

PART - II

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- 1. DIVERSION TUNNEL CONSTRUCTION METHODS
In (Indonesia)**
- 2. DIVERSION TUNNEL CONSTRUCTION METHODS
In (Myanmar)**

PART - II

DIVERSION CHANNEL CONSTRUCTION METHODS

Vs

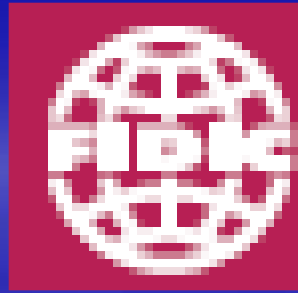
DIVERSION TUNNEL CONSTRUCTION METHODS

Presented by:

WIN MYINT THEIN

AGTI . MINING (1978) BE. MINING (1983)

PE 0202, ACPE 01187/MM, AE 9222



“**FIDIC**” means the Fédération Internationale des Ingénieurs-Conseils,
the International Federation of Consulting Engineers.

Conditions of Contract
for **CONSTRUCTION**

FOR BUILDING AND ENGINEERING WORKS
DESIGNED BY THE EMPLOYER

First Edition 1999





FIDIC Rainbow Suite of Contracts (1)

Color	Title	Edition	Year	Design	Engineer
Red	 CC for Construction (CC: Conditions of Contract) 	1 2 AMD	1999 2017 2022	Empl.	Yes
Pink	 MDB Harmonized Edition CC for Construction	1 2 3	2005 2006 2010	Empl.	Yes
Yellow	 CC for Plant and Design Build 	1 2 AMD	1999 2017 2022	Contr.	Yes
Silver	 CC for EPC/Turnkey Projects 	1 2 AMD	1999 2017 2022	Contr.	No

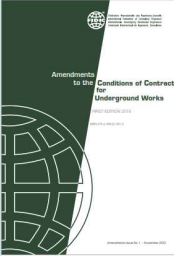
FIDIC Rainbow Suite of Contracts (2)

Color	Title	Edition	Year	Design	Engineer
Green 	Short Form of Contract 	1 2	1999 2021	Empl. or Contr.	No
Blue 	CC for Dredging and Reclamation Work	1	2006	Empl. or Contr.	No
Gold 	CC for Design, Build and Operate Projects	1	2008	Contr.	No
White 	Client/Consultant Model Services Agreement 	1 2 3 4 5	1990 1991 1998 2006 2017	-	-

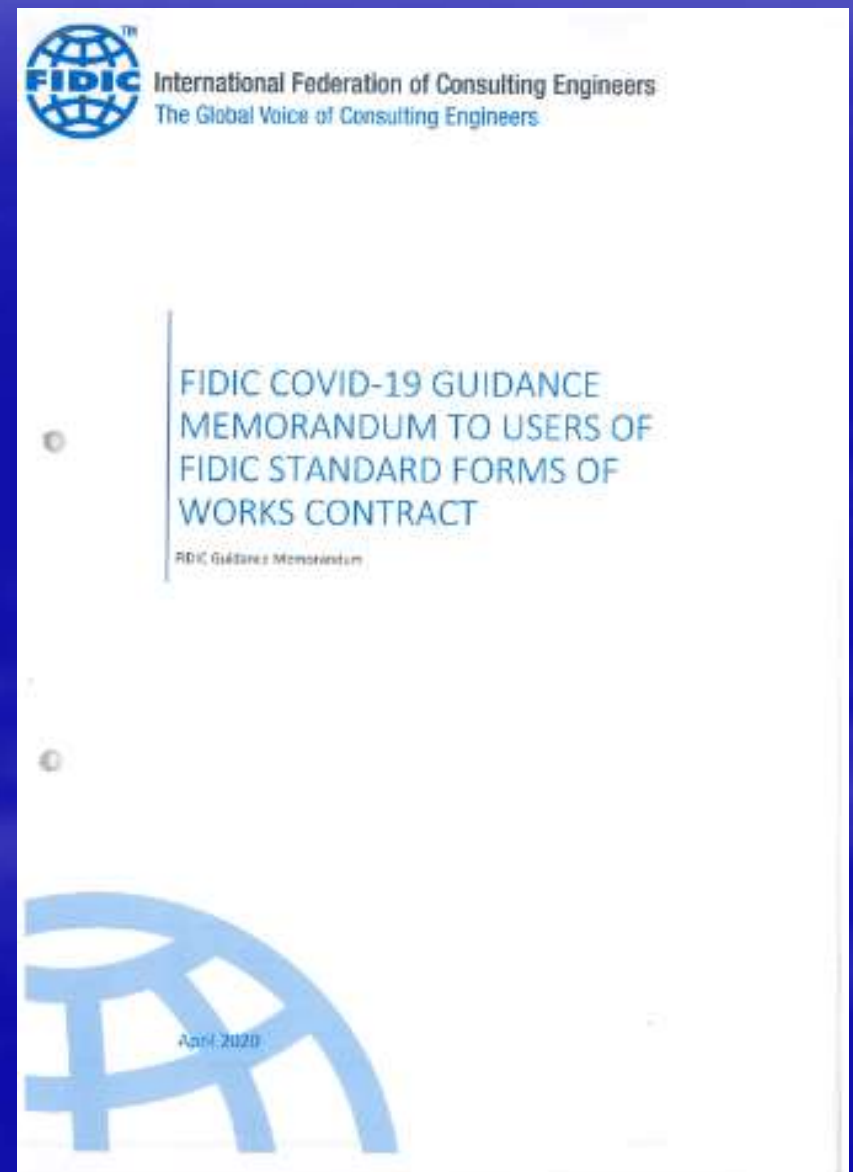
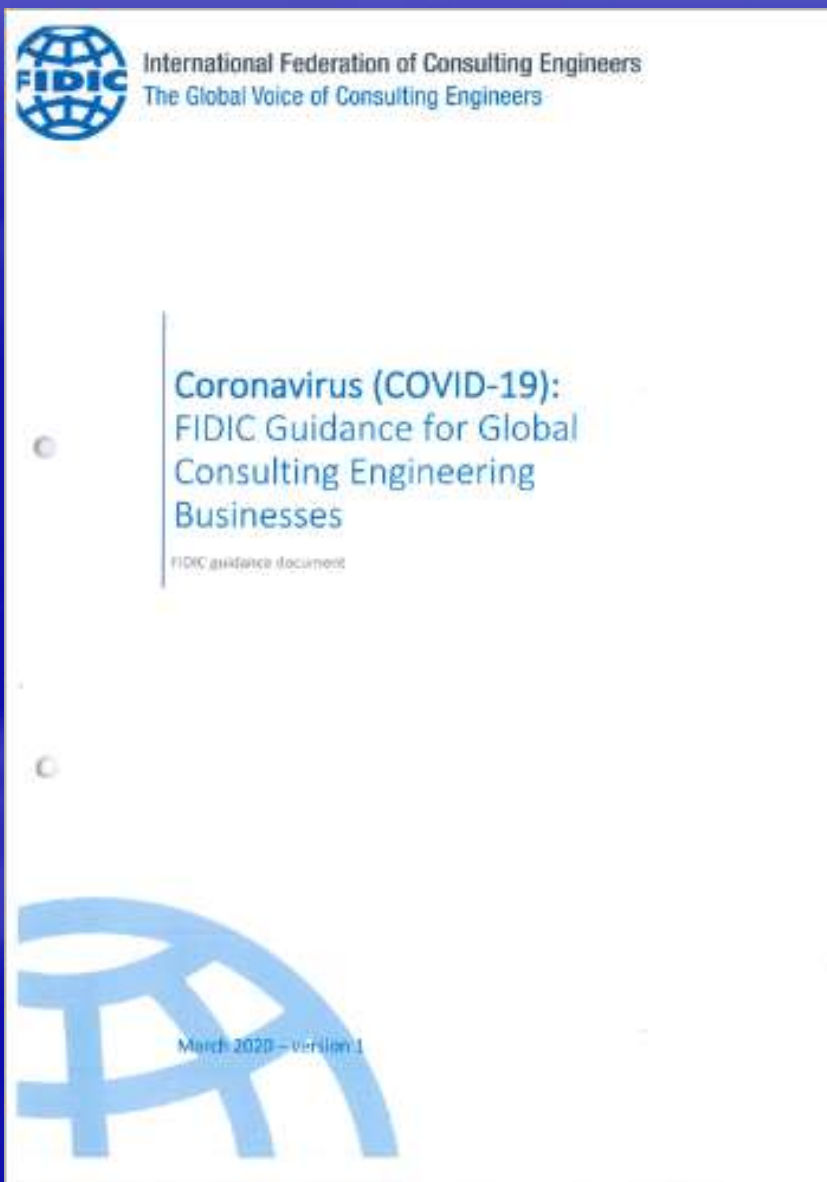
FIDIC Rainbow Suite of Contracts (3)

Color	Title	Edition	Year	Design	Engineer
	Joint Venture Agreement	1	1992	-	-
	Sub-consultancy Agreement	1	1992	-	-
	Construction Sub-contract	1	2011 2017	-	-
Orange 	CC for Design Build and Turnkey	1	1995		

NEW FIDIC CONDITIONS OF CONTRACTS

Color	Title	Edition	Year	Design	Engineer
<div>Emerald</div> 	Conditions of Contract for Underground Works (a joint initiative with ITA-AITES (the International Tunnelling and Underground Space Association)).	1 AMD	2019 2023	Contractor	YES

Covid-19





Fédération Internationale des Ingénieurs-Conseils
International Federation of Consulting Engineers
Internationale Vereinigung Bauingenieur-Ingenieur
Federación Internacional de Ingenieros Consultores

PINK BOOK

Conditions of Contract for Construction

MDB HARMONISED EDITION

FOR BUILDING AND ENGINEERING WORKS DESIGNED BY THE EMPLOYER

GENERAL CONDITIONS
PARTICULAR CONDITIONS
SAMPLE FORMS



ISBN 2 - 81432 - 944 - 9

MDB HARMONISED EDITION 2002



RED BOOK

Fédération Internationale des Ingénieurs-Conseils
International Federation of Consulting Engineers
Internationale Vereinigung Bauingenieur-Ingenieur
Federación Internacional de Ingenieros Consultores

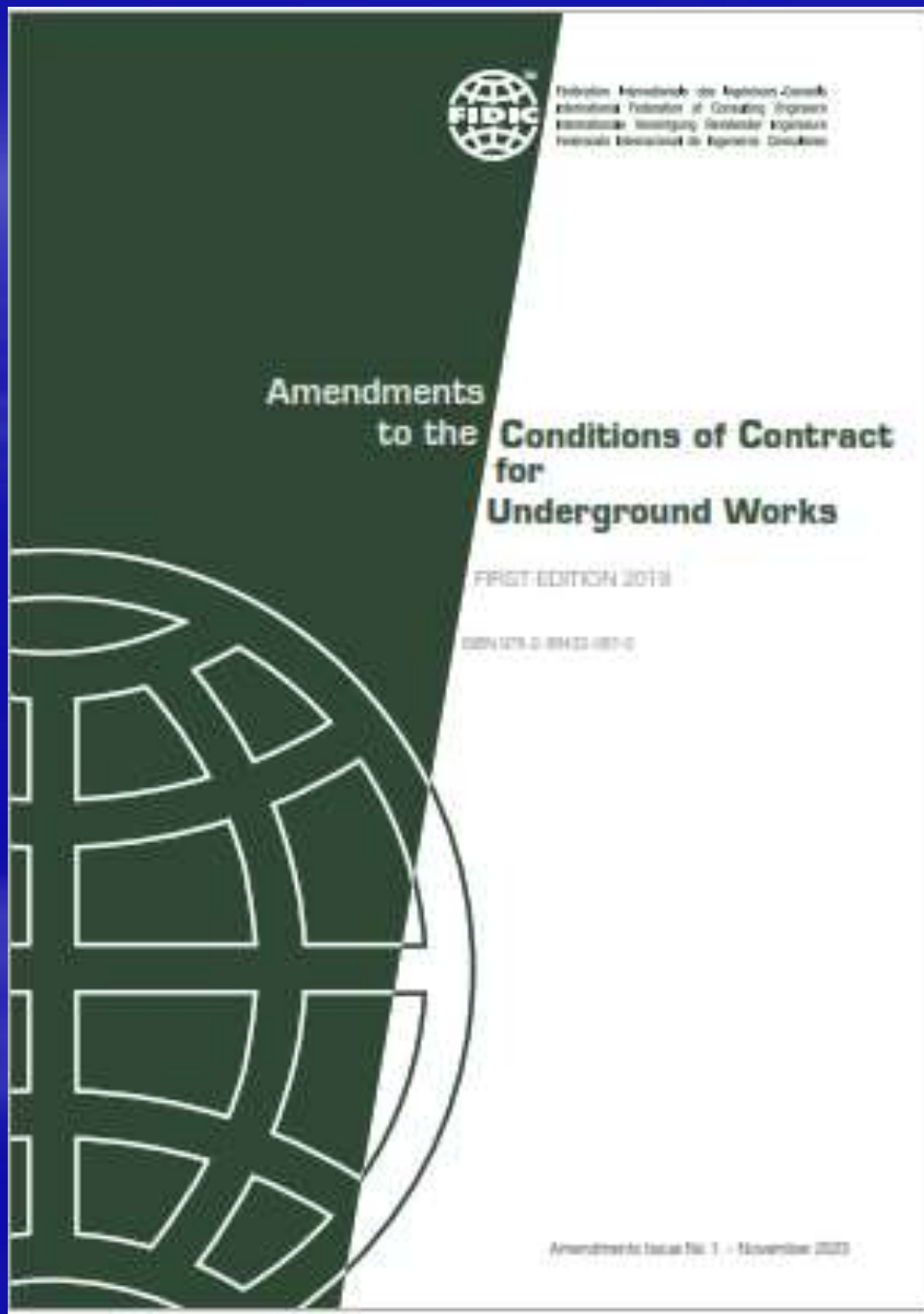
Conditions of Contract for Construction

GENERAL CONDITIONS
GUIDANCE FOR THE PREPARATION
OF PARTICULAR CONDITIONS AND ANNEXES
FORMS OF SECURITIES
FORMS OF LETTER OF TENDER, LETTER OF
ACCEPTANCE, CONTRACT AGREEMENT AND DISPUTE
ADJUDICATION AVOIDANCE AGREEMENT



ISBN 919 2-88432-094-9

SECOND EDITION 2017



The Conditions of Contract for Underground Works

General Conditions

13 VARIATIONS AND ADJUSTMENTS

13.1 Right to Vary

13.2 Value Engineering

13.3 Variation Procedure

13.4 Payment in Applicable Currencies

13.5 Provisional Sums

13.6 Daywork

13.7 Adjustments for Changes in Legislation

13.8 Adjustments for Changes in Cost

INTERNATIONAL CONTRACT DOCUMENTS

The Contract Consists of the following documents:

1. HEAD OF AGREEMENT
2. SCOPE OF WORKS
3. COMMERCIAL TERMS
4. SPECIAL TERMS AND CONDITIONS (STC)
5. GENERAL TERMS AND CONDITIONS (GTC)
6. SPECIFICATIONS
7. DRAWINGS

Special Terms and Conditions of Contract

Value Engineering

The Contractor, the Client and the Client's Representative shall made every effort to find and shall collaborate in implementing cost reduction measure in the execution of the Works. Without limiting the foregoing these cost reduction measures shall apply to the design, methods, materials and construction schedule applicable to the execution of the Works.

The Contractor shall submit a proposal for the cost reduction measure. The proposal shall include:

- 1.A description of the proposal cost reduction measure and a program for the execution
- 2.The Contractor's proposal for any necessary modifications to the Contract schedule.
- 3.The Contractor's proposal for adjustment to the Contract Price.

Implementation of any cost reduction measure shall be subject to written acceptance by the Client's Representative and shall not proposed prior to such acceptance.

The Contract Schedule shall be revised, as agreed between the Contractor and the Client's Representative to include any changes resulting from the implementation of the cost reduction measures.

The monetary value of the cost reduction measure shall be determined in according with the contract clause, pricing for changes in Price Schedule, Commercial Terms.

The amount so determined shall be shared equally between the Contractor and the Client.

Special Terms and Conditions of Contract

LAND SLIDE



LAND SLIDE



SLOPE PROTECTION BEFORE PROJECT COMMENCEMENT



2 12 2005

DIVERSION CHANNEL CONSTRUCTION METHODS

Bill of Quantities

1. Mobilization and Demobilization
2. Excavation and Ground Support Works
3. Concrete Works
4. Grouting Works
5. Mechanical Works

DIVERSION TUNNEL CONSTRUCTION METHODS

Bill of Quantities

1. Mobilization and Demobilization
2. Excavation and Ground Support Works
3. Concrete Works
4. Grouting Works
5. Mechanical Works

Advantages and Disadvantages

Channel

Advantages

1. Easy Construction
2. Less Safety Cost
3. Construct with normal skill workers
4. Normal Construction Equipment

Disadvantages

1. More Environmental Damages
2. More Rock Excavation required for future Construction Access
3. Risk on Working Heavy Rain
4. Higher Slope Protection Cost

Tunnel

1. No. Environmental Damages
2. Reduce Construction Schedule
3. Remain Access Road for Future Construction Works
4. Working on Heavy Rain

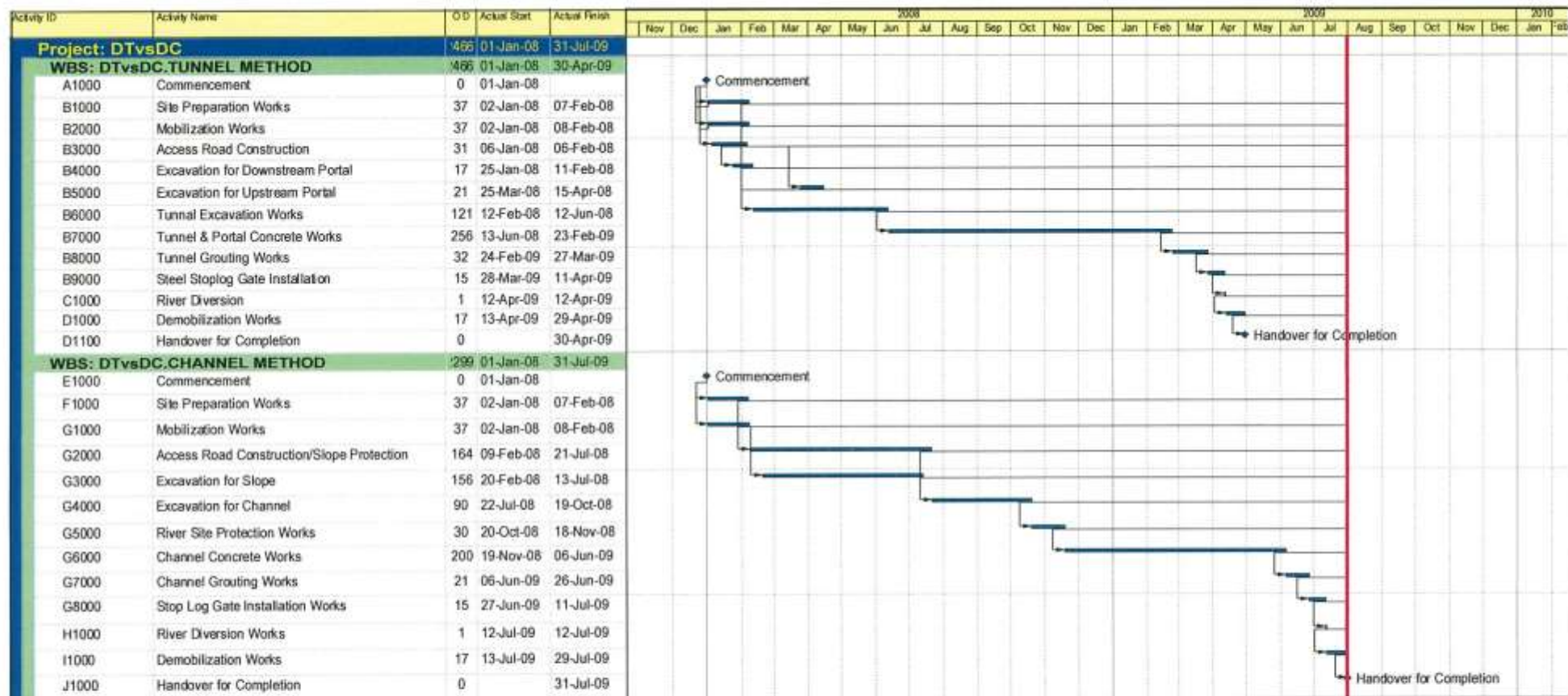
1. Special Skill Workers required
2. More Safety Cost
3. More Length for Concrete Works

COST COMPARISON TABLE

WORK ITEMS DESCRIPTION	UNIT	CHANNEL QTY	TUNNEL QTY				CHANNEL COST US\$	TUNNEL COST US\$
			Main Tunnel	U/S Portal	D/S Portal	Total		
MOBILIZATION & DEMOBILIZATION	LS	1	1			1	806,640	1,109,142
EXCAVATION	m3	108,193	13,573	9893	8273	31,739	4,543,024.07	3,898,153.34
SHOTCRETE 50 ~ 100 mm thick	m2	8,457	4,812	966	165	5,943	987,777.60	694,142.40
WIREMESH	m2	8,457				-	134,381.73	-
ROCKBOLTS	Ea	1,119	1,437	39	47	1,523	412,105.32	560,890.44
Form Work	m2	8,195	4,295	959	1046	6,300	726,077.00	558,180.00
Rebar	ton	1,756	2,492	105	82	2,679	1,791,120.00	2,732,580.00
Concrete	m3	11,657	2088	1232	1028	4,348	1,498,857.06	559,065.84
Grouting	m	395	1423			1,423	52,930.00	190,682.00
Road Side Barries	m	265				-	11,421.50	-
Drain Holes	m	186	1232			1,232	4,320.78	28,619.36
Installation of Steel Stoplog Gate	LS	1	1			1	65,702.00	65,702.00
TOTAL COST							10,964,334.28	10,302,836.02

Result : Channel Cost > Tunnel Cost

SCHEDULE COMPARISON



Project Start: 01-Jan-08

Project Finish: 31-Jul-09

Data Date: 31-Jul-09

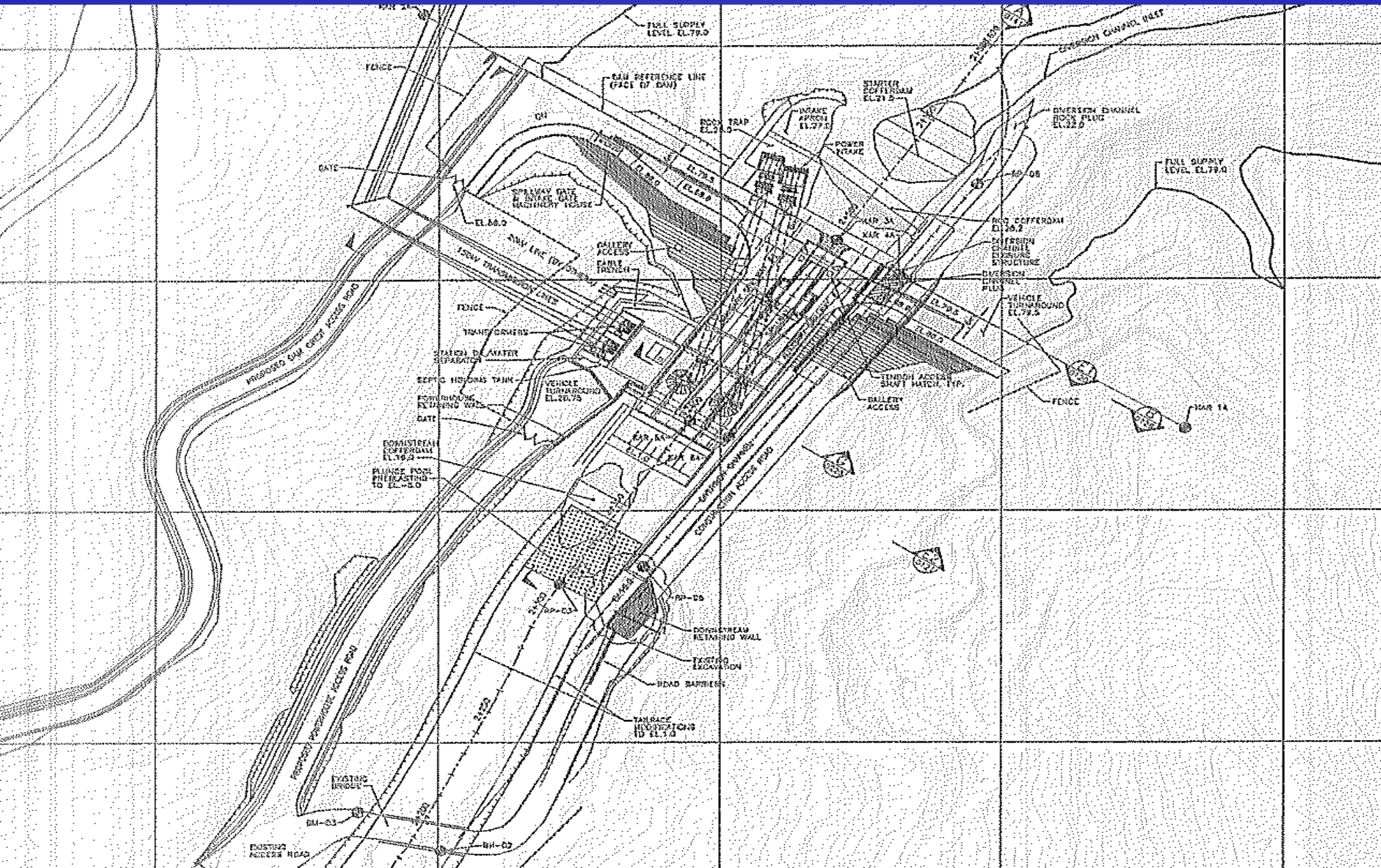
DIVERSION WORKS CONSTRUCTION SCHEDULE

CHANNEL Vs TUNNEL

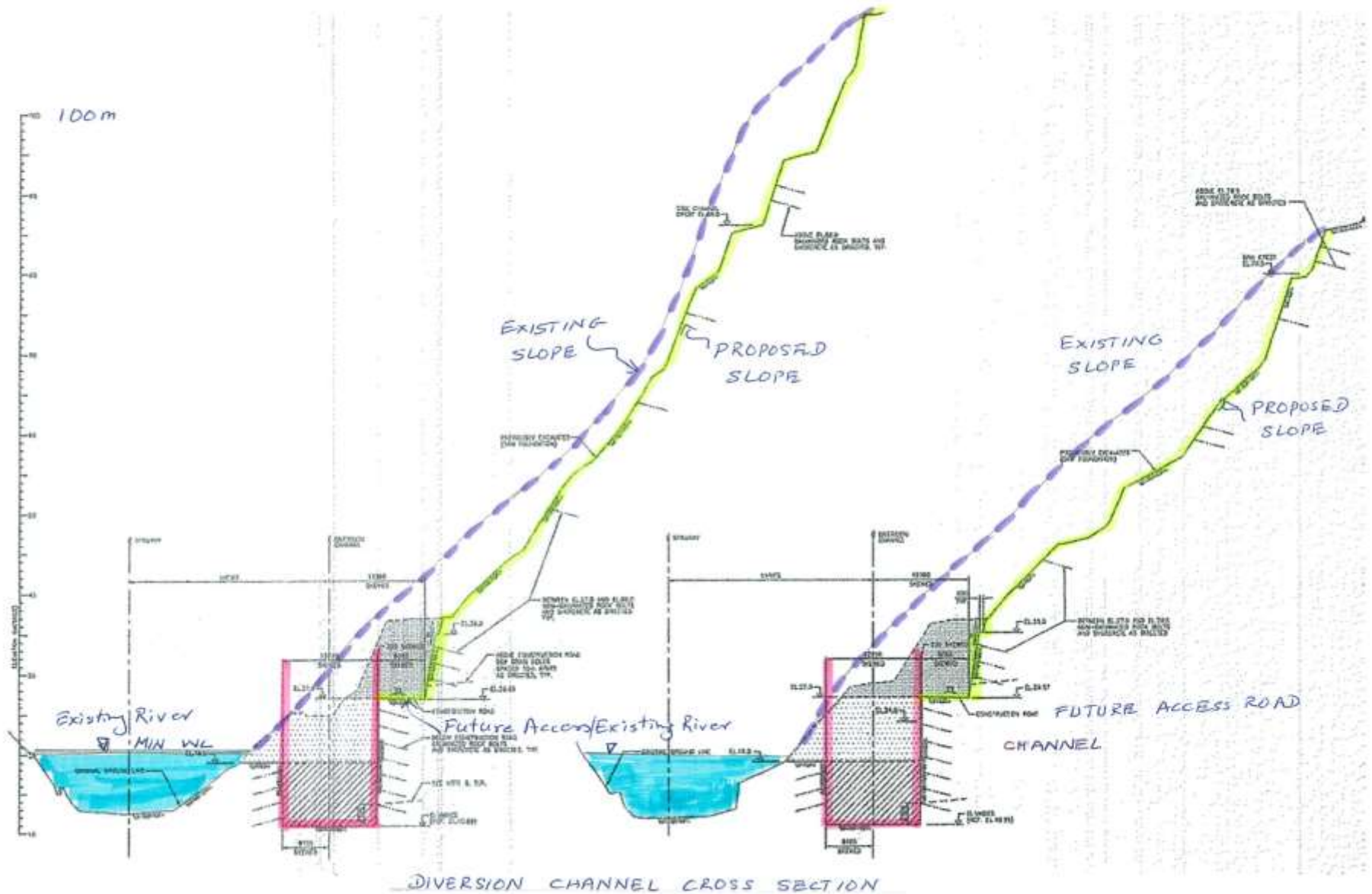
MASTER SCHEDULE

- Baseline
- Critical Bar
- Actual Level of Effort
- Actual Work
- ◆ Milestone

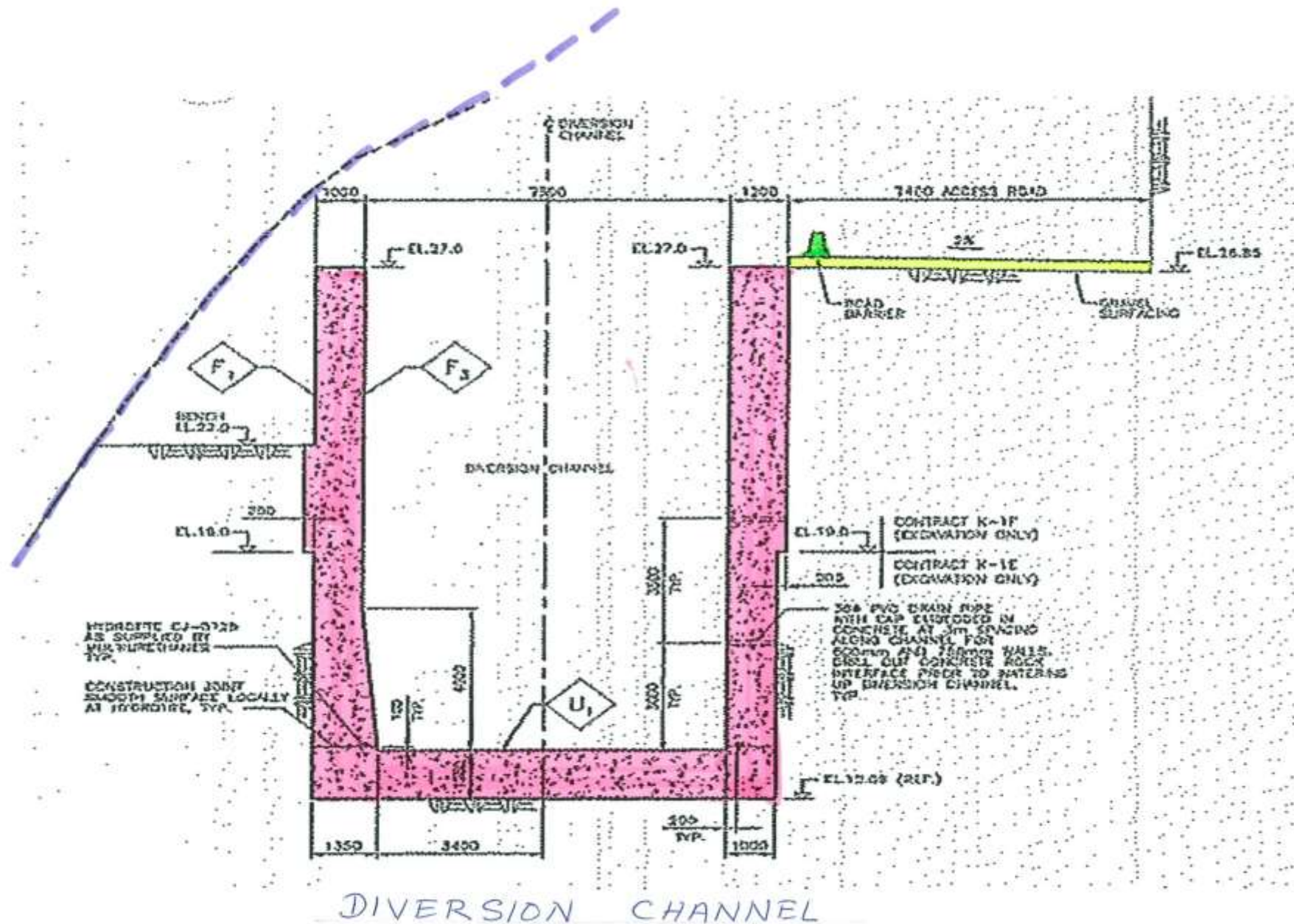
SITE LAYOUT PLAN



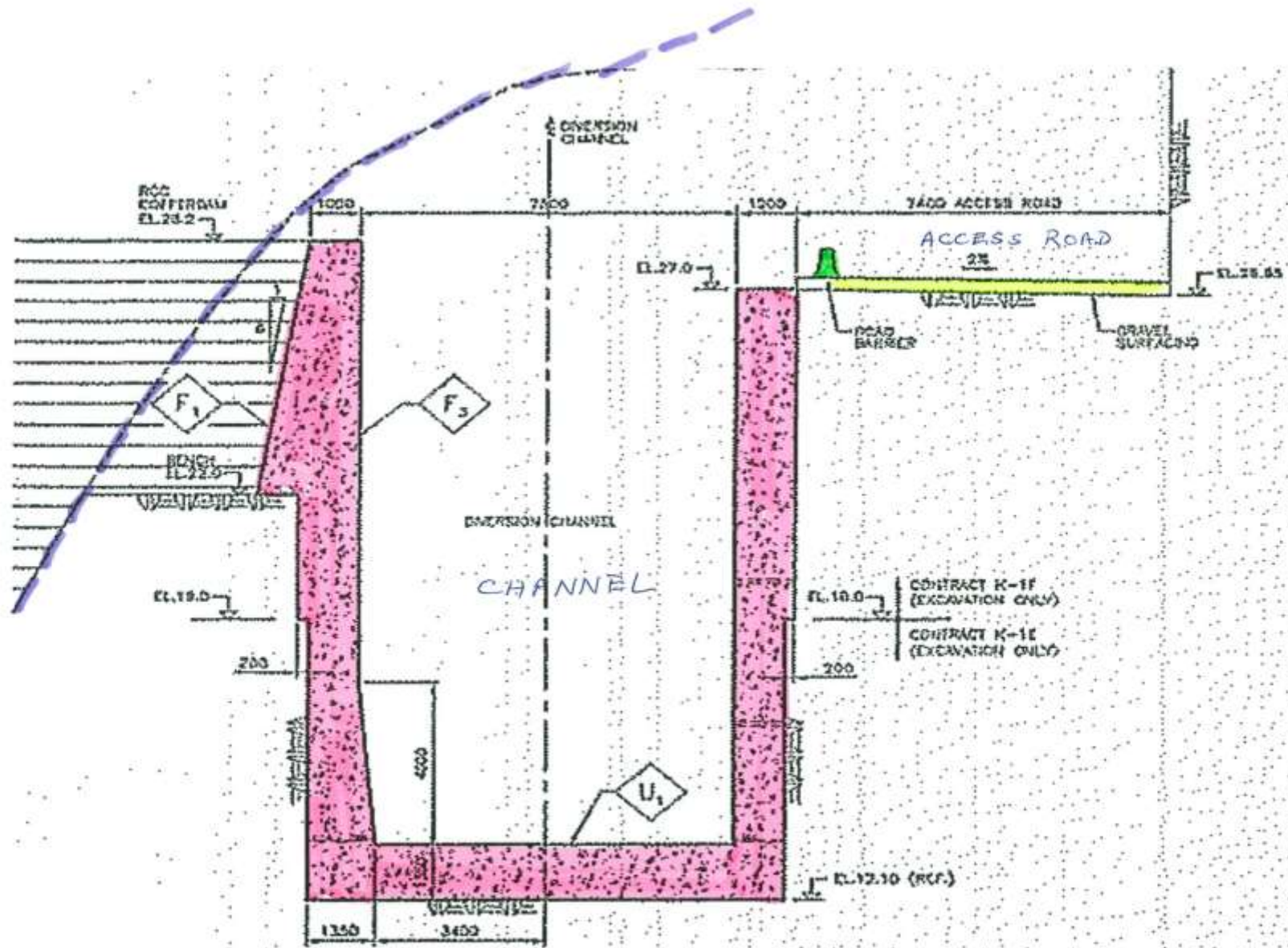
DIVERSION CHANNEL SECTION



DIVERSION CHANNEL SECTION DETAIL



DIVERSION CHANNEL CROSS SECTION

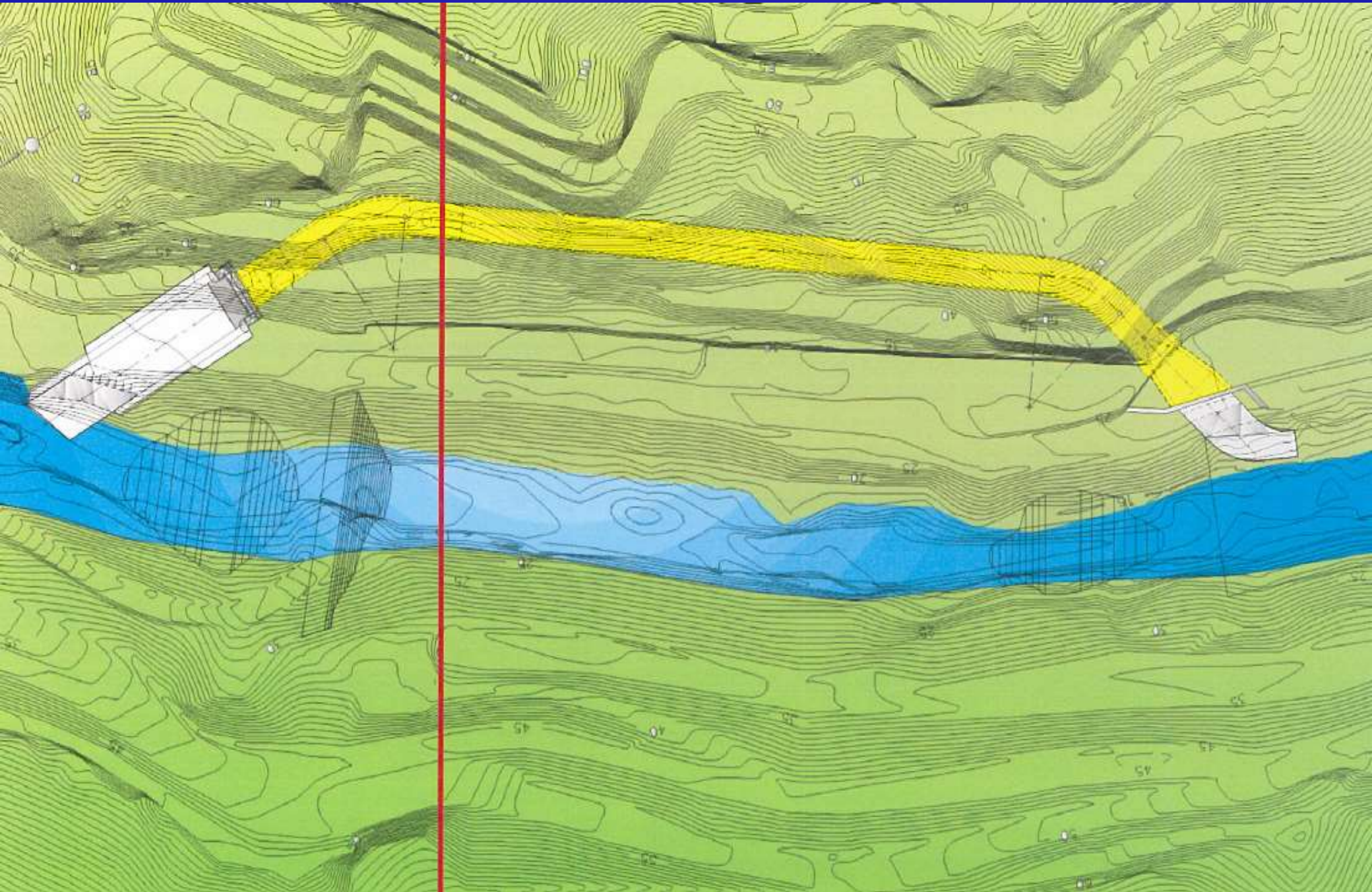


CROSS SECTION

Table 1-2 Quantities of concrete work

Area	Concrete (m ³)	Formwork (m ²)	Reinforcing (ton)	Remarks
UPSTREAM	1,055.78	821.27	38.86	
BOX CULVERT	5,229.02	2,115.46	236.09	
DOWNSTREAM	3,427.90	4,224.05	480.12	
Sub-total	9,712.70	7,160.78	755.07	
RETAINING WALL	1,944.18	1,033.62	0	
Total	11,656.88	8,194.40	755.07	

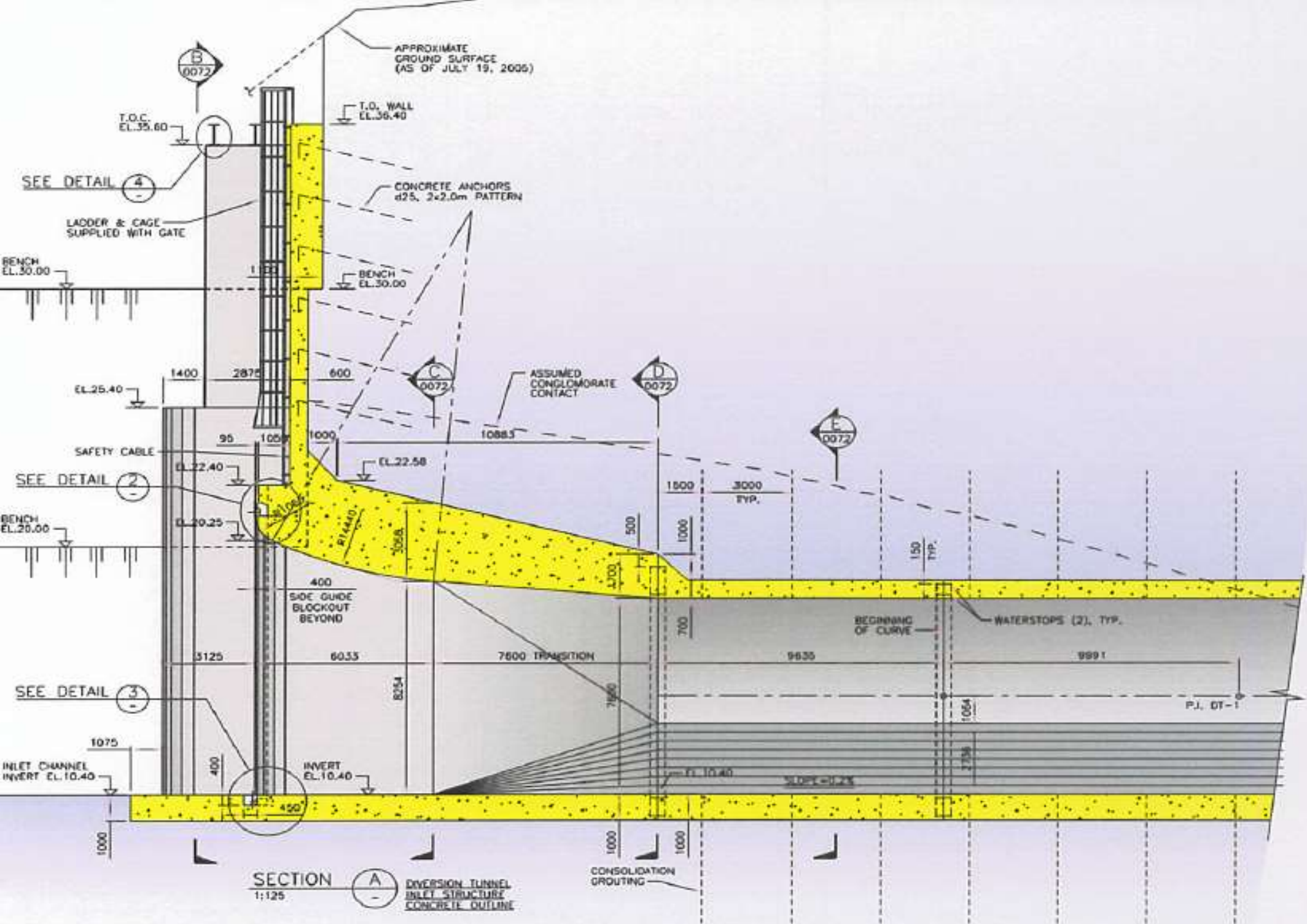
TUNNEL DESIGN

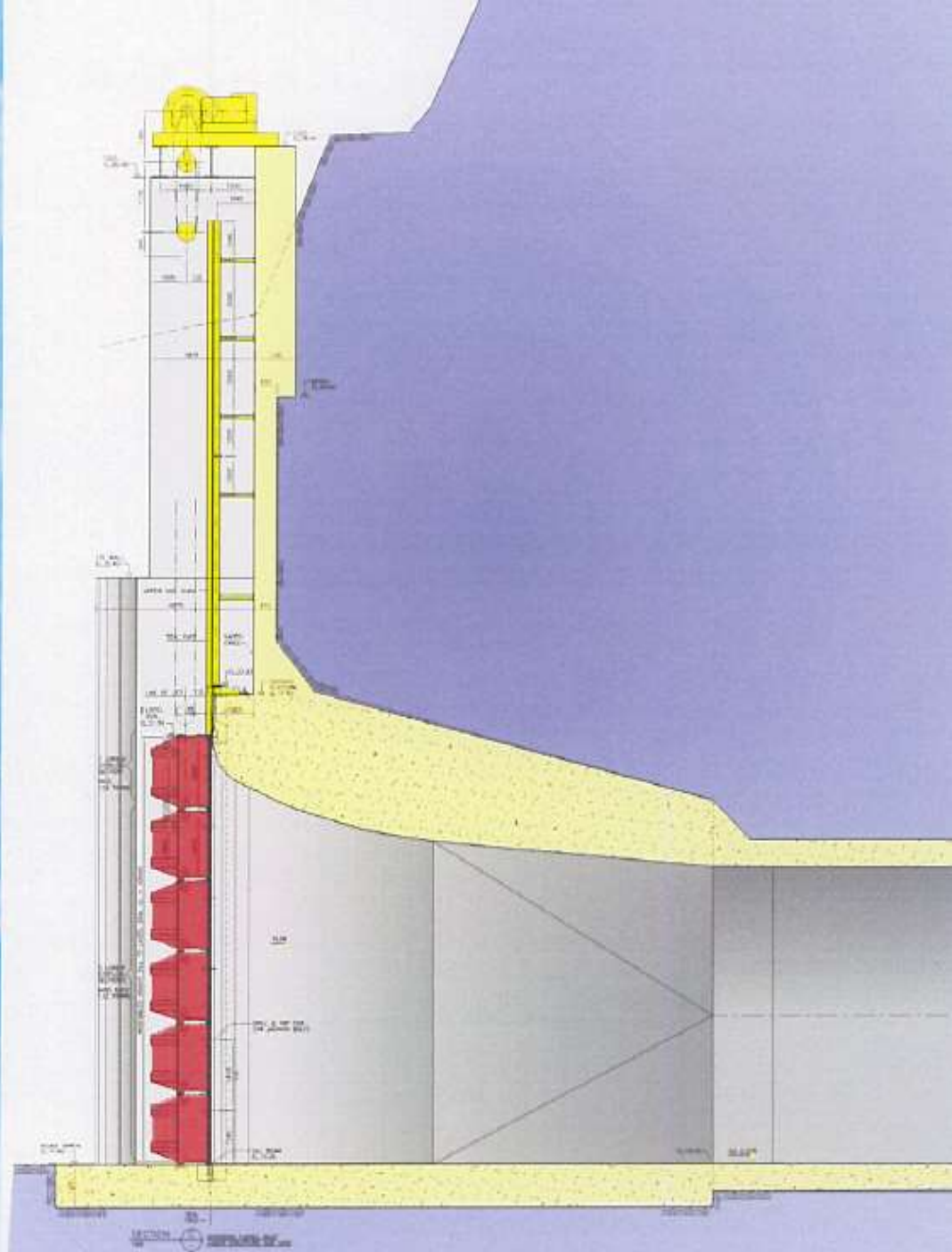
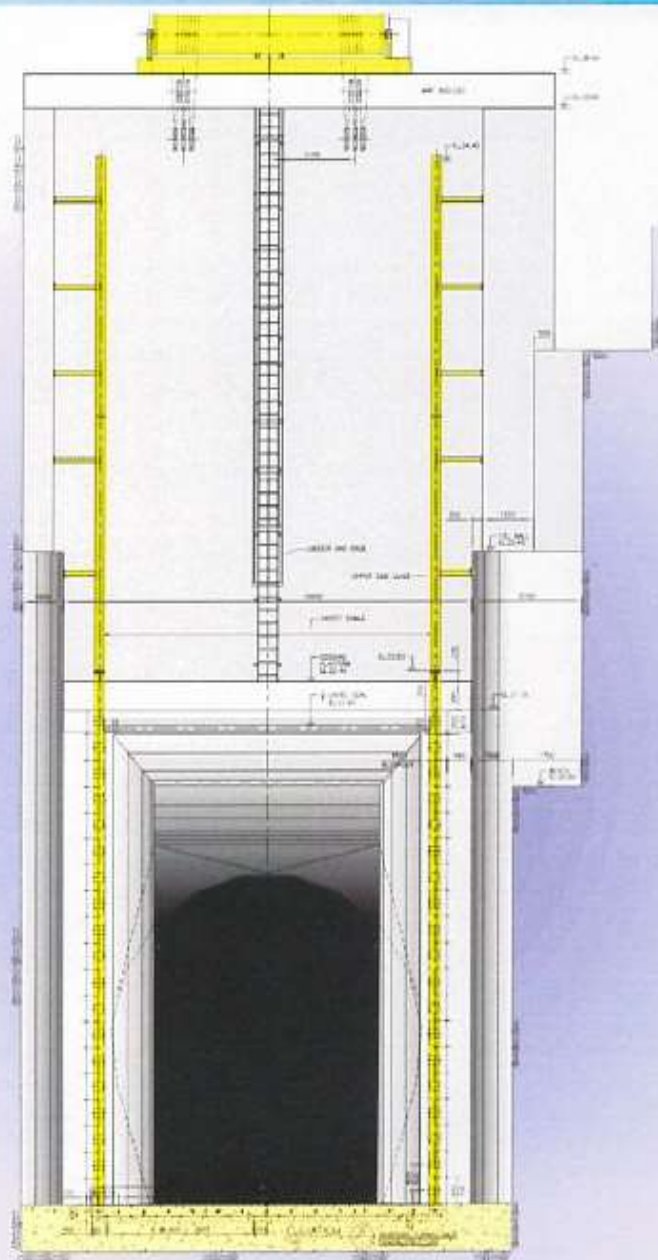


TUNNEL DESIGN CRITERIA

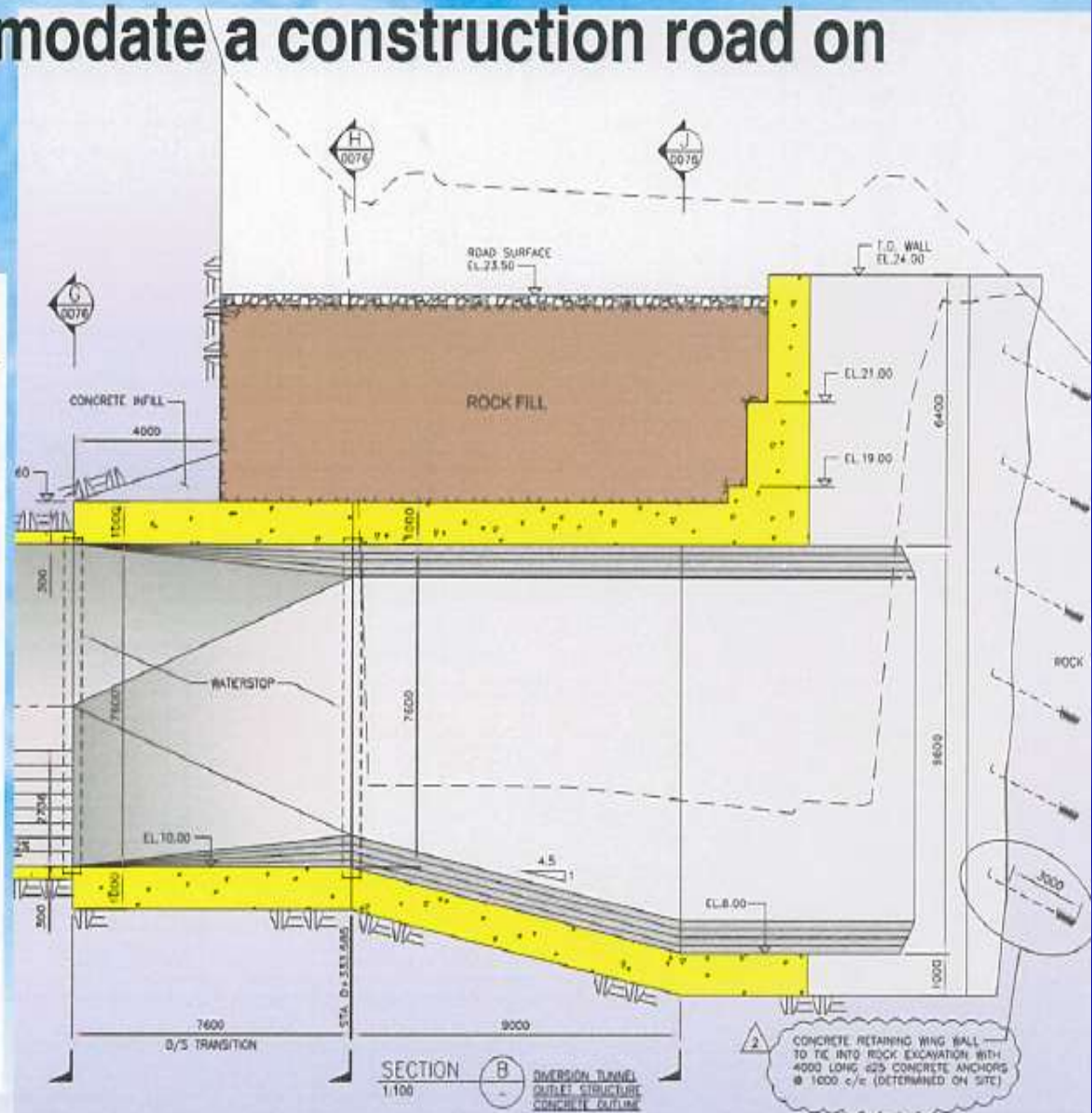
Design Criteria			
Length of Tunnel		218 m	
Lingth of Curve		76 m	
Length of Straight		142 m	
Length of Invert		246.4 m	
Edge of Inlet to Outlet		234.4 m	
Length of Culvert (Out let)		9 m	
Excavation Height of Tunnel (Min)		8.25 m	
Excavation Height of Tunnel (Max)		10 m	
Excavation Width of Tunnel (Min)		6.25 m	
Excavation Width of Tunnel (Max)		9 m	
Height of Tunnel		7.6 m	
Height of Tunnel (Inlet)		10.79 m	
Height of Tunnel (outlet)		7.6 m	
Width of Tunnel		7.6 m	
Width of Tunnel (Inlet)		7.6 m	
Width of Tunnel (outlet)		11 m	
Concrete Thickness (No Pressure)		300 mm	
Concrete Thickness (Pressure)		1000 mm	
Thickness of Shotcrete (Min)		50 mm	
Thickness of Shotcrete (Max)		100 mm	

- [illegible]



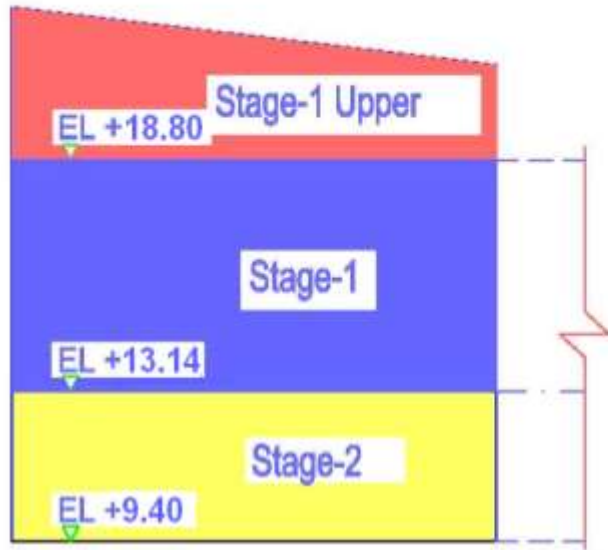


- The outlet structure concrete outline follows the hydraulic profile
- It is designed to accommodate a construction road on top.

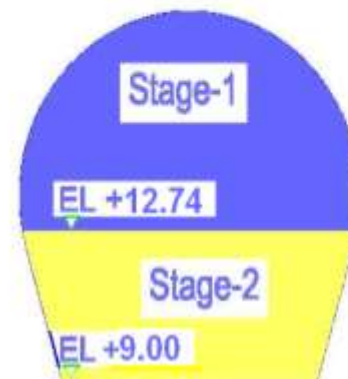
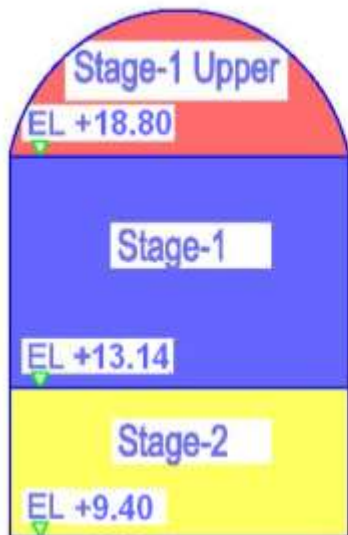
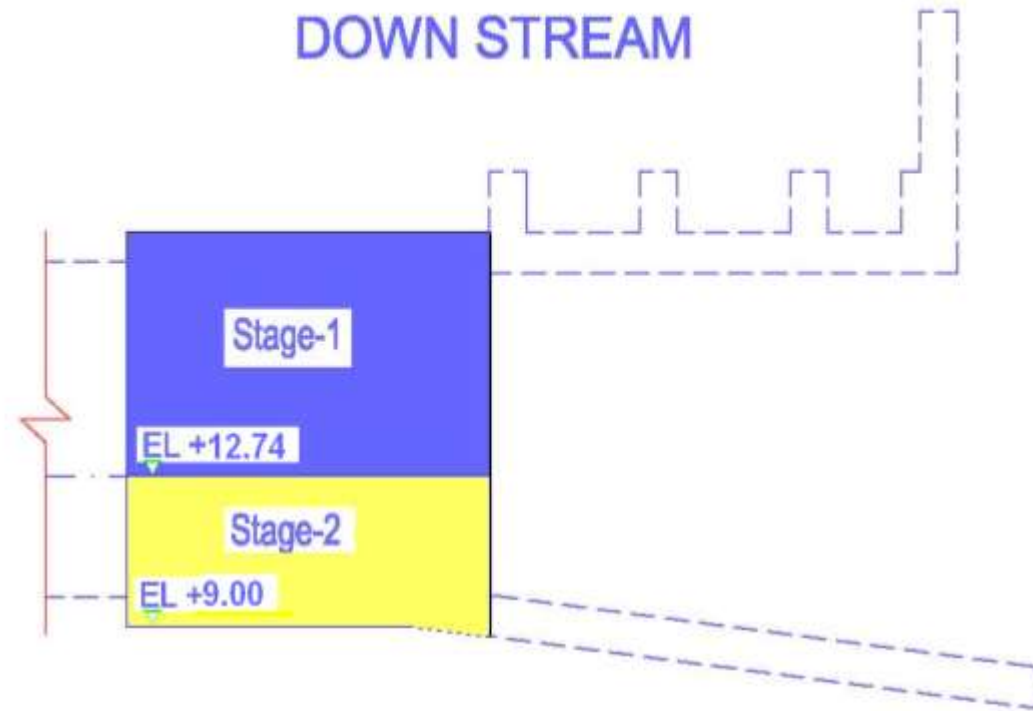


STAGE METHOD

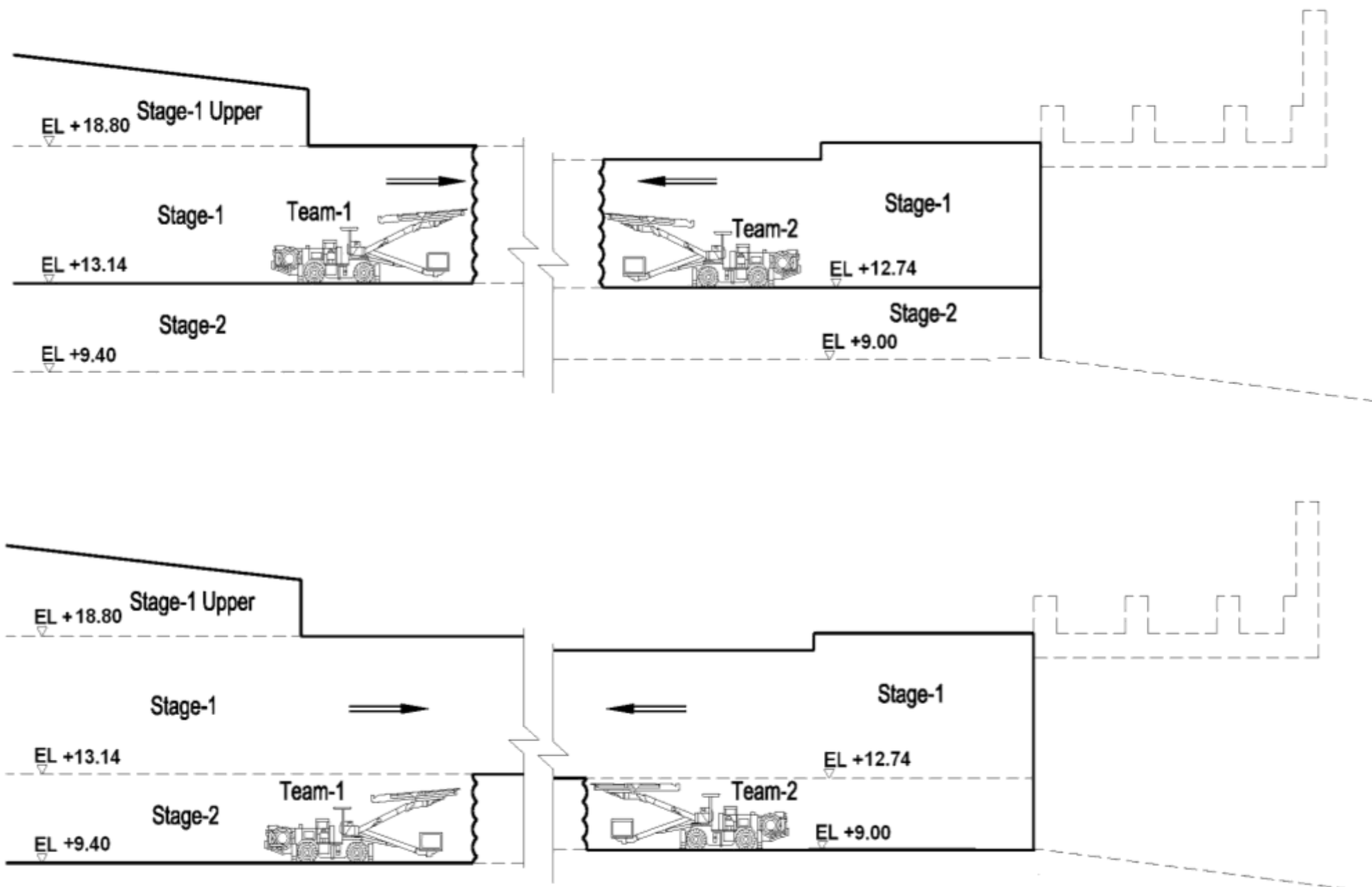
UP STREAM



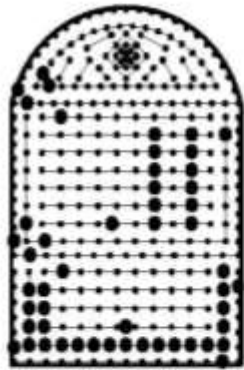
DOWN STREAM



Excavation Stages and Working Team



TUNNEL BLASTING PATTERN

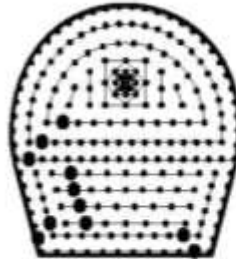


TYPE I (UPPER HALF) = 106 Nos
Area = 23.07 m²

TYPE I (UPPER HALF) = 131 Nos
Area = 50.86 m²

TYPE I (LOWER) = 86 Nos
Area = 33.62 m²

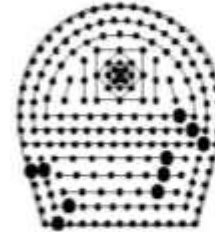
TYPE I



TYPE II (UPPER) = 143 Nos
Area = 42.17 m²

TYPE II (LOWER) = 78 Nos
Area = 24.28 m²

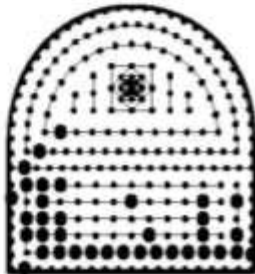
TYPE II



TYPE III (UPPER) = 133 Nos
Area = 33.54 m²

TYPE III (LOWER) = 64 Nos
Area = 20.13 m²

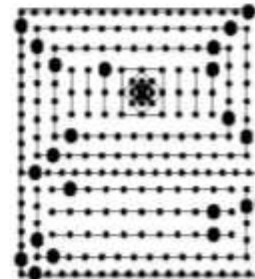
TYPE III



TYPE IV (UPPER) = 155 Nos
Area = 48.41 m²

TYPE IV (LOWER) = 96 Nos
Area = 35.87 m²

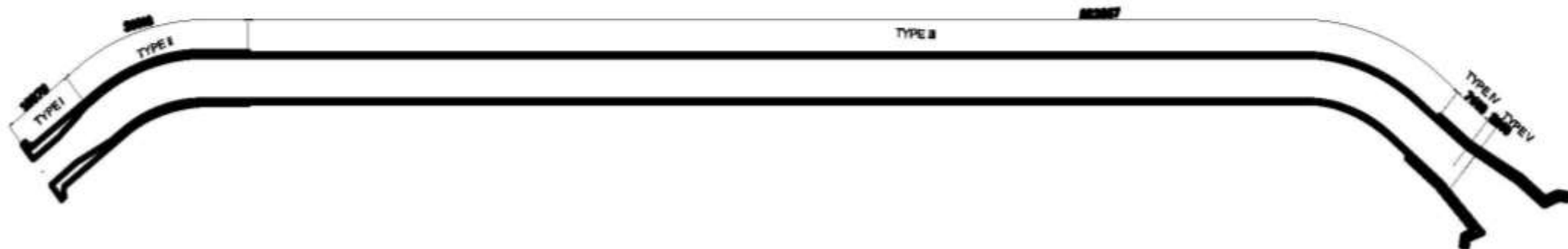
TYPE IV



TYPE V (UPPER) = 170 Nos
Area = 58.29 m²

TYPE V (LOWER) = 86 Nos
Area = 35.87 m²

TYPE V

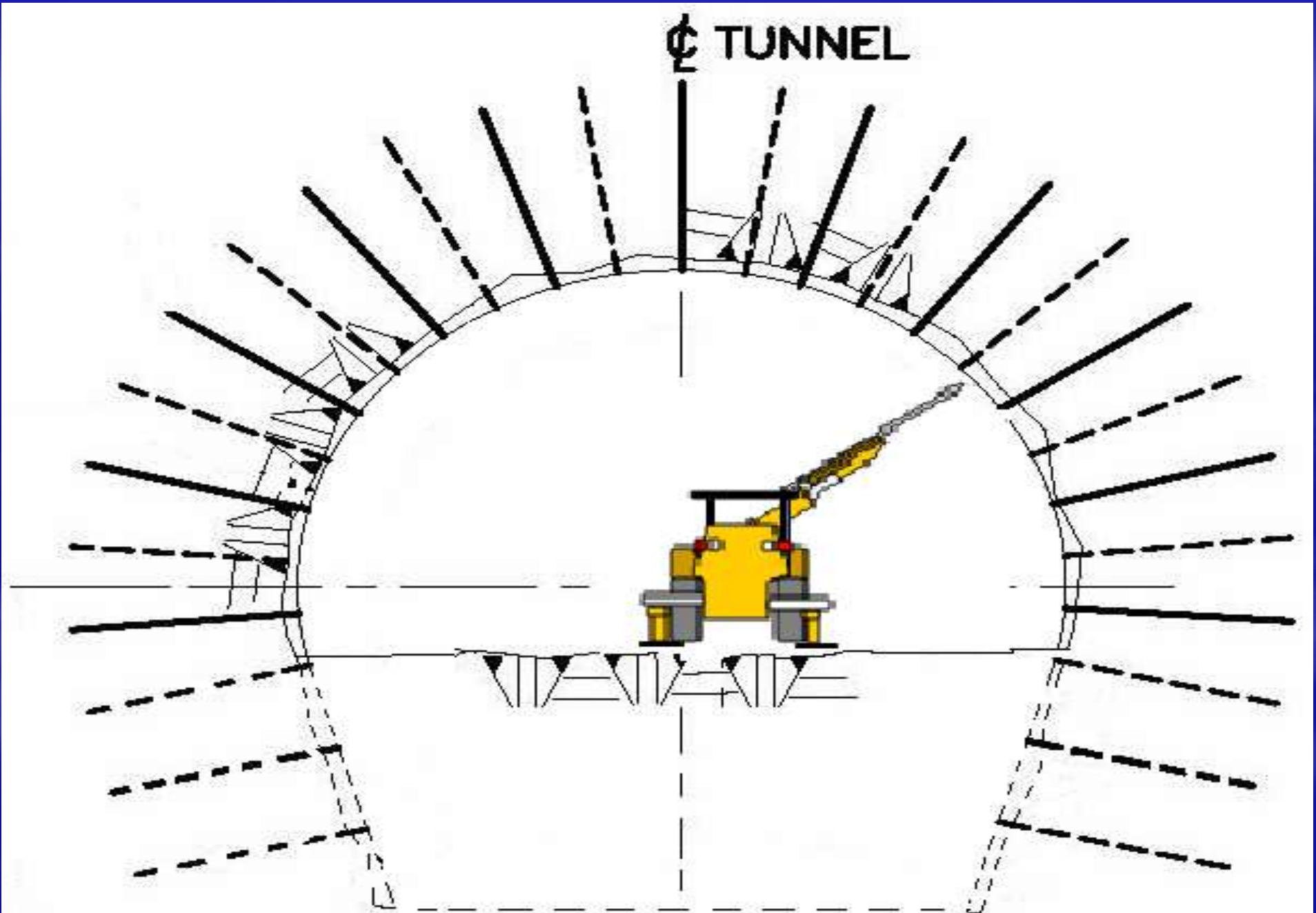


1 Underground Excavation for Diversion Works

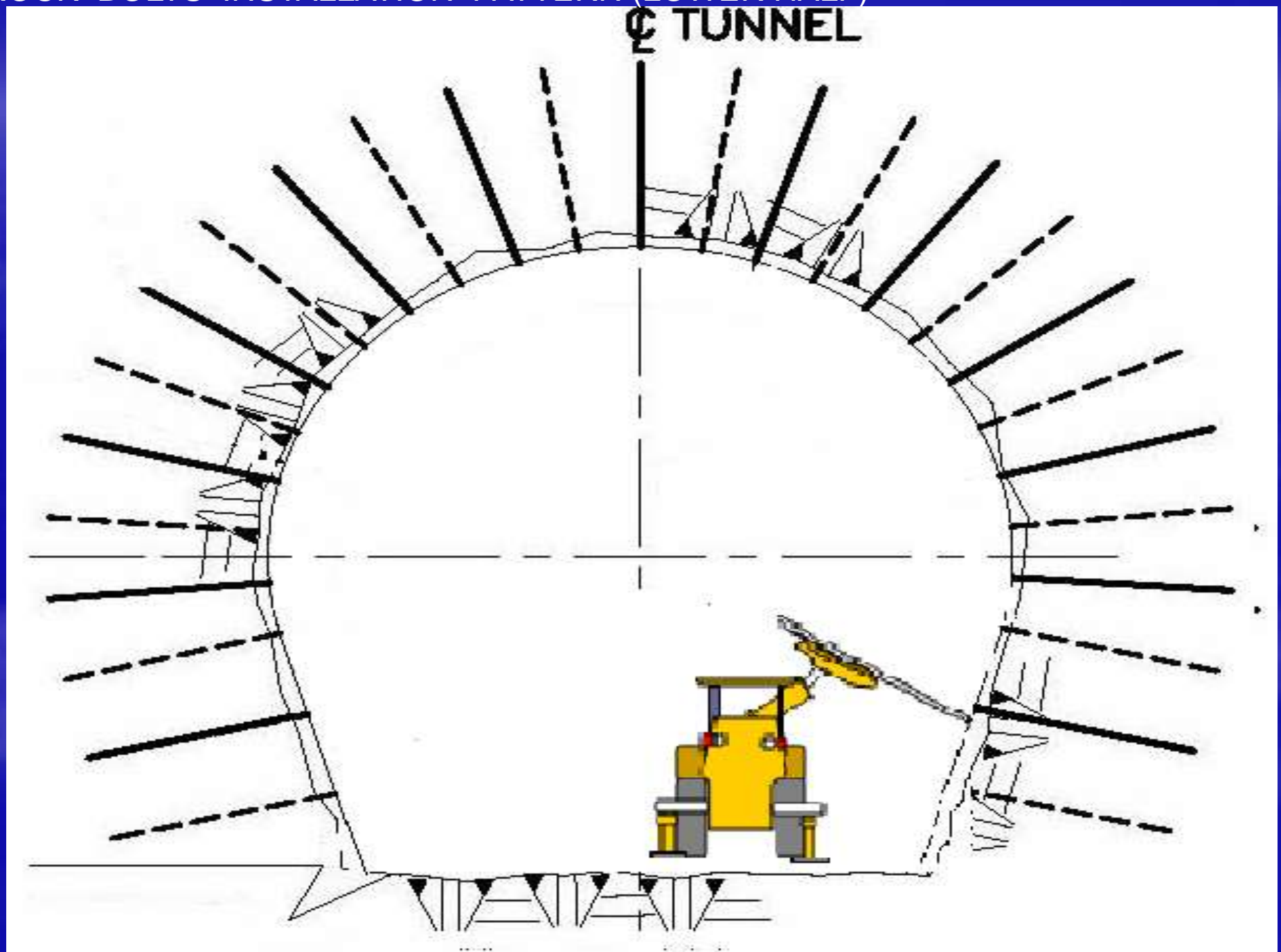
Karebbe Hydro Electric Power Plant

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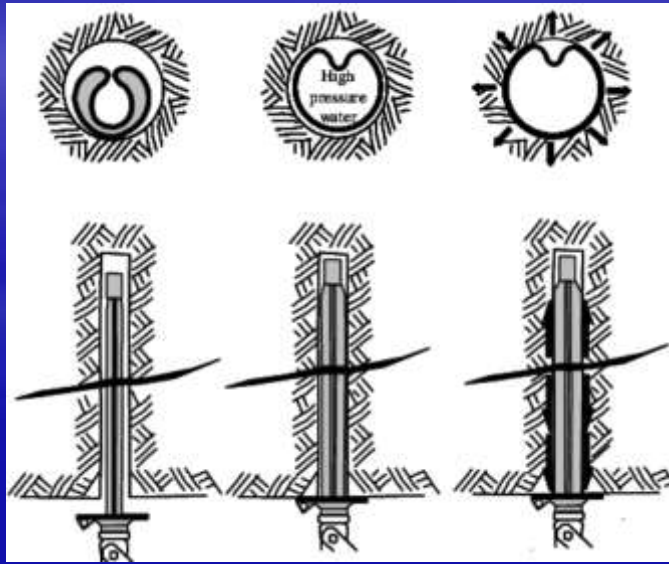
ROCK BOLTS INSTALLATION PATTERN (UPPER HALF)



ROCK BOLTS INSTALLATION PATTERN (LOWER HALF)



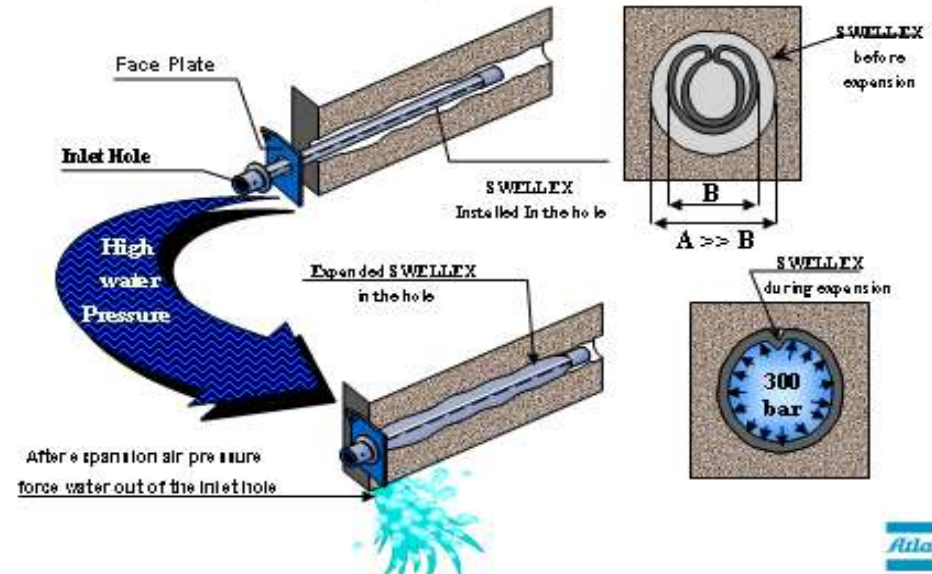
ROCK SUPPORT



Installation sequence

EXPANSION PRINCIPLES

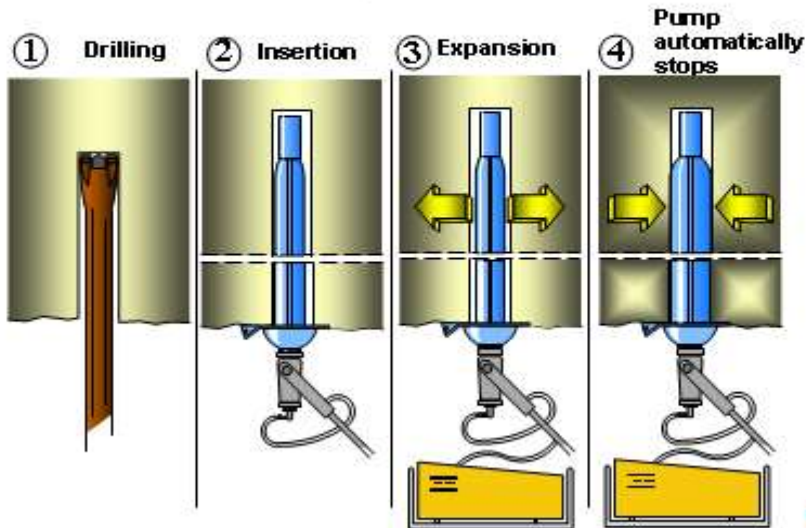
Swellex® Manganese Line



Atlas Copco

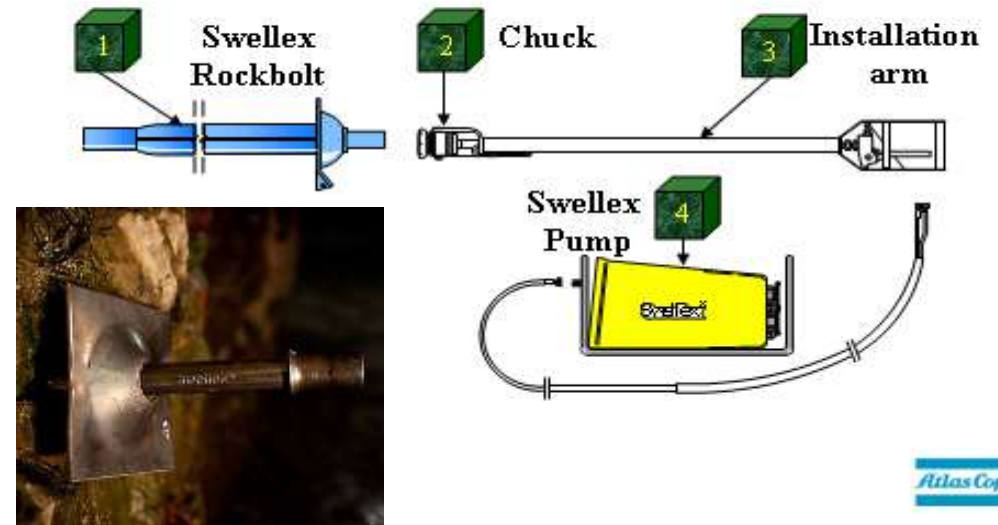
Principal components Swellex System

Swellex® Manganese Line



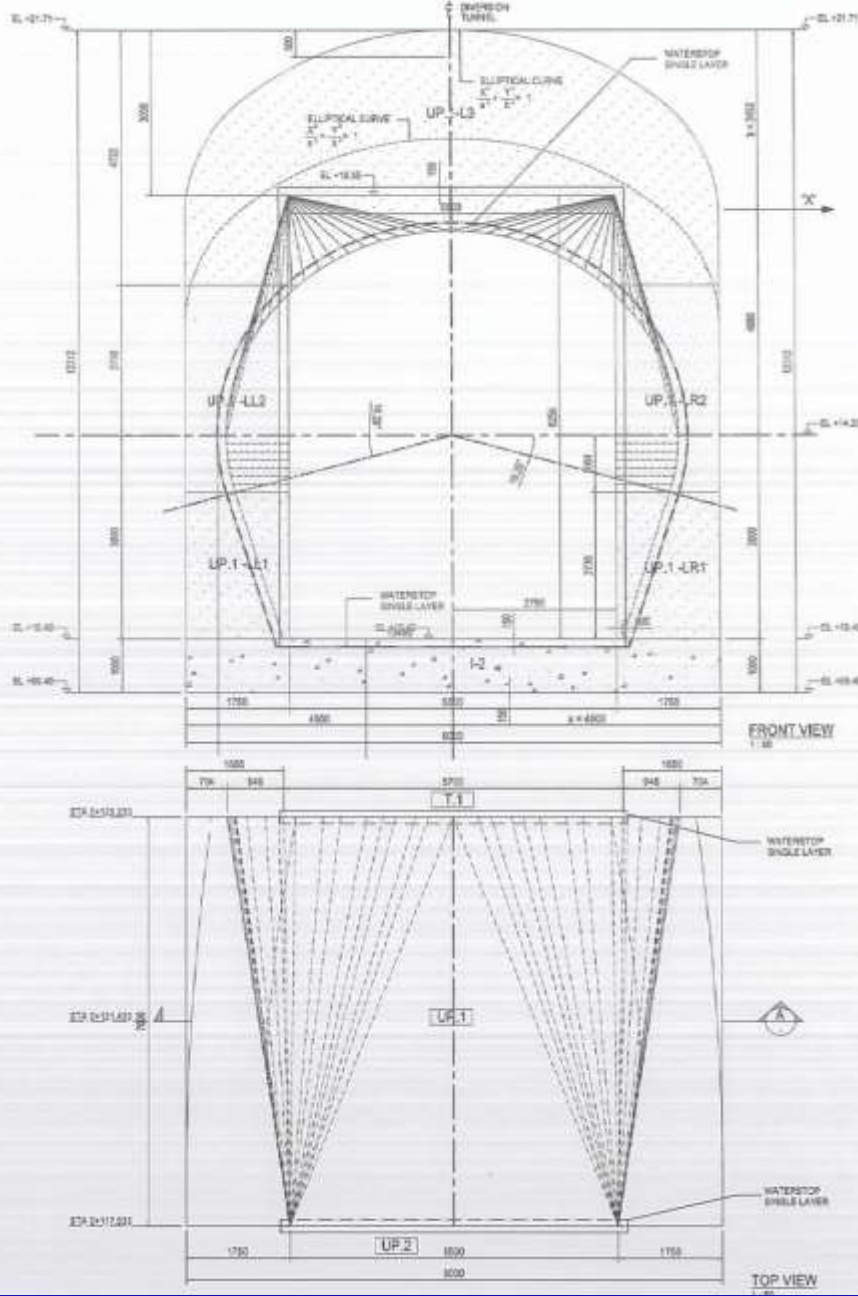
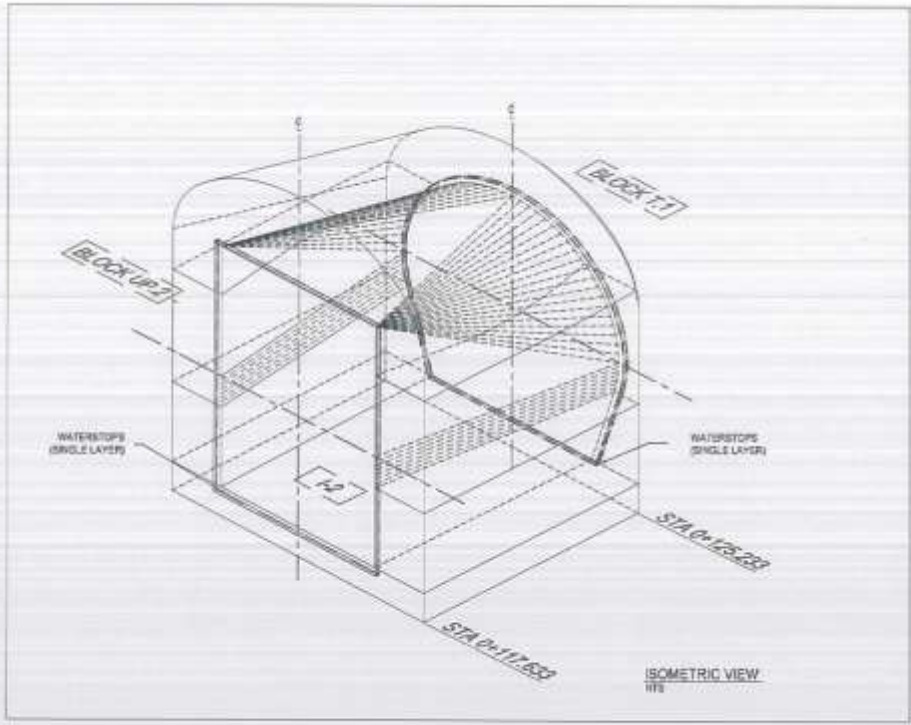
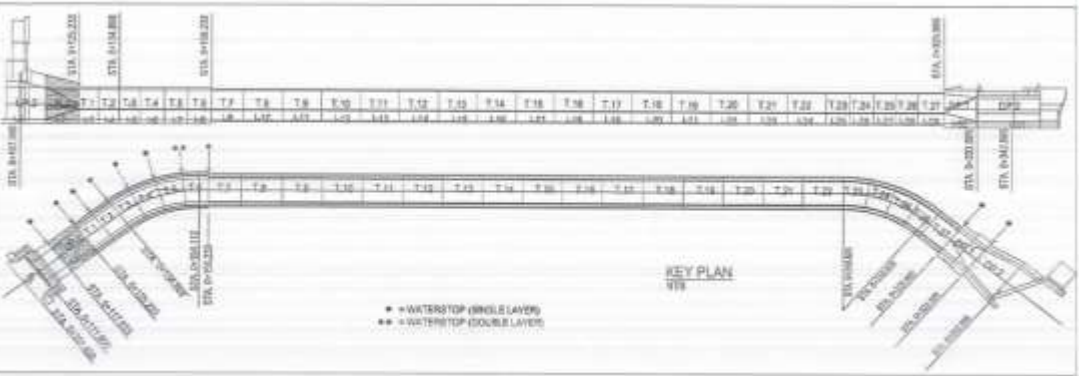
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Swellex® Manganese Line

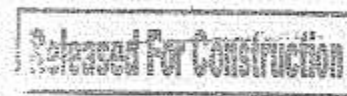
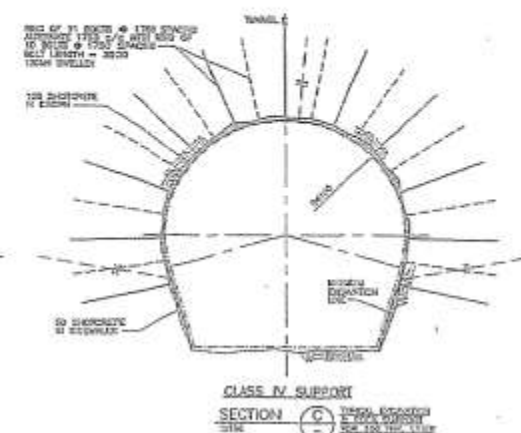
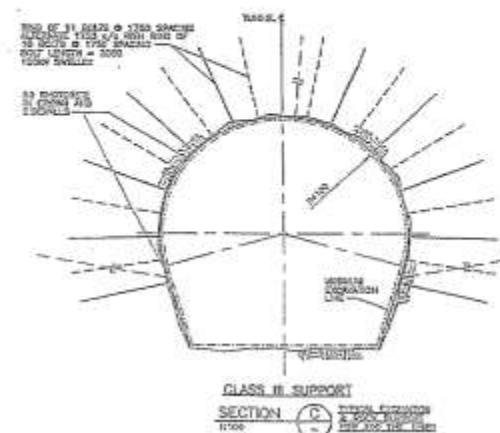
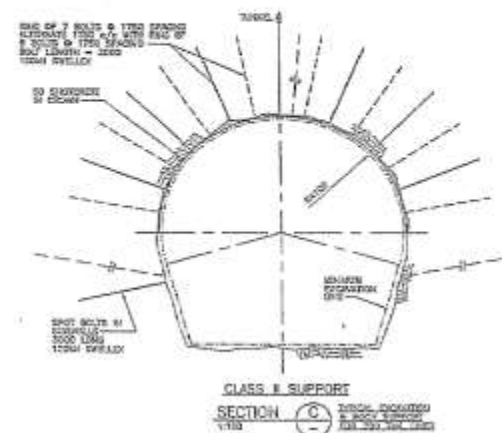
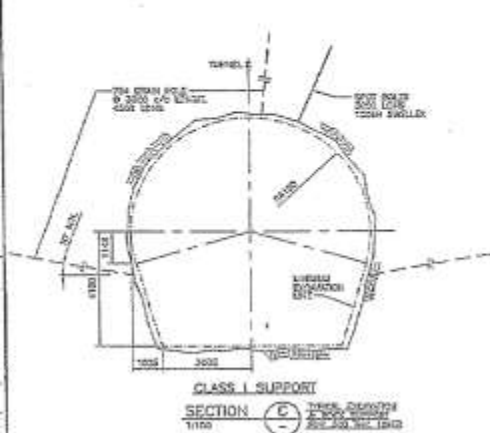
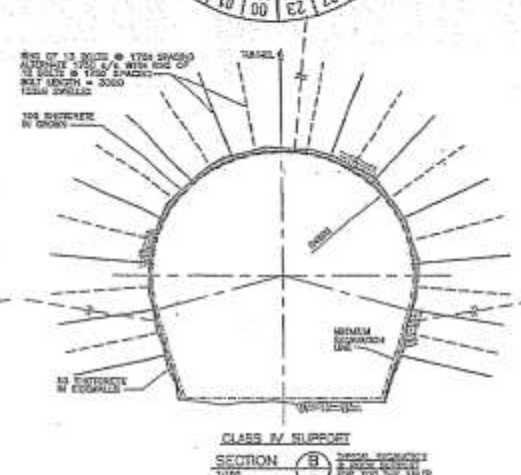
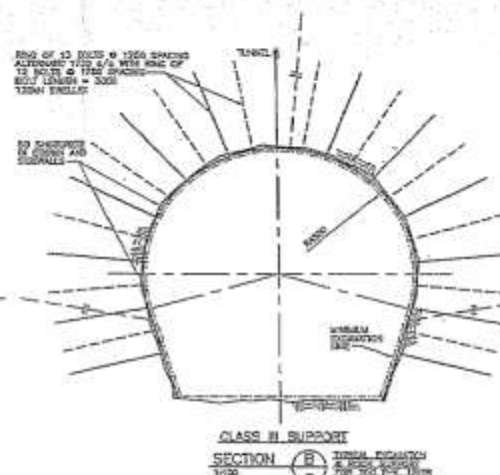
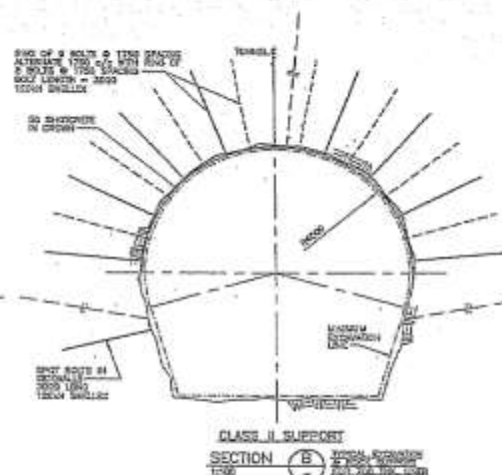
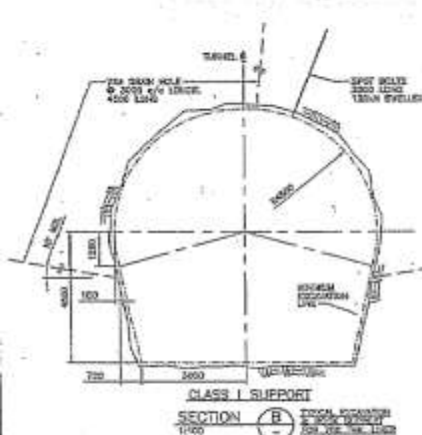
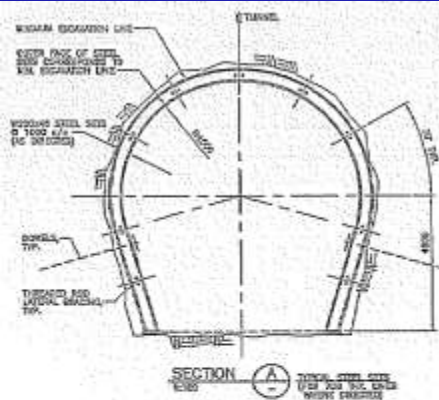


Atlas Copco

TUNNEL DRAWINGS



ROCK BOLT POSITION



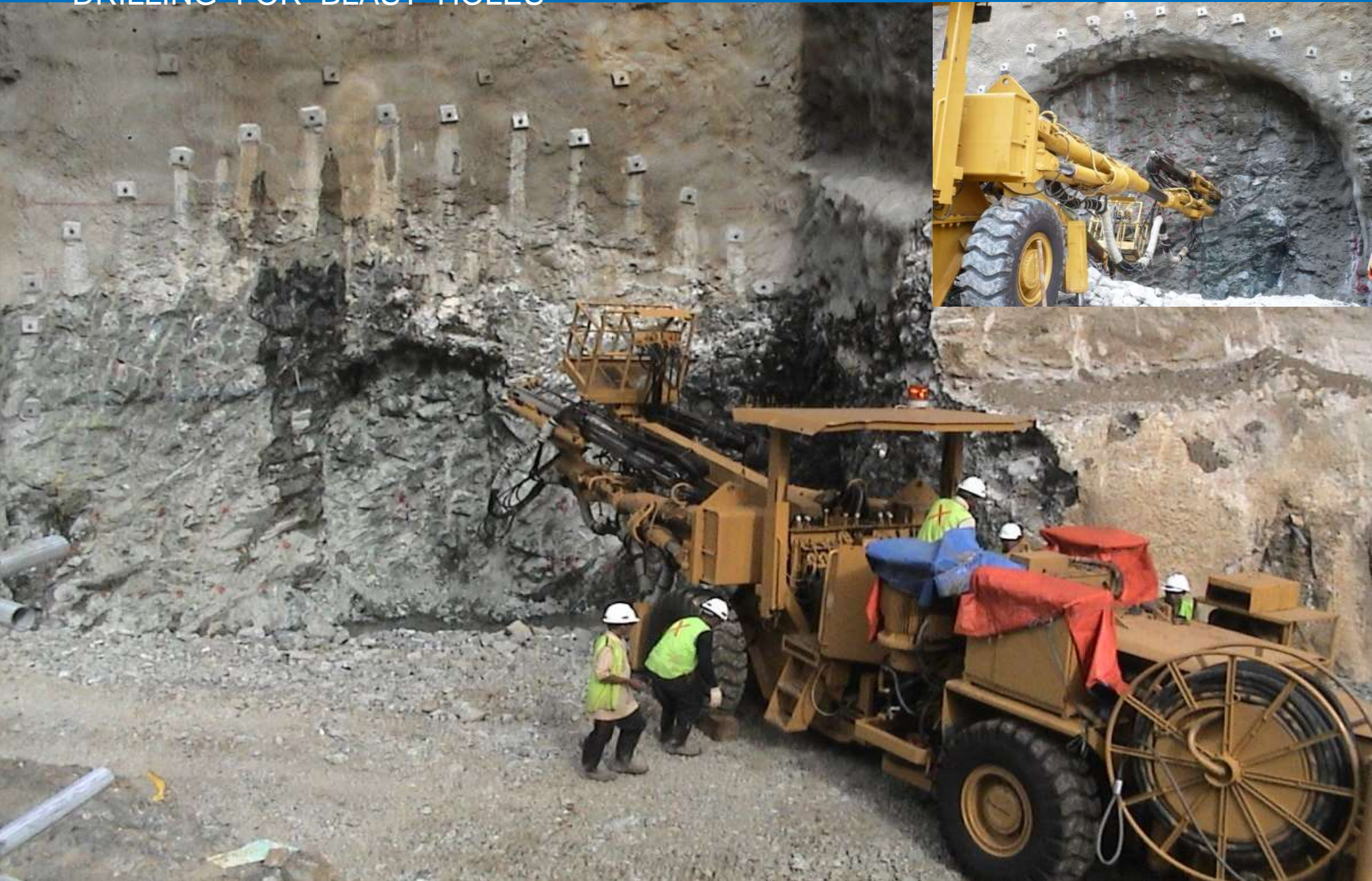
PREPARATION FOR DOWNSTREAM ACCESS



DOWNSTREAM PORTAL UPPER STAGE PREPARATION



DRILLING FOR BLAST HOLES



CHARGING OF EXPLOSIVE



CHARGING OF EXPLOSIVE



BLASTING ROCK



MUCKING



LOADING AND TRANSPORTING TO DISPOSAL SITE



MUCKING



DRILLING FOR ROCKBOLTS



INSTALLATION OF ROCKBOLTS



RIB BAR TYPE



SWELLEX TYPE



RAISON TYPE



ROCKBOLTS PULL TEST



SHOTCRETING



VENTILATING



SHOTCRETE





SURVEYING



PILOT HOLE DRILLING



INSTALL SWELLEX



CHARGING FOR BREAKTHROUGH



UPSTREAM PORTAL ACCESS EXCAVATION



UP-STREAM ACCESS DRILLING



UP-STREAM PORTAL AREA



UP-STREAM MUCKING



UP-STREAM BEFORE BREAK THROUGH



TUNNEL BREAK THROUGH



CONTINUED DRILLING FOR LOWER STAGE



CONTINUED DRILLING AND BLASTING FOR LOWER STAGE



COMPLETED EXCAVATION

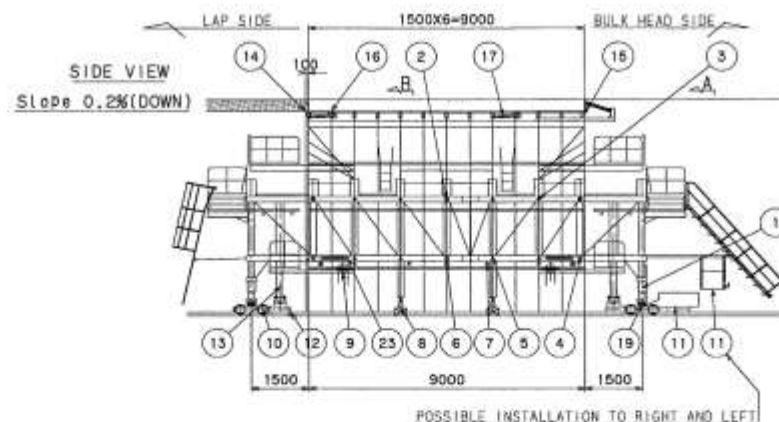
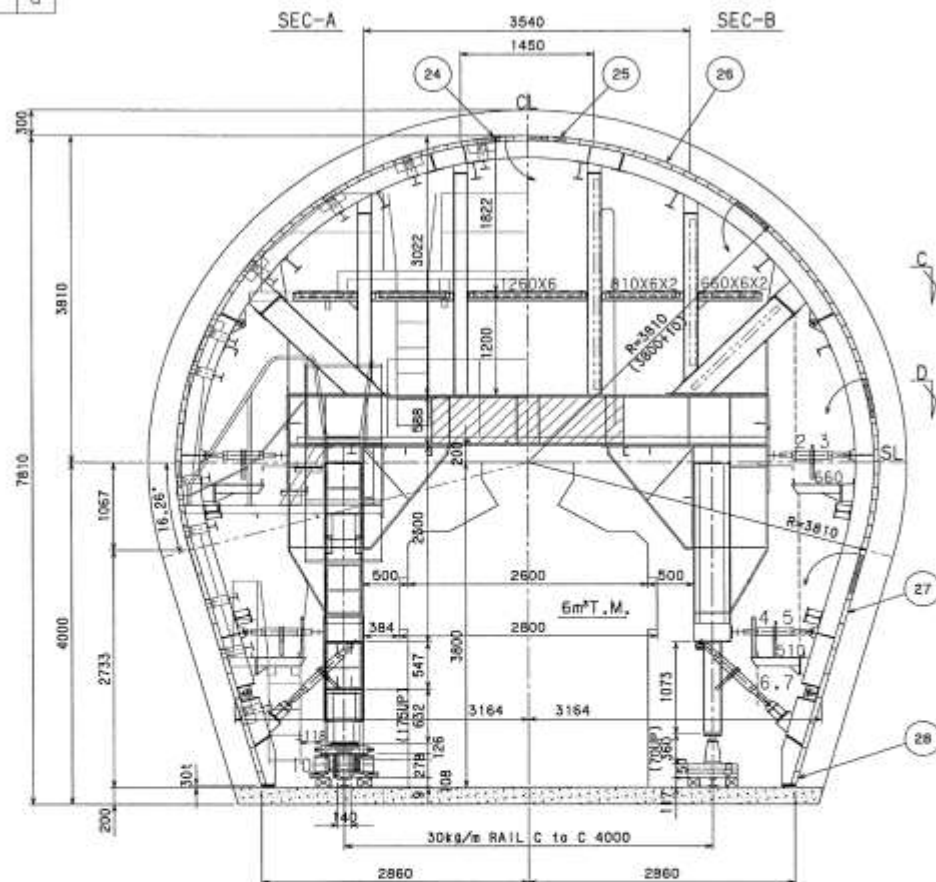


MOVEABLE CURVE FORM AND STRAIGHT FORM

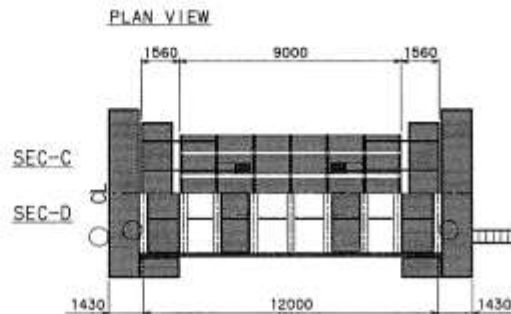
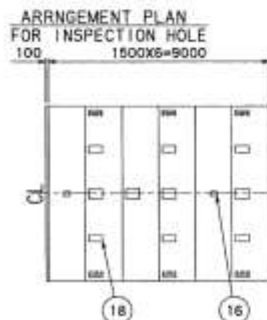


25 2:30AM

STRAIGHT FORM



GO SLOWLY MOST SO THAT THE CLEARANCE IS A LITTLE WHEN THE VEHICLE PASSES.



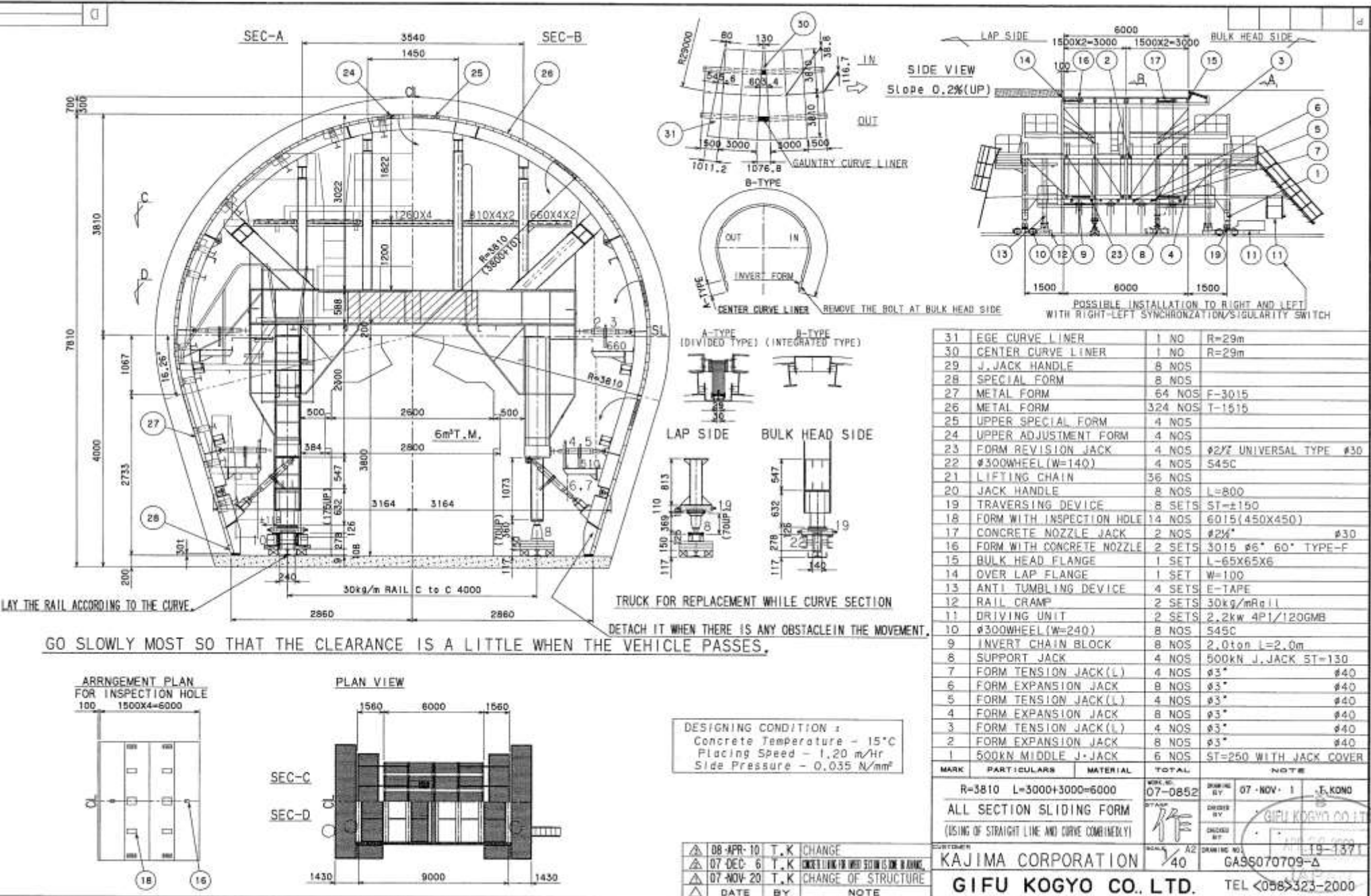
DESIGNING CONDITION :
Concrete Temperature - 15°C
Placing Speed - 1.20 m/Hr
Side Pressure - 0.035 N/mm²
TUNNEL LENGTH TL=140m

28	SPECIAL FORM	12 NOS	
27	METAL FORM	96 NOS	F-3015
26	METAL FORM	484 NOS	T-1515
25	UPPER SPECIAL FORM	6 NOS	
24	UPPER ADJUSTMENT FORM	6 NOS	
23	FORM REVISION JACK	4 NOS	#2X UNIVERSAL TYPE #30
22	J. JACK HANDLE	8 NOS	
21	LIFTING CHAIN	42 NOS	
20	JACK HANDLE	8 NOS	L=800
19	TRAVERSING DEVICE	4 SETS	ST=±150
18	FORM WITH INSPECTION HOLE	22 NOS	6015
17	CONCRETE NOZZLE JACK	2 NOS	#2X #30
16	FORM WITH CONCRETE NOZZLE	2 SETS	3015 #6" 60" TYPE-F
15	BULK HEAD FLANGE	1 SET	L-65X65X6
14	OVER LAP FLANGE	1 SET	W=100
13	ANTI TUMBLING DEVICE	4 SETS	E-TAPE
12	RAIL CRAMP	2 SETS	30kg/m Rail
11	DRIVING UNIT	2 SETS	2.2kw 4P/120GMB
10	#300WHEEL (W=140)	8 NOS	545C
9	INVERT CHAIN BLOCK	4 NOS	2.0ton L=2.0m
8	SUPPORT JACK	4 NOS	500kN J. JACK ST=130
7	FORM TENSION JACK(L)	8 NOS	#3" #40
6	FORM EXPANSION JACK	6 NOS	#3" #40
5	FORM TENSION JACK(L)	8 NOS	#3" #40
4	FORM EXPANSION JACK	6 NOS	#3" #40
3	FORM TENSION JACK(L)	8 NOS	#3" #40
2	FORM EXPANSION JACK	6 NOS	#3" #40
1	500kN MIDDLE J. JACK	4 NOS	ST=250 WITH JACK COVER
MARK	PARTICULARS	MATERIAL	TOTAL

R=3810 L=9000	07-0851	07-MAY-24	T.KONO
ALL SECTION SLIDING FORM			
(FOR STRAIGHT LINE)			
KAJIMA CORPORATION	40	GASSO70339-A	TEL<058>323-2000
GIFU KOGYO CO., LTD.			

08-APR-10	T.K	CHANGE
07-DEC-6	T.K	CHANGE OF SECTION OF LINE
07-NOV-1	T.K	CHANGE OF STRUCTURE
DATE	BY	NOTE

CURVE FORM



CURVED FORM



CLEANING BY WATER JET WASHER



WATER PUMPING AND PREPARING FOR SLAB CONCRETE



LEVELLING CONCRETE



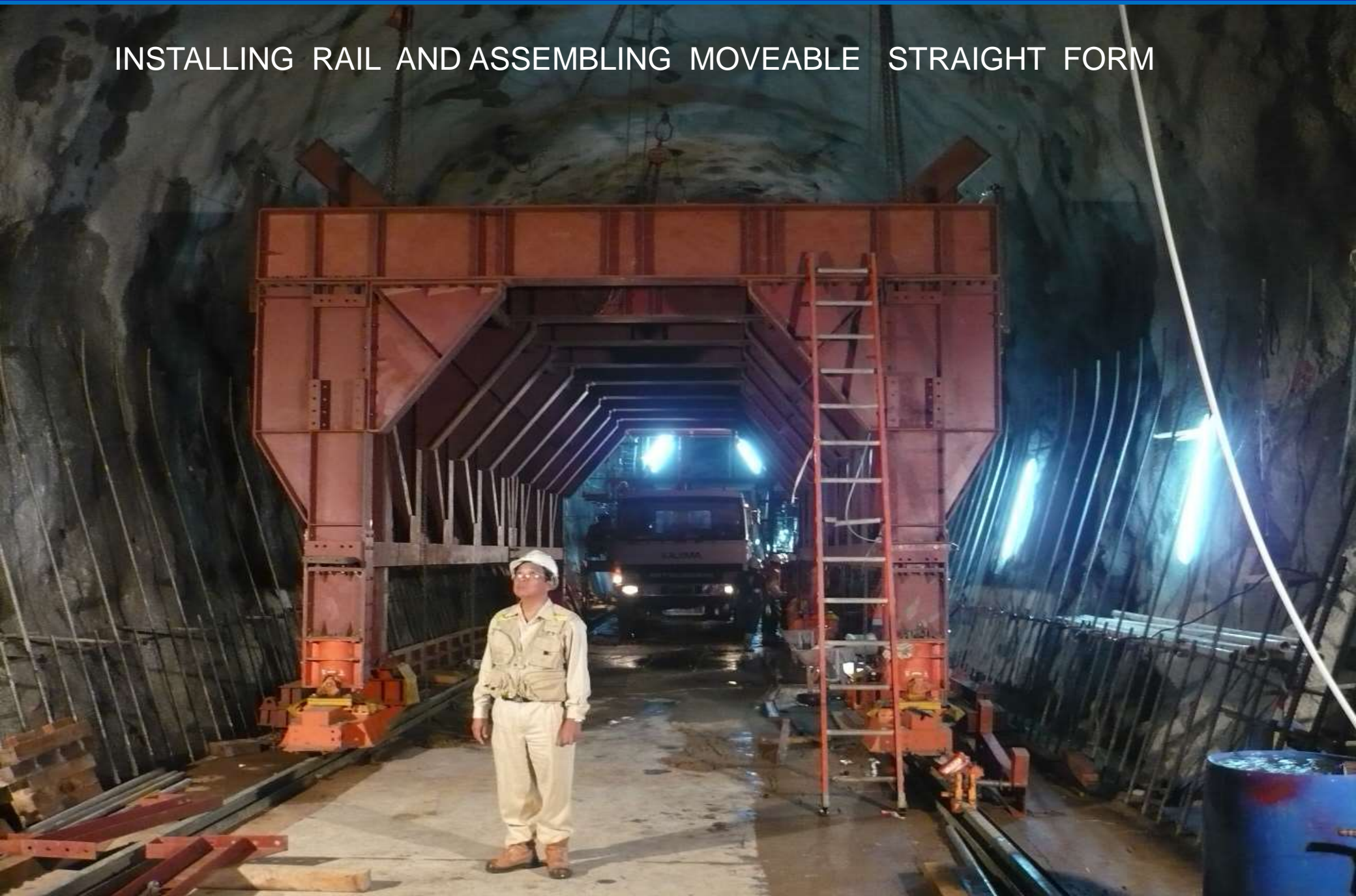
BOTTOM SLAB REBAR INSTALLATION



SLAB CONCRETING



INSTALLING RAIL AND ASSEMBLING MOVEABLE STRAIGHT FORM



ASSEMBLING AND CHECKING ALIGNMENT



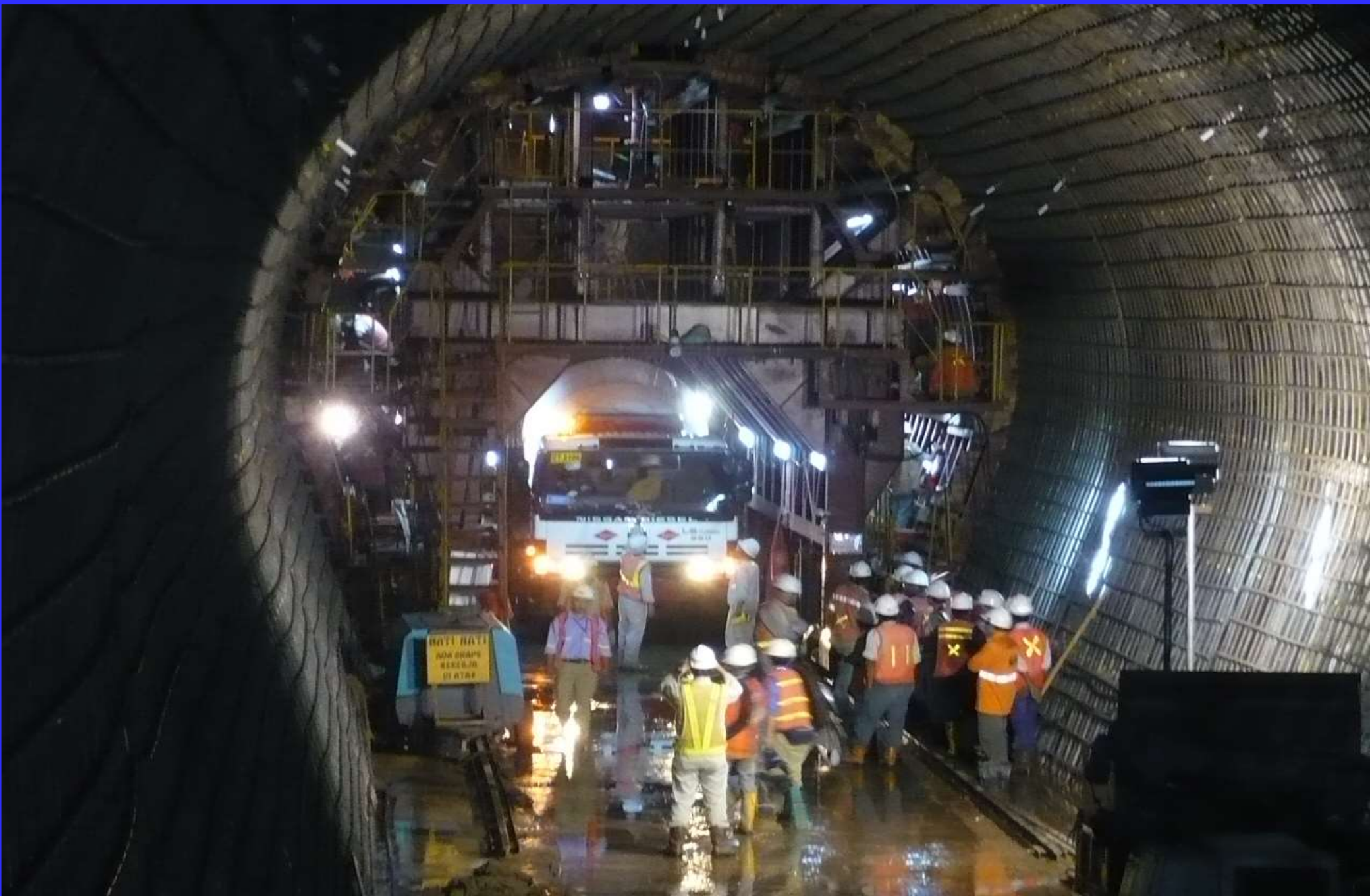
INSTALLATION OF REBAR FOR TUNNEL LINING CONCRETE



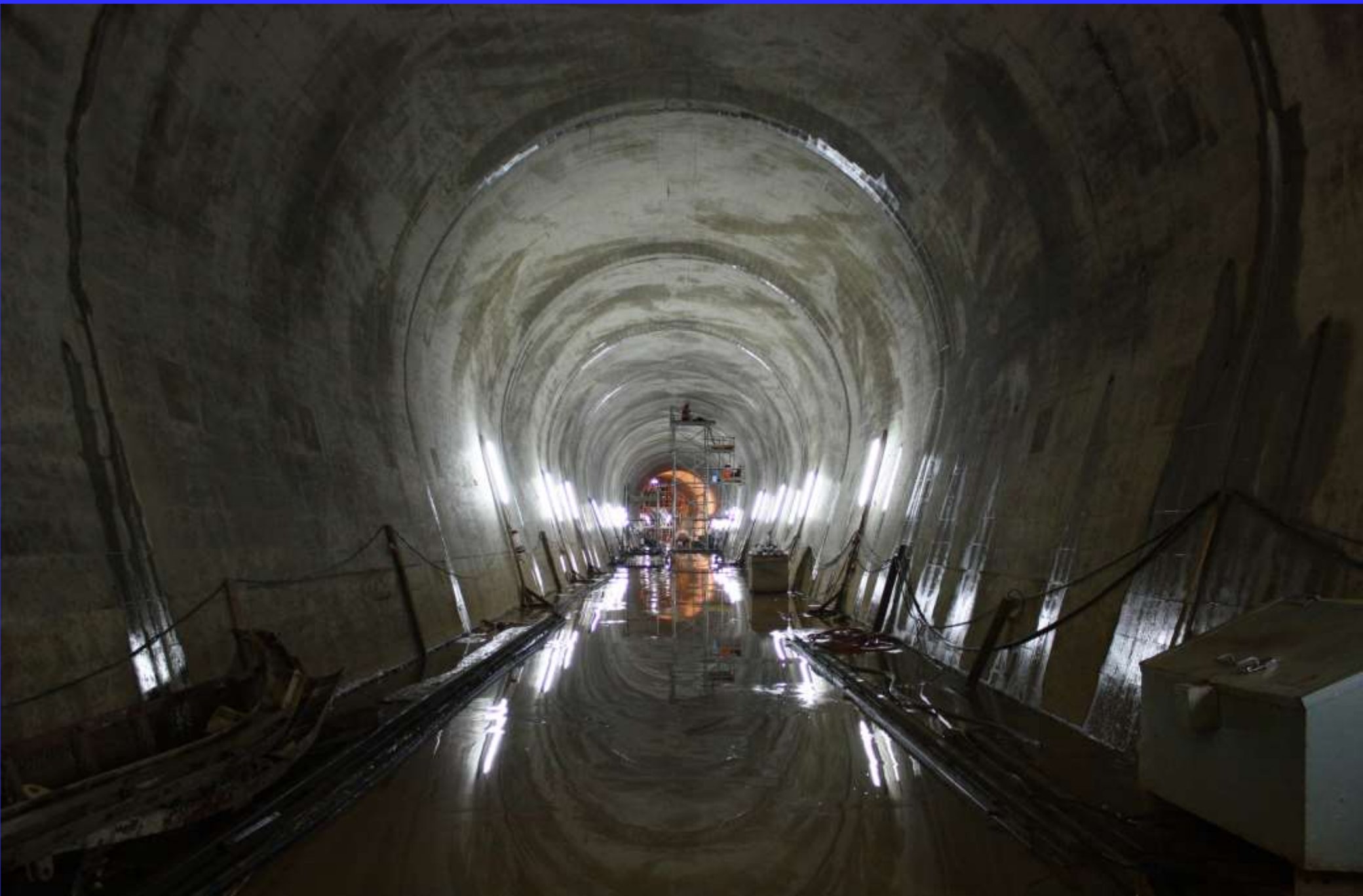
ASSEMBLING OF MOVABLE CURVE FORM



TUNNEL LINING CONCRETING



INSPECTION



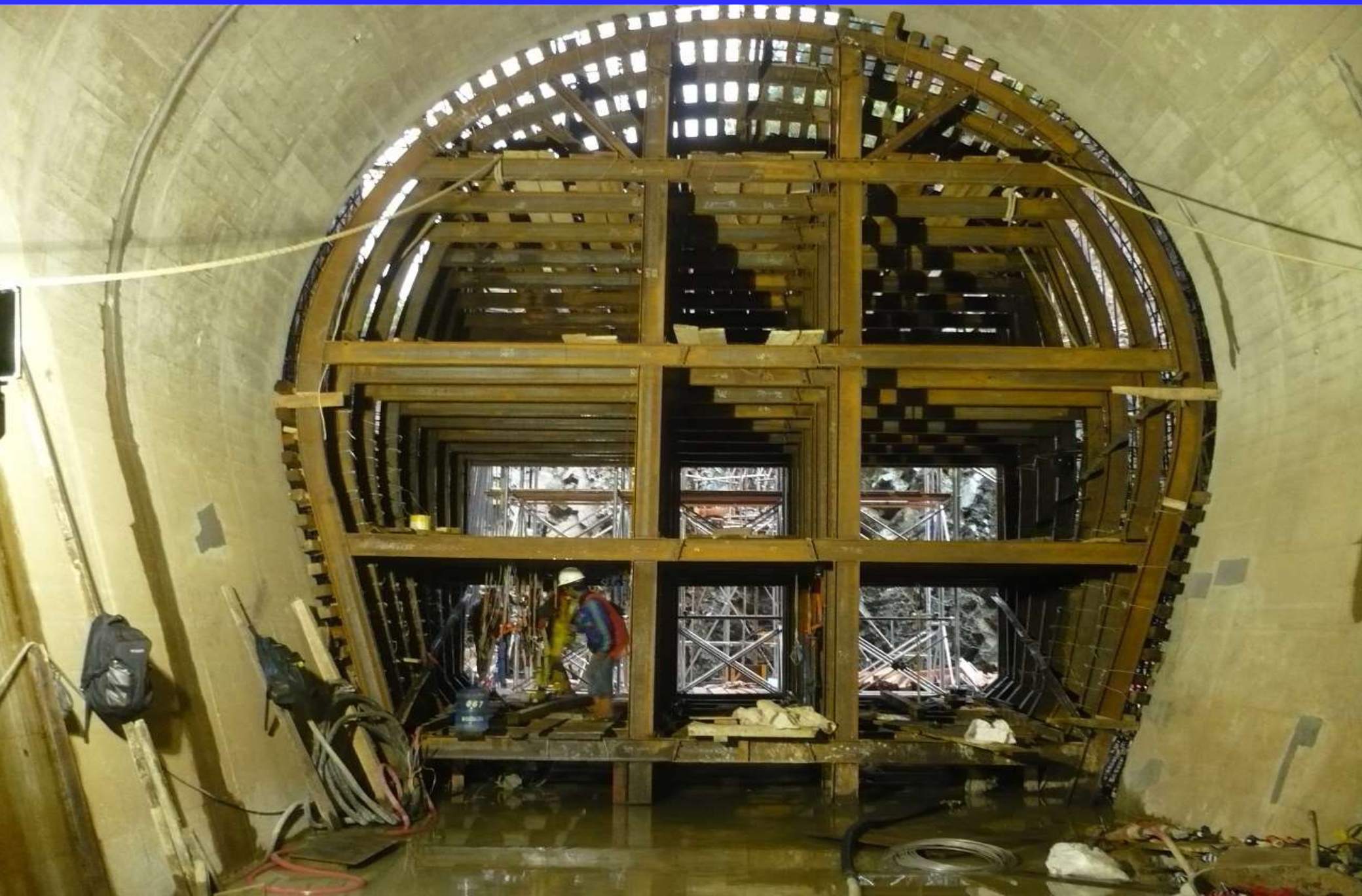
COMPLETED TUNNEL



COMPLETED CONCRETING EXCEPT PORTAL



TRANSION FORM



UP STREAM PORTAL REBAR & FORMWORK



UP STREAM PORTAL CONCRETE WORKS



TUNNEL GROUTING



DOWNSTREAM PORTAL CULVERT WORKS



CONCRETE WORKS COMPLETED



INSTALLATION OF STOPLOG GATE



INLET SLOPE PROTECTION BY GABION



UPSTREAM PORTAL AFTER DIVERSION



EXCAVATION FOR POWER STATION AREA



EXCAVATION FOR POWER STATION AREA



EXCAVATION



UP STREAM SIDE VIEW



DOWN STREAM SIDE VIEW



DAM INPONDING



COMPLETION OF PROJECT



TUNNEL ADVANTAGES AND DISADVANTAGES

Advantages:

- .Potential environmental impacts in terms of noise, dust and visual on sensitive receives are significantly reduced and are restricted to those located near the tunnel portal;
- .Compared with the cut-and-cover approach, quantity of Excavation volume would be much reduced;
- .Compared with the cut-and-cover approach, disturbance to local traffic and associated environmental impacts would be much reduced;
- .Blasting would significantly reduce the duration of vibration, though the vibration level would be higher compared with bored tunnelling (with proper blast design & techniques vibration can be reduced);

Disadvantages:

- .Potential hazard associated with establishment of a temporary magazine site for overnight storage of explosives shall be addressed through avoiding populated areas in the site selection process.

LIST OF TUNNEL EXCAVATION EQUIPMENT

EQUIPMENT

Equipment for diversion tunnel excavation are :

Jumbo Drill	DC 26	Atlas Copco	2 units
Schaeff loader	KL 20	KYMCO	2 units
Wheel Loader	CAT 980	Catterpillar 2.0 m3	2 units
Excavator	PC 200	KOMATSU 0.8 m3	1 units
Dump Truck	FM260 TI	HINO 14 TON	4 units
Dump Truck	PS 120	MITSUBISHI 10 TON	2 units
Generator	400 KVA		1 unit
Generator	250 KVA		3 units
Generator	150 KVA		2 units
Generator	10 KVA		2 units
Blower Fan	20 KW		4 units
Total Station	SET 4B	SOKKIA	2 units
Shotcrete M/C	10m3/hr	15m	1 unit
Shotcrete M/C	10 m3/hr	8m	1 unit
Excavator with Rock breaker		KOMATSU	2 units
Submersible Pump	8" & 4"	Tsurumi	6 units

LIST OF MANPOWER FOR TUNNEL EXCAVATION

MANPOWER

Team work in tunnel divided into two group from D/S and U/S, each group have two shift day and night.

D/S and U/S Team Day

•Tunnel Engineer	(1)
•Operator Jumbo	(4)
•Operator DT 14 ton	(4)
•Operator DT 6 ton	(2)
•Mechanic	(2)
•Minner	(5)
•Blasting Supervisor	(2)
•Electric	(2)
•Surveyor + team	(3)
•Driver LV	(2)
Total :	(25)

D/S and U/S Team Night

- Tunnel Engineer	(1)
- Operator Jumbo	(4)
- Operator DT 14 ton	(4)
- Operator DT 10 ton	(2)
- Mechanic	(2)
- Minner	(5)
- Blasting Supervisor	(2)
- Electric	(2)
- Surveyor + team	(3)
- Driver LV	(2)
Total :	(25)

Non Shift : Project manager, Site Manager, Administration, chief mechanic (4)

WORKING CYCLE

The sequence of works is carried out continuously for 24 hours, divided into two shifts, day and night. The sequence of works are : survey, drilling, charging & blasting, ventilation, mucking & scaling and supporting (if necessary).

SURVEY and MARKING

Survey is carried out using total station to measure the distance, elevation and cross section of tunnel. When the survey team made marking for CL (center line) and continued with marking of drilling hole position (using pylox paint), other operators prepare the equipment (jumbo drill) and facility (electricity and water supply connection) for drilling. Geologist and engineers analyze class of the rock mass and geological condition, to determine allowable advance and depth of blasting hole.

DRILLING

The drilling equipment are jumbo drill DC26, Atlas Copco, wheel type, which each jumbo drill has two drilling boom and one charging boom. Each rock drill COP1238 ME is powered by hydraulic pump - 45kw electric motor. No CO2 gas will be produced during drilling. There is auto parallel control system which is required for parallel blasting pattern, also for controlling over break due to drilling outlook. Flushing system will use clean water, to reduce fly dust, to keep clean air environment.

Burn Cut pattern is considered for drilling pattern but others drilling pattern such as V-cut, Fan-cut will be tried for several times (if necessary) to obtain the best pattern will apply, to produce the maximum progress, minimum amount of explosives and the minimum damage on rock. All perimeter holes is designed to have maximum 450mm distance, to ensure minimum over break due to drilling outlook.

CHARGING & FIRING

Six charging team work with one charging boom and one wheel loader will carry out loading explosives into the holes, non electric detonator (nonel) will be used. Blaster will be connected with detonating cord and two electric detonator for ignition.

Explosive's loading depend on the hole position, Cut holes and floor holes contain more explosives than slope holes. Type of explosive is dayagel magnum dia.32mm, length 200mm (a 20 kg/ box contain 110 pcs).

Perimeter holes is loaded with dayagel magnum dia.25mm, length 200mm (a 20 kg/box contain 150 pcs) and detonating cord. Stemming will use sand which fill in 200mm length plastic bag.

All personnel involved and charging procedure use code of practice for the safe use of explosives in tunnelling.

Powder Factor for diversion tunnel Karebbe Area is 0,5 - 0,6.

SMOKE VENTILATION

Ventilation system is calculated with 2m³/min air for each working personnel, 3m³/min air for each HP diesel equipment operated in the same time. A 20kw ventilation blower is installed at the tunnel portal. For exhaust blasting smoke ventilation, a 7,44 kw ventilation blower is placed at 30 m from tunnel face.

MUCKING

Mucking equipment are consisted of 1 unit schaeff loader with capacity 60m³/min and 1 unit wheel loader 3m³ bucket, loading muck to the 14 ton dump trucks, which haul the materials to spoil bank area.

SCALING

Scaling will use impact hammer attached at SK-200 backhoe, to clear dangerous loose rocks from crown, wall and surface. The power of the hammer is always adjusted to the rock hardness, to ensure no excessive loosen of rocks layers.

ROCK SUPPORT

Type of rock support are depend on the rockmass which is examined and decided by Engineers. Jumbo drills are used for drilling Rockbolts holes and also to install Rockbolts, wire mesh and steel set with charging boom, Robospray are used for shotcrete work. The purpose of rock support is to stop deterioration of the rock surface and to prevent any fall of loose rocks.

Wet type of shotcrete is applied for environment and speed reason.

Type of Rockbolt is mechanical type of bolts, Swellex type.

Rock Drilling Tools

Drifter rods

Dimension	Min. hole dia, mm
R38-Hex 35-R32	45
T38-Hex 35-R32	45
T38-Hex 35-R32 Speedrod	45
R38-Hex35- SR35 Speedrod	45
T38-Hex 35-SR35	45
T38-Rnd 39-SR35	45
T38-Hex 35-R35	48
T38-Hex 35-R35 Speedrod	48
T38-Rnd 39-R35	48
T38-Rnd 39-R35 Speedrod	48

Extension rods for injection drilling/RAS

Dimension	Min. hole dia, mm
R32 Speedrod	51
T38 Speedrod	64

Shank adapters

Thread	Dia, mm	Length, mm	Part No.
R38	38	435	404-09101,00
T38	38	435	435-09101,00
R32	38	525	403-09103,00*
T38	38	525	435-09103,00*

*= Intended for rod adding system, RAS, and extension drilling with BSH 110.

Couplings

Thread	Dia, mm	Length, mm	Part No.
R38	55	170	304-0055,00
T38	55	190	335-0055,00

For other dimensions and more information please see Secoroc General Catalogue, printed matter No. 9851 2156 01.

CYCLE TIME FOR TUNNEL EXCAVATION

		Unit	UPPER HALF					LOWER HALF					
			E (Straight)	E (R=29)	F (Straight)	F (R=29)	F (Straight)	E (Straight)	E (R=29)	F (Straight)	F (R=29)	F (Straight)	
STA	begin		125.233	134.868	154.112	298.624	318.806	125.233	134.868	154.112	298.624	318.806	
STA	end		134.868	154.112	298.624	318.806	325.985	134.868	154.112	298.624	318.806	325.985	
Tunnel Length		m	9.635	19.244	144.512	20.182	7.179	9.635	19.244	144.512	20.182	7.179	
Design Excav. Area	A1	m2	66.79	66.79	53.67	53.67	53.67	66.79	66.79	53.67	53.67	53.67	
Upper Half Area	A2	m2	42.17	42.17	33.54	33.54	33.54						
Lower Half Area	A3	m2						24.62	24.62	20.13	20.13	20.13	
# of Drilling Holes		hole	143	143	133	133	133	78	78	64	64	64	
Round per Cycle	B	m	2.0	3.0	3.0	3.0	2.0	2.0	3.0	3.0	3.0	2.0	
Drilling Length per Hole	B1	m	1.2	1.2	3.2	2.2	3.2	1.2	1.2	3.2	2.2	3.2	
Loose Factor	L		1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	
Dump Truck Volume	H	m3	15	15	15	15	15	15	15	15	15	15	
Excav. Capacity	C	m3/hr	36	36	36	36	36	36	36	36	36	36	
Shotcrete Area per Cycle	M	m2	16.13	16.13	44.62	29.75	44.62	15.2	15.2	22.8	15.2	22.8	
Shotcrete Thickness	N1	m	0.10	0.10	0.05	0.05	0.05	0.10	0.10	0.05	0.05	0.05	
Shotcrete Thickness	N2	m	0.30	0.30	0.15	0.15	0.15	0.30	0.30	0.15	0.15	0.15	
# of Rockbolt per Cycle	P2	pcs	5	8	18	18	12	3	3	3	3	3	
Preparation/Survey		min	30	30	30	30	30	30	30	30	30	30	
Drilling		min	86	86	107	74	107	24	24	52	36	52	1.0m/min*2drill
Charging		min	72	72	67	67	67	39	39	32	32	22	2hole/min
Blasting/Ventilation		min	50	50	50	50	50	50	50	50	50	50	Firing 20min.+Vent. 30min.
Mucking		min	197	296	235	235	157	115	173	141	141	94	36m3/hr
Rockbolts		min	50	80	180	180	120	30	30	30	30	30	
Steel Sets		min	120	120				120	120				
Shotcrete		min	78	78	108	72	108	73	73	55	37	55	5m3/hr
Others		min	90	90	120	120	90	60	60	60	60	60	
Subtotal	Q	min	773	902	897	828	729	541	599	450	416	393	
Total Round per day	L2	m/day	2.6	3.3	3.6	3.9	2.8	3.8	5.4	7.2	7.5	5.4	
# of Shift		shift	1.3	1.1	1.2	1.3	1.4	1.9	1.8	2.4	2.5	2.7	1shift = 600min
Total Round per month	L3	m/mo	59.8	75.9	82.8	89.7	64.4	87.4	124.2	165.6	172.5	124.2	23day/month
Required Month		month	0.2	0.3	1.8	0.3	0.2	0.2	0.2	0.9	0.2	0.1	
			0.5		2.3					1.6			2party
Total Month				2.3						1.6			=2.3+1.6=3.9month

CONCLUSION

1. Three months of Construction time saved
2. Approx. 660,000 US\$ reduce from original total construction cost
3. Overhead cost for three months of Construction saved
4. No disturbing to future Dam Construction works (Safe Access)
5. No environmental damages
6. Potential environmental impacts in terms of noise, dust and visual on sensitive receives are significantly reduced
7. No problem to work in Heavy rainy season

PHOTOS
OF
COMPLETED TUNNEL PROJECT IN MYANMAR
BY
KAJIMA CORPORATION

May 1996 ~ March 1999

Hydro Power Plant 280mW (March 2004)

PAUNG LAUNG DIVERSION TUNNEL



INLET AREA BEFORE TUNNELING WORKS (May 1996)



OUTLET AREA BEFORE TUNNELING WORKS (May 1996)



TUNNEL (I) and TUNNEL (II)

INLET PORTAL EXCAVATION WORKS



TUNNEL VENTILATION WORKS WITH AIR COMPRESSOR



TUNNEL VENTILATION WORKS WITH AIR COMPRESSOR



LIGHTING & POWER SUPPLY WORKS (TRANSFORMER)

An aerial photograph of a large-scale industrial site, likely a quarry or processing plant, situated in a valley. The foreground features a large, flat, light-colored area, possibly a storage yard or a dry riverbed, with several large, dark, irregular shapes that could be piles of material or structures. In the middle ground, there are several large, conical piles of light-colored material, possibly sand or crushed stone, and a large, dark, rectangular structure that appears to be a batch plant or a storage silo. The background is dominated by steep, forested hills or mountains under a clear blue sky with a few scattered clouds. The overall scene depicts a major industrial operation in a natural, hilly environment.

CRUSHING PLANT & BATCH PLANT FOR SHOTCRETE SUPPLY



TUNNEL (I)

INLET PORTAL STEEL RIB SETTING WORKS



TUNNEL (II)

INLET PORTAL STEEL RIB SETTING WORKS



TUNNEL (I) and TUNNEL (II)
TUNNEL EXCAVATION WORKS



TUNNEL (I) and TUNNEL (II)

OUTLET PORTAL EXCAVATION WORKS



TUNNEL (I)

OUTLET PORTAL EXCAVATION WORKS



TUNNEL (I)

OUTLET TUNNEL EXCAVATION WORKS



TUNNEL (II)

OUTLET PORTAL BEFORE EXCAVATION WORKS



TUNNEL (II)

OUTLET PORTAL EXCAVATION WORKS



TUNNEL (II)

OUTLET PORTAL STEEL RIB SETTING WORKS



UPPER SECTION TUNNEL DRILL WORKS



UPPER SECTION TUNNEL CHARGING WORKS



UPPER SECTION TUNNEL MARKING WORKS



UPPER SECTION TUNNEL STEEL RIB & WIRE MESH SETTING WORKS



UPPER SECTION TUNNEL STEEL WIRE MESH SETTING WORKS



UPPER SECTION TUNNEL SHOTCRETING WORKS

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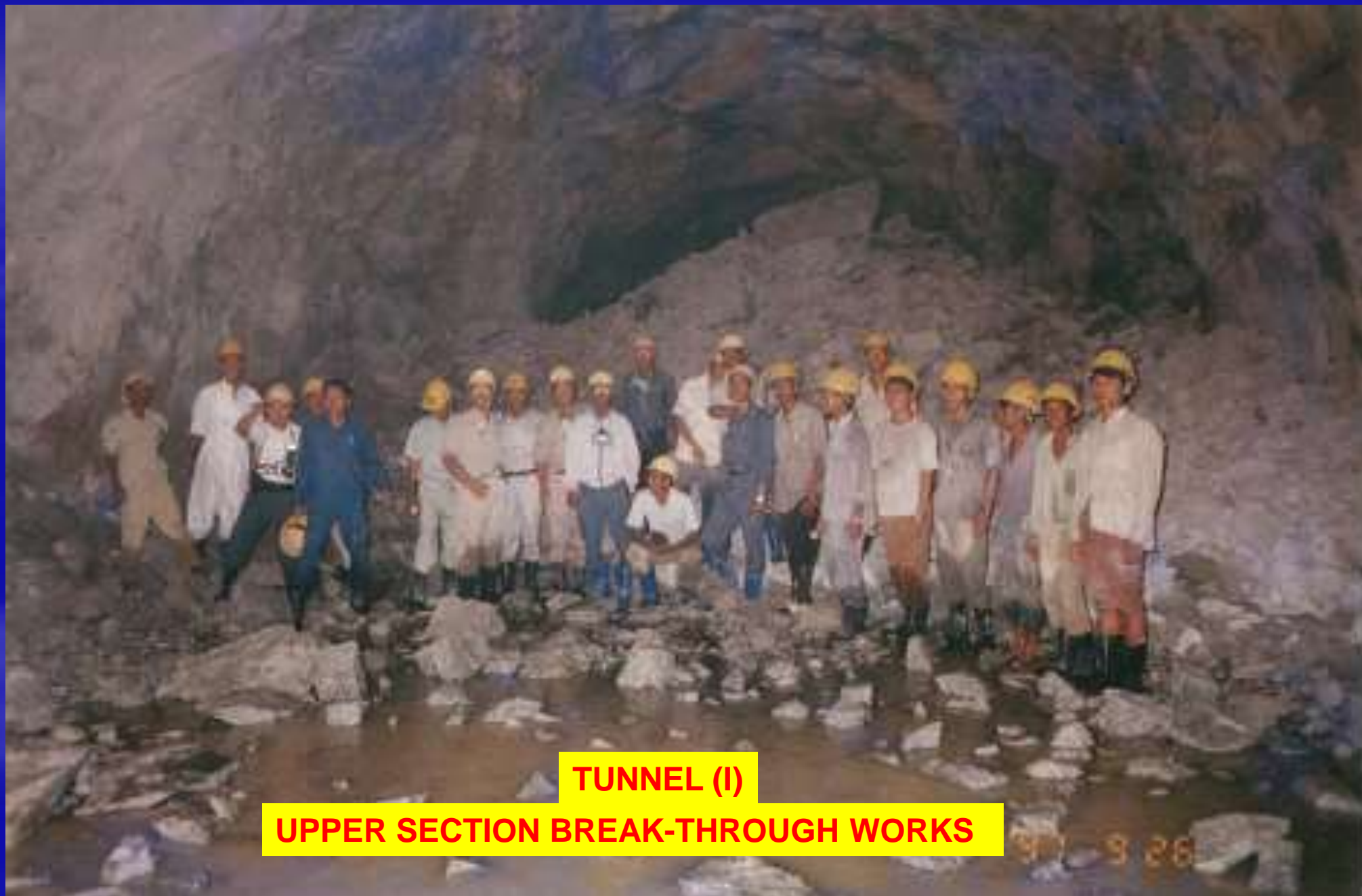


UPPER SECTION TUNNEL SURVEYING WORKS



TUNNEL (I)

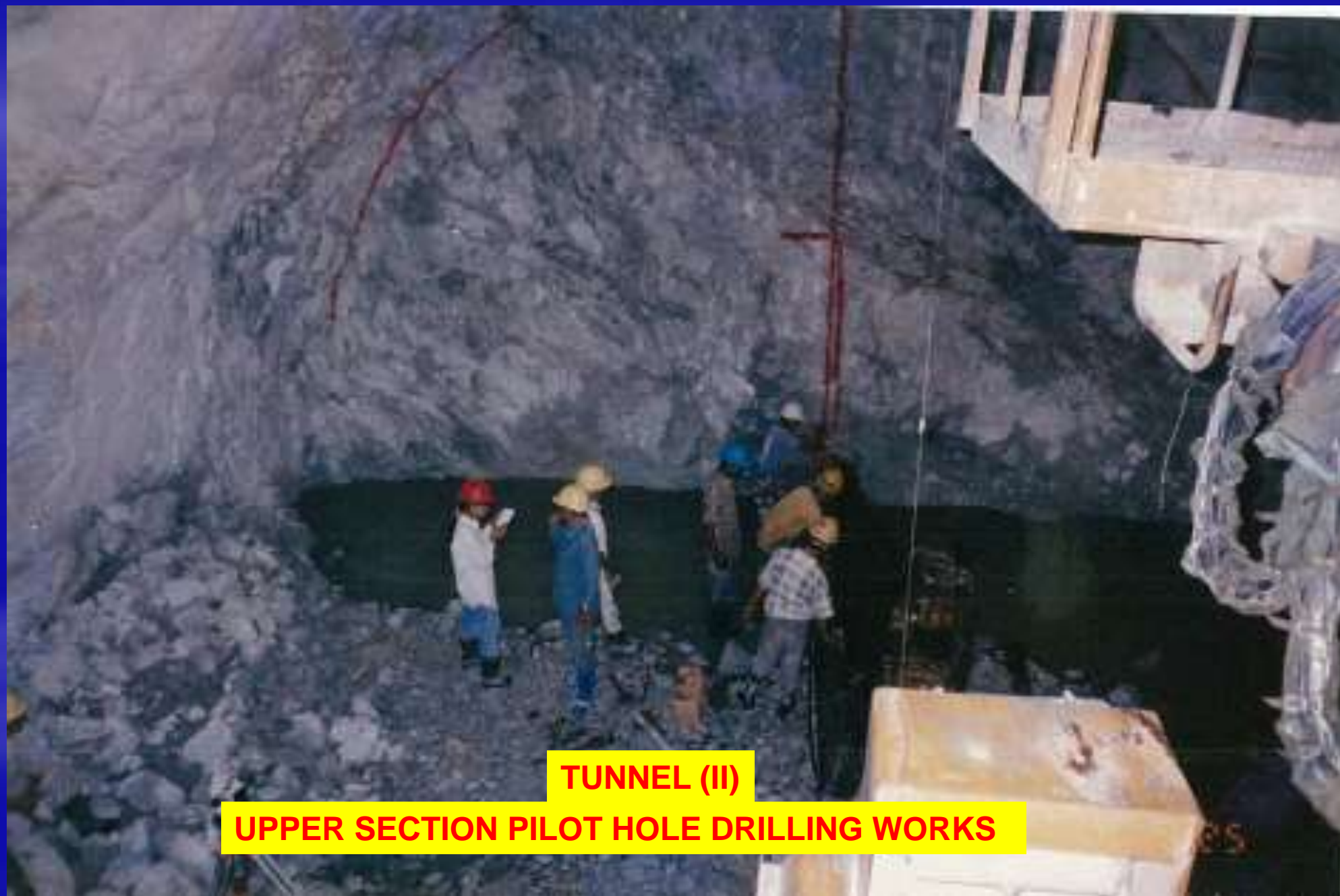
UPPER SECTION TUNNEL-1 PILOT HOLE DRILLING WORKS



TUNNEL (I)

UPPER SECTION BREAK-THROUGH WORKS

9/11/98









TUNNEL (I)

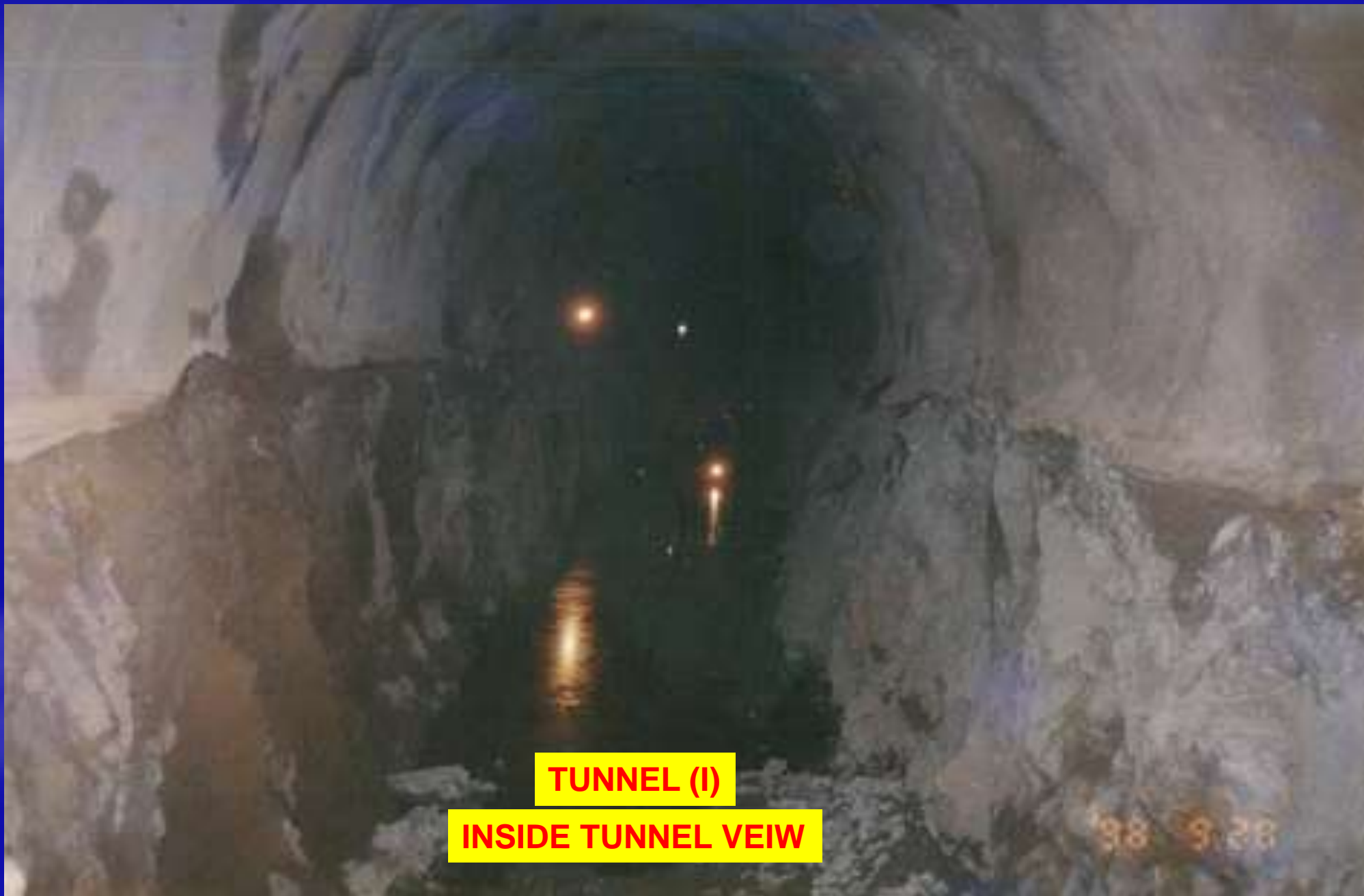
LOWER SECTION TUNNEL DRILLING WORKS

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TUNNEL (I)

LOWER SECTION TUNNEL MARKING WORKS



TUNNEL (I)

INSIDE TUNNEL VIEW

98 9:28



TUNNEL (II)

LOWER SECTION TUNNEL DRILLING WORKS

99 1 29



TUNNEL (II)

LOWER SECTION TUNNEL MARKING WORKS



OUTLET TUNNEL ROCK BOLT SETTING WORKS



TUNNEL (I) and TUNNEL (II)

INLET AREA AFTER TUNNELING WORKS (Jan 1999)



OUTLET AREA AFTER TUNNELING WORKS (Jan 1999)

Work Method Videos

1. NATM Tunnel
2. Hard Rock TBM Tunnel
3. Soft Ground TBM (Shield Tunnel)
4. Cut and Cover Tunnel
5. Immersed Tunnel

THANKS

Q & A

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