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Review of Environmental Contamination

at the

Midnite Mine

Spokane Indian Reservation
Wellpinit, Washington

Prepared
by

The Bureau of Mines

under

Memorandum of Agreement
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with

The Bureau of Indian Affairs

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EXECUTIVE SUMMARY

The Midnite Mine is an inactive, unreclaimed open pit uranium mine, on the Spokane Indian Reservation in Washington State. It was developed and operated under lease by the Dawn Mining Company (DMC). The 321-acre Midnite Mine site is drained by tributaries of Blue Creek. A total of six pits or subpits were mined and terraced at several levels on the site. Chemically reactive rock, waste piles and low-grade uranium ore stockpiles at the mine are forming acid drainage, which affects Blue Creek and a downstream fishery. A pumpback system was installed in 1983 to intercept the contaminated water and store it in an open pit on-site. Approximately 400 million gal of acid waters, contaminated with uranium and heavy metals, have accumulated in the existing open pits. The rate of water accumulation from precipitation is 40-60 million gal a year. The seepage from the mine has produced seeps of contaminated water, which is causing stream contamination and could also lead to slope failures in the waste embankment. Some contaminated water now reaches Blue Creek and the Spokane River arm of Franklin D. Roosevelt Lake, 3 miles away.

One identified option for treating contaminated water and other materials from the Midnite Mine involves the use of the Sherwood, another uranium mine-mill on the Spokane Indian Reservation six air miles away. The Sherwood began operation in 1978 and closed circa 1982. Its owner, Western Nuclear Corporation, has sought Bureau of Indian Affairs (BIA) approval to close the mine and mill, demolish the facilities, and reclaim the site, including a nearly empty tailings pond. The proximity of Sherwood site to the Midnite Mine and the empty tailings pond at the Sherwood Mill caused the BIA to consider its use to solve the Midnite problem. The Bureau of Land Management (BLM) and BIA have extensively evaluated this option and have entered into discussions with Western Nuclear on the possibility of the Spokane Tribe assuming responsibility for the Sherwood facility.

In a letter dated July 11, 1989, the House of Representatives Subcommittee on Interior and Related Agencies requested the Secretary of the Interior to provide a complete assessment of the existing situation and how best to proceed in resolving the environmental contamination from the Midnite Mine. The Subcommittee requested that results of the study, along with recommendations for future action, be provided to them.

The BIA entered into a Memorandum of Agreement (MOA) with the Bureau of Mines (BOM) on December 8, 1989, to review the situation at the Midnite Mine and provide answers to five specific questions by March 31, 1990. In response to the MOA, the BOM formed a review team to evaluate the situation at the Midnite Mine. The five questions and the review team's responses follow:

Question 1. If the Sherwood site and its sludge disposal opportunities are surrendered, how sure can we be that successful reclamation is possible using the Dawn Mine site alone.

Answer: The review team is reasonably certain the Midnite Mine can be successfully reclaimed without use of the Sherwood Mill and the disposal pond on the Sherwood Mill site.

Question 2. Assess the potential threat to the public posed by accumulating mine water. If there is a threat, how serious is that threat? Is there an immediate need to stop additional water accumulations?

Answer: The review team found that there is no imminent danger to the public due to the accumulation of contaminated water and the associated seepage from the Midnite Mine. Adverse environmental or human health effects are possible, because of either slope failure of the lower waste pile causing an uncontrolled release of contaminated water, or long-term degradation of Blue Creek due to continued seepage not captured on the site.

The team concluded that it would be advisable to stop additional water accumulation on-site to prevent further environmental problems.

Question 3. Is the Sherwood mill and tailings system preferable to the use of the existing Dawn Mining Company (DMC) water treatment plant at the mine site? Can the DMC plant be upgraded to improve throughput within reasonable costs? Variables to be considered are treatment time, solid waste disposal, pipeline safety/security, and cost.

Answer: The review team concluded the Sherwood mill and tailings system is not preferable to the use of the existing DMC (Midnite Mine) water treatment plant. The existing DMC water treatment plant, operating at its current design capacity of 300 gpm, can dewater the estimated 400 million gal of contaminated water and the additional annual accumulation of about 50 million gal of water in 4 to 5 years. The review team recommended operation of the DMC water treatment plant begin as soon as practical.

Should it be desired to decrease this time, the treatment plant capacity can be readily upgraded to 500 gpm by increasing the pump size. Operating at this treatment rate, the pits could be dewatered in 2-1/2 to 3 years.

Should a decision be made to dewater the pits in less than 2 years, a "package" water treatment plant could be set up at the Midnite Mine site to operate in parallel with the DMC plant. A plant of about 500 gpm capacity is estimated to cost about $1.5 million.

A package plant should be readily available and could be operational in under 1 year after a decision to install it is made.

Question 4. Assuming that the primary cause of the formation of acid water is the reactivity of the waste rock and the protore, can the waste rock and the protore be chemically isolated on the Midnite Mine site, or must they be disposed of off-site. Which is the most cost-effective?

Answer: The team identified no insurmountable technical problems during this review that would prohibit the isolation of reactive material on the Midnite Mine site. This conclusion is supported by the two completed reclamation plans proposed separately by DMC and BLM, and other materials discussed by the team. The most cost-effective solution, on-site disposal, has a cost of about $21 million.

Question 5. Review the attached Action Plan as a possible approach for setting reclamation standards and objectives. Does the DOI need to acquire these data independently in order to make an informed decision on eventual reclamation plans?

Answer: A review of the Action Plan showed that the tasks in the plan are not defined in sufficient detail to either schedule the subactivities necessary to fulfill the Action Plan or to identify interrelations between tasks. Absent a more detailed development of this plan and a supporting schedule, it is not possible to estimate the funding needs and manpower necessary to properly complete the planning program. The review team recommends development of a more detailed Action Plan leading to a reclamation plan for the Midnite Mine.

Review of Environmental Contamination at the Midnite Mine

INTRODUCTION

In June 1989, the Assistant Secretary - Policy, Budget, and Administration of the Department of the Interior asked the House of Representatives Subcommittee on Interior and Related Agencies of the Committee on Appropriations to make funds available within the Bureau of Indian Affairs (BIA) authorization for the maintenance of the Sherwood Mine complex. An important element of this request was the statement that the "mitigation of the contaminated water and reclamation of the [Midnite] mine site will require removal of reactive rock and water contaminants to an acceptable disposal site."(1) BIA then stated "The Sherwood Mill ... is highly suitable for the treatment and disposal of contaminated water, uranium ore, and wastes of the Midnite Mine."(2)

The Subcommittee responded by providing the funds to hold the Sherwood Mill available, but it declined to fund the additional activities that would lead to use of Sherwood to eliminate the contamination at Midnite. In a letter dated July 11, 1989, the Subcommittee requested the Secretary of the Interior to provide a complete assessment of the existing situation and recommendations on how best to proceed in resolving the environmental contamination from the Midnite Mine on the Spokane Indian Reservation (3). The Subcommittee requested that results of the study, along with recommendations for future action, be provided to them.

The BIA entered into a Memorandum of Agreement (MOA) with the Bureau of Mines (BOM) on December 8, 1989, to review the situation at the Midnite Mine. The agreement called for the BOM to provide the BIA with answers to the following five questions by March 31, 1990:

1. If the Sherwood site and its sludge disposal opportunities are surrendered, how sure can we be that successful

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(1) Assistant Secretary - Policy, Budget and Administration. Correspondence to Sidney R. Yates (Chairman, Subcommittee on Interior and Related Agencies), June 5, 1989.

(2) Ibid.

(3) Yates, Sidney R. (Chairman, Subcommittee on Interior and Related Agencies). Correspondence to Manuel Lujan, Jr. (Secretary, U.S. Department of the Interior), July 11, 1989.

reclamation is possible using the Dawn (Midnite) Mine site alone?

2. Assess the potential threat to the public posed by accumulating mine water. If there is a threat, how serious is that threat? Is there an immediate need to stop additional water accumulations?

3. Is the Sherwood mill and tailings system preferable to the use of the existing Dawn Mining Company (DMC) water treatment plant at the mine site? Can the DMC plant be upgraded to improve throughput within reasonable costs? Variables to be considered are treatment time, solid waste disposal, pipeline safety/security, and cost.

4. Assuming that the primary cause of the formation of acid water is the reactivity of the waste rock and the protore, can the waste rock and the protore be chemically isolated on the Midnite Mine site, or must they be disposed of off-site. Which is the most cost-effective?

5. Review the attached Action Plan as a possible approach for setting reclamation standards and objectives. Does the DOI need to acquire these data independently in order to make an informed decision on eventual reclamation plans?

In the body of this report, the above questions are addressed, but in a different order. The change is made to provide additional clarity in presenting the information developed by the review team to answer the questions. The order in which the questions are addressed is 2, 3, 4, 1, and 5.

In response to its agreement with BIA, the BOM assembled an interagency, interdisciplinary team of experienced personnel to undertake the review. The team members are listed in Appendix A, Table A-1. Members were drawn from three BOM Research Centers: Denver, Salt Lake City, and Spokane. The Bureau of Reclamation (BOR) provided three additional members. The team was headed by Dr. William Fitch of the Denver Research Center.

The review was performed in the period January 29 to March 30, 1990. The first meeting of the team was held in Denver from January 30 to February 2, 1990. At this meeting, members of the team presented summaries of their previous and ongoing work related to the Midnite Mine and structured a number of questions for further study and discussion. An effort also was made to identify and obtain all the available information and documentation necessary to provide the technical base for the review. Members of the review team were assigned to specific technical topics that required evaluation in order to answer the five questions.

In the month following the initial meeting, the review team members worked on their specific assigned tasks while obtaining any additional technical information necessary. The BIA and Bureau of Land Management (BLM) were the source of most of this information. A second meeting of the review team was held in Denver on March 12 to March 16, 1990.

The first 2 days of the meeting consisted of a discussion of the issues and additional fact finding. The review team was assisted by BIA and BLM personnel familiar with the details of all the ongoing and completed studies prepared by the BLM, BOM, BIA, and the Geological Survey (USGS) relating to the Midnite site. The individuals are identified in Appendix A, Table A-2. The BLM and BIA personnel also were familiar with the responses from Washington State agencies and the responsible Federal agencies, specifically the Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC), to the previously proposed reclamation plans and permitting actions related to the site. The team also heard from Mr. Glenn Ford, Vice-Chairman of the Spokane Tribe, and Mr. Lawrence Goodrow, Executive Director for the Tribe who addressed many of the Tribe's concerns. Mr. Nick Lynn, President of N.S. Lynn and Associates, made a presentation to the team on the water treatment plant his company designed and built for the DMC on the Midnite site.

The last 2 days of the March 12-16 meeting were devoted to developing a consensus among the team members on the response to the five questions presented by BIA and the assembly of the findings into a draft report. The last 2 weeks of March 1990 were devoted to review and completion of the final report by the review team.

RELATED AGENCY ACTIVITIES

BOM, BLM, and USGS have all completed studies directed at one or more aspects of concern to the Midnite Mine issue. These past studies provided much of the source material upon which this report is based. Without these past activities, this report could not have been produced in such a short time frame. One thing which should be kept in mind is that many of these past studies were done for slightly different purposes, are now dated by subsequent events, or are still ongoing. Nevertheless, the data from these reports, supplemented and extended by expert opinion, provide much of the technical basis for this document. A summary of some of the key activities follows.

BUREAU OF MINES

The Bureau has two ongoing projects related to the Midnite Mine other than the agreement which led to this report. The first of these was conducted by the Salt Lake City Research Center (SLRC) under IAG 14-09-007-1347 with the Bureau of Indian Affairs. Under this project, investigations of the reactivity of rock at different locations on the Midnite site were conducted. A method to treat the water impounded in Pit 3 was developed and a study of the feasibility of converting the uranium processing circuit at the Sherwood Mill to a water treatment plant for Midnite Mine water were completed.

The second project, conducted by the Spokane Research Center, is a research project entitled "Hydrogeologic Factors in Mine Waste." The project is funded in part through MOU POOC14IA9239 between the BOM and the BIA. A hydrologic study of the Midnite Mine, to define the flow of ground water through the site and the locations where acid mine drainage is generated on the site, will be completed through the project. This study started last summer with the installation of six monitoring wells on the mine site. Discussions of the hydrology and geology of the mine site, presented in Appendix C of this report, are based on this as well as other studies.

BUREAU OF LAND MANAGEMENT

The BLM has prepared a proposed reclamation plan to establish an estimate of the amount of reclamation bond to be requested from DMC. It was prepared in 1987.

U.S. GEOLOGICAL SURVEY

The USGS has an ongoing program to monitor water quality in Blue Creek. The USGS also completed a surface water quality study for the Midnite Mine, for the period beginning in 1983 and ending in

the fall of 1989. The results are reported in a water resources investigation report (4).

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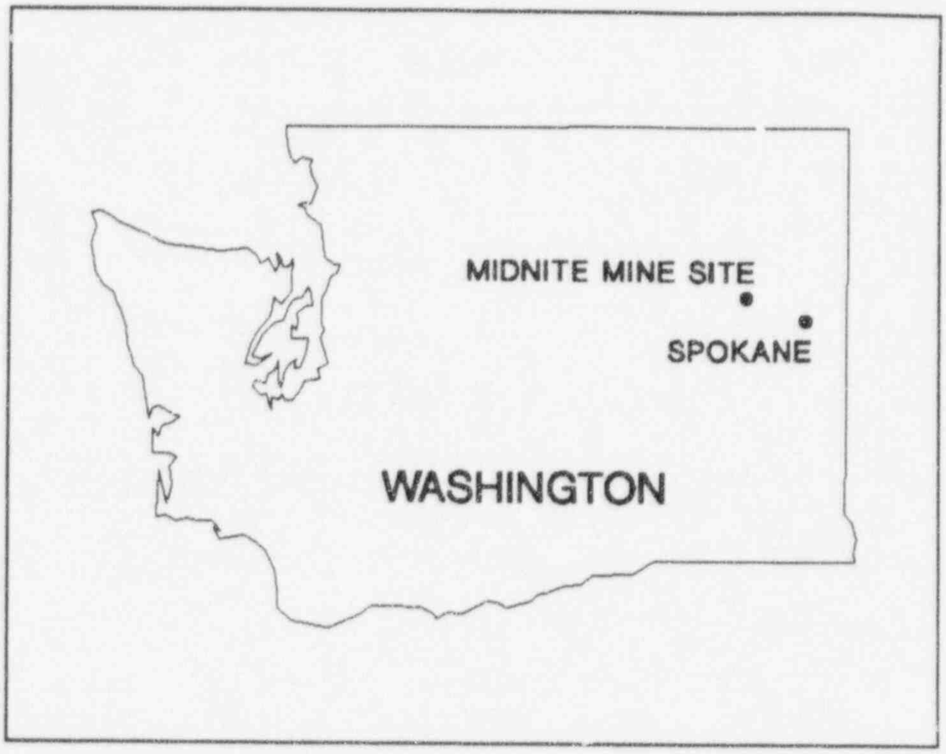
(4) Sumioka, S.S. An Investigation of Hydrologic Conditions at the Midnite Mine and Vicinity, Stevens County, Washington (Draft). U.S. Geologic Survey. October 1988.

BACKGROUND

Figure 1 shows the location of the Midnite Mine in Washington State. The mine site is situated on the Spokane Indian Reservation, near Wellpinit, Washington.

FIGURE 1

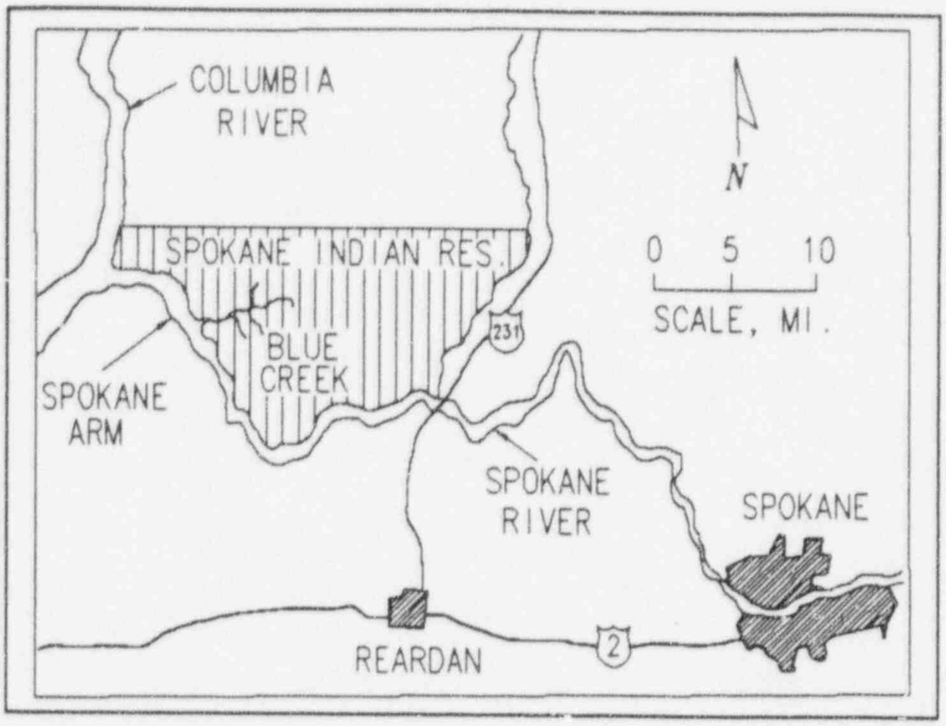
Location of the Midnite Mine Site in Washington State

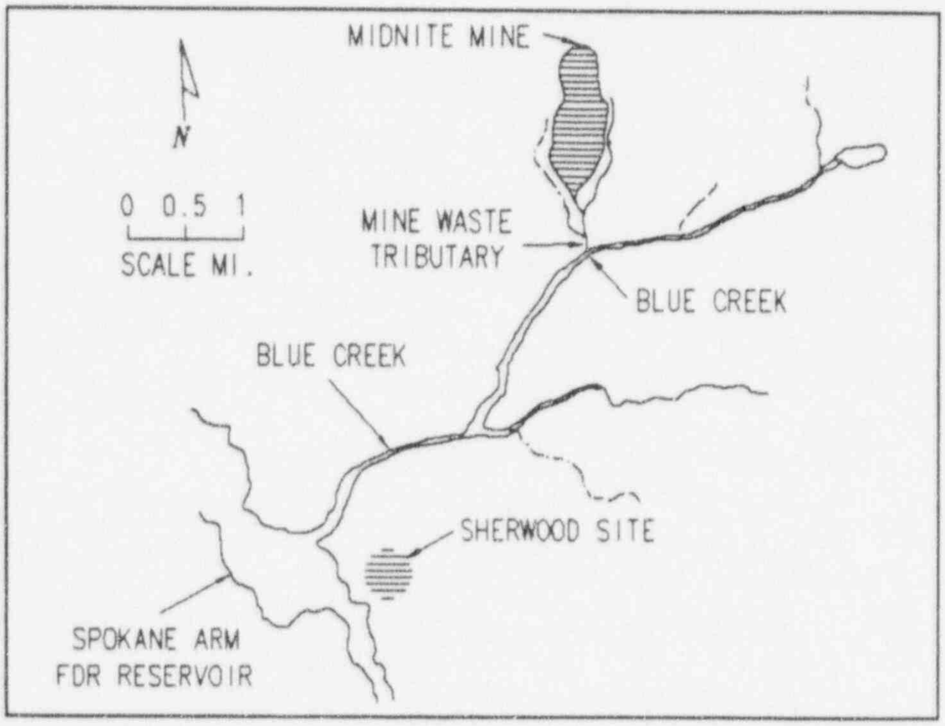


The Mine is approximately 5 miles from Franklin D. Roosevelt Lake on the Columbia River. Blue Creek, a small stream with tributaries that drain the mine site, conveys the drainage from the mine site to Roosevelt Lake. The lake is in the Grand Coulee National Recreational Area. Figure 2 shows the location of the Midnite Mine, the Sherwood Mine-Mill, and the stream system in relation to the Spokane Indian Reservation and nearby communities.

FIGURE 2

The Midnite Mine, Sherwood Mine-Mill, and Environs





The Midnite Mine site was leased by the Dawn Mining Company (DMC) in 1954 for use as a uranium mine. The lease area is 811 acres, 321 acres of which were disturbed during mining (5). Mining operations began in 1957. In 1981, the DMC began mining and shipping high-grade ore to its Ford, Washington mill. Mining of some of the lower grade ore (protore) was delayed and other lower-grade ore was stockpiled on the mine site. In 1981, the USGS District Mining Engineer notified BIA that DMC was not following the approved mining plan. The two agencies responsible for stewardship of the property, BIA and BLM, then took action against DMC to cease mining. Mining stopped in the early winter of 1982. Some high-grade ore also was stockpiled on-site immediately before cessation of mining.

During mining, a total of six pits or subpits were opened on the property. Four early pits were backfilled with overburden and waste from succeeding pits as the mining operation progressed. Two pits, Pit 3 and Pit 4, were left open. An annotated aerial view of the mine site is shown in Figure 3. Pits 3 and 4 are identified on Figure 3 with the numbers 3 and 4.

The waste rock, protore and ore at the Midnite Mine contain pyrite and other reactive sulfide minerals. The more extensive piles of excavated overburden, ore and protore remaining on the site are identified by yellow dots on Figure 3. These sulfide minerals chemically react with atmospheric oxygen and water from rain, snow, and ground water to form acid water. As the acid water percolates through the ground, it leaches metals and radionuclides from the waste, protore, and ore piles left on-site and from in-place rock left in unmined areas.

During mining operations, the only water quality problem noted was that the water discharged from the site contained excessive nitrates, probably from explosive residue. Since the cessation of mining, acidity and dissolved metals, including radionuclides, are contaminants of concern.

Seepage of contaminated mine water from the southern most waste pile on the site was first reported in 1978. The location of that seep is shown as a green dot near the toe pond identified by the number 1 in Figure 3. The toe pond was constructed in 1979 to contain the seepage. A water monitoring program was instituted shortly thereafter by the USGS.

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(5) Bond Recommendation for Reclamation of the Midnite Uranium Mine. Joint BLM/BIA Staff. October 1986.

11-22-89 BPA-BIA 4L-4

FIGURE 3

Annotated Aerial View of the Midnite Mine Site

FIGURE 3
Annotated Aerial View of the Midnite Mine Site

The bottom of Pit 3 is below the ground water table. In March 1982, the water accumulated in Pit 3 was pumped to Pit 4. Pit 4 has retained the water since then. Beginning in 1983, water collected in the toe pond has been pumped back to Pit 3 to prevent the release of contaminated water into Blue Creek. Approximately 400 million gal of water, contaminated with radionuclides, metals, and acid, are stored on-site in Pits 3 and 4. Additional water is accumulating at a rate of 40-60 million gal a year from precipitation (6).

A second pumpback system was established in 1987 to capture new seeps that formed below the toe pond, thus preventing further contamination of Blue Creek. Continued subsurface ground water flow, probably caused by water stored in Pit 3, has produced these seeps of contaminated water. The seeps are located on the southern most waste dump just west of the toe pond, south of the water treatment plant, and in undisturbed soil south of the toe pond . Their locations are illustrated in Figure 3 as green dots. These additional seeps are pumped back to the toe pond where they are combined with the other seepage and pumped to Pit 3. In 1989, a seep containing high levels of dissolved radon, 40,000 pCi/l (7), appeared several hundred yards below the toe pond. Its location is slightly off the area shown in Figure 3. Its approximate location is denoted by the number 10 on that figure.

The drainage of acid water from the Midnite Mine site affects the biota and fish in Blue Creek. A series of studies of the Blue Creek biota by Eastern Washington University was completed after the toe pond was installed and pumping to Pit 3 initiated in 1983 (8)(9)(10)(11). They documented major impacts to the Blue Creek

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(6) Sumioka, op. cit.

(7) Personal Communication with James LeBret, Portland Area Offices, Bureau of Indian Affairs.

(8) Determination of Habitat Availability for Rainbow Trout in Blue Creek using the Instream Flow Incremental Methodology. Department of Biology, Eastern Washington University, Cheney, WA. October 1988.

(9) Analysis of the Impact to Water Quality on Blue Creek, WA by Mine Drainage Effluent from the Midnite Uranium Mine. Department of Biology, Eastern Washington University, Cheney, WA. June 1988.

(10) Rainbow Trout Population Estimates in Blue Creek Spokane Indian Reservation from 1985 to 1987: Determining Impacts of Uranium Mine Discharge on the Rainbow Trout Population. Department of Biology, Eastern Washington University, Cheney, WA. March 1988.

biota from the mine drainage. The populations of benthic invertebrates, such as mayflies, clams, snails, and stoneflies were reduced as were the native salmonid fish populations. The trout population in Blue Creek also was adversely impacted by the mine drainage during the period from 1985 to 1987. Analyses of flesh from netted fish have found levels of contaminants, notably cadmium, exceeding the national standards for consumption (12).

As a result of the concerns about the detention of the pit water and the instream water quality in Blue Creek, DMC contracted with N.S. Lynn and Associates for the design and construction of a water treatment plant. In October 1986, the State of Washington issued a National Pollutant Discharge Elimination System (NPDES) permit WA-002572-1 to the DMC for discharge into Blue Creek of up to 300 gpm of treated effluent from the water treatment plant constructed on the mine site by DMC. Its location is shown by the number 8 in Figure 3. Its construction was completed in 1988. DMC has tested the water treatment plant and has demonstrated that the plant can provide a treated effluent whose quality will meet the NPDES permit effluent standards. The BOM SLRC assessed several water treatment options for the mine water and independently concluded that this type of treatment was the most feasible. The results of these studies are discussed in Appendix D. During this review, SLRC personnel inspected plans for the DMC plant and concluded the DMC plant should meet the water treatment requirements.

Other than short test periods, the DMC water treatment plant has not operated because there is no approved location for disposal of the sludge from the water treatment. The sludge contains the metals which were dissolved in the mine drainage, including uranium. The sludge passes the EPA's Extractive Procedure Toxicity Test (EP Tox Test) and, therefore, is not defined as a Resource Conservation and Recovery Act (RCRA) hazardous waste. However, it contains sufficient radioactivity to cause it to be classified as a low-level radioactive waste. In 1988, the DMC proposed that the sludge be stored temporarily on the Midnite Mine site, but that plan was not approved by the BLM. DMC also proposed permanent disposal by placement of the sludge in the Midnite Mill tailings pond at Ford, Washington. The State of Washington has not approved that proposal.

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(11) The Effect of the Midnite Uranium Mine Drainage Effluent on the Benthic Macroinvertebrate Community of Blue Creek, Spokane Indian Reservation, WA. Department of Biology, Eastern Washington University, Cheney, WA. September 1988.

(12) Rainbow Trout Population Estimates in Blue Creek Spokane Indian Reservation from 1985 to 1987: Determining Impacts Of Uranium Mine Discharge on the Rainbow Trout Population, op. sit.

The BIA and the BLM have evaluated alternative reclamation strategies for the Midnite site. One of these involves the disposal of the ore and protore stockpiled at the Midnite Mine and treatment of the contaminated water at the Sherwood Mill, another uranium mine and mill on the Spokane Indian Reservation. It is approximately six miles by air from the Midnite Mine as shown in Figure 2. The Sherwood Mine and Mill also ceased operations circa 1982. Its owner, Western Nuclear Corporation, has sought BIA approval of a plan to close the mine and mill by demolishing the facilities and reclaiming the mine-mill site, including the nearly empty tailings pond.

DISCUSSION

The results of the team's deliberations are presented in the following discussions. Each of the questions posed by BIA are addressed but, as indicated before, in a different order than contained in the MOA.

QUESTION 2 **Assess the potential threat to the public posed by accumulating mine water. If there is a threat, how serious is that threat? Is there an immediate need to stop additional water accumulations?**

Answer: There does not appear to be any imminent danger to the public due to accumulating mine water. However, there are reasons why additional water accumulations should be stopped as soon as practical.

The question is directed specifically at the issue of accumulating waters. As noted earlier, water is stored in three impoundments on the Midnite site. The first, and highest in elevation, is Pit 4. This pit contains an estimated 50 million gal of water. The water level in Pit 4 has been stable since the water from Pit 3 was pumped into it in 1982. The current water level is about 15 ft below the lowest lip of the pit. During the pumpback of water from Pit 3 to Pit 4 in 1982, it was observed that the water in Pit 4 did not rise above the 3040 elevation. The water level in Pit 4 has remained at about the 3040 elevation for the past 7 years. It appears that the inflow from precipitation is offset principally by ground water flow out of the pit. All or at least a significant part of this ground water probably flows into Pit 3.

Pit 3 is significantly larger than Pit 4. At last report, an estimated 330 million gal of contaminated water were impounded in Pit 3, with a remaining capacity of 286 million gal (13). The pit is known to be leaking, so it is highly unlikely that Pit 3 would ever reach its theoretical capacity. Leakage through the pit walls appears to be the principal source of seeps below Pit 3.

The lowest impoundment is the toe pond. At capacity, this impoundment could hold 7 million gal. It is formed , an earthen dam which has no emergency spillway. In 1983, the DMC installed an automatic, electrically operated system that pumps water from the toe pond back to Pit 3 to prevent overtopping the dam. The

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(13) Courtright, K. Mine Pit 3, Midnite Uranium Mine, Water Elevation vs Volume (Graph). February 18, 1988, updated March 7, 1990.

pumpback system limits the amount of water held in the toe pond to about 4 million gal (14).

The review team identified two possible hazards associated with accumulating waters at the Midnite Mine:

1) slope failure of the lower waste pile and the attendant uncontrolled release of contaminated water, and

2) long-term degradation of water quality in Blue Creek due to continued seepage not captured in the toe pond.

Slope Failure of the Lower Waste Pile

The most immediate potential threat to the public from the Midnite Mine is an uncontrolled release of the contaminated pond water and sediments from the toe pond because of a localized slump of the lower waste dump embankment face into the pond, thereby breaching the toe pond dam. This release would have severe environmental consequences, but would probably not immediately endanger human life. Such a release would contaminate the Blue Creek stream channel downstream through the Spokane Arm of Roosevelt Lake and would probably cause extensive damage to State Highway 22 where it crosses Blue Creek, approximately 1 mile downstream from the mine site. This highway is the major link between the town of Wellpinit and outlying homesteads. This type of event could result in a significant cleanup cost because waste material and contamination would move off the mine site. The restoration of the slope and transport of contaminated material back onto the lease area would be quite costly.

A field inspection of the Midnite site in February 1990 by experienced BOR personnel included an evaluation of the lower waste dump embankment above the toe pond. The embankment showed areas of potential slope instability. It is reported by BIA and BLM personnel that the seepage along the face of the lower waste pile embankment has increased over time. These reports are based on visual observations of discharge from the seeps. The increase may be due to the rising water level in Pit 3. If this is the case, the problem will get worse until the water level in Pit 3 is lowered.

As of this date, no definitive engineering studies of the stability of the waste dump embankment have been made. The team recommends that engineering tests and slope stability analyses should be undertaken as soon as possible to provide a definitive analysis.

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(14) Response to Spokane Tribal Concerns Regarding the Midnite Mine, Spokane Indian Reservation, Washington. Bureau of Land Management, Oregon State Office and Spokane District Office. April 1, 1988.

Long-term Degradation of Water Quality in Blue Creek

USGS water samples from the tributaries to Blue Creek below the Midnite Mine show a trend to increased values of conductivity, dissolved solids, and sulfates over the last 6 years (15). Water quality is deteriorating because a small part of the drainage from the Midnite Mine is not captured by the present pumpback system.

Downstream monitoring at the USGS station on the tributaries to Blue Creek also shows a good correlation between pH and flow rate. An analysis of these data showed that when spring runoff occurs, pH decreases (16). This tends to substantiate that the area is experiencing a seasonal "flushing" of accumulated leachates from the mine site down to the Blue Creek drainage.

There are no known domestic users of surface water from Blue Creek, the mine tributaries or ground water recharged by the drainages. A large National Park Service campground, located on the lakeshore, approximately 1 mile downstream from the mouth of Blue Creek, as well as lakeside residences, take their domestic water from shallow wells recharged by Lake Roosevelt. The dilution capacity of the Lake is very large so the impact of the water quality from Blue Creek on the reservoir is negligible. There is evidence of camping along a sand bar adjacent to the confluence of Blue Creek with Roosevelt Lake. Direct use of the water from Blue Creek by campers at this location is possible.

There is also the possibility of unauthorized visitors suffering injury on the mine site. The existing mine lease site and the mine drainage into Blue Creek are fenced and the DMC conducts periodic inspections of the site. However, the area is not posted against trespass, and people have been known to gain access to the site.

The concentration of metals in the pit water on the Midnite Mine site and in the seeps also are sufficiently high to present potential problems with livestock and wildlife in this area if they used the mine pits for a water source. The area below the Midnite Mine is open range, and Blue Creek is a potential source of water for livestock and wildlife, including deer and elk populations.

An additional concern is the seep referred to earlier with anomalously high levels of dissolved radon. BIA reported this seep was first discovered in 1989 below the toe pond. The specific reason flow started from this seep and the reason for high levels of radon in the water from the seep are unknown, but the underlying cause is certainly subsurface flow from the mine site. The USGS

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(15) Ibid.

(16) Ibid.

has postulated the existence of a plume of contaminated ground water migrating down gradient from the mine pits toward Blue Creek (17). This is one possible cause. Further investigation of this seep is necessary.

While there does not appear to be an imminent hazard associated with Midnite water accumulations, the team believes that prudence dictates action be taken to prevent additional water accumulation and recommends operation of the DMC water treatment plant and proper temporary disposal of the resultant sludge.

QUESTION 3 **Is the Sherwood mill and tailings system preferable to the use of the existing Dawn Mining Company (DMC) water treatment plant at the mine site? Can the DMC plant be upgraded to improve throughput within reasonable costs? Variables to be considered are treatment time, solid waste disposal, pipeline safety/security, and cost.**

Answer: From a technical standpoint, the Sherwood mill and tailings system is not preferable to the use of the existing DMC (Midnite Mine) water treatment plant. The existing DMC water treatment plant can be easily upgraded to improve throughput at minimal costs.

This question relates to water treatment and the matter relates directly to the study team's previous recommendation about reducing the threat posed by the continued accumulation of water in the mine pits. There are a number of issues embedded in this question. For example, the second part of the question, "Can the DMC plant be upgraded to improve throughput within reasonable costs?", suggests a concern about the time required to dewater the pits, and thus the amount of water that can be treated in a given time by the existing treatment facility. The question will be examined by discussing first the operation of an on-site treatment plant ("the DMC plant") and then off-site treatment of the water at the Sherwood mill.

Water Treatment

The same chemical process would be used for water treatment regardless of whether the facility is at the Midnite or Sherwood Mine. The process is lime precipitation with barium addition. In essence, a metal hydroxide precipitate is formed which binds the metal ions, especially the multivalent cations, to hydroxyl groups, thus forming a precipitant. The barium traps any residual radium as a barium radium compound contained in the precipitant.

A "clean" liquid-solids separation is obtained in the clarifier, and the resultant effluent should meet the standards specified in

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(17) Sumioka, op. cit.

the NPDES discharge permit for Midnite Mine. The sludge formed is quite dilute, in that it has a solids content on the order of 0.1 to 0.5 percent (18), because of weak electrochemical bonding of water molecules within the precipitant. Thickening of the precipitant sludge will be required.

On-site water treatment The existing DMC water treatment plant at Midnite Mine was designed and constructed by N.S. Lynn & Associates, Inc. in 1988. Test operations were performed which confirmed the effluent from the plant will be in conformance with the effluent standards contained in the NPDES permit. Studies by the SLRC resulted in essentially the same process design. The ability of the plant to meet the permit requirements is well substantiated by both the test operation and the pilot studies conducted at SLRC. A thickener is included in the DMC (Midnite) water treatment plant, and further volume reduction is provided by dewatering the sludge in a centrifuge.

The lime treatment process is a relatively standard approach to removing metal ions from process wastewater. The addition of barium is an acceptable method of removing uranium from water. The process is relatively stable, and process control should be quite simple. Routine monitoring and control equipment, coupled with a feedback system, should enable automatic correction of problems in effluent quality and rapid diversion of unacceptable effluent to Pit 3 or the toe pond.

Effluent Discharge Location

The normal approach to discharge would be a short pipeline to the nearest surface stream channel, in this case, the east tributary drainage leading to Blue Creek. A 300-yd pipeline would be required. The last section of pipe could be perforated to reduce scour and erosion of the stream bottom.

The NPDES permit issued to DMC specifies a maximum effluent discharge rate of 300 gpm. It is the team's understanding that this number was selected based on bank and channel stability considerations in the tributary drainage to Blue Creek. The east, central, and west drainages from the mine combine to form a single tributary to Blue Creek. The tributary is a perennial drainage. The highest recorded flow at the USGS gauging station on the tributary since 1980 is 630 gpm and the lowest is about 20 gpm.

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(18) Oversight and Planning Study for the Bureau of Indian Affairs to Direct Reclamation of the Midnite Mine, Spokane Indian Reservation. Prepared by the BOM, Salt Lake City Research Center, Under BIA-BOM Agreement No. 14-09-007-1347. January 31, 1990.

Two possibilities exist if a larger effluent discharge rate were desired:

1) Discharge directly to the Spokane Arm of Roosevelt Lake. A 3-mile pipeline would be necessary. Its estimated cost is about $350,000. (Such a pipeline would pose a minimum risk from leakage because the water has already been treated to meet NPDES requirements prior to entering the pipe.) This approach avoids the question of stream channel stability.

2) Raise the permissible discharge via petition to Washington State.

More elaborate strategies could be developed to retain treated effluent on-site during periods of relatively high flow and then discharge at higher rates during the dry periods. These strategies have not been considered in this evaluation.

On-site Treatment Time

Currently, Pits 3 and 4 and the toe pond contain an estimated 400 million gal of water. An estimated additional 50 million gal of water will accumulate each year due to rainfall and snow melt. DMC constructed the water treatment plant in 1988 at a cost of about $1 million (19). Its designed operating rate is 300 gpm. At this rate, and assuming the plant would be available for the purpose, the existing plant could dewater Pits 3 and 4 and the toe pond in 4 to 5 years.

Based on discussions with the designer of the plant, it appears that the treatment plant capacity can be readily upgraded to 500 gpm by increasing the pump size. Operating at this treatment rate, the pits could be dewatered in 2-1/2 to 3 years. This upgrade would cost an estimated $70,000. Major operating costs are reagents (barium chloride and lime), electric power, and personnel.

Should a decision be made to dewater the pits in less than 2 years, a "package" water treatment plant could be set up at the Midnite Mine site to operate in parallel with the DMC plant. A plant of about 500 gpm capacity would probably cost about $1.5 million. Such a plant should be readily available and could be operational in under 1 year after a decision to install it is made.

Water Treatment at the Sherwood Mill

The Sherwood Mill could be modified to treat all the impounded pit waters in a single year once it was in operation, i.e., after construction of a pipeline and plant modification/startup. The

(19) Personal Communication with Nicholas S. Lynn, N.S. Lynn & Associates, Inc.

flow rate through the modified plant would be about 1,500 gpm. Previous studies by the BOM indicate that the cost would involve minor modifications to convert the uranium leach circuit for water treatment at approximately $70,000 in cost and startup costs of approximately $70,000, exclusive of the pump and pipeline cost to move the water to Sherwood (20). However, the NRC license for Sherwood presently precludes such an operation. The NRC addressed this possibility in a letter to the Portland Area Office of the BLM in November 1989. The letter stated that "the NRC would not issue a license permitting this method of waste water cleanup at Sherwood Mill."(21) If uranium were extracted from the sludge, then NRC indicated the "policy decision has not yet been made on this subject; therefore, at least at present, this process would not be permitted under an NRC license."(22)

Even if the NRC were willing to establish a new precedent and allow the operation of the Sherwood to treat the Midnite mine waters, there are other problems. First of all, this option would also require relicensing of the Sherwood Mill by NRC from a zero-discharge facility and a NPDES permit to allow release of treated water to Roosevelt Lake. Uranium mills are not permitted to discharge effluent to surface waters. An evaporation system could possibly be designed to maintain the zero discharge requirement, but would require additional, undetermined cost.

In addition, a pipeline would be required to transport the water from the Midnite Mine to the Sherwood Mill for treatment. A direct 6-mile, cross-country pipeline would cost an estimated $700,000 (as estimated by the team during its analysis). If a pipeline were built beside the existing highway, the pipeline would have a length of 21 miles, and the cost would be significantly higher. Either pipeline would pose an environmental threat because it would transport contaminated water and, if broken, large volumes of contaminated, radioactive water could be discharged into the environment. A pipeline would also be a prime target for damage by vandalism.

If Sherwood Mill were relicensed for water treatment and acquired an NPDES permit, another effluent outfall (a short pipeline) would

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(20) Larson, D.M., and D.C. Seidel, Decontamination of Midnite Mine Water. Salt Lake City Research Center, Bureau of Mines, under BIA/BOM Agreement 14-09-007-1347, no date.

(21) Nelson, Robert E. (Operations Superintendent, Dawn Mining Company). Correspondence to Kelly Courtright (Bureau of Land Management, Spokane District Office), November 10, 1989.

(22) Hall, Ramon E. (Director, Nuclear Regulatory Commission, Region IV). Correspondence to Stanley Speaks (Portland Area Director, Bureau of Indian Affairs), November 21, 1989.

need to be built to transport the processed water approximately 1/4 mile from the mill to Roosevelt Lake. Alternatively, the treated water could be pumped back to the Midnite Mine for discharge. Another pipeline parallel to the untreated water line, a pumping plant and attendant power consumption would add to the costs. The cost of returning treated water to Midnite for discharge was not estimated.

Finally, in addition to all of the above, the relicensing of the Sherwood facility opens up some potentially significant issues of liability for the Department of the Interior. No representatives of the Solicitor's Office were present and so this issue was not explored.

Sludge Disposal

Water treatment produces an effluent, "clean water," and the treatment process residuals, or "sludge" containing the contaminants. In tests of the lime precipitation and barium addition process, the sludge contained 1.8 to 2.4 percent uranium (U_3O_8) on a dry-weight basis. This is enough radioactive material to cause the sludge to be classified as a low-level radioactive waste. The metals contained in the sludge do not leach when subjected to the EP Toxicity test; therefore, it is regarded as a non-hazardous solid waste.

There are basically four options for sludge disposal available:

1) sludge disposal at the Sherwood site under the current NRC license,
2) sludge disposal at the Midnite site,
3) extraction of uranium from the sludge at a uranium processing facility, or
4) sludge disposal at a licensed, low-level radioactive waste disposal site.

Sludge Disposal at Sherwood The NRC permit for the Sherwood mill does not allow for the disposal of wastes not generated in the uranium processing at that location. The review team concluded that NRC was unlikely to modify the present license. According to the team's understanding, disposal of sludges from the Midnite Mine at Sherwood could result in the Department of Interior incurring significant liability for the Sherwood site.

Sludge Treatment and Disposal at Midnite The disposal site would be constructed to meet the requirements for a mixed low-level radioactive and hazardous waste site in accordance with NRC-EPA

disposal procedures (23) as a prudent safety precaution. This would require stabilization of the sludge by mixing it with a cementing agent. The facility required for the disposal of the water treatment sludge for the Midnite Mine water would need to have an estimated capacity of approximately 17,000 cu yd. This equates to a disposal site approximately 300 ft square and 5 ft deep.

Examination of the Midnite site resulted in two possible locations where such a facility could be built. These are reasonably level areas, both above the groundwater table, which could be used for construction of a disposal facility. They are indicated on Figure 3 by the number 6. A cost of $2 million is estimated for construction of the disposal site, including solidification of the sludge.

Sale of the Sludge to a Uranium Processing Facility The team was made aware that the DMC is arranging a test leach of this water treatment sludge at a UMETCO uranium facility in Blanding, Utah. The arrangements are nearly complete. The approval of the State of Utah for shipment of a truckload of sludge is necessary before actual in-plant tests can begin.

While this test has not been completed, similar tests have been conducted at the Bureau of Mines Salt Lake City Research Center on a sludge generated during pilot tests using Pit 3 water and lime-barium treatment. These tests, described in Appendix D, did show that uranium could be leached from the sludge.

The review team cannot determine if the sludge can be processed economically by UMETCO. Should the process be economical and UMETCO agree to take the sludge, then no sludge disposal problem will exist.

Disposal Off-site at an Approved Disposal Facility The sludge may be disposed of in a licensed low-level radioactive disposal site in Utah. The Bureau of Mines, through another of its activities, is now involved in the disposal of low-level radioactive waste at such a disposal facility in Tooele, Utah. Such disposal is clearly technically possible, but it would have to be evaluated economically to establish cost-effectiveness.

In the opinion of the study team, the preferred approach would be to treat the Midnite water at the Midnite site. Technically, the treatment presents no problems that cannot be resolved. The time of treatment can be varied within broad limits. There are a number

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(23) Joint NRC-EPA Guidance on a Conceptual Design Approach for Commercial Mixed Low-Level Radioactive and Hazardous Waste Disposal Facilities, EPA/530-SW-87-027, OSWER Directive #9487.00-8, August 3, 1987.

of options for disposal of the sludge. On balance, this approach is clearly preferable to all of the uncertainties associated with the use of the Sherwood for treatment of water from the Midnite Mine.

QUESTION 4 **Assuming that the primary cause of the formation of acid water is the reactivity of the waste rock and the protore, can the waste rock and the protore be chemically isolated on the Midnite Mine site, or must they be disposed of off-site. Which is the most cost-effective?**

Answer: The team identified no insurmountable technical problems during this review that would prohibit the isolation of reactive material on the Midnite Mine site. From cost estimates developed by the review team, the option of using Midnite alone is also the least costly. Each of these two components to the answer is discussed separately.

On-site Isolation Vs Off-site Disposal

The conclusion regarding isolation of reactive material on-site is based on a technical review of two reclamation plans proposed by DMC and BLM and a conceptual plan independently developed by the team. This conceptual plan was developed using available information on the site conditions, material quantities to be handled, regrading potential on-site, drainage requirements, and techniques for prohibiting water contact with reactive material.

The team did not verify the cost estimates used to prepare the options addressed in the two existing reclamation plans. Instead, they used reasonable and proper costs in developing independent estimates. The costs used by the team are given in Appendix B.

Major components of the conceptual plan involving isolation of the reactive material on-site are described below.

- Pit Dewatering Water will be eliminated from Pits 3 and 4. The details of the dewatering and water treatment are explained in the response to question 3. Included in the dewatering effort should be the elimination of current subsurface water from backfilled Pit 2. One possible method would be drilling a borehole between backfilled Pit 2 and Pit 3. The location of the drill hole would be at approximately the 2,700-ft contour. This would allow drainage of the trapped water from Pit 2 into Pit 3. The water can then be treated in conjunction with the impounded water being treated from Pit 3.

- Hillside Dump Material One option would remove the nonreactive material from the hillside dump (shown as number 5 in Figure 3) and place this material in the drained Pit 4

to promote drainage and avoid water ponding in the pit. Another option for the hillside dump material is to recontour the material and revegetate it in place. A portion of the hillside dump material would be required for covering the capped reactive material areas.

- <u>Reactive Material, Including Protore</u> The basis of the scenarios that handle the reactive material on-site involve isolating the reactive material from both ground water and surface infiltration. This isolation can be accomplished by a combination of: 1) recontouring to improve slope stability and promote drainage away from the open pits and reactive rock; 2) capping the reactive material with either clay, geomembrane, or a combination of both and 3) dewatering of Pits 3 and 4 to eliminate a major source of subsurface water contact with in-place reactive rock.

  One option for capping the disturbed zones of reactive material would be a 4-ft-thick layer of soil material. This includes a 2-ft layer of cover material, a 1-ft layer of compacted clay, and a 1-ft layer of bedding material. Another option would be to use a 1-ft-thick layer of bedding material and cover it with a geomembrane. The membrane would be covered with a 2-ft layer of soil to permit revegetation.

<u>Costs For On-site Isolation Vs Off-site Disposal</u>

In developing a response to part 2 of question 4, a cost comparison was made between on-site disposal and hauling reactive material to the Sherwood Mill. Estimates were made of material quantities, road construction and hauling costs, and site capping requirements after material removal. It is estimated that 35 to 40 million tons of waste material has been produced on the site. Since the location, quantities, and reactivity of the material other than protore is uncertain, capping of potentially reactive areas on the site would be required even if the protore was removed to the Sherwood site. Therefore, the costs associated with capping the site would be essentially the same for both the option to remove the protore and the option to isolate the protore on-site.

It is estimated that the grading, hydraulic isolation, and provision of adequate growth media will cost either approximately $20.6 million if an impervious geotextile membrane is used or $34.5 million if clay is used instead. The major cost components are shown in Table 1. The detailed calculations for these estimates are presented in Appendix B.

As indicated previously, the on-site reclamation cost is not substantially changed by transport of ore and protore stockpiles to Sherwood, because capping would still be required to isolate the in-place reactive rock from infiltration of water.

TABLF 1

Estimated Reclamation Costs Using a Geotextile Membrane or Clay

Cost Component	Estimated Cost (Millions of Dollars)
Surface Preparation Prior to Membrane Installation	$ 7.7
Growth material	8.4
Revegetation	0.6
Hydraulic Isolation:	
A. Impervious Membrane	3.8
B. Clay	17.7
Total Cost	
A. Impervious Membrane Option	$20.5
B. Clay Option	$34.4

As indicated previously, the site reclamation cost is not substantially changed by the transport of ore and protore stockpiled at the Midnite Mine to the Sherwood. All of the reactive pyritic rock left at the mine site subject to leaching must still be isolated from water infiltration by the construction of impermeable caps to control the mine drainage problem. The protore stockpiled at the mine totals approximately 25 percent of the reactive rock on-site. Therefore, removal of the protore does not substantially reduce the need for a cap. Since reactive low-grade ore is generally spread around the mine site, some buried in Pit 2 and some left in place, any acid water generated by percolating water reacting with the pyritic rock will cause some leaching of uranium or other radionuclides. This low-grade ore, although not as high in uranium as the ores shipped to the Ford Mill or stockpiled on the mine site, still contains leachable uranium and other metals. In addition, the useable lower limit of contained uranium was lowered during the operating life of the project, so some ore wasted early on and buried in the waste rock was, by later standards, millable ore with significant concentrations of uranium.

This is the reasoning the team used in determining that the capping cost would be constant, with or without the protore on-site. An advantage of leaving the protore on-site is the piles would provide some easily moved material for shaping and preparing a properly graded subgrade to the receive the cap and impermeable membrane.

Haulage Options

Two options exist for transport of the ore and protore stockpiles to the Sherwood Mine. Both would use truck haul to transport the material, but the first would use the existing paved highway and

the second would construct a haul road some 16 miles shorter than the highway route.

TABLE 2

Estimated Haulage Costs

Cost Component	Estimated Cost (Millions of Dollars)
Existing Road Haulage	$27.95
New Haul Road Constructed	15.98

The detailed calculations for the estimates, shown in Table 2, are presented in Appendix B.

While there is a significant cost advantage to constructing a shorter haul road, there is no technical advantage to removing the material from Midnite Mine. As previously discussed, significant areas of the site would still need to be regraded and covered with an impervious membrane, regardless of the export of the ore and protore stockpiles.

Therefore, the team recommends retention of all ore, protore, and waste rock on-site at Midnite Mine. The above cost estimates illustrate that it is the lower cost alternative.

QUESTION 1 If the Sherwood site and its sludge disposal opportunities are surrendered, how sure can we be that successful reclamation is possible using the Dawn Mine site alone.

Answer: Based on the information presented in answer to the previous questions and their discussions, the review team is reasonably certain the Midnite Mine can be successfully reclaimed without use of the Sherwood site.

The team's review of experience in reclaiming the Rum Jungle Uranium Mine in Australia substantiates this judgment. The Australian mine was reclaimed by covering waste rock with soil and impermeable clay caps. Salt was used to discourage rooting of plants into the clay seal and to promote self-sealing of the clay cap should damage occur (24).

While the team recognizes that there may be other valid public policy reasons for retention of the Sherwood site, its retention is not required for the reclamation of the Midnite Mine site.

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(24) Personal communication with Kelly Courtright, District Mining Engineer, Bureau of Land Management.

There is no doubt satisfactory reclamation of the Midnite Mine site can be planned around the use of the facilities and disposal ponds at the Sherwood Mill. The team finds, however, that use of Sherwood would be more costly and more uncertain than containing all the wastes at the Midnite while reclaiming the mine site.

QUESTION 5 **Review the Midnite Mine Action Plan as a possible approach for setting reclamation standards and objectives. Does the DOI need to acquire these data independently in order to make an informed decision on eventual reclamation plans?**

Answer: The review team concluded that a more detailed <u>program plan</u> leading to a reclamation plan should be developed. The team believes that DOI has the resources to develop such a plan internal to the Department by utilizing the skills of the various DOI organizations.

In April 1989, the Portland Area Office of BIA initiated development of an Action Plan. A meeting was held with personnel of BLM and BOM on April 17 and 18 of that year where it was stated that the purpose of the Action Plan is to produce the Reclamation Plan for Midnite Mine in 2 years. The specific comments on the Action Plan and the briefing material that accompanied it are reproduced in Appendix F.

The BIA is to be commended for this initiative; it gives structure to addressing the problem of reclaiming the Midnite Mine. The Action Plan components and lead agency(ies) are shown in Table 3.

TABLE 3

Action Plan Tasks

Task	Lead Organization	Due
Steering Committee	All	May 1989
Protore	Salt Lake City, BOM	Feb 1990
Waste Dumps	Oregon State Office, BLM	Mar 1990
Remaining Exposed Rock	Salt Lake City, BOM Portland Area Office, BIA	Feb 1990
Hydrology	Spokane, BOM	Jun 1991
Earthmoving & Surface	Oregon State Office, BLM	May 1991
Form Scenarios/Benefit	Portland Area Office, BIA	
Pit high walls	Spokane, BOM Portland Area Office, BIA	Jan 1991

Examination of the tasks and the Action Plan showed that the actions are not defined in sufficient detail to either schedule the

subactivities necessary to fulfill the Action Plan or to identify the obvious interrelations between tasks. Specific comments by the review team on individual tasks are included as Appendix G. In addition to the absence of detail, the informal nature of the arrangements between the various organizations should be rectified. Absent a more detailed development of this plan for reclamation and a supporting schedule, it is not possible to estimate funding needs or necessary manpower. Obtaining proper funding authorizations for performance of the program requires better estimates of resource needs.

The review team recommends development of a more detailed Program Plan leading to a Reclamation Plan for the Midnite Mine. The Program Plan should be formally authorized and the necessary resources identified and provided. Definite assignments to the other participating Bureaus should be formally established and funded at the outset.

The completion of a Program Plan suggested above would

- o provide the capability to accurately estimate the resource needs of the individual Bureaus and the overall cost and schedule;
- o establish a single entity as responsible for the performance of the Reclamation Plan and the other Bureaus as contributors to that effort;
- o recognize and plan for the strong interrelationships between individual problem areas; and
- o complete the rudimentary calculations presented in this review in sufficient detail as to permit confirmation of the results, including checking the assumptions and technical adequacy of the reclamation and water treatment scenarios developed in response to Questions 3 and 4.

The BLM (as the designated agency which permits mining) and the BIA (as a trustee of Indian lands) both cooperatively and independently conducted studies on the Midnite Mine site and both agencies should plan to be heavily involved in carrying out the Program Plan. The ongoing USGS studies are investigating regional water quality. Current BOM studies are determining the hydrology of the mine site and the reactivity of materials on the site. The Department of the Interior should continue to acquire data as outlined in the Action Plan.

CONCLUSIONS

The review team carefully considered the technical information available on the Midnite Mine and the Sherwood Mine and Mill to reach each answer discussed above. The answers are a consensus developed among the team members of the best solution to the problems of reclaiming the Midnite Mine site presented by BIA in the five questions stated in the MOU.

The team concludes that the environmental contamination from the Midnite Mine does not represent an immediate threat to the public health and safety. The degradation to the surrounding environment from the mine is a serious problem and should be stopped as soon as practicable. The team concludes the first step necessary is to begin operation of the existing water treatment plant on the Midnite Mine site to treat the water impounded in Pit 3. Temporary containment and storage of the resultant sludge can be accomplished on-site. Design and construction of a facility for permanent disposal should be the next priority if sale of the water treatment sludge proves to be uneconomic.

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Welch, Barry W. (Acting Liaison Officer, Branch of Energy and Mineral Resource Assistance). Correspondence to Area Director, Portland Area Office, August 25, 1988. (Re: Economic evaluation of the Sherwood Mine/Mill as a Tribal operation)

Yates, Sidney R. (Chairman, Subcommittee on Interior and Related Agencies). Correspondence to Manuel Lujan, Jr. (Secretary, U.S. Department of the Interior), July 11, 1989.

APPENDIX A
REVIEW TEAM ORGANIZATION

The Bureau of Mines assembled a team of experienced personnel and charged them to undertake the review. The team members are listed in Table A-1. Members were drawn from three Bureau of Mines Research Centers: Denver, Salt Lake City, and Spokane. The Bureau of Reclamation provided three additional members. The team was headed by Dr. William Fitch of the Denver Research Center. The review was performed in period January 29 to March 30, 1990.

TABLE A-1

Midnite Mine Review Team

BUREAU OF MINES	
Denver Research Center	William Fitch, Chairman Frederick Allgaier Linda Killoran Terry Radich George Schneider Stephen Tadolini
Salt Lake City Research Center	Richard Sandberg Paulette Altringer
Spokane Research Center	Lani Boldt
Environmental Technology, Washington	William Schmidt Paul Richardson
BUREAU OF RECLAMATION	
Civil Engineering, Denver	Harry Jong Kent Shuyler
Pacific Northwest Region	Harvey Dickensheets

The study team was assisted in this review by the Bureau of Indian Affairs and the Bureau of Land Management personnel listed in Table A-2.

TABLE A-2

Assistance to the Midnite Mine Review Team

BUREAU OF INDIAN AFFAIRS	
Environmental Services, Washington	George Farris
Branch of Land Services, Portland Area Office	James LeBret
Denver	Don Aubertin
BUREAU OF LAND MANAGEMENT	
Oregon State Office, Portland	Eric Hoffman Dennis Seymour Kelly Courtright

APPENDIX B
SITE RECLAMATION CALCULATIONS

GRADING AND CAPPING ESTIMATES

In calculating the reclamation costs for grading and capping the mine site, the following estimates have been made:

West Drainage area =	154 acres
excluding the hillside drainage =	-27.6 acres
excluding outside area 2 =	-10 acres
Net =	116.4 acres
Central Drainage =	49.5 acres
excluding the toe pond =	-2.0 acres
Net =	47.5 acres
East Drainage =	34.7 acres
Pit 3 Basin =	86.3 acres
excluding Pit 3 =	-46.3 acres
Net =	40.0 acres
Pit 4 Basin =	32.5 acres
excluding Pit 4 =	-23.1 acres
including cap area =	10 acres
Net =	19.4 acres
Total	258 acres

Total area = 258 acres = 1,249,000 yd^2 = $1.25x10^6$ yd^2

<u>Impervious Membrane Capping Cost Estimates</u>

The area to be capped with 1 ft of processed non-reactive overburden, an impervious membrane, and 2 ft of earthen cover material is estimated to be 258 acres.

To process 420,000 cu yd of minus 3-in. material from the hillside dump would cost about $\$0.75/yd^3$. To spread the material over the site would cost approximately $\$1.25/yd^3$. The cost to process and spread the hillside material is estimated to be

Cost = (420,000 yd^3 X $\$0.75/yd^3$) + (420,000 yd^3 X $\$1.25/yd^3$)
= <u>$840,000</u>

The installation of an impervious membrane with overlapped joints is estimated at $\$3.00/yd^2$, resulting in a cost of

Cost = ($1.25x10^6$ yd^2 X $\$3.00/yd^2$) = <u>$3,750,000</u>

Approximately 805,000 cu yd of cover material is needed. The amount of on-site topsoil is estimated at 167,000 cu yd. In addition, on-site processed material from the hillside dump at minus 1-1/2" is estimated to be 100,000 cu yd. Therefore, the amount of cover material required to be imported would be

$$805{,}000\ yd^3 - 267{,}000\ yd^3 = 538{,}000\ yd^3$$

To load and mix the topsoil with the processed hillside material is estimated to cost

Cost = $(167{,}000\ yd^3 \times \$0.40/yd^3)$ = <u>\$70,000</u>

The cost to import 538,000 cu yd of cover material from the Sherwood facility is estimated at

Cost = $(538{,}000\ yd^3 \times 1.30\ ton/yd^3 \times 21\ miles \times \$0.50/ton\text{-}mile)$
= <u>\$7,340,000</u>

The cost to place and spread the estimated 805,000 cu yd of cover material would be

Cost = $(805{,}000\ yd^3 \times \$1.25/yd^3)$ = <u>\$1,010,000</u>

The site would need to be graded prior to the placement of the cap. This would include the placement of 1.5×10^6 cu yd from the hillside scalping operation into Pit 4 which would cost approximately

Cost = $(1.5\times10^6\ yd^3 \times \$1.25/yd^3)$ = <u>\$1,875,000</u>

Site grading also includes spreading 2.0×10^6 cu yd of protore and contouring 2×10^6 cu yd of waste rock. The cost of this activity is estimated at

Cost = $(4\times10^6\ yd^3 \times \$1.25/yd^3)$ = <u>\$5,000,000</u>

Re-vegetation, using hydroseeding techniques, for the entire 258 disturbed acres would cost approximately

Cost = (258 acres X \$2,500/acre) = <u>\$645,000</u>

Including the costs for on-site disposal, capping material, import of cover material, and revegetation, the total cost of using the impervious membrane option is estimated to be

<u>Total Cost = \$20,530,000</u>

<u>Clay Capping Cost Estimates</u>

The total area to be covered with clay is estimated to be $1.25\times10^6\ yd^2$. The proposed cover would include a 12-in.-thick layer of

granular base, covered by a 12-in.-thick layer of imported and compacted clay. The clay source, located near Chewelah, WA, is approximately 38 miles from the site. The cost to transport the clay to the Midnite Mine site is estimated to be

$$\text{Cost} = (1.25\text{x}10^6\ \text{yd}^2\ \text{X}\ 0.33\ \text{yd depth X}\ 1.5\ \text{swell factor X}\ \$1.35\ \text{ton/yd}^3\ \text{X}\ \$0.50/\text{ton-mile X}\ 38\ \text{miles})$$
$$= \underline{\$15,870,000}$$

The estimated cost of the clay material is $1.00/yd³ which would result in a cost of

$$\text{Cost} = (1.25\text{x}10^6\ \text{yd}^2\ \text{X}\ 0.33\ \text{yd depth X}\ \$1.00/\text{yd}^3\ \text{X}\ 1.5\ \text{swell factor})$$
$$= \underline{\$619,000}$$

The cost to spread the material is estimated to be $1.25/yd³. To compact the clay material would cost approximately $0.75/yd³. The total cost for placement and compaction is $2.00/yd³, resulting in an estimated cost of

$$\text{Cost} = (1.25\text{x}10^6\ \text{yd}^2\ \text{X}\ 0.33\ \text{yd depth X}\ 1.5\ \text{swell factor X}\ \$2.00/\text{yd}^3)$$
$$= \underline{\$1,238,000}$$

The total cost of importing the clay from off-site, and placing and compacting the material is estimated to be

Cost = <u>$17,730,000</u>

The total cost of using the clay option is estimated to be

Total Cost = $20,530,000 - $3,750,000 + $17,730,000
(option 1) (membrane) (clay)

<u>Total Cost = $34,510,000</u>

COST TO TRANSPORT PROTORE TO THE SHERWOOD FACILITY

<u>Paved Highway Transport</u>

The cost estimates to transport the protore to the Sherwood facility are based on using the existing paved highway (from the Midnite Mine through Wellpinit, WA to the Sherwood Mill), a distance of about 21 miles. The amount of material to be hauled to the Sherwood is approximately $2.0\text{x}10^6$ tons or $2.6\text{x}10^6$ cu yd. The loading cost is $0.25/ton and the hauling cost is $0.50 ton/mile. The total estimated cost for loading and hauling the material is via the paved highway is

Total Cost = (2.6×10^6 tons X \$0.25/ton) +
(2.6×10^6 tons X \$0.50/ton-mile X 21 miles)

<u>Total Cost = \$27,950,000</u>

This option does not change previous cost estimates to grade and cap the Midnite Mine site. This option adds an insurance factor by removing only the most reactive material.

<u>Haulage Road Transport</u>

The cost to construct an adequate shortline haulage road (an estimated distance of 7 miles from the Midnite Mine to Sherwood) is estimated at \$750,000/mile. When the haulage is completed, the road would have to be rehabilitated at a cost of \$400,000/mile. The estimated cost for the haulage road is

Cost = (7 miles X \$1,150,000/mile) = <u>\$8,050,000</u>

To load and haul the material to the Sherwood facility via this haulage road using an off-road haulage cost of \$0.40/ton-mile would be

Cost = (2.6×10^6 tons X \$0.25/ton) +
(2.6×10^6 tons X \$0.40/mile X 7 miles)
= <u>\$7,930,000</u>

The total cost for loading and hauling the material is via the haulage road is estimated at

Total Cost = \$8,050,000 + \$7,930,000
(road cost) (load and haul)

<u>Total Cost = \$15,980,000</u>

APPENDIX C
SITE LOCATION, GEOLOGY, AND HYDROLOGY

MIDNITE MINE SITE

The Midnite Mine is an inactive, hard-rock uranium mine located on the Spokane Indian Reservation, Stevens County, Washington approximately 50 miles northwest of Spokane, and approximately 7 miles west of Wellpinit, Washington. The Dawn Mining Company (DMC) began operating the Midnite Mine in 1955. It was an open-pit uranium mine, located in steep terrain. The mine has not produced uranium since 1982. The disturbed area is 321 acres, approximately 1/2 mile wide and 1 mile long. The DMC has a total of about 811 acres under lease (25) at the location. The elevation ranges from approximately 2,500 to 3,400 ft above mean sea level. The climate at the site is continental with warm dry summers, and clear cold winters. Precipitation from spring through fall occurs as rain, while in the winter, most precipitation falls in the form of snow. Precipitation at Wellpinit (located on Figure 2) averaged 19.4 in./yr from 1951 through 1980. Local vegetation varies greatly from scrub grasses through light brush to conifer forests. However, most of the area of concern for this investigation is only lightly to moderately vegetated. Dirt or gravel roads access the area of concern. The mine is shown on the USGS Turtle Lake, Washington 7-1/2 minute quadrangle topographic map.

The present bottom of Pit 3 is about 450 ft lower in elevation than the bottom of Pit 4. Pit 4 contains water pumped into it during the dewatering and mining phase of Pit 3. This began around 1979. Pit 4 is the highest in elevation and contains approximately 50 million gal of water. The impoundment is stratified with the upper part thought to be less contaminated than Pit 3 water.

Recent estimates indicate that 15 to 20 million gal of water are presently leaking out of the toe pond each year. The toe pond receives only a small amount of surface water directly from the mining disturbance. The inflow of approximately 100 gpm is from the pumping of seeps into the toe pond. The total water pumping system involves pumping the toe pond up to Pit 3. Pumpage into Pit 4 has not recurred since mining ceased in Pit 3 during 1981.

SITE HYDROLOGY

At this time the hydrology of the site is assumed to be dominated by the very low permeability of the granite and quartz monzonite bedrock at the site. Previous reports on the site by the Geological Survey, the site exploration records from Dawn Mining

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(25) Bond Recommendation for Reclamation of the Midnite Uranium Mine, op. cit.

Company, ongoing investigations at the site by the Bureau of Mines Spokane Research Center, observations of committee members and the BLM, the BIA, the Dawn Mining Company personnel at the site, and experience from hydrogeologic investigations by team members in similar rock and geologic structure support this view. The completed USGS study also concludes the ground water component of the hydrologic balance for the site is very small. The permeability of the unweathered granite and quartz monzonite is defined solely by fracture flow. These fractures are presumably closed at relatively shallow depths by lithostatic pressure so that the bedrock is essentially an impermeable barrier to downward ground water flow. The geologic structure at the site results in the bedrock enclosing the site completely except for the outlet where the tributaries to the Blue Creek drainage leave the site. Drilling completed by the Geological Survey as part of a hydrologic study on the watershed containing the mine site indicates the depth to bedrock in the drainage outlet is relatively shallow. All ground water leaving the site should flow through this one outlet. Even in a worst-case situation, for example where engineered containment of disposed material on the site should fail, remedial measures to collect contaminated ground water would be relatively simple. Surface flow off the site is also confined to this single drainage outlet. No evidence of vertical geologic structure, such as shear zones, that would affect the conceptual hydrologic model are known from the completed investigations. The possibility of subsurface flow from the Midnite Mine site to adjacent drainage basins is considered by the committee to be very small after reviewing the available information. The committee does, however, recommend that the site hydrology be verified by completion of the ongoing hydrologic study.

The permeability of the metasediments is somewhat more complex. Ground water flow is determined by fracture permeability, remnant sedimentary structure, and structure related to mineralization. The total permeability is, however, still relatively low.

The major part of the ground water flow at the site is confined to unconsolidated materials: natural alluvium and colluvium, mining wastes, and protore piles. The flow through these materials is complex due to localized changes in materials, the effects of the open and backfilled mine pits, and the effects of underlying bedrock structure. These localized effects must be defined by the ongoing hydrologic study at the site to allow for any necessary subsurface controls on flow to be emplaced, surface flow diversions to be planned, and to plan for the removal or encapsulation of reactive subsurface material. Decisions on grading and capping the protore piles in place or moving and consolidating the protore piles on an engineered pad are less dependent on the definition of the local hydrologic regime.

The broad conceptual model of the ground water flow system presented above is all that is available presently. Testing and

refinement of the ideas are underway. The conceptual model was formulated to guide the collection of additional data and form a starting point for data interpretation.

HYDROGEOLOGY

The quartz monzonite intrusive is prevalent along the west side of the mine. It forms the saddle ridge northwest of Pit 4, as well as the west highwall of Pit 4. It also forms part of the highwall of Pit 3. In the northwestern corner of Pit 3, the intrusive contains large xenoliths of the phyllite. It is unclear whether these intrusive rocks used to outcrop between Pits 3 and 4 because the area is covered by waste rock. Based on some published maps, however, it appears that the intrusive outcropped continuously in that area. In addition, it appears that a lobe of the intrusive outcropped between Pit 3 and the now-backfilled Pit 2.

The quartz monzonite intrusive probably will have a strong influence on the ground water flow system. However, several conflicting scenarios of the exact nature of influence are possible. If the intrusive is continuous along the western flank of the mine, it may act as an impermeable boundary and limit recharge to the pits. If this is the case, then it should simplify greatly the nature of the flow system and recharge to the mine area. On the other hand, if the intrusive weathers quickly and does not produce large amounts of clay as weathering products, then the shallow weathered zones may have high hydraulic conductivity and increase the recharge to the pits.

The primary flow paths in the phyllite and calc-silicate hornfels could be along relict bedding planes or large fracture sets. Joint sets probably will be zones of relatively low hydraulic conductivity. This is based on findings of recent research in Precambrian metasediments at the Bunker Hill Mine.

Water quality degradation takes place on the mine site. Based on the chemical analyses done by the USGS in 1985, the general trend in water quality changes down gradient. The water quality in Pit 4 is fairly good, representing water that has been exposed to only minor amounts of metal leaching from the acid-producing mineralized zones. Pit 3 water is more contaminated than Pit 4, and the retention pond has the most contamination of the three. The range in pH is from 7.6 to 3.6, and the specific electrical conductance varied from 900 to 10,000 millimhos.

The locations of acid production and water quality degradation are not well understood at this time. Acid production is known to take place in protore piles and some of the waste piles. Monitor wells have been installed to determine the distribution of water quality on the mine site. Preliminary tests from well water samples should be available by the end of March. Most of the poor-quality water flowing from the site is being intercepted and pumped back up into

Pit 3. Some poor-quality water is entering the East Drainage. The amount of contaminants and how far they travel in the surface drainage system are not known.

The ore body and associated overburden contains pyritic materials which react with air and water to form acid waters. This acid water is formed within the mine site, including the waste dumps, low-grade ore stockpiles, backfilled pits and at least one of the open pits. The acid mine water mobilizes radioactive compounds, and other metals. These contaminants are carried through the network of ponds and ground water on the mine site into surface waters, namely Blue Creek. If the mine were allowed to drain unrestricted, the acid waters would flow 3 miles via Blue Creek into the Spokane Arm of Franklin D. Roosevelt Reservoir. Such drainage is prevented by capturing the surface flow at the downstream edge of the mine and pumping it back into the toe pond and then pit 3. This pumping has been underway since May 1987 and has resulted in 330 million gal of stored water. The pumpage is estimated at 20 to 30 million gal per year from the toe pond.

SITE GEOLOGY

The basic geology of the mine area is fairly well described in the literature. The mineral deposit was developed at the contact of Precambrian metasedimentary rocks and Cretaceous intrusive porphyritic quartz monzonite. The metasedimentary rocks near the mine pits are primarily folded phyllites and schists. Aplite and pegmatite dikes cross cut some the pit walls. The quartz monzonite near the mine is fractured into blocks 1 to 100 ft in diameter. Thickness of alluvium ranges from nearly nonexistent on some mine roads to several tens of feet in ancestral drainages. Near-surface ore is in the form of autunite and meta-autunite, while deep ore bodies are composed of uraninite and coffinite and are associated with pyrite and marcasite. Geology, mineralization, and geometry of the contacts are discussed in more detail by Nash (26).

The mine surficial deposits are apparently being leached by water flow through the sidehill site. There are six major low-grade ore piles located throughout the site. Identified recoverable reserves, including low-grade and ore-grade rock stockpiled at the Midnite Mine site, are approximately 2.6 million tons. About 100,000 tons of ore remain to be mined in the pits. Between the unmined ore reserves and the stockpiled low-grade ore there is approximately 4 million pounds of uranium oxide. Recent estimates indicate that approximately 36 million tons of waste rock are located on the site near the toe pond. The terraced slopes, approximately sloped at a grade of 3:1, are formed by dumped and

(26) Nash, J.T., Geology of the Midnite Mine area, Washington, Maps, Description, and Interpretation. U.S. Geological Survey Open-File Report 77-592, 1977.

flattened mine waste rock. The slopes also include an approximately 50-ft-terrace width that is sloped 2:1. Another half million tons of waste rock would be created by mining the 100,000 tons of remaining unmined ore.

APPENDIX D
ONGOING INVESTIGATIONS

The Bureau of Mines project entitled, "Hydrogeological Factors in Mine Waste," at the BOM Spokane Research Center (SRC) will establish analytical and technical methodologies to use in controlling contaminant production and migration from the Midnite Mine, an acid producing surface hard-rock mine site located on Federal land. Through formal cooperative agreements with the BIA and the BLM, seven monitoring wells with a total of fifteen different stages have been installed at the mine site this past summer. All the wells are located within the existing lease boundaries of the site. Monitoring from these locations and other surface locations began in December 1989 and will continue to delineate ground water flow quantities and qualities.

Current water sampling includes monthly determinations of water elevation, temperature, pH, electrical conductivity, and Eh. Samples are collected simultaneously and returned to SRC for chemical analyses. Cations are being determined using an ARL Model 34000 inductively coupled plasma emission spectrometer (ICP). The analyses for the following elements will be available: uranium, zinc, lead, cadmium, cobalt, aluminum, silicon, mercury, iron, magnesium, arsenic, tin, vanadium, sodium, molybdenum, selenium, calcium, copper, titanium, nickel, beryllium, potassium, manganese, chromium, and silver. Anions are being determined using a Dionex ion chromatograph (IC). The analyses for the following anions are available: chloride, sulfate, nitrate, and phosphate. This information will be used to determine the sources and the flow path of contaminants, as well as the ground water flow direction. This should allow efficient prioritization of remediation efforts.

In addition, it is planned that the monitoring by the DMC personnel and the USGS will be used to augment the SRC information. The DMC monitors approximately 15 sites quarterly, collects samples and reports the chemical data to the BIA. The USGS monitors approximately six sites down gradient from the mine and collects field measurements of flow, EC, temperature, and Eh. They have no money to perform chemical analyses.

Based on the findings of a completed literature search and follow-up site visits, a detailed drilling, instrumentation, data collection, and monitoring plan was finalized in December 1989 (27). It is anticipated that monitoring of the site will encompass two full seasonal changes, beginning in FY90 and continuing through FY91. In conjunction with the field site monitoring, laboratory

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(27) Riley, J. and B.J. Scheibner. Part I: Hydrogeological Factors in Mine Waste, Midnite Mine Literature and Data Review. December 31, 1988.

analysis of the water and surrounding soils and/or rock is being conducted. Also, options to control or alter the ground water flow will be studied along with the risk assessment of each option beginning in FY91. Finally, an optimum remedial design will be prepared in cooperation with the BIA.

MINERALOGY OF REACTIVE ROCK SAMPLES

The BOM investigated the leaching characteristics of various reactive rock and waste materials located on the Midnite Mine site. The leaching characteristics of these materials significantly affect the water quality draining from the site and will strongly impact the remedial procedures for mine site closure. Sampling was conducted during October 31 to November 3, 1988, at the mine site. Fourteen 80-lb rock samples were taken from trenches cut into the sides of stockpiles with a backhoe.

The 14 crushed and blended reactive rock samples from the Midnite Mine were submitted for mineralogical analysis. Individual grains ranged in size from 0.5 to 5 mm across. All of the samples were examined under the binocular microscope to determine the general rock type of the various grains. The samples were also mounted in epoxy resin and examined by scanning electron microscopy for the presence of rare earth minerals, sulfides, and uranium.

Most of the samples, with the exception of the high-lime protore material, are very similar in composition. Each sample contains all of the following rock types, but the ratio of one to another varies from sample to sample:

- <u>Granite</u> Granite contains 100- to 200-μm-sized grains of quartz, K-feldspar, plagioclase, pyroxene, amphibole, and mica. The feldspars are largely weathered to clay and the ferromagnesian minerals have partially weathered to serpentine, chlorite, and epidote. Common accessory minerals include ilmenite, which is partially weathered to leucoxene (30 to 200 microns), rutile (20 to 200 microns), sphene (20 to 50 microns), zircon, (20 to 50 microns), apatite (20 to 200 microns), magnetite (minor constituent), and pyrite (present in trace amounts). One grain contained a 10-micron-sized inclusion of a Zr, Ce silicate. An (Fe, U)-sulfate occurs as inclusions in the feldspar, up to 100 microns across.

- <u>Quartz Monzonite</u> Quartz Monzonite is similar to granite in composition except that it contains less quartz, more plagioclase, which is more calcic in composition, more ferromagnesian minerals, and more mica (the majority is biotite instead of muscovite which is more common in the granite). The same accessory minerals are present that were in the granite. In addition, a few grains of U- and Th-bearing monazite (rare earth phosphate) occur as inclusions in the monzonite that range in size from 2 to 20 microns. A

few of the ilmenite inclusions in the monzonite contain inclusions of niccolite, pyrite, and a Y silicate.

- o Mica Schist Two varieties of Mica Schist are recognized: a light-colored muscovite schist which is composed mostly of the muscovite and quartz; and a darker colored biotite schist which is composed of biotite, quartz, and a variety of ferromagnesian minerals. This material contains up to 5 percent pyrite and marcasite inclusions which mostly occur in bands or layers parallel to the foliated mica. The sample contains only a trace of sphalerite and gal. Th- and V-bearing monazite is relatively more abundant in the schists than in the monzonite. Monazite was found in trace amounts (much less than 1 percent) in all of the samples. A few rare earth carbonate inclusions were found in the protore ore pile A sample.

- o Amphibolite Amphibolite is a metamorphic rock composed mostly of hornblende that is partially weathered to serpentine, epidote, and chlorite. This is a minor constituent.

- o Quartz 1- to 5-mm-sized quartz grains with no inclusions.

- o Feldspar 1- to 5-mm-sized K-feldspar and plagioclase grains with no inclusions. Many grains are partially weathered to clay.

- o Calcite 1- to 5-mm grains were found in minor amounts in the following samples: protore pile A, protore pile C, protore pile 3-D (south side), protore pile 3-D (top), protore pile G-1 (top), and the Pit 2 waste rock material.

Some of the calcite grains contain 10 to 20 micron-sized inclusions of a U, Th oxide. A few of these grains have numerous 5 to 50 micron-sized pyrite inclusions. One micron-sized gold inclusion was found in one sample.

The high-lime protore material consists mainly of calcite with lesser amounts of K-feldspar, Ca-plagioclase, pyroxene, mica, wollastonite, and apatite. Epidote and serpentine are present as weathering products of the mafic minerals. Sphene occurs as 2 to 50 micron-sized inclusions in plagioclase and in apatite. Zircon occurs as 10 to 20 micron-sized euhedral inclusions in the K-feldspar. Some of the calcite grains contain numerous 2 to 20 micron-size inclusions of a Ca, U silicate (Uranophene).

REACTIVE ROCK LEACHING CHARACTERISTICS

Fourteen samples of reactive rock obtained from the Midnite Mine were leached by laboratory-simulated rainwater for 85 days. The leaching characteristics of these waste materials are being evaluated as they will ultimately affect the water quality draining

from the Midnite Mine site and the selection of remedial procedures for site closure. Sixteen 1.5 in. I.D. columns loaded with reactive rock from the mine site and leached by simulated rain at the rate of 2 in. of precipitation/day released leachate with initial concentrations ranging from 10 to 314 ppm U. Leachate samples obtained after 32 days of operation range from 0.1 to 10. ppm U; after 71 days of operation the effluents ranged from 0.1 to 7.1 ppm U.

The feed rainwater pH for the reactive rock columns has been adjusted to a pH of 4.2. The pH of the resulting leachates have either steadily increased or decreased, depending on the rock type, over the course of column operation. Generally, all reactive rock samples are composed of granite, monzonite, mica schist and a variety of accessory minerals including calcite and pyrite. Those rock types containing significant quantities of calcite, as stated in the mineralogy section, have yielded leachates with increasing pH and uranium extractions less than 10 percent. Those rock types with little calcite present have produced leachates decreasing in pH and yielded uranium extractions in the 10 percent to 60 percent range after 32 days of column operation. Two of the sixteen reactive rock columns contain duplicate samples. The leachates produced by duplicate pair columns are identical with respect to uranium concentration and pH values; the reproducibility of the results appears very high.

Based on the average annual rainfall at the Midnite Mine site of 15 in, each reactive rock column received about 7.8 years of precipitation in the first 71 days of operation. The projected uranium release from the various stockpiles on the site over the 7.8-year period ranges from 5.2 to 170 lb U/1000 st of rock. Pit 2 waste rock and ore pile 4 material are the two greatest acid-producing materials in the column studies. Both these materials produced leachates as low as pH 2.3; the simulated rain feed water has a pH of 4.2. The effluent pH from six other columns, however, increased during the test period; these materials containing more calcite and less sulfides are not acid drainage producing.

Following 71 days of operation, the columns were subjected to a 48-day, no-rain rest period before resumption of rainwater leaching. During the 48-day rest cycle, the material in the columns were exposed to the air by vents at both the top and bottom of the columns. Visually, the samples remained moist throughout the cycle. This should have provided good conditions for the development of biological activity in the columns. The results show that during the rest cycle the acid-producing or sulfide-containing reactive rocks oxidized significantly. Effluent iron concentrations increased, in one case (ore pile 4), from 22 ppm before the rest period to 1,400 ppm after the rest period; the uranium concentration increased from 7.1 to 52 ppm, or from about 160 to 200 lb U leached/1000 st of rock. In each case, there is a sharp increase in the rate of uranium leaching immediately

following the rest cycle; the rate then slows to approximately the same uranium release rate as before the rest cycle.

As identified in the mineralogy section, the calcic reactive rocks which increased the pH of the rainwater were not significantly affected by the rest cycle. Very little, if any, increase in the rate of uranium release following the no-rain period is demonstrated by the results. Overall, if exposed to air, the sulfidic reactive rocks will continue to oxidize and will release greater heavy metal contamination during a rain event. The calcic reactive rocks, however, will slowly and continuously release their contaminant metals content.

Lime was added to some of the highly reactive material in an effort to neutralize the acid-producing sulfide components and immobilize the heavy metals. Columns were loaded with 400 g of the reactive sulfide material mixed with 0, 100, 200, 300, or 400 g of lime. Results showed that the lowest lime addition rate (100 g lime in 400 g reactive rock) neutralized the acid and prevented metal mobility.

Based on the leaching results from the BOM study, the reactive rocks should be isolated from contact with precipitation or ground water. If this contact does occur, water leaving the site through annual runoff or seeps will be contaminated with uranium and possibly other hazardous elements. Such water will probably require treatment before discharge to natural waterways. Ground water containing such contamination could be intercepted by a series of wells and treated before release. Such treatment would be expected to continue for many years.

Data from Bureau of Mines leach testing on protore and reactive rock were compiled and submitted to the BIA in October of 1989. Since that time, additional samples from all three material categories, the protore piles, waste dumps, and remaining exposed rock and ore (in the form of granite from the Pit 3 wall), have been obtained and are undergoing leach tests. Complete data from these tests will not be available until June of 1990.

If a complete definition of the reactivity of pit walls is included in future work, the BOM must obtain additional representative samples of the pit wall material for leaching tests. The one sample of granite obtained to date is not sufficient to accomplish this purpose. Some means will have to be provided for collecting this sample from the steep pit walls. This activity will push the scheduled completion date for leach tests even further into the future than the proposed June of 1990.

PIT 4

Pit 4 has accumulated water since the end of active mining and now contains 50 million gal or more. Water in this pit is not as

highly contaminated as is water in Pit 3, but the water will still need treatment before it can be discharged to natural waterways.

From preliminary water elevations at the Bureau of Mines' monitor well 6, the Pit 4 floor has a small probability of being below the ground water table. Number 6 well locates the water elevation at 3,171 ft. Pit 4, during the 1985 aerial mapping from which elevational contours were drawn, showed a water level at that time of 3,042 ft. If this is the case, it precludes the full use of the pit volume for reactive rock or water treatment sludge disposal.

PIT 3

Pit 3 was the last active mining site and is now accumulating water from Pit 4 and from other surface drainage. Water accumulation in Pit 3 is estimated to be about 350 million gal of highly contaminated water. If this pit overflows, the runoff will enter Blue Creek and, eventually, the Franklin D. Roosevelt Reservoir on the Columbia River. BOM analysis of the Pit 3 water in October of 1986 showed component concentrations or values presented in table 1, which are compared with 30-day average requirements of the NPDES discharge permit for Dawn Mining and the 1974 Drinking Water Standards.

TABLE D-1

Analyses of Pit 3 Water

Component	Pit 3	NPDES Limits	Drinking Water Standards
pH	4.6	6.0-9.0	6.5-8.5
Uranium, mg/l	33	10	(1)
Zinc, mg/l	4	0.5	5.0
Manganese, mg/l	110	0.5	0.05
Copper, mg/l	0.2	0.01	1.0
Cadmium, mg/l	<0.1	0.004	0.01
Aluminum, mg/l	57	N/A	N/A
Sodium, mg/l	86	N/A	20 (2)
Sulfate, mg/l	2560	N/A	250

N/A The limit or standard is not established for the component

(1) Included as gross alpha activity at 15 pCi/l

(2) Not a standard but a reporting level

Clearly, most of the contaminants in the Pit 3 water exceed the discharge permit limits and some exceed the drinking water standards. Dilution of the discharge of the Pit 3 water into the area waterways will occur in Blue Creek and Roosevelt Reservoir.

But overflow of the pit does constitute a small threat to the public and should not be allowed to happen.

Even more stringent limits are placed on water quality to protect aquatic life; overflow of untreated Pit 3 water would threaten aquatic life in Blue Creek. In addition, Roosevelt Reservoir is a designated National Recreation Area, and the Spokane River has at least one major U.S. Park Service campground below the mouth of Blue Creek. At current levels of contamination, the amounts of uranium and other metals from Midnite Mine are reported to be nearly immeasurable in Roosevelt Reservoir; but the public image of any contaminants being in the water could lead to criticism of the Agencies involved.

One of the options considered for treatment of Pit 3 water is in situ treatment. The lime and other reagents would be dumped into the pits and the precipitated sludge would settle out on the bottom. Presumably, after the water was of sufficient quality, it would be discharged into Blue Creek; the pits would be reclaimed with the sludge still in place. This plan raises several questions that must be answered before it can be seriously considered.

1) What would be done to ensure stability of the sludge when contacted with ground water seeping through the reclaimed pit? No lining of the pit bottom is possible with this option, and the pits are known to have seeps.

2) How would mixing of the reagents and the water be carried out? The water treatment plan requires thorough mixing of the water and the lime and other reagents to ensure complete precipitation of the uranium and heavy metals. Given the size of the pits, mixing would be a major problem.

3) What local effects would reagent addition in the required amounts have? This question is tied to the mixing question. Reagent dosages required to treat all of the water in either pit are very large. No data are available on precipitation effects and water conditions at the point of entry of the reagents. Obviously, the lime concentration at the point of entry would be extremely high, as would the barium chloride concentration.

4) How long would it take for the sludge to settle out to the point where water could be discharged? If the water must be filtered before discharge to Blue Creek, the advantages of in situ treatment disappear.

PIT 2

Pit 2 has been completely filled with waste rock from the mining operation. Water may be infiltrating the waste rock through

precipitation or ground water movement. Reclamation of Pit 2 will follow the guidelines prescribed for protore and/or waste rock.

SHERWOOD WATER TREATMENT PLANT

Leach tanks in place at the Sherwood Mill, which may require some modification before use as neutralization tanks, measure 24 ft diam. by 26 ft high and hold nearly 88,000 gal. The Sherwood flow sheet shows a train of seven tanks in place, plus a lime holding tank and mixers, pumps, sand filters, etc. Centrifuges are also available at the mill site and could be used in place of the filters. Estimated water discharge rates from the Sherwood Mill indicate the accumulated water could be completely treated and discharged in about 1.2 years.

WATER TREATMENT PLANT SLUDGE DISPOSAL

Sludge disposal from water treatment must be looked at from several aspects: comparison of different disposal sites, pipeline safety/security, costs, need for long-term disposal, possible reprocessing of the sludge to recover uranium, and fixation of the sludge with cement. These aspects are considered in this section.

<u>Comparison of Disposal Sites</u>

Taking the Midnite material off-site would mean potential contamination at the Midnite mine and the disposal site. Without processing out the uranium prior to disposal, this option has some risk of uranium and heavy metal contamination at the disposal site.

If the DMC tailings pond in Ford is selected as the sludge disposal site, the impounded water at Midnite Mine will presumably be treated on-site, and the sludge will be trucked to Ford for storage. If the Sherwood tailings pond is selected for sludge storage, two options are available: either treat the water on-site at the mine site and truck the sludge to the Sherwood pond for storage, or pump the water to the Sherwood Mill for treatment there.

Use of either the Sherwood Mill tailings pond or the DMC tailings pond at Ford, WA, appears to be highly dependent on regulations promulgated by either the Nuclear Regulatory Commission (NRC) or by the Bureau of Land Management (BLM). NRC regulations allow only "byproduct material" to be placed in tailings ponds. Byproduct material is defined in the Atomic Energy Act as "any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special radioactive material." Because the water treatment sludge will be produced in a process that is not primarily for the exploration, mining, and milling of uranium ore to produce special radioactive material, these regulations may prohibit placement of water treatment sludge in the existing

tailings ponds. Further complications arise from the fact that both NRC and EPA waste management regulations may apply to the sludge because of other contaminant concentrations.

One point in favor of using the Sherwood Mill is the possibility of recovering uranium from both the water treatment sludge and the reactive rock. This would lower the hazardous classification of the wastes and reduce the requirements for waste storage.

Reprocessing of Sludge

Processing the sludge for uranium recovery, has been considered by the BOM. Analysis of the sludge shows a uranium concentration of just over 2 weight percent. The total amount of uranium contained in 500 million gal of Pit 3 water, the theoretical quantity of water to be treated, is 65 st U. Although the value of this quantity of uranium would not support the cost of a plant to extract it, the recovery of uranium from the sludge produced by water treatment is preferred by the Superfund Amendments and Reauthorization Act of 1986. The SARA legislation provides that remedial actions which permanently and significantly reduce the volume, toxicity, or mobility of a hazardous substance, are to be preferred over transport and disposal without treatment. Also, if Western Nuclear's Sherwood Mill is eventually to be used in treatment of the Midnite Mine water, a great quantity of processing hardware would be readily available. Therefore, the selective extraction and recovery of uranium from the water treatment process sludge has been tested at the bench.

An-oven dried precipitate from lime treatment of Pit 3 water containing 2.25 percent U was leached in sodium carbonate - sodium bicarbonate solutions at approximately 50° C for 20 h. Two leach solutions were employed each containing 0.6 M total carbonate at carbonate-to-bicarbonate ratios of 3 and 1. The precipitate was leached at 5 and 1 percent solids in a stirred beaker with 500 mL of leach solution. The carbonate medium was very selective for uranium; pregnant solutions containing 625 ppm U were obtained with no more than 40 ppm total combined other metals. The 3:1 carbonate-to-bicarbonate yielded slightly better results; at 1 percent solids the uranium extraction was 82 percent, and at 5 percent solids the extraction was 58 percent. Greater than 98 percent of the solids were recovered in the residue. Although greater extractions could be obtained with further research, these tests demonstrate that uranium can be selectively leached from the Midnite Mine water treatment sludge.

The pregnant carbonate leach liquor was a clear yellow solution at pH 9.9. This solution was treated with sodium hydroxide to precipitate a uranium product. Analyses indicate the product to be greater than 95 percent pure sodium uranate-polyuranate. Uranium recovery from the pregnant liquor was 72 percent; the raffinate at pH 13.2 contained 137 ppm U. The barren solution,

with the addition of carbon dioxide, would be readily recyclable to the leaching stage. This technology to selectively extract and recover the uranium may alleviate a potential sludge disposal problem in the Midnite Mine water treatment scheme.

Fixation as a Possible Disposal Technique

Fixation of tailings with cement is a technique often discussed as a means to stabilize tailings and reduce metal mobility. No tests have been performed by BOM concerning addition of cement to the water treatment sludge; however, other tailings, which may be similar to the sludge product, have been tested for cement addition. Addition of cement to these other tailings had several effects; effects which may also apply to the water treatment sludge.

1) The moisture content of the tailings was immediately decreased by about 5 percent (dry basis calculation). Other than this immediate decrease, the cement did not significantly affect the drying rate of the tailings.

2) The tailings pH increased to 11.5 or higher. The tailings as obtained had a pH of approximately 6; addition of 6 volume percent cement increased the pH to 11.5 or higher over a period of 2 days.

3) The volume of the tailings increased by adding cement and mixing water. Addition of 6 volume percent cement yielded a 26 percent volume increase; addition of 15 volume percent cement yielded a 33 percent volume increase; and addition of 45 vol percent cement yielded a 93 percent volume increase. These values may be less for the water treatment sludge, which would have a higher initial moisture content.

OPERATION OF SHERWOOD MINE/MILL TO PRODUCE URANIUM

This option has been considered quite seriously by the Spokane Indian Tribe, who have contacted several mining and/or milling companies about operation of the Sherwood complex. If the Tribe selects this option, the Sherwood Mine would reopen and the mill would presumably process ore from both the Sherwood Mine and the Midnite Mine. The mineralogy of ores from the two sites appears sufficiently similar for processing in the same system except for the high pyrite content in ore from the Midnite Mine. A floatation circuit would probably be necessary to remove the pyrite before processing the ore in the Sherwood Mill. A late 1988 economic evaluation of the profit potential indicated that the break-even point for the Sherwood operation was at a price of $16.21/lb for the uranium yellowcake product. The spot price at that time was less than $15/lb, indicating that operation of the mine would not have been profitable. The price of uranium in February 1990 had declined further to $8.85/lb. However, the long-term price

expectations were upwards, so the mine may become profitable in the future. This option has the advantage of removing stockpiled reactive rock from the Midnite Mine site, thus decreasing the production of contaminated drainage water somewhat. Also, the newly uncovered high-grade uranium ore at the bottom of Pit 3 could be mined and processed.

APPENDIX E
ACTION PLAN

ACTION PLAN

TASK	LEAD OFFICIAL	RESPONSIBLE PERSON	TARGET DATE	ACCOMPLISHMENT
1. Steering Committee appointment. Committee will meet quarterly to review and steer data gathering and reclamation objectives.	Bureau Directors	Kim Snyder CO/BIA Don Aubertin Den/BIA Jim LeBret PAO/BIA Eric Hoffman OR/BLM Denny Seymour OR/BLM Don Siedel SLC/BOM	May-89	Obtain appointments to Committee. Formalize information exchange procedures-routine communication.
2. Protore Low grade ore ("protore") pile research. Chemical and mineralogical characteristics, leaching rates and migration of uranium and other elements, information needed to determine if protore can be reclaimed on-site or must be moved.	Research Director Salt Lake City Research Center Bureau of Mines	Don Siedel SLC/BOM	Feb-90	Test leaching-chemical characteristic of protore to quantify contribution to acid water and plan final disposition of the material
3. Waste Dumps-model dump geology using drill core samples, production records, ongoing drilling results and maps. Information needed to design final dump slopes and clay/ dirt vegetation cover.	Oregon State Director Bureau of Land Management	Eric Hoffman OR/BLM	Mar-90	Identify reactive areas in dumps and design final surface contours for most efficient drainage.
4. Remaining exposed rock and ore research slope stability, chemical and leaching tests to define final reclaimed pit wall slopes and in-place reactive rock cover or disposition.	Research Director Salt Lake City Research Center Bureau of Mines Portland Area Director Bureau of Indian Affairs	Jim LeBret PAO/BIA Don Aubertin Den/BIA Don Siedel SLC/BOM	Feb-90	Determine necessity to mine remaining reserves and final surface slopes of pit high walls.

ACTION PLAN

TASK	LEAD OFFICIAL	RESPONSIBLE PERSON	TARGET DATE	ACCOMPLISHMENT
5. Hydrology-determine subsurface mine water movement and chemical characteristics and quantify to design drainage surface and determine necessity or method of drainage subsurface before and after final reclamation.	Research Director Spokane Research Center Bureau of Mines	Lani Boldt Spo/BOM	June-91	Quantify volume/ chemistry of acid water in mine workings, including movement within the workings to design internal and surface drainage.
6. Earthmoving and surface form scenarios/benefit comparison of reclamation/sloping/treatment scenarios, including soil and clay requirements.	Oregon State Director Bureau of Land Management Portland Area Director Bureau of Indian Affairs	Eric Hoffman OR/BLM Jim LeBret PAO/BIA Don Aubertin Den/BIA Lani Boldt Spo/BOM	May-91	Determine cut/fill and slope requirements, material (clay and soil) needs, surface drainage and associated costs.
7. Pit high walls research to determine procedure and necessity of stabilizing pit high walls, including core drilling for rock mechanic studies, chemical leaching/ weathering studies.	Research Director Spokane Research Center Bureau of Mines Portland Area Director Bureau of Indian Affairs	Jim LeBret PAO/BIA Don Auberton Den/BIA Lani Boldt Spo/BOM Don Siedel SLC/BOM	Jan-91	Determine stable slope construction requirements procedures cost.
8. Baselines Environmental Monitoring Installation of monitoring equipment including weather stations, water quality monitoring equipment and radiological hazard survey.			ongoing	Maintain assessment of baseline environmental conditions against which to guage reclamation effectiveness and installation regulated environmental monitoring system.

ACTION PLAN SCHEDULE

May 1989	Jan 1990	Jan 1991	
1) Steering Committee			
2) Protore Research	Feb 1990		
3) Waste Dumps Model	March 1990		
4) Exposed Rock Research	Feb 1990		
5) Hydrology Research			June 1991
6) Earthmoving Model			May 1991
7) Pit High Wall Stability Research		Jan 1991	
8) Reclamation Plan Design			Sept 1991
9) Environmental Impact Statement			// June 1992

APPENDIX F
ACTION PLAN DISCUSSION OF APRIL 1989

During April 17 and 18, 1989, a meeting was held at the Portland Area Office Bureau of Indian Affairs to identify specific technical data requirements and procedures necessary for production of a completed reclamation design/plan for the Midnite Mine. Technical staff were present from the Bureau of Indian Affairs, Bureau of Land Management, and Bureau of Mines.

The individuals at the meeting reviewed an April 12, 1989 Briefing Paper (Appendix I) describing reclamation objectives and information needs and jointly agreed on an action plan (Appendix II) which was generally derived from the Briefing Paper.

INFORMATIONAL NEEDS

The objective of the Briefing Paper and consequently the Action Plan was to address three problems:

1) prevent acid mine water from contaminating Reservation surface streams;

2) form the disturbed surface so mine workings do not represent a public hazard in the form of unstable, steep slope dump faces and pit walls; and

3) mute the visual impact of the mine workings.

The above problems are subdivided for comment.

<u>Problem 1</u> Prevent acid mine water from contaminating Reservation surface streams.

<u>Chemical Characteristics/Reactivity</u>

Data from Bureau of Mines leach testing on protore piles, were compiled and submitted to the BIA in October of 1989. Since that time, additional samples from all three material categories--protore piles, waste dumps, and remaining exposed rock and ore (in the form of granite from the Pit 3 wall)--have been obtained and are undergoing leach tests. In addition to the new samples of these materials for leaching, a sample of high lime materials was obtained and mixed with protore for leaching tests. Complete data from these tests will not be available until June of 1990; therefore, the target dates contained in the Action Plan Standards for completion of leaching activities (Task 2 and 4) should be extended to July 1990.

If a complete definition of the reactivity of pit walls is included in the proposed work, the BOM must obtain representative samples

of the pit wall material for leaching tests in the future. The one sample of granite obtained to date is not sufficient to accomplish this purpose. Some means will have to be provided for collecting this sample from the steep pit walls. This activity will push the scheduled completion date for leach tests even further into the future than the proposed July 1990. Tasks 4 and 7 appear to be overlapping in the area of pit wall research. Task 4 has a target completion date of February 1990, while Task 7 has a target completion date of January 1991. The January 1991 date would be more in line with what the Bureau could accomplish in obtaining samples and leaching materials from the pit walls.

A separate heading under the acid mine water category should be established for these topics, possibly entitled Water Treatment. Treatment of the impounded water, and possibly the subsurface water, is the most pressing problem facing the BIA, and it must be resolved within the next year or two. There is no mention in the Action Plan of determining requirements for processing the water or storing the precipitated sludge. These requirements, which may be different for the impounded water and the subsurface water, should be included in the Action Plan.

Much time and effort are being spent in determining if the existing Dawn Mining treatment plant is adequate for water treatment or if the Sherwood Mill should be acquired for this purpose. The Action Plan needs to include the following items:

a) Reliability testing of the existing DMC treatment facility, which has only operated for short periods of time.

b) Determine location and design of sludge disposal site on Midnite Mine site. The sludge will more than likely have to meet joint NRC/EPA regulations for disposal which include double lining and capping the sludge storage facilities.

c) Alternative disposal of sludge off-site should be considered, such as shipping to Utah's Blanding Uranium Mill for uranium recovery or Utah's disposal site.

Geologic Formation/Rock Structure

The title of this section should be changed to Geohydrology or Hydrogeology since all of the contained subtopics deal with water storage or movement through the ground.

Another entry needs to be added to this section concerning consolidation of all seep outputs after water is removed from Pits 3 and 4, and the toe pond. Can the water from all seeps (both those now existing and those that may be apparent after water removal from the impoundments) be channeled together and treated? These waters will more than likely need to be treated. A possibility is the BOM's new BioFix bead treatment method.

Subsidence due to saturation must also be investigated since this area will become increasingly more saturated as Pit 3 fills. Drilling of these slopes is required as soon as possible to determine the stability of slope above the toe pond.

Required Revegetation Procedures

Revegetation needs should also be considered when determining final slope grades and contours in the restructured mine surfaces. Steep slopes can present a very difficult problem in establishing vegetation. Seeding and planting practices must be considered as should the possible need for fertilization; disturbed lands are often barren of plant nutrients and necessary bacterial cultures for satisfactory plant growth. Plant varieties must also be determined for satisfactory revegetation of the restored mine site. None of these factors is mentioned in the Action Plan.

Problem 2 Form the disturbed surface so mine workings do not represent a public hazard in the form of unstable, steep slopes-dump faces and pit walls.

Disposition of Protore

If protore contains sulfitic material and is left in place without capping, it will continue to leach; however, by knowing which materials are reactive (contain sulfides)/nonreactive (contain calcareous rock), these materials can be stabilized in place with contouring, mixing reactive and nonreactive rock, and clay and Hypalon capping. Additional research should be conducted to investigate the introduction of bactericides prior to capping.

Disposition of Dump Surfaces

Leach tests to determine reactivity of dump materials are still in progress. The Action Plan does not have an entry for this work. It should be included. Bactericides should be investigated as a means of inhibiting leaching from the dump piles in place. In addition, if the dump surfaces are to be re-contoured and re-vegetated, the vegetation needs pertaining to slope gradient should be considered.

Stabilizing Pit High-Walls

If this entry includes chemical reactivity of weathered rock on the pit wall faces, the BOM must include more samples of pit wall materials in their leaching schedule. Such samples have not been obtained to date.

Again, if the restructured pit walls are expected to support vegetation, the vegetation needs in terms of slope gradient and maintenance access must be considered.

Problem 3 Mute the visual impact of the mine workings.

Comments on this problem are found throughout the Action Plan.

APPENDIX G
DETAILED COMMENTS ON THE ACTION PLAN

The following are detailed comments on the Action Plan for development of a completed reclamation design/plan for the Midnite Mine.

TASK 1. STEERING TEAM APPOINTMENT

The BOM representative, Don Seidel, SLRC, has retired and should be replaced with another representative from the BOM. A representative from the BOR should also be included on the steering team because of its involvement in the site investigations.

TASK 2. PROTORE (LOW-GRADE ORE)

The protore leaching tests are not completed and were not used in this review. This task should have a deadline of November 1991, the same deadline as Task 5 (hydrology/chemistry).

TASK 3. WASTE DUMPS

The March 1990 deadline will not be met. Drainage contours will have an impact on contaminant transport in the ground water. Therefore, some coordination is needed between this work and Task 5 (Hydrology). Again, the Action Plan schedule leaves room until early spring 1991 as needed input for Task 6 (earthmoving model). This task could have a deadline of June 1991, the same deadline as Task 5 (hydrology/chemistry).

Leach studies of waste dumps by SLRC should also be included to determine leaching characteristics since some contain pyritic materials and will contribute to the acidity of the mine drainage. Those materials that are calcareous can be mixed with reactive rock to help stabilize the reactive rock or they can be used to backfill Pit 4.

TASK 4. REMAINING EXPOSED ROCK

Data from the SLRC leach tests on protore piles were compiled and submitted to the BIA in October 1989. Since that time, additional samples from all three material categories--protore piles, waste dumps, and remaining exposed rock and ore were obtained and are undergoing leach tests. Additional testing is being conducted on sulfitic/calcareous material mixtures. Complete data from these tests will be available by June 1991.

Should hydrology studies indicate that a geomembrane will not hydraulically isolate the reactive material, information on fracture-controlled ground water flow systems may be necessary to determine if the reactive materials from the walls of Pits 3 and

4 should be removed. Preliminary maps of ground water contours will not be available until late spring of 1990. This task should have the same deadline as Task 5 (hydrology/chemistry).

TASK 5. HYDROLOGY

The June 1991 deadline for the hydrology/chemistry should be considered the latest date in order to be used for Task 8 (Reclamation Plan Design). Tasks 2, 3, and 4 should likewise be scheduled. Input from this task will be needed to evaluate options on other tasks.

TASK 6. EARTHMOVING AND SURFACE FORM SCENARIOS/BENEFIT

This task should be completed after input from the hydrology/chemistry task in order to maximize improvement of ground water quality. August 1991 should be the due date to afford a minimum of 3 months after receipt of Tasks 2, 3, 4, and 5 reports, but should be started prior to any input from Tasks 2-5. As these task inputs become available, they can be added as final technical adjustments to the conceptual framework of the earthmoving plan.

TASK 7. PIT HIGH WALLS

Task 7 should be specifically stated to address highwall stability. Task 4 should be restricted to leaching of material in the pit walls. Task 4 had a target completion date of February 1990, while Task 7 has a target completion date of January 1991. The January 1991 date should be changed to June 1991 to be in line with what can be accomplished in obtaining samples and leaching materials from the pit walls.

TASK 8. BASELINE ENVIRONMENTAL MONITORING

The task is described as baseline environmental monitoring; however, the line chart shows Reclamation Plan Design. Task 8 should be the Reclamation Plan Design, with a February 1992 deadline. This would give 6 months to produce any last-minute adjustments from Tasks 2-6. The Reclamation Plan Design should be reviewed by all steering team members and responsible persons listed in the Action Plan.

TASKS THAT SHOULD BE ADDED TO THE ACTION PLAN

<u>Task 9. Baseline Environmental Monitoring</u>

Task 9 should be added to the Action Plan as Baseline Environmental Monitoring. In fact, such monitoring should be designed around the ongoing work, but it should be expanded to include a wider range of data acquisition. It is imperative to start this task soon.

Task 10. Revegetation and Slope Protection

Task 10 should be added to the Action Plan as Revegetation and Slope Protection so that the provision for a stable surface is considered when determining final slope grades and contours in the restructured mine surfaces. Plant varieties must also be determined for satisfactory revegetation of the restored site.

This task should also include an evaluation the effectiveness and cost of using geomembrane in lieu of clay material.

Task 11. Sludge Disposal

The Action Plan should include a detailed study of the options for disposal of the sludge from water treatment processes, with considerations for on-site/off-site disposal. It is especially important to consider the ramifications of the uranium recovery test in Utah.

Task 12. Emergency Remediation

There is an immediate need to undertake a slope stability study for the southernmost waste pile. It also is recommended that ongoing studies in site hydrology and leaching of reactive rock be continued. The hydrology and leaching tasks are being performed by the BOM with partial financial support from BIA.