NOTICE

SOCONY MOBIL OIL COMPANY, INC.

RESEARCH DEPARTMENT

SPECIAL MEMORANDUM

SCOPING STUDY FOR STAGE II INITIAL CONSTRUCTION REQUIREMENTS

ANVIL POINTS OIL SHALE RESEARCH CENTER

Rifle, Colorado

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NOTICE

The primary object of the Anvil Points Oil Shale Research Center SPECIAL MEMORANDUM is to advise authorized personnel employed by the Participating Parties(1) that various activities are in progress or that certain significant data have been obtained within the Research Center.

These SPECIAL MEMORANDA have been prepared to provide rapid, on-the-spot reporting of research currently in progress at Anvil Points. The conclusions drawn by project personnel are tentative and may be subject to change as work progresses. The SPECIAL MEMORANDA have not been edited in detail.

(1) Socony Mobil Oil Company, Inc., Project Manager

Humble Oil and Refining Company

Continental Oil Company
Pan Americal Petroleum Corporation
Phillips Petroleum Company
Sinclair Research, Inc.

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I. Purpose and Description of Scoping Study

A scoping study, as discussed at the March Technical Advisory Committee meeting, to determine construction requirements in preparation for Stage II of the experimental program has been completed. This study evaluates present facilities at Anvil Points to sustain the Stage II program, and presents schedules for three plans to develop Stage II retorting, mining, crushing, and plant construction and rehabilitation.

Modified PERT diagrams showing time and expenditure of funds have been prepared for each plan. This has been done in an effort to ascertain if there is a time advantage to early construction for the Stage II program. Two different retort configurations have been considered for each plan.

A decision by the Technical Advisory Committee before July 15, 1965 is required in the choice of the plan to be initiated. The retort configuration will be determined by studies now underway.

The criteria for the three plans are:

Plan I Complete designs, purchases, and construction prior to the start of Stage II on or about November 1, 1965.

Plan II Complete plans and purchases of long delivery equipment prior to the start of Stage II. Construction to begin when Stage II is authorized.

Plan III Design, purchases, and construction to begin after Stage II is authorized. Little or no funds to be expended for Stage II needs prior to this time.

Basically, the present Retort No. 3 shell and structure will be used for the retort. Existing mining equipment, crushing equipment, and much of the Retort No. 3 control equipment will also be used. Additional equipment will be needed in all areas to support the retorting program which will utilize up to 500 T/D of several shale sizes at shale mass rates to 700 lbs/(hr)(ft^2).

The retort considered will be rectangular - 6 feet X 10 feet in cross section. This will permit the use of the existing retort shell and much of the present brickwork. The six foot section will be considered as approximately half of the depth of a commercial retort element. The ten foot dimension is deemed more than adequate for a repeating section along the length of a retort element. This retort in no way indicates any advantage of a rectangular section over a circular section. Data developed will be applicable to either type retort section.

II. Conclusions

A. Mining - Crushing - Retorting - Plant Facilities

Existing mining, crushing, retorting, and plant facilities are adequate to support the Stage II program. Extensive revisions and repairs will be required but nothing of a serious nature. A new transformer is needed for the recycle blower on Retort No. 3.

The mine will be rehabilitated and a mining plan submitted to the U. S. Bureau of Mines for approval. Much of the existing mining equipment will be utilized.

The crushers will be reconditioned for full time operation. Preliminary tests have shown the crushing plant capacity to exceed retort needs.

The retort shell, its structure, and controls are in excellent condition and will be put into operations with a minimum of cost. Blowers, piping, pumps, recovery equipment and retort internals will be replaced.

A review of the tank farm indicates storage capacity adequate for 30 days full operation. Means of disposing of product will have to be found. In previous operations, many communities were given this oil for road surfacing programs. This may be a feasible method of disposal.

B. Planning of Construction

The PERT diagram for Plan I shows that the November 1, 1965 completion date for construction cannot be met. The earliest possible date for the completed retorting, mining, and crushing plant construction would be January 15, 1966 even if approval to proceed were given by July 15, 1965.

Plan I now represents the shortest design and construction time from July 15.

Plan II and III are as originally projected.

In all cases, it will be necessary to prepare the mine road and mine water supply by September 20, 1965 with an expenditure of $38,000.

Costs for the three plans are as follows:

		Plan I	Plan II	Plan III
Decision Required By:		7-15-65	7-15-65	7-15-65
Complete Facilities By:		1-15-66	3-7-66	5-1-66
Program Time Remaining After Completion of Construction(1)		15 1/2 mo.	14 mo.	12 mo.
Total Expenditures or Commitments for the Stage II Program Construction				
Retort A	July 1 to November 1, 1965	$ 521	$ 287	$ 38
	November 1, 1965 to Completion Date	150	414	663
	Total	$ 671	$ 701	$ 701
Retort B	July 1 to November 1, 1965	558	304	38
	November 1, 1965 to Completion Date	155	439	705
	Total	$ 713	$ 743	$ 743

(1) Sufficient time and money should be available to complete Stage II, even if Plan III is selected.

Construction will be contracted on a cost-plus basis as would drafting, engineering, crushing plant and plant electrical requirements. A $30,000 penalty has been included in Plan II and Plan III for winter time construction.

Plant labor will be used for most of the mining rehabilitation.

III. Recommendations

We recommend that Plan III be implemented.

Plan III has several advantages over Plan I and II. Much of the present experimental program will not be completed until late summer. Decisions resulting from these experimental programs will have a direct bearing on shale feed and discharge systems and the retort itself. Design criteria for Plan I must be developed by August 13, Plan II by September 3 and Plan III by November 26. Plan III permits completion of experimental programs before designs are required.

Plan I and Plan II require a considerable cash investment prior to authorization of Stage II. The PERT shows a two month time advantage of Plan II over Plan III at a cost risk of $249,000 during Stage I. It is possible to narrow the time differential between Plan III and II to five weeks if authorization were given to initiate purchase of the electrostatic precipitator two to three weeks before Stage II is authorized. The cash risk would be small in comparison to the gain in time.

Both Plan II and Plan III contemplate winter time construction with no relative advantage for either. Plan I is best from a construction weather viewpoint but risks $521,000 during Stage I.

Plan I and Plan II will impose a heavy additional work load upon our engineering personnel at a time when the experimental program is at its height. Plan III will alleviate this condition.

For these reasons, we recommend Plan III for the establishment of Stage II.

IV. Existing Facilities

In order to properly plan for Stage II of the Oil Shale Research Program at Anvil Points, a scoping program was initiated. Development of a full scoping report has been divided into three parts.

Part I Capabilities of existing facilities at Anvil Points that would be used to support retorting, crushing, and mining.

Part II Groundrules and strategies of alternative plans for development of Stage II.

Part III Details and costs of alternative plans.

Existing equipment at Anvil Points that might be needed to support the Stage II retorting, mining, and crushing programs has been reviewed to determine capacities and to some extent condition.

Included in this review are:

1. Mining Equipment
2. Crushing - Screening
3. Storage
4. Conveyors
5. Electric Power
6. Pilot Plant - Retort No. 3
    a. Retort
    b. Blowers
    c. Raw Shale Accounting
    d. Spent Shale Handling
    e. Piping - Gas
    f. Product Recovery Equipment
    g. Product Recovery Storage

h. Instrumentation

i. Unit Electricals

j. Shale Sampling

A. Summary

All equipment except the plant electric power substation appears adequately sized to support a program utilizing shale to a rate between 450 - 500 tons/day.

Existing trucks, bulldozers, and cranes are about adequate to handle both shale supply and crushing plant traffic. Two additional surface trucks will be required.

Calculations and tests indicate that the crushing plant is capable of producing at least 20 tons/hour of any of the four shale ranges being considered. Overhaul and repairs to the crushers for sustained operation is recommended.

The shale feed system requires revision.

Product storage will present problems and means of disposing of liquid product must be developed.

Revisions of a minor nature will be required for equipment such as conveyors and screeners.

The plant power substation is not adequately sized to operate a recycle blower larger than the existing 150 HP-3000 CFM unit. An additional 750 KVA transformer for the recycle blower above will be required.

Most of the equipment to be used for mining purposes will have to be overhauled before being put into operation.

Retort No. 3 will require major revisions to meet process needs for Stage II. The interior of the retort will require revamping to remove the taper. New equipment will include gas piping, recovery equipment, additional instrumentation, pumps,

shale feed and discharge rate control, and spent shale handling.

A large blower, motor, and starter capable of handling 13,000 CFM and producing a 5 Psi pressure differential is being held for use as a recycle gas blower at Anvil Points.

B. Details

1. Mining Equipment

Trucks

Trucks will be needed to haul shale from the mine and simultaneously move side streams of shale from the crushing plant. The four Darts can haul 500 tons of shale from the mine in 1.75 shifts at 18 tons/load. Four round trips/truck/shift.

4 Darts	18 - 20 tons
1 Euclid	10 tons
1 International XL	7 tons (Now used as a water truck)
2 Dodge	3 1/2 tons
1 GMC	2 1/2 tons
1 International	2 1/2 tons

Loading Equipment

Loading equipment will be needed to load trucks at the stored shale area and to fill the grizzly ahead of the crusher plant.

1 Electric Shovel	3 yards (Requires rehabilitation)
1 Northwest Crane	1 1/2 yard
1 Unit Crane	1/2 yard

1 HD 19 Bulldozer, Allis Chalmers

1 D-7 Bulldozer, Caterpiller

1 D-6 Bulldozer, Caterpiller

1 RD-8 Bulldozer, Caterpiller (Requires rehabilitation)

2 TD-18 Bulldozer, International (Requires rehabilitation)

Drilling Equipment

1 Multiple-Drill Heading Jumbo (Requires rehabilitation)

Compressors

1 Joy 770

1 Worthington

Auxiliary Equipment

1 Hydraulic Scaling Rig "Cherry Picker" (Requires modification)

1 Wagner Three Wheeled Platform

1 Bus (Requires rehabilitation)

2. Crushing

The crushing plant appears adequate to produce at least 20 tons/hour of any range of shale now being studied. Crushing will therefore be on a shift basis depending on final needs.

a. Primary Crusher - 36" x 42" Traylor Blake Type
Jaw Crusher, 100 HP - 440 V
Minimum - Maximum Jaw Setting 3" 6"
Rate Capacity 20 - 80 ton/hour

b. Primary Screen - Overstrom - Sans 4' x 10' Heavy Duty
20° angle 10 HP

c. Secondary Crusher 24" x 20" Jeffrey Flextooth
30 HP - Crusher Speed 283 - 1190 RPM - Sheaves
Grids - 1/2" - None
Rate Capacity 8 - 20 ton/hour depending on Grids - Platesetting

d. Secondary Screen - Universal 3 1/2' x 8' Light Duty
30° angle 1 HP

e. Tertiary Crusher No. 19 1/2 Kennedy Van Saun
Gyratory 30 HP 1/4" - 3" setting
Maximum Feed Size - 4"
Rate capacity 8 - 20 ton/hour

A preliminary study - using Bureau of Mines Report of Investigation 5563 was used to develop crushing plant data.

Shale Range Required	1/4 - 3/4	3/4 - 1 1/2	1 1/2 - 3
Shale Feed Rate	29 T/hr	36 T/hr	38 T/hr
Crushers Used	P. S. T.	P. S. T.	P. S.
Crusher Settings	4" 11G 1"	3" 11M 1 1/2"	4" 11M
Product Distribution, ton/hour			
0 - .2	9	4.8	3.3
.2 - .8	20	11.2	6.3
.8 - 1.5	--	20.0	8.4
1.5 - 3.0	--	--	20.0

3. Crushing Screening

Primary Screener 70 Ton/hour Capacity

Secondary Screener 100 Ton/hour capacity

Recommend lowering pitch of each unit to increase screening efficiency.

4. Shale Storage

a. 1 500 Ton Bin

b. 3 100 Ton Bins

5. Conveying Equipment

All belt conveyors are rated at 200 ft/min speed regardless of existing speed, gearing, and motors. Belt size is more the determining factor.

a. Pan Feeder to Primary Crusher

4 x 10 Link Belt 20 - 80 Ton/hour

b. Conveyor - Primary Crusher to Primary Screener

24" belt 150 Ton/hour

c. Bucket Elevator 10 HP Stephens - Adamson 130 Ton/hour

132 ft/min 6" size maximum

d. Fines Conveyor 20" Belt 80 Ton/hour

e. Product Conveyor 20" Belt 60 Ton/hour

f. Secondary Product Conveyor 16" Belt 60 Ton/hour

g. Storage Conveyors 20" Belt 80 Ton/hour

h. Vibrators under 100 Ton Bins 20 Ton/hour

Conveyors to Richardson 15" Belt 40 Ton/hour

i. Vibrator From 500 Ton Bin 20 Ton/hour

Belt Conveyor 18" Belt 70 Ton/hour

j. Vibrator under Richardson

Vibrator 20 Ton/hour

k. Conveyor to Retort 20" Belt 80 Ton/hour

6. Power

Power is fed to the Research Center from Shoshone and Grand Junction. Primary voltage is 69,000 volts.

Primary transformation from 69,000 to 14,400 volts is through a 2,000 KVA transformer station.

The industrial area is served by a 750 KVA substation with a voltage reduction from 14,400 to 480 volts.

Estimated power use at Plant Substation

Crusher	275 KVA	
Boiler	150 KVA	
Plant	100 KVA	
Retort No. 3	225 KVA	(Not including blower larger than existing blower)
Total	750 KVA	

Additional power would be required for the larger recycle blower. (i.e. 14,400/4,160 transformer - 750 KVA)

Feeder lines to the industrial area are adequate.

7. Pilot Plant

Most equipment and piping will not be adequate for the higher shale rates projected for Stage II.

Retort

Cross Section 6' x 10' - Center

5' x 9' - Top

Height 19' Top to Air Gas Distributor

5' A/G Distributor to Recycle Distributor

7' 10" Recycle Distributor to shale outlet

Design Pressure - 5 Psig

Design Temperature - 1700° F Center

200° F Shell

Blowers

2 Spencer Turbine 800 CFM 5 Psig

40 HP 440 Volts at 6,000 feet

2 Spencer Turbine 3,000 CFM 5 Psig

150 HP 440 Volts at 6,000 feet

Shale Feed

Richardson weigh batch - 500 pound loads

at 20 T/H = $\frac{40,000}{60}$ = 650 pounds/min

This would not be feasible - must develop other method to control rate of feed to Retort.

Shale Discharge

Roll feeder 18" diameter cleated rolls

1:1 - 6:1 adjustable speed

1/2" - 6" adjustable clearance

Screw feeder - 16 inch

Star Feeder - 16 x 16 ÷ 4 blades

Piping - Gas

Product Piping 14"

Recycle Gas 12"

Vent 8"

Piping Liquid

Gravity to Storage

Recovery Equipment

Rotoclones #14 - 4,850 CFM

#10 - 3,250 CFM

Multiclone Size 40-5 Type 61D

10,000 CFM at 12 Psia - 150° F - 4" H_2O

Product Liquid Storage

All tanks have steam coils.

6 - 65 bbl

4 - 250 bbl

2 - 500 bbl

2 - 500 bbl - Refinery

2 - 2,000 bbl - Refinery

2 - 5,000 bbl - Lower end of Refinery

Instrumentation

Pressure Flow and Temperature Recorders existing, However, will upgrade to meet exact requirements.

Unit Electricals

Appear adequate - will have to revise to satisfy process requirements.

Sampling

Raw Shale 36" Geary Jennings

1% cutter followed by a 5% cutter

3" x 14" to 9" x 14" cutter adjustment

Spent Shale 1⅛ cutter/size 9" x 14" cutter

Crusher Jeffrey Hammermill and Splitter

V. Criteria For Stage II Retorting Program

In order to properly evaluate and develop schedules and costs for Stage II, agreements on alternative plans were resolved.

Three time schedules were developed and are designated as Plan I, Plan II, Plan III. Timing and fund expenditures have been developed for the following:

Plan I — Design, purchases, and construction to be completed by the beginning of Stage II. (Modified to complete construction by January 15, 1966.)

Plan II — Design and long range delivery equipment completed and ordered before the start of Stage II. Construction to start after Stage II is authorized.

Plan III — Complete Stage I. Begin design, purchases, and construction after Stage II is authorized. Spend little money for the Stage II program before this date.

Four activities must be developed for any one plan. They are

1. Mining
2. Crushing and Shale Preparation
3. Retorting and Shale Flow Studies
4. Plant Facilities

Since much of the Stage I program will determine specifics of the final Stage II retorting, results to date can only serve as a guide.

Retort No. 3 will be revised for Stage II studies. This retort will incorporate all features found of commercial potential in the Stage I program. Shale feed, anti-segregation, spent shale drawoff, distributor configuration, gas disengagers, shale mass flow, shale size range, air and recycle gas rates,

bed heights, spent shale handling and disposal, mist recovery units, and process automation are to be included. Mining and crushing will largely be limited to paper studies in Stage I but expanded to actuality in Stage II.

To plan or scope for Stage II, items listed above should form the basis for alternative retorts. Mining, crushing, and plant facility development are dependent upon alternative retort programs.

The following ground rules were established for the scoping study regarding retorting, mining, crushing, and plant facilities. This resulted in two basic retort configurations. They are designated as Retort A and Retort B and differ mainly due to a single air versus air plus inert gas distributor arrangement.

1. Retort will be nominally designed for 500 T/D based on 700 lbs/(hr)(ft^2).
2. Anti-segregation devices will be employed for raw shale.
3. Multi-pipe or channel drawoff will be used for spent shale.
4. Distributors

   Retort A Single level air inlet - two pass - with a six foot span.

   Retort B An additional distributor row as a hot inert gas inlet above the air distributor. Include inert gas generator.
5. Shale size range: 1/4 - 3/4, 3/4 - 1 1/2, 1 1/2 - 3, 1/4 - 3.
6. Air rates - 6,500 SCF/Ton maximum at 700 lbs/(hr)(ft^2)
7. Recycle - 14,000 SCF/Ton maximum at 700 lbs/(hr)(ft^2)

8. Bed Heights - 17' above air gas distributor (with two-level gas inlets)
   14' above air gas distributor (with one level gas inlet)
   7' below air gas distributor
9. Spent shale disposal - spread type and water spray
10. Mist Recovery Equipment (Item 1 plus item 2)
    1. One rough cut unit as a multiclone, cyclone, or rotoclone.
    2. Electrostatic precipitator.
11. Process Instrumentation
    1. Raw and spent shale weight measuring
    2. Liquid product meter and tank gaging
    3. Test meter for air supply
    4. Temperature, pressure, and flow recorders and controls as required
12. Mining - Mining plans will be developed to support the proposed retort scheduled and shale needs.
13. Crushing - Crushing plant to be rehabilitated for 24 hour/day - 7 day/week operation. Must produce 20 ton/hour of any shale size to be studied.
14. Plant Facilities - Plant facilities, utilities to be upgraded to meet retorting needs.

Conceptual retort drawings (two for Retort A and one for Retort B) showing various types of inlets and drawoff systems are included. These are not final and are being used for estimating purposes only. Two Process Flow Diagrams are also included (one for Retort A and one for Retort B). They are of a conceptual nature and for cost estimating purposes only.

The proposed cross-sectional area of the retort will be 6-feet by 10-feet, which is the same as the Bureau of Mines Retort No. 3. This cross-section is considered adequate as a pilot-plant prototype of a commercial-size rectangular retort; the six-foot dimension can be considered as approximately one-half of a practical maximum span of a commercial rectangular retort, and the ten-foot dimension is large enough to produce any operational difficulties which might occur in a large size unit. The Mechanical Models studies are adaptable to a circular retort configuration. Data developed concerning air gas distributors is also adaptable to a circular retort configuration. Using the existing retort shell offers a considerable cost and time advantage in this program.

VI. Details of Cost Estimates

Conceptual flow diagrams and retort configurations have been developed for Stage II retorting. From these and the criteria established in the previous section, three detailed PERT diagrams and cost estimates have been prepared, Plan I, Plan II, and Plan III. Two retort configurations were considered, Retort A and Retort B.

The retorting program established the supporting facilities of mining, crushing and plant utilities.

As indicated earlier, much of the existing mining, crushing and retorting equipment will be utilized for Stage II. Much of the equipment will require extensive renovation and repair. Some existing equipment is undersized for Stage II needs and will be removed or demolished. New equipment will be purchased where needed.

It will be necessary to hire the services of a reputable engineering firm for engineering and drafting. Construction of retorting, plant, and crushing facilities will be by outside contractors. Most of the mining needs will be furnished by Research Foundation personnel.

Timing for construction for any Plan I, II, or III will require awarding a contract on a cost-plus basis.

The contingency fee is required due to the many unknowns concerning the final retort and mist recovery design.

SUMMARY OF COSTS - PLANS II AND III

Retort-Crusher-Plant Facilities	Engr. Draft Lead Time Wks.	Engr. Draft Cost $	Purchases Lead Time Wks.	Purchases Cost $	Construction Lead Time Wks.	Construction Cost $
Retort A						
1. Crusher Plant and Storage Bins			16	40,000	4	40,000
2. Retorting-Piping			16	115,000	6	80,000
3. Shale handling			16	35,000	4	35,000
4. Instruments-Elec.			12	30,000	3	25,000
5. Plant Facilities			8	15,000	3	10,000
6. Contingency			10	45,000	6	15,000
Total	8	82,000	16	280,000	12	205,000
Retort B-Additional Cost						
1. Hot Inert Gas System	1	7,000	12	20,000	4	15,000

Mining Plan	10 weeks
Bureau of Mines Approval	12 weeks
Develop working faces	12 weeks

Mining Facilities	Lead Time To Prepare For Operation[1]	Cost
Water Supply	3 weeks[2]	$ 8,000
Mine Ventilation	7 weeks	6,000
Mine Service Facilities	4 weeks	20,000
Mine Lighting	1 week	2,000
Transportation	6 weeks	6,000
Road Maintenance	5 weeks[3]	55,000
Roof Bolting Equipment	10 weeks	7,000
Face Drilling Equipment	6 weeks	8,000
Loading Equipment	5 weeks	8,000
Hauling Equipment	6 weeks	20,000
	Total	$134,000

(1) This lead time is required ahead of the 12 weeks necessary to develop working faces. All lead times assume that garage facilities and personnel are available for overhaul and modification work.

(2) This work must be completed during summer conditions before September 20, 1965.

(3) The preliminary surfacing (cost $30,000) must be completed during summer conditions before September 20, 1965.

Notes: (a) Mining plans must be submitted to the Bureau of Mines well in advance of Stage II commencement.

(b) None of the items listed in the Summary above include any dollar allowance for mining research work. These estimates will be submitted later as part of the mining research program forecast.

(c) Mine personnel will be hired and trained during the preliminary 12 week development program.

Discussion of Equipment and Facilities

A. Crusher Plant and Storage Bins

All crushers, screeners, conveyors, elevators and ventilation will be repaired for full time operation. A new fines screener will be added to screen out -1/4-inch particles. Controls and electricals will be upgraded where required.

The 100 ton storage bins will be revised to include anti-segregation devices.

Materials	$40,000
Construction	$40,000

B. Retorting and Piping

All gas piping will be replaced with pipes of larger sizes. Where possible, Victaulic type fittings will be used. A new line burner, control valves, rebricking of the top of the retort, air and recycle gas distributors, structural changes, mist recovery equipment, blowers, and insulation are included. The old Bureau of Mines recycle blowers will be used to supply air. A large Spencer Blower located at the Socony Mobil Oil Company Paulsboro Laboratory has been reserved for the recycle duty for the retort.

An electrostatic precipitator plus one rough cut recovery unit are envisioned in the recovery train. The precipitator will cost approximately $60,000 installed. No air cooled condenser is included in the estimate.

Materials	$115,000
Construction	$ 80,000

Retort B

The only change from Retort A to Retort B is the addition of a recycle gas reheater. It is proposed to draw part of the

recycle after the blower and reheat it to 1,300° F. This gas would be distributed into the retort approximately 3-feet above the air distributor. Controls, a furnace, a distributor, and piping are included in the estimate.

Material	$20,000
Construction	$15,000

C. Shale Handling

New shale rate controllers and spent shale gravimetric systems will be incorporated. Mass flow surge bins at the top of the retort, followed by an anti-segregation inlet section will be designed. The drawoff system will incorporate results of the experimental work of the Mechanical Models Group. Spent shale will be slushed over the cliff with suitable conveyors to vary the point of dumping.

Material	$35,000
Construction	$35,000

D. Instrumentation

Much of the present instrumentation will be used. Additional temperature recorders and controllers will be required. Tank gauging facilities and controls for liquid systems have been included. New thermocouples will be purchased. The unit will be automated to the fullest extent with controls suitable for commercial application.

Material	$30,000
Construction	$35,000

E. Plant Utilities

All systems such as water, steam, heating, lighting, plant air, drainage systems, etc. will be rehabilitated and improved where required. A new transformer will be required for the recycle blower.

Material	$15,000
Construction	$10,000

F. Contingency

This item includes funds for retort, crushing, and plant facilities.

Material	$45,000
Construction	$15,000

G. Mining

All capacity calculations are based upon the assumption that crusher feed will have to average 710 tons/day, seven days/week throughout the 18 month period.

1. Water Supply

There are two sources of supply for mine water. The water can either be hauled up to the mine by truck, or it can be pumped from artificial lakes on top of the mountain directly above the mine.

To continue to haul water by truck, ties up the International 8 ton unit which can otherwise be put to good use hauling ore. It is recommended that the mountain top lakes and pump be rehabilitated to supply the mine with water during Stage II.

Rehabilitation of the artificial lakes involves bulldozer work. The cheapest way to do this work is to use the tractor which will be opening up roads in that area during June and July, 1965.

Est. Cost of repairing pump, and water supply system	$ 3,000
Bulldozing (if done at same time as road work)	2,000
Additional cost of bringing in special bulldozer to do this work	3,000
	$ 8,000

2. Mine Ventilation

It is proposed that the existing ventilation drift be extended a further 350 feet and connected by means of a raise to the new working areas. Main fan portable axial fan capacities will have to be checked to determine if they can provide adequate ventilation at the working faces.

Est. Cost of drifting and raising	$ 6,000

Mine Service Facilities

The mine office building will be rehabilitated. It is necessary to furnish and heat the office, provide a first aid station, washroom, stockroom and maintenance shop.

The shop will be used for preventive maintenance work and minor repairs, routine supplies will be kept at the mine. This will save considerable loss in time transportating personnel, equipment and supplies between the mine and plant.

All major repairs will be done in the plant garage where possible.

Est. cost of rehabilitating office, shops, etc.	$ 20,000

3. Electric Power and Compressed Air

The electric power will be adequate unless there are some large unforeseen ventilation requirements.

The present basic pipe line system for compressed air and water should be adequate for Stage II with normal additions for mining advance.

4. Mine Lighting and Lamps

It will be necessary to extend the lighting system in the mine and purchase miners' lamps.

Est. cost	$ 2,000

5. Transportation

Equipment will be needed to transport the men to and from work and for use by the staff between plant and mine offices.

Est. cost of overhauling bus	$ 2,000
Purchase of new station wagon	4,000
	$ 6,000

6. Road Maintenance

A preliminary cost has been worked out for road maintenance based upon one quotation to supply gravel for surfacing.

Alternatives will be reviewed in an effort to try and reduce this cost.

Before starting haulage of ore from the mine in Stage II it is essential to resurface and ditch the road to put it in a safe operating condition. This work must be completed before the winter starts, it will be impossible to resurface the road properly under freezing conditions.

Preliminary resurfacing of mine and plant roads (1965-66)	$30,000
Additional resurfacing of mine road (1966-67)	20,000
Rehabilitation of road grader	5,000
	$55,000

7. Mine Equipment

a. Roof Bolting

The "Cherry Picker" can be modified to mount a drill, with feed sash, by counter weighting the boom. This would increase the efficiency of roof bolting. A quotation has been obtained to supply a rotary percussion drill for this purpose. Further investigation will be necessary to determine the most suitable and economical drill installation.

Est. cost of overhauling "Cherry Picker" and installing a rotary percussion drill $ 7,000

b. Face Drilling Equipment

For the purpose of producing the ore required for Stage II retorting, the existing jumbo and percussion drills are quite adequate. Further equipment will be necessary for drilling and blasting research, and this will be included in the Stage II Mining Research Program forecasts.

A basic weakness of the present jumbo is that it is difficult and time consuming to level up with the existing manual jacks. It is proposed to install hydraulic jacks on the unit.

Est. cost of installing hydraulic jacks. $ 2,000

Powdering

Powder for horizontal blast holes will be loaded from the "Cherry Picker" platform. Either powdering or roof bolting and scaling may have to be done during the afternoon shift depending upon "Cherry Picker" availability.

c. Loading Equipment

The 3-yard electric shovel sitting idle in the yard will have to be overhauled and put back into operation. It will be necessary to rent a mobile generator to supply power to the shovel while walking it up to the mine. This shovel can load 300 ton/hour and is adequate to handle the entire production.

In addition, the Caterpiller 966 front-end loader should should either be retained on rental or purchased. The loader will be used for clean-up work around the shovel and for standby purposes to load trucks during shovel breakdown periods.

Est. cost of overhauling the 3-yard shovel	$ 7,000
Rental of mobile generator	1,000
Rental of Loader for 18 months	28,000
	$36,000

d. Hauling Equipment

Presently there are 4 Dart, 1 Euclid and 1 International dump trucks available in the yard. They will have to be overhauled before being returned to operation. The water tank on the International must be replaced by the dump body, and a scrubber has to be installed on both the Euclid and International exhaust in accordance with Stage regulations.

These six trucks working two shifts/day for seven days/week can haul the required tonnage of ore.

4 Darts @ 20 tons/trip X 10 trips/day = 800 tons/day

1 Euclid @ 18 tons/trip X 10 trips/day = 180 tons/day

1 International @ 8 tons/trip X 10 trips/day = 80 tons/day

Assuming a 70% availability factor for maintenance and poor operating weather

1,060 tons/day X 0.7 = 740 tons per day.

Use of all six trucks in the mine operations will necessitate the purchase of two 6-ton trucks for the plant operation (or truck rental).

Cost of overhaul of trucks	$ 6,000
Purchase of two 6-ton trucks	14,000
	$20,000

e. Development Work and Personnel Training

Working faces in the mine must be developed before the start of production. Presently there is only one active working face and at least four will be required for continuity of production during Stage II. Development work should be started at least 12 weeks prior to the retort going into operation.

Training equipment operators can be carried out during the 12 week development period.