

March 31, 1982
P5700.11
T.1613

Mr. Remy G. Williams, P.E.
Alaska Power Authority
334 W. 5th Avenue
Anchorage, AK 99501

Dear Mr. Williams:

Susitna Hydroelectric Project
Cost Estimates

In reply to your telephone call on March 26, 1982, we are enclosing the following information relative to the cost estimates included in the Feasibility Report.

1. Indirect Costs

The contractors' indirect costs for the main civil works are summarized in Attachment A. We have summarized the contractors' direct and indirect costs on the first sheet to demonstrate the development of the percentages given to you on March 26.

Indirect costs for the mechanical/electrical installation work and the transmission line erection work have been estimated with directs. They have not been separated at this time.

Indirect costs for camp construction were estimated separately. The range of applicable percentages for indirect costs for various types of work have been shown on Sheet 2. The detailed estimate was made on the basis of the larger camp used in earlier estimates. When the camp was downsized, the same percentage for indirect costs were applied; but the detailed breakdown was not redone. Therefore, we have not included the breakdown at this time. This could be revised and submitted to you if required.

Indirect costs for the access road construction were estimated at 48 percent of direct costs. This was estimated from detailed cost work developed for similar civil works.

2. Breakdown Excavation/Fill Costs for Main Dam at Matana

The breakdown of excavation and fill costs for the main dam at Matana have been summarized in Attachment B. This includes the following information for Accounts 332.311, Excavation, and 332.312, Fill.

Mr. Remy G. Williams, P.E.
Page Two
March 31, 1982

2. Continued

a. Cost Estimate Summary Sheet

This is the same sheet that appears in Appendix C of the Feasibility Report.

b. Cost Estimate Worksheet Summary

This summarizes the breakdown of direct costs for each line item into labor, material, and equipment. The factor for indirect costs is also shown.

c. Cost Estimate Worksheet Summaries for Each Line Item (Sheets 1 through 10)

These sheets show the breakdown of direct costs of each line item used in the estimate.

Please advise if we can provide any further information or clarifications of our cost estimates.

Sincerely,

James R. Plummer

JRP:dmb

Enclosures

SUSITNA HYDROELECTRIC PROJECT
Contractor Indirect Costs for Main
Construction Camp (Account 63)

CONTRACTOR INDIRECT COSTS WERE ESTIMATED FOR GROUPS OF ASSOCIATED ITEMS
AS FOLLOWS:

WATANA

Catering and Support	12% of Direct Construction Costs
Housing Units	18% of Direct Construction Costs
Relocation of 160 Man Camp	22% of Direct Construction Costs
Other Site Buildings	27% of Direct Construction Costs
Heating and Ventilation and Electrical Power	45% of Direct Construction Costs
Site Facilities and Development	48% of Direct Construction Costs

SUSITNA HYDROELECTRIC PROJECT
Feasibility Study Estimate
Civil Works-Direct & Indirect Costs

WATANA TOTAL CIVIL DIRECT COSTS*

	<u>\$000</u>
Account 331	\$ 47,866
332	1,009,007
336	<u>75,104</u>
	\$ 1,131,977

TOTAL ESTIMATED CIVIL INDIRECT COSTS \$ 508,823

INDIRECT COSTS AS % OF DIRECT COSTS 45%

*****/*****

DEVIL CANYON TOTAL CIVIL DIRECT COSTS*

	<u>\$000</u>
Account 331	\$ 43,868
332	389,842
336	<u>27,510</u>
	\$ 461,220

TOTAL ESTIMATED CIVIL INDIRECT COSTS \$ 253,801

INDIRECT COSTS AS % OF DIRECT COSTS 55%

*Includes totals for Accounts 331 and 332 less deduction for mechanical/
electrical items.

Includes totals in Account 336 site roads, airstrip (Watana only) and
road maintenance.



Calculations

SUBJECT: SUSITNA

MATERIAL COSTS - F.O.B. Jobsite

JOB NUMBER PS700.09
 FILE NUMBER _____
 SHEET _____ OF _____
 BY WAK DATE 4/5/82
 APP _____ DATE _____

BAGGED CEMENT \$10.00 / SACK

BULK CEMENT \$ 174.00 / TON

STRUCTURAL STEEL \$ 1235 / TON

PENSTOCK STEEL (ERECTED) \$3100 / TON

FABRICATED STEEL TUNNELSETS \$ 2125 / TON

REINFORCING STEEL \$ 0²⁷ / LB (\$540 / TON)

LUMBER

FRAMING 2X4 - 2X12 (AVE.) \$ 550 / MBF

4X4 - 12X12 (AVE) \$ 675 / MBF

Plywood 3/4" \$ 630 / MBF

Fuel

CAMP HEATING \$1.40 / GAL

CONSTRUCTION EQUIPMENT \$ 1.35 / GAL

Steel FORMS \$ 2.25 / SQ. FT.

EXPLOSIVES \$ 1.50 / LB.

LABOR RATE

The labor rates listed on Table 14-4 were derived from The Alaska Department of Labor, The Association of General Contractors and various trade agreements. The base rates and fringe benefits listed are the prevailing rates as of January 1982.

ADJUSTED RATES

The 1982 base rates have been adjusted to include the following allowances as a percent mark-up:

A. Overtime	13.0%
B. Two Shift Allowance	3.0%
C. Labor Burdens (Not included in fringe benefits):	
- Workmans Compensation	9.60%
- State Unemployment	4.45%
- Federal Unemployment	.70%
- Liability Insurance	2.00%
- Social Security Insurance	6.70%
- Holiday Pay	1.60%
- Travel Allowance	1.70%
	<u>26.75%</u> - Say 27.00%

The overtime and shift allowance (16%) is a percentage mark-up to the base rate, that sum is adjusted by the Labor Burden (27%) to which the fringe benefits are added resulting in an average hourly rate.

Ex. (Base Rate X 1.16)(1.27) + Fringes = Adjusted Rate
or (Base Rate X 1.473) + Fringes = Adjusted Rate.

LABOR MARK-UP BASIS

A. Overtime

It is assumed that the work week will be two shifts of 9 hours each for 6 days per week or 54 hours worked per shift. All hours over 40 are based at the time and a half rate.

14 hours at $\frac{1}{2}$ rate = 7 hours ÷ 54 hours worked = .129 = 13%

60 hrs -

20

10

÷ 11

.157 = 17

B. Two Shift Allowance

1st shift = work 9, pay 9 hours

2nd shift = work 8½, pay 9 hours

work 17½; pay 18 hours

Therefore; ½ hour ÷ 18 hours pay = .028 = 3%

C. Labor Burdens

The Workmans Compensation, Federal & State Unemployment, Liability Insurance and Social Security percentages were obtained from current requirements.

The Holiday pay of 1.6 percent was developed by assuming that of the 8 legal holidays, 5 will be working days and the trades will receive double time pay.

At 52 weeks/year X 6 days/week = 312 days

or

5 paid holidays ÷ 312 days = .016 = 1.6%

D. Travel Allowance

The estimating assumption used is that after every eight weeks worked, the employee will have 2 weeks off without pay and the contractor will pay for the travel expenses and 4 hours pay.

Therefore; 52 weeks/year - 10 weeks off = 42 weeks worked
per year X 54 hours worked/week = 2,268 hours/year

Allowing for 5 round trips at 8 hours pay each = 40 hours
and 40 hours ÷ 2,268 hours = .017 = 1.7%

The labor rates do not include any indirect costs or contractors overhead and profit.

SUSITNA HYDROELECTRIC PROJECT
Indirect Labor Rates

SUPERVISION <u>General Foreman</u>	1982		1982
	<u>BASE</u>	<u>FRINGES</u>	<u>ADJUSTED HOURLY RATE</u>
Laborer	20.25	5.20	35.03
Carpenters	26.60	3.80	42.98
Millwrights	26.81	3.80	43.29
Pile Drivers	25.61	4.15	41.87
Major Mechanics	23.23	4.95	39.17
Bricklayers	22.02	5.29	37.73
Teamsters	20.94	6.94	37.78
Cement Masons	21.26	4.75	36.07
Iron Workers	26.00	5.00	43.30
Pipefitters	24.93	4.23	40.95
 <u>Technical Engineers</u>			
Chief of Parties	20.79	5.84	36.46
Party Chief	19.95	5.84	35.23
Office Work	19.95	5.84	35.23
Instrumentation	18.56	5.84	33.18
Head Chairman	17.94	5.84	32.27
Stakehop	17.94	5.84	32.27
Rear Chairman	17.18	5.84	31.15

The adjusted rates include:

- 13% Overtime (Based on a 54 hour week)
- 3% Shift Allowance
- 27% Labor Burdens

SUSITNA HYDROELECTRIC PROJECT

LABOR RATES AND ADJUSTMENTS
TO COST ESTIMATE

The attached information pertains to the development of the labor rates used in preparing the capital cost estimate for the Susitna Hydroelectric Project.

Exhibit A (Table 14-4) lists the various trade classifications and the adjusted hourly rates as used in the original estimates. The rates represent January 1982 dollars and are based on a 54 hour work week. The rates include the following allowances to the base rates.

- * Overtime 13.0%
- * Two Shifts 3.0%
- * Labor Burdens 27.0%

Backup information for the above percentages is also included for reference.

Subsequent to the preparation of the labor rate table (Exhibit-A) it was decided that not all the construction activities would be on a 54 hour week and adjustments to the cost estimate would be required. Exhibit-B lists the adjustments required for various activities and the percent differences from the 54 hour work week. In addition to labor adjustments, equipment ownership costs had been adjusted to reflect an allowance for spare equipment. Backup is included with Exhibit B for the percent adjustments.

The original cost estimate was not updated for each line item but adjustments were made to bottom line amounts to include the increase costs for various shift changes.

TABLE 14-4
 SUSITNA HYDROELECTRIC PROJECT
 LABOR RATES

EXHIBIT A

CLASSIFICATION	1982			1982 ADJUSTED RATES	
	BASE	FOREMAN	FRINGES	WORKER	FOREMAN
Bricklayers.	20.02	21.02	5.29	34.78	36.25
Carpenters	20.85	23.45	3.80	34.51	38.34
Millwrights	21.45	24.13	3.80	35.40	39.34
Electricians	23.15	25.05	6.13	40.23	43.03
Ironworkers	22.00	24.00	5.00	37.41	40.35
Laborers I - Bull Gang & Flagman	17.20	19.03	5.20	30.54	33.23
II - Compact/Tunnel	17.48	19.03	5.20	30.95	33.23
III - Chuck Tenders	17.81	19.03	5.20	31.43	33.23
IV - Powderman Helper	18.03	19.03	5.20	31.76	33.23
V - Drillers	18.25	19.03	5.20	32.08	33.23
VI - Powderman	18.49	19.74	5.20	32.44	34.28
Operating Engineers I - (-)4 CY Loaders, Cranes, Shovels	20.47	21.22	4.95	35.10	36.21
IA - (+)4 CY Loaders	21.73	22.48	4.95	36.96	38.06
II - Compressors, Screening Plant	19.92	20.67	4.95	34.29	35.40
III - Oiler	19.40	20.15	4.95	33.53	34.63
IV - Pumps	18.26	19.01	4.95	31.85	32.95
Master Mechanic	23.23	- -	4.95	39.17	- -
Pile Drivers	20.24	22.77	4.15	33.96	37.69
Diving Foreman	28.52	- -	4.15	46.16	- -
Working Diver	47.54	- -	4.15	74.18	- -
Plumbers & Steamfitters	22.00	24.20	4.83	37.24	44.75
Teamsters - Buggymobile	17.65	18.65	6.94	32.94	34.41
- Five CY Batch Truck Operator	18.01	19.01	6.94	33.47	34.94
- Fifty CY Off Highway Truck	19.44	20.44	6.94	35.58	37.05
- Eighty CY Off Highway Truck	20.30	21.30	6.94	36.84	38.31
- Tireman	18.01	19.01	6.94	33.47	34.94
- Lo Boy & Twenty-Five CY Truck	19.44	19.54	6.94	35.58	37.05
- Redimix Driver-Twelve CY	19.44	19.54	6.94	35.58	37.05
- Swamper-Pickup & Water Wagon	17.06	18.06	6.94	32.07	33.54
- Water Wagon-Euclid, Flatbed	18.01	19.01	6.94	33.47	34.94
- Greasers	17.65	18.65	6.94	32.94	34.41
Cement Mason I - General	18.87	20.75	4.75	32.55	35.31
II - Form Setters	19.03	20.75	4.75	32.78	35.31
III - Machine Operator	19.25	20.75	4.75	33.11	35.31
IV - Tunnel Workers, Grinder, Nozzleman					
Epoxy Application	19.45	20.75	4.75	33.40	35.31
V - Plasterer	20.10	20.75	4.75	34.36	35.31

Note: For Underground work, add 10 percent to rates listed.



Calculations

SUBJECT: ADJUSTMENTS TO COST ESTIMATE 1 MARCH 1982

JOB NUMBER	P5700.57
FILE NUMBER	
SHEET	1 OF
BY	R. H. Lang DATE 10/27/82
APP	DATE

WATANA

- Increase Labor Unit Costs 4% for Underground Work other than Diversion & Up & Downstream Cofferdams
This will adjust the labor cost from 2-9 hour shifts/day, 6 days/week to 2-10 hr. shifts/day 6 days/week.
- Increase Labor Unit Costs ^{28%} for Diversion Tunnel excavation as indicated on 1 March 82 computer print out.
Crew sizes changed and increased shifts from 9 hours/day 6 days/week to 2-12 hour shifts/day 7 days/week
- Increase Labor Unit Cost for Diversion Tunnel (other than excavation) 18%
This will adjust the labor cost from 2-9 hour shifts/day 6 days/week to 2-12 hour shifts/day 7 days/week
- Increase Labor Unit Cost for Diversion Tunnel Portal excavation, ^{and up & downstream cofferdams} as indicated on computer printout 1 March 82
Crew sizes changed and increased shifts from 2-10 hour shifts/day to 2-12 hour shifts/day 7 days/week. = 13.5% increase
- No change to Labor Unit Costs for work other than Diversion portals & cofferdams.
Labor already based on 2-10 hour shifts/day.

• MATERIAL Increase "All" Material Unit prices by factor 1.01844. This will adjust for Logistics increase of \$12,300,000.

• EQUIPMENT Increase Underground Diversion Activities Ownership Cost 25% to allow for spare equipment and changing shift hours from 9 to 12 hours.

DEVIL CANYON

• Increase Labor Unit Costs 4% for "All" Underground work.
This will adjust labor cost from 2-9 hour shifts/day to 2-10 hour shifts/day.



Calculations

SUBJECT: LOGISTICS COSTS

JOB NUMBER	_____
FILE NUMBER	_____
SHEET	_____ OF _____
BY	R. Lang DATE 10/26/82
APP	_____ DATE _____

Reference: R&M Consultants, Inc.
 Access Planning Study Report Jan 1982
 TABLE F10.4 page F43

Reference: R&M Consultants Inc.
 Supplement Access Planning Study Sept 1982
 TABLE F10.4 page 44A

WATER \$134,388,000
 Rail to Gold Creek 66,522,573
 Rail to Conroy -
 Rail to Levi Canyon 5,390,906
 Truck to Watana 8,159,722

\$134,388,000
 66,522,573
 9,758,058
 2,277,527
 13,826,196

TOTALS \$214,461,201 in March 82 Estimate

\$226,772,354 Revised Total

$$\% \text{ Increase} = \frac{\$226,772,354}{214,461,201} = 1.057 = 5.7\% \text{ Increase for Watana Logistics Costs}$$

$$\text{Amount of Increase to Watana Job \& Permanent Materials Costs} = \$226,772,354 - 214,461,201 = \$12,311,153$$

from March 82 Estimate (Watana)

Job Materials \$232,450,000
 Perm Materials 435,062,000
 Addition Logistics Costs 12,311,153
 \$679,825,153

$$\text{Factor to Adjust April 82 Estimate for Job \& Perm. Materials Unit Costs} = \frac{\$679,825,153}{667,514,000} = 1.01844$$



Calculations

SUBJECT: WATANA - DIVERSION TUNNEL
Excavation Adjustments.

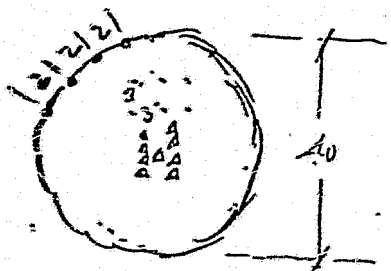
ADJUSTMENTS DUE TO INCREASING FROM 9 hour to 12 hour shift

JOB NUMBER P5720.59
FILE NUMBER _____
SHEET 1 OF 2
BY R. J. [unclear] DATE 6-23-82
LAPP RBEA DATE 10 Jun 82

Reference: Book C page 33 for previous cost information

Changes in estimating assumptions

- Drill production rates increased from 1.1 to 2.2 ft./min.
- Increased heading advance to 6% of diameter
OR 40' φ x .60 = 24 ft. drill = 23 ft. pull.
- Reduced crew sizes since crews will not have a second area to work
- Assume drill & blast by drill crew on 1st shift
- Muck, rock bolt, services, etc. on 2nd shift



Full Face EXCAV.
 AREA $.7854 \times 40^2 = 1257 \text{ SF}$
 VOLUME $1257 \times 23' \text{ pull} / 27 = 1070.5 \text{ BF} / \text{ROUND}$
 $1070.5 \times 1.25 = 1338 \text{ LOOSE BF} / \text{ROUND}$

PERIMETER HOLES = $40 \times \pi / 2 = 62 \text{ Holes}$
 PATTERN HOLES $40 - 2(3) = 34^2 \times .7854 = 101$
 BOLT HOLES 9
 $172 \text{ HOLES} \times 24 \text{ ft} = 4128 \text{ ft}$

USING 2-4 Boom Jumbos @ 2.2 ft/min x 50 min/hr. = 880 ft/hr.

$4128 \text{ ft} \div 880 \text{ ft/hr.} = 4.7 \text{ HOURS DRILL}$
1.0 Hours Set up Drill

$172 \times 5 \text{ min/hole} = 860 \text{ min}$ 4.3 Hours Load

$860 \div 50 \text{ min/hr.} = 17.2 \text{ hrs.}$

$17.2 \text{ hrs} \div 4 \text{ min loading} = 4.3$

BLAST & VENTILATE 1.0 Hours

11.0 Hours = Say 12 hr. shift

LABOR UNIT COST = $\$17.45/\text{BF}$

PREVIOUS = $13.59/\text{BF}$

DIFFERENCE $\$3.86/\text{BF} = 28\% \text{ increase}$

Haul Cycle 2 MILES
 Load = 3.5 min
 Travel loaded = 6.5 min 20 MPH (1760 fpm)
 Dump = 2.0 min
 Return = 4.8 min 25 MPH (2200 fpm)
 Spot = 3.0 min
19.3 min/cycle

$19.3 \text{ min} / 6.5 \text{ min/load} = 2.97 \approx 3 \text{ Trucks Req'd.}$

Muck $\frac{1338 \text{ BF LOOSE}}{20 \text{ BF/Trk.}} = 67 \text{ Loads} \times 6.5 \text{ min/load} = 435.5 \text{ min}$

$435.5 \text{ min} \div 50 \text{ min/hr.} = 8.7 \text{ Hours} = 12 \text{ hr. shift}$

BULL GANG & SERVICE CREW (SAME) = 12 hr. shift

LABOR DRILL & BLAST

1 Foreman/Production 33.15
 2 Jumbo Oper (32.43) 64.86
 4 Drillers (32.02) 128.08
 4 Chuck Tender (31.43) 125.72
 2 Drill Doctors (31.43) 62.86
 2 Comp Oper (33.62) 67.24
 1 Trk. Dr. 32.15
 16 men 514.30

LABOR SUMMARY

DRILL & BLAST 514.30
 MUCK 238.98
 BULL GANG 194.46
 SER. CREW 252.14
 \$ 1199.88
 + 10% ... 119.98
 1319.86

MUCK

1 Foreman 34.30
 3 Trk Dr. (33.90) 101.70
 2 Oper. (36.23) 72.46
 1 Flagman 30.56
 238.98

Shift increase +18%
 \$/HR 1557.32
 X 12 HRS 18,687.84
 = 1070.58

BULL GANG

Foreman from Mucking
 4 laborers (30.54) 122.16
 1 Rigger 37.89
 1 Cherry Pick Oper 34.41

SER. CREW

Foreman 45.33
 pipefit 44.33
 2 helpers (40.79) 81.58
 1 Elect. 40.45
 1 Elect. helper 40.45



Calculations

SUBJECT: DIVERSION TUNNEL

JOB NUMBER P5700.59
 FILE NUMBER _____
 SHEET 2 OF 2
 BY R. J. [unclear] DATE 6-23-82
 APP R. [unclear] DATE 2-1-82

EQUIPMENT

DRILL & BLAST

<u>DRILL</u>	2 - 4 Boom Jumbos (215)	430'
	2 - 1000 cfm compr. (45)	90'
	2 - Bit Grinders (10) ³	20'
	1 Pickup 4x4	25'
		<u>565'</u> x Day 6 Hrs = 3390

BLAST

1 EXPLD LOADER	41'
1 PANEL TRK	25'
1 PICK UP 4x4	25'
	<u>91'</u> x Day 6 Hrs = $\frac{546}{3936} \div 1070\% = \underline{\underline{\$3.68/\$}}$

MUCK

3 - R50 TRUCKS (140)	420'
1 FEL EIND	87'
1 DOZER D-7	85'
1 PICK UP	25'
	<u>617'</u> x 12 Hrs = $\frac{7404}{1070\%} = \underline{\underline{\$6.91/\$}}$

BULL GANG & SERVICE CREW

2 - PICK UP (25)	50'
1 - CHERRY PICKER	60'
1 - F.D. TRUCK	25'
	<u>135'</u> x 12 Hrs = $\frac{1620}{1070\%} = \underline{\underline{\$1.51/\$}}$

12.10
3.02 - +25% allowance for 24 hr/day
 and increase in repair cost
15.12
 +13.14/\$ previous unit cost.
\$1.98 = 15.0% difference = say 15%

MATERIAL - NO CHANGE FROM PREVIOUS ESTIMATE \$5.50/\\$



Calculations

SUBJECT: SCHEDULE ACTIVITY DURATION CHANGES
AS A RESULT OF CHANGING LENGTH OF SHIFTS

JOB NUMBER	_____
FILE NUMBER	_____
SHEET	_____ OF _____
BY	<u>R. Lang</u> DATE _____
APP	_____ DATE _____

Underground Work (Not Including Diversion) change from 2-9 hr shifts/day to 2-10hr shifts/day
 $= \frac{18 \text{ hrs/day}}{20 \text{ hrs/day}} = \underline{90\%}$ of 9hr shift duration - Assume Same Productivity

Underground Work (Diversion) change from 2-9hr shifts/day 6 days/week to 2-12hr shifts/day 7 days/week

$$\frac{18 \text{ hrs/Day}}{24 \text{ hrs/Day}} = \frac{17 \text{ hrs Worked/Day} \times 6 \text{ Days} = 102 \text{ hrs/week}}{21 \text{ hrs Worked/Day} \times 7 \text{ Days} = 147 \text{ hrs/week}} = .694 \approx \underline{70\%}$$
 of 9hr shift duration

Surface Work - Main Dam Rock Excav. Below Elev. 1470 change from 2-10hr shifts/day 6 days/week to 2-12hr shifts/day 7 days/week

$$\frac{20 \text{ hrs/Day}}{24 \text{ hrs/Day}} = \frac{19 \text{ hrs Worked/Day} \times 6 \text{ Days} = 114 \text{ hrs/week}}{21 \text{ hrs Worked/Day} \times 7 \text{ Days} = 147 \text{ hrs/week}} = .775 \approx \underline{78\%}$$
 of 10hr shift durations



Calculations

SUBJECT: SUSITNA

LABOR RATE ADJUSTMENTS REQUIRED
DUE TO WORKING 2-12 HOUR SHIFTS
7 DAYS PER WEEK

JOB NUMBER	_____
FILE NUMBER	_____
SHEET _____	OF _____
BY <u>L. Lang</u>	DATE <u>10/22/82</u>
APP _____	DATE _____

LABOR RATE ADJUSTMENTS

Due to maintaining the construction schedule completion date for the DIVERSION TUNNEL it will be necessary to work 2-12 hour shifts per day 7 days per week or 84 hours worked per man week.

It is assumed that all hours over 40 will be at the premium rate as follows:

40 hours (straight time)	=	40 hours
28 hours (time & a half)	=	42 hours
16 hours (double time (12 hrs Sunday & 4 hrs Sat.))	=	32 hours

84 hours worked 114 hours pay

$$\frac{114 \text{ pay}}{84 \text{ worked}} = 1.357 \approx 36\% \text{ overtime allowance}$$

TRAVEL ALLOWANCE

The estimating assumption used is that after every three weeks worked, the employee will have one week off without pay and the contractor will pay for the travel expenses and 4 hours pay.

Therefore, 52 weeks/year - 12 weeks off/year = 40 Weeks Worked
and 40 Weeks x 84 hours worked/week = 3360 hours/year

Allowing for 12 Round trips @ 8 hours pay each = 96 hours

$$\frac{96 \text{ hours}}{3360 \text{ hours}} = .027 = 2.7\%$$

ADJUSTED RATES (Reference Labor Section in Estimate B & up)

A. OVERTIME	36.0%
B. TWO SHIFT ALLOWANCE	3.0%
C. LABOR BURDENS	
- WORKMANS COMPENSATION	9.60%
- STATE UNEMPLOYMENT	4.95
- FEDERAL UNEMPLOYMENT	.70
- LIABILITY INSURANCE	2.00
- SOCIAL SECURITY INS.	6.70
- HOLIDAY PAY	1.60
- TRAVEL ALLOWANCE	2.70
	<hr/>
	27.75% \approx 28.0%

The overtime and two shift allowance (39.0%) is a percentage markup to the base rate and that sum is adjusted by the labor burden (28.0%) to which the Fringe Benefits are added resulting in an average hourly rate.

$$\text{Ex. } (\text{Base Rate} \times 1.39)(1.28) + \text{Fringe Benefits} = \text{Adjusted Rate} \\ = (\text{Base Rate} \times 1.779) + \text{Fringe Benefits} = \text{Adjusted Rate}$$

The labor adjustment factor to be used for activities being performed in 2-12 hour shift schedule is based on the following:

Base Laborer Rate = \$20.25 x 1.779 + \$520 fringe	=	\$ 41.22
Previous Adjusted Laborer Rate 18 hrs/day	-	35.03
		<hr/>
		\$ 6.19

$$\text{percent/factor change} = \frac{6.19}{35.03} = .177 \approx 18\%$$



Calculations

SUBJECT:

JOB NUMBER	_____
FILE NUMBER	_____
SHEET _____	OF _____
BY <u>R. Long</u>	DATE <u>10-28-82</u>
APP _____	DATE _____

Equipment Rate Adjustment

Due to the accelerated construction schedule it is assumed that an increase in spare/standby equipment will be required to allow for equipment downtime for routine maintenance and breakdowns.

An allowance of 25% for the Equipment Ownership Cost only should be included for the accelerated construction schedule.

Since the current estimate (March 82) has allowed 45% Ownership and 55% Operating cost the revised equipment cost, total adjustment, should be an increase of 11% based on the following:

Ownership Cost	45%	+ 25% increase	=	56%
Operating Cost	<u>55%</u>	_____	=	<u>55</u>
	100%			111%

$111\% - 100\% = 11\% \text{ increase}$

Revise % breakdown = Say Own = 50%
 Oper. = 50%
 100%



Calculations

SUBJECT: DIVERSION TUNNEL

JOB NUMBER	_____
FILE NUMBER	_____
SHEET _____	OF _____
BY <u>L. Lang</u>	DATE <u>10-22-82</u>
APP _____	DATE _____

40' ϕ tunnel

CYCLES

Drill, load & blast \approx 12 hours

Muck & Services \approx 12 hours

24 hours

Production = $1070.5 \text{ B} \div 24 \text{ hrs} = 44.6 \text{ Avg } \text{B}/\text{Hour}$

QUANTITIES & DURATION

LOWER TUNNEL Exc. (Includes Plugexcav) $208,700 \text{ B} \div 44.6 \text{ B/hr} = 4679 \text{ hrs} \div 24 \frac{\text{hr}}{\text{day}} = 195 \text{ days} \div 7 \frac{\text{day}}{\text{week}} \approx 28 \text{ Weeks}$

UPPER TUNNEL Exc. $221,000 \text{ B} \div 44.6 = 4955 \text{ hrs} \div 24 = 207 \text{ days} \div 7 = 30 \text{ WEEKS}$

DOWNSTREAM PORTAL $148,000 \text{ B} \dots = 8 \text{ WEEKS}$

UPSTREAM PORTAL $140,950 \text{ B} \dots = 8 \text{ WEEKS}$



Calculations

SUBJECT: PORTAL EXCAVATION
DIVERSION TUNNEL

2-12 hr shifts/day x 7 days/week

JOB NUMBER _____
 FILE NUMBER _____
 SHEET _____ OF _____
 BY R. Long DATE 10-22-82
 APP _____ DATE _____

Downstream Portal 148,000 cu ft to be excavated in 8 Weeks
 8 Weeks x 7 days/Week = 56 Days x 21^{productive} Hrs/day = 1176 Hrs

$$\frac{148,000 \text{ cu ft}}{1176 \text{ Hrs}} = 125.8 \approx \underline{126 \text{ cu ft/Hour}} \text{ Avg. Required Production Rate}$$

Assume that drill crews can continue drilling during muck operations

Excavation Volume/Round - Drill 23 ft & Pull 20' x 21' x 50' long = 27,777.8 cu ft
 x 1.30 Swell = 1011 cu ft

Production Drilling 1/2 ft/min/drill x 6 Drills = 3 ft/min.

Allow 7x7 ft. drill pattern w/ 2 ft. c.c. line drilling at face

Drilling Requirements (7x7 Spacing) 3 Rows x 7 / Row = 21 holes
 line drilling 50' ÷ 2 ft. c.c. (40') = 10 holes
 31 holes

$$31 \text{ holes} \times 23 \text{ ft depth} = 713 \text{ LF} \div 3 \text{ ft/min} = 238 \text{ min.}$$

$$238 \text{ min} \div 50 \text{ min/hr} = 4.76 \text{ Hrs} \approx \text{Say 2 Cycles per 12 hr shift}$$

$$\text{OR } \frac{777.8 \times 2 \text{ Rds}}{12 \text{ hr shift}} = \underline{130 \text{ cu ft/Hr}} \text{ Avg. \& within Avg Req'd. of } 126 \text{ cu ft/Hour}$$

Blast 31 holes x 10 min/hole = 310 min ÷ 50 $\frac{\text{min}}{\text{hr}}$ = 6.2 hrs
 w/ 2 men = 3.1 hrs ≈ 3 Hrs ≈ 2 Rds/Shift Same as drilling
 130 cu ft/Hr

MUCK/SCALE/HAUL 40 min to spot & load = 20 cu ft/Trk.

$$\frac{1011 \text{ cu ft}}{20 \text{ cu ft/Trk}} = 51 \text{ Loads} \times 40 \text{ min} = 204 \text{ min.} \div 50 \frac{\text{min}}{\text{hr}} = 4.08 \text{ hrs.}$$

Blast & Move Allow 1 hr.
 Say 5.0 hrs.

Say 2 cycles/shift

Truck Requirements 50 min/hr = 12.5 loads/hr
 4 min/load

2 mile haul = 20 min = 3 Trips/Hr/Trk

∴ 12.5 Loads/hr ÷ 3 loads/Hr/Trk = 4 Trucks Req'd.

LABOR

DRILLING	1 foreman	33.25
	6 Drills (32.08)	192.48
	3 helpers (31.43)	94.29
	1 Drill Doc	31.43
	2 Comp. Oper. (34.29)	68.58
		\$420.01/hr.
		(\$420.01/hr. + 18%) ÷ 130 cu ft/hr. = <u>\$3.81/cu ft</u>

BLAST

	1 Powderman	32.43
	2 helpers (31.75)	63.50
		\$65.93/hr.
		(\$65.93/hr. + 18%) ÷ 130 cu ft = <u>\$0.60/cu ft</u>

MUCK

	29 Oper	35.10
	FEL Oper	36.96
	4 Trk Dr. (25.58)	142.32
	1 Lab	30.54
	1/2 Backhoe (35.19)	17.55
		\$260.61
		(\$260.61/hr. + 18%) ÷ 130 cu ft = <u>\$2.36/cu ft</u>

MATERIALS

Explosives	777.8 cu ft x 2.2 x 1.5 =	\$2567
Fused Cord	3.00 x 31 holes =	93
Bits, etc. (Say .30/cu ft x 713 ft)		214
Acc. 15% Expl.		385
Delays 13 x 1.75		23
		\$3282 ÷ 777.8 cu ft = <u>\$4.22/cu ft</u>

Summary

	LABOR	MATL	EQUIP.	TOTAL
DRILL	\$3.81		\$2.86	
BLAST	.60	4.22	.56	
MUCK	2.36		8.14	
	<u>\$6.77</u>	<u>\$4.22</u>	<u>\$11.56</u>	
				OWN Oper. 5.78
				<u>\$22.55</u>

EQUIPMENT

6 Air Tracs (\$28.50)	\$171.00
3-100 Comp. (45.00)	135.00
Grinder	10.00
Pickup	20.00
	\$336.00/11 hr.
	\$336 x 1.11 = \$373.00 ÷ 130 cu ft/hr. = <u>\$2.86/cu ft</u>

EXPL. LOADER

Expl. Loader	\$41.00
Truck	25.00
	\$66.00
	\$66 x 1.11 = \$73.26 ÷ 130 cu ft/hr. = <u>\$0.51/cu ft</u>

HAUL

29	\$175.00
FEL	185.00
4 (25.58 Trk) (1/4)	560.00
1/2 Backhoe Comp (66)	33.00
	\$953.00
	\$953 x 1.11 = \$1058.00 ÷ 130 = <u>\$8.14/cu ft</u>



Calculations

SUBJECT: JUSITNA

LABOR RATE ADJUSTMENT

from 2-10 Hour Shifts/Day 6 days/week
to 2-12 Hour Shifts/Day 7 days/week

JOB NUMBER	_____
FILE NUMBER	_____
SHEET	OF _____
BY <u>R. Lang</u>	DATE <u>10/20/82</u>
APP	DATE _____

2-12 Hour Shifts/day / 7 day week

40 hours (straight time)	40 hours
28 hours (time & half)	42
16 hours (double time)	32

84 hours worked 114 hours paid

$$\frac{114 \text{ hours paid}}{84 \text{ hours worked}} = 1.357 \approx \underline{36\%} \text{ overtime allowance}$$

ADJUSTED RATE

- A - OVERTIME 36%
- B - TWO SHIFTS 3%
- C - LABOR BUREAUS 28%

(Base Rate x 1.39)(1.28) + Fringes = Adjusted Rate
 Use laborer base (20.25 x 1.39 x 1.28) + 5.20 = \$41.22

2-10 Hour Shifts/day / 6 day week

40 hours (straight time)	40 hours
18 hours (time & half)	27
2 hours (double time)	4

60 hours worked 71 hours paid

$$\frac{71 \text{ hours paid}}{60 \text{ hours worked}} = 1.183 \approx \underline{18\%} \text{ over time allowance}$$

ADJUSTED RATE

- A. OVERTIME 18%
- B TWO SHIFTS 3%
- C LABOR BUREAUS 27%

(Base Rate x 1.21)(1.27) + Fringes = Adjusted Rate
 Use laborer base (20.25 x 1.21 x 1.27) + 5.20 = \$36.31

$\frac{\$41.22}{36.31}$ Adjusted 2-12 hr shift / 7 day week rate = 1.135 = say 13.5% increase.
 - 2-10 hr shift / 6 day week



Calculations

SUBJECT: SUSITNA

LABOR RATE ADJUSTMENT

2-10 hour shifts from
2-9 hour shifts
6 Days/WEEK

JOB NUMBER	_____
FILE NUMBER	_____
SHEET	OF
BY <u>R. J. [unclear]</u>	DATE 10/25/80
APP	DATE

For All Underground Work (except Division Tunnels)

$$\begin{array}{l} 40 \text{ hours (straight time)} = 40 \text{ hours} \\ 18 \text{ hours (time \& half)} = 27 \\ 2 \text{ hours (double time)} = 4 \end{array}$$

60 hours worked = 71 hours paid.

$\frac{71 \text{ paid}}{60 \text{ worked}} = 1.183 = 18.3\% \text{ premium pay.}$

No change in travel assumptions (same as 6-9 hour days)

Adjusted Rates

- A Overtime 18.3% > 21.3%
- B Shift Allow 3.0% > 21.3%
- C Labor Burden 7.0% - 27.0%

$$\begin{aligned} (\text{Base Rate} \times 1.213)(1.27) + \text{Fringe Benefits} &= \text{Adjusted Rate} \\ = \text{Base Rate} \times 1.54 + \text{Fringe Benefits} &= \text{Adjusted Rate} \end{aligned}$$

$$\begin{aligned} \text{Use Laborer Rate } \$20.25 \times 1.54 + \$5.20 &= \$36.39 \\ \text{previous Adjusted Rate for 9 hour day} &= \underline{35.03} \\ & \$ 1.36 \end{aligned}$$

$$\text{percent factor change } \frac{\$ 1.36}{\$ 35.03} = .0388 = \text{say } \underline{4.0\% \text{ increase}}$$

~~Additional Equipment Ownership Costs~~

~~Previous Equipment Cost Assumptions for~~

$$\begin{array}{l} 2 - 12 \text{ hr shifts per day} \times 7 \text{ days/week} = 168 \text{ hrs} = 125\% \\ \text{of ownership cost for} \\ 2 - 9 \text{ hr shifts per day} \times 6 \text{ days/week} = 108 \text{ hrs} = 100\% \\ \hline 60 \text{ hrs} = 25 \end{array}$$

~~Since 60 hours increases the equipment ownership costs 25% or .417% per hour~~

~~Working 2-10 hour shifts per day 6 days per week will increase the ownership cost.~~

$$\begin{aligned} (2 \times 10 \times 6) - (108 \text{ hrs}) &= 12 \text{ hours} \\ 12 \text{ hours } (.417\%) &= \underline{5.0\% \text{ increase for ownership costs.}} \end{aligned}$$