

SUSITNA HYDROELECTRIC PROJECT

WATANA

CONCRETE ARCH DAM

OCTOBER 1981

RKF
8 10/6/91

SUSITNA HYDROELECTRIC PROJECT

CONCRETE DAM AT WATANA
ESTIMATE BASED ON SCHEME "2A"

10/6/91

	<u>(\$000)</u> <u>Jan 82</u>	<u>2A For Comparison</u>
Land	36,750	Same
Reservoir	15,750	Same
Main Dam	1,447,184	1,184,944
Penstocks	15,120	Same
Power Intakes	60,180	Same
Powerhouse	189,730	Same
Tailrace Outlet	2,303	Same
Saddle Dam	47,774	Same
Switchyard	7,369	Same
Misc. Structures	8,400	Same
Access	74,865	Same
Diversion	97,420	101,386
Service Spillway	128,149	Same
Emergency Spillway	NA	NA
Tailrace Tunnel	6,815	13,107
Rock Credit	<u>NA</u>	<u>(11,728)</u>
Total	2,137,809	1,874,099
Camp, Constr. and Owner Costs 1.16 X 1.2 X 1.125	3,347,809	2,934,839
	<u>\$3.3 Billion</u> =====	<u>\$2.9 Billion</u> =====

Susitna Hydroelectric Project



Calculations

SUBJECT: CONCRETE DAM
AT WATANA

JOB NUMBER _____
FILE NUMBER _____
SHEET 1 OF 8
BY DM? DATE OCT. 05 1981
APP WuX DATE 10/5/81

Please
type

	SCHEME	
ROUGH ESTIMATE	BASED ON "2A"	SEP 28 1981 PRINT
	\$000 JAN 82	OF SK 5700-66-241
		2A FOR
		↓ COMPARISON
LAND	36 750 ✓	Same
RESERVOIR	15 750 ✓	Same
MAIN DAM	2 394 236 ✓ 1,447,184	1 184 944
PENSTOCKS	15 120 ✓	Same
POWER INTAKE	60 180 ✓	Same
Power house	189 730 ✓	Same
Tailrace outlet	2 303 ✓	Same
Saddle Dam	47 774 ✓	Same
Switchyard	7 369 ✓	Same
Misc. Structures	8 400 ✓	Same
Access	74 865 ✓	Same
Diversion	97 420 ✓	101 386
Service Spillway	128 149 ✓	Same
Emergency "	NA	NA
Tailrace Tunnel	6 815 -	13 107
Rock Credit	NA -	< 11 728 >
	3 084 861 ✓	1 874 099
	2,137,809	1 311

"CAMP
1.16 x 1.2
x 1.125

↑
OWNER
COSTS

3 347 809
~~4 830 893~~

2 934 839

3.3
~~4.8~~ BILLION

2.9 BILLION

~~CONCRETE~~

~~2A ROCK DAM~~

WATANA CONCRETE DAM
 USE SCHEME 2A AS COMPARISON

ROUGH

OCT. 05 1981 10/18/81

2078 JML

WATANA
 COMPARATIVE COST ESTIMATE - COMMON ITEMS
 JULY 1981 (JANUARY 1982 DOLLARS)

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE \$	\$000 TOTAL	\$000 ITEM TOTAL
COMMON ITEMS - ALL SCHEMES						
LAND	Land Acquisition		LS	36,750,000	36,750	36,750
RESERVOIR	Reservoir Clearing		LS	15,750,000	15,750	15,750
MAIN DAM	Excavate Rock	28875 2100 2800 000	cy	21	60638	58500
	Excavate Overburden	800 000	cy	8.40	52800 6720	
	Excavate Grout Gallery - Horizontal	12,000	cy	90	1,080	
	Excavate Grout Gallery - Vertical	2,200	cy	105	231	
	Surface Preparation	60000	sy	15.80	948000	
	DAM & THRUST BLOCKS	8750 000	cy	150	1237500	
	Concrete Grout Gallery - Horizontal	15,400	cy	250	3,850	
	Concrete Grout Gallery - Vertical	300	cy	475	143	
	Consolidation Grouting	474,000	LF	63	29,862	
	Grouting from Surface	93,000	LF	53	4,929	
Grouting from Adits	176,000	LF	63	11,088		
Relief Drains		LS	3,150,000	3,150		
Rockbolts Grout Gallery	200	ton	3,500	700		
Support Steel-Grout Gallery	350	ton	3,700	1,295		
Low Level Release		LS	26,250,000	26,250		
PLNSTOCKS	Excavate Tunnel	59,000	cy	55	3,245	
	Concrete Line	20,000	cy	380	7,600	
	Rockbolts	530	ton	3,500	1,855	
	Steel Line	550	ton	4,400	2,420	
POWER INTAKES	Excavate Rock	737,000	cy	12.50	9,213	
	Excavate Overburden	300,000	cy	6.30	1,890	
	Concrete Base Slab	23,000	cy	190	4,370	
	Concrete Structures	74,000	cy	300	22,200	
	Reinforcing Steel	4,365	ton	2,100	9,167	
	Rockbolts	180	ton	3,500	630	
	Gates, Etc.		LS	12,710,000	12,710	

716/117 82500
 2000

ASSUME
 GROUTING
 IS SAME

SAME

SAME

1,485,904 / 1,447,184
~~2,394,236~~

15,120 - SAME

SAME

60,180

WATANA
COMPARATIVE COST ESTIMATE - COMMON ITEMS (Cont'd)

30A 8
OCT. 05 1981 Page 2

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE \$	\$000 TOTAL	\$000 ITEM TOTAL
POWERHOUSE AND ASSOCIATED ITEMS	Excavate Powerhouse Vault	201,000	cy	42	8,442	
	Excavate Draft Tube	20,000	cy	47	940	
	Excavate Surge Chamber	102,000	cy	42	4,284	
	Excavate Transformer Gallery	38,000	cy	47	1,786	
	Excavate Rock Tunnel Portal	3,700	cy	15	55	
	Excavate Overburden Tunnel Portal	11,000	cy	5.30	59	
	Excavate Access Shaft	10,900	cy	68	741	
	Excavate Cable & Transformer Shafts	14,400	cy	68	980	
	Excavate Access Tunnel	119,400	cy	42	5,015	
	Concrete Substructure Powerhouse	41,200	cy	315	12,978	
	Concrete Superstructure Powerhouse	20,600	cy	380	7,828	
	Concrete Draft Tube	12,400	cy	525	6,510	
	Concrete Surge Chamber	30,500	cy	360	10,980	
	Concrete Transformer Gallery	10,100	cy	315	3,182	
	Concrete Transformer Shaft	4,000	cy	475	1,900	
	Concrete Line Access Shaft	850	cy	475	404	
	Concrete Line Cable Shaft	1,900	cy	475	902	
	Concrete Line Access Tunnel	9,000	cy	250	2,250	
	Concrete Access Tunnel Portal	1,000	cy	315	315	
	Support Steel Access Tunnel	480	ton	3,675	1,764	
	Rockbolts Powerhouse/Draft Tube	310	ton	3,530	1,085	
	Rockbolts Access Shaft	100	ton	3,500	350	
	Rockbolts Cable Shaft	60	ton	3,500	210	
	Rockbolts Access Tunnel	340	ton	3,500	1,190	
	Rockbolts Access Tunnel Portal	10	ton	3,500	35	
	Reinforcing Steel Powerhouse	3,700	ton	2,100	7,770	
	Reinforcing Steel Transformer Gallery	650	ton	2,100	1,365	
	Reinforcing Steel Surge Chamber	1,850	ton	2,100	3,885	
	Reinforcing Steel Draft Tube	750	ton	2,100	1,575	
	Turbines and Valves		LS	28,300,000	28,300	
	Cranes		LS	2,730,000	2,730	
	Generators		LS	32,550,000	32,550	
Mechanical/Electrical Equipment		LS	19,430,000	19,430		
Auxiliary Mechanical/Electrical Equipment		LS	12,600,000	12,600		
Draft Tube Gates		LS	610,000	610		
Architectural Powerhouse		LS	1,580,000	1,580		
Auxiliary Generators			3,150,000	3,150		
					189,730	SAME
TAILRACE OUTLET	Excavate Rock Outlet	37,000	cy	15	555	
	Excavate Overburden Outlet	46,000	cy	5.30	244	
	Concrete Base Slab Outlet	2,200	cy	230	506	
	Concrete Walls Outlet	700	cy	315	221	
	Reinforcing Steel	120	ton	2,100	252	
	Rockbolts	150	ton	3,500	525	
					2,303	SAME

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OCT. 05 1

WATANA
COMPARATIVE COST ESTIMATE - COMMON ITEMS (Cont'd)

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE \$	\$000 TOTAL	\$000 ITEM TOTAL	
SADDLE DAM	Surface Preparation	16,600	sy	10.50	174		
	Rockfill	120,000	cy	12.60	1,512		
	Filters	18,000	cy	15.80	285		
	Impervious Material	81,000	cy	10.50	851		
	Excavate Overburden	140,000	cy	6.30	882		
	Slurry Trench	78,000	sy	565	44,070		47,774 SAME
SWITCHYARD	Excavate Switchyard Overburden	146,000	cy	4.20	613		
	Fill	146,000	cy	4.20	613		
	Surface Preparation	35,000	sy	10.50	368		
	Electrical		LS	4,200,000	4,200		
	Civil Works		LS	1,575,000	1,575		7,369 SAME
MISCELLANEOUS STRUCTURES & EQUIPMENT	Recreation Facilities		LS	1,050,000	1,050		
	Buildings and Grounds		LS	4,200,000	4,200		
	Permanent Operating Equipment		LS	3,100,000	3,150		8,400 SAME
ACCESS/ROAD AIR STRIP	Permanent Access Road	70	miles	630,000	44,100		
	Permanent Bridges		LS	21,000,000	21,000		
	Construction Access Site	15	miles	231,000	3,465		
	Airstrip		LS	6,300,000	6,300		74,865 SAME
SUBTOTAL	COMMON ITEMS					1,643,485	

OCT. 05 1981

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WAT
COMPARATIVE COST ESTIM
JULY 1981 (JANUA

Description	Unit	Unit Price	Scheme 2A	
			Quantity	\$000
<u>Diversion/Cofferdams</u>				
Excavate Rock Portal	cy	15	290,000	\$ 4,350
Excavate Tunnels	cy	55	435,000	23,925 32,000
Concrete Liner at Portals	cy	260	4,200	1,092
Concrete Liner Tunnel	cy	250	52,600	16,900 15,550
Concrete Inlet Portal Headwall	cy	260	17,200	4,472
Concrete Inlet Portal Pier	cy	295	600	177
Concrete Outlet Headwall	cy	260	7,500	1,950
Concrete Plugs	cy	500	20,000	10,000
Upstream Cofferdam	cy	4.20	3,140,000	13,188
Downstream Cofferdam	cy	7.35	125,000	919
Dewatering	LS	3,675,000		3,675
Cutoff	LS	6,825,000		6,825
Reinforcing Steel	Ton	2,100	1,226	2,575 2,315
Rockbolts Tunnels	Ton	3,500	475	1,665 1,530
Rockbolts Portals	Ton	3,500	125	438
Rock Surface Treatment	sy	15.80	2,700	43
Support Steel	Ton	3,675	1,250	4,594 4,226
Gates, Etc.	LS	4,600,000		4,600
SUBTOTAL DIVERSION/ COFFERDAMS				101,386

ADJUSTED
QUAN

400,000

62,200

SAY
100 @ PORTALS

$100 + (.92)(1124) = 1135$

437

1150

97,420

USE
0.92
FOR
TUNNEL
ITEMS

ptgdm

OCT. 05 1981

ANA
COMPARATIVE COST ESTIMATE - NON-COMMON ITEMS (Cont'd)

Description	Unit	Unit Price	Scheme 2A	
			Quantity	\$000
<u>Service Spillway</u>				
Excavate Rock	cy	17	1,567,200	26,642
Excavate Overburden	cy	6.30	1,301,000	8,196
Concrete Walls Formed One Face	cy	260	32,600	8,476
Concrete Walls Formed Both Faces	cy	280	19,100	5,348
Concrete Slab Approach	cy	190	2,900	551
Concrete Slab No Forms	cy	170	79,600	13,532
Concrete Slab Formed One Face	cy	190	2,100	399
Concrete Slab Formed Both Faces	cy	200	15,500	3,100
Concrete Gate/Chute Formed One Side	cy	295	2,500	738
Concrete Gate/Chute Formed Both Sides	cy	315	5,100	1,607
Concrete Structure No Forms	cy	210	2,100	441
Concrete Structure Formed	cy	250	11,400	2,850
Concrete Bridge	cy	600	2,150	1,290
Concrete Lower Piers Bridge	cy	295	NA	NA
Concrete Lower Bridge Deck	cy	500	NA	NA
Reinforcing Steel	Ton	2,100	5,896	12,382
Rockbolts	Ton	3,500	1,000	3,500

SAME

20 of 8 DM

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WATANA
COMPARATIVE COST ESTIMATE - NON-COMMON ITEMS (Cont'd)

Description	Unit	Unit Price	Scheme 2A	
			Quantity	\$000
Gates	LS			4,500
Dental Concrete	LS			4,800
Grouting	LS			2,100
Winterization	LS			7,000
Alluvium Removal Above Water Level	cy	SAME	760,000	5,320
Alluvium Removal Below Water Level	cy		17	860,000
Additional Haul Roads	Mile	40,000	2	80
Surface Treatment Vertical	sy	15.80	17,000	274
Surface Treatment Horizontal	sy	10.50	38,400	403
SUBTOTAL SERVICE SPILLWAY				128,149
<u>Emergency Spillway</u>				
Excavate Rock	cy	17		NA
Excavate Overburden	cy	6.50	NA	NA
Place Fuse Plug	cy	6		NA
SUBTOTAL EMERGENCY SPILLWAY				

By f ppm

OCT. 05 1983

WATANA
COMPARATIVE COST ESTIMATE - NON-COMMON ITEMS (Cont'd)

Description	Unit	Unit Price	Scheme 2A	
			Quantity	\$000
<u>Tailrace Tunnel</u>				
Excavate Tunnels	cy	50	97,200	4,860
Concrete Line Tunnels	cy	275	14,850	4,084
Reinforcing Steel	Ton	2,100	150	315
Rockbolts	Ton	3,500	480	1,680
Support Steel	Ton	3,675	590	2,168
SUBTOTAL TAILRACE TUNNEL				15,107
				6815
Credit for Use of Rock in Dam	cy	0	1,466,000	<11,728>
TOTAL NON-COMMON ITEMS				230,914

- 50544 25,278
- 7722 2124
- 78 164
- 250 874
- 307 1127

0.52

6816

DELETE

~~4,000,000~~

2,137,809,000



(E)

WATAWA

OFFICE MEMORANDUM

TO: See Distribution Date: January 16, 1982

FROM: James R. Plummer File: P5700.07.09

SUBJECT: Susitna Hydroelectric Project Task 9 Estimating/Takeoff Assumptions

cc: D. MacDonald J. Lawrence
 F. Toth J. Hayden
 R. Lang R. Ibbotson
 R. Beal D. Lamb
 D. Meilhede N. Bond

The following assumptions have been developed for use on the Susitna Hydroelectric Project and will be used for the Feasibility Study Estimate:

1. Concrete Mix-For Sizing of Batch Plants

- Nominal 4,000 psi mix (28 day)
- Ratios: Water/cement 0.51
 Aggregate/cement 5.74
- Weight lbs/cy: Water 275
 Cement 540
 Fine Aggregate 1,250
 Coarse Aggregate 1,850

2. Reinforcing Steel

- GALLERY SLABS*
- Structural slabs & beams 70 lbs/cy
- Structural walls 100 lbs/cy
- Shotcrete mesh (6") 80 lbs/cy
- Shotcrete mesh (9") 80 lbs/cy or 1.48 lbs/sf
- Concrete in underground caverns 60 lbs/cy or 1.66 lbs/sf
- Concrete in underground caverns 100 lbs/cy
- Devil Canyon main dam & thrust blocks 7 lbs/cy

A review of these items by the project designers has been requested.

3. Steel Mesh

Steel mesh (safety protection) will be required for all underground work except grout and access galleries of 10 feet or smaller diameter. Mesh will cover 100 percent of crown from springline to springline. It is assumed that a mesh will be left in place in all concreted areas and that no additional mesh will be required as a separate item in these areas. This item will be taken off on a square foot basis. Pricing will include additional bolting for mesh support. Steel mesh will also be required for 100 percent of vertical or near vertical cuts above concrete structures. Pricing will be for complete installation on a square foot basis.

4. Underground Rockbolts (High Yield, Resin Grout)

Underground rockbolts will be estimated as an "each" basis according to Schedule 1. Aboveground bolting will be taken off on a structure-by-structure basis. Generally 1 inch bolts by 15 feet long will be used in a 10 foot by 10 foot pattern for 25 percent of the exposed rock side slopes unless otherwise noted or shown on drawings.

5. Underground Support

Underground support will be estimated as shown on Schedule 2 on a per ton basis.

6. Shotcrete

Shotcreting will be estimated as shown on Schedule 3 on a square foot basis.

7. Surface Preparation

Surface preparation will be taken as a square foot item for the invert of all underground excavation. No surface preparation will be listed for inclined (wall) underground surfaces. Aboveground surface preparation will be taken on a square foot basis and be identified as horizontal (slab or invert) and inclined (walls) for all concrete contact areas. In addition, surface preparation quantities will be developed for contact areas of the fill dam shells and core/filters.

8. Dental Concrete & Overbreak

No dental
Concrete will be estimated except under the main Watana Dam ^{*Core/Filter*} (1 cf/sf contact area). The concrete overbreak allowance will include any dental concrete needed elsewhere. As previously developed, this overbreak allowance is as follows:

Aboveground & Major Underground--

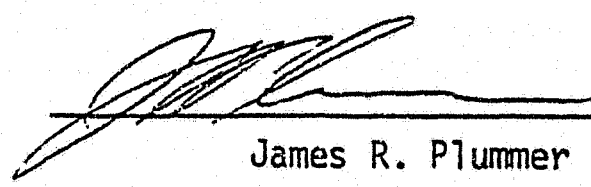
Horizontal (Slab) Surfaces - 1.5 cf/sf concrete contact area
Inclined (Walls) Surfaces - 1.0 cf/sf concrete contact area

Tunnels--

0.5' Additional Thickness for Walls & Slabs

9. Penstock

A line item for consolidation grouting and contact grouting (behind liner) will be developed.



James R. Plummer

DM:dmb

Attachments



(E)

OFFICE MEMORANDUM

TO: Dave H. MacDonald
FROM: James R. Plummer
SUBJECT: Susitna Hydroelectric Project
Concrete Mix Design

Date: January 20, 1982
File: P5700.07.09

Reference should be given to your memo of January 15, 1982.

1 - Arch Dam

Concrete mix design for Devil Canyon arch dam shall be:

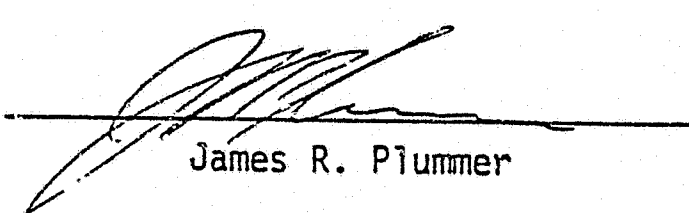
- a) Strength: 5,000 psi at 90 days
- b) Cement: Low Heat, Type IV.
- c) Water Cement Ratio: .40
- d) Maximum Aggregate Size: 3"

The estimate shall also be based on:

- a) Lift Height: 5'
- b) Joint Spacing: 50' along the length of dam fall width
of arch dam
- c) Reinforcing Steel: 7 lbs/cy

2 - Other Structures

Please refer to our memo dated January 16, 1982, attached.


James R. Plummer

JRP:dmb

Attachment

cc: F. Toth
R. Lang
R. Beal
J. Lawrence
J. Hayden
R. Ibbotson
D. Lamb
N. Bond