L3023 (661)

SEP 0 5 1995

Memorandum

To: Chief, Resource Evaluation Branch
Geologic Resources Division

From: John E. Burghardt /s/ John E. Burghardt
Geologist, Resource Evaluation Branch
Geologic Resources Division

Subject: Trip Report: Grand Canyon National Park - Investigation of Orphan Mine; May 22, 24, and 25, 1995

PURPOSE

At the request of Heather Davies, Hazardous Materials Coordinator for the former Western Regional Office, I traveled to Grand Canyon National Park (GRCA) to assist Heather in developing a scope of work for a site investigation of radiological hazards at the abandoned Orphan Uranium Mine. Linden Snyder, supervisory mining engineer of the U.S. Bureau of Mines (USBM), joined Heather and me on this trip. Radiation specialists under his supervision will most likely conduct the site investigation. The investigation will be conducted as specified under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The need for a site investigation was identified by Harding Lawson Associates (HLA) in a CERCLA preliminary assessment report dated July 1993. The HLA report recommends that if the surface facilities of Orphan Mine were to be opened to the public, that a baseline risk assessment should be performed to assess the health effects of direct exposure to the site, or that the site should be reclaimed to background specifications.

We took an additional day while at the park to inspect the Grandview Mine (a.k.a., Last Chance Mine), which is located below the South Rim on Horseshoe Mesa approximately 15 miles east of Grand Canyon Village. Our findings for this mine are discussed in a separate report.

BACKGROUND

Orphan Mine produced extremely rich uranium ore, is now abandoned, and is known to have elevated levels of ionizing radiation at its surface facilities along the West Rim Trail near Grand Canyon Village. These surface facilities are connected to the major underground mine workings via a 1,600-foot, 3-compartment vertical shaft. The shaft's headframe, cages, hoist, as well as an air compressor building, numerous building foundations, and miscellaneous scrap, remain in the surface yard. This yard is fenced on three sides and is open on its northeast side abutting Grand Canyon's South Rim. The surface yard is rectangular in shape, measuring approximately 430 feet by 335 feet (3.3 acres). The lower workings of the mine have collapsed to form a "glory hole" approximately 1,100 feet below the canyon rim.

SUMMARY

Heather Davies, Linden Snyder, and I have developed a course of action for conducting a CERCLA site investigation of Orphan Mine. Heather will use her funding to contract USBM and a private environmental consultant to collect and analyze radiological data from the site, to develop risk scenarios and identify all pathways of radiological exposure to the public and environment, and to develop mitigation proposals. After the site investigation is initiated, Heather will transition her role in the project to Mike Schene, Hazardous Materials Coordinator for the newly-created Intermountain Field Area in Lakewood, Colorado.

Linden Snyder of the USBM (also in Lakewood) and his staff will set up a long-term air monitoring program which will entail three monitoring stations and one weather monitoring station. These stations will collect data for a period of 1 year prior to any site mitigation to fully document baseline radiation levels and their seasonal variations at Orphan Mine. This instrumentation, which will be owned and maintained by the park, should also be used to monitor the site during and after mitigation (when funding is secured) to ensure and document that mitigation has improved site conditions without spreading contamination to the surrounding area. Pending a proposed Phase I Environmental Assessment for all contaminants, USBM has offered to conduct a detailed gamma (γ) radiation survey on Orphan Mine's surface yard along the West Rim Trail. I will coordinate dealings with the USBM and will interact with USBM and the environmental consultant on interpretation of radiological data, site cleanup parameters and design, and other hazard mitigation measures such as closure of the main shaft and radiological exposures from the mine's lower workings.

During our meetings with park staff, it became apparent that there is some difference of opinion among managers at GRCA as to how Orphan Mine should be managed, especially its surface facilities. We would appreciate clear direction from the park on their objectives for Orphan Mine before final reports and reclamation proposals are drafted.

DISCUSSION

Previous Reports on Orphan Mine: Numerous reports have been written on Orphan Mine from the perspectives of historical significance, geology, mineral economics, and reclamation strategies. I have used the following references in my research of the property, and will refer to them by author and date in the body of this report. On request, I will gladly make copies of these reports for any readers who cannot locate them.

Dodge, Matt and John W. McKlveen, *Hogan's Orphan Mine*, True West Magazine, Special Treasure and Mining Issue, December, 1978.

Hom, Moon, *Reclamation Report: Orphan Mine, Grand Canyon National Park, Arizona*, Bureau of Land Management, memorandum of June, 1986.

Magleby, Dan N., *Orphan Lode Uranium Mine, Grand Canyon, Arizona*, Flagstaff Section, Grants Branch, Production Evaluation Division, Grand Junction Office, U.S. Atomic Energy Commission, March, 1961.

O'Brien, Robert D., *Brief History of the Orphan Mine, Grand Canyon National Park*, National Park Service, Western Regional Office, Office of Mining and Minerals, memorandum, (no date).

Phase I Preliminary Assessment: Orphan Mine, Grand Canyon National Park, Arizona, Harding Lawson Associates, July, 1993.

Proposal to the National Park Service, Grand Canyon National Park, for Reclamation of the Orphan Mine Site, Landmark Reclamation, (no date given, but included map is dated March, 1986.)

Orphan Mine Planning Meeting and Subsequent Correspondence: On our first day in the park (May 22), Heather Davies, Linden Snyder, and I spent the morning meeting with the following park employees:

Lois Hoddenbach	Chief Safety Officer
John Reiss	Hydrologist (previously a mining geologist)
Doug Brown	Compliance Specialist
Brad Trevor	Chief, General Services

We discussed what a site investigation of the Orphan Mine would entail, what responsibilities would be assumed by the various parties involved, what our eventual goal would be relative to reclaiming the site, and how all of this would be financed. Linden Snyder and I gave the group a brief orientation to issues of concern at radiologically contaminated sites, means of detecting radioactive emissions, and methods of limiting

public and employee exposure. I left Lois Hoddenbach several draft copies of my paper, *Effective Management of Radiological Hazards at Abandoned Radioactive Mine and Mill Sites*, and promised her a copy of the final document when I have received and incorporated comments anticipated from the U.S. Environmental Protection Agency (USEPA) and USBM. I am still awaiting comments from USEPA and the U.S. Department of Energy (DOE), which also offered to review the paper.

USBM proposes that they conduct a 1-year air monitoring program, to be initiated as soon as possible, to collect data on existing conditions at Orphan Mine. USBM further proposes that air monitoring be continued during reclamation of the site to ensure that contaminants do not migrate from the site during reclamation activities, and after reclamation for an unspecified period of time to document improvements as a result of what was done. Monitoring would be achieved using two air monitoring stations located in the vicinity of Orphan Mine's surface yard (east and west of the fenced enclosure), one air monitoring station at the western end of Grand Canyon Village, and a weather monitoring station inside of Orphan's fenced enclosure. Each air monitoring station will include an air pump with filter and a nuclear track detector. Filters will be analyzed for total Uranium, Thorium-230, Radium-226, and Lead-210, and the nuclear track detectors will measure the average level of radon gas. The park staff committed to supplying power to this equipment, and to periodically servicing the monitoring stations by changing air filters and nuclear track detectors and mailing them to an EPA-certified laboratory for analysis, as arranged by USBM.

USBM is also capable of continuous radon monitoring, but feels that this would incur unnecessary expense since there is a relatively small amount of uranium-bearing material on the surface. I concur with this opinion, especially because the only direct connection between the surface yard to the actual mine workings (the major source of radon) is the 1,600-foot main shaft, which will most likely be backfilled with material from the surface yard and then capped (see ensuing discussion). Backfill or no, we agree that any treatment of the Orphan site should include capping the main shaft with an airtight seal to block the flow of radon gas from the mine workings below.

USBM also proposes that they conduct a detailed gamma radiation survey on the surface facilities along the West Rim Trail, the ore haulage road, and the railroad siding where ore was loaded from trucks onto trains. Prior to this survey, USBM recommends that a complete Phase I Environmental Site Assessment be conducted on the property. This assessment would be for all contaminants on the site, in part, for protection of those doing radiological testing and reclamation work. This assessment would involve, but not be limited to researching literature, maps, and photographs to establish accurate locations of all potentially contaminated areas and their historic uses. Specific concerns that we noted would be to assess the status of two underground storage tanks noted on pages 13 and 14 of the HLA Preliminary Assessment Report, and to determine if PCBs were released to the property from several empty transformer casings we noticed in the surface yard.

Also included in the assessment should be locating the site of the Grand Canyon Inn, which reportedly was built on the Orphan property in 1936 and supposedly operated until 1966, at which time it was to have been removed. (Dodge, 1978) The possibility has been raised that the Inn's foundation might have been constructed using waste rock from Orphan Mine, accounting for some of the high gamma readings documented outside the present-day fenced enclosure. This seems unlikely. Efficient ore handling was not achieved until the aerial tramway was built in 1956, and when the main shaft was constructed in 1959. (Dodge, 1978) Prior to the aerial tramway, I understand that Hogan packed ore on-foot 1,000 feet elevation up to the canyon rim. It seems unlikely that he carried any sub-grade rock over this terrain, let alone enough to build foundations for the inn.

With the present effort in Congress to cut back government spending, the fate of the USBM is somewhat questionable. This could have significant bearing on committing to USBM for long-term monitoring at Orphan. We discussed this quite openly with Linden Snyder, and have designed the project so that if USBM or his division should cease to exist, the project would go on. If monitoring begins soon, USBM will construct and install the air monitoring equipment using funds from Heather Davies' accounts. All equipment purchased will be the property of GRCA. USBM will also instruct designated park staff on maintenance of this equipment, including changing of filters and shipping them for analysis. USBM will make arrangements with an EPA-approved lab to analyze the samples, billing directly to Heather Davies for all expenses. In these ways, USBM can initiate and manage the project, but remain isolated from NPS funding sources. USBM will keep track of the data collected and keep it tabulated so that it could be accessed at any time. I could continue this function in the unfortunate event that USBM were unable to see the project through to its completion. Detailed analysis and data interpretation, whether or not USBM remains in the project, is to be handled by a private environmental consulting firm as arranged by Heather Davies.

Just after our meeting of May 22, Heather Davies encountered Assistant Superintendent Gary Cummins and had a brief discussion with him on this project. Apparently there is some difference of opinion among managers at GRCA as to how Orphan Mine, especially the surface facility, should be managed. Opinions seem to range from leaving the site fenced off from the public with minimal reclamation, to reclaiming the area so that the fence could be removed and the site would be open and interpreted to the public. We need clear direction from the park on their objectives for Orphan Mine before final reports and reclamation proposals are drafted.

Orphan Mine: Surface Facilities along the West Rim Trail : Airflow in the mine shaft was strongly downcast (outside air venting into the shaft) at the time of our inspection, so we did not take any radon daughter [alpha (α) radiation] readings. If airflow had been upcast, we might have gotten very high readings originating from the deep mine workings. On page 8-9 of their report, HLA cites a 1981 report of the Mine Safety and Health Administration (MSHA) which documents alpha readings between 50-60 WL α.

To put this in perspective, MSHA regulations for active mines require use of a dust-filtering respirator at alpha concentrations between 1-10 WL α, and a supplied air device in concentrations above 10 WL α. We had an MDA Instant Working Level Meter with us, but our air pump developed problems which would have made our data somewhat questionable. The sensitivity of the MDA is too course for monitoring radon daughter concentrations we would expect in an open space such as the surface yard. I would appreciate a copy of the referenced MSHA report if someone from the park has it.

Several gamma surveys have already been conducted on the surface yard. We roughly retraced the survey done by Landmark Reclamation on March 3, 1986, which was copied in the HLA report of July 1993. Landmark used an Eberline PRM-7 Micro R Meter carried at waste level for their survey, taking readings on a 50-foot grid throughout the fenced surface yard facility. We used a new, freshly-calibrated Ludlum Model 19 Micro-R Meter and corroborated their data within about 10 percent.

Surprisingly, Landmark confined their survey to inside the fenced enclosure, even though they found some very high levels of gamma radiation along the fence perimeter. Landmark's survey begs the question of how far outside the fenced area the contamination extends, especially in the vicinity of the West Rim Trail and toward Grand Canyon Village. Another survey conducted by Moon Hom, Mining Engineer for the Bureau of Land Management, found elevated gamma values beyond the fence line (Hom, 1986). Hom outlines a 5.6-acre area of contamination which takes in the fenced enclosure and a substantial area to the west of the fence. (See Figure 4 of Hom's report.) His values inside the fenced enclosure also are relatively consistent with the values documented by Landmark.

On our last day at the park (May 25), we had approximately 1 hour in lightning and hail to conduct our own (very rough) survey outside the fence line. We took readings at waist level as we paced off a 50-foot by 50-foot grid aligned with the grid used by Landmark inside the fence. Our results are appended to the Landmark map, as shown in Figure 1. Our rough data indicate that background values of 30-40 μR/hour are reached within 50-100 feet east and south of the fenced enclosure. To the west, however, values tend to increase, some of which are quite high in the immediate vicinity of the West Rim Trail. Operations at some point must have extended beyond the present-day fenced yard. Historic photographs of the operation could aid in identifying the full extent of the contaminated area. The highest value we measured, 1,250 μR/hour, was found 50 feet northwest (outside) of the fenced enclosure, just 100 feet from the West Rim Trail. This value approaches a 2 mR/hour (2000 μ/hour) evacuation level set by the Nuclear Regulatory Commission for sites under its jurisdiction.

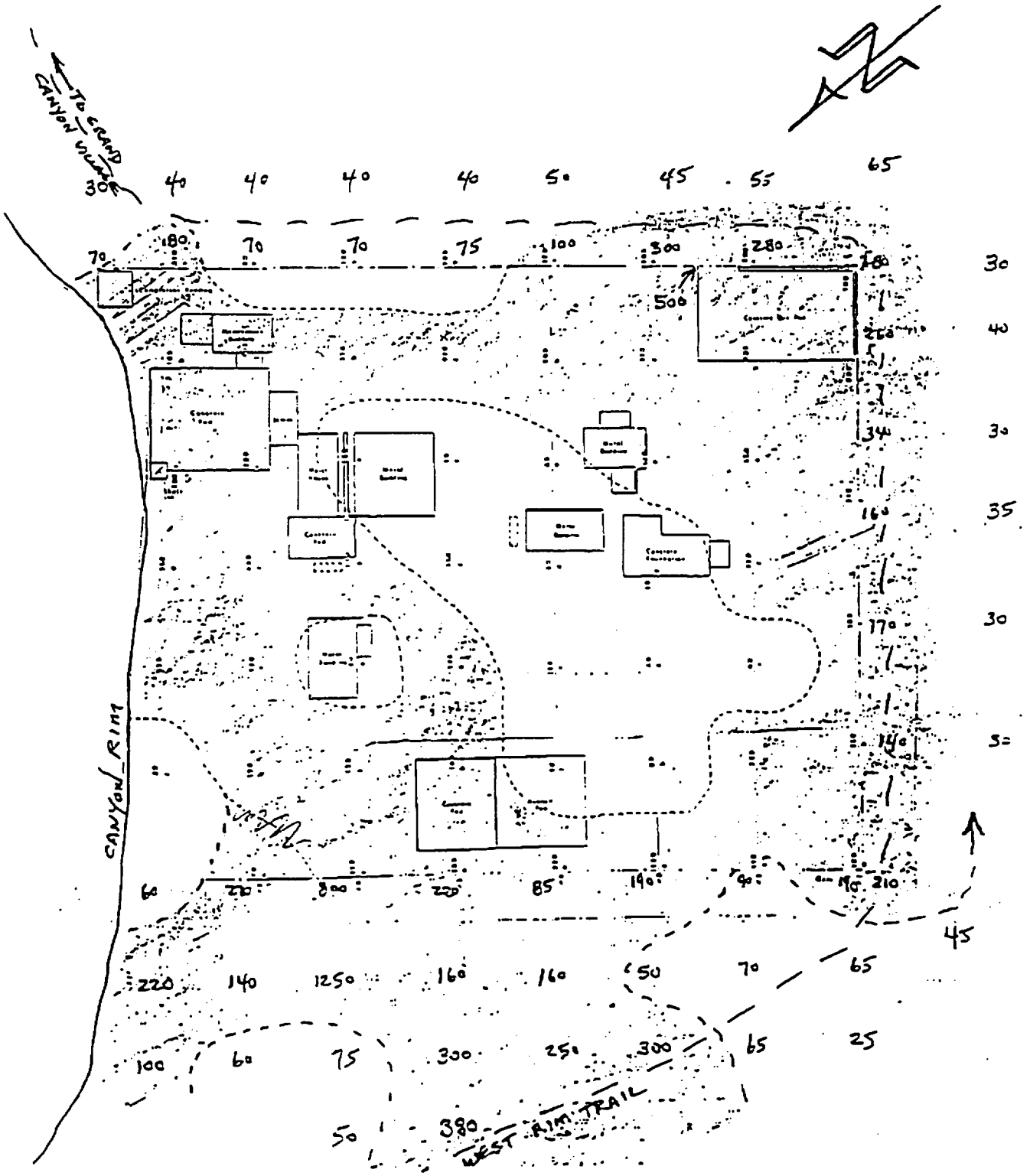
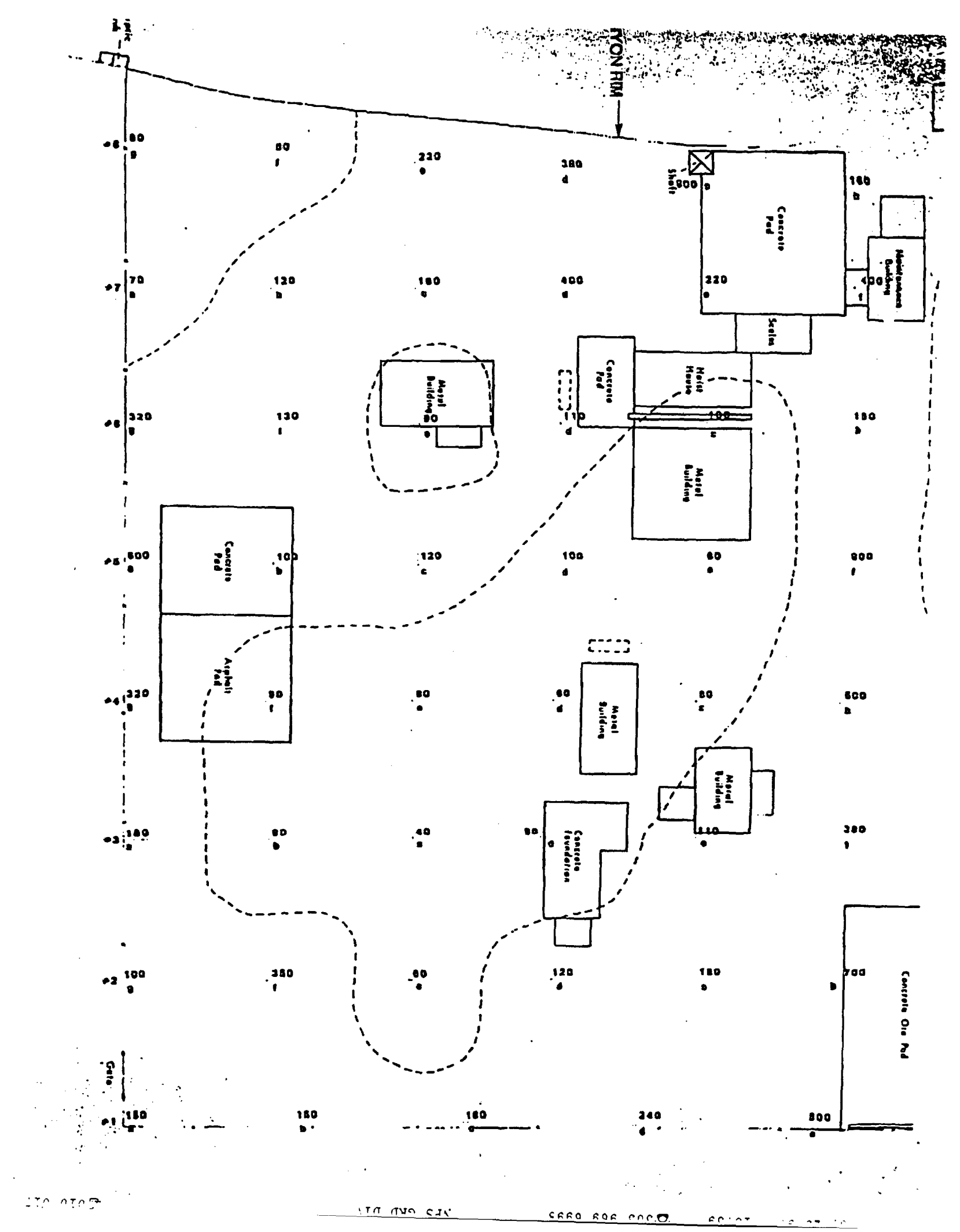


Figure 1. Gamma radiation (in μR/hour) outside fenced enclosure at surface yard of Orphan Mine. Measurements taken at waist level on approximate 50-foot grid using a Ludlum Model 19 Micro-R Meter on May 25, 1995. [Burghardt (NPS), Snyder (USBM)]


RYON RIM
Shaft
Concrete Pad
Maintenance Building
Scales
Concrete Pad
Hoist House
Metal Building
Metal Building
Concrete Pad
Asphalt Pad
Metal Building
Metal Building
Concrete foundation
Concrete Ore Pad
Gate

Parameters to be Used for Reclamation of the Orphan Mine Surface Facility: Assuming that our work is geared toward developing a reclamation proposal for Orphan Mine, we need to decide what parameters to use for site cleanup. It is still the case, as noted in previous reclamation proposals, that there are no standards specifically addressing reclamation of abandoned mines. I suggest that we look at regulations for active mine sites and protection of the general public and see what applies to the situation at Orphan Mine. The reader is referred to my paper, *Effective Management of Radiological Hazards at Abandoned Radioactive Mine and Mill Sites*, for a detailed analysis of these regulations and how they can be applied to cleanup of abandoned sites. (Copies available on request.) Much of the following discussion is my opinion based on my own research and experience in this field. At some point in our process, we should consult an accredited health physicist for a more authoritative opinion. USBM has several such contacts we could use. I propose that the actual cleanup parameters used at Orphan be derived in a meeting or telephone conference involving a health physicist, park management, the NPS area office hazardous materials coordinator (Heather Davies or Michael Schene), the environmental consultant selected by Heather Davies, and me.

Several suggestions have already been proposed for the cleanup of Orphan's surface facility. Hom (1986) recommends cleanup so that all gamma measurements (taken from waist level) would not exceed 57 μR/hour. Hom cites regulations promulgated by the Nuclear Regulatory Commission (NRC) at 10 CFR 20.105 as the basis of this recommendation, which specify an annual gamma dose limit of 0.5 rem (= 500 mrem = 500,000 μrem). Hence, Hom apparently derived:

$$(500{,}000\ \mu\text{rem/year}) \div (365\ \text{days/year}) \div (24\ \text{hours/day}) \approx 57\ \mu\text{R/hour}$$

I am forced to scrutinize Hom's line of reasoning, since no one will be spending 24 hours per day, 365 days per year at this site.

The CFR has been revised since Hom's analysis. The current regulations on this issue are found at 10 CFR 20.1301. The new regulations require a dose limit of 0.1 rem/year, with certain occasional exceptions allowing up to 0.5 rem/year pending special authorization from the NRC. These values are in keeping with the USEPA's recently-proposed Radiation Protection Guideline (RPG) for the general public, announced in the Federal Register for December 24, 1994. The RPG suggests permissible exposures of 0.1 rem/year, or 0.5 rem/year in exceptional cases. The RPG goes on, however, to recommend that no member of the general public should receive more than 10% of these annual limits (0.01 rem = 10 mrem = 10,000 μrem) from any given site.

The gamma survey map in Landmark Reclamation's July 1993 report draws a line segregating readings above and below 100 μR/hour. Although this line seems to imply an acceptable limit of 100 μR/hour, the report fails to state this outright. No reasoning used to arrive at this number is given. The HLA report includes Landmark's map with this 100 μR/hour line, but only makes a passing comment that in the absence of

conducting a detailed risk analysis, the site should be cleaned up to background levels if public access is allowed.

Our office recently attended a field session conducted by DOE to review reclamation of some of its uranium lease tracts in remote areas of western Colorado. DOE developed risk assessments, based on probable use scenarios for these sites, to arrive at what they believe are reasonable, site-specific cleanup standards. Their reclamation involves filling abandoned mine openings with the "hottest" material left outside the mine, then capping the remaining radioactive material with the lowest-level material they could find on-site. With this process, DOE economically reclaimed and revegetated their sites, resulting in gamma emissions on the order of 100 μR/hour throughout most of each site. We measured anomalous readings as high as 250 μR/hour in small zones within the reclaimed areas. Although this is eight times background values for the area, it is also eight times below the 2 mR/hour acute limit regulated by the NRC. Given the limited use these remote areas receive, DOE's completed reclamation is probably appropriate, especially when weighed against the constraints of available funding.

Since abandoned sites are not regulated, it is incumbent on the NPS to use the most current theory of permissible exposures to arrive at an acceptable cleanup standard for Orphan Mine. I believe we should use USEPA's proposed RPG which suggests a 0.01 rem annual exposure limit from any given site. This limit is based upon the actual use a site receives. I reject Hom's rationale for deriving a permissible limit based on occupancy of 24 hours per day, 365 days per year. Obviously, this will not be the case for anyone at Orphan Mine. Hopefully, GRCA will be prudent never to build (or allow building of) lodging or administrative facilities on this site. That assumed, and since the typical visitor would probably spend no more than a portion of one day at the site during their lifetime, I believe the highest exposure for the site would be to GRCA staff directly involved in the maintenance and interpretation of the site. If we assume that an Orphan Mine interpreter might spend a given amount of time on the site, we could derive a permissible limit which would protect that individual and all others who receive less exposure. For instance, if we assume an Orphan Mine interpreter might give two 1-hour tours of the site per week, we could derive a permissible limit of 100 μR/hour:

$$(10{,}000\ \mu\text{rem/year}) \div (52\ \text{weeks/year}) \div (2\ \text{hours/week}) \approx 100\ \mu\text{R/hour}$$

This number happens to coincide with the 100 μR/hour line on the Landmark Reclamation report, but rather than being an arbitrary number which the park may have trouble defending if challenged, it is a defensible value based on scientific data, regulatory guidelines, and actual use of the site. The park must decide how Orphan's surface facilities are to be used before we can target a specific cleanup standard. I suggest that cleanup to background levels may be difficult and prohibitively expensive to achieve. If park management limits exposure of its employees, a cleanup standard significantly in excess of background gamma values could be justified. Exposure limits can be enforced by requiring employees to log time spent on-site and keeping track of

cumulative exposure. This procedure is used in active mines with radiological contamination, and is used by the NPS for cave management, as delineated in NPS-14, *Cave Radiation Safety and Occupational Health Management Guideline.*

Orphan Mine: Main workings below the South Rim: On May 24, Linden Snyder, Doug Brown (GRCA Compliance Specialist), and I hiked from the South Rim down the Bright Angel Trail, then contoured west along the Coconino sandstone / Hermit shale contact to the glory hole and main workings of Orphan Mine. We first encountered the bunk houses and two adits described in numerous other accounts of the property. The adits are at the Coconino / Hermit contact, which is an aquifer apparently due to the less permeable underlying Hermit shale. The so-called "water adit" is dammed with timbers at its entrance, and most likely served as a reservoir of water for mining operations. We did not sample the water, but we did measure a pH of 11.7 with an inexpensive pocket-pH meter. Because of deep water, we could not enter the water adit.

We did enter the other adit. The Landmark Reclamation report mistakenly states, "[this] opening extends approximately 50-75 feet back into the canyon rim, at which point it takes a right turn apparently into the old mine workings." (Landmark, 1986: See Section 3, Task 4. Pages in the report are not numbered.) Landmark must not have entered this opening. We found that this adit extends into the hillside at a bearing of S 60°W, then bends to the northwest and ends abruptly 73 feet in from the portal. Twenty feet into the adit we measured 0.09 WL α and 360 μR/hour γ. At the adit's terminus we measured 0.43 WL α and 1050 μR/hour γ. [To put this in perspective, these gamma readings are in the same range as what we measured in the fenced yard above, and the alpha readings are elevated, but not alarming. As stated above, miners in active mines are required to wear breathing protection at and above 1.0 WL α.] This adit may also have been used for water retention at one time. Judging from copper mineralization (chrysocolla) in narrow veins along this adit (and, I suspect, the water adit), I believe these were Dan Hogan's original workings, which were reported by O'Brien to be 70 feet long (the adit we inspected) and 40 feet long (the water adit). (O'Brien, no date.)

Just west and downhill of these adits is the glory hole. At this time, the glory hole is approximately 100 feet in diameter and possibly as deep as 400 feet. Hom (1986) stated that the glory hole was 30 feet in diameter at the time of his investigation, so a great deal of subsidence has obviously taken place in the past decade. Since the diameter of the mined area at the 350-foot level (350 feet below the top of the glory hole) is reported to be approximately 400 feet, the glory hole is probably still unstable and subject to further collapse.

From earlier accounts, the glory hole used to be separate from the adit level of the mine. Now, the adit portal, half of which is occupied by a large ventilation fan, is perched at the very edge of the glory hole. The deeper recesses of the adit have collapsed into the glory hole, so there is no longer any connection to the main workings through the adit.

Knowing from literature, maps, and what we could see that the entire area is undercut, unstable, and prone to further collapse, we did not venture close to the edge. We did not take alpha radiation measurements because conditions were very windy and raining, which would have given us useless data. From a safe vantage point, we estimated the glory hole diameter. Tossing a rock over the edge and timing the fall to the best of our ability at 4 seconds, I believe the glory hole may extend as deep as the 400-foot level of the mine (the level that connects to the main shaft), which from my sources, is the deepest extent of any significant mine workings.

Due to the remoteness of the adits and glory hole and what we could see, I suspect they receive little or no visitation. Gamma radiation in this remote location is of little consequence, and any airborne contaminants (e.g., emitters of alpha radiation such as radon gas or radon daughters) would be diluted to reasonable levels before they could reach any significant target population. The glory hole would be a major concern if it were more easily accessible, but I believe that it is not a high priority for mitigation, given its location and the enormous expense that would be required to seal it off. If it were to be treated, I would recommend a broad fence with warning signs blocking access to the glory hole, placed well beyond any zone of anticipated subsidence. This fence could extend through the outcrop of the Hermit shale, between the cliff-forming Coconino and Supai sandstones, just east of the glory hole. I am unfamiliar with accessing the glory hole from the west, but if that is a possibility, a similar fence could be erected west of the glory hole. If the surface yard is reclaimed and its fence is dismantled, that fencing could be used below at the glory hole.

For the two small adits, I would recommend gates or bulkheads that would allow for drainage. Landmark (1986) and Hom (1986) both suggested blasting these adits shut. I do not advocate blasting closures in this instance, since the adits are situated at the base of the Coconino sandstone cliff, and a blast of this sort would destabilize the overhanging rock. Also, since these adits are probably the original Hogan workings, I suspect the park might wish to preserve them for their historic significance.

ACTION ITEMS

I will perform the following tasks:

1. Coordinate all dealings with the USBM.

2. Interact with USBM and the private environmental consultant on interpretation of radiological data.

3. Work with the park, USBM, the private environmental consultant, and an accredited heath physicist to derive appropriate radiological cleanup parameters for the surface yard and the glory hole area below.

4. Work with USBM on a design for the main shaft closure.

5. Assume USBM's role if they are unable to see this project through to its conclusion.

Heather Davies and Mike Schene will perform the following tasks:

1. Heather will draft an interagency agreement under the USBM / NPS cooperative agreement, which will essentially be a scope of work for the project.

2. Heather will contract with a private environmental consultant to perform the tasks listed below.

3. Heather will provide the initial funding for USBM as set forth in the interagency agreement, and for the private environmental consultant.

4. Since Heather initiated much of the recent efforts on this project, she has assumed the foregoing responsibilities to get the site investigation under way. In the current NPS restructuring, GRCA is passing from the Western Region into the Intermountain Field Area, so Heather will eventually transition her responsibilities for this project to Mike Schene, Hazardous Materials Coordinator for the new Intermountain Field Area in Lakewood, Colorado.

The USBM, with Linden Snyder as lead, will perform the following tasks:

1. Search their resources for historic aerial photographs of the mine and surface facilities to get a better idea of the operations that were carried out on the surface, and how they relate to radiological data collected.

2. Conduct air monitoring and gamma surveys of the upper surface facilities on the South Rim.

3. Once the park has decided on how they wish to reclaim and manage the site and radiological testing is nearing completion, design a seal for the top of the main shaft.

4. Produce a report summarizing all data collected from the site. This report will have minimal interpretation of the data relative to applicable regulations.

GRCA staff will be responsible for the following tasks:

1. When arrangements are finalized with USBM to conduct the site investigation, arrange for power to be available to the three air monitoring sites and the weather station.

2. Once the monitoring system is set up, receive training from USBM personnel on maintenance of monitoring equipment; periodically change filters in the equipment and send them to a specified laboratory for analysis.

3. Research the park files, archives, and museum for historic photographs and other documentation of Orphan Mine. Share this information with USBM and others involved in cleanup of the site.

4. Provide clear direction as to how they wish to proceed with Orphan Mine. Is the park willing to do complete site reclamation? Is there funding available for such an endeavor? If so, to what standards should we clean the site? Would the park rather leave the site as is? Should we merely fence off a larger area once the extent of the contaminated area is defined?

The private environmental consultant will accomplish the following tasks:

1. Conduct a record search on the historic Grand Canyon Inn which operated concurrently with the mine on the same property, apparently until 1966.

2. Conduct interviews with NPS employees and other individuals who worked at the Orphan Mine.

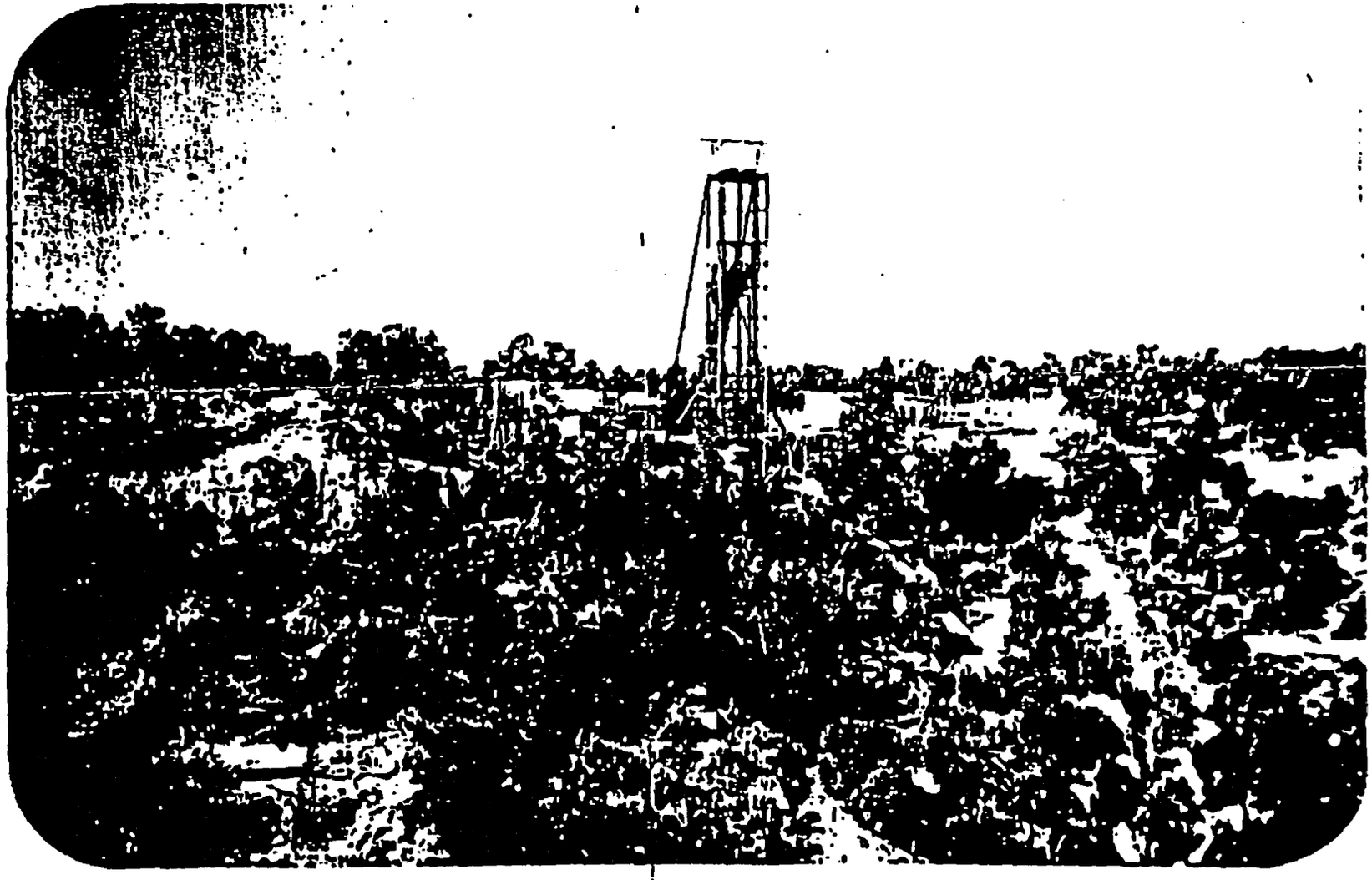
3. Conduct a Phase I Environmental Site Assessment of the surface yard.

4. Sample to analyze whether the concrete foundations for the Grand Canyon Inn and various buildings on-site were constructed using radiologically contaminated mine wastes.

5. Further evaluate the ore haulage road and rail siding for evidence of radiological contamination.

6. Develop risk scenarios for the site.

7. Submit a detailed report for mitigation of the site, incorporating information collected in steps 1-6 above. Interpret all data, information, and photographs collected by the park and USBM, especially as it relates to applicable radiological regulations and guidelines for site mitigation.



View of the Orphan Mine from Maricopa Point.

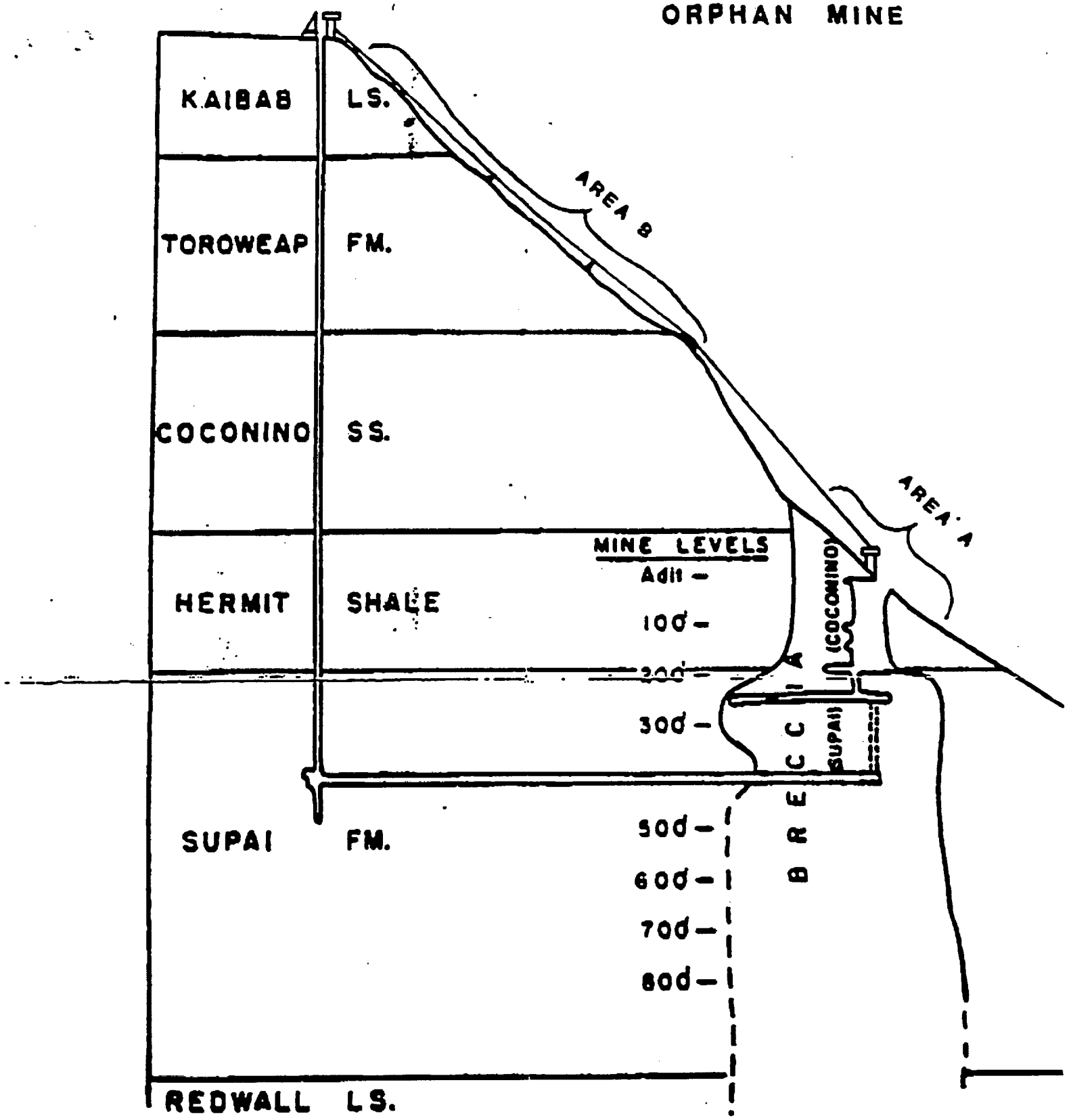


FIGURE 4
SCHEMATIC OF LOWER MINE AREA