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Impact Analysis on ESF Design For Calico Hills Penetration and Exploratory Drift And Tuff Main Extension to Limits of the Repository Block

YMPO ACTION ITEM #88-1995

Prepared By:
J. Grenia and L. Weyand
Of
Fenix & Scisson, Inc.
101 Convention Center Drive
Las Vegas, NV 89109
November 15, 1988

Prepared For
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And

Tuff Main Extension to Limits of the Repository Block

ABSTRACT

The study covers the impacts on project costs, schedule, human resources and engineering designs caused by increases in site characterization activity consisting of penetration of the Calico Hills formation by ES-1 shaft with exploratory drifting to the Ghost Dance fault and/or drifting 10,000 feet southward from the MTL ESF test complex area to the end of the future repository block.

The Calico Hills penetration activity consists of deepening ES-1 from the MTL to the Calico Hills after ES-1 is equipped from surface to the MTL. This could be done immediately after equipping or at a later date. The impacts of either schedule would be as follows:
1) Design and construction of a second sinking stage would be required
2) Expansion of the utility infrastructure on the MTL
3) Removal of some shaft equipage if sinking below the MTL is delayed
4) Modification of the ES-1 headframe
5) The work would require one year and cost $3,380,000

Future exploratory drifting of approximately 1000 feet on the Calico Hills level will create the following impacts:
1) Twenty additional subsurface personnel
2) Additional mining equipment
3) Utility capacity increases
4) The time required would be 318 shifts and the cost would be $2,188,000

An increase in exploratory drifting activity of 10,000 feet would cause impacts to the design, construction, testing and schedule as follows:
1) Increased subsurface ventilation fan capacity and reuse of more air
2) Increased subsurface population
3) Increased utility capacity
4) The construction schedule would be lengthened by 475 to 800 days
5) The mapping and testing personnel would be increased and mapping time increased by 39 weeks

Prepared by YUCCA Mountain Project (YMP) Participants as part of the Civilian Radioactive Waste Management Program. The YMP Project is managed by the Waste Management Project Office of the U. S. Department of Energy, Nevada Operations Office. YMP Project work is sponsored by the U. S. Department of Energy, Office of Civilian Radioactive Waste Management, Washington D.C.

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PART 1

PART 1 - CALICO HILLS PENETRATION AND EXPLORATORY DRIFT

1.1 Purpose

The Calico Hills unit is an important barrier between the repository horizon and the underlying ground water table. Prior to penetrating this strata, it must be shown that there are not adverse impacts on the waste isolation capability of the site. This analysis is to delineate the consequences of Calico Hills level activity on the present design, construction and testing of the ESF. The analysis will also point out any impacts which can be mitigated through the Title II design effort.

1.2 Technical Scope Scenarios to be evaluated are as follows:

Option 1 As soon as possible after ES-1 is sunk to the Main Test Level (MTL) and equipped:

a) ES-1 shaft is deepened and Calico Hills penetration is limited to the drill room shown on drawing R07048A/6. (figure 1.1)

b) ES-1 shaft is deepened, the drill room excavated, and an exploratory drift driven approximately 1000 ft. to the Ghost Dance Fault. (figure 1.2)

Option 2 After ESF drifting on the Main Test Level (MTL) is essentially complete:

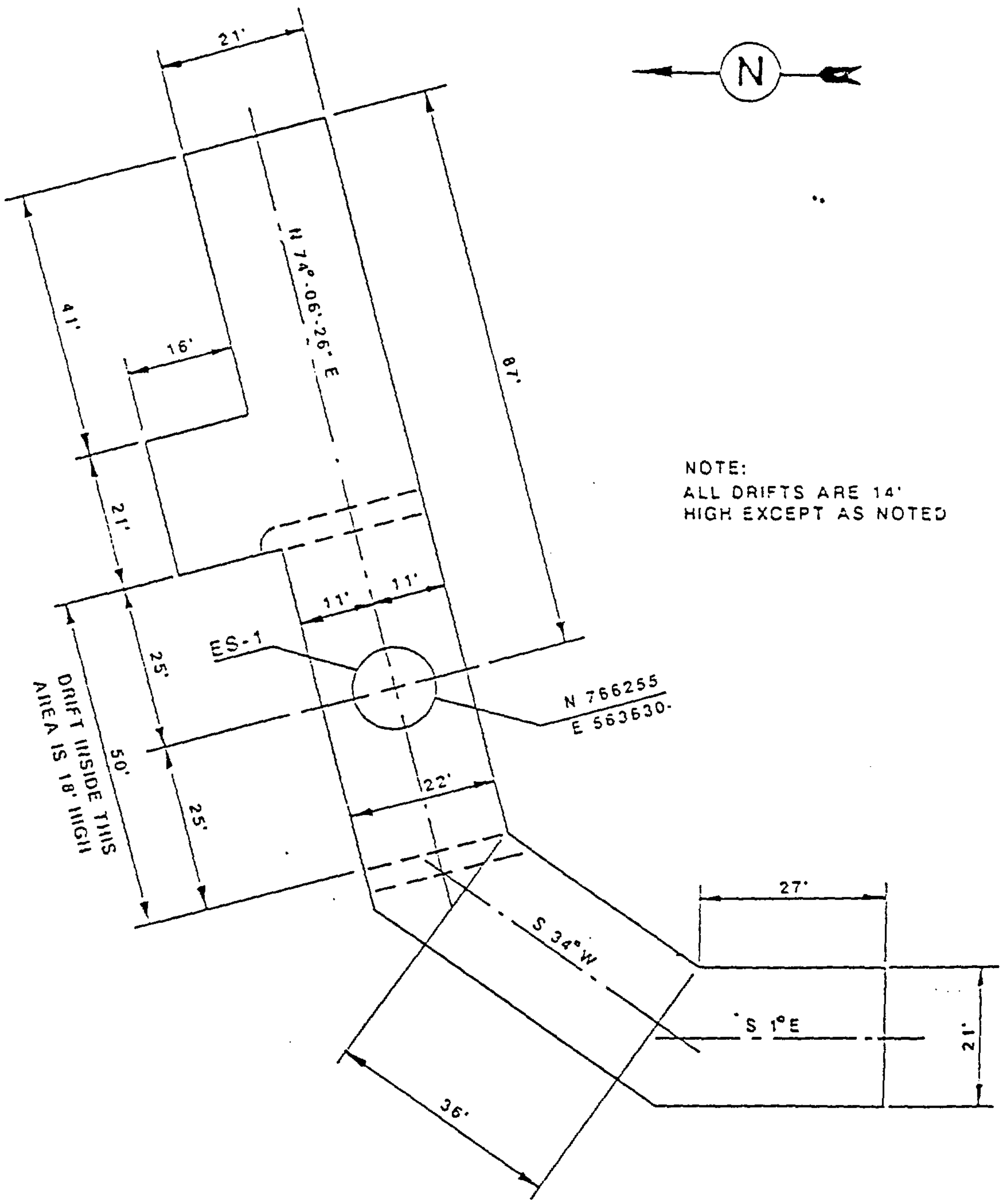
a) ES-1 shaft is deepened and Calico Hills penetration is limited to the drill room shown on drawing R07048A/6. (Figure 1-1)

b) ES-1 shaft is deepened, the drill room excavated, and an exploratory drift driven approximately 1000 ft. to the Ghost Dance Fault. (Figure 1-2)

1.3 Assumptions:
Given - (IN WMPO LETTER DHI-2334)

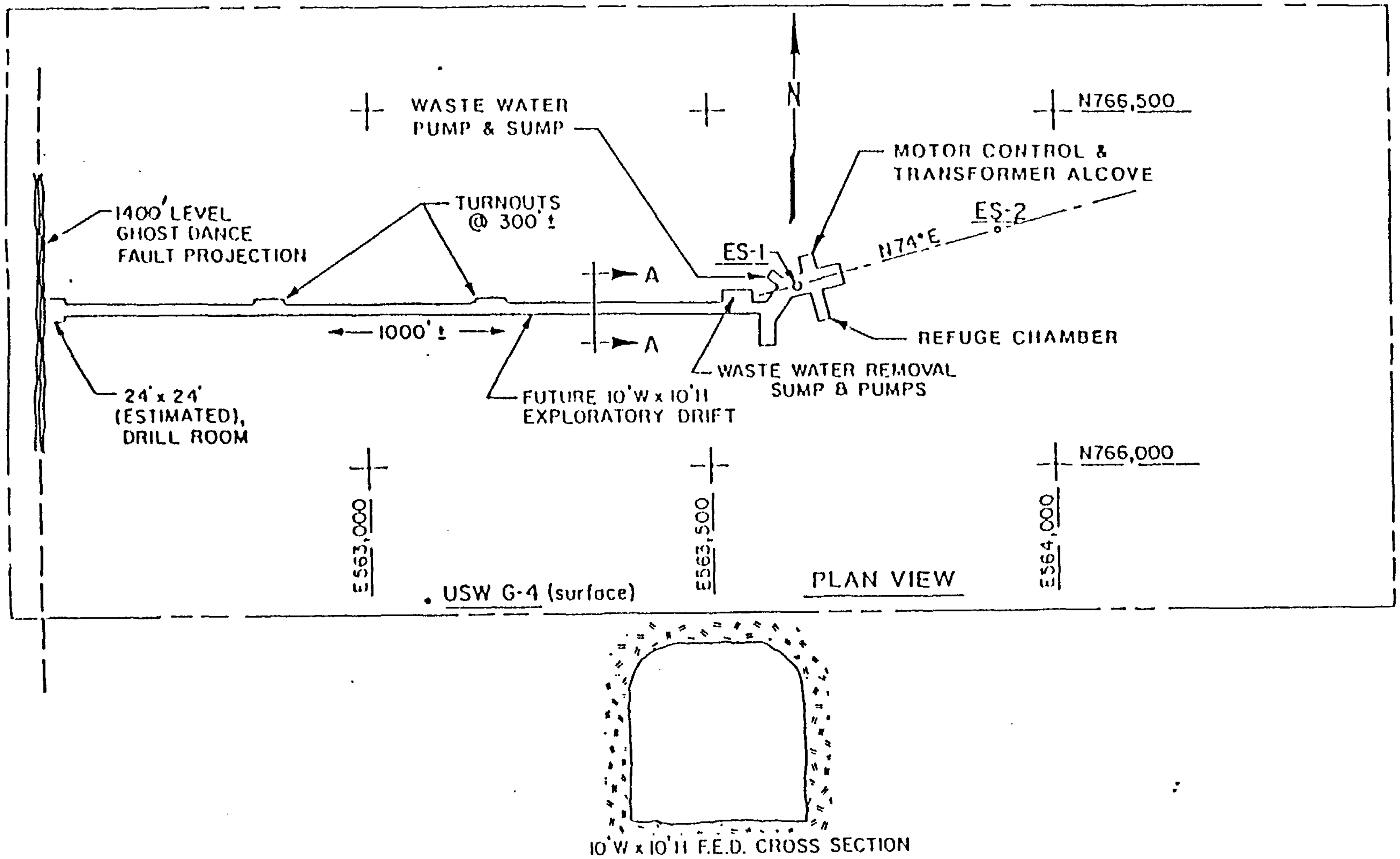
1.3.1 The Title II Subsystem Design Review Document (SDRD) limits the Exploratory Shaft (ES-1) depth to the top of the Calico Hills.

1.3.2 After ES-1 sinking and equipping is complete, the decision can be made to deepen the shaft and also penetrate Calico Hills.



BASIC CHDR ESF STATION LAYOUT

FIGURE 1-1



FUTURE EXPLORATORY DRIFT (FED) LAYOUT & CROSS SECTION

FIGURE 1-2

1.3.3 Base case for this study assumes that ES-1 shaft stops just below the (MTL).

1.3.4 Access to test locations in ES-1 must be maintained during shaft deepening and Calico Hills level development.

1.3.5 The primary reason for drifting on the Calico Hills level is to gain access to the target zone (Ghost Dance Fault). Therefore, a minimum size drift of safe design for proposed mining equipment and personnel will be sufficient.

1.3.6 ESF quality of drifting will be maintained, i.e. drifting will be mapped, control drilled and blasted, minimum water usage, etc.

1.3.7 No special, large size testing equipment will be required at the testing target area.

1.3.8 The electrical systems for the Integrated Data System (IDS) must be extended to the target area.

1.3.9 Natural water inflow from the Ghost Dance Fault may be expected to be on the order of 250 gallons per minute.

1.4 Technical Study

The base case scenario has the ES-1 shaft stopping approximately 60 ft. below the MTL. At this point, the entire shaft is equipped with all guides, buntons, utilities, landings, ladderway, permanent conveyance, vent tube and sump materials. As designed, the ES-1 shaft will function to support testing both underground and in ES-1 by transporting testing personnel to the Upper Demonstration Break Room (UDBR), MTL and various locations throughout the shaft.

In this study, impacts will be evaluated on present ESF design, construction, and testing, caused by extending ES-1 from the MTL to the Calico Hills level, development of the Calico Hills Drill Room (CHDR) and possible drift extension to the Ghost Dance Fault.

1.4.1 Shaft Extension

Both impacting scenarios Option 1 and Option 2 dictate that ES-1 shall be deepened after the shaft is equipped. In the case of Option 1 where the deepening is done as soon as possible after reaching the MTL, shaft equipping would not extend below the MTL, but would stop just above the shaft station.

Shaft outfitting will interfere with suspension ropes as used for sinking from the surface to the MTL. However, through redesign and careful positioning of work stage suspension ropes, it is possible

1.4.1 - Continued

to suspend a new galloway from the surface using the same sheaves and winches. Special modifications would be necessary to pass these ropes through the landing grating, perhaps using pipe sleeves or removing the grating altogether. This will eliminate the need to place galloway winches on the MTL station.

Mucking in the lower shaft would be serviced by a guided bucket operating on permanent guides above and below the MTL, installed as the shaft is deepened. The arrangement of a crosshead and bucket only, is chosen for safety reasons in lieu of a cage over crosshead arrangement. The latter results in a dangerous shock effect on the sinking stage and/or MTL landing when a cage is lowered onto a support mechanism under normal travel conditions. If a cage is absolutely necessary for personnel access in the shaft, the bucket can be removed and replaced with the cage for temporary use.

Shaft bottom mucking would function as normal and hoisting of buckets would be done using the main 900 h.p. hoist through an offset bucket well in the work deck. The offset well is to maintain alignment with permanent guide fixtures in the rest of the shaft. The dump chute at the surface needs to be changed under this arrangement to accommodate the offset conditions. The sinking work deck for shaft extension would be a new item designed for the same offset features.

Due to space limitations on the MTL ES-1 shaft station, form winches cannot be accommodated. Therefore, the new sinking stage will need to be designed to handle liner form movement from the work deck as currently practiced on many North American projects. A cryderman winch can be accommodated on the MTL, therefore no change in handling procedure for mucking or drilling is anticipated.

All utilities used for shaft extension would originate from the MTL, i.e. electrical, compressed air, water, mine waste water, ventilation and testing. Systems handled in this way would be an extension of the permanent facilities installed on the MTL. Since the shaft extension will be equipped while being sunk, some permanent size utility lines will be installed and used as necessary. These are anticipated to be compressed air, water, and ventilation ducting.

The above description applies for both scenarios Option 1 and Option 2 except that, in the case of Option 2 where construction is delayed until ESF drifting on the MTL is essentially complete, additional work must be done. Since ES-1 would be equipped in this case through the MTL station and sump (about 60 ft. below the MTL), some equipping would have to be stripped from just above the shaft

1.4.1 - Continued

station to the sump, and sump pumping facilities, liners, etc. would need to be removed. Enough space to construct a galloway in the shaft, and leave at least 20 ft. clearance to the shaft bottom would be needed, thereby dictating the removal of a number (if not all) of the steel sets from the MTL to the sump bottom. This entire preparation process is estimated at 2 weeks.

The following is included to quantify the amount of work to accomplish the options. Impacts to the present design, if any, will be identified.

To provide a basis for estimating a shaft sinking rate for ES-1 shaft, the shaft sinking rates achieved at the White River Oil Shale project and at the Inco C. C. South Mine were used. At the White River Oil Shale project, 300 feet of completed shaft was sunk per month and at Inco's C.C. South Mine 225 feet of shaft was sunk per month. An average of these 2 sinking rates (263 ft/month) was used in the calculation of a sinking rate for ES-1 shaft.

A smooth wall shaft round of 14 feet diameter and 8 feet in depth is estimated to take 811 minutes. The round breaks 7.5 feet. It is assumed mapping, geologic sampling, and periodic seismic testing will be required. Quality Assurance inspections are assumed to require 50 minutes per round.

- A working month is assumed as 30 days. The actual working time is assumed as:

  Work day = 24 hrs. - 1.5 hrs. (lunch) - 1.5 hrs. (travel) = 21 hrs.

  Work month = 30 days x 21 hrs./day = 630 hrs/mo.

- The monthly time to drill (D), blast (B) and muck (M) cycle is:

  $$\text{D-B-M Cycle} = \frac{263 \text{ ft./mon.}}{7.5 \text{ ft./rd.}} \times \frac{811 \text{ min./rd.}}{60 \text{ min./hr.}} = 474 \text{ hrs./mo.}$$

  $$\text{This equates to } \frac{474 \text{ hrs./mo.}}{263 \text{ ft./mo.}} = 1.80 \text{ hrs./ft.}$$

- The installation of concrete and shaft steel in a normal shaft is:

  Concrete and steel time = 630 - 474 = 156 hrs./mo.

  $$\text{This equates to } \frac{156 \text{ hrs./mo.}}{263 \text{ ft./mo.}} = 0.59 \text{ hrs./ft.}$$

1.4.1 - Continued

- Time to map the shaft and take geologic samples is:

  Mapping time = $\frac{8 \text{ hrs.}}{7.5 \text{ ft.}}$ = 1.07 hrs./ft.

- Time to do seismic instrumentation and monitoring is:

  Seismic Time = $\frac{1.5 \text{ hrs.}}{7.5 \text{ ft.}}$ = 0.20 hrs./ft.

- Time to perform Quality Assurance inspection is assumed to be 50 min./rd.

  QA time = $\frac{.83 \text{ hrs.}}{7.5 \text{ ft.}}$ = .11 hrs./ft.

- Therefore, the advance rate (X) is calculated as:

  1.80 (X) + 0.59 (X) + 1.07 (X) + 0.20 (X) + 0.11 (X) = 630 hrs./mo. X = 167 ft./mo. or 5.57 ft./day.

- Time to excavate an additional 295 ft. of shaft to the Calico Hills level is:

  295 ft. x $\frac{1 \text{ day}}{5.57 \text{ ft.}}$ = 53 days - say 8 weeks

For all options, the ES-1 headframe sinking arrangement would be modified to accommodate a different sheave setting, winch location(s) and dump arrangement.

- Estimated time for redesign of the headframe, surface structures, shaft internals and considerations for galloway ropes is 8 weeks.

- Time to construct, install and modify such structures after the initial outfitting is taken to be 5 weeks.

- With the above mentioned work being done on weekends and evening shifts, there is no apparent impact on routine functioning.

A new sinking stage would be necessary to sink from the MTL to the Calico Hills level after the upper shaft section has been outfitted. This is due to the offset bucket well configuration, relocation of cryderman winches on the MTL, and features necessary for handling forms from the work deck.

1.4.1 - Continued

- o New galloway construction is estimated to have the following impact:

  8 weeks design
  6 months procurement
  2 weeks construction in place

- o Moving and resetting winches on the MTL is taken at 2 weeks.

  Cryderman winch + misc. utility winches or cranes.

- o Installing new utility lines for lower shaft extension on the ES-1 MTL station is taken to be 1 week, design of utility lines is 2 weeks.

- o Roping up all winch systems is taken at 1 week.

- o Excavation of CHDR as shown on drawing R07048A/6 is estimated at 3 weeks.

- o Final demobilization and finish equipping is set at 3 weeks.

Total Schedule Cost impacts of extending ES-1 shaft from just below the MTL to the Calico Hills level and excavating the Calico Hills Drill room is as follows:

o	Redesign of headframe and internals	8 weeks
o	Construct, modify/install	5 weeks
o	Galloway - design, procure, install	36 weeks
o	Subsurface site prep	2 weeks
o	Utility lines - design, install	3 weeks
o	Rope up	1 week
o	Sink shaft	8 weeks
o	Excavate CHDR	3 weeks
o	Demobilization and final outfitting	3 weeks
	Additive Total	69 weeks

Due to schedule overlap of activities use 52 weeks or 1 year.

1.4.1 - Continued

Cost impact is as follows:

Shaft	-	777,000
Internals	-	836,000
Mapping	-	64,000
Standby	-	108,000
CHDR Excavation	-	434,000
Tests	-	1,063,000
Engineering	-	98,000
		$3,380,000 Total

1.4.2 Future Exploratory Drifting (FED)

Options 1b and 2b include an exploratory drift driven as an extension from the Calico Hills Drill room to the Ghost Dance Fault. This drift is approximately 1000 ft. in length, and is orientated in an assumed position for this analysis as shown in Figure 1-2. Support services for this effort will originate in the CHDR, and will include a muck handling system, refuge chamber, and any necessary utility substation or facilities.

1.4.2.1 Testing in the FED

Tests to be conducted along the FED and at the Ghost Dance Fault have not as yet been determined. Therefore, it will be assumed that tests, similar to those planned for the present ESF program to determine local rock structure and hydrology, will be conducted at the geologic target. Also, it is assumed that drift wall mapping and rock sampling, similar to that which will take place in all other ESF drifts, will be performed.

1.4.2.2 FED Contribution to ESF Design Occupancy Level

The development and testing to be performed in the FED will occur in two distinct phases: drift mining, followed by the testing phase. Estimates of the total number and type of personnel required for working the FED (construction and testing), are provided as follows:

Mining Phase Occupancy

The estimates for Design Occupancy of the FED during mining are shown in Table 1-1.

1.4.2.2 - Continued

Table 1-1. FED Design Occupancy Level

Personnel (Types)		Numbers
Construction Management		2
Mining Labor		
Walker (Supervisor)	1	
Lead Miner	1	
Miners	4	
LHD Operator	1	
Skip Tender	1	
TOTAL MINING LABOR	8	8
Principal Investigators - Mapping		5
F&S Inspection		2
H&N		2
DOE		1
TOTAL DESIGN OCCUPANCY		20

Testing Phase Occupancy

With no specific tests presently proposed, assume a total of 20 persons, which include: the P.I., Geologists, Hydrologists, drilling crews, Construction Management, mining inspection, and visitors:

TOTAL DESIGN OCCUPANCY 20

1.4.2.3 FED Size and Layout

For the purpose of this study, it has been assumed that the Drift Wall Mapping Test, and the Rock-Matrix Hydrological Properties Test will be conducted in the exploratory drift, concurrent with mining. While these tests do not affect size or orientation, they do significantly impact mining schedules. It is also assumed that no other tests will be scheduled to take place in the exploratory drift.

1.4.2.3 - Continued

As a result of the preceding assumptions, it is assumed that a minimum size drift with equipment and personnel turnouts, adequate only to the extent that safe access to the Ghost Dance Fault target is ensured, is required. Based on professional experience the practical, minimum sized drift is judged to be about, 10-foot wide by 10-foot high. Therefore, it is proposed that the exploratory drift size be 10-feet wide by 10-feet high as generally located and shown in Figure 1-2.

It is also assumed that tests at the Ghost Dance Fault will require diamond drilling, using either water or air for cuttings removal. For the purpose of this study, it has been estimated that dry air coring, using an IR drill rig and the Odex drill system, requires a space 24-feet long by 24-feet wide by 12-feet 6 inches high. Therefore, a test drill room of the size required to accommodate this equipment at the end of the exploratory drift is planned.

1.4.2.4 FED Mining Method

The mining of the FED will be accomplished by use of conventional mining techniques (drill, blast, muck), using smoothwall blasting. Excavation of the FED will be performed by the MTL Development Contractor.

1.4.2.5 FED Mining Equipment

Because of the limited extent of drifting for the FED on the Calico Hills level, it is proposed that a 3-1/2 yd.^{3} Load-Haul-Dump Vehicle (LHD) be used.

A combination of a 1-boom drill jumbo and a single, rubber tired, diesel-powered, 3-1/2 yd.^{3} LHD can support a production rate of 1 round per day; which is equivalent to 55 cy of muck production per day and 10 ft. of advance per day. In addition to its primary task of muck removal, the LHD can be used to move materials and supplies as mining progresses.

Therefore, the recommended mining spread for the FED is as shown in Table 1-2.

Table 1-2. 1400 L - FED Equipment List

Major Equipment	Required
3-1/2 yd.^{3} Load-Haul-Muck (LHD)	1
Transportation	1
IR CMM-2 Drill	1
1-boom Drill Jumbo	1
Electric over Hydraulic	

1.4.2.6 Muck Loading System

After ES-1 is sunk to the Calico Hills level, the CHDR is excavated and the shaft outfitted, the exploratory drift may be driven. Since the shaft is outfitted, either a bucket loading arrangement or muck car system are possibilities. For present consideration a muck handling system comprised of cars hoisted in a cage to the surface is selected.

A hopper and conveyor system would be constructed at the CHDR which would be fed by the 3-1/2 yd^3 LHD. A short rail system with turn-outs would accommodate small muck cars which fit into the cage planned for ES-1 (the cage designed with rails in the floor).

- Muck cars - assumed dimensions 4 ft. x 4 ft. x 3.5 ft.

  = 56 $ft.^3$ capacity
  x .8 fill factor
  45 $ft.^3$ loaded capacity

  1 round = 10^2ft. x 10 ft. x 1.5 swell = 150 $ft.^3$

  1500/45 = 33.3 use 34 cars/round

- Try using a double deck cage -
  Broken muck - use 98 lbs/cu. ft.
  45 cu. ft. x 98 = 4410 lbs./carload
  x 2 cars/trip
  8820 lbs./trip

  8820 lbs./trip
  \+ 3600 lbs. weight of 2 cars (assumed)
  \+ 9000 lbs. cage weight (assumed)
  21,420 lbs. Total
  -18,600 lbs. Hoist Load Limit
  2,820 lbs. Overload

- Therefore: use single deck cage as presently planned.

  45 cu. ft. x 98 lbs/cu. ft. = 4410 lbs.
  \+ 1800 lbs. 1 car
  \+ 6000 lbs. cage weight
  12,210 lbs. Total

- Hoist duty cycle calculations (re: FS-CA-0067) indicate 8 trips/hr.

  $$34 \frac{\text{cars}}{\text{round}} \times \frac{1 \text{ trip}}{1 \text{ car}} \times \frac{1 \text{ hr.}}{8 \text{ trips}} = 4.25 \frac{\text{hrs. hoisting}}{\text{round}}$$

1.4.2.7 FED Safety Requirements

The Calico Hills safety considerations shall be similar to those proposed for the MTL and UDBR.

One of the main safety considerations concerns emergency escape from the CHDR, since this level is not connected to the ES-2. Escape from the Calico Hills can only be made via the ES-1 hoist or the ES-1 ladderway. For this reason, a refuge chamber has been proposed for the CHDR, as a part of the basic ESF development. The proposed refuge chamber of 16-feet by 40-feet provides 640 square feet of floor space. At 14 square feet/person (standard allowance), this room will accommodate a maximum population of 40 people.

1.4.2.8 FED Utility Requirements

The mining and testing in the FED will require the same types of utilities as other drift levels.

The assumption that the Calico Hills FED mining and testing will take place after all other scheduled ESF development is substantially completed means: (1) the maximum system design loads for most utility systems will not be increased, and, (2) the utility distribution/collection systems serving the Calico Hills level must be increased in size to handle the future FED requirements.

The following paragraphs quantifies FED utility requirements and provides suggestions for handling modifications to utility systems to accommodate this future drifting and testing requirement.

1.4.2.9 FED Dust Abatement

Reference Information Base (RIB) information, as referenced in the SDRD, for the Calico Hills Formation in which the CHDR Level Station and FED will be constructed, indicates that the rock may contain a high zeolite content. The respirable particles of dust from rock, having a high zeolite content, could be a serious health threat.

The primary dust abatement method for the FED will be to use water and fog sprays at the face of the heading, during and after blasts, and at the muck dump. For the purpose of this study, assume that an exhaust hood at the muck dump will add at least 400 cubic feet per minute (CFM) to the ventilation air requirements. This air will be used to accelerate airborne particles into the exhaust air stream. The fog spray nozzles contemplated for use at the face and muck dump will require 3 gallon per minute (GPM) of water supply at each location.

1.4.2.10 Water Supply Requirements

The water supply requirements for the FED are shown in Table 1-3. Based on assumption 1.3.3, the FED will not occur until after other ESF mining is substantially complete; therefore, the water requirements shown in Table 1-3 do not add to the total ESF water requirements. These figures may be added to anticipated water requirements shown in other studies.

Table 1-3. FED Water Requirements List

Purpose	Total Added to CHDR System*
Mining/Drilling/Wet Core Drill Testing	7.5 GPM
Personnel (20 people @ 0.10 GPH)	Negligible
**Fire	**
Dust Abatement at Face	4 GPM Not Additive)
Total	7.5 GPM

*GPH = Gallons Per Hour, GPM = Gallons Per Minute
**Assume use of dry-type extinguishers in FED

1.4.2.11 FED Water System Description

The proposed water supply line in ES-1, to be used to supply water from the MTL for the basic CHDR development, will be adequate to supply the Calico Hills FED requirements.

1.4.2.12 Waste Water Control

As in the development of all other ESF underground space, the use of water in the mining and testing of the FED shall be minimized.

1.4.2.13 Waste Water Removal

In addition to the removal of mining (drilling) water, F&S has assumed that up to 250 GPM of water inflow could occur at the Ghost Dance Fault. This is a significant flow, as compared to the requirements for mining at the FED. Therefore, it is recommended that system capacity, capable of handling this future potential flow, be incorporated into the design and construction of the initial basic ESF Waste Water Removal System.

1.4.2.13 - Continued

Portable air-powered collection pumps, combined with an electrical-powered pumping system for larger flows, pumping into an extendable piping system, as described for other ESF drifting, will be required at the FED. This system will be used to convey mine waste water to the MTL sump.

1.4.2.14 FED Compressed Air

The FED will require compressed air, but since it is assumed the FED will follow basic ESF development, the FED requirement will not add to the ESF compressed air design requirements.

A system used to distribute compressed air to the FED will be required to supply the amounts shown in Table 1-4, to meet the FED compressed air requirements (demands).

Table 1-4. FED Compressed Air Requirements List

Purpose	Requirement (*SCFM @ 90 psig)
Mining	
Drilling	125
Waste Water Removal Sump Pump	8
TOTAL MINING DEMAND	133
Testing	
Drilling (Hi-Pressure Drill and Equip)	907
Waste Water Removal Sump Pump	8
TOTAL TESTING DEMAND	915

These quantities of compressed air can be supplied along the drift using an extendable 4-inch diameter piping system.

*SCFM = cubic feet per minute at standard temperature and pressure.

1.4.2.15 FED Electric Power

The minimum requirements for electrical power to be supplied to the FED are listed in Table 1-5.

Table 1-5. FED Electrical Power Requirements List

Purpose	Requirement
Mining	
Test Drilling - Coring	85 HP @ 480 V
Jumbo - 1 boom	65 HP @ 480 V
Permanent Facilities	
Lighting for 10 ft. -0 in. x 10 ft. -0 in.	
Drift - 1000 ft.	3 KW @ 120 V
Waste Water Pumps 3 @ 30	90 HP @ 480 V
Waste Water Pumps 2 @ 6	12 HP @ 480 V
Waste Water Pumps 4 @ 11	44 HP @ 480 V
Booster Ventilation Fan 2 @	50 HP @ 480 V

1.4.2.16 FED IDS Systems

It is assumed that some extension of ESF IDS systems may be required to accommodate testing in the FED. Space is available in the proposed drift to allow the conduit or cable tray to carry the IDS transmission systems.

1.4.2.17 FED Excavation Production, Schedule, Manpower and Supply Estimates

The estimates that summarize the major factors established by the requirements for FED mining and testing operations, and their associated costs and schedules, are provided in the following paragraphs.

1.4.2.18 Excavation Production

The excavation production values (quantities and rates) associated with the mining and testing of the FED and Test Drill Room (TDR) are:

a. Drift and TDR Excavation Volume
   1000 feet of Drift (10 ft. W x 10 ft. H) = 3700 Yd^3
   Test Drill Room (24 ft. W x 24 ft. L x 12 ft. -6 in. H) = 267 Yd^3

   TOTAL EXCAVATION VOLUME = 3967 Yd^3

b. Muck Volume (Swell Factor = 1.5) = 5950 Yd^3

c. Drift Advance (Footage Mined) per Shift
   without wall mapping = 7.0 ft./shift (26 Yd^3)
   with wall mapping = 5.5 ft./shift (20 Yd^3)

d. Total Number of Hoist Lifts (1.67 Yd^3/Lift) = 3563

1.4.2.19 Mining Rate

Estimated mining rate is taken at the following rates:

Total DBM Cycle	=	463 mins.
Utilities	=	120 mins.
Bolting	=	120 mins.
Mapping	=	60 mins.
Total	=	763 mins.
	=	12.7 hrs.
	=	1 round/day

$$3 \text{ shifts/day} \times \frac{1 \text{ day}}{\text{round}} \times 106 \text{ rounds} = 318 \text{ shifts.}$$

$$318 \text{ shifts} \times \frac{8 \text{ hrs.}}{\text{day}} \times \frac{5 \text{ men}}{\text{Crew}} = 12{,}720 \text{ man hours.}$$

1.4.2.20 FED Major Excavation Supplies

The estimated quantities of major mining supplies and materials that will be required to complete the mining are listed in Table 1-6.

Table 1-6. FED Major Mining Materials Requirements List

Material (Units)	Quantity
Explosives	
Water Gel (pounds)	34,000
Caps (ea)	4,500
Detonating Cord (feet)	11,000
Rock Bolts (6-foot long ea)	910
Wire Mesh (square feet)	15,000

1.4.2.21 FED Development Costs

Schedule and cost impacts as a result of mining 1000 feet of drift to the Ghost Dance Fault are the same for both scenarios mentioned in Option 1 and Option 2.

o Time = 1 day/round x 106 rounds = 106 days

use 110 days

o Cost impact

Mining	-	$1,695,000
Mapping	-	100,000
Standby	-	178,000
Capital	-	215,000
Total		$2,188,000

1.4.3 Conclusion

The consequences of each option mentioned in Section 1.2 of this report were evaluated for impacts of hoisting, ventilation, electrical, utilities, population and schedule on the present ESF configurations for design, construction and testing. The basic ESF design as described in the 50% Title I review package included provisions for sinking ES-1 to the Calico Hills level and excavation of the CHDR. In all cases the effect was no impact. That is to say that as currently planned, the activity of extending ES-1 from the MTL to the Calico Hills level, excavating the CHDR, and driving 1000 feet of drift to the Ghost Dance Fault will not cause any significant changes in our currently designed systems, nor will they exceed the capacities of any system. Base case development and construction of the currently designed spatial configurations, mechanical/electrical systems, utility systems and testing programs is a stand alone system which will function normally regardless of the addition of Calico Hills activity.

As the text points out, Calico Hills development is not without its own inherent costs and schedule. The scope of work would require additions of various components in each system mentioned above, and would carry its own development schedule and applicable costs. An indication of those times and cost figures is included in the text. Each system has been examined as to how it would function and interrelate to the current systems' capacities. If Calico Hills development is activated as an option, procurement, construction and cost, impacts should be considered under a separate program phase of ESF development.

Since no adverse impacts were found to exist, no mitigating actions can be identified as part of the Title II design effort.

PART 2

PART 2 - EXTENSION OF EXPLORATORY DRIFTING ON REPOSITORY LEVEL

2.1 PURPOSE

The current lateral extent of excavation at the repository level may not provide the representative information needed to construct a reliable three-dimensional model of the repository block and to evaluate ranges of parameters that affect repository performance.

This analysis is to evaluate the consequences of constructing a long drift south in the future repository to develop additional site characterization information and to determine what future impacts, if any, can be efficiently mitigated during presently proposed Title II ESF design.

2.2 ASSUMPTIONS

2.2.1 Given in WMPO Letter DHI-2334

- o An exploration drift is required to cross the main repository block to access southern portions of the future repository.
- o The drift defined by points "A" to "F" on interface drawing R07048A/1 will be extended to the SW, along the centerline of the repository mains to the limits of the block.

2.2.2 F&S derived assumptions

- o The ESF, as designed and presented at the 50% Title I Review, is considered the present baseline facility, against which the various extended drift options will be evaluated.
- o The SDRD requirement to provide for a 100% expansion of the MTL test areas must be maintained, and this expansion will occur after present MTL development is complete. The extended south drift is in addition to this requirement.
- o Redundancy of power and utility systems in the present design must be maintained.
- o Impacts upon present IDS design and facilities were not included in F&S evaluations.
- o The type and size of mining equipment presently planned for ESF development will be used on extended drifts, or a more effective combination may be substituted.
- o The development of either one or two parallel drifts will not adversely impact site characterization.

2.3 TECHNICAL FACTORS TO BE EVALUATED

2.3.1 Drift Opening - What are the recommended drift openings?

2.3.2 Ventilation - What is the recommended ventilation system?

2.3.3 Drift Configuration - What is the recommended drift configuration?

2.3.4 Option 1 - The extended drifting is to be accomplished as soon as practical in site characterization.

2.3.5 Option 2 - The extended drifting is to be accomplished after the completion of the currently planned drifting for ESF underground tests (i.e. MTL and 3 exploratory drifts complete).

2.3.6 Option 3 - The extended drifting is accomplished concurrently with drifting on the Calico Hills level.

2.3.7 Present ESF Capabilities - What potential scope of work and schedule can the presently planned ESF support?

2.4 IMPACT ANALYSIS METHODOLOGY

The methodology used in evaluating the impacts of the proposed south drift extension upon the presently proposed ESF consisted of the following activities. Major results of each of the activities are shown under each section, together with references to support analyses provided in this impact analysis.

2.4.1 Select appropriate extended drift cross-section.

- o A 14 ft. x 14 ft. drift section recommended for the long, horizontal ESF exploratory drifting, was also selected as the basis for this impact analysis and efficient equipment operation.
- o See Appendix D for supporting rationale.

2.4.2 The various ventilation system options for the extended drifting addition were evaluated.

- o The present two down-cast shaft systems, and surface fans are adequate to supply ventilation air for the present MTL, and future CHDR and extended drift development. A significant increase in subsurface fan horsepower will be necessary to supply air for development and testing in the extended south drift.
- o Conversion of the entire ESF ventilation system to a "flow-through" ventilation system, will provide better ventilation air efficiency, reduced connected fan horsepower, and greater system operating flexibility.

2.4.2 - Continued

- o See Appendix B for supporting rationale and calculations.

2.4.3 Two drift configurations were considered:

- o A single 14 ft. x 14 ft. drift, for minimum mining excavation of the extended drift development.
- o Two 14 ft. x 14 ft. drifts for maximum mining advance rate, safety, traffic and ventilation system efficiency.
- o Support rationale and calculations are shown in Appendix C.

2.4.4 The maximum capability of present ESF system designs which could be impacted by the extended south drift were extracted from completed or "in-progress" ESF calculations.

These maximum system capabilities are shown in Table 2-1 together with the present ESF design requirements, and allowances set aside to provide for expansion of MTL test areas. The remaining flexibility allowance is available to service, or support the development of the south drift.

2.4.5 The various mining and hoisting production and system capacities for Options 1 and 2 were developed.

Table 2-2 indicates the results of this analysis for one and two heading developments, as well as the use of LHD and the combination of LHD and truck muck transport.

Support rationale and calculations are shown in Appendix C.

SYSTEM	Present Maximum ESF System Capability	Present MTL Design Capacities or Requirements	Required for 100% Expansion of MTL Test area after present development	Remaining Flexibility Allowance for Surplus provided in present ESF Design	
ES-2 Hoist System					
Maximum Hoist Rate, TPH	249	249	249	249	
Hours for hoisting, Hr/d	18	7-1/2	7-1/2	10-1/2 (1)	
Production, TPD	4482	1868	1868	2615	
ESF Ventilation System					
Air Volume, required at heading, SCFM	165,000	164,000	164,000	164,000 (2)	Required
Surface Fan, HP	600	600	600	600	Available
Subsurface Fan, HP	550	550	700	2450	Required
ESF Power (4160V) KVA (3)	5400	3400	1200	800	
Utilities Water, gpm (3)	1000 gpm	500 gpm	40 gpm	460 gpm	
Waste Water, gpm (3)	1000 gpm	500 gpm	40 gpm	460 gpm	
Compressed Air, SCFM (3)	10,700 scfm	7900 scfm	300 scfm	2500 scfm	
Design Population (4) ES-1 ES-2	136 272	187	33	188	

(1) Requires that some reallocation of personnel and material transport will be made to ES-1

(2) Presumes that regulatory acceptable reuse of ventilation air will be allowed

(3) Present estimate, subject to change

(4) Based on emergency evacuation capability

TABLE 2-1

PRESENT ESF MAXIMUM SYSTEM CAPABILITIES

Table 2-2

Mining & Hoisting Rates for Various Options

	Option #1 Drift Concurrent w/MTL				Option #2 Drift After MTL			
No. of Headings	1 (LHD)	1 (LHD/TRK)	2 (LHD)	2 (LHD/TRK)	1 (LHD)	1 (LHD/TRK)	2 (LHD)	2 (LHD/TRK)
Total New Drift Footage	9780	9780	20,016	20,016	9780	9780	20,016	20,016
Total New Drift yd^3	75,690	75,690	143,818	143,818	75,690	75,690	143,818	143,818
Total New Drift Tons	99,911	99,911	189,840	189,840	99,911	99,911	189,840	189,840
New Drift ft/day	13.3	15.0	24.5	27.7	13.3	15.0	24.5	27.7
New Drift Tons per day	127	143	233	263	127	143	233	263
Actual Tons To hoist per day	892	908	998	1028	765	765	765	765
Total New Drifting days	788	701	817	723	788	701	817	723
Total Dev. Days From start of MTL	1017	930	1060	966	1363	1286	1416	1322
Overall Extension of Present Schedule (days)	432	345	475	381	778	701	831	737

2.4.6 The various utility system requirements for Options 1 and 2 were developed.

- It is estimated that approximately 40 gpm water supply is required to support mining in options 1 and 2. The additions of this amount has no impact upon the present ESF design water supply capacity, which is set by fire protection requirements.

- Collection of the above 40 gpm as mine waste water, will not impact present ESF design or systems.

- The present ESF Mine Waste Water Sump near the ES-1 on the MTL, will have adequate space provided for this additional waste water. This, plus present plans to provide a discharge pipe in each shaft, provides full redundant capability for handling the present ESF Mine Waste Water full design flow. Thus the system, as presently designed, will handle up to 1000 gpm of unexpected ground water, should it be encountered.

- A 300 SCFM compressed air allowance is included to allow for horizontal core drilling in the extend drifts. This amount has no impact upon the presently designed system.

2.4.7 Present ESF Capabilities

The preceding analyses indicate that both concurrent or sequential development of the MTL and extended development (both south drift and CHDR) are possible. The only major impact to the present ESF systems is to the electrical power system. This impact can be mitigated by providing space for a future mine cable in each shaft and space for MTL switchgear additions. Therefore, the existing ESF systems can support all presently envisioned development required for site characterization.

Although a portion of this concern is addressed in Tables 2-1 and 2-2, in-depth evaluation of the ultimate capacities and limits of the ESF is sufficiently complex so as to prohibit its analysis within the allotted scope of this study.

Additional flexibility can be realized by:

- Utilization of ES-1 to handle personnel and materials which would increase muck hoisting capacity at ES-2.

- Convert the ventilation system to a more optimum flow-through configuration.

2.5 CONCLUSIONS

The addition of a drifting program to explore approximately 10,000 ft. to the SW edge of the repository block, would not have any prohibitive impacts on the presently planned ESF design construction and testing.

2.5 - Continued

If this development is done concurrent with the presently planned ESF development, minor impacts to some of the existing systems will result. Better ventilation efficiency, utilities, underground mining equipment and provisions for human occupancy must be provided. The hoisting plan is adequate. The schedule for the completion of the presently planned development and testing would not be significantly affected. The impact of providing for the items listed above, could easily be mitigated in Title II design.

If the additional drifting is done after presently planned ESF program is complete, very little adverse impact would result.

The information presented in Tables 2.3, 2.4 and 2.5 support the final conclusion that no significant adverse impact to the presently designed ESF will be experienced through the expansion of the Tuff Main exploratory drift to the southern limits of the proposed repository block. As currently designed, mechanical and functional concepts of the ESF embody sufficient flexibility and capacity to operate either in conjunction with, or in addition to, an expanded scope of underground development.

It should be recognized that certain system requirements attributed to the additional 10,000 ft. of drifting <u>can be optimized</u> through judicious engineering in Title II efforts. Specifically, the extreme ventilation horsepower requirements for expansion, and its inherent impact of physical electrical system changes, can be mitigated by altering the initial ventilation concept to a flow-through system. Since the possibility of this change for expansion purposes has been recognized throughout development of the ESF design, the current layout maintains the flexibility for change to accommodate various operational needs. As always, design modifications incorporated as early as possible in the Title II effort would ensure maximum optimization and integration among all project components of electrical systems, utilities and physical limitations.

TABLE 2-3

OPTION 1

o "Drifting is to be accomplished as early as practical in site characterization."

EXISTENCE OF IMPACT ON PRESENTLY DESIGNED FACILITY

	DESIGN	CONSTRUCTION	TESTING
HOIST	NO	NO	NO
VENTILATION (2)	NO	NO	NO
POWER (1)	YES (2)	NO	NO
UTILITIES	NO	NO	YES
POPULATION	NO	YES (3)	YES (3)
SCHEDULE	NO	NO	NO

(1) Even though the present system may be adequate, a conventional flow-through ventilation system for the entire ESF would result in substantial installation and power cost savings. A redesign of the present MTL layout and ventilation system would be necessary.

(2) Extension of the present exhaust duct system to service the extended south drift will add approximately 1800 KVA to the ESF 4160V power systems. This will require larger 4160V mine cables, presently designed as 350 MCM mine cables (about maximum size). Later design could consider dropping 2 additional mine cables, with no other present design consideration other than providing space in the shaft arrangement.

Present design of the MTL substation has space for added switch gear, so no impact is obvious.

(3) Construction and Testing population will increase hoist use for personnel transport, but can be mitigated by allocations of more transport to ES-1.

TABLE 2-4

OPTION 2

o "Drifting is to be accomplished after MTL development is essentially complete."

EXISTENCE OF IMPACT ON PRESENTLY DESIGNED FACILITY

	DESIGN	CONSTRUCTION	TESTING
HOIST	NO	NO	NO
VENTILATION (1)	NO	NO	NO
POWER (1)	YES (2)	NO	NO
UTILITIES	NO	NO	YES
POPULATION	NO	NO	NO
SCHEDULE	NO	NO	NO

(1) Even though the present system may be adequate, a conventional flow-through ventilation system for the entire ESF would result in substantial installation and power cost savings. A redesign of the present MTL layout and ventilation system would be necessary.

(2) Extension of the present exhaust duct system to service the extended south drift will add approximately 1800 KVA to the ESF 4160V power systems. This will require larger 4160V mine cables, presently designed as 350 MCM mine cables (about maximum size). Later design could consider dropping 2 additional mine cables, with no other present design consideration other than providing space in the shaft arrangement.

Present design of the MTL substation has space for added switch gear, so no impact is obvious.

TABLE 2-5

OPTION 3

o "Drifting is to be accomplished concurrently with Calico Hills development.

EXISTENCE OF IMPACT ON PRESENTLY DESIGNED FACILITY

	DESIGN	CONSTRUCTION	TESTING
HOIST	NO	NO	NO
VENTILATION (1)	NO	NO	NO
POWER (1)	YES (2)	NO	NO
UTILITIES	NO	NO	YES
POPULATION	YES (3)	YES (3)	YES (3)
SCHEDULE	NO	NO	NO

(1) Even though the present system may be adequate, a conventional flow-through ventilation system for the entire ESF would result in substantial installation and power cost savings. A redesign of the present MTL layout and ventilation system would be necessary.

(2) Extension of the present exhaust duct system to service the extended south drift will add approximately 1800 KVA to the ESF 4160V power systems. This will require larger 4160V mine cables, presently designed as 350 MCM mine cables (about maximum size). Later design could consider dropping 2 additional mine cables, with no other present design consideration other than providing space in the shaft arrangement.

Present design of the MTL substation has space for added switch gear, so no impact is obvious.

(3) Construction and Testing population will increase hoist use for personnel transport, but can be mitigated by allocations of more transport to ES-1.

APPENDIX A

APPENDIX A
TESTING IMPACTS

I. Test Related Activity Associated with Sinking of ES-1 Shaft from MTL to CHDR and Development of an Exploratory Drift to the Ghost Dance Fault on the CHDR Level.

The testing that has been proposed in the Appendix B of SDRD revision dated July 31, 1987, for those areas that would be located below the MTL have been reviewed to determine what resources would be required should ES-1 be sunk to the Calico Hills formation.

The purpose of this section is to assess the impact on the design, schedule and construction should ES-1 be sunk from the MTL to the Calico Hills Drill Room (CHDR) Level. The impact is quantified in terms of numbers of schedule weeks required to accomplish the actual test drilling and installation, the IDS (DAS) additional requirements and additional support services that would be required over and above those that would be needed for those tests at or above the MTL. The scope of the impact on the construction and configuration of the shaft and stations is addressed elsewhere.

The following tabulation of schedule impacts resulting from conducting tests in the ES-1 and on the CHDR is based upon recently furnished construction schedule information.

Shaft Mapping- 295 ft @ 4 hr/7ft = 169 hrs.	=	1.0 wk
Radial Bore Hole Test - 4 places @ 2 wks/ea	=	8.0 wks
Shaft Convergence Test - 1 place @ 2 wks/ea	=	2.0 wks
Hydro Chemistry and CH/36 - no impact		
Calico Hills Test - Drilling and Set-up of test	=	5.0 wks
Diffusion Test - Drilling only (set-up concurrent with Calico Hills Test)		
Overcore Stress Test - Concurrent w/above no additional impact		
Mapping on CHDR Station Area	=	0.5 wk
Mapping of Exploratory drift to Ghost Dance Fault 1000 ft	=	2.0 wks
Exploratory Drilling at the Ghost Dance Fault	=	6.0 wks
Drill hole instrumentation (piezometers, temperature sensors, water samplers, etc.)	=	4.0 wks
Total		29.5 wks

Note: Mapping Crews for shaft deepening and CHDR drifting will be extra since mapping will be done on MTL concurrently.

Total additional weeks of testing activity below the MTL will be approximately 30 weeks. This estimate does not reflect delay to the start or completion of scheduled MTL tests but rather assumes that the additional human and material resources will be furnished to avoid delays to testing on the MTL.

Additional material resources that would be required to accomplish testing below MTL are listed below. These resources are only those directly related to proposed tests. No attempt has been made to assess the impact on power or water consumption since these items are assumed to be required for the shaft and station development regardless of testing needs.

Item		Quantity
1.	Booster Compressor for Calico Hills and Diffusion test dry drilling (extra)	1
2.	DAS and transformers on CHDR Level	2
3.	DAS units in the shaft for Radial Bore Hole Tests	3
4.	Ventilation Air Filtration unit required for dry drilling dust removal	1
5.	Temperature Gradient Measurement Devices	Unknown
6.	Piezometers & well screens	Unknown
7.	Core Drill (Electro Hydraulic column mounted)	1
8.	Wiring in shaft to MTL	Not Quant.
9.	Additional IDS capacity (May not be required)	Not Quant.

The additional human resource requirements created by testing planned below the MTL are not clearly identifiable for the following reasons:

(1) The test management group has not made an assignment of required personnel for tests contemplated on the CHDR Level.

(2) The tests contemplated for CHDR level can be operated concurrently with some MTL scheduled tests with the same personnel.

(3) No additional test construction personnel may be required for wiring and test facility installation. An additional group of drill crews will be required, to accomplish drilling in the exploratory drift and CHDR station area.

Testing activity in areas below the MTL will have an effect upon the utilization of the ES-1 shaft and hoisting system. Evacuation of testing personnel from the CHDR will increase the ES-1 hoist capability requirements. ES-1 shaft availability for supply and equipment lowering to the MTL will be reduced or virtually eliminated during test development and operations on the CHDR since the ES-1 is the only access to the CHDR and any significant tie-up of the ES-1 hoist would prevent emergency evacuation of CHDR Level personnel except to ladderway.

II. Test related activity associated with development of a 10,000 feet long exploratory drift driven from near the ESF core area in a Southerly direction.

The following tests will be assumed to be conducted during or after the completion of a 10,000 feet long exploratory drift driven to the Southeast through the center of the proposed repository block on the main test level.

- Drift wall mapping and photographing.
- Rock matrix hydrologic properties (sampling).
- Horizontal exploratory core drilling.
- Bulk permeability testing.

Comprehensive test planning at a later date may indicate that the scope of the testing in this exploratory drift should be expanded. Ample provisions for power, water, and ventilation should be made for an expanded testing program.

The reasons for assuming that the above listed tests will be conducted are as follows:

- Drift wall mapping and photography is scheduled for all excavation work.
- Rock matrix hydrological properties involves sampling larger rock fragments, this is planned for all other excavation work at the ESF.
- Horizontal core drilling at selected intervals along the course of the drift is appropriate. The exploratory drift affords an excellent opportunity for accomplishing exploratory core drilling to the East and West of the drift and thereby gain valuable information concerning the mineralogy, petrology, structure, and hydrological properties of the proposed repository rockmass.
- Bulk permeability testing is reasonably assumed because the present planning for this shows several locations as far from each other as possible. The purpose being to characterize a rock mass that is as feasibly representative of the whole.

The following tabulation of schedule impacts resulting from conducting the assumed tests listed above is based upon construction schedule information prepared for the presently planned ESF development:

- Drift wall mapping and photography 10,000 feet	-	20 wks
- Rock Matrix Hydrologic properties (no impact)	-	0
- Exploratory Core Drilling - excavation of Alcoves 18'x 28' x 14' high at 2000 feet intervals, 5 required	-	5 wks
- The core drilling can be carried on during the drift construction, therefore the only impact on the schedule will occur at the end of the drift where 500 feet long holes might be drilled. This would require	-	12 wks

- Bulk permeability testing - this test(s) will require dry mined alcoves and dry drilled holes, along with construction of a DAS at each location. Assume a minimum of four locations. Twenty feet of each alcove advances past the proposed test location. All other test excavation and drilling could be done later and would have a later impact on the drift and construction schedule. Four locations at 20 feet each X 1 day/10 feet plus DAS Alcoves will require.

	- 2 wks
Total Schedule Impact	- 39 wks

Additional Material resources that would be required to accomplish testing in the 10,000 feet long exploratory drift are as follows:

	No. of Items
Core Drill capable of drilling 1000 feet of HQ. sizehole	1
Mapping (scissor lift) vehicle	1
Camera and lighting equipment	1
DAS station	4

Additional Human Resources that would be required to accomplish testing in the 10,000 feet long exploration drift are as follows:

	Number of Persons
Drift Mapping Crew	4
Core Drill Crew	6
Laboratory Personnel (extra)	1
Total	11

The above quantity estimate is based upon the assumption that, regardless of the scheduling of the drift, the logistics of the situation will require that the test activity in the 10,000 feet of drift be supported by separate equipment and crews at sometime during the ESF project.

APPENDIX B
VENTILATION IMPACTS

This section deals with the impact of ventilation requirements relative to both Part 1 and Part 2 studies on the present ESF design, construction and testing features. Impacts were evaluated while considering the case involving the most stringent air flow requirement. The worst case considered is the simultaneous development of the exploratory drifts and the operation of the MTL. Under this assumption, the following SDRD requirements apply:

- o Maximum shaft velocity 2000 fpm
- o Maximum drift velocity 1500 fpm
- o Minimum drift velocity 60 fpm
- o Minimum air quantity for diesel 100 cfm/brake horsepower
- o Minimum air quantity/worker 200 cfm

The spread of mining activities into a wider area may result in about 70% overall air utilization, i.e. for air flows of about 235,000 cfm in the shaft collar going underground, about 164,000 cfm will effectively reach the face. The breakdown of face quantities is as follows:

1. MTL Test operation - 42,000 cfm
   (Excludes the air quantity that pass through the MTL on the way to other active areas.)

2. Calico Hills' 10'x 10'x 1000' drift development to Ghost Dance fault and ES1 shaft station areas below MTL-22,000 cfm.
   (To support one 3.5-yard^3 loader)

3. MTL Imbricate's 14'x 14'x 1400' drift development-40,000 cfm.
   (To support one 5-yard^3 loader and one utility vehicle.)

4. MTL Exploratory Drifts-60,000 cfm
   To support:
   a) 14' x 14' x 500' Tuff Main Access
   b) 14' x 14' x 1670' Drill Hole Wash Drive
   c) 14' x 14' x 400' Access Drive to Ghost Dance and Tuff Main Long Drift
   d) 14' x 14' x 1150' Ghost Dance Drive
   e) 14' x 14' x 10,000' Tuff Main Long Drift to Southwest Boundary of Proposed Repository Block (Single or Double Entry drives.

   Note that the air quantity supply can only support two 5-yard^3 loader and one utility vehicle or one five-yard^3 loader, two 8.8-yard^3 trucks (13-ton each), and one utility vehicle at any given time in the area.

The Ventilation system can be designed to support these activities. Direction to alter the current design in order to incorporate these additional features would be needed by 30% of Title II.

Impacts of the expansion:

1. Calico Hills' 10' x 10' x 1000' drift to Ghost Dance Fault

    - Air quantity requirement - 22,000 cfm
    - Ventilation duct 30" 0 x 1000' long.
    - Two 50 HP fans in series, spaced at 500' apart.

2. Tuff Main's 14' x 14' x 10,000' Long drift to Southwest Boundary of Proposed Repository:

    - Air quantity requirement - 60,000 cfm.
    - Ventilation duct 48" 0 x 11,000' long.
    - Ten 175 HP fans in series, spaced at 1000' apart.
    - Single entry 10,000 ft. drive would incur the rough costs of:

a)	$ 550,000	Ducting (11,000 ft. @ $50/ft.)
b)	250,000	Electrical changes to present systems
c)	$ 250,000	Fans 10 - 175 H.P. ea.
	$1,050,000	Total

    - If double entry concept is chosen, rough costs amount to:

a)	$100,000	Ducting (2,000 ft @ $50/ft)
b)	75,000	Electrical changes to present system
c)	$ 45,000	Fans
	$220,000	Total

3. Additional time requirement to design the system, supported by computer simulation and modelling.

4. Safety analysis need to compare the 10,000' single drift development versus double entry flow-through system.

Relative to identifying an alternate mitigating design feature in a Title II effort, the potential exists to design the entire ventilation scheme as a simple flow-through system rather than an exhaust ducting system as currently planned. This would be particularly applicable when driving the 10,000 foot Tuff Main exploratory drift to the South, especially in the double entry option. A tertiary level comparison follows which outlines the advantages and disadvantages of converting the design to flow-through ventilation:

Disadvantage of Exhaust Ducting

1. Crowded shaft, impaired visibility to liner.

2. Potential airflow expansion, flexibility nil or limited.

3. Estimated cost to fabricate and install ducting, $400,000.

4. Estimated number of days devoted solely for duct installation 45 days (shaft schedule impact)

5. Surface ducting adapters and noise abatement cost estimate, $300,000.

6a. Six primary fans needed at estimated capital cost of $300,000 (Excluding electrical substation, wirings and switch gears).

6b. Six primary fans to maintain and monitor for life safety.

7. Maintenance of high pressure duct and leakage losses cost estimate, $100,000/year.

8. Primary System Power requirement

   1000 HP

9. Ability to contain dust of the return air (only advantage)

10. Decommissioning estimate 45 days and $150,000.

Advantages of Shaft flow Through Ventilation

1. Shaft Ducting space is saved.

2. Potential for 25% expansion without much impact to the system (SDRD to be changed to increase max. shaft velocity from 2000 to 2500 fpm).

3. No ducting cost.

4. No downtime for duct installation and maintenance.

5. Underground primary fan bulkhead and noise abatement cost estimate, $75,000.

6a. One primary fan at estimated cost of $200,000 (Excluding electrical substation, wirings and switchgears).

6b. One primary fan to maintain and monitor for life safety.

7. No air leakage from vent duct.

8. Primary system power requirement

   350 HP

9. No decommissioning cost

Cost estimates used are industry practices without the impact of government quality assurance control.

There is an overwhelming advantage of the shaft flow-through ventilation over that of the currently plan exhaust duct system. It is recommended that study -of the impacts on ESF Testing and shaft sinking schedule be made if flow through ventilation mode is used.

APPENDIX C

CALCULATIONS ON EXTENSION OF EXPLORATORY DRIFTING ON REPOSITORY LEVEL

CALCULATIONS

1.0 STATEMENT OF WORK

Drive an Exploratory Drift from point F on R07048A/1, southwesterly along the centerline of the Tuff Main, to the limit of repository block.

2.0 OPTIONS TO BE EVALUATED

1) Drifting to be accomplished as soon as practical.

2) Drifting to be accomplished after completion of drifting currently planned for ESF tests (i.e., MTL test bed and alcove mining).

3) Drifting accomplished concurrent with drifting on Calico Hills level.

3.0 ADDITIONAL EVALUATIONS

1) What is recommended opening for ventilation configuration?

2) What potential scope of work and schedule can the presently planned ESF support?

3.1 Quality - Distance and Excavation Volume

			N	E	EL
(R07003A)	Tuff Main at SW Limit of Block		758,278.1	557,832.7	3765.0
	Tuff Main at F		766,401.6	563,236.2	3134.2
		=	8,123.5′	5,403.5	630.8

Horiz. Dist. $= [8123.5^2 + 5403.5^2]^{1/2} = 9756.5$ ft

Slope Dist. $= [9756.5^2 + 630.8^2]^{1/2} = 9776.9$
Say 9780

Muck Volume

Assume 14h x 14w drift same as presently planned for long exploratory drifts.

Calculation JBM-B04 for FS-ST-0024 (See Attachment #1), a drill round is designed and face area calculated at 194 ft^2 which includes 4" of overbreak in back and both ribs.

3.1 - Continued

Muck Volume Per Round (Drill 12 ft, Pull 11 ft)

$= 194\ ft^2 \times 11\ ft \times 1.6\ Swell = 3414.4\ ft^3$
$= 126.5\ yd^3/round$

3.2 Excavation Cycle Times -

In FS-ST-0024 Calc# JBM-B04 (See Attachment #2), the following cycle times for this round were calculated.

Drill Cycle (Two Boom Hydr. Jumbo)

= 122 min = 2.03 hr

Say 2.0 hr

Blast Cycle = 119 min = 1.98 hr

Say 2.0 hr

Rock Bolt Cycle (21 - 8 ft. Bolts/Round)

= 126 min = 2.1 hr

Say 2.1 hr

Geologic Mapping Cycle

= 200 min = 3.33 hr

Say 3.3 hr

Muck Cycle

The muck cycle is dependent on the haul distance, type and size of the equipment, and the number of pieces of equipment.

3.2.1 Haul Distance

Drift Length = 9780 ft

Additional Haul Distance

Pt. F to Pt. C (R077048 A/1)

	N	E	EL
C	766,733.1	563,459.7	3124.2
F	766,401.6	563,236.2	3134.2
=	331.5	223.5	10.0

Horizontal Distance = $[331.5^2 + 223.5^2]^{1/2}$ = 399.8

Slope Distance = $[399.8^2 + 10^2]^{1/2}$ = 399.93 ft

Pt C to Pt 21 (R07048 A/3) - ES-2 X-Cut Intersect

	N	E	EL
C	766,251.0	563,743.6	3075.9
F	766,733.1	563,459.7	3124.2
=	482.1	283.9	48.3

Horizontal Distance = $[428.1^2 + 283.9^2]^{1/2}$ = 559.5 ft

Slope Distance = $[559.5^2 + 48.3^2]^{1/2}$ = 561.5 ft

Pt C to the Muck Dump (R07048 A/2, Rev. 1)

Dist = 22.7 ft + 39.5 ft = 62 ft

Total Average Haul Distance

21	>	Dump	=	=	62 ft
21	>	C	=	=	560 ft
C	>	F	=	=	400 ft
			Sub Total		1022 ft
Avg. F	>	Finish	= 9780/2	=	4890 ft
					5912 ft

Use <u>5910 ft</u> Avg. Haul Dist.

3.2.2 Muck Cycle

Assume 8-1/2 mph avg. tramming speed on 5900 ft haul. Assume 6-1/2 mph on 1020 ft portion of haul (turning corners, congestion, etc.)

Calculated muck cycle based on two options

1) 5 yd^3 LHD's load and haul
2) 5 yd^3 LHD's loading an 8.5 yd^3 (13 tons nom./truck)

3.2.2 - Continued

Load & Tram Cycle - LHD Haul

(a) Load Bucket = 1.0 min

(b) Back 4890 ft + 50 ft
at 8-1/2 mph avg.
$= \frac{4940 \text{ ft}}{748 \text{ fpm}}$ = 6.6 min

(c) Turns and tram forward 1020 ft + 50 ft
at 6-1/2 mph avg.
$= \frac{1070 \text{ ft}}{572 \text{ fpm}}$ = 1.9 min

(d) Dump bucket = 0.5 min

(e) Back out and turn 62 ft + 50 ft
at 1-1/2 mph avg.
$= \frac{112 \text{ ft}}{132 \text{ fpm}}$ = 0.8 min

(f) Tram 5910 ft back to face
at 8-1/2 mph
$= \frac{5910 \text{ ft}}{748 \text{ fpm}}$ = 7.9 min

Total Load/Tram/Dump/Return = 18.7 min

Load & Tram Cycle - LHD & 8.5 yd^3 Truck

5 yd^3 LHD cannot load a 8.5 yd^3 truck in a 14 ft wide drift. They cannot pass.

(185 hp	16,000 cfm)	LHD WD Approx.	8 ft	(St-5)
(139 hp	12,000 cfm)	TRK WD Approx.	6 ft 3 in	(MT-413)
			14 ft 3 in	

Assume a loading bay is developed every 500 ft (widen out drift to 25 ft wide x 50 ft long).

Assume LHD has ejector bucket and trams back 500 ft/2 = 250 ft average, to load the truck. Truck trams 5910 ft - 250 ft = 5660 ft average.

3.2.2 - Continued

Cycle Time

(a) Load Truck (Two trips)

(1)	Load Bucket	=	1.0 min
(2)	Back 250 ft at 2-1/2 mph avg. = 250 ft / 220 fpm	=	1.1 min
(3)	Pull forward & dump in truck	=	0.6 min
(4)	Back	=	0.2 min
(5)	Tram to Face 250 ft / 220 fpm =		1.1 min
	Sub Total		4.0 min
			X 2 Loads
	Total Time To Load Truck	=	8.0 min

(b) Tram & Dump Truck

(1)	Tram 5660 ft to just past ES-2 cross-cut at 8-1/2 mph = 5660 ft / 748 fpm	=	7.6 min
(2)	Back 40 & 62 ft into dump at 1-1/2 mph avg. = 110 ft / 132 ft	=	0.8 min
(3)	Dump	=	0.8 min
(4)	Pull forward and turn - 100 ft = 100 ft / 132 fpm	=	0.8 min
(5)	Tram 5660 ft back to leading bay at 8-1/2 mph	=	7.6 min
	Total Truck Cycle Time	=	17.6 min
	Plus loading tine	=	8.0 min
	Total truck cycle time	=	25.6 min

3.2.2 - Continued

Yd^3/Hr Mucking Rate

$$2 - 5yd^3 = \frac{60 \text{ min}}{18.7 \text{ min/load}} \times 5 \text{ yd}^3 \times 2 = 32 \text{ yd}^3\text{/hr}$$

1 - 5 yd^3 LHD + 2 - 8.5 yd^3 Trucks
Since loading time (8.0 min) is less than tramming time, only count tramming time.

$$= \frac{60 \text{ min}}{17.6 \text{ min/trip}} \times \frac{8.5 \text{ yd}^3}{\text{trip}} \times 2 \text{ trucks} = 58 \text{ yd}^3\text{/hr}$$

Total Muckout Time

Two LHD's

(1) Wet Down Muck Pile & Scale = 30 min

(2) Load & Haul 126.5 yd^3 @ 32 yd^3/hr

$$= \frac{126.5 \text{ yd}^3}{32 \text{ yd /hr}} \times 60 \text{ min/hr} = 237 \text{ min}$$

(3) Final Clean up = 20 min

287 min/round

= 4.8 hr/round

1 LHD AND 2 Trucks

(1) Wet Down and Scale = 30 min

(2) Load & Haul 126.5 yd^3 @ 58 yd^3/hr

$$= \frac{126.5 \text{ yd}^3}{58 \text{ yd}^3\text{/hr}} \times 60 \frac{\text{min}}{\text{hr}} = 131 \text{ min}$$

(3) Final Clean up = 20 min

= 3.0 hr/round

3.2.3 Total Round Cycle Time

Two LHD'S

Drill	*2.0 hr
Blast	*2.0 hr
Rock Bolt	*2.1 hr
MAP	*3.3 hr
MUCK	4.8 hr
	14.2 hr/round

One LHD & Two Trucks

Drill	*2.0 hr
Blast	*2.0 hr
Rock Bolt	*2.1 hr
MAP	*3.3 hr
MUCK	3.0 hr
	12.4 hr/round

*See Attachment #2

3.2.4 Maximum Average Advance Rate Per Day Driving a Single Heading

ft/round = 11 ft
hrs/day = 24 - (3 hr shift change) - (1-1/2 hr lunch)
= 19.5 hr/day

(a) Using Two LHD's

$$\text{ft/day } \frac{19.5}{14.2} \times 11 - \text{Utility Installation Time}$$

$$= 15.1 \text{ ft/day} - \text{Utility Installation Time}$$

Assume 3-1/2 hr/20 ft advance, to install utilities and vent lines.

$$\text{Utility time/round} = \frac{11 \text{ ft/rnd}}{20 \text{ ft}} \times 3.5 \text{ hrs} = 1.9 \text{ hr/round}$$

Max. Avg. Single Heading Advance Rate

$$= \frac{19.5 \text{ hr/day}}{14.2 \text{ hr/round} + 1.9 \text{ hr/round}} \times 11 \text{ ft/round}$$

$$= 1.21 \text{ round/day} \times 11 \text{ ft/round} = 13.3 \text{ ft/day}$$

3.2.4 - Continued

(b) Using 1 LHD & 2 Trucks

$$= \frac{19.5 \text{ hr/day}}{12.4 \text{ hr/round} + 1.9 \text{ hr/round}} \times 11 \text{ ft/round}$$

$$= 1.36 \text{ round/day} \times 11 \text{ ft/round} = 15.0 \text{ ft/day}$$

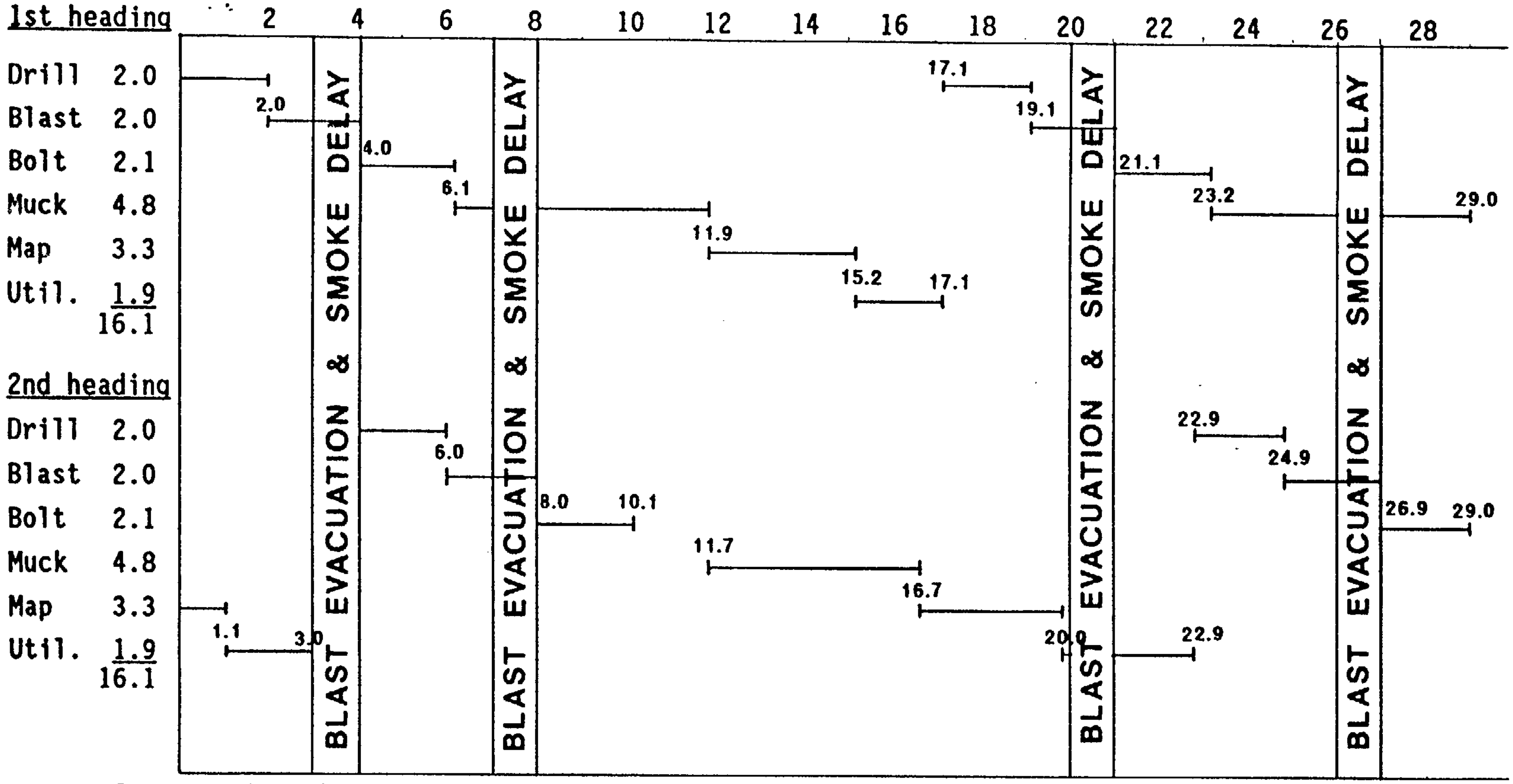
3.2.5 Assume driving parallel headings for safety reasons, 38 ft apart

<u>With Two Equipment Spreads</u>

If there was an equipment spread dedicated to each heading, then one could theoretically get 13.3 ft/day with two LHD's or 15.0 ft/day with one LHD and two trucks, from each face.

DRIVE TWO PARALLEL HEADINGS W/ONE EQUIPMENT SPREAD

Two 5 yd^3 LHDs for Mucking



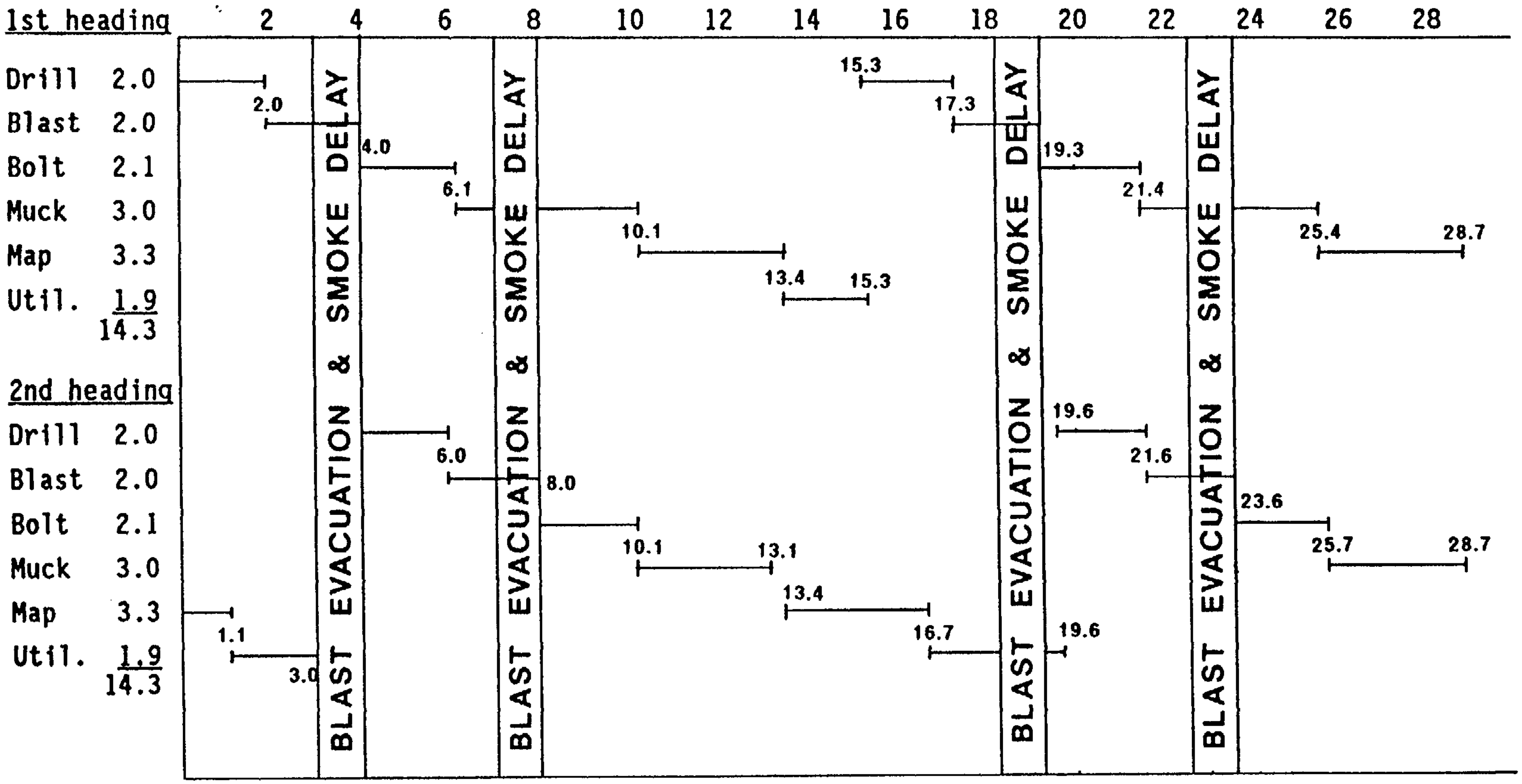
In 29 Working hours

1st Heading adv. $= 11 \text{ ft plus } \left(\frac{2.0 + 2.0 + 2.1 + 4.8}{16.1}\right) 11 \text{ ft} = 11 \text{ ft} + \left(\frac{10.9}{16.1}\right) 11 = 18.4 \text{ ft}$

2nd Heading adv. $= \left(\frac{1.1 + 3.0}{16.1}\right) 11 \text{ ft} + 11 \text{ ft} + \left(\frac{2.0 + 2.0 + 2.1}{16.1}\right) 11 \text{ ft} = 2.8 \text{ ft} + 11 \text{ ft} + 4.2 \text{ ft} = 18.0 \text{ ft}$

Theoretical ft/day $= \frac{19.5 \text{ hr/day}}{29 \text{ hr}} (18.4 + 18.0) = 24.5 \text{ ft/day}$

DRIVE TWO PARALLEL HEADINGS W/ONE EQUIPMENT SPREAD
One LHD & Two Trucks



In 28.7 Working hours

1st Heading adv. $= 11 \text{ ft} + \left(\frac{2.0 + 2.0 + 2.1 + 3.3}{14.3}\right) 11 \text{ ft} = 11 \text{ ft} + \left(\frac{12.4}{14.3}\right) 11 \text{ ft} = 20.5 \text{ ft}$

2nd Heading adv. $= \left(\frac{1.1 + 1.9}{14.3}\right) 11 \text{ ft} + 11 \text{ ft} + \left(\frac{2.0 + 2.0 + 2.1 + 3.0}{14.3}\right) 11 \text{ ft} = 2.3 \text{ ft} + 11 \text{ ft} + 7.0 \text{ ft} = 20.3 \text{ ft}$

Theoretical ft/day $= \frac{19.5 \text{ hr/day}}{28.7 \text{ hr}} (20.5 \text{ ft} + 20.3 \text{ ft}) = 27.7 \text{ ft/day}$

3.2.6 SUMMARY OF AVERAGE MAXIMUM PRODUCTION RATES

OPTIONS USING ONE EQUIP. SPREAD	FT/DAY	* BROKEN yd^3/DAY	** TONS/DAY
Single Heading			
1) Using 2 - 5 yd^3 LHDs	13.3	96	127
2) Using 1 - 5 yd^3 LHD & 2 - 8.5 yd^3 Trucks	15.0	108	143
Two Parallel Headings			
1) Using 2 - 5 yd^3 LHDs	24.5	176	233
2) Using 1 - 5 yd^3 LHD & 2 - 8.5 yd^3 Trucks	27.7	199	263

$$* \quad yd^3/ft = \frac{194\ ft^3/ft}{27\ ft^3/yd^3} = 7.2\ yd3/ft$$

$$** \quad tons/yd^3 = \frac{27\ ft^3 \times 98\ lbs/ft^3}{2000\ \#/ton} = 1.32\ tons/yd^3$$

4.0 LAYOUT & SCHEDULE

Compare Two Layouts

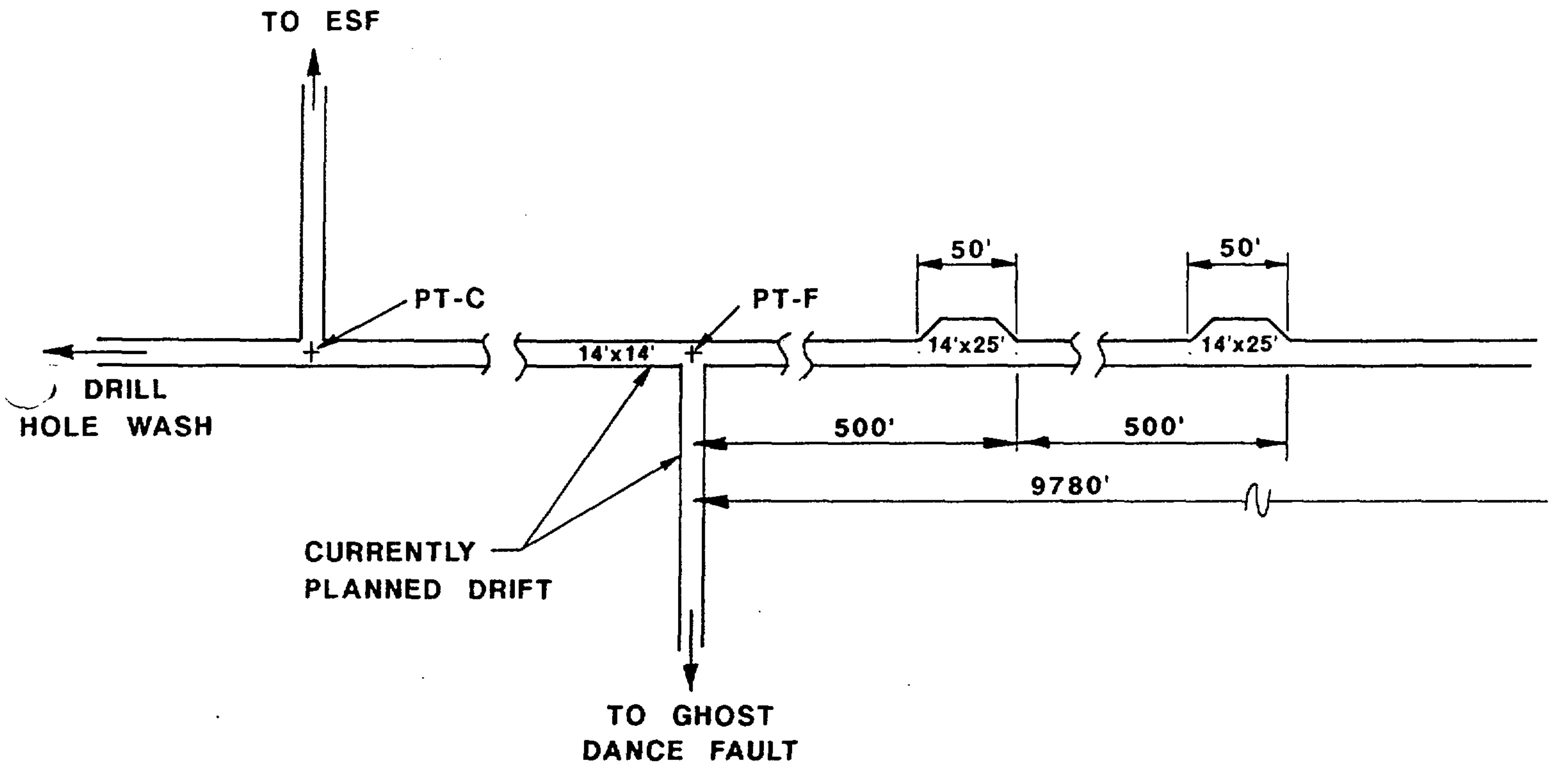
4.1 Layout #1

Single 14 ft x 14 ft drift 9780 ft long with passing parking areas 25 ft wide x 50 ft long every 500 ft.

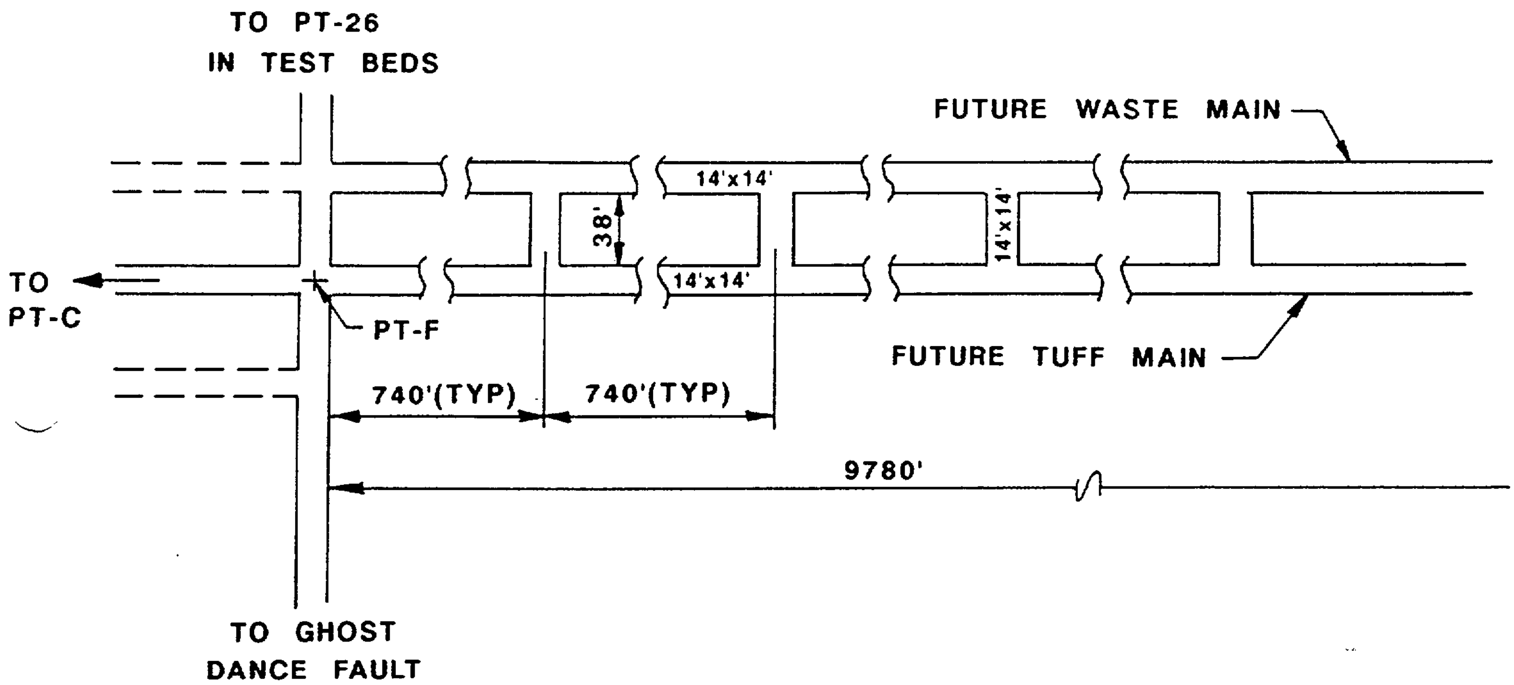
4.2 Layout #2

Two parallel 14 ft x 14 ft drifts with 38 ft wide pillar between drifts at a 14 ft x 14 ft cross cut connecting the drifts on 740 ft centers. The drifts are on the alignment of the Tuff Main and the Waste Main with the cross cuts located per repository main cross-cuts shown on R07003A.

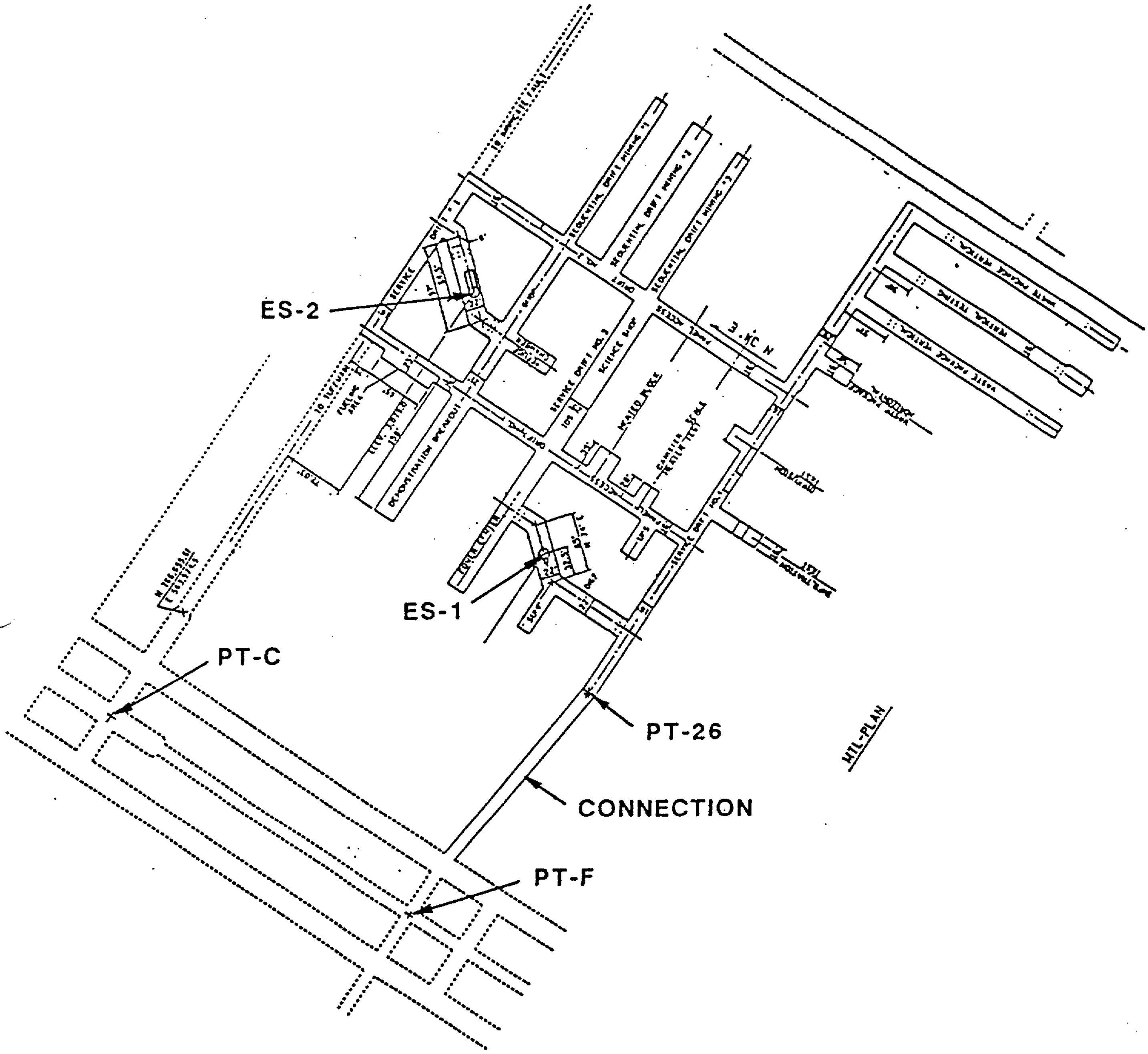
* With this layout, in order to establish complete flow through ventilation system, connect waste main exploratory drift to Pt-26.


TO ESF
PT-C
PT-F
50'
50'
14'x14'
14'x25'
14'x25'
DRILL
HOLE WASH
500'
500'
9780'
CURRENTLY
PLANNED DRIFT
TO GHOST
DANCE FAULT

2.3.1 LAYOUT #1



2.3.2 LAYOUT #2a



2.3.2 LAYOUT #2b

4.3 EXCAVATED VOLUMES

4.3.1 Layout #1

Exc Vol.
Drift 14 ft x 14 ft drift @ 9780 ft x 194 ft^3/ft
= 1,897,320 ft^3 Neat
= 70,271 yd^3 Neat

Passing Sections

$$No = \frac{9780}{500} = \underline{19\ ea}$$

$$Vol\ ea = \frac{11 \times 14 \times 50}{27} = 285\ yd^3$$

$$Total\ Vol = 19 \times 285\ yd^3 = 5419\ yd^3$$

$$Total\ Exc\ Vol = 70{,}271\ yd^3 + 5419\ yd^3 = 75{,}690\ yd^3$$

4.3.2 Layout #2

Excavated Volume
Drift = 2 x 70,271 yd^3 = 140,542 yd^3
cross-cuts
No Req = 12

$$Vol = \frac{12 \times 38 \times 194\ ft^3}{27\ ft^3/yd^3} = 3276\ yd^3$$

$$Total\ Vol = 140{,}542 + 3276 = 143{,}818\ yd^3$$

4.4 LAYOUT SCHEDULE

4.4.1 Layout #1 - Single Heading - 75,690 yd^3

(a) Using 2 - 5 yd^3 LHDs

$$\frac{75{,}690\ yd^3}{*\ 96\ yd\ /day} = 788\ days$$

(b) Using 1 - yd^3 LHD & 2 - 8.5 yd^3 Trucks

$$\frac{75{,}690\ yd^3}{*108\ yd\ /day} = 701\ days$$

*See Page 48

4.4.2 Layout #2 - Two Parallel Headings - 143,818 yd^3

(a) $\frac{143,818\ yd^3}{*\ 176\ yd\ /day}$ = 817 days

(b) $\frac{143,818\ yd^3}{*\ 199\ yd\ /day}$ = 723 days

*See Page 48

4.5 ESF HOISTING CAPACITY

In F&S Analysis #FS-CA-00067 and FS-CA-0068, the duty cycles for the GFE 900 HP Hoist and the GFE 1500 HP Hoist were calculated. The results are tabulated on Attachment #3.

From this Table (Attachment #3), the 1500 HP Hoist, which will be used on ES-2, has a maximum production rate of 249.1 tons/hr or 227.9 tons/hr., depending on counterweight/skip configuration. Therefore, the 127 tons/day to 263 tons per day productions rates for this drifting could be accommodated fairly easily by the hoist.

Example:

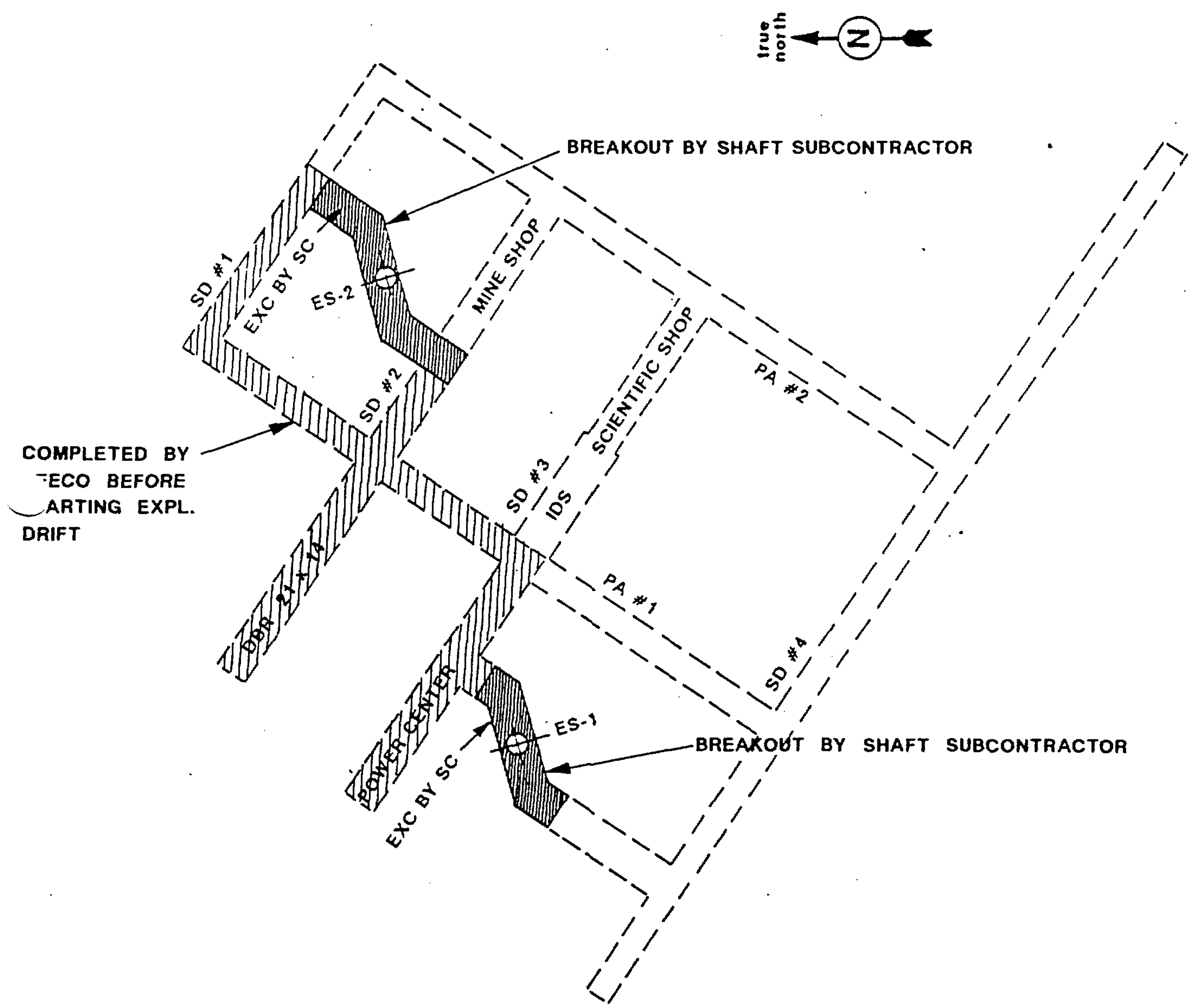
263 tons per day maximum case is in 104.5 ton surges (tons in one round) delivered to the shaft in 2.2 hrs. tons/hr = 263/2.2 = 119.5 $\frac{\text{tons}}{\text{hr}}$

This requires utilizing $\frac{119.5}{227.5} \times 100$ = 53% Hoist Capacity over the 2.2 hr

4.6 SCHEDULE OPTIONS

4.6.1 Drifting To Be Accomplished As Soon As Practical.

The earliest practical schedule would be to start driving the currently planned exploratory drift towards PT-F as soon as possible during the service core area development. In order to have ventilation, assume starting as soon as the connection between ES-2 and ES-1 is complete, and the power center alcove is excavated. Also, the access around to the ES-2 muck dump has to be completed.



EARLIEST PRACTICAL DRIFTING

4.6.1.1 Drive DBR, Connect ES-1 & ES-2, Drive Run Around and Power Center

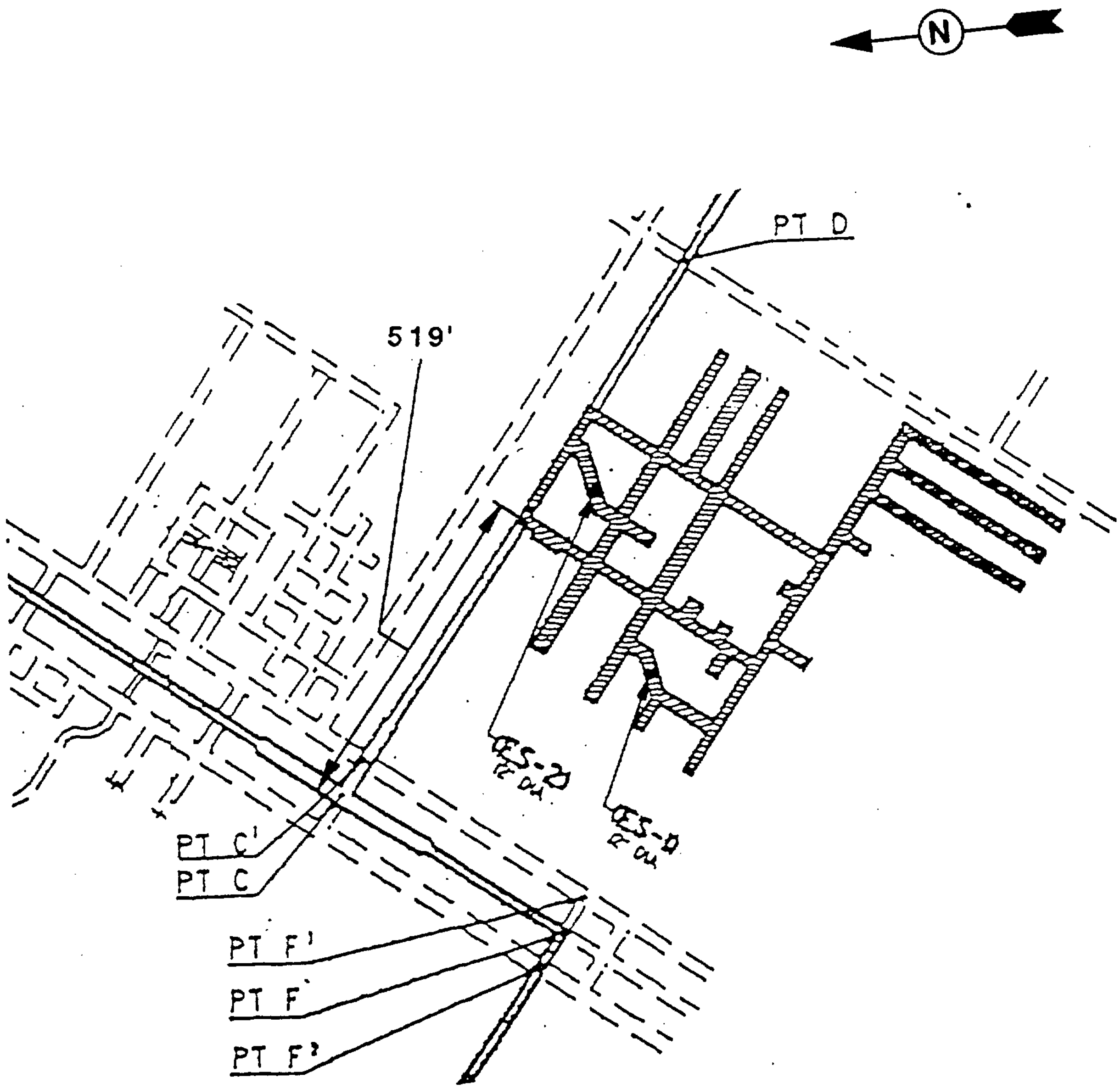
The total time to do this excavation (cross hatched) calculated in FS-ST-0024 was:

After shaft subcontractor demobilizes and REECo mobilizes for MTL mining.

1) Mine access to DBR, & Mine & Test DBR (See Attachment #4,)	= 74 days
2) Drive Connection to ES-1 (See Attachment #4,)	= 33 days
3) Drive access around to #S-2 Dump (See Attachment #4,)	= 39 days
4) Excavate Power Center (See Attachment #4,)	= 16 days
<u>Total Time for 4.6.1.1</u>	= 162 days

4.6.1.2 Concurrent With Continuing Core Area Development, Drive SD#1 Northwest to Pt C.

Use Mining Time Estimate calculated for this segment in FS-ST-0024 (See Attachment #5).



EST TIME = 37 DAYS

CORE AREA DEVELOPMENT

4.6.1.3 Mine Tuff Main SW to PT-F, and

(a) Drive 150 ft enlarged section

This was estimated at 15.2 days in FS-ST-0024.

(See Attachment #6)

use 15 Days

(b) Drive 250 ft of 14 ft x 14 ft to PT-F

FS-ST-0024 est. 44 days to drive 713 ft, therefore, 250 ft takes $\frac{250}{713} \times \underline{44} = 15$ days

(See Attachment #6)

Total = 15 + 15 = 30 days

4.6.1.4 <u>Recap</u> Total development time before starting 9780 ft of drifting

After shaft subcontractor demobilizes and REECo is mobilized for MTL development

(a) Complete necessary core area (4.6.1.1) = 162 days

(b) Drive currently planned exploratory drift to PT-F

(1)	NW	>	PT-C	(4.6.1.2)	=	37 days
(2)	SW	>	PT-F	(4.6.1.3)	=	<u>30 days</u>

Single Heading Drift > 229 days

In order to make full use of a flow through ventilation scheme for the double heading drift option, drive a connecting drift between ESF Service Drift #4, and the beginning of the optional parallel drift at PT-F'. Use the rate of advance from 4.6.1.3 above, to calculate additional time for this development.

Dist.- 230 ft

Time $= \frac{230}{713} \times 44 =$ 14 days

Total development time before starting parallel heading drifts

229 + 14 = 243 days

4.6.1.5 Total pre-development & drifting times from 4.4

(a) Single heading drift

(1) Muck with 2 LHDs only = 229 + 788 = 1017 days

(2) Muck with LHD & 2 Trucks = 229 + 701 = 930 days

(b) Two parallel heading with cross-cuts

(1) Muck with 2-LHDs only = 243 + 817 = 1060 days

(2) Muck with LHD & 2 Trucks = 243 + 723 = 966 days

4.6.2 Drifting to be accomplished after currently planned MTL drifting is complete.

FS-ST-0024 estimated 19.5 months to complete currently planned MTL drifting after REECo mobilize for drifting.

19.5 Months X 30 = 585 days

Total Development & Drifting Time

(a) Single heading, LHDs only

(1) 585 days + 788 days = 1363 days

- Single Heading, LHD & trucks

(2) 585 days + 701 days = 1286 days

(b) Two Parallel Headings

(1) 2 - LHDs Only
= 585 days + 14 days + 817 days = 1416 days

(2) LHD & 2 Trucks
= 585 days + 14 days + 723 days = 1322 days

4.6.3 Drifting Accomplished Concurrent With Calico Hills Drifting

Since Calico Hills Drifting will require hoisting through ES-1 and all MTL hoisting will be through ES-2, no direct hoisting conflict will occur. Muck hoisting in ES-1 however, will require more personnel, material and supply hoisting through ES-2 which may cut into muck hoisting availability.

4.6.4 Impacting of Schedule

The present schedule for the MTL development, according to FS-ST-0024, is 585 Days for MTL after REECo takes over. Therefore, subtract 585 Days from total time for each new drift option, to get schedule impact for that option.

4.6.5 Muck Hoisting in ES-2

In FS-ST-0024, the maximum muck production was determined to be 765 tons per day, which occurred while exploratory drifting and test bed mining were going on simultaneously. Assume this maximum rate will still occur, and add the muck hoisting requirements for driving the additional drifting concurrently.

Option #1 - Single Heading, 2 LHDs

* 765 tpd + 127 tpd = <u>892 tons/day</u>

Full speed hoisting hrs/day = $\frac{892 \text{ tpd}}{228}$ = 3.9 hr/day

Option #2 - Single Heading, LHD & 2 Trucks

* 765 tpd + 143 tpd = <u>908 tons/day</u>

Full speed hoisting hrs/day = $\frac{908}{228}$ = 4.0 hr/day

Option #3 - Double Heading, 2 LHDs

* 765 tpd + 233 tpd = <u>998 tons/day</u>

Full speed hoisting hr/day = $\frac{998}{228}$ = 4.4 hr/day

Option #4 - Double Heading, LHD & 2 Trucks

765 tpd + 263 tpd = <u>1028 tons/day</u>

Full speed hoist hr/day = $\frac{1028}{228}$ = 4.5 hr/day

*See Page 48

APPENDIX D

CONCLUSIONS ON OPTIONS AND FEATURES EVALUATED

1.0 "What is the recommended opening and ventilation configuration?"

<u>Conclusion</u>

The recommended opening size is 14 ft x 14 ft in order to get adequate clearance for equipment, and accommodate the required ventilation duct.

Two configurations were considered as follows:

<u>Configuration 1</u>

Single 14 ft x 14 ft drift on the centerline alignment of the TUFF MAIN, with passing/truck loading/parking areas slashed out to 14 ft high x 25 ft wide every 500 ft along the drift. The total slope distance used to estimate schedule impacts was 9780 ft. This was calculated from coordinates and elevations shown on SNL Dwg. No. R07003A for Point F and the SW end of the TUFF MAIN.

<u>Configuration 2</u>

Two parallel 14 ft x 14 ft drifts on the centerline alignment of the TUFF MAIN and the WASTE MAIN, with 14 ft x 14 ft connecting cross-cuts spaced at approximately 740 ft on the alignments of future repository block cross-cuts. The pillar width between the parallel drifts, and thus the cross-cut lengths, is 38 ft. The total length of drifts and cross-cuts used for estimating was 20,016 ft.

In order to realize the most benefit of flow through ventilation with configuration #2, the addition of a connecting ventilation 14 ft x 14 ft cross-cut was included in the time estimates. This cross-cut is 230 ft. long (estimated) and extends from the NW end of drift SD #4 (near ES-1) of the ESF, to the beginning of the WASTE MAIN exploration drift.

The recommended configuration for safety, ventilation and operational flexibility, is configuration #2, the parallel drift scheme. Even though the total excavation footage is much greater, due to the considerable increase in efficiency, the impact on cost and schedule are not excessive. The small increases in excavation cost and schedule will be regained when and if repository construction starts, since the added drift and cross-cuts follow repository alignments. Also, the ventilation operating costs will be considerably less with this parallel drift configuration.

2.0 "Drifting is to be accomplished as early as practical in site characterization".

To determine schedule impacts, time estimates were made for both the single entry configuration and the double entry configuration. The same equipment spread was assumed for both configurations, with one spread being shared between the two headings in configuration #2.

Also, because of possible ventilation limitations, two different muck loading and hauling systems were considered.

(1) Muck & Haul with 2 - 5 yd^3 LHDs only. (Requires less total ventilation).

(2) Muck with 1 - 5 yd^3 LHD with ejector bucket, loading, 2 - 8.5 yd^3 trucks. (Requires more total ventilation).

In the ventilation analysis, the worst case scenario was used, and it was determined that adequate ventilation could be provided. Therefore, either system could be used. The LHD and trucks combination would result in the shortest schedules.

The time estimates are for controlled drill & blast excavation, rock bolting, and geologic mapping. Also, muck sampling for rock matrix, hydrochemistry, and chlorine -36 tests are included. No other testing is provided for in the estimate.

For "accomplishing drifting as soon as practical", drifting toward the "Point F" starting intersection (interface drawing #R07048A/1) is assumed to start as soon as the DBR is finished, ES-2 and ES-1 are connected, the muck dump station is fully accessible, and the power center has been excavated. This means that exploratory drifting, which is currently scheduled to be started after the MTL service core area is finished, would be in progress concurrent with most of the service core area development.

The estimated times for mining the above pre-drifting MTL development were taken from FS-ST-0024, Design Mining Rates.

2.1 SCHEDULE

2.1.1 Following are the estimated times required to complete the additional drifting.

2.1.1.1 Single Heading and Passing Bays - 9,780 ft

(a)	Using LHDs only, to muck	788 days
(b)	Using LHDs and trucks, to muck	701 days

2.1.1.2 Double Heading and Cross-cuts - 20,016 LF

(a) Using LHDs only, to muck 817 days

(b) Using LHD and trucks, to muck 723 days

2.1.2 Minimum pre-new-drift development time

2.1.2.1 Drive DBR, ES-2 to ES-1 connection, ES-2 muck dump run around, and power station alcove 162 days

2.1.2.2 Drive currently planned exploration drift to Pt-F 67 days

2.1.2.3 (Required for parallel heading option only). Drive ventilation drift from SD #4 near ES-1, to Pt-F.
14 days

2.1.3 Total pre-new-drift and additional drift drifting time.

2.1.3.1 Single heading and passing bay - 9780 LF of additional drifting

(a) Using LHD only, to muck new drift
= 162 days + 67 days + 817 days = 1017 days

(b) Using LHD & trucks to muck new drift
= 162 days + 67 days + 726 days = 930 days

2.1.3.2 Double heading and cross-cuts - 20,016 LF of additional drifting

(a) Using LHD only, to muck new drift
= 162 days + 67 days + 14 days + 817 days = 1060 days

(b) Using LHD & trucks to muck new drift
= 162 days + 67 days + 14 days + 723 days = 966 Days

2.1.4 Total Schedule Impact

In FS-ST-0024, Design Mining Rates, it was estimated that the MTL core area development test bed mining, and exploratory drifting, would take 19.5 months. 19-1/2 months x 30 days/mo = 585 days.

The impact on the total construction schedule, for the additional drift to be accomplished "as early as practical" would be the total days listed under 2.1.3, minus 585 days.

2.1.4.1 Single Heading & Passing Bays

(a) Using LHDs only

Schedule Impact = 1017 - 585 = 432 Additional days to complete MTL excavation

(b) Using LHD & Trucks

Schedule impact = 930 - 585 = 345 Additional days to complete excavation

2.1.4.2 Double heading and cross-cuts

(a) Using LHDs only

Schedule impact = 1060 - 585 = 475 Additional days to complete MTL excavation

(b) Using LHD and trucks

Schedule impact = 966 - 585 = 381 Additional days to complete MTL excavation

2.2 HOISTING CAPACITY

2.2.1 Tons per day produced by additional drifting

2.2.1.1 Single heading

(a) Using LHDs only, to muck = 127 tpd

(b) Using LHD and Trucks, to muck = 143 tpd

2.2.1.2 Double heading

(a) Using LHDs only = 233 tpd

(b) Using LHD and trucks = 263 tpd

2.2.2 Tons per day produced by concurrent work on MTL.

In FS-ST-0024, the maximum rate of production was when MTL exploratory drifting was being done concurrent with test drift development. The peak rate of production was calculated to be 765 tons per day. This only lasted for 10 days, and then tapered off as haulage distances increased.

2.2.3 Maximum tons per day for additional drifting concurrent with currently planned work.

Add 2.2.1 rates to 2.2.2

2.2.3.1 Single heading

(a) Using LHDs only
= 765 tpd + 127 tpd = 892 tpd

(b) Using LHD & trucks
= 765 tpd + 143 tpd = 908 tpd

2.2.3.2 Double heading

(a) Using LHDs only
= 765 tpd + 233 tpd = 998 tpd

(b) Using LHDs and trucks
= 765 tpd + 263 tpd = 1028 tpd

2.2.4 Hoist Capacity

In FS-ST-0068, the maximum hoisting rate for the GFE 1500 HP double drum hoist planned for ES-2, was determined to be 228 tons per hour to 249 tons per hour, depending on skip and counterweight configuration. Using the lower rate of 228 tons per hour, the maximum tons per day that could be hoisted with this hoist, if no other use was required, would be about 18 hrs per day x 228 tons per hour = 4100 tons per day. This hoist will not be available for muck hoisting for a considerable amount of time each day, due to the requirement for personnel, materials, and supplies hoisting. Therefore, the impact on the hoisting system can be stated as the percentage of total theoretical hoist capacity required for muck hoisting.

2.2.4.1 Total Impact on Hoisting

2.2.4.1.1 Single Hoisting

(a) Using LHDs only
$= \frac{892 \text{ tpd}}{4100 \text{ tpd}} \times 100 = 21.8\%$ Hoist capacity needed for muck

(b) Using LHD & truck
$= \frac{908 \text{ tpd}}{4100 \text{ tpd}} \times 100 = 22.2\%$ Hoist capacity needed for muck

2.2.4.1.2 Double heading

(a) Using LHDs Only
$= \frac{998 \text{ tpd}}{4100 \text{ tpd}} \times 100 = 24.3\%$ Hoist capacity needed for muck

(b Using LHDs & Trucks
$= \frac{1028 \text{ tpd}}{4100 \text{ tpd}} \times 100 = 25.1\%$ Hoist capacity needed for muck

These figures compare to

$\frac{765 \text{ tpd}}{4100 \text{ tpd}} \times 100 = 18.7\%$

Hoist capacity need to hoist muck with the currently planned MTL work. Therefore, the additional drifting would not make a significant impact on the hoist system, even when done concurrent with the presently planned MTL development.

2.3 MINING EQUIPMENT REQUIREMENTS IMPACT

To start the additional drifting concurrent with presently planned work, the following additional mining equipment would be required.

1 - 2 - Boom Electric/hydraulic drill jumbo with hydraulic drills

plus either:

2 - 5 yd^3 Diesel LHDs

or:

1 - 5 yd^3 Diesel LHD with ejector bucket

and

2 - 8.5 yd^3 Haulage trucks

1 - One Rock-bolting jumbo

2.4 MINING PERSONNEL

One more face crew would be required each shift.

3.0 "Drifting is to be accomplished after completion of the currently planned drifting for ES underground tests."

The total time in this option, for each configuration and muck handling spread, is merely the total additional drifting times listed in 2.1.1 plus the 585 day MTL development time determined in 2.1.4. An exception is with the two parallel heading configuration, the 14 days for the extra ventilation drift has to be added in.

3.1 Total time schedule for MTL currently planned development plus the additional drifting.

3.1.1 Single Heading and Passing Bays, 9780 ft additional drift:

(a) Using LHDs Only

585 + 788 = 1363 days

(b) Using LHD and trucks

585 x 701 = 1286 days

3.1.2 Double Heading and Cross-Cuts 20,016 ft additional drift

(a) Using LHDs Only

585 + 14 + 817 = 1416 days

(b) Using LHD and trucks

585 + 14 + 723 = 1322 days

3.2 <u>Total Schedule Impact</u>

The total schedule impact is the additional drift time, since this option assumes doing all of the new drifting after the currently planned work is done. With the double heading configuration, the 14 days for driving the additional ventilation drift, must be added.

The schedule impacts are:

3.2.1 Single Heading

(a) Using LHDs Only = 788
additional days to complete MTL excavation

(b) Using LHD and trucks = 701
additional days to complete MTL excavation

3.2.2 Double Heading

(a) Using LHDs Only

817 + 14 = 831
Additional days to complete MTL excavation

(b) Using LHD and Trucks

723 + 14 = 737
Additional days to complete MTL excavation

3.3 Other Impacts

The impacts on the hoisting system, mine equipment spread, and mine crew size, discussed in the schedule for additional drifting to be done during presently planned MTL development, will not occur in this schedule. Hoisting requirements, equipment and mine personnel requirements will diminish in this option, compared to the requirements of the currently planned work.

4.0 "What additional impacts, if any, result if this work is accomplished concurrently with drifting in the Calico Hills?"

Drifting concurrently in the Calico Hills will be done through ES-1 shaft. The main impact this will cause will be to deny the use of ES-1 for personnel, material, and equipment hoisting, related to MTL development. Since the impact on the ES-2 hoisting system, caused by additional drifting on the MTL, would not be too great, the impact of losing the use of ES-1 should not be serious.

5.0 "What potential scope of work and schedule can the presently planned exploratory shaft facilities support?"

The presently planned ESF can support itself plus the additional drifting on the MTL and Calico Hills level being investigated in this impact analysis. To determine what additional work can be supported is not practicable without defining the additional work under consideration.

6.0 Electrical Impact

Analysis Scenario: 10,000 ft exploratory core drifting and add CHDR level with 1000 ft drifting. (worst case)

Impact: The following list is the change in equipment necessary to handle the approximately 3900 H.P. of ventilation and mining to supply the exploratory drifting. Overall electrical costs will increase as additional equipment is added.

- o Possibly, 2 larger cables per shaft at 4.16kV
- o Larger 5kV U/G mine power switchgear of an additional power center
- o Increase in number of power cabling in drifts
- o Possibly, 1 to 2-5kV medium voltage starters
- o Possibly, 10 - 4.16kV - 480V step-down transformers
- o Associated 480V switches, etc.
- o Larger mine power center alcove due to increase in switchgear
- o Possibly, two additional cables per shaft at 4.16kV

This scenario may possibly impact H&N's equipment sizing for the surface substation transformer and switchgear and the stand-by generators.

7.0 Conclusion

The addition of a drifting program to explore approximately 10,000 ft. to the SW edge of the repository block, would not have any prohibitive impacts on the presently planned ESF design construction, and testing. Depending on when the additional drifting was done, i.e. concurrent with or subsequent to the presently planned development and testing, impacts to some systems would result.

If the work is done concurrent with presently planned work, more ventilation capacity, electrical power capacity, utilities, underground mining equipment, and provisions for human occupancy, would have to be provided. The hoisting plant would not have to be redesigned. The schedule for the completion of the presently planned development and testing would not be significantly affected. The impact of providing the increased capacities listed above, could easily be mitigated in Title II design.

If the additional drifting was done after the presently planned ESF program is complete, very little adverse impact would result.

The over all schedule for completion of the ESF, including the additional drifting, would receive the greatest impact, in that this schedule would be increased by from 345 to 830 days, depending on the drifting schedule, configuration, and equipment spread.

ATTACHMENT 1

Exploratory Drifts

Drill 12 ft Pull 11 ft

No. Holes and Drills Footage

Burn Cut	=	11 ea. x 12 ft
Stope	=	15 ea. x 12 ft
Perimeter	=	25 ea. x 12 ft
		51 ea. x 12 ft = 612 linear ft

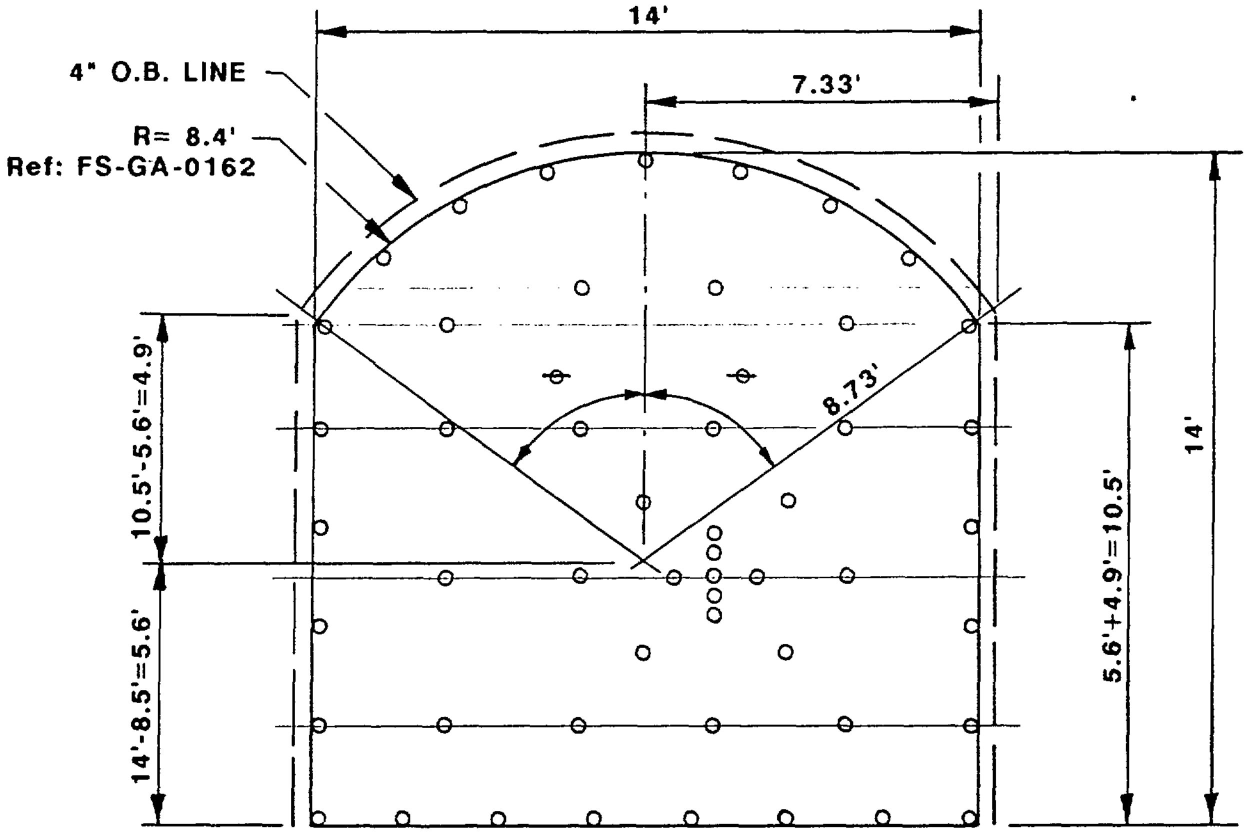
Area of Face (with 4" Overbreak)

Angle $\theta = \sin^{-1} \frac{7.33}{8.73} = 57.1014$ DEG.

Area $\triangle = \pi 8.73 \text{ ft}^2 \times \frac{2(57.1014)}{360}$ ft $-(4.9 \times 7.33) = 40$ sq. ft

Area $\square$ = 10.5 ft x 14.67 ft = 154 sq. ft

Total Area = 194 sq. ft



SECTION A-A DRILL ROUND

ATTACHMENT 2

Excavation Cycles - Exclude mucking of differing haul distances, use 1 Hydr., 2 Boom Jumbo and 1 - 5 yd LHD, ea. heading

<u>14 x 14 Drift</u> (See A-A)

<u>Drill Cycle</u> (51 Holes, 612 Linear ft)

Move in and set up	=	20 min
Collar 51 at 1 min w/2 mach.	=	26 min
Drill 612 LF and 5 fpm w/2 mach.	=	61 min
Rig out	=	15 min
		122 min

<u>Blast Cycle</u>

Load 48 holes at 3 1/2 min./3 men	=	56 min
Wire up	=	18 min
Clean up, hook up and shoot	=	15 min
Smoke delay	=	30 min
		119 min

Exploratory Drifts

Bolt Cycle

8 ft Bolts on 4 ft c/c from 4' high area bolted per round

	arch = pi (8.73)(2)(57.1)(2) / 360	=	17.4 ft
Area =	11 ft x [17.4 ft + 2(6.5) ft]	=	334 sq. ft
No. bolts = 334 SF/16 SF/bolt		=	21 bolts/rnd

Install bolts at start of drill cycle

Collar 21 holes at 1 min/1 drill	=	21 min
Drill 21 x 8 ft = 168 linear ft at 4 fpm/1	=	42 min
Install 21 bolts at 3 min.	=	63 min
Total bolting time		126 min

Mapping Cycle

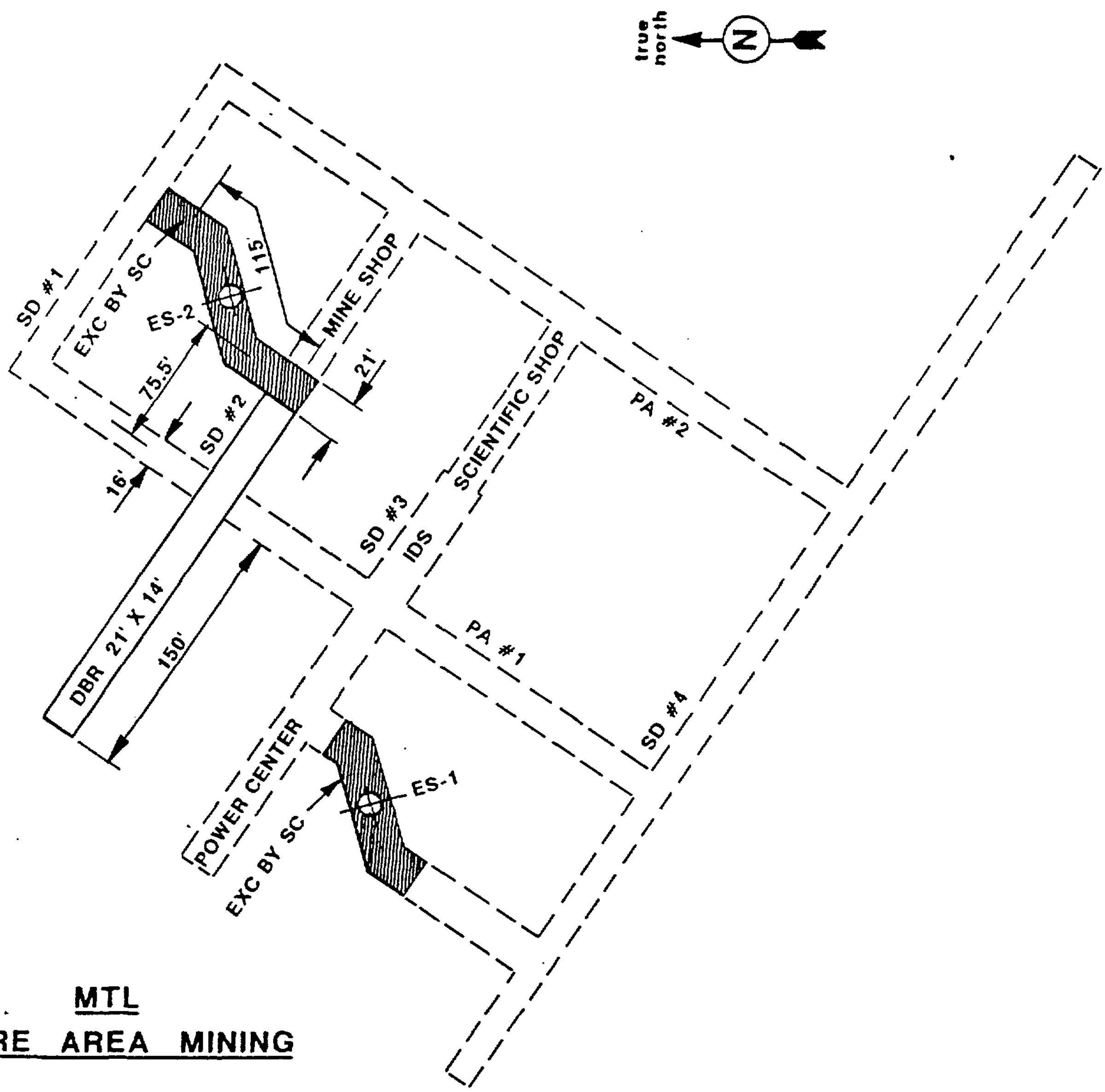
Same as 16 x 14 drift = 3.33 hr	=	200 min
Total 14 x 14 Exc. Time Excl. mucking	=	567 min
	=	9.45 hr

HOIST DUTY CYCLES

GFE 900 HP YULCAN DENVER - GFE 1500 HP ALLIS CHALMERS

	UNITS	UNBALANCED	"A" COUNTER-WEIGHTED	"B" COUNTER - WEIGHTED	"C" UNBALANCES
TYPE OF HOIST		SINGLE DRUM	DOUBLE DRUM	DOUBLE DRUM	SINGLE DRUM
HOISTING DISTANCE	FT	1365	1150	1150	1150
MAX. ROPE SPEED	FT/SEC	22.5 (130FPM)	33.33 (2000FPM)	33.3 (2000FPM)	10 (600FPM)
ACCELERATION	FT/SEC	2.0	2.0	2.0	2.0
DECELERATION	FT/SEC	2.5	2.5	2.5	2.5
CREEP SPEED	FT/SEC	1.0	1.0	1.0	1.0
INITIAL CREEP TIME	SEC	7.0	4.0	4.0	4.0
FINAL CREEP TIME	SEC	14.0	4.0	4.0	4.0
IDLE TIME	SEC	120.0	15.0	15.0	60.0
DUTY CYCLE TIME	SEC	421.72	144.52	144.52	373.4
PRODUCTION RATE	TONS/HR	-	249.1	227.93	-
MAX. PAYLOAD	LBS	9000	20,000	18,300	20,000
WEIGHT OF EMPTY CAGE	LBS	6000	18,850	18,300	18,300
WT. OF COUNTERWT.	LBS	0	28,850	27,450	0
ROPE TYPE		FLATTENED STRAND	FLATTENED STRAND	FLATTENED STRAND	FLATTENED STRAND
NO. OF ROPES/ROPE DIA.	INCHES	1/1"	1/1.5	1/1.5	1/1.5
DIA. OF DRUM/FACE WIDTH	INCHES	72"/84"	144"/72"	144"/72"	144"/72"
ROPE WT. PER FOOT	LBS/FT.	1.74	3.95	3.95	3.95
ROPE BREAKING STRENGTH	LBS	116,000	265,000	265,000	265,000
FACTOR OF SAFETY (STATIC)		6.68	6.02	6.35	6.1
RMS HP/MOTOR HP	HP	723/800	1227/1300	1164/1200	888/900
TYPE OF CONVEYANCE & SIZE		SINGLE DECK 5 X 5	SKIP/CAGE 5 X 5	SKIP/CAGE 5 X 5	SKIP/CAGE 5 X 5
CAGE CAPACITY		17 PERSONS	34 PERSONS	34 PERSONS	34 PERSONS
MAX. ROPE PULL		18,600	44,100	44,100	45,900
NO. OF LOADS/HR		8.54	24.9	24.9	9.64

FS-ST-0024 - DESIGN MINING RATES



MTL
CORE AREA MINING

MINE SD #2 N.W. FROM ES-2 X-CUT TO DBR MINE & TEST DBR

DBR

Mine Access to DBR and Mine DBR

Drift X-Section = 21 ft w x 14 ft h (per sect. C-C) on Sandia Input Dwg. # R07048A/4

* Excavation round = 63 holes at 12 ft = 756 linear ft
Vol:

* Neat, W/4" OB = 273 SF x 11 = $3003\ ft^3$

Tons = $\frac{3003\ ft^3 \times 150\ lbs/ft^3}{2000}$ = 225 Tons

Yd^3 to Muck = $\frac{3003\ ft^3}{27} \times 1.7$ = $189\ yd^3$

Cycle Times

Drill (2 Boom Pneumatic Jumbo)

Rig in Jumbo	=	20 min
Collar 33 holes at 1 min./2 drills	=	17 min
Drill 33 holes at 12′ = 408 LF at 2 fpm/2	=	102 min
Move Jumbo	=	10 min
Collar 30 holes at 1 min./2	=	15 min
Drill 30 holes at 12′ = 360 LF at 2 fpm/2	=	90 min
Rig Out	=	15 min
Total Drill Time		269 min

*Reverence FS-ST-0024, Part A, Page 4 of 115

Blast

Load 61 holes at 3 1/2 min./3 men	=	71 min
Wire up	=	20 min
Clean up, hookup and shoot	=	15 min
Smoke Delay	=	30 min
Total Blast Time		136 min

Muck Cycle

Don't have access to the loading pocket from the NS of ES-2. Have to dump into temporary conveyor to transfer muck around shaft to muck pocket.

Haul Distance (in linear feet)

In Existing Station	=	115 linear ft
New Drift Avg. = $(75.5 - \frac{21}{2} + 150)/2$	=	118 linear ft
		233 linear ft

No. of Loads = 189 $yd^3/(1\ yd^3 \times 0.8)$ 236 Loads

Trip Time

Load	=	1.0 min
Tram 233 ft at 2 mph avg. = $\frac{233}{176\ fpm}$	=	1.3 min
Pull Forward to Dump	=	0.3 min
Dump	=	0.5 min
Back away	=	0.3 min
Tram to face at 2 mph	=	1.3 min
Total trip time		4.7 min/trip

Muck Out Cycle

Wet down and scale	=	30 min
Muck first 232 loads = 232 x 4.7	=	1090 min
4 loads final clean up	=	20 min
Total muck out cycle		1140 min

Rock Bolt

Assume 8' bolts on 4' c/c (16 sq. ft/bolt) from 4' above drift floor

Area of back arch

$$= \pi\, 2(12.93)(2)\left(\frac{56.88}{360}\right) = 25.7\ \text{sq. ft}$$

Area of Walls

= (8.5 - 4)2 = 9.0 sq. ft/ft

= 25.7 + 9 = 34.7 sq. ft/linear ft

sq. ft/rnd = 34.7 x 11 = 382 sq. ft

No. bolts/rnd = $\frac{382}{16}$ = 24 bolts/rnd

Drill and bolt with 1 Jumbo Boom. Bolt at start of drill cycle so no set up or rig out time is required.

Collar 24 holes		=	24 min
Drill 24 x 8′ at 2 fpm		=	96 min
Install bolts = 24 x 3 min ea.		=	72 min
	Total		192 min/rnd

Total Cycle time for 11 ft exc.

Drill		=	269 min
Blast		=	136 min
Muck		=	1140 min
Bolt		=	192 min
	Total		1737 min

L.F. Drift to mine access to DBR	=	75.5 ft
DBR	=	150.0 ft
		225.5 ft

In the first 75.5 ft., the only testing required is drift wall mapping.

Mapping Time

Assume 2 hr/2 M drift = 2 hr/6.6 ft

Time per round (11′ adv.)

= $\frac{11}{6.6}$ x 2 hr = 3.33 hrs

Say 4 hrs/rnd incl. wash down and set up time

Rate of advance in access to DBR

Excavation and ground support	=	1737 min
Testing 4 x 60	=	240 min
		1977 min/rnd

Hr/rnd = $\frac{1977}{60}$ = 32.95

Available hrs/day = 21

rnds/day = $\frac{21}{32.95}$ = .637

ft/day = .637 x 11 = 7.01 ft/day

ft^3/day = 7.0' LF x 273 SF = 1914 ft^3/day

Total time to drive 1st 75.5 ft from ES-2 Station to beginning of DBR

= 75.5 ft/7.0 ft/day	=	11 days
Add 10% Cont.		1 days
		12 days

Drive DBR (150 linear feet)

Excavation, bolting and mapping time

= 150 ft/7	=	21.4 days
10% Cont.	=	2.0
Total mining and mapping time	=	23.4 days

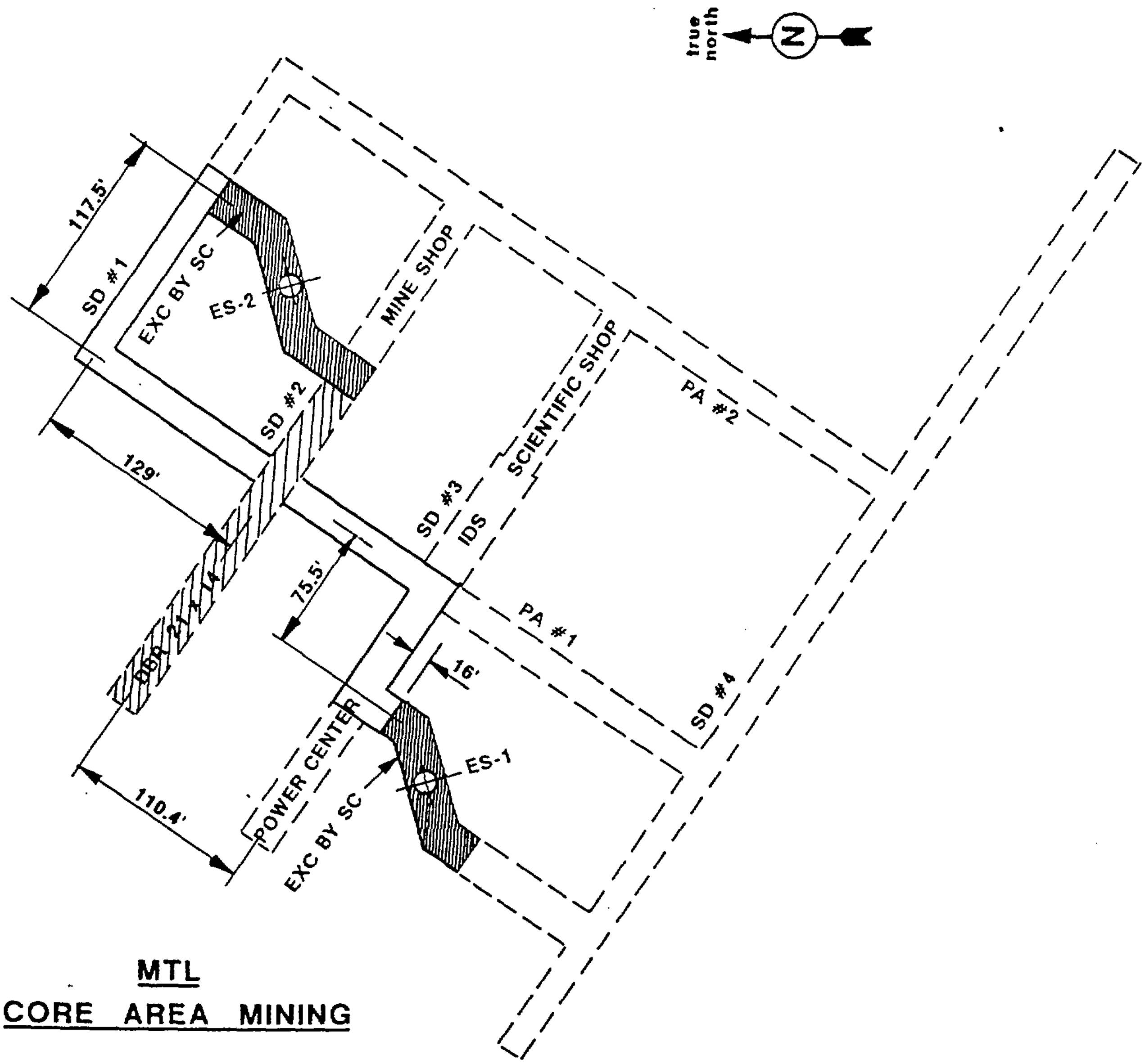
1987 WPAS est. scheduled 62 days to mine and test DBR

Therefore assume testing will take 62 - 23.4 = 38.6 days

Total elapse time for DBR = 62 days

Total elapsed time for access and DBR = 12 + 62 = 74 days

FS-ST-0024 - DESIGN MINING RATES



MTL

CORE AREA MINING

Drive Connection to ES-1

Total Distance

SD #1 (16 ft x 14 ft) = $117.5 \text{ ft} + \frac{21}{2} \text{ ft} + \frac{16}{2} \text{ ft}$ = 136 ft

PA #1 (16 ft x 14 ft) = $129 \text{ ft} + 110.4 - \frac{16}{2} - 21 + \frac{21}{2}$ = 220.9 ft

Total 16 x 14 — 357 linear ft

SD #3 (21 ft x 14 ft) = $75.5 - \frac{16}{2} + \frac{21}{2}$ = 78 ft

ES-1 x-cut (21 ft x 14 ft) = 16 ft = 16 ft

Total 21 ft x 14 ft = 94 linear ft

Total Footage 451 ft

Have to keep total exc. to under 600 ft until connection is made between ES-2 and ES-1, up to now, have DBR (150′) SD#2 $(75.5 + \frac{21}{2})$ + ES-2 x-cut from SD#2 to ES-2 (32.5 + approx. 22).

Dist. = $150 \text{ ft} + 75.5 \text{ ft} + \frac{21}{2} + 32.5 + 22$ = 290.5 ft

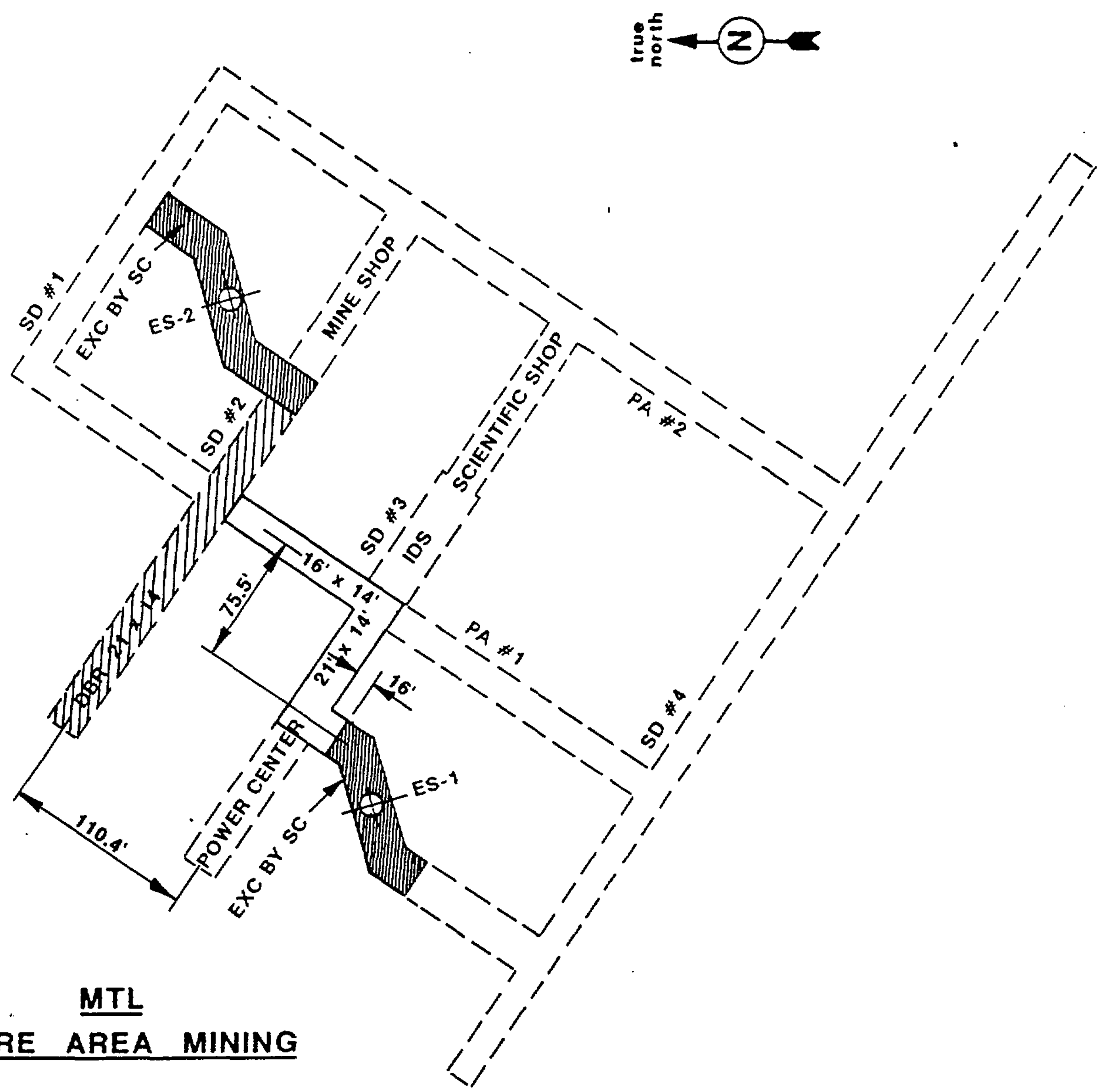
290.5 ft + 451 ft = 742 ft > 600′ so can't drive the portion around ES-2, Subtract this from 451

= $451 \text{ ft} - (117.5 + \frac{21}{2} + 129 - \frac{21}{2})$ = 205 ft

205 ft + 290.5 ft = 496 ft < 600 ft so okay

FS-ST-0024 - DESIGN MINING RATES

Connect To ES-1



MTL
CORE AREA MINING

MINE PA #1 SW FROM SD #2 TO SD #3
MINE SD #3 NW FROM PA #1 TO ES-1 X-CUT
MINE ES-1 X-CUT SW TO ES-1 STATION

Drive connection from DBR to ES-1 x-cut

a. Drive PA#1 16 ft x 14 ft x 110.4 ft SW
b. Drive SD#3 21 ft x 14 ft x 78 ft NW
c. Drive EX-1 x-cut 21 ft x 14 ft x 16 ft SW

16 x 14 Exc. Cycle

* No holes/rnd = 57
* Drill footage = 684 linear ft
* Muck Vol. (4" OB, Pull 11')

Neat Vol. = 216 sq. ft x 11 ft = 2376 ft^3

Tons = $\frac{2376 \times 150}{2000}$ lb/ft = 178.2 ton/rnd

yd^3 Muck - $\frac{2376\ ft^3}{27} \times 1.7 = 150\ yd^3$

Avg. haul dist.

= 110/2 + 75.5 + 115' = 246 ft

Cycle Times

Drill Cycle

Rig in jumbo	=	20 min
Collar 57 holes at 1 min/2 mach	=	29 min
Drill 684 LF/2 mach - 2 fpm	=	171 min
Rig out	=	15 min
Total drill time	=	235 min/rnd

Blast Cycle

Load 54 holes at 3½ min/3 min	=	63 min
Wire up	=	20 min
Shoot and smoke time	=	45 min
Total blast cycle	=	128 min

*Reference FS-ST-0024, Part A, Page 3 of 115

Muck Cycle

(Still have to use a 1 yd^3 machine and haul around shaft at the station in order to get to the loading pocket).

No loads = $\frac{150\ yd^3}{1\ yd \times .8}$ = 188 trips

Trip time

Load		=	1.0 min
Tram 246 ft at 2 mph	= $\frac{246}{176}$ fpm	=	1.4 min
Pull fwd to dump		=	0.3 min
Dump		=	0.5 min
Back away		=	0.3 min
Tram to face at 2 mph		=	1.4 min
	Total		4.9 min/trip

Muck Cycle

Wet down and scale	=	30 min
Muck 1st 184 loads x 4.9M	=	902 min
4 loads final clean up	=	20 min
Total muck cycle		952 min

Rock bolt (8 bolts on 4' c/c)

Area of arched back

* = pi (2)(9.93)(2) $\frac{57.02}{360}$ = 19.8 ft.

Area of ribs (4' above floor)

* = (9.8 - 4)(2) = 11.6

Total ft^2/linear ft = 31.4
x 11 linear ft
345 sq. ft

*Reference FS-ST-0024, Part A, Page 3 of 115

No. bolts = 345/16 = 22 bolts/rnd
say = 24 bolts

Bolt as start of drill cycle

Collar 24 holes	=	24 min
Drill 24 x 8 /2 fpm	=	96 min
24 bolts at 3 min	=	72 min
		192 min

Total exc. time for 11 ft adv.

Drill	=	235 min
Blast	=	128 min
Muck	=	952 min
Bolt	=	192 min
		1507 min/rnd
	=	25.12 hr/rnd

Mapping Time

2 hr/2 m of 21 ft x 14 ft drift is equiv. $\left[\frac{19.8 + 2(9.8)}{25.7 + 2(8.5)}\right] 2$

$= \frac{39.4}{42.7} \; 2 = 1.8$ hr/2 m of drift

Time to map 11 ft/rnd $= \frac{11}{6.6} \times 1.8$ hr = 3 hrs

Wash down and set up = .33 hrs

3.3 hrs

Total time/rnd = 25.12 hr mining
3.33 hr mapping
28.45 hr/rnd

No of rounds $\frac{110.4 \text{ ft}}{11 \text{ ft./rnd}}$ = 10 rnds (in PA #1 @ 16 x 14)
x 28.45 hrs

16 ft x 14 ft time = 284.5

<u>94 linear ft of 21 ft x 14 ft Exc. Cycle</u>

Drill cycle = 269 min (page 75)
Blast cycle = 136 min (page 76)
Muck cycle - add incr. haul distance

Avg. distance

Dist. 94/2 + 110.4 + 75.5 + 115 =
Dist. = 348 ft

* Additional min/trip

$$= \frac{348 \text{ ft} - 223 \text{ ft}}{176 \text{ fpm}} (2) = 1.4 \text{ M/trip}$$

x 236 trips

330 min/rnd

* Total muck cycle = 1140 + 330 = 1470 min

* Rock bolt = 192 min
* Mapping time = 240 min

Total time/ 21 x 14 rnd = 2307 min
38.45 hrs

No. of rounds = 94/11 = 9.0 rnds

Total time in 21 x 14 = 9 x 38.45 = 346 hrs
Plus 16 x 14 time = 285 hrs

Total time for ES-1 Connection = 631 hrs

<u>Drive PA #1 NE to SD #1 and drive SD#1 SE to ES-2 x-cut to complete run around for ES-2 connection.</u>

All drifts 16 ft x 14 ft

$$\text{Exc. Dist.} = 129 - \frac{21}{2} - \frac{16}{2} + 117.5 + \frac{16}{2} + \frac{21}{2}$$

$$= 129 + 117.5 = 246.5 \text{ ft.}$$

Avg. haul dist W/1 yd^3 LHD

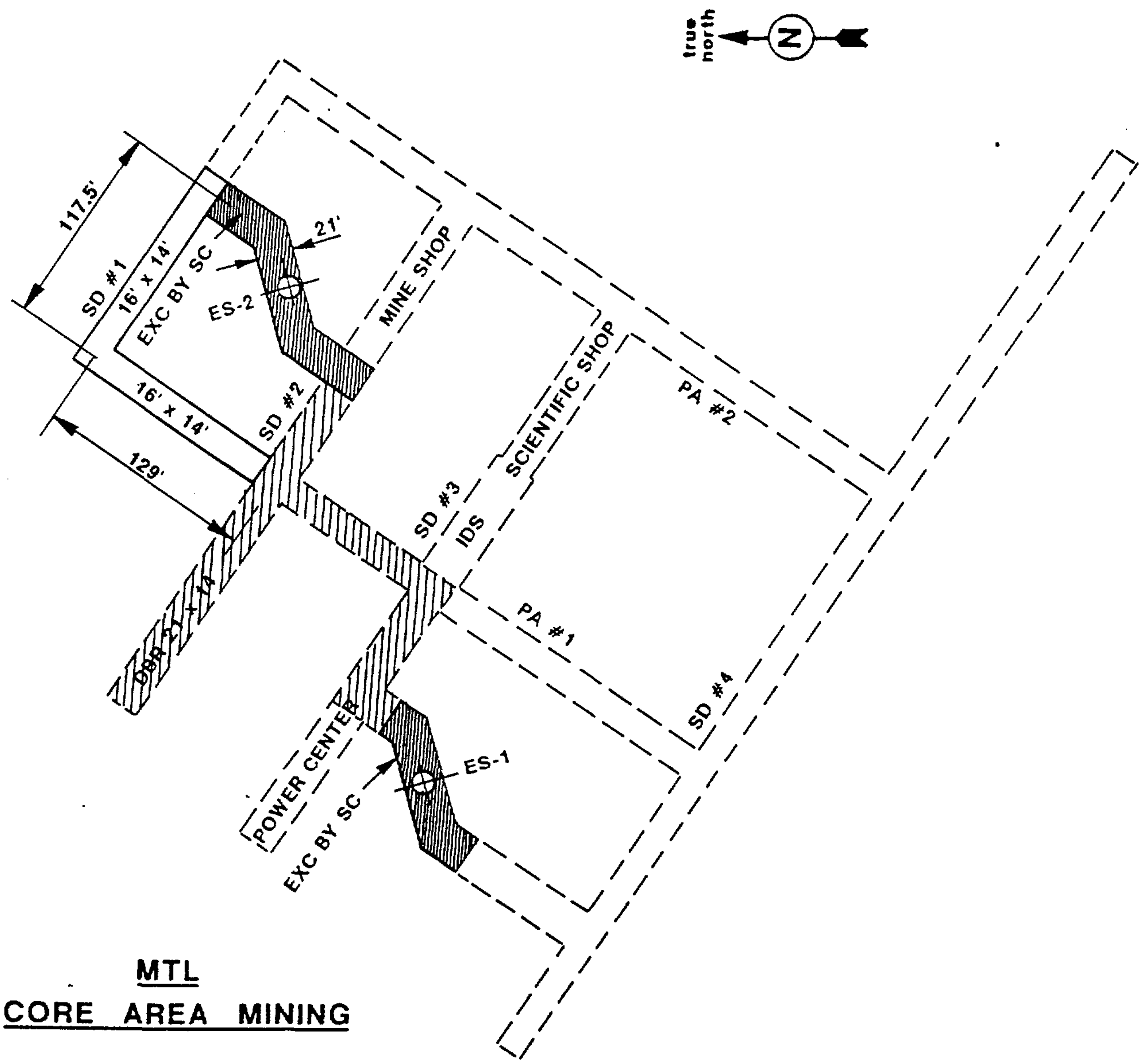
$$= \frac{246.5}{2} + 75.5 + 115 = 314 \text{ ft}$$

Cycle times same as in 16 ft x 14 ft drift except for muck haul distance adjustment.

*Reference Page 76

FS-ST-0024 - DESIGN MINING RATES

COMPLETE ES-2 RUNAROUND



MTL
CORE AREA MINING

MINE PA #1 NE FROM SD #2 TO SD #1
MINE SD #1 SE FROM PA #1 TO ES-2 X-CUT

Drill time = 235 min
Blast time = 128 min

Trip time loss

$$\frac{314 \text{ ft} - 246 \text{ ft}}{176 \text{ fpm}} (2) = 0.8 \text{ min/trip}$$

x 188 trip
150 min

Muck time = 952 + 150 = 1102 min
Bolt time = 192 min
Mapping time = 3.33 hr x 60 = 200 min

1857 min/rnd

= 30.95 hr/rnd

$$\text{No. of rounds} = \frac{246.5 \text{ ft}}{11\text{ft/rnd}} = 23 \text{ rounds}$$

Total exc. time = 23 rnds x 30.95 hrs/rnd = 712 hrs

Add 10% Contingency Time

631 hrs x 110% = 694 hrs
712 hrs x 110% = 783 hrs

Total hrs = 1477 hrs

Total days ea. phase

$$\frac{694 \text{ hrs}}{21 \text{ hr/day}} = 33 \text{ days}$$

$$\frac{783 \text{ hrs}}{21 \text{ hr/day}} = 37 \text{ days}$$

70 days total

Avg. ft^3/24 hr day

$$\frac{(114.4 \text{ LF} \times 216 \text{ ft}^3\text{/LF}) + (94 \text{ LF} \times 273 \text{ ft}^3\text{/LF})}{33 \text{ days}}$$

$$= \frac{50{,}372\ ft^3}{33\ days} = 1526.4\ ft^3/day$$

$$ft^3/24\ hr = \frac{1526.4}{24} = 63.6\ ft^3/hr \text{ elapsed time}$$

$$\frac{246.5\ ft \times 216\ ft^2}{37\ days}$$

$$= \frac{53{,}244\ ft^3}{37\ days} = 1439\ ft^3/day$$

$$= \frac{1435}{24} = 60.0\ ft^3/hr \text{ elapsed}$$

Power Center

Mine out power center (107 ft of 21 ft x 14 ft) NW in SD #3 so that substation and distribution system can be installed as soon as possible to provide power for future work.

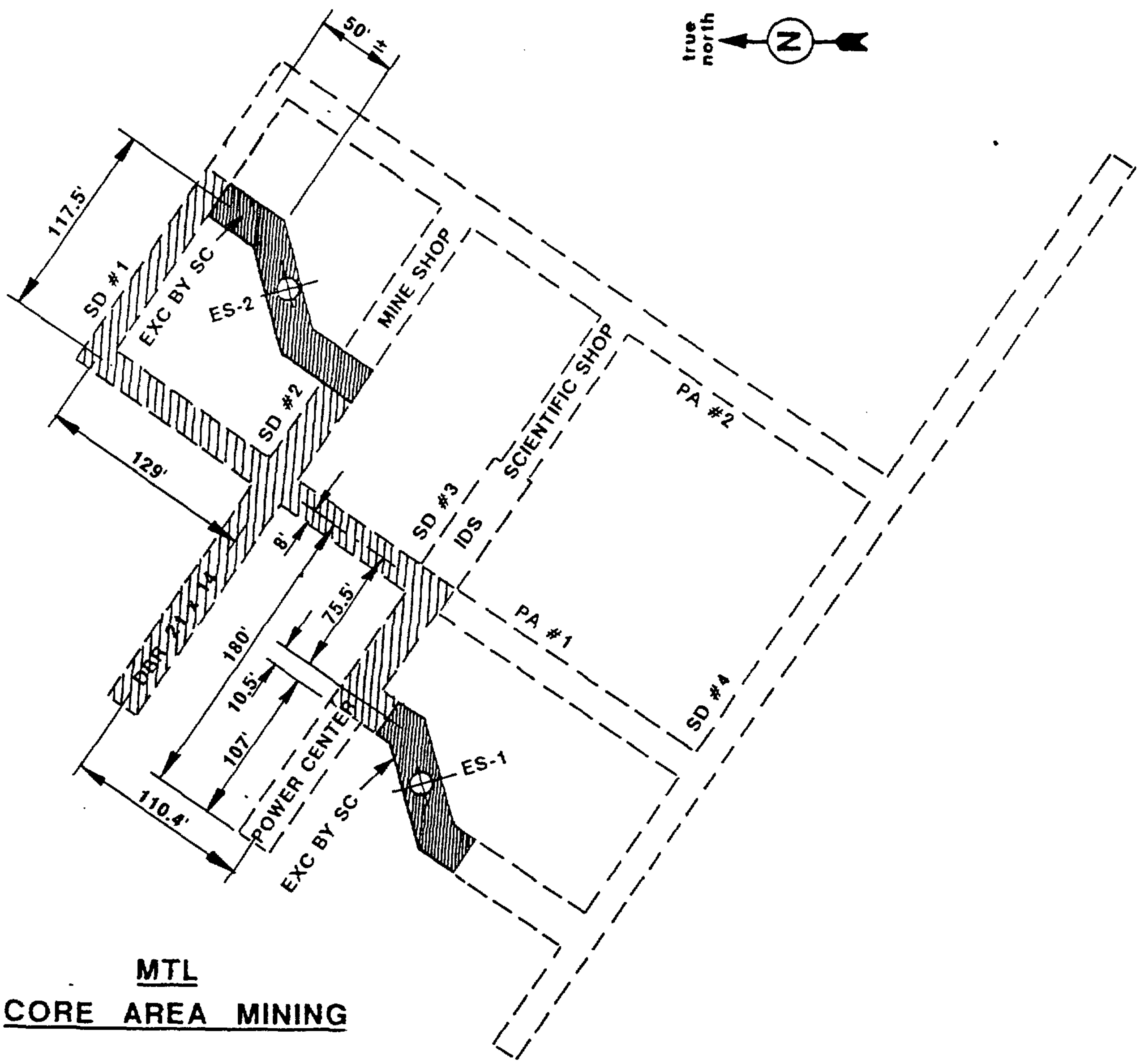
Now have drifts open all the way around ES-2 so that 5 yd^3 LHDs can now reach the loading pocket. - Mob one 5 yd^3 LHD.

Cycle Times

Drill Cycle		
Still using pneumatic jumbo same as previous calc.	=	269 min
Blast Cycle		
Same as previous calc.	=	136 min
Muck		
Using 5 yd^3 LHD to recalculate later	=	TBD
Rock bolt	=	192 min
Map	=	240 min
Total W/O Muck Time	=	837 min/rnd

FS-ST-0024 - DESIGN MINING RATES

POWER CENTER



MTL
CORE AREA MINING

DIST = 180' - (75.5 + 8 - 10.5) = 107' POWER CENTER

<u>Muck Cycle</u> (W/5 yd^3 LHD)

Area of face with O.B.	=	273 sq. ft
Vol. of 11 rnd - 11 x 273	=	3003 ft
Swell factor		x 1.7
Vol. broken		5105 ft^3
	=	189 yd^3

No. LHD loads = 189/(5 x .8) = 189/4 = 48 loads

<u>Muck Cycle</u>

Avg. haul dist.

$$= \frac{107}{2} + (180 - 107) + 110.4 + 129 + 117.5 + 50 \text{ ft}$$

$$= 533 \text{ ft}$$

Trip cycle

a.	Load bucket	=	1.0 min
b.	Back and turn approx. 90 ft at 1½ mph = $\frac{90 \text{ ft}}{132 \text{ fpm}}$	=	0.7 min
c.	Tram 533 - $\frac{107}{2}$ = 480 at 4 mph avg. = 480/352 fpm	=	1.4 min
d.	Dump	=	0.5 min
e.	Back 480 at 4 mph = 480/352	=	1.4 min
f.	Pull fwd 90 ft to muck pile at 1.5 mph	=	0.7 min
	Time per trip		5.7 min/trip

Muck out Cycle

Wet down and scale	=	30 min
Muck 1st 46 loads = 46 x 5.7	=	262 min
2 loads final clean up x down	=	20 min
Total muck cycle	=	312 min
Other cycles	=	837 min
Total cycle time per rnd	=	1149 min

$$\frac{1149 \text{ min}}{60 \text{ min/hr}} = 19.2 \text{ hrs}$$

Each round takes 19.2 hrs at 100% efficiency.

Add 10% contingency

$$19.2 \ \frac{hr}{rnd} \times 110\% = 21.1 \text{ hrs.}$$

Round per day (21 usable hrs/day)

$$= \frac{21}{21.1} = 1 \text{ rnd/day}$$

ft^3/day

ft^3/rnd = 273 sq. ft x 11 LF = 3003 ft^3/rnd

ft^3/day = 3003 ft^3/rnd x 1 rnd/day = 3003 ft^3/day

ft^3 hr on 24 hr day

$$= \frac{3003}{24} = 125 \ ft^3/hr$$

Now that both shafts are connected there will be other construction, and scientific installations and activities interfering with excavation. Estimate the interference factor to be 40%.

Use 60% x 125 ft^3/hr = 75 ft^3/hr
as average excavation rate per 24 hr elapsed day

Total neat ft^3 in power center

= 273 sq. ft x 107 LF = 29,211 ft^3

Total elapsed days to complete excavation, ground support, and mapping

$$= \frac{29{,}211 \ ft^3}{75 \ \frac{ft}{hr} \times 24 \ \frac{hr}{day}} = \frac{29{,}211 \ ft^3}{1800 \ ft\ /day} = 16.2 \text{ days}$$

Say = 16 days

ATTACHMENT 5

Imbricate Fault NW

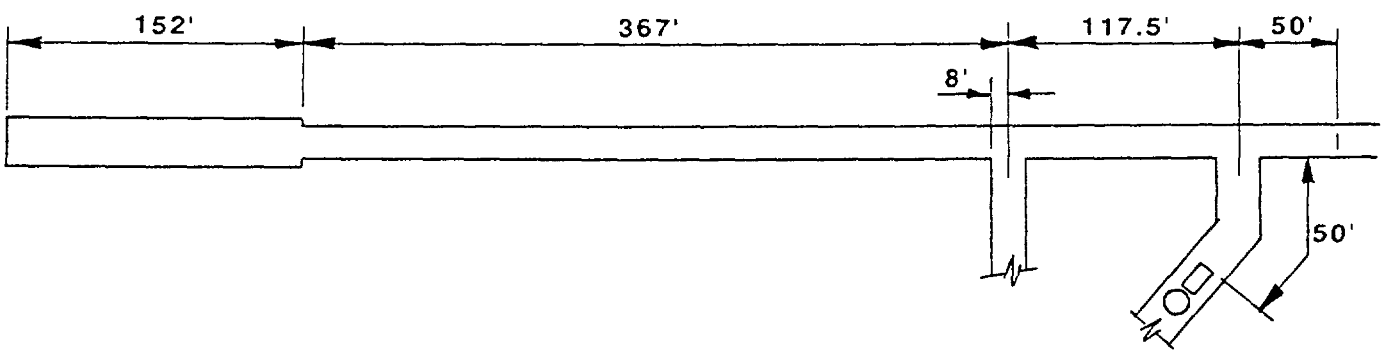
LN - NW corner core area to Pt C'

	N	E	
PT C'	766,697.8	(-)563,511.9	(R07048A/1 - Rev. 0)
PT 3	(-)766,450.0	563,877.5	(R07048A/3 - Rev. 0)
	= 247.8	365.6	

HD = $[247.8^2 + 365.6^2]$ - 441.67 ft

Δ EL = 3124.2 + 3081.8 = 42.4 ft

SD = $[441.67^2 + 42.4^2]$ = 443.7 ft



HAUL DISTANCE

Imbrication Fault NW (Cont.)

LN - Pt C' - Pt C

	N	E	
Pt C	766,733.1	-563,459.7	(R07048A/1 - Rev. 0)
Pt C'	-766,697.8	563,511.9	(R07048A/3 - Rev. 0)
	= 35.3	52.2	

$$HD = SD = [35.3^2 + 52.2^2]^{\frac{1}{2}} = 63.02 \text{ ft}$$

Total drift length = 443.7 + 63.0 = 506.7 ft

Plus 1/2 intersection

= Plus 25/2 = + 12.5 ft

519.2 ft

Total drift Say 519 ft

Drift sizes and length

16 ft x 14 ft = 506.7 ft - 140 ft = 367 ft

25 ft x 19 ft = 140 ft + 12.5 = 152 ft

519 ft

Excavation Cycle Times

25 ft x 19 ft

Drill blast bolt and map = 14.68 hr/rnd *

Muck cycle
No loads and vol. = 306 yd^3 = 77 loads *

*Reference FS-ST-0024, Part A, Page 65 of 115

Imbrication Fault NW (Cont.)

<u>25 ft X 19 ft Cycle</u>

Muck trip cycle

Load bucket = 1.0 min

back $\frac{152}{2}$ + 367 + 117.5′ + 50′ = 610.5

At 4 mph avg. = 610.5/352 fpm = 1.7 min

pull fwd 100 ft to dump

At 1 mph = 100 ft/132 fpm = 0.8 min

Dump = 0.5 min

Back out and turn 100 ft/132 fpm = 0.8 min

Tram fwd 610.5′ @ 5 mph

= 610.5′/440 fpm = <u>1.4 min</u>

Total trip time 6.2 min

Muck out cycle

Wet down and scale	=	50 min
Muck 75 loads at 6.2M	=	465 min
Final clean up = 2 loads	=	<u>20 min</u>
Total muck cycle	=	535 min = 8.92 hrs

Total average 25 ft x 19 ft exc. cycle

Drill, blast, bolt, map	14.68 hr
Muck	<u>8.92 hr</u>
	23.6 hr

Rnds/day = $\frac{21 \text{ hr/day}}{23.6 \text{ hr/rnd}}$ = .89 rnds/day

Ft/day = .89 rnds x 11 ft/rnd = 9.8 ft/day

Tons/day = 9.8 ft/day $\frac{\times\ ^{*}442\ ft^3/ft \times 150 lb/ft^3}{2000\ lb/ton}$ = 325 tons/day

<u>16 ft x 14 ft Cycle Time</u>

<u>Drill cycle</u> (2 Boom hyd. jumbo) drill 57** holes at 12 ft = 684 LF

Set up jumbo	=	20 min
Collar 57 holes @ 1 /min - 2 drills	=	29 min
Drill 684 linear ft @ 5 fpm/2 drills	=	68 min
Rig out jumbo	=	<u>15 min</u>
Total drill time		132 min

* Reference FS-ST-0024, Part A, Page 60 of 115

**Reference FS-ST-0024, Part A, Page 3 of 115

Imbrication Fault NW (Cont.)

Blast Cycle

= 128 min*

Bolt Cycle

No. of bolts = 24 bolts**

Bolt at start of drill cycle

Collar 24 hole w/1 drill	=	24 min.
Drill 24 x 8′ = 192′ @ 5 fpm	=	38 min
Install 24 bolts @ 3 min	=	72 min
Total bolt time	=	134 min/rnd

Mapping Time 200 min***

Total 16 ft x 14 ft exc cycle excl. muck = 594 min
= 9.9 hrs/rnd

Muck Cycle

**** Vol./rnd $= 11' \times \frac{216 \text{ sq. ft}}{27 \text{ ft /yd}} \times 1.7 \text{ swell}$

$= 150 \text{ yd}^3/\text{rnd}$

No. loads $= \frac{150 \text{ yd}^3}{(5 \times .8) \text{ yd}^3/\text{ld}} = 38 \text{ loads}$

Trip Time

Load bucket = 1.0 min

back $\frac{367 \text{ ft}}{2} + 117.5 + 50 = 351 \text{ ft}$

At 4 mph avg. = 351/352 fpm = 1.0 min
dump = 0.8 + .5 + .8 = 2.1 min (Ref. PP, 95)

Tram 351 ft to face at 5 mph
= 351 ft/440 fpm = 0.8 min
Trip time 4.9 min

*Reference FS-ST-0024, Part A, Page 17 of 115
**Reference FS-ST-0024, Part A, Page 18 of 115
***Reference FS-ST-0024, Part A, Page 19 of 115
****Reference FS-ST-0024, Part A, Page 3 of 115

Imbrication Fault NW (Cont.)

Muck Cycle

Wet down and scale	=	30 min
Muck 1st 36 loads @ 4.9M	=	176 min
Clean up - 2 loads	=	20 min
		226 min/rnd
	=	3.77 hr/rnd

Total 16 ft x 14 ft cycle

Drill, blast, bolt, map	=	9.90 hr
Muck		3.77 hr
		13.7 hrs

14 x 16 rounds

Rounds/day $= \frac{21\ \text{hr}}{13.7\ \text{hr/rnd}} = 1.53$ rd/day

Ft/day $= 1.53\ \frac{\text{rnd}}{\text{day}} \times 11$ ft/rnd = 16.8 ft/day

Tons/day $= 16.8\ \text{ft/day} \times \frac{216\ \text{ft}^3/\text{ft} \times 150\text{lb/ft}^3}{2000\ \text{lb/ton}}$

= 272 tons/day

Schedule

A	16 ft x 14 ft =	359 ft @ 16.8 ft/day	=	21 days
B	25 ft x 19 ft =	152 ft @ 9.8 ft/day	=	16 days
		511 Total		37 days

Concurrent work status (expl, D only)

Drive imbricate fault drift NW to intersection with tuff main during first 37 days of driving the imbricate fault drift SE to target, which takes 103 days. Then the imbricate fault drift SE will continue on another 103-37=66 days concurrent with the next leg of exploratory drifting.

ATTACHMENT 6

Concurrent with the last 69 days of DHW drivage, drive tuff main south to intersection with ghost dance fault drift (PT F), and turn corner and begin driving GHD drift west.

Have 69 days left for concurrent work.

HD (PT C to PT F) (Ref. SNL R07048A/1 - Rev. 1)

$N = 766{,}733.1 - 766{,}401.6 = 331.5$ ft

$E = 563{,}459.7 - 563{,}236.2 = 223.5$ ft

$HD = [331.5^2 + 223.5^2]^{\frac{1}{2}} = 399.8$ ft

$\triangle EL = 3134.2 - 3124.2 = 10.0$ ft

$SD = [399.8^2 + 10^2]^{\frac{1}{2}} = 399.93$ ft Say 400 ft

HD (PT F to PT G)

$N = 766{,}660.2 - 766{,}401.6 = 258.6$ ft

$E = 563{,}236.2 - 562{,}852.8 = 383.4$ ft

$HD = [258.6^2 + 383.4^2]^{\frac{1}{2}} = 462.46$ ft

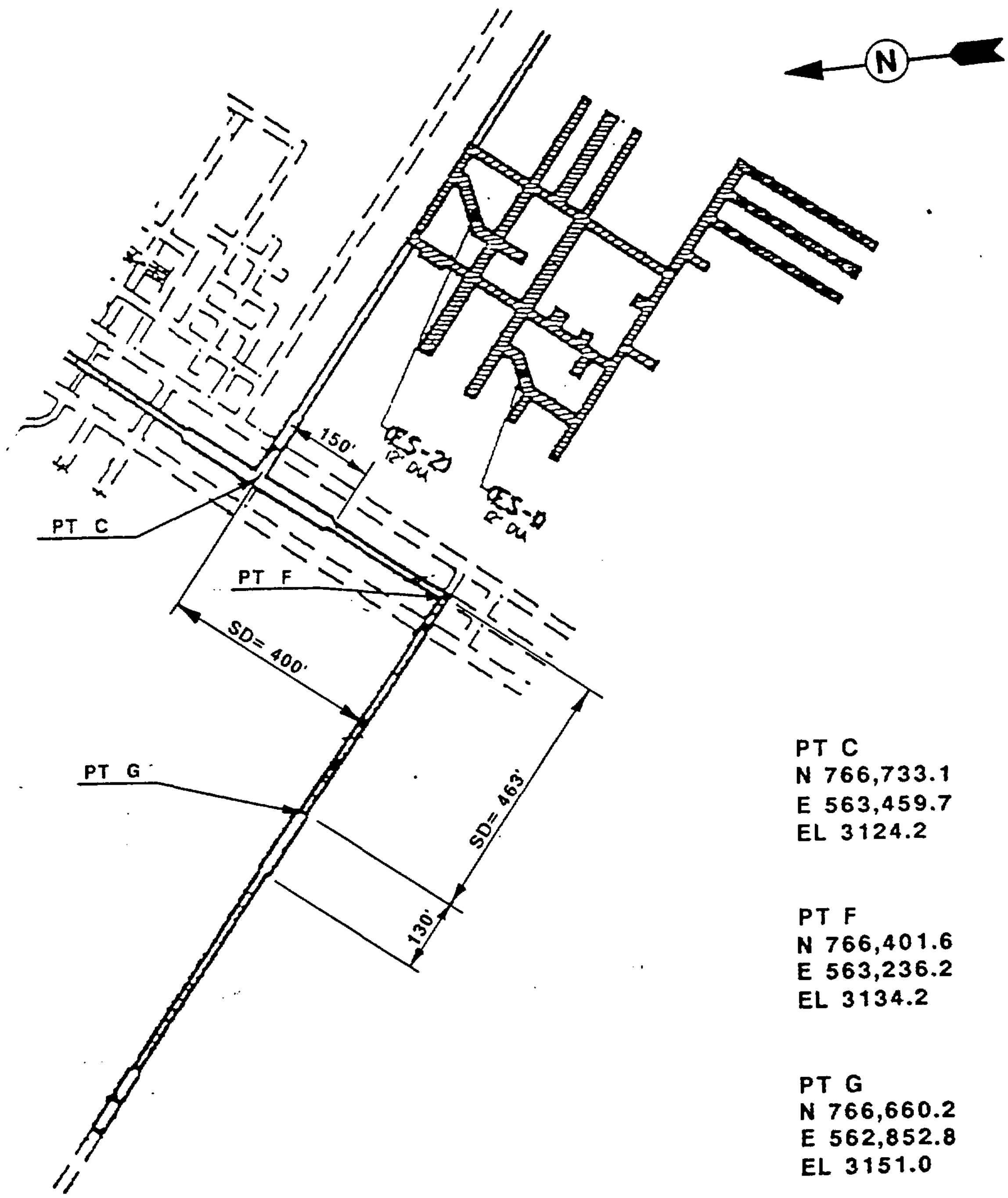
$\triangle EL = 3151.0 - 3134.2 = 16.8$ ft

$SD = [462.46^2 + 16.8^2]^{\frac{1}{2}} = 462.77$ ft Say 463 ft

A. Drive 150′ enlarged section SW from intersection with imbricate fault drift.

Same length and time as enlarged section (25 ft x 19 ft) going NE

Length (effective) = 150 ft
Time = 15.2 days



PT C
N 766,733.1
E 563,459.7
EL 3124.2

PT F
N 766,401.6
E 563,236.2
EL 3134.2

PT G
N 766,660.2
E 562,852.8
EL 3151.0

GHOST DANCE FAULT

EXPLORATORY DRIFTING

B. Drive 14 ft x 14 ft to the next enlarged section

Dist. = (400 ft - 150 ft) + 463 ft = 713 ft

Muck cycle trip timed

Load bucket	=	1.0 min
Back 556' @ 4 mph = 556'/352 fpm	=	1.6 min
Tram fwd 724' to dump @ 5 mph = 724/440 fpm	=	1.6 min
Dump	=	0.6 min
Back 100' @ 1.5 mph = 100/132 fpm	=	0.8 min
Fwd 1180' @ 6.5 mph = 1180/572 fpm	=	2.1 min
		7.7 min

Muck out cycle

Scale and wet down	=	30 min
** Muck 32 loads @ 7.7 min	=	246 min
Final clean up		20 min
		296 min
Total muck cycle	=	4.93 hrs
* Drill, blast, bolt and map	=	9.45 hr
Total cycle		14.38 hrs

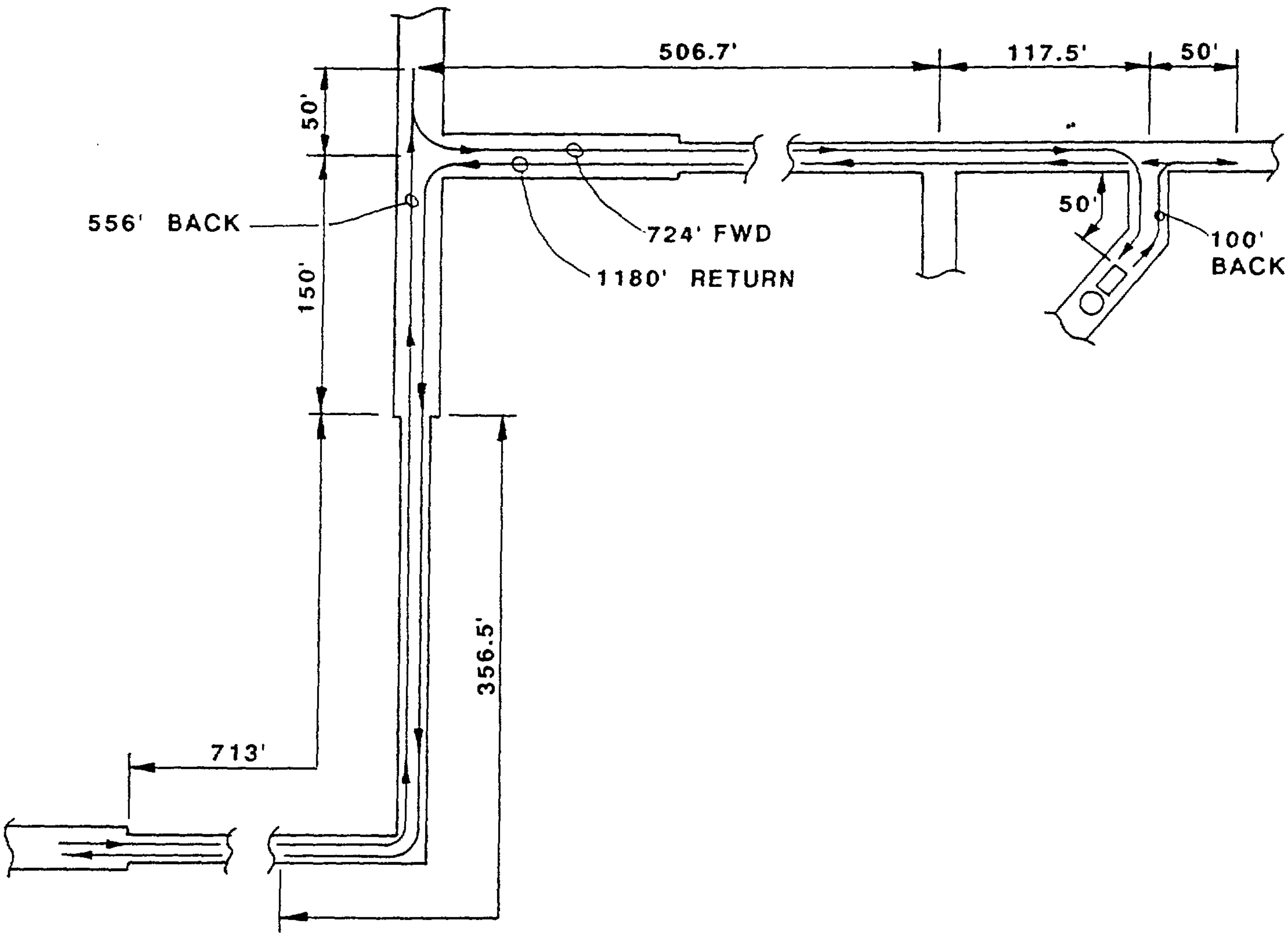
Rounds/day = $\frac{21}{14.38}$ = 1.46

Ft/day = 1.46 x 11 = 16.1

*** Tons/day = $16.1 \text{ ft} \times \frac{194 \text{ ft}^3/\text{ft} \times 150 \text{lb/ft}^3}{2000 \text{ lb/ton}}$

= 234 tons/day

* Ref FS-ST-0024, Part A, Page 62 of 115
** Ref FS-ST-0024, Part A, Page 68-69 of 115
*** Ref FS-ST-0024, Part A, Page 2 of 115



<u>AVG. HAUL DISTANCE</u>