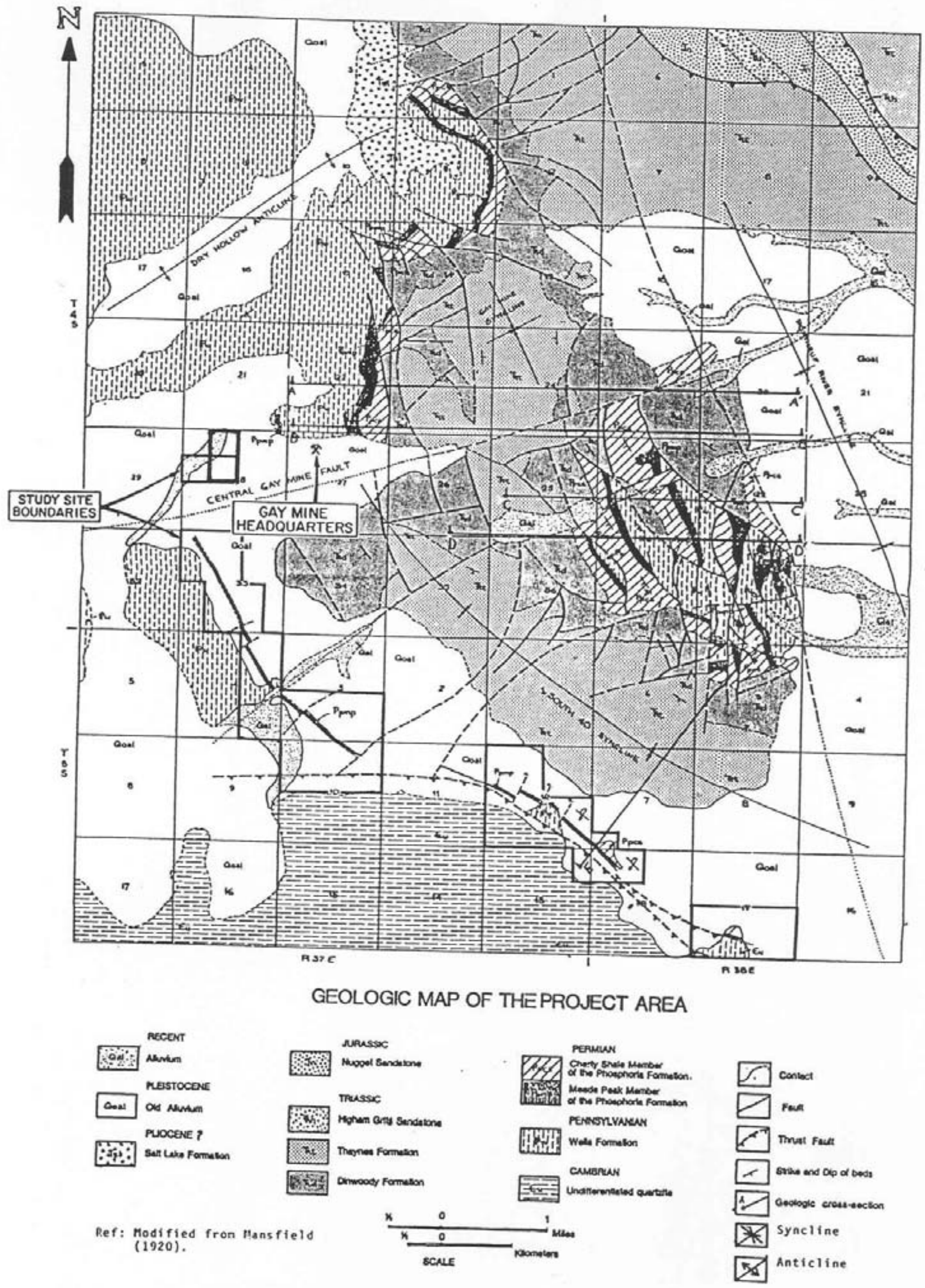
The climate at Gay Mine is classified as semi-arid. The primary vegetation types are sagebrush, aspen, juniper, and a variety of grasses. Because the mine site is on elevated terrain it receives almost twice the annual precipitation of nearby stations on the Snake River Plain. Mean monthly precipitation is heaviest in May at 1.52 inches, and lightest in July at 0.58 inches, with an annual total of 16 inches. Average snowfall is heaviest in January (6.5 inches) and December (5.1 inches), based on 1948-2001 period of record. Total snowfall averages 57 inches (as snow) per year. Average maximum daily temperatures range from 33 degrees Fahrenheit in January to 87 degrees Fahrenheit in July. Average minimum temperatures range from 13 degrees Fahrenheit in January to 51 degrees Fahrenheit in July (BIA, 2002, DRI, 2002). A comprehensive climatology of southeastern Idaho (NOAA, 1989), including evapotranspiration and atmospheric dispersion data, is available to complement the 14-year period of record of meteorological data at the mine site.

2.1.5 Geological Description

A geologic map of the Gay Mine area is presented in **Figure 3**. All near-surface geologic resources in the Gay Mine area are sedimentary in origin, of Mississippian through Tertiary age. As noted by Schmitt (1967), the mine is located on the southwestern edge of the Idaho-Wyoming fold and thrust belt, a compressional geologic feature of the laramide (post-Cretaceous) age. The basis for the Gay Mine reserves is a north-trending, south plunging syncline in which phosphate reserves are exposed on both the east and west flanks. The syncline is heavily deformed by normal faults having displacements of 600 feet or more.

<u>Structural Features</u> At the Gay Mine, the Phosphoria Formation outcrops both on the east and west limbs of a north-south striking, south-plunging, syncline which has a breadth of 2 1/2 miles. Each limb of the syncline dips at approximately 15-30 degrees. The syncline is intersected by normal faults which have displacements of 600 feet and greater. Associated with these faults are numerous minor normal faults that complicated the mining of ore horizons and necessitated a close order (50-foot spacing) drill hole grid in the pits to formulate mining procedures and to maintain ore grade. Thrust faulting is a minor structural feature that occurs within the Phosphoria Formation, having displacements of less than 50 feet. However, there is one major thrust zone on the north-west end of the Gay Mine. Here, the Grandeur limestone was thrust over the Phosphoria, but this is not typical of the mine as a whole.

Geologic Map of the Gay Mine



Source: Dames and Moore, 1981

Figure 3

Figure 3
Geologic Map of the Gay Mine

Typically the Rex Chert member of the Phosphoria Formation lies stratigraphically on top of the Mead Peak, ore bearing, member of the Phosphoria Formation. In the Fort Hall / Gay Mine Region of Southeast Idaho, The Rex Chert member is generally considered absent from this section. It has both a naturally-occurring decreased presence and a naturally-occurring decreased exposure.

In most areas of Southeast Idaho the Rex Chert is composed of 50-100 feet of black chert mixed with limestone and massive red chert that combine to form conspicuous ridges and outcrops. This unit is covered by the Cherty Shale member. They are similar, but the Cherty Shale member contains more mudstone and siltstone.

In the Gay Mine area, due to naturally-occurring facies changes, the Rex Chert member of the Phosphoria Formation is much thinner, less distinctive, and composed of more mud and silt than in other areas. It is not just overlain by the Cherty Shale unit, but is often replaced by it (McKelvey, 1959). The Rex Chert is also naturally less exposed at Gay Mine than at some of the other mines. In areas where the stratigraphy is generally flat lying, the higher clay and silt content has increased the erosion of the chert and thus naturally decreased its exposure. Due to natural compression and folding of strata in this area, some of the pits at the Gay Mine area have overturned stratigraphy where the chert is below the ore zones and not exposed at the surface or in the pits.

<u>Stratigraphic Section of the Meade Peak Member</u> **Figure 4** presents a typical stratigraphic section for the Gay Mine. "Acid-grade" ore was mined from relatively thin deposits that occurred as much as 150 feet below original grade, and was converted to fertilizer by Simplot. "Furnace-Grade" phosphatic shales and mudstones occurred in two separated, more extensive, sets of strata and was processed to elemental phosphorus by FMC.

The Mead Peak phosphatic shale member consists of about 145 feet of siltstone, phosphatic mudstone, phosphatic shale, dolomitic limestone, phosphorite, and chert. It is overlain by the cherty mudstone of the Rex Chert Member, and it is underlain by the Grandeur Member of the Park City Formation. The Mead Peak Member at the Gay Mine can be divided into the following mappable units (Schmitt, 1967), listed in order of increasing depth:

- Upper siltstone.
- Upper phosphatic mudstone
- Middle siltstone
- Lower phosphatic mudstone
- Limestone false cap rock
- Phosphatic shale
- Limestone cap rock
- Main "A" bed phosphorite
- Footwall limestone

Because of erosion, varying amounts of the upper strata may be missing. The following descriptions of the beds in the Mead Peak Member of the Phosphoria Formation was developed by N. E. Lehman of Simplot, as cited in Schmitt (1967). In the text that follows, the discussion begins with the bottom unit of the phosphate member and works up:

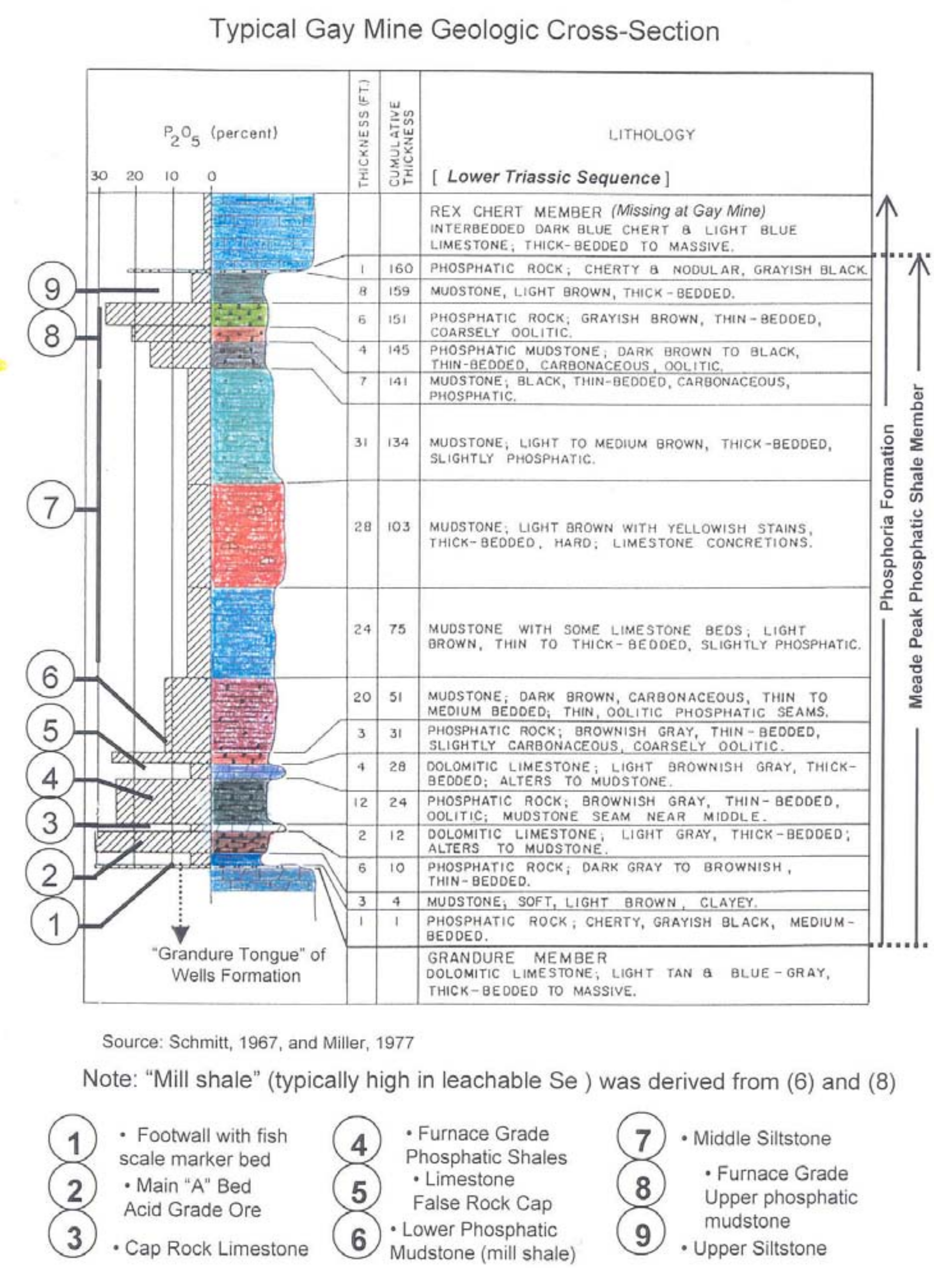


Figure 4

Figure 4
Stratigraphic Section for the Gay Mine

1 FOOTWALL

This is the bottom unit of the phosphate member and may have a discontinuous contact with the underlying Grandeur Member of the Park City [limestone] Formation. It ranges from 11 to 14 feet in thickness. The "fish scale" phosphorite marker bed is usually found at the base of this unit. Overlying this marker bed there are about 8 feet of interbedded siliceous limestones and black chert, followed by 2 to 5 feet of siltstone grading into the overlying lower one foot of the main bed of phosphorite.

2 MAIN BED OR "A" BED PHOSPHORITE

This zone ranges from 3 to 6 feet in thickness and from 29 to 36 percent P_2O_5 (acid-grade ore) where it has not been deformed or crushed by faulting. Thrust faulting at the top and bottom of this zone is common because of the brittle nature of the rock. The bed is oolitic and is easily recognized as high-grade phosphate ore.

3 LIMESTONE CAP ROCK

“Limestone Cap Rock” is the name given to a small layer within the lower ore of the Mead Peak member of the Phosphoria Formation. It ranges in thickness from 1 to 6 feet. It is not a true, clean limestone. It is muddy and silty and contains just enough carbonate (CO_3) material to distinguish itself from the Mead Peak. As **Figure 4** shows, it does contain a small amount (3-13%) of P_2O_5. The more weathered the bed is, the more phosphate it contains. Depending on many factors, some companies still include the “Limestone Cap” with the ore, and some, where possible, segregate it out.

4 PHOSPHATIC SHALES

The thickness of the phosphatic shale zone ranges from 17 to 24 feet and averages from about 22 to 27 percent P_2O_5. It was mined as furnace-grade shales. If the shales have been weathered or leached, the lower part of the unit is gradational with the underlying limestone cap rock. In areas where there has been no leaching there is about 2 1/2 feet of argillaceous limestone about 13 feet above the base of the section, along with interbedded and concretionary limestone. The upper 1 1/2 feet of the zone consists of thin beds of cherty phosphorite, up to 32 percent P_2O_5, that are used as marker beds to distinguish the limestone false cap rock from other limestone beds that are present in the lower phosphatic mudstone zone.

5 LIMESTONE FALSE CAP ROCK

This cap rock usually consists of from 3 inches of clayey material to 3 1/2 feet of hard, white, fossiliferous dolomitic limestone occurring between cherty phosphate beds. In highly weathered areas where the phosphate content has been concentrated by leaching, the cap rock was mined with the phosphatic shale zone.

6 LOWER PHOSPHATIC MUDSTONE

This zone is about 30 feet thick and averages about 14 to 20 percent P_2O_5. It was mined as low-grade phosphatic shales and was stockpiled as *"mill shale"* for future use. In some cases, the lower 6 to 10 feet was high enough in P_2O_5 to be mined as furnace-grade phosphatic shale. A 0.2-foot thin layer of black carbonaceous mudstone, identifiable in most sections of the Gay Mine, occurs about 6 to 8 feet above the limestone false cap rock.

7 MIDDLE SILTSTONE

This zone is about 22 feet thick and can be recognized by its banding and tan color. The section contains a 1 1/2-foot bed of phosphorite but the average grade of the zone rarely exceeds 10 percent P_2O_5.

8 UPPER PHOSPHATIC MUDSTONE

This zone is 30-40 feet thick and resembles the lower phosphatic mudstone and interbedded limestone, averaging about 13 to 17 percent P_2O_5. At the top of the zone there is 4 feet of phosphorite (the "hanging wall") averaging about 26 percent P_2O_5, but dilution from the overlying siltstones usually prevented its recovery as ore. At the base of the zone there is a 4-foot (the "buckshot" phosphorite) section averaging 22 to 26 percent P_2O_5. Where possible, it was mined as ore.

9 UPPER SILTSTONE

This zone is similar in color and banding to the middle siltstones, and is 12 to 25 feet in thickness. It contains no appreciable amount of phosphate.

Extensive blending and stockpiling of ores occurred at the north side of the Headquarters Area of the mine. Ore with marginal phosphate content, generally comprising inter burden between the richer production horizons, was stockpiled for potential future beneficiation and use. These substances are relatively rich in mining-related metals or metalloids, notably selenium, cadmium, and vanadium, that can be oxidized and mobilized after exposure and storage at the surface. Relatively good records exist for the locations, volume, and content of these stockpiled "mill shale wastes". (BLM, 1996, Hagius, 1988). Because the majority of these piles have been reclaimed with cover vegetation, they are a preferred grazing location and source of forage for cattle that graze at the mine. Because of bioaccumulation of metals in the plants, these preferred forage areas constitute the dominant risk pathway for grazing livestock and wildlife.

Selenium Geology Selenium characteristics and the origins of selenium geology have been summarized in DOI (1998)

> “Selenium is a semi-metallic trace element which has biochemical properties similar to sulfur. The pure element most often appears as lustrous trigonal crystals of gray selenium. Other common forms include a dark red powder; the glassy, dark brown vitrous selenium; and dense monoclinic crystals of red selenium, but these are all less stable than the gray variety and tend to convert to it over time. The most common selenium compounds in natural waters are selenious acid (H_2SeO_3) and selenic acid (H_2SeO_4), which correspond, respectively, to the salts selenite (Se^{+4}) and selenate (Se^{+6}). Certain metals and organic selenides (Se^{-2}) are also common in some environments, such as bottom sediments.
>
> “Selenium is widely distributed in rocks, soils, water, and living organisms. In the Western United States, it is common in the upper Cretaceous and Tertiary marine sedimentary rocks (Seiler, 1997). Many geologic formations are seleniferous and capable of contributing to the mobile forms of selenium in soils. Selenium is highly mobile and biologically available in arid regions having alkaline soils – conditions typical of the Western United States. A number of plants such as *Astragalus* (loco weed and milkvetch) can concentrate selenium extracted from the soil into a biologically available form, which is toxic to livestock when eaten (Hedlund, 1993)”

2.2 Gay Mine History

2.2.1 Ownership History

The Simplot Fertilizer Company, now known as the J. R. Simplot Company (Boise, Idaho) leased lands beginning in 1946 to support opening of the mine. In 1956, additional mine leases were initiated by the Westvaco Chemical Products Company (a division of Westvaco that was later purchased by FMC Corporation, Chicago, Illinois). Lands for the mine and facilities were leased from the BIA (on behalf of individual landowners and the Shoshone- Bannock Tribes), and royalties were paid to the beneficiaries. Mining leases were issued by BIA. BLM provided operational oversight for mineral extraction. Business leases supporting the mine were used for road building, ore storage locations, and structures. **Figure 5** provides a representative summary of lease holdings during the middle operating life of the Gay Mine. Boundaries for these leases are presented in **Figure 15**. During the latter term of the mine, leases were jointly held by Simplot and FMC. For all leases, the J. R. Simplot Company performed mining operations throughout the life of the mine, sometimes subcontracting overburden [mill shale] stripping and hauling.

2.2.2 Mining and Operational History

Mining was performed between 1946 and 1993 at a peak ore production rate of approximately 2 million tons per year. The Headquarters area was the initial (1946) area mined. It encompasses mine offices, a railcar loading tipple, scales, and maintenance and support facilities in addition to mine pits. Mining proceeded northward into the North Limb area in the early 1950s. The East Limb was opened in 1955, and the South Forty Area was opened for mining in 1986. Shortly before termination of mining operations in 1993, the rail spur in the Headquarters area was repositioned to allow opening of new pits in that area, near the positions of the original mining activity. **Figure 6** depicts the areas mined as a function of time. Annual ore production reached 2 million tons at peak extraction rates in the 1970s. Production in 1991 had declined to 1.3 million tons annually.

In 1983, Simplot opened the Smokey Canyon Mine and in 1991 began shipment of ore from that mine via slurry pipeline to Simplot's Pocatello processing facility. FMC bought the remaining ore reserves at Gay Mine as part of that transition. Mining was terminated prior to July 7, 1993, based on a letter from FMC and Simplot to the BIA dated July 11, 1996. The last ore was shipped in September, 1993.

During operation of the mine, multiple pits were mined in parallel. In many cases, waste rock (overburden) removed to open an active pit was used to backfill other pits. This backfilling sequence continued as the mining progressed. Red chert was used for access road maintenance (Hernandez, 2003). After removal of the upper phosphorite ore strata, interburden shales (called "mill shale", and having less than 19% phosphorite content) were mined and stored above ground in anticipation of improved market conditions that would make their processing cost-effective. There are forty-one (41) mill shale piles on the Gay Mine site, containing 27,049,743 tons of material. Within the southeast Idaho phosphate mining area, mill shale accumulation and storage is unique to Gay Mine.

Because winter temperatures at Gay Mine caused the moisture in the ore to freeze within the rail cars and prevent unloading, year-round loading and shipment of ore was precluded.

	Gay Mine Pit and Stockpile Chronology 1955- 1972									
								approximate		
Mine Allotment	Stockpile	Pit	Start	End		Mine Allotment	Stockpile	Pit	Start	End
J.R. Simplot Co.	M-1/L-2		55	55		FMC Corporation	DD-2	U-1	64	69
J.R. Simplot Co.	A-2		56	56		FMC Corporation	DD-2	X-2	64	69
J.R. Simplot Co.	A-3		57	57		FMC Corporation	DD-2	X-3	64	69
J.R. Simplot Co.	I-1		57	57		FMC Corporation	DD-2	Y-2	64	69
J.R. Simplot Co.	I-2		57	57		FMC Corporation	DD-2	XX-2	64	69
J.R. Simplot Co.	I-3		57	57		FMC Corporation	DD-2	T-1	64	69
FMC Corporation	II-2	NN-1	57	57		FMC Corporation	DD-2	Z-2	64	69
FMC Corporation	II-2	OO-5	57	57		J.R. Simplot Co.	C-1		65	66
FMC Corporation	II-2	II-5	57	57		FMC Corporation	HH-3	HH-3	65	71
J.R. Simplot Co.	P-2	P-2	57	57		FMC Corporation	HH-4	GG-1	65	71
J.R. Simplot Co.	M-2		58	62		FMC Corporation	HH-4	GG-3	65	71
J.R. Simplot Co.	A-5		59	61		FMC Corporation	HH-4	HH-2	65	71
J.R. Simplot Co.	B-2	II-5	59	59		FMC Corporation	HH-4	XX-1	65	71
J.R. Simplot Co.	B-2	NN-1	59	59		J.R. Simplot Co.	W-2		65	68
J.R. Simplot Co.	B-2	NN-2	59	59		FMC Corporation	LL-2		67	68
J.R. Simplot Co.	B-4		59	59		FMC Corporation	BB-2		68	70
J.R. Simplot Co.	M-3	O-2	59	63		FMC Corporation	QQ-1		68	69
J.R. Simplot Co.	M-3	O-5	59	63		FMC Corporation	QQ-2		69	70
J.R. Simplot Co.	O-1	O-1	59	59		FMC Corporation	AA-6		70	70
J.R. Simplot Co.	O-1	O-2	59	59		J.R. Simplot Co.	M-4	O-2	70	71
J.R. Simplot Co.	O-1	O-3	59	59		J.R. Simplot Co.	M-4	O-6	70	71
J.R. Simplot Co.	B-2	OO-4	59	59		J.R. Simplot Co.	M-4	R-2	70	71
J.R. Simplot Co.	C-2		60	60		J.R. Simplot Co.	M-5	M-7	71	71
J.R. Simplot Co.	C-2A	Z-2	60	60		FMC Corporation	BB-3	II-1	72	
J.R. Simplot Co.	C-3		60	60		FMC Corporation	BB-3	II-3	72	
J.R. Simplot Co.	K-2	K-1	60	61		FMC Corporation	BB-3	II-4	72	
J.R. Simplot Co.	K-2	K-260	60	61		FMC Corporation	BB-3	II-5	72	
J.R. Simplot Co.	K-2	K-261	60	61		FMC Corporation	BB-3	BB-3	72	
J.R. Simplot Co.	K-2	K-4	60	61		FMC Corporation	BB-3	BB-4	72	
J.R. Simplot Co.	K-2	LL-3	60	61		FMC Corporation	BB-3	OO-3	72	
J.R. Simplot Co.	O-2	M-4	60	61		FMC Corporation	BB-3	OO-4	72	
J.R. Simplot Co.	O-2	M-5	60	61		FMC Corporation	BB-3	AF-1	72	
J.R. Simplot Co.	O-2	M-6	60	61		FMC Corporation	BB-3	XX-4	72	
J.R. Simplot Co.	O-2	M-7	60	61		J.R. Simplot Co.	F-6	Z-2		
J.R. Simplot Co.	G-2	JG-1	61	65		J.R. Simplot Co.	J-2	JG-1		
J.R. Simplot Co.	G-2	JH-1	61	65		J.R. Simplot Co.	J-2	JH-1		
FMC Corporation	DD-1		64	69		J.R. Simplot Co.	I-2(S-1 Bas	JG-1		
FMC Corporation	DD-2	DD-2	64	69		J.R. Simplot Co.	I-2(S-1 Bas	JH-1		
FMC Corporation	DD-2	DD-6	64	69		J.R. Simplot Co.	T-2	Z-2		
FMC Corporation	DD-2	DD-3	64	69		J.R. Simplot Co.	T-2	X-3		
FMC Corporation	DD-2	DD-5	64	69		J.R. Simplot Co.	T-2	X-4		
FMC Corporation	DD-2	EE-1	64	69		J.R. Simplot Co.	T-2	Y-2		
FMC Corporation	DD-2	EE-2	64	69		J.R. Simplot Co.	T-2	EE-3		
FMC Corporation	DD-2	EE-3	64	69		J.R. Simplot Co.	T-2	T-1		
FMC Corporation	DD-2	S-1	64	69		J.R. Simplot Co.	T-2	T-2		
FMC Corporation	DD-2	FF-2	64	69		J.R. Simplot Co.	T-2	NN-2		
FMC Corporation	DD-2	FF-3	64	69		J.R. Simplot Co.	X-2(X2-S)	X-2		
FMC Corporation	DD-2	FF-4	64	69		J.R. Simplot Co.	X-2(X2-S)	Z-1		
FMC Corporation	DD-2	GG-2	64	69		J.R. Simplot Co.	X-2(X2-S)	Z-2		
FMC Corporation	DD-2	GG-3	64	69		J.R. Simplot Co.	X-2(X2-S)	YY-2		
FMC Corporation	DD-2	YY-3	64	69		J.R. Simplot Co.	Y-2	T-2		
FMC Corporation	DD-2	HH-3	64	69						

Figure 5
Lease holdings during the middle operating life of the Gay Mine

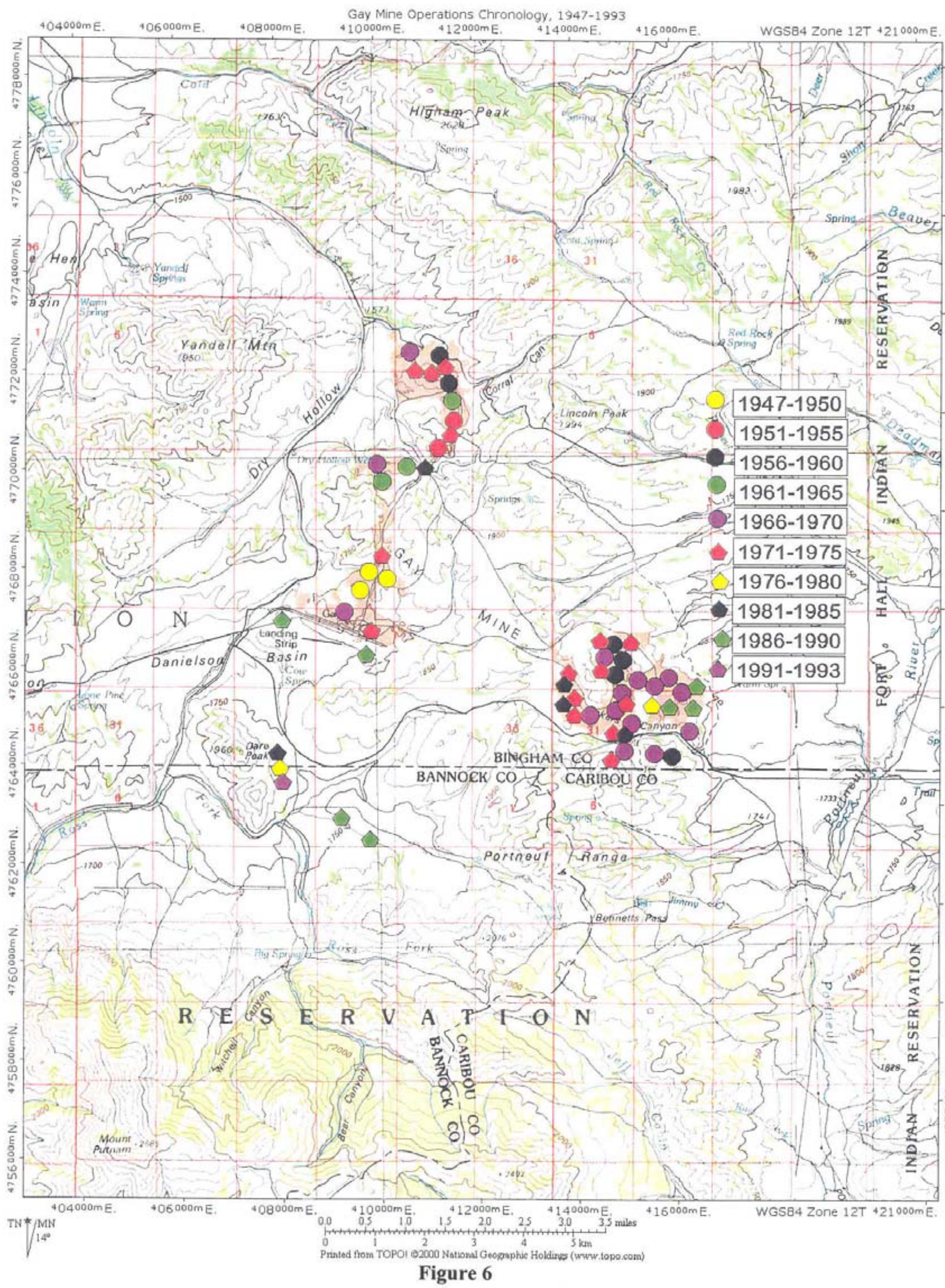


Figure 6

Figure 6
Areas mined as a function of time.

Mining continued during the winter season, but all ore that was produced during the six-month off-season was stored on site and was shipped during the summer season. As a result, Gay Mine has had multiple very large surge piles of ore in the Headquarters area throughout the life of the mine.

<u>Ore Transportation</u> From 1946 until 1948, ore was trucked by Simplot over the Simplot road to the railhead at the Fort Hall town site (See Reservation Map, Figure 1) where it was dumped and reloaded into railcars for shipment by Union Pacific Railroad to Pocatello. In 1948, the Oregon Short Line Railroad (then an operating unit of Union Pacific Railroad) built a twenty-one mile rail spur to allow shipment of ore directly to the processing plants via the railroad. Union Pacific Railroad operated the rail line (Simplot, 1948). In 1974, rail shipments were estimated at two unit-trains per day, each pulling 100 open cars loaded with ore (20,000 tons per day) in the shipping season between April and November. The rail speed limit was 20 miles per hour on the spur.

<u>Ore Releases Outside Mine Boundary</u> Several instances of train derailments that released ore to the environment were identified. Known derailment locations are depicted in **Figure 7.** Photos of a May 26, 1986 derailment are provided in **Figure 8.** In each of these cases, ore was recovered from the site of the mishap, and efforts were made to restore the site to its pre-accident condition. Derailments occurred at multiple locations immediately west of the Headquarters area, frequently as a result of runaway cars during the makeup of unit trains. One of these accidents occurred October 5, 1973, and resulted in the loss of eight railroad cars of high grade ore and 37 railroad cars of furnace shale (Simplot 1974).

Additional multiple derailments occurred at the two locations shown further west. At least two of these events involved loss of ore material into the adjacent stream (Broncho 2002, Hagius 2003) .

Photos courtesy Shoshone-Bannock Tribes

Figure 8
May 26,1986 Train Derailment

Although no documents were found that identified trucking accidents in the 1946 – 1948 period that may have released ore outside the mine area, or of derailments on the Union Pacific main line between Fort Hall and the processing plant in Pocatello, a potential exists that hazardous substances were used in the construction of the eastern portions of the access road and of

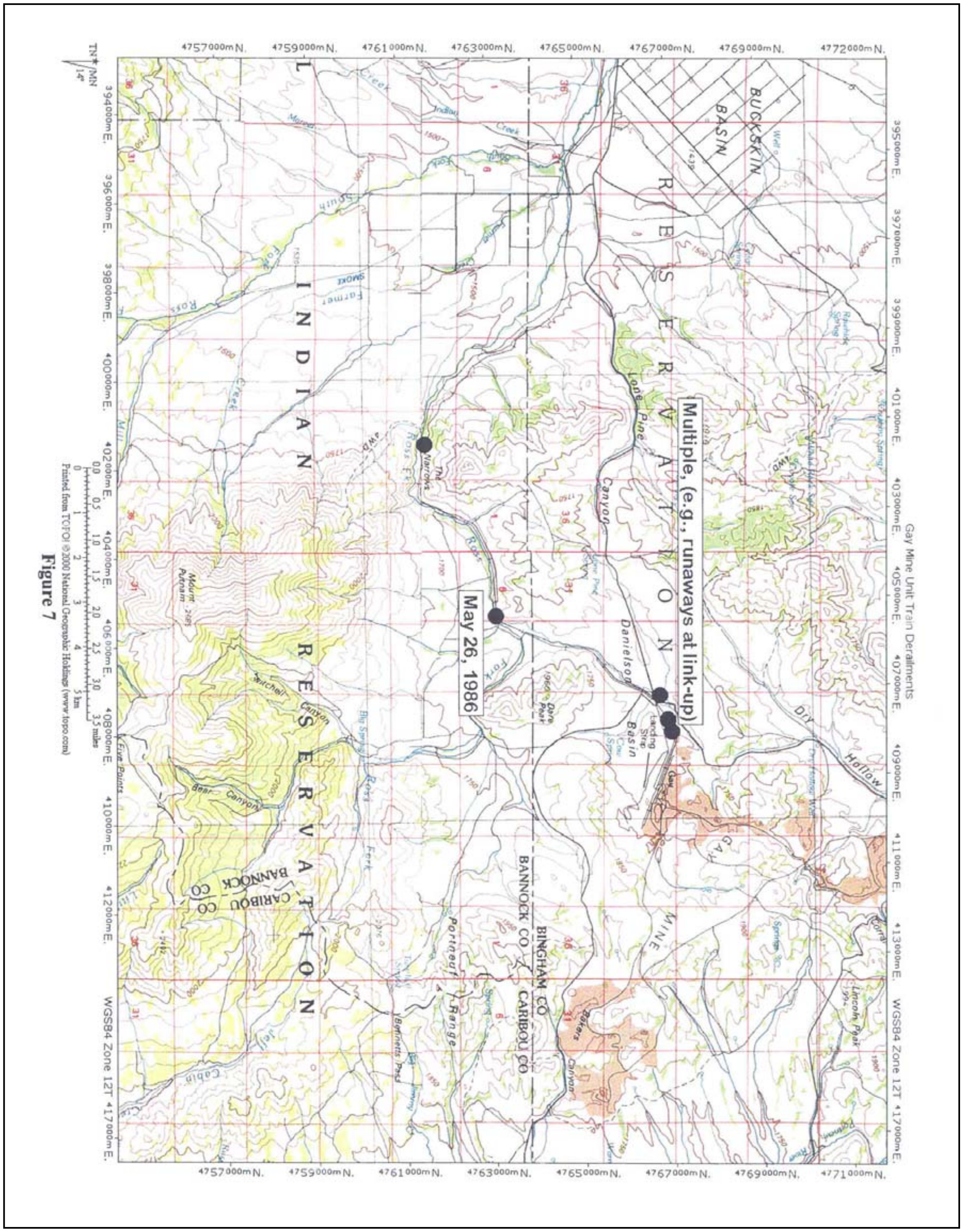


Figure 7
Known Train derailment locations

the spur line railroad grade outside the mine boundary. Further west, both the access road and the rail grade were built from material that was borrowed from pits along the respective right-of-ways (USDA, 1956). BIA arranged with Simplot to maintain (regrade and surface) the unpaved portion of the road between the end of the pavement on the western side of Danielson Basin to the mine tipple. Red chert was used for this maintenance (Hernandez, 2003).

Mine operating personnel (Broncho, 2002) noted instances in which bottom gates on ore-carrying hopper-cars would not close completely, opening the possibility that (in addition to fugitive losses by wind erosion of the open cars) some ore may have been lost during the rail transit to processing.

2.2.3 Investigative / Regulatory History

File Search A file search was performed of available written records, reports, and data possessed by federal, state, local and Tribal entities that pertain to the Gay Mine and its operational history. Records located at the Bureau of Indian Affairs Fort Hall Agency and the Bureau of Land Management Pocatello Regional Office were found to encompass the key issues that are required for CERCLA decision-making. The BIA files include mining and business leases, as well as technical data. The BLM archives include originals and photocopies of leases and royalty calculations, as well as mine plan approvals, inspection reports, operating summaries and mineral and environmental studies that pertain to Gay Mine.

Interviews EMI interviewed key parties who, by working experience at the mine or their involvement in natural resource agencies, were in a position to provide helpful information for the development of the PA. These parties included employees of the BIA Fort Hall Agency, the BLM Pocatello Regional office, the Shoshone-Bannock Tribes Land Use Commission, and the Idaho Department of Environmental Quality's project manager for the area-wide investigation, as well as former mine employees. Summaries of these interviews are available in the references.

Site Reconnaissance A site reconnaissance was performed by EMI on May 6, 2002 (EMI 2002c, 2002d). Aerial photographs of the various pits within the mine (EM I 2002e) are provided in Appendix B to help show the current status and the spatial relationships of the mine components. Surface photographs taken by EMI as part of the on-site reconnaissance are provided in the references (EMI 2002d).

No search of the operating companies' corporate records was performed in this PA. A bibliographic reference list of cited materials is provided in Section 8.0.

Mining Oversight Oversight of mining operations was performed by the US Geological Survey (USGS) from the inception of the initial mine leases in 1946 until 1983. During the 1982-1983 period the Department of the Interior Minerals Management Service (MMS) was formed. Gay Mine oversight was transferred from USGS to MMS, and MMS was integrated within the Bureau of Land Management (BLM) in 1983. The BLM has maintained oversight of operational practices at Gay Mine since that time. **Figure 9** summarizes archived mine and drilling plans as a function of time.

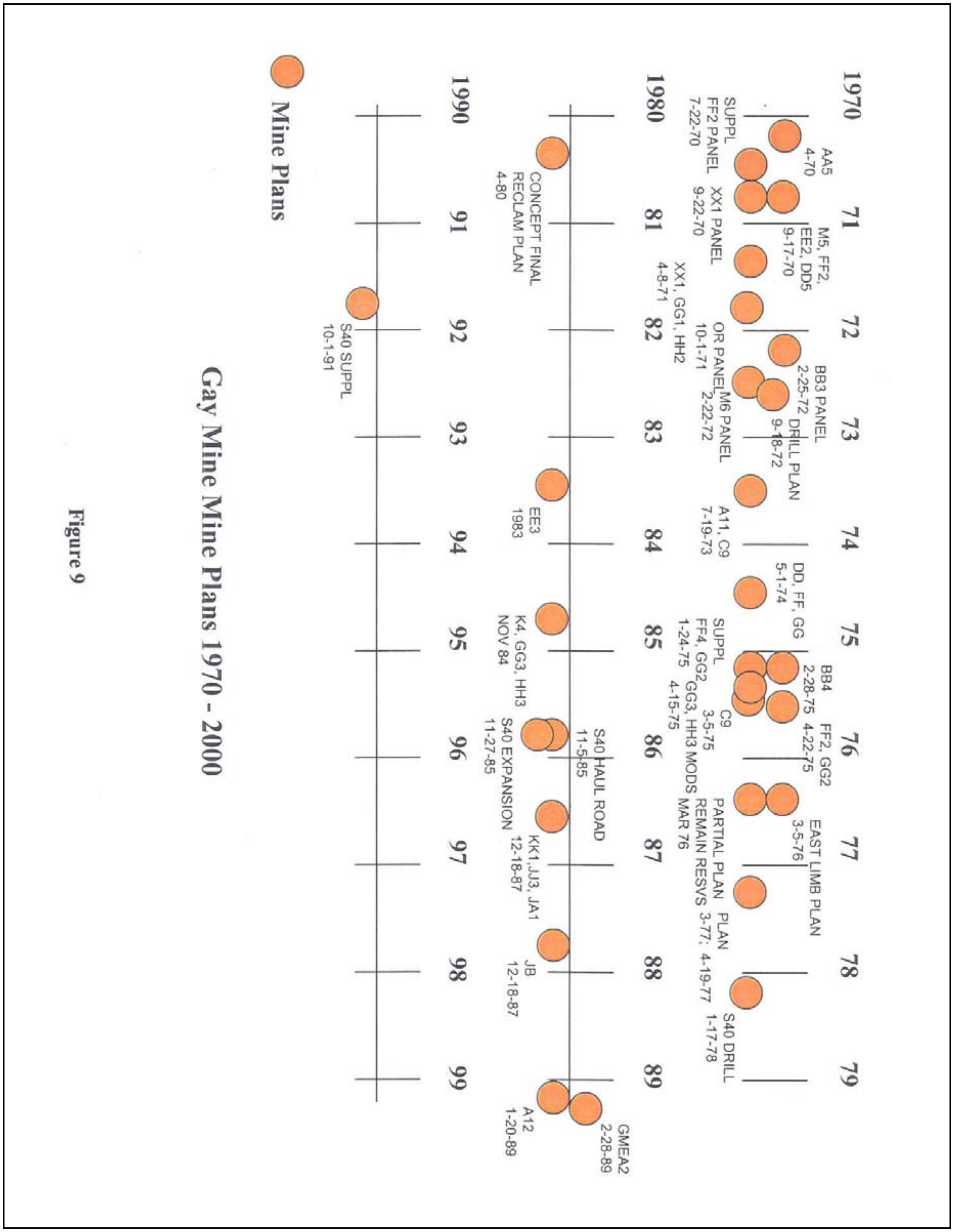


Figure 9
Mine and drilling plans as a function of time

Environmental Oversight Prior to 1970, although lease and royalty records appear to be complete, mine plans and environmental documentation is fragmentary. During that period environmental compliance was addressed in general terms within the mining permits that were issued for individual leases. Excerpts of the Mine Plans are included in the references (see e.g., Simplot, 1970, 1971, 1974, 1986).

Following passage of the National Environmental Policy Act (NEPA) in 1970, Environmental Assessments (EA) and Environmental Impact Statements (EIS) were required for significant actions on federally-administered land with potential to harm human health or the environment. These documents necessitated more detailed environmental studies to support their conclusions. **Figure 10** summarizes archived Gay Mine environmental permitting documents and supporting studies as a function of time.

In 1973 the BIA requested that Simplot, the mine operator, prepare an EA. The 1973 EA requirement resulted in the 1974 Mine Plan. It addressed expansion of the mine into the East Limb area, and was the first site-specific environmental summary document. It described mine development and specific reclamation activities that were required after mining was complete. The South 40 Mine Plan was issued in 1986, and also addressed mining regulation and control of reclamation. During the last fifteen years of mine operation, multiple environmental studies and hydrogeological investigations were performed to support permitting of a joint Simplot-FMC lease ("Joint Lease Area" and "South Limb Area") in the area south and east of the South 40 pits.

2.2.4 Restoration and Other Actions

Reclamation requirements varied over time. Some mine reclamation occurred after termination of mining in September, 1993; however mining and reclamation equipment was removed before closure work was completed, and to date, mining leases have not been released pending that reclamation. At present, the mine reclamation status is essentially unchanged from that reported by Koehler and Hernandez (1997) in *Status of Reclamation Compliance at Gay Mine, Fort Hall Agency Idaho, 1996-1997.*

During the life of the mine, ore with marginal phosphate content was stockpiled for potential future beneficiation and use. Over 27 million tons (BLM, 1996, Hagius, 1988) of these stockpiled "mill shale wastes" remain at the mine. In multiple cases, overburden or waste shale has been placed outside the geographical bounds of the mine leases (see, for example lease areas and disturbed areas depicted in **Figure 15**, *Gay Mine CERCLA Site Boundary,* EMI, 2002g).

2.3 Description of Gay Mine Waste Characteristics

Ore Characteristics Two categories of ore were produced at Gay Mine. High-grade phosphate rock ("acid grade ore"), containing about 31% phosphorite, was used in the production of fertilizer by the J.R. Simplot Company facility at Pocatello, Idaho. Lower-grade phosphatic shale ("furnace grade ore"), containing about 24% phosphorite, was used for production of elemental phosphorus at the Food Machinery and Chemical Corporation (now FMC Corporation) facility at Pocatello, Idaho. Throughout the life of the mine, various ore grades were mixed to obtain an optimum 24% phosphorite content for the FMC operation. Blending of ores occurred in the vicinity of large ore storage piles north of the rail yard in the Headquarters area.

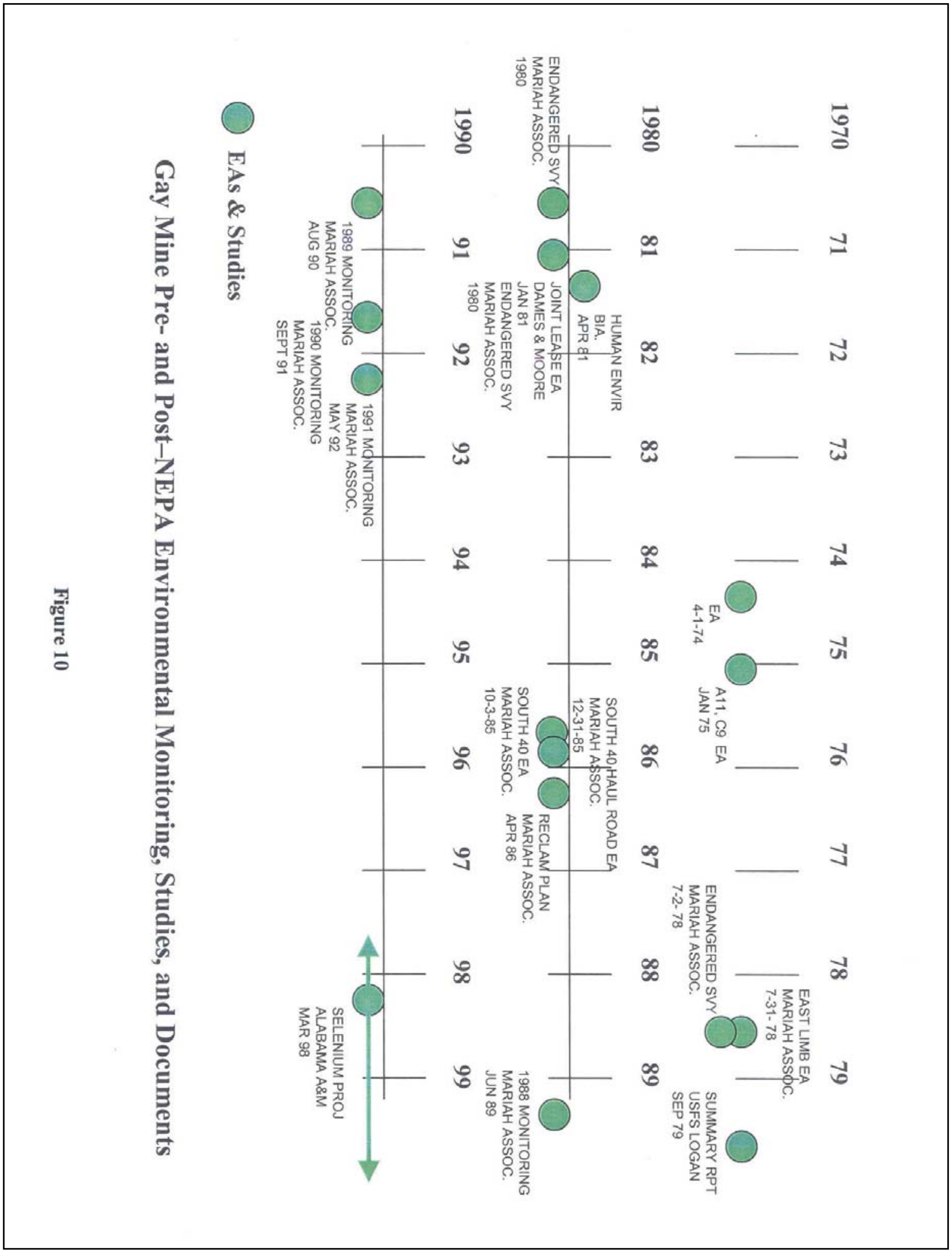


Figure 10
Environmental permitting documents and supporting studies

Waste Shale Characteristics Mill shale that was derived from near the economic phosphate strata (see **Figure 4**) is also typically rich in a variety of other metals. Separation of these shale wastes from the phosphate ore and subsequent storage of the mill shale on the surface results in a situation in which ore with high concentrations of metals that occur within the mined strata are displaced to the surface, where they are subject to greatly increased oxidation, mobilization, and transport. These processes allow distribution of hazardous substances to the environment through erosion by wind and water, accumulation by plants, and consumption of contaminated plants or water by wildlife and livestock.

Metals in Exposed Soils[1] Total metal-in-soil concentrations derived from a limited number of samples in each of the work areas of the Gay Mine are presented in **Table 1** of Section 4. Alabama A&M University (2000), which conducted the sampling and analyses, summarized these data by noting that

> "Molybdenum (Mo), Chromium (Cr), Boron (Bo), and Aluminum (Al) were absent or present in only a few samples at moderate levels. Zinc (Zn), Lead (Pb), Iron (Fe), Manganese (Mn), Magnesium (Mg), Copper (Cu), and Calcium (Ca) were present in generally harmless amounts except for [three mill shale waste samples] which were relatively high in copper. Cadmium (Cd) and Nickel (Ni) were present in excessive amounts in several samples for calcium and in all samples for nickel."

These data reveal that undisturbed soil in the Gay Mine area has about 1 ppm selenium, while black shale mined at depth may contain over 100 times that concentration. Interestingly, fluorides, which are typically present in phosphate rock and have a potential for redistribution (Turner, 2002), were not found. Vanadium is also present in Gay Mine ores, and in quantities that are economically recoverable. After first processing "furnace-grade ore", FMC segregated "ferro phos" from the furnace slag, which was then shipped off-site for vanadium extraction by others (Cundick, 2003).

The Idaho Department of Environmental Quality's *Area-Wide Human Health and Ecological Risk Assessment* (Tetra Tech, 2002) screened all of the potential Chemicals of Potential Concern (COPC) for humans, and all of the potential Chemicals of Potential Ecological Concern (COPEC), and concluded that Contaminants of Concern (COC) should include Cadmium, Chromium, Copper, Nickel, Selenium, Vanadium, and Zinc. Most of these substances have not been studied at Gay Mine.

Selenium -- an Important COPEC EMI reviewed studies and reports prepared by the Idaho Mining Association relating to selenium contamination from mining activities in Southeastern Idaho, and interviewed task force personnel. Noteworthy is a final report titled *Evaluation* of *Selenium Status In* Gay *Mine Reclamation Project. Fort Hall. Idaho* produced by Alabama A&M University and the USDA Agricultural Research Service (Alabama A&M, 2000).

Selenium is an essential element for animals; however, it can be toxic, even fatal, in animal diets that contain more or less selenium than the optimum. Selenium poisoning occurs through bioaccumulation by plants of selenium that is brought to the surface as part of the mining process and mobilized through oxidation. Based on the known margins of safety between

normal and toxic dietary exposures, selenium is more poisonous than either arsenic or mercury

[1] "Soil: the upper layer of earth that may be dug or plowed and in which plants grow"[Webster] is distinguished from "spoil material: earth or rock excavated or dredged". The *USFS Preliminary Interim Soil Salvage Guideline* [Jones, 2003] for the Southeast Idaho Phosphate Area defines waste shales with <1 ppm total Se and <1 ppm extractable Se as suitable growth media. Soils with <13 ppm total Se and <1 ppm extractable Se are suitable as growth media.

(Sorensen, 1991). Available Gay Mine sampling data for selenium in plants and associated soils are summarized in **Table 2** of Section 4.

Local Selenium Hot Spots Suspected Selenium in its oxidized forms can be highly toxic to animals, and has been the subject of a long-term interagency study in the Southeast Idaho phosphate area (DEQ, 2002). Almost all plants used for mine land reclamation are selenium bioaccumulators to some degree (DEQ, 2002), with the legumes alfalfa and sainfoin being particularly efficient (Alabama A&M, 2000). The definition of these hot spots, their potential exposure pathways and their affected populations is important at Gay Mine, where individual parcel land ownership occurs within the mine area, and therefore potential future residential land use is more relevant than at other mines in Southeast Idaho.

Past and Ongoing Releases Available written records have been used to assess past and ongoing releases of potentially harmful substances to the environment. Contaminates Of Potential Ecological Concern (COPECs) are dominated by mining-related metals and metalloids arising from open and reclaimed mill shale piles (e.g., selenium and cadmium). In addition, other hazardous substances released to the environment include hydrocarbons and solvents in limited areas (e.g., Headquarters Area equipment maintenance locations), and the explosives residues (two powder magazines and an ANFO mixing area were used at the mine). Elevated concentrations of selenium are present in vegetation within the Gay Mine. Based on these records, releases have occurred, and (based on presence of mill shale piles and other sources) appear to be continuing.

Local Releases of Hazardous Substances Although Gay Mine contamination is dominated by metal compounds that originate in the ore and mill shale, multiple instances of limited, local-scale releases of other hazardous substances to the environment were identified in the document review, interviews, and site reconnaissance. These releases may constitute local hazards at the mine.

- Oil staining was observed in the Headquarters Area in locations near former above-ground oil storage tanks, however, no petroleum staining was observed outside the Headquarters Area. The shop and fuel tank areas, which were known to be sites where significant releases of oils and solvents occurred, have been excavated, followed by landfarming of the petroleum-contaminated soil. Landfarming was declared successful by EPA (Brown and Caldwell, 2000) in June, 2000.
- The mine used the A-12 pit as a landfill. Although no rigorous characterization or closure under RCRA Subtitle D was undertaken, documentation of closure for that landfill is available (Simplot, 1992). Discarded tires are visible in the waste material dumped over the highwall of the open HH pit in the East Limb, and indicate a probability of disposal of additional refuse there.
- Several drums of what appeared to be used oil remain in the Headquarters Area.
- The use of PCB-containing oil in electrical equipment was investigated by EPA Region 10, who concluded on September 3, 1998, that no PCB-containing oils remained in Gay Mine's electrical facilities. Many fluorescent light fixtures remain in the Headquarters Area buildings and may include PCB-containing ballasts, however no leakage of ballast material was observed during site reconnaissance.
- Two explosive magazines exist, one in the Headquarters Area and another in the East Limb Area. These structures were emptied of dangerous materials during the development of the PA. No sampling has been performed in either area.

- Ammonium nitrate and fuel oil (ANFO) was used as a bulk explosive at the mine. A 30-ton capacity ANFO prill tower tank and a 1000 gallon diesel tank were located in the East Limb area, approximately 2 miles east of the Headquarters area. Soil sampling below the prill tower revealed total petroleum hydrocarbon values as high as 0.884% (8840 mg/kg) within an area of approximately 200 square feet (Brown and Caldwell, 1993). Nitrate-nitrogen values of 4.2 to 175 mg/kg were found in an area approximately 30 feet East of the tank (Brown and Caldwell, 1993). No cleanup and closure documentation for these areas was found during the development of the PA.

3.0 POTENTIAL TARGETS

3.1 Groundwater Pathway

3.1.1 Hydrologic Setting

Disturbed areas at Gay Mine occur at both the east and west ends of a north-south oriented syncline approximately 2.5 miles wide, having edges that dip at 15 -30 degrees. Major folding occurs in the North Limb area. The strata in the central portion of the syncline contains the Dinwoody formation (Triassic), the upper portion of which is interbedded limestone and discontinuous shale which can support an aquifer. The Phosphoria formation is classified as an aquatard, with best water-conducting strata located below, in the Wells formation (Dames and Moore, 1981).

The mine area is highly faulted, with several major and numerous minor transverse faults. These discontinuities suggest a complex nature to the ground water flow patterns near the mine. Perched water has been found at depths of 10 to 180 feet throughout the mined area, however some of the exploration drill holes in the zones where water might be expected (based on findings in adjacent holes) are dry.

3.1.2 Ground Water Targets

Drinking water at Gay Mine was obtained from a still-existing production well located on the east end of the Headquarters area (well GMW in **Figure 11).**

Three domestic wells located 5-8 miles southwest of Gay Mine (T5S, R36E), and two single wells located 3-5 miles east of Gay Mine (Section 7, 4S, R39E and Section 6, T4S, R39E) were reported by Dames & Moore (1981), and remain the closest groundwater target wells to the Gay Mine. The nearest community well is at Fort Hall, 15 miles west of the mine.

3.1.3 Ground Water Monitoring

<u>Groundwater Wells</u> The locations of wells that have been used for groundwater data collection are presented in **Figure 11**. No groundwater wells are known in the East Limb or North Limb areas. The South Forty area has been most heavily monitored for water levels, although not for contamination. Groundwater data collection there has consisted of monitoring water levels in wells, and performing slug tests in which the rate of movement of injected water out of wells was measured. These studies have concluded that a wide variability in hydraulic conductivity of the same formation and at different test sites exists, and that the range is large enough that attempts to assign hydraulic coefficients to the formation, based on slug test data, are not valid. Although no potentiometric maps of the mine area can be completed based on available data[1], both Dames and Moore (1981) and Brown and Caldwell (1993) made preliminary hypotheses that groundwater flow in the upper aquifers of the Gay Mine may be in a westerly direction.

Much work remains to be done to define groundwater flow and contaminant transport in each of the four work areas of the Gay Mine to enable specification of groundwater contamination and development of a cleanup remedy in a Remedial Action Work Plan. Specification of the characterization work that may be needed will be part of the CERCLA Site Investigation (SI) and

[1] Note: Development of potentiometric maps of the groundwater surface from which groundwater flow may be inferred require simultaneous measurements of water levels in a representative array of wells that is continuous in the water-bearing strata of the mine area.

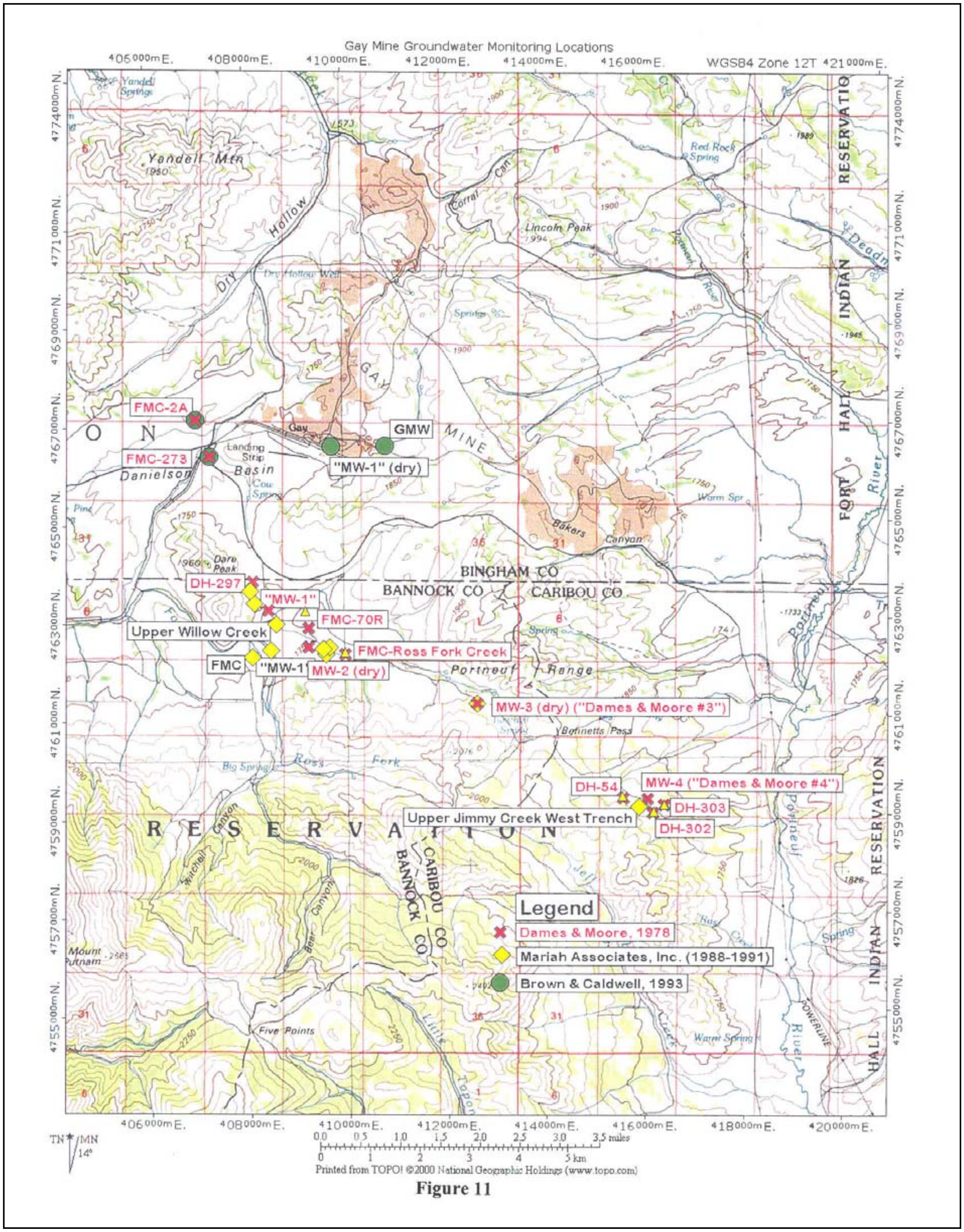


Figure 11
Groundwater Monitoring

CERCLA Engineering Evaluation / Cost Analysis (EE/CA) activities that may follow this PA. This observation is consistent with the requirement of the Interagency Selenium Working Group that as a next step in locating selenium hot spots and their impacts, local-scale groundwater resources, flow and contaminant transport need to be defined at each of the Southeast Idaho phosphate mines (DEQ, 2002).

Well Monitoring Results Groundwater from three wells in the headquarters area was analyzed for selenium and other contaminants by Brown and Caldwell (1993). The wells were not cased nor designed as monitoring wells. Although selenium was detected in all three wells between 5 and 10 ppb, no regional background concentration was established, and efforts to define relationships between the wells and Gay Mine activities were inconclusive. Groundwater that appears as ponds in the mine's excavated pits contains metals in high concentrations, and may indicate that some perched aquifers in the mine area may contain naturally-high background levels of metals. The Brown and Caldwell data are presented in **Table 5** of Section 4. All available analysis results for Gay Mine groundwater are presented in **Table 6** of Section 4. Although radioactive substances are common to phosphate ores, and have been detected in Gay Mine ores (**Table 7** of Section 4), no monitoring for radioisotopes in Gay Mine groundwater has been performed.

The Shoshone-Bannock Tribes have taken drinking water samples at the nearest residential locations on Ross Fork Creek (Hernandez, 2002), several miles potentially down-gradient from the mine, and found that metals concentrations were near the detection limit for selenium, two orders of magnitude below the 50 ppb drinking water standard.

3.1.4 Groundwater Conclusions

The effect of the Gay Mine operations on groundwater resources has not been determined. The size of the mine and the wide variation in geology and surface topography suggest that separate groundwater studies in each of the Gay Mine working areas will be necessary. These studies should be comprehensive enough to define groundwater resources, flow, and contaminant transport, on a local level, for each of the disturbed areas of the mine. The groundwater gradient needs to be defined at a level adequate to support the development of groundwater flow and contaminant transport modeling. Because of the high cost of monitoring well development, groundwater resources that are currently used or planned for use should be identified and used to guide the prioritization of resources.

3.2 Surface Water Pathway

3.2.1 Hydrologic Setting

Precipitation **Figure 12** compares the monthly water equivalent precipitation at a rain gage near the Gay Mine[1] (Mt. Putnam, 7750 ft MSL vs Gay Mine Headquarters 5600 ft MSL) with similar equipment at Fort Hall and a site further upwind on the Snake River Plain. Mt. Putnam gage precipitation is significant, totaling almost twice the amount received in these Snake River Plain areas. Much of this precipitation falls as snow, and is released as snowmelt during the spring and early summer. Recharge to the mine site and surrounding hills occurs primarily from such snowmelt during the months of October through March.

[1] No credible precipitation data were identified within the Gay Mine lease boundaries. Higher terrain at the Mt. Putnam precipitation gage (best available data) is likely to affect higher precipitation at that location.

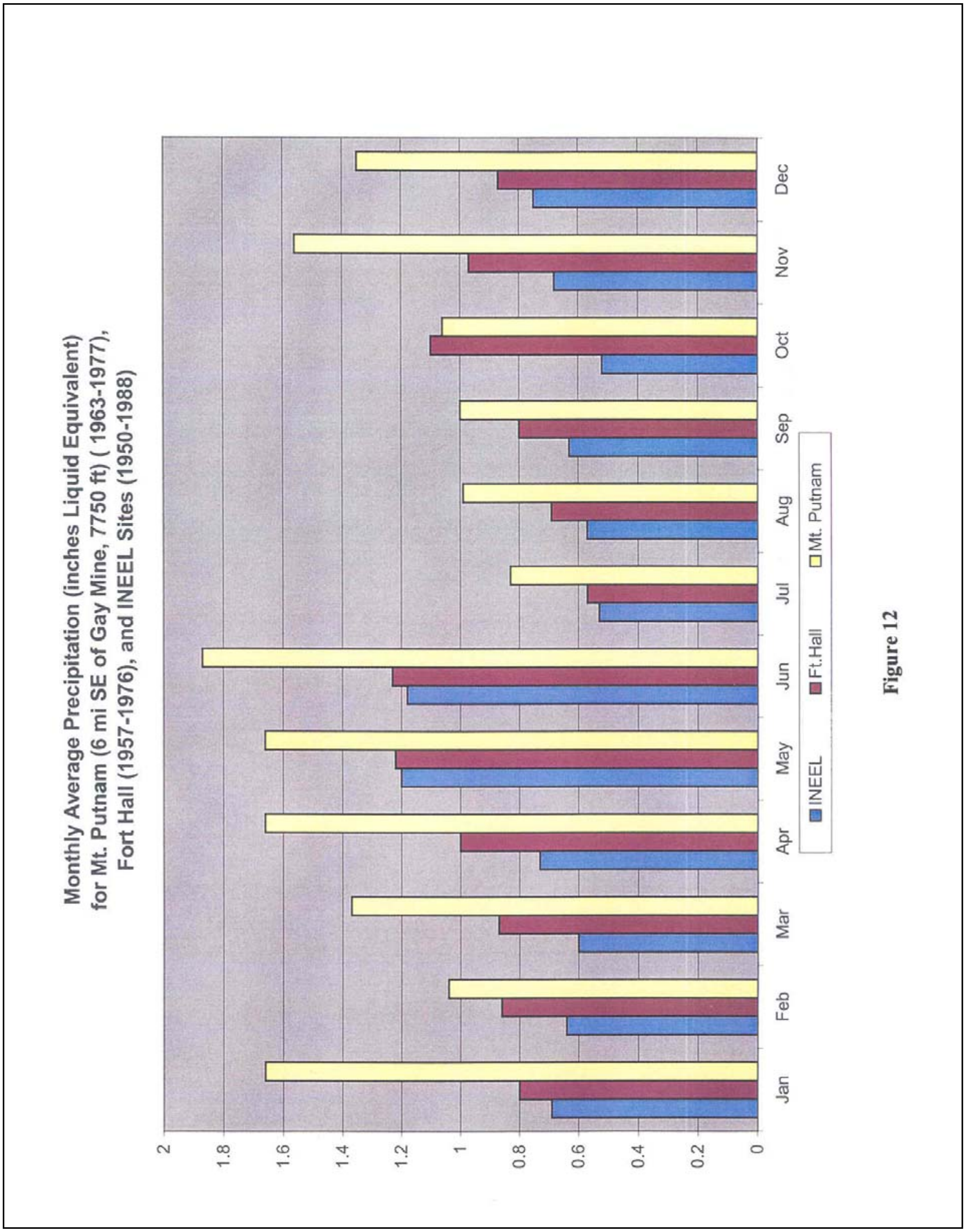

Monthly Average Precipitation (inches Liquid Equivalent)
for Mt. Putnam (6 mi SE of Gay Mine, 7750 ft) (1963-1977),
Fort Hall (1957-1976), and INEEL Sites (1950-1988)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
INEEL
Ft.Hall
Mt. Putnam
Figure 12

Figure 12

Springs and Seeps Multiple springs and seeps exist along both the east and west faces of Gay Mine terrain (**Figure 13**). With few exceptions (e.g., Ross Fork Spring at over 1600 gpm), all of the springs are ephemeral, suggesting that they are associated with local- or intermediate-scale groundwater systems, since recharge is minimal during the summer months. Based on organic content, water quality at these ephemeral springs is generally good (Dames & Moore, 1981), however few analyses for metals or other inorganic chemicals have been made.

Streams A major portion of the Gay Mine lies in the Portneuf River drainage basin. Major drainage from the mine site is to the west along Ross Fork Creek **(Figure 1 and Figure 13**). A topographic high referred to as Bennett's Pass is located five miles southeast of the Headquarters area, and serves as a surface water divide. Surface waters east of the divide flow to the east, into the upper reaches of the south-flowing Portneuf River. During the summer season between early May and mid-October, waters from Ross Fork Creek are diverted into irrigation canals once Ross Fork Creek enters the Snake River Plain. Diversions occur at several locations east of Fort Hall (in dry years, those diversions take all the available water) and at a primary diversion located just east of the Interstate highway. At this primary diversion, Ross Fork Creek waters lose their identity by mixing with waters from 3 other sources (Blackfoot River Storage, Sand Creek waters when they exist, and Snake River natural flow). During poor water flow years, all remaining Ross Fork Creek waters are taken by this "Main Fort Hall" canal which flows southward to reenter the Portneuf River. During good water years, Ross Fork Creek waters that are not taken by the primary diversion canal are returned to the original Ross Fork Creek natural channel in which they flow westward to join the Snake River at the upstream end of American Falls Reservoir (Oliver, 2002). Lincoln Creek, a tributary of the Blackfoot River, provides drainage for a limited portion of Gay Mine's North Limb area.

The Gay Mine area is composed of rolling terrain broken by dry washes, and moderately steep sloping hills, with higher terrain surrounding the mine site on the north and south. Ross Fork Creek exits the mine site at approximately 5600 feet elevation, and Lincoln Creek at 5100 feet.

3.2.2 Surface Water Targets

Drinking Water Throughout the Gay Mine area, drinking water is obtained from groundwater sources, not surface water. Consequently, surface water does not directly influence drinking water targets, except through the human food chain elements of irrigation of agricultural crops and watering of livestock.

Human Food Chain No agricultural crops are grown on Gay Mine properties. Cattle grazing in the Gay Mine area is the dominant current land use. However, cattle have access to springs, streams, and pit lakes throughout the mine area. Additionally, soils, vegetation, and wildlife are significant components of the human food chain process.

Terrestrial Wildlife Wildlife have access to springs, streams, and pit lakes throughout the mine area. Their exposure to both the water supply and to forage may be more transitory than for grazing cattle however, as a result of their larger ranges and typical patterns of migration through the mine area. Several studies (Mariah, 1978, 1980, 1989, 1990, 1991, 1992; Dames & Moore, 1981) have been performed to scope the numbers and use patterns of wildlife in the southern portion of the Gay Mine area. Similar data for the North Limb and East Limb areas of the mine have not been taken.

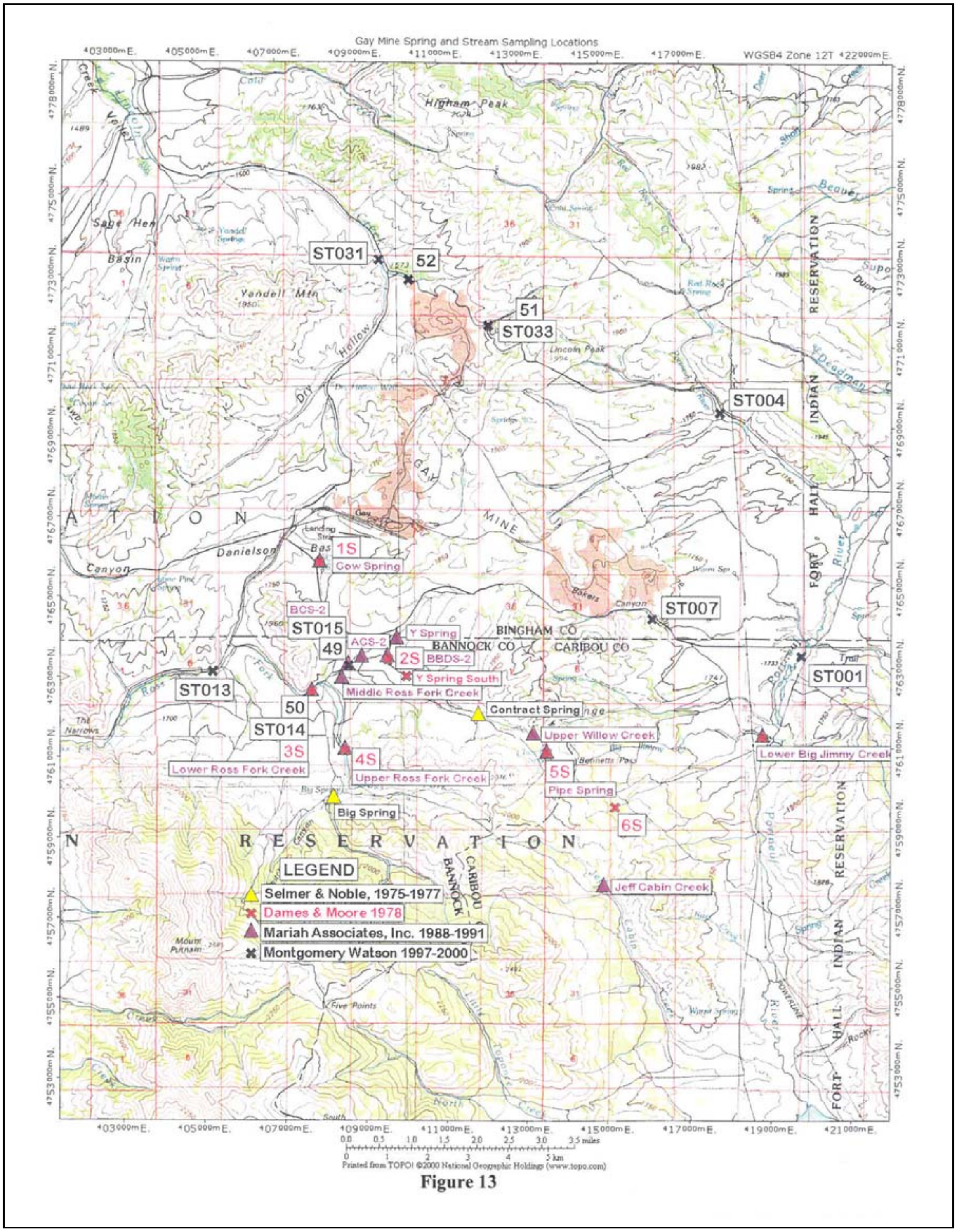

Gay Mine Spring and Stream Sampling Locations
WGS84 Zone 12T
Higham Peak
Yandell Mtn
Lincoln Peak
ST031
52
51
ST033
ST004
ST007
ST001
1S
Cow Spring
BCS-2
ST015
49
ACS-2
Y Spring
2S
BBDS-2
Y Spring South
Middle Ross Fork Creek
ST013
50
ST014
3S
Lower Ross Fork Creek
4S
Upper Ross Fork Creek
Contract Spring
Upper Willow Creek
5S
Pipe Spring
6S
Lower Big Jimmy Creek
Big Spring
Jeff Cabin Creek
BINGHAM CO
BANNOCK CO
CARIBOU CO
RESERVATION
FORT HALL INDIAN RESERVATION
LEGEND
Selmer & Noble, 1975-1977
Dames & Moore 1978
Mariah Associates, Inc. 1988-1991
Montgomery Watson 1997-2000
Printed from TOPO! ©2000 National Geographic Holdings (www.topo.com)
Figure 13

Figure 13

Aquatic Wildlife The Gay Mine area has a limited fishery resource, one that, at one time, was judged healthy and self-sustaining (Mariah, 1992), but one that is declining as a result of a long-term (since 1986) drought and limited stream flows, as well as by grazing practices (Galloway, 2002). Ross Fork Creek has been stocked with hatchery fish on several occasions (Mariah, 1992). Fisheries studies have documented a decrease in fish populations there. Stream macroinvertebrates are valuable indicators of water quality degradation because they are relatively immobile and generally less able (than fish, for example) to avoid exposure to environmental stress (Mariah, 1990). Fish and aquatic wildlife are the important primary surface water targets.

Dewatering Effluent Discharges During the final phase of mining, some pits were temporarily dewatered to allow excavation of an additional lift of ore from below the local water table (Hagius, 2002). In such cases, pump output was released nearby onto disturbed areas. A reference in the mine documents (Drilling and Water Test Summary, Sept 13, 1972, Lease 197, Grid B) that such pump output was released to Queedup Spring has been clarified by operations personnel (Hernandez, 2002; Hagius, 2002; Galloway, 2002) to refer to the Queedup Springs *area,* not to the spring or its stream.

3.2.3 Surface Water Monitoring

Pit Lakes Mining-related metals or metalloids have been detected in surface water features near Gay Mine. Only limited sampling has been undertaken in the ponds within on-site open pits (all of which are available to grazing cattle and wildlife). However, most of the available samples reveal levels of selenium (e.g., A-12-Pit lake, Fall, 1997, at 100 ppb; Z-Pit lake, Sept 1998, at 6.2 ppb; JD-Pit lake, Sept 1998, at 5.9 ppb) that exceed the Cold Water Biota Criterion of 5 ppb. The drinking water standard for selenium is 50 ppb. Although radioactive substances are common to phosphate ores, and have been detected in Gay Mine ores (**Table 7** of Section 4), no monitoring for radioisotope concentrations in Gay Mine ponds, streams, or other surface water has been performed.

Streams - Ecology A number of fisheries studies (Greider, 1989; Taki, 1990a, 1990b, 1991; Montgomery Watson, 1999, 2001a, 2001b), and aquatic ecology studies that address macroinvertebrates (Mariah, 1978, 1980, 1989, 1990, 1991, 1992) have documented substantial seasonal and annual changes in the aquatic environment. These studies focused on Ross Fork Creek and the southern portion of the Gay Mine area, with no data obtained from streams on the north and east of the Gay Mine. Early studies reported that in general, stream water quality in the Gay Mine area was good (Dames & Moore, 1981: "surface waters [in the southern portion of the area] meet EPA primary and secondary drinking water standards…"), while later studies of macroinvertebrate populations and diversity (Mariah, 1990) noted "an unusual level of environmental stress… and severely stressed communities," and that "The Ross Fork fishery appears to have experienced a substantial decline in the number of resident trout…" Fishery data for the Gay Mine area are inconclusive; however, a reservation-wide fish inventory by Tribal resource specialists is underway at this time.

Streams – Contamination All available Gay Mine stream sample selenium data, including surface water sampling data derived from the Area-Wide Investigation, are summarized in **Table 3** of Section 4, and the locations where surface water monitoring has been performed are shown in **Figure 13**. A comparison of the original data sources show that most of these samples are for stream flow and bulk physical parameters - only a very few of these locations were sampled and analyzed for contaminants. Dames & Moore (1981) noted a reduction in Ross Fork Creek stream flow (1630 gpm to 1140 gpm over 1.5 miles) that was attributed to stream seepage through valley floor alluvium. Analytical detection limits for selenium have improved with the passage of time so that more recent samples show significant figures in the parts- per-trillion range in contrast to detection limits in the 1-2 ppb range for earlier samples. One stream sample that showed selenium in excess of the Cold Water Biota Criterion of 5 ppb appears to have occurred in Lower Ross Fork Creek (Fall, 1984,6 ppb). Baker Creek below East Limb showed 4.8 ppb in September 1999. Not all mine areas have been characterized; in fact upstream-downstream sample pairs for any mine-related disturbance do not yet exist.

Stream Sediment Sediment sampling in the area's larger streams is summarized in **Table 4** of Section 4, and reveals sediment selenium concentrations in the 2000 - 5000 ppb range. These relatively high concentrations of metal compounds in sediment emphasize the need to identify hot spots that are likely to exist in impact areas that may be linked to Gay Mine activities.

Ephemeral Surface Water Features Many of the wetlands that are potential habitat or watering sources for wildlife are vernal wetlands (present only during the spring) which water sampling surveys to date appear to have completely neglected in favor of sampling rivers, streams, and perennial impoundments. Because waterborne selenium concentrations are highest in vernal melt and run-off, and decline substantially by fall, vernal wetlands may often provide the highest risk habitats for breeding water birds. No sampling has been performed to date to characterize mine-related contamination in ephemeral surface water features that may be strongly affected by Gay Mine's disturbed areas or waste storage piles. Sampling of these areas is recommended.

3.2.4 Surface Water Conclusions

A comprehensive characterization of all Gay Mine surface waters is needed to identify hot spots for selenium and other hazardous substances in individual stream segments and ponds. Surface water impacts to sediments and to vegetation need to be quantified. Monitoring needs to be correlated (e.g., upstream and downstream) to mine features that are determined to be potential selenium sources.

3.3 Vegetation Pathway for Bioaccumulation

3.3.1 Vegetation and Wildlife Setting

General Vegetation A general vegetation survey was performed at Gay Mine (Dames and Moore, 1981) that defined general vegetation communities, noxious weeds, and threatened and endangered plant species.

Threatened and Endangered Vegetation A separate Threatened and Endangered Plant survey specifically for the Gay Mine Expansion [South Forty] area was performed by Mariah Associates, Inc. (1980), following a 1978 botanical survey of the Group II Expansion leases (west-central East Limb) that was performed by D. Terrance Booth (cited: Dames and Moore, 1981). At that time, none of the surveys found evidence of listed or proposed plant species. Currently, the following plants are listed as special status plants in the three-county area in which the Gay Mine lies (IFG, 2002).

ALLENROLFEA OCCIDENTALIS	IODINE BUSH
ASTRAGALUS DIVERSIFOLIUS	MEADOW MILKVETCH
CAREX PARRYANA SSP IDAHOA	IDAHO SEDGE
CAREX TUMULICOLA	FOOTHILL SEDGE
LESQUERELLA MULTICEPS	MANYHEAD BLADDERPOD
MUHLENBERGIA RACEMOSA	GREEN MUHLY

SALICORNIA RUBRA	RED GLASSWORT
SALIX CANDIDA	HOARY WILLOW
SPIRANTHES SPIRALIS*	LADY'S TRESSES
STIPA VIRIDULA	GREEN NEEDLEGRASS

* added by the Tribal biologist

Additional field work and sampling will be required to verify the presence or absence of threatened and endangered species. No vegetation surveys have been identified that address riparian vegetation or vegetation that exists in Gay Mine disturbed areas, with or without reclamation. Such data are likely to be required to address the soil-plant-grazing animal pathway for exposure to hazardous substances.

General Wildlife Based on literature and knowledge of the available habitats, Dames and Moore, (1981) speculated that 60 species of mammals, 166 species of birds, 10 species of reptiles, and 5 species of amphibians may utilize habitat in the Gay Mine area at some time during the year. To the Shoshone-Bannock Tribes and to tribal members, these resources have a value that reflects their cultural, spiritual, medicinal and subsistence usage. Tribal members have noted that all animals possess significant cultural and natural values. Wildlife occurring in the Gay Mine area were surveyed in 1978 by Mariah Associates (1978) and by Dames and Moore (1981). Mariah Associates included an assessment of fisheries and wildlife in each of four monitoring reports for the Gay Mine Expansion [South Forty] area (Mariah 1989, 1990 1991, 1992). Each of these short-duration studies were designed to document numbers of wild animals within or crossing a very limited area of Gay Mine. The fisheries studies documented a decrease in fish populations in Ross Fork Creek.

Threatened and Endangered Wildlife A Threatened and Endangered bird survey was performed by Mariah Associates (1978) for the 400 square mile Gay Mine regional area. The Gay Mine area is rich in wildlife resources. Currently, the following animals are listed as special status animals in the total three-county area in which the project lies (IFG, 2003). Additional field work will be required to determine the presence of threatened and endangered species in the mine area.

ACCIPITER GENTILIS	NORTHERN GOSHAWK
AECHMOPHORUS CLARKII	CLARK'S GREBE
AECHMOPHORUS OCCIDENTALIS	WESTERN GREBE
AEGOLIUS FUNEREUS	BOREAL OWL
ANTROZOUS PALLIDUS	PALLID BAT
ARDEA ALBA	GREAT EGRET
BRACHYLAGUS IDAHOENSIS	PYGMY RABBIT
BUBULCUS IBIS	CATTLE EGRET
BUFO BOREAS	WESTERN TOAD
BUTEO REGALIS	FERRUGINOUS HAWK
CALAMOSPIZA MELANOCORYS	LARK BUNTING
CARDUELIS PSALTRIA	LESSER GOLDFINCH
CHLIDONIAS NIGER	BLACK TERN
CICINDELA ARENICOLA	IDAHO DUNES TIGER BEETLE
COCCYZUS AMERICANUS	YELLOW-BILLED CUCKOO
CORYNORHINUS TOWNSENDII	TOWNSEND'S BIG-EARED BAT
CYGNUS BUCCINATOR	TRUMPETER SWAN
DIADOPHIS PUNCTATUS	RINGNECK SNAKE
EGRETTA THULA	SNOWY EGRET

FALCO PEREGRINUS ANATUM	PEREGRINE FALCON
GRUS AMERICANA	WHOOPING CRANE
GULO GULO LUSCUS	NORTH AMERICAN WOLVERINE
GYMNORHINUS CYANOCEPHALUS	PINYON JAY
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE
LARUS DELAWARENSIS	RING-BILLED GULL
LARUS CALIFORNICUS	CALIFORNIA GULL
LARUS PIPIXCAN	FRANKLIN'S GULL
LYNX CANADENSIS	LYNX
MYOTIS CILIOLABRUM	WESTERN SMALL-FOOTED MYOTIS
MYOTIS EVOTIS	LONG-EARED MYOTIS
MYOTIS YUMANENSIS	YUMA MYOTIS
NUMENIUS AMERICANUS	LONG-BILLED CURLEW
NYCTICORAX NYCTICORAX	BLACK-CROWNED NIGHT-HERON
OTUS FLAMMEOLUS	FLAMMULATED OWL
PELECANUS ERYTHRORHYNCHOS	AMERICAN WHITE PELICAN
PHALACROCORAX AURITUS	DOUBLE-CRESTED CORMORANT
PLEGADIS CHIHI	WHITE-FACED IBIS
PODICEPS NIGRICOLLIS	EARED GREBE
QUISCALUS QUISCULA	COMMON GRACKLE
RANA PIPIENS	NORTHERN LEOPARD FROG
SCELOPORUS GRACIOSUS*	SAGEBRUSH LIZARD
SOREX MERRIAMI	MERRIAM'S SHREW
STERNA CASPIA	CASPIAN TERN
STERNA FORSTERI	FORSTER'S TERN
STERNA HIRUNDO	COMMON TERN
STRIX NEBULOSA	GREAT GRAY OWL
TYMPANUCHUS PHASIANELLUS COLUMBIANUS	COLUMBIAN SHARP-TAILED GROUSE
VERMIVORA VIRGINIAE	VIRGINIA'S WARBLER

* added by the Tribal biologist

Migratory Birds and Waterfowl   In addition to providing habitat for the special status animals that are listed above, the Gay Mine area provides habitat for migratory waterfowl and other migratory birds that constitute important natural and cultural resources for the Fort Hall Reservation.

3.3.2 Bioaccumulation Targets

Selenium Concentrating Vegetation   Selenium easily enters metabolic pathways and therefore is highly bioaccumulative (DOI, 1998). The high propensity for biotic uptake of selenium is at least partially explained by its biochemical similarity to sulfur. Different plant species have widely varying abilities to take selenium from the soil, accumulate it, and tolerate it. Common types of selenium concentrating vegetation include *Astragalus* (loco weed and milkvetch, 24 species) *Machaeranthera* (hoary aster) *Haplopappus* (goldenweed), and *Stanleya* (mustard). These plant species have an extraordinary ability to accumulate selenium and can achieve selenium concentrations of hundreds or even thousands of milligrams per kilogram, dry weight. On seleniforous soils, non-accumulator plants may contain 1-200 mg Se/kg, and selenium accumulator plants contain even higher concentrations (Girling, 1984)

The quality of habitat for fish and wildlife is closely linked to particular plant communities. Therefore, selenium contamination could impact fish and wildlife populations indirectly if plant communities are altered by its toxic effects.

Biotic Effects of Selenium
Based on the known margins of safety between normal and toxic dietary exposures, selenium is more poisonous than either arsenic or mercury (Sorensen, 1991). Both deficiency and toxicity cause similar effects: e.g., reproductive depression, anemia, weight loss, and immune dysfunction (Koller and Exon, 1986). The known effects of selenium exposure to various classes of organisms are summarized in **Table 3-1.**

Table 3-1
Summary of Comprehensive Biotic Effects of Selenium

Medium	No effect [1]	Level of Concern [2]	Toxicity Threshold [3]	Comments / Explanation
Water (ug/L, total recoverable Se)	< 1	1-2	>2	Peterson and Nebeker, (1992)
Sediment (mg/kg dw)	< 1	1-4	>4	Van Derveer and Canton (1997)
Diet (mg/kg/day, dw)	< 2	2-3	>3	SJVDP (1990), Lemley and Smith (1987)
Waterbird eggs (mg/kg dw)	< 3	3-6	>6	No-effect level from Skorupa and Ohlendorf (1991), Toxicity threshold from Skorupa (1998)
Fish, whole body (mg/kg dw) Cold water Species	< 2	2-4	>4	Lemley (1996)

[1] Concentrations lower than this value produce no discernable adverse effects on fish and wildlife, and are typical of background concentrations in uncontaminated environments.
[2] Concentrations in this range rarely produce discenable adverse effects, but are elevated above typical background concentrations.
[3] Concentrations above this value appear to produce adverse effects on some fish and wildlife species.

Data from field cases (DOI, 1998) reveal that selenium exposures in the range of 30-50 times normal levels are almost certain to cause widespread *severe* adverse biological effects. Levels in this range have been encountered in the limited Gay Mine mill shale sampling (Section 4, **Table 1**) and soil sampling (Section 4, **Table 2**) that has been performed to date. Bioaccumulation processes are likely to increase these concentrations even further.

In some cases, levels of exposure to selenium that would not be directly toxic may increase susceptibility to otherwise benign pathogens due to selenium-induced immune dysfunction (Fairbrother and Fowles 1990, Whiteley and Yuill 1991, Schamber et al. 1995).

Vertebrate Targets – Human Health   On an area-wide basis, the studies to date have concluded a minimal human health risk from selenium (DEQ, 2002, HHS 2001a, HHS 2001b). They have, however, emphasized significant ecological data gaps - that significant selenium hot spots in individual mine areas exist that have not yet been well characterized (DEQ, 2002), and that population -level effects are difficult to substantiate with available data.

Vertebrate Targets – Livestock   Horses are susceptible to selenium poisoning (hoof effects, death) as well as sheep (motor functions, reproductive effects, death) and cattle (motor functions, reproductive effects, death). Livestock deaths from mine-related selenium poisoning have been reported in Southeast Idaho (DEQ, 2002, Galloway, 2002). Reproductive effects are suspected, but have not been documented near Gay Mine, partly because the test population consisted of steers only (Galloway, 2002). Most domestic animals exhibit signs of toxicity on diets containing greater than or equal to 3-5 mg/kg (natural selenium) (NRC 1980, Eisler 1985, Olson 1986). More recently, O'Toole and Raisbeck (1998) reported for cattle and horses that hepatic selenium concentrations exceeding 2 mg/kg wet weight (6-8 mg/kg dry weight) combined with other typical clinical symptoms, was a sufficient basis for a firm diagnosis of selenium poisoning.

Vertebrate Targets – Fish Among vertebrates, reproductive toxicity is one of the most sensitive endpoints; however, egg-laying vertebrates such as fish seem to have substantially lower thresholds for reproductive toxicity than placental vertebrates (mammals) (DOI, 1998).

Vertebrate Targets –Birds, Migratory Waterfowl Heinz (1996) provides an excellent recent review of selenium toxicity thresholds for birds. He found that reproductive impairment is one of the most sensitive response variables, and that eggs are the most reliable tissues for interpretive purposes. Although bird species differ substantially in embryo sensitivity to selenium exposure, egg-laying vertebrates such as birds have been found to have substantially lower thresholds for reproductive toxicity than mammals (DOI, 1998). As large bodied-herbivores, geese can be expected to be more sensitive to selenium poisoning than any species of bird studied in the lab to date (DuBowy 1989).

Reduction of the lower bill is reported to be a distinctive feature of selenium-induced avian teratogenesis among ducks (O'Toole and Raisbeck 1998). Reduction or absence of eyes is the most common threshold effect in shorebirds, and reduction or malfunction of the bill (beak) is generally the most common threshold effect in dabbling ducks.

Teratogenic risk is only one component of embryo risk from selenium exposure (Skorupa 1999). Controlled experiements have shown that embryo death without teratogenesis is induced at lower concentrations of selenium exposure that embryo death with teratogenesis. Furthermore, non-teratogenic and teratogenic selenium-induced embryo mortality are additive with a constant component of 30-40 % non-teratogenic embryo death being caused before the first signs of teratogenic death are induced. (Stanley et al. 1996; Skorupa 1999; Detweiler 2002).

Invertebrates and Aquatic Vegetation Targets DOI (1998) reported that there are almost no selenium toxicity data for terrestrial invertebrates. Absent comprehensive data, selenium is thought to be much less toxic to most plants and invertebrate animals than to vertebrate animals. However, when compared with terrestrial vegetation, much lower concentrations of selenium in water can be bioaccumulated to toxic levels in fish and wildlife via dietary exposure to the aquatic food chain.

Primary producers are the foundation for most food chains supporting fish and wildlife populations. In aquatic ecosystems, algae serve as the primary source of energy assimilation and as the base of most aquatic food chains. (Ogle, et al. 1988) Aquatic macrophytes are important in chemical cycling and as a major input source for detrital food chains (DOI, 1998). As noted earlier, the quality of habitat for fish and wildlife is closely linked to particular plant communities. Therefore, selenium contamination could impact fish and wildlife populations indirectly if aquatic vegetation communities are altered by its toxic effects.

3.3.3 Monitoring the Vegetation Pathway for Bioaccumulation

At least eleven incidents of fish or wildlife poisoning by selenium, studied in the field, have been documented in the technical literature (DOI, 1998). No site-specific studies have been identified that focus on potential effects to Gay Mine wildlife that may result from releases of hazardous substances. The area-wide selenium study points to local, site-specific impacts on wildlife (DEQ, 2002). On the other hand, effects to a local population of salamanders at Gay Mine have been reported (Christopherson, 2002). Defining impacts to aquatic wildlife is likely to be required to understand Gay Mine impacts to the total ecosystem.

3.3.4 Vegetation Pathway for Bioaccumulation Conclusions

Selenium is present at elevated levels in Gay Mine ores and mill shale (Section 4, **Tables 1 and 2**). Selenium easily enters metabolic pathways and therefore is highly bioaccumulative in organisms to toxic levels (DOI, 1998). At least eleven incidents of fish or wildlife poisoning by selenium, studied in the field, have been documented in the technical literature (DOI, 1998). Data from field cases (DOI, 1998) reveal that selenium exposures in the range of 30-50 times normal levels are almost certain to cause widespread *severe* adverse biological effects. Levels in this range have been encountered in the limited Gay Mine mill shale sampling and soil sampling that has been performed to date. At Gay Mine, bioaccumulation processes are likely to increase these concentrations beyond the concentrations found in soils.

3.4 Soil Exposure and Air Pathways

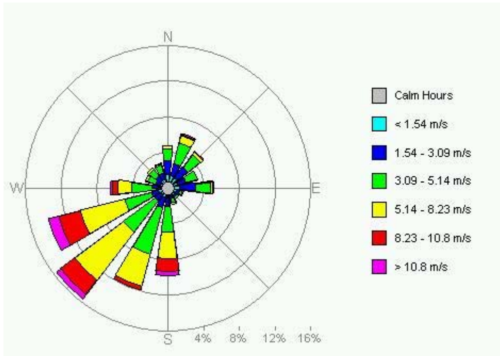
3.4.1 Setting

Meteorology Windroses for locations on the eastern Snake River Plain (NOAA 1989) indicate that on a seasonal basis, most atmospheric transport from the Gay Mine is toward the northeast, an area with little population. **Figure 14** presents annual wind roses for the Pocatello Airport and the Idaho Falls Airport, 24 miles southwest, and 31 miles north of Gay Mine, respectively. Winds are strongest in the winter and spring, when regional-scale storms are strongest. Late spring and summer thunderstorms often have very strong winds. When surface conditions are dry, strong winds result in blowing dust.

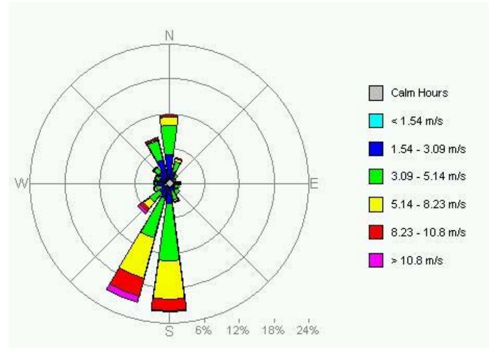
Wind Erosion During the site reconnaissance, wind erosion of exposed ore in the C Pit resulted in visible blowing dust. BLM mine inspection reports and interviews with former mine personnel both refer to airborne dust from active haul roads and material transfer operations during the time the mine operated. Based on the metals content and the potential radioactivity content of ore, mill shale, and mine soils; wind erosion of exposed ore piles ("mill shale") and of remaining open pits appears to be a credible release mechanism for hazardous substances.

3.4.2 Soil and Air Targets

Resident Population Targets Gay Mine does not have a resident human population, and land to the northeast of the mine, where airborne impacts are most likely, is uninhabited forest and range land. The closest settlements, Fort Hall and Blackfoot, are approximately 15 miles west (upwind) of the mine site (**Figure 1**). However, because Gay Mine contains tracts of land that are privately held, the potential of future settlement exists. For air, the human population target locations are therefore close-range locations within the current mine boundary.



Pocatello, ID 1997 Annual Wind Rose



Idaho Falls, ID 1997 Annual Wind Rose

Figure 14
Annual Wind Roses for Regional Locations Near Gay Mine
(direction from which the winds are blowing)

Environmental Targets   Both terrestrial flora (e.g., as forage for deer, moose and elk), and aquatic wildlife (fish and aquatic flora) are environmental targets for airborne transport of Gay Mine substances.

Human Food Chain Targets   Dust transport by wind erosion appears to be a possible mechanism to transport Gay Mine ore materials to nearby vegetation for potential ingestion by cattle. However, because of the relatively efficient bioaccumulation process in some plants, the amount of hazardous material moved to food chain targets by wind transport may be relatively small. These comparative impacts have not been quantified to date.

3.4.3 Soil and Air Monitoring

Soils   A soils survey of the Fort Hall Reservation (McDole et al, 1977) was performed by USDA Soil Conservation Service and the Bureau of Indian Affairs. It included a general description of soils in the Gay Mine area. Dames and Moore (1981) completed a comprehensive study and definition of soils in the South Forty area to support planned mine expansion. These analyses are judged to be adequate for CERCLA planning that may be required for *undisturbed* areas of the mine, given the availability of aerial photographs for those areas. *However, no soils analyses have been identified that address in-place soils that exist in Gay Mine disturbed areas, with or without reclamation.* Such data are likely to be a required component of vegetation studies that address the soil-plant-grazing animal pathway for exposure to hazardous substances.

Conclusions have been made by some of the investigators (e.g., Alabama A&M, 2000) contributing to the PA that metals such as selenium may not be readily bioaccumulated by plant life in the mine area because high pH soil conditions limit their solubility. Other investigators (Turner, 2002) note that acidic precipitation over the years may have increased the solubility of these metals, along with increased potential for uptake by living organisms, and that this potential effect should be addressed in future characterization work.

Air Quality In compliance with stipulations associated with an expansion permit for the South 40 joint leases, Simplot performed site-specific ambient air monitoring during the summer seasons in the 5-year period 1987-1991 (Mariah,1992). 24-hr Total Suspended Particulate (TSP) data were obtained on a 1-day-per-week basis (1987-1988) and then a 1-day-per-month basis (1989-1991), using a single sampler that was located in the Headquarters area. 24-hr concentrations ranged from 22-186 $\mu g/m^3$, or 8 -71% of the applicable 24-hr standard. These data were not obtained on a schedule consistent with the national 6-day TSP monitoring schedule, and may not meet siting and quality standards (EPA, 1980) for this type of monitoring.

No dispersion modeling appears to have been performed to assess the magnitude of off- site transport and dispersion of dust from sources within the active or inactive Gay Mine.

Airborne Radioactivity Although radioactive substances are commonly found as components of phosphate ores (EPA, 1975), and have been detected in Gay Mine ores (**Table 7** of Section 4), no monitoring for airborne radioisotope concentrations at Gay Mine has been performed. One should note that, for airborne dust, *gamma activity* monitoring of the type reported in the available data is not as important from a human health standpoint as is *alpha activity,* since alpha particles are the dominant inhalation and dose hazard. No alpha activity monitoring has been performed at Gay Mine.

3.4.4 Soil Exposure and Air Pathway Conclusions

Wind erosion of exposed ore piles ("mill shale") appears to be a less effective mechanism for transport and release of hazardous substances to the human or animal food chain, given the comparative efficiency of metals bioaccumulation in reclamation vegetation. However, since no data exist, sampling to determine the comparative impact of wind-blown dust in the air-to-food chain pathway, and an assessment of alpha particle doses due to airborne dust are needed.

4.0 SAMPLING RESULTS

All analytical data that report or relate to releases or threats of releases of hazardous substances at the Gay Mine are summarized in the data tables of this section. Data that describe potential migration pathways for these substances and potential receptors (human and ecological) impacted by these substances have been included.

Table 1: Gay Mine Total Metal-in-Soil Concentrations

Sample Location	Sample No.	Total Metal-in-Soil Concentrations (ppb) **										
		Se	Cr	Zn	Pb	Cd	Ni	Fe	Mn	Mg	Cu	Ca
U4 Area, East Limb												
	1-1	20.2	3.4	1207	9	142.2	49.167	118	45	518.4	69.3	433
	1-2	16.5		1112	7.8	276.8	55.501	102.5	31	556	67.1	520
	1-3	20.4		1183	3.6	432.3	109.287		46	158.1	88.3	421
	1-4	5.9	0.9	168	8.9	22	6.028	57	71	407.8	17	519
(mill shale)	1-5	47.7		1586	10	184.7	93.297	16.2	11	301.7	99	461
	1-6	12.7		781	9.6	1018	29.764	5.4	11	246.1	97.6	519
I-Pit, North Limb												
	2-1	11.6		492	8.3	108.2	6.939	43.8	53	227.3	34.9	523
	2-2	21.5		1031	10	269.3	21.172	36.9	39	287.6	50.3	517
	2-3	18		1239	14.5	193.1	93.778	108.3	54	771.2	63.7	579
(undisturbed soil)	2-4	0.8		726	36.9	27.6	61.913	815.4	424	2174.7	10.7	579
A-12 Pit, Headquarters												
	3-1	5.4		276	24.4	31	14.111	67.3	101	1136.3	29.3	578
(black shale)	3-2	117		3602	7.6	114.7	411.556	578	16	146.1	307.6	237
(mud from pond)	3-3	13.5		270	55.4	10.4	65.056	1200	505	1169.3	31.1	568
E-Pit, Headquarters												
	4-1	15.5		827	16.7	122.8	74	115.7	121	804.6	87	579
	4-2	1.2		39	21.4	3.2	5.5	67.3	105	1520.7	14.9	582
	4-3	11.1		1497	16.8	253	118.111	341.7	104	1008.6	175.9	545
SA-JD Pit Area, South 40												
(undistrubed soil)	5-1	0.4		46	31.7	4	13.369	414.4	278	2487.8	17.1	584
	5-2	0.7		21	21.6		1.705	98.1	54	1150.4	11.5	572
	5-3	1.1		36	21.6	4.3	3.464	116.5	82	3653.4	17.8	557
(mud from pond)	5-4	1		29	20.6	3.2	16.722	432.5	907	3759.3	29.3	577
(mill shale)	5-5	18.2		454	16.8	296.8	40.444	74.8	8	953.2	501.1	570

Source: Alabama A&M, 2000

Table 2: Gay Mine Soil and Vegetation Selenium Data

	ppb		ppb
		Summer 1998	
Montgomery Watson, 1998	**SOIL**		**VEGETATION**
N Limb O/P Fill			
WD-019-01	7200		1200
WD-019-02	15000		4900
WD-019-03	22000		1000
WD-019-04	8700		210
WD-019-05	16000		190
E Limb Dump 4E			
WD-031-01	18000		3100
WD-031-02	2300		8400
WD-031-03	31000		6600
WD-031-04	10000		5800
WD-031-05	1800		7200
E Limb Dump 19			
WD-034-01	33000		24000
WD-034-02	17000		5000
WD-034-03	17000		12000
WD-034-04	17000		1400
WD-034-05	11000		1300

Note: Original data were reported in mg/kg, approximating ppm.

Table 3: Gay Mine Stream Sample Selenium Data

Gay Mine Selenium Monitoring
Surface Water

	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
Mariah Associates, 1989	Spring 1984	Fall 1978	Fall 1984			Spring 1988	Fall 1988	Fall 1997	Fall 1997	Fall 1997
Upper Ross Fork Creek	<2	<1	2			<1	<1			
Middle Ross Fork Creek	<2		3			<1	<1			
Lower Ross Fork Creek	<2	<1	6			<1	<1			
Mariah Associates, 1990	Spring 1984		Fall 1984	Spring 1987-88	Fall 1987-88	Spring 1989	Fall 1989			
Upper Ross Fork Creek	<2	<2	2	<1	<1	<1	<1			
Middle Ross Fork Creek	<2		3	<1	<1	<1	<2			
Lower Ross Fork Creek	<2	<2	6	<1	<1	<1	<2			
Mariah Associates, 1991				Spring 1987-89	Fall 1987-89	Spring 1990	Fall 1990			
Upper Ross Fork Creek	<2	<2	2	<1	<1	<1	<1			
Middle Ross Fork Creek	<2		3	<1	<1<2	<1	<1			
Lower Ross Fork Creek	<2	<2	6	<1	<1<2	<1	<1			
Mariah Associates, 1992				Spring 1987-90	Fall 1987-90	Spring 1991	Fall 1991			
Upper Ross Fork Creek	<2	<2	2	<1	<1	<1	<5			
Middle Ross Fork Creek	<2		3	<1	<1<2	<1	<1			
Lower Ross Fork Creek	<2	<2	6	<1	<1<2	<1	<1			
Dames & Moore, 1981										
Cow Spring		<1								
Y Spring South		<1								
Ross Fork Creek Downstream		<1								
Ross Fork Creek Upstream		<1								
Prospect Spring		<1								
Jimmy Creek Spring		<1								
Montgomery Watson, 1997										
Ross Fork Above South 40								0.509	0.509	
Ross Fork Below South 40								0.36	0.517	0.655
Lincoln Creek Above North Limb								0.634	0.744	0.781
Lincoln Creek Below North Limb								0.871	0.915	
Montgomery Watson, 1998	Sep-97	May-98		Sep-98						
Portneuf River Downstream Baker Creek		0.47		0.58						
Portneuf River Upstream U Creek		0.45		0.63						
Ross Fork Downstream Danielson Creek	0.5	-0.08		-0.43				0.509	0.509	
Ross Fork Upstream S40 Unit	0.5	0.3		0.097				0.36	0.517	0.655
Lincoln Creek Downstream Dry Hollow Creek	0.9	2.3		0.13				0.634	0.744	0.781
Lincoln Creek Upstream N Limb Unit	0.7	0.62		0.007				0.871	0.915	
Montgomery Watson, 1999-2000		Sept. 1999 - April 2000								
Baker Creek Below E Limb		4.8								
Ross Fork Below S40		0.06								
Lincoln Creek Upstream N Limb Unit		0.62								

Cold Water Biota Standard (EPA, 1977): 5mg/L
Drinking Water Standard (EPA, 2002): 50mg/L
Original data were reported in mg/l, approximating ppm.

Table 4: Gay Mine Stream Sediment Sample Selenium Data

	ppb
Montgomery Watson, 1998	Sept. 1998
Portneuf River Downstream Baker Creek	2500
Portneuf River Upstream U Creek	1200
Ross Fork Downstream Danielson Creek	1300
Ross Fork Upstream S40 Unit	2200
Lincoln Creek Downstream Dry Hollow Creek	2900
Lincoln Creek Upstream N Limb Unit	1700
Montgomery Watson, 1999-2000	Sept. 1998
Baker Creek Below E Limb	5400
Ross Fork Below S40	620
Lincoln Creek Upstream N Limb Unit	1000

Note: Original data were reported in mg/l, approximating ppm.

Table 5: Gay Mine Pit Pond Sample Selenium Data

Gay Mine Selenium Monitoring
Pond Water

	ppb	ppb	ppb
Montgomery Watson, 1998	Sept. 1997	May-98	Sept. 1998
W Pit Lake	0.4	0.52	0.81
Z Pit Lake	58.3	55	62
JD Pit Lake	n/a	52	59
Pond 1 Above A12 Pit	0.95		
Pond 2 Above A12 Pit	1.59		
JF Lake in JF Pit	46.8		
A12 Lake in A12 Pit	100		

Note: Original data were reported in mg/l, approximating ppm.
Cold Water Biota Standard (EPA, 1977): 5mg/L
Drinking Water Standard (EPA, 2002): 50mg/L

Gay Mine Selenium Monitoring
Pond Sediment

	ppb
Montgomery Watson, 1998	
W Pit Lake	1200
Z Pit Lake	17000
JD Pit Lake	17000

Note: Original data were reported in mg/kg, approximating ppm.

Table 6: Gay Mine Well Water Sample Selenium Data

Gay Mine Selenium Monitoring
Groundwater

	ppb
Brown and Caldwell, 1993	Spring 1984
GMW (Domestic Well)	9
FMC-2A	5
FMC-273	9

Note: Original data were reported in mg/l, approximating ppm.

Table 7: Gay Mine Radiological Sample Data (from Dames & Moore, 1981)

	Gay Mine Ore Concentrations	Gay Mine Concentrations from Same Ore Sample	Source:
U	69 ug/g		Dames & Moore, 1975
U	24 ug/g		Simplot, 1975
Ra-226	28 ug/g		EPA, 1978
Ra-226	16 ug/g		Simplot, 1975
U-238		12 +/- 1 pCi/g	Simplot, 1975
U-234		13 +/- 1 pCi/g	Simplot, 1975
Th-230		0.3 +/- 0.1 pCi/g	Simplot, 1975
Ra-226		16.4 +/- 0.1 pCi/g	Simplot, 1975

5.0 RECOMMENDED CERCLA SITE BOUNDARY

Recommended CERCLA Site Boundary   Consistent with evidence regarding releases and threats of releases from the Gay Mine within the Fort Hall Reservation, the recommended CERCLA site boundary for the Gay Mine is presented in **Figure 15.** The recommended *Site Boundary* encompasses all Gay Mine leased areas, with their interconnecting roads, as a contiguous parcel. It includes the Gay Mine Headquarters Area, the North Limb and East Limb areas, and the South 40. Reclaimed areas, and areas containing "mill shale" piles are included within the boundary. If the proposed Site Boundary is located downhill from a mine-disturbed area, its placement has been extended at least one-quarter mile downhill from the disturbance to account for potential near-site impacts. The rail spur from the mine tipple to the intersection of the main Union Pacific line rail at Fort Hall is included, with a recommended width of 100 feet on both sides of the centerline. The Gay Mine access road, formerly used as a haul road from the mine tipple to the former materials loading area on the main Union Pacific line rail at Fort Hall is included, with a recommended width of 100 feet on both sides of the centerline. That portion of the Union Pacific rail track that is on reservation lands, from Fort Hall town site to the processing plants, is also included, with a width of 100 feet on both sides of the centerline. Surface water features that cross mine disturbed areas are extended to a distance of 2 miles downstream of the site boundary. The stream segment study area boundaries that are shown on the map follow stream centerlines, and are not to scale. The designated stream segments include all areas of riparian vegetation that are associated with the stream segment. The 2 mile distance criteria is a current best estimate of the downstream range of detectable contamination in sediment or aquatic vegetation, and is subject to modification when sampling data become available.

The Site Investigation should include a goal to expand the boundaries of the CERCLA study area if sampling shows migration of COPECs from the proposed CERCLA boundaries.

6.0 RECOMMENDATIONS FOR FUTURE ACTIONS

CERCLA Site Investigation Based on the review of available documents that was made in this Preliminary Assessment, it appears that releases of hazardous substances to the environment have occurred, and continue to occur, at the Gay Mine. Significant data gaps exist in many disciplines that would allow development of a conceptual model to understand how these releases affect human health and the environment, and to quantify the level of risk they represent. Although various areas of the mine have been characterized for limited time periods in certain disciplines as permitting requirements dictated and as resources allowed, none of the Gay Mine work areas has been adequately delineated to support CERCLA risk analyses. A *CERCLA Site Investigation* (SI) is recommended to fill these data gaps. The recommended preliminary boundaries of the Gay Mine SI are presented in **Figure 15.** (available at the repository at the BIA Fort Hall Agency, Fort Hall, Idaho)

The Gay Mine's potential future land uses will include cattle and sheep grazing, hunting, fishing, and gathering, collecting, and use of traditional plants. In contrast to other Southeast Idaho mines, the possibility exists for residential land use in the Gay Mine area, given individual land ownership within the mine lease areas there. Therefore, all elements of the Site Investigation should be performed in the context of long-term individual land ownership that exists within the Gay Mine area.

As noted throughout the PA, selenium, cadmium, and other substances have been identified as risk sources in Southeast Idaho. These substances are present at the Gay Mine. Available data suggest that mill shales, relatively rich in selenium, are brought to the surface as part of the mining process and are stored in surface piles (many reclaimed with vegetation) in large volumes at Gay Mine. There, selenium is oxidized by exposure to air and water, becoming both toxic and mobile. Precipitation and significant snowmelt may act to transport the material to surrounding waters and soils. Vegetation planted during the mined-land reclamation process has become a magnet to grazing cattle and wildlife. These plants are known to be effective bioaccumulators of selenium, concentrating it for any animals that use the vegetation for forage, with resulting risks to wildlife and the environment.

The Site Investigation should address, but is not limited to, the following issues:

Action Levels The SI should develop and define action levels, consistent with other area-wide studies, for hazardous substances in each of the environmental media. Special consideration should be given for cultural significance.

Sources The chemical forms (i.e., speciation, oxidation state) of Contaminates of Potential Ecological Concern need to be defined and related to sources at the Gay Mine.

Surface Water A comprehensive characterization of all Gay Mine surface waters is needed to identify hot spots for selenium and other hazardous substances in individual stream segments and ponds. Surface water impacts to sediments, and sediment and water impacts to vegetation need to be quantified. Monitoring needs to be correlated (e.g., upstream and downstream) to mine features that are determined to be potential sources of selenium, cadmium, nickel, or other hazardous substances.

Groundwater Groundwater resources need to be characterized for each of the four Gay Mine working areas. The groundwater gradient needs to be defined to support the development of groundwater flow and contaminant transport modeling. Because of the high cost of monitoring well development, groundwater resources that are currently used or planned for use should be identified and used to guide the prioritization of resources. As part of this effort, water quality should be determined for seeps, springs, and areas of snowmelt, in areas related to the Gay Mine, as well as in the mine pit lakes.

<u>Soils</u> Soils that exist in the Gay Mine areas (undisturbed, reclaimed, and near the CERCLA site boundary) need to be defined and characterized as a required prerequisite for vegetation studies that address the soil, plant, animal, and human pathways for exposure to hazardous substances.

<u>Air</u> Additional air dispersion modeling and ambient air studies should be performed to determine the extent of mine dust distribution, and its relationship to bioaccumulation. These studies should include an assessment of alpha radioactivity dose from mine-related particulate dispersion.

<u>Vegetation</u> Vegetation studies to define damage to resources and to define bioaccumulation and food-chain effects should be performed on aquatic and terrestrial biota on mined-land reclamation areas, as well as on naturally- reclaimed mine areas. Such studies should address the use of traditional plants by tribal members for cultural and medicinal purposes. The scope of the vegetation study should include the area of wind-blown dust distribution, as determined by the air dispersion study.

<u>Livestock Grazing</u> The SI should include studies of cattle, horses, and sheep grazing. Controlled studies of grazing female cattle should be included to evaluate the effects of selenium on reproduction.

<u>Wildlife Uses</u> The SI should include studies of Gay Mine-related wildlife use by Fort Hall Indians, and of most commonly used wildlife harvest scenarios. Impacts of COPECs on wildlife and migratory waterfowl should be defined.

<u>Cultural Uses</u> An assessment of cultural uses of the Gay Mine area, as well as the risks associated with such use, supported by interviews, should be included in the SI.

7.0 SUMMARY AND CONCLUSIONS

- The Gay Mine is an inactive surface phosphate mine that is located on the Fort HaII Reservation, approximately 25 miles northeast of Pocatello, Idaho, and 16 miles east of Fort Hall, Idaho. The Gay Mine is the largest mine development in the Southeast Idaho regional phosphate formation (4694 acres disturbed) and is also the longest (47 years) operating. The mine area is in a rural mountain setting, and no permanent residents live in the mine area; however much of the mine area land is privately-held, and has no restrictions on future (e.g., residential) land use. Cattle grazing dominates the current land uses
- The J. R. Simplot Company (Boise, Idaho) leased lands beginning in 1946 to support opening of the mine. In 1956, additional mine leases were initiated by FMC Corporation, (Chicago, IL). Mining leases were issued by BIA. BLM provided operational oversight for mineral extraction. During the latter term of the mine, leases were jointly held by Simplot and FMC. For all leases, the J. R. Simplot Company performed mining operations throughout the life of the mine, sometimes utilizing subcontractors for stripping overburden [mill shale]. Ore transportation was provided by Simplot (2-year trucking period) and Union Pacific Railroad (dedicated rail spur and unit trains).
- Mining was performed between 1946 and 1993 at a peak ore production rate of approximately 2 million tons per year.
- Some mine reclamation occurred after termination of mining in September, 1993; however mining and reclamation equipment was removed before closure work was completed, and to date, mining leases have not been released pending that reclamation. At present, the mine reclamation status is essentially unchanged from that reported by Koehler and Hernandez (1997) in *Status of Reclamation Compliance at Gay Mine, Fort Hall Agency, Idaho,* 1996-1997.
- Based on the review of available documents that was made in this Preliminary Assessment, it appears that releases of hazardous substances to the environment have occurred, and continue to occur, at the Gay Mine.
- Separation of shale wastes from the phosphate ore and subsequent placement of the mined material on the surface has resulted in a situation in which material with high concentrations of metals are subject to greatly increased oxidation, mobilization, and transport. There are forty-one (41) mill shale piles on the Gay Mine site, containing 27,049,743 tons of material. Within the southeast Idaho phosphate mining area, mill shale accumulation and storage is unique to Gay Mine.
- All analytical data that report or relate to releases or threats of releases of hazardous substances at the Gay Mine are summarized.
- The Idaho Department of Environmental Quality's *Area-Wide Human Health and Ecological Risk Assessment* (Tetra Tech, 2002) screened all of the candidate Chemicals of Potential Concern (COPC) for humans, and all of the candidate Chemicals of Potential Ecological Concern (COPEC), and concluded that Contaminants of Concern (COC) should include Cadmium, Chromium, Copper, Nickel, Selenium, Vanadium, and Zinc. Most of these substances have not been studied at Gay Mine.
- Significant data gaps exist in many disciplines that would allow development of a conceptual model to understand how these releases affect human health and the environment, and to quantify the level of risk they represent.
- The effect of the Gay Mine operations on groundwater resources has not been determined. The size of the mine and the wide variation in geology and surface topography suggest that separate groundwater studies in each of the Gay Mine working areas will be appropriate. Because of the high cost of monitoring well development,

groundwater resources that are currently used or planned for use should be identified, and these should be used to guide the prioritization of resources.

- A comprehensive characterization of all Gay Mine surface waters is needed to identify hot spots for selenium and other hazardous substances in springs, individual stream segments, and ponds. Surface water impacts to sediments and to vegetation need to be quantified. Monitoring should be correlated (e.g., upstream and downstream) to mine features that are determined to be potential selenium sources.
- Wind erosion of exposed ore piles ("mill shale") and of remaining open pits appears to be a less effective mechanism for transport and release of hazardous substances into the food chain, given the comparative efficiency of metals bioaccumulation in reclamation vegetation. Sampling to determine the comparative impact of wind- blown dust in the air-to-food chain pathway, and an assessment of alpha particle doses due to airborne dust are needed.
- Although Gay Mine contamination is dominated by metal compounds that originate in the ore and mill shale, multiple instances of limited, local-scale releases of other hazardous substances to the environment were identified in the document review, interviews, and site reconnaissance. These releases may constitute local hazards at the mine.
- A *CERCLA Site Investigation* (SI) is recommended to fill these data gaps. Recommendations are made for the SI content with respect to action levels, sources, surface water, groundwater, soils, air, vegetation, grazing, and wildlife use.
- A CERCLA site boundary for the Gay Mine is recommended.

8.0 REFERENCE LIST

Alabama A&M University and USDA Agricultural Research Service, 2000. “Evaluation of Selenium Status in Gay Mine Reclamation Project, Fort Hall, Idaho,” 12 pp, prepared for US Bureau of Land Management, Boise, ID, March, 2000.

Broncho 2002. “Notes of Interview with Claudio Broncho, Shoshone-Bannock Tribes, Fort Hall, ID by N. R. Ricks, EMI Services, December 5, 2002.

Brown and Caldwell, 1993. “Gay Mine Site Characterization Report”, Brown and Caldwell, Boise, ID, February 22, 1993.

Brown and Caldwell, 1994. “1994 Bioremediation Work Plan”, Brown and Caldwell, Boise, ID.

Brown and Caldwell, 2000. “Gay Mine Landfarming Closure Report”, Brown and Caldwell, Boise, ID, samples taken October, 12, 1999.

BIA, 2002. “Precipitation Gage Records, Mt. Putnam, Bingham County, ID”, 71 pp 1963-1977. US Bureau of Indian Affairs, Fort Hall Agency, Idaho July, 2002.

BLM, 1992. Personal correspondence from Lloyd Ferguson, BLM Idaho Falls Office to William Schmitt, Gay Mine Manager, 2 pp, August 19, 1992.

BLM, 1996. “Gay Mine Lease Map,” 9 pp, fax from Jeff Cundick, Bureau of Land Management Pocatello Office to Albert C. Jones, Shoshone Bannock Tribal Attorney, Pocatello, Idaho

Christopherson, 2002. Personal communication, Dan Christopherson, Shoshone-Bannock Wildlife Biologist, to Norman Ricks, EMI Services, November 10, 2002.

Cundick, 2003. “Notes of Interview with Jeff Cundick, Bureau of Land Management Pocatello Office by N. R. Ricks, EMI Services, February 24, 2003.

Dames and Moore, 1981. “Environmental Assessment Report: Proposed Joint-Lease Phosphate Mine, Fort Hall Indian Reservation, Idaho for J. R. Simplot Company”, Dames and Moore, Salt Lake City, Utah Job 4048-034-06, January 1981.

DEQ, 2002. “Notes of Interview with Rick Clegg, Idaho Division of Environmental Quality Soda Springs Field Office by N. R. Ricks, EMI Services, Sept 6, 2002.

Detweiler, 2002. Toxicokinetics of Selenium in the Avian Egg: Comparisons Between Species of Differing Embryonic Tolerance. PhD Dissertation, University of California, Davis, CA, 185pp.

DOI, 1998. *National Irrigation Water Quality Program Information Report No. 3: Guidelines for Interpretation of the Biological Effects of Selected Constituents in Biota, Water, and Sediment*, U.S. Department of the Interior, Washington, DC. November, 1998.

DRI, 2002. “Period of Record Monthly Climate Summary for Fort Hall Indian Agency”, Desert Research Institute Western Regional Climate Center, Reno, NV, Period of Record 8/1/1948 to 12/31/2001.

DuBowy, P. 1989. Effects of Diet on Selenium bioaccumulation in marsh birds, Journal of Wildlife Management, 53:776 – 781.

Eisler, R. 1985. *Selenium Hazards to Fish, Wildlife, and Invertebrates: a synoptic review.* U.S. Fish and Wildlife , Patuxent Wildlife Research Center, Laurel, MD, Contaminant Hazard Reviews, Report 5.

EMI, 2002a. Notes of Interview with Alvin F. Edmo, Gay Mine employee 1963-1976, by Thomas J.A. Kim and Richard Denton, EMI Services, Idaho Falls, ID, 2 pp, May 14, 2002.

EMI, 2002b. Notes of Interview with Buckley Blackhawk, Gay Mine employee 1968-1971, by Thomas J.A. Kim and Richard Denton, EMI Services, Idaho Falls, ID, 1 p, May 14, 2002.

EMI, 2002c. “Gay Mine Preliminary Assessment Notebook”, 8 pp, by Richard Denton, EMI Services, Idaho Falls, ID, April 2, 2002.

EMI, 2002d. “Site Reconnaissance Photographs of the Gay Mine”, by Thomas J. A. Kim, EMI Services, Idaho Falls, ID, May 6, 2002.

EMI, 2002e. “Aerial Photographs of the Gay Mine”, 48 pp, by Norman R. Ricks, EMI Services, Idaho Falls, ID, June 20, 2002.

EMI, 2002f. “Maps and Diagrams of the Gay Mine”, 11 pp, by Norman R. Ricks, EMI Services, Idaho Falls, ID, July 1, 2002.

EMI, 2002g, Field Validation of Gay Mine Disturbed Areas vs Plotted Mine Lease Boundaries”, EMI Gay Mine Work File, August, 2002.

EPA, 1969. “The National Environmental Policy Act of 1969” 24 USC 4331 et seq., Washington, DC, October, 1969.

EPA, 1975. “Radioactivity Distribution in Phosphate Products, By-Products, Effluents, and Wastes” ORP/LSD-75-3, Washington, DC, August 1975.

EPA, 1980. “Ambient Monitoring Guidelines for Prevention of Significant Deterioration” EPA/450/4-80/012, Office of Air Quality Planning and Standards, Washington, DC, 1980.

EPA, 1991. “Guidance for Performing Preliminary Assessments Under CERCLA” EPA/540/G-91/013, Office of Emergency and Remedial Response, Washington, DC, September, 1991.

EPA, 1998a. EPA Superfund Record of Decision, Eastern Michaud Flats Contamination, OU1, Pocatello, ID EPA 541-R98-034, 226 pp, June 6, 1998.

EPA, 1998b. Personal correspondence from Daniel L. Duncan, Region 10 PCB Coordinator, Solid Waste and Toxics Unit, to Steve Herndon, Idaho Power Company, 1 p, July 20, 1998.

EPA, 1998c. Personal correspondence from Daniel L. Duncan, Region 10 PCB Coordinator, Solid Waste and Toxics Unit, to Ward Wolleson, Simplot Senior Environmental Engineer, 2 pp, September 3, 1998.

Fairbrother, A. and J. Fowles 1990. "Subchronic effects of sodium selenite and selenomethionine on several immune functions in mallards", *Arch. Environ. Contam. Toxicol.* 19: 836-844.

Galloway, 2002. "Notes of Interview with Tony Galloway, Sr., Shoshone-Bannock Tribes Land Use Commission, by N. R. Ricks, EMI Services, Sept 5, 2002.

Girling, C.A. 1984. *Selenium in agriculture and the environment*, Agricult. Ecosys. Environ. 11: 37-65

Greider, Frederick L. 1989. "Fishery Investigation: Ross Fork Creek 1988, Gay Mine Expansion Area, Fort Hall Reservation, Idaho" Tribal Fisheries Biologist, 1989.

HHS, 2001a. "Health Consultation: Evaluation of Selenium in Beef, Elk, Sheep, and Fish in the Southeast Idaho Phosphate Resource Area," EPA Facility ID No. IDN001002245, US Department of Health and Human Services, Public Health Service, Atlanta, GA, June 27, 2001.

HHS, 2001b. "Health Consultation: Evaluation of Selenium in Groundwater," EPA Facility ID No. IDN001002245, US Department of Health and Human Services, Public Health Service, Atlanta, GA, September 19, 2001.

Hagius, Fred, 1988. "Mill Shale Stockpiles as of January 1, 1988," 8 pp annotated tables plus 24x30 inch annotated mine plot plan received from Dean Hatch, 12-12-88, Bureau of Land Management Regional Office, Pocatello, Idaho, December, 1988.

Hagius, Fred, 2002. Notes of Interview with Fred Hagius, Retired BLM Mine Engineer assigned to Gay Mine, by N.R. Ricks, EMI Services, August 8, 2002.

Hedlund, J. D. 1993. *Conservation Planning for Water Quality Concerns: Toxic Element – Selenium*, U.S. Soil Conservation Service, West National Technical Center, Portland, OR, Technical Note, Water Quality Series No. W1.

Heinz, G. H. 1996. Selenium in Birds. In: W.N. Beyer, G.H. Heinz, and A.W. Redmon, eds. *Interpreting environmental contaminants in animal tissues*, Lewis Publishers, Boca Raton, FL, pp 453-464.

Hernandez, F. A. Sam 2002. Notes of Interviews with Sam Hernandez, Bureau of Indian Affairs Fort Hall Agency, by N.R. Ricks, EMI Services, August, 2002.

Hernandez, F. A. Sam 2003. Notes of Interviews with Sam Hernandez, Bureau of Indian Affairs Fort Hall Agency, by N.R. Ricks, EMI Services, February, 2003.

IFG, 2002. *Special Status Plants*, Bannock County, Bingham County, Caribou County. Web Site, Idaho Department of Fish and Game, www2.state.id.us/fishgame/info/cdc

IFG, 2003. *Special Status Animals*, Bannock County, Bingham County, Caribou County Web Site, Idaho Department of Fish and Game, www2.state.id.us/fishgame/info/cdc

James, L.F., W.J. Hartley, and K.R. Van Kampen, 1981. *Syndromes of Astragalus poisoning in livestock*, J. Am. Vet. Med. Assoc. 178: 146-150.

Koehler, David A. and F.A. Sam Hernandez, 1997. “Status of Reclamation Compliance at Gay Mine, Fort Hall Agency, Idaho 1996-97,” 61 pp, Bureau of Land Management Idaho State Office, Boise Idaho and Bureau of Indian Affairs, Ft. Hall Agency, Idaho, July, 1997.

Jones, 2003. Personal communication, Jeff Jones, USDA Forest Service, Soda Springs, ID, to Dean Fox, Bureau of Indian Affairs, 2003.

Koller, L.D. and J. H. Exon, 1986. *Two faces of selenium –deficiency and toxicity – are similar in animals and man*. Can J. Vet. Res. 50: 297-306

Lemley, A. D. and G. J. Smith 1987. *Aquatic cycling of selenium: implications for fish and wildlife*. U.S. Fish and Wildlife Service, Washington, D.C., Fish and Wildlife Leaflet 12.

Lemley, A. D. 1996. Selenium in Aquatic Organisms In: W.N. Beyer, G.H. Heinz, and A.W. Redmon, eds. *Interpreting environmental contaminants in animal tissues*, Lewis Publishers, Boca Raton, FL, pp 427-445.

Mariah Associates, Inc. 1978. “Endangered Species Studies at Simplot’s Gay Mine, Fort Hall Indian Reservation, Idaho, During Early Summer, 1978”, Mariah Associates, Inc., Laramie, WY. July 2, 1978

Mariah Associates, Inc. 1980. “Endangered and Threatened Plant Survey, Gay Mine Expansion Areas, Fort Hall Reservation, Idaho, 1980” Mariah Associates, Inc., Laramie, WY. 1980

Mariah Associates, Inc. 1989. “Monitoring Report for J. R. Simplot Company’s Gay Mine Expansion Area, Fort Hall Reservation, Idaho – 1988” 60 pp, Mariah Associates, Inc., Laramie, WY. June 1989

Mariah Associates, Inc. 1990. “Monitoring Report for J. R. Simplot Company’s Gay Mine Expansion Area, Fort Hall Reservation, Idaho – 1989 Results” 65 pp, Mariah Associates, Inc., Laramie, WY. August, 1990

Mariah Associates, Inc. 1991. “Monitoring Report for J. R. Simplot Company’s Gay Mine Expansion Area, Fort Hall Reservation, Idaho – 1990 Results” 63 pp, Mariah Associates, Inc., Laramie, WY. September, 1991

Mariah Associates, Inc. 1992. “Monitoring Report for J. R. Simplot Company’s Gay Mine Expansion Area, Fort Hall Reservation, Idaho – 1991 Results” 88 pp, Mariah Associates, Inc., Laramie, WY. May, 1992

McKelvey, V. E. 1959. “The Phosphoria, Park City, and Shedhorn Formations in the Western Phosphate Field”, USGS Professional Paper 313-A, U.S. Geological Survey, Washington DC.

McDole, R. E., D. R. Jones, D. M. Park, R. K. Buder, A.L. Decker, R. J. Swensen, 1977. “Soil Survey of Fort Hall area, Idaho – Parts of Bannock, Bingham, Caribou, and Power Counties” USDA Soil Conservation Service and USDOI Bureau of Indian Affairs, in Cooperation with University of Idaho Experiment Station

Montgomery Watson, 1999. “Draft 1998 Regional Investigation Report” 63 pp, Montgomery Watson Harza, Pasadena, CA. June 1999.

Montgomery Watson, 2001a. "Fall 1997 Interim Surface Water Survey , Southeast Idaho Phosphate Resource Area Selenium Monitoring Project" 63 pp, Montgomery Watson Harza, Pasadena, CA. April 2001

Montgomery Watson, 2001b. "Draft Data Report for Surface Water, Sediment and Aquatic Biota Sampling Activities, September 1999", 63 pp, Montgomery Watson Harza, Pasadena, CA. April 2001

NOAA, 1989. "Climatography of the Idaho National Engineering Laboratory, 2nd Edition, DOE/ID-12118, 154 pp, National Oceanic and Atmospheric Administration Air Resources Laboratories, Idaho Falls, ID, December 1, 1989.

NRC (National Research Council) 1980. *Recommended Daily Allowances*, 9th ed., National Research Council Food and Nutrition Board, Committee on Dietary Allowances, National Academy Press, Washington.

Ogle, R.S., K. J. Maier, P. Kiffney, M. J. Williams, A. Brasher, L. A. Melton, and A. W. Knight, 1988. "Bioaccumulation of selenium in aquatic ecosystems", *Lake Reservoir Manage*. 4: 165-173.

Olson, O. E. 1986. *Selenium toxicity in animals with emphasis on man*, J. Am. Coll. Toxicol. 5: 45-70

Oliver, 2002. Notes of Interviews with Alan Oliver, Bureau of Indian Affairs Fort Hall Agency, by N.R. Ricks, EMI Services, December 5, 2002.P

Oregon Short Line Railroad, 1948. "Application of Oregon Short Line Railroad Company for a railroad right of way through Indian lands within the Fort Hall Indian Reservation, Idaho", 11 pp, Omaha, Nebraska, April 1, 1948

O'Toole, D. and M. F. Raisbeck 1998. *Magic numbers, elusive lessons: Comparative Pathology and toxicology of selenosis in waterfowl and mammalian species*, In: W. T. Frankenburger, Jr. and R.A. Engberg, eds., Environmental Chemistry of Selenium, Marcel Decker Inc., New York, p 335-395.

Peterson, J. A. and A. V. Nebeker, 1992. *Estimation of waterborne selenium concentrations that are toxicity thresholds for wildlife*, Arch. Environ. Contam. Toxicol. 23: 154-162.

Schamber, R. A., E. L. Belden, and M. F. Raisbeck, 1995. "Immunotoxicity of chronic selenium exposure" in: G. E. Schuman and G. F. Vance, eds. *Decades Later: A time for re-assessment*, Proceedings of the 12th Annual National Meeting, American Society of Surface Mining and Reclamation, Princeton, West Virginia, pp 384-393.

Schmitt, William O., 1967. "The Gay Mine, Fort Hall, Idaho", 8 pp, in *Anatomy of the Western Phosphate Field*, 15th Annual Field Conference of Intermountain Association of Geologists

Seiler, R. L. 1997. *Methods to identify areas susceptible to irrigation-induced selenium contamination in the Western United States*, U. S. Geological Survey Fact Sheet FS-038-97.

Simplot, 1948. "Agreement between Oregon Short Line Railroad Co., Union Pacific Railroad Company, The J.R. Simplot Co. and WestVaco Chlorine Products Corp…. covering construction, maintenance, and operation of railroad trackage from Fort Hall, Idaho to Gay Phosphate Rock Mine", 12 pp, March 22, 1948

Simplot, 1970. Correspondence from Simplot Minerals and Chemical Division to John Skinner, USGS District Mining Engineer, Pocatello, ID, "Plans for a sequence of pits in a continuing program of mining at Gay Mine …supplemental to plans submitted", September, 1970.

Simplot, 1971. Correspondence from Simplot Minerals and Chemical Division to John Skinner, USGS District Mining Engineer, Pocatello, ID, "Plans for a sequence of pits in a continuing program of mining at Gay Mine …supplemental to plans submitted", April, 1971.

Simplot, 1974. Personal correspondence from Simplot Minerals and Chemical Division to John Skinner, USGS District Mining Engineer, Pocatello, ID, "Plans for a sequence of pits in a continuing program of mining at Gay Mine", 4 pp, March 21, 1974.

Simplot, 1986. "South 40 Mine Plan", 10 pp, J.R. Simplot Company, Pocatello, ID, BLM received date January 31, 1986.

Simplot, 1991. Personal correspondence from William Schmitt (Geologist), Gay Mine Manager to Lloyd Ferguson, BLM Idaho Falls Office, 2 pp, January 25, 1991.

Simplot, 1992. Personal correspondence from William Schmitt (Geologist), Gay Mine Manager to Lloyd Ferguson, BLM Idaho Falls Office, 1 p, August 25, 1992

Simplot, 1997. Personal correspondence from Ward Wolleson, Senior Environmental Engineer to Daniel Tangarone, Engineering & Investigation Section, USEPA Region 10, 2 pp, October 22, 1997.

SJVDP (San Joaquin Valley Drainage Program) 1990. *Fish and wildlife resources and agricultural drainage in the San Joaquin Valley, California*, Sacramento, CA San Joaquin Valley Drainage Program, Vol 1, Section 3.

Skorupa, J. P. and H.M. Ohlendorf 1991. *Contaminants in drainage water and action thresholds*. In: A. Dinar and D. Zilber The Economics and management of water and drainage in agriculture. Kluwer Academic Publishers, Boston, MA

Skorupa, J. P. 1998. Selenium Poisoning of Fish and Wildlife in Nature: Lessons from twelve real-world examples, In: W. T. Frankenburger, Jr. and R.A. Engberg, eds., Environmental Chemistry of Selenium, Marcel Decker Inc., New York, p 325-354.

Skorupa, J. P. 1999. "Beware missing data and undernourished statistical models: Comment on Fairbrother et al.'s critical evaluation." Human and Toxicological Risk Assessment, 5:1255-1262.

Sorensen, M.B.E. 1991. *Metal Poisoning in Fish*, Lewis Publishers, Boca Raton, FL

Stanley, T. R. Jr., G. J. Smith, D. J. Hoffman, G. H. Heinz, and R. Rosscoe 1996. Effects of boron and selenium on mallard reproduction and duckling growth and survival. Environmental Toxicology and Chemistry, 15: 1124-1132.

Taki, Doug 1990a. “Fishery Investigation: Ross Fork Creek 1989, Gay Mine Expansion Area, Fort Hall Reservation, Idaho”, Tribal Fisheries Biologist, Fort Hall, ID, June 1990.

Taki, Doug 1990b. “Fishery Investigation: Ross Fork Creek 1990, Gay Mine Expansion Area, Fort Hall Reservation, Idaho”, Tribal Fisheries Biologist, Fort Hall, ID, December 1990.

Taki, Doug 1991. “Fishery Investigation: Ross Fork Creek 1991, Gay Mine Expansion Area, Fort Hall Reservation, Idaho”, Tribal Fisheries Biologist, Fort Hall, ID, December, 1991.

Tetra Tech, 2002. “Final Area-Wide Human Health and Ecological Risk Assessment: Selenium Project, Southeast Idaho Phosphate Mining Resource Area, 2 vols, Contract C023 Task Order AWI-00-01, Boise, ID, December, 2002.

Turner, 2002. Personal Communication Roger Turner, Shoshone Bannock Interim CERCLA-RCRA Manager to Norman R. Ricks, EMI. October 7, 2002.

USDA 1956. 1:20,000 scale aerial photograph of Danielson Basin, photo serial CXV-5R-132 dated 10-15-56, US Department of Agriculture Soil Conservation Service, Salt Lake City, UT

USGS , 1981a. “Lincoln Peak, Idaho 7.5 minute Quadrangle” US Geological Survey, Denver, CO, edited 1981.

USGS , 1981b. “Yandell Springs, Idaho 7.5 minute Quadrangle” US Geological Survey, Denver, CO, edited 1981.

USGS , 2001. J. D. Causey and P. R. Moyle, Open File Report 01-142: “USGS Digital Database of Mining-Related Features at Selected Historic and Active Phosphate Mines, Bannock, Bear Lake, Bingham, and Caribou Counties, Idaho” Chart 2: Chart of Phosphate mining-related disturbed lands…” and Table 1: Mine feature acreage for 19 mines and total for southeastern Idaho phosphate resource area”.

Van Derveer, W.D. and S. Canton 1997. *Selenium Sediment toxicity thresholds and derivation of water quality criteria for freshwater biota of western streams*, Environ. Toxicol. Chem. 16: 1260-1268.

Whiteley, P. L. and T. M. Yuill 1991. “Interactions of environmental contaminants and infectious disease in avain species. In: B. D. Bell, et al. eds. *Acta XX Congressus Internationalis Ornithologici, Christchurch, New Zealand, 2-9 December 1990.* Ornithological Congress Trust Board, Wellington, New Zealand. Vol 4, pp 2338-2342.

INTERVIEW REFERENCES

Broncho 2002. “Notes of Interview with Claudio Broncho, Shoshone-Bannock Tribes, Fort Hall, ID by N. R. Ricks, EMI Services, December 5, 2002.

Cundick, 2003. “Notes of Interview with Jeff Cundick, Bureau of Land Management Pocatello Office by N. R. Ricks, EMI Services, February 24, 2003.

DEQ, 2002. “Notes of Interview with Rick Clegg, Idaho Division of Environmental Quality Soda Springs Field Office by N. R. Ricks, EMI Services, Sept 6, 2002.

EMI, 2002a. Notes of Interview with Alvin F. Edmo, Gay Mine employee 1963-1976, by Thomas J.A. Kim and Richard Denton, EMI Services, Idaho Falls, ID, 2 pp, May 14, 2002.

EMI, 2002b. Notes of Interview with Buckley Blackhawk, Gay Mine employee 1968-1971, by Thomas J.A. Kim and Richard Denton, EMI Services, Idaho Falls, ID, 1 p, May 14, 2002.

Galloway, 2002. “Notes of Interview with Tony Galloway, Sr., Shoshone-Bannock Tribes Land Use Commission, by N. R. Ricks, EMI Services, Sept 5, 2002.

Hagius, Fred, 2002. Notes of Interview with Fred Hagius, Retired BLM Mine Engineer assigned to Gay Mine, by N.R. Ricks, EMI Services, August 8, 2002.

Hernandez, F. A. Sam 2002. Notes of Interviews with Sam Hernandez, Bureau of Indian Affairs Fort Hall Agency, by N.R. Ricks, EMI Services, August, 2002.

Hernandez, F. A. Sam 2003. Notes of Interviews with Sam Hernandez, Bureau of Indian Affairs Fort Hall Agency, by N.R. Ricks, EMI Services, February, 2003.

Oliver, 2002. Notes of Interviews with Alan Oliver, Bureau of Indian Affairs Fort Hall Agency, by N.R. Ricks, EMI Services, December 5, 2002.P

PHOTOGRAPHS FROM SITE RECONNAISANCE
MAY 6, 2002

GAY MINE
FORT HALL INDIAN RESERVATION
FORT HALL, IDAHO

FEBRUARY 18, 2003

Thomas J. A. Kim
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EMI Document C310.1.2 Rev 7

Reviewed By

Norman R. Ricks
EMI Services
Project Manager

Source: EMI 6-6-02	Digital file

Figure 19-1
North Limb of Gay Mine
View to NE. C Pit showing eroding highwalls.

Source: EMI 6-6-02	Digital Camera File

Figure 19-2
Derailment Location Site with Railcar Debris.
View to northeast. Near Ross Fork, approximately four miles from loading site.

Source: EMI 6-6-02	Digital Camera File

Figure 19-3
Derailment Debris Near Derail Site
View to north. Near Ross Fork, approximately four miles from loading site.

Source: EMI 6-6-02	Digital Camera File

Figure 19-4
Cattle Loading Chute Inside Mine Area
View to west. West of Headquarters Area.

Source: EMI 6-6-02	Digital Camera File

Figure 19-5
Mill Shale Pile Along Rail at Headquarters Train Makeup Area
View to north. Area shown is west of tipple.

Source: EMI 6-6-02	Digital Camera File

Figure 19-6
Ore Sample Shack at Headquarters Area

Source: EMI 6-6-02	Digital Camera File

Figure 19-7
Rock Samples in envelopes inside Sample Shack.
Samples represented operational history of the mine

Source: EMI 6-6-02	Digital Camera File

Figure 19-8
Hillside South of Headquarters Area:
View to north. Vents may indicate presence of an underground tank

Source: EMI 6-6-02	Digital Camera File

Figure 19-9
Water Well on Hillside above Headquarters Area

Source: EMI 6-6-02	Digital Camera File

Figure 19-10
Water Well on Hillside above Headquarters Area
View to northwest.

Source: EMI 6-6-02	Digital Camera File

Figure 19-11
View of A-12 Pit East of Headquarters Showing Reclaim Area in Foreground, with Pit Beyond.
View to northeast.

Source: EMI 6-6-02	Digital Camera File

Figure 19-12
Lake in A-12 Pit
Pit is accessible to grazing livestock.

Source: EMI 6-6-02	Digital Camera File

Figure 19-13
South 40 Area JD Pit Showing Slough Area and reclaimed Mine Road.
View to southwest. Hillside above shows scarp indicative of movement.

Source: EMI 6-6-02	Digital Camera File

Figure 19-14
View of Office Building and Bunkhouse in Headquarters Area
View to northwest. This area is west of the Tipple, near the mine entrance.
Re-vegetated waste dump is visible just behind Office Building.

Source: EMI 6-6-02	Digital Camera File

Figure 19-15
Manhole Covers Outside Bunkhouse, Headquarters Area
Concrete tank located below appeared to be part of a septic system.

Source: EMI 6-6-02	Digital Camera File

Figure 19-16
Petroleum Tank Outside Dry Building, Headquarters Area

Source: EMI 6-6-02	Digital Camera File

Figure 19-17
Petroleum Staining Below Tank At Dry Building, Headquarters Area
Tank appears to contain fuel oil.

Source: EMI 6-6-02	Digital Camera File

Figure 19-18
Floor tiles in Office Building, Headquarters Area
Tiles may contain asbestos

Source: EMI 6-6-02	Digital Camera File

Figure 19-19
Headquarters Area Showing Tipple and Support Facilities, Looking North
Re-vegetated waste dumps are visible just behind (north of) the tipple.

Source: EMI 6-6-02	Digital Camera File

Figure 19-20
Storage Tank in Headquarters Area South of Tipple
Tank appears to be a previously removed above-ground storage tank

Source: EMI 6-6-02	Digital Camera File

Figure 19-21
Maintenance Building Southwest of Tipple

Source: EMI 6-6-02	Digital Camera File

Figure 19-22
Headquarters Area. Former Equipment Maintenance Area showing where soil was removed to clean up petroleum contamination.
View to north. This area is west of Tipple.

Source: EMI 6-6-02	Digital Camera File

Figure 19-23
Headquarters Area. Former Equipment Maintenance Area showing where soil was removed to clean up petroleum contamination.
View to northwest. Contaminated soil was landfarmed east of this area.

Source: EMI 6-6-02	Digital Camera File

Figure 19-24
Debris Near Tipple in Headquarters Area
View to east.

Source: EMI 6-6-02	Digital Camera File

Figure 19-25
Fuel Piping outside Maintenance Building
South of the Tipple in Headquarters Area

Source: EMI 6-6-02	Digital Camera File

Figure 19-26
Pressure Tank and Piping, Western End of Tipple
Petroleum staining was observed on the soil in this area.

Source: EMI 6-6-02	Digital Camera File

Figure 19-27
Piping System and Tank West of Tipple at Headquarters
Petroleum staining of soil was observed here.

Source: EMI 6-6-02	Digital Camera File

Figure 19-28
Waste Shale Piles West of Tipple at Headquarters
Railcars were loaded with ore here.

Source: EMI 6-6-02	Digital Camera File

Figure 19-29
C Pit and Reclaim Area in North Limb
View to north. Black material left of road is furnace grade phosphatic shale.

Source: EMI 6-6-02	Digital Camera File

Figure 19-30
Weathered Phosphatic Shale near C Pit in North Limb

Source: EMI 6-6-02	Digital Camera File

Figure 19-31
Eroded Highwall at C Pit in North Limb
View to east. Dark-appearing trails are meltwater flow paths.
Note alluvial fan where shale has been deposited by water.

Source: EMI 6-6-02	Digital Camera File

Figure 19-32
Eroding Highwalls at C Pit in North Limb
View to north.

Source: EMI 6-6-02	Digital Camera File

Figure 19-33
Mill Shale Pile in North Limb Near C Pit

Source: EMI 6-6-02	Digital Camera File

Figure 19-34
Re-vegetated Mill Shale Pile North of C Pit, North Limb

Source: EMI 6-6-02	Digital Camera File

Figure 19-35
Explosives Magazine West of Roadway in North Limb

Source: EMI 6-6-02	Digital Camera File

Figure 19-36
Vent Above Explosives Magazine in North Limb

Source: EMI 6-6-02	Digital Camera File

Figure 19-37
Explosives Magazine

Source: EMI 6-6-02	Digital Camera File

Figure 19-38
Reseeded Reclaim Area in North Limb

Source: EMI 6-6-02	Digital Camera File

Figure 19-39
Livestock Water Trough at #14 Mill Shale Pile in North Limb

Source: EMI 6-6-02	Digital Camera File

Figure 19-40
Water Drainage Path Through Mill Shale Pile 14 in North Limb
Drainage Path is to the West. In Lincoln Creek Watershed.

Source: EMI 6-6-02	Digital Camera File

Figure 19-41
Mill Shale Pile 13 in North Limb

Source: EMI 6-6-02	Digital Camera File

Figure 19-42
Water Drainage at Mill Shale Pile 14 in North Limb
Water source is snow melt.

Source: EMI 6-6-02	Digital Camera File

Figure 19-43
Pond and water tank above A-12 Pit, east of Headquarters
Water was taken from here for dust suppression.

Source: EMI 6-6-02	Digital Camera File

Figure 19-44
FF Pit in East Limb

Source: EMI 6-6-02	Digital Camera File

Figure 19-45
Eroded Water Course Above FF Pit in East Limb

Source: EMI 6-6-02	Digital Camera File

Figure 19-46
Debris Visible in the Eroding Backfill Material of FF / HH Pit

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Source: EMI 6-6-02	Digital Camera File

Figure 19-47
Eroded Backfilled, Reclaimed JG Pit At Willow Creek In the South 40, Looking East
View to west. In Ross Fork Watershed.

Source: EMI 6-6-02	Digital Camera File

Figure 19-48
Willow Creek Drainage Through Damaged Culverts in South 40
Viewing is looking West. In Ross Fork Watershed

Source: EMI 6-6-02	Digital Camera File

Figure 19-49
JD Pit Showing Reclaimed Partial Backfill
View is looking north.

Source: EMI 6-6-02	Digital Camera File

Figure 19-50
Queedup Spring at Eastern End of the Gay Mine Area

Source: EMI 6-6-02	Digital Camera File

Figure 19-51
Mill Shale Pile in North Limb
Some Mill Shale Piles show little revegetation.

ANNOTATED AERIAL PHOTOGRAPHS
JUNE 20, 2002

GAY MINE
FORT HALL INDIAN RESERVATION
FORT HALL, IDAHO

FEBRUARY 18, 2003

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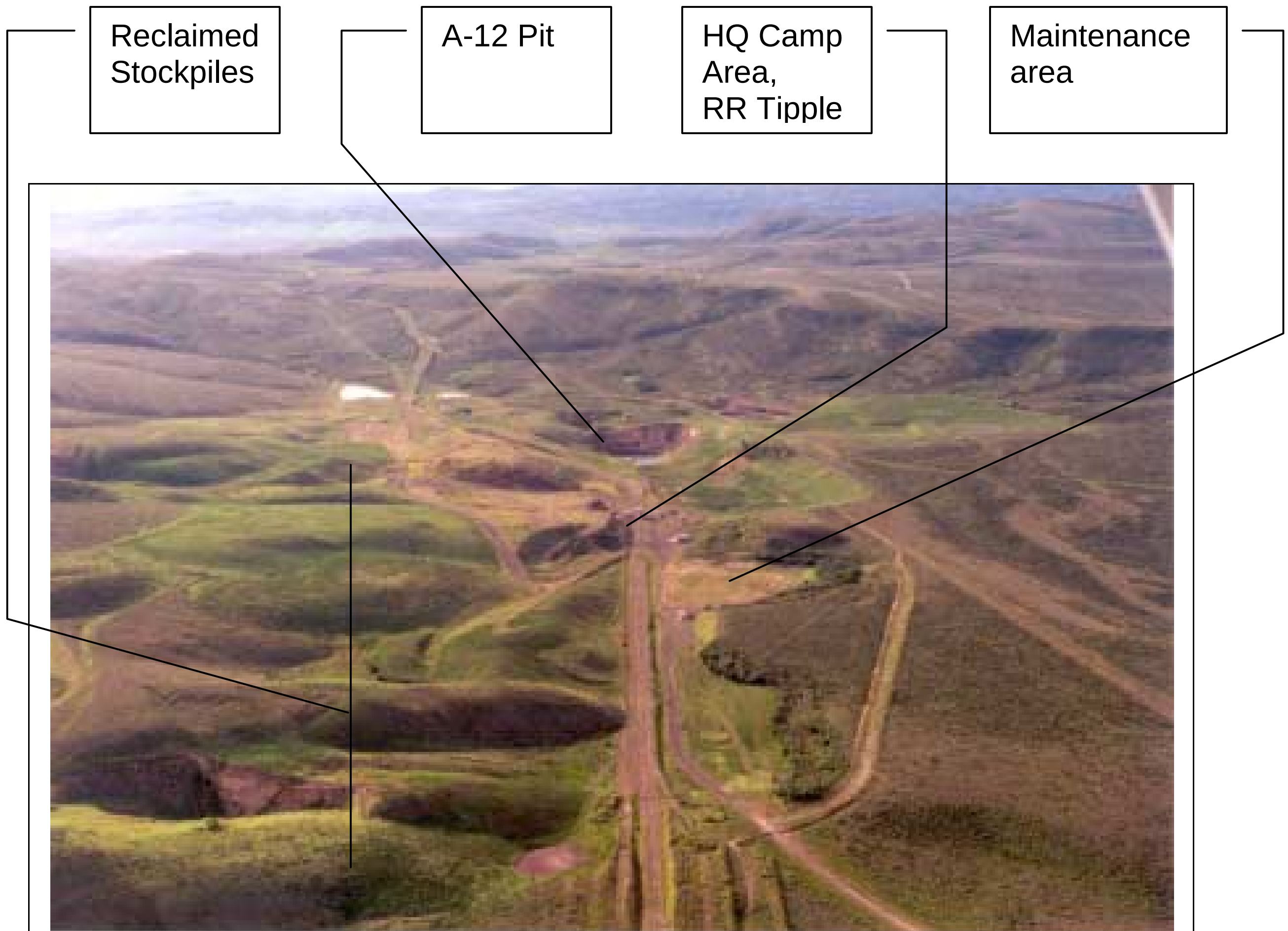
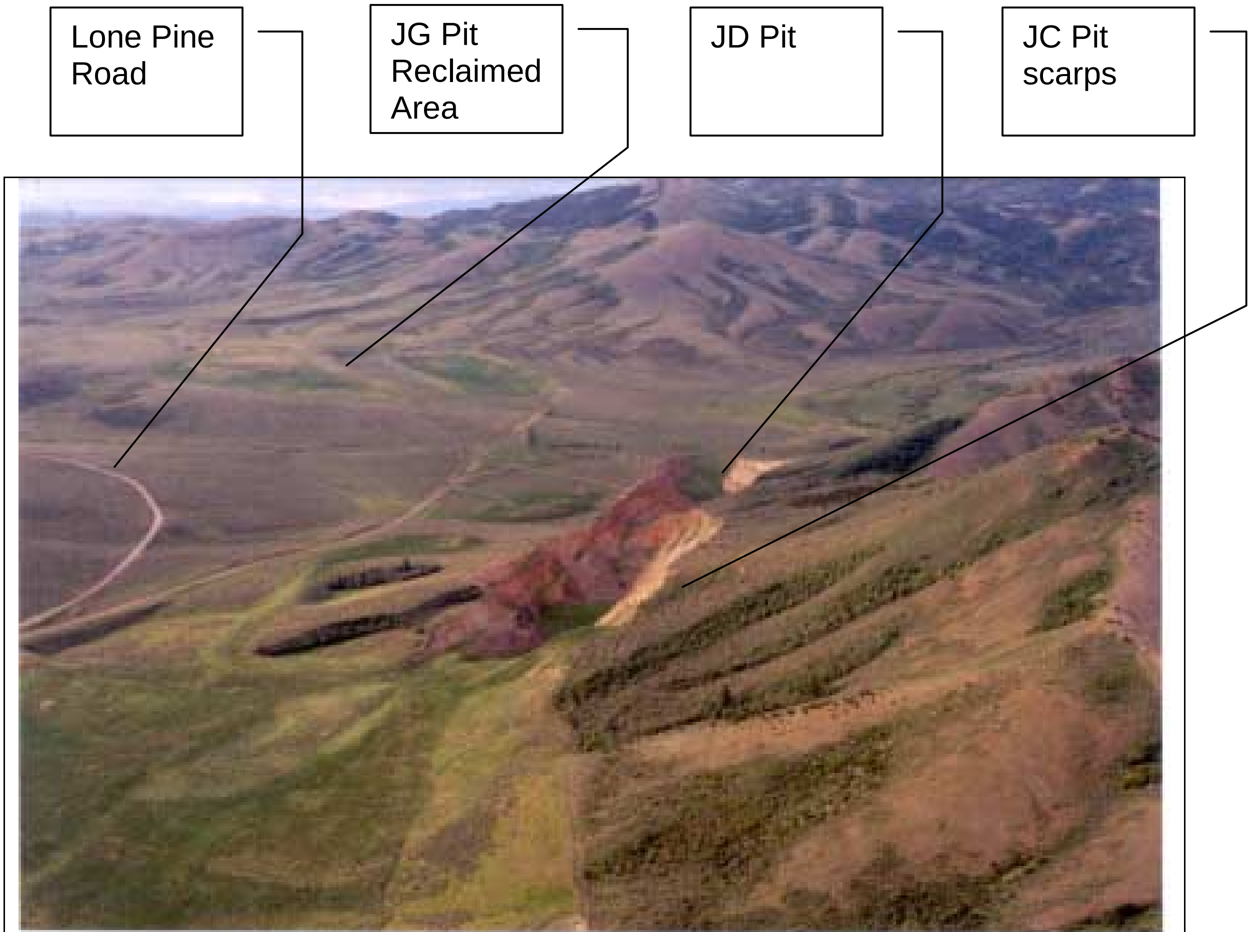


Source: EMI 6-20-02	Roll 1, Frame 1- file 48

Figure 1-1
View to E Over Rail Spur of Gay Mine Headquarters Area
Extensive seasonal stockpiling of phosphate ore and phosphatic shales occurred on the north (left) edge of this area throughout the life of the mine.

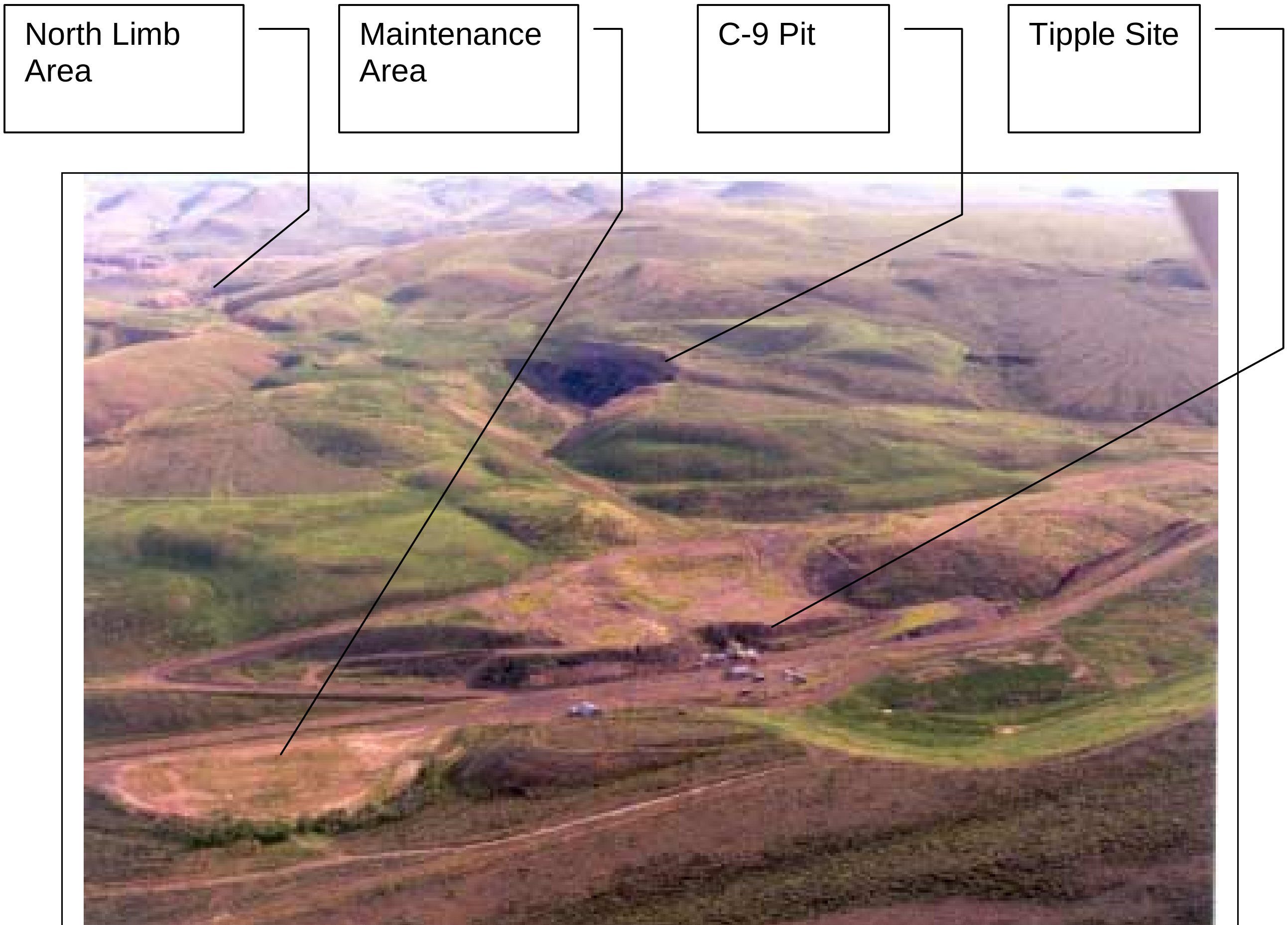
Source: EMI 6-20-02	Roll 1, Frame 2 file 47

Figure 1-2
View to E Over Rail Spur of Gay Mine Headquarters Area



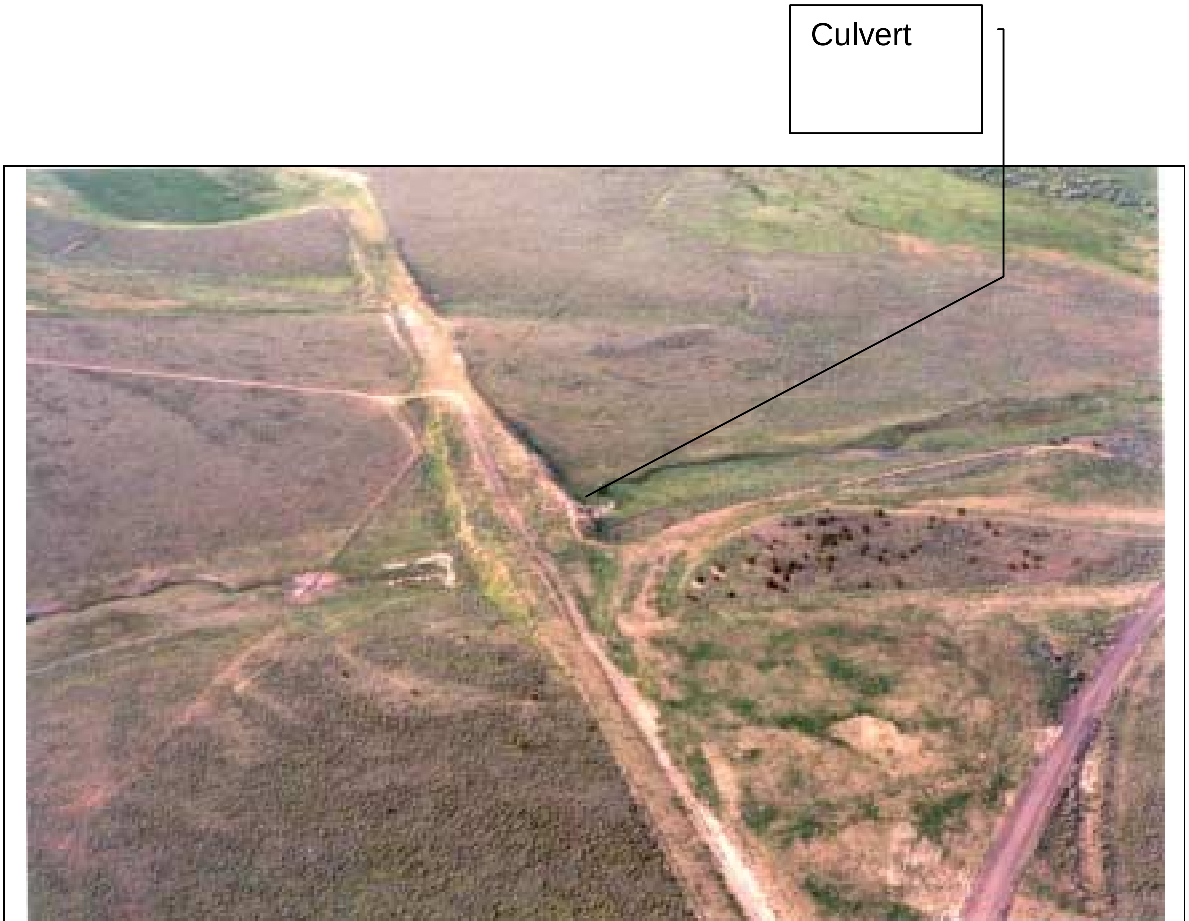
Source: EMI 6-20-02	Roll 1, Frame 3 File 46

Figure 1-3
View to S of Gay Mine South Forty JD Pit



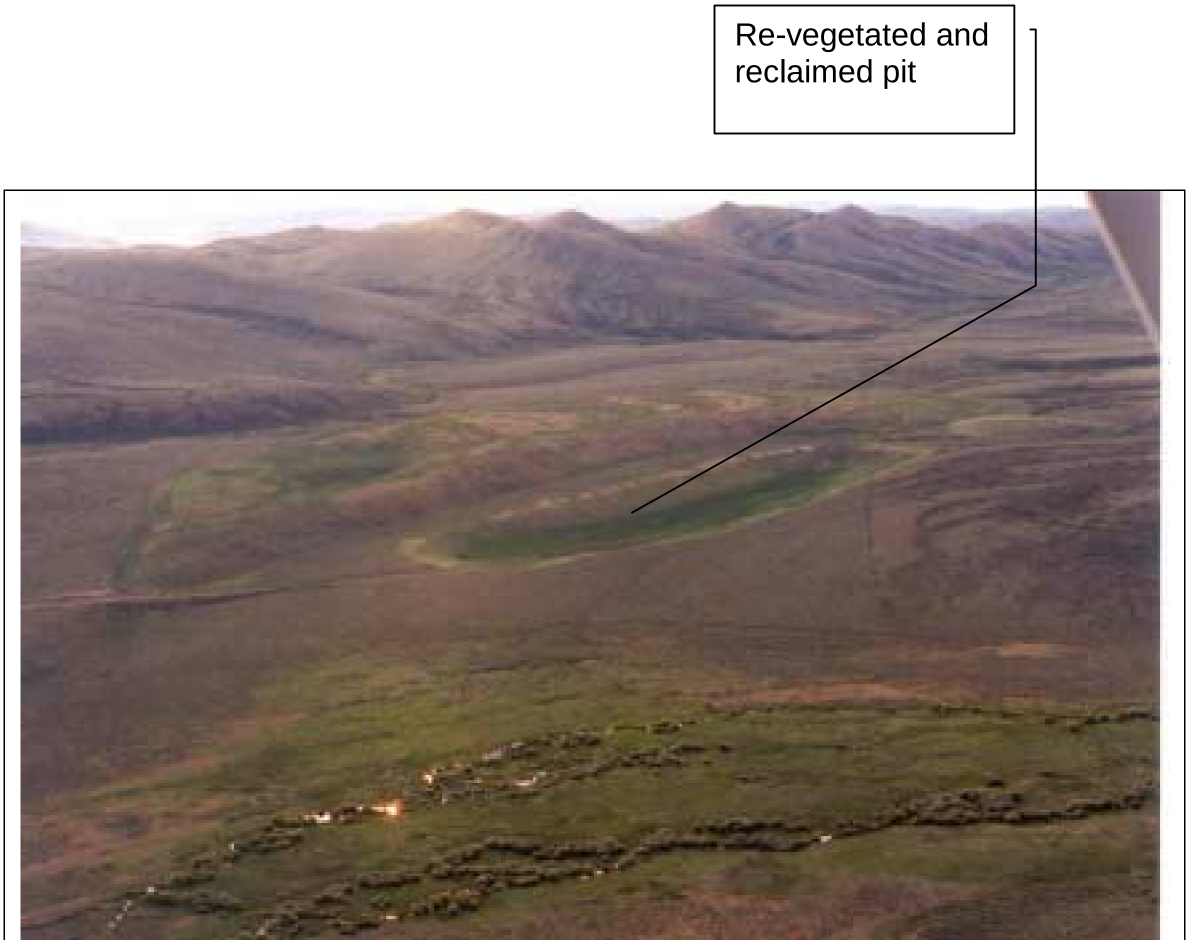
Source: EMI 6-20-02 | Roll 1, Frame 4 File 45

Figure 1-4
View to N of Rail Load Tipple at Gay Mine Headquarters Area



Source: EMI 6-20-02	Roll 1, Frame 5 File 44

Figure 1-5
View to S from Gay Mine South Forty
Showing Broken Culvert Site at Willow Creek
Stream flow is from left to right in photo.
Ross Fork Creek Watershed

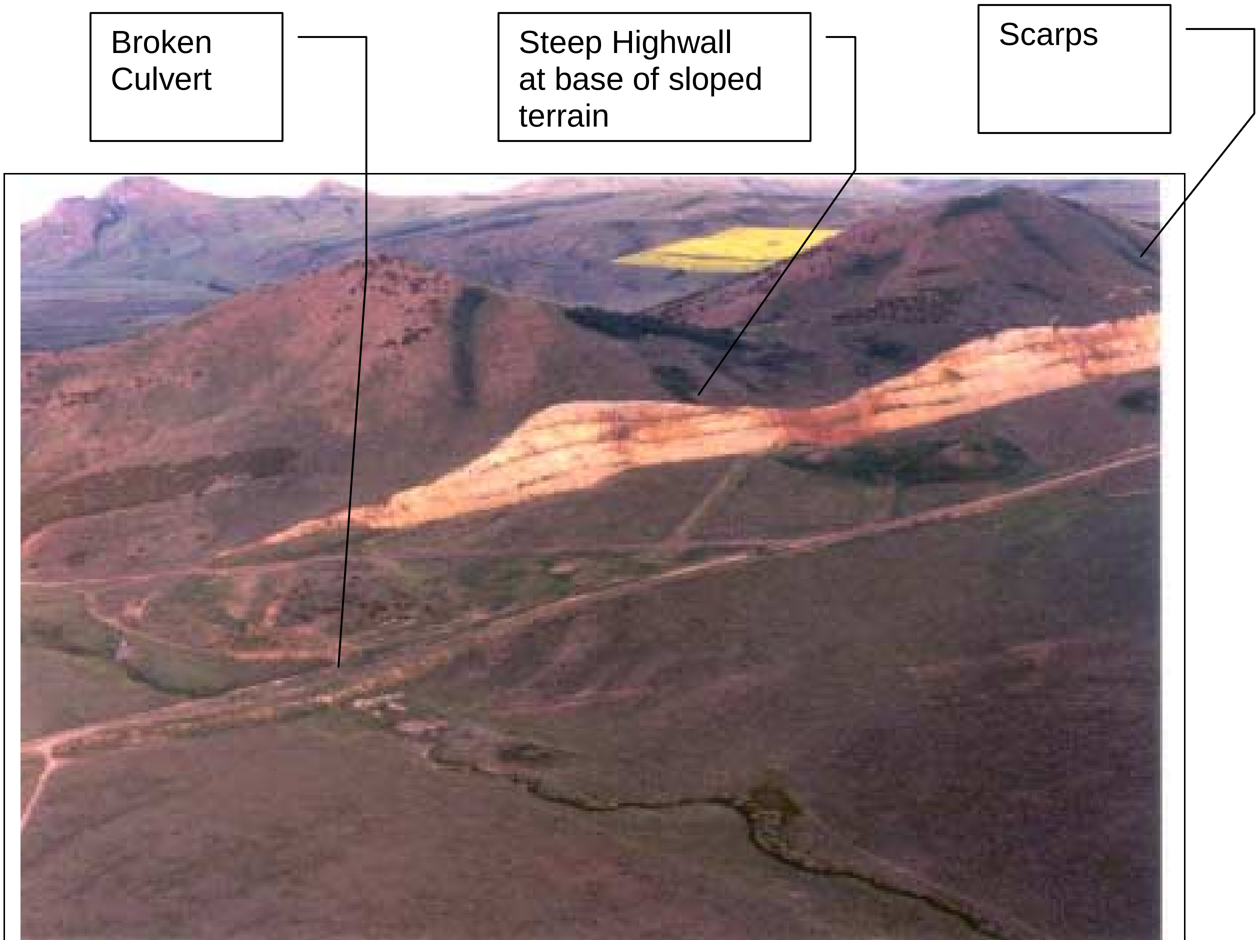


Source: EMI 6-20-02	Roll 1, Frame 6 File 43

Figure 1-6
View to SW from Gay Mine South Forty Area
Showing Willow Creek Drainage from left to right near JF Pit Area

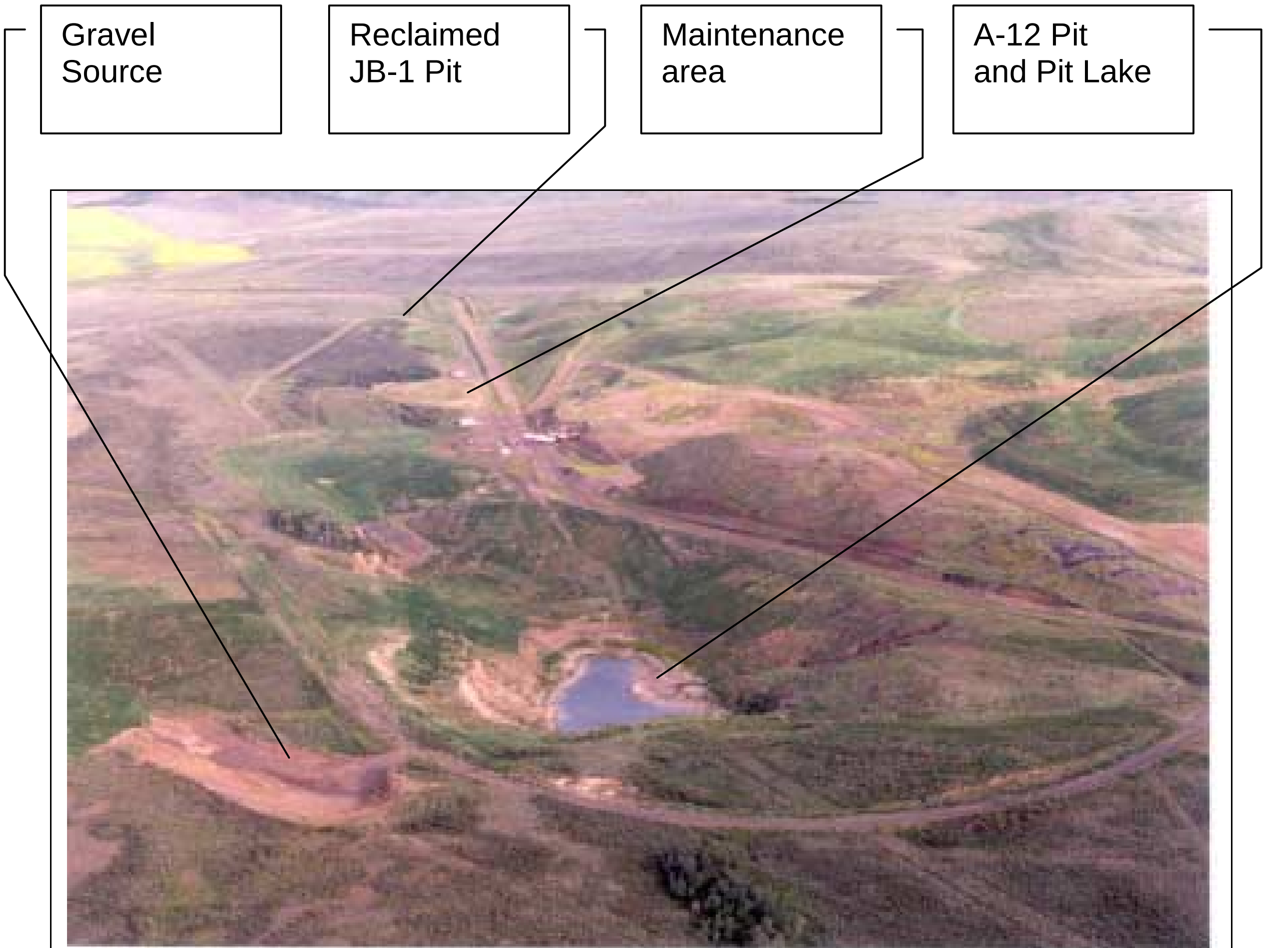
Source: EMI 6-20-02 | Roll 1, Frame 7 File 42

Figure 1-7
View to N of Gay Mine South Forty JD and JC Pits
Broken culvert site is at right center.
Ross Fork Creek Watershed



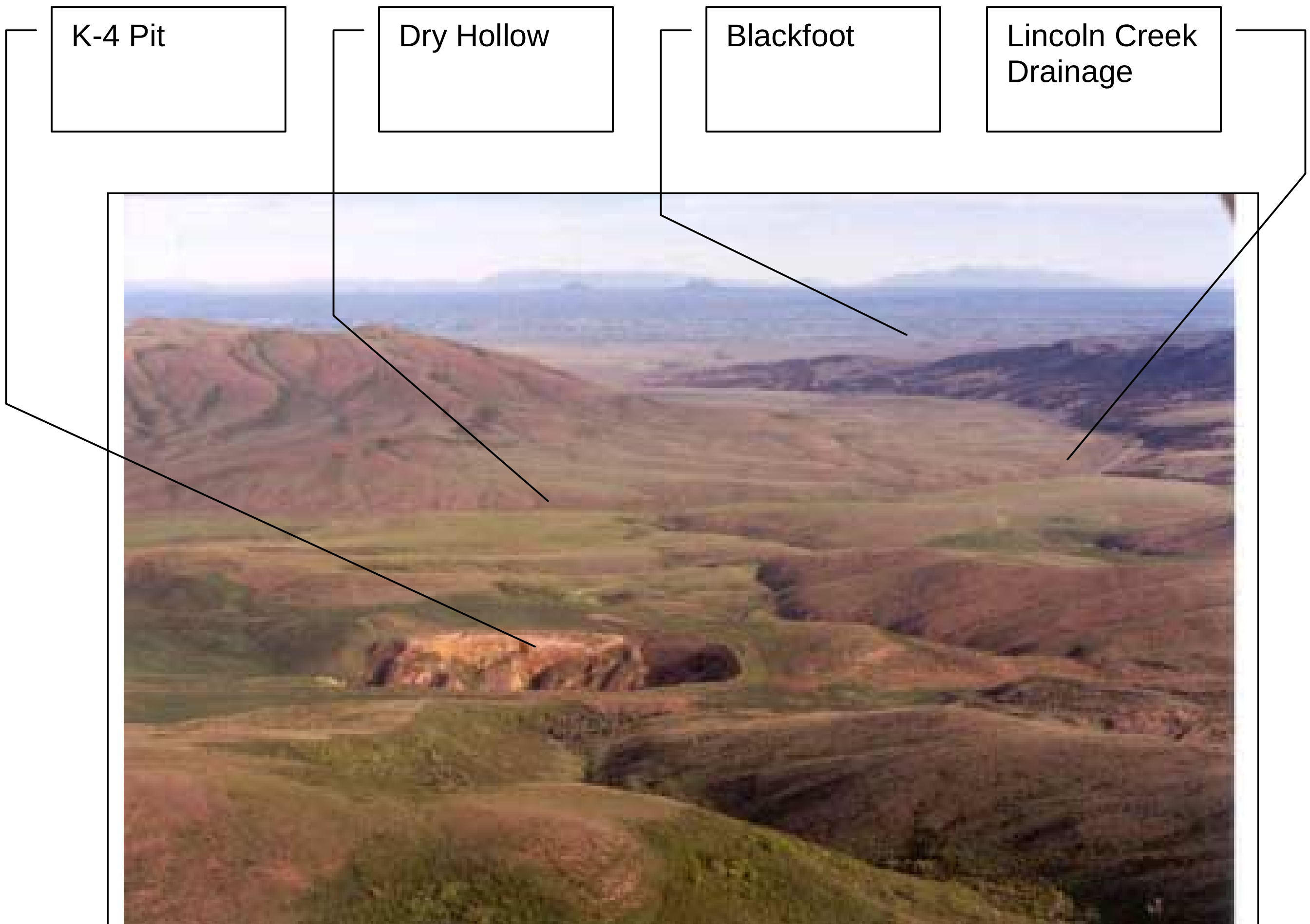
Source: EMI 6-20-02	Roll 1, Frame 8 File 41

Figure 1-8
View to NW of Gay Mine South Forty JD Pit



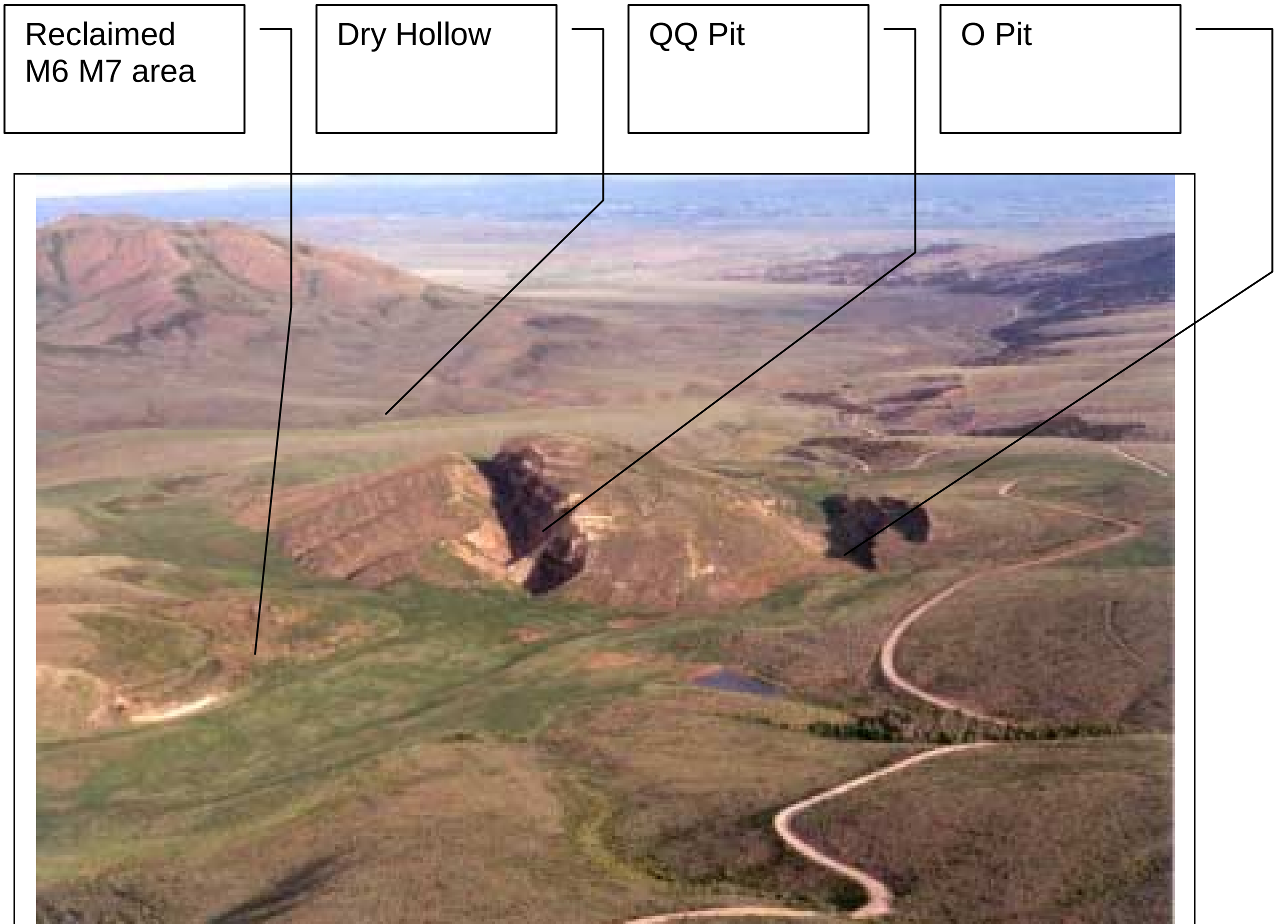
Source: EMI 6-20-02 | Roll 1, Frame 9 File 40

Figure 1-9
View to W of Gay Mine Headquarters Area



Source: EMI 6-20-02 | Roll 1, Frame 10 File 39

Figure 1-10
View to NW from Gay Mine North Limb



Source: EMI 6-20-02 | Roll 1, Frame 11 File 38

Figure 1-11
View to NW from Gay Mine North Limb
Lincoln Creek Watershed

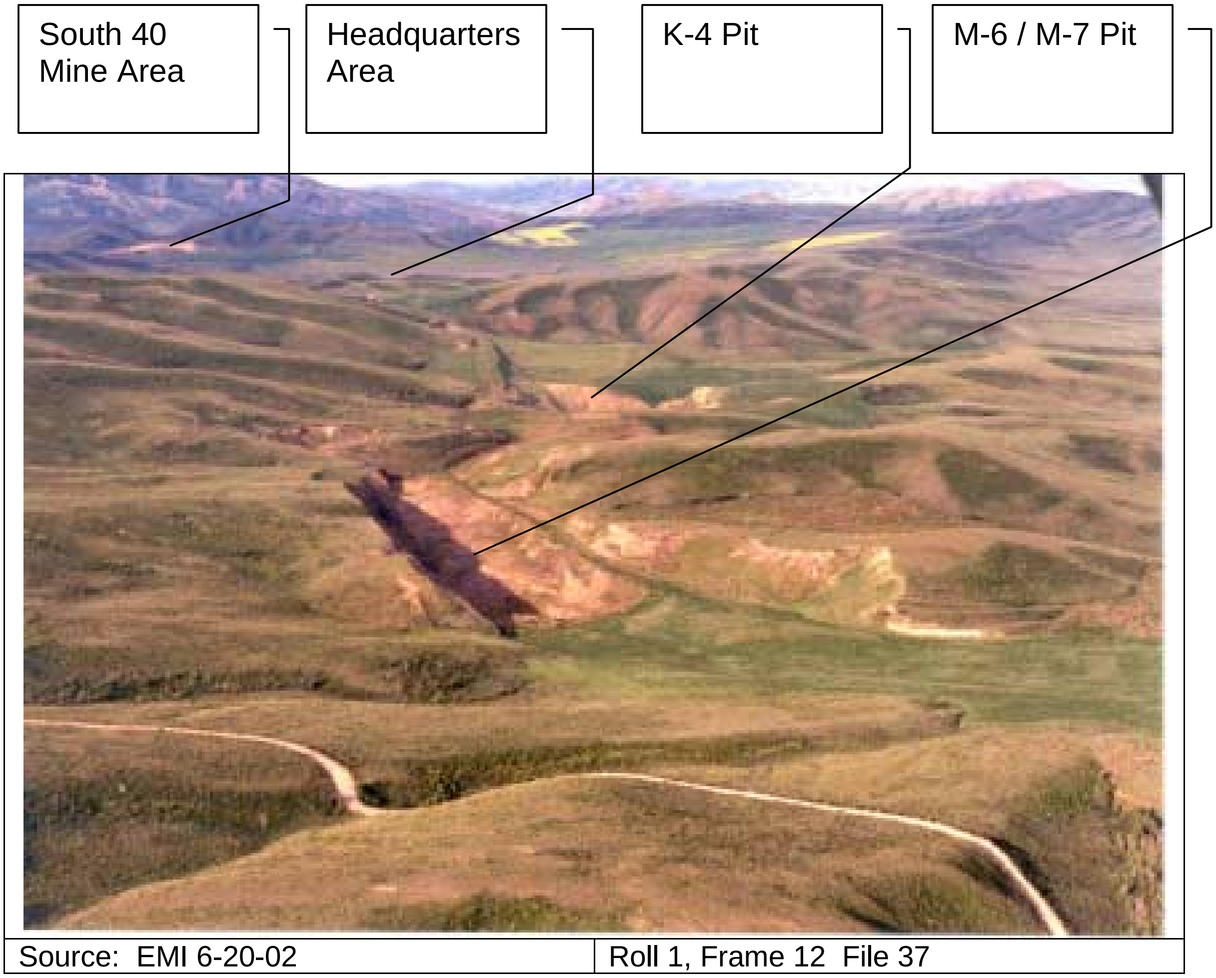
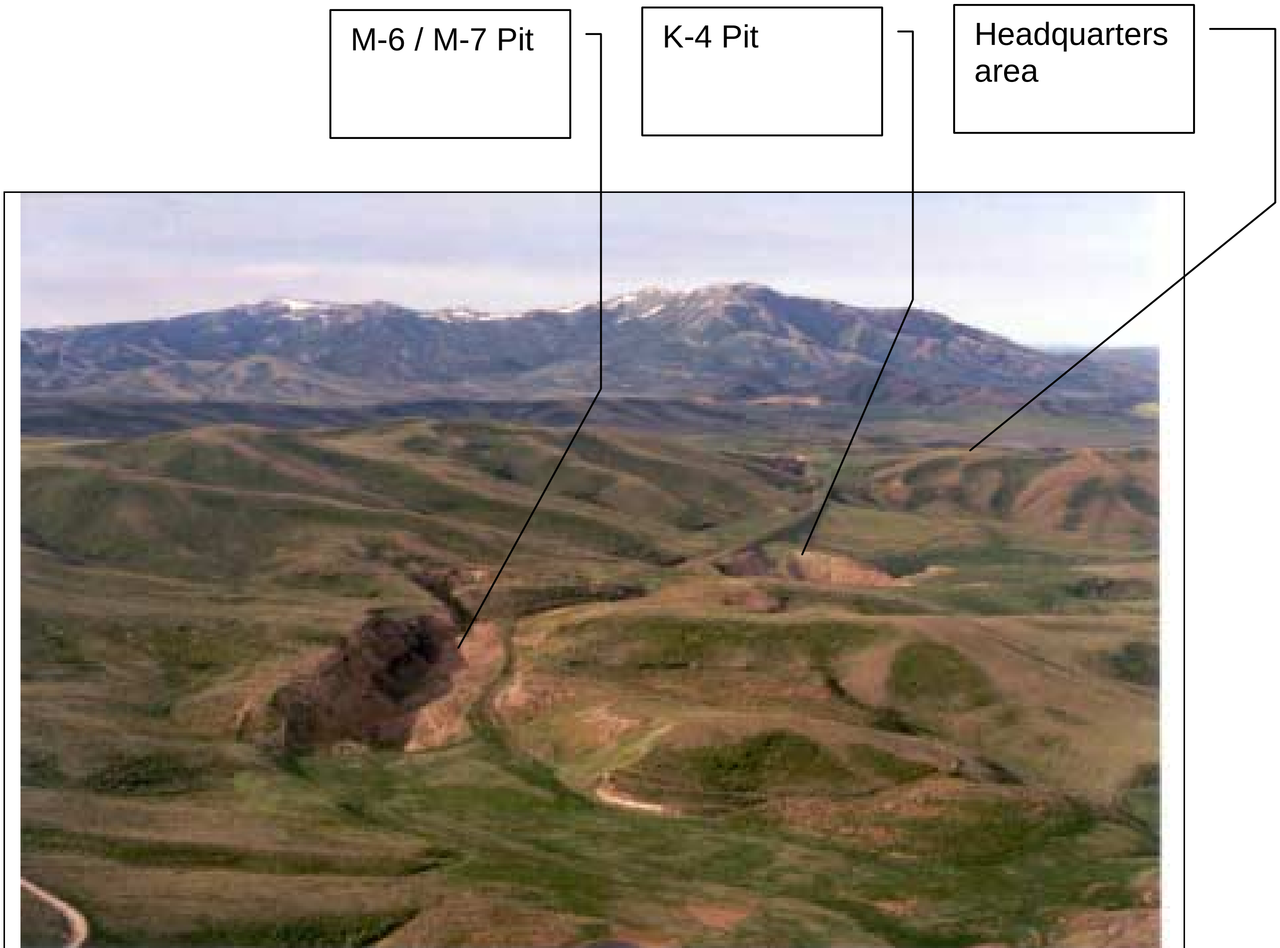
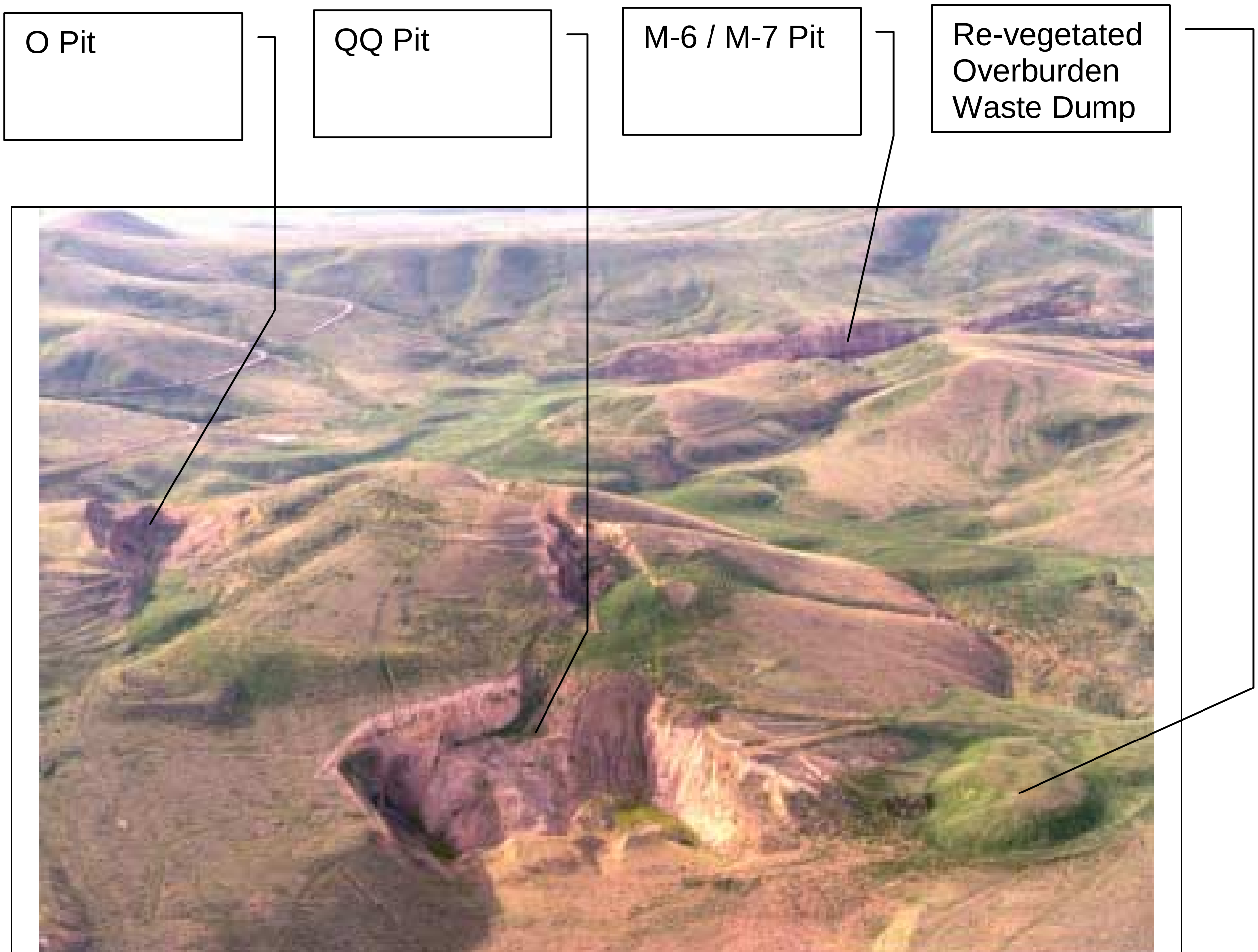


Figure 1-12
View to S from Gay Mine North Limb Pits



Source: EMI 6-20-02	Roll 1, Frame 13 File 36

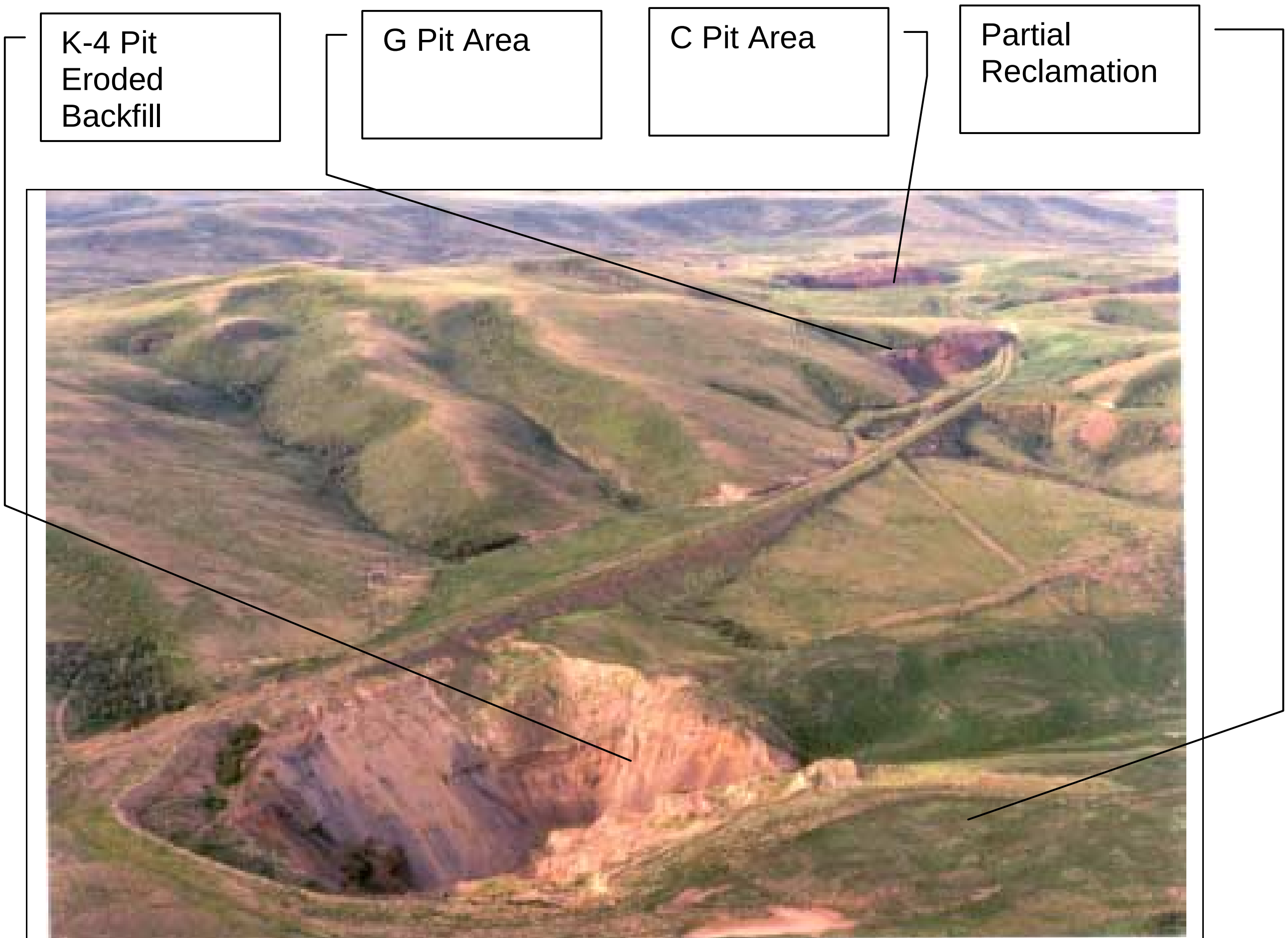
Figure 1-13
View to S from Gay Mine North Limb Pits



Source: EMI 6-20-02	Roll 1, Frame 14 File 35

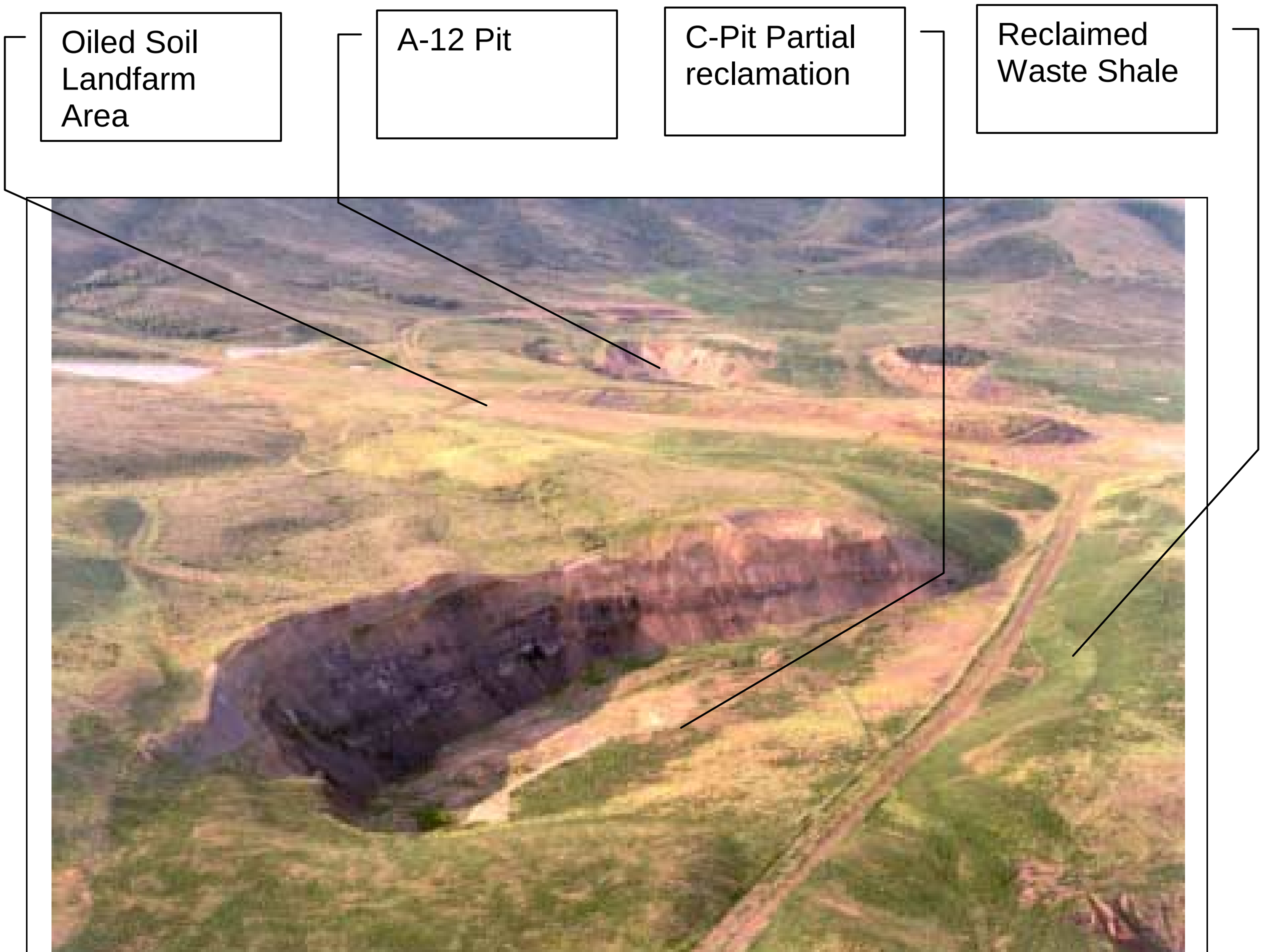
Figure 1-14
View to E from Gay Mine North Limb Pits

.



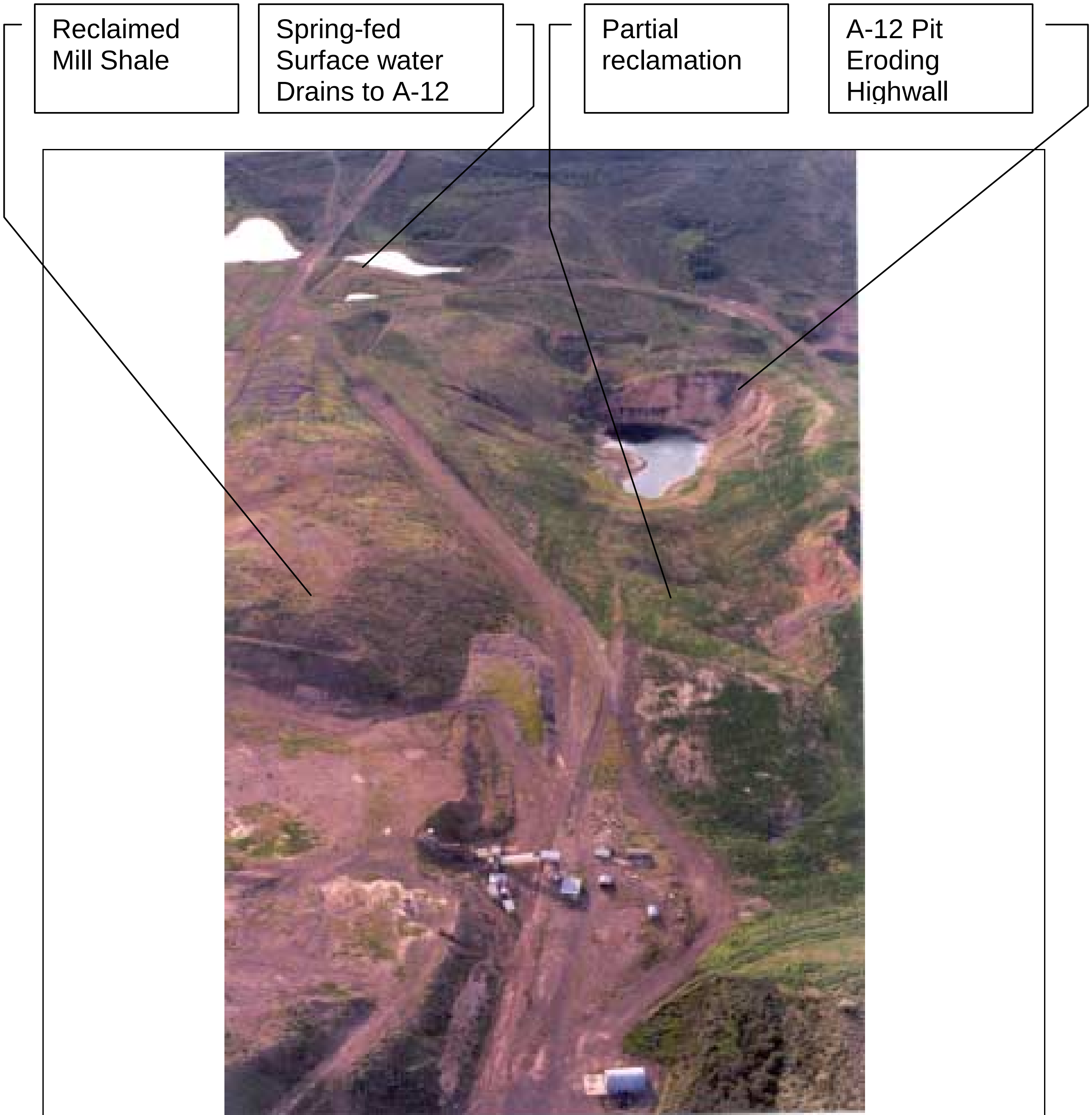
Source: EMI 6-20-02	Roll 1, Frame 15 File 34

Figure 1-15
View to SE from Gay Mine North Limb K-4 Pit
Headquarters Area is at rear of photo, off field of view to the right.



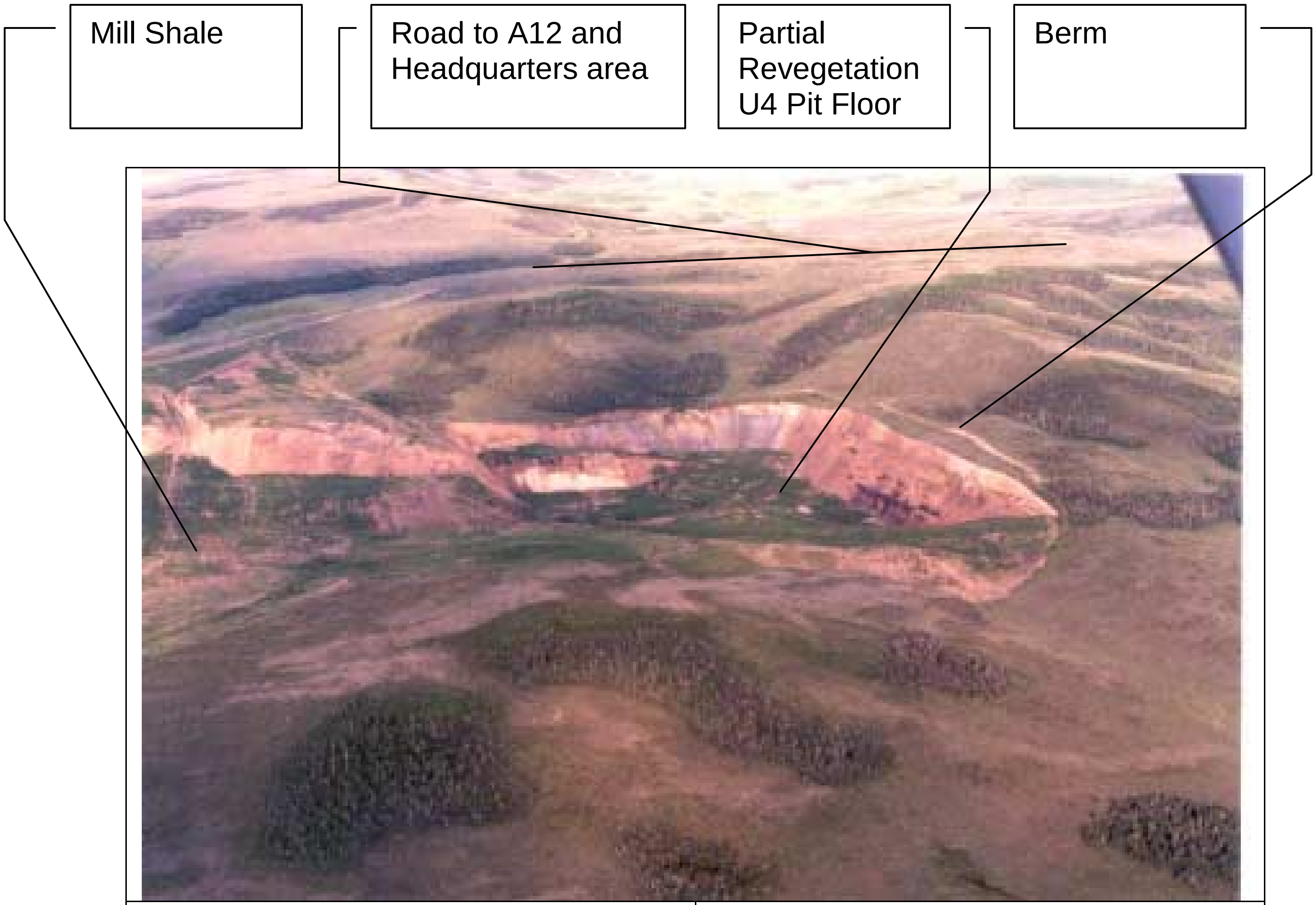
Source: EMI 6-20-02	Roll 1, Frame 16 File 33

Figure 1-16
View to SE from Gay Mine North Limb C Pit
Headquarters Area is at rear of photo, off field of view to the right.



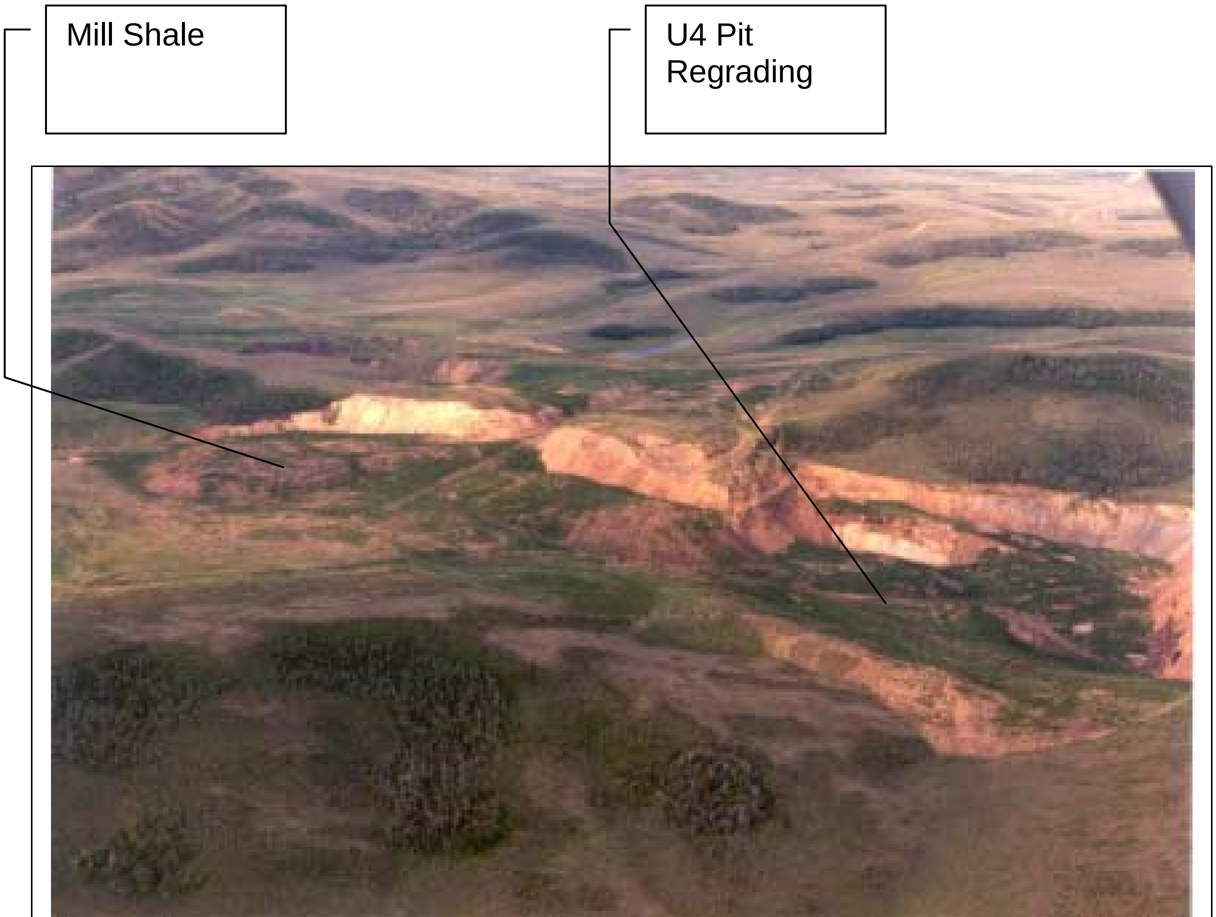
Source: EMI 6-20-02	Roll 1, Frame 17 File 32

Figure 1-17
View to E of Gay Mine Headquarters Area
Rail load tipple shown at left front. A-12 Pit and Pond in right upper, with water ponds and road to East Limb in left rear.
All ponds are accessible to grazing livestock.



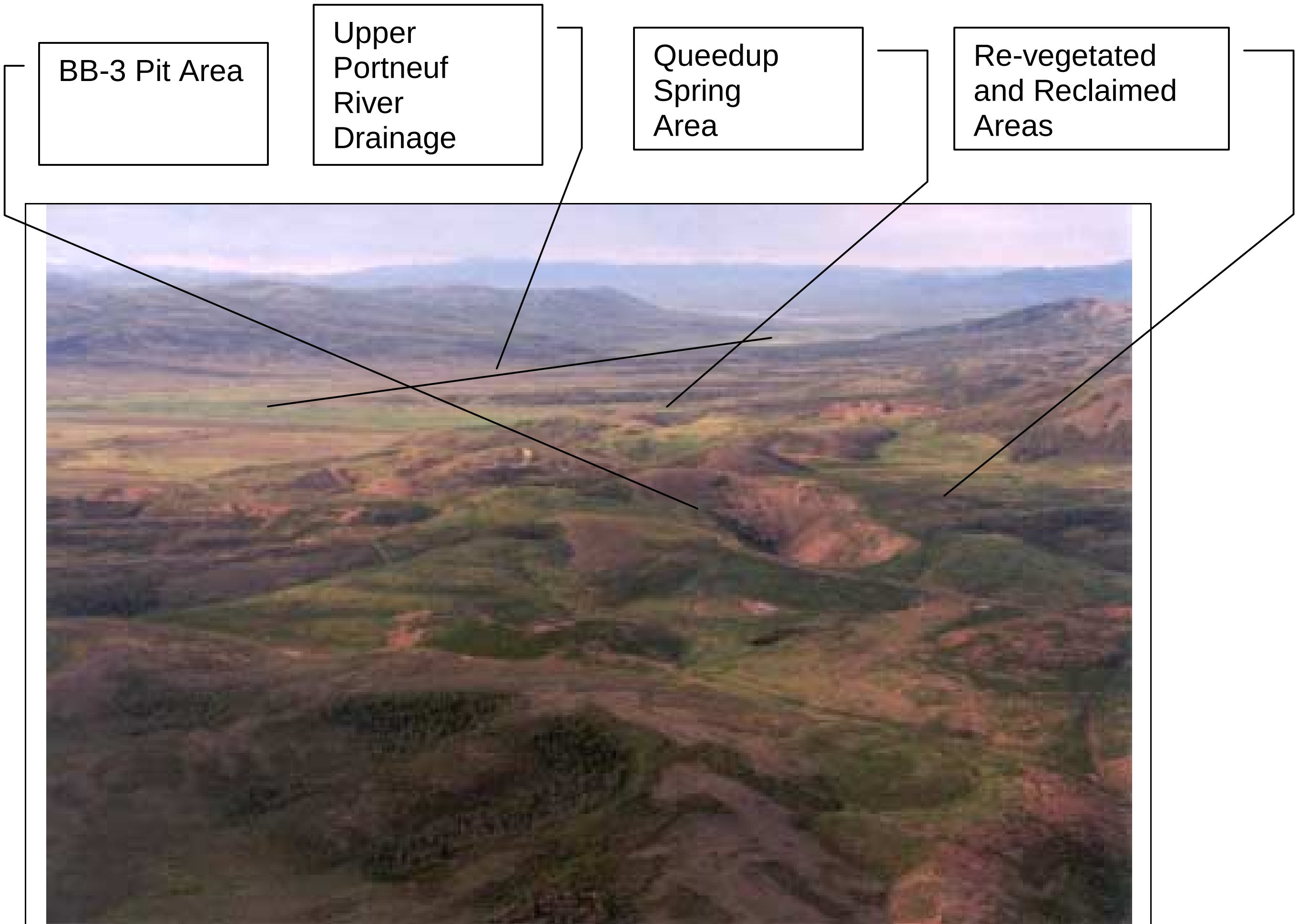
Source: EMI 6-20-02	Roll 1, Frame 18 File 31

Figure 1-18
View to SW over U4 Pit area located in NE portion of Gay Mine



Source: EMI 6-20-02	Roll 1, Frame 19 File 30

Figure 1-19
View to S over U4 Pit, NE portion of Gay Mine

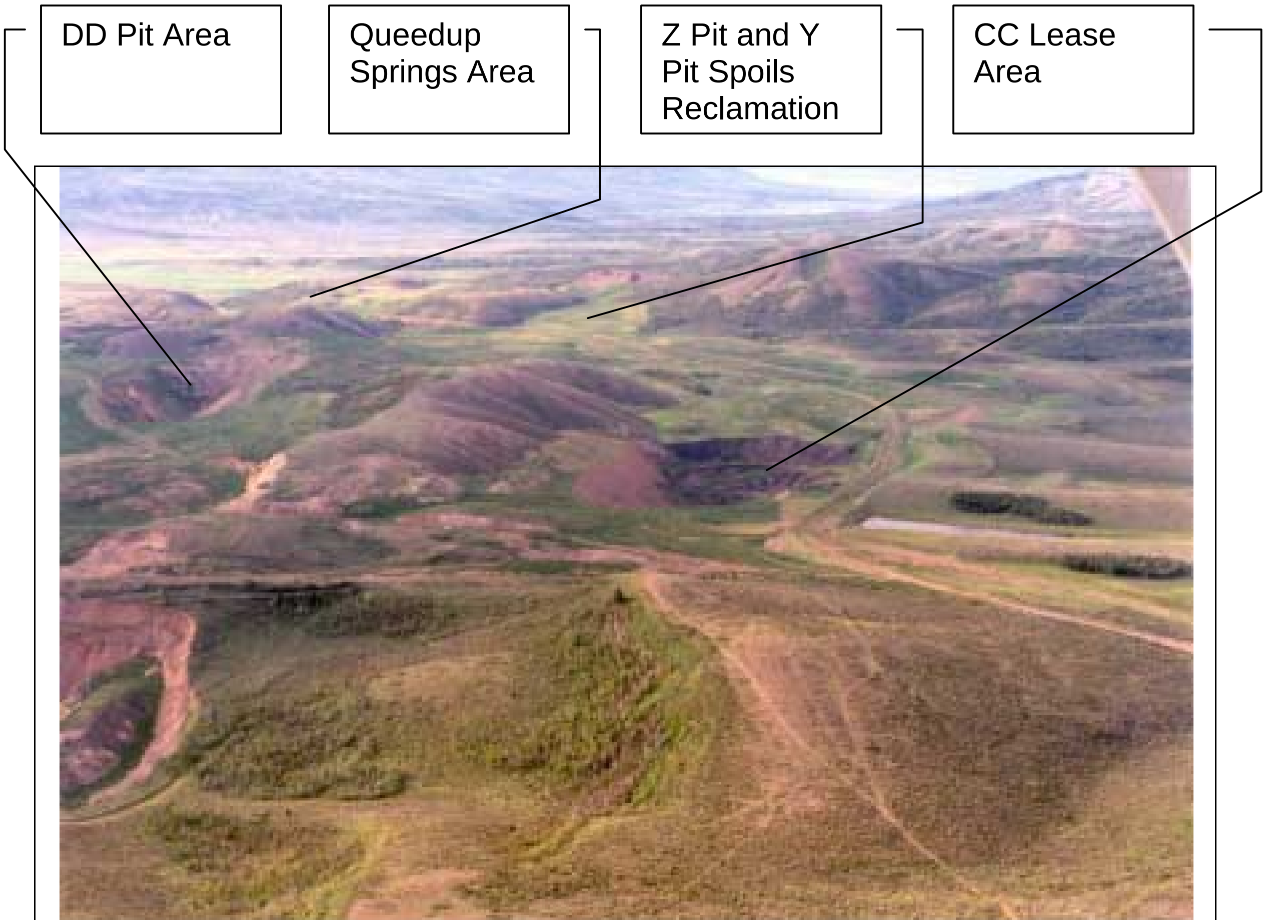


Source: EMI 6-20-02	Roll 1, Frame 20 File 29

Figure 1-20
View to SE over East Limb of Gay Mine
East Limb reclaim areas shown.

Source: EMI 6-20-02	Roll 1, Frame 22 File 28

Figure 1-21
View to SE of Gay Mine East Limb
FF Pit Southwestern Portion.



Source: EMI 6-20-02	Roll 1, Frame 23 File 27

Figure 1-22
View to SE of Gay Mine East Limb Area
Water ponds in right center
Southern Portion of FF Pit in left front corner

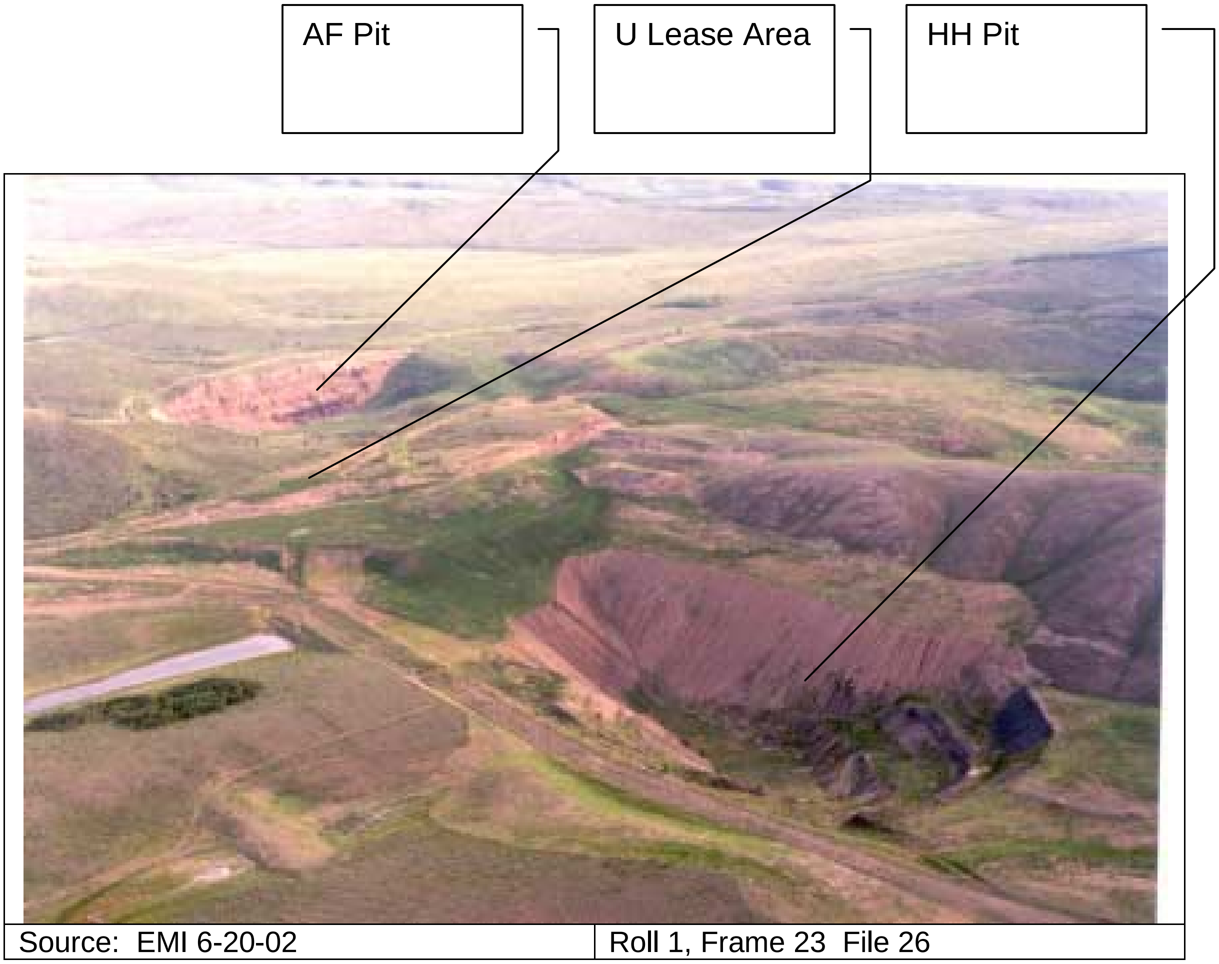
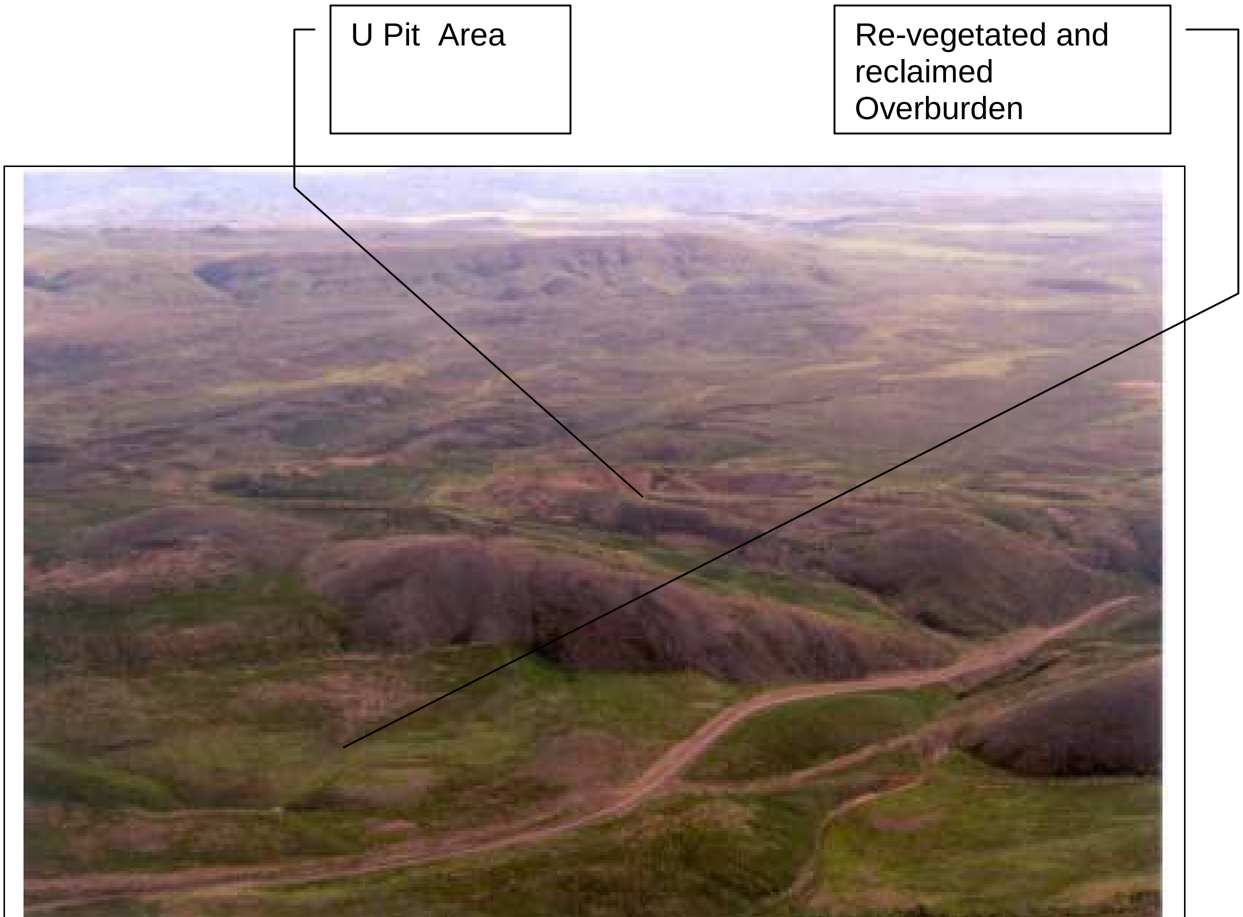
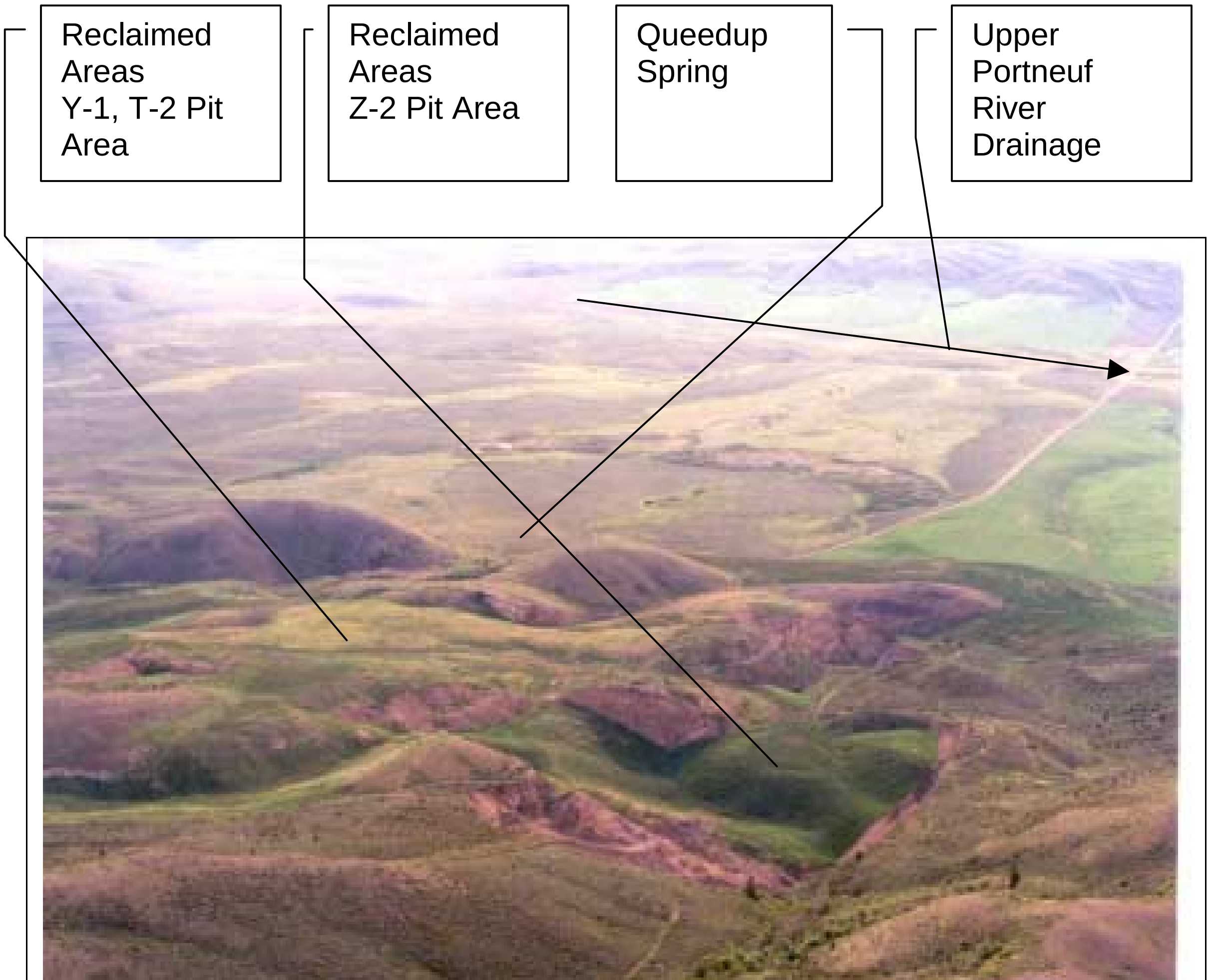


Figure 1-23
View to N of Gay Mine East Limb HH Pit



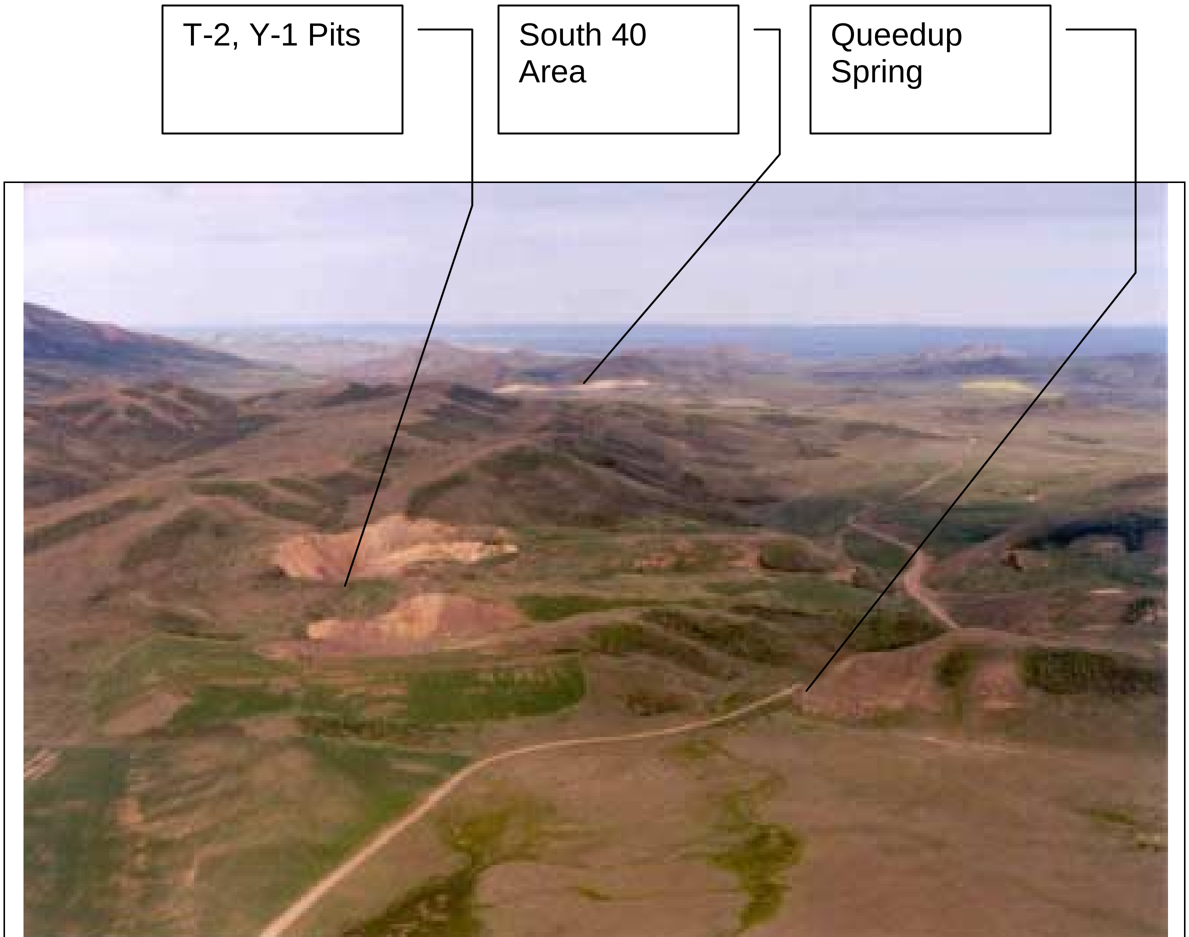
Source: EMI 6-20-02	Roll 1, Frame 24 File 25

Figure 1-24
View to NE of Gay Mine East Limb Area
Showing reclaimed mine pits.



Source: EMI 6-20-02	Roll 1, Frame 25 File 24

Figure 1-25
View to NE Across Baker Canyon Road.



Source: EMI 6-20-02	Roll 2, Frame 4 File 23

Figure 1-26
View to W across East Limb, Group II, Gay Mine

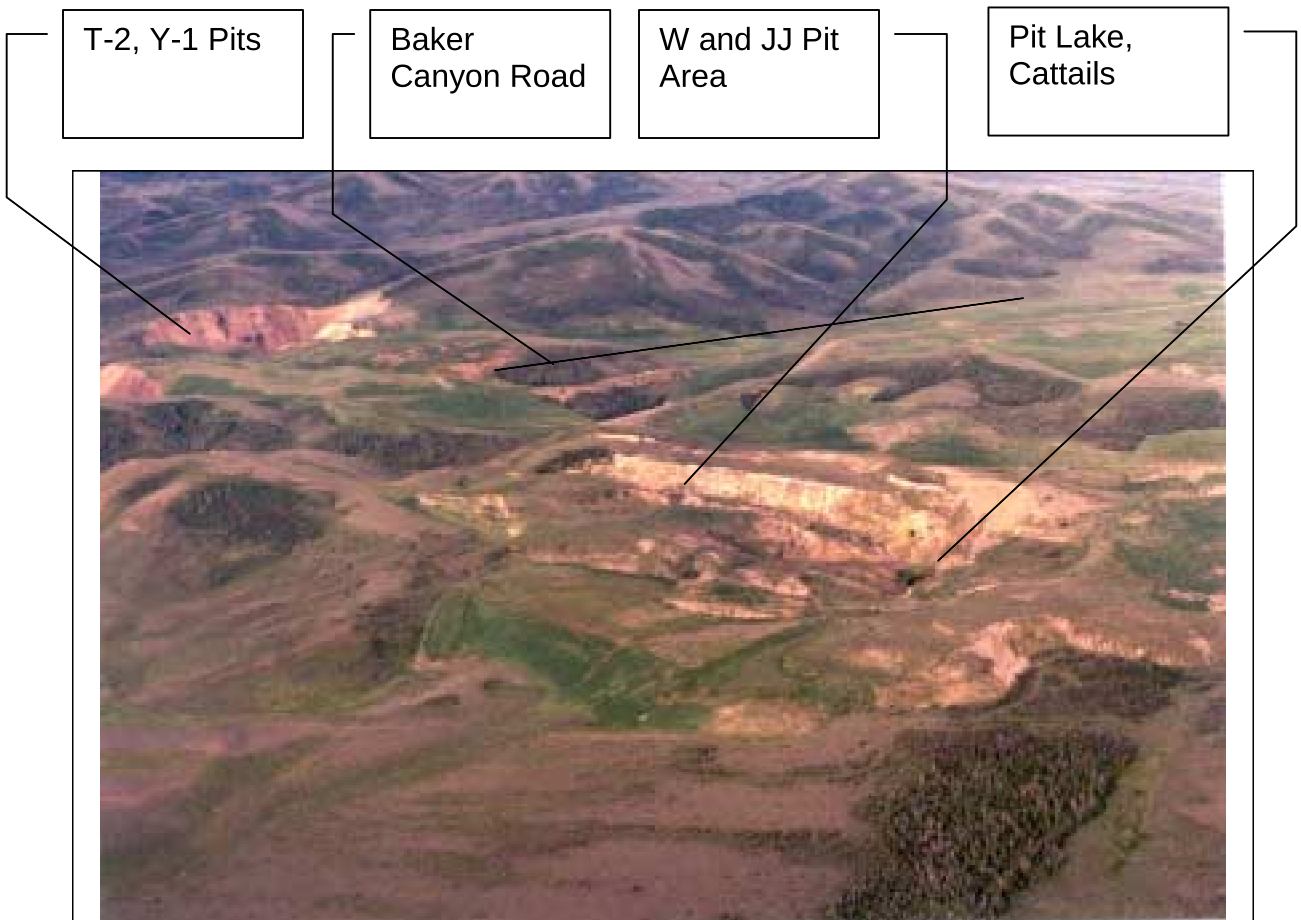


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Figure 1-27
View to SW of Gay Mine W, JJ Pit Area

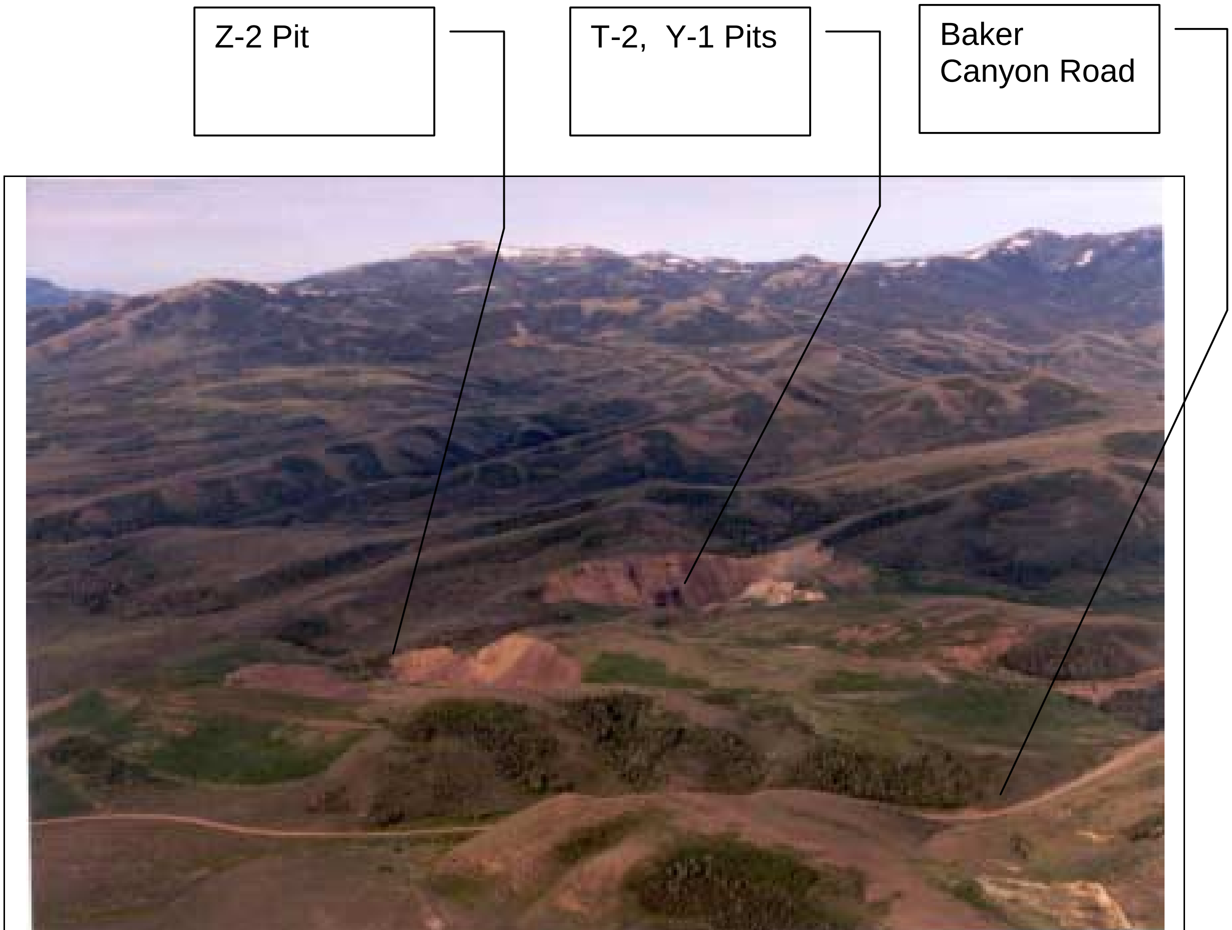

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Figure 1-28
View to S, East Limb Area

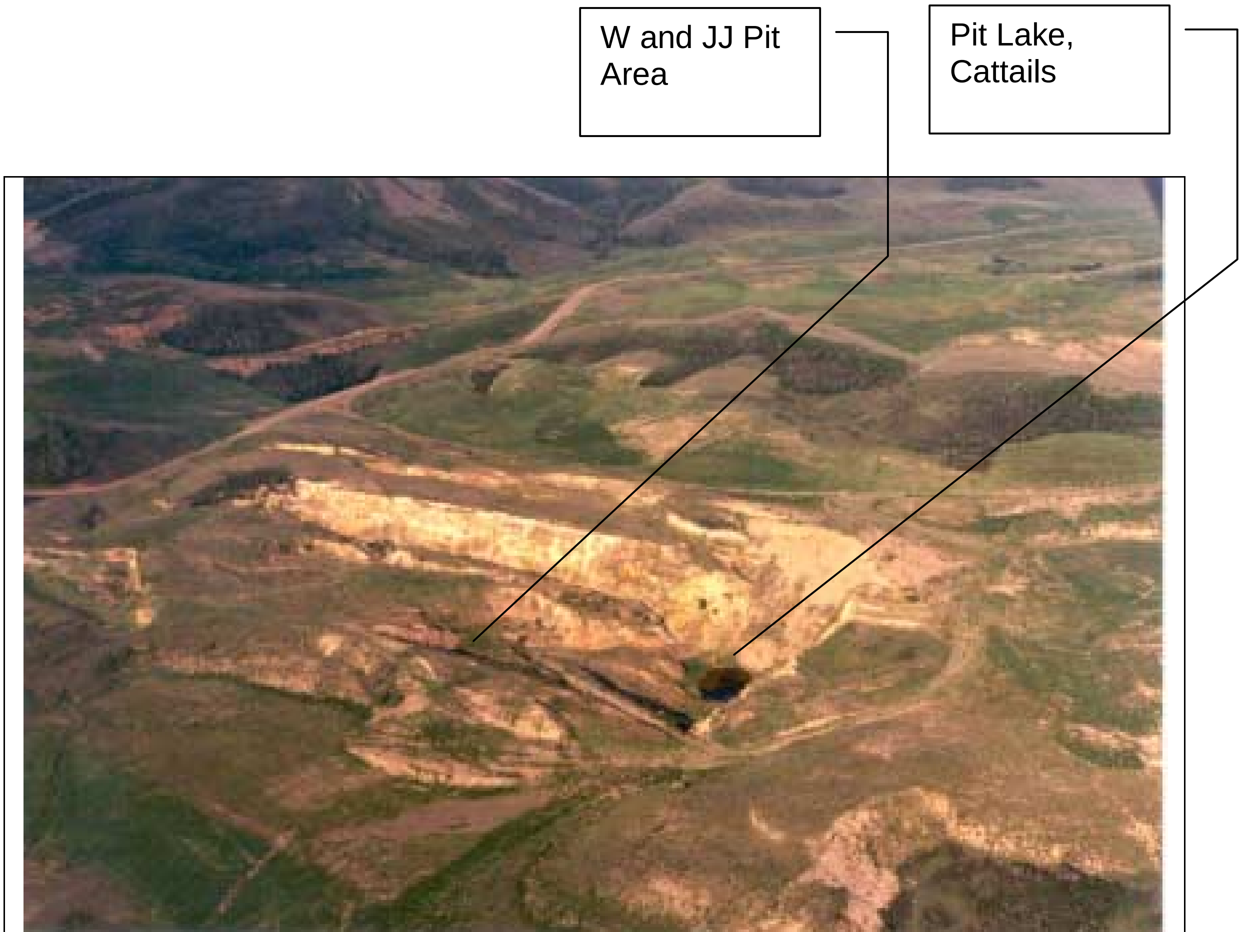

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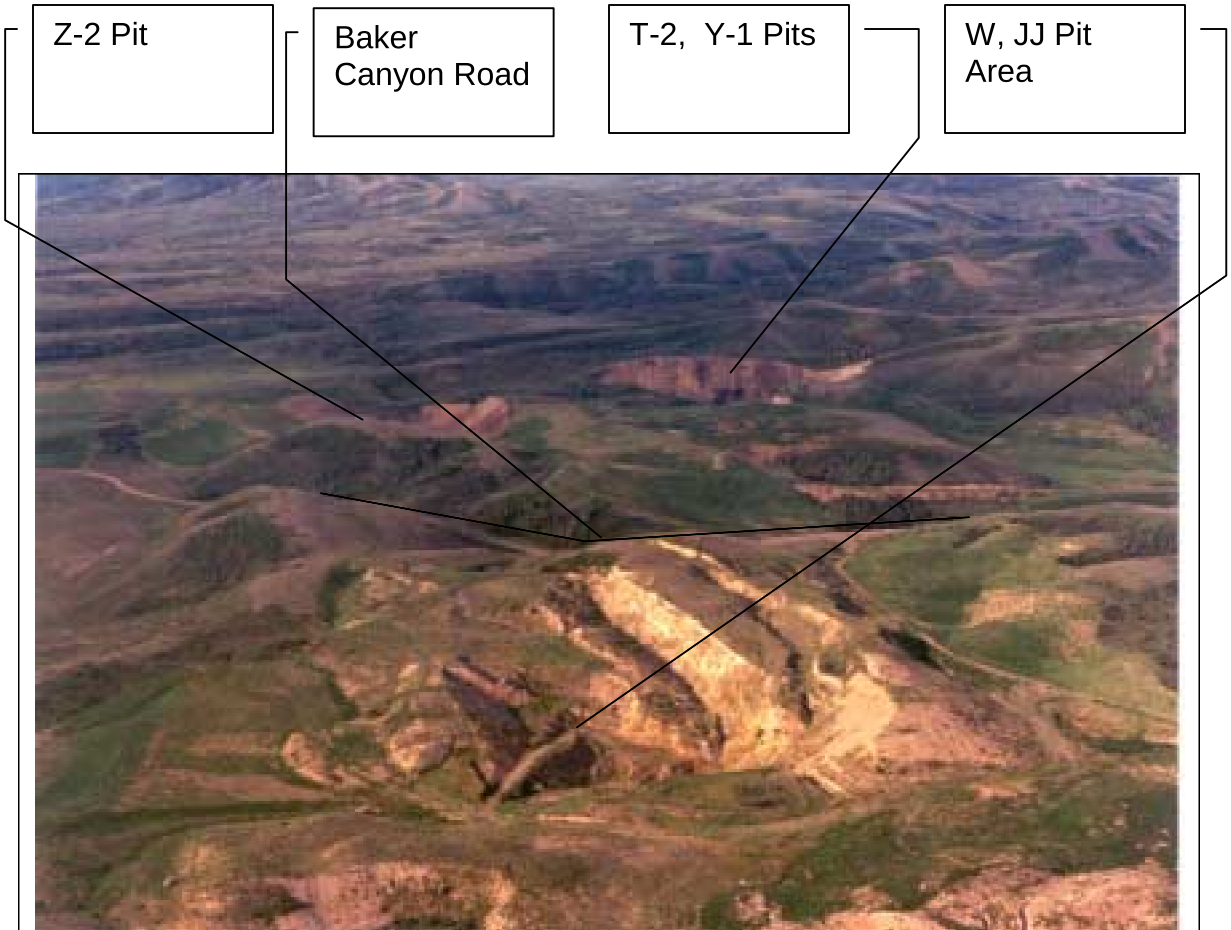
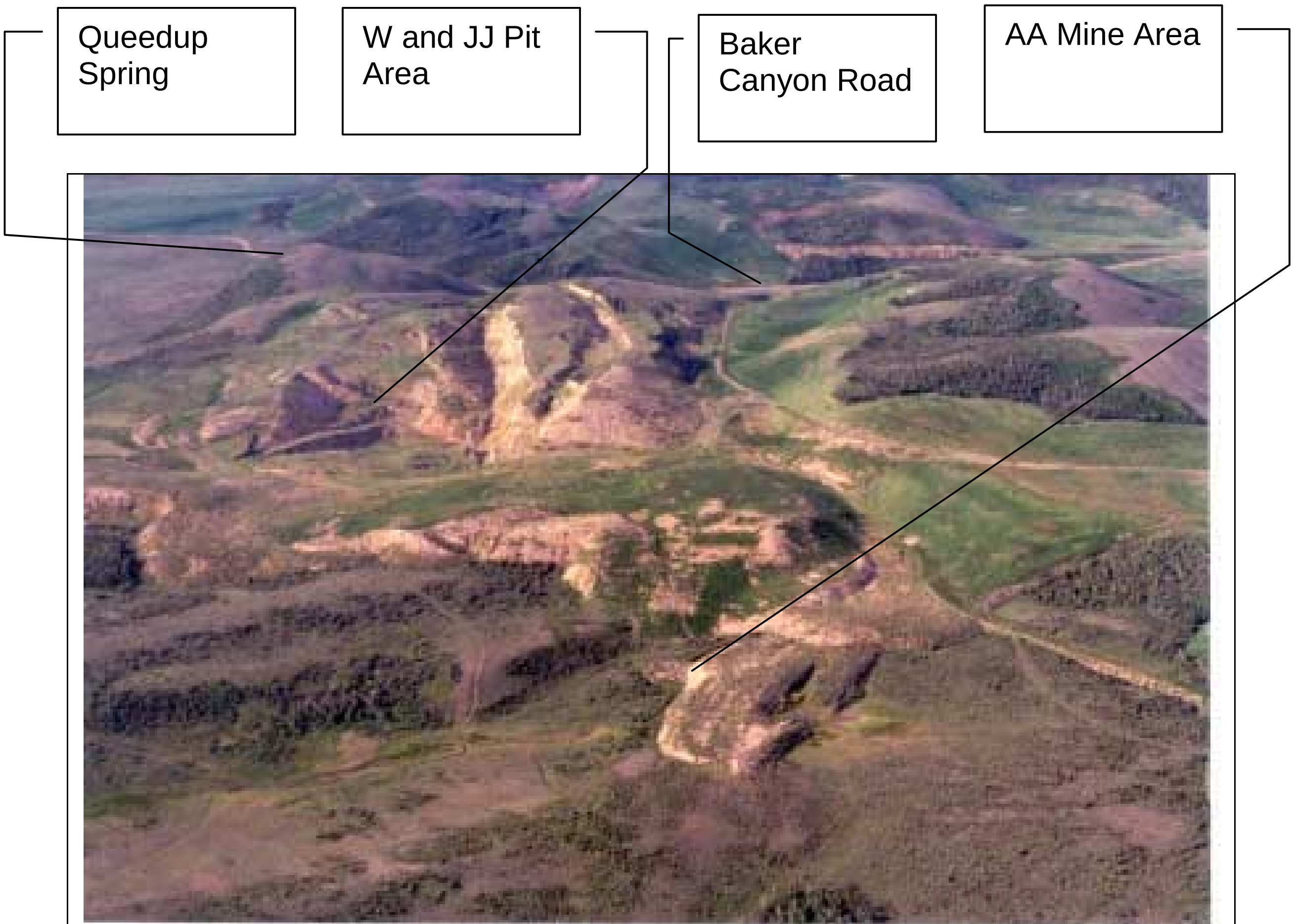
Figure 1-29
View to SW of Gay Mine W, JJ Pit Area



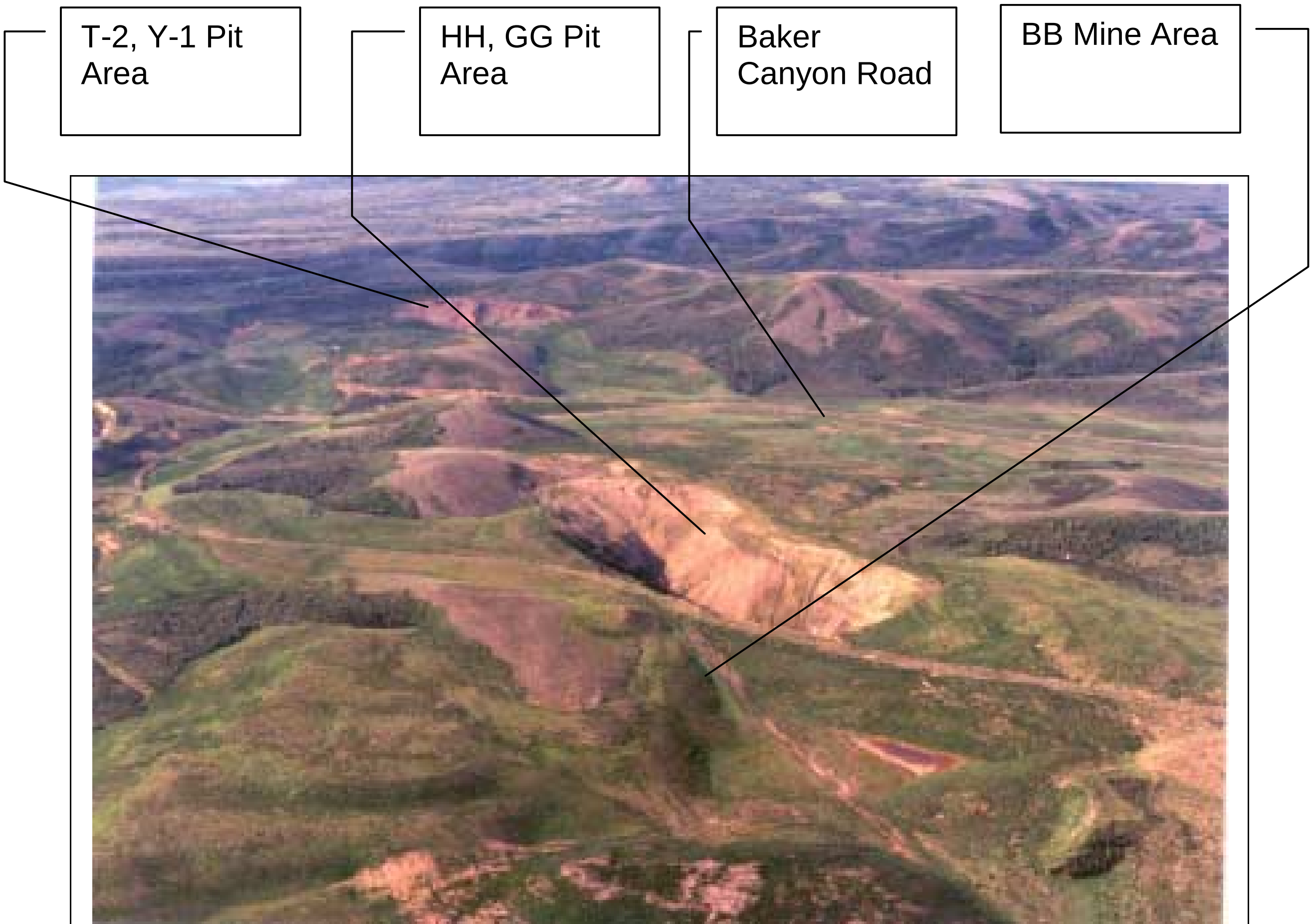
Source: EMI 6-20-02	Roll 2, Frame 8 File 19

Figure 1-30
View to SE over Gay Mine W, JJ Pit Area



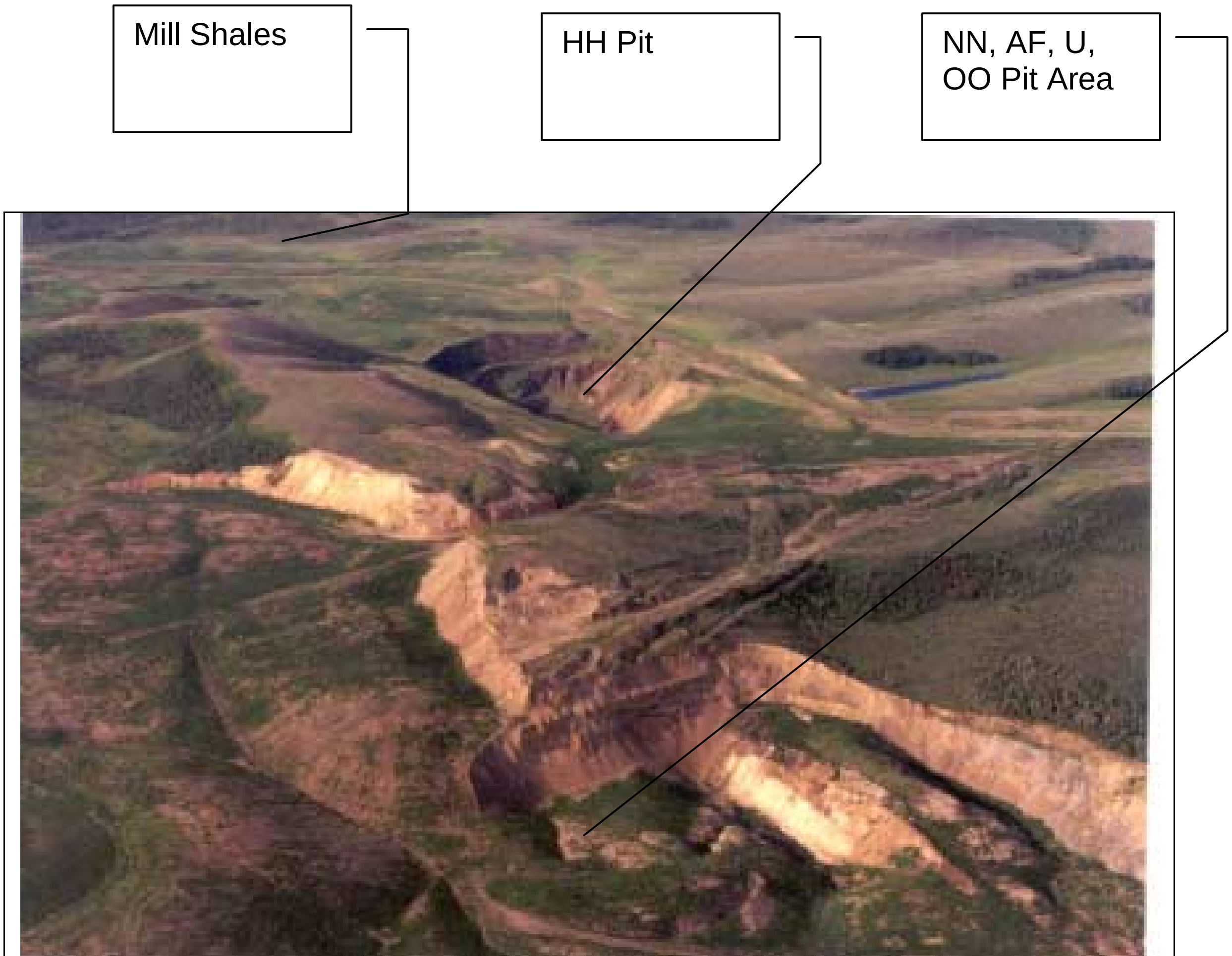
Source: EMI 6-20-02	Roll 2, Frame 9 File 18

Figure 1-31
View to SE of Gay Mine
Showing East Limb Pits and Reclamation.



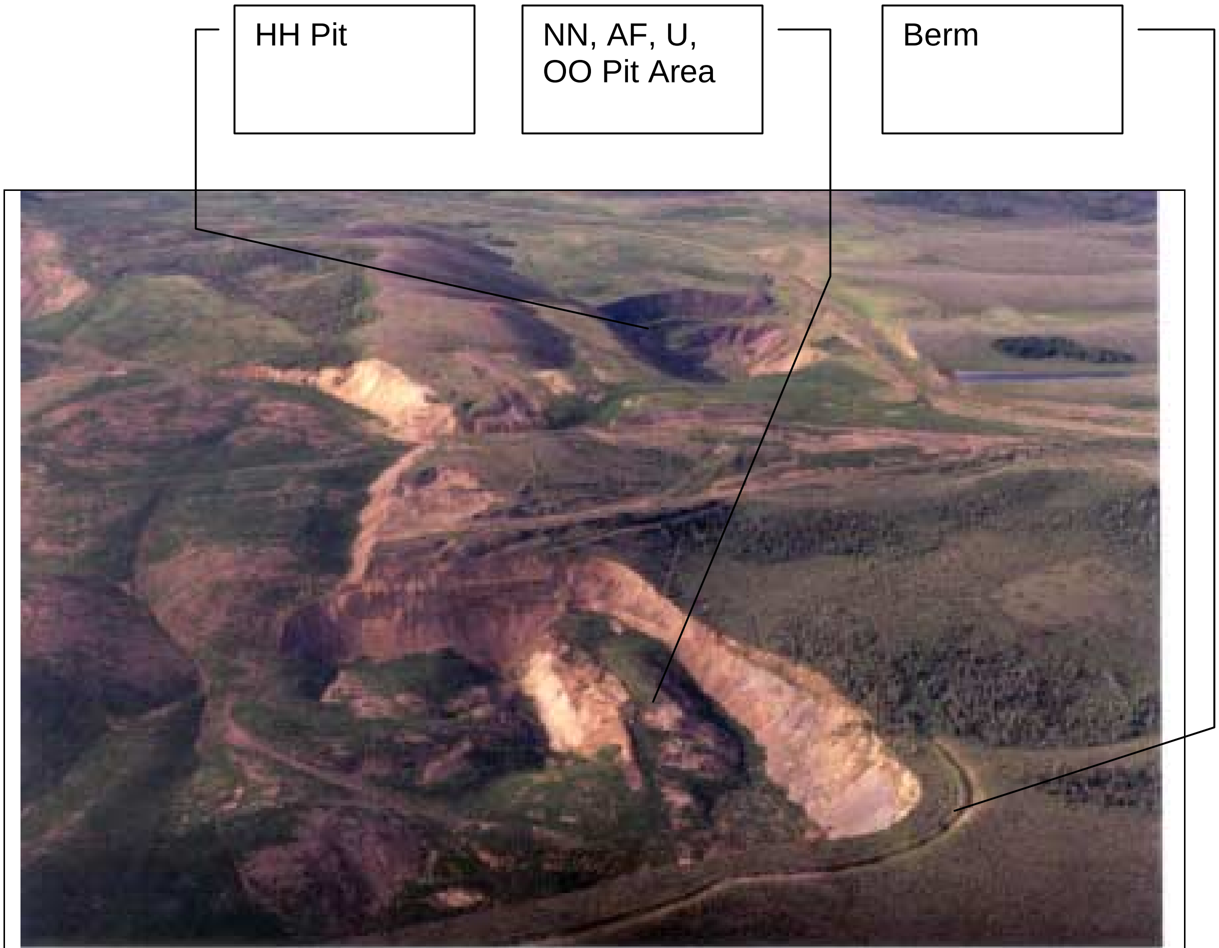
Source: EMI 6-20-02	Roll 2, Frame 10 File 17

Figure 1-32
View to S of Gay Mine East Limb HH, GG Pit Area



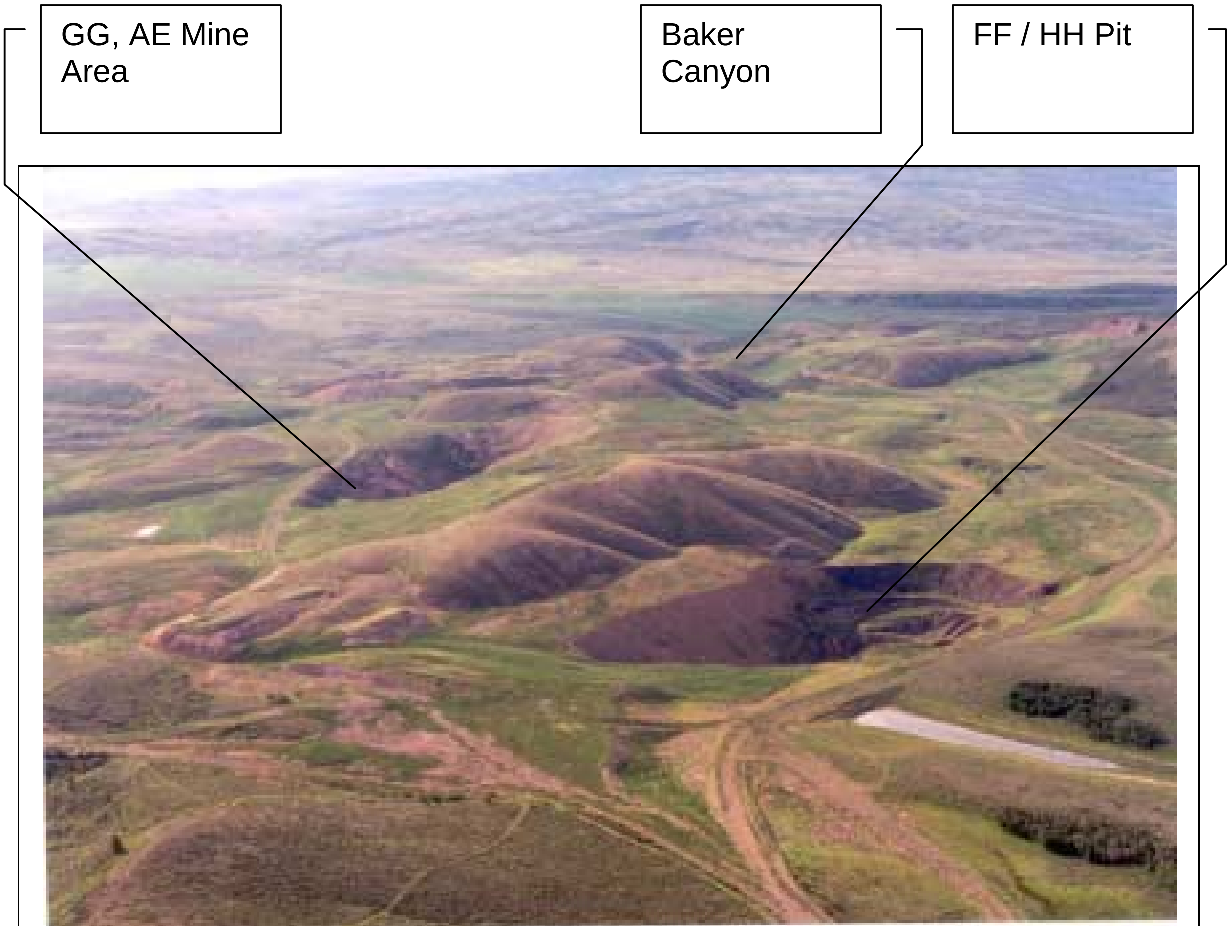
Source: EMI 6-20-02	Roll 2, Frame 11 File 16

Figure 1-33
View to S over Gay Mine NN, AF, U, OO Area



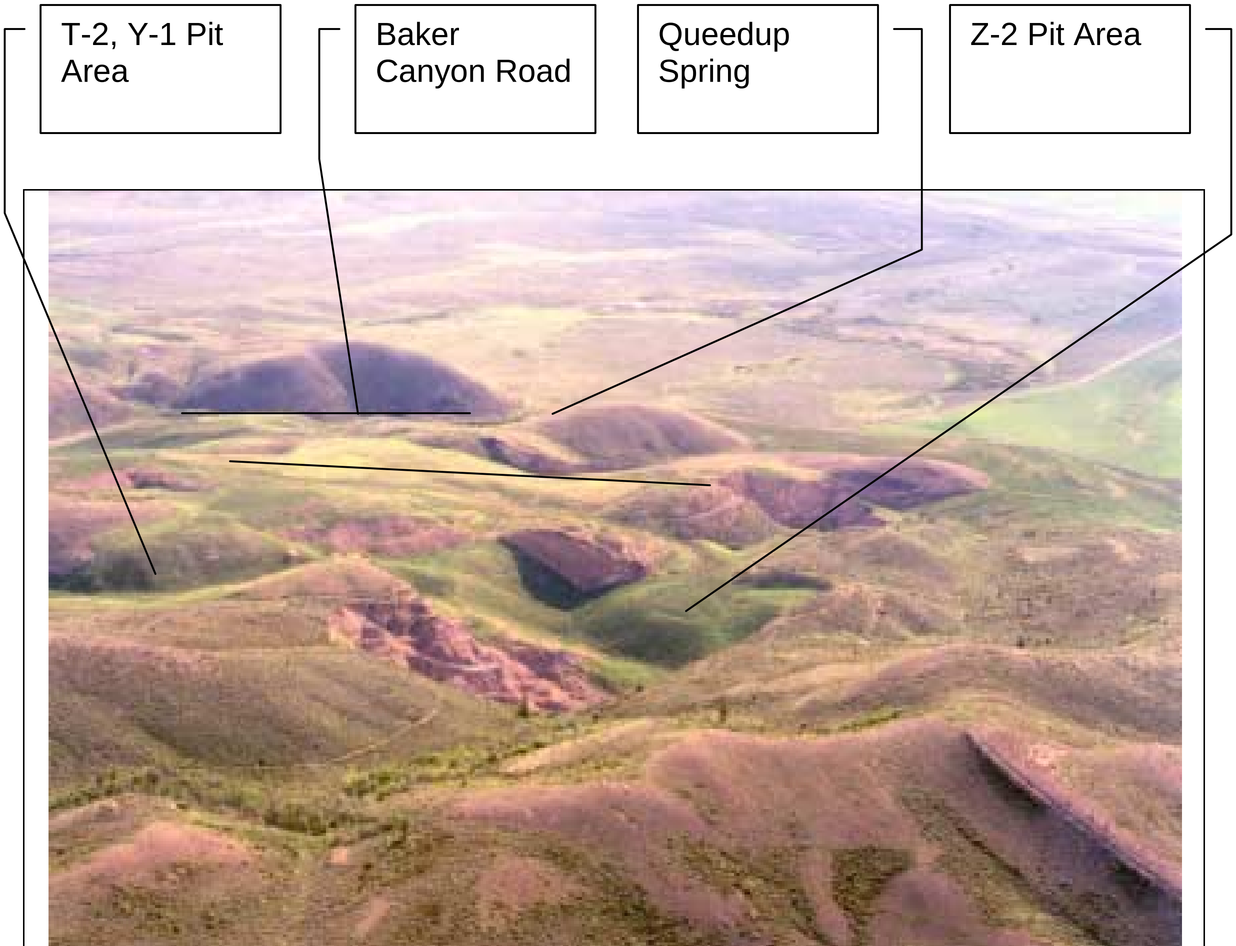
Source: EMI 6-20-02	Roll 2, Frame 12 File 15

Figure 1-34
View to S over Gay Mine NN, AF, U, OO Area



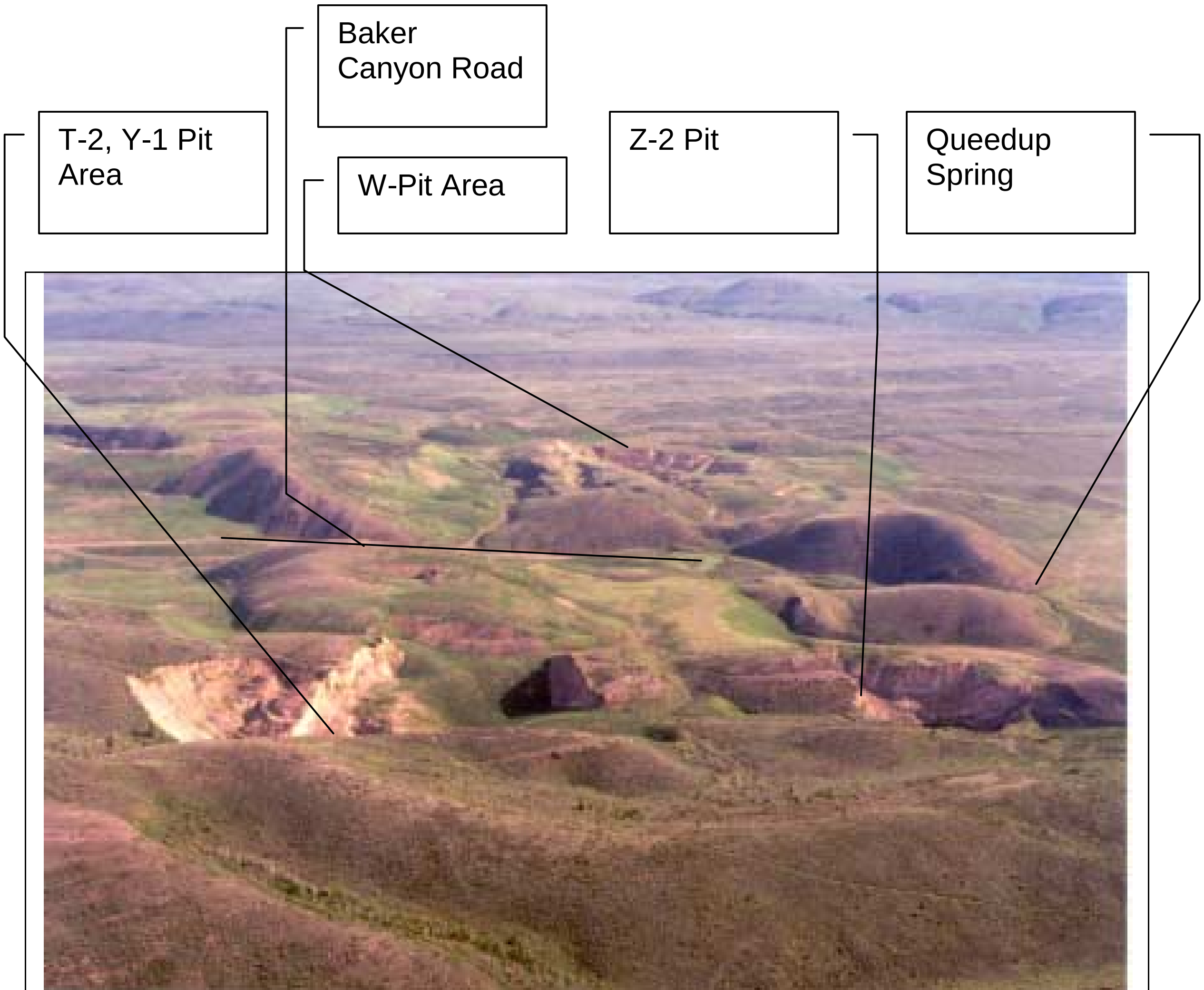
Source: EMI 6-20-02	Roll 2, Frame 13 File 14

Figure 1-35
View to SE over Gay Mine East Limb Group I



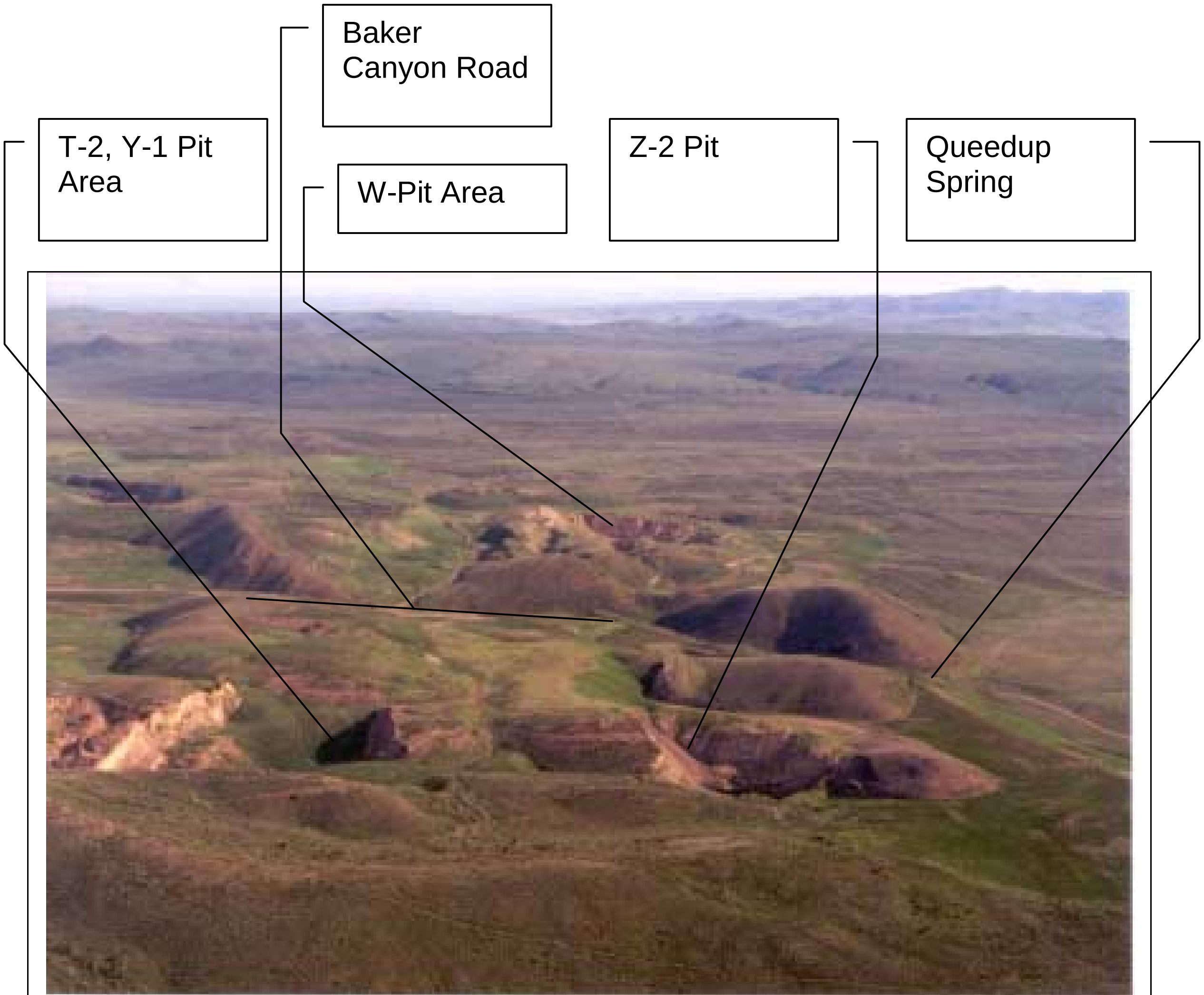
Source: EMI 6-20-02 | Roll 2, Frame 14 File 13

Figure 1-36
View to NE over Gay Mine East Limb Group II Area



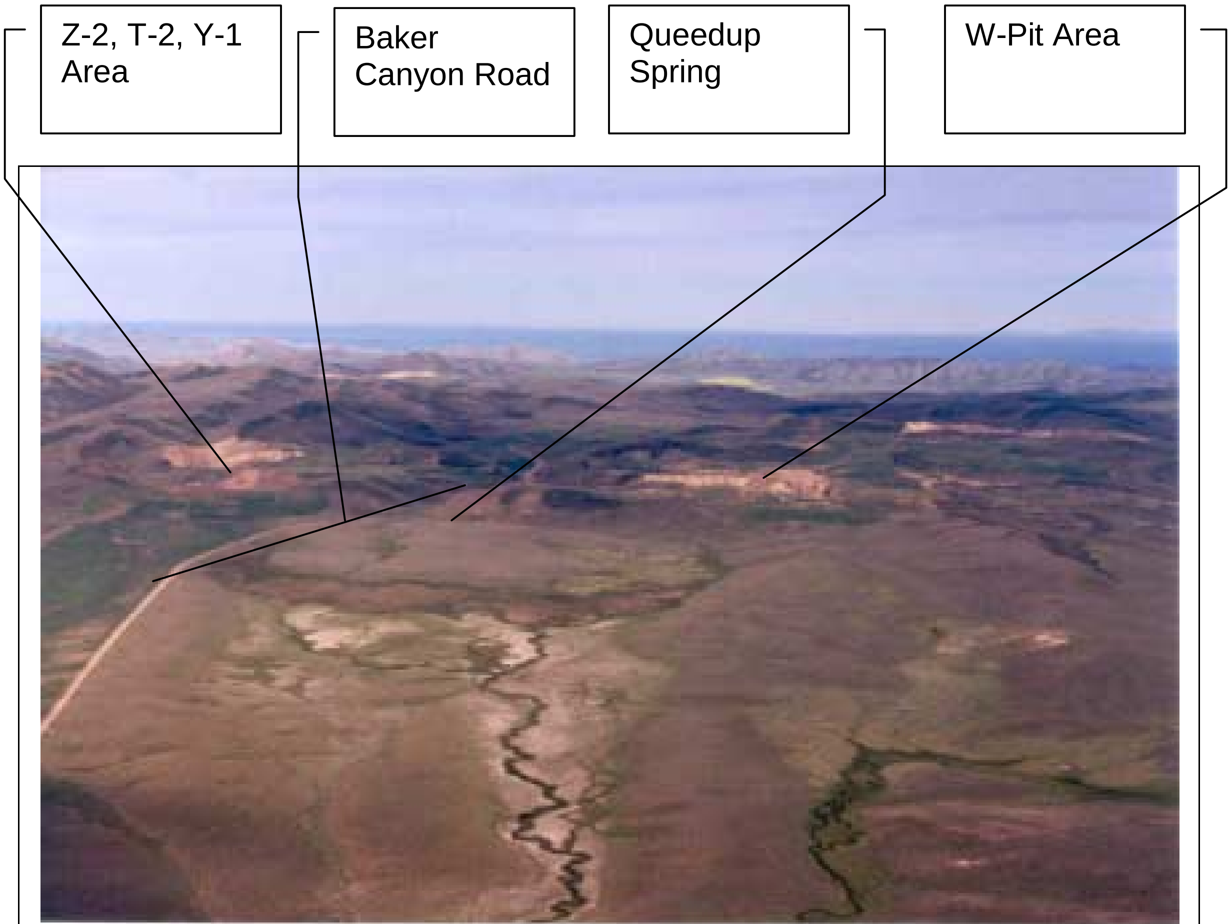
Source: EMI 6-20-02	Roll 2, Frame 15 File 12

Figure 1-37
View to N over Gay Mine East Limb Group II Area



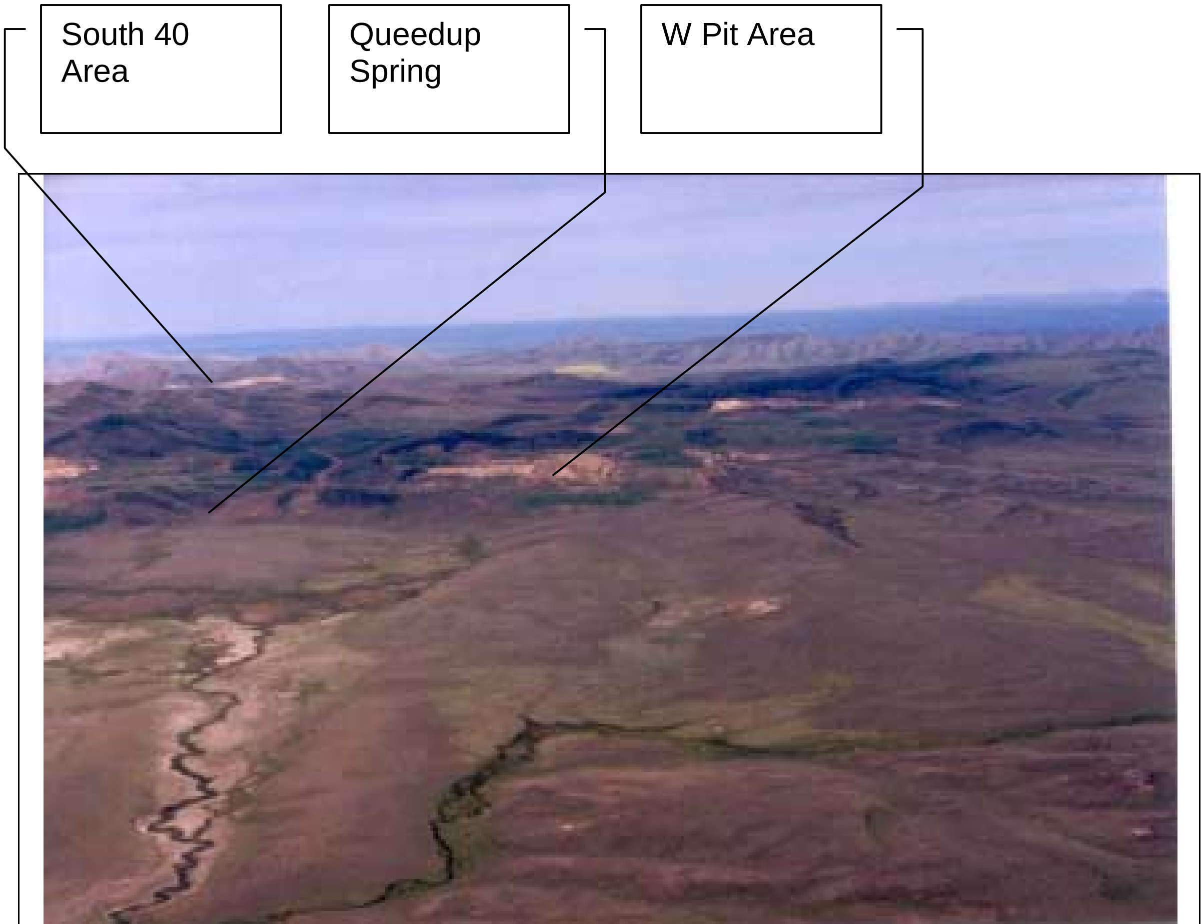
Source: EMI 6-20-02	Roll 2, Frame 16 File 11

Figure 1-38
View to N over Gay Mine East Limb Group II Area



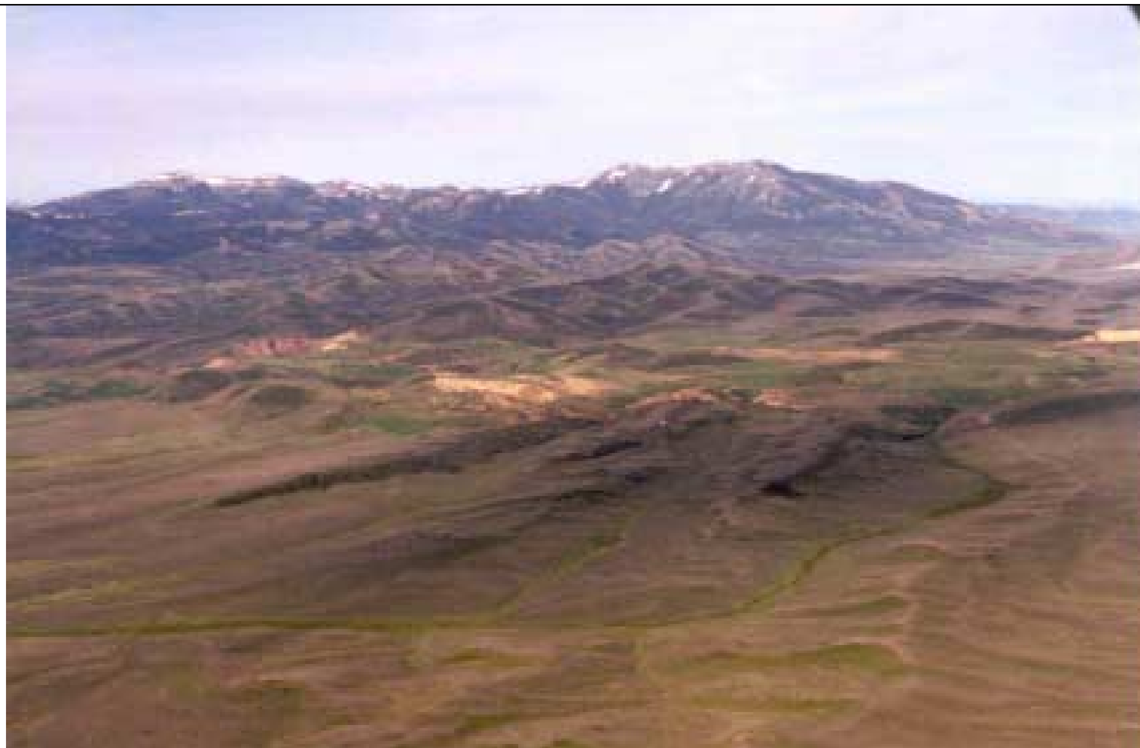
Source: EMI 6-20-02	Roll 2, Frame 17 File 10

Figure 1-39
View to W of Gay Mine East Limb, Seen from over Portneuf River



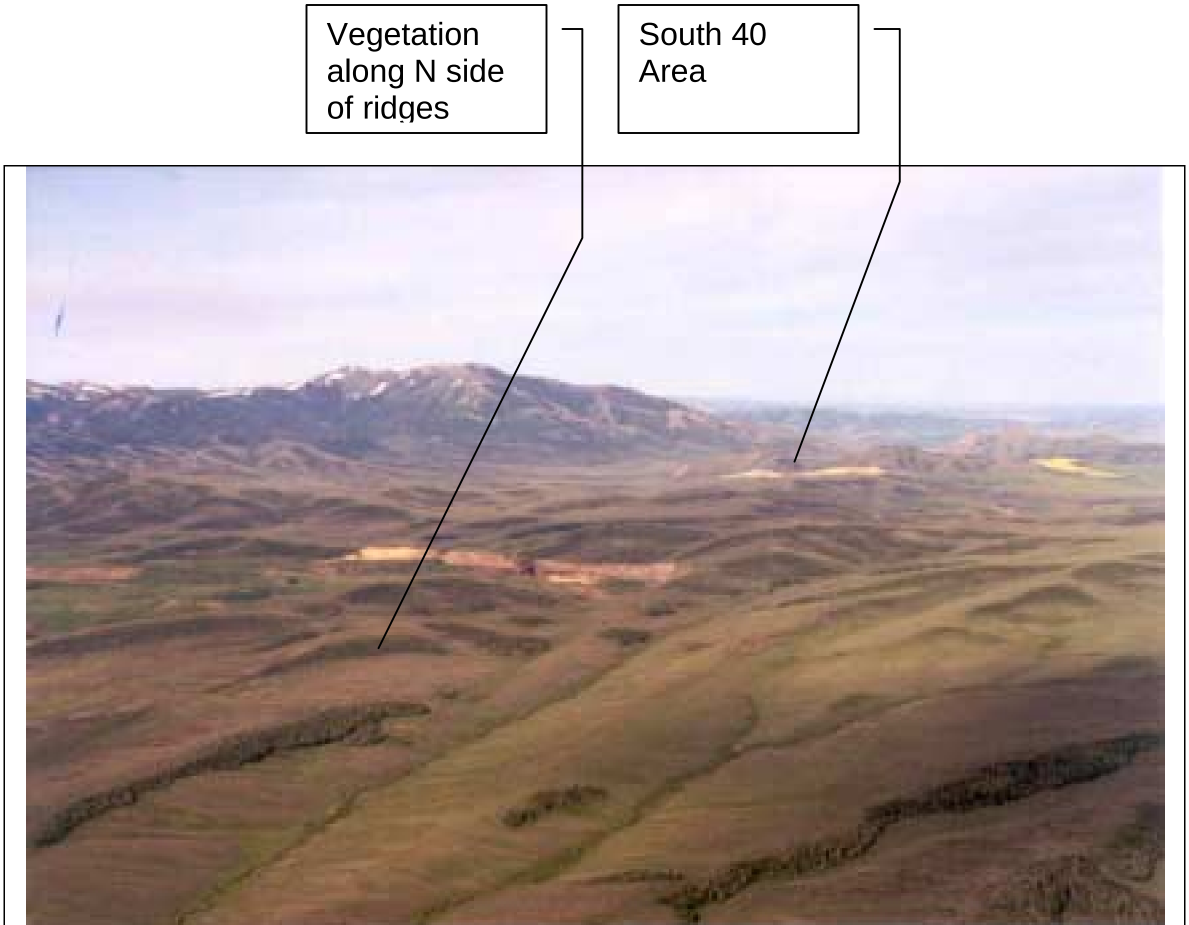
Source: EMI 6-20-02	Roll 2, Frame 18 File 9

Figure 1-40
View to W of Gay Mine Eastern Access to East Limb
Queedup Springs in left central portion with East Limb Pits to west.



Source: EMI 6-20-02	Roll 2, Frame 19 File 8

Figure 1-41
Perspective View (to South) of Gay Mine Area
East Limb Pits are central in photo.

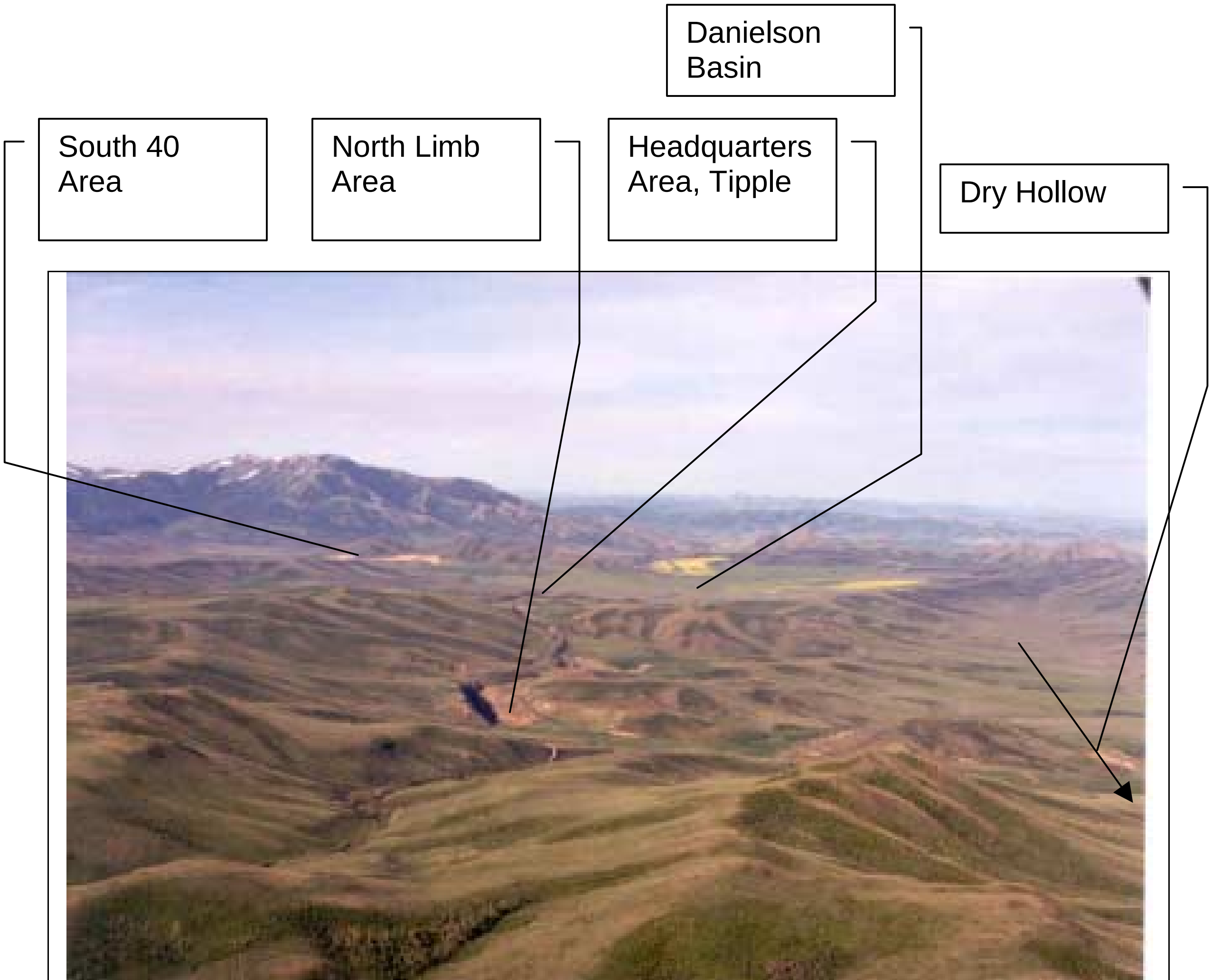


Source: EMI 6-20-02	Roll 2, Frame 20 File 7

Figure 1-42
View to SW across Gay Mine, East Limb to South 40

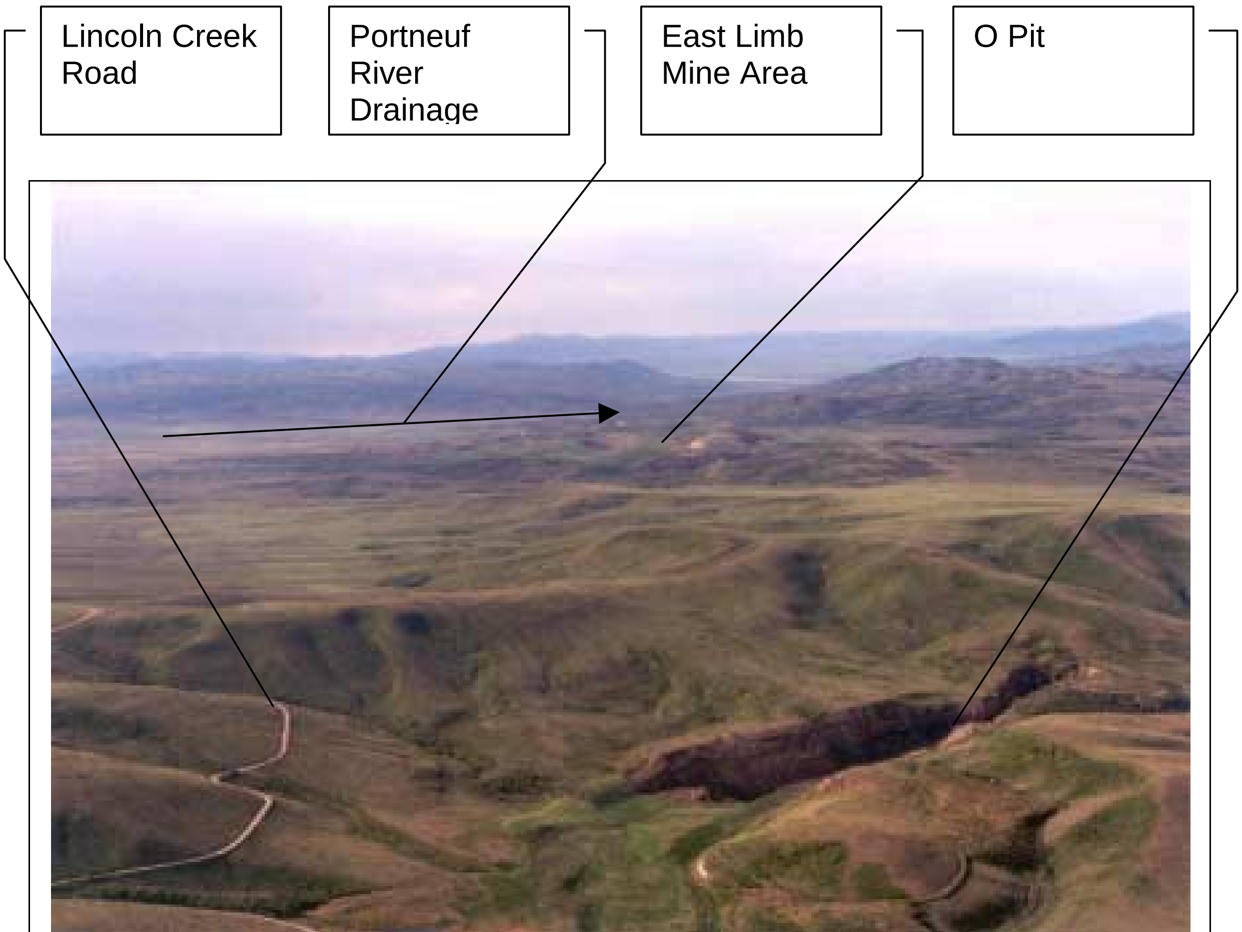
Source: EMI 6-20-02	Roll 2, Frame 21 File 6

Figure 1-43
Perspective View (to South) of Gay Mine across East Limb



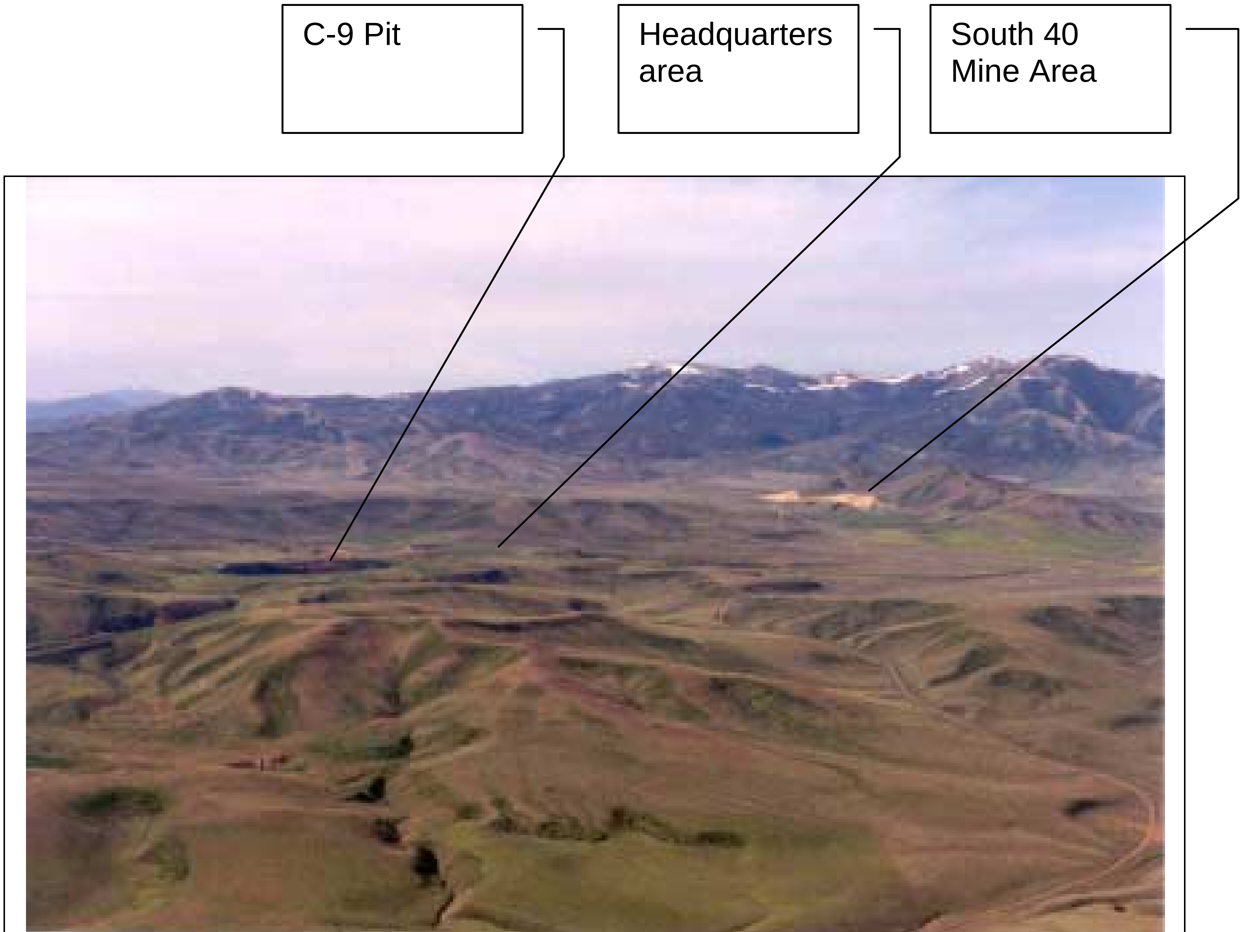
Source: EMI 6-20-02 | Roll 2, Frame 22 File 5

Figure 1-44
View to SW across Gay Mine, North Limb to South 40
South Forty Pit is visible in distant left center.
North Limb Pits are center in photo.



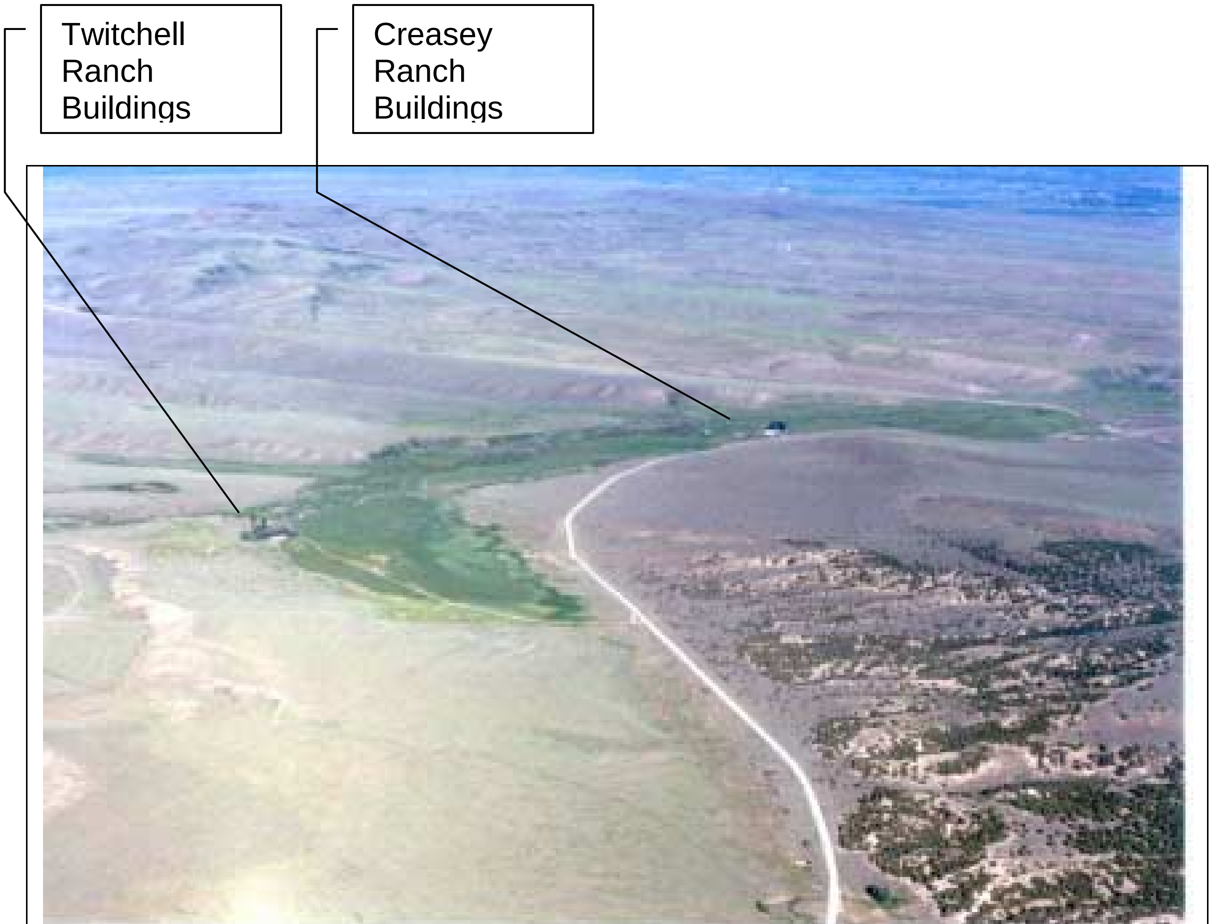
Source: EMI 6-20-02	Roll 2, Frame 23 File 4

Figure 1-45
Perspective View (to Southeast) of Gay Mine
North Limb Pits in foreground, East Limb in background.



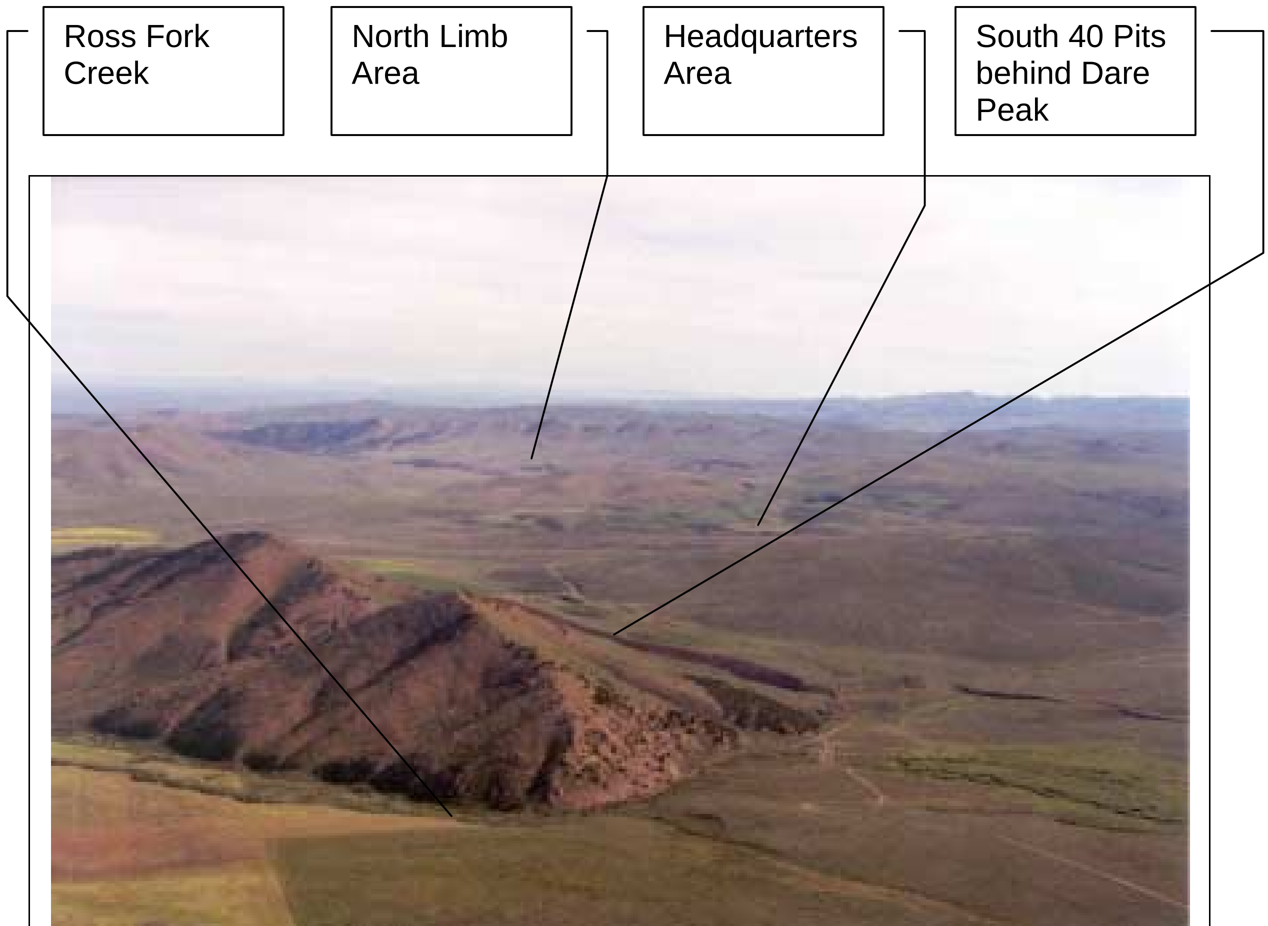
Source: EMI 6-20-02	Roll 2, Frame 24 File 3

Figure 1-46
Perspective View to South of Gay Mine Central Area



Source: EMI 6-20-02	Roll 2, Frame 25 File 2

Figure 1-47
View to West Down Lincoln Creek from Gay Mine North Limb
Nearest ranch houses (nearest domestic wells) visible
at left center and near right center of photo.



Source: EMI 6-20-02	Roll 2, Frame 26 File 1

Figure 1-48
View to NE across Gay Mine, South 40 to North Limb

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