

PLAN

GENERAL NOTES FOR ALL DRAWINGS:

- ALL REFERENCE POINTS, TUNNEL CONTROL BEACONS AND GEODETIC TRIANGULATION BEACONS FOR THIS SET OF DRAWINGS ARE BASED ON THE LO 29' (LHWP TUNNEL SYSTEM) CO-ORDINATE SYSTEM. THE EXCEPTIONS ARE LAND ACQUISITION BOUNDARIES (PURCHASE BEACONS) AND FENCE CORNER POST CO-ORDINATES WHICH ARE BASED ON THE LO 29' CO-ORDINATE SYSTEM.
- ALL DISTANCES AND CHAINAGES SHOWN ON THIS SET OF DRAWINGS ARE ADJUSTED FOR 1700 MASL, AND MEASURED HORIZONTALLY UNLESS OTHERWISE NOTED.

NOTES:

- ALL DIMENSIONS IN METRES UNLESS OTHERWISE SHOWN.
- ALL LEVELS IN METRES ABOVE SEA LEVEL.
- DISTANCES GIVEN IN TABLE ARE MEASURED HORIZONTALLY FROM P.I. TO P.I.
- DRAWING BASED ON 1:50 000 TOPOGRAPHICAL MAPPING.
- HYDRAULIC GRADE LINE IS BASED ON OPERATING LEVEL 1773,500 M.A.S.L. IN MUELA TAILPOND AND CORRESPONDING LEVEL 1735,500 M.A.S.L. AT ASH RIVER OUTFALL.
- FOR DETAILS OF THE GEOLOGICAL HORIZONS (CLARENS, T. U. ETC.) AND BOREHOLE LOGS SEE DRG. No's 0735-0737.
- POSITIONS OF POINTS OF INTERSECTION (P.I.) OF HORIZONTAL BENDS ARE SHOWN FOR CORRELATION WITH PLAN LAYOUTS.
- LOCAL CHAINAGES USED ON CALEDON TUNNEL CHAINAGE FOR BC VLS = 0,000m. SEE DRG. No. 0714 FOR DETAILS OF CALEDON RIVER CROSSING AREA.
- REFER TO DRG. No's 0803 AND 0809 FOR DETAILS OF ASH TUNNEL ALIGNMENT.
- SETTING OUT OF THE TUNNEL IS TO BE BASED STRICTLY ON THE CO-ORDINATE VALUES AND NOT ON THE BEARINGS. THE BEARINGS ARE GIVEN FOR INDICATION ONLY.
- THE TYPE OF LINING IN THIS LOW COVER SECTION IS TO BE CONFIRMED DEPENDENT ON METHOD STATEMENT DETAILS TO BE SUBMITTED BY THE CONTRACTOR. (AN ALTERNATIVE REINFORCED CONCRETE LINING MAY BE PROPOSED).
- SEE DETAILS 1 AND 2 ON DRG. No. 0714 FOR CURVE AND LEVEL DEFINITIONS.

POST - CONSTRUCTION NOTE

THIS DRAWING HAS NOT BEEN AMENDED TO REFLECT AS-FOUND/AS-BUILT CONDITIONS, BUT RATHER CONTINUES TO SERVE AS A RECORD OF THE EXPECTED CONDITIONS PRIOR TO EXCAVATION. THE ROCK TYPE, SUPPORT DISTRIBUTION, EXCAVATION AND LINING INSTRUMENTATION DETAIL RECORDS HAVE BEEN SUMMARISED IN THE DELIVERY TUNNEL NORTH CONSTRUCTION REPORT: VOLUME 3, SECTION 1 OR ON THE GEOLOGICAL LONG SECTION AND CONSTRUCTION RECORD DRAWINGS PRESENTED IN THE SAME VOLUME.

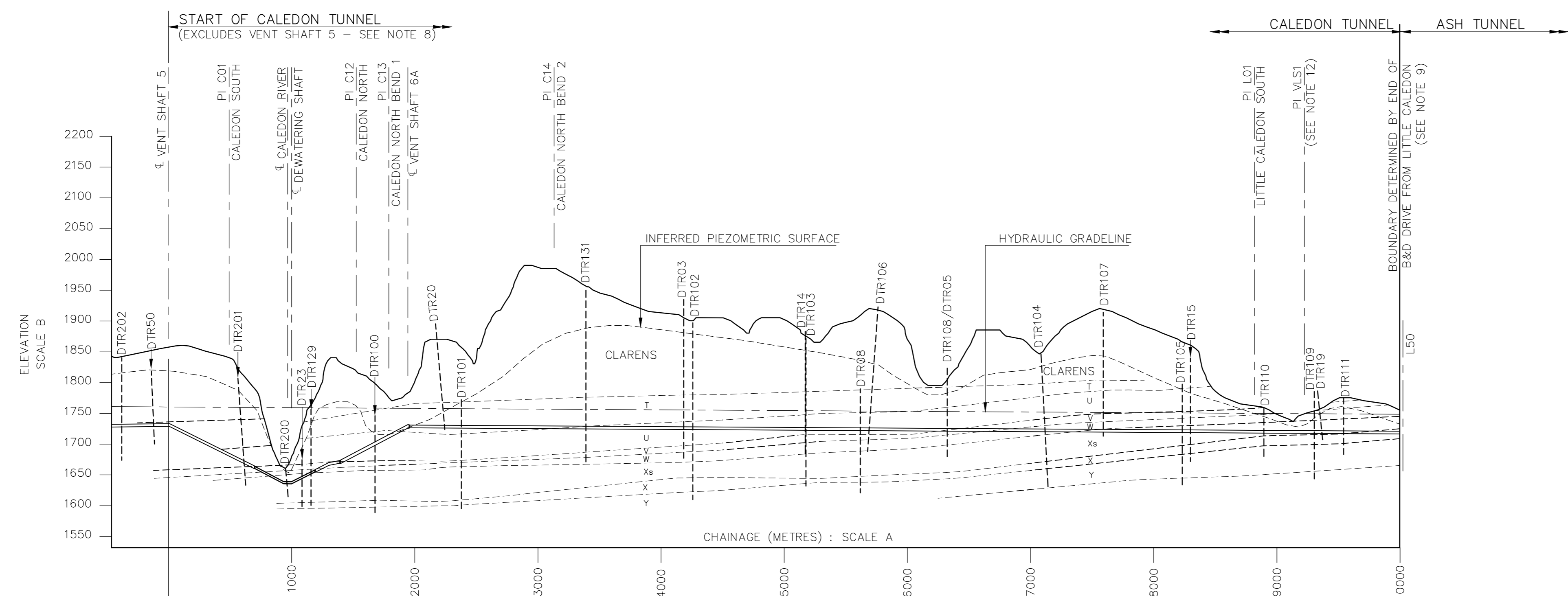
LEGEND:

- INFERRED PIEZOMETRIC SURFACE
- INFERRED ROCK TYPE DIVISION LINE
- DTR101----- BOREHOLE (IN SECTION)
- CDB BOREHOLE (IN PLAN)
- ▨ STEEL TUNNEL LINING (SL)
- ▨ UNREINFORCED CONCRETE LINING (UC)
- ▨ PRECAST CONCRETE SEGMENT LINING (PCS)
- HYDRAULIC GRADE LINE
- 1:60 1 IN 60 DOWN GRADE
- CO-ORDINATE POINT IDENTIFICATION
- POINT NUMBER
- CALEDON (L = LITTLE CALEDON)
- CO-ORDINATE POINT
- ▨ NEW TOWNSHIP AREA

TUNNEL DATA					
LIST OF CO-ORDINATES, BEARINGS AND DISTANCES					
P.I. DESCRIPTION	P.I. REF	P.I. CO-ORDINATES		BEARING (SEE NOTE 10)	DISTANCE (SEE NOTE 3)
		+ X	+ Y		
NGOAJANE NORTH	N07	3 173 311,940	53 030,578		
CALEDON SOUTH	C01	3 167 546,128	55 371,910	157° 53' 57,6"	6224,500
CALEDON NORTH	C12	3 166 529,800	55 191,992	190° 02' 20,2"	1032,369
CALEDON NORTH BEND 1	C13	3 166 327,732	55 011,602	221° 45' 21,1"	270,935
CALEDON NORTH BEND 2	C14	3 164 984,916	55 245,006	170° 08' 22,4"	1363,266
LITTLE CALEDON SOUTH	L01	3 159 300,056	55 112,999	181° 19' 48,8"	5687,712
LITTLE CALEDON NORTH (*)	L11	3 155 664,079	55 100,007	180° 12' 17,0"	3636,844

(*) SEE NOTE 9

PLAN (SEE NOTE 4) SCALE A



LONGITUDINAL SECTION (SEE NOTE 12)

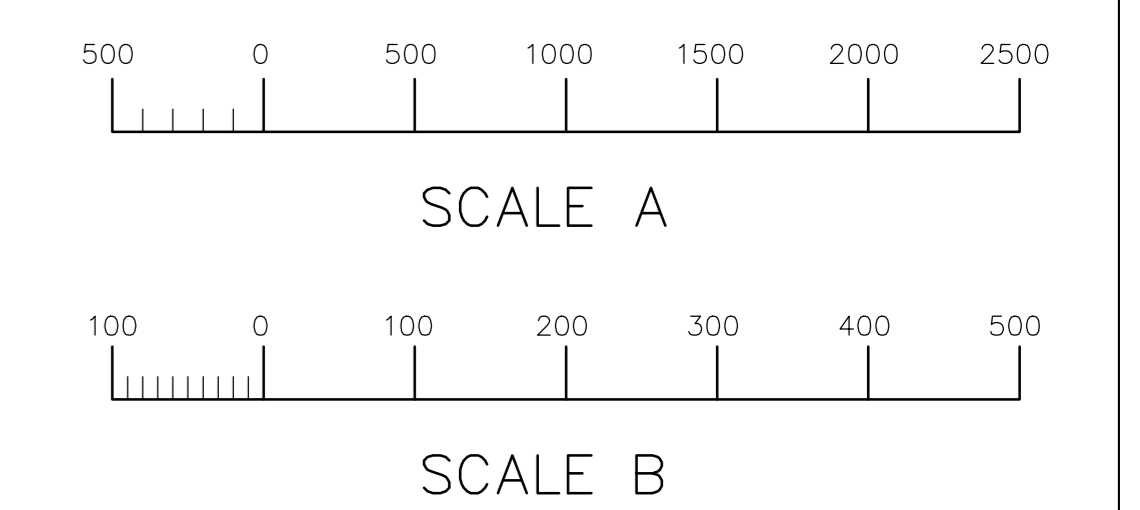
CHAINAGE	0,000	703,547	485,944	771,919	215,000	780,602
HYDRAULIC GRADE LINE	1750,290	1761,1	1760,4	1760,4	1750,8	1748,6
LEVELS ON Q ₁	1750,290	1760,4	1760,4	1760,4	1750,8	1748,6
GRADIENT (INDICATIVE ONLY)	1:525,1	1:10	1:10,7	1:110,7	1:786,7	1:578,1
EXCAVATION METHOD	D&B			TBM		
LENGTH	703,547	485,944	771,919	703,876	215,000	780,602
PERMANENT LINING	UC	SL	UC	PCS	PCS	PCS
INTERNAL DIAMETER OF LINING	4,5	3,4	4,5	5,7	4,6	4,6

HORIZONTAL CURVE DATA				
P.I. DESCRIPTION	P.I. REF	RADIUS TO Q	ANGLE OF DEVIATION	CURVE LENGTH
CALEDON SOUTH	C01	18,000	32° 08' 22,6"	10,097
CALEDON NORTH	C12	398,072	31° 43' 00,9"	220,359
CALEDON NORTH BEND 1	C13	326,417	51° 36' 58,7"	294,061
CALEDON NORTH BEND 2	C14	1500,000	11° 11' 26,4"	292,971
LITTLE CALEDON SOUTH	L01	1500,000	01° 07' 31,8"	29,466

VERTICAL CURVE DATA*					
LOCATION	CHAINAGE ON Q	CENTRELINE LEVEL	INVERT LEVEL	RADIUS TO Q	CURVE LENGTH ON Q
BC VLS 1	9223,003	1719,124	1716,824		
PI VLS 1	9223,347	1719,124	1716,824	1500,000	0,688
EC VLS 1	9223,691	1719,123	1716,823		

(*SEE NOTES 8 & 12)

Related Drawings	
Drg. No	Description
0714	CALEDON RIVER CROSSING - UNDERGROUND WORKS - GENERAL ARRANGEMENT, LONGITUDINAL SECTION AND SETTING OUT DETAILS
0735-0737	TUNNEL WORKS - VENT SHAFTS TO L.C. SOUTH - LONGITUDINAL SECTION - GEOTECHNICAL DETAILS/EXPECTED CONDITIONS
0803	LITTLE CALEDON CROSSING TO ASH OUTFALL - HORIZONTAL ALIGNMENT AND LONGITUDINAL SECTION
0809	LITTLE CALEDON RIVER CROSSING - UNDERGROUND/SURFACE WORKS - GENERAL ARRANGEMENT, LONGITUDINAL SECTION AND SETTING OUT DETAILS



2.	RECORD DRAWING		
3.	VERTICAL CURVE VLS LEVELS AND No7 COORDS CORRECTED.	M.R.E.	06/08/93
2.	TUNNEL ALIGNMENT AND TABLES REVISED, NOTES AND RELATED DRAWINGS AMENDED	M.R.E.	30/07/93
1.	VENT SHAFT 6A POSITION AND BOUNDARY BETWEEN ASH AND CALEDON TUNNELS REVISED.	B.C.V.	31/07/92
0.	ISSUED FOR CONSTRUCTION	B.C.V.	07/91
NO.	AMENDMENTS	CHKD.	DATE

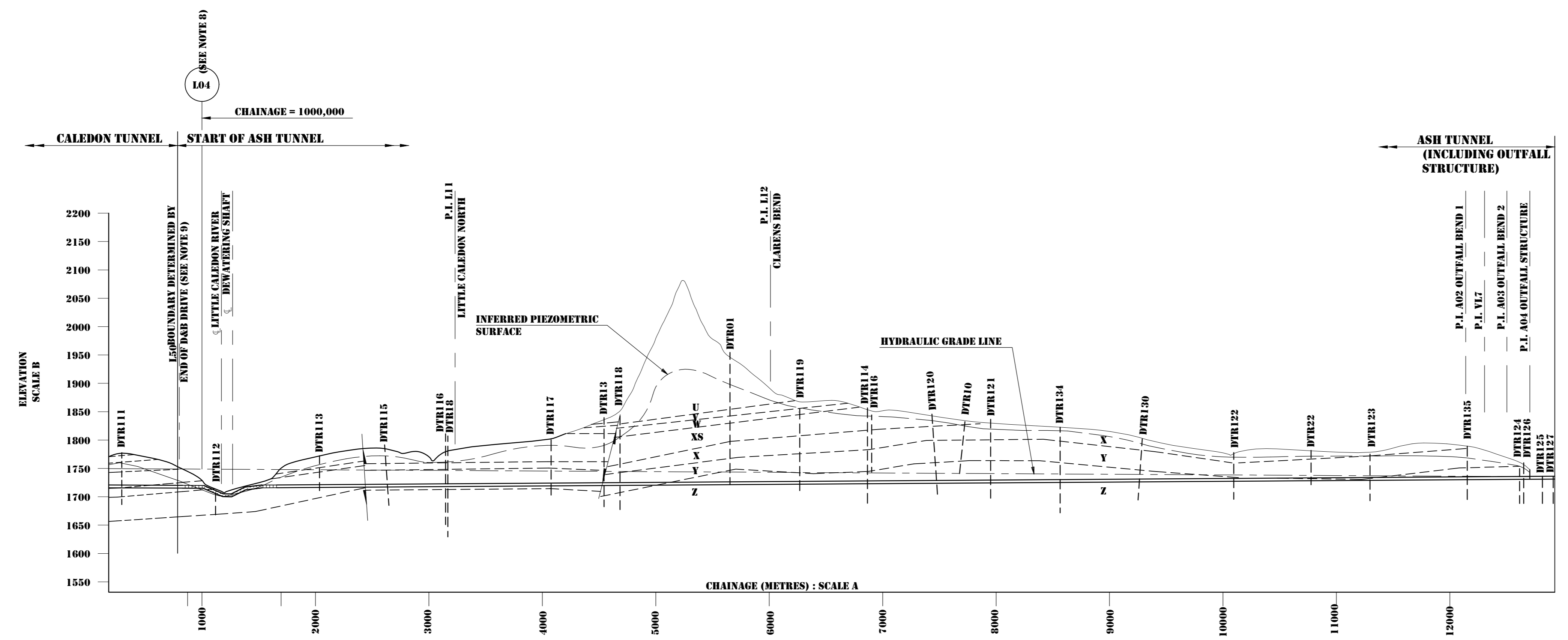


LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A DELIVERY TUNNEL NORTH

CALEDON TUNNEL VENT SHAFT 5 TO LITTLE CALEDON CROSSING HORIZONTAL ALIGNMENT AND LONGITUDINAL SECTION



Date:	Designed:	Drawn:	Checked:
JUL 1991			
Client Contract No.	HDTC Drawing No.	Rev. No.	
TCTA - 20	C20-0703	Z	



PLAN
(SEE NOTE 4)
SCALE A

GENERAL NOTES FOR ALL DRAWINGS:

1. ALL REFERENCE POINTS, TUNNEL CONTROL BEACONS AND GEODETIC TRIANGULATION BEACONS FOR THIS SET OF DRAWINGS ARE BASED ON THE LO 29° (LHWP TUNNEL SYSTEM) CO-ORDINATE SYSTEM. THE EXCEPTIONS ARE LAND ACQUISITION BOUNDARIES (PURCHASE BEACONS) AND FENCE CORNER POST CO-ORDINATES WHICH ARE BASED ON THE LO 29° CO-ORDINATE SYSTEM.
2. ALL DISTANCES AND CHAINAGES SHOWN ON THIS SET OF DRAWINGS ARE ADJUSTED FOR 1700 M.A.S.L. AND MEASURED HORIZONTALLY UNLESS OTHERWISE NOTED.

NOTES:

1. ALL DIMENSIONS IN METRES UNLESS OTHERWISE SHOWN.
2. ALL LEVELS IN METRES ABOVE SEA LEVEL.
3. DISTANCES GIVEN IN TABLE ARE MEASURED HORIZONTALLY FROM P.I. TO P.I.
4. DRAWING BASED ON 1:50 000 TOPOGRAPHICAL MAPPING.
5. HYDRAULIC GRADE LINE IS BASED ON OPERATING LEVEL 1775.500 M.A.S.L. IN MUELA TAILPOND AND CORRESPONDING LEVEL 1735.300 M.A.S.L. AT ASH RIVER OUTFALL.
6. FOR DETAILS OF THE GEOLOGICAL HORIZONS (E, V, W, XS, ETC) AND BOREHOLE LOGS SEE DRG. NOS 0835-0837.
7. POSITIONS OF POINTS OF INTERSECTION (PI) OF HORIZONTAL BEARS ARE SHOWN FOR CORRELATION WITH PLAN LAYOUTS.
8. LOCAL CHAINAGES USED ON ASH TUNNEL CHAINAGE FOR 104 = 1000M.
9. REFER TO DRG. NO. 0702 FOR FURTHER DETAILS.
10. SETTING OUT OF THE TUNNEL IS TO BE BASED STRICTLY ON THE CO-ORDINATE VALUES AND NOT ON THE BEARINGS. THE BEARINGS ARE GIVEN FOR INDICATION ONLY.

POST - CONSTRUCTION NOTE

THIS DRAWING HAS NOT BEEN AMENDED TO REFLECT AS-FOUND/AS-BUILT CONDITIONS, BUT RATHER CONTINUES TO SERVE AS A RECORD OF THE EXPECTED CONDITIONS PRIOR TO EXCAVATION. THE ROCK TYPE, SUPPORT DISTRIBUTION, EXCAVATION AND LIVING INSTRUMENTATION DETAIL RECORDS HAVE BEEN SUMMARISED IN THE DELIVERY TUNNEL NORTH CONSTRUCTION REPORT VOLUME 3; SECTION 1 OR ON THE GEOLOGICAL LONG SECTION AND CONSTRUCTION RECORD DRAWINGS PRESENTED IN THE SAME VOLUME.

TUNNEL DATA					
LIST OF CO-ORDINATES, BEARINGS AND DISTANCES					
P.I. DESCRIPTION	P.I. REF	P.I. CO-ORDINATES		BEARING (SEE NOTE 10)	DISTANCE (SEE NOTE 3)
		+ X	+ Y		
LITTLE CALEDON SOUTH	L01 (*)	3 159 300,056	55 112,999	180° 12' 17"	3 636,844
LITTLE CALEDON NORTH	L11	3 155 664,079	55 100,007	162° 52' 45"	2 788,447
CLARENS BEND	L12	3 152 909,817	55 920,701	152° 42' 58"	6 127,238
OUTFALL BEND 1	A02	3 147 555,521	58 728,774	162° 53' 20"	362,914
OUTFALL BEND 2	A03	3 147 208,752	58 835,828	140° 48' 46"	206,119
OUTFALL STRUCTURE	A04	3 147 049,029	58 965,735		

(*) SEE NOTE 9

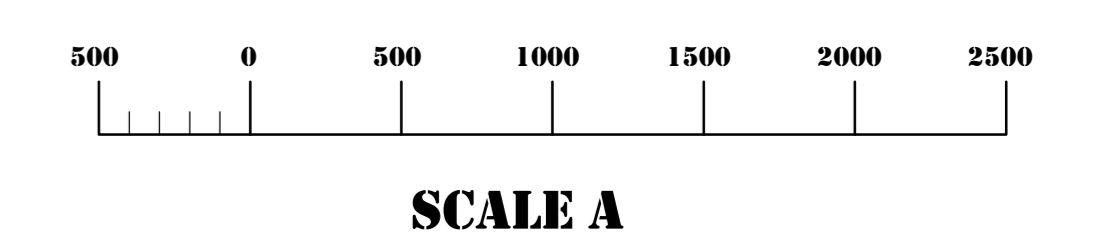
HORIZONTAL CURVE DATA				
P.I. DESCRIPTION	P.I. REF	RADIUS TO C L	ANGLE OF DEVIATION	CURVE LENGTH
LITTLE CALEDON NORTH	L11	800	17° 19' 32"	241,911
CLARENS BEND	L12	800	10° 09' 47"	141,903
OUTFALL BEND 1	A02	800	10° 10' 22"	222,025
OUTFALL BEND 2	A03	800	22° 04' 33"	388,225

LEGEND:

- INFERRED PIEZOMETRIC SURFACE
- INFERRED ROCK TYPE DIVISION LINE
- FAULT
- DTR101 BOREHOLE (IN SECTION)
- DTR116 BOREHOLE (IN PLAN)
- REINFORCED CONCRETE LINED TUNNEL WITH OR WITHOUT WATERPROOF MEMBRANE (RC & WM)
- REINFORCED CONCRETE CUT AND COVER CONDUIT (CCC)
- PRECAST CONCRETE SEGMENT LINING (PCS)
- HYDRAULIC GRADE LINE
- 1:60 1 IN 60 DOWN GRADE
- CO-ORDINATE POINT IDENTIFICATION
- POINT NUMBER LITTLE CALEDON (A = ASH TUNNEL) CO-ORDINATE POINT
- NEW TOWNSHIP AREA

RELATED DRAWINGS

DRG. NO.	DESCRIPTION
0703	VECT SHAFT 5 TO LITTLE CALEDON CROSSING - HORIZONTAL ALIGNMENT AND LONGITUDINAL SECTION
0809	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - GENERAL ARRANGEMENT, LONGITUDINAL SECTION AND SETTING-OUT DETAILS
0835-0837	TUNNEL WORKS - L.C. SOUTH TO ASH OUTFALL - LONGITUDINAL SECTION - SPECIFICATION DETAILS/EXPECTED CONDITIONS
0860	ASH RIVER OUTFALL - OVERALL LAYOUT



SCALE A

CHAINAGE	HYDRAULIC GRADE LINE	LEVELS ON C L	GRADIENT (INDICATIVE ONLY)	EXCAVATION METHOD	LENGTH	PERMANENT LINING	INTERNAL DIAMETER OF LINING
1718,231	1717,53	1718,000	1:999	TBM	87,550	PCS	4,6
1718,200	1717,068	1718,000	VARIES	D&B	126,450	RC & WM	VARIES
1719,040	1716,706	1719,000	1:1055	OPEN EXCAVATION	621,510	CCC	4,5
1720,000	1716,244	1720,000	1:1055	TBM	95,738	RC & WM	4,6
1723,187	1715,066	1723,000	1:1055	TBM	10980,841	PCS	4,6
1729,128	1710,130	1729,000	1:1100	TBM	107,000	RC OUTFALL STRUCTURE	VARIES
1729,248	1710,000	1729,000	1:1100	TBM	10,000	RC	VARIES
1729,238	1710,000	1729,000	1:1100	TBM	88,000	RC	VARIES
1729,200	1710,000	1729,000	1:1100	TBM	107,000	RC	VARIES
1729,200	1710,000	1729,000	1:1100	TBM	107,000	RC	VARIES

LONGITUDINAL SECTION
SCALE A



APPROVED: DATE:

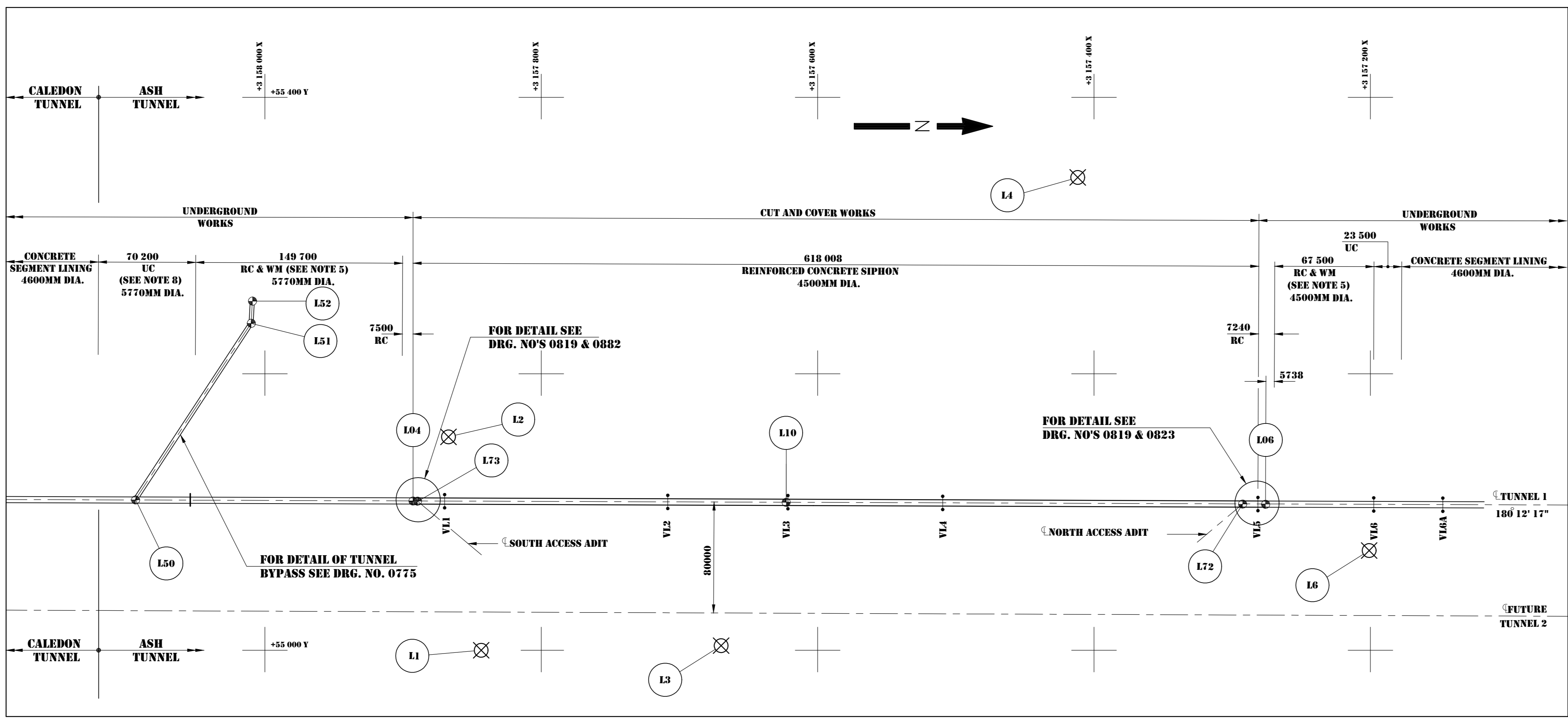
LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A
DELIVERY TUNNEL NORTH

ASH TUNNEL

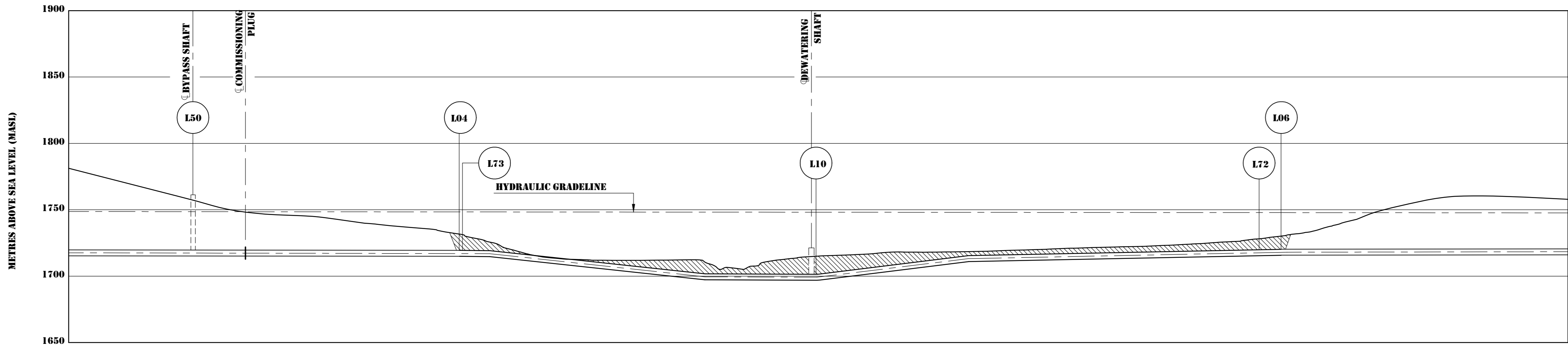
LITTLE CALEDON CROSSING TO ASH OUTFALL
HORIZONTAL ALIGNMENT AND LONGITUDINAL SECTION

HDTC HIGHLANDS DELIVERY TUNNEL CONSULTANTS
SHARON SHAND INC. VAN DERBURG, KELYN & EDW. JEN
KEVE STEYN INC. STEFFEN, ROBERTSON & KRISTEN

DATE: JUL 1991	CHECKED:	SIGNED:
CLIENT CONTRACT NO. TCTA - 20	HDTC DRAWING NO. C20-0803	REV. NO. Z

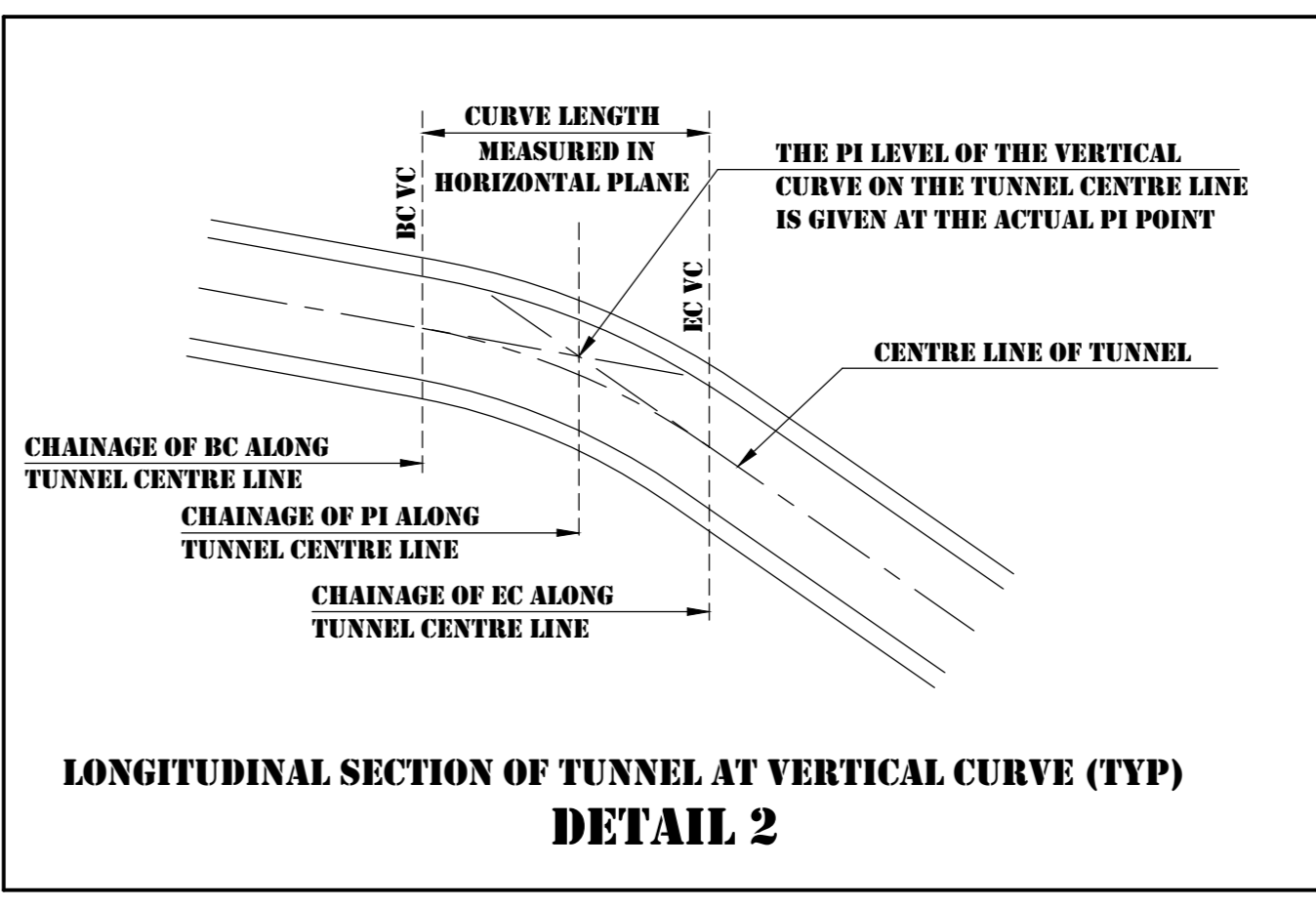
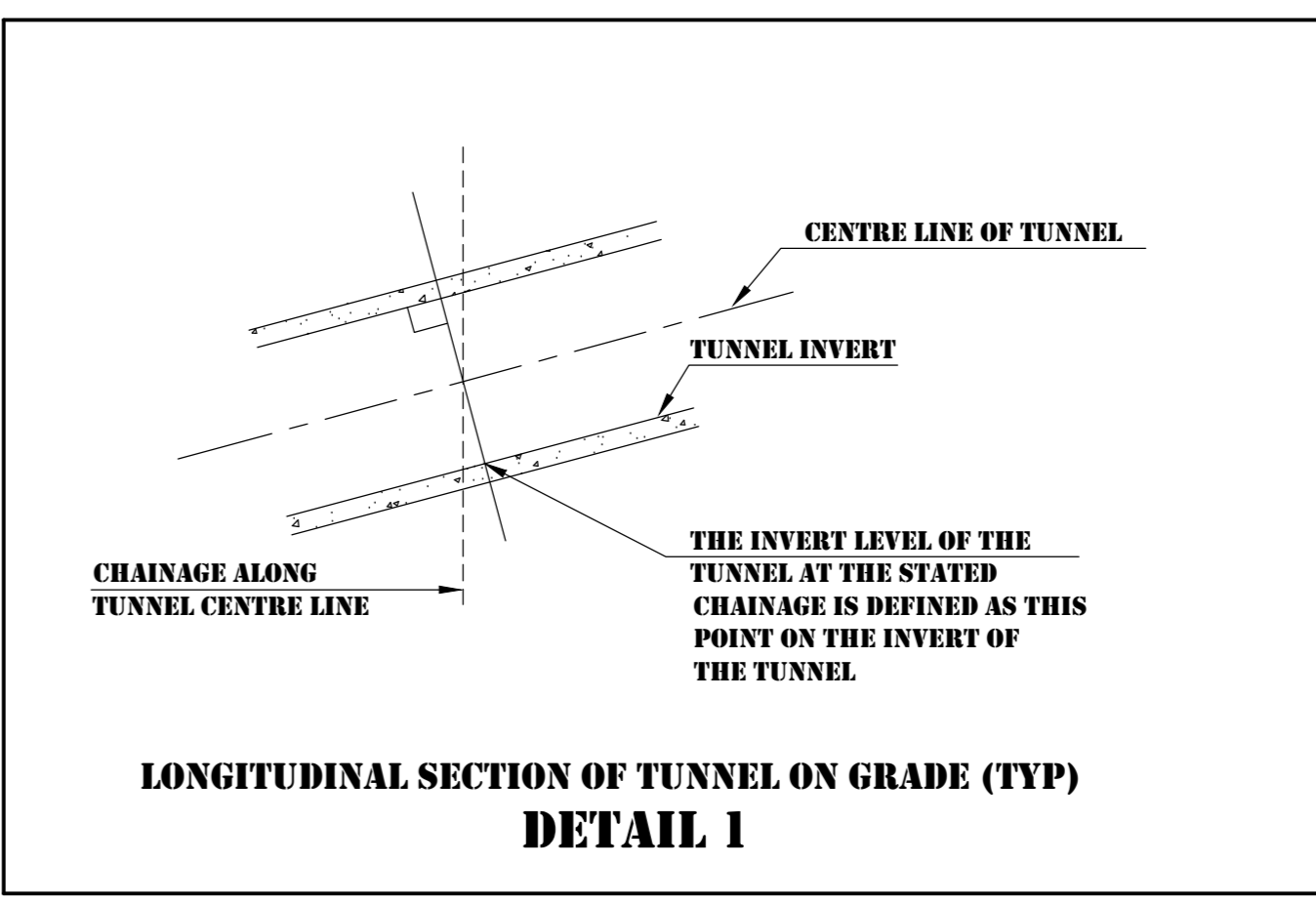


PLAN ON UNDERGROUND / SURFACE WORKS



CHAINAGE (M)	70+200	149+700	618+000	838+000
HYDRAULIC GRADE LINE LEVEL	1772.686	1774.773	1770.935	1774.827
INVERT LEVEL (SEE DETAIL 1)	1774.666	1774.773	1770.935	1774.827
CENTRE LINE LEVEL	1772.686	1774.773	1770.935	1774.827
LOCATION	L50	L04	L10	L06
VERTICAL CURVES ON C (SEE NOTE 6)	PI V15	PI V12	PI V13	PI V16
RADIUS TO L (M)	15000.00	18000.00	18000.00	8000.00
CURVE LENGTH ON C (SEE DETAIL 2)	1936.00	1800.00	2323.00	2892.00
PI LEVELS AND CHAINAGES (M) (SEE DETAIL 2)	1772.686	1774.773	1770.935	1774.827
GRADE ON C L (INDICATIVE ONLY)	1:552.6	1:994.7 (SEE NOTE 9)	1:9.3	1:200.4

LONGITUDINAL SECTION

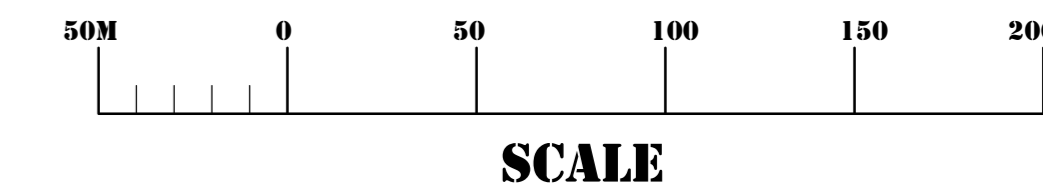


- NOTES:**
1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.
 2. ALL LEVELS ARE IN METRES ABOVE SEA LEVEL (MASL).
 3. HYDRAULIC GRADE LINE IS BASED ON A WEIR & RESERVOIR LEVEL OF 1773.500 MASL AND A TAIL WATER LEVEL OF 1735.500 MASL AT ASH RIVER OUTFALL.
 4. LOCAL CHAINAGES BASED ON ASH TUNNEL CHAINAGE AT L04 = 1000M.
 5. SEE DRG. NO. 0830 FOR DETAILS OF REINFORCED CONCRETE LINING AND WATERPROOF MEMBRANE.
 6. SEE DRG. NOS 0810 AND 0811 FOR DETAILS OF VERTICAL CURVE RC'S AND RC'S.
 7. FOR CO-ORDINATE POINT VALUES SEE DRG. NO. 0804.
 8. TUNNEL DIAMETER AND CENTRE LINE LEVELS ARE SUBJECT TO FINAL DECISION ON CONSTRUCTION METHOD TO BE MADE BY THE CONTRACTOR. INVERT LEVELS GIVEN ARE HOWEVER FINAL AND MUST THEREFORE BE STRICTLY ADHERED TO.
 9. THE GRADES SHOWN REFLECT THE GRADE AT TUNNEL INVERT. ALSO SEE NOTE 2.
 10. SEE DRG. NO. 0820 FOR DETAILS OF DEWATERING SHAFT.
 11. SEE DRG. NO. 1270 FOR DETAILS OF COMMISSIONING PLUG.

- LEGEND:**
- CAST IN-SITU CONCRETE OR CONCRETE SEGMENT LINED TUNNEL
 - CUT & COVER CAST IN-SITU REINFORCED CONCRETE SIPHON
 - PI OF CURVE
- CURVE IDENTIFICATION:**
- E (DK V 1 2) CURVE NUMBER
 - LITTLE CALEDON
 - VERTICAL CURVE
 - BEGINNING OF END OF
- CO-ORDINATE POINT IDENTIFICATION:**
- L03 POINT NUMBER
 - LITTLE CALEDON
 - CO-ORDINATED POINT
 - L5 TUNNEL CONTROL BEACON

RELATED DRAWINGS

DRG. NO.	DESCRIPTION
0775	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - GENERAL ARRANGEMENT
0779	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - SHAFT - EXCAVATION AND CONCRETE DETAILS
0804	LITTLE CALEDON RIVER CROSSING - OVERALL LAYOUT
0810	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON - PLAN ON CENTRELINE AND LONGITUDINAL SECTION - SHEET 1 OF 2
0811	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON - PLAN ON CENTRELINE AND LONGITUDINAL SECTION - SHEET 2 OF 2
0819	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON - TUNNEL PORTALS - EXCAVATION, ROCK SUPPORT AND CONCRETE DETAILS - GENERAL ARRANGEMENT
0820	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - DEWATERING WORKS - GENERAL ARRANGEMENT
0823	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - NORTH ACCESS ADIT PORTAL - LAYOUT AND SECTIONS - SHEET 1 OF 2
0830	LITTLE CALEDON RIVER CROSSING - ENLARGED BAR TUNNELS - 5.77M & 4.5M DIA. JUNCTION - LITTLE CALEDON SOUTH AND NORTH DRIVE - CONCRETE LAYOUT
0882	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - SOUTH ACCESS ADIT PORTAL - LAYOUT AND SECTIONS - SHEET 1 OF 2
1270	ASH/CALEDON TUNNEL - TUNNEL WORKS - LAYINGS - COMMISSIONING PLUGS - CONCRETE DETAILS



SCALE

Z	RECORD DRAWING	DATE
5	RC'S AND RC'S ADDER, HYDRAULIC GRADE LINE LEVELS REVISED	04/09/93
4	HYDRAULIC GRADELINE ADDED AND POSITION OF COMMISSIONING PLUG INDICATED	06/03/93
3	SOUTH ADIT TUNNEL DIAMETER ENLARGED AND VERTICAL ALIGNMENT REVISED. SUT. RELATED DRAWINGS AMENDED.	08/02/93
2	VERTICAL CURVE V16 ADDED AND VERTICAL CURVES V15, V16, V17 AND RELATED DRAWINGS AMENDED	31/07/92
1	POSITION OF SIPHON (TUNNEL PORTALS) REVISED, TABLE AND POSITION OF DEWATERING SHAFT AMENDED	RCV 22/07/91
0	ISSUED FOR CONSTRUCTION	RCV 3/91
NO.	AMENDMENTS	CHKD. DATE

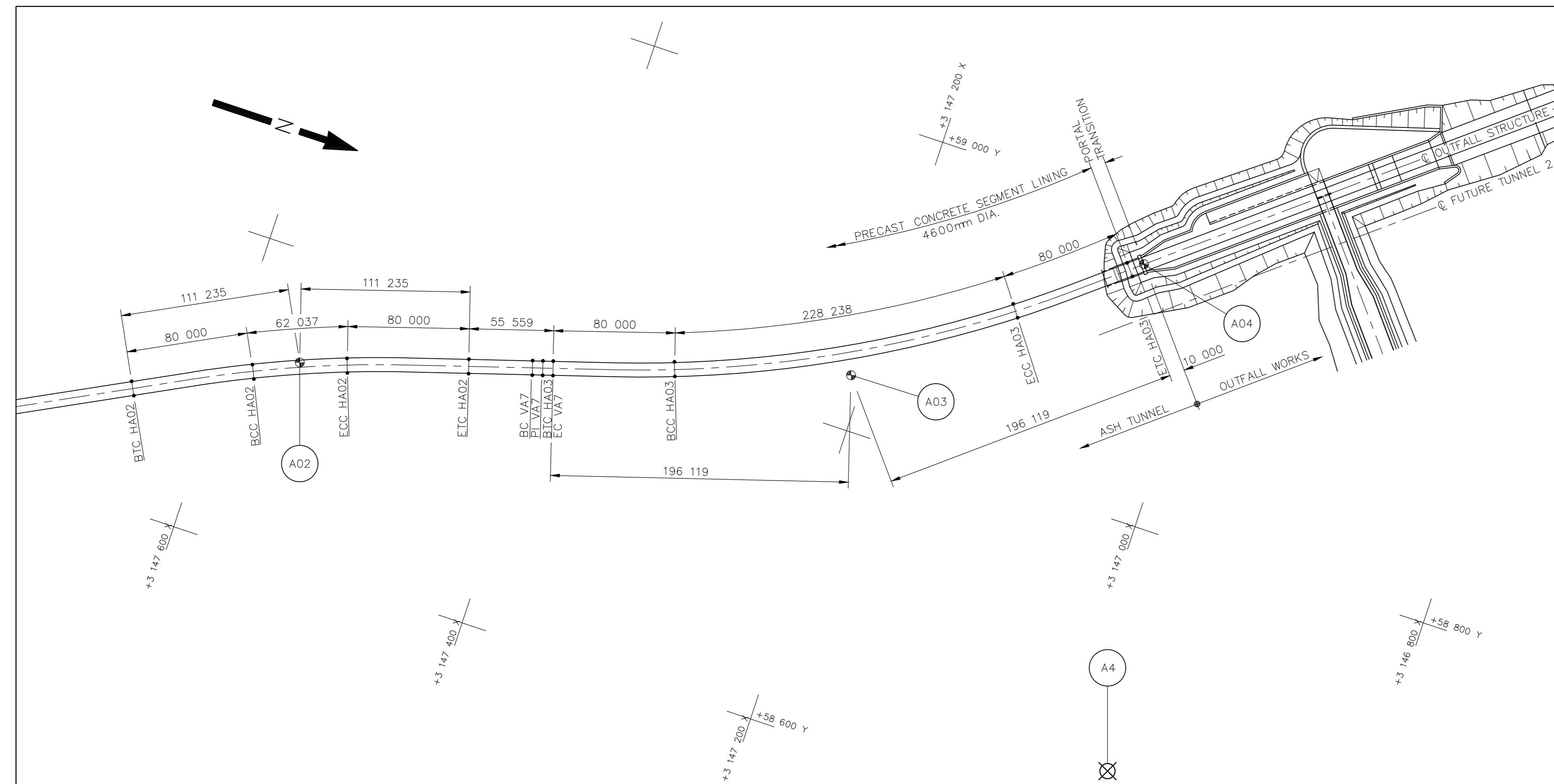
TCTA TRANSCALEDON TUNNEL AUTHORITY

APPROVED: *F. K...* DATE: 03-91

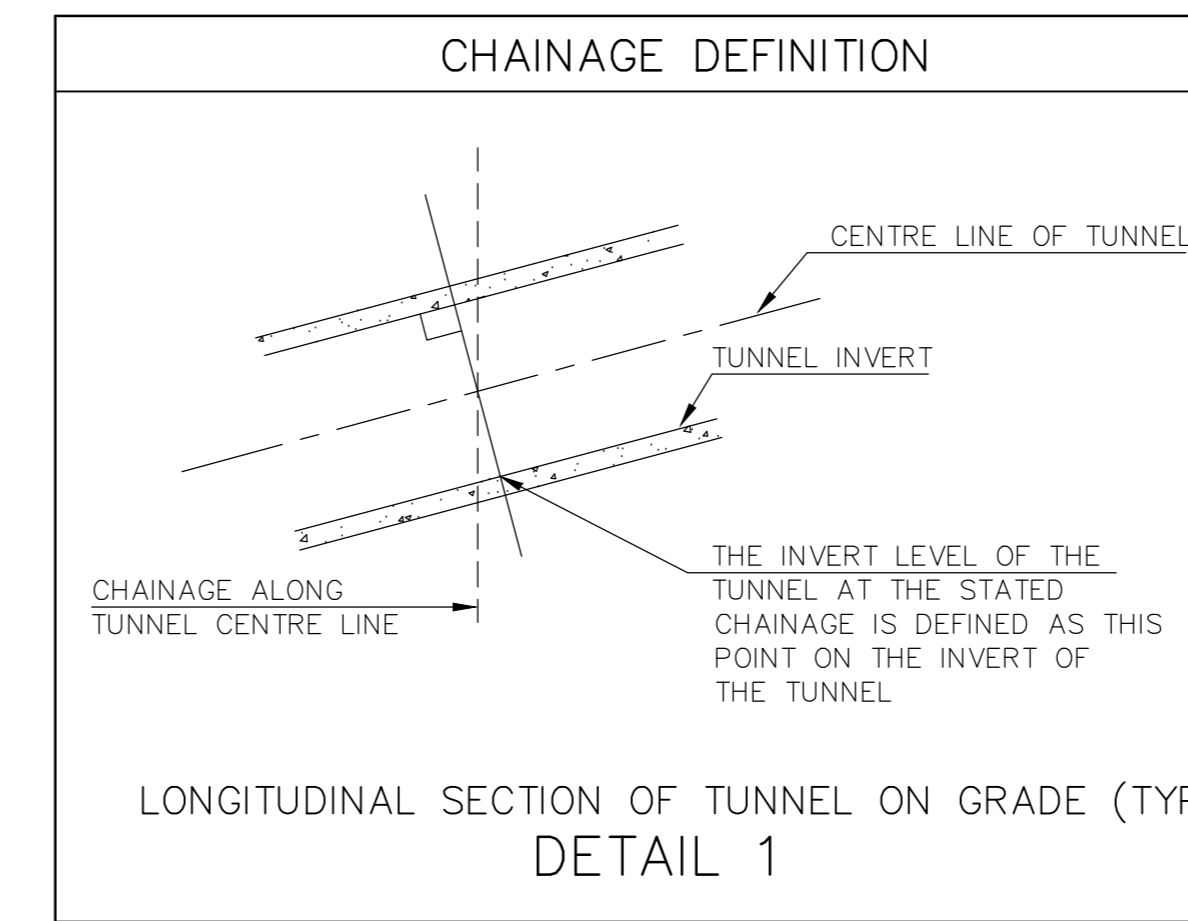
LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A
DELIVERY TUNNEL NORTH
ASH TUNNEL
LITTLE CALEDON RIVER CROSSING
UNDERGROUND/SURFACE WORKS
GENERAL ARRANGEMENT, LONGITUDINAL SECTION AND SETTING OUT DETAILS

HDTIC HIGHLANDS DELIVERY TUNNEL CONSULTANTS
 SIMILAM SHAND INC. VAN NIEKERK, KLEYN & EDWARDS
 KEVIE STEYN INC. STEFFEN, ROBERTSON & KRISTINA

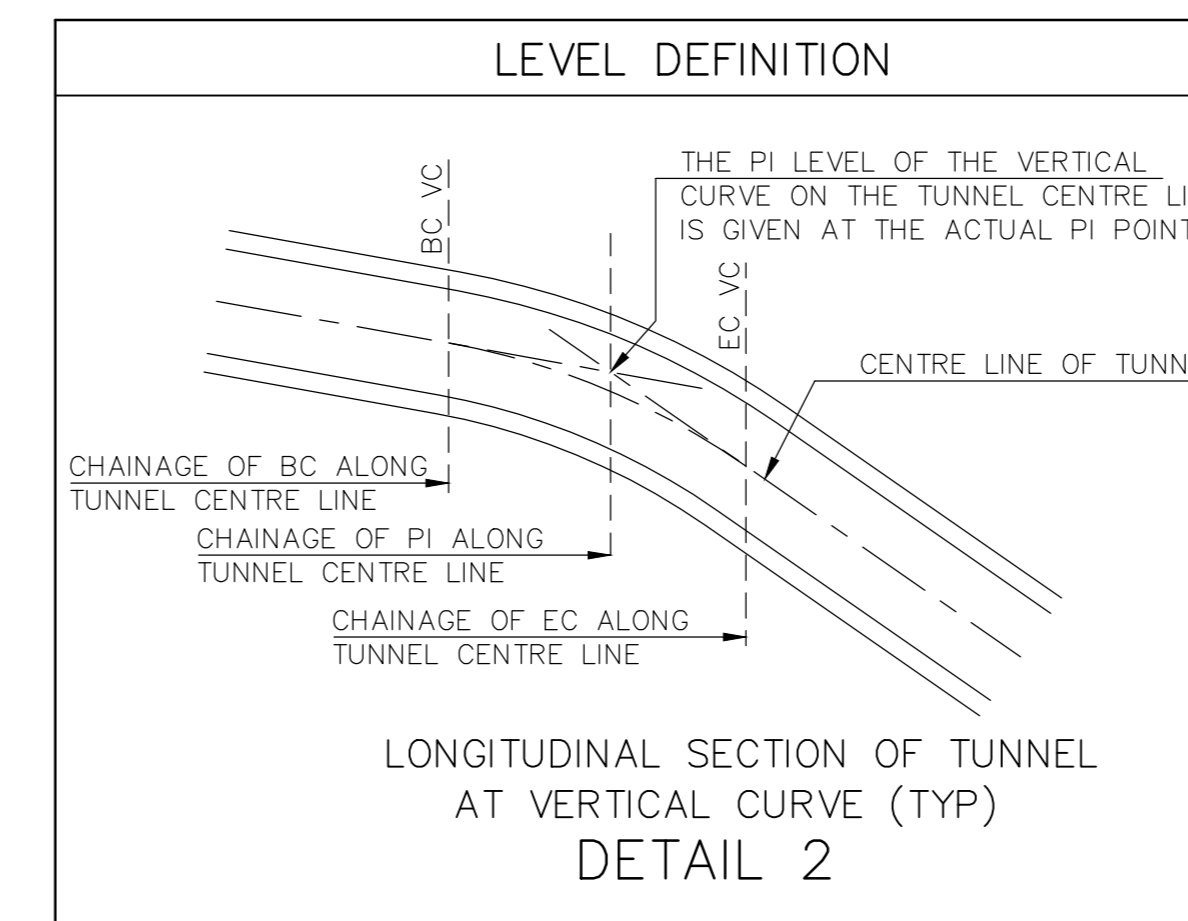
DATE:	DESIGNER:	DRAWN:	CHECKED:
FEB 1991	HDTIC DRAWING NO.	C30-0809	REV. NO. Z
CLIENT CONTRACT NO.	TCTA - 20		



PLAN ON UNDERGROUND WORKS

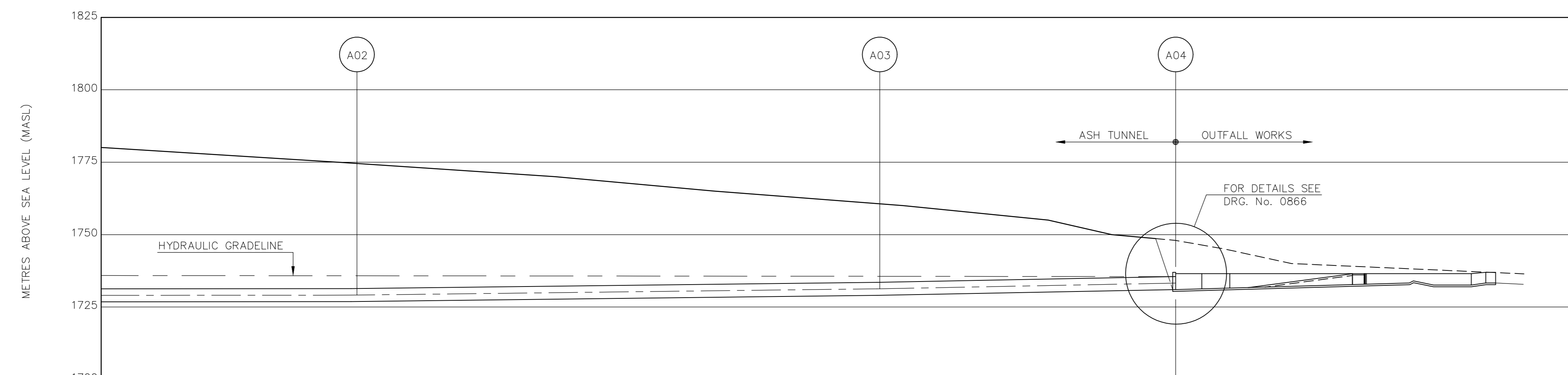


LONGITUDINAL SECTION OF TUNNEL ON GRADE (TYP) DETAIL 1



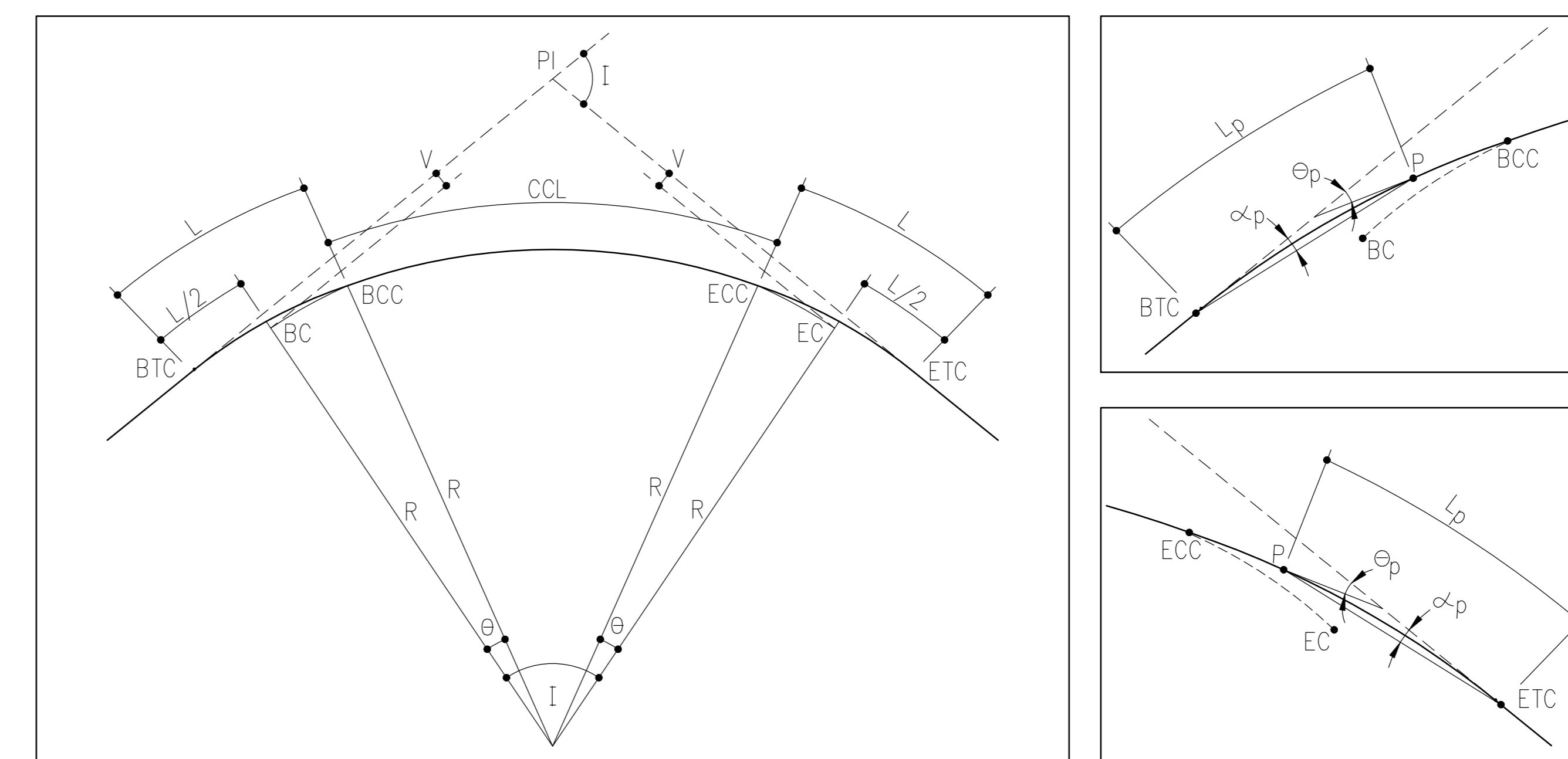
LONGITUDINAL SECTION OF TUNNEL AT VERTICAL CURVE (TYP) DETAIL 2

CO-ORDINATE LIST		
CO-ORDINATES BASED ON LD 29° (LHWP TUNNEL SYSTEM)		
No.	+Y	+X
BTC HA02	58 677,795	3 147 654,358
BCC HA02	58 713,265	3 147 582,682
A02	58 728,774	3 147 555,521
ECC HA02	58 736,694	3 147 525,264
ETC HA02	58 761,495	3 147 449,234
BC VA1	58 773,845	3 147 409,116
PI VA1	58 775,842	3 147 402,631
EC VA1	58 777,838	3 147 396,146
BTC HA03	58 777,838	3 147 396,146
BCC HA03	58 802,639	3 147 320,117
A03	58 835,528	3 147 208,752
ECC HA03	58 909,927	3 147 119,597
ETC HA03	58 959,418	3 147 056,778
A04	58 965,735	3 147 049,029



LONGITUDINAL SECTION

CHAINAGE (m)	HYDRAULIC GRADE LINE LEVEL	INVERT LEVEL (SEE DETAIL 1)	CENTRE LINE LEVEL	LOCATION	VERTICAL CURVES ON ϵ	RADIUS TO ϵ (m)	CURVE LENGTH ON ϵ (m) (SEE DETAIL 2)	P.I. LEVELS AND CHAINAGES (m) (SEE DETAIL 2)	GRADE ON ϵ (INDICATIVE ONLY)
62.037	1736.5	1726.693	1728.993	BTC HA02					
111.235	1736.5	1726.769	1729.069	BCC HA02					
196.119	1736.2	1726.828	1729.128	ECC HA02					
228.238	1736.2	1726.804	1729.204	ETC HA02					
250.100	1735.7	1726.900	1729.244	BC VA1				1729.250	
267.114	1735.5	1727.018	1729.318	PI VA1				17302.690	
287.114	1735.5	1727.018	1729.318	EC VA1					
388.238	1736.2	1727.818	1730.118	BTC HA03					
409.116	1735.7	1728.818	1731.118	BCC HA03					
449.234	1735.5	1729.818	1732.118	ECC HA03					
479.234	1735.5	1729.818	1732.118	ETC HA03					



TRANSITION CURVE DATA

CURVE No. 02	CURVE No. 03
$\epsilon = 10.173^\circ$	$\epsilon = 22.076^\circ$
$R = 800,000\text{m}$	$R = 800,000\text{m}$
$L = 80,000\text{m}$	$L = 80,000\text{m}$
$V = 0,334\text{m}$	$V = 0,334\text{m}$
$CCL = 62,037\text{m}$	$CCL = 228,238\text{m}$
$TL = 111,235\text{m}$	$TL = 196,119\text{m}$
$TCL = 222,037\text{m}$	$TCL = 388,238\text{m}$

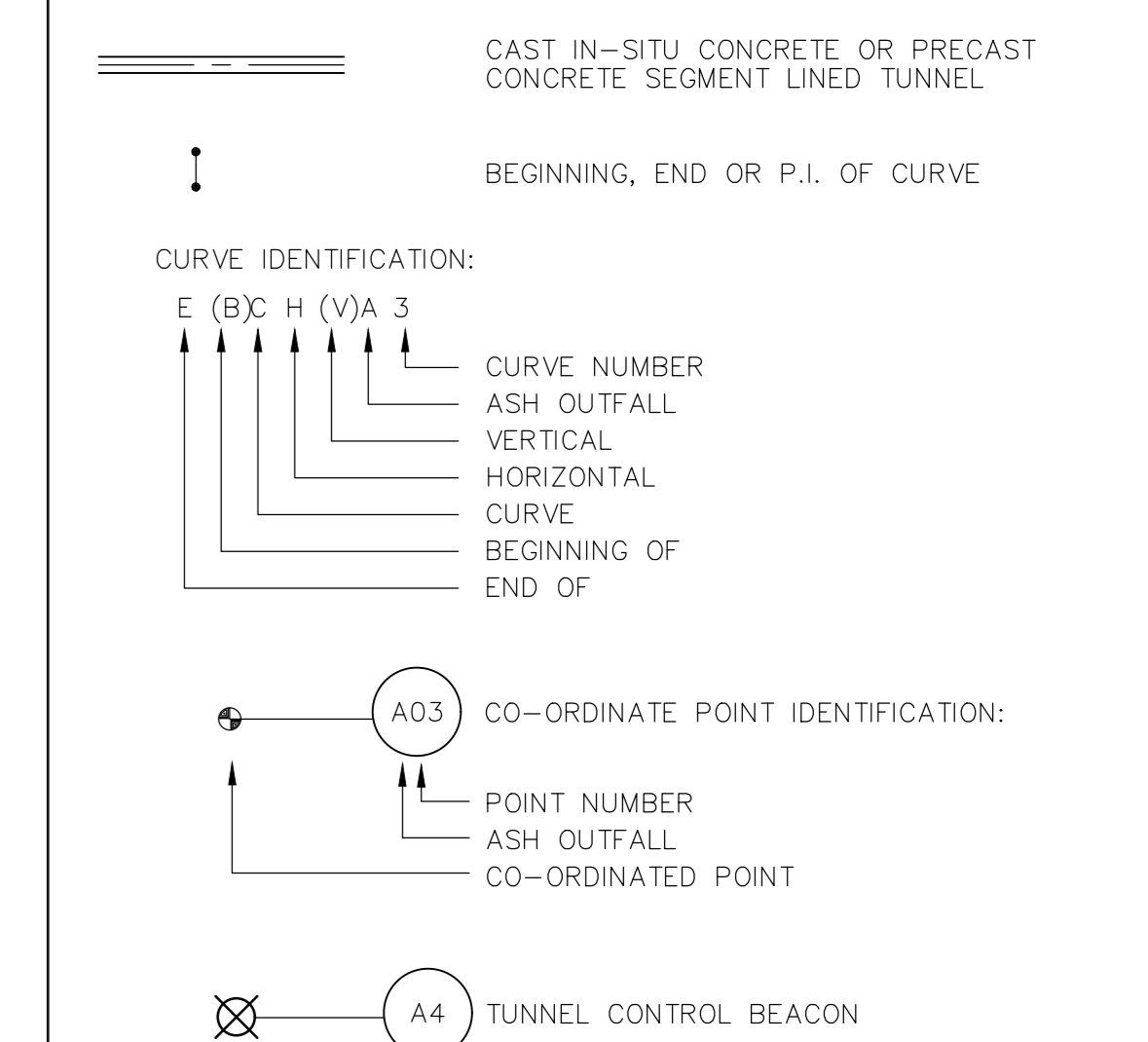
TYPE OF CURVE : FROUDE OR CUBIC PARABOLA
SHIFT : $V = \frac{L^2}{2R} - R(1 - \cos\theta)$
CIRCULAR CURVE LENGTH : $CCL = R(1 - \cos\theta)$
TANGENT LENGTH : $TL = ((R+V) \tan(\theta/2) + L/2)$
TOTAL CURVE LENGTH : $TCL = R\theta + L$
WHERE θ = INTERSECTION ANGLE IN RADIAN
 R = CIRCULAR CURVE RADIUS
 L = TRANSITION CURVE LENGTH
 $\theta = \theta_p$ AS DEFINED BELOW AT $L_p = L$, ie. AT THE BCC, IN RADIAN
FOR ANY POINT P ON THE TRANSITION CURVE BETWEEN BTC AND BCC, ie. BETWEEN START TRANSITION CURVE AND WHERE TRANSITION CURVE INTERSECTS CIRCULAR CURVE
 $\theta_p = \arctan\left(\frac{L_p^3}{6R^2} - \frac{L_p^7}{336R^4}\right) \left(\frac{L_p - L_p^5}{40R^2}\right)$
 θ_p = ANGLE IN RADIAN BETWEEN THE STRAIGHT LINE JOINING BTC TO P AND THE TANGENT LINE FROM BTC
 θ_p = ANGLE IN RADIAN BETWEEN THE TANGENT TO THE TRANSITION CURVE AT P AND THE TANGENT LINE FROM BTC
 L_p = LENGTH ALONG THE TRANSITION CURVE FROM BTC TO P

THE ABOVE IS ALSO APPLICABLE WORKING FROM ETC TO ECC, ie. IN THE OPPOSITE DIRECTION TO TUNNELLING

NOTES:

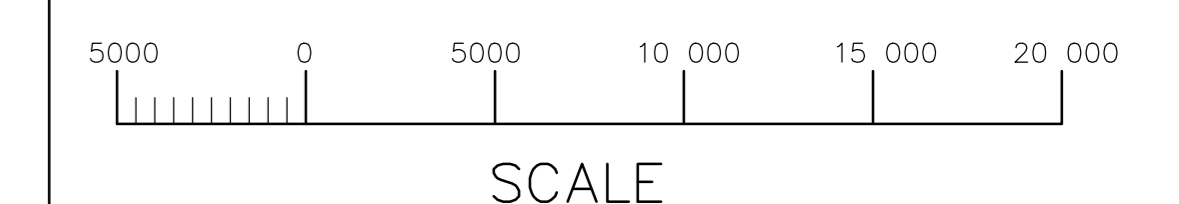
1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.
2. ALL LEVELS ARE IN METRES ABOVE SEA LEVEL (M.A.S.L.)
3. HYDRAULIC GRADE LINE IS BASED ON A MUELA TAILPOND LEVEL OF 1773,500 AND A TAIL WATER LEVEL OF 1735,500 AT ASH RIVER OUTFALL.
4. FOR CO-ORDINATE POINT VALUES SEE DRG. No's 0803 AND 0860.

LEGEND:



Related Drawings

Drg. No.	Description
0803	LITTLE CALEDON RIVER CROSSING - ASH OUTFALL - HORIZONTAL ALIGNMENT AND LONGITUDINAL SECTION
0860	ASH RIVER OUTFALL - OUTFALL WORKS - OVERALL LAYOUT
0866	ASH RIVER OUTFALL - OUTFALL WORKS - OUTFALL STRUCTURE - EXCAVATION BACKFILL AND SUPPORT - GENERAL ARRANGEMENT
0867	ASH RIVER OUTFALL - OUTFALL WORKS - OUTFALL STRUCTURE - EXCAVATION AND SUPPORT DETAILS - SHEET 1 OF 2



Z.	RECORD DRAWING	MRE	DATE
2.	TABLE REVISED	MRE	10/9/93
1.	TUNNEL ALIGNMENT REVISED, RELATED DRAWINGS AMENDED, CO-ORDINATE LIST AND TRANSITION CURVE DATA ADDED	MRE	23/6/93
0.	ISSUED FOR CONSTRUCTION	BCV	07/91

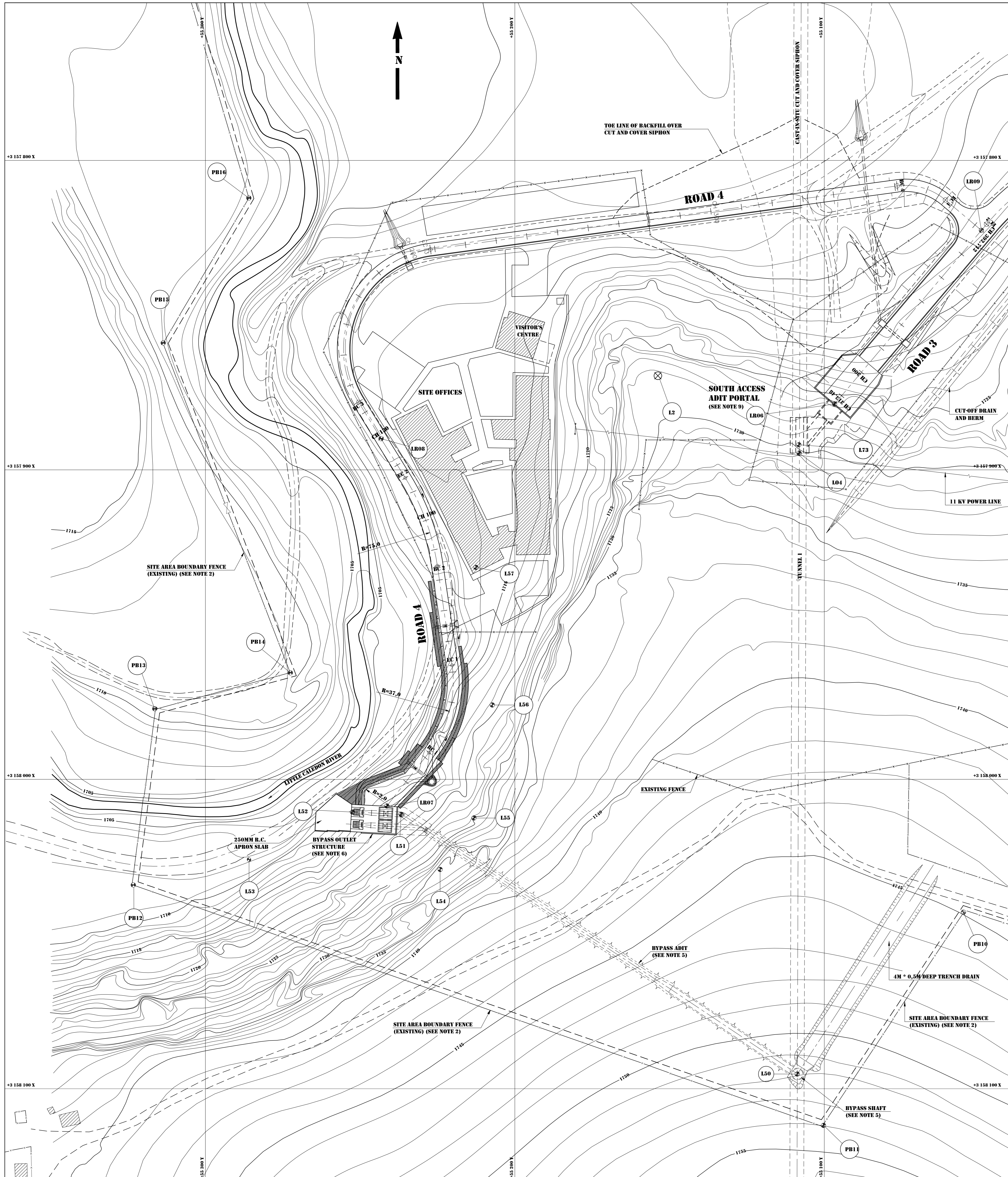


LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A DELIVERY TUNNEL NORTH

ASH TUNNEL ASH RIVER OUTFALL UNDERGROUND WORKS GENERAL ARRANGEMENT, LONGITUDINAL SECTION AND SETTING OUT DETAILS



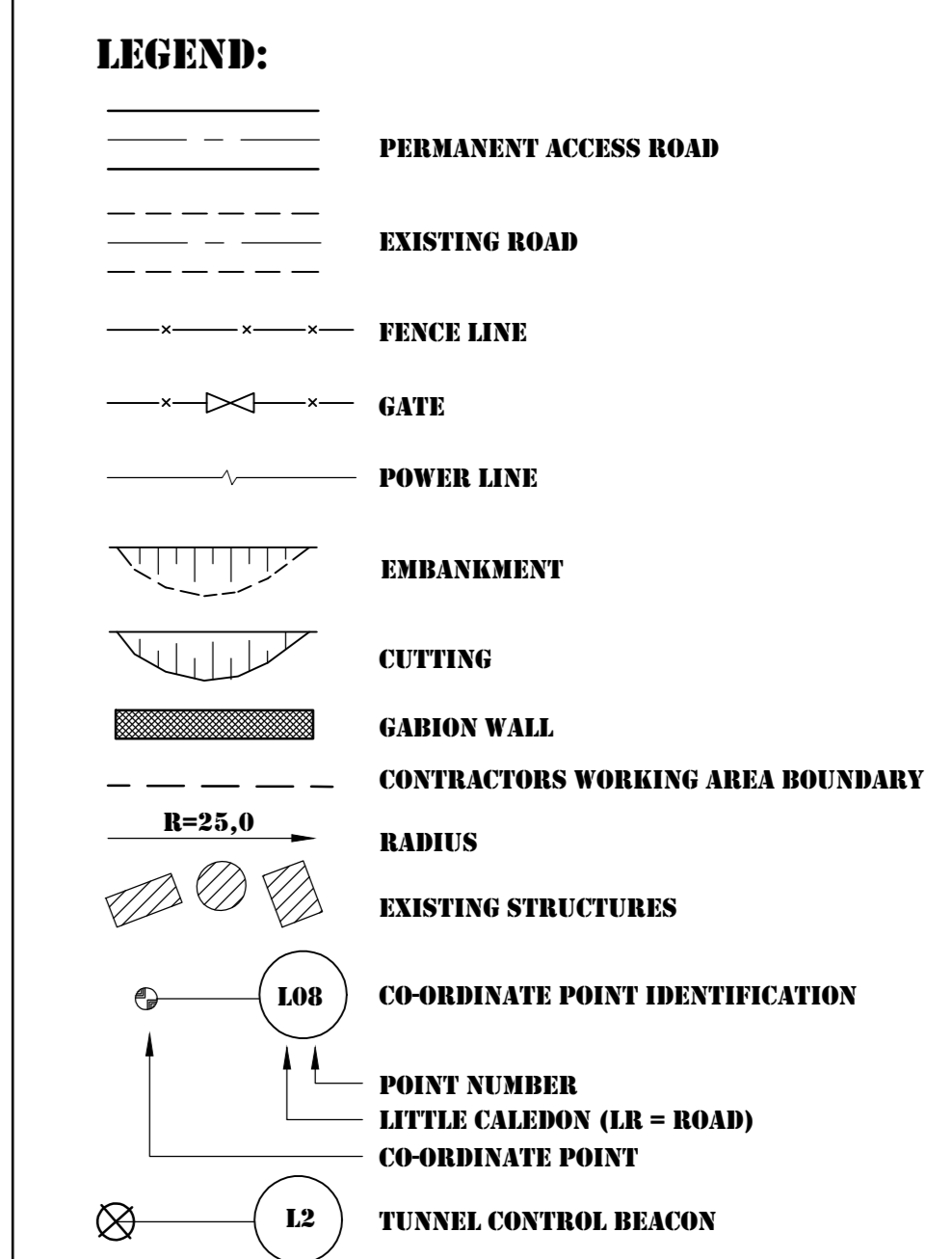
Date: JAN 1992	Designed:	Drawn:	Checked:
Client Contract No: TCTA - 20	HDTC Drawing No: C30-0865	Rev. No: Z	



SETTING OUT DATA - ROAD 4

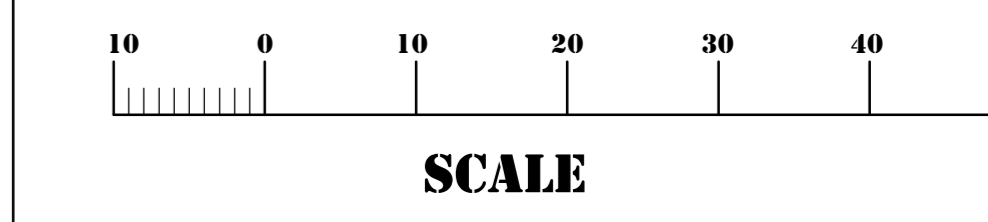
POINT	CHAINAGE	DIRECTION	LO SYSTEM 29° (LHWP TUNNEL SYSTEM)		CURVE DATA
			Y	X	
LR07	0,000		CONSTANT 0,000M	CONSTANT 3 100 000,000M	
BC 1	22,179		+55 241,416	+58 008,828	
PI 1		218° 02' 19"	+55 227,750	+57 991,360	RAD. = 37M-LEFT ± 46° 27' 04"
EC 1	52,175		+55 217,966	+57 978,855	CL = 29,997M
		171° 35' 15"	+55 220,289	+57 963,148	TL = 15,878M
BC 2	84,684		+55 225,045	+57 930,990	
PI 2		171° 35' 15"	+55 227,302	+57 915,727	RAD. = 75M-LEFT ± 23° 14' 56"
EC 2	115,116		+55 235,400	+57 902,595	CL = 30,433M
		148° 20' 19"	+55 243,213	+57 889,926	TL = 15,429M
LR08	130,000		+55 243,213	+57 889,926	
BC 3	143,959		+55 250,540	+57 878,044	RAD. = 32,5M-RIGHT ± 113° 54' 02"
PI 3		148° 20' 19"	+55 276,759	+57 835,528	CL = 64,608M
EC 3	208,567		+55 227,266	+57 828,783	TL = 49,951M
		262° 14' 22"	+55 076,464	+57 808,231	RAD. = 20M-RIGHT ± 47° 57' 49"
BC 4	360,763		+55 067,649	+57 807,030	CL = 16,742M
PI 4		310° 12' 11"	+55 060,854	+57 812,773	TL = 8,897M
EC 4	377,505		+55 049,239	+57 822,589	
LR09	392,712		+55 049,239	+57 822,589	

- NOTES:**
- ALL DIMENSIONS IN METRES.
 - SEE NOTES ON DRG. NO. 0804.
 - SEE DRG. NOS 0783 AND 0784 FOR DETAILS OF ACCESS ROAD TO TUNNEL BYPASS - ROAD 4.
 - NOT USED.
 - SEE DRG. NOS 0779 AND 1112 FOR DETAILS OF BYPASS SHAFT AND CAPPING STRUCTURE RESPECTIVELY.
 - SEE DRG. NO. 0778 FOR DETAILS OF OUTLET STRUCTURE.
 - SEE DRG. NO. 0782 FOR DETAILS OF EXCAVATION FOR BYPASS ADIT AND OUTLET STRUCTURE.
 - REPAIR APRON TO BE 2500MM THICK COMPRISING MATERIAL BASALT ORIGIN; D SIZE = 1250MM.
 - SEE DRG. NO. 0882 FOR DETAILS OF SOUTH ACCESS ADIT PORTAL.
 - SEE DRG. NO. 0765 FOR DETAILS OF ACCESS ROAD TO SOUTH ADIT PORTAL - ROAD 5.



RELATED DRAWINGS

DRG. NO.	DESCRIPTION
0763	LITTLE CALEDON RIVER CROSSING - PERMANENT ACCESS ROADS - ROAD TO SOUTH PORTAL - ROAD 3
0777	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - LONGITUDINAL SECTION - LAYING AND GRADING DETAILS
0778	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - OUTLET STRUCTURE - CONCRETE DETAILS - SHEET 1 OF 2
0779	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - SHAFT - EXCAVATION AND CONCRETE DETAILS
0782	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - LONGITUDINAL SECTION - EXCAVATION DETAILS
0783	LITTLE CALEDON RIVER CROSSING - PERMANENT ACCESS ROADS - ROAD TO TUNNEL BYPASS - ROAD 4 - SHEET 1 OF 2
0784	LITTLE CALEDON RIVER CROSSING - PERMANENT ACCESS ROADS - ROAD TO TUNNEL BYPASS - ROAD 4 - SHEET 2 OF 2
0804	LITTLE CALEDON RIVER CROSSING - OVERALL LAYOUT
0882	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - SOUTH ACCESS ADIT PORTAL - LAYOUT AND SECTIONS - SHEET 1 OF 2
1112	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - SHAFT CAPPING STRUCTURE - CONCRETE DETAILS



Z.	RECORD DRAWING		
0.	ISSUED FOR CONSTRUCTION	R.C.V.	07/91
NO.	AMENDMENTS	CHKD.	DATE

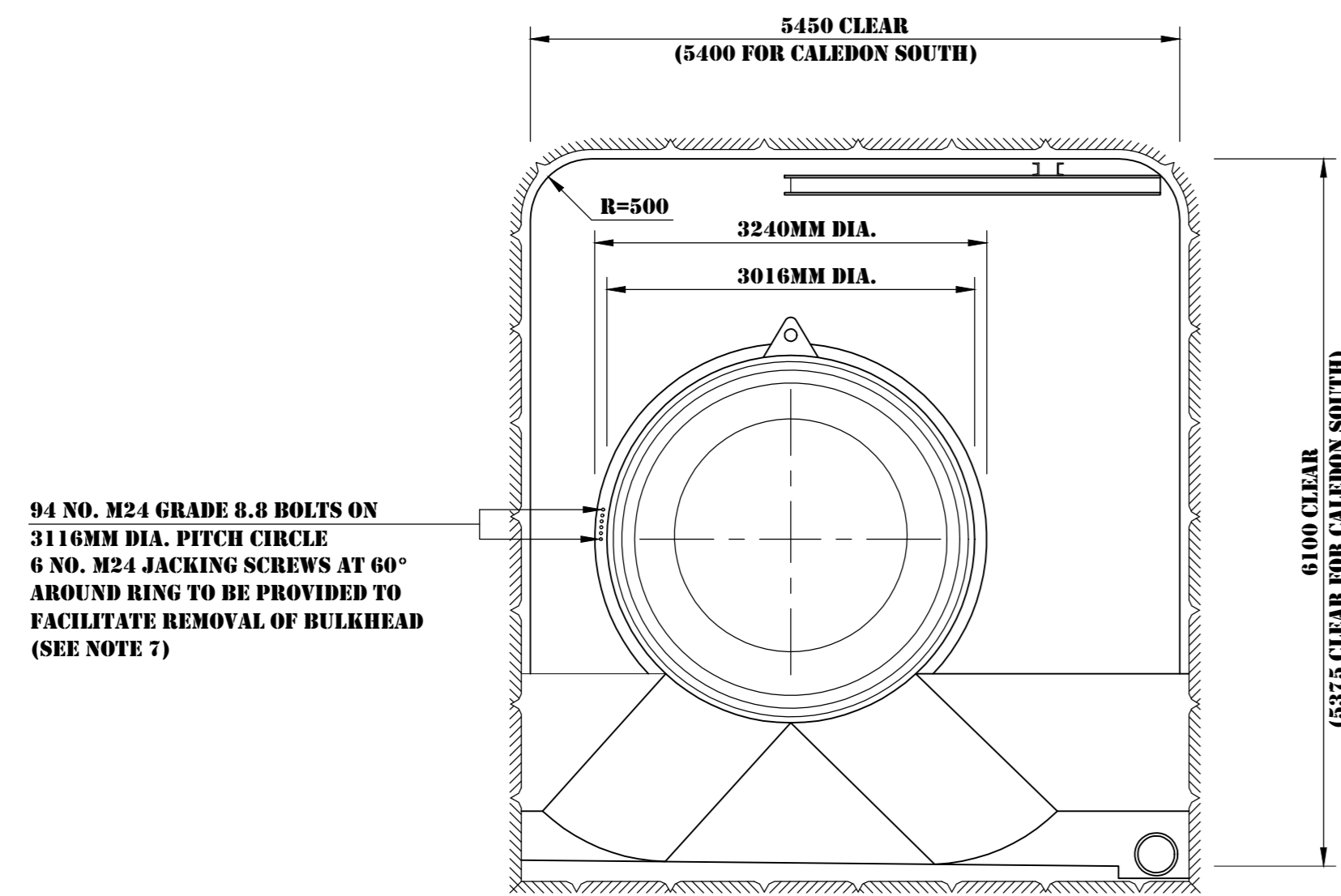
CTA TRANSCALEDON TUNNEL AUTHORITY
 APPROVED: *F. Clerk* DATE: 8-3-91

LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A
DELIVERY TUNNEL NORTH

CALEDON TUNNEL
LITTLE CALEDON RIVER CROSSING
UNDERGROUND WORKS
TUNNEL BYPASS
GENERAL ARRANGEMENT

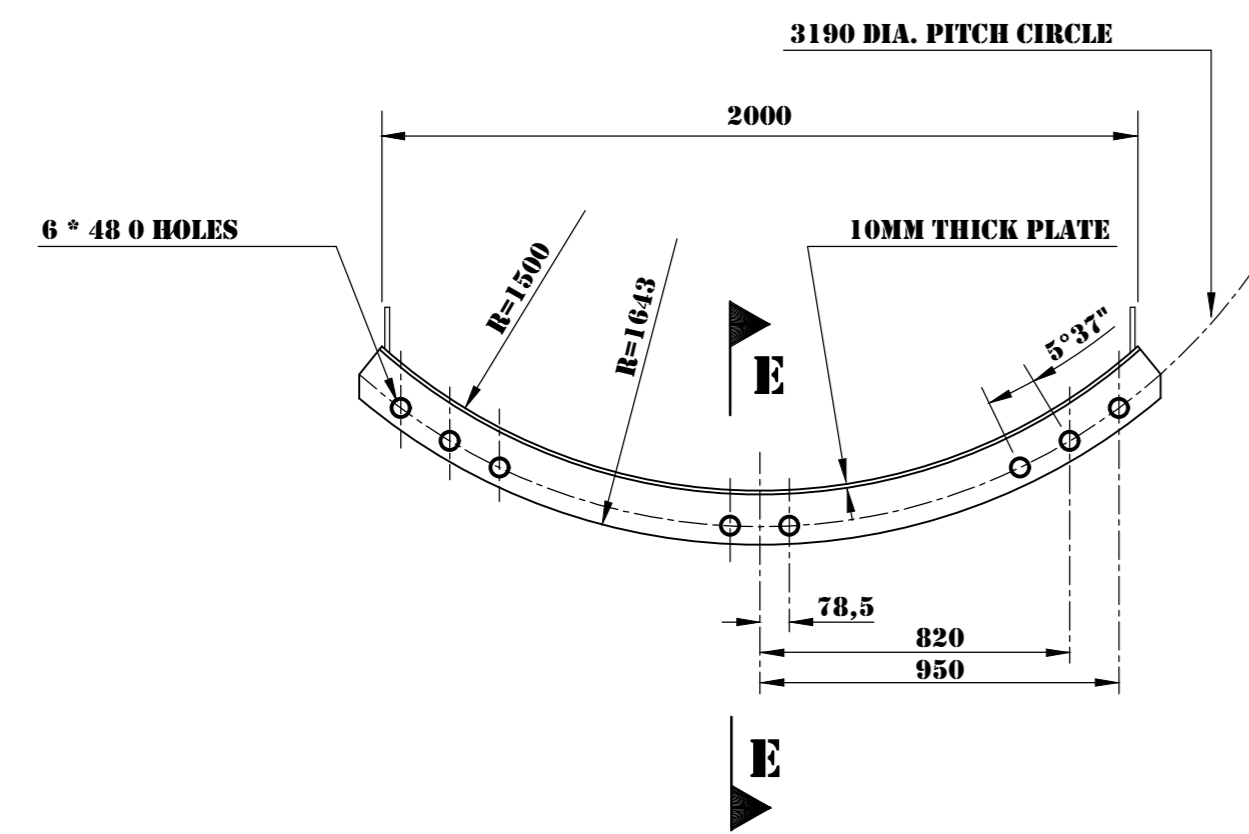
HDTIC HIGHLANDS DELIVERY TUNNEL CONSULTANTS
 SIMILAN SHAND INC. VAN NIEKERK, REYN & EDWARDS
 KEVIE STEYN INC. STEFFEN, ROBERTSON & KIRSTEN

DATE: **MAR 1991** CHECKED: **HDTIC DRAWING NO. C31-0775** REV. NO. **Z**

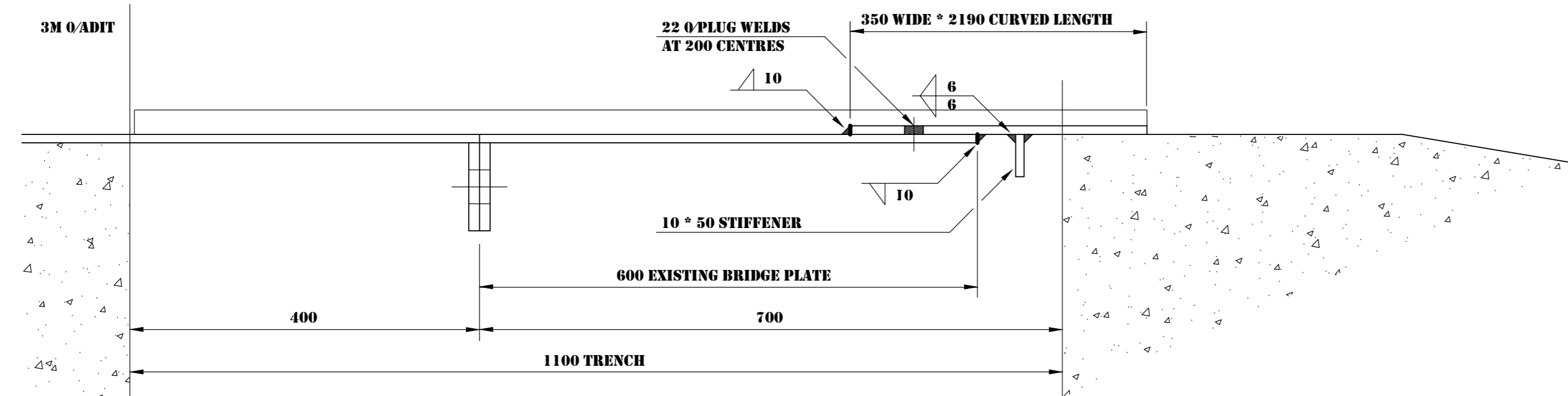


94 NO. M24 GRADE 8.8 BOLTS ON 3115MM DIA. PITCH CIRCLE
6 NO. M24 JACKING SCREWS AT 60° AROUND RING TO BE PROVIDED TO FACILITATE REMOVAL OF BULKHEAD (SEE NOTE 7)

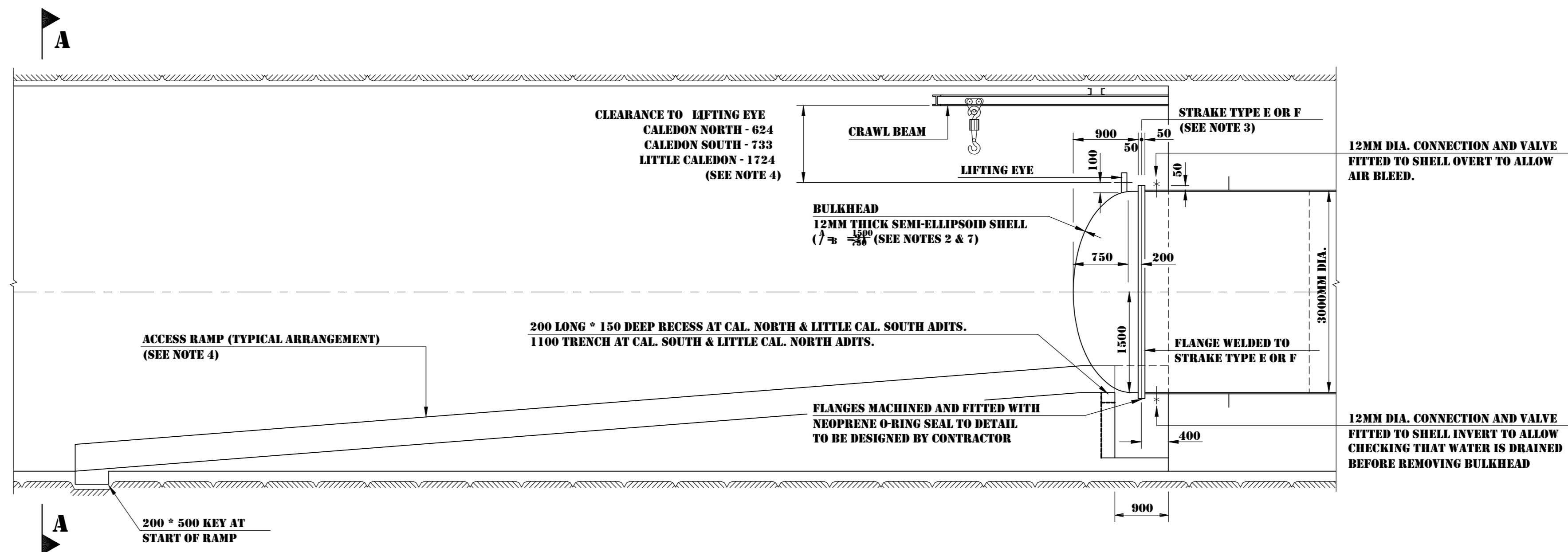
SECTION A-A
SCALE A



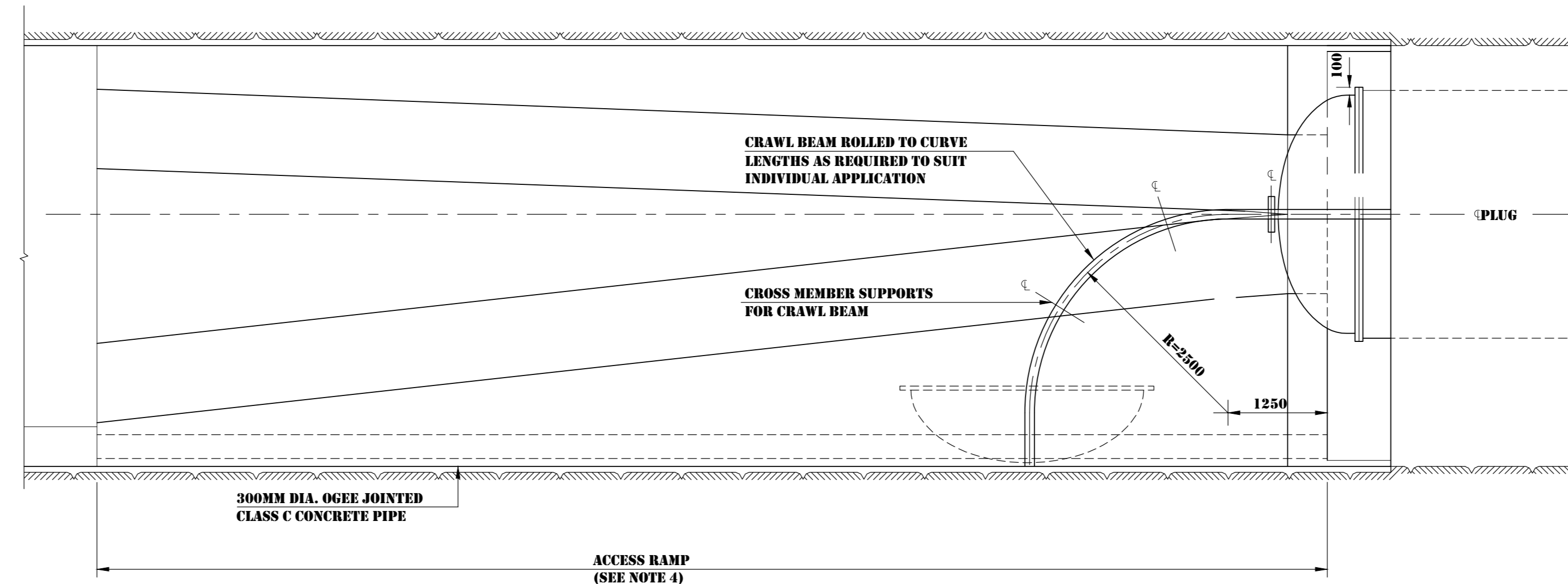
ELEVATION ON BRIDGING PLATE
SCALE C



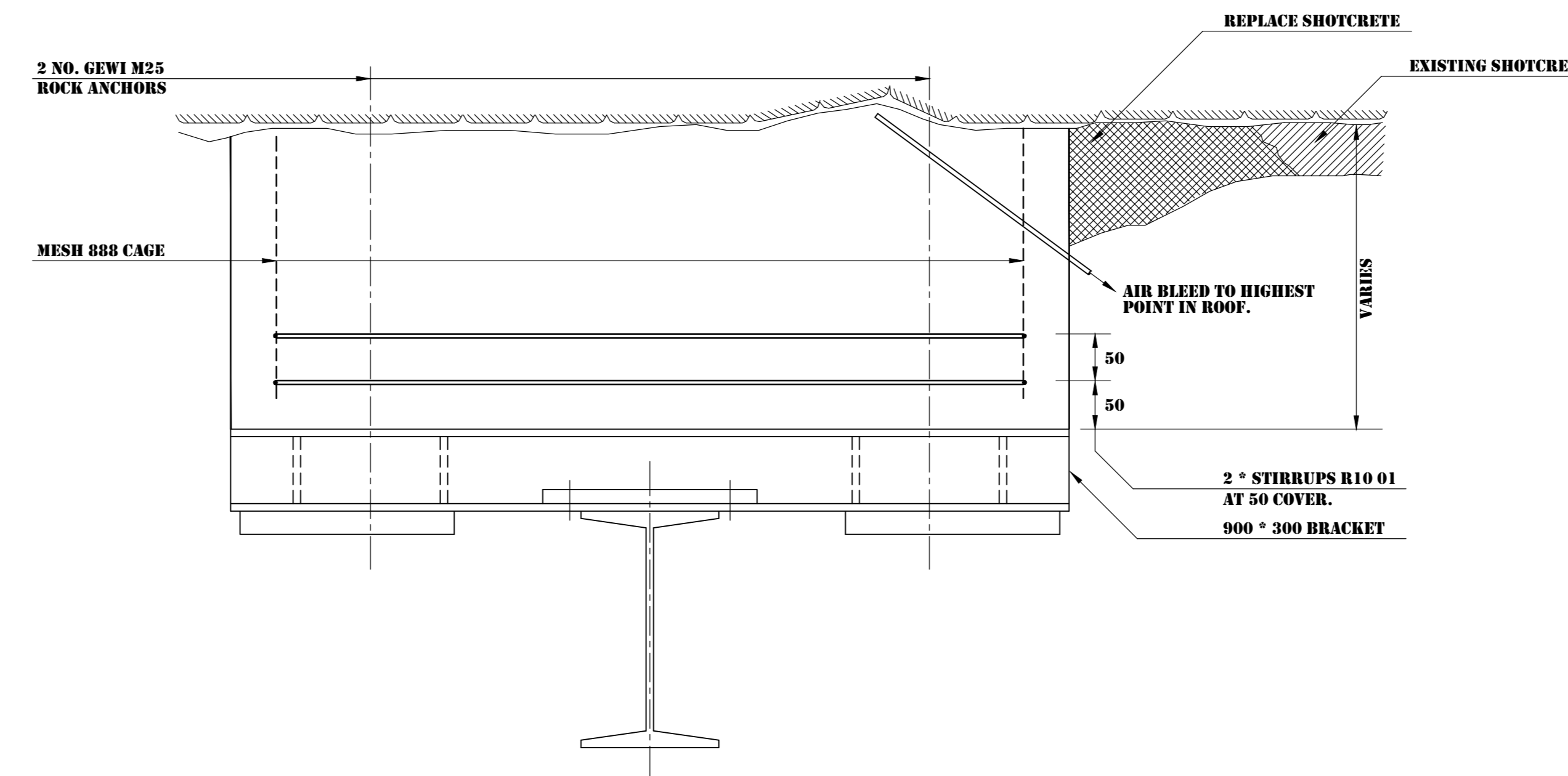
SECTION E-E THROUGH BRIDGING PLATE
SCALE B



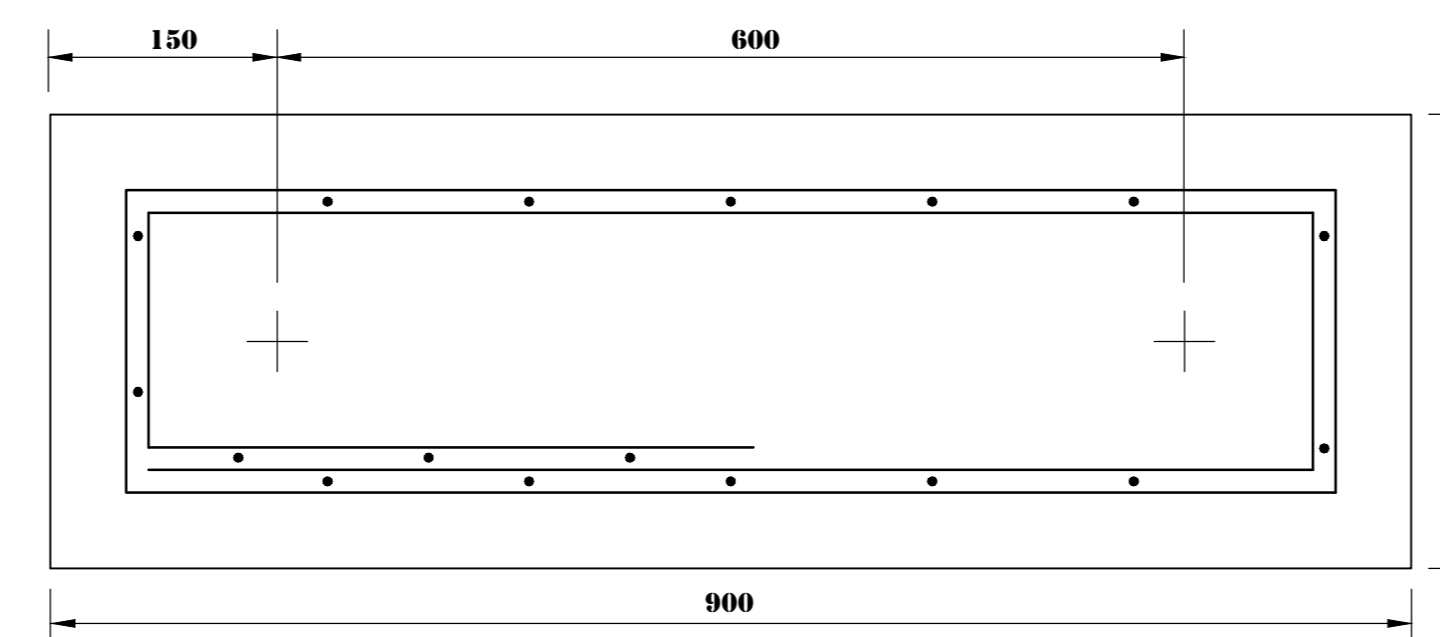
TYPICAL ELEVATION
SCALE A



TYPICAL PLAN ON ROOF OVER
SCALE A



ELEVATION ON CRAWL BEAM SUPPORT
NTS



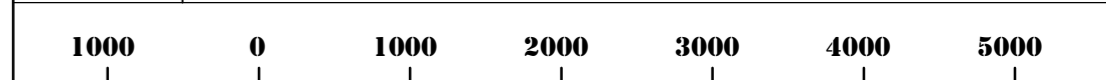
PLAN ON CRAWL BEAM SUPPORT
NTS

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.
2. BULKHEAD, FLANGE AND RELATED STEEL FABRICATION DETAILS SHOWN ON THIS DRAWING ARE SUBJECT TO FINAL DESIGN BY CONTRACTOR. DIMENSIONS SHOWN ARE TYPICAL FOR TENDER PURPOSES ONLY AND ARE BASED ON THE USE OF STEEL TO BS 1501-223 GRADE 40A E1720.
3. SEE DRG. NO. 0723 FOR DETAILS OF STRAKE TYPE E AND F.
4. SEE DRG. NOS 0715, 0720 AND 0766 FOR GENERAL ARRANGEMENT OF TUNNEL/ADIT INTERSECTIONS AT CALEDON NORTH, CALEDON SOUTH AND LITTLE CALEDON SOUTH.
5. THE BRIDGING PLATE IS REQUIRED TO ALLOW VEHICULAR ACCESS INTO PILE STEEL LINER WHEN BULKHEAD IS REMOVED. THE PLATE IS BOLTED TO THE LOWER PART OF THE FIXED FLANGE AND SPANS ONTO THE RAMP CONCRETE ACROSS THE TRENCH. SEE DRG. NO. 0716 FOR ARRANGEMENT.
6. BULKHEAD AND RELATED FABRICATED STEEL SHOWN ON THIS DRAWING TO BE CORROSION PROTECTED IN ACCORDANCE WITH SPECIFICATION BEFORE INSTALLATION. CORROSION PROTECTION TO BE REAPPLIED AS DIRECTED BY THE ENGINEER IN ACCORDANCE WITH SPECIFICATION AFTER COMPLETION.
7. REFER TO SDEM DRGS. S523 AND S524 FOR ACTUAL FABRICATION DETAILS.

RELATED DRAWINGS

DRG. NO.	DESCRIPTION
0715	CALEDON RIVER CROSSING - UNDERGROUND WORKS - NORTH ADIT/TUNNEL 1 INTERSECTION - GENERAL ARRANGEMENT AND CONCRETE DETAILS - SB 1 OF 2
0716	CALEDON RIVER CROSSING - UNDERGROUND WORKS - NORTH ADIT/TUNNEL 1 INTERSECTION - GENERAL ARRANGEMENT AND CONCRETE DETAILS - SE 1 OF 2
0723	CALEDON TUNNEL - TUNNEL WORKS - LININGS - STEEL LININGS - TYPICAL DETAILS - SHEET 2 OF 2



SCALE A



SCALE B



SCALE C

Z	RECORD DRAWING		
0.	ISSUED FOR CONSTRUCTION.	B.C.V.	07/91
NO.	AMENDMENTS	CHKD.	DATE



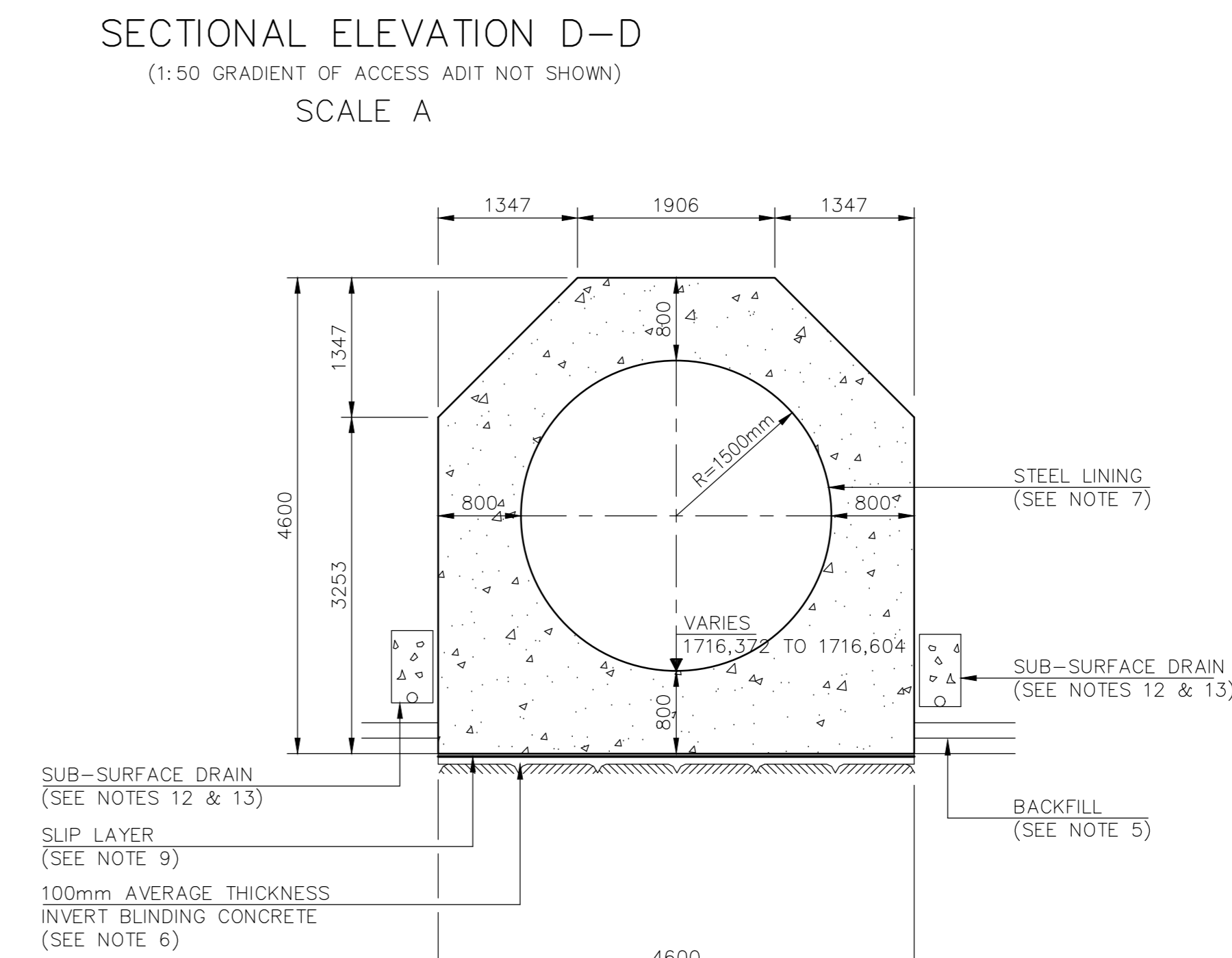
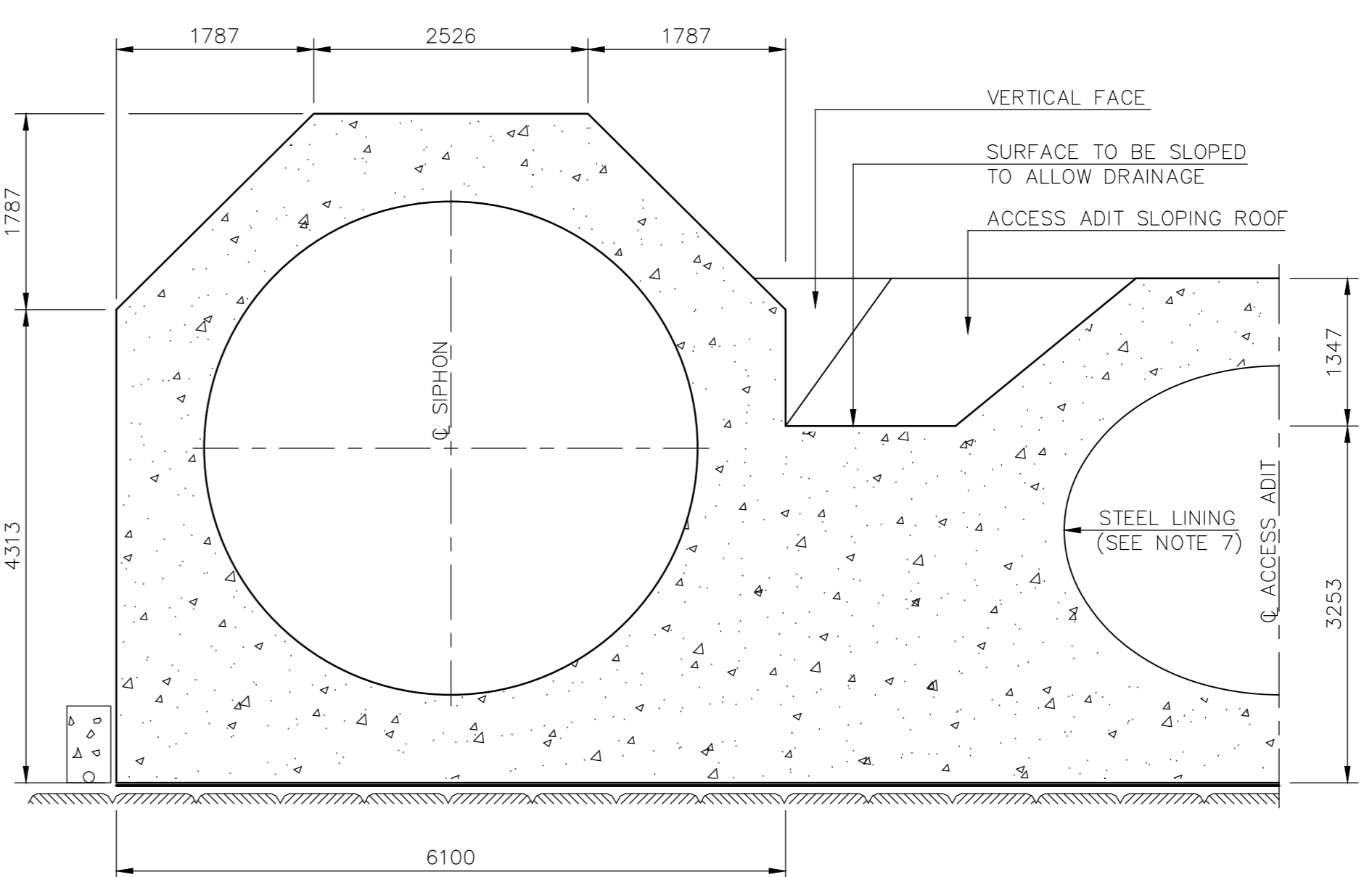
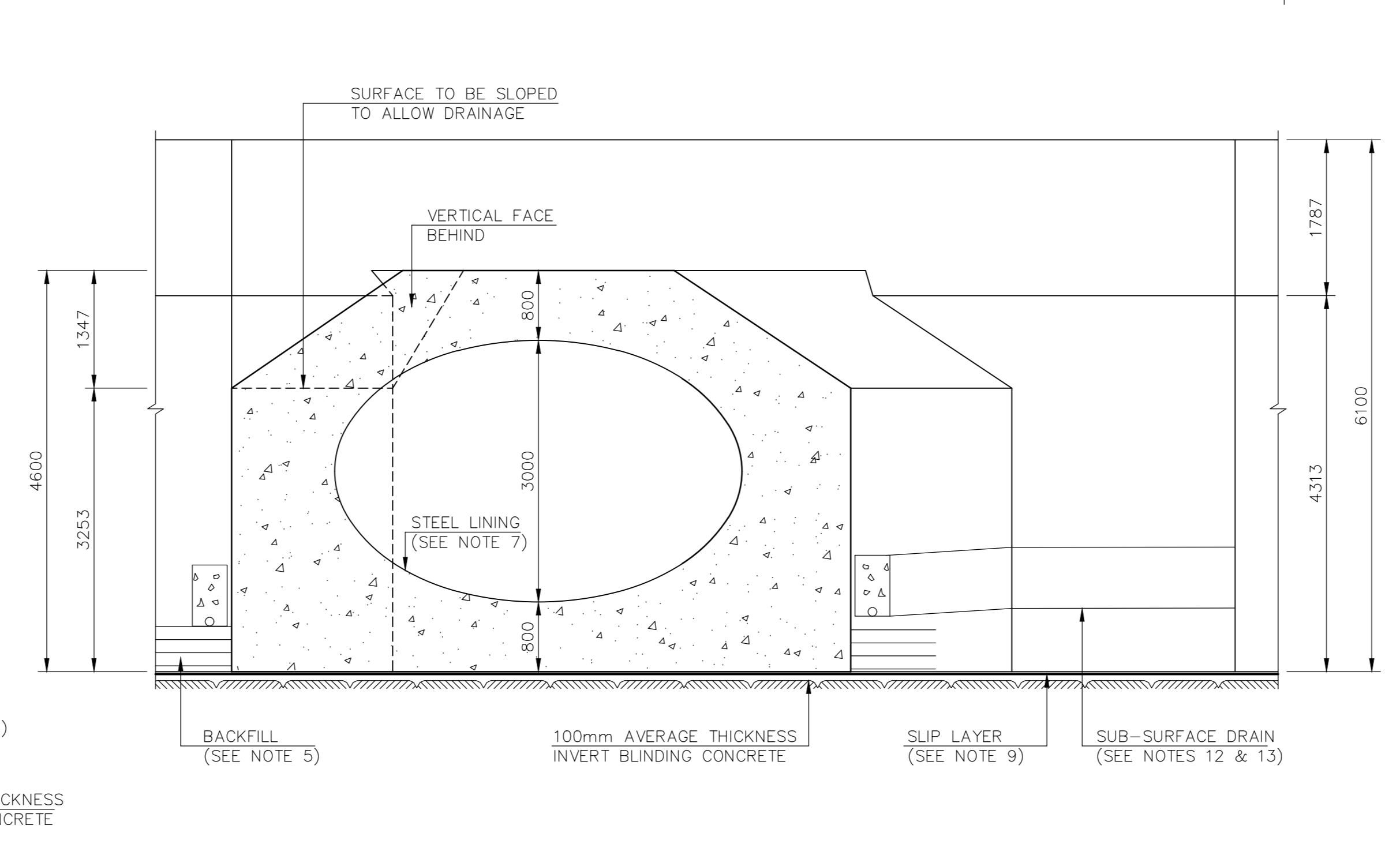
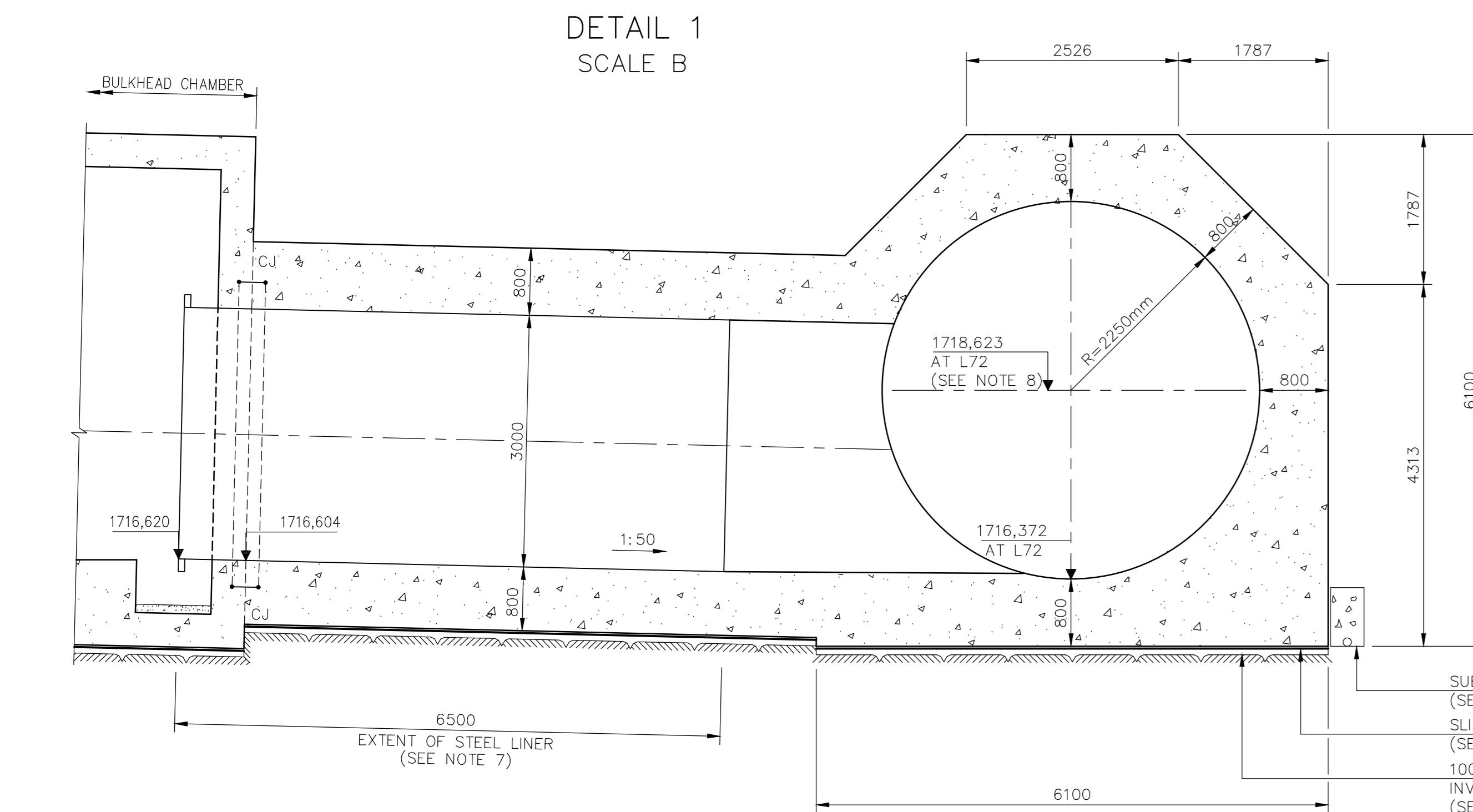
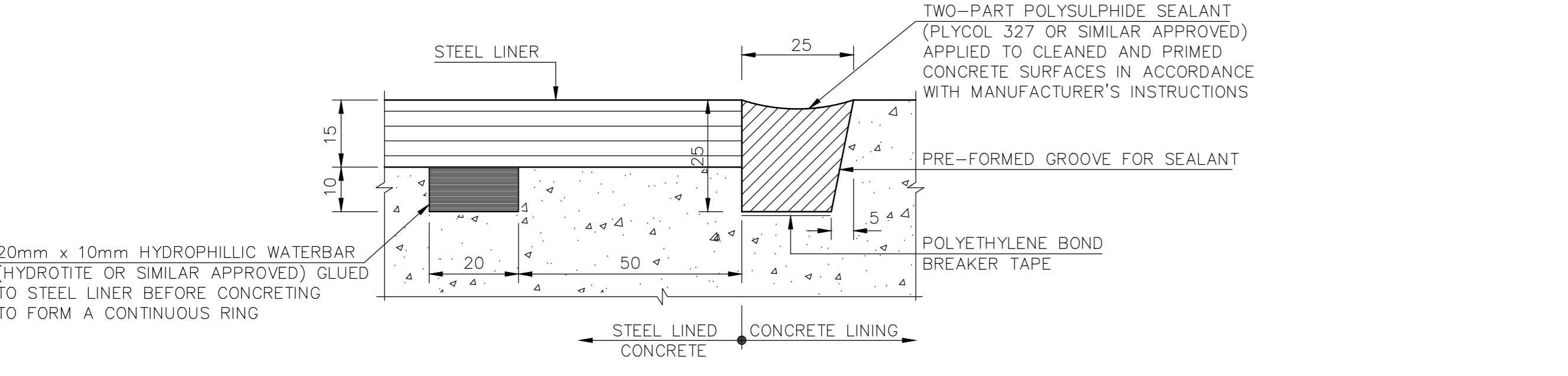
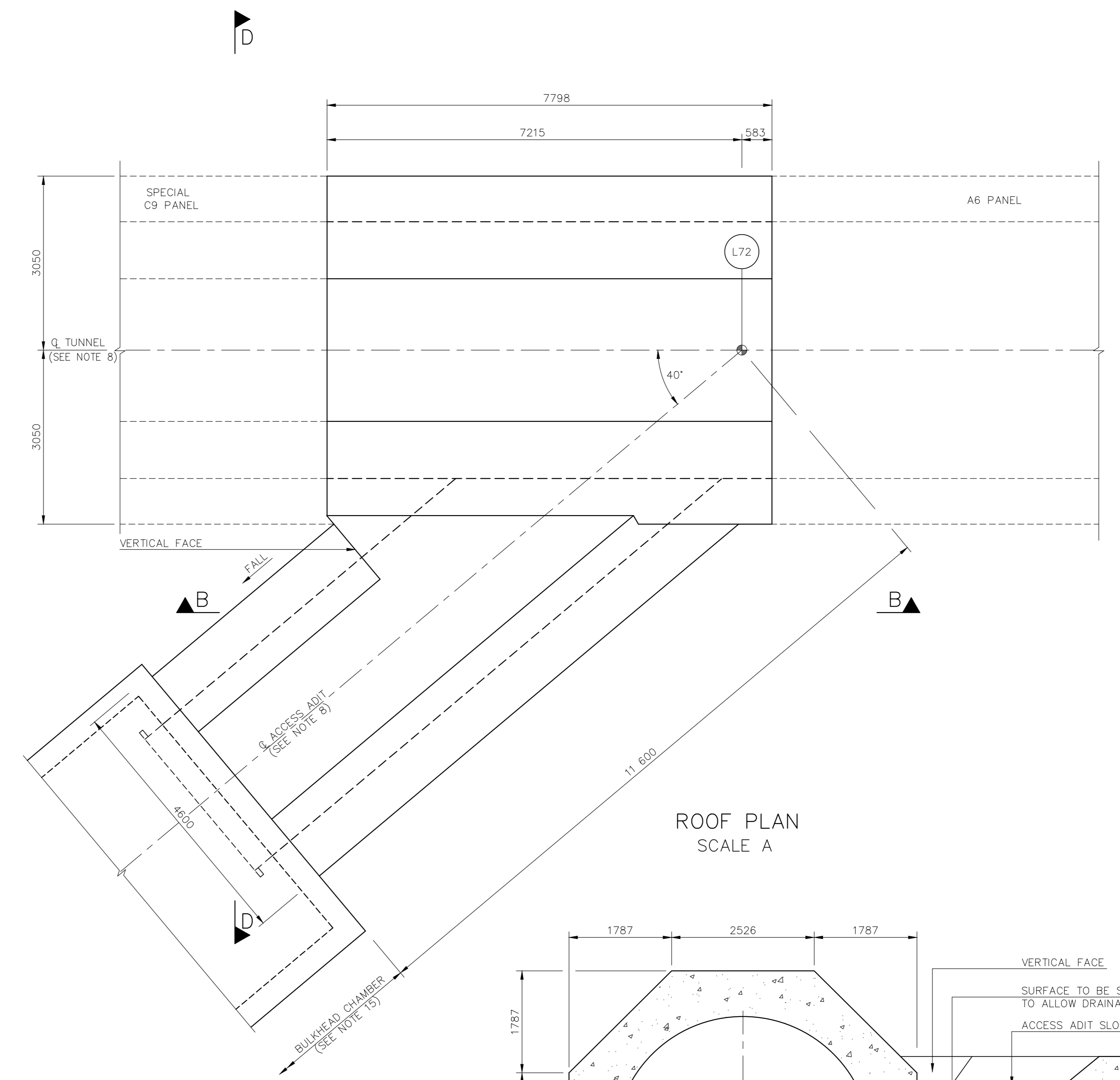
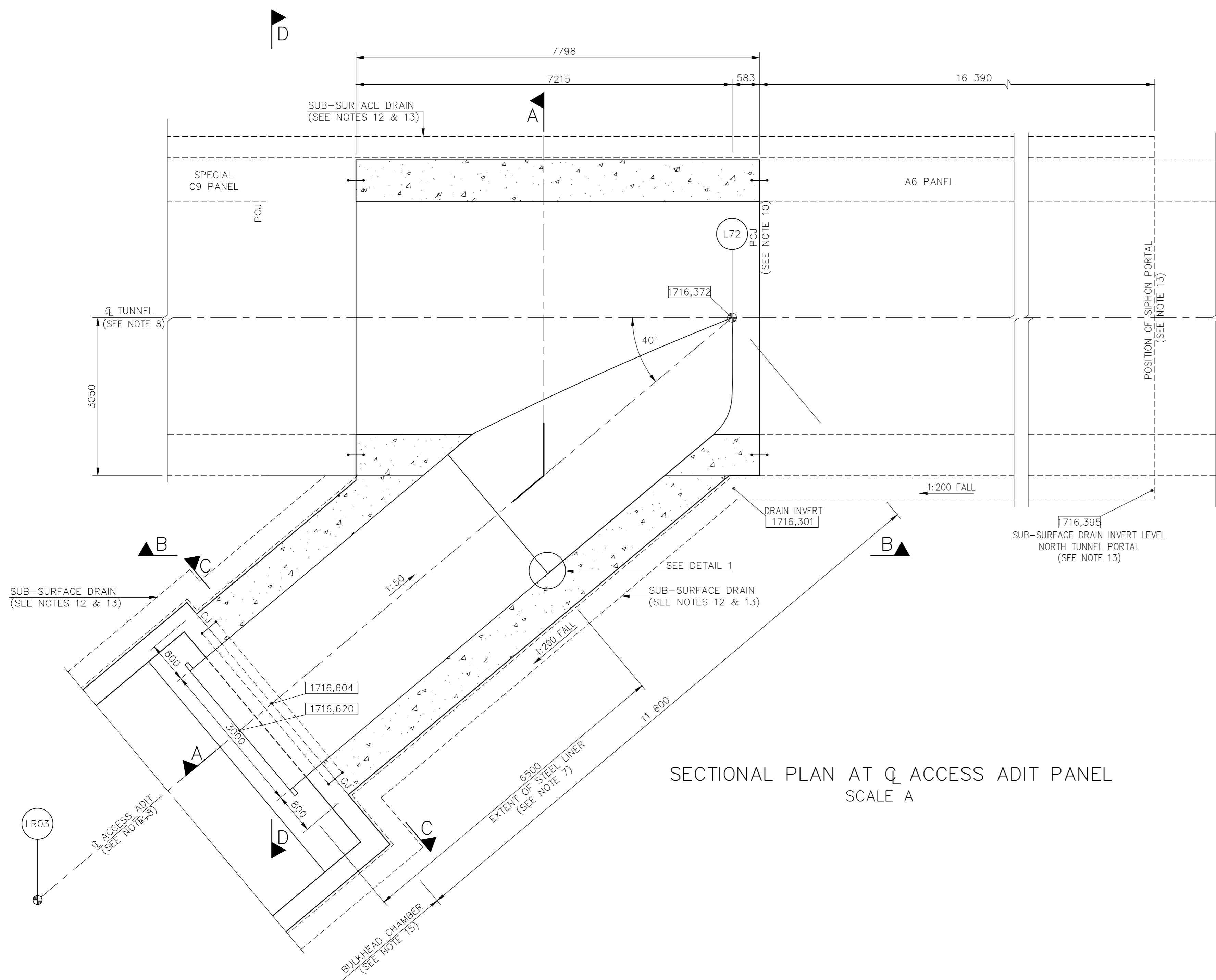
APPROVED _____ DATE _____

**LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A
DELIVERY TUNNEL NORTH**

**CALEDON TUNNEL
TUNNEL WORKS
ACCESS ADIT PLUGS
BULKHEAD AND CRAWL BEAM
GENERAL ARRANGEMENT AND DETAILS**



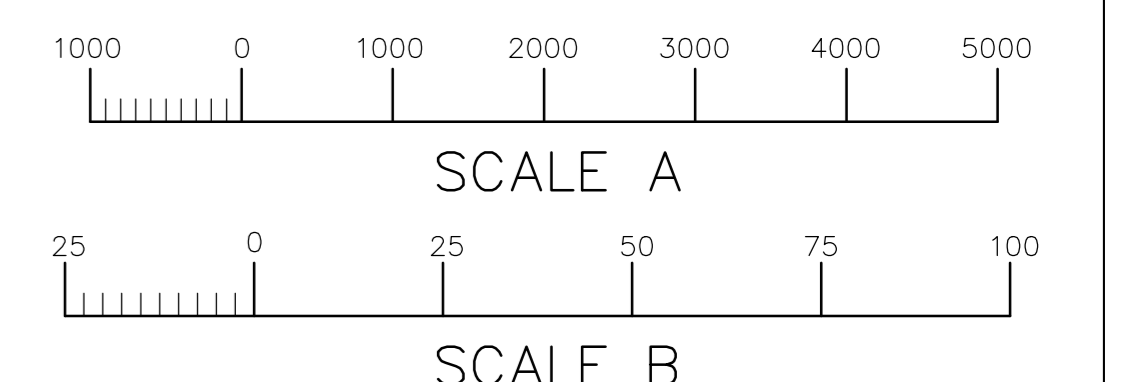
DATE: APR 1995	DESIGNER:	DRAWN:	CHECKED:
CLIENT CONTRACT NO. TCTA - 20	HDTC DRAWING NO. C34-0757	REV. NO. Z	



- NOTES:**
1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.
 2. ALL LEVELS IN METRES ABOVE SEA LEVEL.
 3. ALL CONCRETE CLASS 40/75 UNLESS OTHERWISE NOTED.
 4. CONCRETE TO HAVE F2/U2 CLASS FINISH UNLESS OTHERWISE NOTED.
 5. BACKFILL TO SIDES AND OVER STRUCTURE TO BE IN 150mm LAYERS COMPACTED TO 90% MOD. AASHTO USING LIGHT COMPACTION EQUIPMENT.
 6. MASS OR INVERT BLINDING CONCRETE TO EXCAVATED SURFACES TO BE PLACED AFTER REMOVAL OF ALL LOOSE ROCK, MUCK, DIRT AND OIL. MINIMUM THICKNESS OF INVERT BLINDING TO BE NOT LESS THAN 50% OF AVERAGE AT ANY POINT.
 7. SEE DRG. No. 0722 FOR DETAILS OF STEEL LINER, DETAILS OF STEEL LINER SUBJECT TO FINAL DESIGN BY THE CONTRACTOR.
 8. SEE DRG. No's 0804, 0805 AND 0811 FOR SETTING OUT DETAILS.
 9. SEE DRG. No's 0812 AND 0813 FOR FURTHER EXCAVATION, CONCRETE AND SLIP LAYER DETAILS.
 10. SEE DRG. No. 0818 FOR LAYOUT OF CONSTRUCTION JOINTS AND DETAILS OF WATERSTOPS AND SEALANTS.
 11. SEE DRG. No. 0823 FOR EXCAVATION DETAILS.
 12. SEE DRG. No. 0879 FOR DETAILS OF SUB-SURFACE DRAIN.
 13. SEE DRG. No's 0881, 0876, 0887 AND 1240 FOR LAYOUT OF SUB-SURFACE DRAINS.
 14. SEE DRG. No. 0881 FOR DETAILS OF NORTH ACCESS ADIT PORTAL STRUCTURE.
 15. SEE DRG. No. 0887 FOR DETAILS OF BULKHEAD CHAMBER.
 16. SEE DRG. No. 0898 FOR REINFORCEMENT DETAILS.

- LEGEND:**
- 1718.623 CONSTRUCTION LEVEL (IN SECTION)
 - 1716.623 CONSTRUCTION LEVEL (IN PLAN)
 - R=2250 CENTRE OF CURVATURE AND RADIUS
 - PCJ PARTIAL CONTRACTION JOINT
 - CJ CONSTRUCTION JOINT (REINFORCEMENT CONTINUOUS)
 - LO6 CO-ORDINATE POINT IDENTIFICATION
 - POINT NUMBER LITTLE CALEDON
 - CO-ORDINATE POINT

Related Drawings	
Drg. No.	Description
0722	CALEDON TUNNEL - TUNNEL WORKS - LININGS - STEEL LINING - TYPICAL DETAILS - SHEET 2 OF 2
0804	ASH TUNNEL - LITTLE CALEDON RIVER CROSSING - OVERALL LAYOUT
0805	ASH TUNNEL - LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - LAYOUT
0811	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON - PLAN ON CENTRELINE AND LONGITUDINAL SECTION - SHEET 2 OF 2
0812	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON - TYPICAL CROSS-SECTIONS - SHEET 1 OF 2
0813	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON - TYPICAL CROSS-SECTIONS - SHEET 2 OF 2
0818	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON - JOINT AND WATERSTOP DETAILS
0823	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - NORTH ACCESS ADIT PORTAL LAYOUT AND SECTIONS - SHEET 1 OF 2
0876	LITTLE CALEDON RIVER CROSSING - PERMANENT ACCESS ROADS - ROAD TO NORTH PORTAL AND WATERING SHAFT - ROAD 2
0879	ASH/CALEDON TUNNEL - PERMANENT ACCESS ROADS - DRAINAGE DETAILS - SHEET 2 OF 2
0881	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - NORTH ACCESS ADIT PORTAL CONCRETE DETAILS
0887	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON - NORTH AND SOUTH BULKHEAD CHAMBERS - CONCRETE DETAILS
0898	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON - NORTH ACCESS ADIT PANEL - REINFORCING DETAILS
1240	LITTLE CALEDON RIVER CROSSING - ENLARGED DMG TUNNELS - 4.5m DIA. LINING - LITTLE CALEDON NORTH DRIVE - CONCRETE AND WATERPROOF MEMBRANE DETAILS



Z	RECORD DRAWING		
0.	ISSUED FOR CONSTRUCTION	B.C.V.	07/91
NO.	AMENDMENTS	CHKD.	DATE

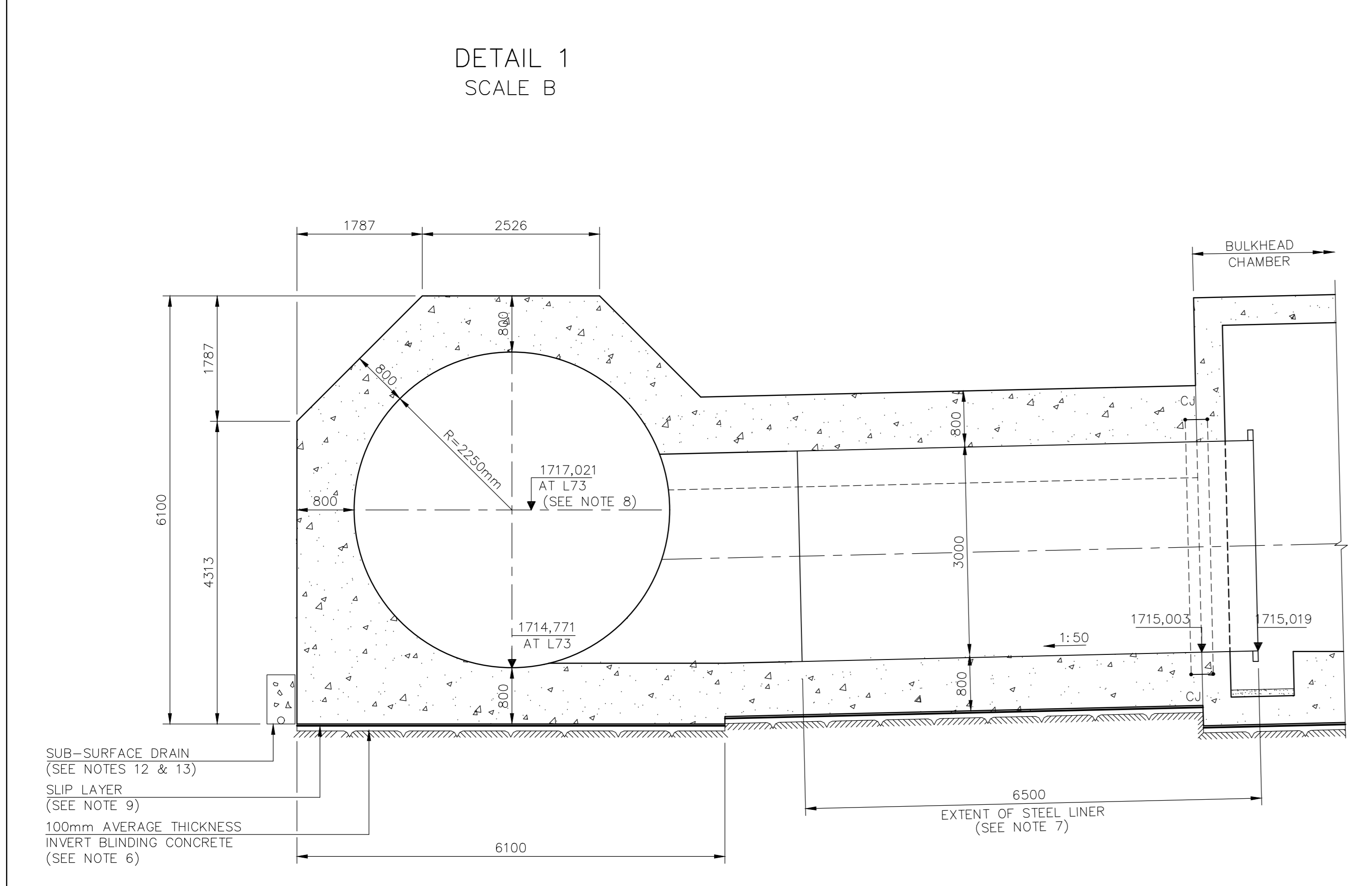
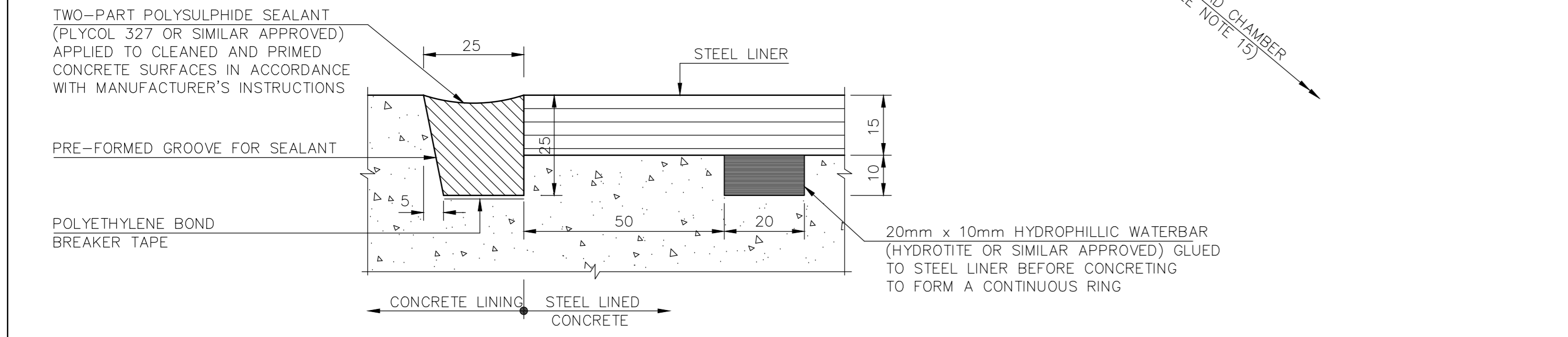
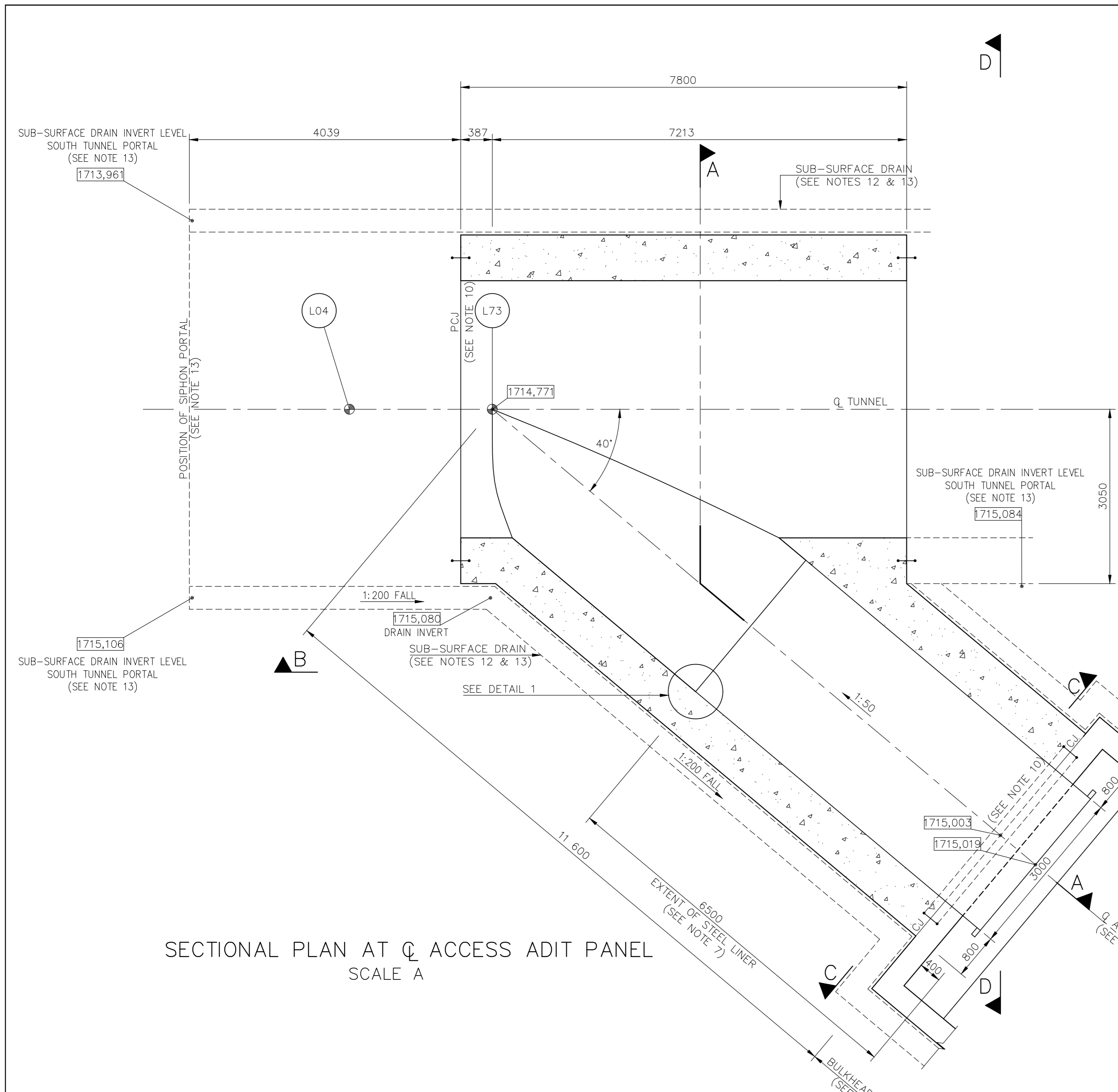


LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A
DELIVERY TUNNEL NORTH

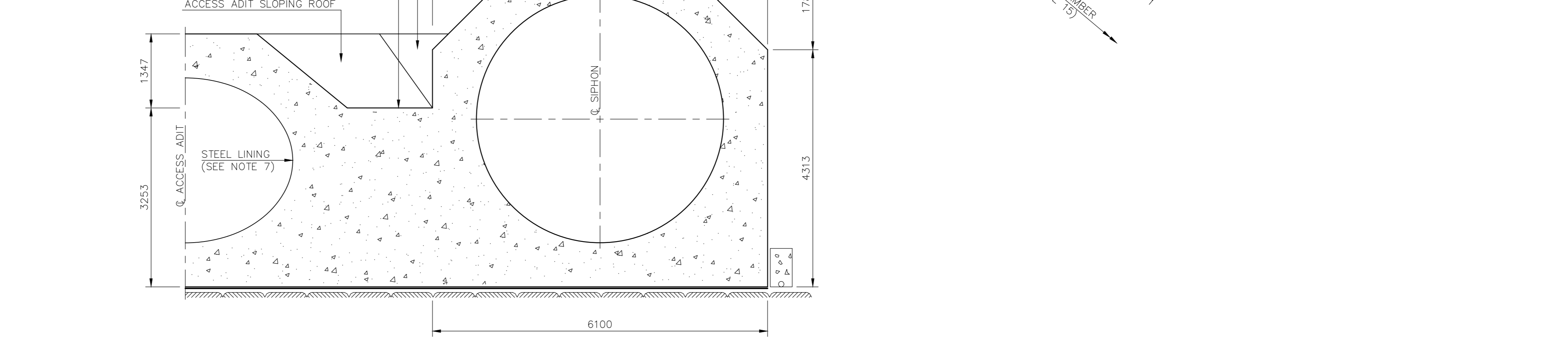
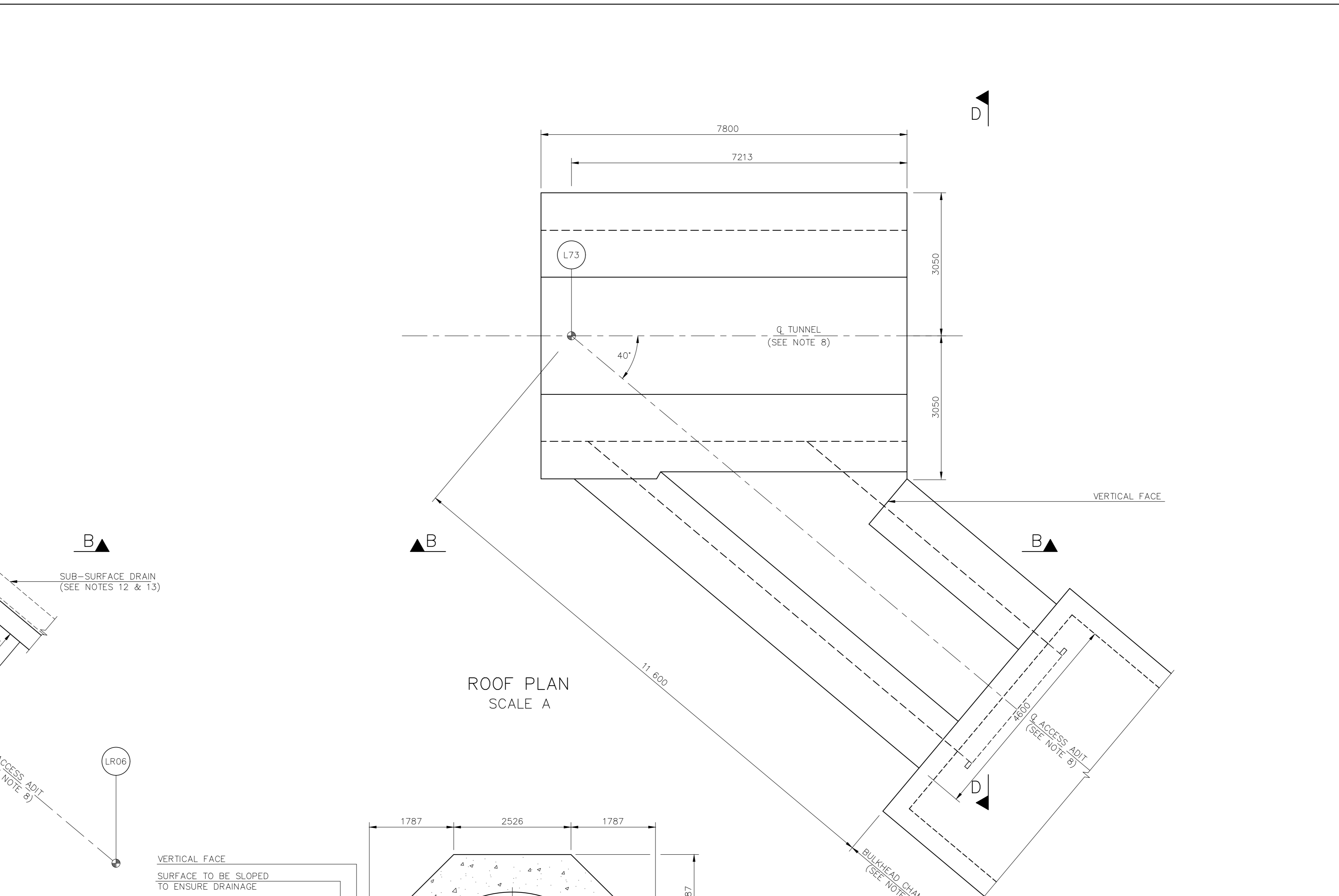
ASH TUNNEL
LITTLE CALEDON RIVER CROSSING
SURFACE WORKS
CUT AND COVER SIPHON
NORTH ACCESS ADIT PANEL
CONCRETE DETAILS

HDTC HIGHLANDS DELIVERY TUNNEL CONSULTANTS
Ntshani Shand Inc. Van Niekerk, Hagen & Edwards
Keeve Steyn Inc. Steffen, Robertson & Kirsten Inc.

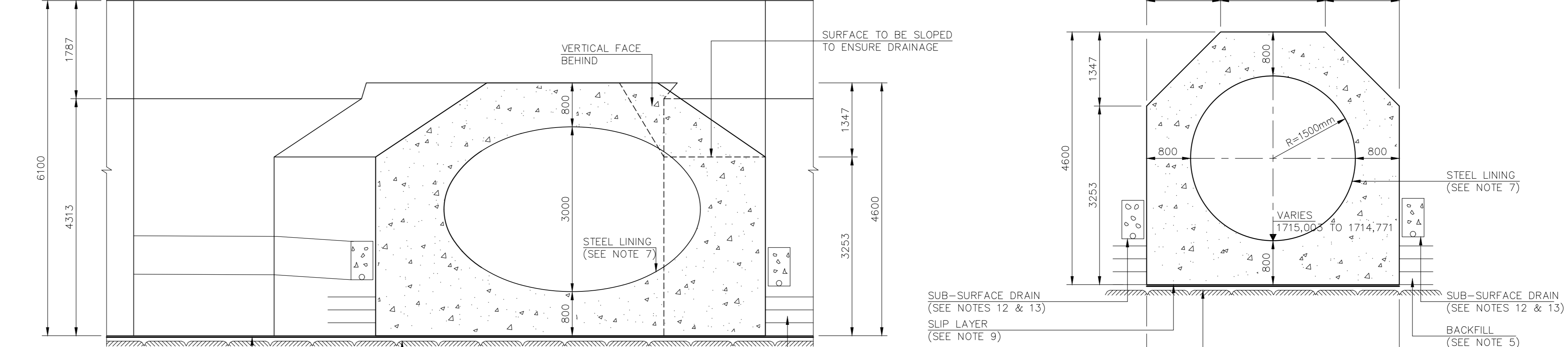
Issue: APR 1995	Designed:	Drawn:	Checked:
Client Contract No. TCTA - 20	HDTC Drawing No. C34-0885	Rev. No. Z	



SECTION A-A
SCALE A



SECTIONAL ELEVATION D-D
(1:50 GRADIENT OF ACCESS ADIT NOT SHOWN)
SCALE A



SECTION B-B
(1:50 GRADIENT OF ACCESS ADIT NOT SHOWN)
SCALE A



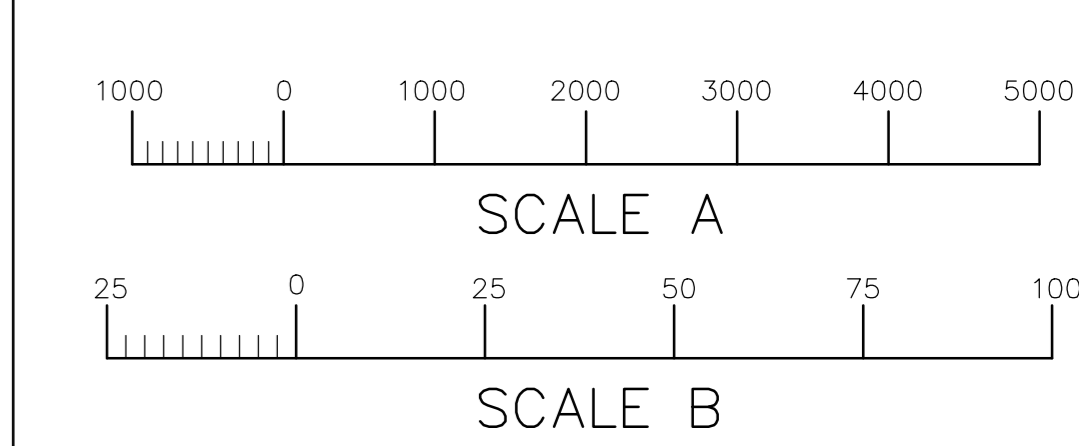
SECTION C-C
SCALE A

- NOTES:
- ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.
 - ALL LEVELS IN METRES ABOVE SEA LEVEL.
 - ALL CONCRETE CLASS 40/25 UNLESS OTHERWISE NOTED.
 - CONCRETE TO HAVE F2/U2 CLASS FINISH UNLESS OTHERWISE NOTED.
 - BACKFILL TO SIDES AND OVER STRUCTURE TO BE IN 150mm LAYERS COMPACTED TO 90% MOD. ASHTO USING LIGHT COMPACTION EQUIPMENT.
 - MASS OR INVERT BLINDING CONCRETE TO EXCAVATED SURFACES TO BE PLACED ONLY AFTER REMOVAL OF ALL LOOSE ROCK, MUCK, DIRT AND OIL. MINIMUM THICKNESS OF INVERT BLINDING TO BE NOT LESS THAN 50% OF AVERAGE AT ANY POINT.
 - SEE DRG. No. 0722 FOR DETAILS OF STEEL LINER, DETAILS OF STEEL LINER SUBJECT TO FINAL DESIGN BY THE CONTRACTOR.
 - SEE DRG. No's 0804, 0805, 0810 AND 0830 FOR SETTING OUT DETAILS.
 - SEE DRG. No's 0812 AND 0813 FOR FURTHER EXCAVATION, CONCRETE AND SLIP LAYER DETAILS.
 - SEE DRG. No. 0818 FOR LAYOUT OF CONSTRUCTION JOINTS AND DETAILS OF WATERSTOPS AND SEALANTS.
 - SEE DRG. No. 0890 FOR EXCAVATION DETAILS.
 - SEE DRG. No. 0879 FOR DETAILS OF SUB-SURFACE DRAIN.
 - SEE DRG. No's 0763, 0831, 0884 AND 0887 FOR LAYOUT OF SUB-SURFACE DRAINS.
 - SEE DRG. No. 0884 FOR DETAILS OF SOUTH ACCESS ADIT PORTAL STRUCTURE.
 - SEE DRG. No. 0887 FOR DETAILS OF BULKHEAD CHAMBER.
 - SEE DRG. No. 0899 FOR REINFORCEMENT DETAILS.

- LEGEND:
- 1718,623 CONSTRUCTION LEVEL (IN SECTION)
 - 1718,623 CONSTRUCTION LEVEL (IN PLAN)
 - R=2250 CENTRE OF CURVATURE AND RADIUS
 - PCJ PARTIAL CONSTRUCTION JOINT
 - CJ CONSTRUCTION JOINT (REINFORCEMENT CONTINUOUS)
 - L04 CO-ORDINATE POINT IDENTIFICATION
 - LITTLE CALEDON CO-ORDINATE POINT

Related Drawings

Drg. No	Description
0722	CALEDON TUNNEL - TUNNEL WORKS - LININGS - STEEL LININGS - TYPICAL DETAILS SHEET 1 OF 2
0763	LITTLE CALEDON RIVER CROSSING - PERMANENT ACCESS ROADS - ROAD TO SOUTH PORTAL - ROAD 3
0804	ASH TUNNEL - LITTLE CALEDON RIVER CROSSING - OVERALL LAYOUT
0805	ASH TUNNEL - LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - LAYOUT
0810	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON - PLAN ON CENTRELINE AND LONGITUDINAL SECTION - SHEET 1 OF 2
0812	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON - TYPICAL CROSS-SECTIONS - SHEET 1 OF 2
0813	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON - TYPICAL CROSS-SECTIONS - SHEET 2 OF 2
0818	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON - JOINT AND WATERSTOP DETAILS
0830	LITTLE CALEDON RIVER CROSSING - ENLARGED DAB TUNNELS - 5,77m AND 4,5m DIA LININGS - LITTLE CALEDON SOUTH AND NORTH DRIVE - CONCRETE LAYOUT
0831	LITTLE CALEDON RIVER CROSSING - ENLARGED DAB TUNNELS - 5,77m AND 4,5m DIA LININGS - LITTLE CALEDON SOUTH DRIVE - REINFORCED CONCRETE WITH WATERPROOF MEMBRANE - CONCRETE AND WATERPROOF MEMBRANE DETAILS
0879	ASH/CALEDON TUNNEL - PERMANENT ACCESS ROADS - DRAINAGE DETAILS - SHEET 2 OF 2
0882	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - SOUTH ACCESS ADIT PORTAL LAYOUT AND SECTIONS - SHEET 1 OF 2
0883	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - SOUTH ACCESS ADIT PORTAL LAYOUT AND SECTIONS - SHEET 2 OF 2
0884	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - SOUTH ACCESS ADIT PORTAL CONCRETE DETAILS
0887	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON - NORTH AND SOUTH BULKHEAD CHAMBERS - CONCRETE DETAILS
0899	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON - SOUTH ACCESS ADIT PANEL - REINFORCING DETAILS



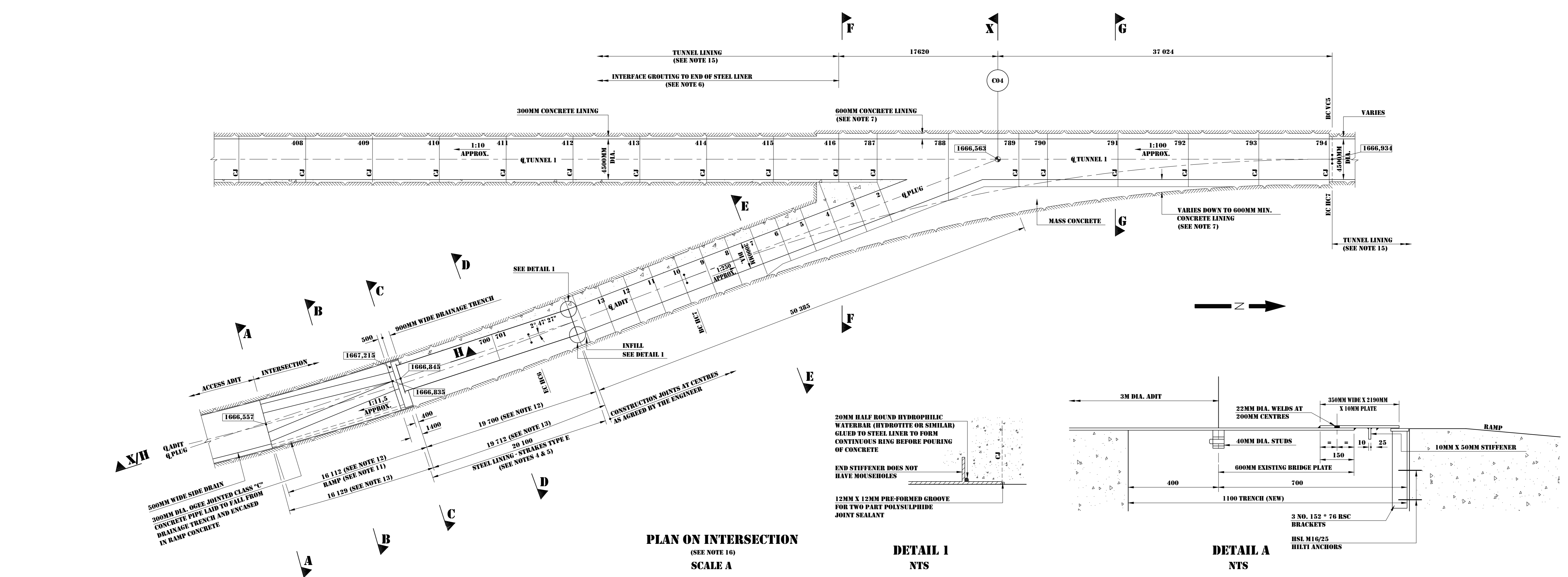
NO.	AMENDMENTS	B.C.V.	CHKD.	DATE
2	RECORD DRAWING			
0.	ISSUED FOR CONSTRUCTION			07/91



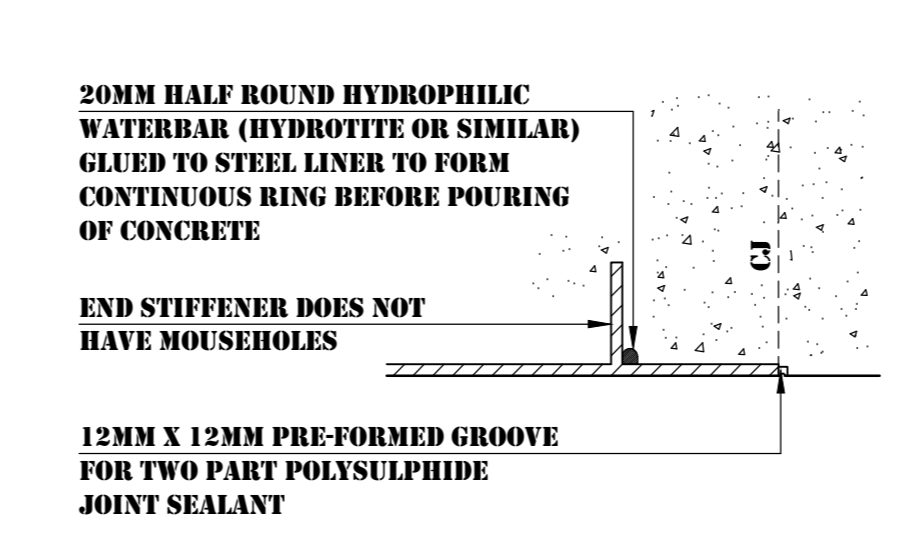
LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A
DELIVERY TUNNEL NORTH

ASH TUNNEL
LITTLE CALEDON RIVER CROSSING
CUT AND COVER SIPHON
SOUTH ACCESS ADIT PANEL
CONCRETE DETAILS

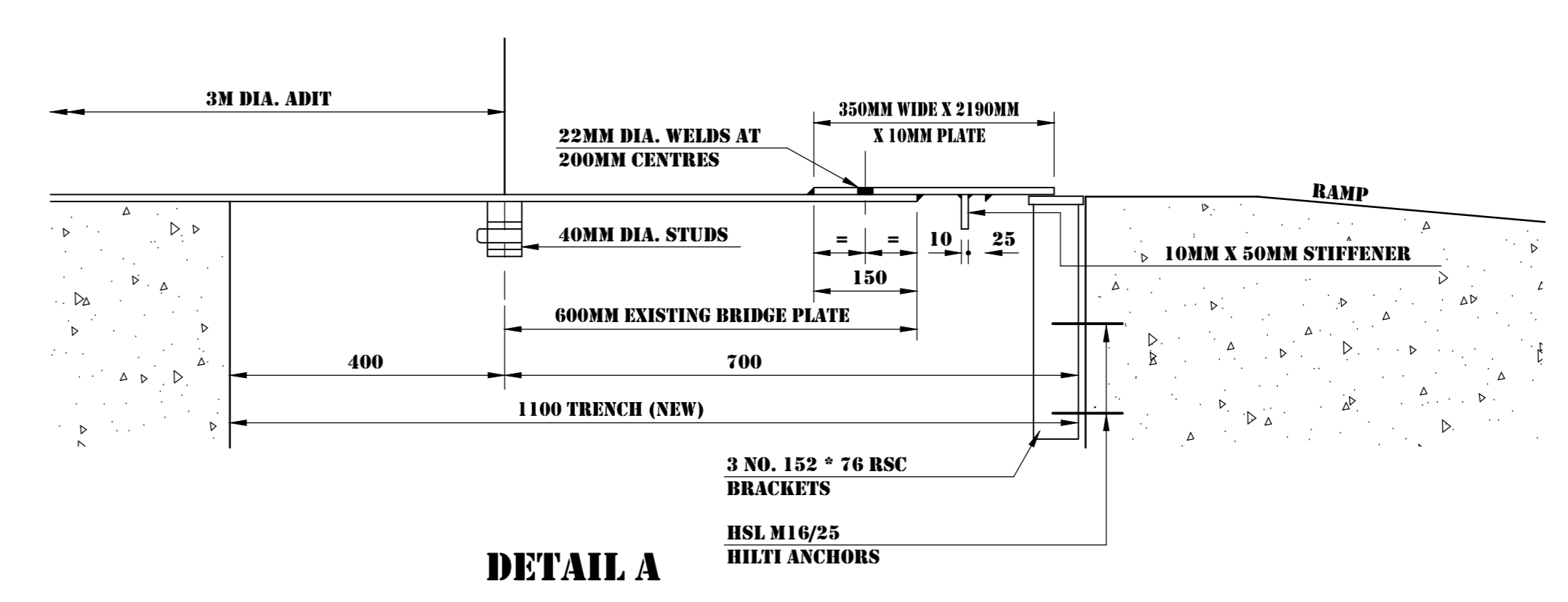
APPROVED	DESIGNED	DRAWN	CHECKED
APR 1995			
Client Contract No. TCTA - 20	Designed: HDTC Drawing No. C34-0886	Drawn: Rev. No. Z	Checked:



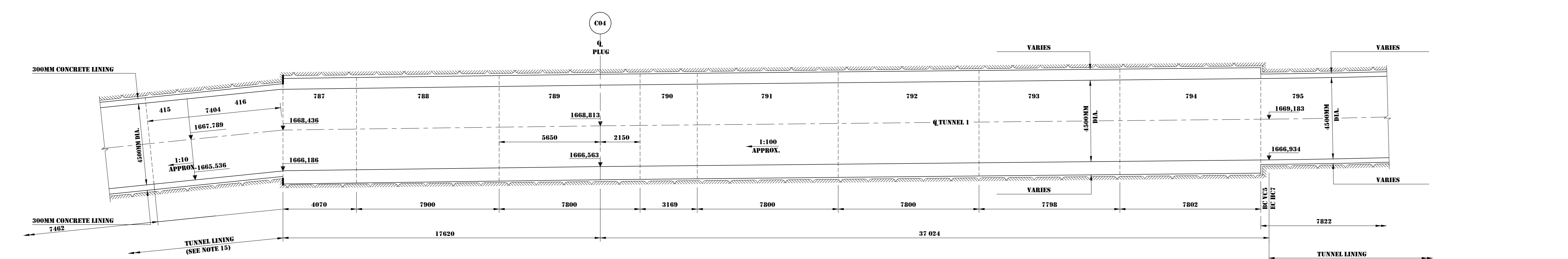
PLAN ON INTERSECTION
(SEE NOTE 16)
SCALE A



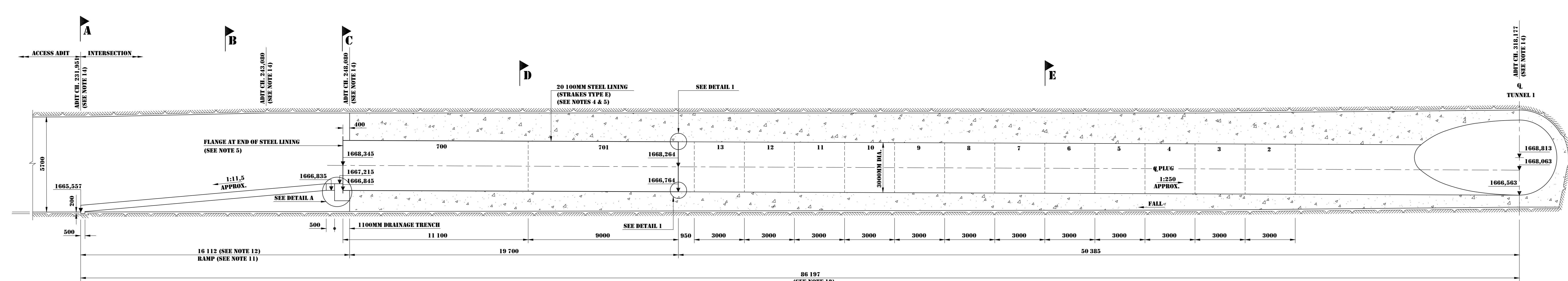
DETAIL 1
NTS



DETAIL A
NTS



LONGITUDINAL SECTION ALONG C OF TUNNEL
SCALE B



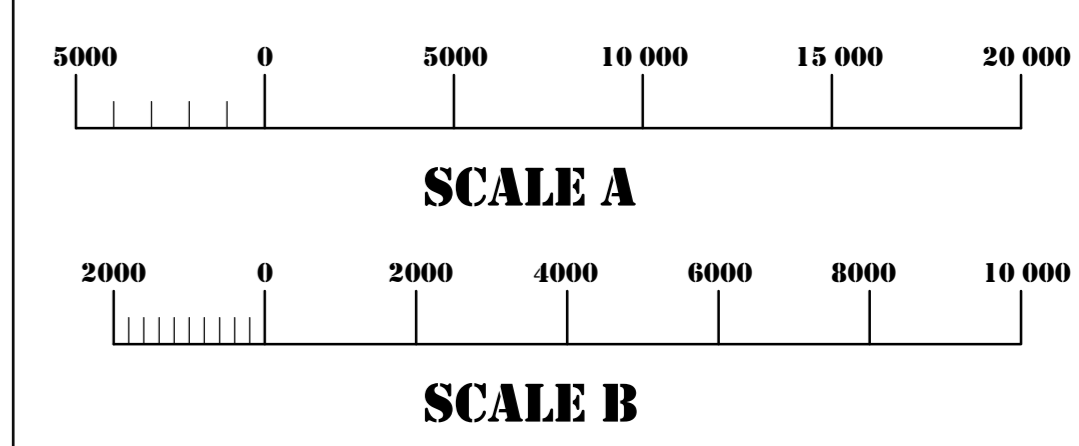
SECTION X-X ALONG C OF PLUG
(SEE NOTE 16)
SCALE B

- NOTES:**
1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.
 2. ALL LEVELS IN METRES ABOVE SEA LEVEL.
 3. SEE DRG. NO'S 0714 AND 0733 FOR GENERAL ARRANGEMENT AND SETTING OUT DETAILS.
 4. SEE DRG. NO. 0723 FOR DETAILS OF STEEL LINING STRAKES TYPE E. (SEE NOTE 16)
 5. BULKHEAD AT END OF STEEL LINING NOT SHOWN. SEE DRG. NO. 0757 FOR DETAILS.
 6. SEE DRG. NO'S 0725 AND 0726 FOR DETAILS OF INTERFACE GROUTING.
 7. SEE DRG. NO. 0854 FOR DETAILS OF EXCAVATION, SUPPORT AND LINING THICKNESS AND TOLERANCE DEFINITIONS.
 8. SEE DRG. NO. 0718 FOR GROUTING DETAILS.
 9. SEE DRG. NO. 0717 FOR EXCAVATION AND ROCK SUPPORT DETAILS.
 10. CONCRETE CLASS 30/25 TO TUNNEL AND PLUG LININGS AND TO PLUG STEEL LINING ENCASING. CONCRETE CLASS 20/40 TO RAMP CONCRETE.
 11. SEE DRG. NO. 0716 FOR SECTIONS AND OTHER DETAILS.
 12. DISTANCES MEASURED ALONG THE CENTRELINE OF THE PLUG.
 13. DISTANCES MEASURED ALONG THE CENTRELINE OF THE ADIT.
 14. ADIT CHAINAGES GIVEN ALONG CENTRELINE OF THE ADIT.
 15. SEE DRG. NO. 0742 FOR TUNNEL LINING DETAILS.
 16. STEEL LINING LENGTH AND ADIT PLUG GRADIENT SHOWN TO SUIT SPECIALIST DESIGNER'S REQUIREMENTS.

- LEGEND:**
- 1668.629 CONSTRUCTION LEVEL (IN PLAN)
 - 1668.629 CONSTRUCTION LEVEL (IN SECTION)
 - R=49 725 RADIUS OF CURVATURE
 - END OR BEGINNING OF CURVE
 - CONSTRUCTION JOINT
 - E (B/C) (V) C 3 CURVE IDENTIFICATION
 - CURVE NUMBER
 - CALEDON
 - VERTICAL
 - HORIZONTAL
 - CURVE
 - BEGINNING OF CURVE
 - END OF
 - C04 CO-ORDINATE POINT IDENTIFICATION
 - POINT NUMBER
 - CALEDON
 - CO-ORDINATE POINT

RELATED DRAWINGS

DRG. NO.	DESCRIPTION
0714	CALEDON RIVER CROSSING - UNDERGROUND WORKS - GENERAL ARRANGEMENT, LONGITUDINAL SECTION AND SETTING OUT DETAILS
0716	CALEDON RIVER CROSSING - UNDERGROUND WORKS - NORTH ADIT/TUNNEL 1 INTERSECTION - GENERAL ARRANGEMENT AND CONCRETE DETAILS - SH 2 OF 2
0717	CALEDON RIVER CROSSING - UNDERGROUND WORKS - NORTH ADIT/TUNNEL 1 INTERSECTION - EXCAVATION AND ROCK SUPPORT DETAILS
0718	CALEDON RIVER CROSSING - UNDERGROUND WORKS - NORTH ADIT/TUNNEL 1 INTERSECTION - GROUTING DETAILS
0723	CALEDON TUNNEL - TUNNEL WORKS - LININGS - STEEL LINING - TYPICAL DETAILS - SHEET 2 OF 2
0725	CALEDON RIVER CROSSING - INTERFACE GROUTING - EXCAVATION PREPARATION AND GROUT CONTAINMENT DETAILS
0726	CALEDON RIVER CROSSING - INTERFACE GROUTING - CONCRETE AND GROUTING DETAILS
0733	CALEDON RIVER CROSSING - UNDERGROUND WORKS - NORTH ACCESS ADIT - GENERAL ARRANGEMENT, LONGITUDINAL SECTION AND SETTING OUT DETAILS
0742	CALEDON RIVER CROSSING - RAB TUNNELS - 5.7M AND 4.2M DIA. LININGS - NORTH DRIVE - CONCRETE AND GROUTING LAYOUT - SHEET 1 OF 2
0757	CALEDON TUNNEL - TUNNEL WORKS - ACCESS ADIT PILES - BULKHEAD AND CRANE BEAM - GENERAL ARRANGEMENT AND DETAILS
0854	SHOULDER TUNNEL - TUNNEL WORKS - EXCAVATIONS, SUPPORT AND LININGS - THICKNESS AND TOLERANCE DEFINITIONS



Z	RECORD DRAWING		
1.	SETTING OUT TO SUIT ACTUAL TUNNEL EXCAVATION AND FINAL STEEL LINING DESIGN AND NOTES REVISED.	M.R.E.	
9.	ISSUED FOR CONSTRUCTION.	B.C.V.	07/91
NO.	AMENDMENTS	CHKD.	DATE

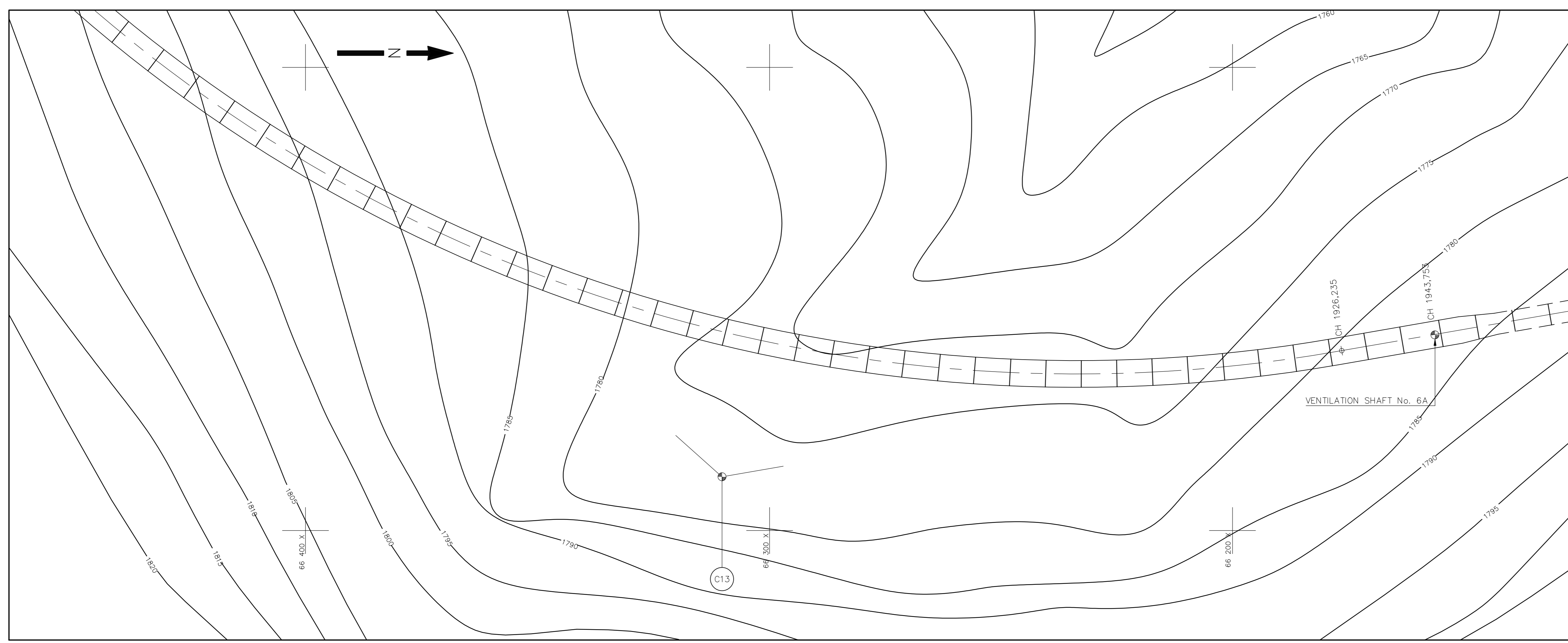


LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A
DELIVERY TUNNEL NORTH

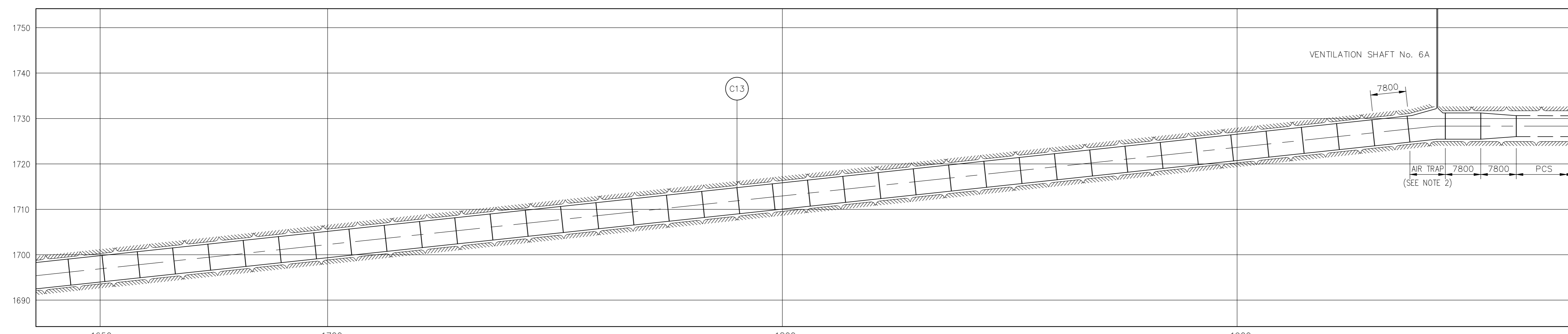
CALEDON TUNNEL
CALEDON RIVER CROSSING
UNDERGROUND WORKS
NORTH ADIT/TUNNEL 1 INTERSECTION
GENERAL ARRANGEMENT AND CONCRETE DETAILS
SHEET 1 OF 2

DATE: NOV 1991	DESIGNER:	DRAWN:	CHECKED:
CLIENT CONTRACT NO. TCTA - 20	HDTC DRAWING NO. C36-0715	REV. NO. Z	

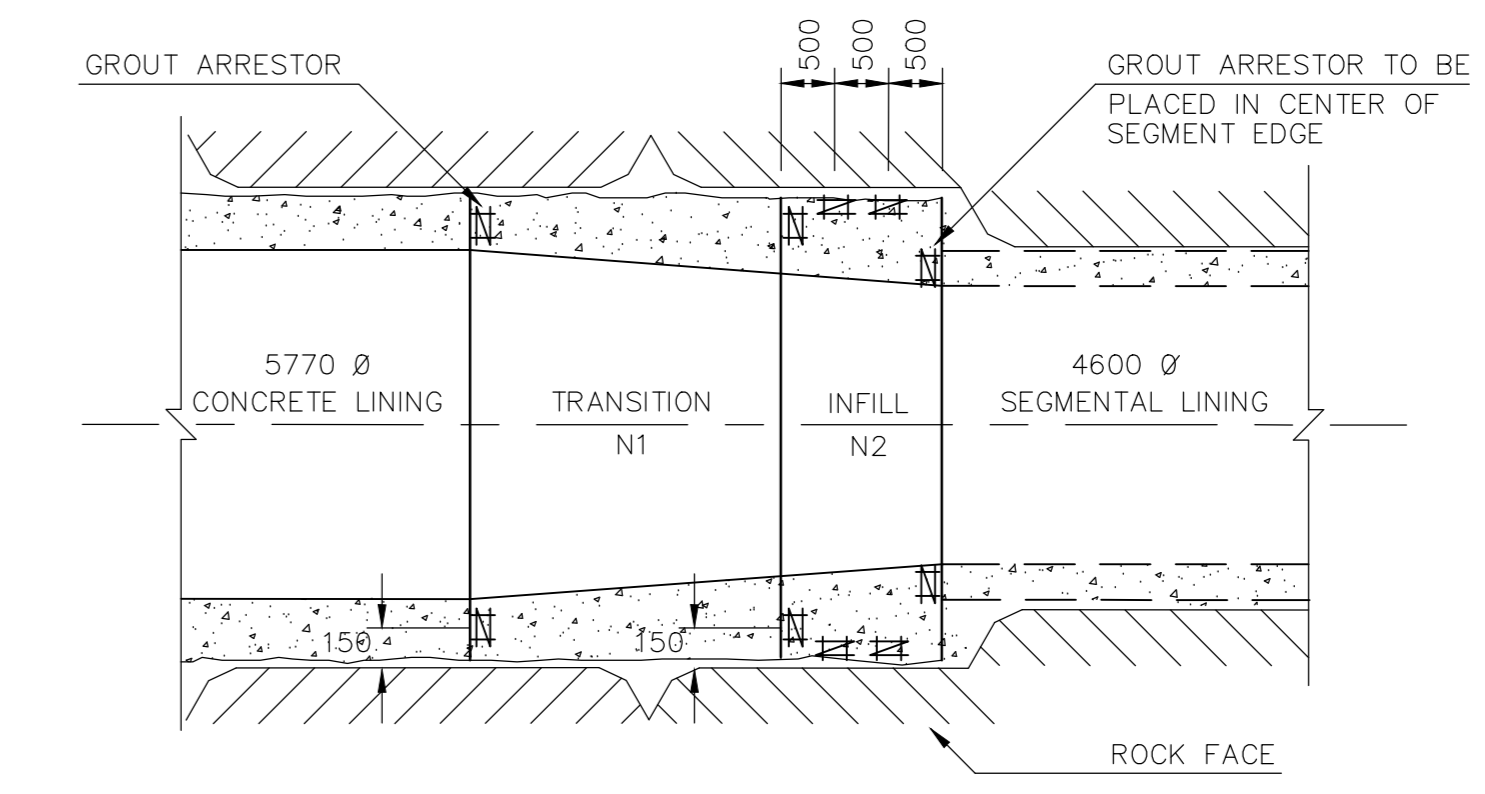
NOTES:
 1. SEE NOTES ON DRG. No. 0742.
 2. SEE DRG. No. 0758 FOR DETAILS OF VENT SHAFT 6A AIR TRAP CONCRETE PANEL AND GROUTING.



STRIP PLAN



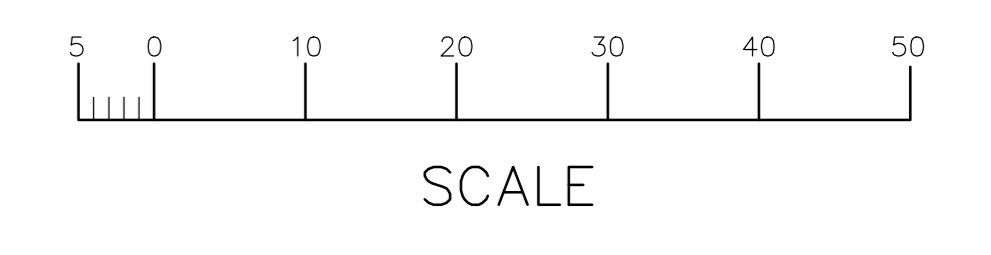
LONGITUDINAL SECTION



TRANSITION BETWEEN 5,770 Ø CONCRETE LINING AND 4,600 Ø SEGMENTAL LINING POSITION OF GROUT ARRESTORS

LEGEND:

Related Drawings	
Drg. No	Description
0742	CALEDON RIVER CROSSING - D&B TUNNELS - 4.5m DIA. LINING - NORTH DRIVE - CONCRETE AND GROUTING LAYOUT - SHEET 1 OF 2
0758	CALEDON TUNNEL - TUNNEL WORKS - VENT SHAFT 6A - AIR TRAP AND CAPPING STRUCTURE - GENERAL ARRANGEMENT AND CONCRETE DETAILS



PANEL CHAINAGES (m) (SEE NOTE 1)	1652.683	1660.162	1667.653	1675.193	1682.728	1690.228	1697.768	1705.296	1712.888	1720.483	1727.993	1735.518	1743.038	1750.633	1758.142	1765.662	1773.127	1780.617	1788.162	1795.677	1803.187	1810.722	1818.232	1825.762	1833.212	1840.712	1848.207	1855.687	1863.107	1870.567	1878.007	1885.487	1892.917	1900.387	1907.807	1915.267	1922.743	1930.173	1937.643	1945.093	1952.593	1960.013	PCS																																									
LINING TYPE	UNREINFORCED CONCRETE																												REINFORCED CONCRETE (SEE NOTE 2)	UNREINFORCED CONCRETE	PCS																																																					
PANEL TYPE	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	M2	N																																						
FINISHED TUNNEL DIAMETER (m)	5,77																												5,77	4,6																																																						
LINING THICKNESS (mm)	350																												350	250																																																						
SETTING OUT POINTS (SEE NOTE 1)																													E.C. 1003	E.C. 1003																																																						
GRADE ON ϕ (INDICATIVE ONLY)	1:9,348																													1:786,719																																																						
ROCK TYPE IN SIDEWALL AND CHAINAGES AT TUNNEL ϕ	CLAYEY SILTSTONE FINE SANDSTONE										CLAYEY FINE SANDSTONE SILTSTONE		CLAYEY SILTSTONE FINE SANDSTONE		DOLERITE SILTSTONE FINE SANDSTONE		FINE SANDSTONE DOLERITE		CLAYEY SILTSTONE FINE SANDSTONE																																																																	
EROSION MEMBRANE	MEMBRANE																																																																																			
GROUT TYPE	300 kPa CAVITY				1300 kPa CONSOLIDATION (SEE NOTE 1)				300 kPa CAVITY				1100 kPa CONSOLIDATION (SEE NOTE 1)				300 kPa CAVITY				900 kPa CONSOLIDATION (SEE NOTE 1)				CAVITY GROUTING AND CONSOLIDATION GROUTING (SEE NOTE 1)				(SEE NOTE 2)																																																							
MAXIMUM ALLOWABLE GROUT PRESSURE (kPa)	1066,542				1200 kPa CONSOLIDATION (SEE NOTE 1)				1066,542				1732,077				1000 kPa CONSOLIDATION (SEE NOTE 1)				1744,099				1362,357				800 kPa CONSOLIDATION (SEE NOTE 1)				1797,634				300 kPa CAVITY				530 kPa CONSOLIDATION (SEE NOTE 1)				1837,168				300 kPa CAVITY				470 kPa CONSOLIDATION (SEE NOTE 1)				1883,703				300 kPa CAVITY				400 kPa CONSOLIDATION (SEE NOTE 1)				1930,217				300 kPa CAVITY				380 kPa CONSOLIDATION (SEE NOTE 1)				1981,371			
DIRECTION OF GROUTING	→																																																																																			
LINING INSTRUMENTATION (SEE NOTE 1)																																																																																				

NOTES ON GROUT ARRESTORS:
 1. FILTER FABRIC 300 WIDE TRIPLE FOLDED AND NAILED TO PREPARED SURFACE TO FORM CLOSED RING.
 2. FILTER FABRIC TO BE BIDIM U44 OR SIMILAR APPROVED.
 3. A STRIP OF 'CHICKEN MESH' TO BE ATTACHED TO END OF FILTER FABRIC FACING NEW CONCRETE. (AS AGREED ON SITE)

Z.	RECORD DRAWING		
Q.	ISSUED FOR CONSTRUCTION	B.C.V.	07/91
NO.	AMENDMENTS	CHKD.	DATE

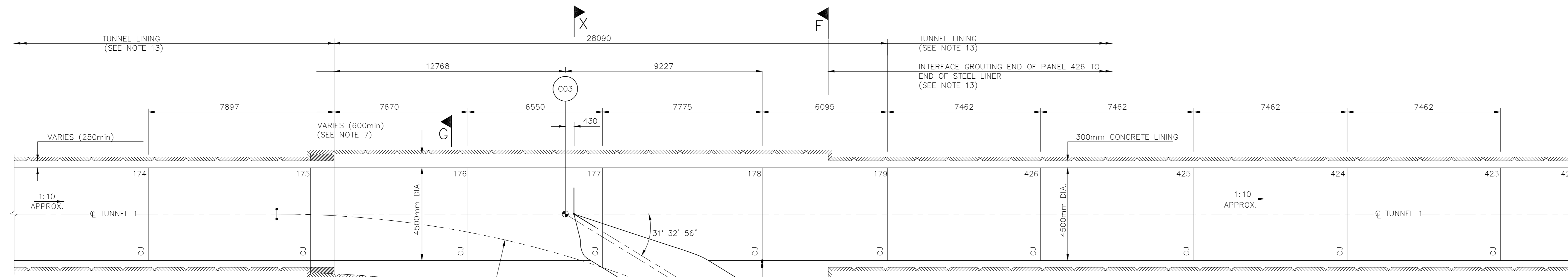
TCTA TRANSPORTATION AUTHORITY
 Approved: *F. Ules* Date: 2/19/93

LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A
DELIVERY TUNNEL NORTH

CALEDON TUNNEL
 CALEDON RIVER CROSSING
 D&B TUNNELS
 5,77m DIA. LINING - NORTH DRIVE
 CONCRETE AND GROUTING LAYOUT
 SHEET 2 OF 2

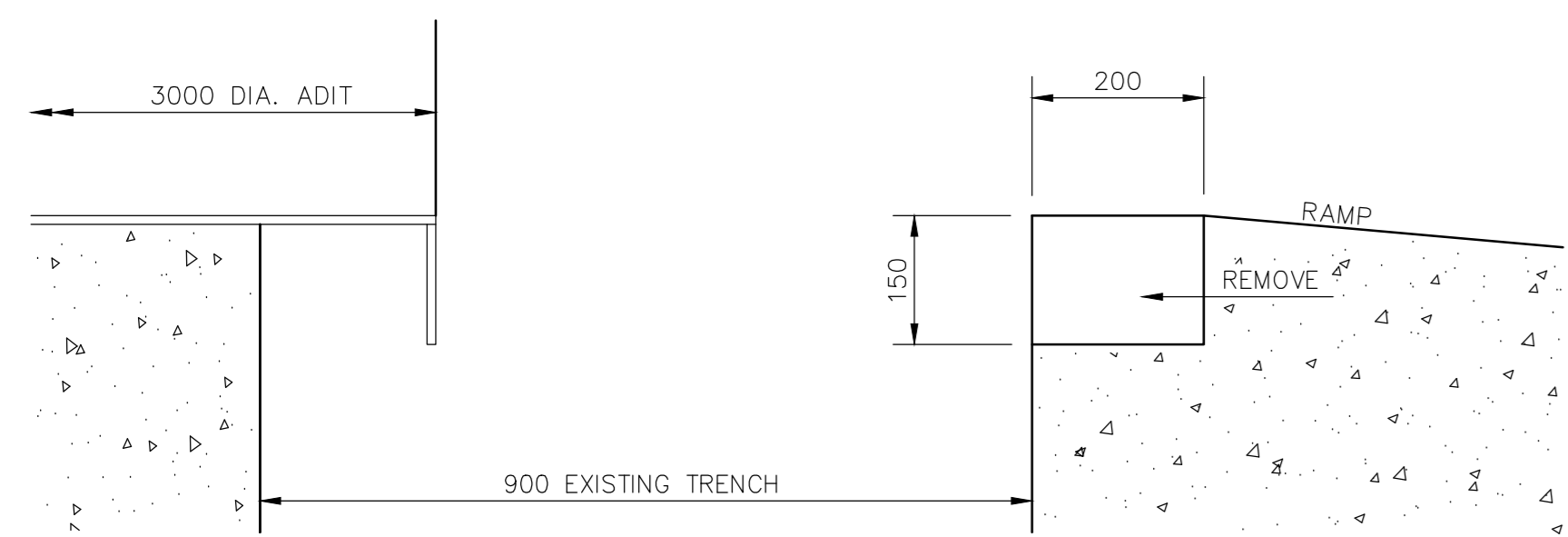
HDTC HIGHLANDS DELIVERY TUNNEL CONSULTANTS
 Ntshani Shand Inc. van Niekerk, Kluge & Edwards
 Keesee Steyn Inc. Steffen, Robertson & Kirsten Inc.

Date: SEP 1993	Designed:	Drawn:	Checked:
Client Contract No: TCTA - 20	HDTC Drawing No: C36-0743	Rev. No: Z	



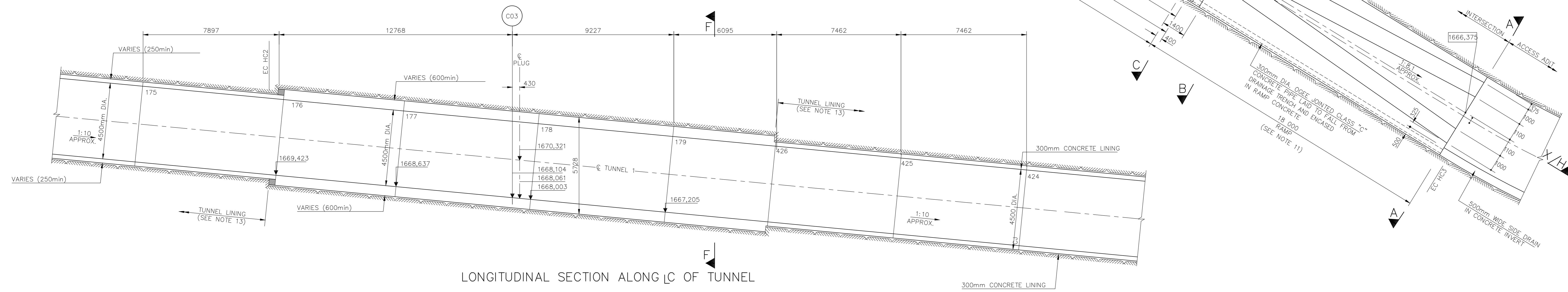
20mm HALF ROUND HYDROPHILIC WATERBAR (HYDROTITE OR SIMILAR), GLUED TO STEEL LINER TO FORM CONTINUOUS RING BEFORE POURING OF CONCRETE
 END STIFFENER DOES NOT HAVE MOUSEHOLES
 12mm x 12mm PRE-FORMED GROOVE FOR TWO PART POLYSULPHIDE JOINT SEALANT

DETAIL 1
NTS

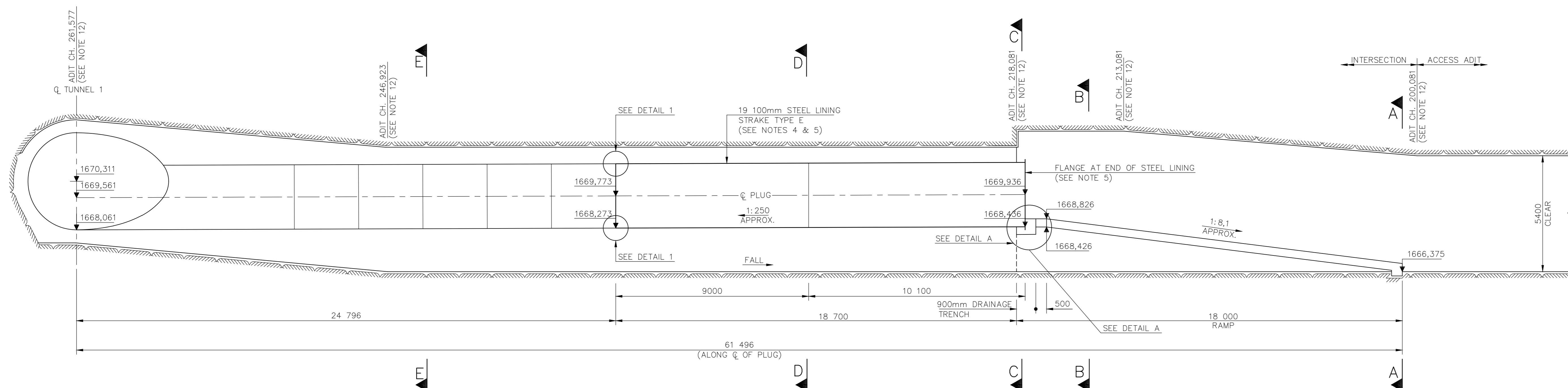


DETAIL A
NTS

PLAN ON CENTRELINES OF TUNNEL AND ADIT
(SEE NOTE 14)



LONGITUDINAL SECTION ALONG LC OF TUNNEL

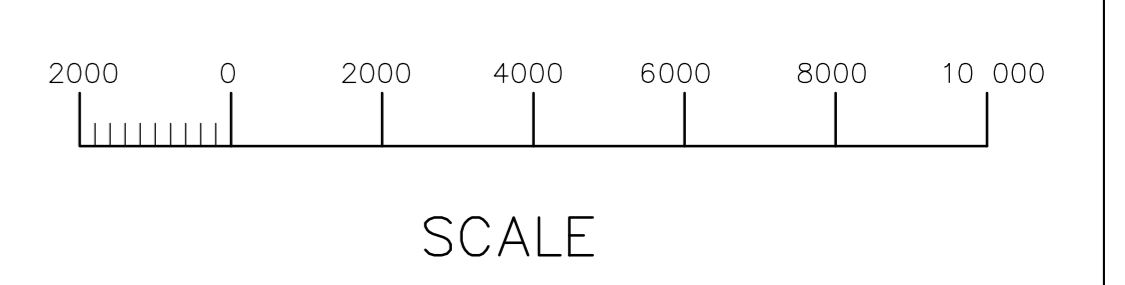


SECTION X-X ALONG LC OF PLUG
(SEE NOTE 14)

- NOTES:
- ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.
 - ALL LEVELS IN METRES ABOVE SEA LEVEL.
 - SEE DRG. No's 0714 AND 0785 FOR GENERAL ARRANGEMENT AND SETTING OUT DETAILS.
 - SEE DRG. No. 0723 FOR DETAILS OF STEEL LINING STRAKES TYPE E. (SEE NOTE 16)
 - BULKHEAD AT END OF STEEL LINING NOT SHOWN, SEE DRG. No. 0757 FOR DETAILS.
 - SEE DRG. No's 0725 AND 0726 FOR DETAILS OF INTERFACE GROUTING.
 - SEE DRG. No. 0854 FOR DETAILS OF EXCAVATION, SUPPORT AND LINING THICKNESS AND TOLERANCE DEFINITIONS.
 - SEE DRG. No. 0789 FOR GROUTING DETAILS.
 - SEE DRG. No. 0788 FOR EXCAVATION AND ROCK SUPPORT DETAILS.
 - CONCRETE CLASS 30/25 TO TUNNEL AND PLUG LININGS AND TO PLUG STEEL LINING ENCASMENT. CONCRETE CLASS 20/40 TO RAMP CONCRETE.
 - SEE DRG. No. 0787 FOR SECTIONS AND OTHER DETAILS.
 - ADIT CHAINAGES GIVEN ALONG CENTRE LINE OF THE ADIT.
 - SEE DRG. No. 0741 FOR TUNNEL LINING DETAILS.
 - STEEL LINER LENGTH AND ADIT PLUG GRADIENT SHOWN TO SUIT SPECIALIST STEEL LINER DESIGNER'S REQUIREMENTS.

- LEGEND:
- C.J. CONSTRUCTION JOINT
 - 1668,700 CONSTRUCTION LEVEL (N PLAN)
 - 1668,700 CONSTRUCTION LEVEL (N SECTION)
 - R=49 725 RADIUS OF CURVATURE
 - COB CO-ORDINATE POINT IDENTIFICATION
 - POINT NUMBER CALEDON
 - CO-ORDINATE POINT
 - END OR BEGINNING OF CURVE
 - E (B) C H (V) C 3 CURVE IDENTIFICATION
 - CURVE NUMBER
 - CALEDON
 - HORIZONTAL
 - CURVE
 - BEGINNING OF
 - END OF

Related Drawings	
Drg. No	Description
0714	CALEDON RIVER CROSSING - UNDERGROUND WORKS - GENERAL ARRANGEMENT LONGITUDINAL SECTION AND SETTING OUT DETAILS
0723	CALEDON TUNNEL - TUNNEL WORKS - LININGS - STEEL LININGS - TYPICAL DETAILS - SH 2 OF 2
0725	CALEDON TUNNEL - TUNNEL WORKS - LININGS - INTERFACE GROUTING - EXCAVATION PREPARATION AND GROUT CONTAINMENT DETAILS
0726	CALEDON TUNNEL - TUNNEL WORKS - LININGS - INTERFACE GROUTING - CONCRETE AND GROUTING LAYOUT - SH 2 OF 2
0741	CALEDON RIVER CROSSING - DIRT TUNNELS - 4.5m DIA. LINING - SOUTH BRK CONCRETE AND GROUTING LAYOUT - SH 2 OF 2
0757	CALEDON TUNNEL - TUNNEL WORKS - ACCESS ADIT PLUGS - BULKHEAD AND CRAWL BEAM - GENERAL ARRANGEMENT AND DETAILS
0785	CALEDON RIVER CROSSING - UNDERGROUND WORKS - SOUTH ACCESS ADIT - GENERAL ARRANGEMENT LONGITUDINAL SECTION AND SETTING OUT DETAILS
0787	CALEDON RIVER CROSSING - UNDERGROUND WORKS - SOUTH ADIT/TUNNEL 1 INTERSECTION - GENERAL ARRANGEMENT AND CONCRETE DETAILS - SH 2 OF 2
0788	CALEDON RIVER CROSSING - UNDERGROUND WORKS - SOUTH ADIT/TUNNEL 1 INTERSECTION - EXCAVATION AND ROCK SUPPORT DETAILS
0789	CALEDON RIVER CROSSING - UNDERGROUND WORKS - SOUTH ADIT/TUNNEL 1 INTERSECTION - GROUTING DETAILS
0854	ASH/CALEDON TUNNEL - TUNNEL WORKS - EXCAVATION, SUPPORT AND LINING THICKNESS AND TOLERANCE DEFINITIONS



Z	RECORD DRAWING	
1	DIMENSIONS, LEVELS, CONSTRUCTION JOINTS AND NOTES REVISED TO SUIT FINAL STEEL LINER DESIGN. DETAIL 1 ADDED.	B.C.V. 26/04/95
0	ISSUED FOR CONSTRUCTION	B.C.V. 07/91
NO.	AMENDMENTS	CHKD. DATE



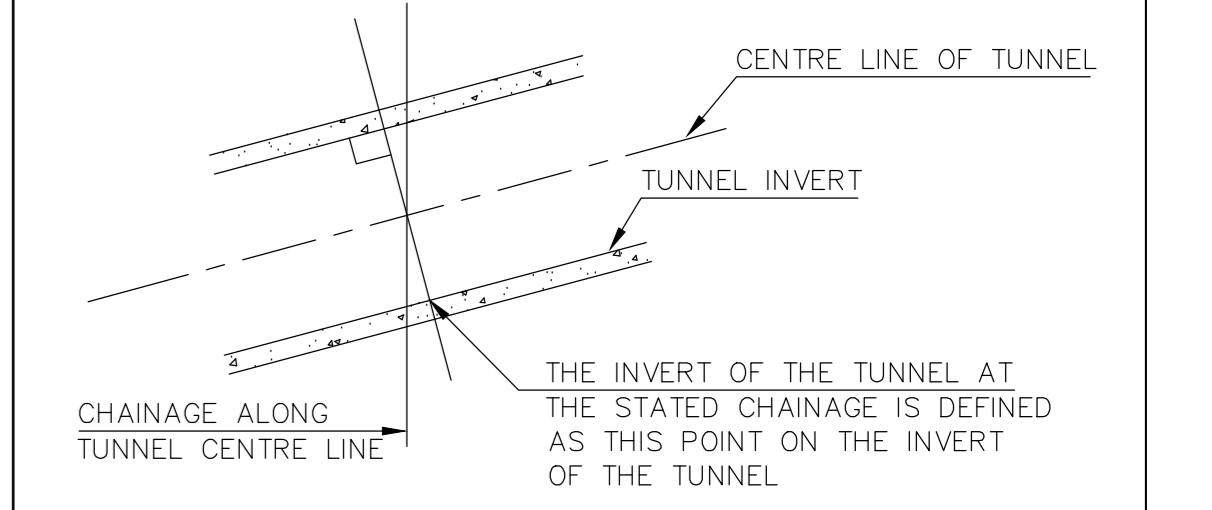
LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A
DELIVERY TUNNEL NORTH

CALEDON TUNNEL
CALEDON RIVER CROSSING
UNDERGROUND WORKS
SOUTH ADIT/TUNNEL 1 INTERSECTION
GENERAL ARRANGEMENT AND CONCRETE DETAILS
SHEET 1 OF 2

HDTC HIGHLANDS DELIVERY TUNNEL CONSULTANTS
Ntshani Shanyani
Van Niekerk, Megan & Edwards
Keeve Steyn Inc.
Stellen, Robertson & Kirsten Inc.

Date: AUG 1991	Designed:	Drawn:	Checked:
Client Contract No: TCTA - 20	HDTC Drawing No: C36-0786	Rev. No: Z	

- NOTES:**
1. ALL DIMENSIONS IN METRES UNLESS OTHERWISE SHOWN.
 2. ALL LEVELS ARE IN METRES ABOVE SEA LEVEL.
 3. ROCK SUPPORT NOT SHOWN. SEE DRG. No. 0835 FOR DETAILS OF ROCK SUPPORT CLASS, DISTRIBUTIONS AND EXPECTED GEOTECHNICAL CONDITIONS.
 4. SEE DRG. No. 0809 FOR CO-ORDINATES & VERTICAL CURVE DETAILS.
 5. SEE DRG. No. 0805 FOR LITTLE CALEDON CROSSING LAYOUT.
 6. SEE DRG. No. 0775 FOR LAYOUT OF LITTLE CALEDON TUNNEL BYPASS.
 - 7.

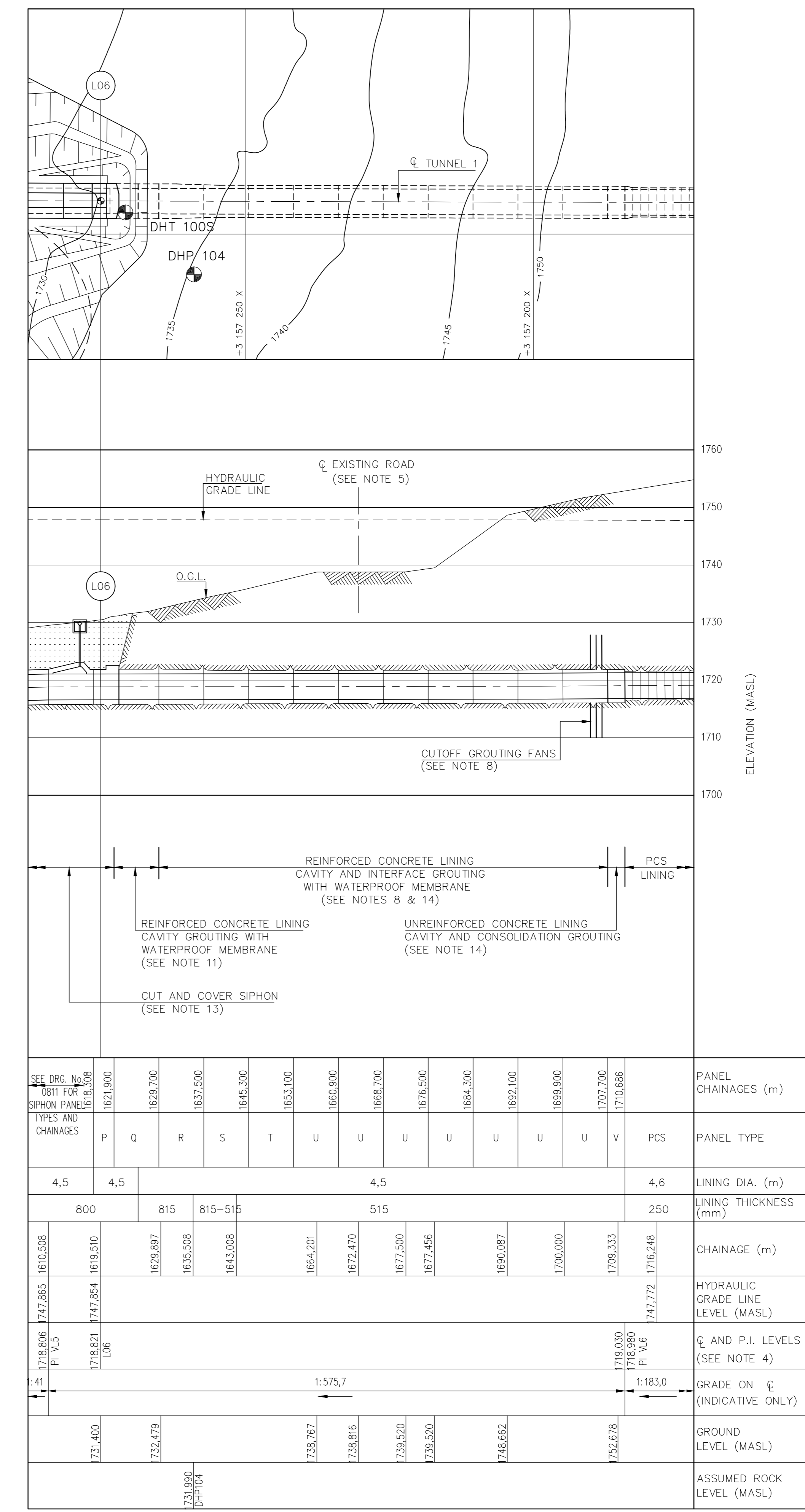
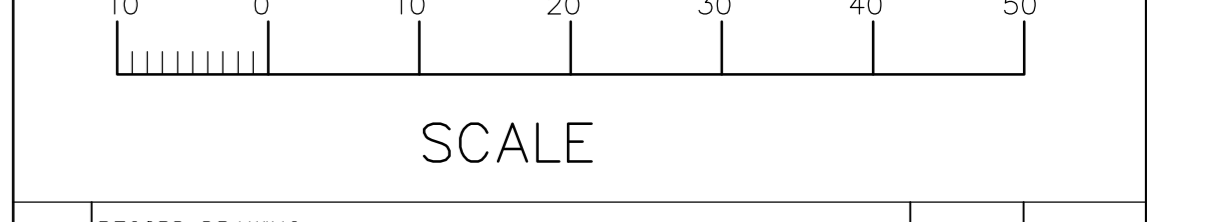


8. SEE DRG. No's 0831 AND 1240 FOR CONCRETE AND WATERPROOFING MEMBRANE SYSTEM DETAILS AND DRG. No's 0755 AND 0832 FOR GROUTING DETAILS.
9. SEE DRG. No's 1130 AND 1131 FOR DETAILS OF EXCAVATION AND ROCK SUPPORT FOR 5,77m DIA. UNREINFORCED TUNNEL LININGS.
10. SEE DRG. No's 1132 AND 1133 FOR DETAILS OF EXCAVATION AND ROCK SUPPORT FOR 5,77m DIA. REINFORCED TUNNEL LININGS.
11. SEE DRG. No. 0819 FOR EXCAVATION, SUPPORT AND CONCRETE DETAIL OF TUNNEL PORTALS.
12. SEE DRG. No. 1270 FOR COMMISSIONING PLUG DETAILS.
13. SEE DRG. No's 0810 AND 0811 FOR DETAILS OF CUT AND COVER SIPHON.
14. SEE DRG. No's 0845 AND 0846 FOR DETAILS OF EXCAVATION AND ROCK SUPPORT FOR 4,5m DIA. TUNNEL LININGS.
15. AUGER HOLE, TEST PIT AND TRENCH LOGS ARE GIVEN IN VOLUME 5 - DATA FOR TENDERERS.

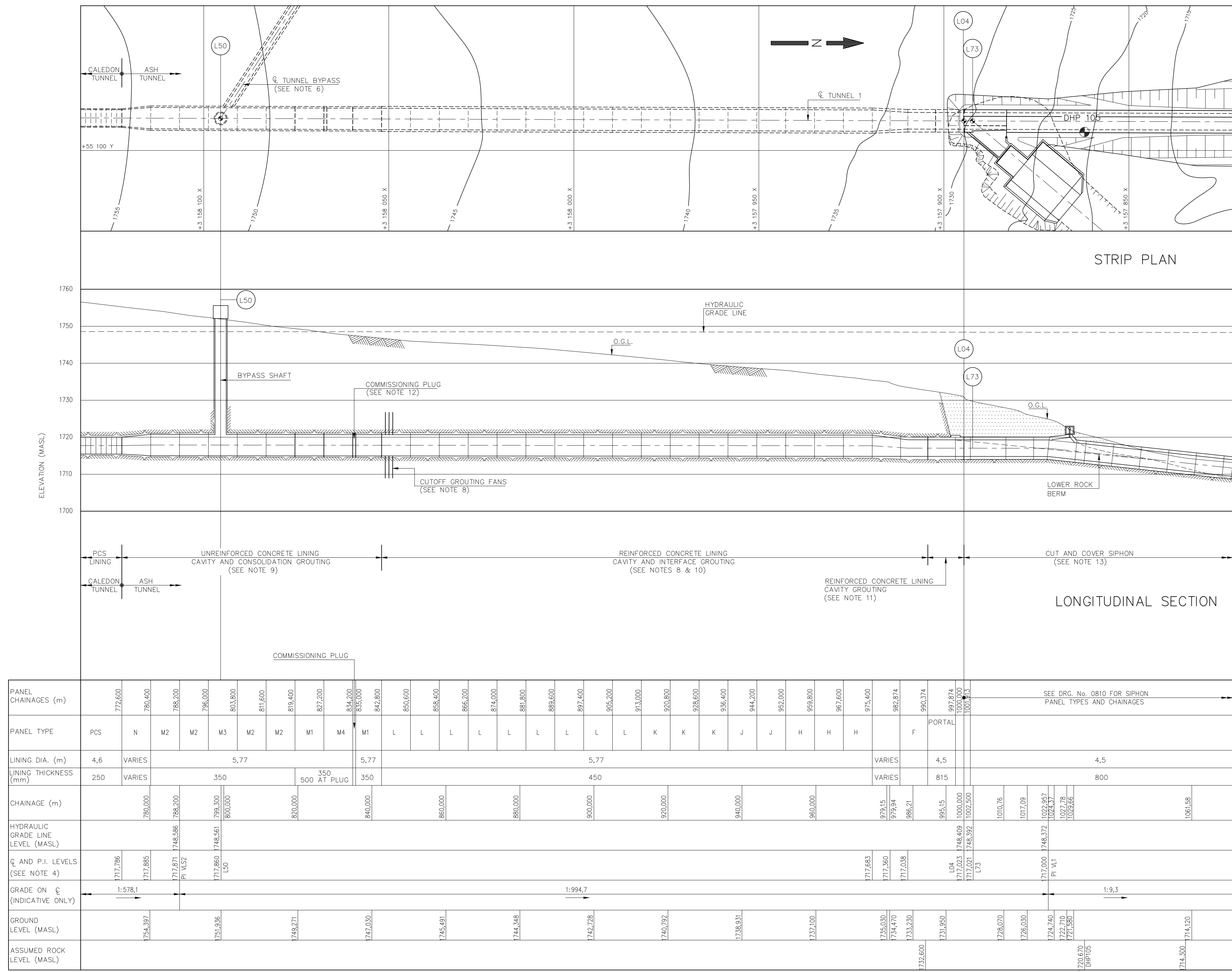
- LEGEND:**
- DHT 100S TRENCH (SEE NOTE 15)
 - DHP 10S TRIAL PIT (SEE NOTE 15)
- CO-ORDINATE POINT IDENTIFICATION:**
- POINT NUMBER
 - LITTLE CALEDON
 - CO-ORDINATE POINT

Related Drawings

Drg. No	Description
0755	CALEDON TUNNEL - TUNNEL WORKS - LININGS - UNREINFORCED CONCRETE LININGS - DAB TUNNELS - CONCRETE AND GROUTING DETAILS
0775	CALEDON TUNNEL - LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS TUNNEL BYPASS - GENERAL ARRANGEMENT
0805	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - LAYOUT
0809	LITTLE CALEDON RIVER CROSSING - UNDERGROUND SURFACE WORKS - GENERAL ARRANGEMENT, LONGITUDINAL SECTION AND SETTING OUT DETAILS
0810	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON PLAN ON CENTRELINE AND LONGITUDINAL SECTION - SHEET 1 OF 2
0811	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - CUT AND COVER SIPHON PLAN ON CENTRELINE AND LONGITUDINAL SECTION - SHEET 2 OF 2
0819	LITTLE CALEDON RIVER CROSSING - CUT AND COVER SIPHON - TUNNEL PORTALS EXCAVATION, ROCK SUPPORT AND CONCRETE DETAILS
0831	LITTLE CALEDON RIVER CROSSING - ENLARGED DAB TUNNELS - 5,77m & 4,5m DIA LININGS - LITTLE CALEDON SOUTH DRIVE - CONCRETE AND WATERPROOF MEMBRANE DETAILS
0832	LITTLE CALEDON RIVER CROSSING - ENLARGED DAB TUNNELS - 5,77m & 4,5m DIA LININGS - LITTLE CALEDON SOUTH AND NORTH DRIVE - REINFORCED CONCRETE WITH WATERPROOF MEMBRANE - GROUTING DETAILS
0835	ASH TUNNEL - TUNNEL WORKS - LITTLE CALEDON SOUTH TO ASH OUTFALL - LONGITUDINAL SECTION AND GEOTECHNICAL DETAILS - EXPECTED CONDITIONS
0845	ASH/CALEDON TUNNEL - TUNNEL WORKS - ENLARGED DAB TUNNELS FOR TEMP ACCESS - EXCAVATION DETAILS AND ROCK SUPPORT CLASSES - SH 1 OF 2
0846	ASH/CALEDON TUNNEL - TUNNEL WORKS - ENLARGED DAB TUNNELS FOR TEMP ACCESS - EXCAVATION DETAILS AND ROCK SUPPORT CLASSES - SH 2 OF 2
1130	ASH/CALEDON TUNNEL - TUNNEL WORKS - ENLARGED DAB TUNNELS - 5,77m DIA LININGS - EXCAVATION DETAILS AND ROCK SUPPORT CLASSES - SH 1 OF 2
1131	ASH/CALEDON TUNNEL - TUNNEL WORKS - ENLARGED DAB TUNNELS - 5,77m DIA LININGS - EXCAVATION DETAILS AND ROCK SUPPORT CLASSES - SH 2 OF 2
1132	ASH/CALEDON TUNNEL - TUNNEL WORKS - ENLARGED DAB TUNNELS - 5,77m DIA LININGS - EXCAVATION DETAILS AND ROCK SUPPORT CLASSES - SH 1 OF 2
1133	ASH/CALEDON TUNNEL - TUNNEL WORKS - ENLARGED DAB TUNNELS - 5,77m DIA LININGS - EXCAVATION DETAILS AND ROCK SUPPORT CLASSES - SH 2 OF 2
1240	LITTLE CALEDON RIVER CROSSING - ENLARGED DAB TUNNELS - 4,5m DIA LINING LITTLE CALEDON NORTH DRIVE - CONCRETE AND WATERPROOF MEMBRANE DETAILS
1270	ASH/CALEDON TUNNEL - TUNNEL WORKS - LININGS - COMMISSIONING PLUGS - CONCRETE DETAILS



LITTLE CALEDON NORTH DRIVE



LITTLE CALEDON SOUTH DRIVE

PANEL CHAINAGES (m)	PANEL TYPE	LINING DIA. (m)	LINING THICKNESS (mm)	CHAINAGE (m)	HYDRAULIC GRADE LINE LEVEL (MASL)	GRADE ON ϵ (INDICATIVE ONLY)	GROUND LEVEL (MASL)	ASSUMED ROCK LEVEL (MASL)
772,650	PCS	4,6	250	772,650	717,996	1:578,1	754,397	
789,400	N	VARIABLES	VARIABLES	789,400	717,885		754,396	
798,200	M2	5,77	350	798,200	717,871		748,271	
798,000	M2	5,77	350	798,000	717,851		748,278	
803,850	M3	5,77	350	803,850	717,860		745,456	
811,600	M2	5,77	350	811,600	717,851		748,271	
819,400	M1	5,77	350	819,400	717,851		748,271	
827,200	M4	5,77	350	827,200	717,851		748,271	
834,200	M1	5,77	350	834,200	717,851		748,271	
835,000	L	4,5	800	835,000	717,851		748,271	
842,800	L	4,5	800	842,800	717,851		748,271	
850,600	L	4,5	800	850,600	717,851		748,271	
858,400	L	4,5	800	858,400	717,851		748,271	
866,200	L	4,5	800	866,200	717,851		748,271	
874,000	L	4,5	800	874,000	717,851		748,271	
881,800	L	4,5	800	881,800	717,851		748,271	
889,600	L	4,5	800	889,600	717,851		748,271	
897,400	L	4,5	800	897,400	717,851		748,271	
905,200	L	4,5	800	905,200	717,851		748,271	
913,000	L	4,5	800	913,000	717,851		748,271	
920,800	K	4,5	800	920,800	717,851		748,271	
928,600	K	4,5	800	928,600	717,851		748,271	
936,400	K	4,5	800	936,400	717,851		748,271	
944,200	J	4,5	800	944,200	717,851		748,271	
952,000	J	4,5	800	952,000	717,851		748,271	
959,800	H	4,5	800	959,800	717,851		748,271	
967,600	H	4,5	800	967,600	717,851		748,271	
975,400	H	4,5	800	975,400	717,851		748,271	
983,200	F	4,5	800	983,200	717,851		748,271	
991,000	PORTAL	4,5	800	991,000	717,851		748,271	

SCALE

5. RECORD DRAWING

6. CHAINAGES AND GRADIENTS REVISED TO SUIT CONTRACTOR'S METHOD

7. PANEL LENGTHS CHANGED

8. COMMISSIONING PLUG POSITION CHANGED TO SUIT CONTRACTOR'S METHOD. LEVELS CHANGED AS REQUESTED BY CONTRACTOR

9. PANEL M3 CHANGE REVISED. PANEL A9 REMOVED. NOTES AND RELATED DRAWINGS AMENDED

10. HYDRAULIC GRADE LINE, CHAINAGE, NOTES, RELATED DRAWINGS AND PANEL TYPES REVISED

11. ISSUED FOR CONSTRUCTION

NO. AMENDMENTS

DATE

TCTA TRANS-CALEDON TUNNEL AUTHORITY

Approved: *F. Udo* Date: 2-2-93

LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A

DELIVERY TUNNEL NORTH

ASH TUNNEL

LITTLE CALEDON RIVER CROSSING

ENLARGED D&B TUNNELS

5,77m AND 4,5m DIA. LININGS

LITTLE CALEDON SOUTH AND NORTH DRIVE

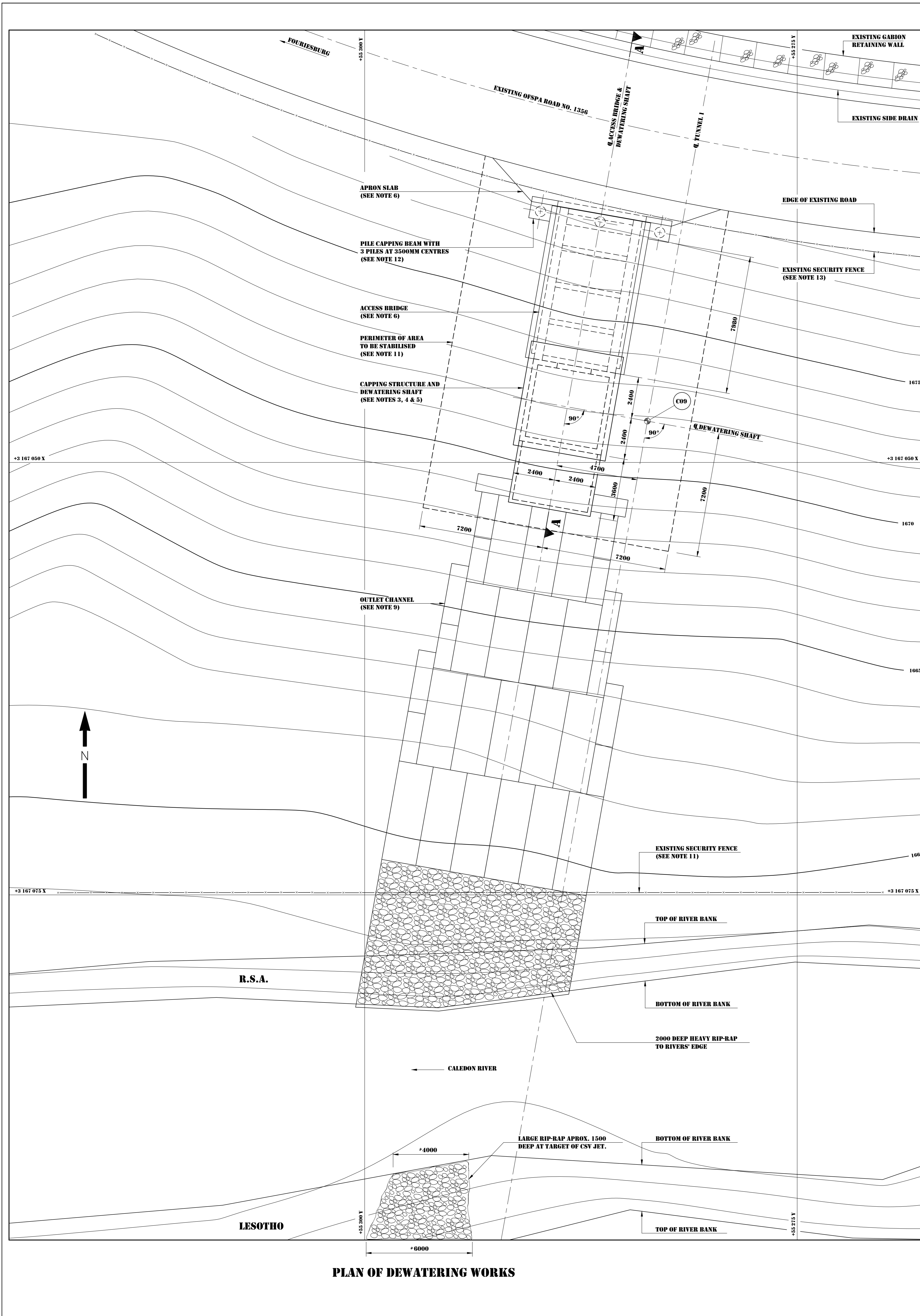
CONCRETE LAYOUT

HDTC HIGHLANDS DELIVERY TUNNEL CONSULTANTS

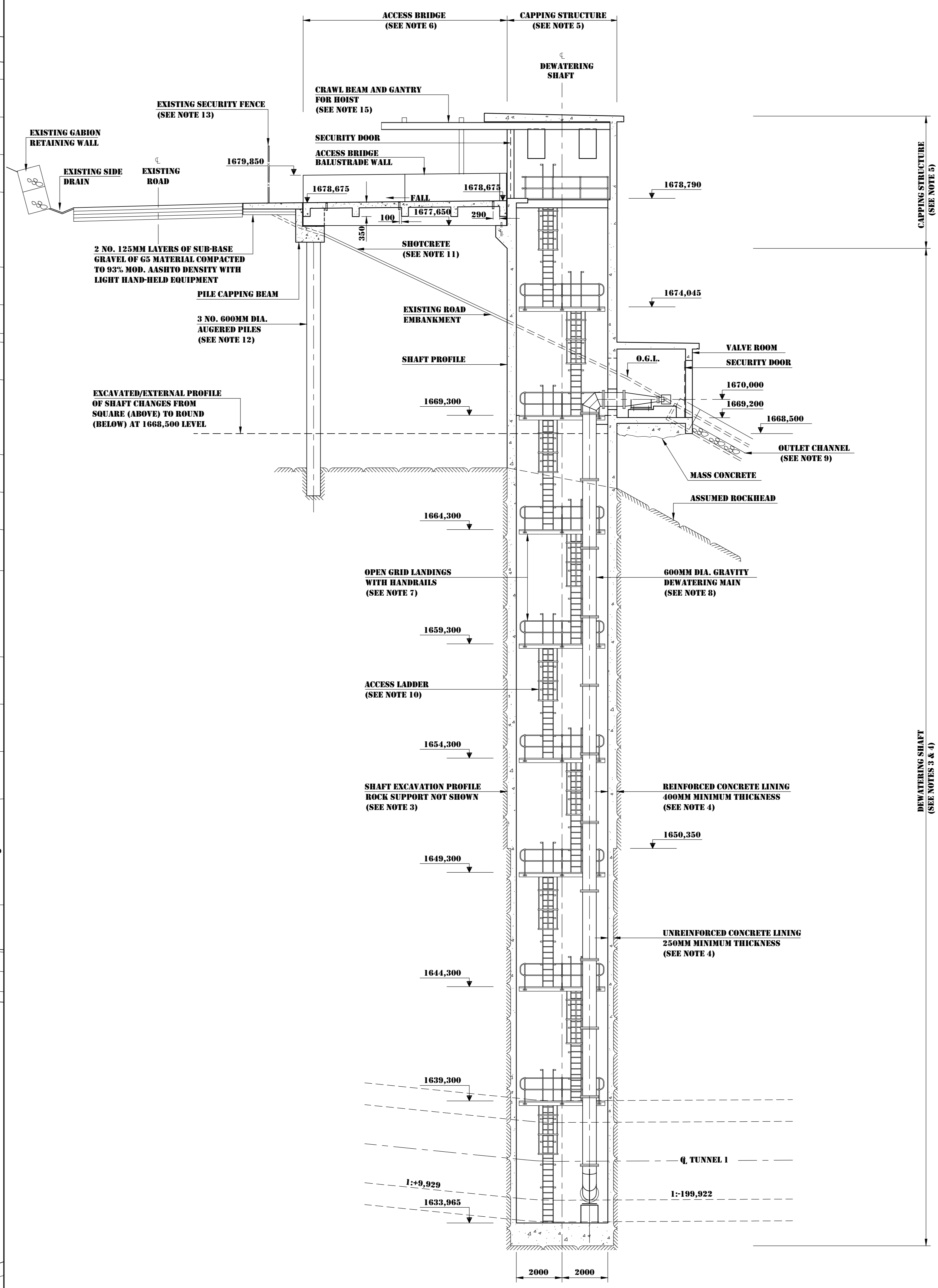
Ntshani Shand Inc. Van Niekerk, Hagen & Edwards
Keeve Steyn Inc. Stellen, Robertson & Kirsten Inc.

Date: **JAN 1993** Designed: Drawn: Checked:

Client Contract No. **TCTA - 20** HDTC Drawing No. **C36-0830** Rev. No. **Z**



PLAN OF DEWATERING WORKS



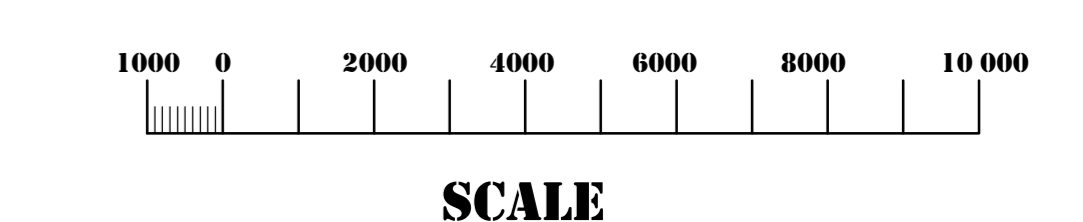
SECTION A-A
(ROCK SUPPORT NOT SHOWN)

- NOTES:**
1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
 2. ALL LEVELS ARE IN METRES ABOVE SEA LEVEL.
 3. SEE DRG. NO. 0729 FOR DETAILS OF DEWATERING SHAFT EXCAVATION AND SUPPORT DETAILS.
 4. SEE DRG. NO. 0730 FOR CONCRETE DETAILS OF DEWATERING SHAFT.
 5. SEE DRG. NO. 0731 FOR DETAILS OF CAPPING STRUCTURE.
 6. SEE DRG. NO. 0732 FOR DETAILS OF ACCESS BRIDGE.
 7. SEE DRG. NO. 1123 FOR DETAILS OF LANDINGS AND HANDRAILING.
 8. SEE DRG. NOS 1123 AND 1125 FOR DETAILS OF PIPEWORK AND VALVES.
 9. SEE DRG. NO. 1126 FOR DETAILS OF OUTLET CHANNEL.
 10. SEE DRG. NO. 1122 FOR DETAILS OF CAT LADDERS.
 11. THE DESIGNATED AREA SHALL BE STABILIZED (AFTER CLEARING OF VEGETATION AS DIRECTED BY THE ENGINEER ON SITE), BY MEANS OF REF. 193 WELDED STEEL MESH HELD BY 1500MM LONG V25 HOOK DOWELS AT 1500MM CENTRES EACH WAY AND 75MM THICK SHOTCRETE COVER TO MESH 25MM MINIMUM. SEE DRG. NO. 0751 FOR DETAILS OF HOOK DOWELS.
 12. PILE DIMENSIONS ARE APPROXIMATE. FINAL DESIGN OF PILES TO BE CARRIED OUT BY THE CONTRACTOR. DESIGN LOADS TO BE SUPPLIED BY THE ENGINEER.
 13. THE SITE WORKING AREA SECURITY FENCE SHALL REMAIN UNBROKEN WITH CONTROLLED ACCESS AT ALL TIMES, WHERE TEMPORARY ACCESS POINTS ARE PERMITTED, THE CONTRACTOR SHALL MAKE ALL NECESSARY ARRANGEMENTS TO ENSURE THAT ACCESS IS CONTROLLED IN COMPLIANCE WITH THE REQUIREMENTS OF THE CONTRACT.
 14. SEE DRG. NO. 0704 FOR CO-ORDINATES OF POINT C09.
 15. SEE DRG. NO. 1129 FOR DETAILS OF CRAWL BEAM.
 16. SEE DRG. NO. 1118 FOR ELECTRICAL DETAILS.

- LEGEND:**
- PERMANENT ACCESS ROAD
 - EXISTING ROAD
 - FENCE LINE
 - GATE
 - EMBANKMENT
 - CUTTING
 - CONSTRUCTION LEVEL (IN SECTION)
 - CONSTRUCTION LEVEL (IN PLAN)
 - COORDINATE POINT IDENTIFICATION
 - POINT NUMBER
 - COORDINATE POINT

RELATED DRAWINGS

DRG. NO.	DESCRIPTION
0704	CALEDON TUNNEL - CALEDON RIVER CROSSING - OVERALL LAYOUT
0729	CALEDON RIVER CROSSING - UNDERGROUND WORKS - DEWATERING WORKS - DEWATERING SHAFT - EXCAVATION AND SUPPORT DETAILS
0730	CALEDON RIVER CROSSING - UNDERGROUND WORKS - DEWATERING WORKS - DEWATERING SHAFT - CONCRETE AND GROUTING DETAILS
0731	CALEDON RIVER CROSSING - UNDERGROUND WORKS - DEWATERING WORKS - CAPPING STRUCTURE - CONCRETE DETAILS
0732	CALEDON RIVER CROSSING - UNDERGROUND WORKS - DEWATERING WORKS - ACCESS BRIDGE - CONCRETE DETAILS
0751	ASPHALT/CALEDON TUNNEL - TUNNEL WORKS - ROCK REINFORCEMENT - SUPPORT ELEMENTS - TYPICAL DETAILS
1118	CALEDON RIVER CROSSING - UNDERGROUND WORKS - DEWATERING WORKS - ELECTRICAL DETAILS
1122	CALEDON RIVER CROSSING - UNDERGROUND WORKS - DEWATERING WORKS - CAT LADDER DETAILS
1123	CALEDON RIVER CROSSING - UNDERGROUND WORKS - DEWATERING WORKS - DEWATERING SHAFT - LANDINGS AND HANDRAILING
1124	CALEDON RIVER CROSSING - UNDERGROUND WORKS - DEWATERING WORKS - PIPEWORK AND VALVES - SHEET 1 OF 2
1125	CALEDON RIVER CROSSING - UNDERGROUND WORKS - DEWATERING WORKS - PIPEWORK AND VALVES - SHEET 2 OF 2
1126	CALEDON RIVER CROSSING - UNDERGROUND WORKS - DEWATERING WORKS - OUTLET CHANNEL
1129	CALEDON RIVER CROSSING - UNDERGROUND WORKS - DEWATERING WORKS - CRAWL BEAM DETAILS



SCALE

Z.	RECORD DRAWING	ISSUED FOR CONSTRUCTION	B.C.V.	07/91
1.	VALVE ROOM, ACCESS BRIDGE, OUTLET CHANNEL, LEVELS, NOTES AND RELATED DRAWINGS AMEND			
6.				

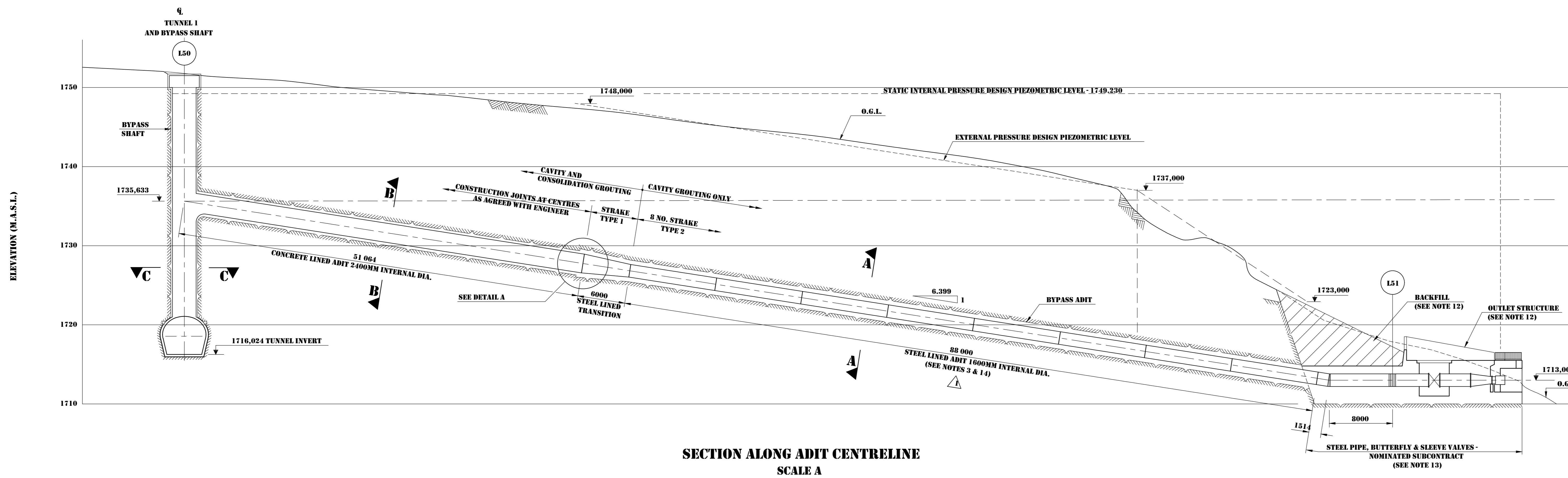
HTA TRANS-CALEDON TUNNEL AUTHORITY
 APPROVED: *F. Ullrich* DATE: 3 Nov 92

**LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A
 DELIVERY TUNNEL NORTH**

**CALEDON TUNNEL
 CALEDON RIVER CROSSING
 UNDERGROUND WORKS
 DEWATERING WORKS
 GENERAL ARRANGEMENT**

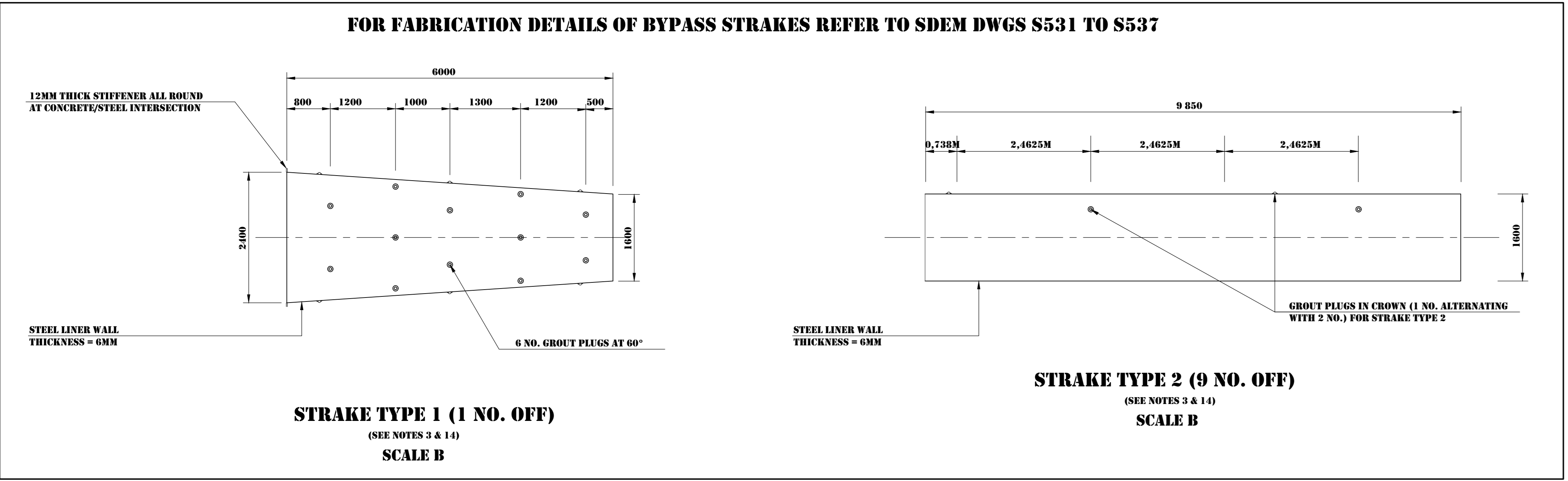
HDTC HIGHLANDS DELIVERY TUNNEL CONSULTANTS
 SYDNEY SHAW INC. VAN DERBURG, RILEY & EDWARDS
 KEVE STEYN INC. STEFFEN, ROBERTSON & KRISTEN E.

DATE	DESIGNER	DRAWN	CHECKED
01 OCT 1992			
CLIENT CONTRACT NO.	HDTC DRAWING NO.	REV. NO.	
TCTA - 20	C38-0728	Z	



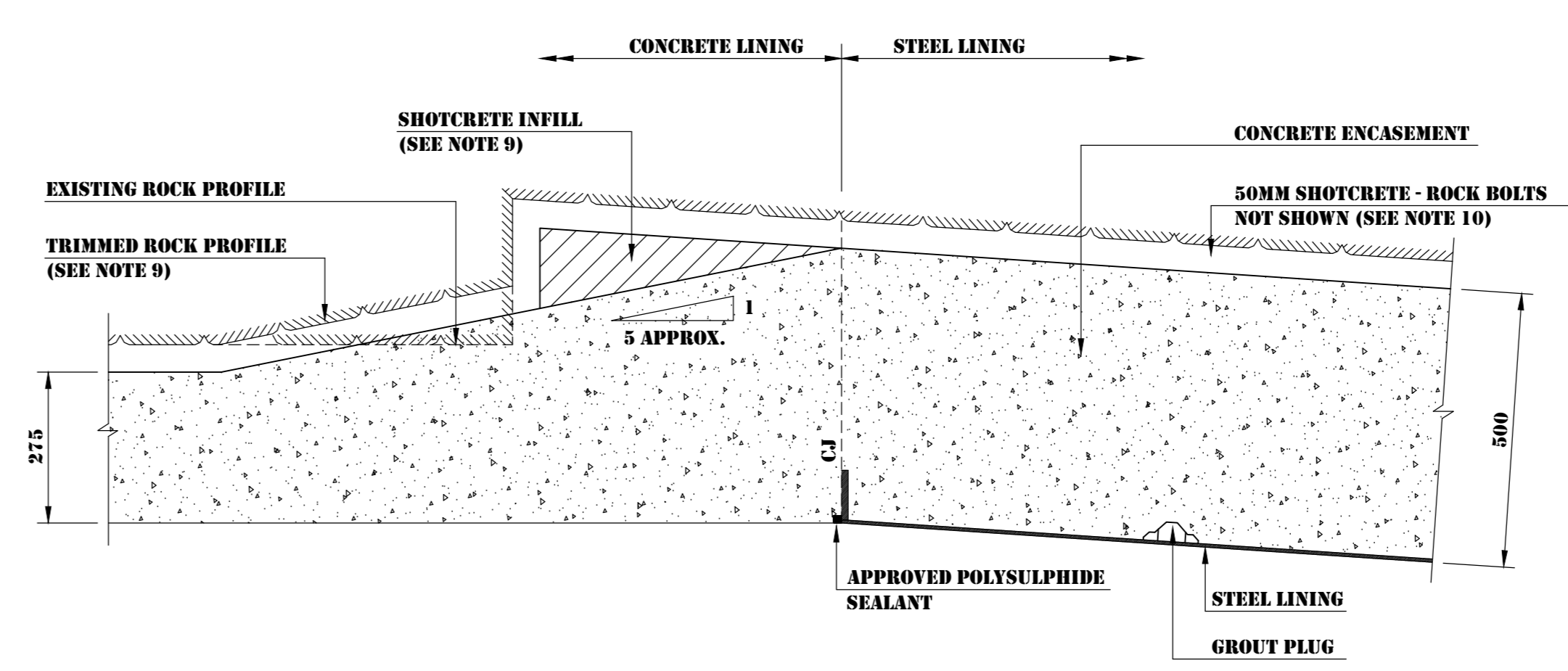
SECTION ALONG ADIT CENTRELINE
SCALE A

- NOTES:**
- ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.
 - ALL LEVELS IN METRES ABOVE SEA LEVEL.
 - 3CR12 STEEL LININGS:
 - DETAILS SHOWN ON THIS DRAWING ARE SUBJECT TO FINAL DESIGN BY THE CONTRACTOR. DIMENSIONS SHOWN ARE TYPICAL.
 - ALL STEEL LINER INTERNAL SURFACES TO BE CORROSION PROTECTED IN ACCORDANCE WITH SPECIFICATION AS REVISED FOR 3CR12 STEEL.
 - SEE SPECIFICATIONS FOR DETAILS OF SHOP AND FIELD WELD JOINT PREPARATION AND WELDING RULES. THE FOLLOWING ADDITIONAL REQUIREMENTS APPLY FOR 3CR12 STEEL:
 - (A) E308L STAINLESS STEEL WELDING RODS TO BE USED.
 - (B) HEAT AFFECTED ZONE TO BE PICKLED AND PASSIVATED AFTER WELDING.
 - (C) SHOP WELDS NOT SHOWN.
 - (D) GROUT DETAILS AS DETAIL 3 ON DRG. NO. 0722.
 - (E) CONSOLIDATION GROUTING REQUIRED ONLY AT STRAKE TYPE 1.
 - CAVITY GROUTING:
 - HOLES IN AND IMMEDIATELY ADJACENT TO CROWN TO BE DRILLED TO DEPTHS AS SHOWN OR MINIMUM 400MM INTO ROCK WHICHEVER IS THE GREATER. CAVITY GROUTING PRESSURE = 1 BAR.
 - CONSOLIDATION GROUTING:
 - DRILL OR REDRILL RADIAL HOLES TO DEPTHS AS SHOWN.
 - CONSOLIDATION GROUTING PRESSURE TO BE MAXIMUM OF 1.3 TIMES THE WATER HEAD FROM TUNNEL CENTRELINE TO SURFACE AT ANY POINT. TEST PRESSURE TO BE 50% OF CONSOLIDATION GROUTING PRESSURE.
 - GROUTING PATTERNS DETAILED ARE THE MINIMUM REQUIRED. THE ENGINEER MAY DIRECT THAT THE LONGITUDINAL SPACING BETWEEN ROWS OF HOLES BE REDUCED AND/OR LONGER HOLES (UP TO 6000MM) BE DRILLED.
 - CONCRETE TO CLASS 30/25 UNLESS OTHERWISE SHOWN.
 - CONCRETE TO HAVE U2/P2 FINISHES UNLESS OTHERWISE SHOWN.
 - EXISTING ROCK PROFILE TO BE TRIMMED AND/OR SHOTCRETE INFILL TO BE PLACED TO ACHIEVE A 1 IN 5 TRANSITION IN THE CONCRETE LINING THICKNESS AT THE END OF THE STEEL LINED SECTION.
 - SEE DRG. NO. 0782 FOR EXCAVATION AND ROCK SUPPORT DETAILS.
 - SEE DRG. NO. 0779 FOR EXCAVATION AND CONCRETE DETAILS FOR BYPASS SHAFT.
 - SEE DRG. NO. 0778 FOR DETAILS OF OUTLET STRUCTURE AND BACKFILL.
 - SEE DRG. NO. 1114 FOR DETAILS OF PIPEWORK AND VALVES OF OUTLET STRUCTURE.
 - ALL STEEL TO BE 3CR12 B2 STEEL UNLESS OTHERWISE SHOWN.



STRAKE TYPE 1 (1 NO. OFF)
SCALE B

STRAKE TYPE 2 (9 NO. OFF)
SCALE B

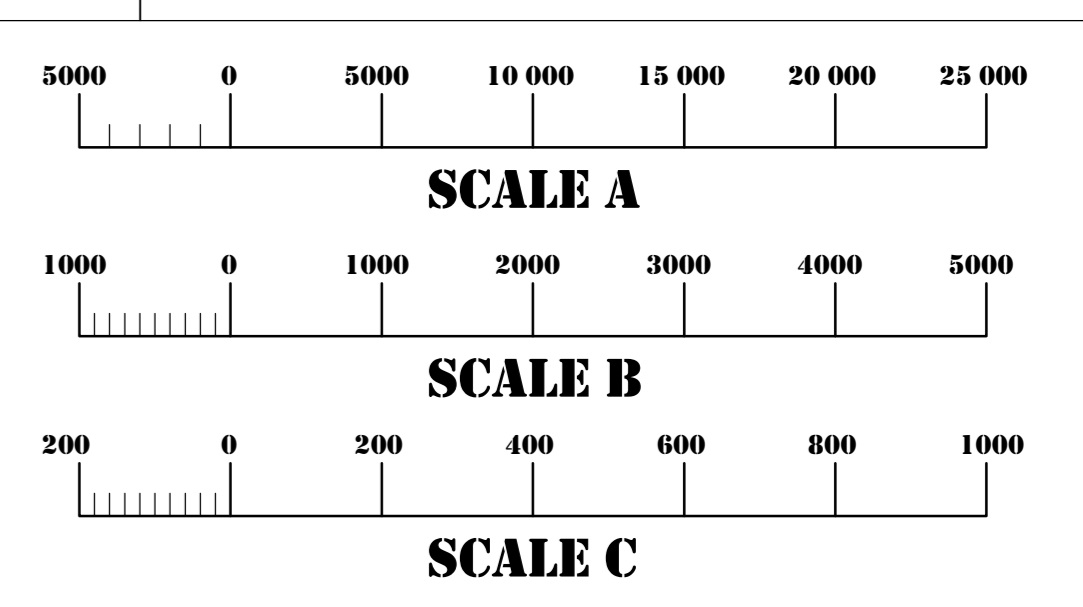


DETAIL A
TRANSITION BETWEEN CONCRETE LINING AND STEEL LINING
SCALE C

- LEGEND:**
- 1713.000 CONSTRUCTION LEVEL (IN SECTION)
 - CONSTRUCTION JOINT
 - CO-ORDINATE POINT IDENTIFICATION
 - POINT NUMBER
 - LITTLE CALEDON CO-ORDINATE POINT

RELATED DRAWINGS

DRG. NO.	DESCRIPTION
0722	TUNNEL WORKS - STEEL LININGS - TYPICAL DETAILS - SHEET 1 OF 2
0775	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - GENERAL ARRANGEMENT
0778	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - OUTLET STRUCTURE - CONCRETE DETAILS - SHEET 1 OF 2
0779	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - SHEET - EXCAVATION AND CONCRETE DETAILS
0782	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - LONGITUDINAL SECTION - EXCAVATION DETAILS
1114	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - OUTLET STRUCTURE - PIPEWORK AND VALVES



Z.	RECORD DRAWING.	DATE
1.	3CR12 B2 STEEL SPECIFIED, NOTE 3 AND RELATED DRAWINGS	B.W. 27/03/92
1.	AMENDED, NOTE 11 ADDED	B.C.Y. 07/91
6.	ISSUED FOR CONSTRUCTION.	

USA TRANSCALEDON TUNNEL AUTHORITY

APPROVED: *F. [Signature]* DATE: 19-11-97

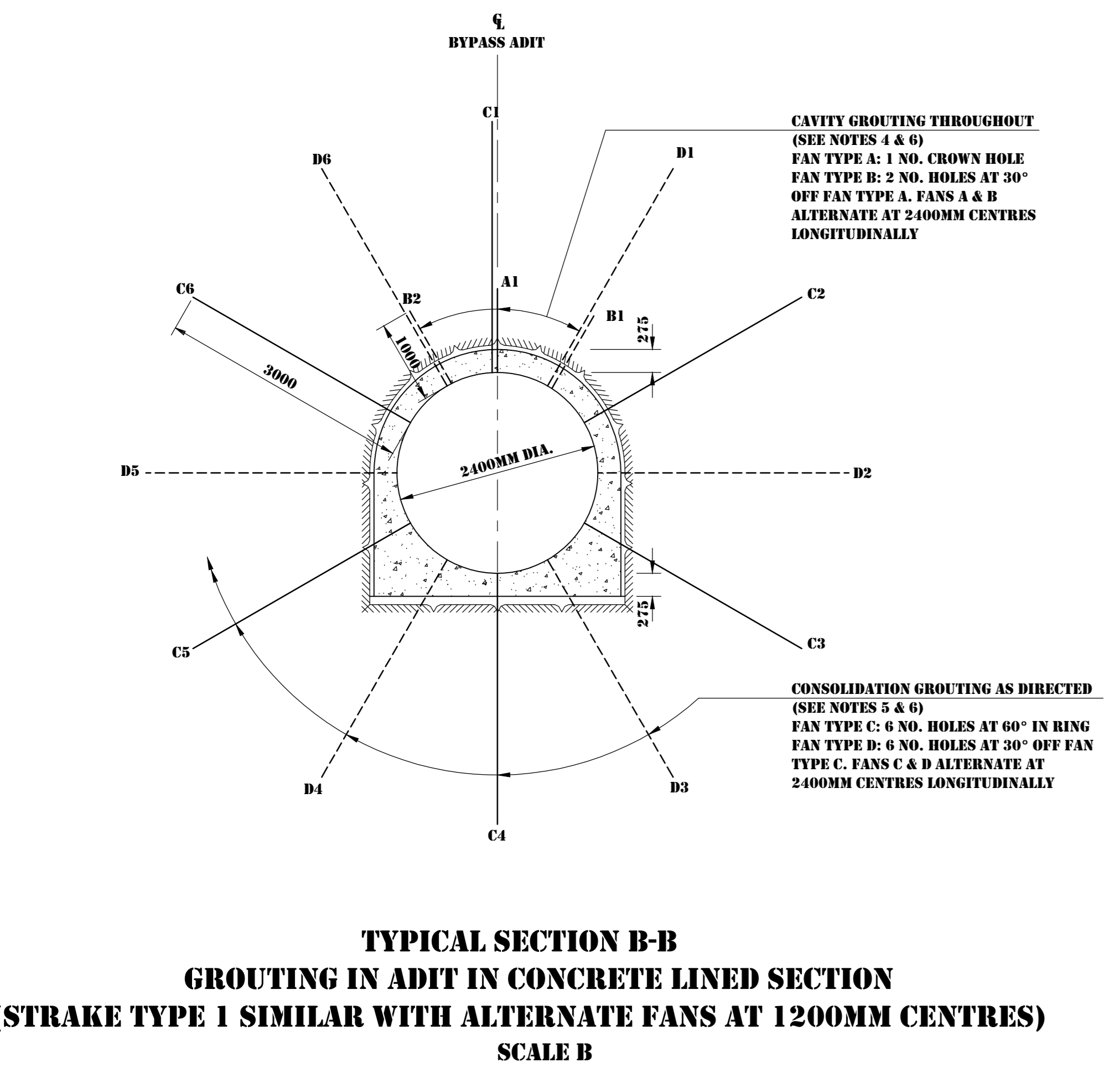
LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A
DELIVERY TUNNEL NORTH

CALEDON TUNNEL
LITTLE CALEDON RIVER CROSSING
UNDERGROUND WORKS
TUNNEL BYPASS
LONGITUDINAL SECTION
LINING AND GROUTING DETAILS

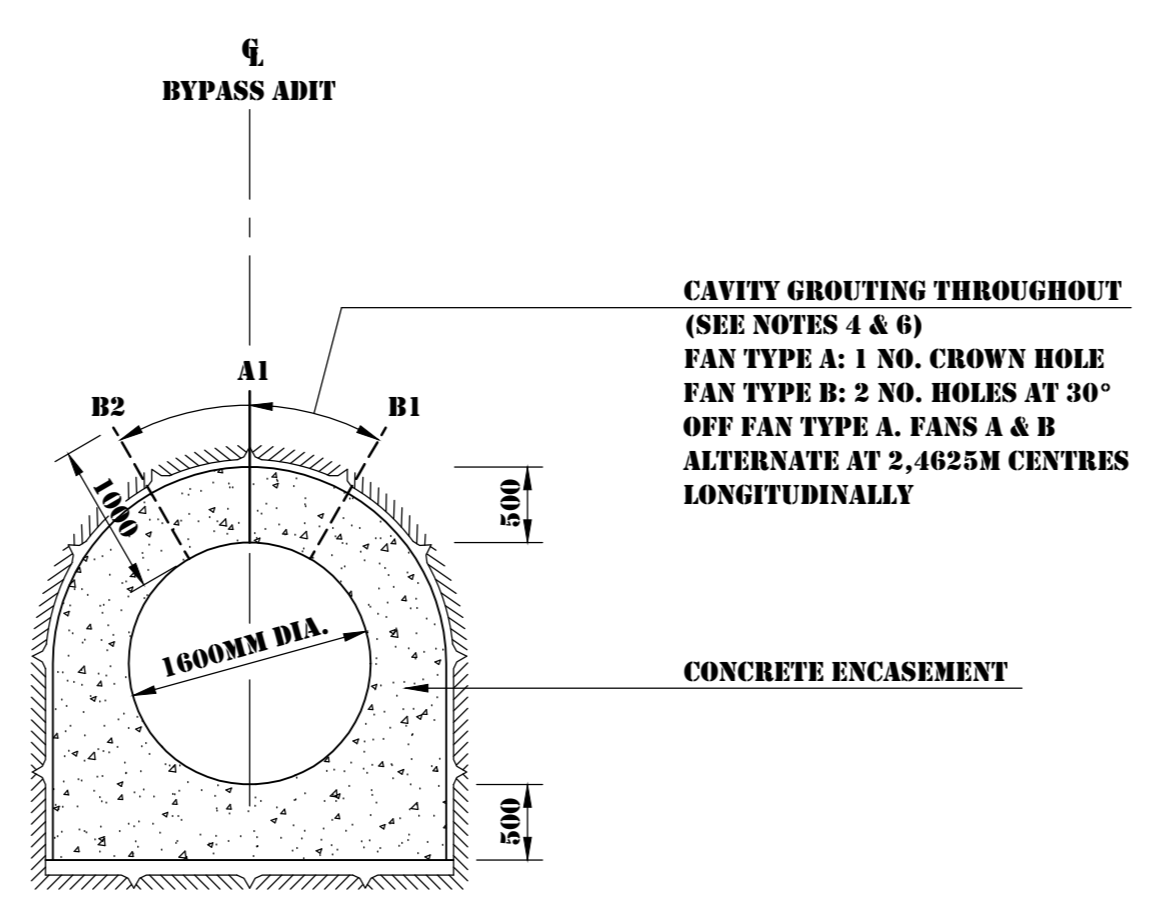
HDTC HIGHLANDS DELIVERY TUNNEL CONSULTANTS
SHARON SHAW INC. VAN MERILDE, KLEIN & EDWARDS
KEVIN STEYN INC. STEFFEN, ROBERTSON & KIRSTEN

DATE	DESIGNER	DRAWN	CHECKED
NOV 1991			

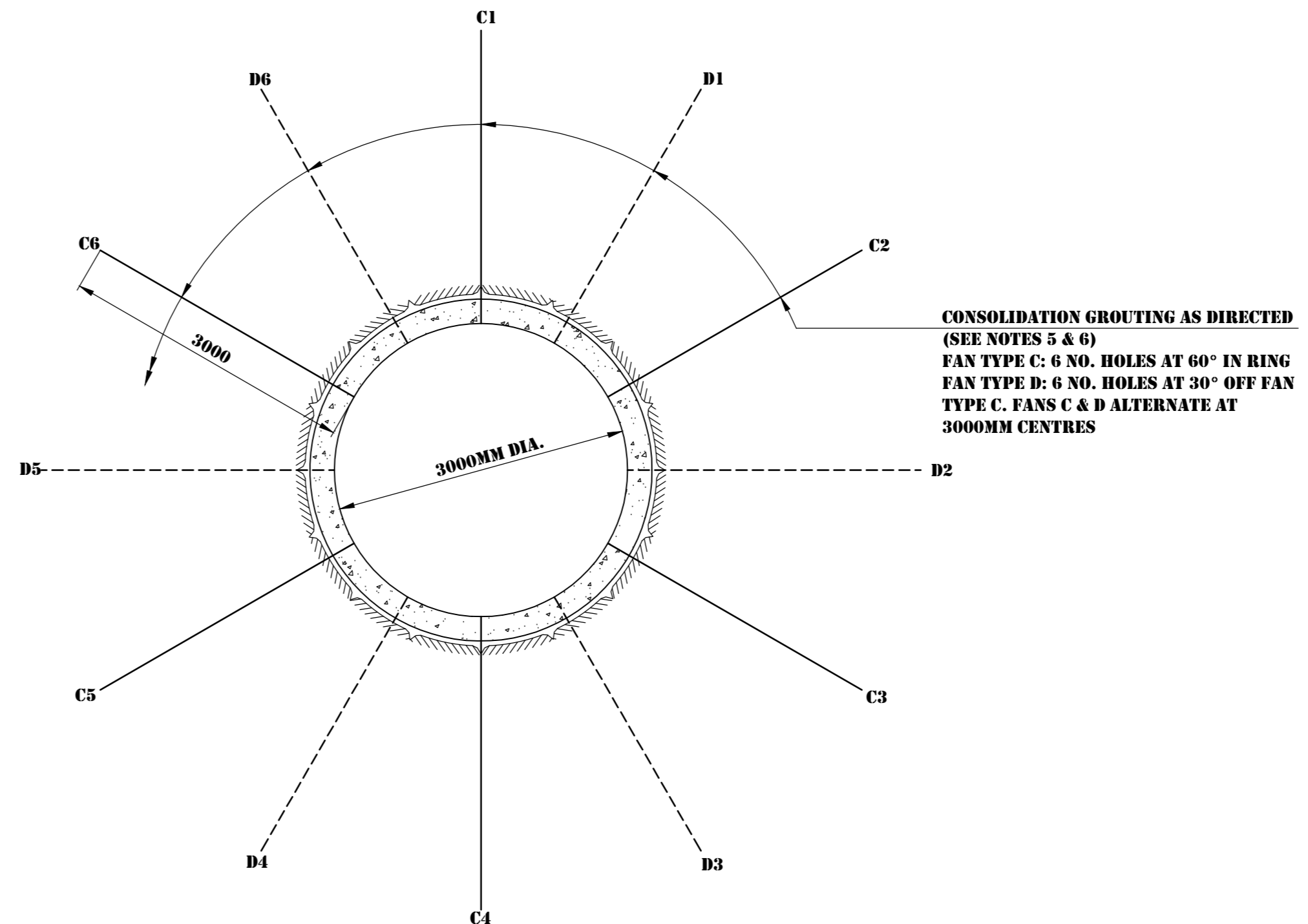
CLIENT CONTRACT NO.	HDTC DRAWING NO.	REV. NO.
TCTA - 20	C38-0777	Z



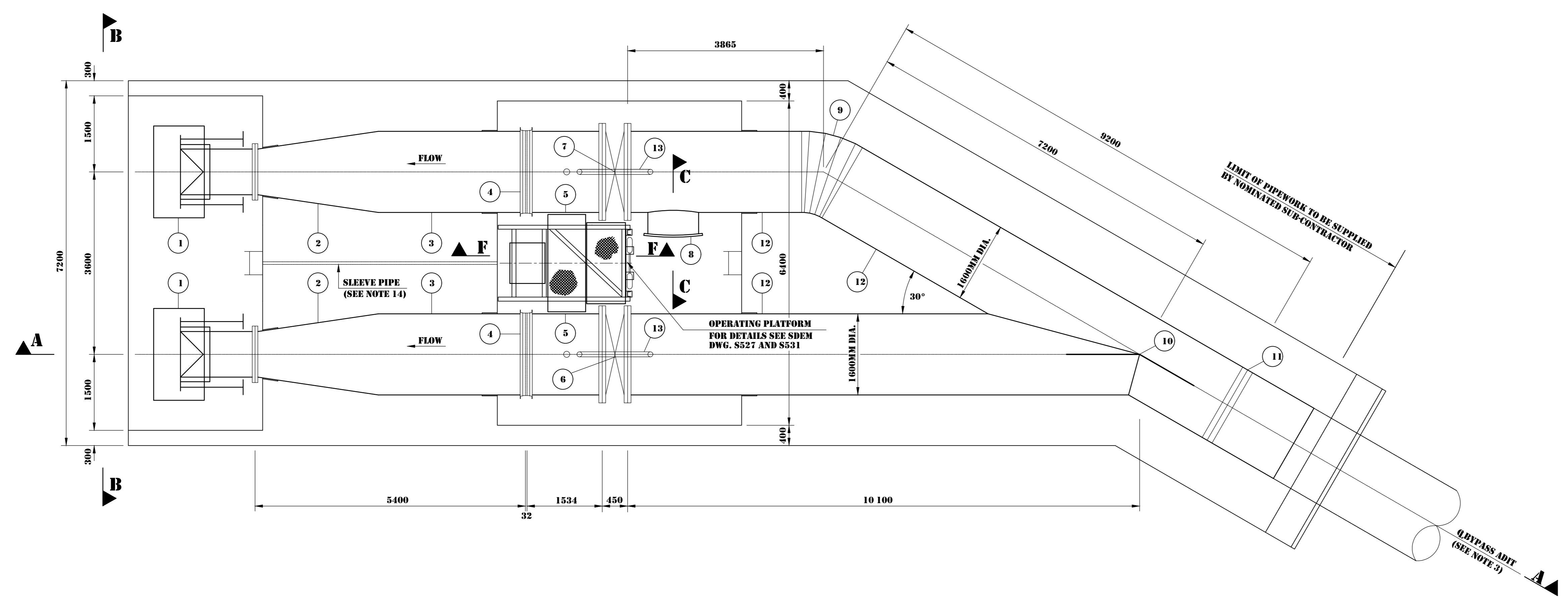
TYPICAL SECTION B-B
GROUTING IN ADIT IN CONCRETE LINED SECTION
(STRAKE TYPE 1 SIMILAR WITH ALTERNATE FANS AT 1200MM CENTRES)
SCALE B



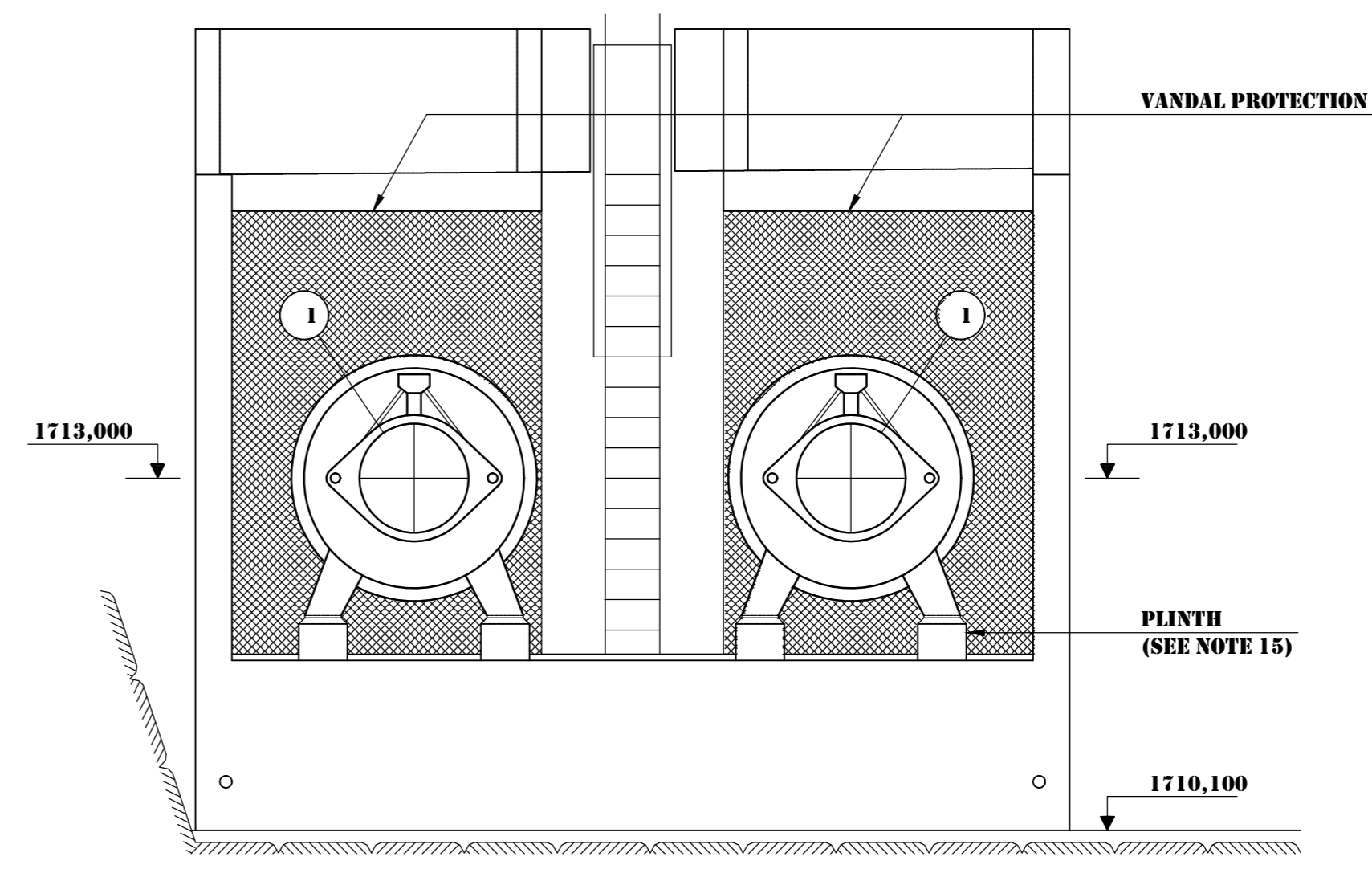
TYPICAL SECTION A-A
GROUTING IN ADIT IN STEEL LINED SECTION
SCALE B



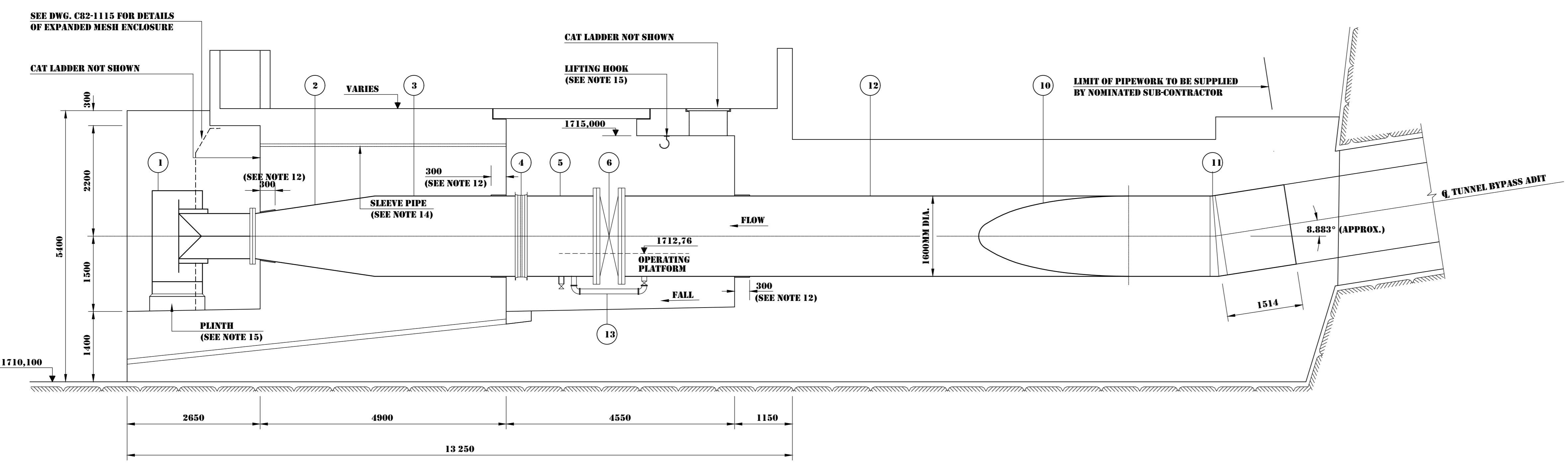
TYPICAL SECTION C-C
GROUTING IN SHAFT BETWEEN LEVELS 1748.000 & 1721.000
SCALE B



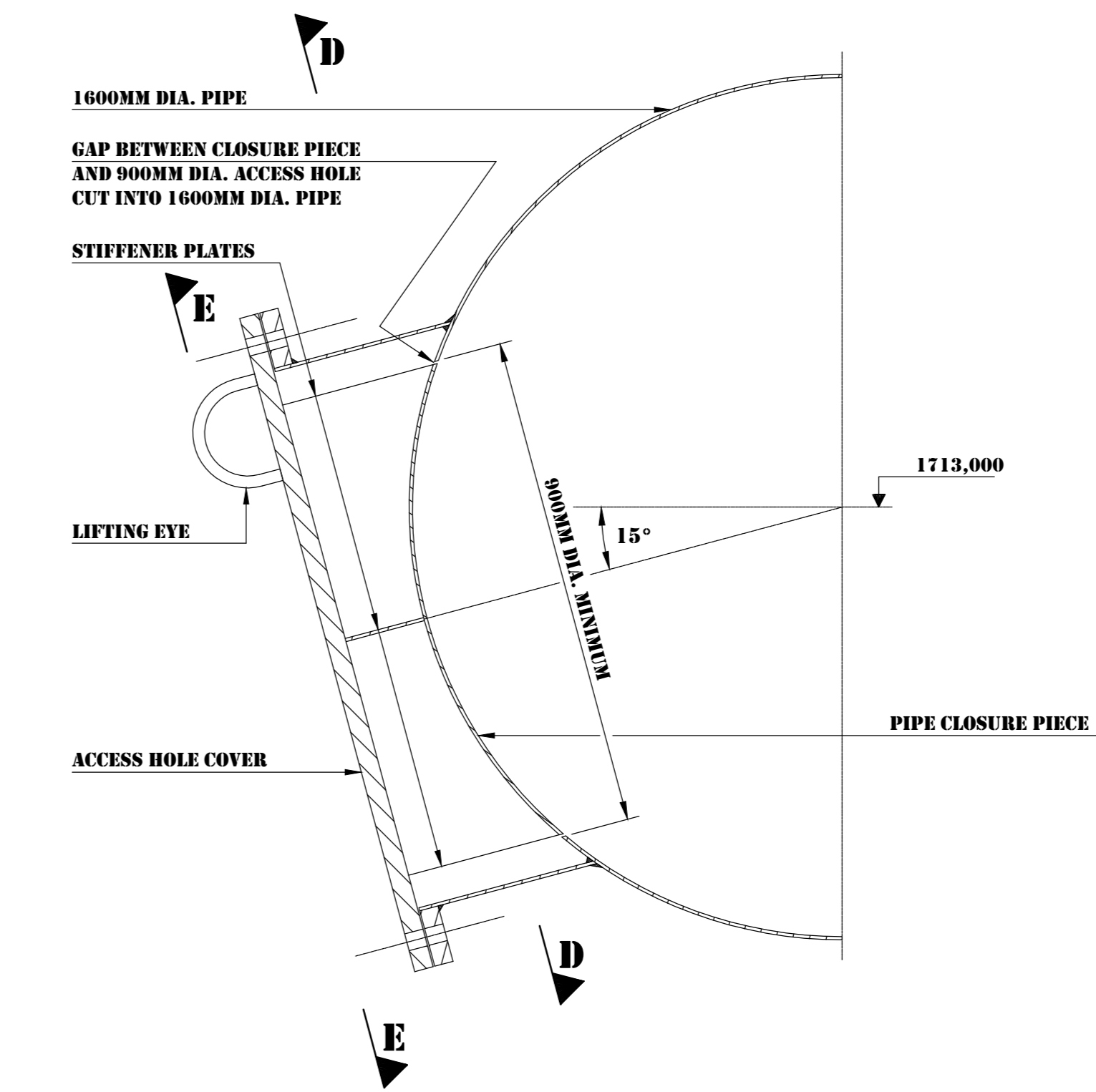
PLAN ON OUTLET STRUCTURE AT PIPE C L
(SEE NOTE 15)
SCALE A



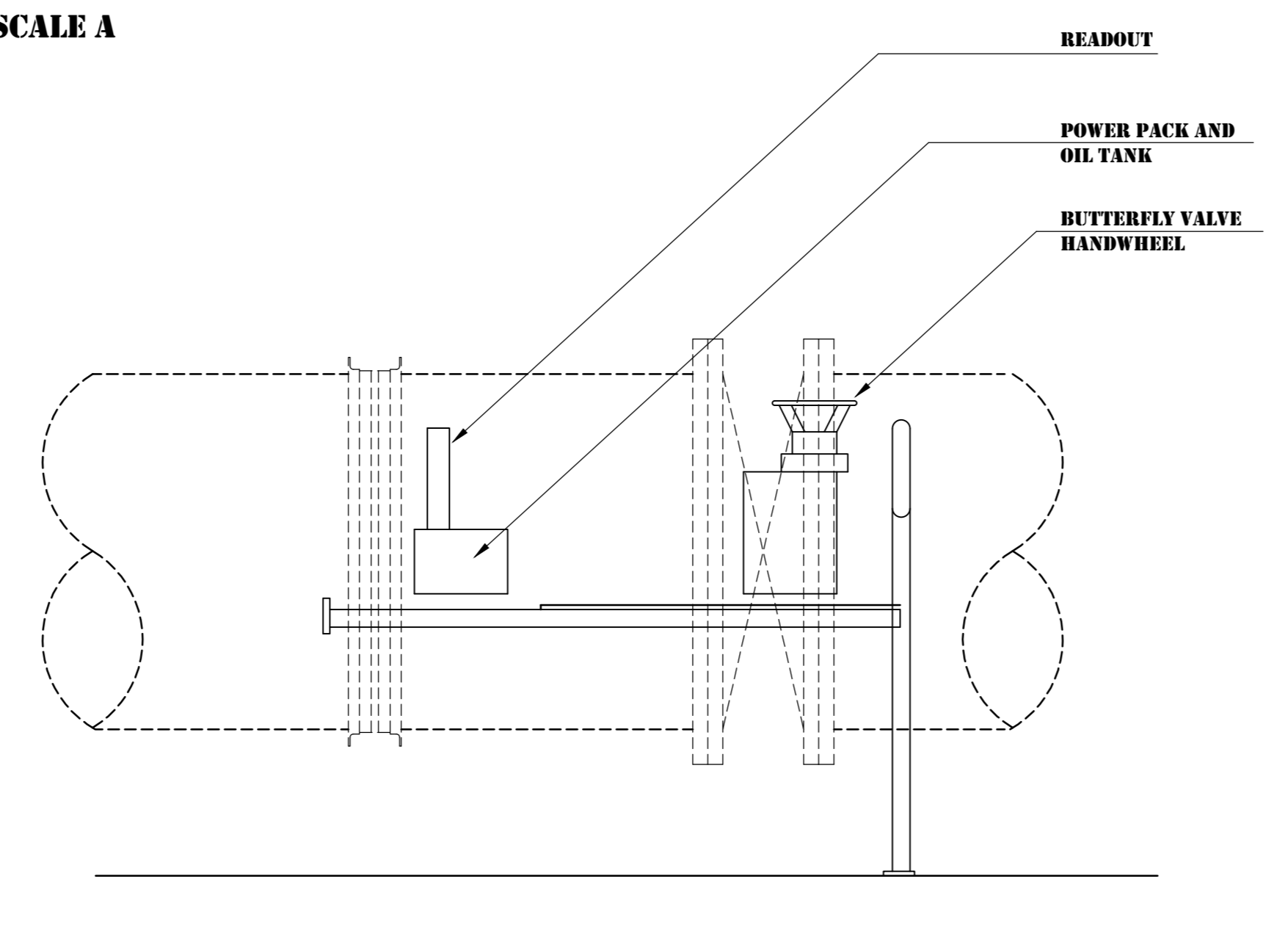
SECTIONAL ELEVATION B-B
(SEE NOTE 15)
SCALE A



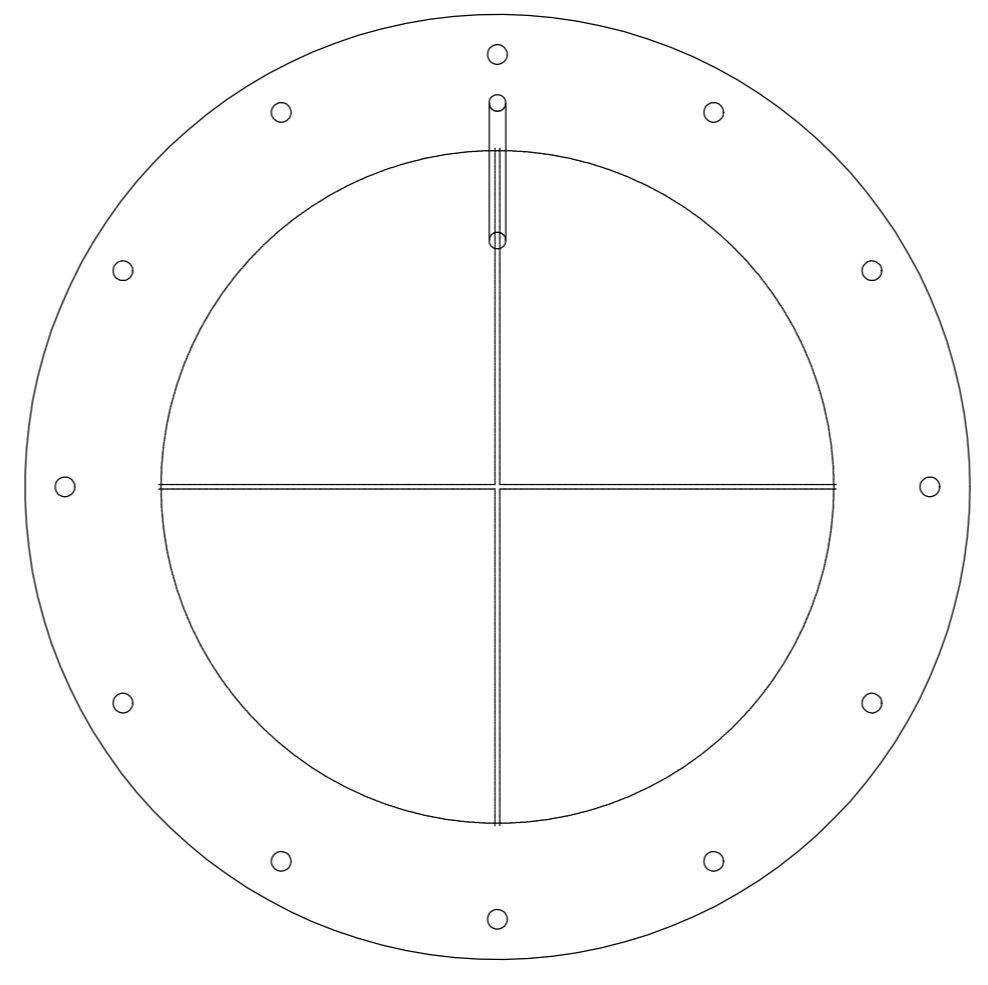
SECTIONAL ELEVATION A-A
(SEE NOTE 15)
SCALE A



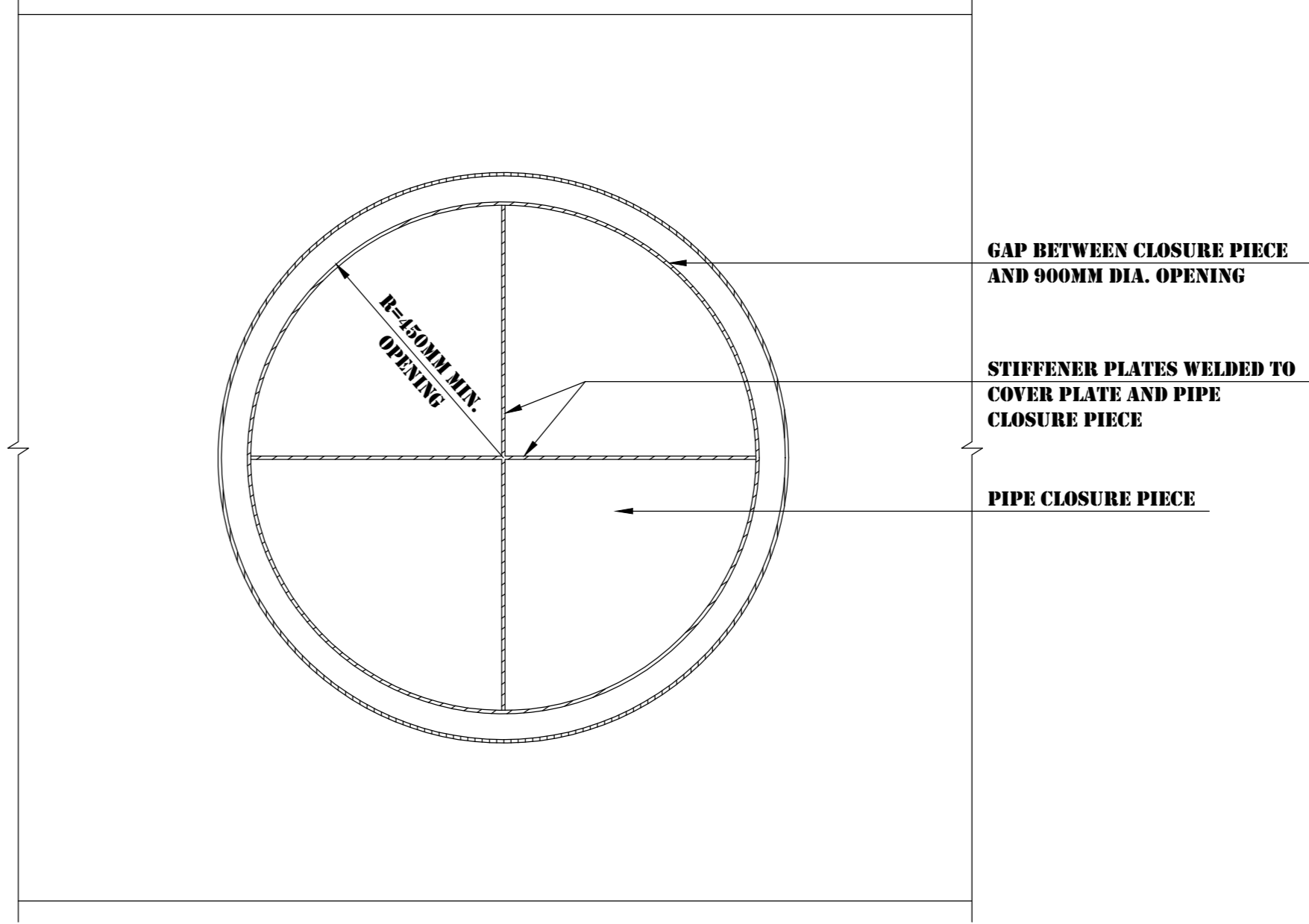
SECTION C-C
(SEE NOTE 15)
SCALE B



SECTION F-F
N.T.S.



SECTION E-E
(SEE NOTE 15)
SCALE B



SECTION D-D
(SEE NOTE 15)
SCALE B

PIPE AND VALVE SCHEDULE (SEE NOTE 15)			
ITEM NO.	DIA.	NO.	DESCRIPTION
1	900	2	SLEEVE VALVE WITH REMOVABLE 3CR12 HOOD
2	1600 - 900	2	REDUCER, 2500MM E/F
3	1600	2	2834MM (APPROX.) LONG PIPE FLANGED ONE END
4	1600	2	1600MM DIA. VIKING JOHNSON COUPLING
5	1600	2	1484MM (APPROX.) LONG PIPE FLANGED ONE END WITH 50MM DIA. OFFTAKE ENDING WITH 50MM DIA. GATE VALVE
6	1600	1	FLANGED BUTTERFLY VALVE, 450MM E/F, CLOCKWISE CLOSING, HANDWHEEL ON RIGHT OF FLOW DIRECTION
7	1600	1	FLANGED BUTTERFLY VALVE, 450MM E/F, CLOCKWISE CLOSING, HANDWHEEL ON LEFT OF FLOW DIRECTION
8	900	1	900MM DIA. ACCESS MANHOLE WITH COVER PLATE SECURED WITH STAINLESS STEEL BOLTS
9	1600	1	30° MEDIUM RADIUS BEND
10	1600	1	30° LATERAL
11	1600	1	8,883° (APPROX.) MEDIUM RADIUS BEND
12	1600		FILLER PIPES OF VARIOUS LENGTHS BETWEEN COMPONENTS ABOVE
13	100	2	BYPASS WITH 100MM DIA. GATE VALVE

NOTES:

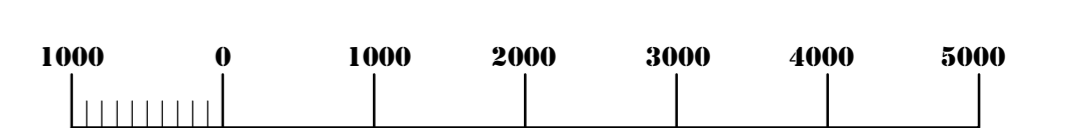
- ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.
- ALL LEVELS IN METRES ABOVE SEA LEVEL.
- SEE DRG. NO. 0777 FOR LAYOUT AND STEEL LINING DETAILS OF BYPASS ADIT.
- SEE DRG. NOS 0778, 0780 AND 0781 FOR LAYOUT AND CONCRETE DETAILS OF BYPASS OUTLET STRUCTURE.
- SEE DRG. NOS 1110 AND 1111 FOR REINFORCING DETAILS OF BYPASS OUTLET STRUCTURE.
- SEE DRG. NO. 1115 FOR DETAILS OF CAT LADDERS.
- ALL STEEL TO BE 3CR12 B2 STEEL UNLESS OTHERWISE SHOWN.
- VALVE INSTALLATIONS TO BE DELAYED AS LATE AS POSSIBLE BUT BEFORE COMMISSIONING OF THE TUNNEL.
- COATING OF STEEL OTHER THAN 3CR12 STEEL TO BE DONE IN ACCORDANCE WITH SECTION 18, VOLUME 2 OF THE SPECIFICATIONS.
- COATING OF 3CR12 STEEL TO BE DONE IN ACCORDANCE WITH THE DOCUMENT DESCRIBED IN NOTE 16.
- WELDING TO BE DONE IN ACCORDANCE WITH SECTION 18, VOLUME 2 OF THE SPECIFICATIONS. STAINLESS STEEL WELDING RODS TO BE USED IN CONJUNCTION WITH 3CR12 STEEL.
- 20MM THICK POLYSTYRENE GLUED IN PLACE TO FORM COMPRESSIBLE PACKING ALL AROUND THE PIPE BEFORE PLACING OF THE CONCRETE. SURFACE TO BE SEALED WITH A 20MM X 20MM APPROVED POLYURETHANE SEALANT.
- MINIMUM THICKNESS OF PIPEWORK NOT ENCASED IN CONCRETE TO BE 12MM.
- SLEEVE PIPE TO ACCOMMODATE HOSE LINE FOR SLEEVE VALVE HYDRAULIC DRIVE. LOCATION AND SIZE OF SLEEVE PIPE TO BE DETERMINED BY VALVE SUPPLIER. CONTROL BOX TO BE POSITIONED IN CHAMBER FOR BUTTERFLY VALVES.
- DETAILS SHOWN ON THIS DRAWING ARE SUBJECT TO FINAL DESIGN BY THE CONTRACTOR. THIS IS TO INCLUDE THE FOLLOWING:
A: PIPEWORK DIMENSIONS AND DISTANCE OF FLANGES TO CONCRETE FACES.
B: LIFTING HOOK DESIGN AND POSITION.
C: DIMENSIONS AND POSITION OF PLINTH AND HOLDING DOWN BOLT DETAILS.
- ALL WORK TO BE CARRIED OUT IN ACCORDANCE WITH THE FOLLOWING DOCUMENT AS ISSUED BY THE ENGINEER:
"SUPPLY, INSTALLATION AND COMMISSIONING OF VALVES, PIPES, SPECIALS, NEW ALTERING PUMPS AND ASSOCIATED EQUIPMENT".
- INSTALLATION OF VALVES AND PUMPS TO BE DELAYED AS LATE AS POSSIBLE UNTIL JUST BEFORE COMMISSIONING OF TUNNEL.
- REFER TO SDGM DWG. 8527 FOR DETAILS OF VALVE PIT OPERATING PLATFORM.

LEGEND:

- 12 PIPE SCHEDULE REFERENCE
- 1713,000 CONSTRUCTION LEVEL (IN SECTION)
- 1713,000 CONSTRUCTION LEVEL (IN PLAN)
- R = 450 CENTRE OF CURVATURE AND RADIUS

RELATED DRAWINGS

DRG. NO.	DESCRIPTION
0777	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - LONGITUDINAL SECTION - LINING AND GROUTING DETAILS
0778	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - OUTLET STRUCTURE - GENERAL ARRANGEMENT
0780	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - OUTLET STRUCTURE - CONCRETE DETAILS - SHEET 1 OF 2
0781	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - OUTLET STRUCTURE - CONCRETE DETAILS - SHEET 2 OF 2
1110	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - OUTLET STRUCTURE - REINFORCING DETAILS - SHEET 1 OF 2
1111	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - OUTLET STRUCTURE - REINFORCING DETAILS - SHEET 2 OF 2
1115	LITTLE CALEDON RIVER CROSSING - UNDERGROUND WORKS - TUNNEL BYPASS - OUTLET STRUCTURE - LADDERS AND CRAWL BEAM DETAILS



SCALE A



SCALE B

Z	RECORD DRAWING		
1.	PIPES, PIPE SCHEDULE AND NOTES AMENDED.		
6.	ISSUED FOR CONSTRUCTION	R.C.Y.	07/91
NO.	AMENDMENTS	CHKD.	DATE



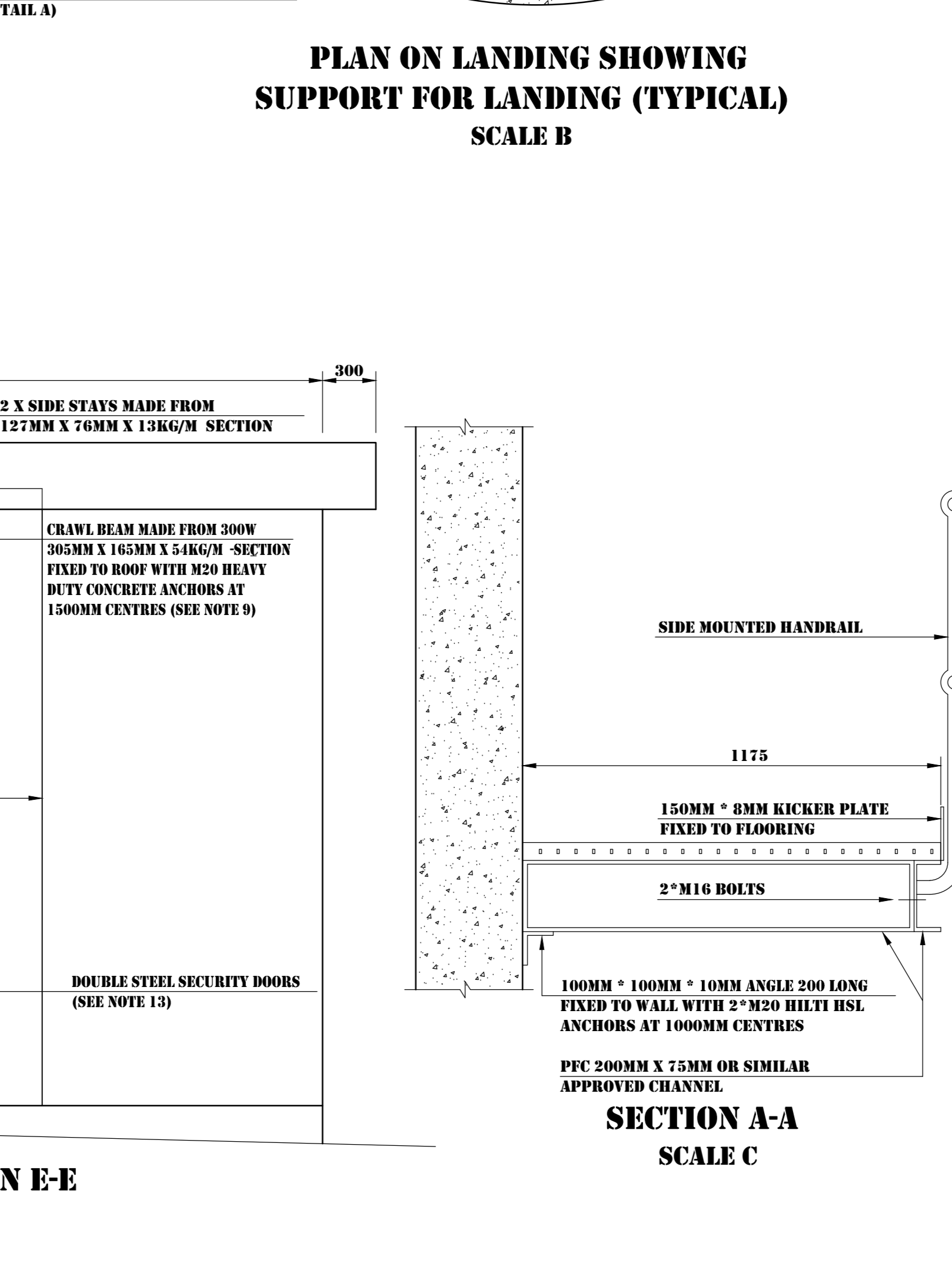
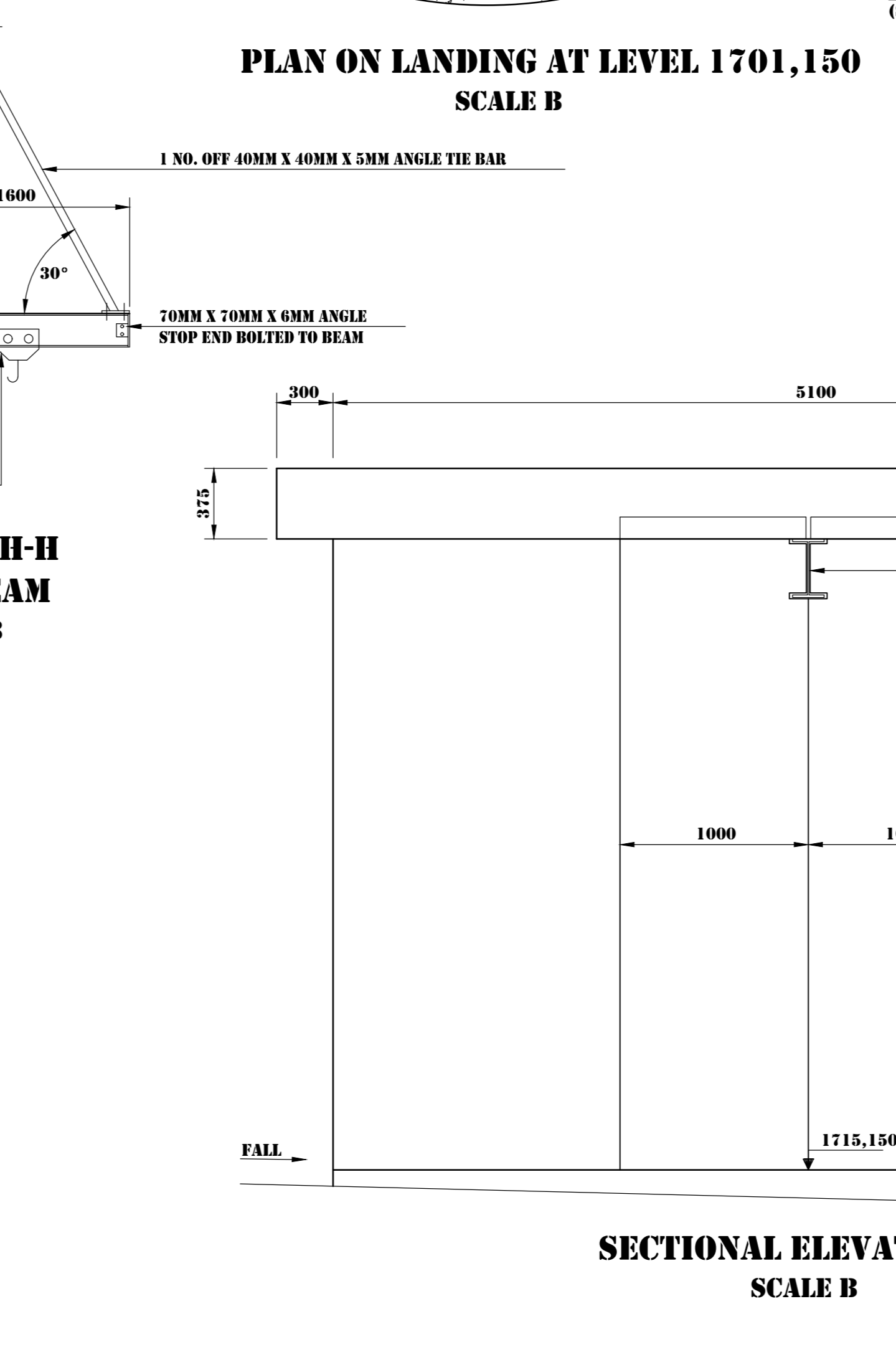
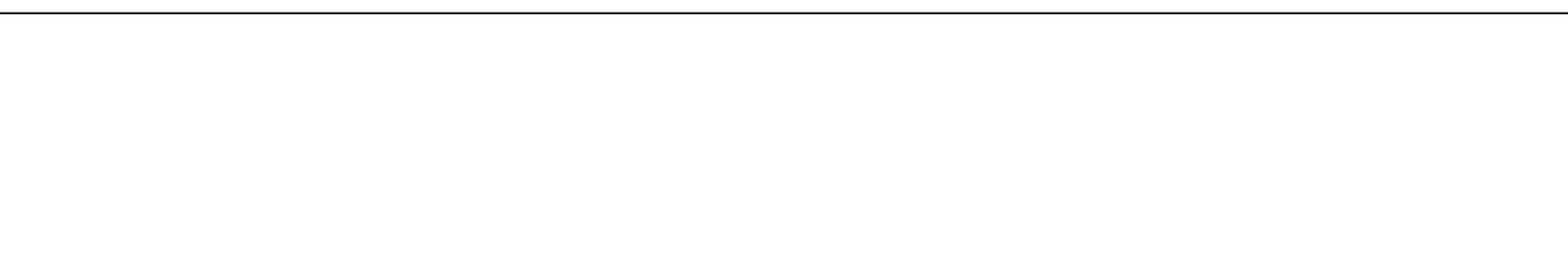
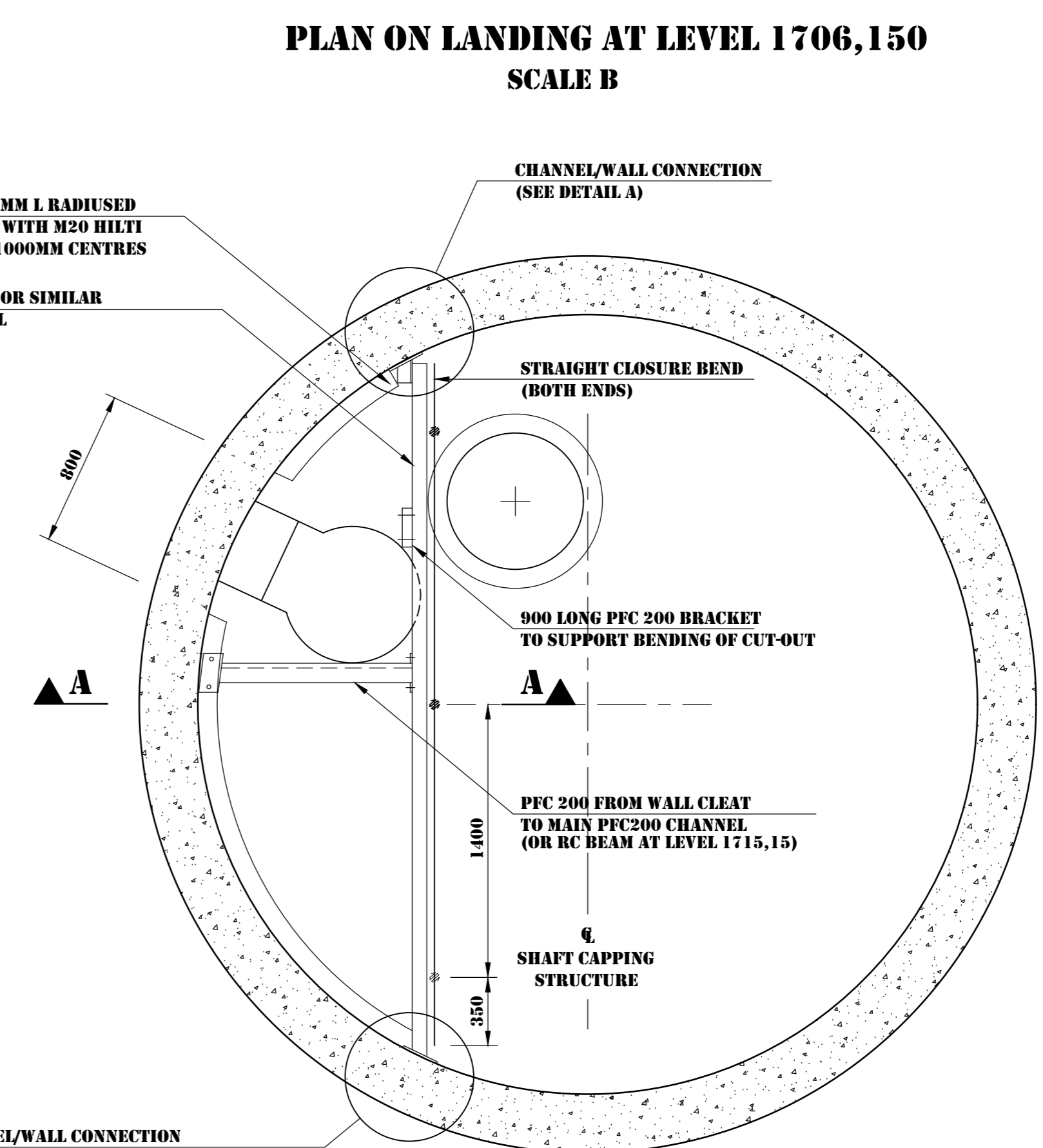
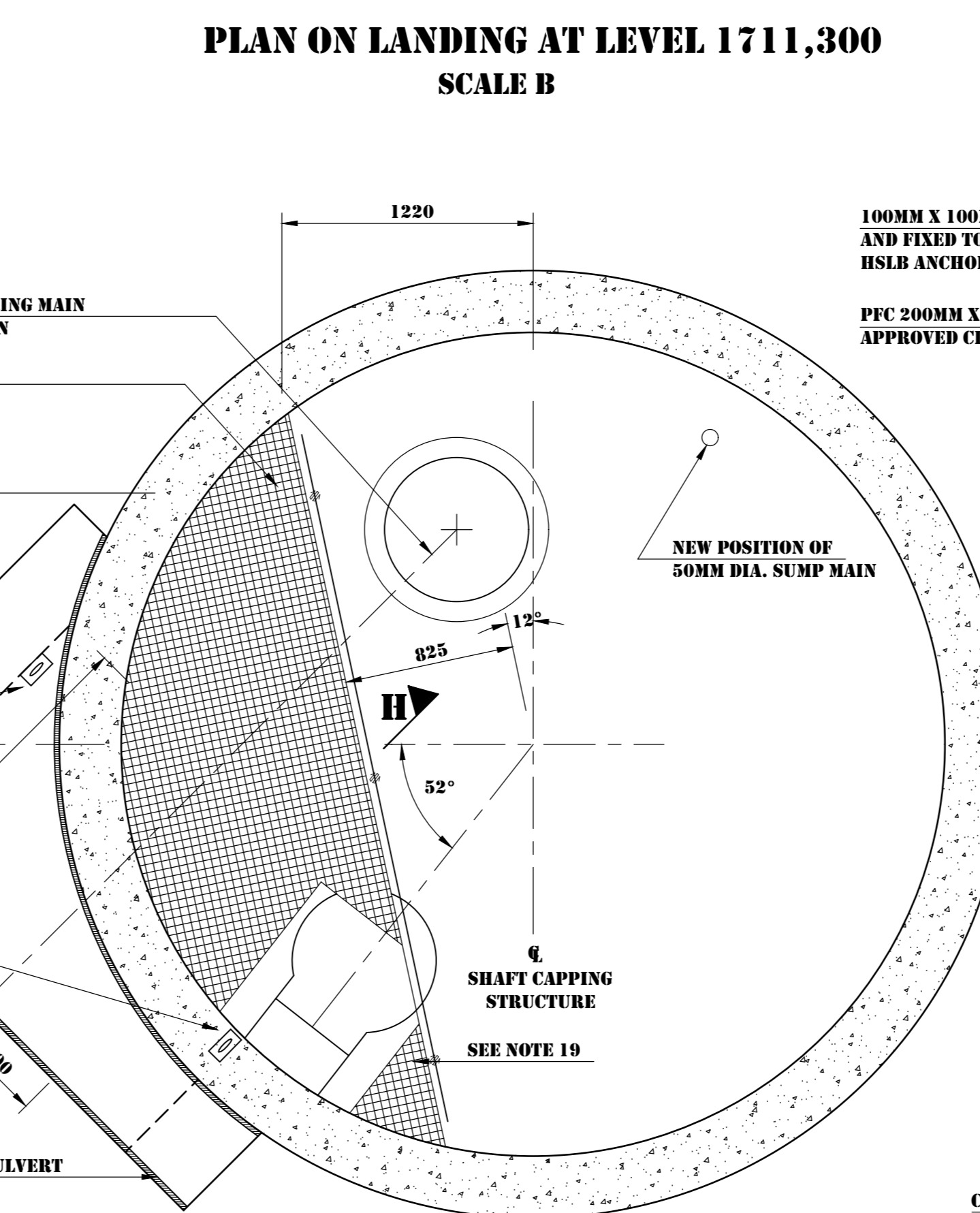
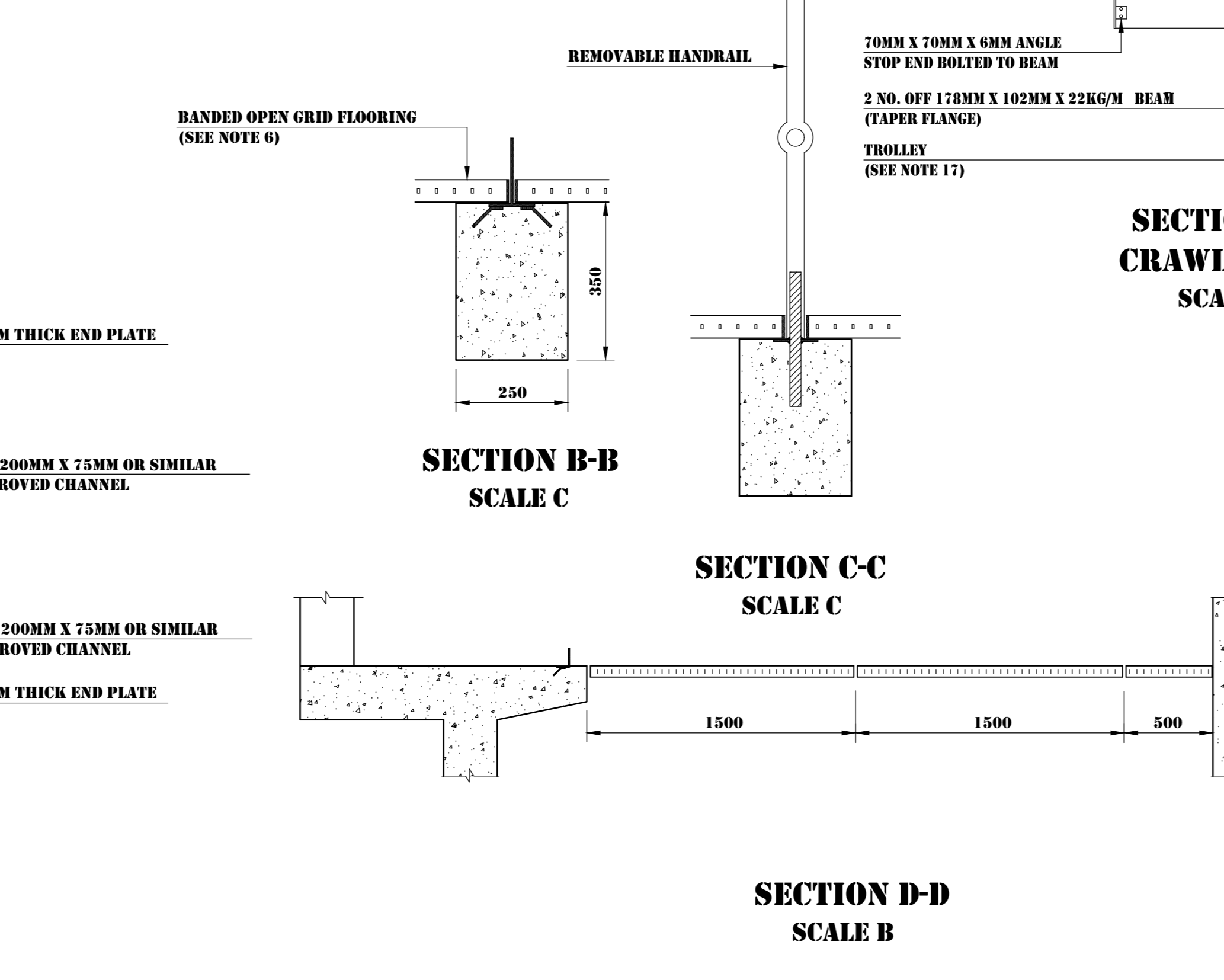
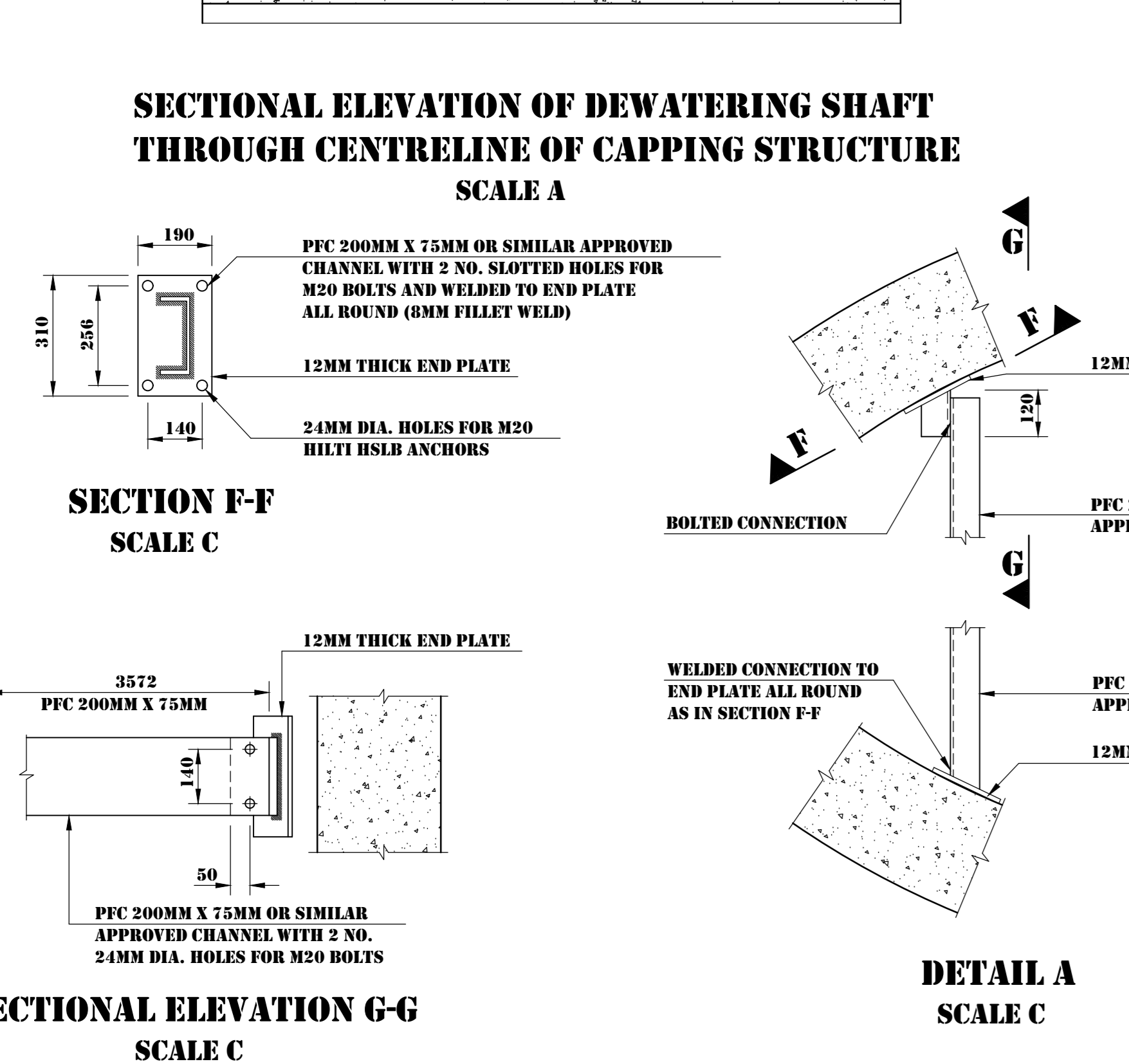
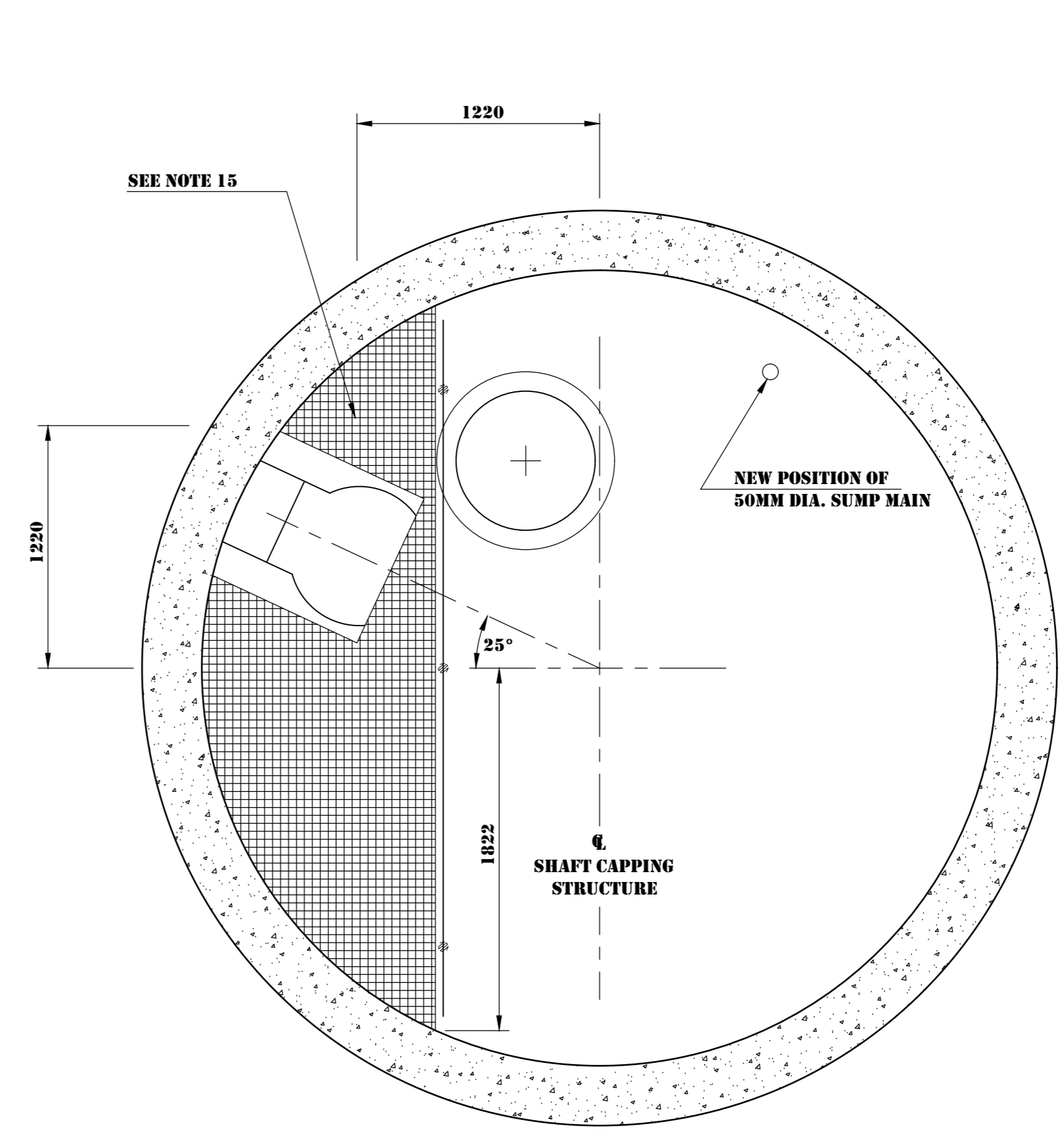
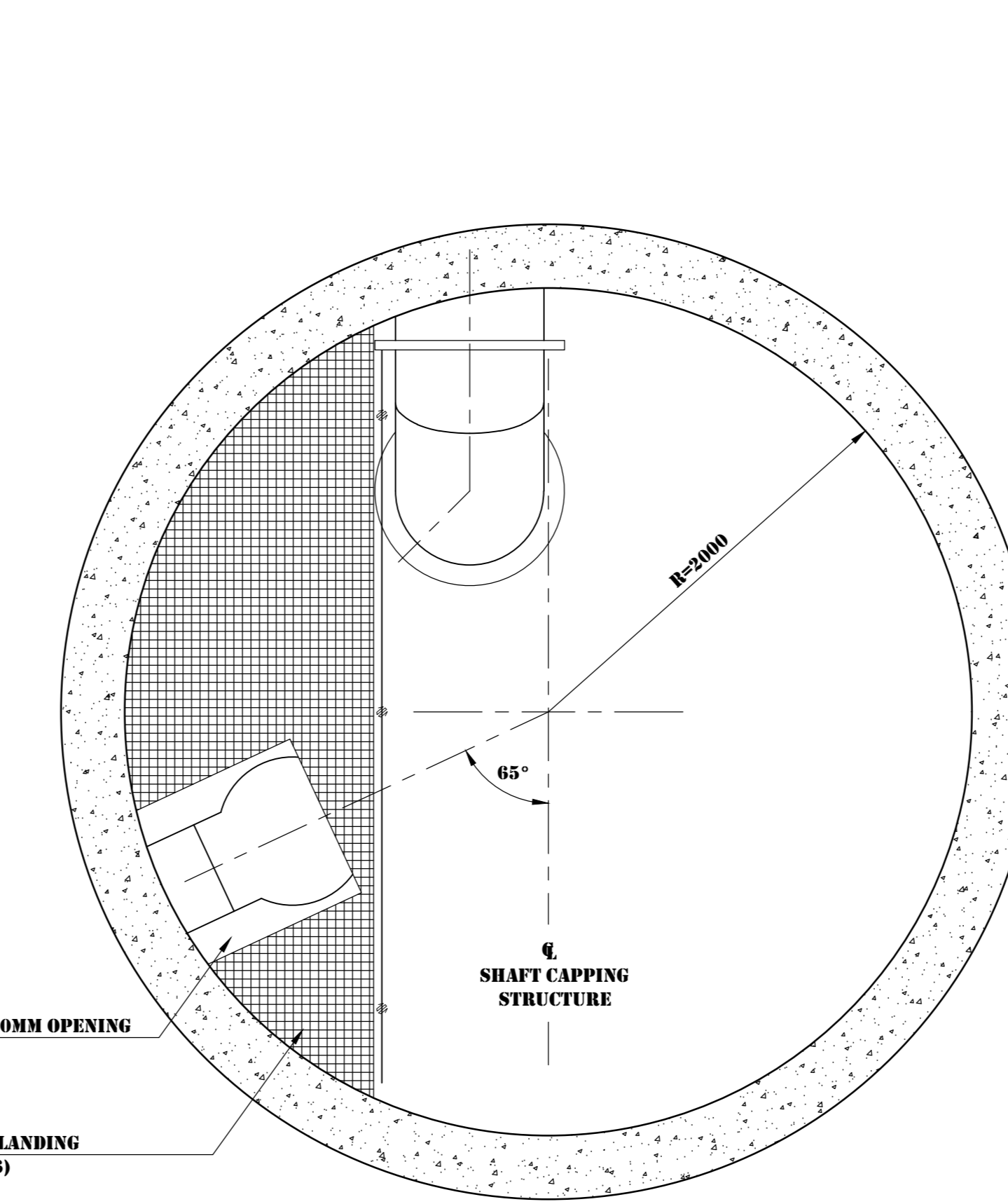
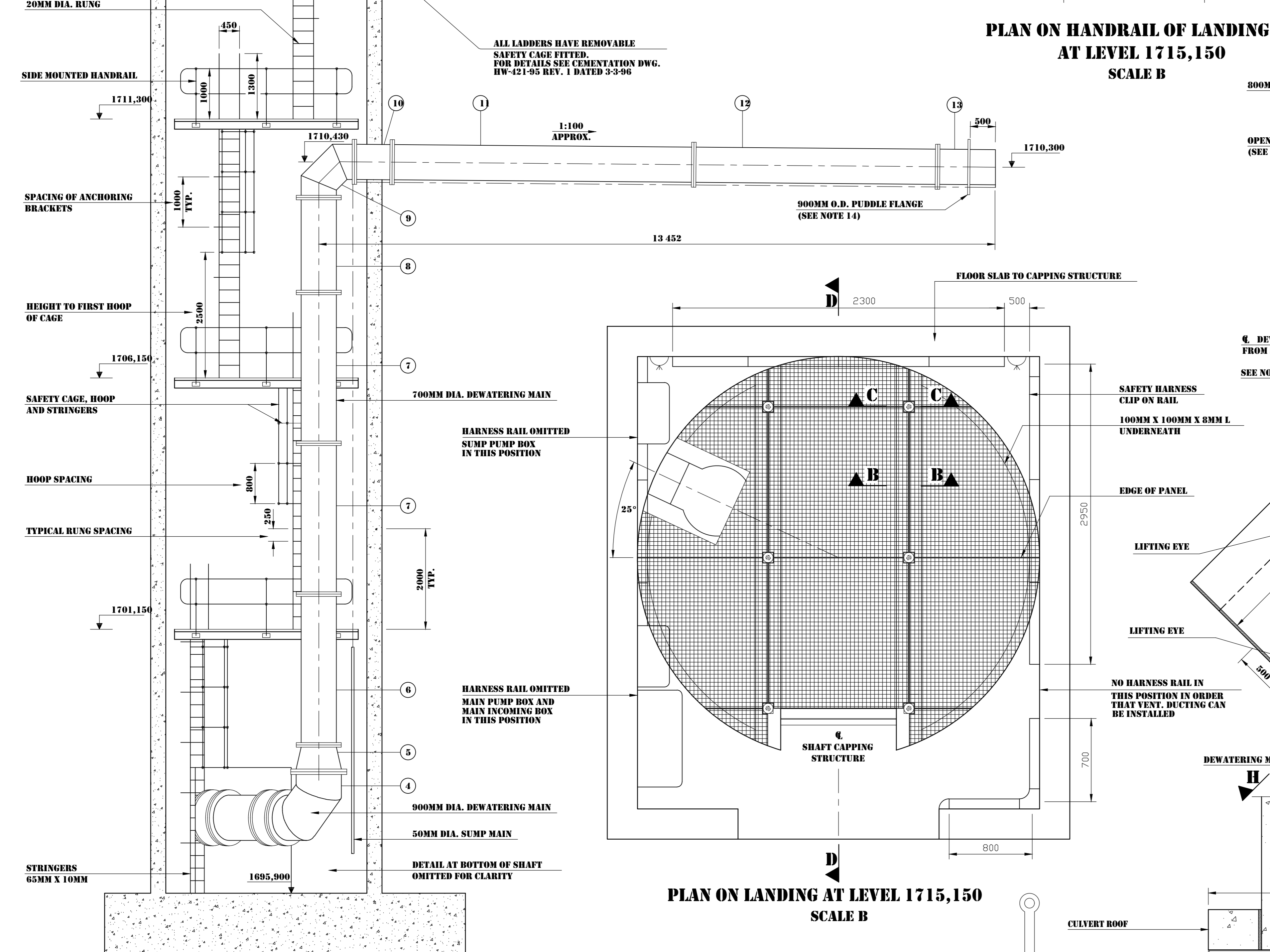
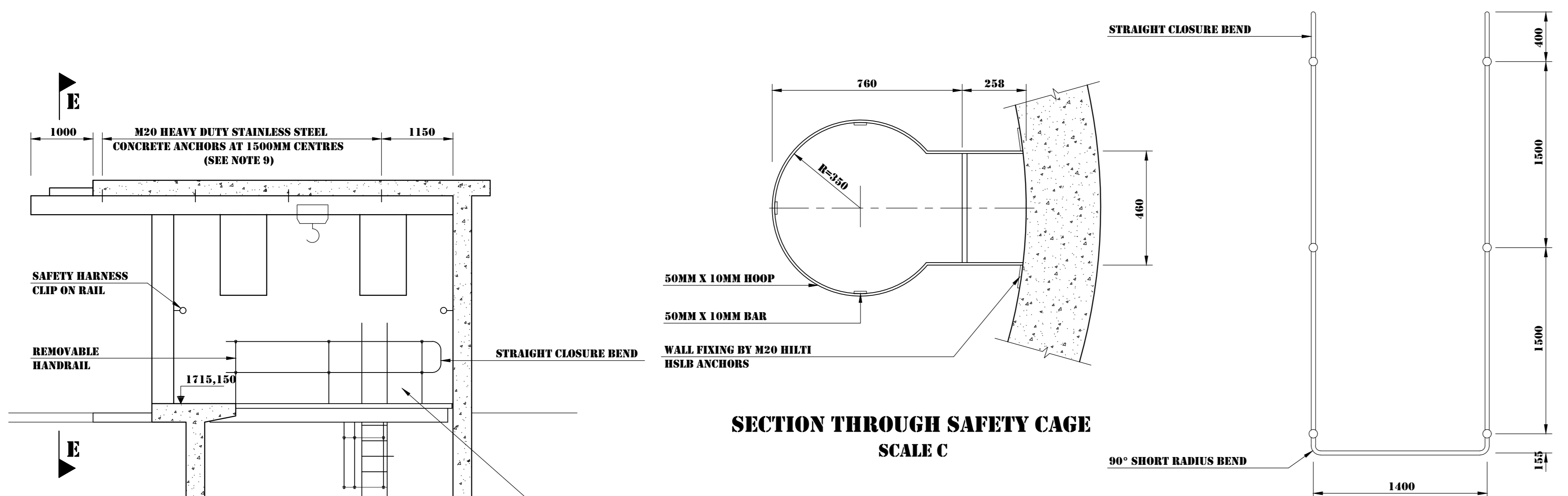
APPROVED: _____ DATE: _____

LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A
DELIVERY TUNNEL NORTH

CALEDON TUNNEL
LITTLE CALEDON RIVER CROSSING
UNDERGROUND WORKS
TUNNEL BYPASS
OUTLET STRUCTURE
PIPEWORK AND VALVES

HDTIC HIGHLANDS DELIVERY TUNNEL CONSULTANTS
SHARON SHAND INC. VAN MERILDE, KLEIN & EDWARDS
KEVIE STEYN INC. STEFFEN, ROBERTSON & KRISTEN

DATE:	DESIGNER:	DRAWN:	CHECKED:
FEB 1993			
CLIENT CONTRACT NO. TCTA - 20	HDTIC DRAWING NO. C38-1114	REV. NO. Z	

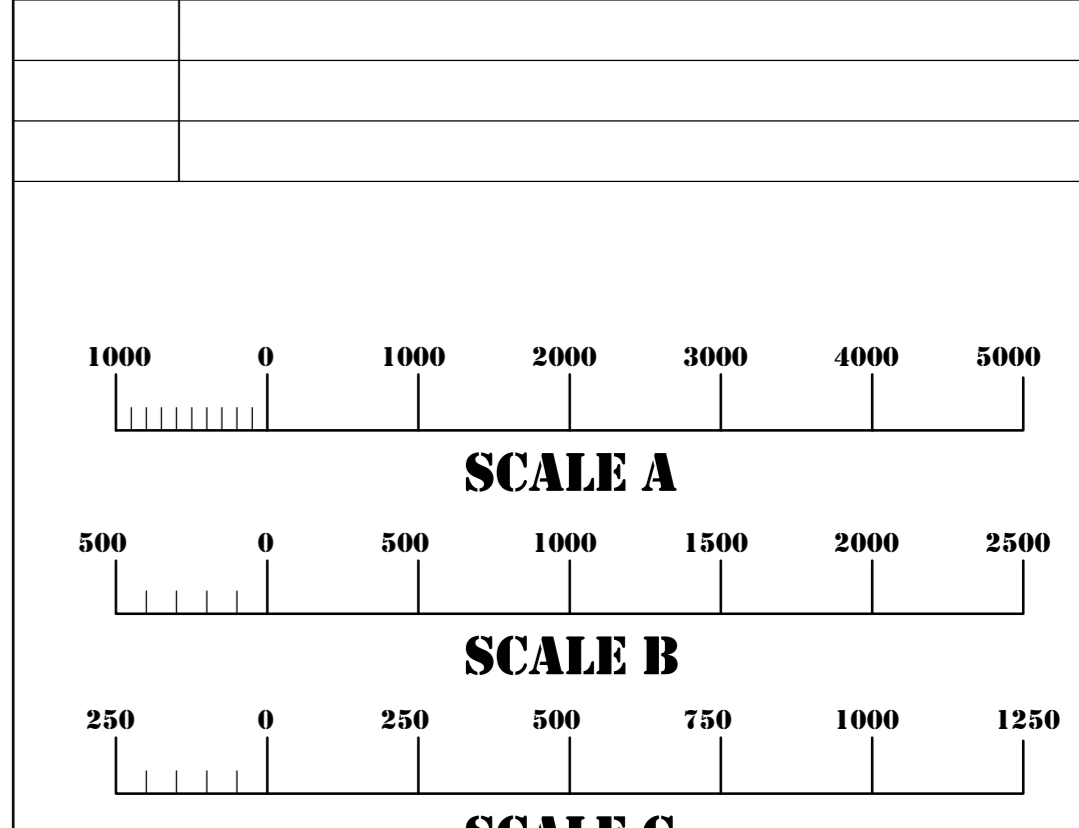


- NOTES:**
1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.
 2. ALL LEVELS IN METRES ABOVE SEA LEVEL, (O.A.S.L.)
 3. SEE DRG. NO. 1210 FOR CONCRETE DETAILS OF DEWATERING SHAFT.
 4. SEE DRG. NO. 1211 FOR CONCRETE DETAILS OF SHAFT CAPPING STRUCTURE.
 5. ALL OPEN GRID FLOORING, HANDRAILS, AND ASSOCIATED SUPPORT STEELWORK, CRAWL BEAMS, TIE BARS, FASTENERS AND CONCRETE ANCHOR BOLTS (UNLESS OTHERWISE SHOWN) TO BE HEAVY DUTY HOT DIP GALVANISED (MINIMUM THICKNESS 105 MICRONS) TO SABS 763.
 6. OPEN GRID LANDINGS TO BE BARRICADED TYPE BS40, OR SIMILAR APPROVED, WITH 50MM X 5MM BEARER BARS.
 7. SEE DRG. NO. 1218 FOR PIPE SCHEDULE.
 8. NOT USED.
 9. FINAL DESIGN BY THE CONTRACTOR OF CRAWL BEAM ARRANGEMENT TO ACCOMMODATE THE APPROVED HOISTING EQUIPMENT AND MAXIMUM LOADS. CRAWL BEAM TO BE MADE OF GRADE 300W STEEL.
 10. PIPEWORK AND ASSOCIATED METAL FITTINGS AND FASTENERS TO BE DUPLEX COATED IN ACCORDANCE WITH THE FOLLOWING DOCUMENT AS ISSUED BY THE ENGINEER: "SUPPLY, INSTALLATION AND COMMISSIONING OF VALVES, PIPES, SPECIALS, DEWATERING PUMPS AND ASSOCIATED EQUIPMENT".
 11. NOT USED.
 12. NOT USED.
 13. SEE DRG. NO. 1252 FOR DETAILS OF DOUBLE STEEL SECURITY DOOR.
 14. SEE DRG. NO. 1212 FOR OUTLET STRUCTURE DETAILS.
 15. 50MM DIA. SUMP MAIN MAY MOVE TO POSITION SHOWN. FINAL POSITION TO BE DETERMINED BY PIPEWORK AND VALVE SUBCONTRACTOR.
 16. SEE DRG. NO. 1218 FOR RIGGING NOTES APPLICABLE TO CRAWL BEAMS IN CULVERT.
 17. 3 TON CAPACITY TROLLEY TO BE SUPPLIED FOR THE MAIN CRAWL BEAM. CRAWL BEAM SIZE TO BE CONFIRMED BY THE PIPE AND VALVE INSTALLATION CONTRACTOR.
 18. DESIGN OF CRAWL BEAMS IN CULVERT TO BE CONFIRMED BY PIPE AND VALVE INSTALLATION CONTRACTOR.
 19. BOTTOM LANDING TO BE PROTECTED WITH WOODEN PLANKING FROM DAM AGES CAUSED BY CAPPING STRUCTURE CRAWL BEAM CABLE DURING INSTALLATION.
 20. THERE ARE NO FURTHER FABRICATION DRAWINGS.

- DESIGN CRITERIA:**
1. MINIMUM WORKING LOADING ON LANDINGS IS 5 KN/M² OR 2 KN WHICH EVER PRODUCES THE GREATER MEMBER SIZE.
 2. MEMBER SIZES GIVEN ARE THE MINIMUM SIZES REQUIRED.
- LEGEND:**
- 12 PIPE SCHEDULE REFERENCE (SEE NOTE 7)
 - 1715,000 CONSTRUCTION LEVEL (IN SECTION)
 - R=2000 RADIUS OF CURVATURE

RELATED DRAWINGS

DRG. NO.	DESCRIPTION
1210	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - DEWATERING WORKS - DEWATERING SHAFT - CONCRETE DETAILS
1211	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - DEWATERING WORKS - CAPPING STRUCTURE - CONCRETE DETAILS
1212	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - DEWATERING WORKS - OUTLET STRUCTURE - CONCRETE DETAILS
1218	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - DEWATERING WORKS - PIPEWORK AND VALVES
1252	ASH/CALEDON TUNNEL - STEELWORK - DOUBLE STEEL SECURITY DOOR - STEELWORK DETAILS



NO.	REVISIONS	AMENDMENTS	CHKD.	DATE
2.	RECORDED DRAWING			
3.	CULVERT CRAWL BEAM DETAILS ADDED, NOTES REVISED			
2.	CORROSION PROTECTION NOTES AND CRAWL BEAM DETAILS REVISED	NRE		10/09/03
1.	PIPE NUMBERING REVISED, TITLE, NOTES AND RELATED DRAWINGS AMENDED, 50MM DIA. SUMP MAIN MOVED, ELECTRICAL DETAILS REMOVED	NRE		10/09/03
0.	ISSUED FOR CONSTRUCTION	BCY		07/01

TCTA TRANS-CALEDON TUNNEL AUTHORITY

APPROVED: *F. Ullrich* DATE: 17-1-92

LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A

DELIVERY TUNNEL NORTH

ASH TUNNEL

LITTLE CALEDON RIVER CROSSING

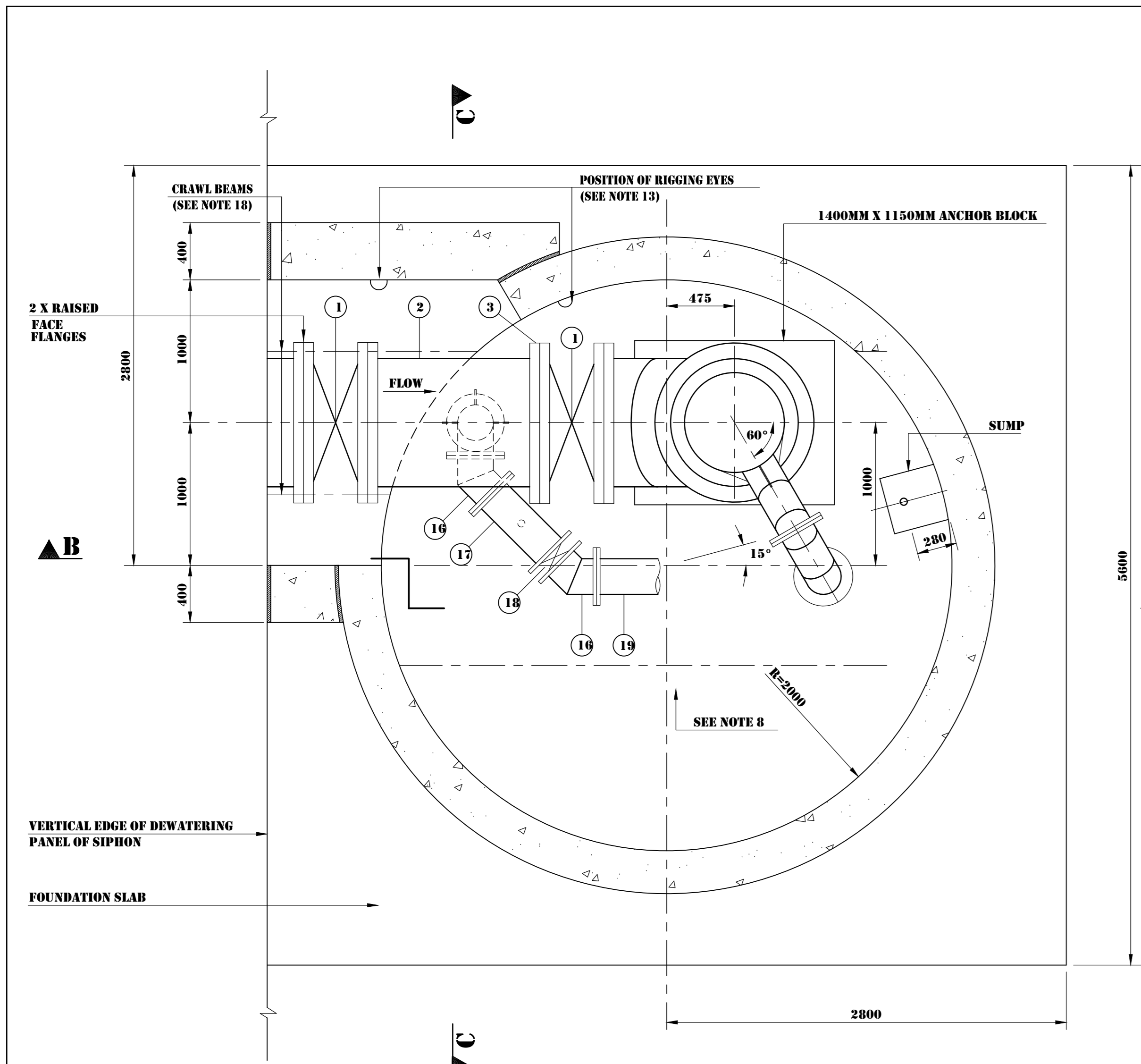
SURFACE WORKS

DEWATERING WORKS

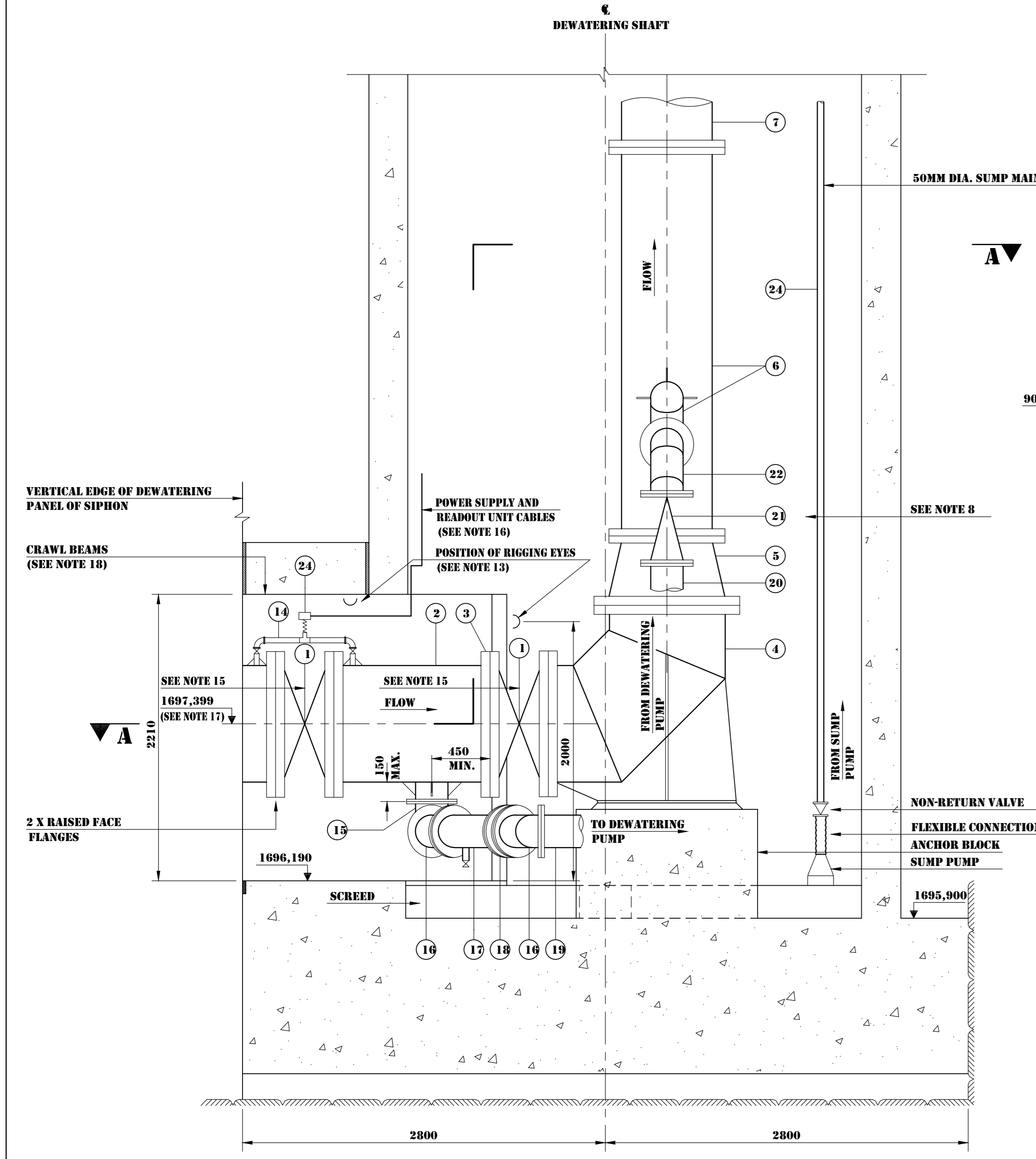
STEELWORK DETAILS

HDTC HIGHLANDS DELIVERY TUNNEL CONSULTANTS
 SHARON SHAND INC. VAN STERRE, KELLY & EDWARDS
 KEVIE STEVENS INC. STEFFEN, ROBERTSON & KRISTEN

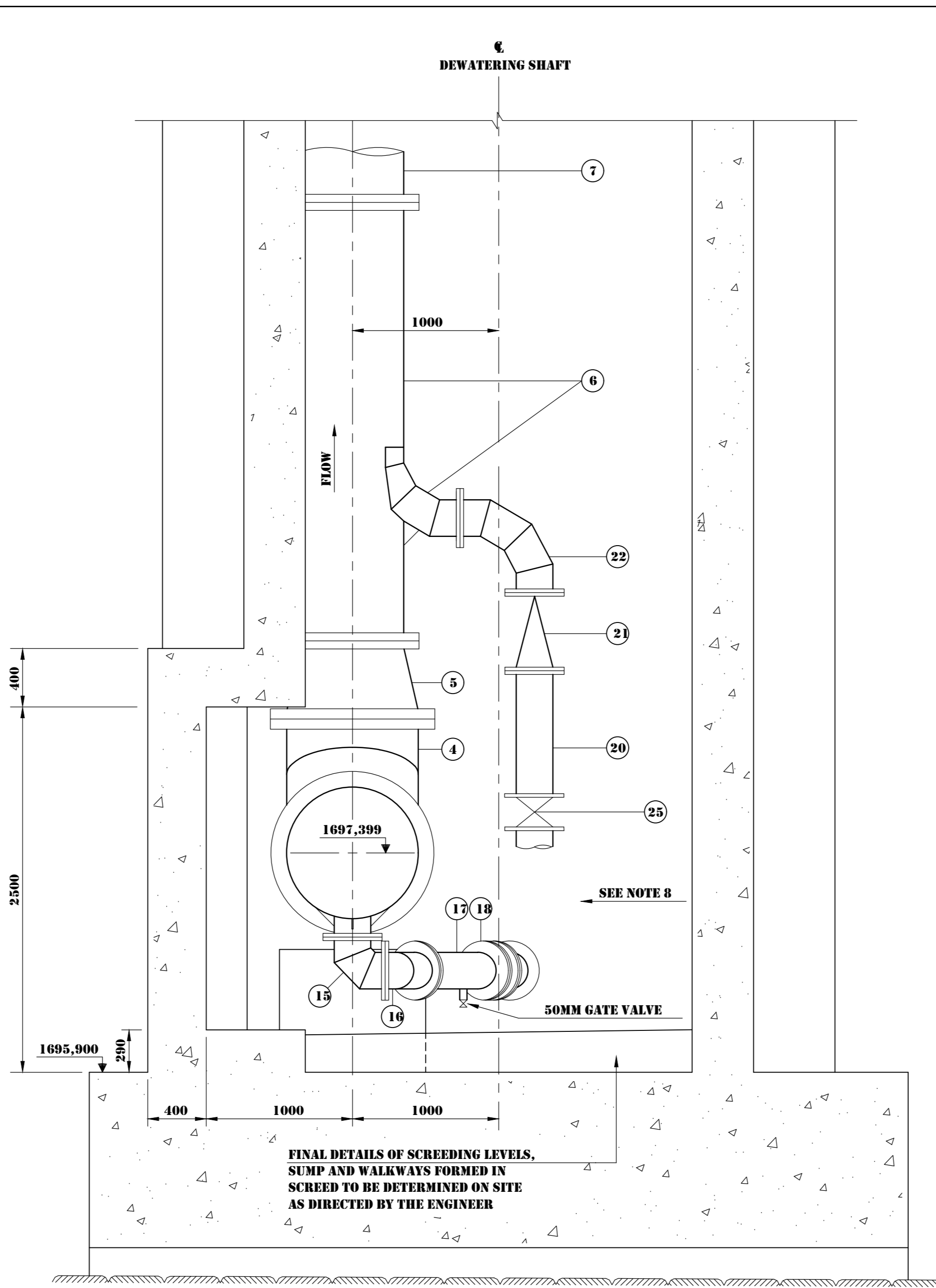
DATE: JAN 1992
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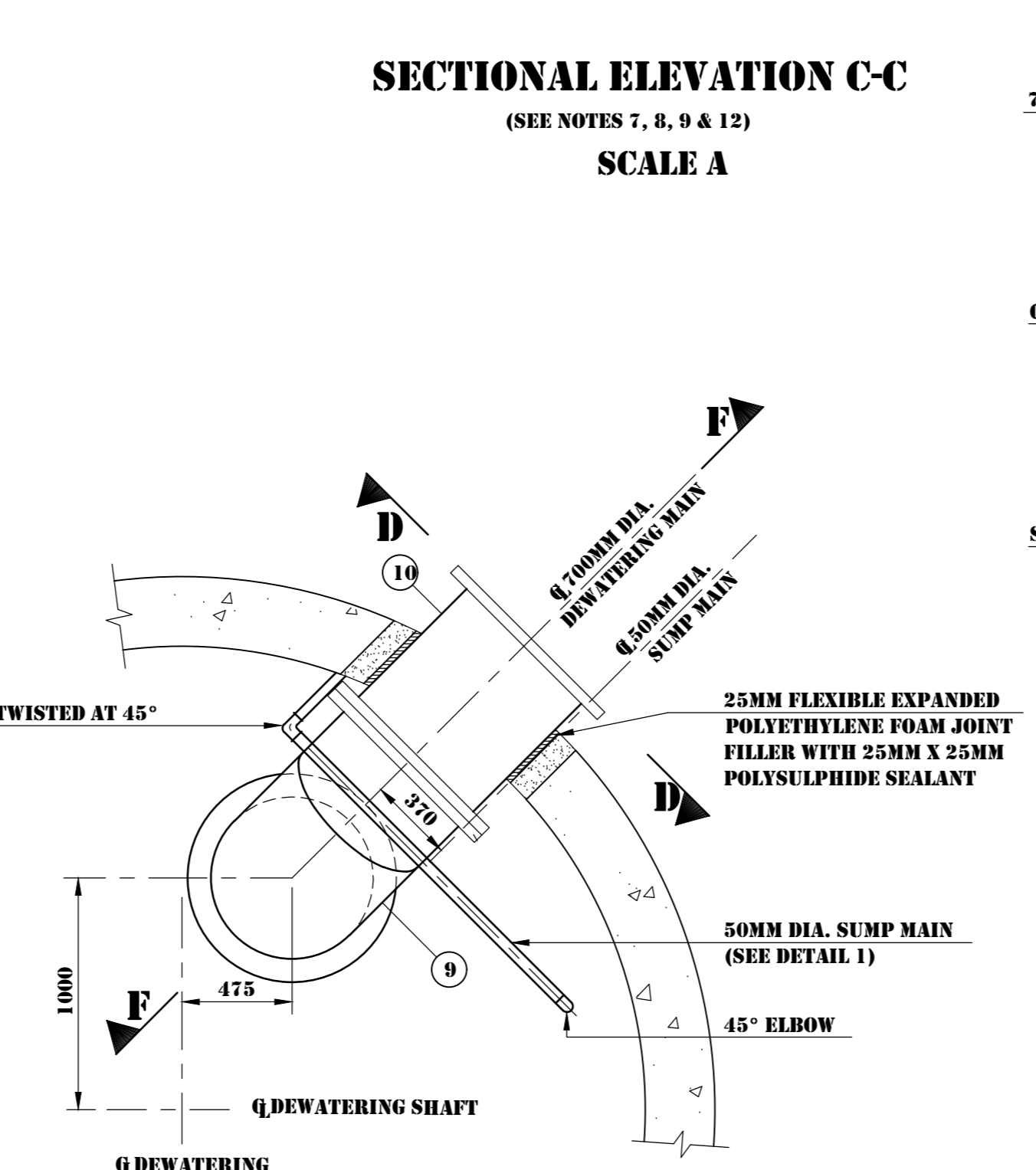
SECTIONAL PLAN A-A
(SEE NOTES 7, 8, 9 & 12)
SCALE A



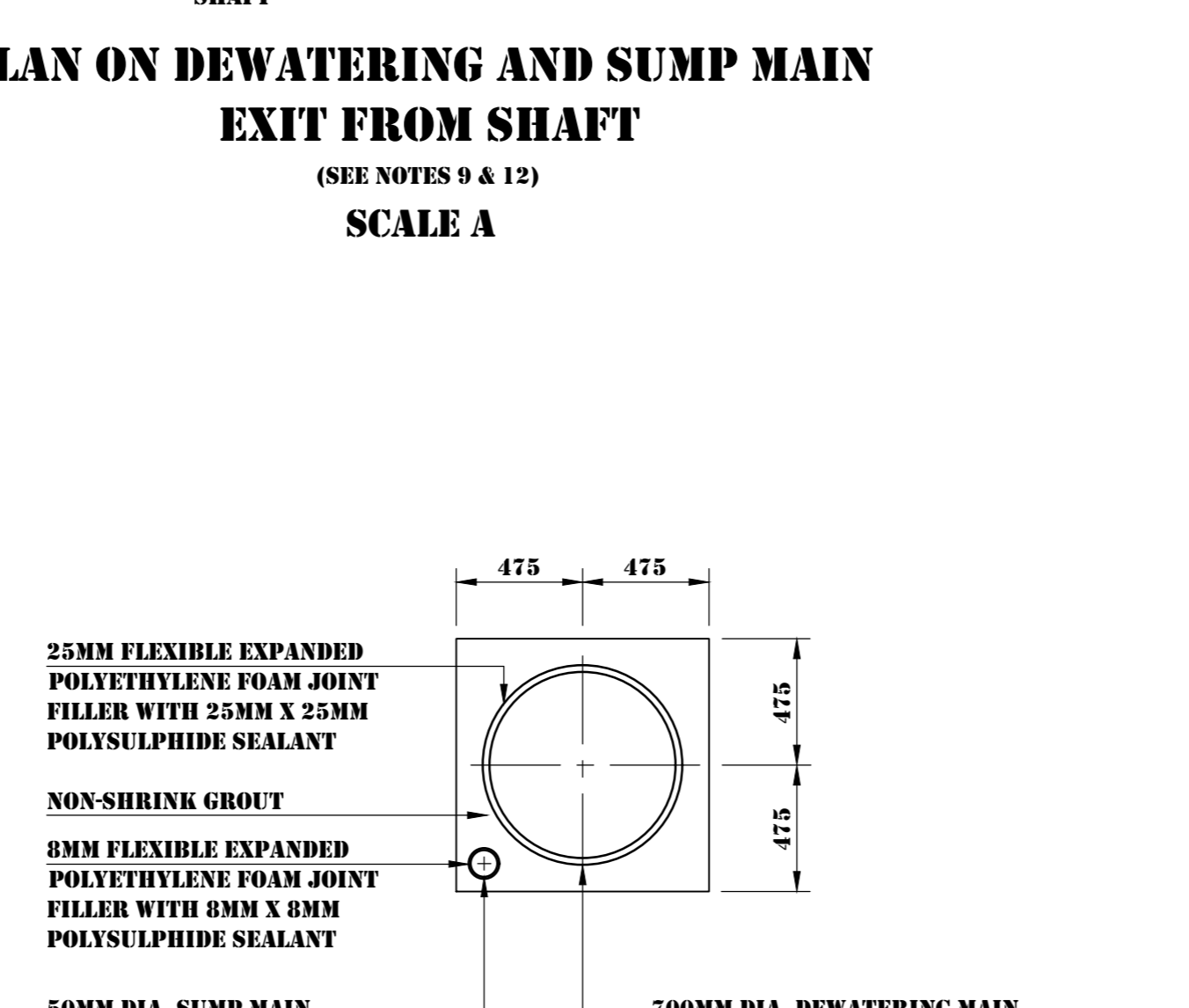
SECTIONAL ELEVATION B-B
(SEE NOTES 7, 8, 9 & 12)
SCALE A



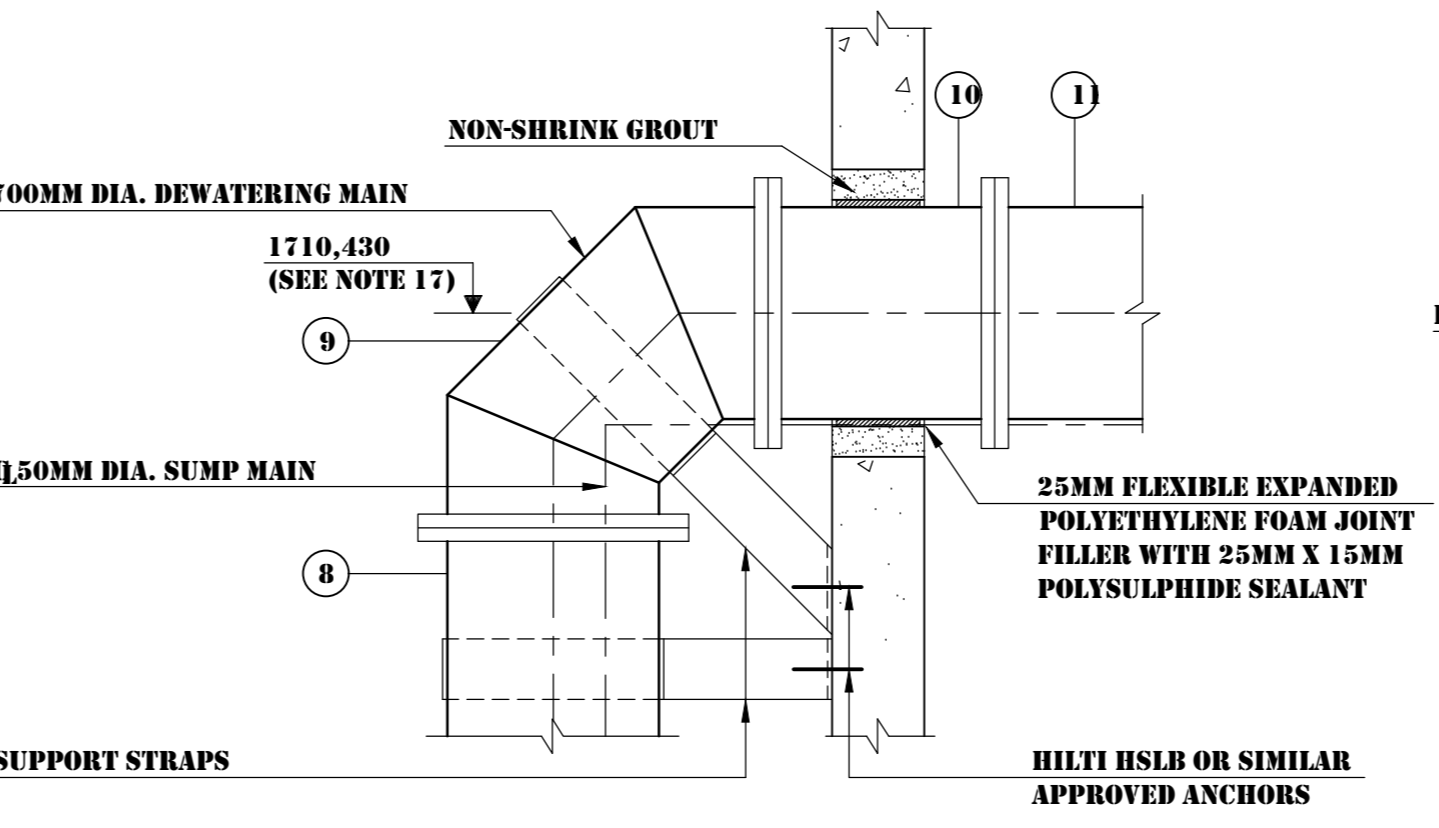
SECTIONAL ELEVATION C-C
(SEE NOTES 7, 8, 9 & 12)
SCALE A



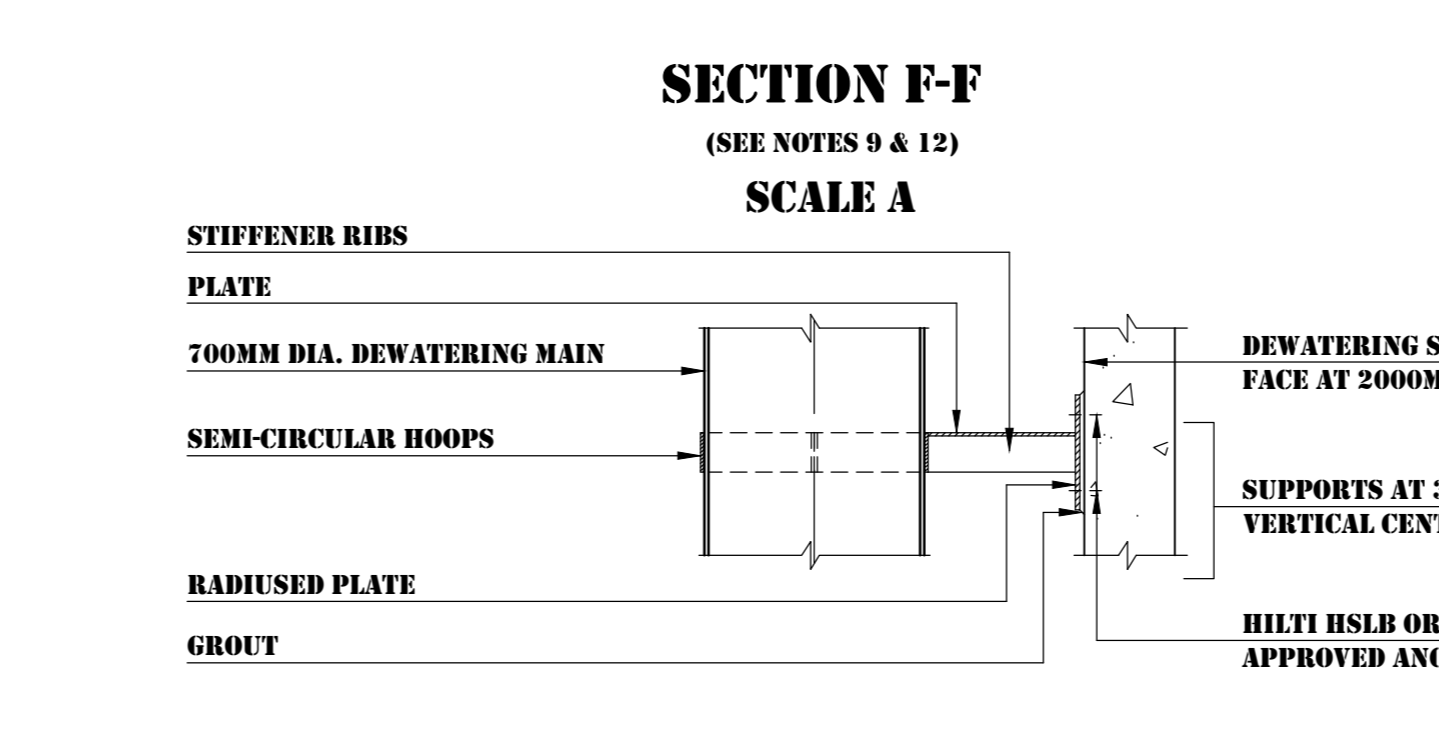
PLAN ON DEWATERING AND SUMP MAIN EXIT FROM SHAFT
(SEE NOTES 9 & 12)
SCALE A



SECTION D-D
SCALE A

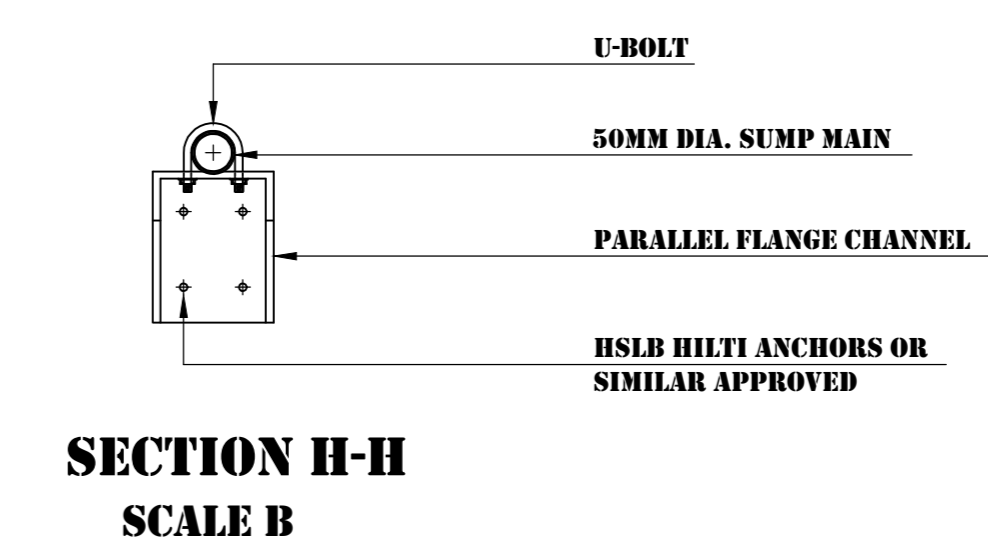


SECTION F-F
(SEE NOTES 9 & 12)
SCALE A

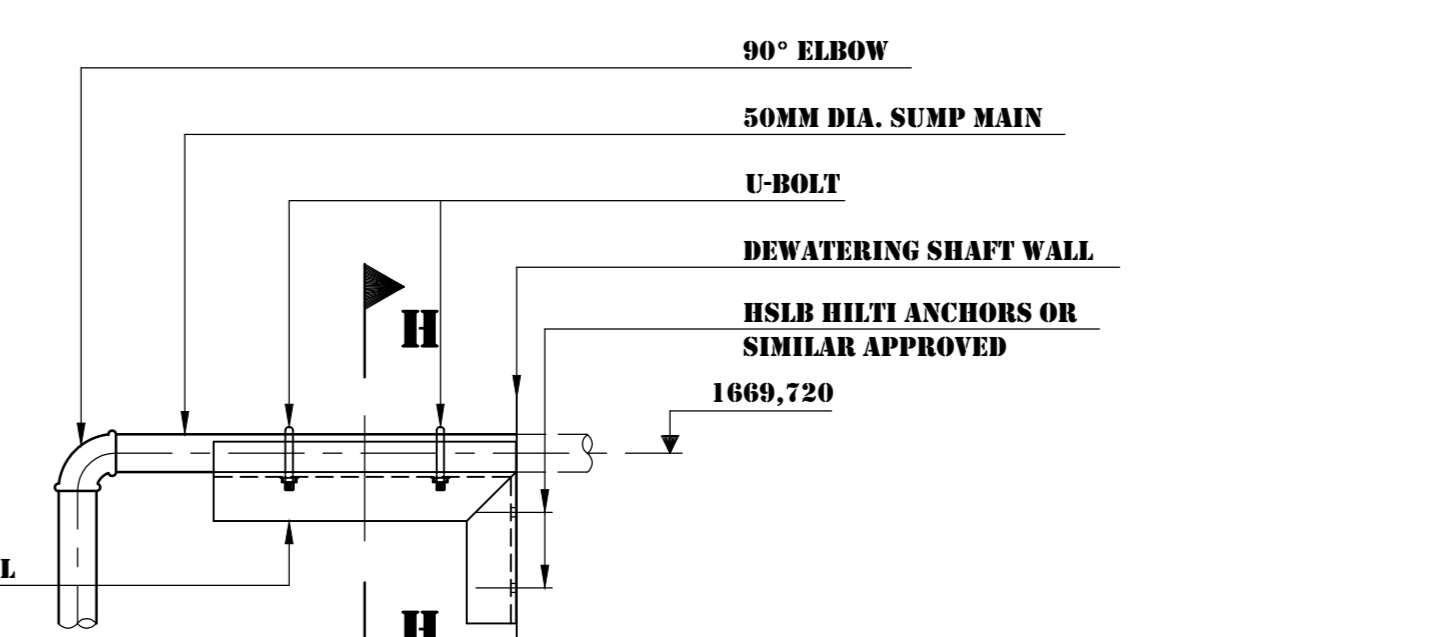


PLAN ON DEWATERING MAIN SUPPORT
(SEE NOTES 9 & 12)
SCALE A

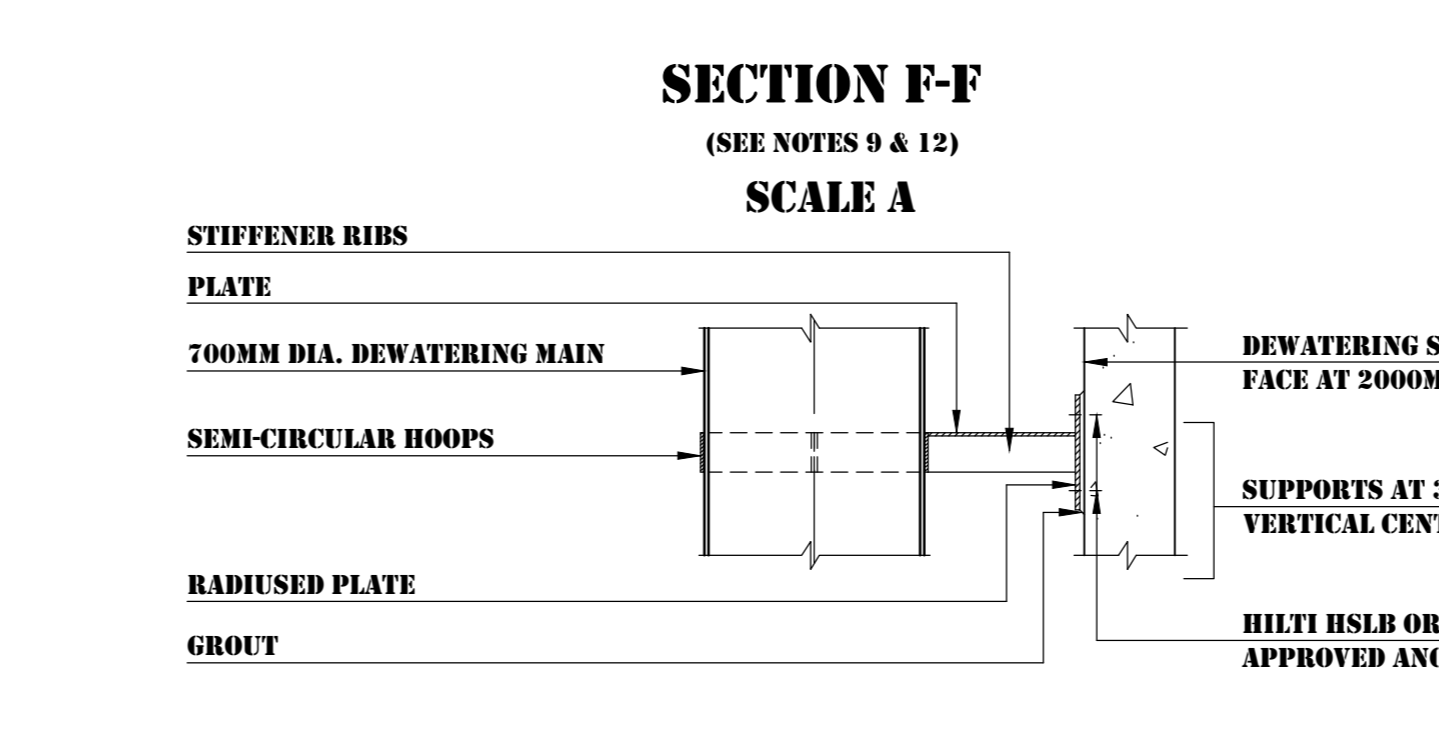
PIPE AND VALVE SCHEDULE			
PIPE LENGTHS GIVEN HAVE NOT MADE ALLOWANCE FOR GASKETS (SEE NOTES 7, 8 & 17)			
ITEM NO.	DIA.	NO.	DESCRIPTION
1	900	2	900MM DIA. FLANGED BUTTERFLY VALVE, 450MM F/F, CLOCKWISE CLOSING, HANDWHEEL ON RIGHT OF FLOW DIRECTION, ONE FLANGE AS INDICATED
2	900 AND 250	1	FLANGED OFFTAKE
3	900	2	VIKING JOHNSON FLANGE ADAPTOR
4	900	1	DECKFOOT 90° ELBOW, 915MM C/F
5	900-700	1	REDUCER, 535MM F/F
6	700 AND 250	1	700MM DIA. FLANGED PIPE, 3000MM F/F WITH 250MM DIA. FLANGED SWEEP THE MEDIUM RADIUS OFFTAKE
7	700	2	FLANGED PIPE, 3000MM F/F (SEE NOTE 5)
8	700	1	FLANGED PIPE, 1671MM F/F (SEE NOTES 5 & 17)
9	700	1	90° ELBOW, 1100MM C/F (SEE NOTE 5)
10	700	1	FLANGED PIPE, 1500MM F/F (SEE NOTE 5)
11	700	1	FLANGED PIPE, 6000MM F/F (SEE NOTE 5)
12	700	1	FLANGED PIPE, 450 F/F (SEE NOTE 5)
13	700	1	11500MM LONG PIPE, FLANGED ONE END WITH 900MM OUTSIDE DIA. PUDDLE FLANGE 5000MM FROM OTHER END (SEE NOTE 5)
14	50	1	BYPASS WITH 2 NO. ELBOWS AND 2 NO. 50MM DIA. GATE VALVES WITH 50MM DIA. TEE PICE
15	250	1	90° ELBOW, 200MM C/F
16	250	2	45° ELBOW, 100 C/F
17	250	1	250MM DIA. FLANGED PIPE WITH 50MM DIA. OFFTAKE ENDING WITH 50MM DIA. GATE VALVE
18	250	1	250MM DIA. FLANGED BUTTERFLY VALVE, 80MM F/F, CLOCKWISE CLOSING, HANDWHEEL ON RIGHT OF FLOW DIRECTION
19	250	1	FLANGED PIPE
20	250	1	FLANGED PIPE
21	250	1	250MM DIA. "0884" TYPE SWING CHECK VALVE, 635MM F/F
22	250	1	60° MEDIUM RADIUS BEND, 3100MM C/F
23	50	-	50MM DIA. SCH 40S MAIN WITH 45° AND 90° LONG RADIUS ELBOWS AS REQUIRED
24	-	1	VEICAM 20 (CR22UC32) PRESSURE TRANSMITTER (SUITABLY WATERPROOFED) WITH 1/2 INCH PIG TAIL GAUGE CONNECTION AND SUITABLE REDUCER INTO TEE PICE IN ITEM 14
25	250	1	FLANGED GATE VALVE



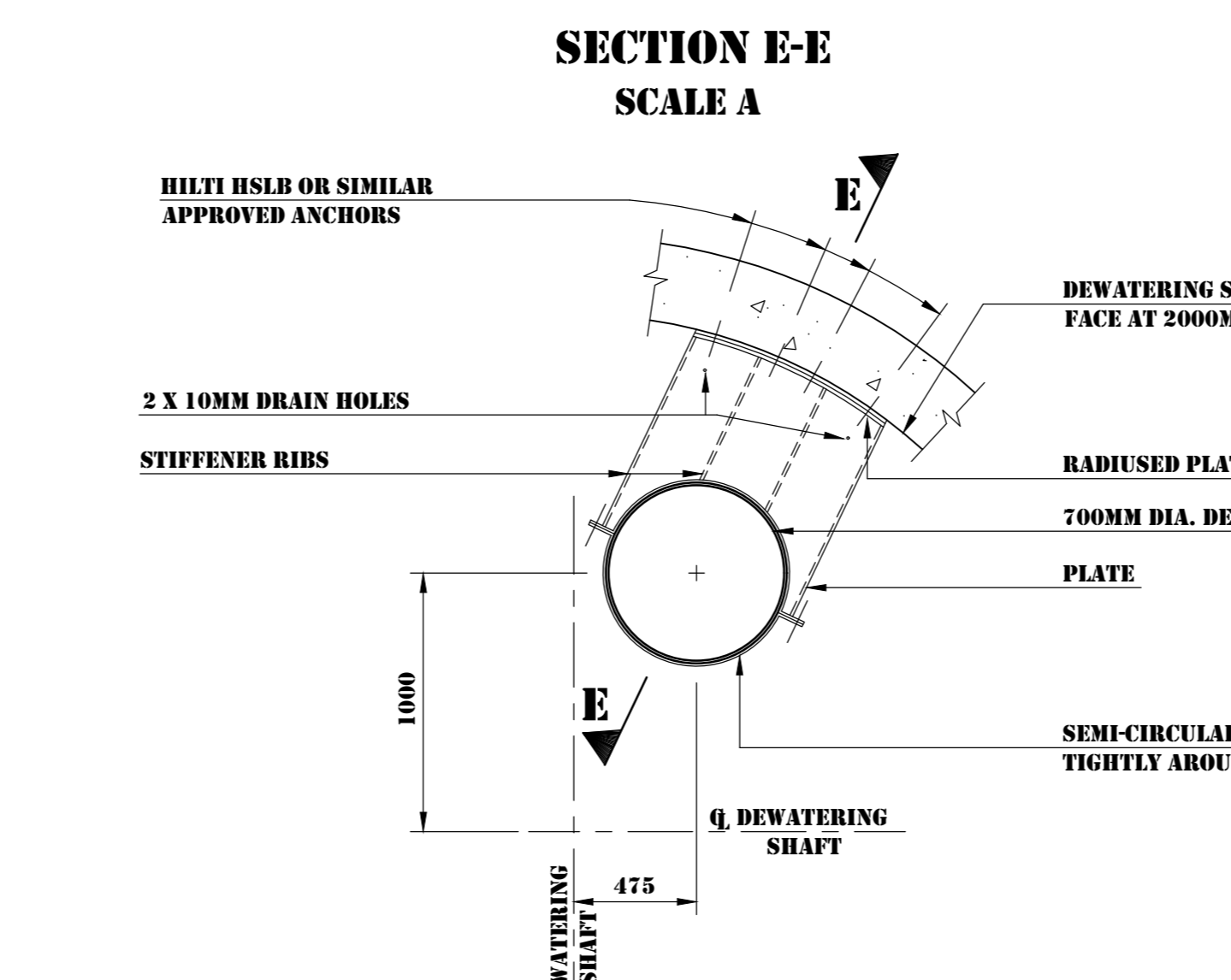
SECTION H-H
SCALE B



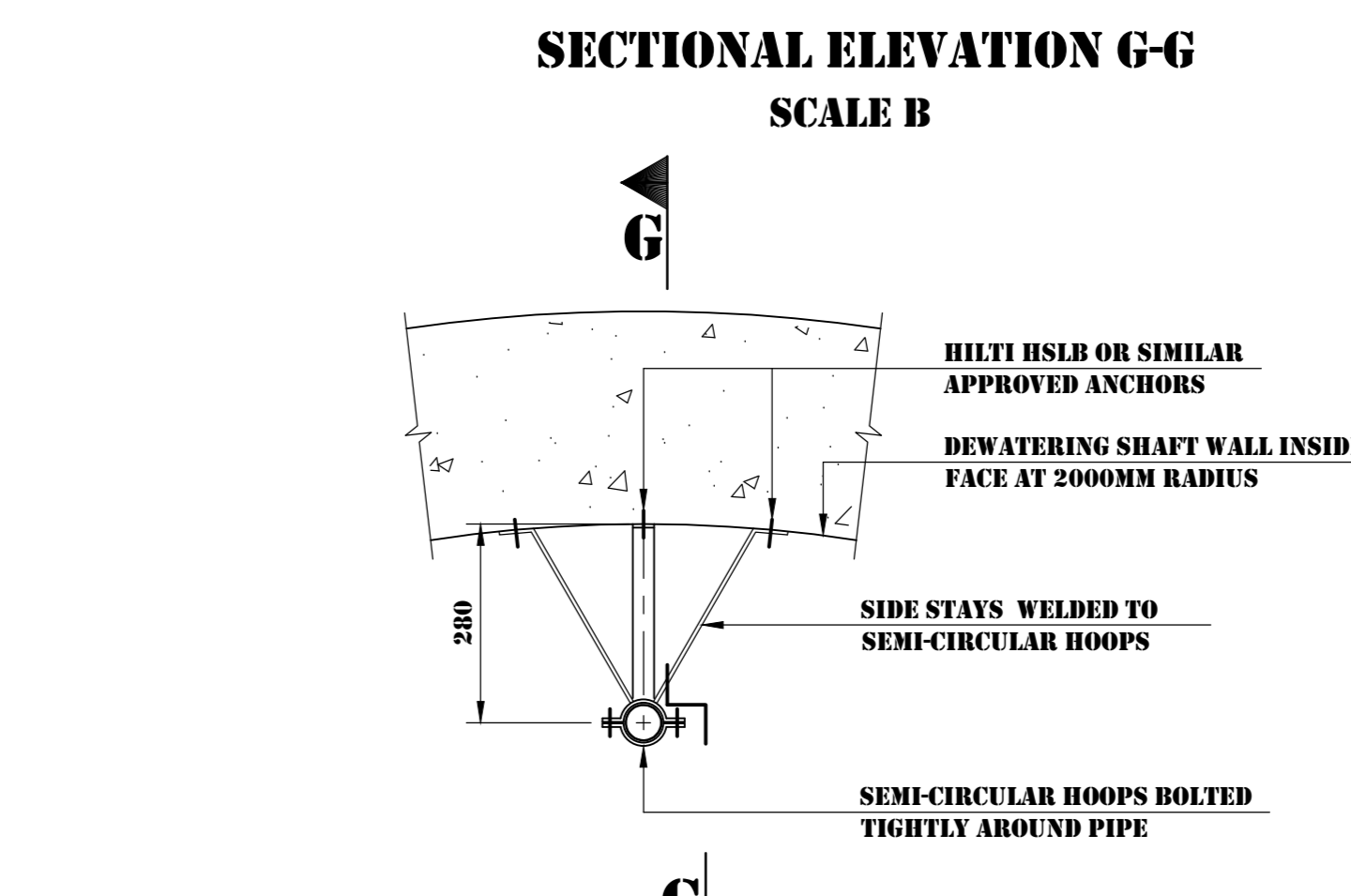
DETAIL 1 - SECTION
(SEE NOTES 9 & 12)
SCALE B



SECTION E-E
SCALE A



PLAN ON DEWATERING MAIN SUPPORT
(SEE NOTES 9 & 12)
SCALE A



SECTIONAL ELEVATION G-G
SCALE B



PLAN ON SUMP MAIN SUPPORT
(SEE NOTES 9 & 12)
SCALE B

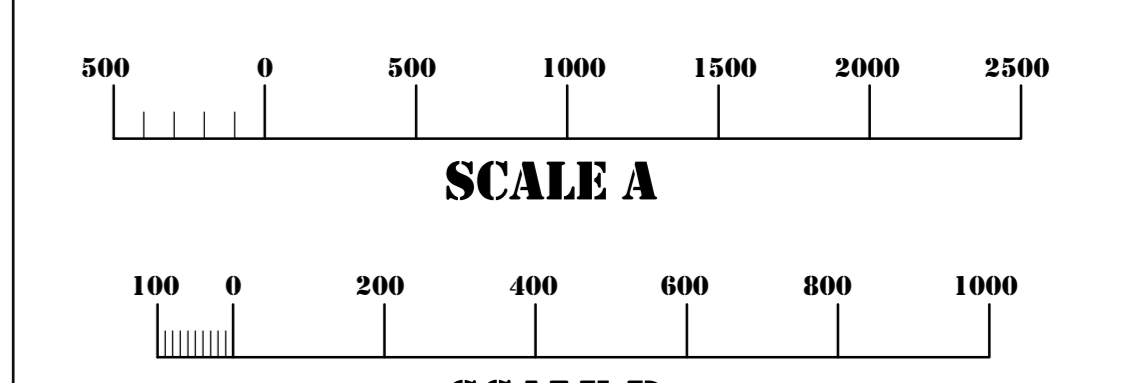
- NOTES:**
- ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.
 - ALL LEVELS IN METRES ABOVE SEA LEVEL (M.A.S.L.).
 - SEE DRG. NO. 1217 FOR LOCATION OF THIS ITEM.
 - CONCRETE ANCHOR BOLTS TO BE HEAVY DUTY HOT DIP GALVANISED (MINIMUM THICKNESS 105 MICRONS) TO SABS 763.
 - PIPEWORK LAYOUT, SUMP POSITION, SCREEN FALLS AND ANCHOR BLOCK SIZES SUBJECT TO FINAL DESIGN BY PIPEWORK AND VALVE SUBCONTRACTOR. ADDITIONAL ANCHOR BLOCKS AND OTHER SUPPORT DETAILS MAY BE REQUIRED AS ADVISED BY THE SUBCONTRACTOR. SEE DRG. NO. 1212 FOR OUTLET STRUCTURE.
 - DEWATERING PUMP AND ADJACENT PIPEWORK NOT INCLUDED IN PIPE AND VALVE SCHEDULE OR ON THIS DRAWING - SUBJECT TO FINAL DESIGN BY PIPEWORK AND VALVE SUBCONTRACTOR AND PUMP MANUFACTURER'S SPECIFICATIONS.
 - SUPPORT DETAILS SUBJECT TO FINAL DESIGN BY PIPEWORK AND VALVE SUBCONTRACTOR.
 - INSTALLATION OF VALVES AND PUMPS TO BE DELAYED AS LATE AS POSSIBLE UNTIL JUST BEFORE COMMISSIONING OF TUNNEL.
 - ALL WORK TO BE CARRIED OUT IN ACCORDANCE WITH THE FOLLOWING DOCUMENT AS ISSUED BY THE ENGINEER: "SUPPLY, INSTALLATION AND COMMISSIONING OF VALVES, PIPES, SPECIALS, DEWATERING PUMPS AND ASSOCIATED EQUIPMENT".
 - PIPEWORK AND VALVE SUBCONTRACTOR TO CONFIRM THE DESIGN CRITERIA LOADS USING DOCUMENT IN NOTE 11 AND FINAL PIPE AND VALVE LAYOUT, ANCHOR BLOCKS AND OTHER SUPPORTS TO BE DESIGNED TO SUIT THE CONFIRMED AND ANY OTHER RELEVANT LOADS, EG. REDUCER, CONSTRUCTION/FABRICATION DRAWINGS TO BE SUBMITTED TO THE ENGINEER FOR APPROVAL.
 - RIGGING EYE TO BE 1.5 TON CAPACITY AND HEAVY DUTY HOT DIPPED GALVANISED (MINIMUM THICKNESS 105 MICRONS) TO SABS 763. TYPE OF EYE TO BE APPROVED BY THE ENGINEER. VALVE AND PIPE INSTALLATION CONTRACTOR TO CONFIRM RIGGING EYE POSITION OR PROVIDE ALTERNATIVE DETAILS FOR APPROVAL BY THE ENGINEER. INSTALLATION CONTRACTOR TO PROVIDE ONLY NON-PERMANENT RIGGING EQUIPMENT (CABLES, RATCHET LEVER HOISTS, ETC).
 - ALL PIPEWORK, METAL FITTINGS AND FASTENERS TO BE DUPLEX COATED IN ACCORDANCE WITH THE DOCUMENT IN NOTE 11 ABOVE.
 - BUTTERFLY VALVE HANDWHEELS TO BE POSITIONED TO ENSURE MANUAL OPERATION WITHOUT THE NEED FOR ANY PLATFORMS.
 - POWER AND READOUT CABLES TO EXTEND TO DISTRIBUTION BOARD IN CAPPING STRUCTURE. LCD READOUT UNIT WITH DIGITAL AND QUASI-ANALOG INDICATION THAT IS SUPPLIED WITH PRESSURE TRANSMITTER IS TO BE MOUNTED IN AN IP68 RATED WATERPROOF HOUSING TO BE SITUATED NEAR THE DISTRIBUTION BOARD AT APPROX. 1.400MM ABOVE FLOOR LEVEL.
 - AS-BUILT LEVELS TO BE DETERMINED AND USED FOR DETAILING OF PIPE LENGTHS. ITEM 8 LENGTH TO MAKE ALLOWANCE FOR GASKET THICKNESSES AND AS-BUILT LEVELS.
 - SEE DRG. NO. 1217 FOR DETAILS OF CRAWL BEAMS, VALVE AND PIPE INSTALLATION CONTRACTOR TO CONFIRM POSITION OF CRAWL BEAMS OR PROVIDE ALTERNATIVE DETAILS FOR APPROVAL BY THE ENGINEER.
 - REFER TO DEWATERING SHAFT DATA BOOK FOR PIPE/PUMP DETAILS.

- DESIGN CRITERIA:**
- MAXIMUM LOADS WITH SURGE:
- 900MM ELBOW AT 1697,399 - H = 380 KN
V = 460 KN
 - 700MM ELBOW AT 1710,430 - H = 195 KN
V = 195 KN

- LEGEND:**
- 1 PIPE AND VALVE SCHEDULE REFERENCE
 - 1695,900 CONSTRUCTION LEVEL (IN PLAN)
 - 1695,900 CONSTRUCTION LEVEL (IN SECTION)
 - R=2000 RADIUS OF CURVATURE

RELATED DRAWINGS

DRG. NO.	DESCRIPTION
0820	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - DEWATERING WORKS - GENERAL ARRANGEMENT
1210	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - DEWATERING WORKS - DEWATERING SHAFT - CONCRETE DETAILS
1212	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - DEWATERING WORKS - OUTLET STRUCTURE - CONCRETE DETAILS
1217	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - DEWATERING WORKS - STEELWORK DETAILS
1219	LITTLE CALEDON RIVER CROSSING - SURFACE WORKS - DEWATERING WORKS - ELECTRICAL DETAILS



Z.	RECORD DRAWING	DATE
A4.	NOTES, PIPE SCHEDULE AND NUMBERING REVISED, RIGGING DETAILS ADDED	
A3.	PRESSURE MEASUREMENT DETAILS ADDED, NOTES AND RELATED DRAWINGS REVISED	MRE 29/2/95
A2.	CORROSION PROTECTION NOTES AND PIPE AND VALVE SCHEDULE REVISED	MRE 10/9/93
A1.	ITEM 6, NOTES AND SCHEDULE REVISED, ITEM 14 REMOVED	MRE 25/9/93
A.	TITLE, NOTES, SUMP LAYOUT, PIPEWORK ITEM NUMBERS AND PIPE SUPPORTS REVISED	MRE 18/5/93
6.	ISSUED FOR CONSTRUCTION	BCY 07/91
NO.	AMENDMENTS	CHKD. DATE

TCTA TRANS-CALEDON TUNNEL AUTHORITY

APPROVED: *F. Ules* DATE: 21/11/93

LESOTHO HIGHLANDS WATER PROJECT - PHASE 1A
DELIVERY TUNNEL NORTH

ASH TUNNEL
LITTLE CALEDON RIVER CROSSING
SURFACE WORKS
DEWATERING WORKS
PIPEWORK AND VALVES

HDTC HIGHLANDS DELIVERY TUNNEL CONSULTANTS
MILIND SHENOI INC. VAN STERIGHE, KLEYN & DEWILDE
KEVE STEYN INC. STEFFEN, ROBERTSON & KRISTEN

DATE: **MAY 1993** DRAWING NO.: **C3B-1218** CLIENT CONTRACT NO.: **TCTA - 20** REV. NO.: **Z**