ARABIAN MINE SURVEY AND RECONNAISSANCE

ENGINEERS INTERNATIONAL, INC. PROJECT NO. AZ1075

SEPTEMBER, 1991

prepared for

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION
PHOENIX, ARIZONA

REGISTERED GEOLOGICAL ENGINEER
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September 17, 1991
Ref. No. AZ1075

A.D.O.T. - Materials Section
1221 North 21st Ave., MD 068R
Phoenix, AZ 85009-3740

ATTN: Nick Priznar

RE: ARABIAN MINE SURVEY AND RECONNAISSANCE Final Report and Deliverables.
ADOT Contract No. T92-0119-00
Project No. F-068-1-402, TRACS No. H 2734-01D

Ladies and Gentlemen:

Per the subject contract, we are transmitting herewith one (1) original and two (2) copies of the subject report. As Mr. Priznar requested, one of the copies of the report is being sent directly to Mr. Priznar under separate cover. Also included is one (1) set of reproducible level maps and cross-sections, and a set of three (3) maps of surface features.

Considerable discussions have occurred regarding the findings, observations, and recommendations contained in this report. Please let us know if any of your impressions or understandings conflict with your interpretation of the report.

We appreciate this opportunity to have been of service.

Sincerely,
ENGINEERS INTERNATIONAL, INC.

Robert Cummings

Robert Cummings, P.E.
Project Manager

REGISTERED GEOLOGICAL ENGINEER
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EI Project AZ1057

SURVEYING OF THE ARABIAN MINE, MOHAVE COUNTY, AZ
TRACS NO. H273401D
State Route 68, M.P. 007

16 September, 1991

1.0 PURPOSE AND SCOPE OF WORK

The Arizona Department of Transportation (ADOT) is considering widening and straightening a section of SR 68, near Milepost 7, in Mohave County, AZ. SR 68 was constructed by the Bureau of Reclamation in 1942 to access the Davis Dam Project. The section of road to be improved passes near an inactive mine occupying the Arabian claim group. The mine recovered gold values from ore shoots occurring along a rhyolite dike. The dike strikes roughly parallel to the road and dips steeply toward it, raising the question of how much of the right-of-way and roadway improvement will be undermined and at what depth.

1.1 Background

The Arabian Mine was worked intermittently from before 1917 into the 1930s. The mine is developed along a steeply-dipping, rhyolite dike that intruded an older, granitic mass, apparently along a significant fault zone. The shallower portions of the hanging wall of the dike contacts gravel fill that comprises the adjacent wash. Inasmuch as the wash drains a considerable portion of the surrounding upland terrain, the mine was wet during the period of operation, making about 35 gpm, and most of the old workings are presently flooded; the mine pool can be seen from the surface in some open stopes.

The deeper portions of the dike hanging wall are in fault contact with porous rhyolite tuffs. The mine was developed along a mineralized zone averaging about 30 ft wide, chiefly within the dike but also extending into the granite footwall, consisting of quartz stringers. The Arabian vein was reported to dip 82 degrees overall, but the inclinations of the Philadelphia No. 1 and Philadelphia No. 2 shafts are much shallower.

According to old records, the site of the deeper mining was initially worked on the Rising Fawn claim by the Mines Company of America, a contract mining group from Great Britain. Apparently, production and mine access was through three shafts at that time: the R-1, R-A, and R-2. These shafts are no longer accessible; careful cross-checking of field conditions against the records show that stoping conducted after 1930 (probably between 1934 and 1938) has obliterated these shafts.

Subsequent to the early mining activity, the Mines Company sank the Philadelphia No. 1 and Philadelphia No. 2 shafts on the adjoining claim to the northeast, following a dispute with the mine owners. From this time forward, the main production shaft was the Philadelphia No. 2. It was 280 ft deep at the time of the most detailed mapping of the workings in its vicinity (1931). Later, a survey by a G. F. Chock (undated but traced by a Fred W. Becker in November 1938) was used to generate longitudinal section in "the plane of the vein". This section shows the Philadelphia No. 2 to extend below 300 ft, with levels and stoping to what appears to be the 250 ft level. Other records indicate that the Philadelphia No. 2 Shaft reached 500 ft, a common depth for principal development shafts in Mohave County gold mines at the time. However, there are no records pertaining to the Arabian mine that indicate stoping to this depth. The shaft was originally timbered through a muck pile and is inclined about 60 degrees near the present collar, flattening with depth according to the dip of an ore shoot, about 53 degrees. Most available records indicate levels at 100 and 200 ft; other records mention levels at 80 ft and one map shows a sublevel originating along the Philadelphia No. 1 Shaft at 60 ft.

Stoping was reportedly accomplished through shrinkage methods. In addition to the stopes shown on the Chock survey, a series of large stopes breaks to the surface as tabular voids 5 to 15 ft across with random pillars, dipping moderately, and widening beneath the surface. These surface stopes were probably extracted after Chock did his survey, as his longitudinal section shows ore passes in the vein but no stoping above the 100 level.

Production reportedly reached 50 tpd for certain periods of operation; altogether, production was in the neighborhood of 50,000 tons.

Underground, the drifts run chiefly along the strike. Crosscutting is indicated on old maps to have reached the footwall contact with the granite and the hanging wall contact with the gravel. An efficient means exists in the subsurface for ground water in the rhyolite complex and gravel to reach and flood the workings. The 100-level drift between the Philadelphia No. 1 and Philadelphia No. 2 shafts was reportedly caved in 1931.

Other miscellaneous workings, including a shaft, and an adit extending back into the granite footwall mass, found several thousand feet southwest of the main mine workings, and a vertical shaft further to the southwest toward Bullhead City. The shafts are presently filled a short distance below the surface and are not accessible now, even if they ever connected to the main workings, which is doubtful. The adit system is small and not connected to the main mine workings, either. The hilltop behind the workings contains numerous trenches, shallow prospect pits, and short adits, all of which are above the main shaft elevations.

Because of the flooding, none of the mine levels below the "100 level" could be accessed without extensive pumping of the mine. Water levels now are very similar to those reported in the records from as long ago as the 1930s.

1.2 Purpose

The purpose of the work was to assemble information and document the occurrence of underground workings with respect to the proposed roadway improvements and right of way at the surface, so that the potential for subsidence and associated road failures may be minimized. Accessible portions of the underground workings were mapped and surveyed, to the extent that safe access permitted. The positions with respect to the surface of the inaccessible workings were indicated by extrapolation of available records, on the basis of the survey.

1.3 Scope

Because not all portions of the underground workings are accessible, it was not feasible to directly observe and measure the position, dimensions, and condition of the deeper workings, some of which were apparently developed subsequent to the available records, which date to the 1930s. The underground survey pertained to those workings that were safely accessible without extraordinary effort, such as pumping, resupporting, or underground construction.

The scope entailed three phases: an initial reconnaissance and site briefing, the underground survey with photographic documentation, and the preparation of mine level maps and cross sections showing the relation of the workings to surface features. Standard mine surveying methods were used. The general conditions of the accessible workings were observed and recorded with notes and photographs. The initial reconnaissance included an overall site inspection with notation of all surface features according to station and offset from roadway plans provided by ADOT.

ADOT provided available mine records consisting chiefly of reports, mine maps of various dates and scales, and journal articles; aerial photographs, survey notes, and site topography. EI tied the principal shafts and surface stopes in to the existing survey control.

2.0 TECHNICAL APPROACH

2.1 Overview

Work was carried out in three phases: an initial reconnaissance and site briefing, the underground survey with photographic documentation, and the preparation of this report, mine level maps, and cross sections showing the relation of the workings to surface features.

2.2 Phase 1 - Reconnaissance, Inventory, and Site Conditions Briefing

The EI team reviewed and correlated the available mine maps and other information found in the literature, to develop a general understanding of the mine development and likely underground situation. Those workings that were indicated in the records to have potential to extend towards the roadway any significant distance were indicated to ADOT personnel in the field at the site briefing, and inaccessible workings were identified.

A ground reconnaissance was made of the area, and the depths and dimensions of mine features were noted on a topographic map. Later, these were assigned station and offset according to the ADOT road stationing shown on the plans.

2.3 Phase 2 - Underground Survey and Mapping

2.3.1 Site Safety Plan

Safety was a paramount concern. EI performed its work according to a Safety Plan conforming to the ADOT confined space procedures and approved by the ADOT safety department. It included verification of the mine atmospheric conditions, and recognition of physical hazards. Local medical facilities were notified, and the Hualapai Fire Department provided personnel on standby at the site during all underground activity. EI also had a person at the surface full-time whenever underground work was ongoing, who was in communication with those underground.

2.3.2 Subsurface Access

Subsurface access was obtained using ship's ladders. At the Philadelphia No. 1 Shaft, the ship's ladder was hung or draped over a pipe framework placed over the shaft collar (see Photo 2). In this way a free-hanging condition was established at the collar and rocks or debris was less likely to be dislodged by movement of the ladder and fall onto persons below.

At the Philadelphia No. 1, the shaft collar timber was found to be in good condition, although there was a considerable hazard from collapsed ladders and old wooden shaft guides hanging in the shaft. These held back significant rocks that had fallen into the shaft. To alleviate any chance of personnel working in the shaft with loose debris or rocks overhead, the old ladders and other debris was hoisted out of the shaft and discarded. The ladders were later destroyed to prevent unauthorized replacement of these hazards into the shaft.

At the Philadelphia No. 2, there was no way to set the pipe framework without disturbing the old timber loading platform and the considerable debris atop it, which posed a potential for clogging the shaft or damaging the fragile shaft collar timber if it fell and would certainly have obscured visibility and compromised air quality due to dust in the shaft. Therefore, EI set pins at the collar to affix the shaft ladder at the surface. Concern for damaging the shaft collar timber, and the very limited working room around the collar, prevented more than 35 ft of ladder from being lowered into the Philadelphia No. 2, although more could have been lowered in an emergency. Further access had to be gained by climbing down the old steel rail in the shaft, and this prevented transferring much gear or material for bridges, etc. underground.

Comparison of the old records with present conditions reveals that the Philadelphia No. 2 Shaft no longer collars at the same elevation it originally did. Shaft timbers once extended about 44 ft below the collar; they presently stop a little over 10 ft down. Apparently the dump material that once comprised the shaft walls has been mined, and this has disturbed the collar timbers and surrounding fill considerably. The lowermost 4 courses of collar timbers are loose and hanging, and an unknown number of the bottom ones have detached in the past and have been lost into the shaft. The courses of timber on the entire north rib are not in contact with the shaft wall due to erosion of the old fill surrounding the collar. Altogether, there is no way to accurately relate the current to the former position of the collar. The bottom course of shaft timber at the invert is undercut by approximately 3 ft in loose fill.

This condition is extremely hazardous; during the one trip into the shaft made by EI the collar timber loosened noticeably and the surrounding fill was frequently observed running out in small quantities from beneath the timbers, due to the disturbance. Therefore the EI Project Manager determined that exposure time in the shaft should be minimized to reduce the chance for a cave-in, and the reconnaissance was kept brief.

If further exploration through the Philadelphia No. 2 is to occur, the collar will at the least need to be stabilized, which would probably require excavating the collar to firm ground and retimbering.

2.3.3 Survey Methods and Notes

A theodolite was used to turn the angle and plunge of the Philadelphia No. 1 shaft centerline off a baseline established on the surface, by sighting to a plumb bob affixed with reflective tape that was left hanging from a spad at the shaft bottom earlier. The underground survey was performed by using a transit. Conventional mine surveying methods were used, taking advantage of existing spads that were renumbered for the purposes of the survey.

The stope at the bottom was shot in with the transit using azimuth-and-tape. Drift wall sections at waist height were taken by the offset method, using a tape strung tightly between spads. Because the winze was inaccessible, its vertical dimension was not surveyed below its opening at the "60" level.

The Philadelphia No. 2 shaft inclination could not be safely measured with a transit. However, a good approximation of the inclination was obtained during the short underground period by laying a clinometer along the rail, which in the lower half of the portion above water level is still well-fixed to the invert and parallels the shaft axis quite closely. Distances relative to the present shaft collar were pulled with a 100-ft tape. No spads were found in the portions examined that would correspond to available survey data showing spads, and stopes cut the accessible workings to either side of the shaft. Sketches of the drift layout off the shaft were made.

Both the Philadelphia No. 1 and No. 2 shaft collar locations were established at the surface using a theodolite and an EDM for distance. In the case of the Philadelphia No. 2, a major uncertainty lies in relating this location to previous mapping of the shaft, for the reasons already described. It is also not certain that the Philadelphia No. 1 shaft collar is in its original location, judging from the depression around the collar, although the error is not as great as it is for the Philadelphia No. 2.

The general conditions of accessible stopes, drifts, and shafts at each station, were noted and documented with photographs.

2.3.4 Surface Tie-In and Site Plan

The locations of the shaft collars and the respective starting points of the underground survey were tied in to the existing surface survey for the roadway, so that the location in plan view of the mine workings accessed can be related to the road alignment and the right-of-way.

2.4 Phase III - Mine Level Plan, Cross-Sections, Site Report

Workings recorded in the survey, or indicated in the records, and that pose an apparent threat to the integrity of the roadway, were depicted on maps, and cross-sections, which are submitted separately. The assessment of the integrity of the mine workings and the likelihood and character of potential threats to the roadway due to the presence of the workings beneath was based on judgement, as mechanical analyses were not parts of the Scope.

Correlation of existing records with the ADOT road construction plans were relied upon extensively. Substantial effort was needed to assemble these records in the absence of direct underground observations and measurements. The principal lack is the definition of the extent of stopes in inaccessible areas. Underground observations showed that the stopes cannot be accurately described as regular, tabular voids that have consistent orientations.

A map of the accessible accessways surveyed was prepared on reproducible media, at the same scale as the topographic base map, and depicting survey control common to both maps, so that the relationship between mine and surface can be ascertained. Approximate locations of workings not safely accessible were also indicated and differentiated by hidden lines from those actually measured.

Illustrative relationships of the new roadway alignment to workings apparently underlying the new roadway alignment were depicted on conceptual cross-sections. The cross-sections provided by ADOT do not extend far enough northward to cover the areas indicated in the records and by the field observations to potentially be underlain by stopes or significant workings. Therefore, cross-sections showing typical relationships were developed from the site topography and the available mine maps. These cross-sections are vague because the extent of the stopes on the deeper levels cannot be accurately developed from the existing information.

3.0 OBSERVATIONS

3.1 Philadelphia No. 1 Shaft

The Philadelphia No. 1 Shaft is inclined downward at an overall angle of 57 degrees. It opens at the bottom into a chamber that probably served as the shaft and loading station. Rock conditions in the shaft itself are excellent; however, the fact that the collar timbers are now 2-4 ft below the top of the dump suggests that some timbers may have been removed along with the shaft appurtenances.

Spads were located in the shaft chamber and branching drifts that appear to be the same ones shown on the 1916 survey map. Unfortunately, the bearings and distances on the reproduction of this map are not legible in all cases, but the general layout appears to correspond quite closely to the results of our survey. The 1931 map indicates that a short drift extended along the strike direction; this drift location is now occupied by a stope, and the position of the drift is now a cemented masonry bulkhead (see photos). The full extent of the workings was surveyed on what is described as the "60" level by some and the "75" level by others (the latter agrees more closely with the measured slope distance of 71.00 ft from the top of the dump). The stope is not large and will not extend near enough the roadway to be of concern.

The winze was accessed and opens into a landing chamber about 15 ft below the level. The continuation of the winze was apparent and the ladder is still in place, but the opening has been clogged with timber, probably from the landing. Attempts to remove the timber resulted in a release of the free-running muck that has sloughed off the sides of the chamber, and the winze became plugged. The floor of the chamber slopes steeply and the muck tends to run into the winze, creating an entrapment hazard, so further work in the winze was stopped. The rock in the winze chamber is a strongly altered and sheared granite porphyry that spalls and sloughs readily.

None of the Philadelphia No. 1 workings appears to persist as far as the roadway. The furthest drift to the east is nearly filled to the back and stops at the contact with the gravel. The entire level seems to be above the water level at all times, and there are no drips or seeps, although some locations of minor past seepage were noted. The gravel is very dense and compact, and tends to fall in chunks. It may be weakly cemented.

An undated drawing prepared by others as result of some sampling done in the past, and provided by ADOT, shows a cross-section and level map of the workings off this shaft, together with the locations of many assay samples. It correlates closely with the sample numbers, which were prominently painted yellow on the ribs at many places.

The ribs are generally drummy and the rhyolite, though silicified and intensely fractured or crushed without much clay, appears to be fairly ductile. A fault along the drift over to the winze contains as much as 1 ft of slickensided, clayey gouge, and has spalled moderately. The stability of the workings is probably attributable mostly to the absence of rock stress, owing to the shallow depth.

3.2. Philadelphia No. 2 Shaft

As described above, the Philadelphia No. 2 shaft was accessed but the poor stability conditions around the collar precluded bringing surveying equipment into the shaft safely. Slope distances to levels and breakthroughs were pulled with a tape to the surface, and the inclination was measured at 48 degrees in the upper part and 50 degrees in the lower part. Available records indicate that the shaft was steeper in the timbered portion.

The timber sets are, as described before, no longer in contact with the fill that surrounds the shaft. The lower courses of shaft timber have come apart, and rock and soil are running in behind the remaining timbers. Presently, the lowest timber is about 10.7 ft below the upper course. As the timbered section was originally about 42 ft on the slope (scaling off the 1931 cross section) about 30 ft of timber have been removed. It is uncertain how many courses are now missing from the bottom, however, so this is only an estimate.

The lower course of timber is overhung 2-4 ft and the weight of the ladder hanging over the lip of the overhang tended to disturb the entire collar area, so no further ladder was hung in the shaft, and no attempt was made to add weight and disturbance by making multiple trips carrying equipment.

Below the collar and the fill contact, the rock conditions are generally fair to good. The shaft is dry above the permanent water level in the bottom. Below the timber, the shaft is generally 8 ft by 8 ft in cross-section. (Layne, ca. 1915, describes all the shafts on the property as being 10 x 7 clear.)

About 30 ft below the surface is a shallow alcove that provided access to a drift running back to the west, now caved, that probably accessed the R-2 shaft.

At a measured slope distance of 50.8 ft below the collar is the invert of a breakthrough that accesses the top of the extensive stope on the Kingman side of the shaft. The stope cannot be accessed directly as it drops very steeply; it contains many pillars of varying sizes.

The same stope is accessible through a breakthrough on the same side at a measured slope distance of 67.7 ft. Allowing for 30 ft of timber removed, this corresponds to the "100" level in depth and agrees closely with the slope distance of 94 ft shown on Chock's (1938) longitudinal section. A similar breakthrough was found on the opposite side of the shaft. As is shown by Chock, the "100" level has been stoped out and cannot be followed more than a few tens of feet in either direction from the shaft. No spads were found at the level station or in the drift intersection to the south, although Chock shows one in the intersection. A reflector was hung in the shaft at the "100" level with the intent of being able to see it from the surface, but it is not visible when the outside sunlight is bright.

The stopes are very extensive both down the dip and along the strike. It was possible to discern the continuation of the "100" level past the stope in both directions, although reaching them was impossible under the circumstances. To the north, it appears that the "100" level has been partially filled with muck. To the south, the level appears to be open, but it doglegs to the left and conditions beyond remain unclear. The accessible portions of the "100" level coincide closely with Chock's and other maps. However it appears that an ore chute was added above the stope on the south side of the shaft that is not shown on any maps, and this suggests that a shallower stope and some deeper workings may not be shown on Chock's map.

The stopes appear to be in generally good condition, despite prevalent ravelling and drummy ribs. No large slabs or extensive cracking was noted.

The striking feature of the stopes in terms of assessing their dimensions and stability is the irregularity in dimension perpendicular to the dip. Vertical distances to the stope backs range up to an estimated 40 ft and stope widths range between 10 ft or so and at least 40 ft. Apparently, stopes were widened along ore shoots that may have been elongate perpendicular to the general structural trend. There are no level maps that depict the dimensions of the stopes in this direction, although it appears that the Chock longitudinal section may be a good source of estimated stope lengths along the strike. Layne's report (ca. 1915, p.9) describes the "hanging wall ore shoot" at the 200 level as being about 35 ft wide, which may be indicative of stoping widths.

The stopes that break to the surface apparently obliterated the three older shafts, which now can be generally seen as open voids extending to depth. These stopes are not shown on the Chock longitudinal section and were apparently extracted sometime after 1938, perhaps associated with the further activity on the property in the early 1940s. USBM IC 6901 mentions shrinkage stoping activity above the 80-ft level ("100" level) in 1934, and that some drifting was then under way to get under an ore shoot that contacted the gravels on the 180-ft ("200") level. It reported production (mill heads) of 50 tpd.

3.3 Surface Features

Surface reconnaissance revealed numerous short adits, shallow prospect pits, and sampling trenches. These are inventoried on Table 1. None of the other workings

TABLE 1 - LOCATION AND TYPE OF MISCELLANEOUS FEATURES

Point	Description	Station	Offset
1	trench 30'x 15'x 3'	428+96	103L
2	trench 30'x 15'x 4'	428+95	127L
3	hole 12"dia x 4'dp	428+50	113L
4	trench 30'x 10'x 4'	428+17	138L
5	hole 15"dia x 3'dp	428+05	130L
6	hole 18"dia x 4'dp	427+43	135L
7	hole 17"dia x 4'dp	426+36	156L
8	hole 17"dia x 4'dp	425+78	164L
9	trench 100'x 20'x 5'	424+07	185L
10	trench 75'x 15'x 10'	421+71	230L
11	hole 15"dia x 6'dp	420+37	424L
12	hole 8"dia x 8'dp	418+29	360L
13	trench 25'x 15'x 5'	418+54	320L
14	adit 3'w x 5'dp	418+25	260L
15	2 holes 8" x 8 ft sep	418+81	255L
16	pit 30'x 20'x 8'	411+04	81L
17	pit 50'x 30'x 12'	410+87	62L
18	primitive shaft 25'	407+84	83L
19	trench 15'x 5'x 3'	403+10	298L
20	hole 10" dia	402+79	299L
21	trench 10'x 10'x 5'	402+61	283L
22	trench 20'x 8'x 8'	402+54	263L
23	hole 60" dia x 3' dp	402+88	138R
24	trench 20'x 6'x 4'	399+40	48R
25	trench 50'x 15'x 8'	431+95	316L
26	trench 25'x 10'x 6'	431+25	246L
27	trench y-shaped	431+04	267L
28	trench 25'x 8'x 5'	430+95	312L
29	adit 2'h x 3'w x 5'	430+75	321L
30	trench 20'x 5'x 3'	430+68	311L
31	adit 2'h x 3'w x 10'	430+54	310L
32	adit 4'h x 3'w x 4'	430+39	316L
33	trench 15'x 8'x 5'	430+25	302L
34	adit 5'h x 6'w x 40'	429+98	311L
35	adit 5'h x 4'w x 40'	430+10	270L
36	trench 20'x 12'x 5'	429+95	254L
37	powder magazine (adit)	333+37	45R
38	Loading Dock (Timber)	432+63	111L

TABLE 1 - LOCATION AND TYPE OF MISCELLANEOUS FEATURES (continued)

Point	Description	Station	Offset
	Philadelphia No.1	435+02	261L
	Philadelphia No.2	430+65	110L
	adit 4'x 6'x 50'	418+05	260L
	shaft 5x7 22'@ 55 deg	418+75	255L
	quarry (lower)	410+83	62L
	quarry (upper)	411+02	80L

indicates any potential to connect with the main Arabian Mine or the stopes that were part of the Philadelphia Group described above.

The inclined shaft and nearby adit on the Rising Fawn property near Station 418+50 are well off the road and the distance from the main workings and the size of the dumps associated with them indicate that these are not of great enough extent to reach either the road or the main property. These may be discerned from the discussion by Layne, and are still visible; the shaft has caved below a depth of about 20 ft.

Layne also mentions the "Rising Fawn Tunnel" and a 60-ft-deep vertical shaft on the Rising Fawn Claim. These appear on a claim map of the Rising Fawn and were apparently covered or mined through as the "Arabian Cut" (USBM IC 6901), a benching operation along the surface expression of the vein nearly 150 ft high and 60 ft wide, was being mined in the 1930s. The Tunnel was 197 ft long and contained a 100-ft deep winze, a 57-ft-long crosscut (in a direction toward the road), and a decline on the vein. Layne describes the 60-ft-deep shaft, 70 ft south of the tunnel, as being discontinued because the vein was too disaggregated by an andesite intrusion. The shaft was apparently at the foot of the hill and is no longer visible. The position of these workings at present cannot be ascertained. Layne speculates that the crosscut had to go another 120 ft to reach the hanging wall. Even if it had, it would have stopped about 50 ft from the road. Because no further evidence or mention of heavy production from these features has been found, it is concluded that the crosscut probably was not extended.

Layne's description reveals another shaft, constructed "382 ft" south of the 60-ft-deep shaft on the Rising Fawn Claim. Plotting of this and comparing it with the claim map provided by ADOT indicates that the shaft referred to by Layne might have been the "No. 4 Shaft" shown on the claim map as being 50 ft deep. Such a shaft plots, depending on how the claim boundaries are aligned, within 40 ft right of the roadway centerline at approximate station 411+40 based on the claim map or, if Layne's 382 ft dimension is correct, potentially on the road at about 412+70. Regardless, there is no evidence of such a shaft at present, and if there were one in the vicinity in the past, it would probably have been filled in by the Bureau of Reclamation during construction of the road.

In any event, the shaft in the side drainage opposite 407+84 no longer appears to be the "Rising Fawn" shaft as we once believed; in fact, it does not appear on any records of the claim.

4.0 RECOMMENDATIONS

4.1. Stability of Stopes and Drifts

It appears that the new road alignment is underlain by stopes and drifts whose orientations, dimensions, or stability has not been observed. In formulating a plan to consider these factors, it is necessary to resort to judgement and inference. The chief uncertainty in extrapolating the location and condition of the workings at depth is the lack of direct access or other information indicating the width and condition of the stopes in the inaccessible areas, which happen to lie beneath the road.

It is unlikely that even substantial ground failures in single drifts could affect the road construction, unless such single drifts were very shallow. Most of the drifts are 4x6 or 5x7, and are deeper than 60 ft. One can infer that there are no such drifts beneath the alignment shallow enough to be of concern because the miners consistently avoided crossing through the gravels, which persist to well below the "100" level, according to the few cross-sections available.

Therefore, failures of ground in single drifts would not be of major concern for the stability of the road. In fact, such failures have occurred (the drift on the 100 level between the No. 1 and No. 2 shafts was caved in 1938; the drift toward the road off the No. 1 shaft has caved, etc.) and there is no evidence of apparent surface subsidence.

The potentials for failure of the stopes, and the effect any such failures might have on the ground surface, are other matters entirely. The stopes accessed are open or water-filled; there is no indication that any were backfilled. Rock mass strength is likely to be low in the intensely fractured rhyolites and very low in the pervasively altered granites, but the workings are generally open because rock stresses are not high at these generally shallow depths. Where faults with gouge were seen, considerable spalling and sloughage had developed in the immediate vicinities of the faults. Such faults could serve as the points of initiation of ground failures, and further weaken the rock mass. The spacings of the stope pillars indicated on Chock's longitudinal section suggest relatively strong wall rock conditions, consistent with the strength of a hangingwall of extrusive, massive rhyolite.

Where underground observations were possible, stope as well as drift deterioration in this case appeared to be a progressive occurrence characterized by ravelling and sloughage, rather than large-scale block failures. Stulls were used sparingly as stope support, if at all, so the deterioration of timber probably would play only a localized role in the potential for ground failures. The principal mode of stope support seems to have been pillars of natural rock, probably relatively barren vein material. All the pillars within the stopes observed are hourglassed to some degree; the smaller pillars more severely than the larger ones. This indicates that sloughage from the sides of pillars has been occurring in the past. However the length of time that the workings have remained open argues that the sloughage process is very slow overall, and should remain so unless major changes occur. Where the hangingwall is an extrusive, massive rhyolite, extensive spans could be maintained.

Major changes in water level would be expected to introduce further sloughing of pillars and perhaps lead to collapse of certain areas. Other possibilities would be excessive blasting vibration from the road construction, placement of considerable fill atop the mine workings, seismic events leading to slippage along faults, introduction of liquids into the mine, and so on. In the absence of such disturbances, the potential for ground failures during the life of the roadway is probably low, but cannot be quantified from currently-available data.

4.2. Subsidence Potential

Ground failures at depth do not necessarily result in surface subsidence, but in this case the considerable vertical extent of the workings, the presence of faults and other discontinuities that dip moderately to steeply, the presence of weakly-consolidated gravels, and the relatively shallow depths of the larger stopes beneath the road, indicate that collapse (as opposed to local stope wall sloughage) in stopes shallower than the 200 or 250 level would be very likely to affect the surface. The effect of collapse of deeper stopes is not clear, as these are shown in the record to be more limited in extent. The degree of surface movement would be dependent on the vertical or down-dip extent of the ground movement, but ground movements of feet to tens of feet could very well occur as a result of massive stope collapse, particularly if the collapse occurred at shallower depth so that collapsed material could move downward through water-filled workings. If any ground movement were to occur at all, discrete, large-scale surface ground movements are more likely than slow, persistent subsidence.

Such failures are rare but not unheard of in abandoned metal mines. They usually are precipitated by some sort of change, such as the introduction or withdrawl of water, or the loading of the surface by buildings or fill.

4.3. Effect of Blasting

Properly-conducted blasting at the distances presently under consideration is not likely to trigger the scale of stope collapse that would be prerequisite to large-scale ground movement, unless that collapse is imminent anyway. Both the granite and the rhyolite in the workings seem, by virtue of alteration and fracturing, respectively, to be inefficient overall transmitters of seismic energy. These appear to be the types of rock masses that will tend to absorb and dampen energy, which for blasting would have the effect of attenuating the incident seismic waves, damping them, and introducing a capacity for displacements. At the depths of interest, accelerations likely to reach the site from blasting of the hillside near the curve would be only a very small percentage of the existing rock stresses. Nonetheless, for an added margin of safety, we would recommend that the blasting be conducted with sequential delays such that individual holes are fired at least 25 milliseconds apart, so that the charge weight per delay is limited, in order to assure that accelerations remain small.

4.4. Further Exploration

Assessment of the risk of subsidence to the roadway will require knowledge of the actual depths and dimensions of the stopes that underlie the road or that are close enough to it to affect the road by draw effects. To measure these first-hand, the Philadelphia No. 2 collar would need to be stabilized and the mine pumped out, which is not advisable.

Instead, a core drilling program is recommended and should be followed up with borehole video work. The site topo gives suggestions for drill hole locations -- these are intended to penetrate stopes at various depths and that exhibit various spans on the Chock drawing. The shallower stopes may not have much rock between their hanging walls and the gravels, so caution will be needed. The drill holes need not be precisely located as the targets are large and the uncertainty in the depth and dimensions of the stopes is also large. It would probably be sufficiently accurate to locate the holes by compass-and-tape off the shaft collar.

It is recommended that the gravels be augered through and that the hole be cased in the gravel layer, noting carefully the thickness of the gravel. The rock should be cored with a split inner tube if at all possible. This type of drilling should be treated as a probing operation as well as a sampling operation. The extent of all rod drops and any associated "sponginess" in the rods below drops should be carefully noted. For holes below the water table, coring could be continued below voids, but care in regulating circulation should be practiced because it is more important to preserve the clarity of the mine water for visibility than it is to obtain core production in the footwall.

If a borehole video camera is to be used, the holes should be vertical. Angled holes present some advantage with respect to measuring the width of voids, but this is a small benefit when compared with the trouble angled holes cause in using and interpreting the data from borehole video observations. Ideally, the holes should be surveyed, because the dip of the strata could deflect the drill string, but the deflections should be tolerable at the depths of interest if the drilling is done carefully.

Before using the borehole video camera, adequate time should be allotted for the particulates in the mine water that will be introduced by drilling to settle out. The camera should be capable of focusing at extended distances and should provide adequate lighting to penetrate 40 ft or so. Apparatus ordinarily used by the well drilling industry to examine well casings will not satisfy this requirement. It will be necessary to record the direction of view, and an articulated lens is desirable. Distances will be difficult to estimate with a borehole camera but if some work is done at the surface viewing objects of known size and distance, an idea can be gained of the manner in which the lens delivers the image underground.

It is important not to rush borehole camera work. Depths should be recorded either on-screen or with a voiceover. It is advisable to let the camera sit for a few minutes before hanging it in a void to be sure the water is not flowing too fast to remove the apparatus. Repeated observations should be made of the borehole walls and stope boundaries to discern any open fractures or detachment surfaces as well as the condition and dimensions of the stopes.

Drilling logs should record fracturing, RQD, fluid circulation, and lithologic data, and should be correlated with borehole video data.

APPENDIX -- PHOTOGRAPHS

Photo 1 Philadelphia No. 1 Shaft. View down the shaft, taken at night prior to the mine entry. Note the generally intact condition of the collar timber. The loose timbers and ladders were removed prior to mine entry.

Photo 2 Philadelphia No. 1 Shaft. Hazardous timber and ladders were removed prior to mine entry. Here, a 20-ft section of damaged shaft ladder is being removed. Ship's ladders hanging off a temporary pipe framework were used to support the mine entry and mapping activity.

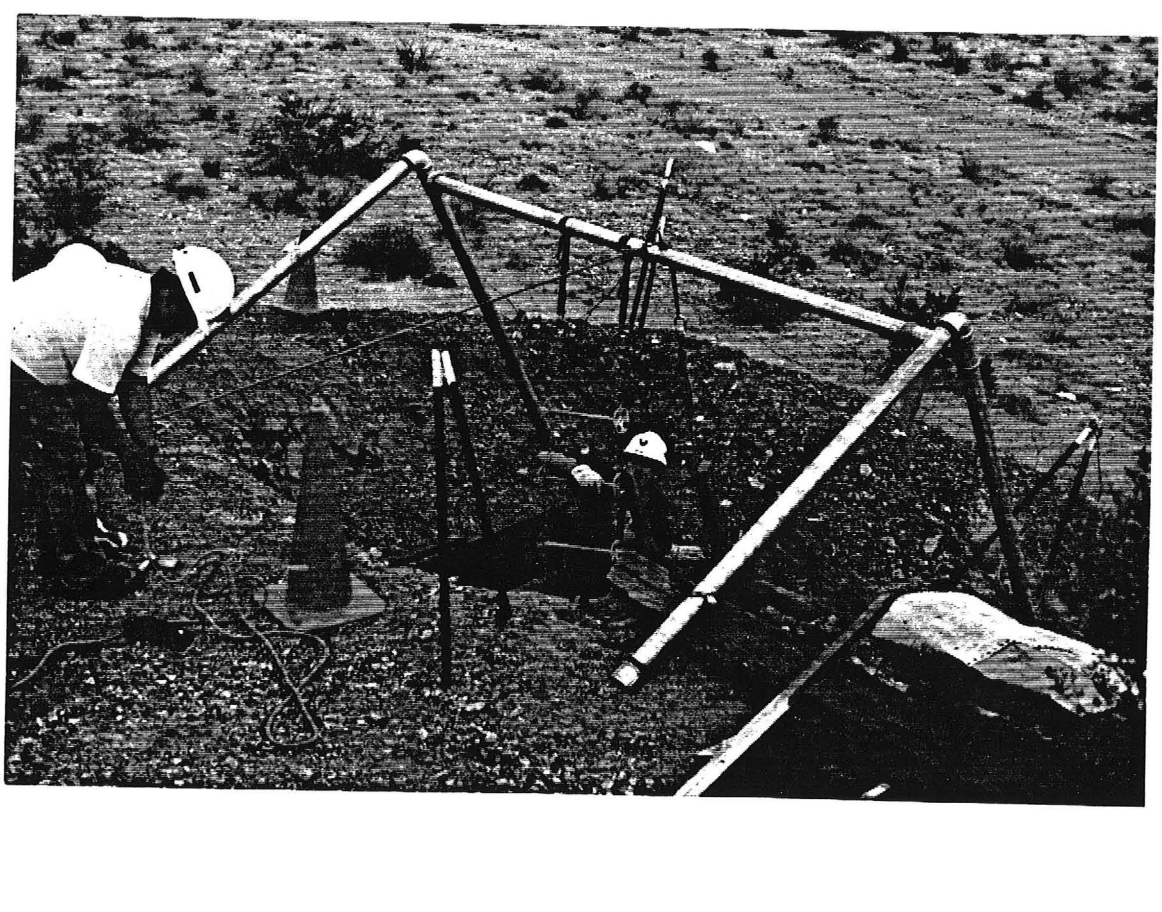


Photo 3 Philadelphia No. 1 Shaft. Shaft collar was tied in with a theodolite and an EDM. Note the proximity of S.R. 68 in the background.

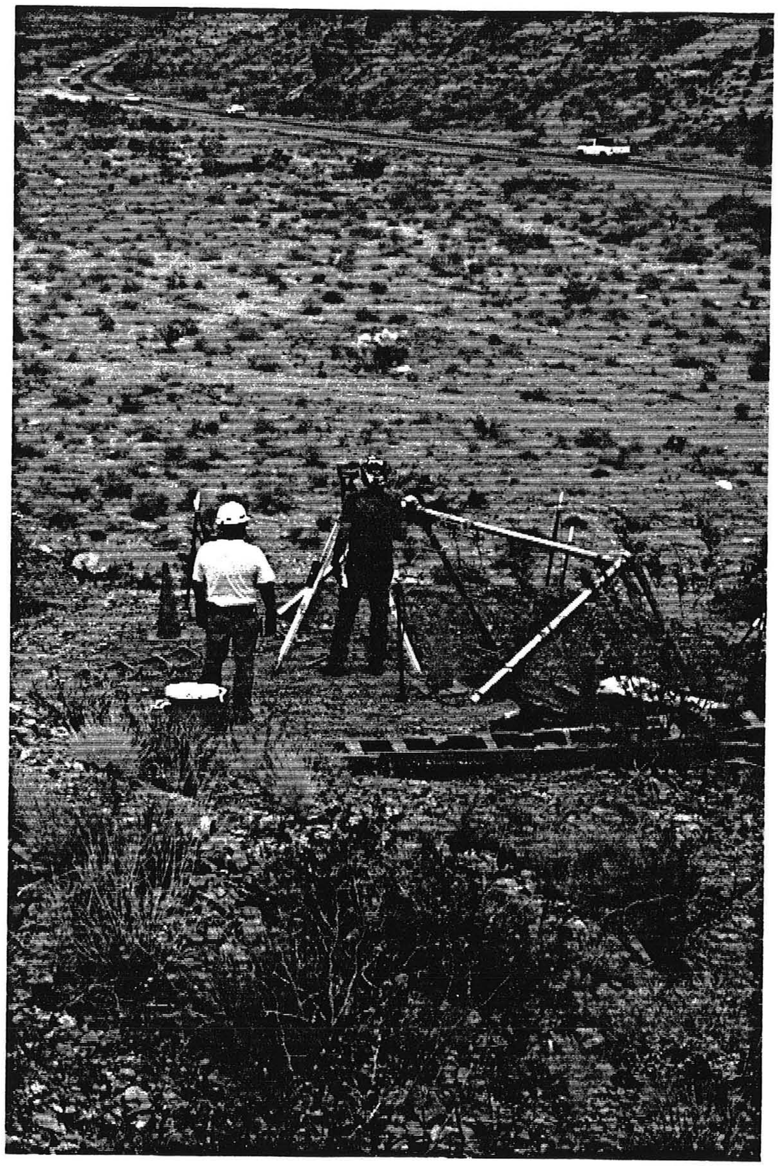


Photo 4 Philadelphia No. 1 Shaft. View ahead from existing spad (designated EI-1) at the bottom of the shaft ("60 level"), looking at the old shaft station. The drift ahead is in the direction toward the highway (same general bearing as the shaft) but dead-ends in granite and gravels. To the left is a stope and to the right is the drift over to the winze between the "60-ft" and "100-ft" levels. All workings on the "60" level were dry at the time of the survey and probably are dry most or all the time.

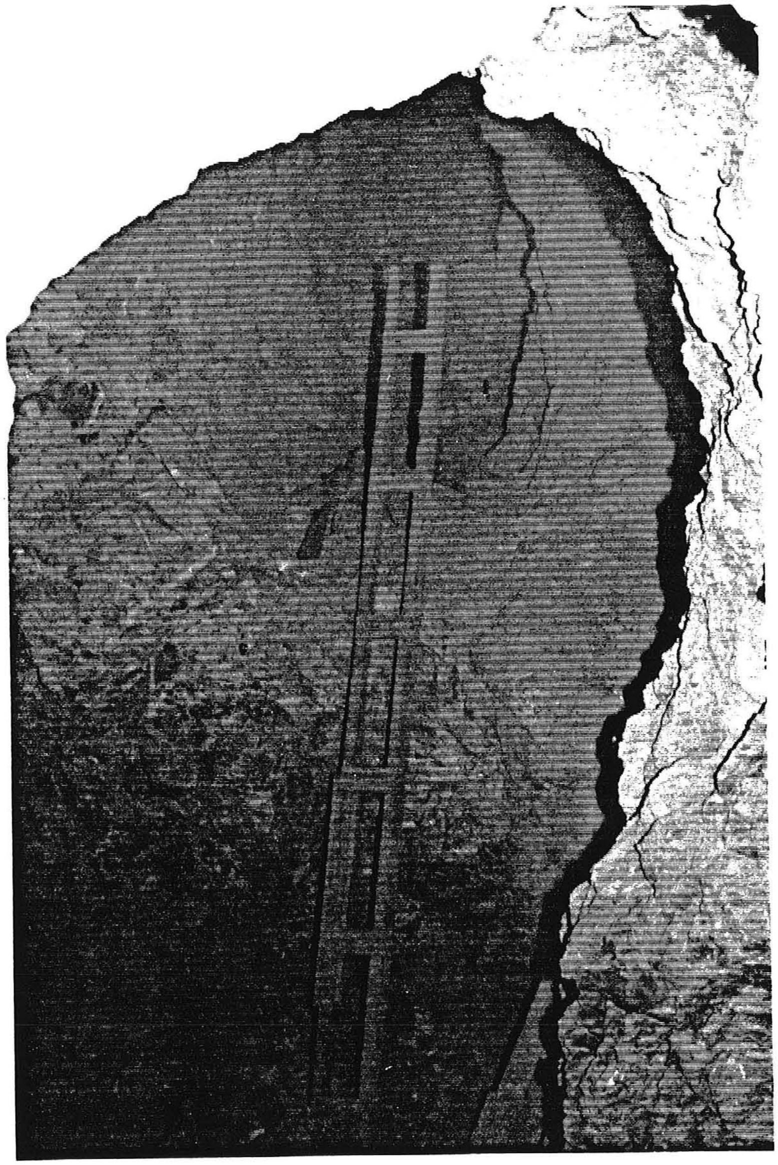


Photo 5 Philadelphia No. 1 Shaft. View ahead from existing spad (designated EI-2) at the shaft station ("60 level"). Shaft station invert is about 6 ft below the invert of the level. The strike of the vein is roughly transverse to the line of the photo. The yellow numbering corresponds to channel sample locations shown on assay maps provided by the Owner. Drift ahead dead-ends in granite and gravels.

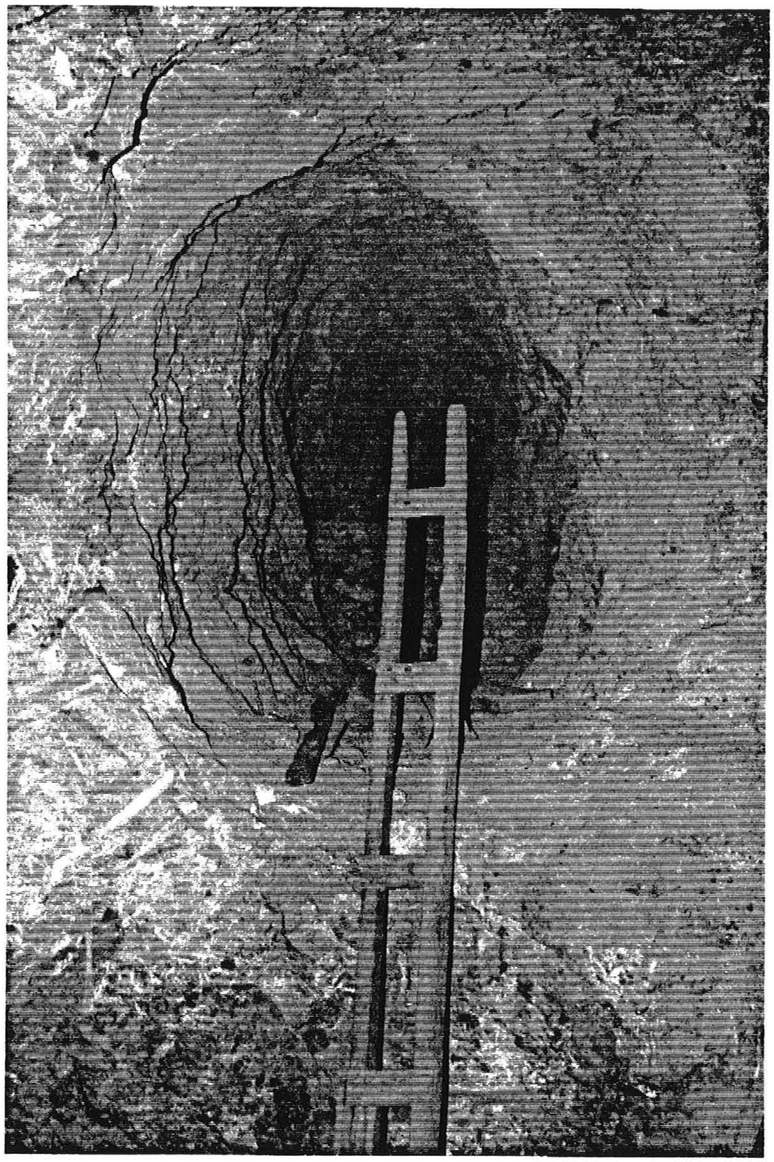
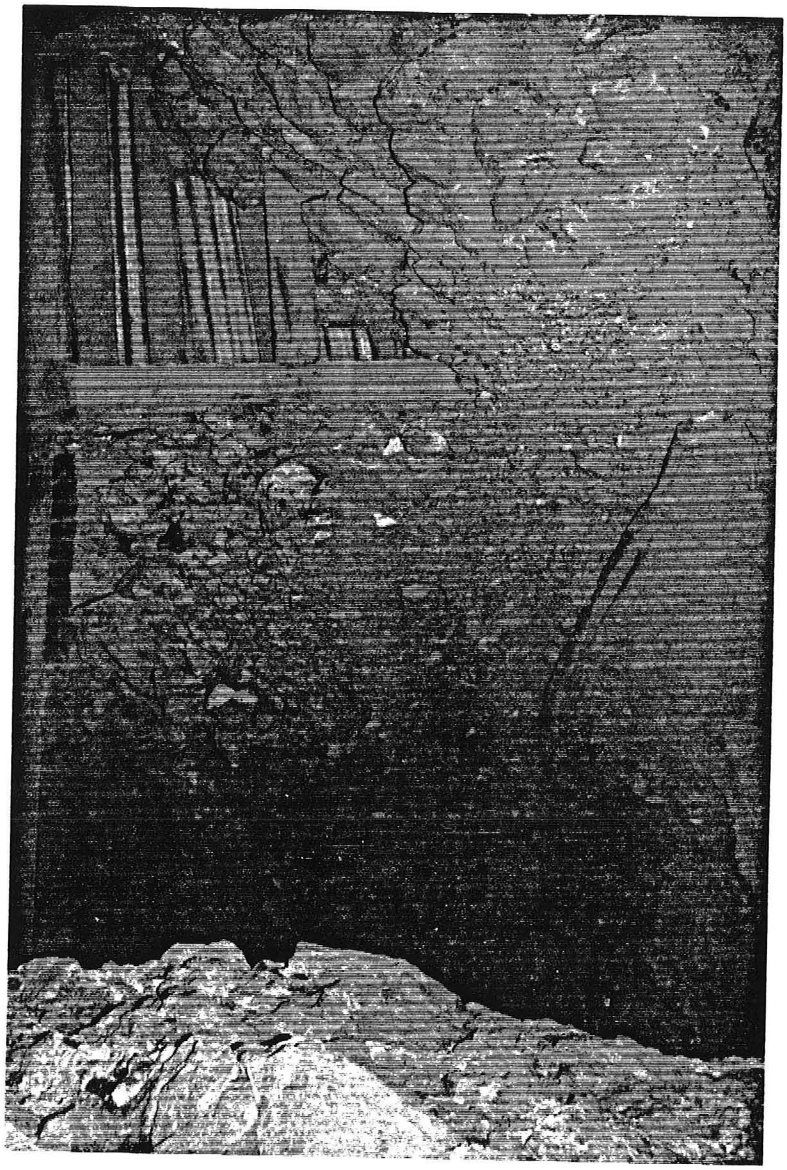


Photo 6 Philadelphia No. 1 Shaft. From shaft station ("EI-2") looking north-east up the strike at the end of the stope. To the right is a bulkhead that contains a loading chute. The stope is inclined upwards above the "60" level. Footwall and hanging wall are sheared and silicified rhyolite; the stope ends in gravels or heavily decomposed granite (center and right center). There is evidence that water seeps at times into the stope from an old drill hole that penetrates the gravel. The opening at extreme left is only 5 ft long and terminates in vein footwall.

Photo 7 Philadelphia No. 1 Shaft. View of stope shown in Photo 5 but taken from directly beneath EI-2 and showing the hand-laid masonry bulkhead, consisting of pieces of vein material in cement matrix.



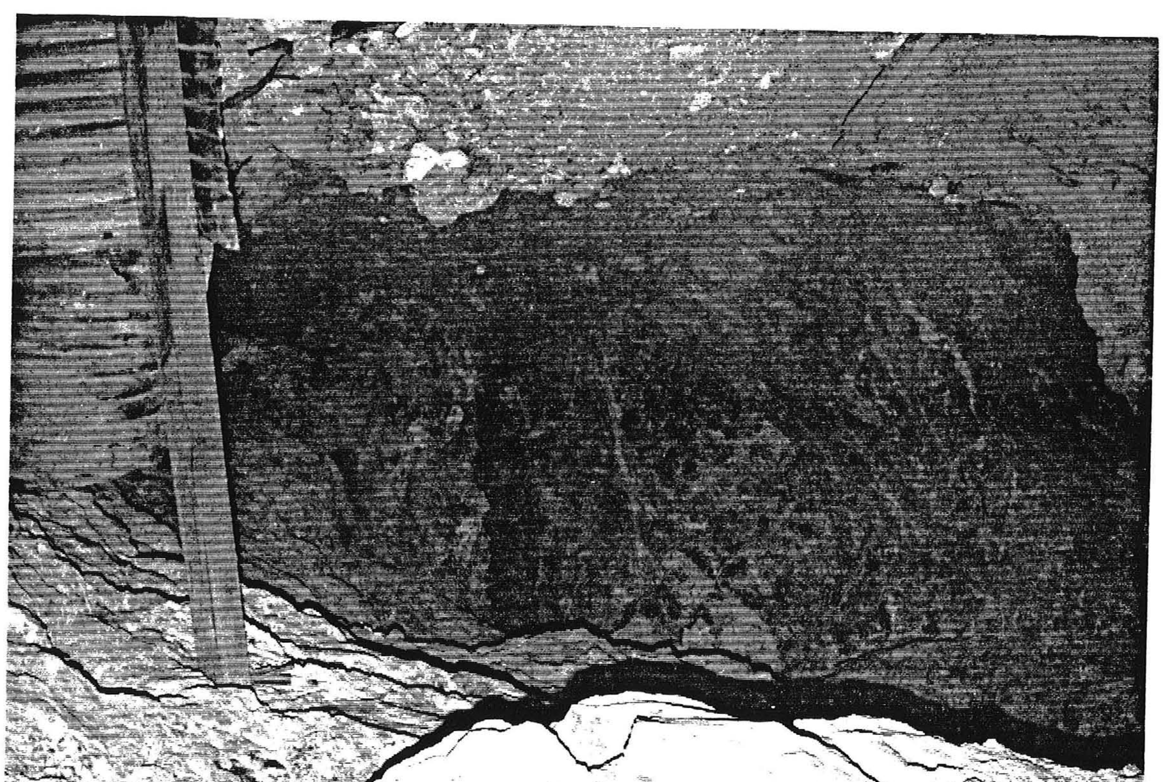
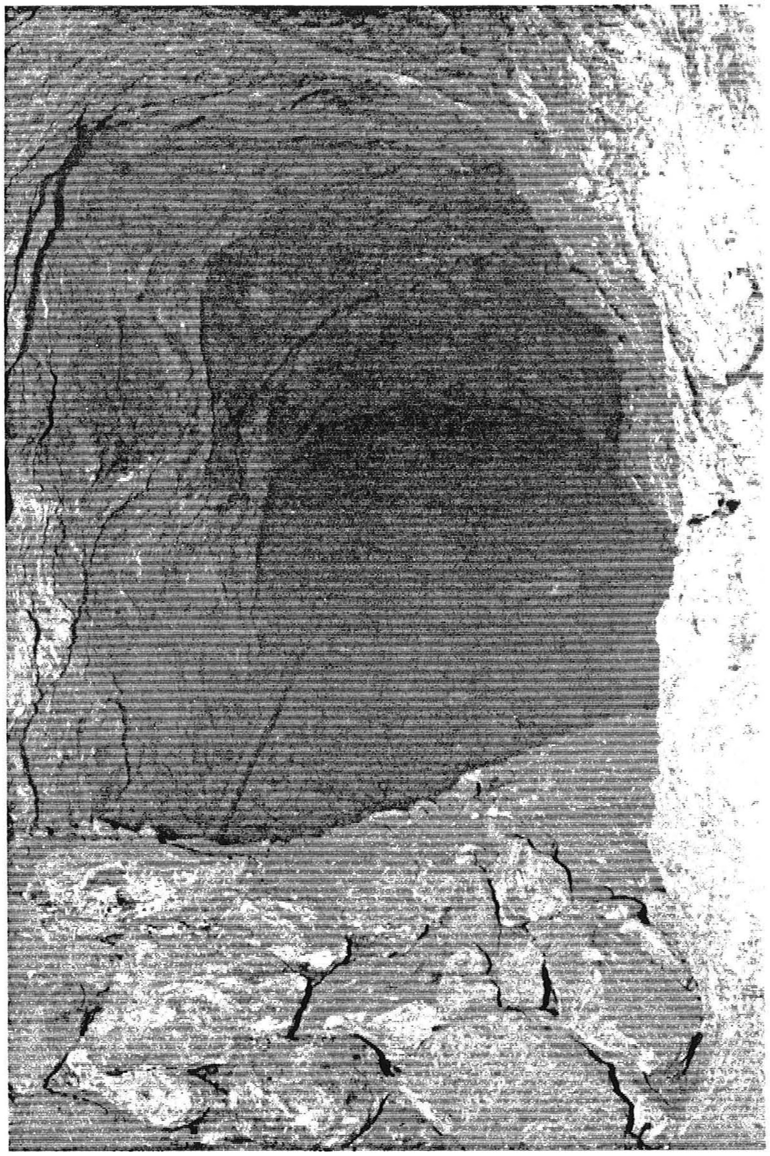


Photo 8 Philadelphia No. 1 Shaft. View of crosscut ahead of shaft bottom, taken from just in front of spad EI-2. See Photos 4 and 5. Orange spot in top center on back of drift is an existing spad, labeled EI-2a.

Photo 9 Philadelphia No. 1 Shaft. View from in front of spad EI-2a, showing termination of crosscut in gravels to left, in contact with granite to right. Note 2 in. by 2 in. wood block at center, and rail at left, for scale.



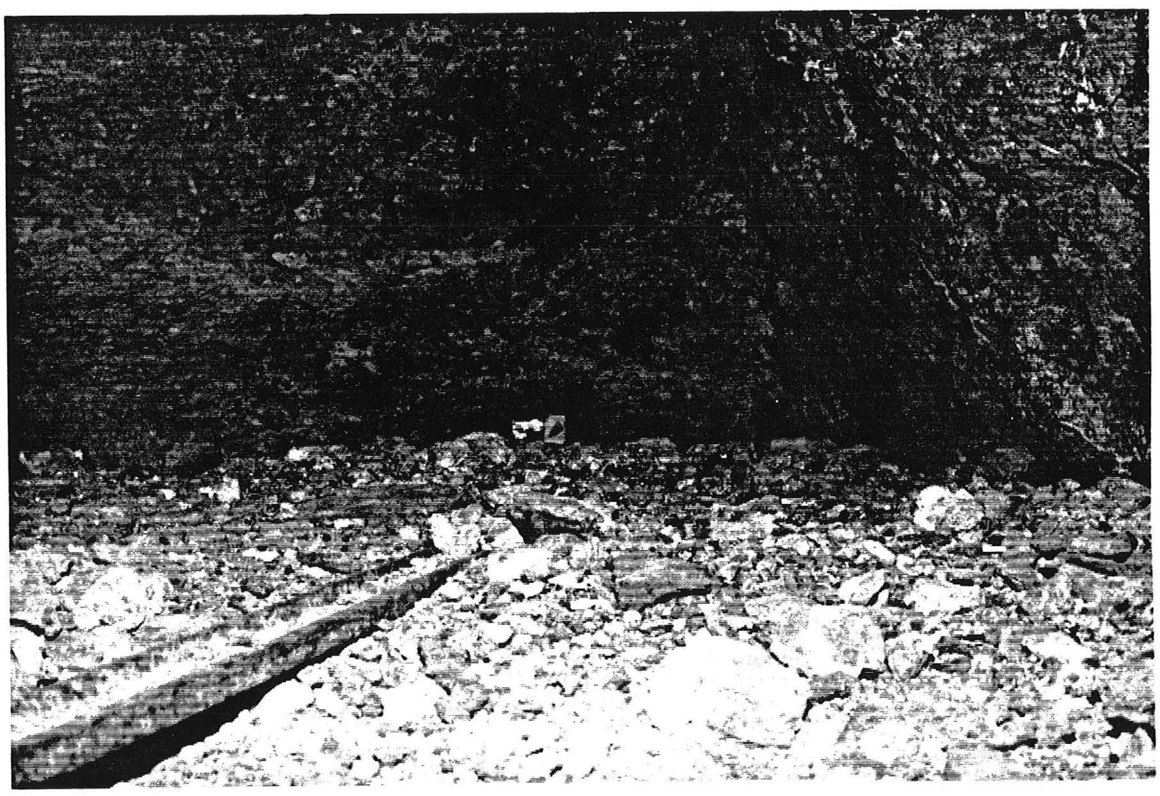
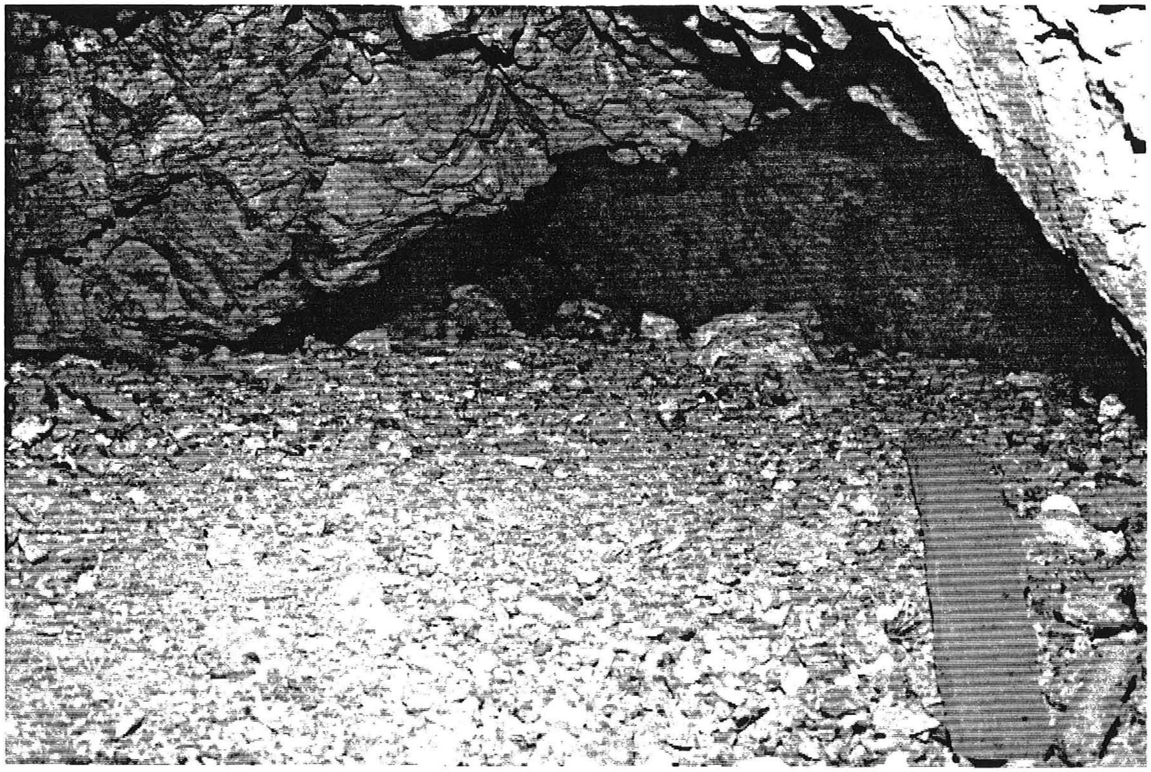


Photo 10 Philadelphia No. 1 Shaft. View from in front of spad EI-2a, of possible fork in crosscut to right of location of Photo 9. It makes an estimated 30-degree angle with the meridian formed by EI-2 and EI-2a. Caving makes access impossible. Note cactus thorn clusters in foreground for scale. The extent of this crosscut appears to be about 18 ft past the spad. The source of the muck filling the drift is uncertain.

Photo 11 Philadelphia No. 1 Shaft. View from the spad marked EI-2 down the drift leading to the winze ("60 level"); photo taken in the direction of the Philadelphia No. 2 Shaft. Lip of the shaft station is visible at extreme bottom. Note the spalling along a slickensided shear zone along the right rib. The existing spad designated EI-2R1 may be found at upper right center, and is located by the vertical orange marks painted on the ribs by the EI survey team.



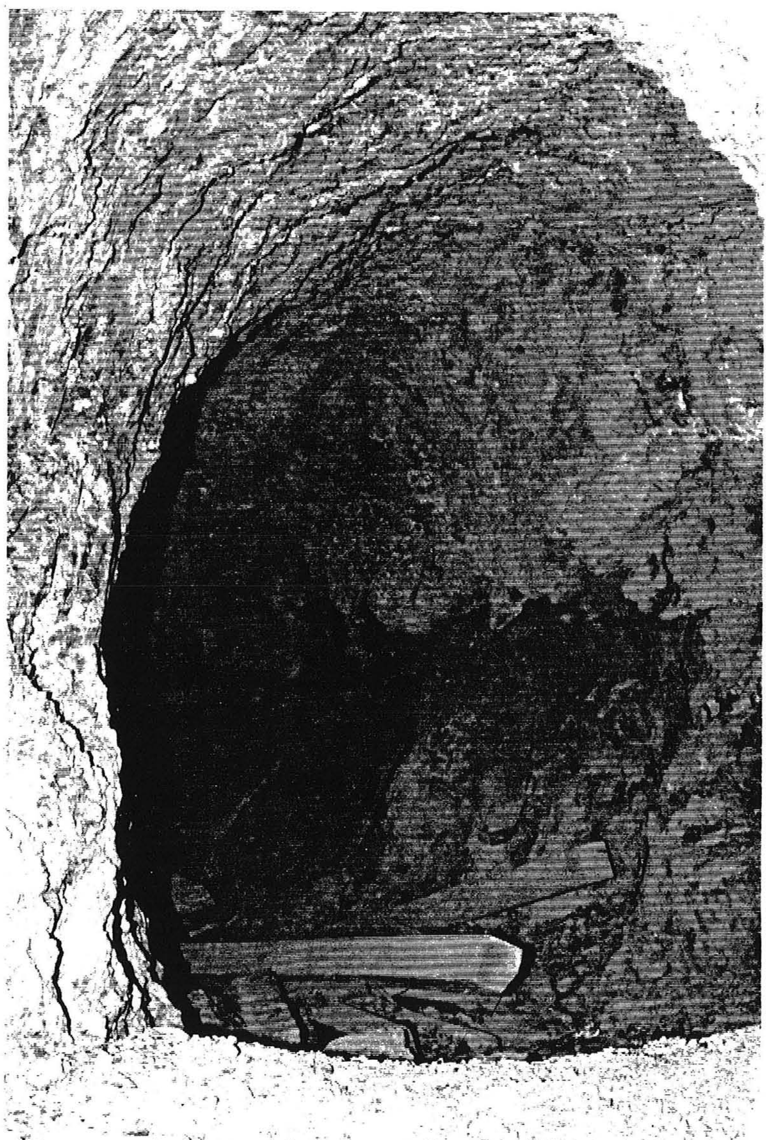


Photo 12 Philadelphia No. 1 Shaft. View towards Philadelphia No. 2 Shaft from the spad EI-2R1. Note the overhang along the shear zone mentioned above. The far-distant rib in the center of the photo is one rib of a crosscut to the left. The drift continues to the right. The existing spad designated EI-2R2 is in this intersection.

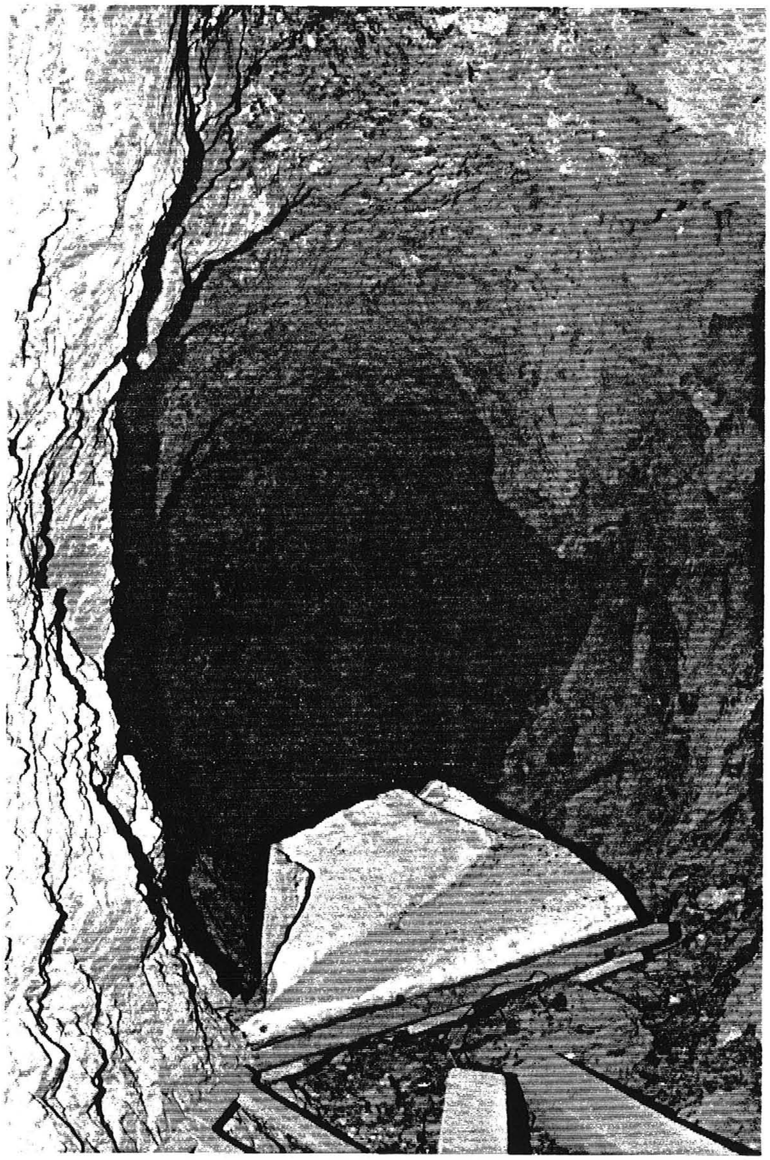


Photo 13 Philadelphia No. 1 Shaft. Severely altered and silicified rhyolite in the short crosscut to the left, view taken in the general direction of the highway from beneath EI-2R2. The vertical dimension in the photo is about 7 ft.

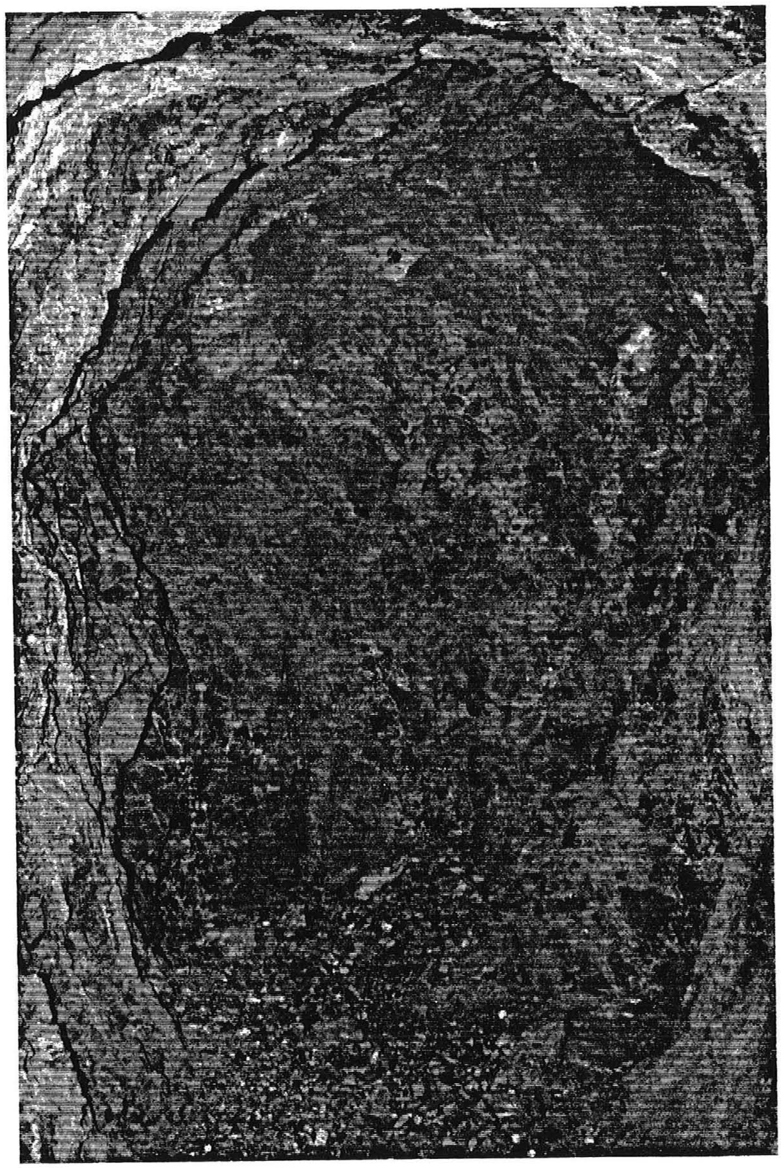
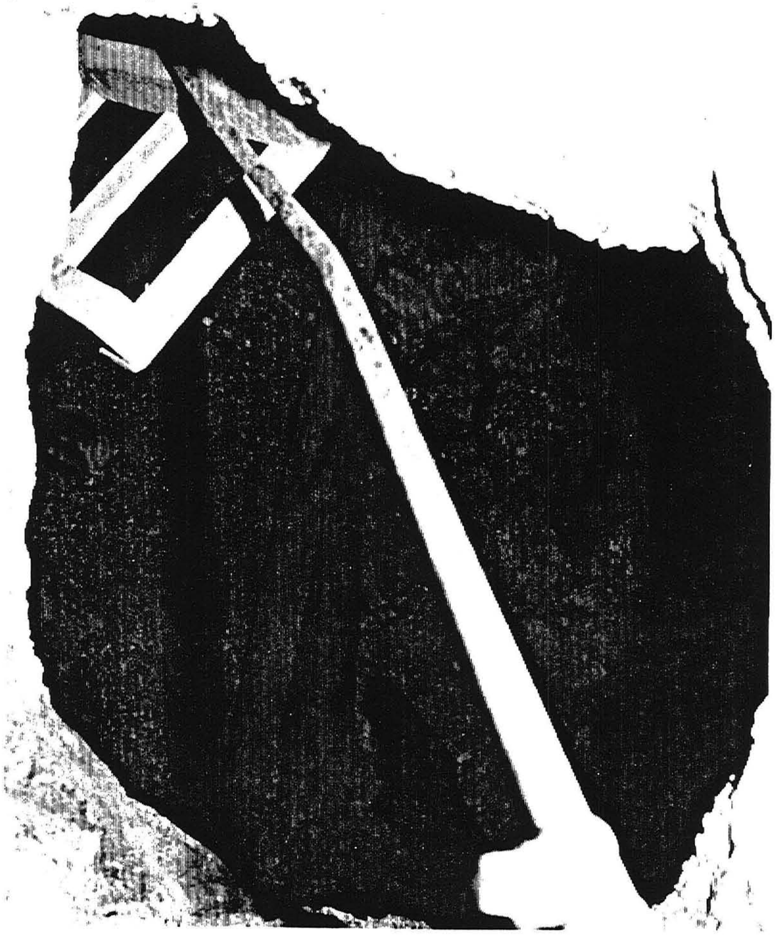
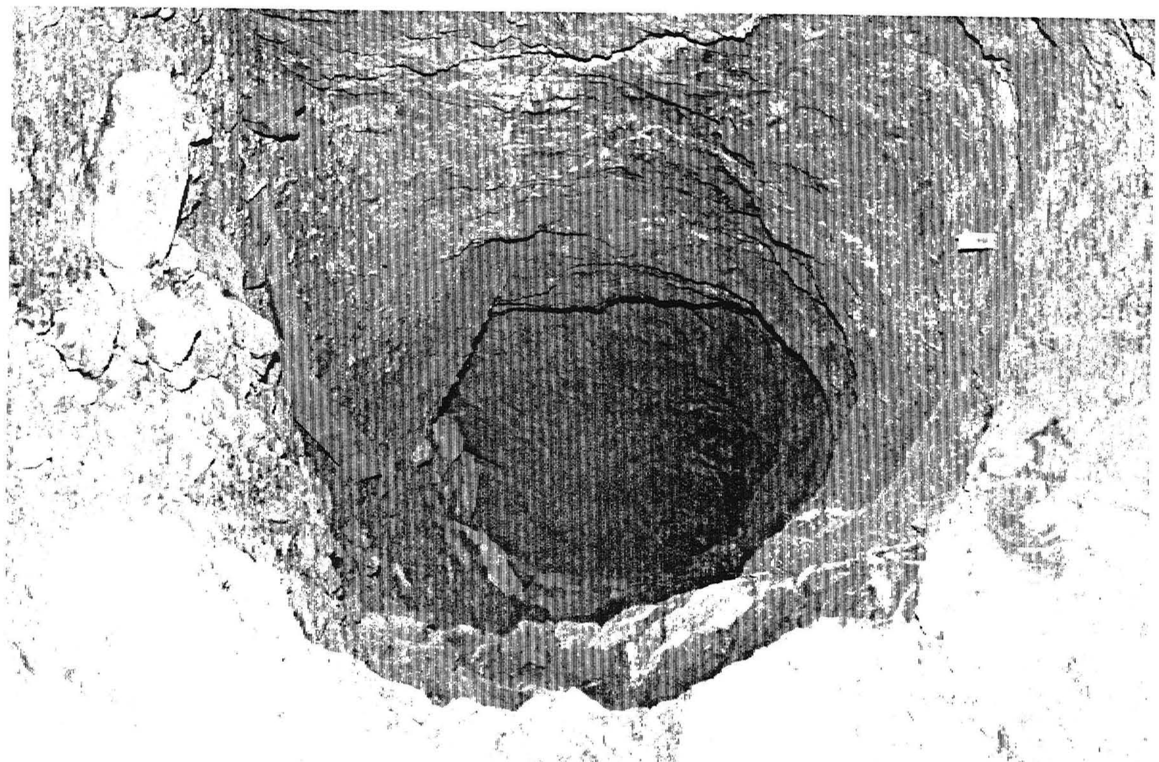


Photo 14 Philadelphia No. 1 Shaft. Photo taken from EI-2R2 toward the Philadelphia No. 2 shaft. The drift ends at the winze, which is where the water pipe projects up in the photo. An existing spad was noted atop the winze and was designated EI-2R3. The spad block at upper left was placed by EI but was not used in the survey. Note the ravelling of the left rib, attesting to the sugary fracturing of the vein material. The vein material is not blocky and not brittle. Contrast this ravelling with that of the right rib, which is block fall from the fault comprising the footwall.

Photo 15 Philadelphia No. 1 Shaft. View down winze, which reportedly provided access between the "60 ft" and "100 ft" levels. Winze is now filled with timber, probably from a landing, and clogged with caved rock that appears to have been derived from the chamber shown in the photo. The chamber is in an intensively-altered and clayey granite that is pervasively sheared, with considerable ravelling, and exhibiting slabby response to rock stress. No water was found in the accessible portions of the winze.





Note: color is off in this photo

Photo 16 Philadelphia No. 2 Shaft. View down the shaft; note the rail and the interfering timber at right. The timbering of the collar at left has lost contact with the ground, is sagging and loose, and very unstable.

Photo 17 Philadelphia No. 2 Shaft. View from old headframe site above shaft. Note that the shaft is partially covered by a loading platform built to accommodate removal of muck from the depression to the right, which was probably the location of the R-2 Shaft. Note also that the shaft collar timbers are now below the existing ground surface. At one time the shaft collar was near the elevations of the concrete footings in the photo.

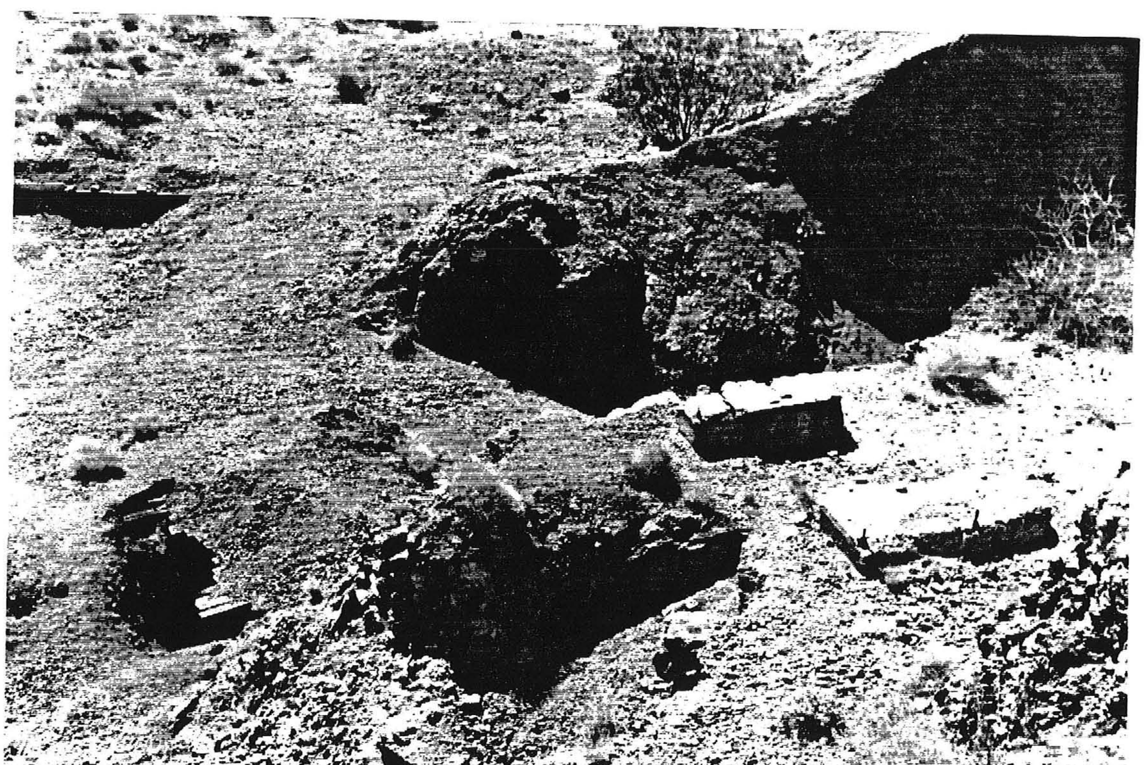


Photo 18 Philadelphia No. 2 Shaft. View of stope adjacent to shaft to the northeast, looking in the general direction of the Philadelphia No. 1 Shaft, at a location about 25 ft above water level. Access to this stope from the shaft is through a breakthrough above the "100" level. There is a chute, now plugged with trash, into the shaft just below this elevation. The stope is probably 30 ft high and dips on average 60 degrees, with the hanging wall dipping as much as 80 degrees at this location and the footwall dipping about 50 degrees. The stope is very irregular in width, ranging between about 10 to over 25 ft wide, perpendicular to the dip. The stope drops below to water level which has considerable floating trash and timber. Pillars are irregular in size and shape; some are as small as 3 ft by 3 ft. Rock surfaces are drummy and intensely fractured, with prevalent ravelling. The stope overall does not appear to be overstressed; large-scale slabs and block falls are absent. The timbered workings in the far distance in the photo are not the continuation of the "100" level, which is a short distance below, but are probably at an old chute location.

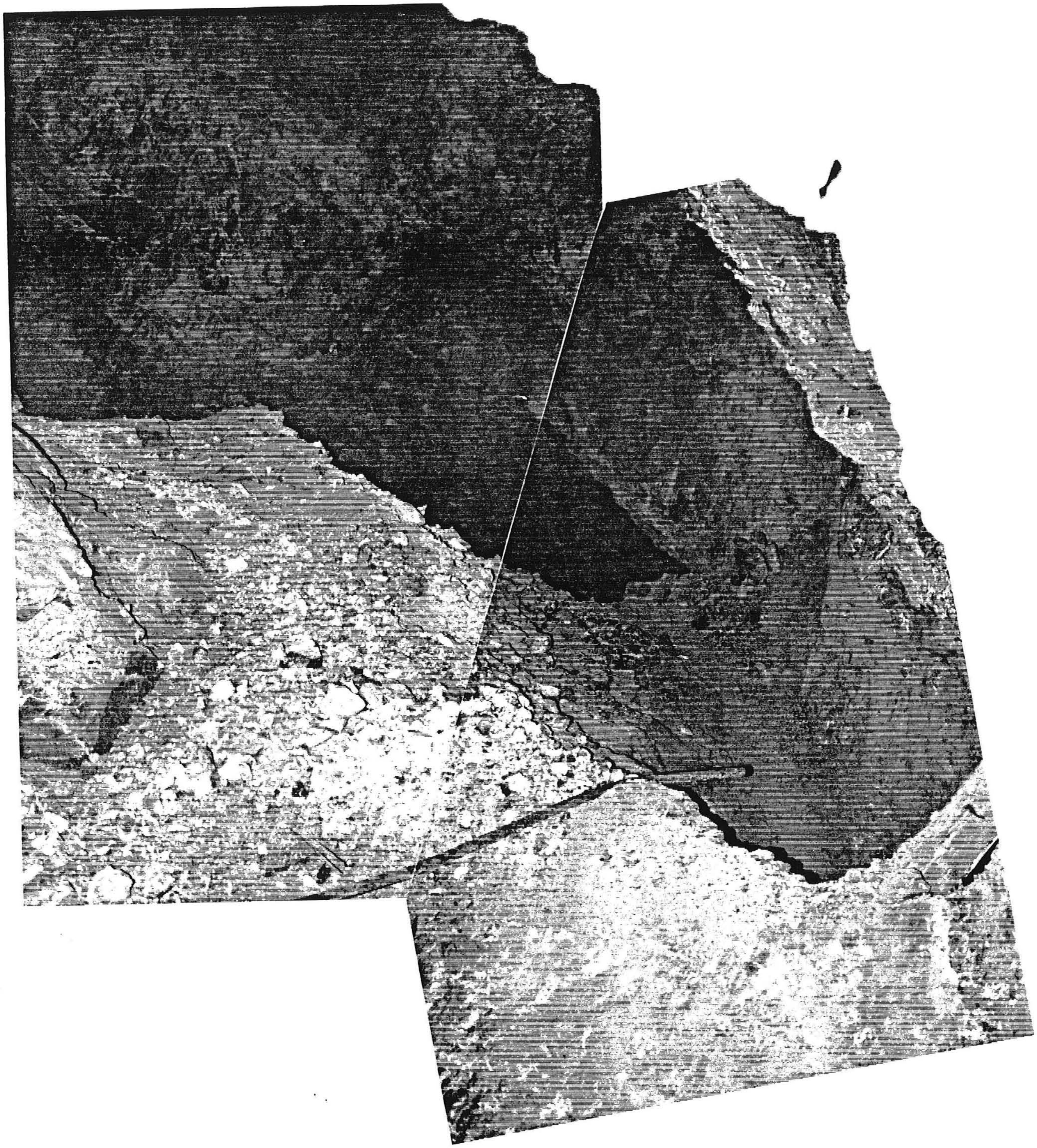


Photo 19 Philadelphia No. 2 Shaft. View of the stope described above, but looking down the dip of the stope. Note that the dip of the footwall, which was moderate in the preceding photo, is nearly vertical here. These workings are inaccessible without building ladders and bridges. The water level is just out of view at the extreme lower right.

Photo 20 Philadelphia No. 2 Shaft. View of "100" ft level off the shaft, bearing southwest, looking down the strike toward Bullhead City. Photo is taken from the lip of the shaft station, at an intersection with a nearly east-west crosscut running toward the highway that dead-ends in gravels. Shown are the opening of a very steep stope at lower left, and two chutes at right, that empty at the near and far limits of the stope. At lower left is the muck from a third loading chute, caved, that centers about 17 ft from the shaft centerline. The "100" level continues beyond, but is not safely accessible without means to bridge the stope. The accessible portion of the drift runs about 20 degrees west of the strike of a quartz vein that dips moderately eastward. The shaft was enlarged at the level station, which is provided with timber staging. Water is at the same level in the stope as it is in the shaft, which is filled with trash. Beneath the trash, considerable timber clogs the shaft below water level.

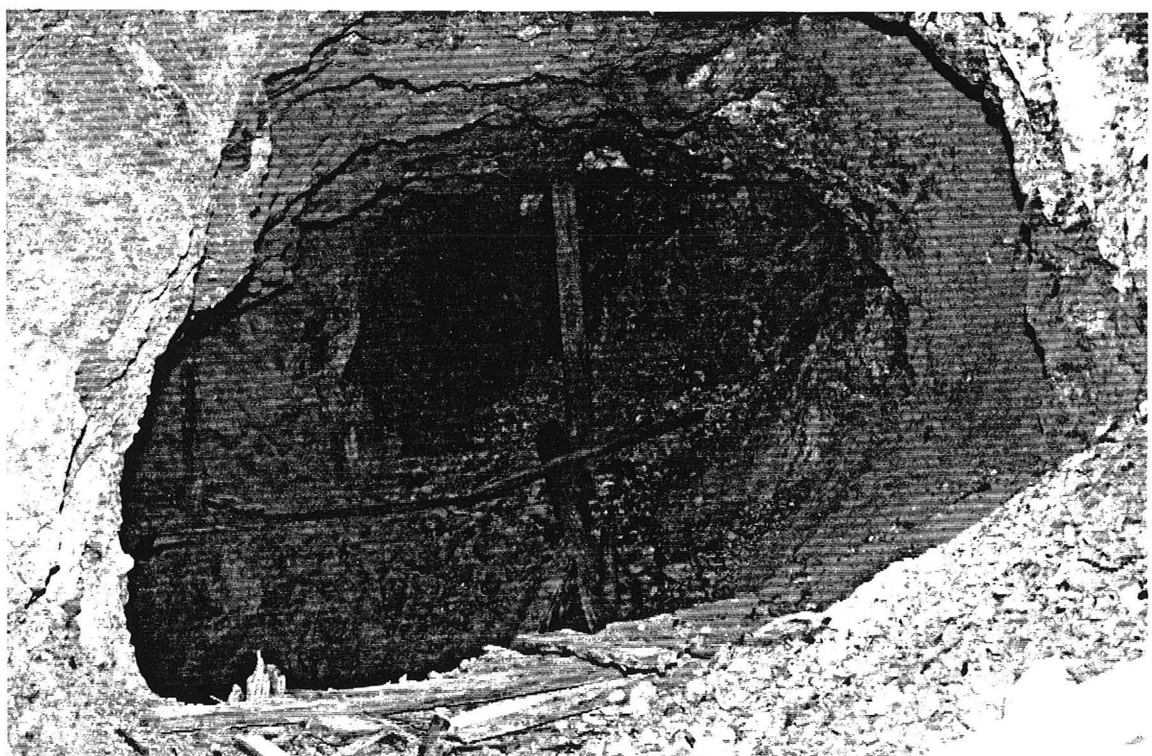


Photo 21 Philadelphia No. 2 Shaft. View of the same drift as in Photo 19, but taken from the lip of the stope. Water level in the stope was measured at 13 ft below the drift invert. The angle to the left made by the "100" level as it continues beyond the stope appears to be about 30 degrees.

Photo 22 Philadelphia No. 2 Shaft. View of stope entrance in the opposite direction from Photo 17 (northeast). This was also the "100" level. It drops immediately into an inaccessible stope just beyond the shaft wall. The track still remaining in the inclined shaft is visible at left. At top center is a reflector set by EI that was moved downward in order to be visible from the shaft collar. Note the trash that has been scattered by animals.

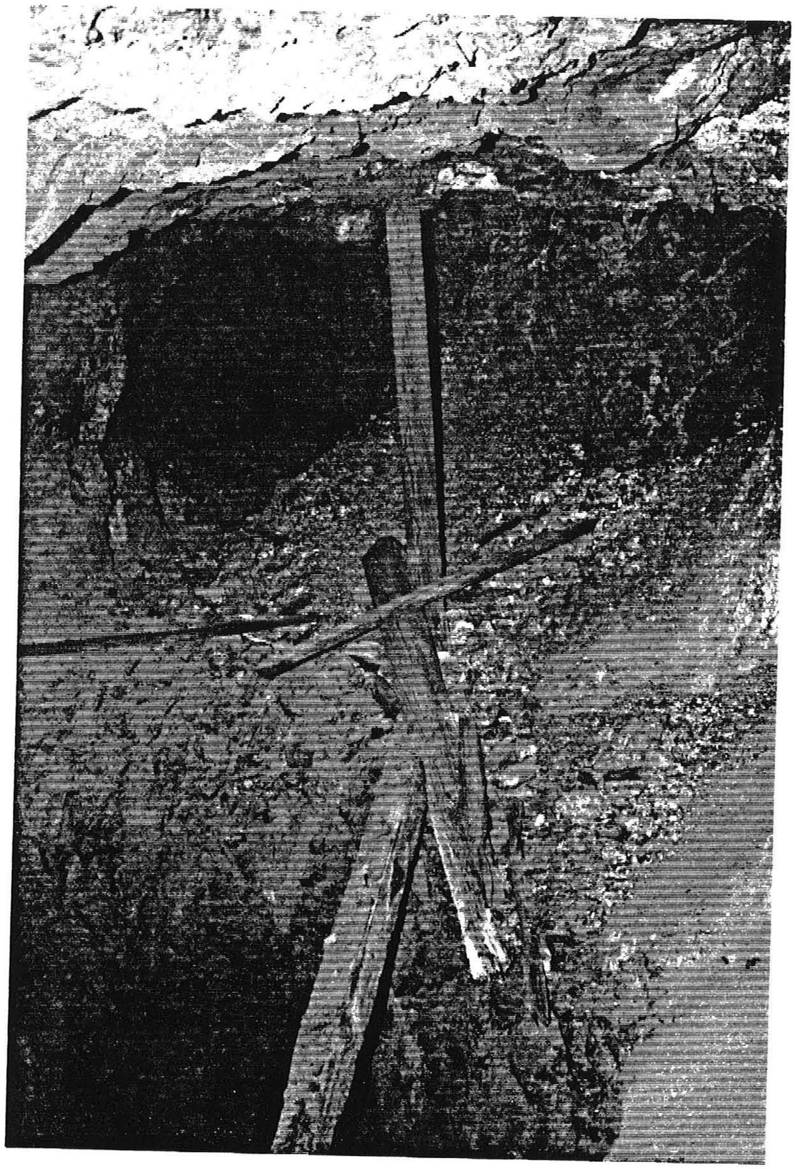


Photo 23 Philadelphia No. 2 Shaft. View of the stope accessed through the opening described in Photo 21, which is the continuation of the stope shown in Photos 17 and 18. This stope is very large and steep. Note the water level (lower right) and the continuation of the stope across the dip (upper left). The stope occupies and crosses the location of the "100" level, and is very irregular, about 60 ft long and 40 ft high. As the photo shows, the stope probably is as much as 40-50 ft wide, horizontally, at right angles to the strike. The continuation of the 100 level is on the footwall beneath a pillar that is probably 8 or 9 ft high, but the continuation of the level is blocked by muck from an old loading chute. The floor of the stope is covered in debris above the water level, but continues down the dip below the water as far as can be seen.

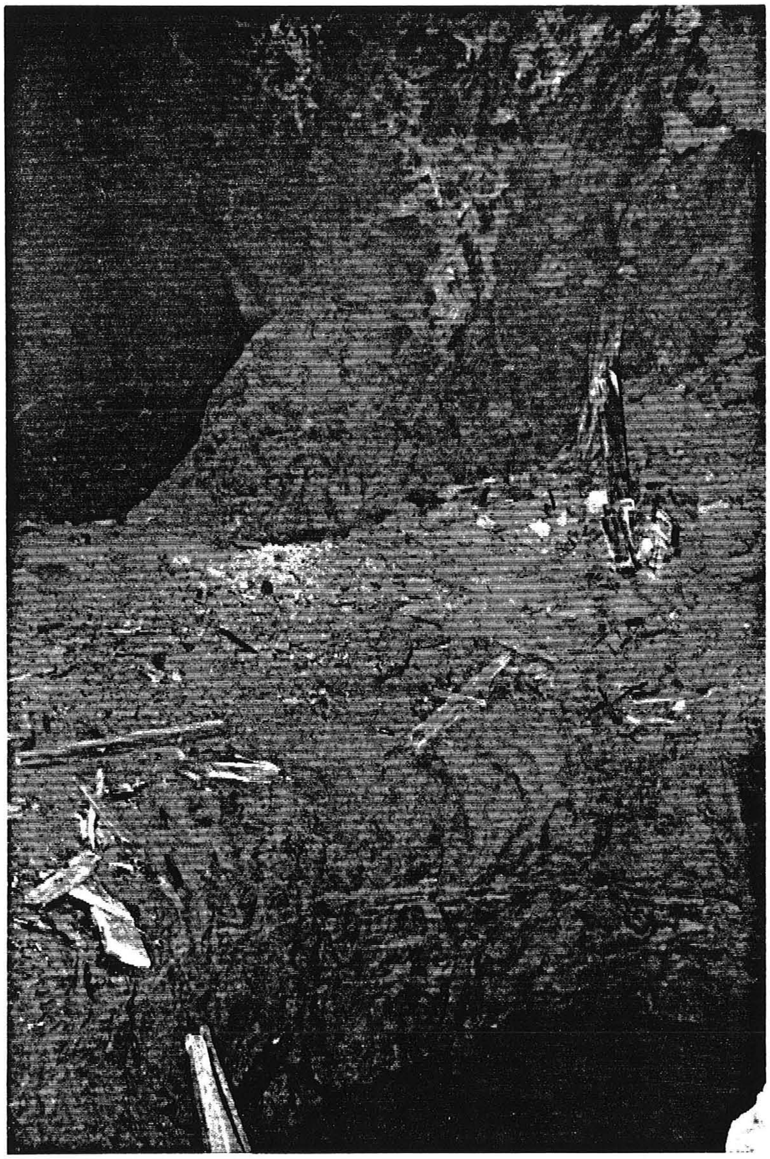


Photo 24 Philadelphia No. 2 Shaft. View of surface expression of stopes that break to the surface. Such stopes have obliterated the older shafts, and are largely inaccessible due to the presence of water at a depth of about 58 ft below the surface, which would be about 20 ft below the deepest pillar visible in the photo. The stopes generally dip flatter than appears here; the steep dip is a result of the camera angle.

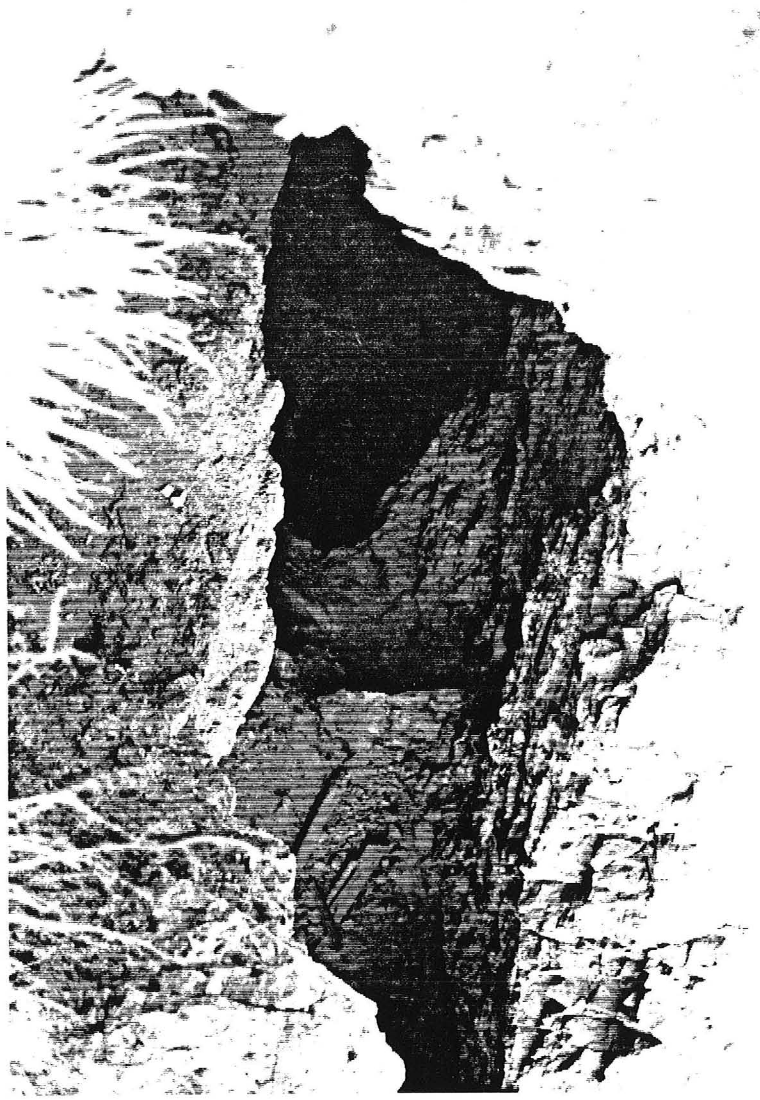
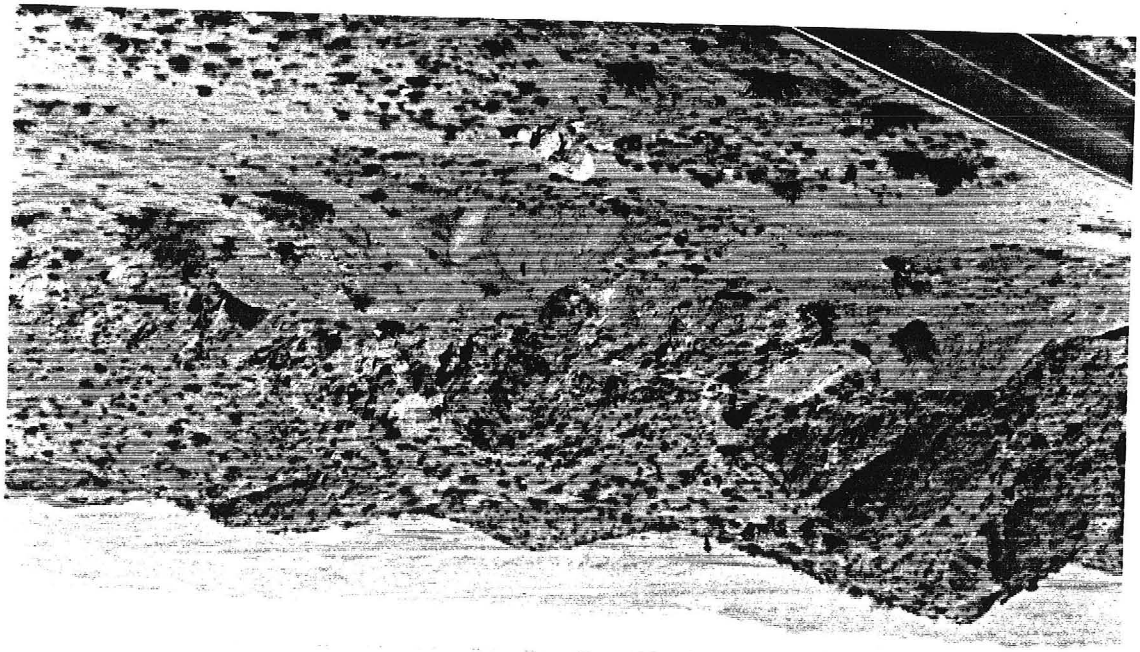
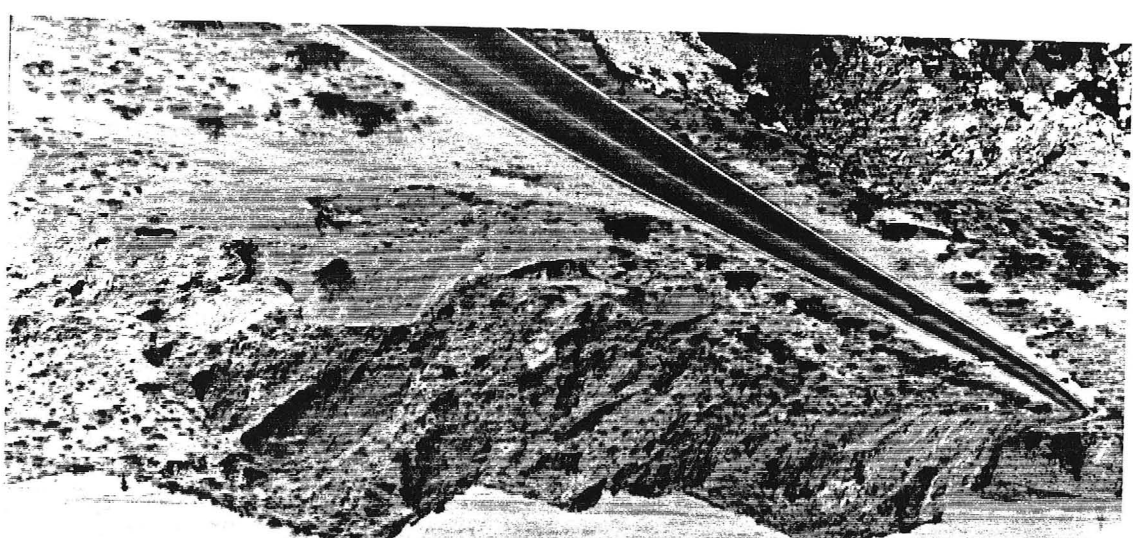


Photo 25 Philadelphia No. 2 Shaft. View down the strike of one of the shallow stopes that break to the surface. The depth below surface is about 20 ft here. The R-1 Shaft probably occupied a position near the center of the photo. The water line probably supported a pumping operation that occurred in the 1980s.

Photo 26 Philadelphia No. 2 Shaft. Another view of the stopes breaking to the surface. This is facing the southernmost extension of these stopes. The timber probobly occupies the position of the R-A Shaft.

Photo 27 Arabian Mine. Long distance view showing the Philadelphia No. 1 and No. 2 shafts, S.R. 68, and associated dumps and cuts. Photos, top to bottom, are from south to north.





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ARABIAN MINES SURVEY
LETTER AGREEMENT No. 91-28
ADOT CONTRACT No. T92-0119-00
PROJECT NO. F-068-1-402
TRACS NO. H 2734 01D

EI PROJECT No. AZ1075

⊼ GRC	INSTRUMENT MAN		8/30/91
♀ RAC	ROD MAN		1:46 PM
♀ TH	ROD MAN		CLOUDY

SET BASE PT ON NAIL @ COLLAR

PHIL #1

	PT#	AZ	DIST	∡	DESC.
BS		0-00-00	110.80		PVC PIPE
		85-00-00	76.93	147°30'	EI#1 BOTTOM OF SHAFT

DESCEND SHAFT

	AZ	DIST	∡	DESCRIPTION
TP#1	92-00-00	18.00	+13°	BS EI#1 S-83°-E
	152°-59'	21.0	+ 32-30'	STOPE WALL
	200°-14'	13.5'	+32°	CHUTE WALL
	189-3'	26.3	+ 24-35'	BACK OF STOPE
	181°27'	30.8	+ 23°-40'	4' TO GRAVEL

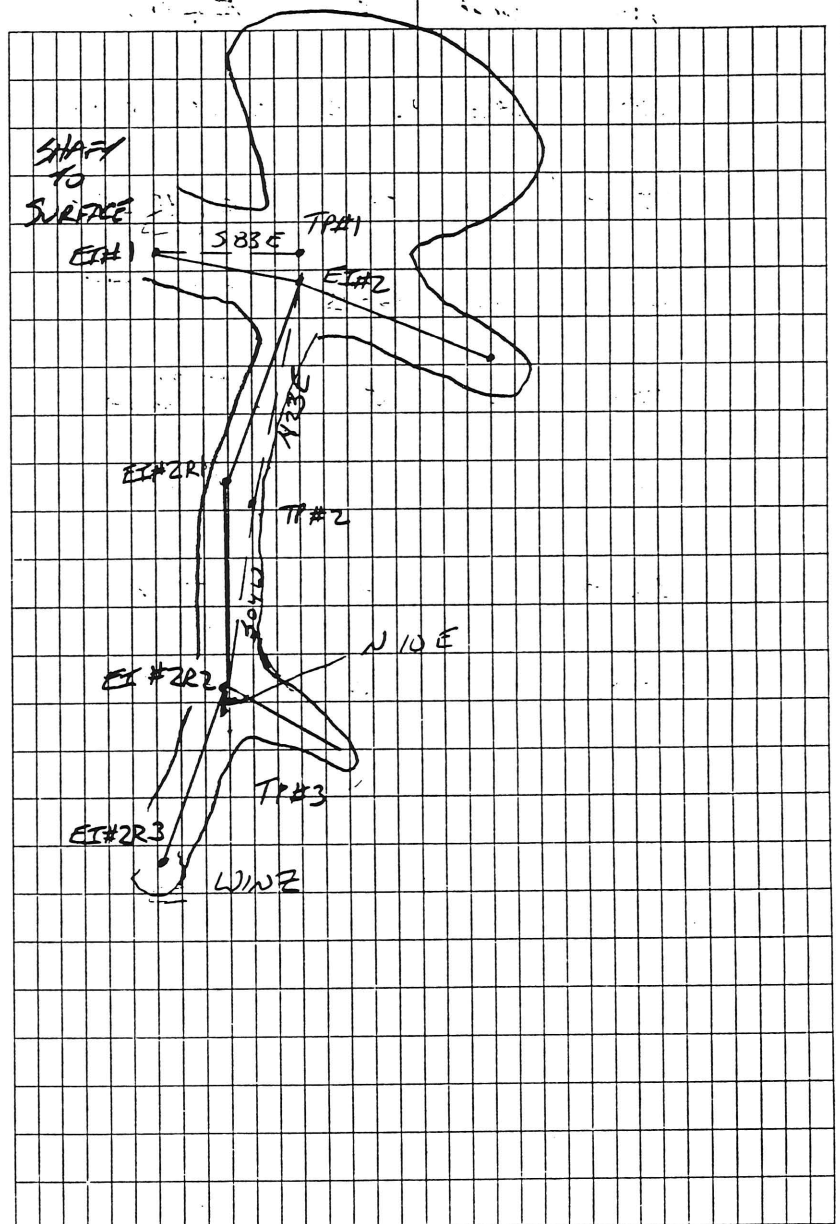
LINE / OFFSET

	HORIZ	LEFT	RIGHT
EI#1	0	4.3	4.2
	4.5	2.0	3.5
	10	3.3	3.0
	12	3.8	4.5
	14	6.2	5.7
TP#1	18	10.7	5.5
DEAD END	22.3		

AZ	DIST	∢	DESCRIPTION
			CORNER OF DOG HOLE
160°-4'	29.0	+22°-15'	5.5 x 5.4' AXIS N44W
173-54'	32.6	+31°-15'	HEIGHT SHOT
208-30'	13.3'	-0-45"	HOPPER CHUTE
220-21'	15.4	∅	BULKHEAD INT W/ROCK
281°	4.0'	⊖	"223"
358°-25'	4.5'	37°-10'	EI #2

TP#2 BS: EI#2 BEARING N-23° E

AZ	DIST	∢	DESCRIPTION
129-53-00	22.3	-12°-30'	B.S. EI#2 BEARING N23 E
	17.6'		EI#2 - EI#2R1
93-46-47	6.3	12°-30'	EI # 2R1
290-53-00"	21.4	-3°-30'	EI #2R2
			BEARING S-04-W



	AZ	DIST	∢	DESCRIPTION
TP#3	BS	EI#2R2	BEARING	N-10°-E
	133°-02'	2.9	-5°-0'	EI#2R2
	225°-41'-15"	13.9	+3°-30'	DOG LEG LEFT X-SECT 4X6
	339-10'	32.4'	-2°	EI# 2R3 OVER WINZE

SET UP ON EI#2
BS EI #2A BEARING S-57°-E

	0-00-00	24.1	0°	EI#2A

LINE / OFFSET

	HORIZ	LEFT	RIGHT	
EI#2	0			
	5	–	–	LIP OF SHAFT
	6	2.7	2.5	
	10	2.9	1.5	
	15	3.1	1.8	
EI#2R1	18	2.7	2.8	
EI#2R1	0			
	6	1.9	3.8	
	12	1.5	4.6	
	18	2.5	2.5	
	24	3.1	3.4	
EI#2R2	27	4.1	5.0	

LINE / OFFSET

	HORIZ	LEFT	RIGHT
EI#2R2	0	X-CUT	4.5
	3	4.3	3.5
	10	1.7	3.5
	15	2.3	3.7
	22	3.0	2.8
	27	2.7	2.4
EI#2R3	33	2.6	2.6
EI#2	0		
	3	3'	UNKNOWN
	4	2.5	3.3
	10	2.0	2.75
	15	2.1	2.2
	20	2.0	2.5
EI#2A	24.1	1.5	2.5

3' TO CAVED AREA

2R2 TOWARDS 2R3

2R2 = 0

~~LEFT~~

STATION	LEFT	RIGHT		
0	4.5	X-CUT		
3	3.5	4.3	7.8	CORNER LT
10	3.5	1.7	5.2	
15	3.7	2.3	6.0	
22	2.8	3.0	5.8	
27	2.4	2.7	5.1	
33	2.6	2.6	5.2	

PHILADELPHIA #2 SHAFT

INCLINATION ≈ 50°
LENGTH OF COLLAR 10.4'
DISTANCE TO WATER 82'
BEARING OF SHAFT
DIMENSIONS OF SHAFT – 4.0' high (I.D.) CLEAR
6.0' WIDE CLEAR.

INC. ON RAIL	DISTANCE FROM TOP OF COLLAR TIMBER	BEARING	
49°	33.8'		
48°30'	50.8'		STOPE ON KINGMAN SIDE COMPLEX, MANY PILLARS.
	66.7	S-17-W (N-03-E)	LEVEL TOWARDS BULL HEAD CITY
50°-20'	82'		WATER LEVEL IN SHAFT
	67.7		REFLECTOR HANGING FROM BACK 2.7'
50°	30.0		℄ of alcove Bullhead city SIDE
	8.9'		CLEAR WIDTH IN ROCK OF SHAFT
	16.5' (ON SLOPE)		REFLECTOR TAPE 5' FROM TAPE TO BOTTOM TIMBER

RADIAL LOCATION SURVEY

8/31/91
3:00PM
CLOUDY
π GRC
P TH

SET BM#1 (NORTH SIDE)

BS	STA	427+00	DIST	235.92
BS	STA	430+00	DIST	93.93

SET BM #2 TACK IN HUB w/ WHITE ROCKS

CONTROL PT HI = 5.0

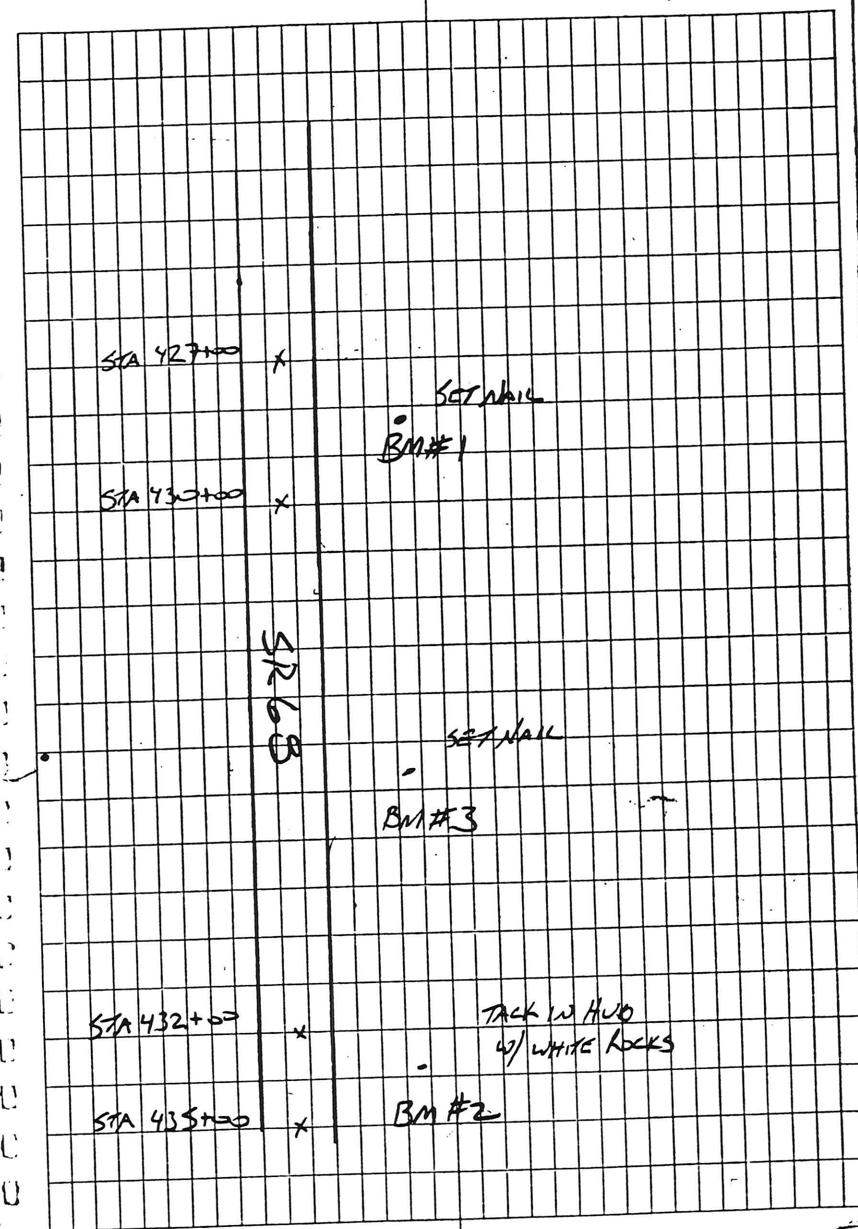
BS	STA	432+00	DIS	163.56
BS	STA	435+00		150.02

AZ = 00-00-00

87-19-20

PT#	AZ	DIST	H	DESC
1	139-53-40	330.16	20.25"	PVC PIPE BS FOR MINE SURVEY

PT#	AZ	DIST	∡	DESC
1	139-53-40	330.16	87-19-20	PVC PIPE BS FOR MINE SURVEY 20.25" HI
2	123-26-40	258.70	93-52-20	NAIL @ COLLAR
	PHIL #1	70" W 6'		
		64" H 5'		
3	124-56-00	251.67	84-30-00	℄ OF TIMBER PHIL #1
4	123-47-00		84-5-00	℄ OF BACK PHIL #1



PT#	AZ	DIST	∡	DESCRIPTION
5	24-17-40	456.71	79-33-20	ADOT AERIAL CONTROL PT
6	58 51 55	284.61	79 29 40	CORNER CONC. STRUCT. 23'-8"X 11'-5½" INSIDE EDGE
	BULLHEAD CITY SIDE			
7	61-32-00	264.75	78-48-40	KINGMAN SIDE OF STRUCT
8	44-00-25	212.04	84-43-40	CONC FOUNDAT.
9	40-35-40	203.23	84-58-15	FOR HOIST HOUSE
10	51-19-20	165.00	83-57-35	ETC FOR PHIL #2
11	54-34-05	178.05	84-16-00	
12	47-46-00	137.91	91-35-55	PHIL#2 COLLAR TIMBER KINGMAN SIDE
13	48-41-30	140.24	92-16-50	H ROD 5.7
14	29-53-20	122.37	90-26-30	LOADING DOCK 2'
15	29-55-50	105.44	90-41-50	HIGH TOP OF TIMBER

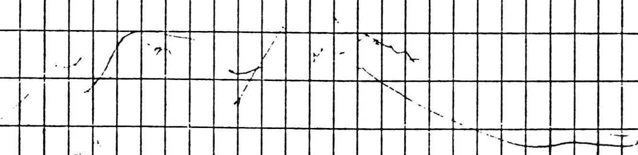
SET ON BM#1 HI = 58.5"

BS BM#2 H = 5' AZ = 00-0000

DIST = 432.01

∡ = 87-02-10

PT#	AZ	DIST	∡	DESC.
16	313-58-05	73.74	86-17-00	AROUND RA-RI STOPE ON TIMBER
17	325-02	66.54	35-50-45	ON TIMBER
18	335-~~38~~-20	110.61	85-50-40	
19	331-11-45	114.70	86-12-40	
20	325-19-40	120.22	84-38-30	ON SLOPE OF STOPE
21 -	325-50-40	127.93	84-53-00	OPEN STOPE WEST EDGE
22 -	127-54-40	124.66	35-84-10	SOUTH EDGE
23 -	330-43-20	127.30	86-06-30	SOUTH EDGE
24 -	332-~~23~~-20	132.05	86-35-40	ON EDGE OF STOPE



	AZ	DIST	∡	
25	332-01-00	140.37	86-33-50	℄ OF LAND BRIDGE BETWEEN STOPES
26	333-54-00	139.27	86-47-40	WEST EDGE OF NEW STOPE
27	334-34-00	159.27	86-31	E SIDE EDGE ON MTN
28	332-22-30	152.75	86-15-20	℄ MTN SIDE EDGE
29	330-51-40	146.63	86-05-35	MTN SIDE EDGE WEST SIDE ℄ BRIDGE
30	333-24-40	174.16	86-21-00	W SIDE ~~MTN SIDE~~ NEW STOPE

9/1/96

π GRC

9 TH

SET ON BM#2

			DIST	V ∡	
FS	STA	432+00	168.54	91-44-40	
FS	STA	435+00	149.99	85-56-10	

BS BM#1 AZ 00-00-00

PT#	AZ	DIST	∡	REMARKS
31	50-23-00	144.72	92-47-00	NAIL AT NORTH OF PHIL#2 SHAFT
BM#1		432.84		96" TO SHAFT

SET BM#3 MID POINT OF BM#1 & BM#2

DIST FROM BM#2 = 326.10

SET ON BM#3 HZ - 5.7'

BS BM#2 326.04 ∡ 86-59-10

BS BM#1 H. ROD = 5.0' HI = 5.7'

BS BM#1 DIST = 106.76 ∡ 92-57-20

AZ = 00-00-00

PT#	AZ	DST	Z∠	REMARKS
32	112-9-30	60.01	87-18-40	EDGE OF LARGE STOPE 3
33	122-00-30	~~64~~. 37	87-08-30	EDGE
34	120-44-00	72.07	86-53-20	℄ E EDGE STOPE #3
35	129-20-20	75.91	87-05-00	EDGE STOPE #4
36	144-50-00	65.42	86-06-30	
37	156-03-00	74.78	87-23-00	
38	160-41-40	107.79	87-20-20	℄ E SIDE
39	154-41-00	124.08	85-43-50	
40	143-58-10	135.67	84-17-25	℄ MTN SIDE
600	136-48-00	114.53	85-56-30	
	TIE IN BM#1			
STA	430+00	93.82		86-02-20
	427+00	235.96		91-53-00

SET NEW BASE LINE X 4937~~4~~63.052
Y 1524296.254

SET ON ADOT PIN 2342-2 (1989)
HI=5.0

BS. STA 409+00 127.87 V∡ 86-1-20
AZ 00-00-00

PT#	AZ	DIST	Z∡	
41	283-08-30	104.28	91-02-40	COLLAR TIMBER FOR RISING
42	280-10-20	100.99	91-07-00	FAWN SHAFT
43	281-45-20	95.54	90-38-00	WEST ROAD CORNER

SET NEW BASE LINE

SET ON RP ∡ PT 409+87.13
100' RT

BS STA 409+00 176.54 V∡ 91-08-00
AZ = 00-00-00
HI-5.15

15.8' DEPTH OF
RISING FAWN SHAFT
TO TOP OF TIMBER

6 X 6 SHAFT

50 filled to 60' from to

PAGE 27

PT#	AZ	DIST	∡	REMARKS
		℄		CORNERS OF
44	56-0-20	220.55	83-50-40	QUARRY
45	49-42-00	257.04	82-42-20	
46	49-24-20	187.68	82-18-20	
47	54-59-40	187.20	82-27-20	℄ ROADSIDE QUARRY
48	61-58-05	189.27	82-45-30	E CORNER ROADSIDE
49	61-32-00	213.40	83-00-00	
50	63-18-40	216.61	80-50-00	TOP OF WALL
51	58-37-00	224.98	81-00-20	℄ TOP OF WALL
52	55-45-00	211.86	81-52-00	MTN SIDE TOP OF WALL
53	57-31-00	232.49	81-04-00	PROSPECT
54	59-35-00	246.59	81-21-00	|
55	65-26-20	238.71	81-24-00	PROSPECT
56	64-22-40	225.96	80-59-00	
57	66-47-00	242.37	80-19-00	PROSPECT
58	59-10-50	250.84	81-11-00	
59	64-01-40	~~266.38~~ 255.38	79-48-00	PIN 2842-28

ARIZONA DEPARTMENT OF TRANSPORTATION

HIGHWAYS DIVISION

206 South Seventeenth Avenue - Phoenix, Arizona 85007-3213

FIFE SYMINGTON
Governor

CHARLES E. COWAN
Director

GARY K. ROBINSON
State Engineer

14 August 1991

Mr. Robert A. Cummings, P.E.
Engineers International, Inc.
PO Box No. 43817
Tucson, AZ 85733-3817

RE: Letter Agreement No. 91-28
ADOT Contract No.T92-0119-00
Project No. F-068-1-402
TRACS No. H 2734 01D
Project Description: Arabian Mine Survy and Reconnaissance

Dear Mr. Cummings:

The Arizona Department of Transportation requests you furnish consultant services to provide a mine survey and reconnaissance of the Arabian Mine at MP 7.5 on State Route 68 in Mohave County, Arizona.

All work is to be completed in strict accordance with the attached Scope of Work (Attachment A) and your proposal dated 10 August 1991, incorporated herein by reference, and under the direction and coordination of Mr. Nick Priznar, Geotechnical Engineer for the Department. The General Provisions applicable to this agreement are included in Attachment B hereto.

Notice to Proceed will commence on your signature date to this letter agreement. The work under this agreement is to be completed no later than sixty (60) days after your receipt of Notice to Proceed. Your fee will be a lump sum of $9,518.00. Request for payment is to be made as specified in Section J of Attachment B.

If these arrangements are satisfactory, please sign both copies and return the original document to: Mr. E. Jack Hammitt, Joint Projects Administrator, Arizona Department of Transportation, Engineering Consultants Services, 205 South 17th Avenue Mail Drop 616E, Room 222E, Phoenix, Arizona 85007.

Mr. Robert A. Cummings
Letter Agreement No. 91-28
14 August 1991
Page two

Questions may be directed to Mr. Hammitt at (602) 255-8369 or Mr. Nick Priznar at (602) 255-8089.

Sincerely,

VERNE L. DOYLE
Contract Administrator

Accepted: ENGINEERS INTERNATIONAL, INC. 16 August 91 (date)

3923j

SCOPE OF WORK

SPECIFICATIONS & GUIDELINES

UNDERGROUND MINE SURVEY AND INVENTORY

FOR

ARIZONA DEPARTMENT OF TRANSPORTATION

MATERIALS SECTIONS

TO SUPPORT A

GEOTECHNICAL INVESTIGATION

OF THE

BULLHEAD CITY - KINGMAN HIGHWAY

STATE ROUTE 68 MP 7 TO MP 8

TRACS NO. H273401D

F-068-1-402

Attachment A-1

SITE DESCRIPTION

The Arabian Mining property consists of 3 patented (M.S. 3255) and 31 unpatented lode mining claims, located in Sec. 20 T.21N R20W Mohave County, Arizona. (See attached map temporary entry plat). Within the boundary of the patented group and to the adjacent unpatented claims precious metals were mined during the late nineteenth and early twentieth century using shrinkage scope and room and pillar mining methods.

Within the same vicinity, the Bureau of Reclamation reconstructed SR 68 to support their activities at the Davis Dam Project (1942).

Increased traffic along SR 68 due to the population growth in Bullhead City and Laughlin, Nevada, requires that the existing highway be improved. It is therefore necessary to inventory and map the existing underground workings, in so much as practical, to avoid potential road failures due to collapse or subsidence, in the vicinity of the Arabian Mine.

The greater portion of the underground work are flooded and generally unaccessible. However, portions of the mine are accessible and the general trend of the workings can be re-established by these fragments and using existing records.

The existing information (1930-1936), indicates that the major portion of underground mine workings were concentrated in the vicinity of the Resaca and New Philadelphia claims. However, this information is quite dated and other extensive mine workings may exist.

The following description of the mine is abstracted from U.S.B.M. I.C. 6901. Gardner (1936).

<u>Arabian Mine.</u> The Arabian mine is on the Kingman-Katherine Road about 8 miles from the Katherine Mill. Intermittent work has been carried on at the mine since before 1917. It was taken over by the Gold Standards Mining Co. late in 1933. The 1933 production amounted to 593 ounces of gold and 1,156 ounces of silver.

The country rock is granite in which a rhyolite-porphyry dike has been intruded. Rhyolite tuffs have been faulted against the hanging-wall side of the dike. The Arabian vein occurs in the dike close to the fault; the dip is 82^{0}. A portion of the dike south of the underground workings occurs as a bold outcrop. Between 60 and 70 feet of the outcrop next to the hanging wall is reported to run 0.10 to 0.11 ounce of gold to the ton.

A mineralized zone, 30 feet wide, consisting of a number of quartz stringers, occurs in the dike and to some extent in the granite footwall. A shaft on the north end of the property has exposed a stringer vein 3 to 8 feet wide that contains 0.25 to 0.40 ounce of gold to the ton on the 80-foot level.

Development work consists of a 280-foot shaft with levels at 80 and 180 feet. The shaft and ore shoot dip at 53°. Most of the ore is above the 100-foot level and comes to the surface in contact with the gravels in the wash as the hanging wall. In March 1934, a shrinkage stope 125 feet long was being worked from above the 80-foot level. Chutes were 25 feet apart. Triangular pillars 15 feet long and 10 feet high were left between the chutes. Three manways built of stulls with outside lagging were maintained in the stope. Except for the manways and chutes, no timber was used.

In May 1935, drifting and crosscutting were being done to get under the shoot on the 180-foot level, and the upper portion of the ore shoot in contact with the gravels was being mined. About 50 tons per day, including development rock, was being milled from the underground workings.

The ore was raised in a 1-ton skip by a hoist run by a 25-horsepower gas engine. Compressed air was furnished by a 8 by 10 inch compressor. The ore was dumped into an 18-ton bin at the shaft and then trammed to a 25-ton storage bin.

SCOPE OF WORK

The scope of work can be divided into three phases. Each will be considered a separate end product.

(1) RECONNAISSANCE, INVENTORY, AND SITE CONDITIONS BRIEFING

(2) UNDERGROUND SURVEY AND MAPPING, WITH PHOTOGRAPHIC DOCUMENTATION

(3) MINE LEVEL PLAN, CROSS SECTION, FORMAL SITE REPORT

PHASE I - RECONNAISSANCE, INVENTORY, SITE CONDITIONS BRIEFING

The selected consultant, will physically inspect the site conditions at the Arabian Mine, and adjacent properties. See Site Plan for Phase I limits.

An informal inventory will be made of the significant mine workings within the Phase I limits. A preliminary description of these workings will be made.

A briefing will be conducted with the members of ADOT's Materials Section outlining the findings of the reconnaissance and inventory. This briefing will occur no later than one (1) week after notice to proceed has been given. Mine workings unaccessible by ordinary means should be brought to ADOT's attention at this time.

PHASE II - UNDERGROUND SURVEY AND MAPPING

All accessible shafts, drifts, crosscuts, adits, and winzes (hereafter called accessways) will be located so that its horizontal and vertical position will be identified with an accuracy of ± 1 foot in 1,000 feet of its true position. All accessible accessways designated by ADOT will be located with stationing. The main course of the accessways will be identified by bearings and horizontal distances from station to station. Offsets left and right of the bearing line, or angle right methods, will be used to fill in appropriate details of the accessways.

Elevations will be carried from station to station by either trigonometric or differential leveling methods. In places where there is greater than 6 feet of difference between the floor and back of the accessways, elevations will be taken at both positions.

A photograph will be taken at each transit station depicting the general condition of the mine workings, and also in areas of structural instability.

Shaft plumbing to transfer bearings underground should be avoided if possible. The use of a gyroscopic theodolite or a closed magnetic bearing survey will be considered acceptable methods of transfering bearings to the underground workings.

It is recognized that stopes may form irregular geometries. In order to identify the position of a stope, hand methods, using a Brunton compass, cloth tape, hand level, and sketch maps will be acceptable techniques, when properly recorded in a field book and documented with photographs.

The stopes will be located in such a manner that a plumb vertical bore hole drilled from the surface to the depth indicated by the stope survey will intersect the true horizontal and vertical position of the stope within ± 3 feet. The average plunge and bearing of each stope will be recorded.

The general condition of each accessible stope will be recorded by photographs and referenced with established survey stations.

At the completion of the survey, points will be established on the surface, at which vertical drill holes will intersect the stopes or accessways as directed by ADOT's site representative.

The consultant is advised that the majority of the mine workings are flooded.

PHASE III - MINE LEVEL PLAN, CROSS SECTION SITE REPORT

The mine workings determined to be a significant potential hazard to the new roadway will be plotted to the following specification.

Mine Level Plan:

All survey information will be reduced to create a mine level plan along the bearing lines of the accessways.

The plans will be drafted on transparent medium so that they will accurately overlay the established topographic base map, and demonstrate the relative geometry of the underground mine workings. At least two (2) underground level plans are anticipated. In the event that the existing underground condition precludes a complete survey, the consultant will indicate the approximate location of suspected mine workings, based on record information. These approximations will be marked distinctly so that they will not be confused with existing (as-built) information.

Cross Sections:

ADOT will provide surface cross sections along the route of the new alignment.

The consultant will annotate the relative position of the surveyed and the suspected mine workings that underlay each cross section.

Site Report:

A brief site report will be prepared, describing the conditions encountered in the mine and the methods employed to complete the project. All photographs will be labeled and referenced to station points, for further engineering study.

Additionally the final report will describe the position of all mine workings discovered in the Phase I portion of this contract. A tabulation of these workings will be made with a brief description of each discovered mine site, together with a highway station and offsets left or right of the proposed centerline.

COMPLETION:

The completion date of all three (3) phases will be thirty (30) days from the date upon which the consultant was given notice to proceed.

Delivery of three (3) copies of the final report, with referenced photographs, the transparent level plans, annotated cross sections, field notes and calculations sheets will occur before 4 PM on the 31st day.

Estimate:

All consultants will provide an estimate to complete all three phases outlined as a lump sum.

Qualifications:

Because of the limited time frame in which to accomplish the project objectives, award of this contract will not be based solely on low estimate only. The consultant will have to demonstrate that he has the available manpower and experience to begin work immediately, and complete all three phases within the stipulated time period.

A list of three former clients which can certify the consultant's level of expertise will be attached to the proposal.

At a minimum, the selected consultant will demonstrate ten (10) years of underground mine surveying experience.

Access Equipment:

It is anticipated that access to some of the workings will be gained by rope and ladders. Additionally, some manual labor will be necessary to gain access, while performing the reconnaissance and inventory as outlined in Phase I. These items and underground equipment, such as lights, hard hats, self rescuer, and other safety devices are considered incidental to performing the survey. No additional compensation will be allowed for these articles.

No heavy equipment will be utilized to gain access to the mine workings. If equipment is necessary it will be provided with the property owners consent with ADOT forces.

Safety Requirements:

By accepting this contract the consultant agrees to abide by all safety regulations stipulated below.

SURFACE SAFETY REQUIREMENTS

When working within 30 feet of the highway shoulder, hard hats, steel toe shoes and high visibility shirts will be worn.

Before starting work on the highway a traffic control plan will be submitted. It will conform to the MUTCD standards.

UNDERGROUND SAFETY REQUIREMENTS

Before commencing underground work the selected consultant will forward to the A.D.O.T. Safety Office the following documentation:

1. A permit obtained from a qualified individual indicating the oxygen, combustible, and toxin levels existing in the workings are within safe limits. Information will be provided to indicate the type of testing equipment used and it calibration date.

2. A rescue plan and an emergency transportation plan will be filed with A.D.O.T. Safety Office.

Whenever personnel are working underground, one individual will be present on the surface.

Modern illumination techniques are required. The use of carbide fueled equipment shall not be accepted.

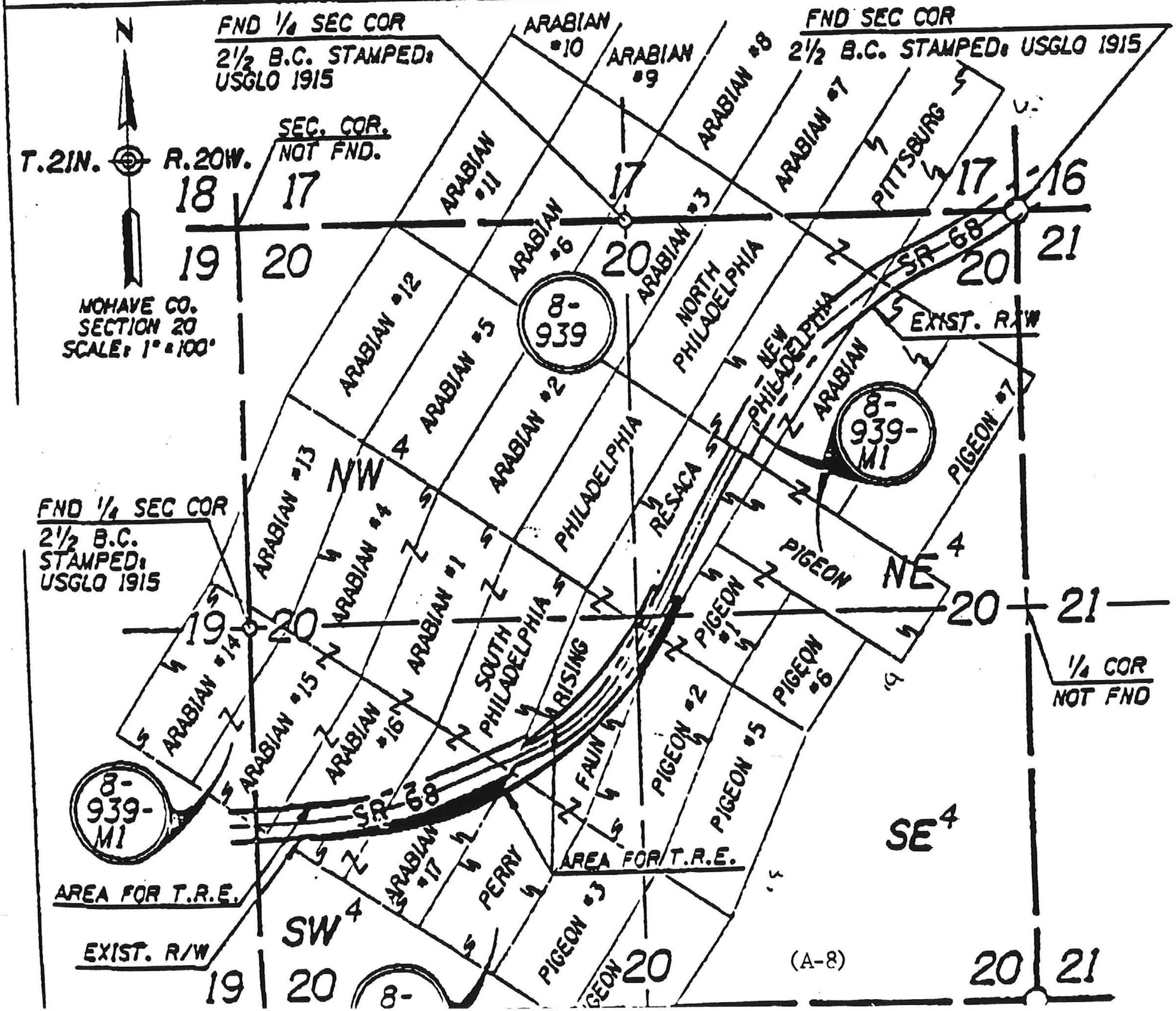
ADOT RESERVES THE RIGHT TO REFUSE ANY AND ALL ESTIMATES.

ARIZONA DEPARTMENT OF TRANSPORTATION

TEMPORARY RIGHT OF ENTRY PLAT

R/W PLANS MGR. [signature] DATE 1-17-91		DRAWN BY J.R.C.	DATE 1-14-91
		CHECKED BY N. GILES	DATE 1-15-91
HIGHWAY: DAVIS DAM - KINGMAN HWY.		PROJECT NO.: HES-068-1	
TRACS NO.: 68 MO 007 H 2734 01D		SECTION: EAST OF BULLHEAD	

PARCEL NO.	OWNER	DESCRIPTION	AREA
8-938	THOMAS F. MOLHERIN	PT. SEC. 20. T.21N. R.20W.	
8-939	UNITED STATES OF AMERICA (B.L.M.)	PT. SEC. 20. T.21N. R.20W.	
8-939-M1	GERALD E. BROCK, MARY A. BROCK & MARY AGNES PEMBERTON	PT. SEC. 20. T.21N. R.20W.	



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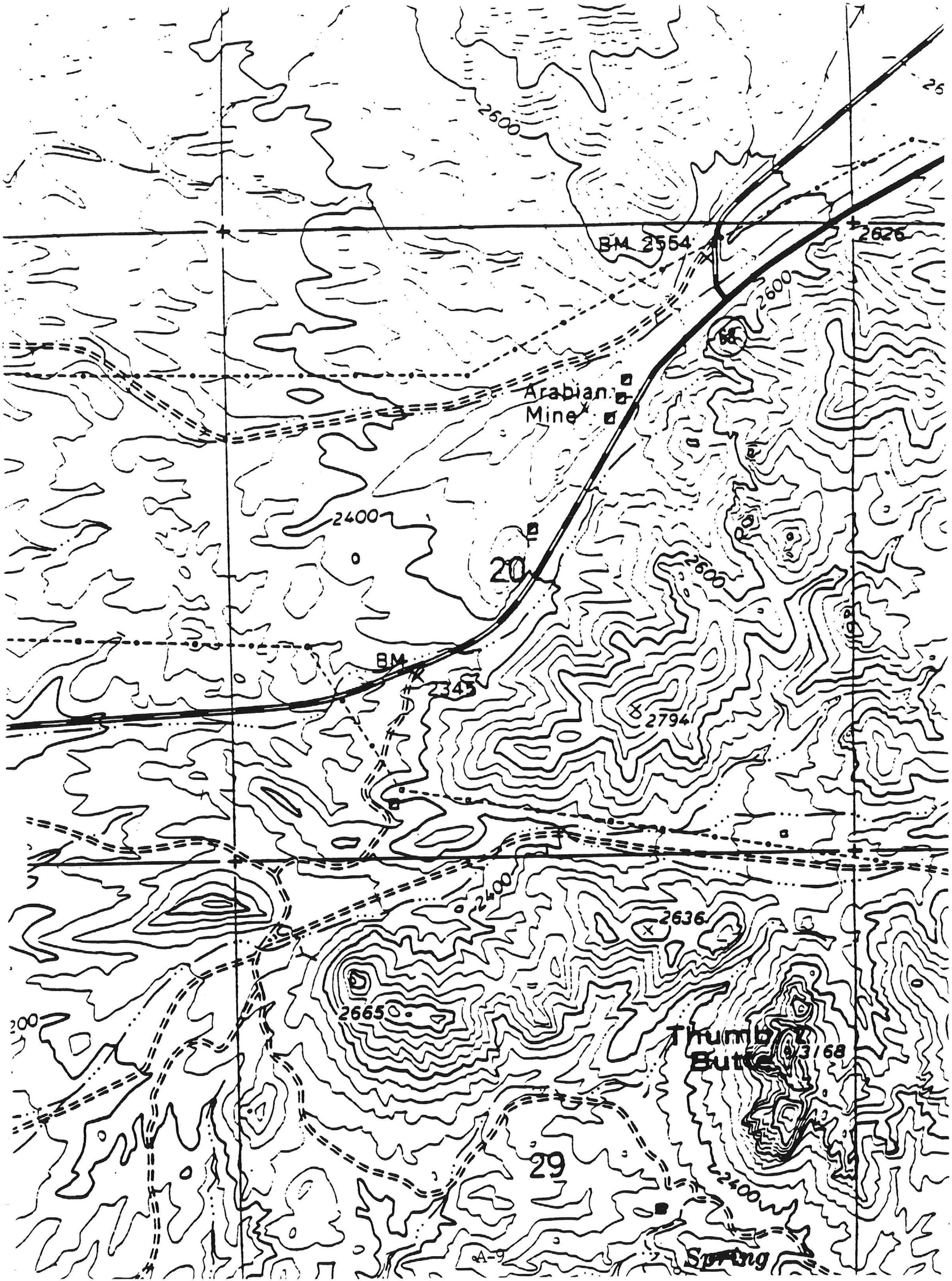
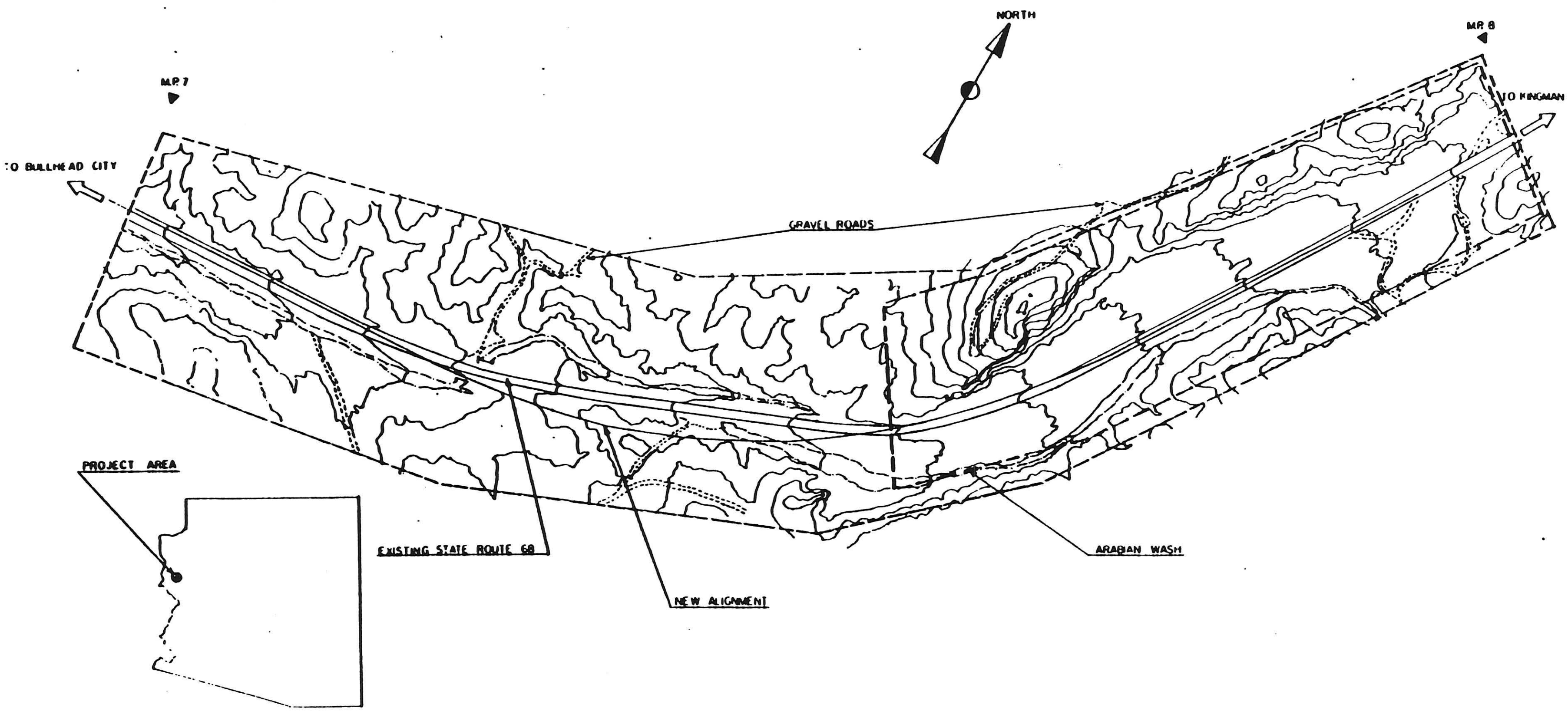

2600
BM 2554
2626
2600
Arabian
Mine
2400
20
BM
2345
2600
2794
2400
2636
2665
Thumb Butte
3168
29
2400
Spring



- - - ARABIAN WASH BOUNDARIES
- - - - - GRAVEL ROAD BOUNDARIES
——— LIMITS OF RECONNAISSANCE AND INVENTORY - PHASE I

SITE PLAN
ARABIAN MINE SURVEY
SR. 68 AT MP 7.5

LETTER AGREEMENT NO. LA 91-28
GENERAL PROVISIONS

A. COVENANT AGAINST CONTINGENT FEES:

The CONSULTANT warrants that it has not employed or retained any company or person, other than a bona fide employee working for the CONSULTANT, to solicit or secure this agreement, and that it has not paid or agreed to pay any company or person, other than a bona fide employee, any fee, commission, percentage, brokerage fee, gift, or any other consideration, contingent upon or resulting from the award or making of this agreement. For breach or violation of this warranty, the STATE shall have the right to annul this agreement without liability, or, in its discretion to deduct from the agreement price or fee, commission, percentage, brokerage fee, gift, or contingent fee.

B. CHANGES IN WORK:

Significant changes in the scope, character, or complexity of the work may be negotiated if it is mutually agreed that such changes are desirable and necessary. Changes defining and limiting the work and compensation must be authorized by the State Engineer or his duly authorized representatives. In no event, will payment exceeding $10,000.00 be paid for work performed under this contract, inclusive of supplemental agreements.

C. DELAYS AND EXTENSIONS:

If, during the course of this work, situations arise which prevent its completion within the time allotted, an extension of time may be granted. However, any time extension so granted shall not constitute or operate as a waiver by the STATE or any of its rights herein.

D. RESPONSIBILITY FOR CLAIMS AND LIABILITIES:

The CONSULTANT hereby agrees to save and hold harmless the STATE, any of its departments, divisions, agencies, officers, or employees from all sums which the STATE, any of its departments, divisions, agencies, officers or employees may be obligated to pay by reason of any liability imposed upon any of the above for damages arising out of the performance of professional services for the STATE or caused by any error, negligence, omission or act of the CONSULTANT or any person employed by him, or any others for whose acts the CONSULTANT is legally liable. The sums shall include, in the event of any action, court costs, expenses of litigation, and reasonable attorney's fees.

E. RETENTION OF RECORDS:

The CONSULTANT and any subcontractor shall maintain all documents, papers, accounting records, and other evidence pertaining to costs incurred for this work, and shall make all such materials available at any reasonable time during the term of work and for five (5) years from the date of final payment to the CONSULTANT.

F. TERMINATION, POSTPONEMENT OR ABANDONMENT:

The right is reserved by the STATE to terminate, indefinitely postpone or abandon this work. This agreement may be terminated by giving written notice to the CONSULTANT at least twenty-four (24) hours prior to the effective date of termination. In the event of such termination, the STATE shall be liable to the CONSULTANT only for work performed up to the effective date of termination.

G. COMPLIANCE WITH EXECUTIVE ORDER 75-5 ISSUED BY THE GOVERNOR AND WITH TITLE VI OF THE CIVIL RIGHTS ACT OF 1964:

The CONSULTANT shall comply with the above stated regulations relative to non-discrimination. These regulations are herein incorporated by reference and made a part of this addendum.

H. CANCELLATION OF STATE CONTRACTS:

All CONSULTANTS are hereby put on notice that this agreement is subject to cancellation pursuant to Arizona Revised Statute 38-511, the provisions of which are incorporated herein.

I. TERMINATION FOR CONVENIENCE:

The STATE by written notice, may terminate this contract in whole or in part, when it is deemed in the best interest of the STATE OF ARIZONA. If this contract is so terminated, CONSULTANT will be compensated for work performed up to the time of the termination notification. In no event shall payment for such costs exceed the current contract price.

J. COMPENSATION PROCEDURES:

All CONSULTANTS are to use ADOT Form 12-6903 R7/87 for invoicing the Department. If a copy of this form is unavailable, one can be obtained by calling 602/255-7525. A summary of rates (if applicable - for other than lump sum agreements) should be attached to The Form. Requests for payment are to be directed to Engineering Consultants Services at the address indicated on the cover letter of this Letter Agreement.

K. PARTICIPATION BY DISADVANTAGED BUSINESS ENTERPRISES:

The CONSULTANT is required to adhere to the commitment made to participation by ADOT certified Disadvantaged Business Enterprises (DBE) as indicated in the firm's Technical Proposal, or subsequently agreed to by the STATE during negotiations. The STATE, at its discretion and on a case by case basis, may waive the above limitations.

L. MISCELLANEOUS PROVISIONS

Contract Modifications

Contract modifications, defining and limiting the terms of the contract and compensation, must be approved by the State Engineer or his duly authorized representative. The CONSULTANT will be compensated only with prior written authorization by the STATE.

i. Supplemental Agreements

Significant changes in the scope, character, or complexity of the work may be negotiated if it is mutually agreed that such changes are desirable and necessary. Contract changes defining and limiting the work and compensation must be authorized by the State Engineer or his duly authorized representative. Such supplemental agreement shall be made in writing, and it is expressly understood and agreed that no claim for extra work performed or materials furnished shall be made by the CONSULTANT until authorization to proceed is granted, in writing, by the STATE.

ii. Changes Orders

The STATE may at any time, by written order, and without notice to sureties, if any, make (or direct) changes within the general scope of this contract in the services to be performed.

ARIZONA DEPARTMENT OF TRANSPORTATION
ENGINEERING CONSULTANTS SERVICES

Progress ____	Final ____	Payment Report

Report No.	FA	Non FA	Fund Code Account Code	Contract No. LA 91-28

TRACS Number: H 2734 01D
Federal Number: F-068-1-402 Month Ending

Name of Project: Arabian Mine Survey

Name of Consultant: ENGINEERS INTERNATIONAL, INC., PO Box 43817, Tucson, AZ 85733-3817

Date Started	Date Accepted Estimated Completion Date	% Billed	% Complete

SUMMARY OF WORK FOR WHICH PAYMENT IS REQUESTED

Item	Description	Total Contract Amount	Previous Accumulative Amount	Current Month	Accumulative Amount
	Consultant Services (Lump Sum)	$9,518.00			
	Contract Total (NTE)	$9,518.00			

Submitted by ________ Date ____ ENGINEERS INTERNATIONAL, INC.	Total To Date	$
Approved ________ Date ____ NICK PRIZNAR, P.E.	Total Previous Report	
Approved ________ Date ____ Assistant Contract Manager, E.C.S.	Current Report	$

P.O. BOX NO. 43817
TUCSON, AZ 85733-3817

ENGINEERS INTERNATIONAL, INC.

TELEPHONE: 602/884-8818

RECEIVED

September 17, 1991
Ref. No. AZ1075

A.D.O.T. - Materials Section
1221 North 21st Ave., MD 068R
Phoenix, AZ 85009-3740

ATTN: Nick Priznar

RE: ARABIAN MINE SURVEY AND RECONNAISSANCE Final Report and Deliverables.
ADOT Contract No. T92-0119-00
Project No. F-068-1-402, TRACS No. H 2734-01D

Ladies and Gentlemen:

Per the subject contract, we are transmitting herewith one (1) original and two (2) copies of the subject report. As Mr. Priznar requested, one of the copies of the report is being sent directly to Mr. Priznar under separate cover. Also included is one (1) set of reproducible level maps and cross-sections, and a set of three (3) maps of surface features.

Considerable discussions have occurred regarding the findings, observations,and recommendations contained in this report. Please let us know if any of your impressions or understandings conflict with your interpretation of the report.

We appreciate this opportunity to have been of service.

Sincerely,
ENGINEERS INTERNATIONAL, INC.

Robert H Cummings

Robert Cummings, P.E.
Project Manager

MAIN OFFICE
98 E. Naperville Road, Westmont, IL 60559-1595 Tel: 312/963-3460 Telex: 280102

ARABIAN MINE SURVEY AND RECONNAISSANCE

ENGINEERS INTERNATIONAL, INC. PROJECT NO. AZ1075

SEPTEMBER, 1991

prepared for

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION
PHOENIX, ARIZONA

ENGINEERS INTERNATIONAL, INCORPORATED

P.O. BOX 43817 TUCSON, ARIZONA 85733 (602) 884-8818

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EI Project AZ1057

SURVEYING OF THE ARABIAN MINE, MOHAVE COUNTY, AZ
TRACS NO. H273401D
State Route 68, M.P. 007

16 September, 1991

1.0 PURPOSE AND SCOPE OF WORK

The Arizona Department of Transportation (ADOT) is considering widening and straightening a section of SR 68, near Milepost 7, in Mohave County, AZ. SR 68 was constructed by the Bureau of Reclamation in 1942 to access the Davis Dam Project. The section of road to be improved passes near an inactive mine occupying the Arabian claim group. The mine recovered gold values from ore shoots occurring along a rhyolite dike. The dike strikes roughly parallel to the road and dips steeply toward it, raising the question of how much of the right-of-way and roadway improvement will be undermined and at what depth.

1.1 Background

The Arabian Mine was worked intermittently from before 1917 into the 1930s. The mine is developed along a steeply-dipping, rhyolite dike that intruded an older, granitic mass, apparently along a significant fault zone. The shallower portions of the hanging wall of the dike contacts gravel fill that comprises the adjacent wash. Inasmuch as the wash drains a considerable portion of the surrounding upland terrain, the mine was wet during the period of operation, making about 35 gpm, and most of the old workings are presently flooded; the mine pool can be seen from the surface in some open stopes.

The deeper portions of the dike hanging wall are in fault contact with porous rhyolite tuffs. The mine was developed along a mineralized zone averaging about 30 ft wide, chiefly within the dike but also extending into the granite footwall, consisting of quartz stringers. The Arabian vein was reported to dip 82 degrees overall, but the inclinations of the Philadelphia No. 1 and Philadelphia No. 2 shafts are much shallower.

According to old records, the site of the deeper mining was initially worked on the Rising Fawn claim by the Mines Company of America, a contract mining group from Great Britain. Apparently, production and mine access was through three shafts at that time: the R-1, R-A, and R-2. These shafts are no longer accessible; careful cross-checking of field conditions against the records show that stoping conducted after 1930 (probably between 1934 and 1938) has obliterated these shafts.

Subsequent to the early mining activity, the Mines Company sank the Philadelphia No. 1 and Philadelphia No. 2 shafts on the adjoining claim to the northeast, following a dispute with the mine owners. From this time forward, the main production shaft was the Philadelphia No. 2. It was 280 ft deep at the time of the most detailed mapping of the workings in its vicinity (1931). Later, a survey by a G. F. Chock (undated but traced by a Fred W. Becker in November 1938) was used to generate longitudinal section in "the plane of the vein". This section shows the Philadelphia No. 2 to extend below 300 ft, with levels and stoping to what appears to be the 250 ft level. Other records indicate that the Philadelphia No. 2 Shaft reached 500 ft, a common depth for principal development shafts in Mohave County gold mines at the time. However, there are no records pertaining to the Arabian mine that indicate stoping to this depth. The shaft was originally timbered through a muck pile and is inclined about 60 degrees near the present collar, flattening with depth according to the dip of an ore shoot, about 53 degrees. Most available records indicate levels at 100 and 200 ft; other records mention levels at 80 ft and one map shows a sublevel originating along the Philadelphia No. 1 Shaft at 60 ft.

Stoping was reportedly accomplished through shrinkage methods. In addition to the stopes shown on the Chock survey, a series of large stopes breaks to the surface as tabular voids 5 to 15 ft across with random pillars, dipping moderately, and widening beneath the surface. These surface stopes were probably extracted after Chock did his survey, as his longitudinal section shows ore passes in the vein but no stoping above the 100 level.

Production reportedly reached 50 tpd for certain periods of operation; altogether, production was in the neighborhood of 50,000 tons.

Underground, the drifts run chiefly along the strike. Crosscutting is indicated on old maps to have reached the footwall contact with the granite and the hanging wall contact with the gravel. An efficient means exists in the subsurface for ground water in the rhyolite complex and gravel to reach and flood the workings. The 100-level drift between the Philadelphia No. 1 and Philadelphia No. 2 shafts was reportedly caved in 1931.

Other miscellaneous workings, including a shaft, and an adit extending back into the granite footwall mass, found several thousand feet southwest of the main mine workings, and a vertical shaft further to the southwest toward Bullhead City. The shafts are presently filled a short distance below the surface and are not accessible now, even if they ever connected to the main workings, which is doubtful. The adit system is small and not connected to the main mine workings, either. The hilltop behind the workings contains numerous trenches, shallow prospect pits, and short adits, all of which are above the main shaft elevations.

Because of the flooding, none of the mine levels below the "100 level" could be accessed without extensive pumping of the mine. Water levels now are very similar to those reported in the records from as long ago as the 1930s.

1.2 Purpose

The purpose of the work was to assemble information and document the occurrence of underground workings with respect to the proposed roadway improvements and right of way at the surface, so that the potential for subsidence and associated road failures may be minimized. Accessible portions of the underground workings were mapped and surveyed, to the extent that safe access permitted. The positions with respect to the surface of the inaccessible workings were indicated by extrapolation of available records, on the basis of the survey.

1.3 Scope

Because not all portions of the underground workings are accessible, it was not feasible to directly observe and measure the position, dimensions, and condition of the deeper workings, some of which were apparently developed subsequent to the available records, which date to the 1930s. The underground survey pertained to those workings that were safely accessible without extraordinary effort, such as pumping, resupporting, or underground construction.

The scope entailed three phases: an initial reconnaissance and site briefing, the underground survey with photographic documentation, and the preparation of mine level maps and cross sections showing the relation of the workings to surface features. Standard mine surveying methods were used. The general conditions of the accessible workings were observed and recorded with notes and photographs. The initial reconnaissance included an overall site inspection with notation of all surface features according to station and offset from roadway plans provided by ADOT.

ADOT provided available mine records consisting chiefly of reports, mine maps of various dates and scales, and journal articles; aerial photographs, survey notes, and site topography. EI tied the principal shafts and surface stopes in to the existing survey control.

2.0 TECHNICAL APPROACH

2.1 Overview

Work was carried out in three phases: an initial reconnaissance and site briefing, the underground survey with photographic documentation, and the preparation of this report, mine level maps, and cross sections showing the relation of the workings to surface features.

2.2 Phase 1 - Reconnaissance, Inventory, and Site Conditions Briefing

The EI team reviewed and correlated the available mine maps and other information found in the literature, to develop a general understanding of the mine development and likely underground situation. Those workings that were indicated in the records to have potential to extend towards the roadway any significant distance were indicated to ADOT personnel in the field at the site briefing, and inaccessible workings were identified.

A ground reconnaissance was made of the area, and the depths and dimensions of mine features were noted on a topographic map. Later, these were assigned station and offset according to the ADOT road stationing shown on the plans.

2.3 Phase 2 - Underground Survey and Mapping

2.3.1 Site Safety Plan

Safety was a paramount concern. EI performed its work according to a Safety Plan conforming to the ADOT confined space procedures and approved by the ADOT safety department. It included verification of the mine atmospheric conditions, and recognition of physical hazards. Local medical facilities were notified, and the Hualapai Fire Department provided personnel on standby at the site during all underground activity. EI also had a person at the surface full-time whenever underground work was ongoing, who was in communication with those underground.

2.3.2 Subsurface Access

Subsurface access was obtained using ship's ladders. At the Philadelphia No. 1 Shaft, the ship's ladder was hung or draped over a pipe framework placed over the shaft collar (see Photo 2). In this way a free-hanging condition was established at the collar and rocks or debris was less likely to be dislodged by movement of the ladder and fall onto persons below.

At the Philadelphia No. 1, the shaft collar timber was found to be in good condition, although there was a considerable hazard from collapsed ladders and old wooden shaft guides hanging in the shaft. These held back significant rocks that had fallen into the shaft. To alleviate any chance of personnel working in the shaft with loose debris or rocks overhead, the old ladders and other debris was hoisted out of the shaft and discarded. The ladders were later destroyed to prevent unauthorized replacement of these hazards into the shaft.

At the Philadelphia No. 2, there was no way to set the pipe framework without disturbing the old timber loading platform and the considerable debris atop it, which posed a potential for clogging the shaft or damaging the fragile shaft collar timber if it fell and would certainly have obscured visibility and compromised air quality due to dust in the shaft. Therefore, EI set pins at the collar to affix the shaft ladder at the surface. Concern for damaging the shaft collar timber, and the very limited working room around the collar, prevented more than 35 ft of ladder from being lowered into the Philadelphia No. 2, although more could have been lowered in an emergency. Further access had to be gained by climbing down the old steel rail in the shaft, and this prevented transferring much gear or material for bridges, etc. underground.

Comparison of the old records with present conditions reveals that the Philadelphia No. 2 Shaft no longer collars at the same elevation it originally did. Shaft timbers once extended about 44 ft below the collar; they presently stop a little over 10 ft down. Apparently the dump material that once comprised the shaft walls has been mined, and this has disturbed the collar timbers and surrounding fill considerably. The lowermost 4 courses of collar timbers are loose and hanging, and an unknown number of the bottom ones have detached in the past and have been lost into the shaft. The courses of timber on the entire north rib are not in contact with the shaft wall due to erosion of the old fill surrounding the collar. Altogether, there is no way to accurately relate the current to the former position of the collar. The bottom course of shaft timber at the invert is undercut by approximately 3 ft in loose fill.

This condition is extremely hazardous; during the one trip into the shaft made by EI the collar timber loosened noticeably and the surrounding fill was frequently observed running out in small quantities from beneath the timbers, due to the disturbance. Therefore the EI Project Manager determined that exposure time in the shaft should be minimized to reduce the chance for a cave-in, and the reconnaissance was kept brief.

If further exploration through the Philadelphia No. 2 is to occur, the collar will at the least need to be stabilized, which would probably require excavating the collar to firm ground and retimbering.

2.3.3 Survey Methods and Notes

A theodolite was used to turn the angle and plunge of the Philadelphia No. 1 shaft centerline off a baseline established on the surface, by sighting to a plumb bob affixed with reflective tape that was left hanging from a spad at the shaft bottom earlier. The underground survey was performed by using a transit. Conventional mine surveying methods were used, taking advantage of existing spads that were renumbered for the purposes of the survey.

The stope at the bottom was shot in with the transit using azimuth-and-tape. Drift wall sections at waist height were taken by the offset method, using a tape strung tightly between spads. Because the winze was inaccessible, its vertical dimension was not surveyed below its opening at the "60" level.

The Philadelphia No. 2 shaft inclination could not be safely measured with a transit. However, a good approximation of the inclination was obtained during the short underground period by laying a clinometer along the rail, which in the lower half of the portion above water level is still well-fixed to the invert and parallels the shaft axis quite closely. Distances relative to the present shaft collar were pulled with a 100-ft tape. No spads were found in the portions examined that would correspond to available survey data showing spads, and stopes cut the accessible workings to either side of the shaft. Sketches of the drift layout off the shaft were made.

Both the Philadelphia No. 1 and No. 2 shaft collar locations were established at the surface using a theodolite and an EDM for distance. In the case of the Philadelphia No. 2, a major uncertainty lies in relating this location to previous mapping of the shaft, for the reasons already described. It is also not certain that the Philadelphia No. 1 shaft collar is in its original location, judging from the depression around the collar, although the error is not as great as it is for the Philadelphia No. 2.

The general conditions of accessible stopes, drifts, and shafts at each station, were noted and documented with photographs.

2.3.4 Surface Tie-In and Site Plan

The locations of the shaft collars and the respective starting points of the underground survey were tied in to the existing surface survey for the roadway, so that the location in plan view of the mine workings accessed can be related to the road alignment and the right-of-way.

2.4 Phase III - Mine Level Plan, Cross-Sections, Site Report

Workings recorded in the survey, or indicated in the records, and that pose an apparent threat to the integrity of the roadway, were depicted on maps, and cross-sections, which are submitted separately. The assessment of the integrity of the mine workings and the likelihood and character of potential threats to the roadway due to the presence of the workings beneath was based on judgement, as mechanical analyses were not parts of the Scope.

Correlation of existing records with the ADOT road construction plans were relied upon extensively. Substantial effort was needed to assemble these records in the absence of direct underground observations and measurements. The principal lack is the definition of the extent of stopes in inaccessible areas. Underground observations showed that the stopes cannot be accurately described as regular, tabular voids that have consistent orientations.

A map of the accessible accessways surveyed was prepared on reproducible media, at the same scale as the topographic base map, and depicting survey control common to both maps, so that the relationship between mine and surface can be ascertained. Approximate locations of workings not safely accessible were also indicated and differentiated by hidden lines from those actually measured.

Illustrative relationships of the new roadway alignment to workings apparently underlying the new roadway alignment were depicted on conceptual cross-sections. The cross-sections provided by ADOT do not extend far enough northward to cover the areas indicated in the records and by the field observations to potentially be underlain by stopes or significant workings. Therefore, cross-sections showing typical relationships were developed from the site topography and the available mine maps. These cross-sections are vague because the extent of the stopes on the deeper levels cannot be accurately developed from the existing information.

3.0 OBSERVATIONS

3.1 Philadelphia No. 1 Shaft

The Philadelphia No. 1 Shaft is inclined downward at an overall angle of 57 degrees. It opens at the bottom into a chamber that probably served as the shaft and loading station. Rock conditions in the shaft itself are excellent; however, the fact that the collar timbers are now 2-4 ft below the top of the dump suggests that some timbers may have been removed along with the shaft appurtenances.

Spads were located in the shaft chamber and branching drifts that appear to be the same ones shown on the 1916 survey map. Unfortunately, the bearings and distances on the reproduction of this map are not legible in all cases, but the general layout appears to correspond quite closely to the results of our survey. The 1931 map indicates that a short drift extended along the strike direction; this drift location is now occupied by a stope, and the position of the drift is now a cemented masonry bulkhead (see photos). The full extent of the workings was surveyed on what is described as the "60" level by some and the "75" level by others (the latter agrees more closely with the measured slope distance of 71.00 ft from the top of the dump). The stope is not large and will not extend near enough the roadway to be of concern.

The winze was accessed and opens into a landing chamber about 15 ft below the level. The continuation of the winze was apparent and the ladder is still in place, but the opening has been clogged with timber, probably from the landing. Attempts to remove the timber resulted in a release of the free-running muck that has sloughed off the sides of the chamber, and the winze became plugged. The floor of the chamber slopes steeply and the muck tends to run into the winze, creating an entrapment hazard, so further work in the winze was stopped. The rock in the winze chamber is a strongly altered and sheared granite porphyry that spalls and sloughs readily.

None of the Philadelphia No. 1 workings appears to persist as far as the roadway. The furthest drift to the east is nearly filled to the back and stops at the contact with the gravel. The entire level seems to be above the water level at all times, and there are no drips or seeps, although some locations of minor past seepage were noted. The gravel is very dense and compact, and tends to fall in chunks. It may be weakly cemented.

An undated drawing prepared by others as result of some sampling done in the past, and provided by ADOT, shows a cross-section and level map of the workings off this shaft, together with the locations of many assay samples. It correlates closely with the sample numbers, which were prominently painted yellow on the ribs at many places.

The ribs are generally drummy and the rhyolite, though silicified and intensely fractured or crushed without much clay, appears to be fairly ductile. A fault along the drift over to the winze contains as much as 1 ft of slickensided, clayey gouge, and has spalled moderately. The stability of the workings is probably attributable mostly to the absence of rock stress, owing to the shallow depth.

3.2. Philadelphia No. 2 Shaft

As described above, the Philadelphia No. 2 shaft was accessed but the poor stability conditions around the collar precluded bringing surveying equipment into the shaft safely. Slope distances to levels and breakthroughs were pulled with a tape to the surface, and the inclination was measured at 48 degrees in the upper part and 50 degrees in the lower part. Available records indicate that the shaft was steeper in the timbered portion.

The timber sets are, as described before, no longer in contact with the fill that surrounds the shaft. The lower courses of shaft timber have come apart, and rock and soil are running in behind the remaining timbers. Presently, the lowest timber is about 10.7 ft below the upper course. As the timbered section was originally about 42 ft on the slope (scaling off the 1931 cross section) about 30 ft of timber have been removed. It is uncertain how many courses are now missing from the bottom, however, so this is only an estimate.

The lower course of timber is overhung 2-4 ft and the weight of the ladder hanging over the lip of the overhang tended to disturb the entire collar area, so no further ladder was hung in the shaft, and no attempt was made to add weight and disturbance by making multiple trips carrying equipment.

Below the collar and the fill contact, the rock conditions are generally fair to good. The shaft is dry above the permanent water level in the bottom. Below the timber, the shaft is generally 8 ft by 8 ft in cross-section. (Layne, ca. 1915, describes all the shafts on the property as being 10 x 7 clear.)

About 30 ft below the surface is a shallow alcove that provided access to a drift running back to the west, now caved, that probably accessed the R-2 shaft.

At a measured slope distance of 50.8 ft below the collar is the invert of a breakthrough that accesses the top of the extensive stope on the Kingman side of the shaft. The stope cannot be accessed directly as it drops very steeply; it contains many pillars of varying sizes.

The same stope is accessible through a breakthrough on the same side at a measured slope distance of 67.7 ft. Allowing for 30 ft of timber removed, this corresponds to the "100" level in depth and agrees closely with the slope distance of 94 ft shown on Chock's (1938) longitudinal section. A similar breakthrough was found on the opposite side of the shaft. As is shown by Chock, the "100" level has been stoped out and cannot be followed more than a few tens of feet in either direction from the shaft. No spads were found at the level station or in the drift intersection to the south, although Chock shows one in the intersection. A reflector was hung in the shaft at the "100" level with the intent of being able to see it from the surface, but it is not visible when the outside sunlight is bright.

The stopes are very extensive both down the dip and along the strike. It was possible to discern the continuation of the "100" level past the stope in both directions, although reaching them was impossible under the circumstances. To the north, it appears that the "100" level has been partially filled with muck. To the south, the level appears to be open, but it doglegs to the left and conditions beyond remain unclear. The accessible portions of the "100" level coincide closely with Chock's and other maps. However it appears that an ore chute was added above the stope on the south side of the shaft that is not shown on any maps, and this suggests that a shallower stope and some deeper workings may not be shown on Chock's map.

The stopes appear to be in generally good condition, despite prevalent ravelling and drummy ribs. No large slabs or extensive cracking was noted.

The striking feature of the stopes in terms of assessing their dimensions and stability is the irregularity in dimension perpendicular to the dip. Vertical distances to the stope backs range up to an estimated 40 ft and stope widths range between 10 ft or so and at least 40 ft. Apparently, stopes were widened along ore shoots that may have been elongate perpendicular to the general structural trend. There are no level maps that depict the dimensions of the stopes in this direction, although it appears that the Chock longitudinal section may be a good source of estimated stope lengths along the strike. Layne's report (ca. 1915, p.9) describes the "hanging wall ore shoot" at the 200 level as being about 35 ft wide, which may be indicative of stoping widths.

The stopes that break to the surface apparently obliterated the three older shafts, which now can be generally seen as open voids extending to depth. These stopes are not shown on the Chock longitudinal section and were apparently extracted sometime after 1938, perhaps associated with the further activity on the property in the early 1940s. USBM IC 6901 mentions shrinkage stoping activity above the 80-ft level ("100" level) in 1934, and that some drifting was then under way to get under an ore shoot that contacted the gravels on the 180-ft ("200") level. It reported production (mill heads) of 50 tpd.

3.3 Surface Features

Surface reconnaissance revealed numerous short adits, shallow prospect pits, and sampling trenches. These are inventoried on Table 1. None of the other workings

TABLE 1 - LOCATION AND TYPE OF MISCELLANEOUS FEATURES

Point	Description	Station	Offset
1	trench 30'x 15'x 3'	428+96	103L
2	trench 30'x 15'x 4'	428+95	127L
3	hole 12"dia x 4'dp	428+50	113L
4	trench 30'x 10'x 4'	428+17	138L
5	hole 15"dia x 3'dp	428+05	130L
6	hole 18"dia x 4'dp	427+43	135L
7	hole 17"dia x 4'dp	426+36	156L
8	hole 17"dia x 4'dp	425+78	164L
9	trench 100'x 20'x 5'	424+07	185L
10	trench 75'x 15'x 10'	421+71	230L
11	hole 15"dia x 6'dp	420+37	424L
12	hole 8"dia x 8'dp	418+29	360L
13	trench 25'x 15'x 5'	418+54	320L
14	adit 3'w x 5'dp	418+25	260L
15	2 holes 8" x 8 ft sep	418+81	255L
16	pit 30'x 20'x 8'	411+04	81L
17	pit 50'x 30'x 12'	410+87	62L
18	primitive shaft 25'	407+84	83L
19	trench 15'x 5'x 3'	403+10	298L
20	hole 10" dia	402+79	299L
21	trench 10'x 10'x 5'	402+61	283L
22	trench 20'x 8'x 8'	402+54	263L
23	hole 60" dia x 3' dp	402+88	138R
24	trench 20'x 6'x 4'	399+40	48R
25	trench 50'x 15'x 8'	431+95	316L
26	trench 25'x 10'x 6'	431+25	246L
27	trench y-shaped	431+04	267L
28	trench 25'x 8'x 5'	430+95	312L
29	adit 2'h x 3'w x 5'	430+75	321L
30	trench 20'x 5'x 3'	430+68	311L
31	adit 2'h x 3'w x 10'	430+54	310L
32	adit 4'h x 3'w x 4'	430+39	316L
33	trench 15'x 8'x 5'	430+25	302L
34	adit 5'h x 6'w x 40'	429+98	311L
35	adit 5'h x 4'w x 40'	430+10	270L
36	trench 20'x 12'x 5'	429+95	254L
37	powder magazine (adit)	333+37	45R
38	Loading Dock (Timber)	432+63	111L

TABLE 1 - LOCATION AND TYPE OF MISCELLANEOUS FEATURES (continued)

Point	Description	Station	Offset
	Philadelphia No.1	435+02	261L
	Philadelphia No.2	430+65	110L
	adit 4'x 6'x 50'	418+05	260L
	shaft 5x7 22'@ 55 deg	418+75	255L
	quarry (lower)	410+83	62L
	quarry (upper)	411+02	80L

indicates any potential to connect with the main Arabian Mine or the stopes that were part of the Philadelphia Group described above.

The inclined shaft and nearby adit on the Rising Fawn property near Station 418+50 are well off the road and the distance from the main workings and the size of the dumps associated with them indicate that these are not of great enough extent to reach either the road or the main property. These may be discerned from the discussion by Layne, and are still visible; the shaft has caved below a depth of about 20 ft.

Layne also mentions the "Rising Fawn Tunnel" and a 60-ft-deep vertical shaft on the Rising Fawn Claim. These appear on a claim map of the Rising Fawn and were apparently covered or mined through as the "Arabian Cut" (USBM IC 6901), a benching operation along the surface expression of the vein nearly 150 ft high and 60 ft wide, was being mined in the 1930s. The Tunnel was 197 ft long and contained a 100-ft deep winze, a 57-ft-long crosscut (in a direction toward the road), and a decline on the vein. Layne describes the 60-ft-deep shaft, 70 ft south of the tunnel, as being discontinued because the vein was too disaggregated by an andesite intrusion. The shaft was apparently at the foot of the hill and is no longer visible. The position of these workings at present cannot be ascertained. Layne speculates that the crosscut had to go another 120 ft to reach the hanging wall. Even if it had, it would have stopped about 50 ft from the road. Because no further evidence or mention of heavy production from these features has been found, it is concluded that the crosscut probably was not extended.

Layne's description reveals another shaft, constructed "382 ft" south of the 60-ft-deep shaft on the Rising Fawn Claim. Plotting of this and comparing it with the claim map provided by ADOT indicates that the shaft referred to by Layne might have been the "No. 4 Shaft" shown on the claim map as being 50 ft deep. Such a shaft plots, depending on how the claim boundaries are aligned, within 40 ft right of the roadway centerline at approximate station 411+40 based on the claim map or, if Layne's 382 ft dimension is correct, potentially on the road at about 412+70. Regardless, there is no evidence of such a shaft at present, and if there were one in the vicinity in the past, it would probably have been filled in by the Bureau of Reclamation during construction of the road.

In any event, the shaft in the side drainage opposite 407+84 no longer appears to be the "Rising Fawn" shaft as we once believed; in fact, it does not appear on any records of the claim.

4.0 RECOMMENDATIONS

4.1. Stability of Stopes and Drifts

It appears that the new road alignment is underlain by stopes and drifts whose orientations, dimensions, or stability has not been observed. In formulating a plan to consider these factors, it is necessary to resort to judgement and inference. The chief uncertainty in extrapolating the location and condition of the workings at depth is the lack of direct access or other information indicating the width and condition of the stopes in the inaccessible areas, which happen to lie beneath the road.

It is unlikely that even substantial ground failures in single drifts could affect the road construction, unless such single drifts were very shallow. Most of the drifts are 4x6 or 5x7, and are deeper than 60 ft. One can infer that there are no such drifts beneath the alignment shallow enough to be of concern because the miners consistently avoided crossing through the gravels, which persist to well below the "100" level, according to the few cross-sections available.

Therefore, failures of ground in single drifts would not be of major concern for the stability of the road. In fact, such failures have occurred (the drift on the 100 level between the No. 1 and No. 2 shafts was caved in 1938; the drift toward the road off the No. 1 shaft has caved, etc.) and there is no evidence of apparent surface subsidence.

The potentials for failure of the stopes, and the effect any such failures might have on the ground surface, are other matters entirely. The stopes accessed are open or water-filled; there is no indication that any were backfilled. Rock mass strength is likely to be low in the intensely fractured rhyolites and very low in the pervasively altered granites, but the workings are generally open because rock stresses are not high at these generally shallow depths. Where faults with gouge were seen, considerable spalling and sloughage had developed in the immediate vicinities of the faults. Such faults could serve as the points of initiation of ground failures, and further weaken the rock mass. The spacings of the stope pillars indicated on Chock's longitudinal section suggest relatively strong wall rock conditions, consistent with the strength of a hangingwall of extrusive, massive rhyolite.

Where underground observations were possible, stope as well as drift deterioration in this case appeared to be a progressive occurrence characterized by ravelling and sloughage, rather than large-scale block failures. Stulls were used sparingly as stope support, if at all, so the deterioration of timber probably would play only a localized role in the potential for ground failures. The principal mode of stope support seems to have been pillars of natural rock, probably relatively barren vein material. All the pillars within the stopes observed are hourglassed to some degree; the smaller pillars more severely than the larger ones. This indicates that sloughage from the sides of pillars has been occurring in the past. However the length of time that the workings have remained open argues that the sloughage process is very slow overall, and should remain so unless major changes occur. Where the hangingwall is an extrusive, massive rhyolite, extensive spans could be maintained.

Major changes in water level would be expected to introduce further sloughing of pillars and perhaps lead to collapse of certain areas. Other possibilities would be excessive blasting vibration from the road construction, placement of considerable fill atop the mine workings, seismic events leading to slippage along faults, introduction of liquids into the mine, and so on. In the absence of such disturbances, the potential for ground failures during the life of the roadway is probably low, but cannot be quantified from currently-available data.

4.2. Subsidence Potential

Ground failures at depth do not necessarily result in surface subsidence, but in this case the considerable vertical extent of the workings, the presence of faults and other discontinuities that dip moderately to steeply, the presence of weakly-consolidated gravels, and the relatively shallow depths of the larger stopes beneath the road, indicate that collapse (as opposed to local stope wall sloughage) in stopes shallower than the 200 or 250 level would be very likely to affect the surface. The effect of collapse of deeper stopes is not clear, as these are shown in the record to be more limited in extent. The degree of surface movement would be dependent on the vertical or down-dip extent of the ground movement, but ground movements of feet to tens of feet could very well occur as a result of massive stope collapse, particularly if the collapse occurred at shallower depth so that collapsed material could move downward through water-filled workings. If any ground movement were to occur at all, discrete, large-scale surface ground movements are more likely than slow, persistent subsidence.

Such failures are rare but not unheard of in abandoned metal mines. They usually are precipitated by some sort of change, such as the introduction or withdrawl of water, or the loading of the surface by buildings or fill.

4.3. Effect of Blasting

Properly-conducted blasting at the distances presently under consideration is not likely to trigger the scale of stope collapse that would be prerequisite to large-scale ground movement, unless that collapse is imminent anyway. Both the granite and the rhyolite in the workings seem, by virtue of alteration and fracturing, respectively, to be inefficient overall transmitters of seismic energy. These appear to be the types of rock masses that will tend to absorb and dampen energy, which for blasting would have the effect of attenuating the incident seismic waves, damping them, and introducing a capacity for displacements. At the depths of interest, accelerations likely to reach the site from blasting of the hillside near the curve would be only a very small percentage of the existing rock stresses. Nonetheless, for an added margin of safety, we would recommend that the blasting be conducted with sequential delays such that individual holes are fired at least 25 milliseconds apart, so that the charge weight per delay is limited, in order to assure that accelerations remain small.

4.4. Further Exploration

Assessment of the risk of subsidence to the roadway will require knowledge of the actual depths and dimensions of the stopes that underlie the road or that are close enough to it to affect the road by draw effects. To measure these first-hand, the Philadelphia No. 2 collar would need to be stabilized and the mine pumped out, which is not advisable.

Instead, a core drilling program is recommended and should be followed up with borehole video work. The site topo gives suggestions for drill hole locations -- these are intended to penetrate stopes at various depths and that exhibit various spans on the Chock drawing. The shallower stopes may not have much rock between their hanging walls and the gravels, so caution will be needed. The drill holes need not be precisely located as the targets are large and the uncertainty in the depth and dimensions of the stopes is also large. It would probably be sufficiently accurate to locate the holes by compass-and-tape off the shaft collar.

It is recommended that the gravels be augered through and that the hole be cased in the gravel layer, noting carefully the thickness of the gravel. The rock should be cored with a split inner tube if at all possible. This type of drilling should be treated as a probing operation as well as a sampling operation. The extent of all rod drops and any associated "sponginess" in the rods below drops should be carefully noted. For holes below the water table, coring could be continued below voids, but care in regulating circulation should be practiced because it is more important to preserve the clarity of the mine water for visibility than it is to obtain core production in the footwall.

If a borehole video camera is to be used, the holes should be vertical. Angled holes present some advantage with respect to measuring the width of voids, but this is a small benefit when compared with the trouble angled holes cause in using and interpreting the data from borehole video observations. Ideally, the holes should be surveyed, because the dip of the strata could deflect the drill string, but the deflections should be tolerable at the depths of interest if the drilling is done carefully.

Before using the borehole video camera, adequate time should be allotted for the particulates in the mine water that will be introduced by drilling to settle out. The camera should be capable of focusing at extended distances and should provide adequate lighting to penetrate 40 ft or so. Apparatus ordinarily used by the well drilling industry to examine well casings will not satisfy this requirement. It will be necessary to record the direction of view, and an articulated lens is desirable. Distances will be difficult to estimate with a borehole camera but if some work is done at the surface viewing objects of known size and distance, an idea can be gained of the manner in which the lens delivers the image underground.

It is important not to rush borehole camera work. Depths should be recorded either on-screen or with a voiceover. It is advisable to let the camera sit for a few minutes before hanging it in a void to be sure the water is not flowing too fast to remove the apparatus. Repeated observations should be made of the borehole walls and stope boundaries to discern any open fractures or detachment surfaces as well as the condition and dimensions of the stopes.

Drilling logs should record fracturing, RQD, fluid circulation, and lithologic data, and should be correlated with borehole video data.