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ESKOM HENDRINA POWER STATION

PRELIMINARY DESIGN REPORT

PROPOSED WET ASH DISPOSAL FACILITY (ADF) WITH ASH WATER RETURN DAMS (AWR'S)

REV 6

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Eskom

ESKOM HENDRINA POWER STATION

PRELIMINARY DESIGN REPORT

PROPOSED ADF WITH AWRD'S

REV 6

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ESKOM HENDRINA POWER STATION
PRELIMINARY DESIGN REPORT
PROPOSED ASH ADF, WITH AWRD'S

REV 6

EXECUTIVE SUMMARY

A Preliminary Design has been carried out on the selected Site E which is able to accommodate 43 million m^3 of ash from the Hendrina Power Station. The purpose of this report is to provide preliminary design information for the wet ash disposal facilities, and associated pollution control structures for the remaining 17 years of the operational life of the Hendrina Power Station, until July 2035.

This report specifically covers the preliminary design of Ash disposal facility on Site E, with AWRD'S and associated storm water control measures, taking into consideration the topographical and physical constraints. For the purpose of this project, the Ash has been classified as Type 3 Waste, requiring a Class C landfill barrier system.

Because of the possibility of seepage occurring into the subsoils beneath the disposal area, a single Class C composite barrier, and HDPE liner will be provided to control the leachate, which will then be led into the AWRD's, via a solution trench, and then be pumped back to the station for reuse.

The Class C barrier design should incorporate a drainage layer on top of the barrier system containing drainage pipes of adequate size, spacing and strength to ensure atmospheric pressure within the drainage application for the service life of the ash disposal facility as per the DEA's National Norms and Standards.

Unfortunately, in view of the limited extent of this site it is not possible to phase the construction of the ADF. The Area to the East of the Dam has been "ear-marked" for topsoil and subsoil stockpiling.

As part of the stormwater control measures on the site, two pollution control dams (AWRD's) are planned to cater for the facility, and will be integrated into the existing system, by means of pressure pipelines. The AWRD's will be lined with a composite Class C barrier, comprising a 2,0 mm HDPE, to arrest seepage. The dams have been sized to contain all stormwater runoff, such that they do not spill into a clean water system more, than once in fifty years on average.

Also in terms of GN704, all clean and dirty water separation is enforced, and all channels are required to convey the 50-year flood peak.

The water accumulated in AWRD should never be more than 10 to 15% of its capacity, at any time, to minimise the likelihood of spilling during a storm event.

Some of the test holes encountered a perched aquifer above a ferricrete layer, and more boreholes will be need to fully understand the aquifer characteristics of the site, both shallow and at depth.

A more detailed cost estimate for the infrastructure will be prepared at Tender stage. Some indication of the expected construction costs for the various facilities related to the ash disposal. Appendix C contains the costing estimate as at July 2013.

ESKOM HENDRINA
PRELIMINARY DESIGN REPORT
PROPOSED ASH DISPOSAL FACILITY AT SITE E WITH AWRD'S

1. SCOPE OF WORK

A Preliminary Design has been carried out on the selected Site E which is able to accommodate 43 million m^3 of ash from the Hendrina Power Station.

The purpose of this report is to provide preliminary design information for the ash disposal facility at site facilities for the ash facilities and associated pollution control structures for the remaining 17 years of the operational life of the Power Station, until July 2035.

2. SITE SELECTION AND SIZING

The rationale for the selection of the location of the ash disposal facility is as follows:

- DMR is currently busy with a prospecting application on the preferred alternative, and Eskom is in the process of objecting to this. **Verification of mining rights does not form part of the scope of this report.**
- The areas are in close proximity to the existing Power Station, as defined by the station's technical requirements/criteria.
- The topography is acceptable in terms of surface gradients to accommodate pollution control measures
- The area is unaffected by sensitive or pristine wet lands and associated flood plains.

3. DESIGN ASSUMPTIONS

The design assumptions used, are given below, with the following comments:

a) The maximum ADF height is subject to review once the final Geotechnical investigation has been carried out. The factor of safety given below, will be the minimum allowable, and will be determined from soil and topographical conditions. These will be verified at Detailed Design Stage.

b) Design Parameters (* to be verified)

- Average ADF side Slope	1:3 to 4
- Storm Design Criteria	GN704
- Min. factor of safety	1,5
- Pool free board (m)	0,8m
- Ash Bulk Density (t/m^3)	1,4 (measured)
- Dry density of ash (t/m^3)	1,0 *
- ADF Capacity	$43,5 \times 10^6$ m^3
- Ash production	30,7% *
- Ash SG	2,36
- Maximum rate of rise	3,5m/year
- Ash Permeability	5m/year ($1,6\ No^{-7}$ m/sec) *

4. ASH DISPOSAL

For the purposes of this project, the Ash has been classified as a Type 3 Waste requiring a Class C landfill barrier system. The ash disposal area comprises various components and the layout is shown on the drawings as:

- Two pollution control dams (AWRD's)
- Wet Ash Disposal facility
- Clean water diversion trench/bund walls
- Dirty water drains/leachate interception and collection systems
- Penstock and outlet pipelines
- Silt Trap

4.1 Production Rates

The expected Ash production is 40 million m^3 of ash, over the remaining 17 years, based on the most recent estimate, provided by Eskom.

4.2 Construction of the disposal facility

In summary, the following construction phases are envisaged :

Phase 0	Relocate water mains and power lines.
Phase I	Remove topsoil and subsoil to a depth of 600 mm, and stockpile separately
Phase II	Earthworks to cut and fill in situ material, to form the platform within the footprint for the dam.
Phase III	Construct penstock and clean and dirty water drains.
PhaseIV	Place and weld 1,5mm HDPE "embossed" liner and other layers, as detailed to levels and grades, to form a Class C composite barrier.
Phase V	Construct starter wall to accommodate initial rate of rise.
Phase VI	Deposit ash as detailed below, and on the drawings.

The ring dyke or paddock systems will be used to construct the ADF as follows:

The impoundment wall, or daywall, is formed by a perimeter outer paddock wall and a parallel inner paddock wall. These walls are constructed between 30 m and 60 m apart, and are formed into paddocks by the construction of perpendicular ash cross walls. The water pond lies within the daywall in the night paddock.

The ash deposited in these paddocks comprises about 80% fly ash and 20% coarse or bottom ash. The ash is mixed with water, and pumped at a water to solids ratio of 1:5 by mass, for both fly ash and coarse or bottom ash. The ash is then pumped, via a ring

main, as a slurry to the ADF complex through large steel pipes. Only fly ash is used for wall construction (daywalls), while coarse or bottom ash or fly ash is deposited in the inner portion or night paddock of the ADF.

Vibrating wire electronic Piezometers, should be installed just before Ash deposition and extended as the level rises, to monitor porewater pressure levels, for stability evaluation in critical areas. The positions will be determined at the detailed design stage, based on the underlying soils and stability analysis.

4.3 Stability and Rate of Rise

The maximum height of the ADF is 61m ie 1688m above MSL.

In order to accommodate the initial rate of rise a 16,5m high starter wall to elevation of 1644m is required. Towards the end of life, the R.O.R rises to 3,5. The expected rate of rise has been plotted and presented in Appendix D.

The Stability of ADF E has been assessed on the available laboratory test results. The overall side slope is 1:3, but this may need to be "flattened" to provide a suitable Factor of Safety, once the full set of laboratory tests are available. The available tests have provided immediate un-drained shear parameters, and additional testing will be needed to assess long term underlying soil properties, after consolidation.

Indications critical failure surfaces at various sections with the factor of safety for circular and non-circular "failure" modes are given in Appendix D with the phreatic line as shown. The following soil parameters were used in the analysis.

		C'	**Ø'**	**Density**
		(kPa)	**(deg)**	**(kN/m^3)**
Ash	Day Wall	5*	35*	1,4*
	Inner	0*	35*	1,4*
A4/HDPE (interface)		0*	22*	1,0*
Fill Platform		40*	30*	2,0*
Shallow (Poor)	Soil	18*	26*	2,0*
Deeper	Soil	150*	35*	2,0*

* These figures to be verified by additional testing, taking the liner into account.

The sections analysed are as follows :

	FOS Circular	**FOS Wedge**
Section 1 at D7	1,93	1,88
Section 2 at D18	1,69	2,02
Section 3 at D21	2,75	2,67
Section 4 at D14	2,41	2,51

As can be seen from the figures above, the Dam is stable at a 1:3 average side slope, with the assumed soil parameters, and effective toe draining in place.

The factor of safety can be improved by removing areas of soft clay, if needed, and replacing it with selected compacted material of at least G8 quality.

The stability of ADF needs to be re-assessed at detail design stage, in conjunction with the proposed HDPE liner, and its interaction with the insitu soils.

5. HYDROLOGY & WATER BALANCE

The site is not affected by floodlines and all drains and AWRD's will be sized in terms of the criteria set out in the ILANDA Water Services Report, which will be issued under separate cover.

The water balance has been carried out to assess the water utilisation, and to size the AWRD's. The interaction of the proposed ash disposal areas with this resource has been given in the ILANDA Report, in Appendix B.

6. DESIGN OF ASH DISPOSAL FACILITY

6.1 Seepage Control

Because of the possibility of seepage occurring into the subsoils beneath the disposal area, a Class C composite barrier, and HDPE liner will be provided to control the leachate, which will then be led into the AWRD's, via a solution trench and will then be pumped back to the station for reuse.

The Class C barrier design should incorporate a drainage layer on top of the barrier system containing drainage pipes of adequate size, spacing and strength to ensure atmospheric pressure within the drainage application for the service life of the ash disposal facility as per the DEA's National Norms and Standards.

Some of the test holes encountered perched aquifer above a ferricrete layer and more boreholes will be need to fully understand the aquifer characteristics at depth, so in the case of the ADF, a 1,5mm embossed or co-extruded HDPE, with suitable frictional properties must be used.

6.2 Stormwater Control

As shown on the drawings the open drains and berms separate the "clean" water runoff, from the "dirty" water, to divert clean run-off around the AWRD's and ADF.

The AWRD's have been sized to collect the dirty water via the penstock from the "top" of the ADF. The water from the sides of the ADF and solution trenches will be directed into a separate compartment in the AWRD, as clear water.

The solution trenches will be lined with concrete.

6.3 Capping/rehabilitation

The Contractor shall, in accordance with the requirements of the Operations and Maintenance Manual be responsible for the:

- Gradual stripping and stockpiling of topsoil
- Gradual shaping of side slopes and top of the ADF
- Gradual spreading of topsoil to cover shaped ADF side slopes and top surface
- Planting of grass for erosion control on prepared slopes
- Establishment of veld grass on the prepared areas
- Establishment of indigenous trees and shrubs
- Aftercare of rehabilitated areas to ensure continued stability and eventual self sustainability
- The upkeep of a complete rehabilitation progress manual.

7. ASH WATER RETURN DAMS (AWRD'S)

All the dirty water run-off which accumulates on top of the ADF will find its way into one of the AWRD's. Water from the sides and seepage collection drains will be routed to a separate compartment in the AWRD, as "clear" water.

The ash return dams perform the following functions, in conjunction with the silt trap :

a) They provide a facility for settling out the very fine material which does not settle out on the ADF.

b) They provide short term emergency storage capacity for stormwater from

the ADF.

The AWRD's will be used in conjunction with temporary storage on top of the ADF for periods of up to three days, until it is taken up in the normal ashing cycle. In addition, excess polluted stormwater can only be stored on top of the ADF if it has sufficient freeboard.

None of the AWRD's available capacities may fall below 75% of the total capacity of the dam as a result of the ash settlement. Should the total capacity of an AWRD be reduced to 75% of the total capacity by silting, the settled ash must be dredged or cleaned from the bottom of the dam so as to return the dam to its correct capacity, and so not to affect the integrity of the ash disposal facility.

Spillways will be provided for from each dam, to cater for the unlikely event of an overflow occurring.

The storage facilities will be formed by excavating into the virgin subsoils or importing fill from within the site, to create the required capacity, in a "cut and fill" operation, taking the ground water table level into account.

Two AWRD's and a silt trap are proposed, for the Ash disposal facility, details of which are shown on the drawings.

The AWRD's will be lined with a composite Class C type barrier, comprising a 2,0 mm HDPE liner with compacted clay layers, to arrest seepage. The dams have been sized to contain all stromwater runoff, such that they do not spill more than once in fifty years on average.

In terms of GN704, all clean and dirty water separation is enforced, and all channels are required to convey the 50-year flood peak.

The Report by ILANDA Water Services provides details of the design criteria and assumptions made.

8. CAPEX COSTING

A more detailed cost estimate for the various components of the infrastructure, will form part of the Tender Design stage. Indicative costs are given in Appendix C, and the estimate figures based on current rates are including VAT and 2,5% contingencies are:

ADF E	R354 million*

AWRD's (East & West) R27,1 million*

This translates to R8,86 per m^3 of dry ash deposited, as at July 2013.

9. RISK EVALUATION

The following risks will be taken into account during the next phase of the design:

9.1 Geotechnical Conditions – the maximum ADF height and side slope will be reviewed, based on the actual soil properties, once these are to hand.

Boreholes and possibly Geophysical studies will also be needed to fully understand the Geohydrological conditions, together with the location and type of aquifers beneath the ADF.

A number of test holes and DPSH tests have been carried out, and the results with an evaluation of the site, is covered in a separate Geotechnical Report to be issued shortly.

The areas of perched water Table and poorer soils, based on the test hole logs and DPSH tests, generally correlate with the areas which are not cultivated, and highlighted on the Google Earth Image.

Generally the soils are poorer along the Eastern and North Eastern boundaries of the proposed ADF.

9.2 Residue Characterisation – in terms of the DEA's National Norms of 2013, an Ash Classification was carried out by Jones and Wagner and reported on in their report JW175/14/E699 – Rev 00.

The new waste classification system, which replaced the Department of Water Affairs and Forestry's Minimum Requirements classification system on 23 August 2013, focuses on the long term storage (in excess of 90 days) and disposal of waste on land or waste disposal facilities. The system is based on the Australian State of Victoria's waste classification system for disposal, which using the Australian Standard Leaching Procedure (ASLP) to determine the leachable concentrations (LCs) or pollutants (DEA, 2013a).

a) The Ash has been characterised to identify any potential significant health and safety hazards together with environmental impact that may be associated with the residue being stockpiled.

b) The residue deposits have been characterised in terms of their physical

characteristics including size, distribution, permeability, void ratios, strength, SG and water content.

c) The chemical characteristics which have been identified would include an assessment of the propensity to oxidise or undergo spontaneous combustion. The PH and chemical composition of the leachate water would also be assessed.

The ash seepage water reporting to the base of the ash disposal facility represents the actual threat to the receiving environment, especially the surface and groundwater. The ash seepage water was assessed as a Type 3 waste. The chemical constituents resulting in this outcome are aluminium, boron, TDS and sulphate are given in Table 3-3 of the J&W Report.

9.3 Chemical Profile

The following is an extract from the J&W report :

"Based on the assessment carried out, the ash was assessed as a Type 3 waste requiring disposal on a waste disposal facility with a Class C barrier system. This barrier system is the least conservative composite barrier system currently accepted by the DWS . As the ash seepage water has a low risk of impacting on the groundwater in the area (as was demonstrated by Infotox, Groundwater Sequire and Geostratum in their draft report Health-risk Based Assessment of the Hendrina ADF Expansion Project dated September 2013) (Van Niekerk et al 2013) the installation of a Class C barrier system for the new wet ash disposal facility should be sufficient to protect the environment in the long term. A more conservative barrier system should, however, be considered for the return water dams.

9.4 Safety Classification

In terms of safety classification the ash disposal facility will be differentiated between high, medium and low hazard on the basis for the potential to be a risk to life and property.

The SABS 0286/1998 Code will be used to classify the ADF in terms of a prescribed Safety Classification system that differentiates between high, medium and low hazard potential. This classification as well as the completion of the safety questionnaire will be done during the Risk Assessment on the ADF, during detailed design stage.

The initial conclusion is that the ADF has a medium to high Hazard Classification.

10. REHABILITATION

Sufficient cover material for the sides and top of the dam will be stockpiled prior to construction from within the “footprint” of the facility.

Once the decommissioning phase is completed, the top of the Dam will be paddocked and covered with 300mm of compacted clayey sub- soil, followed by 200mm of topsoil from the previously stockpiled material.

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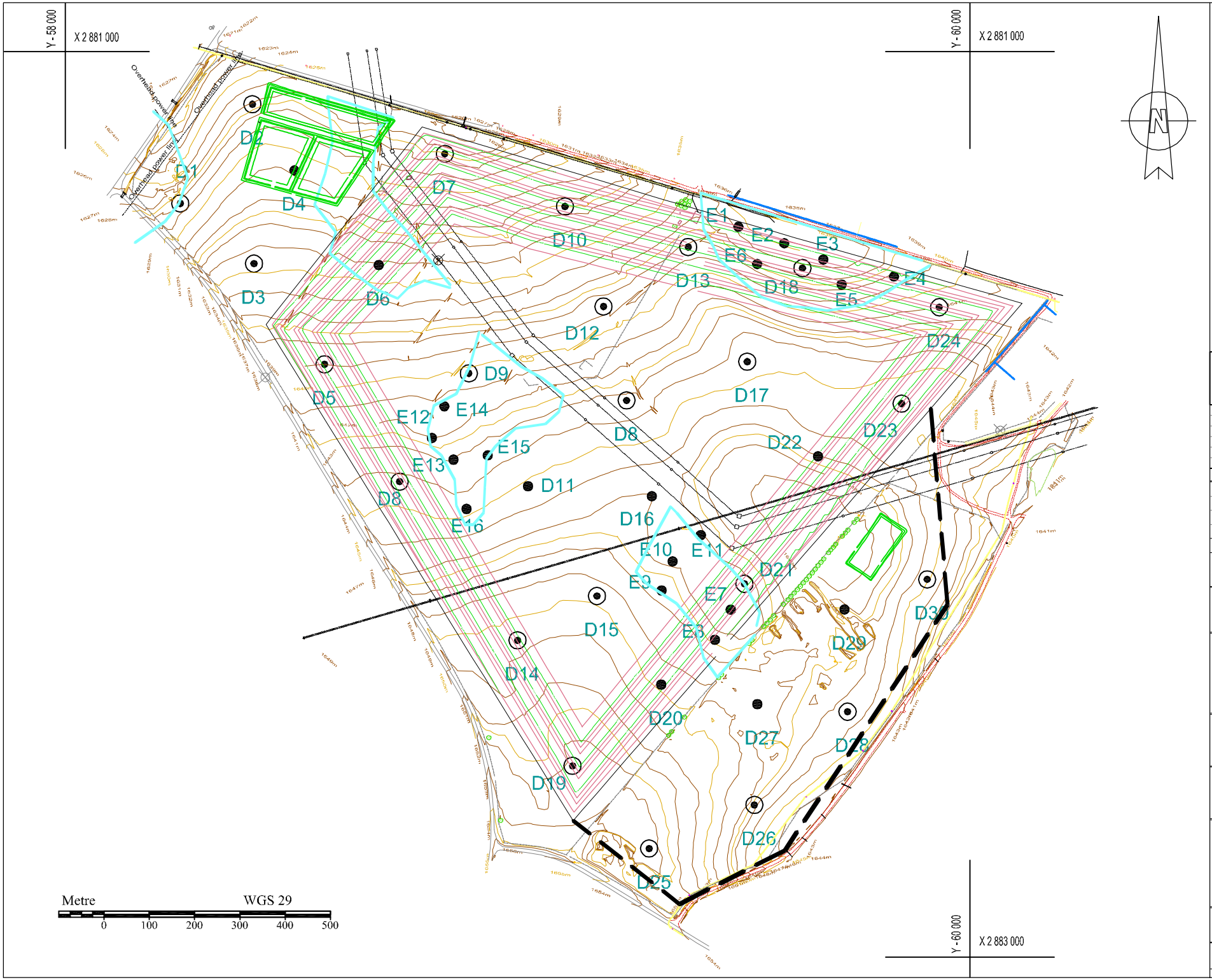
APPENDIX A
DRAWINGS

Drawing No.	Rev.	Title
618/300	A	ADF E test positions
618/305	B	DPSH depth to dense or firm material
618/310	C	Proposed ADF E layout plan
618/320	O	ADF typical details (wall section)
618/332	A	AWRD West and East safety details
618/333	A	AWRD East wall section
618/335	A	AWRD East and West pipe spillways
618/336	A	AWRD East inlet details
618/342	C	AWRD West safety details
618/343	B	AWRD West (clear water) wall section
618/346	A	AWRD West inlet details
618/350	0	Silt trap wall section
618/382	0	HDPE liner details
618/384	0	Standard details Sheet 1
618/386	0	Energy dissipation structure and pipe crossing
618/390	0	ADF standard details (Sheet 1)
618/391	0	ADF standard details (Sheet 2)
618/392	0	ADF standard details (Sheet 3)
618/400	C	ADF and AWRD barrier details
-		Plot of rate of rise

Google earth

miles 800
km 1000



LEGEND

- TH & DPSH
- DPSH ONLY
- D2 HOLE No.
- APPROXIMATE POOR SOIL OR PERCHED WATER TABLE BOUNDARY

ISSUED FOR DISCUSSION PURPOSES ONLY

No.	Amendments	Appr.	Date
A	DRAWING UPDATED		16/02/15
0	DRAWING CREATED		04/06/13

Surveyed		Book No.	
Plotted		Survey Checked	
Drawn		Drawing Checked	
Designed		Design Checked	

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Client: LIDWALA

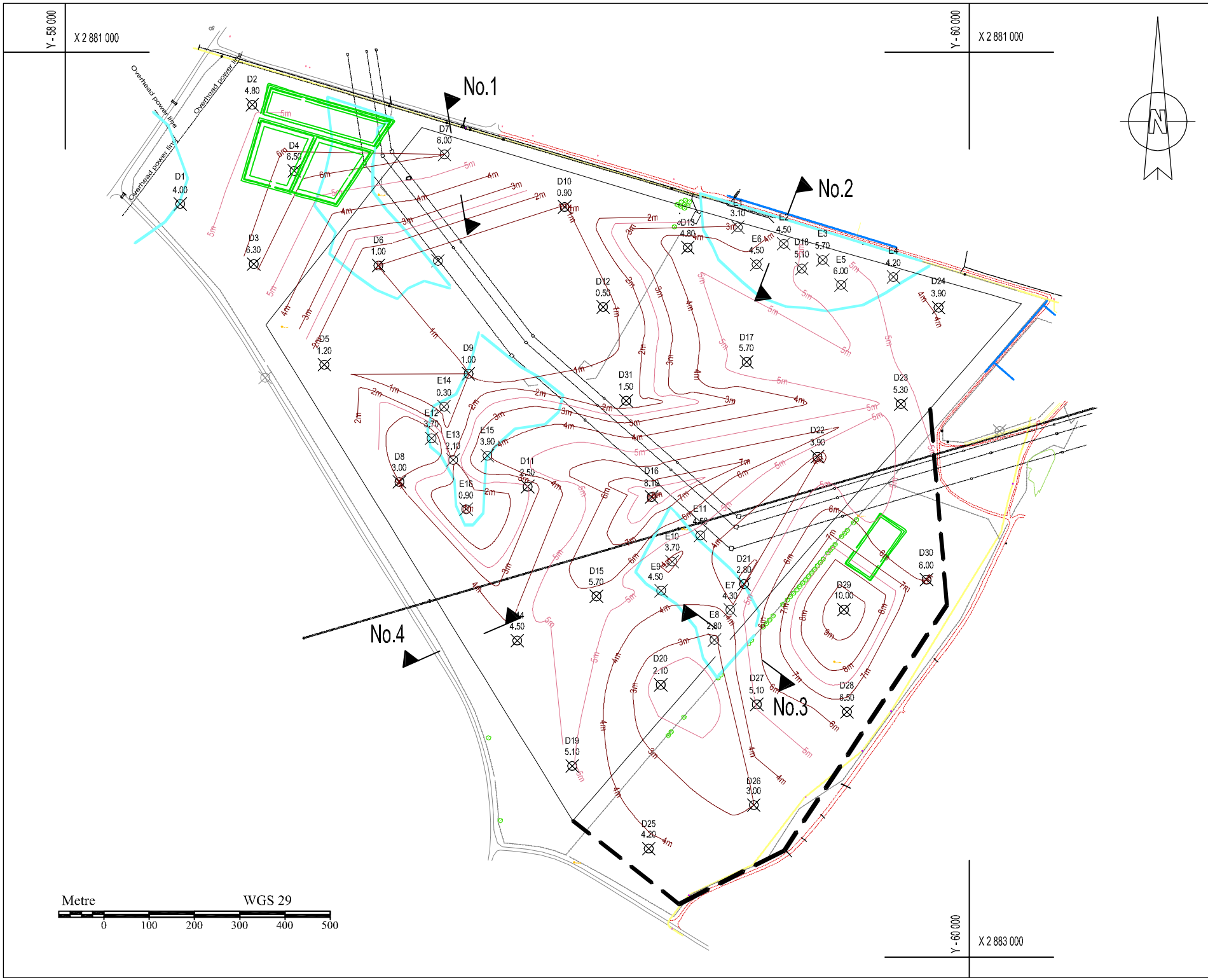
Project: HENDRINA POWER STATION

Description: WADF E TEST POSITIONS

SCALE: N.T.S

SHEET 1 OF 1 SHEETS

Drawing No. 618/300 A



LEGEND

- TH & DPSH
- DPSH ONLY
- D2 HOLE No.
- APPROXIMATE POOR SOIL OR PERCHED WATER TABLE BOUNDARY
- D161.5 TO DENSE OR FIRM MATERIAL
- 1m CONTOURS
- STABILITY SECTION

ISSUED FOR DISCUSSION PURPOSES ONLY

No.	Amendments	Appr.	Date
B	DRAWING UPDATED		16/02/15
A	DRAWING UPDATED		12/11/14
0	DRAWING CREATED		15/07/13

Surveyed		Book No.	
Plotted		Survey Checked	
Drawn		Drawing Checked	
Designed		Design Checked	

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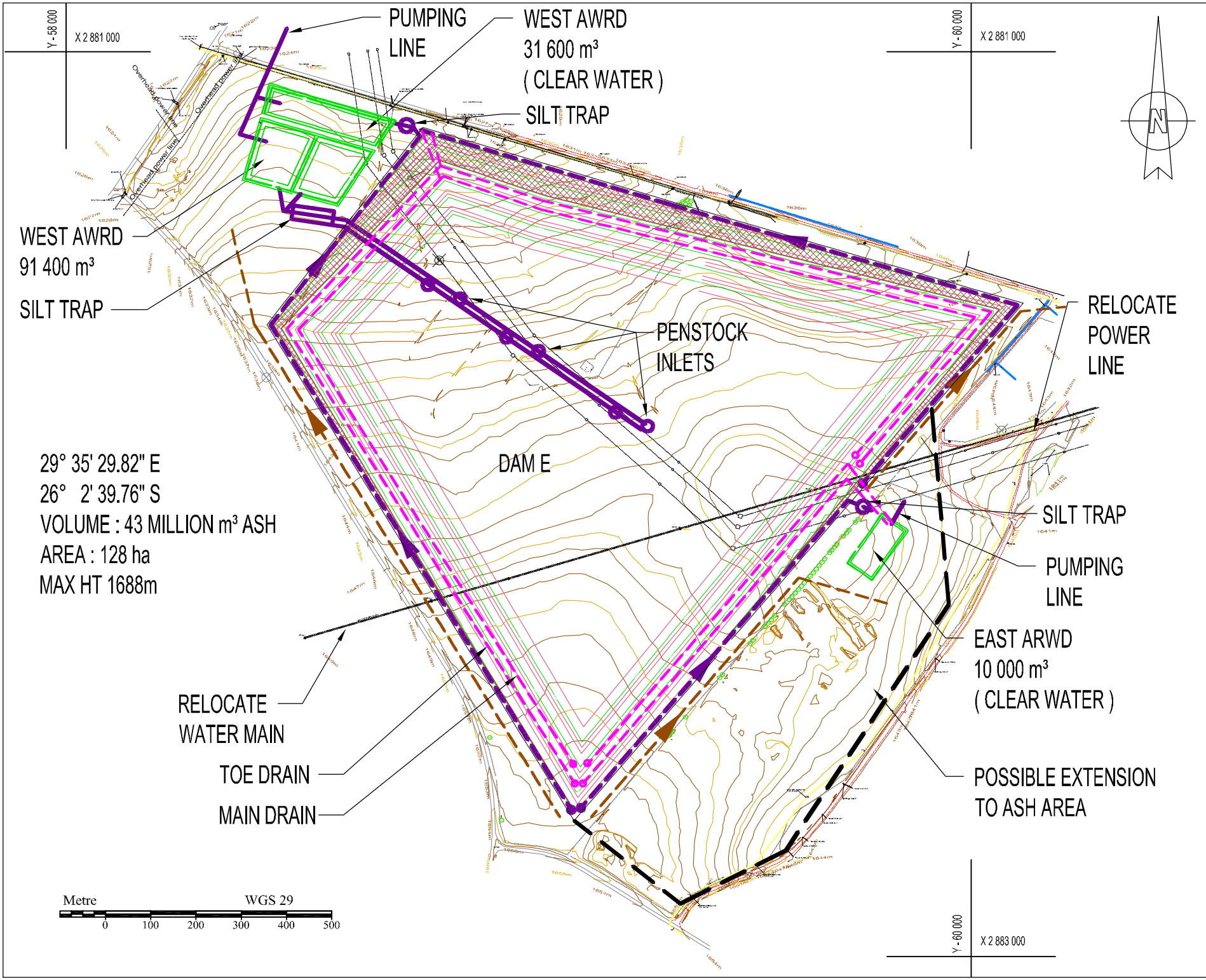
Project: HENDRINA POWER STATION

Description: DPSH DEPTH TO DENSE OR FIRM MATERIAL

SCALE: N.T.S

SHEET 1 OF 1 SHEETS

Drawing No. 618/305 B



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C	DRAWING UPDATED		16/02/15
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A	QUANTITIES AMENDED		17/07/13
0	DRAWING CREATED		09/07/13

Surveyed		Book No.	
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Drawn		Drawing Checked	
Designed		Design Checked	

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Client: LIDWALA

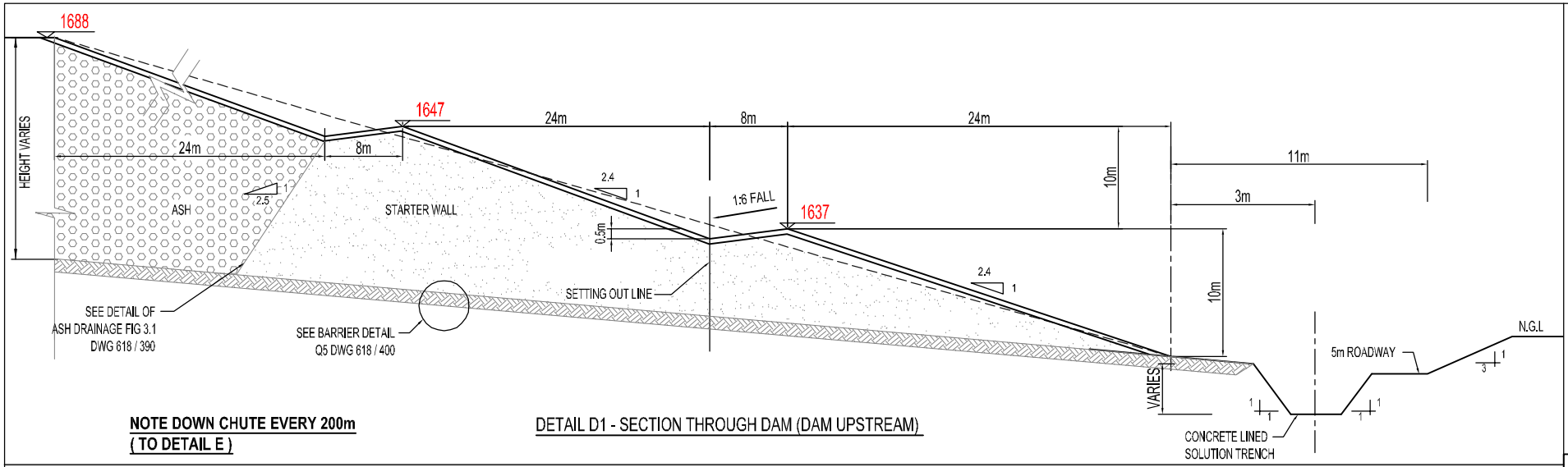
Project: HENDRINA POWER STATION

Description: PROPOSED WADF E LAYOUT PLAN

SCALE: N.T.S

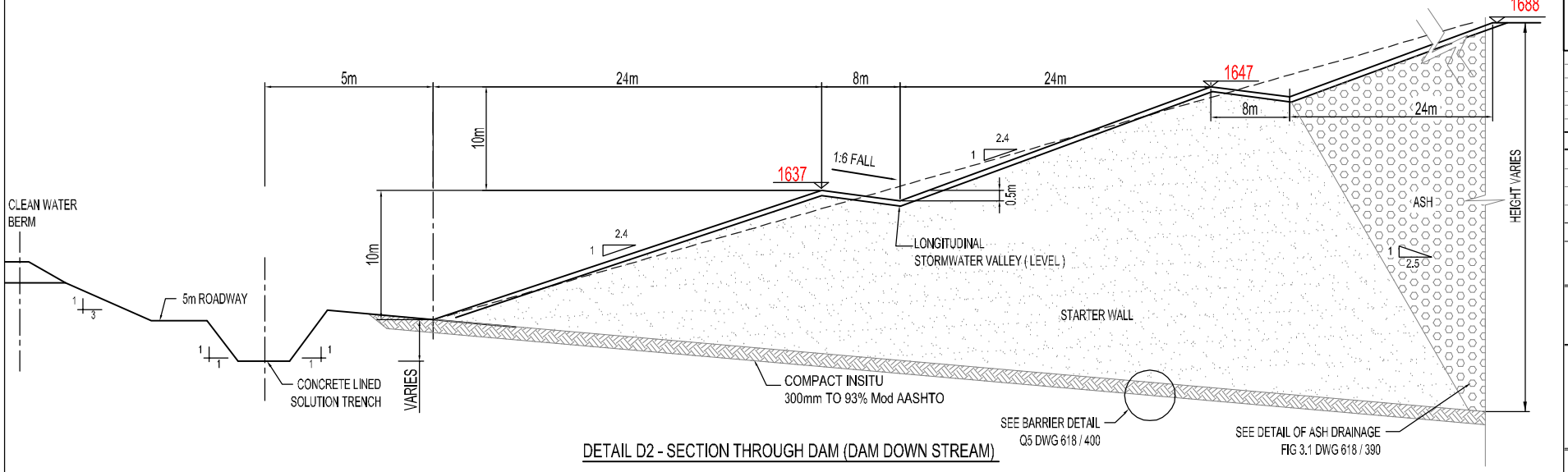
SHEET 1 OF 1 SHEETS

Drawing No. 618/310 C

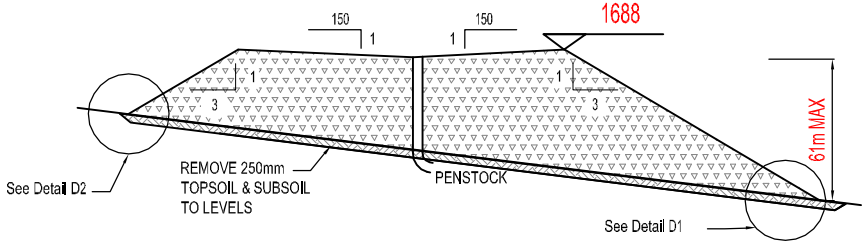


NOTE DOWN CHUTE EVERY 200m
(TO DETAIL E)

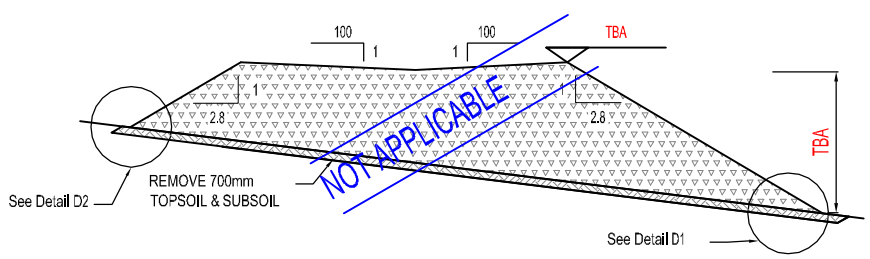
DETAIL D1 - SECTION THROUGH DAM (DAM UPSTREAM)



DETAIL D2 - SECTION THROUGH DAM (DAM DOWN STREAM)



DUMP E - DETAIL S1



DUMP 2 - DETAIL S2

Eskom

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ONLY

No.	Amendments	Appr.	Date
0	DRAWING CREATED		07/12/11

Surveyed		Book No.	
Plotted		Survey Checked	
Drawn		Drawing Checked	
Designed		Design Checked	

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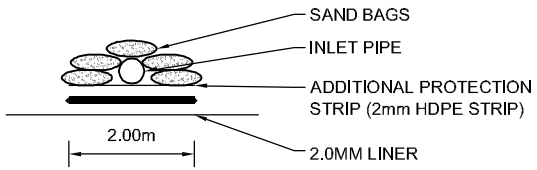
Client:
LIDWALA

Project:
ESKOM ASH HENDRINA

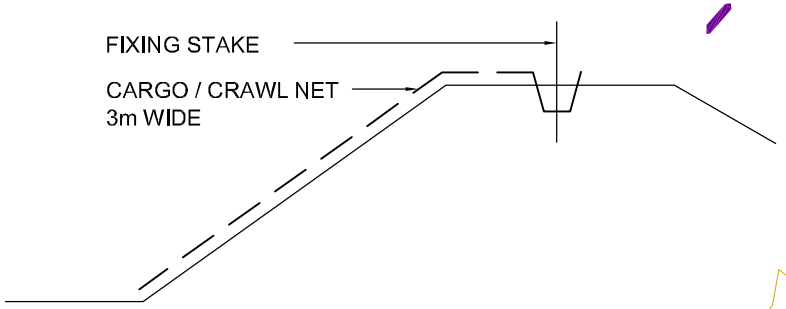
Description:
WADF TYPICAL DETAILS (WALL SECTION)

SCALE	SHEET
N.T.S	SHEET 1 OF 1 SHEETS

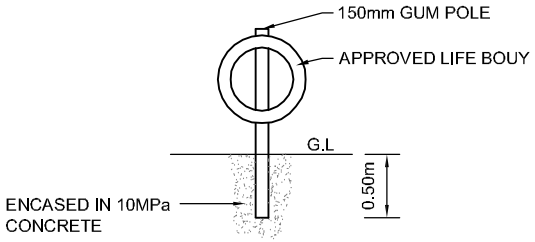
Drawing No.
618/320 0



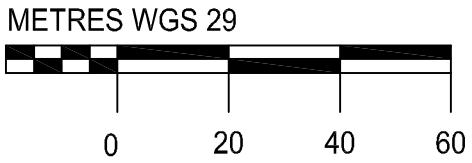
DETAIL X3 - INLET PIPE
N.T.S.

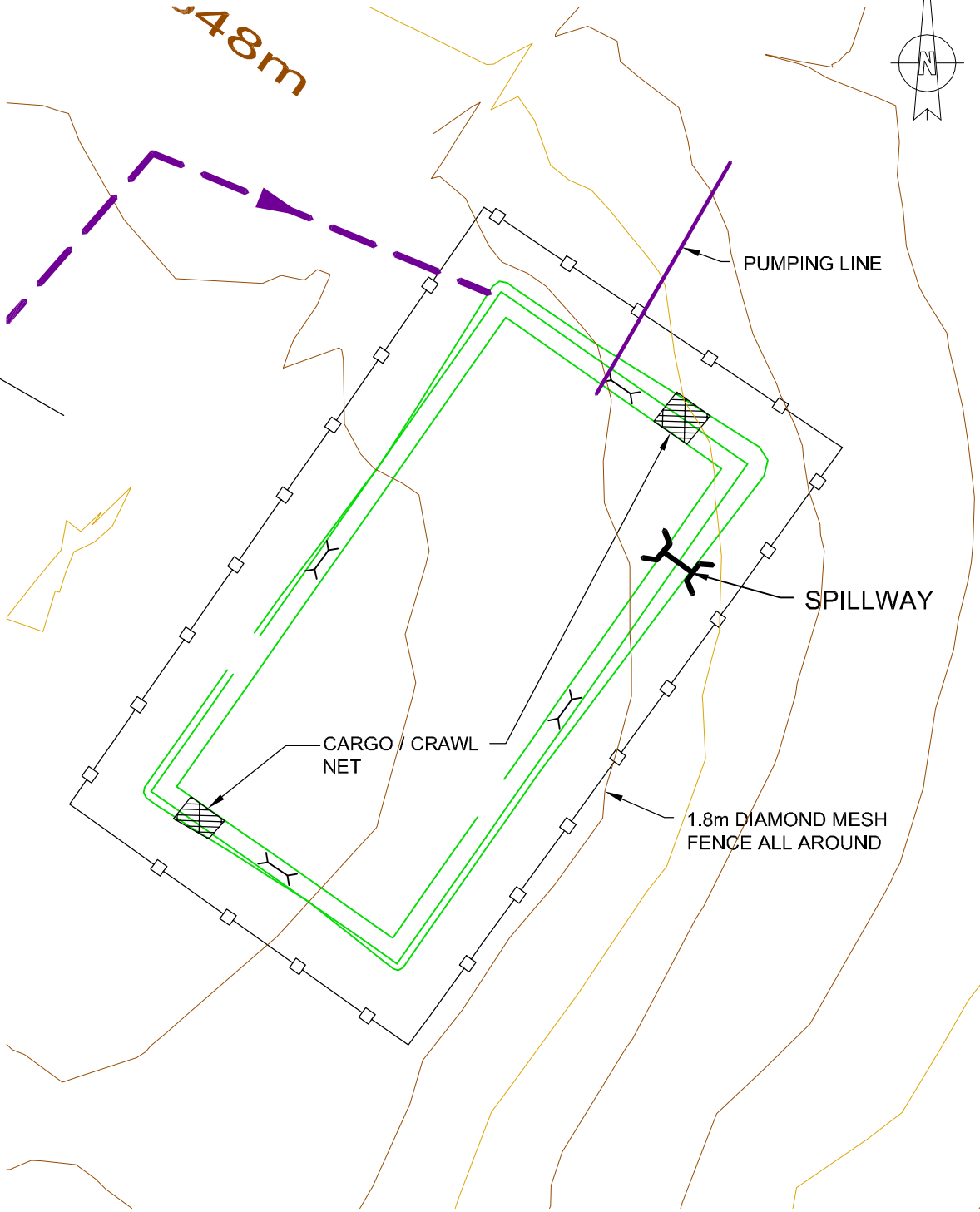


DETAIL X2 - CRAWL NET
N.T.S.



DETAIL X1 - LIFE BOUY
N.T.S.





Eskom

LEGEND

A1 +4.1 SETTING OUT POINTS & DEPTH (+ ABOVE / - BELOW GL)

NOTE:
ALL WORK IS TO BE DONE TO SABS 1200

TEST HOLE
TH1
LIFE BOUY
UNDERDRAIN (DETAIL W)
PENSTOCK PIPE
SOLUTION TRENCH
HEADWALL

ISSUED FOR DISSCUSSION PURPOSES ONLY

No.	Amendments	Appr.	Date
A	DRAWING UPDATED		12/11/14
0	DRAWING CREATED		10/07/13

Surveyed		Book No.	
Plotted		Survey Checked	
Drawn		Drawing Checked	
Designed		Design Checked	

ECSA 750 693

For ALAN ROBINSON Pr Eng

ALAN ROBINSON
CONSULTING CIVIL & GEOTECHNICAL ENGINEERS
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2115
Tel: (011) 476-4266
Cell: 0826-10-12-23
Fax: 086 894 657

Client:
LIDWALA

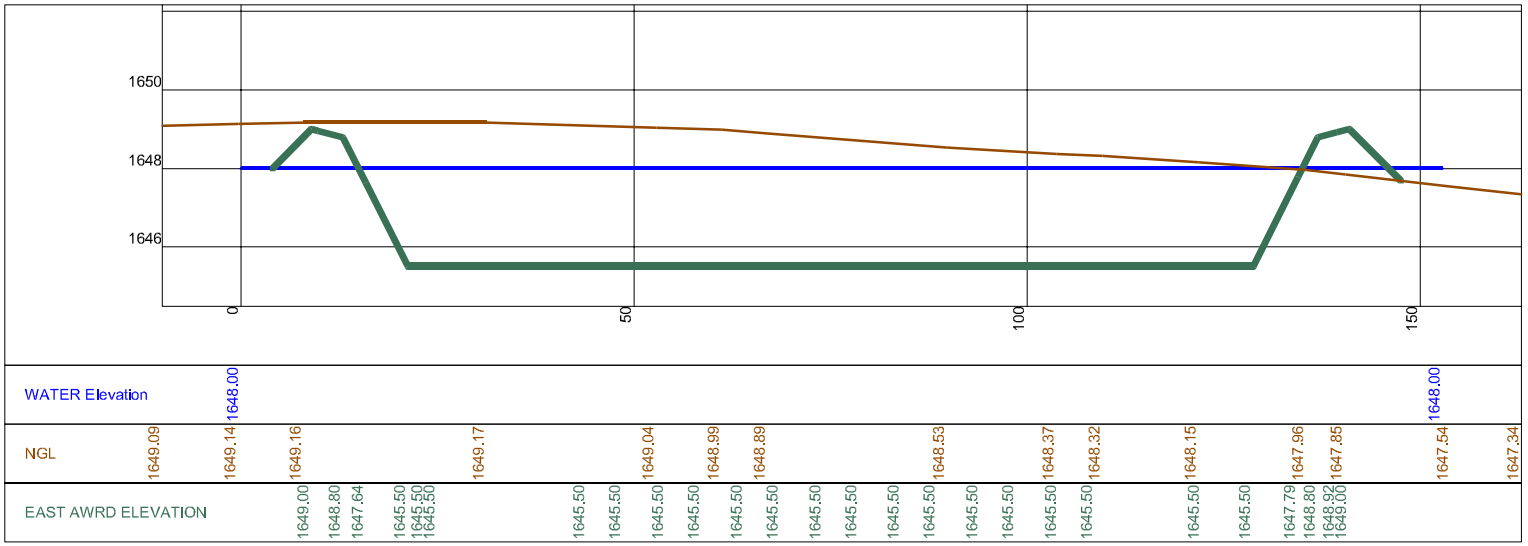
Project:
ESKOM ASH HENDRINA

Description:
AWRD EAST
SAFETY DETAILS

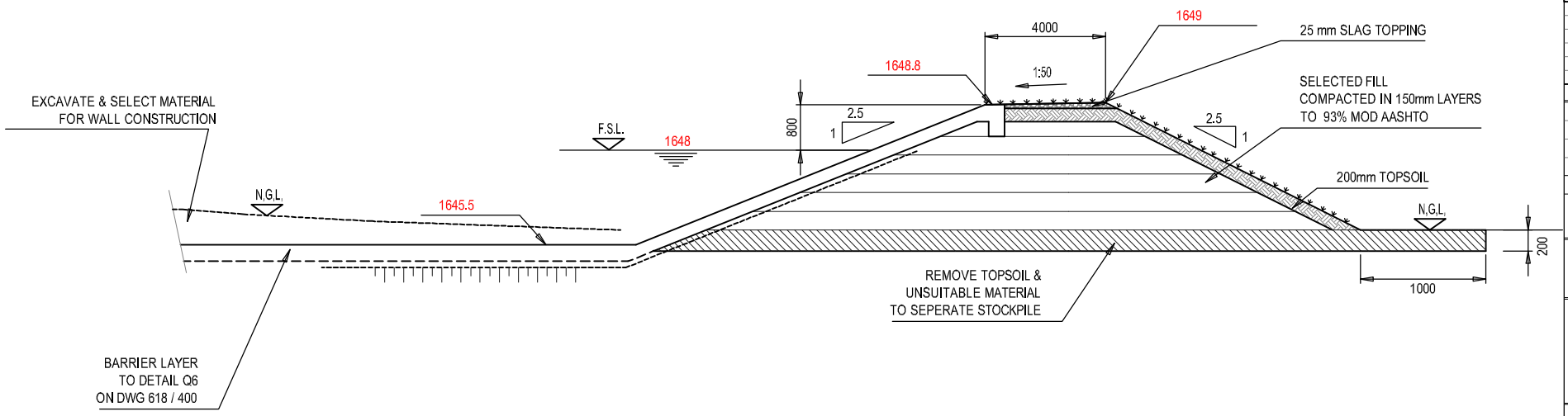
SCALE
as shown

SHEET 1 OF 1 SHEETS

Drawing No.
618/332
A



SECTION B-B



SECTION - AWRD WALL
(CLEAR WATER)

NOTE:
70kg SAND FILLED BALLAST BAGS
PLACED ON 5m GRID ON FLOOR

Eskom

NOTE:
ALL WORK IS TO BE DONE
TO SABS 1200

ISSUED FOR
DISCUSSION PURPOSES
ONLY

No.	Amendments	Appr.	Date
A	DRAWING UPDATED		12/11/14
0	DRAWING CREATED		10/07/13

Surveyed		Book No.	
Plotted		Survey Checked	
Drawn		Drawing Checked	
Designed		Design Checked	

ECSA 750 693

For ALAN ROBINSON Pr Eng

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Fax: 086 894 657

Client:
LIDWALA

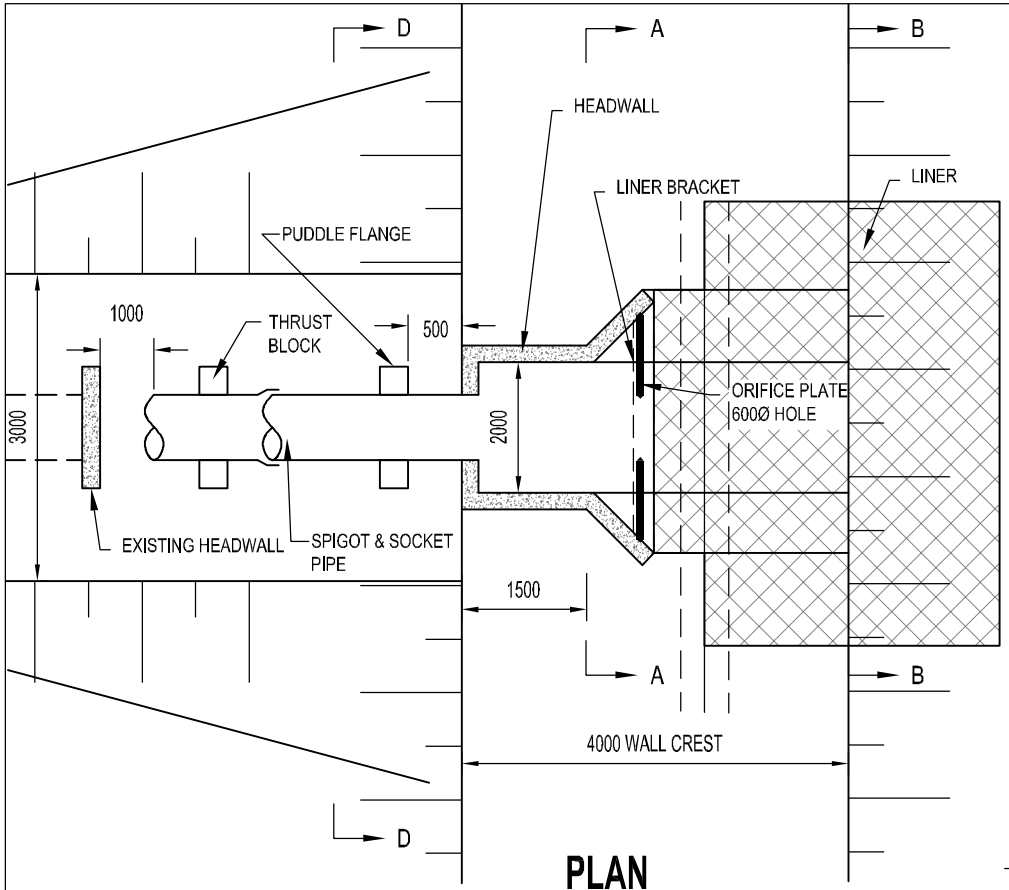
Project:
ESKOM ASH HENDRINA

Description:
AWRD EAST WALL SECTION

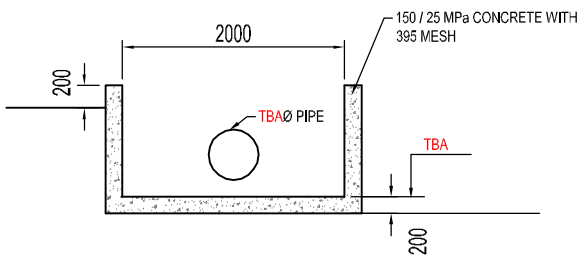
SCALE
N.T.S

SHEET 1 OF 1 SHEETS

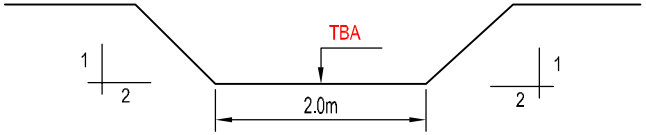
Drawing No.
618/333 A



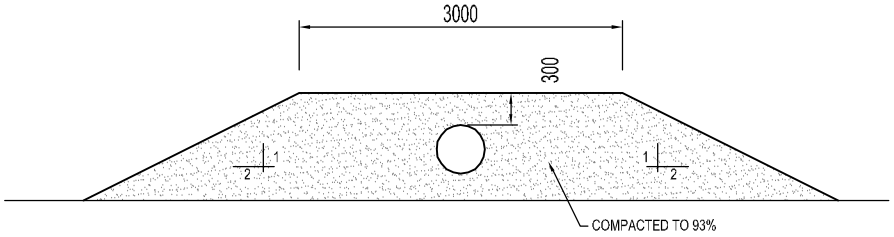
PLAN



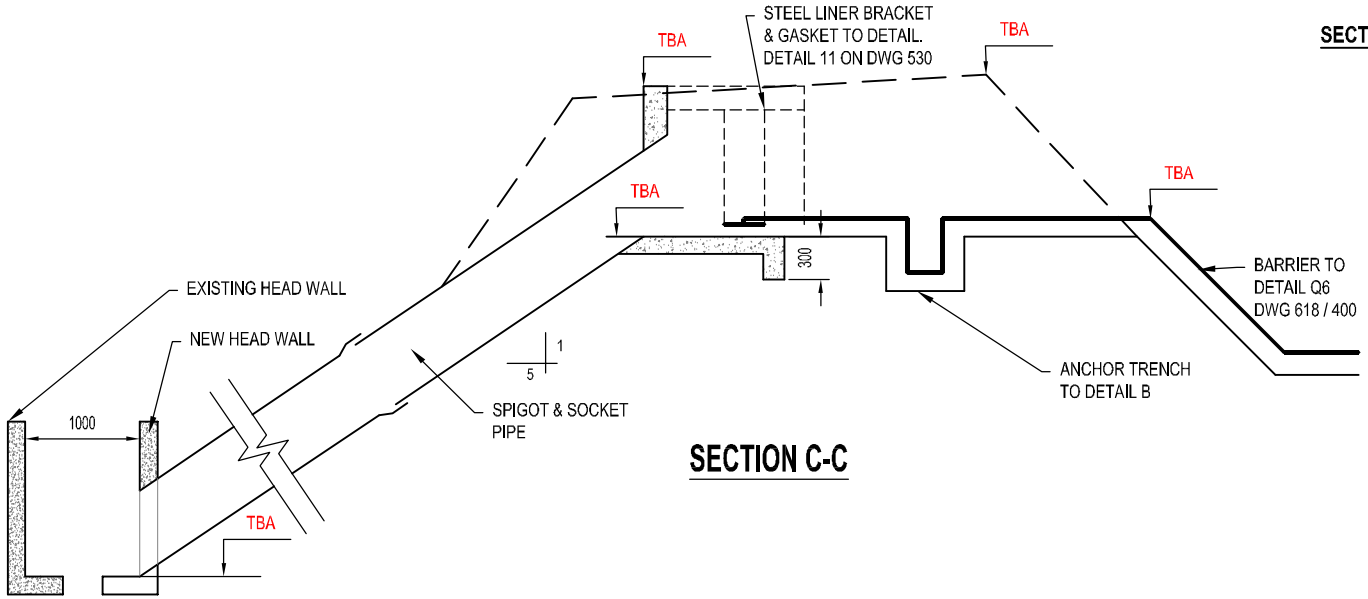
SPILLWAY (SECTION A-A)



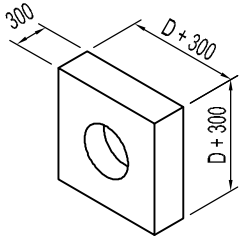
SECTION B-B



SECTION D-D (SOIL RAMP)



SECTION C-C



PUDDLE FLANGE /
CONCRETE THRUST BLOCK ON EACH JOINT

Eskom

ISSUED FOR DISCUSSION PURPOSES

No.	Amendments	Appr.	Date
A	DRAWING UPDATED		12/11/14
0	DRAWING CREATED		10/07/13

Surveyed		Book No.	
Plotted		Survey Checked	
Drawn		Drawing Checked	
Designed		Design Checked	

ECSA 750 693

For ALAN ROBINSON Pr Eng

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Fax: 086 694 657

Client:
LIDWALA

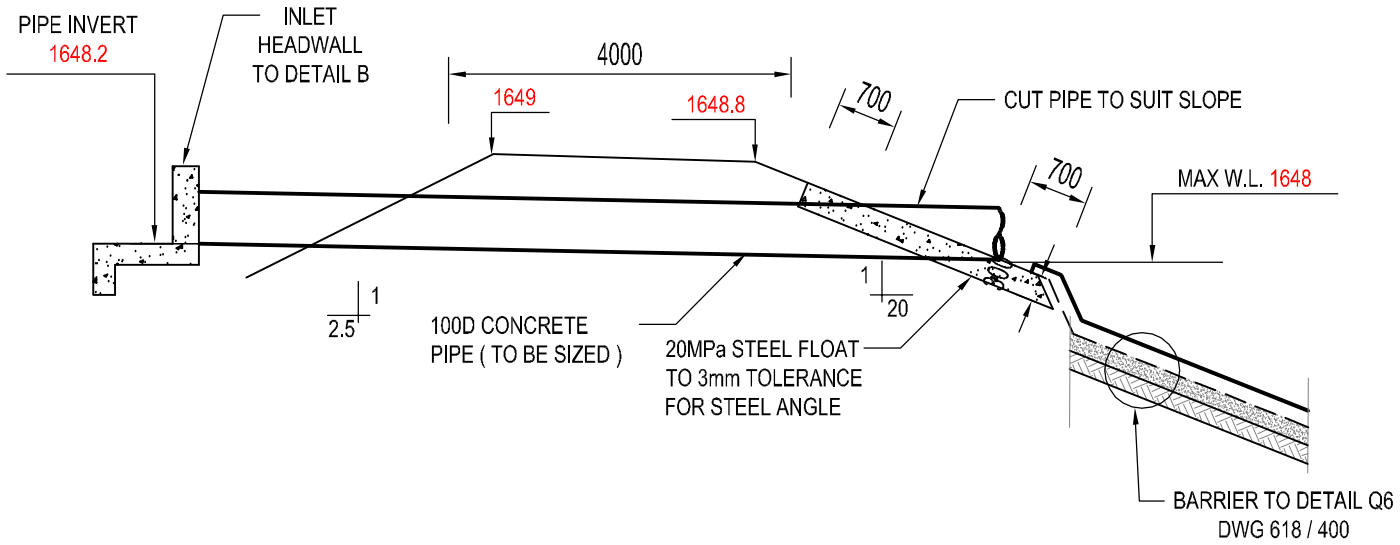
Project:
ESKOM ASH HENDRINA

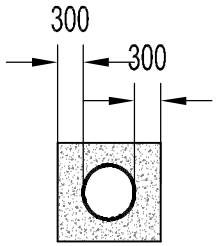
Description:
AWRD EAST & WEST PIPE SPILLWAYS

SCALE: **N.T.S**

SHEET 1 OF 1 SHEETS

Drawing No.
618/335 A





FRONT VIEW

DETAIL P - INLET (FROM SOLUTION TRENCH) TO AWRD EAST

Eskom

ISSUED FOR
DISCUSSION PURPOSES

No.	Amendments	Appr.	Date
A	DRAWING UPDATED		12/11/14
0	DRAWING CREATED		10/07/13

Surveyed		Book No.	
Plotted		Survey Checked	
Drawn		Drawing Checked	
Designed		Design Checked	

ECSA 750 693

For ALAN ROBINSON Pr Eng

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Fax: 086 694 657

Client:
LIDWALA

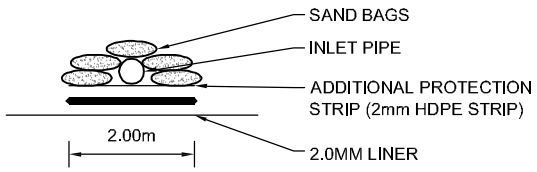
Project:
ESKOM ASH HENDRINA

Description:
AWRD EAST INLET DETAILS

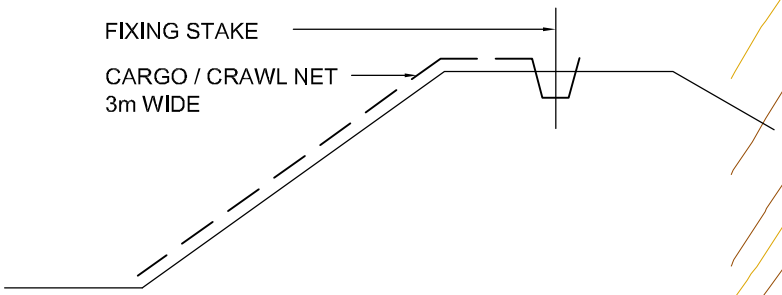
SCALE
N.T.S

SHEET 1 OF 1 SHEETS

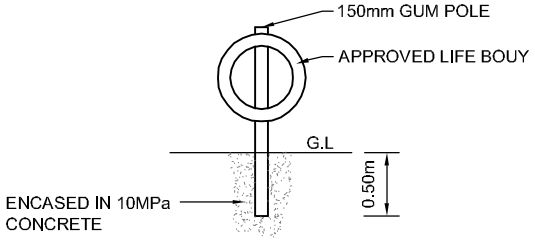
Drawing No.
618/336 A



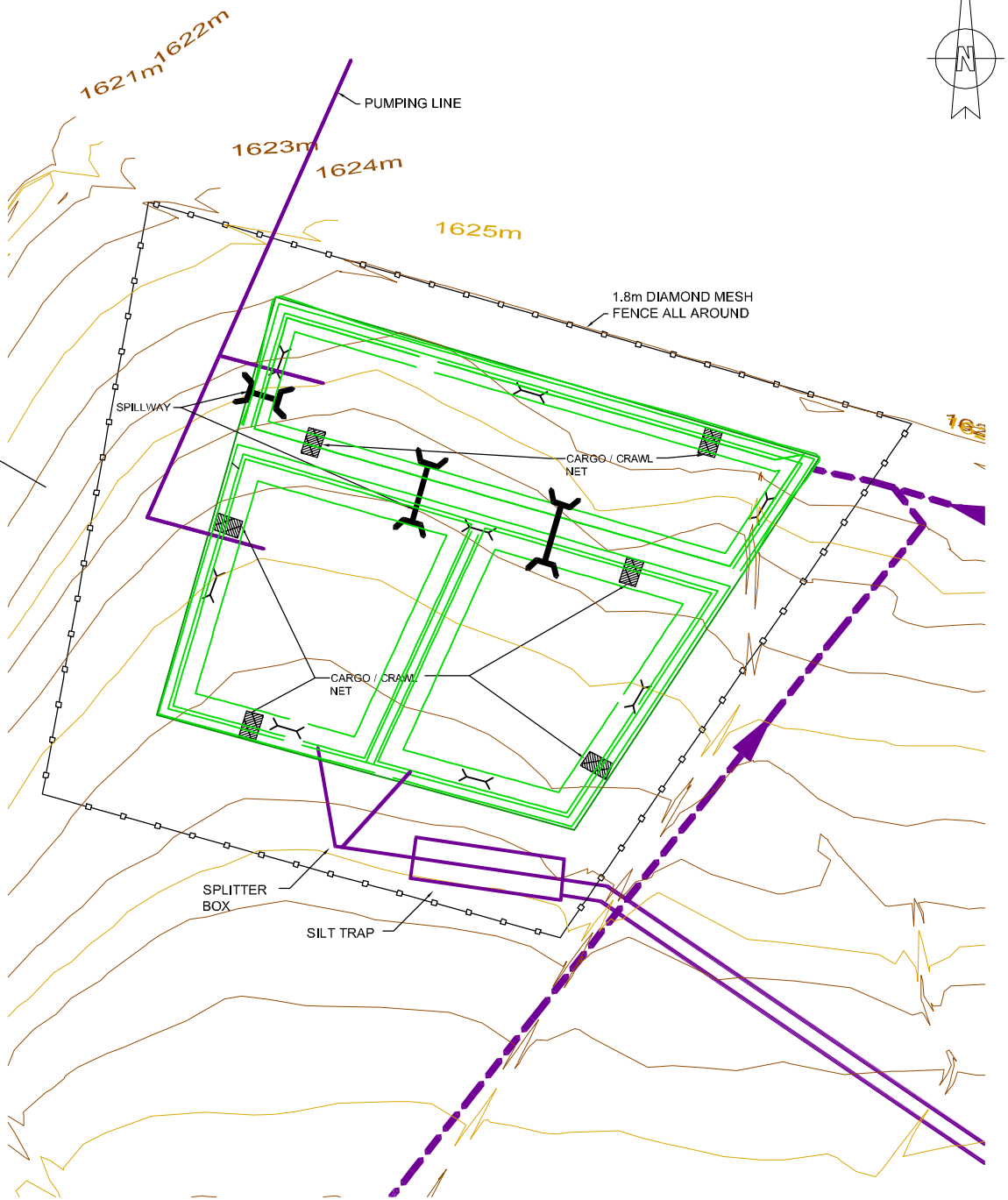
DETAIL X3 - INLET PIPE
N.T.S.

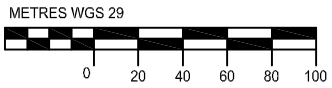


DETAIL X2 - CRAWL NET
N.T.S.



DETAIL X1 - LIFE BOUY
N.T.S.





Eskom

LEGEND

A1 +4.1 SETTING OUT POINTS & DEPTH (+ ABOVE / - BELOW GL)

NOTE:
ALL WORK IS TO BE DONE TO SABS 1200

TEST HOLE
TH1
LIFE BOUY
UNDERDRAIN (DETAIL W)
PENSTOCK PIPE
SOLUTION TRENCH
HEADWALL

ISSUED FOR DISSCUSSION PURPOSES ONLY

No.	Amendments	Appr.	Date
C	DRAWING UPDATED		16/02/15
B	DRAWING UPDATED		12/11/14
A	DRAWING UPDATED		30/10/14
0	DRAWING CREATED		10/07/13

Surveyed	Book No.
Plotted	Survey Checked
Drawn	Drawing Checked
Designed	Design Checked

ECSA 750 693

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Cell: 0826-10-12-23
Fax: 086 694 657

Client:
LIDWALA

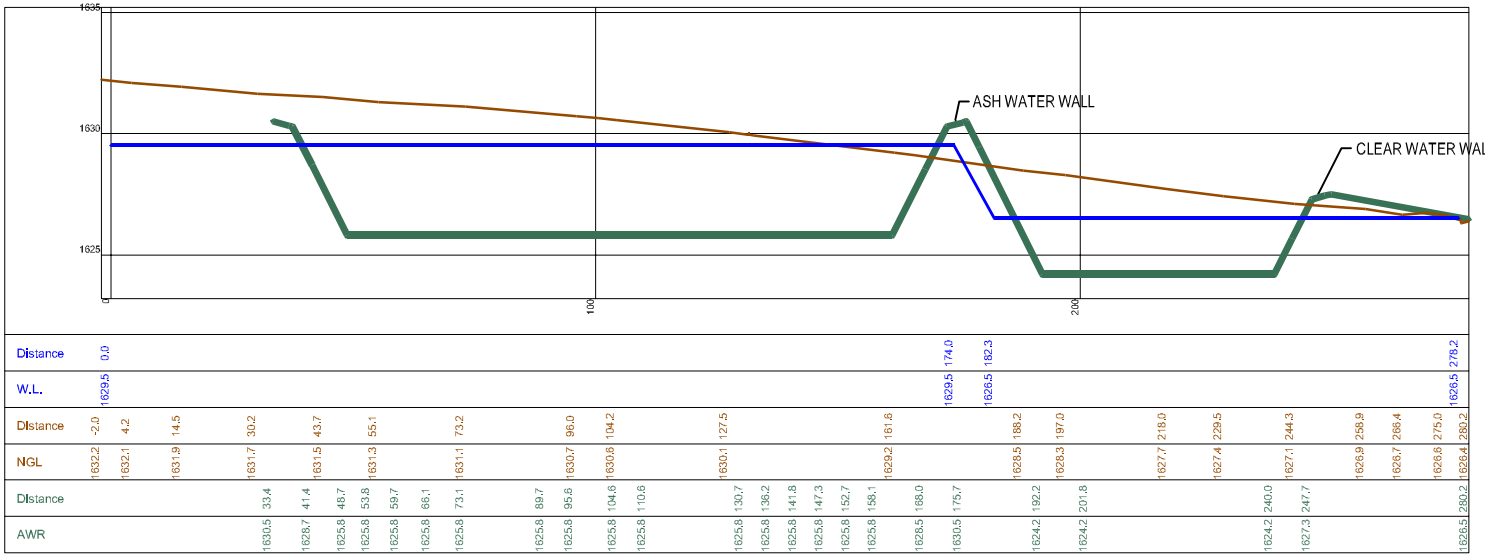
Project:
ESKOM ASH HENDRINA

Description:
AWRD WEST SAFETY DETAILS

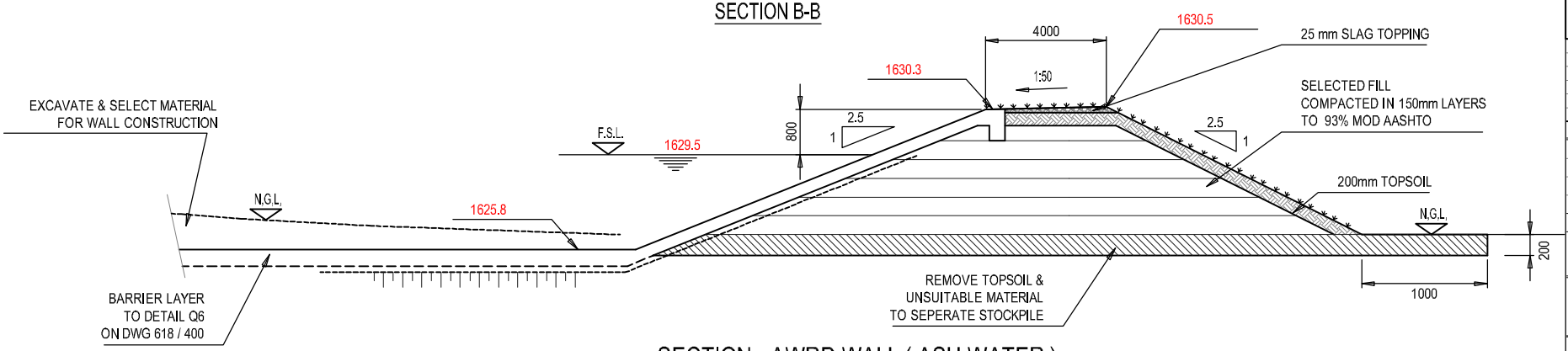
SCALE
as shown

SHEET 1 OF 1 SHEETS

Drawing No.
618/342
C

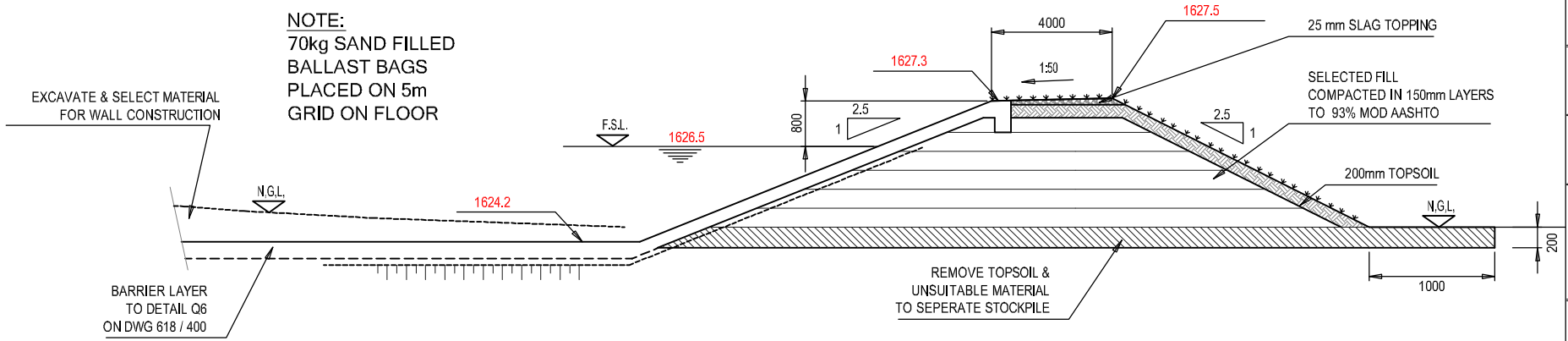


SECTION B-B



SECTION - AWRD WALL (ASH WATER)

NOTE:
70kg SAND FILLED BALLAST BAGS PLACED ON 5m GRID ON FLOOR



SECTION - AWRD WALL (CLEAR WATER)

Eskom

NOTE:
ALL WORK IS TO BE DONE TO SABS 1200

ISSUED FOR DISCUSSION PURPOSES ONLY

No.	Amendments	Appr.	Date
B	DRAWING UPDATED		16/02/15
A	DRAWING UPDATED		12/11/14
0	DRAWING CREATED		10/07/13

Designed: Book No.
Plotted: S. No. Checked
Drawn: Drawing Checked
Designed: Date Checked

ECSA 750 693

For ALAN ROBINSON Pr. Eng

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Fax: 086 894 657

Client: **LIDWALA**

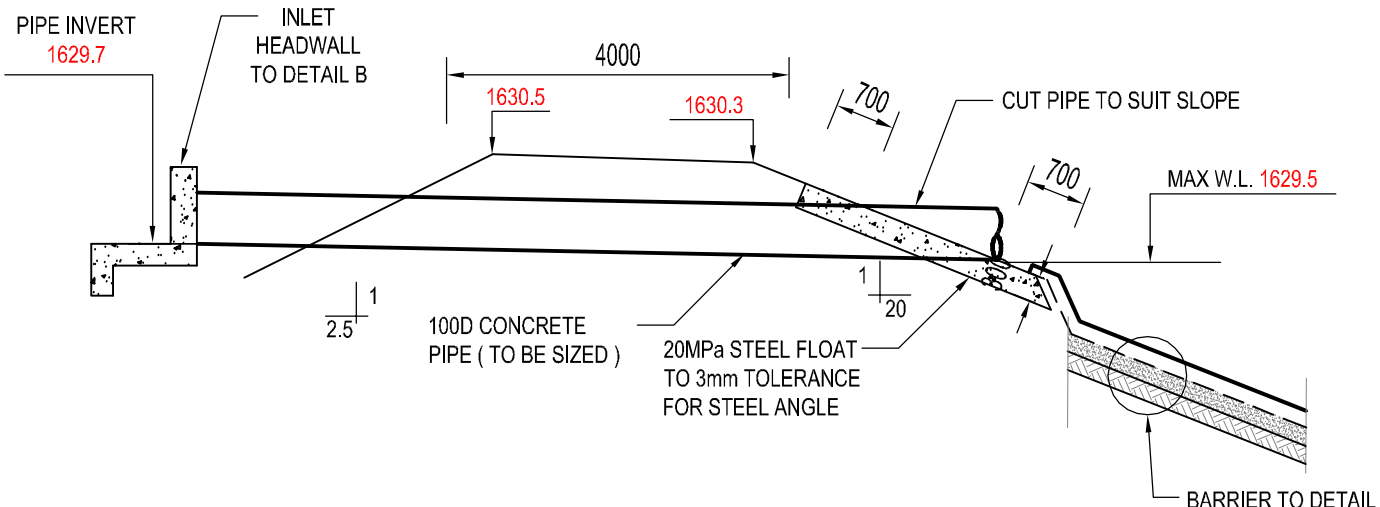
Project: **ESKOM ASH HENDRINA**

Description: **AWRD WEST (CLEAR WATER) WALL SECTION**

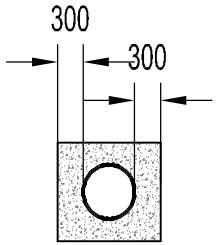
SCALE: **N.T.S**

SHEET 1 OF 1 SHEETS

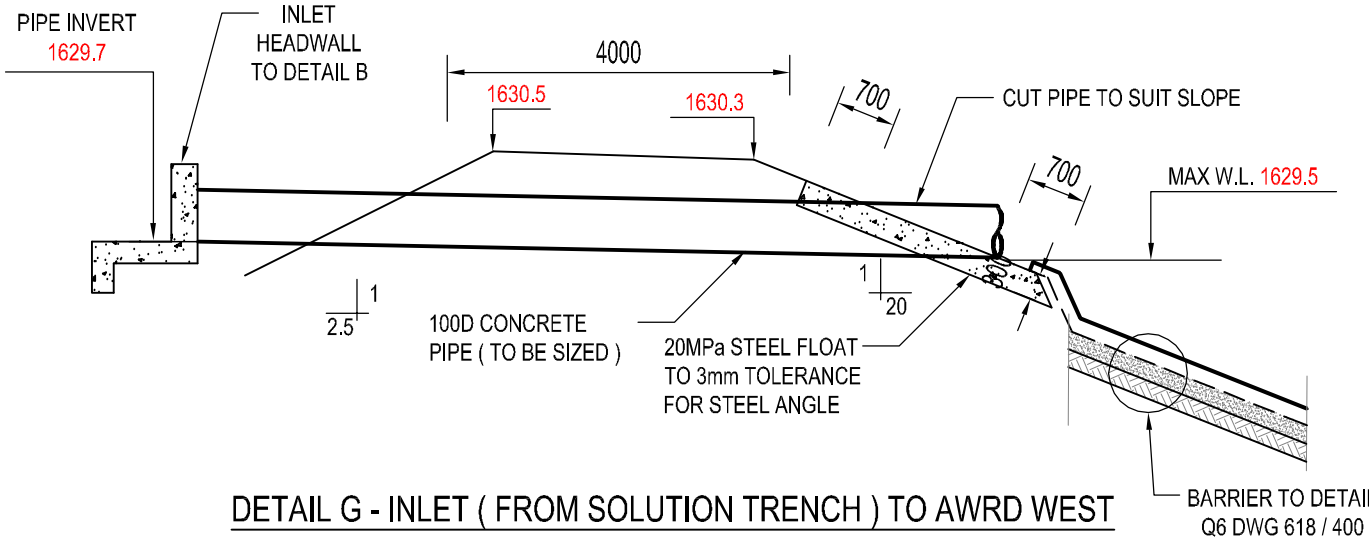
Drawing No. **618/343** B



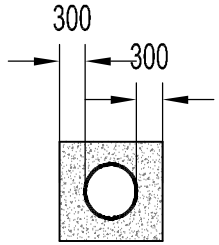
DETAIL P - INLET (FROM SILT TRAP) TO AWRD WEST



FRONT VIEW



DETAIL G - INLET (FROM SOLUTION TRENCH) TO AWRD WEST



FRONT VIEW

Eskom

ISSUED FOR
DISCUSSION PURPOSES

No.	Amendments	Appr.	Date
A	DRAWING UPDATED		12/11/14
0	DRAWING CREATED		10/07/13

Surveyed		Book No.	
Plotted		Survey Checked	
Drawn		Drawing Checked	
Designed		Design Checked	

ECSA 750 693

For ALAN ROBINSON Pr Eng

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2115

Tel: (011) 476-4266
Cell: 0826-10-12-33
Fax: 086 894 657

Client:

LIDWALA

Project:

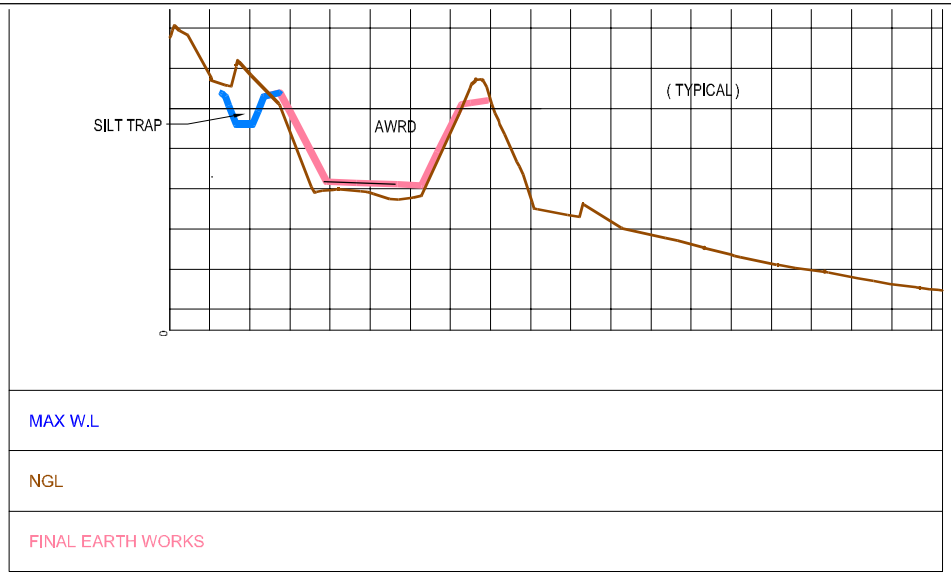
ESKOM ASH
HENDRINA

Description:

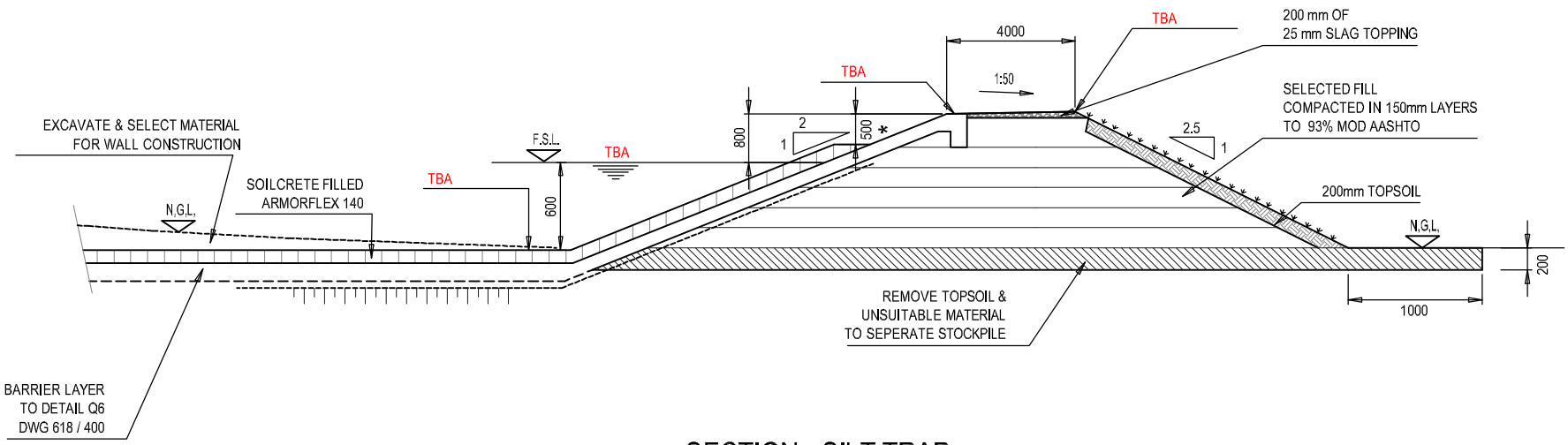
AWRD WEST
INLET
DETAILS

SCALE	SHEET
N.T.S	SHEET 1 OF 1 SHEETS

Drawing No.
618/346
A



SECTION B-B



SECTION - SILT TRAP

* NOTE:
AT THE END OPPOSITE THE RAMP INTO THE SILT TRAP THE BLOCKS ARE TO BE PLACED TO THE WALL HEIGHT

NOTE:
ALL WORK IS TO BE DONE TO SABS 1200

ISSUED FOR DISCUSSION PURPOSES ONLY

No.	Amendments	Appr.	Date
0	DRAWING CREATED		15/07/13

Surveyed		Book No.	
Plotted		Survey Checked	
Drawn		Drawing Checked	
Designed		Design Checked	

ECSA 750 693

For ALAN ROBINSON Pr Eng

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CONSULTING CIVIL & STRUCTURAL ENGINEERS
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Fax: 086 694 657

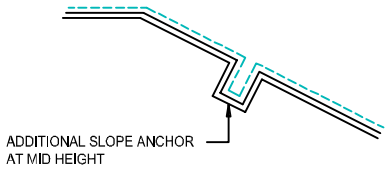
Client:
LIDWALA

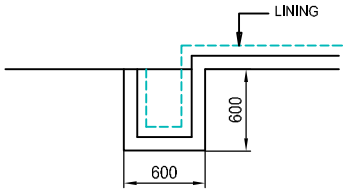
Project:
ESKOM ASH HENDRINA

Description:
SILT TRAP WALL SECTION

SCALE	SHEET 1 OF 1 SHEETS
as shown	

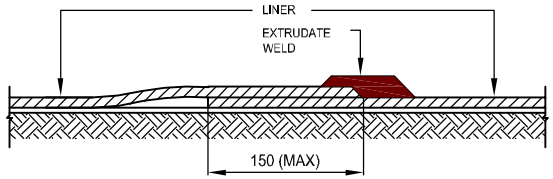
Drawing No.
618/350 0





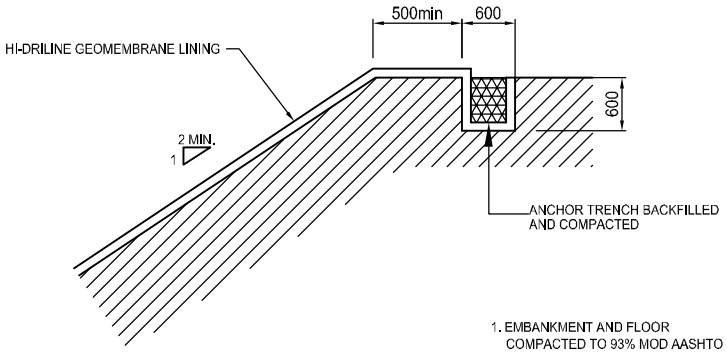
DETAIL 7

1. REFER TO THE QUALITY CONTROL CONSTRUCTION MANUEL FOR SPECIFIC DESTRUCTIVE AND NON-DESTRUCTIVE TEST METHODS.
2. ALL SHEETS NEEDED TO BE BEVELED.



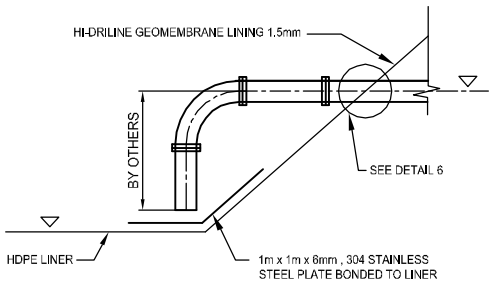
TYPICAL EXTRUSION WELD DETAIL
DETAIL 4

GENERAL LINER DETAILS
DETAIL 1

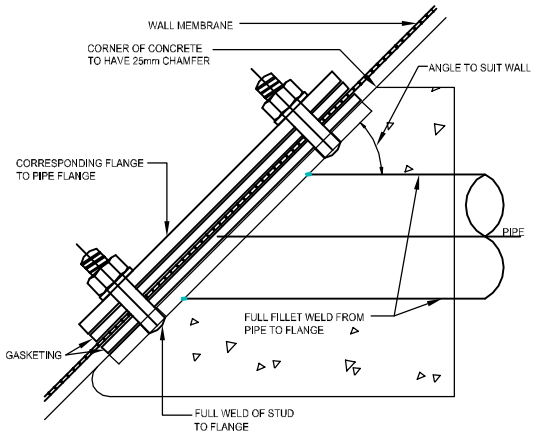


1. EMBANKMENT AND FLOOR COMPACTED TO 93% MOD AASHTO

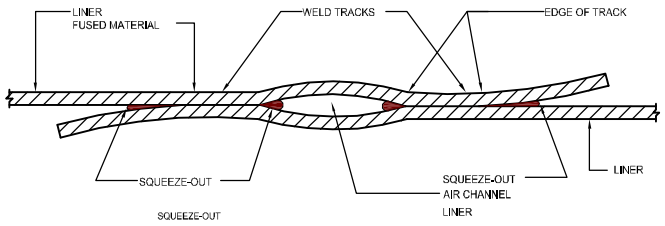
ANCHOR TRENCH DETAIL
DETAIL 2



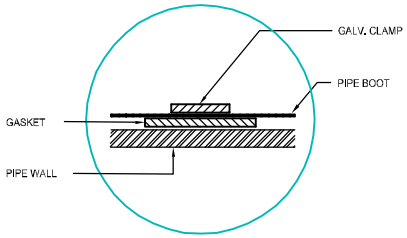
INLET / OUTLET : LINER PROTECTION
DETAIL 5

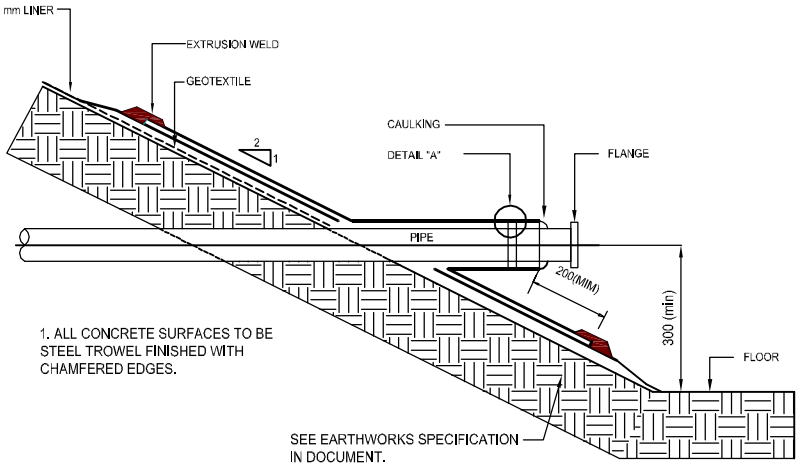


ANGLE PIPE FLANGE MAKE OFF DETAIL
DETAIL 11



TYPICAL DOUBLE FUSION HOT WEDGE WELD DETAIL
DETAIL 3





1. ALL CONCRETE SURFACES TO BE STEEL TROWEL FINISHED WITH CHAMFERED EDGES.

TYPICAL PIPE BOOT
DETAIL 6

Eskom

NOTE:
ALL WORK IS TO BE DONE TO SABS 1200 & AQUATAN SPECIFICATIONS and SANS 10406 and 1526

ISSUED FOR DISCUSSION PURPOSES

No.	Amendments	Appr.	Date
0	DRAWING CREATED		10/07/13

Surveyed	Book No.
Plotted	Survey Checked
Drawn	Drawing Checked
Designed	Design Checked

ECSA 750 693

For ALAN ROBINSON Pr Eng

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Cell: 0836-10-12-23
Fax: 086 694 657

Client:
LIDWALA

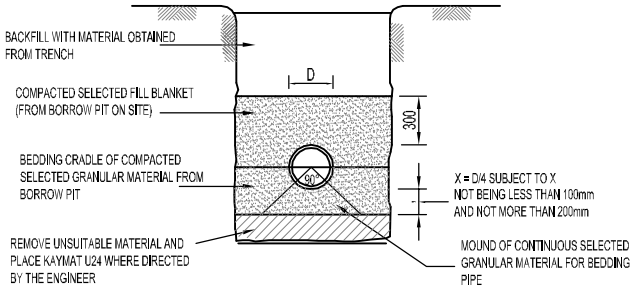
Project:
ESKOM ASH HENDRINA

Description:
HDPE LINER DETAILS

SCALE
N.T.S

SHEET 1 OF SHEETS

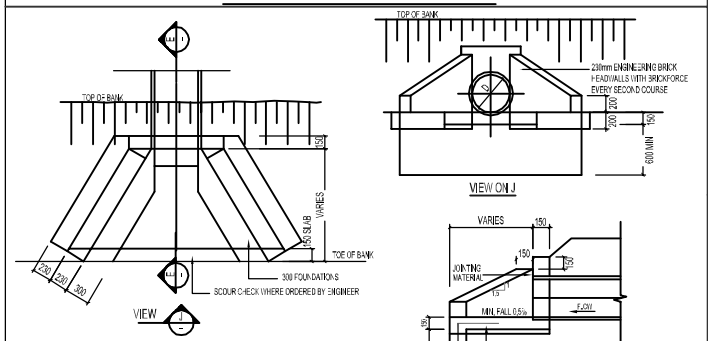
Drawing No.
618/382
0



b) RIGID PIPE ON CLASS "B" BEDDING

DETAIL F -

STORMWATER PIPE BEDDING DETAILS



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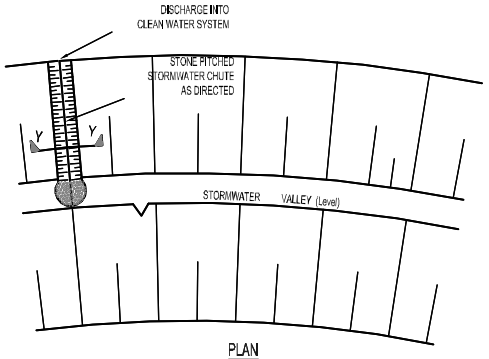

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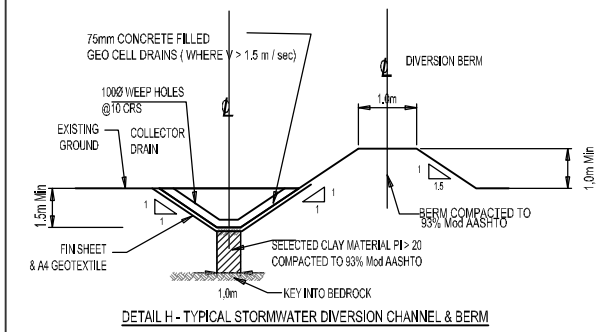
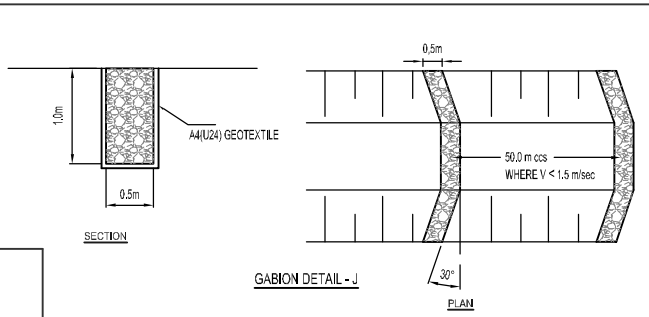
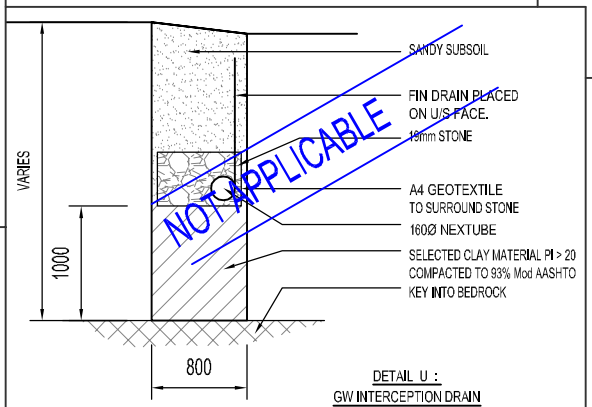
(POSITION AS DIRECTED)



DETAIL H - TYPICAL STORMWATER DIVERSION CHANNEL & BERM

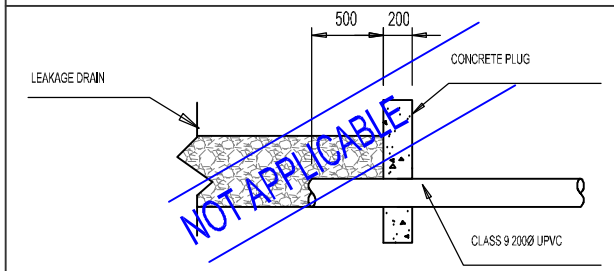


GABION DETAIL - J

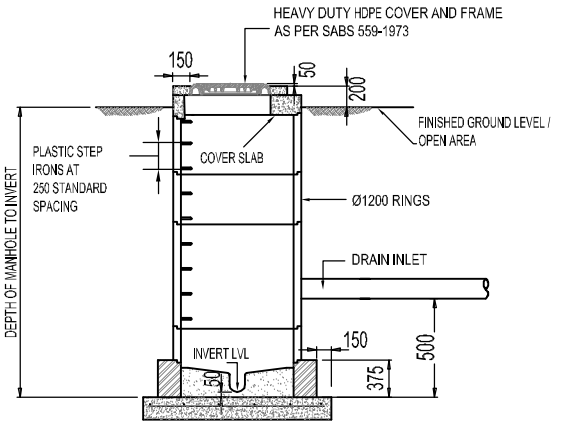


DETAIL U :

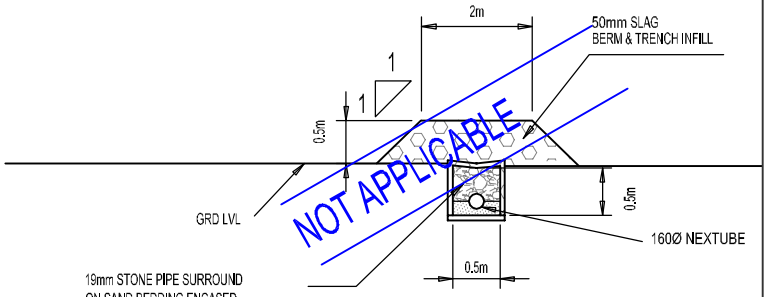
GW INTERCEPTION DRAIN



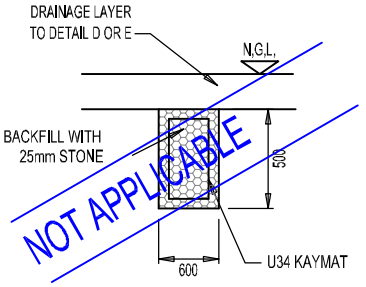
DETAIL A - DRAIN TO PIPE OUTLET (ELEVATION)



DETAIL C - CONCRETE MANHOLE



DETAIL I - SEEPAGE DRAIN



DETAIL W -

LEAKAGE DETECTION DRAIN

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ESKOM ASH HENDRINA

Description:

STANDARD DETAILS SHEET 1

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Drawing No.

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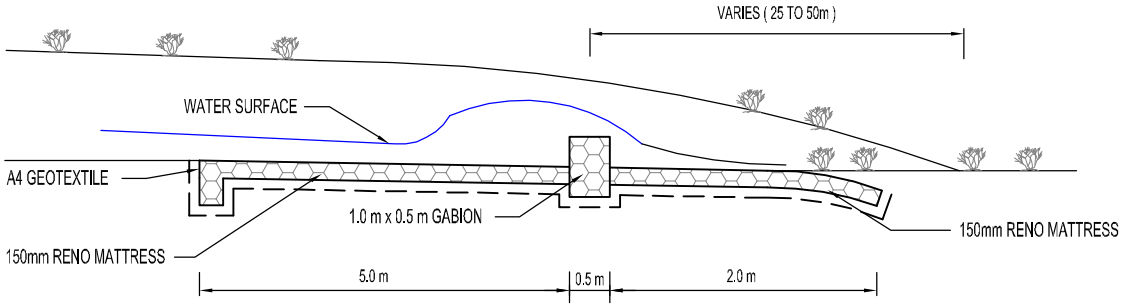

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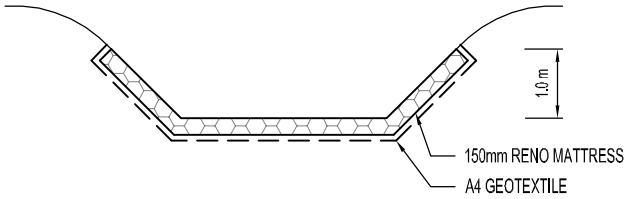
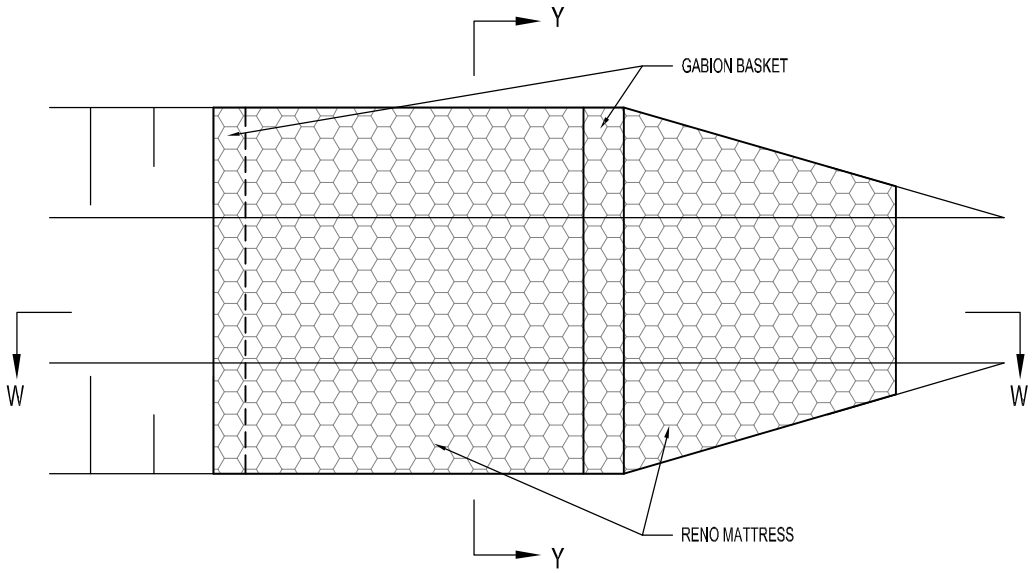
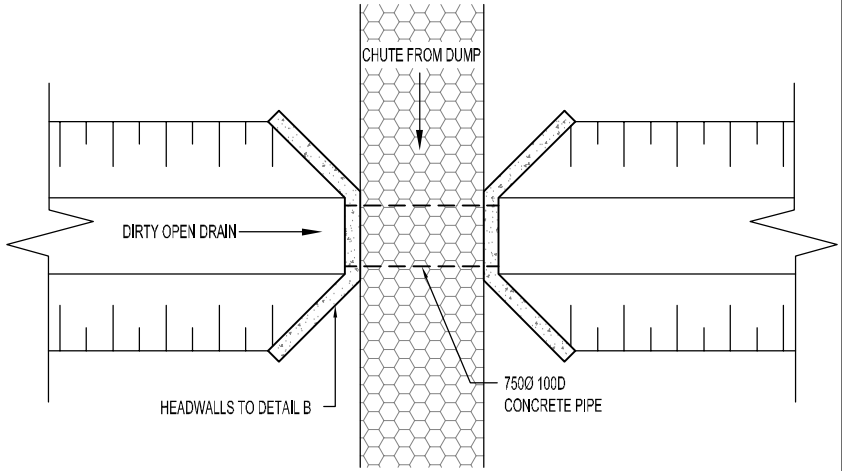


TYPICAL SECTION Y-Y



PLAN - OF OPEN CHANNEL



PIPE CROSSING - DETAIL B1

DETAIL - Z OPEN CHANNEL OUTLET

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Description: ENERGY DISSIPATION STRUCTURE &PIPE CROSSING

SCALE N.T.S

SHEET 1 OF 1 SHEETS

Drawing No. 618/386 0

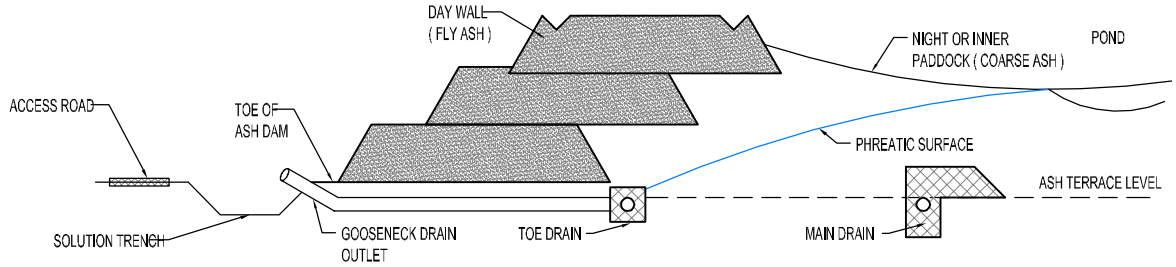

FIG 2.2 - DUMP DRAINAGE

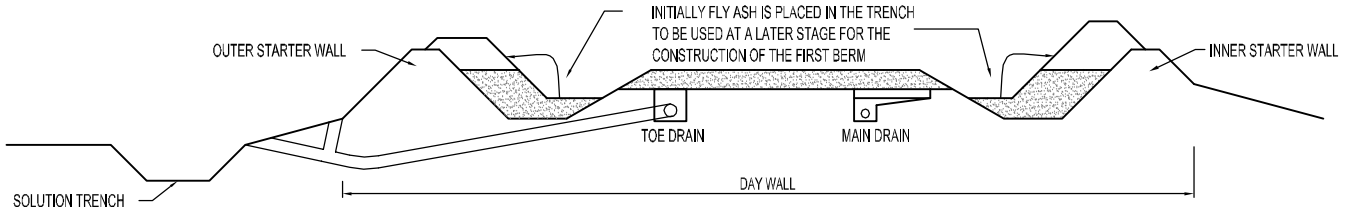

FIG 3.1 - SECTION THROUGH ASH DAM INDICATING CONSTRUCTION OF THE FIRST ASH BERMS

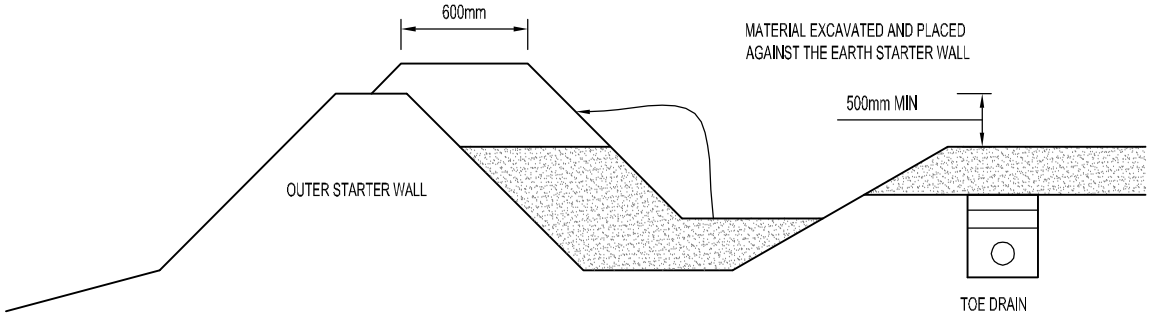

FIG 3.2 - CONSTRUCTION OF THE FIRST BERM & STEP

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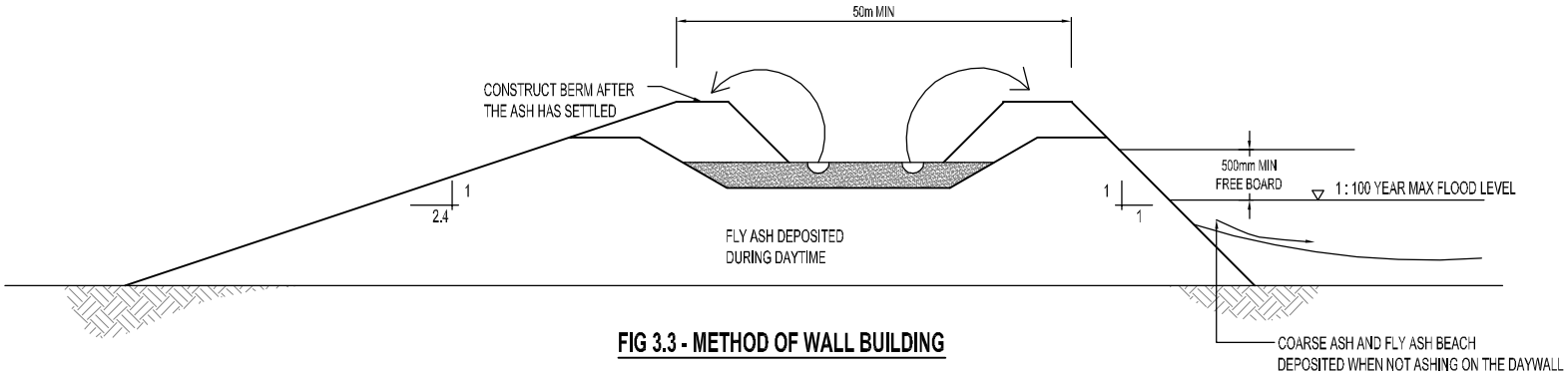
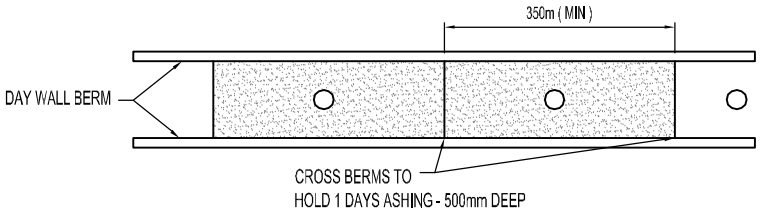
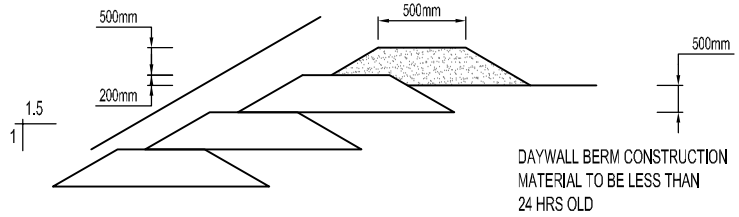


FIG 3.3 - METHOD OF WALL BUILDING

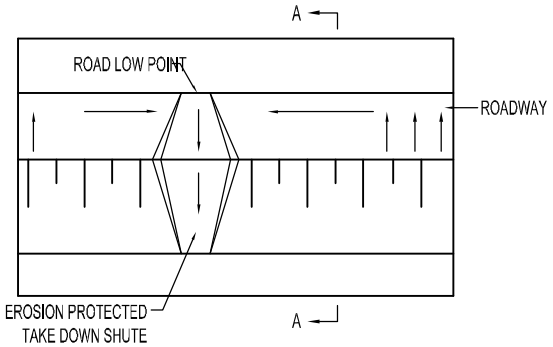


PLAN



SECTION

FIG 3.4 - CROSS BERMS ON DAYWALL



PLAN - BERM DRAIN

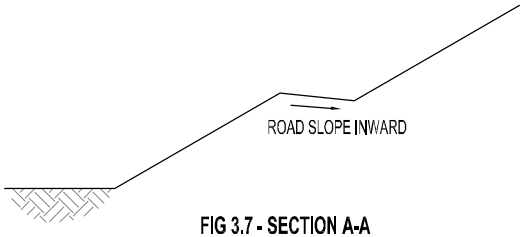


FIG 3.7 - SECTION A-A

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WADF STANDARD DETAILS SHEET 2

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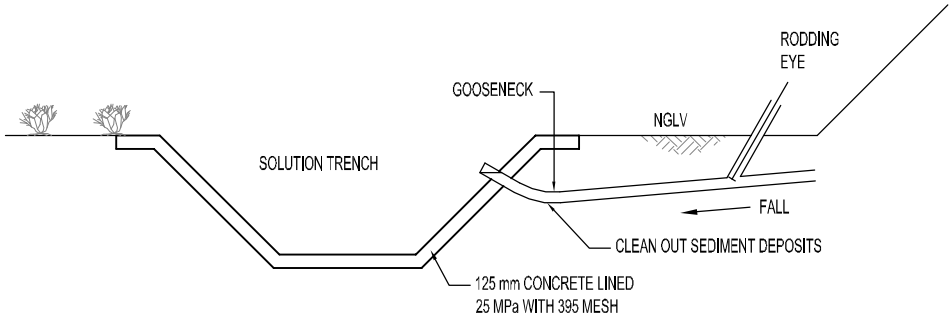

FIG 3.8 - SECTION

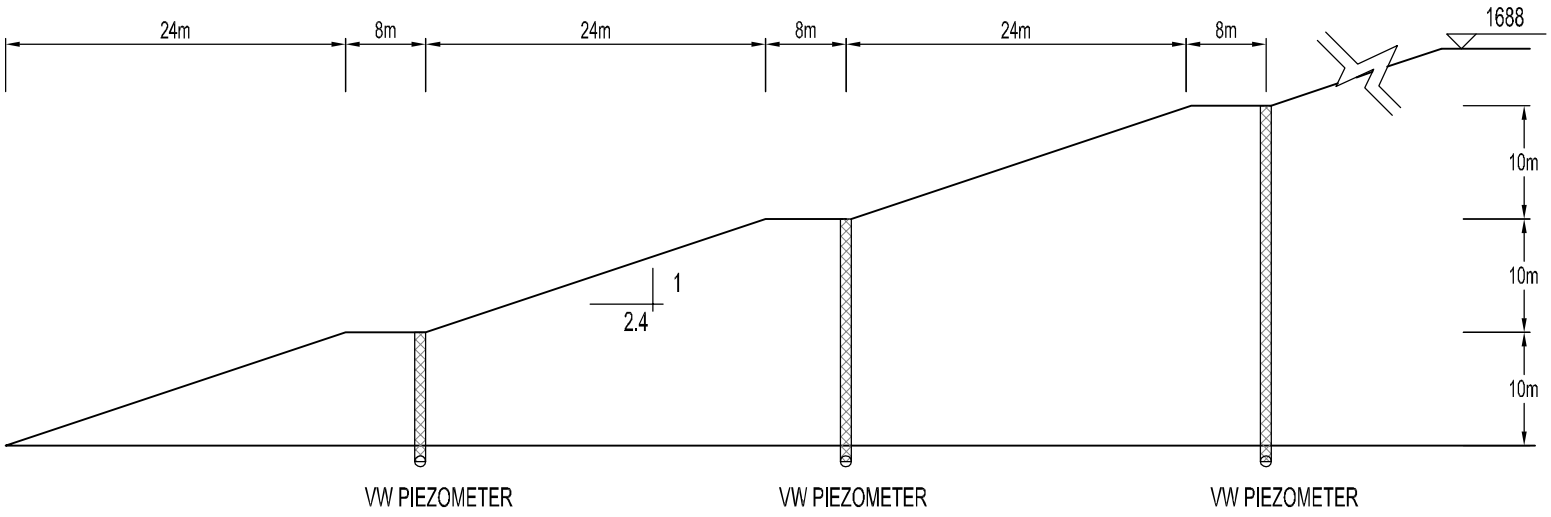

FIG 3.15 - PROPOSED PIEZOMETER POSITIONS

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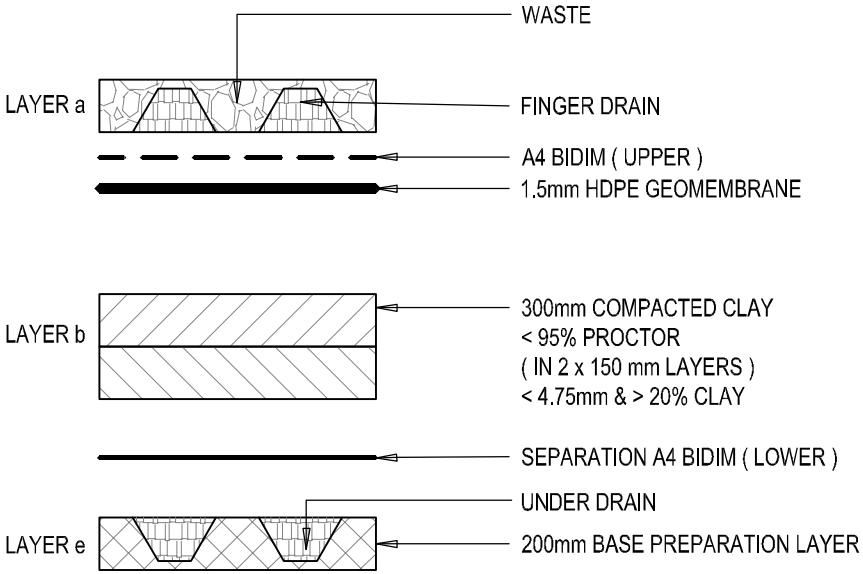
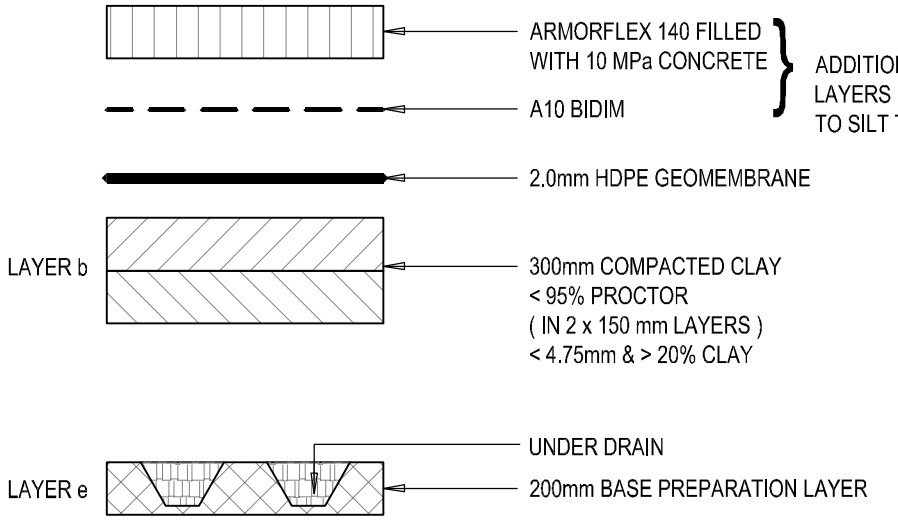


DETAIL Q5 (WET ASH)
(CLASS C BARRIER)



DETAIL Q6 (AWRD)
(CLASS C BARRIER)

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B	DETAILS UPDATED		13/11/14
A	DETAILS UPDATED		30/10/14
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Project:
ESKOM ASH
HENDRINA

Description:
WADF & AWRD
BARRIER DETAILS

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N.T.S	SHEET 1 OF 1 SHEETS

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618/400 C

APPENDIX B
WATER BALANCE

Report by ILANDA Water Services

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REPORT ON

HENDRINA ASH DAM WATER BALANCE

Report No : 0096-Rep-001 Rev 4

Submitted to:

Alan Robinson Consulting Civil & Geotechnical Engineers
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February 2015 0096

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REVISION TRACKING

Rev 0: Original document

Rev 1: Review comments addressed

Rev 2: Water balance diagram updated

Rev 3: West AWRD capacity updated

Rev 4: Minor text changes

1 INTRODUCTION

Alan Robinson Consulting Civil & Geotechnical Engineers commissioned iLanda Water Services CC to calculate the water balance for the proposed Hendrina Ash Dam. This report details methods of analysis, the water balance results and the hydrology relating to the ash dam for a pre-feasibility study.

2 STUDY OBJECTIVES

The study objectives are as follows:

- Size the ash water return dam
- Size the decant system
- Size the return water pumping system

3 CLIMATE DATA SUMMARY

Monthly rainfall data for the area was obtained from the CCWR (Computing Centre for Water Research, Natal University) database. Gauge number 0516480 (Schoonoord) was used. Evaporation data and its monthly distribution were sourced from the Water Resources of South Africa Study data set, zone 4A (Midgley et al., 1990). Runoff factors were informed by average runoff for the quaternary catchment B12B, documented in the Water Resources of South Africa Study report (Middleton et al., 2009).

The mean annual precipitation and mean annual evaporation data are presented in Table 1.

Table 1: Climate data summary

Parameter	Value (mm)
Mean annual rainfall	648
Mean annual evaporation (S-Pan)	1 552

3.1 Storm Events

Peak rainfall data was sourced from Adamson's (Adamson, 1981) TR102 gauge 0516480 (Schoonoord). The 50-year and 100-year, 24-hour rainfall depths are presented in Table 2.

Table 2: Peak 24-hr rainfall depths

Recurrence Interval	24-hr rainfall depth (mm)
50-year	126
100-year	144

4 WATER BALANCE METHODOLOGY

The water balance is a continuous monthly time step water balance. The water balance represents average flows between components and along hydrological interfaces.

A static average water balance diagram is provided in Appendix A. The diagram represents average flows between components and along hydrological interfaces. These are the average flows, as calculated by the continuous monthly water balance. The inflows are presented on the left of the water balance diagram. The components and inter-facility flows are shown in the centre of the water balance diagram. The outflows are shown on the right of this diagram. The direction of water movement is shown in black arrows. The values next to the arrows represent average flows in m^3/day. Clean water flows are shown in blue, while dirty flows are shown in red.

The continuous monthly water balance contains the following components:

- Ash dam wet beach
- Ash dam dry beach
- Ash dam pool
- Slurry stream (slurry water)
- Decant stream
- Ash return water dam
- Return water stream (return water)

The power station is external to the water balance and is assumed to be a source of slurry water and a receptor of return water. The make-up source is included in the slurry water.

The main inflows (sources) and outflows (sinks) are:

<u>Inflows (Sources)</u>

- Rainfall falling on the ash dam basin.
- Slurry water.

<u>Outflows (Sinks)</u>

- Evaporation losses from the ash dam and ash return water dam.
- Seepage to deep groundwater from the ash dam basin and ash return water dam (both these facilities are lined).
- Interstitial lockup in the ash dam.
- Return to plant.

One of the fundamental principles of a water balance is that inflows must equal outflows unless the difference is accommodated in storage changes. The water balance is a steady state water balance and therefore storage changes are assumed to be zero.

Runoff factors for the dry beach were based on experience and documented runoff factors of catchments in similar climates in South Africa - documented in the Water Resources of South Africa, 2005 Study (Middleton and Bailey, 2009). The input data is summarised in Appendix B.

5 WATER BALANCE RESULTS

5.1 Make-up and Return

The water balance is a deficit water balance, and significant quantities of make-up water will be required. The make-up requirements are seasonal. During the wet season, storm water will be harvested from the ash dam basin and the external catchment above the ash dam. Returns consequently increase and make-up requirements decrease. The opposite is true during the dry season.

The average annual return is 79% of the slurry water. The low density slurry results in interstitial and evaporative losses forming a small percentage of the total water in the system.

Make-up demands range between 2 650 m^3/day and 6 700 m^3/day. The monthly water balance results were statistically analysed to produce monthly average return and make-up flows. These are presented in Figure 1.

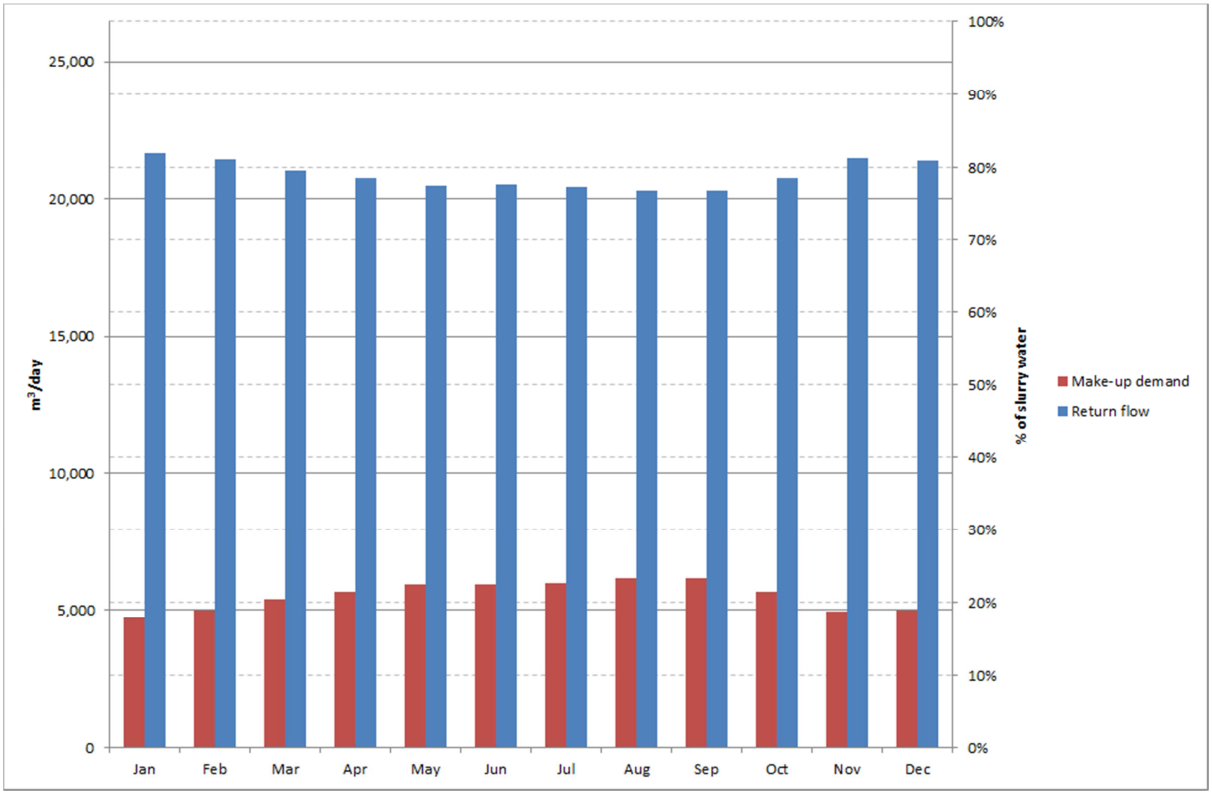


Figure 1: Monthly Average Return and Make-up Flows

5.2 Decant System and Pool Control

The penstock is sized to remove the runoff generated by a 50-year, 24-hour design storm in 3 days. This is to minimise the time that a large pool is stored on the ash dam basin. The storm water volume generated during a 50-year, 24-hour storm event is approximately 123 500 m^3. The ash dam requires a penstock capable of decanting 41 170 m^3/day, or 1 715 m^3/hr, assuming a 24-hour decanting day. Two 750 mm diameter penstocks or three 510 mm diameter penstocks will have sufficient capacity to decant this volume with a depth of no more than 160 mm above the penstock crest. The outlet pipe should have a capacity larger than the required decant rate.

This will ensure that the pool volume rarely exceeds 50 000 m^3 provided the penstock is operated to the design intent. Water should not be stored on the ash dam basin. This will have the benefit of reducing water losses, decreasing make-up volumes, increased consolidation rates of the ash and increasing the stability of the ash dam.

5.3 Ash Water Return Dam Sizing and Management

The ash water return dam must comply with Government Notice 704 of the South African National Water Act, Act 36 of 1998. The dam sizing methodology was therefore based on the excess water resulting from a long term monthly water balance, plus the 50-year storm runoff volume. The 50-year storm was added to the monthly time series because individual storms during the month are not modelled and are averaged out during the month.

In view of the above, it is concluded that the ash water return dam should have a capacity of at least 123 000 m^3. The ash return water dams may require registration with the Department of Water Affairs' Dam Safety Office. Topography and site specific water management requirements dictate that three dams are required. The three dams are described below:

The main return water dam (West AWRD – North Paddock) should have a capacity of at least 31 600 m^3. This water should be pumped empty at a rate of at least 7 l/s. The main return water dam (West AWRD – South Paddock) should have a capacity of at least 91 400 m^3. The penstocks should discharge into this dam via a silt trap.

A 10 000 m^3 dam (East AWRD) is required in the eastern side of the ash dam to collect storm water from the ash dam sides and drainage water from the south western corner of the ash dam. This water should be pumped into the solution trench and run down to the main return water dam (West AWRD) and then returned to the power station, either directly or via the existing AWR dams. The pumps should have a capacity of at least 3.5 l/s. This dam will only be required once the ash dam rises above the topography in the south eastern corner. It therefore does not contribute to the 123 000 m^3 required dam capacity in the early years of the dump life.

The ash return water dams should be operated as empty as possible and not used to store water for future consumption. All captured storm water should be consumed as fast as possible. If operated correctly, the dams should be mostly dry and should only contain water for short periods after large storms. The locations of the dams are shown in Figure 2.

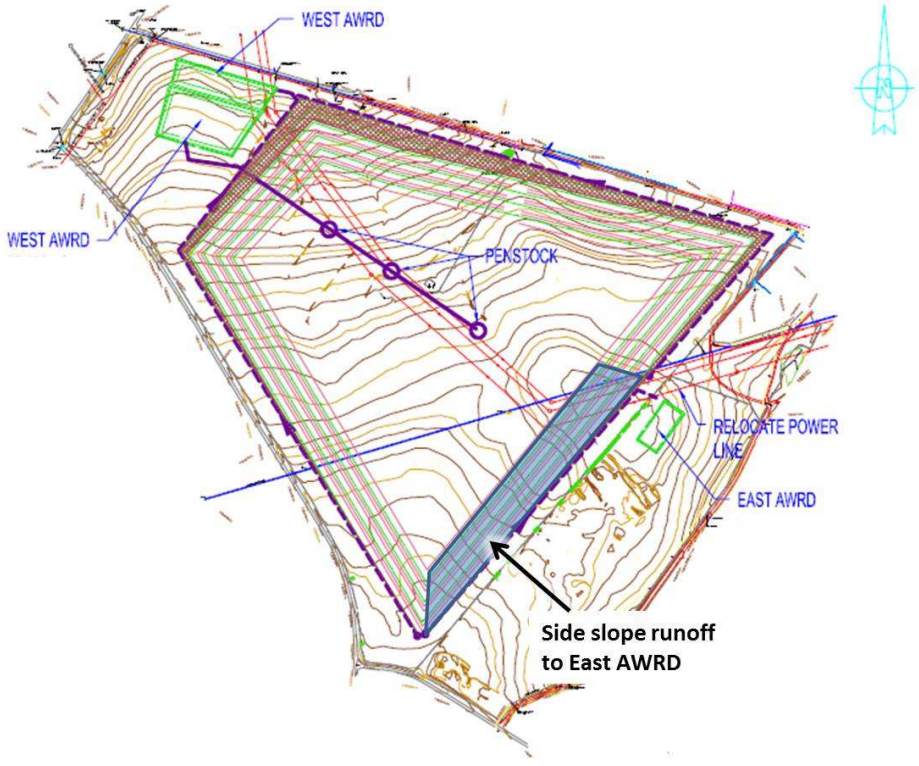


Figure 2: Location of ash water return dams

5.4 Return Water System

The water return system should be sized to return at least 100% of the slurry water requirement. This is 805 044 m^3/month, or 26 500 m^3/day. This equates to 1 200 m^3/hr for a 22-hour pumping day.

6 REFERENCES

Middleton, B.J. and Bailey, A.K.. *Water Resources of South Africa, 2005 study (WR2005)*, 2009. WRC Report No TT 382/08.

ILANDA WATER SERVICES

BN Randell
C:\ILANDA\PROJECTS\0096 HENDRINA WATER BALANCE\REPORT\REV 4\0096-REP-001 REV 4 HENDRINA ASH DAM WATER BALANCE.DOCX

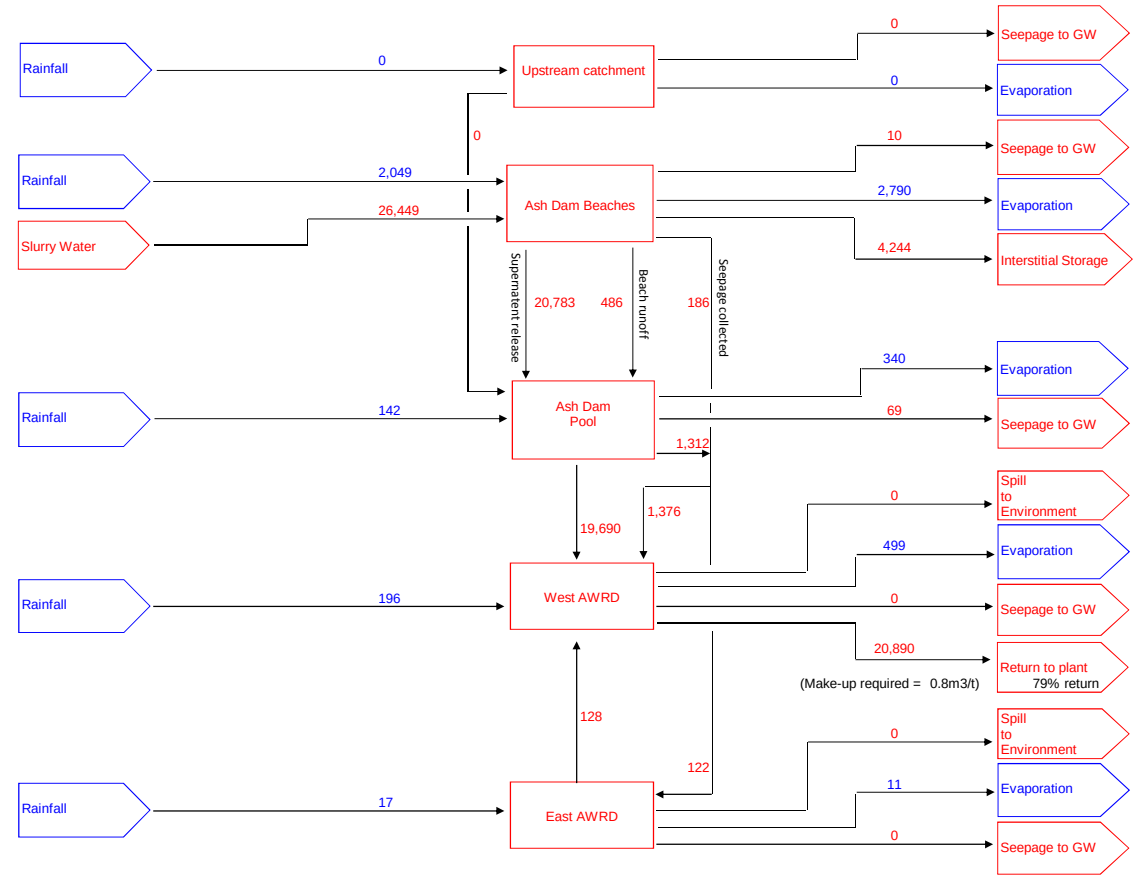
APPENDIX A

WATER BALANCE DIAGRAM

Daily Average: m³/day

Rev 4

Hendrina Ash Dam
Water balance



Prepared by

Total Inflows
28,853

Total Outflows
28,853

Legend

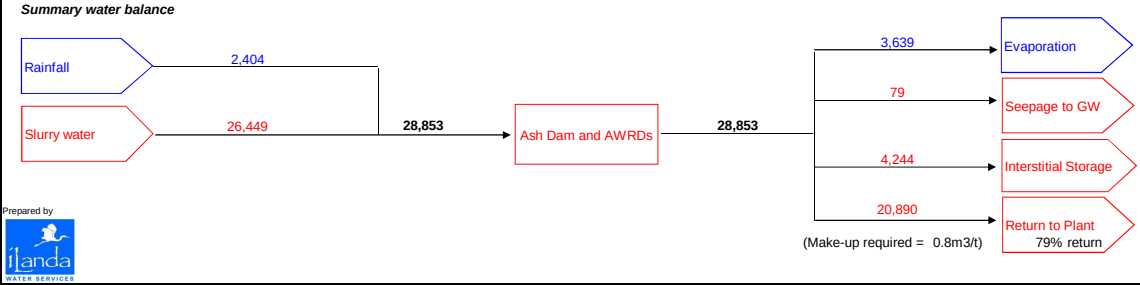
000 Dirty Flow (m³/day)
000 Clean Flow (m³/day)

Note: These flows are rounded to zero decimal places for clarity. Consequently some flows may appear out of balance

Daily Average: m³/day

Rev 4

Hendrina Ash Dam
Summary water balance



Prepared by

Legend

000 Dirty Flow (m³/day)
000 Clean Flow (m³/day)

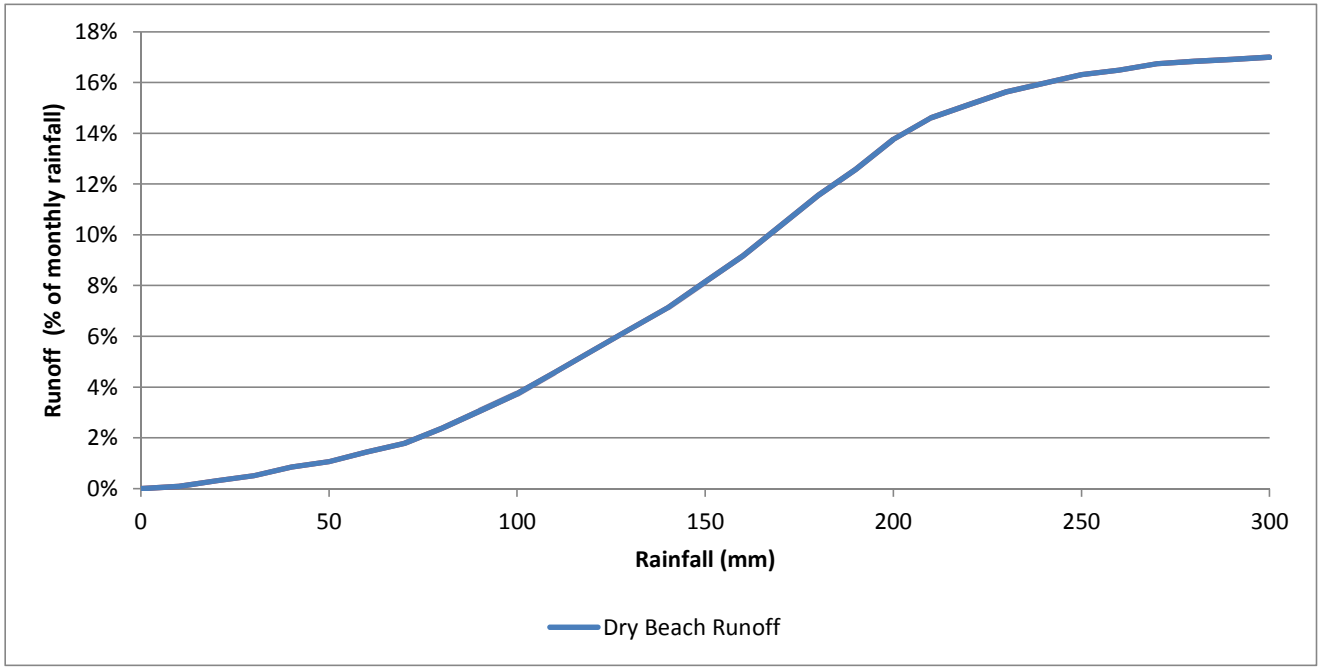
Note: These flows are rounded to zero decimal places for clarity. Consequently sone flows may appear out of balance

APPENDIX B

INPUT INFORMATION

Parameter	Value	Units	Source
Deposition rate	210,784	tpm	Alan Robinson
SG	2.36		Alan Robinson
Slurry density	20.8%	solids by mass	Alan Robinson
Ash placed density	55.0%	solids by mass	Estimate based on experience of similar projects
Ash consolidated density	62.0%	solids by mass	Estimate based on experience of similar projects
Ash consolidated dry density	0.96	tonne/m3	Estimate based on experience of similar projects
Interstitial storage	16%	of slurry water	Estimate based on experience of similar projects
Ash dam basin area	1,234,297	m^2	Alan Robinson
Max pool area	80,000	m^2	Estimate based on experience of similar projects
Pool seepage rate	2.00E-07	m/s	Estimate based on experience of similar projects
Wet beach size	25%	of total beach area	Estimate based on experience of similar projects
Wet beach runoff factor	80%		Estimate based on experience of similar projects
Ash dam upstream catchment	0	m^2	Alan Robinson

Catchment and dry beach rainfall/runoff response



APPENDIX C

BUDGET COSTING

HENDRINA AWRD's - REV C

1 - SITE ESTABLISHMENT

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
1.1		1 - SITE ESTABLISHMENT					
1.1.1		Site Establishment (fixed)	LS	1.0	0.00	0	00
1.1.2		Site Establishment (time)	mths	12.0	0.00	0	00
1.1.3		Preliminary and General (fixed)	LS	1.0	5344225.00	5344225	00
1.1.4		Preliminary and General (time)	mths	12.0	0.00	0	00
Total Carried Forward To Summary						5344225	00
2.1		2 - SITE CLEARING					
		Clearing and grubbing					
2.1.1		(a) Drainage channels & drains	ha	1.0	10000.00	10000	00
		Clearing and grubbing within "footprint" including bush and trees.					
2.1.2		(a) AWRD (East)	ha	1.3	15000.00	19500	00
2.1.3		(b) AWRD (West)	ha	6.0	15000.00	90000	00
2.1.4		c) Silt Trap	ha	0.1	15000.00	1500	00
2.1.5		Load to clear, haul and dump existing stockpiles on site as directed. (Provisional)	m³	0.0	0.00	0	00
Total Carried Forward To Summary						121000	00
3.1		3 - EXCAVATIONS					
		Note: No "double" handling from stockpiles will be paid for, unless indicated.					
		Excavations for clean Stormwater diversion trench and berm construction to Detail.					
3.1.1		(a) AWRD	m³	100.0	30.00	3000	00
		Remove topsoil within dam footprint to nominal depth of 200mm and stockpile on site within 1,0km					
3.1.2		(a) AWRD (East)	m³	2600.0	20.00	52000	00
3.1.3		(b) AWRD (West)	m³	12000.0	20.00	240000	00
3.1.4		(c) Silt Trap	m³	200.0	20.00	4000	00
		Excavate to stockpile from basin					
3.1.5		a) AWRD (East)	m³	17300.0	25.00	432500	00
Total Carried Forward						731500	00

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
Brought Forward						731500	00
3.1.6		b) AWRD (West)	m³	151000.0	25.00	3775000	00
3.1.7		c) SiltTrap	m³	1000.0	25.00	25000	00
		Excavate selected material to stockpile for clay liner for AWRD (East)					
3.1.8		(a) To layer b (2 x150mm)	m³	0.0	25.00	0	00
3.1.9		(b) To layer d (1x 200mm)	m³	0.0	25.00	0	00
		Excavate selected material to stockpile for clay liner for AWRD (West)					
3.1.10		(a) To layer b (2x150)	m³	15000.0	25.00	375000	00
3.1.11		(b) To layer d (1x200mm)	m³	0.0	25.00	0	00
		Excavate selected material to stockpile for clay liner for SILT TRAP					
3.1.12		(a) To layer b (2x150mm)	m³	600.0	25.00	15000	00
3.1.13		(b) To layer d (1x200mm)	m³	0.0	25.00	0	00
		Excavate selected material from stockpile for Base preparation Layer g					
3.1.14		(a) AWRD (East)	m³	0.0	30.00	0	00
3.1.15		(b) AWRD (West)	m³	0.0	30.00	0	00
3.1.16		c) Silt Trap	m³	0.0	30.00	0	00
3.2		POOR SUBGRADE					
3.2.1		Excavate unsuitable soft and wet material to spoil	m³	1500.0	35.00	52500	00
3.2.2		Supply and place A6 Geotextile to floor of excavation if required as directed (provisional)	m²	5000.0	15.00	75000	00
3.2.3		Supply and place nominal 200mm Dump rock and "blind" with finer material as directed to levels given, from stockpile on mine	m³	500.0	100.00	50000	00
3.3		DEWATERING					
Total Carried Forward						5099000	00

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
Brought Forward						5099000	00
3.3.1		To supply, operate and maintain dewatering and pumping equipment as directed.	days	40.0	2000.00	80000	00
Total Carried Forward To Summary						5179000	00
4.1		4 - EARTHWORKS Note: No "double" handling from stockpiles will be paid for, unless indicated. Load from stockpiles to construct and compact to 95% PROCTOR in 150mm layers including levelling trimming and forming side slopes					
4.1.1		(a) AWRD (East)	m³	11100.0	40.00	444000	00
4.1.2		(b) AWRD (West)	m³	8730.0	40.00	349200	00
4.1.3		c) Silt Trap	m³	500.0	40.00	20000	00
4.1.4		Excavate to spoil within 1,0km freehaul	m³	150000.0	25.00	3750000	00
4.1.5		Excavate from borrow on site, load, haul & place 200mm G5 Quality material & compact to 95% PROCTOR to floor of silt trap (max particle size 10mm) Load from Stockpile place and compact to 95% PROCTOR to lines and levels to form clay liner AWRD (East)	m³	200.0	50.00	10000	00
4.1.6		(a) To layer b (2x150mm)	m³	2800.0	50.00	140000	00
4.1.7		(b) To layer d (1x200mm) Load from Stockpile place and compact to 95% PROCTOR to lines and levels to form clay liner AWRD (West)	m³	0.0	50.00	0	00
4.1.8		(a) To layer b (2x150mm)	m³	15000.0	50.00	750000	00
4.1.9		(b) To layer d (1x200mm) Load from Stockpile place and compact to 95% PROCTOR to lines and levels to form clay liner SILT TRAP	m³	0.0	50.00	0	00
4.1.10		(a) To layer b (2x150mm)	m³	600.0	50.00	30000	00
4.1.11		(b) To layer d (1x200mm) Place topsoil to sideslopes of of wall 200mm layer	m³	0.0	50.00	0	00
Total Carried Forward						5493200	00

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
Brought Forward						5493200	00
4.1.12		(a) AWRD (East)	m³	100.0	40.00	4000	00
4.1.13		(b) AWRD (West)	m³	800.0	40.00	32000	00
4.1.14		c) Silt Trap	m³	50.0	40.00	2000	00
		Supply and place 25mm Slag to crest of wall in 200mm layer					
4.1.15		(a) AWRD (East)	m³	304.0	250.00	76000	00
4.1.16		(b) AWRD (West)	m³	942.0	250.00	235500	00
4.1.17		c) Silt Trap	m³	200.0	250.00	50000	00
4.2		FLOOR PREPARATION					
		Rip and compact 200mm insitu floor 93% Mod AASHTO					
4.2.1		(a) AWRD (East)	m³	4400.0	20.00	88000	00
4.2.2		(b) AWRD (West)	m³	25000.0	20.00	500000	00
4.2.3		c) Silt Trap	m³	400.0	20.00	8000	00
		Load from stockpile, haul and place 200mm and compact to 90% Mod AASHTO Density to base preparation layer					
4.2.4		(a) AWRD (East)	m³	1700.0	50.00	85000	00
4.2.5		(b) AWRD (West)	m³	10000.0	50.00	500000	00
4.2.6		c) Silt Trap	m³	200.0	50.00	10000	00
Total Carried Forward To Summary						7083700	00
5.1		GEOTEXTILE (KAYTECH)					
		Supply and place geotextile to floor and sides A4 Bidim (Upper)					
5.1.1		(a) AWRD (East)	m²	8600.0	10.00	86000	00
5.1.2		(b) AWRD (West)	m²	50000.0	10.00	500000	00
5.1.3		(c) To Silt Traps	m²	1000.0	10.00	10000	00
		Supply and place geotextile to floor and sides A4 Bidim (Lower)					
5.1.4		(a) AWRD (East)	m²	0.0	10.00	0	00
5.1.5		(b) AWRD (West)	m²	0.0	10.00	0	00
Total Carried Forward						596000	00

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
Brought Forward						596000	00
5.1.6		(c) To Silt Traps	m²	1000.0	10.00	10000	00
5.1.7		Supply all labour and materials to construct 1200 Ø manhole rings to pump sump as detailed. (including cover)	No	1.0	5000.00	5000	00
		Supply and place KAYTECH Flownet 700HP					
5.1.8		(a) AWRD (East)	m²	8600.0	50.00	430000	00
5.1.9		(b) AWRD (West)	m²	50000.0	50.00	2500000	00
5.1.10		(c) To Silt Traps	m²	1000.0	50.00	50000	00
Total Carried Forward To Summary						3591000	00
6.1		6 - DAM LINER					
		To: HDPE SANS 10409:2005 and SANS1526:2003					
		Excavate anchor trench to wall and backfill after liner has been placed.					
6.1.1		(a) AWRD (East)	m³	200.0	200.00	40000	00
6.1.2		(b) AWRD (West)	m³	425.0	200.00	85000	00
6.1.3		(c) To Silt Trap	m³	85.0	200.00	17000	00
		Trim earthworks to supplier tolerances prior to placing liner					
6.1.4		(a) AWRD (East)	m²	8600.0	1.00	8600	00
6.1.5		(b) AWRD (West)	m²	35000.0	1.00	35000	00
6.1.6		(c) To Silt Trap	m²	2000.0	1.00	2000	00
		Supply and lay AQUATAN HDPE liner 2,0mm thick to SABS and supplier standard details.					
6.1.7		(a) AWRD (East)	m²	8600.0	70.00	602000	00
6.1.8		(b) AWRD (West)	m²	35000.0	70.00	2450000	00
6.1.9		(c) To Silt Traps	m²	2000.0	70.00	140000	00
6.1.10		Supply lay, and anchor ARMORFLEX 140 Blocks with soilcrete infill to supplier's specifications to floor, walls and access road of Silt Trap	m²	2000.0	200.00	400000	00
Total Carried Forward						3779600	00

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
Brought Forward						3779600	00
6.1.11		Supply and place Kaytech A10 beneath AMORFLEX	m²	2000.00	20.00	40000	00
Total Carried Forward To Summary						3819600	00
7.1		7 - DRAINAGE Excavate to form channel inlet to PCD					
7.1.1		(a) AWRD (East)	m³	50.0	50.00	2500	00
7.1.2		(b) AWRD (West)	m³	200.0	50.00	10000	00
7.1.3		(c) To Silt Traps	m³	30.0	50.00	1500	00
		Construct concrete headwalls complete to detail					
7.1.4		(a) AWRD (East)	No	2.0	2000.00	4000	00
7.1.5		(b) AWRD (West)	No	4.0	2000.00	8000	00
7.1.6		(c) To Silt Traps	No	4.0	200.00	800	00
		Construct concrete pipe collar to supplier details through lining					
7.1.7		(a) AWRD (East)	No	2.0	3000.00	6000	00
7.1.8		(b) AWRD (West)	No	2.0	3000.00	6000	00
7.1.9		(c) To Silt Traps	No	2.0	3000.00	6000	00
		Supply and lay 750mm diam. concrete spigot and socket 100 D pipes on Class B bedding to inlets					
7.1.10		(a) AWRD (East)	m	30.0	1200.00	36000	00
7.1.11		(b) AWRD (West)	m	30.0	1200.00	36000	00
7.1.12		(c) To Silt Traps	m	30.0	1200.00	36000	00
7.1.13		Class B bedding	m³	6.0	400.00	2400	00
		Supply and place 2,5mm wire Galvanised Gabions and Reno to stormwater drains.					
7.1.14		Drain 1	m³	0.0	0.00	0	00
		To 2,0mm HDPE liner under Gabions					
7.1.15		Drain 1	m²	0.0	0.00	0	00
Total Carried Forward						155200	00

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
Brought Forward						155200	00
		To A4 Geotextile under Gabions					
7.1.16		Drain 1	m²	0.0	0.00	0	00
		SPILLWAY (TO DETAIL) AWRD - East					
7.1.17		Earthworks	m³	50.0	60.00	3000	00
7.1.18		Supply and place 600mm diam Spigot and Socket 100D concrete pipes	m	30.0	1100.00	33000	00
7.1.19		Concrete to head walls to detail	No	2.0	2200.00	4400	00
		SPILLWAY (TO DETAIL) AWRD - West					
7.1.20		Earthworks	m³	50.0	60.00	3000	00
7.1.21		Supply and place 600mm diam Spigot and Socket 100D concrete pipes	m	30.0	1100.00	33000	00
7.1.22		Concrete to head walls to detail	No	2.0	2200.00	4400	00
Total Carried Forward To Summary						236000	00
8.1		GENERAL					
		30 MPa Concrete Edge Beam to Roadway					
8.1.1		(a) AWRD (East)	m³	1.1	1500.00	1650	00
8.1.2		(b) AWRD (West)	m³	1.1	1500.00	1650	00
		Reconstruct 5m wide Bakkie Access Road, and compact to perimeter					
8.1.3		(a) AWRD (East)	m²	1900.0	50.00	95000	00
8.1.4		(b) AWRD (West)	m²	5900.0	50.00	295000	00
		Supply & install crawl-net complete (4No)					
8.1.5		(a) AWRD (East)	m²	200.0	50.00	10000	00
8.1.6		(b) AWRD (West)	m²	200.0	50.00	10000	00
8.1.7		(c) To Silt Traps	m²	200.0	50.00	10000	00
		Supply & install life-buoy & mounting Pole complete					
8.1.8		(a) AWRD (East)	No	4.0	500.00	2000	00
8.1.9		(b) AWRD (West)	No	8.0	500.00	4000	00
8.1.10		(c) To Silt Traps	No	4.0	500.00	2000	00
Total Carried Forward To Summary						431300	00

HENDRINA AWRD's - REV C

SUMMARY OF SECTIONS

SECTION	DESCRIPTION	AMOUNT (RAND)	
1	SITE ESTABLISHMENT	5344225	00
2	SITE CLEARING	121000	00
3	EXCAVATIONS	5179000	00
4	EARTHWORKS	7083700	00
5	BARRIER SYSTEM	3591000	00
6	DAM LINER	3819600	00
7	DRAINAGE	236000	00
8	GENERAL	431300	00
	SUB TOTAL	25805825	00
		0	00
	5 % CONTINGENCIES	25805825	00
		1290291	25
	VAT @ 14 % :	27096116	25
		0	00
Total Carried Forward To Summary Of Schedules		27096116	25

HENDRINA ASH DAM E - REV B

1 -SITE ESTABLISHMENT

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
1.1		1 - SITE ESTABLISHMENT					
1.1.1		Site Establishment (fixed)	LS	1.0	68166541.00	68166541	00
1.1.2		Preliminary and General (time)	mths	30.0	0.00	0	00
1.1.3		Preliminary and General (fixed)	LS	0.0	0.00	0	00
1.1.4		Site Establishment (time)	mths	30.0	0.00	0	00
Total Carried Forward To Summary						68166541	00
2.1		2 - SITE CLEARING					
2.1.1		Clearing and grubbing beneath Ash Dam	ha	128.0	10000.00	1280000	00
2.1.2		Clearing to drains	ha	1.0	10000.00	10000	00
Total Carried Forward To Summary						1290000	00
3.1		3 - EXCAVATIONS					
3.1.1		Remove topsoil to nominal depth of 250mm and stockpile on site within 0,5km below Ash Dam	m³	320000.0	20.00	6400000	00
		Remove material to levels given					
3.1.2		a) Cut to fill below Ash Dam	m³	249000.0	30.00	7470000	00
3.1.3		b) Cut unsuitable to spoil or stockpile on site	m³	700000.0	20.00	14000000	00
3.1.4		c) Cut to Stockpile 500mm subsoil within 1,0km	m³	640000.0	25.00	16000000	00
		Excavations for clean Stormwater diversion trenches and berm construction					
3.1.5		(a) Soft Material	m³	2000.0	30.00	60000	00
3.1.6		(b) Extra over for hard material	m³	500.0	250.00	125000	00
3.1.7		(c) Extra over to form berm	m³	1000.0	15.00	15000	00
		Excavations to stockpile for drains to Detail in soft material					
3.1.8		(a) Solution Trench	m³	7700.0	30.00	231000	00
3.1.9		(b) Penstock pipe	m³	5320.0	30.00	159600	00
3.1.10		(c) Toe Drain	m³	10700.0	50.00	535000	00
3.1.11		(d) Main under drain	m³	17900.0	50.00	895000	00
Total Carried Forward						45890600	00

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
Brought Forward						45890600	00
3.1.12		(g) Extra over for hard material for drains	m³	2000.0	250.00	500000	00
3.1.13		(h) e.o for excavation in Wet Conditions	m³	5000.0	15.00	75000	00
		Excavate selected material to stockpile					
3.1.14		(a) To clay layer b (2x150mm)	m³	0.0	25.00	0	00
3.1.15		(b) To clay layer d (1x200mm)	m³	0.0	25.00	0	00
3.1.16		(c) For starter wall	m³	960000.0	25.00	24000000	00
3.2		POOR SUBGRADE					
3.2.1		Excavate unsuitable soft and wet material to spoil	m³	50000.0	35.00	1750000	00
3.2.2		Supply and place A6 Geotextile to floor of excavation if required as directed (provisional)	m²	5000.0	15.00	75000	00
3.2.3		Supply and place nominal 200mm Dump rock and "blind" with finer material as directed to levels given, from stockpile on mine	m³	5000.0	100.00	500000	00
Total Carried Forward To Summary						72790600	00
4.1		EARTHWORKS					
4.1.1		Doze "push up" starter walls including levelling trimming and to Ash Dam perimeter.	m³	0.0	25.00	0	00
4.1.2		Excavate selected material to stockpile for Base preparation Layer g (1 x 200mm)	m³	0.0	25.00	0	00
4.1.3		Rip in situ material to a depth of 200mm and compact to 93% Mod AASHTO Density, under Ash Dam	m³	256000.0	15.00	3840000	00
		Load from stockpiles to construct and compact to 95% PROCTOR in 150mm layers including levelling trimming and forming side slopes and including freehaul up to 1,0km					
4.1.4		(a) Starter Wall	m³	960000.0	30.00	28800000	00
4.1.5		(b) Clay layer b (2 x 150mm)	m³	384000.0	30.00	11520000	00
4.1.6		(c) Clay layer d (1 x 200mm)	m³	0.0	30.00	0	00
Total Carried Forward						44160000	00

HENDRINA ASH DAM E - REV B

4 - EARTHWORKS

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
Brought Forward						44160000	00
4.1.7		(d) Base prep layer (1 x 200mm)	m³	0.0	30.00	0	00
Total Carried Forward To Summary						44160000	00
5.1		5 - BARRIER SYSTEM Supply and place 19mm stone to drains & pipe surround to Detail Ash Dam					
5.1.1		a) Finger Drain Leachate layer a	m³	19200.0	300.00	5760000	00
5.1.2		b) Main Drain	m³	17900.0	300.00	5370000	00
5.1.3		c) Toe Drain	m³	10700.0	300.00	3210000	00
5.1.4		d) leakage detection underdrain layer e	m³	19200.00	300.00	5760000	00
5.1.5		Supply and place A4 Bidim (Lower) geotextile to floor	m²	1280000.0	10.00	12800000	00
5.1.6		Supply and place A4 Bidim (Separation) geotextile to floor	m²	128000.00	10.00	1280000	00
5.1.7		Supply and place A4 Bidim (Upper) geotextile to floor	m²	128000.0	10.00	1280000	00
5.1.8		Supply and place A4 Bidim (Separation) geotextile to the floor	m²	0.00	10.00	0	00
5.1.9		Load haul and place washed river sand to Main and Toe drain	m³	9000.0	300.00	2700000	00
5.1.10		Supply all labour and materials to construct manholes as detailed.	No	2.0	4500.00	9000	00
5.1.11		Supply and place Class 16 UPVC pipes with elbow into Solution Trench	m	4500.0	50.00	225000	00
Total Carried Forward To Summary						38394000	00
6.1		6 - LINER SYSTEM To: HDPE SANS 10409:2005 and SANS1526:2003 Excavate anchor trench and backfill after liner has been placed.					
6.1.1		(a) Ash Dam E Trim earthworks to supplier tolerances prior to placing liner	m³	2000.0	200.00	400000	00
6.1.2		(a) Ash Dam E	m²	1280000.0	1.00	1280000	00
Total Carried Forward						1680000	00

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
Brought Forward						1680000	00
6.1.3		Supply and lay embossed AQUATAN HDPE liner 1,5mm thick to SABS and supplier standard details to ADF.	m²	1190000.0	50.00	59500000	00
Total Carried Forward To Summary						61180000	00
7.1		7 - PENSTOCK AND DECANT SYSTEM					
7.1.1		Supply and install 750mm dia 100D Spigot and Socket with insitu surround	m	790.0	3500.00	2765000	00
7.1.2		Supply and install Class B granular pipe bedding	m³	700.0	250.00	175000	00
7.1.3		Supply all material and labour to construct penstock intake including shuttering, fittings, reinforcing, concrete	No	3.0	12000.00	36000	00
7.1.4		Supply and place penstock rings (750mm diam) with insitu surround	No	100.0	520.00	52000	00
7.1.5		Supply and install catwalks allowing for surround to penstock intakes excavations concrete timber and all fittings	m	100.0	2200.00	220000	00
7.1.6		Timber platforms to penstock outlets	No	3.0	6000.00	18000	00
Total Carried Forward To Summary						3266000	00
8.1		8 - FENCING					
8.1.1		Clear 3,0m wide strip	ha	0.6	10000.00	6000	00
8.1.2		Supply and erect fencing including concrete and all fittings - 5 strand fence	m	2000.0	28.00	56000	00
8.1.3		Supply and erect farm gates	No	4.0	3800.00	15200	00
8.1.4		Supply and erect warning signs on fencing	No	15.0	180.00	2700	00
8.1.5		Dismantle existing fences	m	2000.0	10.00	20000	00
Total Carried Forward To Summary						99900	00
9.1		9 - STORM WATER/DRAINAGE To trim and compact floor and sides to 93% Mod AASHTO to solution Trench					
9.1.1		a) Northern Drain	m²	6550.0	2.50	16375	00
Total Carried Forward						16375	00

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
Brought Forward						16375	00
9.1.2		b) Southern Drain	m²	6000.0	2.50	15000	00
9.1.3		c) Eastern Drain	m²	3200.0	2.50	8000	00
		To supply, place and finish 125mm 25 MPa concrete to Solution Trenches					
9.1.4		a) Northern Drain	m³	820.0	2500.00	2050000	00
9.1.5		b) Southern Drain	m³	750.0	2500.00	1875000	00
9.1.6		c) Eastern Drain	m³	400.0	2500.00	1000000	00
		To supply and place 395 mesh to concrete in solution trenches					
9.1.7		a) Northern Drain	t	26.0	13000.00	338000	00
9.1.8		b) Southern Drain	t	24.0	13000.00	312000	00
9.1.9		c) Eastern Drain	t	13.0	13000.00	169000	00
9.1.10		Wingwalls / Head walls to pipe crossing	No	2.0	9000.00	18000	00
		Supply and place rockfill to fill SABS Gabions to open drains stepped to detail.					
9.1.11		(a) To steps	m³	50.0	1200.00	60000	00
9.1.12		(b) To Detail J	m³	30.0	1200.00	36000	00
9.1.13		Supply and place A6 Geotextile below Gabions	m²	58.0	15.00	870	00
9.1.14		Supply and place 2,00mm HDPE liner below Gabions	m²	58.0	70.00	4060	00
9.1.15		Supply & install 20 MPa concrete filled 75mm Geocells to spillway	m²	50.0	200.00	10000	00
Total Carried Forward To Summary						5912305	00
		10 - ACCESS ROAD					
10.1		SITE CLEARING					
10.1.1		Clearing and grubbing for access road	ha	1.2	10000.00	12000	00
10.1.2		Remove unsuitable material (topsoil to nominal depth of 150mm) and spoil on site	m³	1800.0	20.00	36000	00
		Earthworks					
Total Carried Forward						48000	00

HENDRINA ASH DAM E - REV B

10 - ACCESS ROAD

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
Brought Forward						48000	00
10.1.3		(a) Windrow 200mm insitu	m³	1800.0	10.00	18000	00
10.1.4		(b) Compact insitu to 90%	m³	1800.0	15.00	27000	00
10.1.5		(c) Replace Windrow and compact to 93%	m³	1800.0	20.00	36000	00
Total Carried Forward To Summary						129000	00

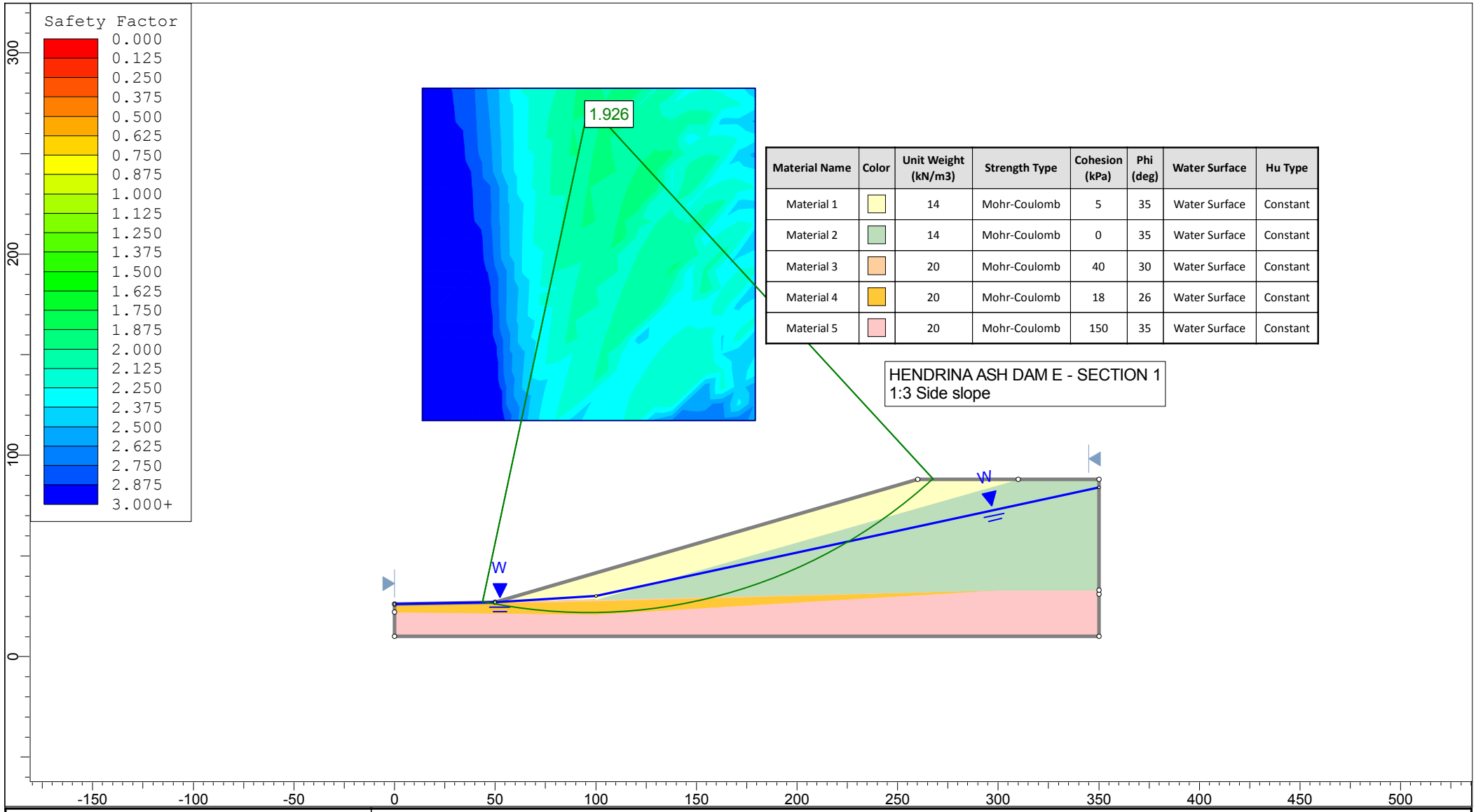
HENDRINA ASH DAM E - REV B

SUMMARY OF SECTIONS

SECTION	DESCRIPTION	AMOUNT (RAND)	
1	SITE ESTABLISHMENT	68166541	00
2	SITE CLEARING	1290000	00
3	EXCAVATIONS	72790600	00
4	4 - EARTHWORKS	44160000	00
5	BARRIER SYSTEM	38394000	00
6	LINER SYSTEM	61180000	00
7	PENSTOCK AND DECANT SYSTEM	3266000	00
8	FENCING	99900	00
9	STORM WATER/DRAINAGE	5912305	00
10	ACCESS ROAD	129000	00
	SUB TOTAL	295388346	00
		0	00
	CONTINGENCIES 5 % :	295388346	00
		14769417	30
	VAT @ 14 % :	310157763	30
		43422086	86
Total Carried Forward To Summary Of Schedules		353579850	16

APPENDIX D

STABILITY AND RATE OF RISE



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type
Material 1		14	Mohr-Coulomb	5	35	Water Surface	Constant
Material 2		14	Mohr-Coulomb	0	35	Water Surface	Constant
Material 3		20	Mohr-Coulomb	40	30	Water Surface	Constant
Material 4		20	Mohr-Coulomb	18	26	Water Surface	Constant
Material 5		20	Mohr-Coulomb	150	35	Water Surface	Constant

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SLIDEINTERPRET 6.023

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description			
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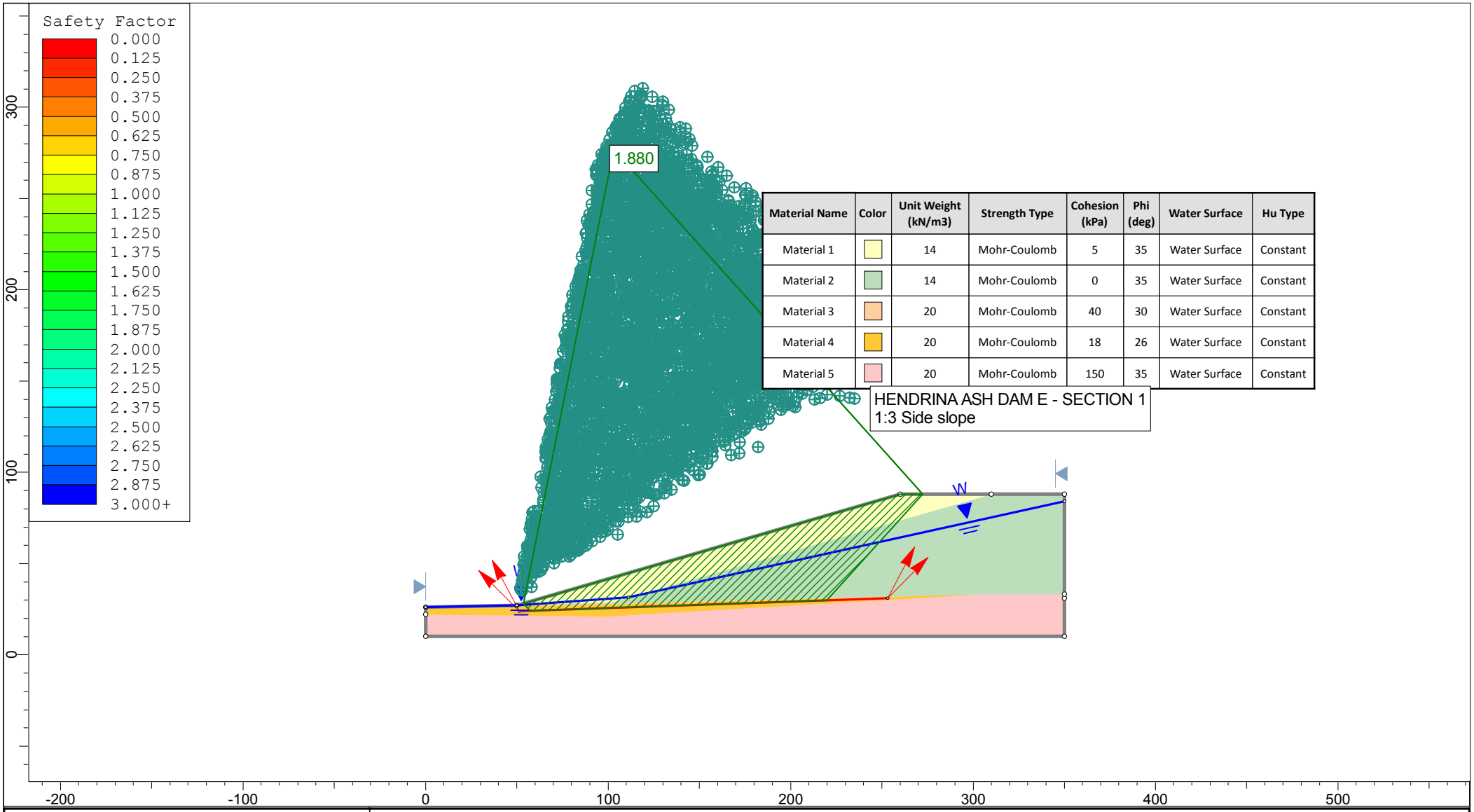
Date	2013/07/18, 12:49:13 PM		*File Name* Section 1 MOD.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type
Material 1		14	Mohr-Coulomb	5	35	Water Surface	Constant
Material 2		14	Mohr-Coulomb	0	35	Water Surface	Constant
Material 3		20	Mohr-Coulomb	40	30	Water Surface	Constant
Material 4		20	Mohr-Coulomb	18	26	Water Surface	Constant
Material 5		20	Mohr-Coulomb	150	35	Water Surface	Constant

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SLIDEINTERPRET 6.023

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description			
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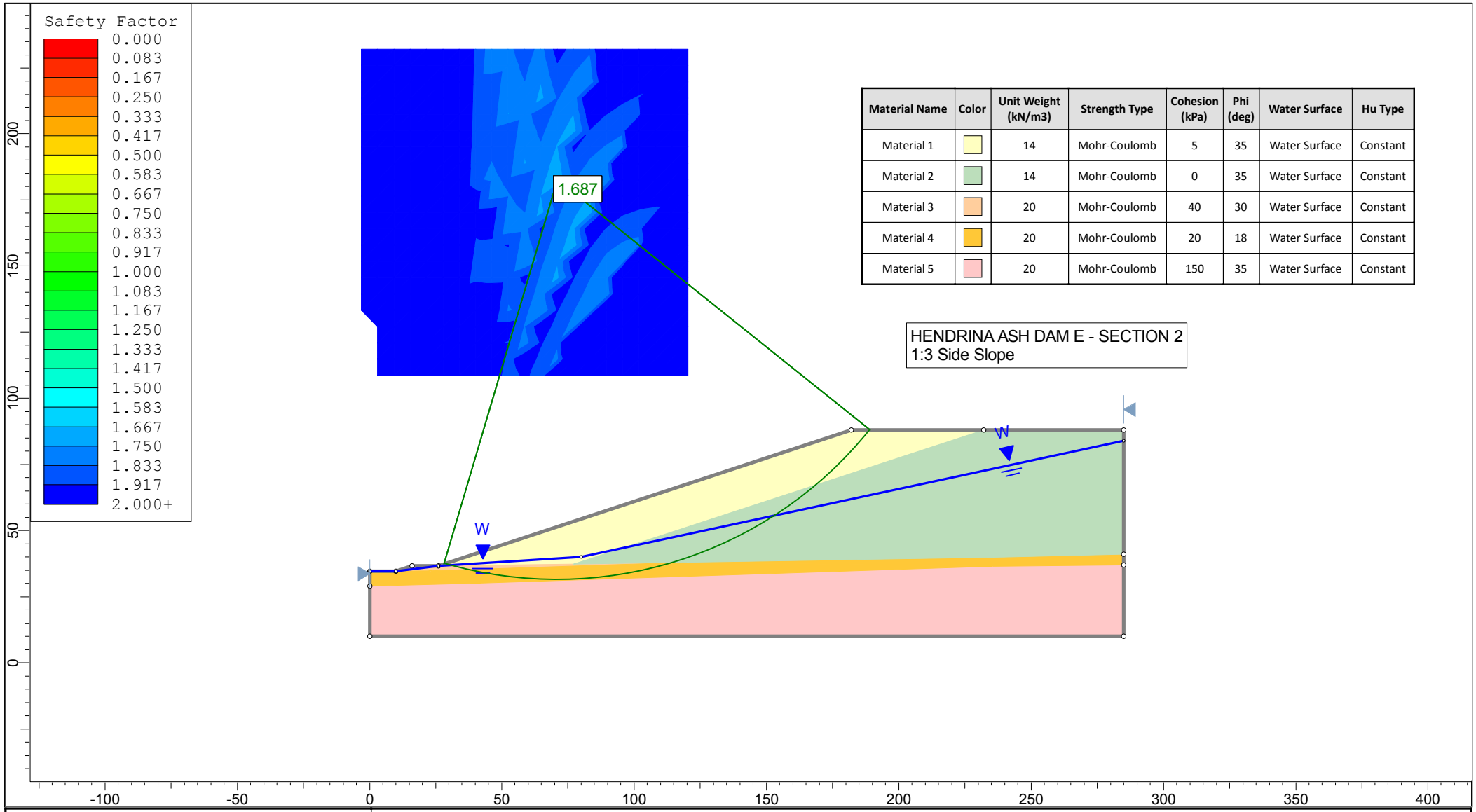
Date	2013/07/18, 12:49:13 PM		*File Name* Section 1.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type
Material 1		14	Mohr-Coulomb	5	35	Water Surface	Constant
Material 2		14	Mohr-Coulomb	0	35	Water Surface	Constant
Material 3		20	Mohr-Coulomb	40	30	Water Surface	Constant
Material 4		20	Mohr-Coulomb	20	18	Water Surface	Constant
Material 5		20	Mohr-Coulomb	150	35	Water Surface	Constant

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SLIDEINTERPRET 6.023

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description			
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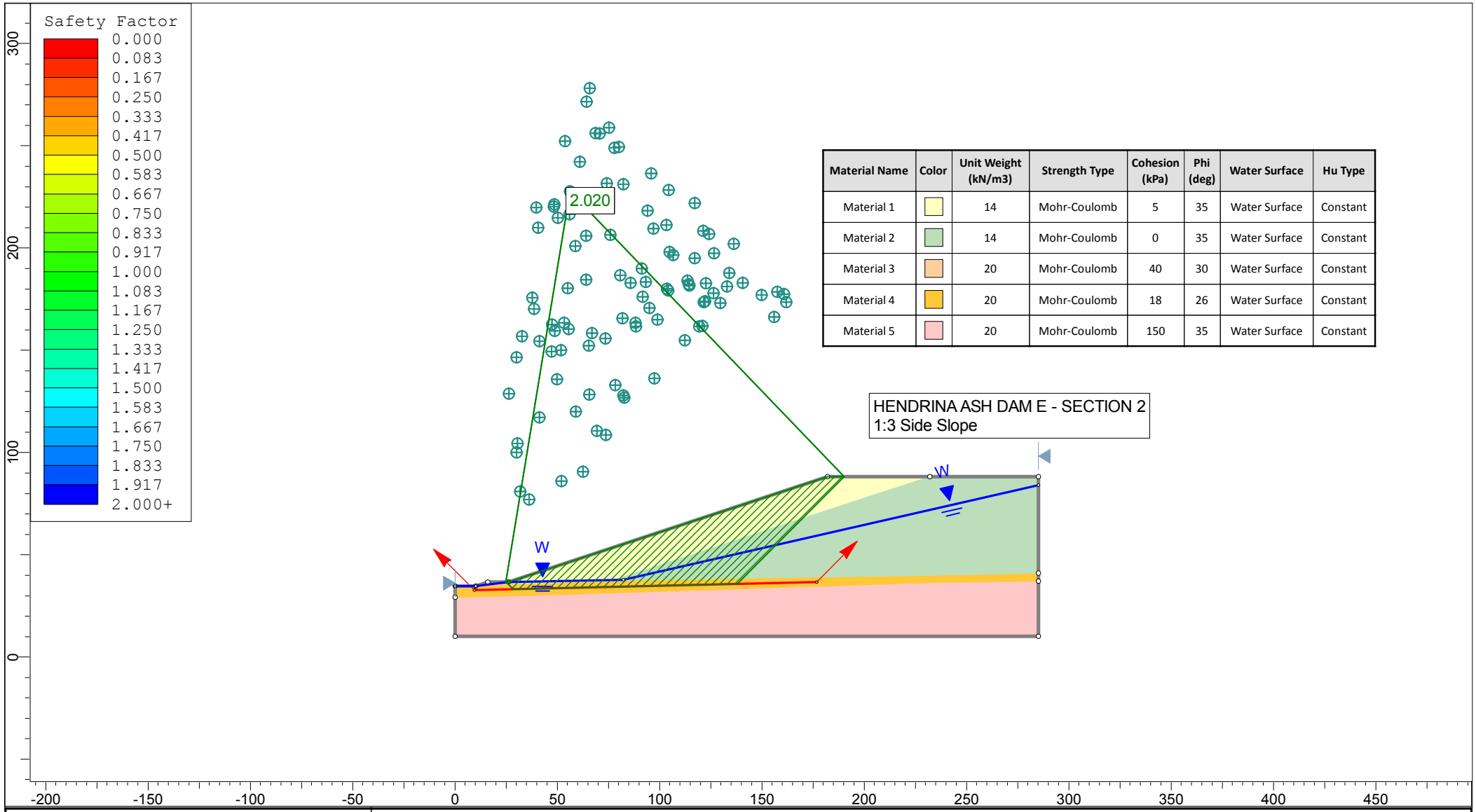
Date	2013/07/18, 12:49:13 PM		*File Name* Section 2 MOD.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type
Material 1		14	Mohr-Coulomb	5	35	Water Surface	Constant
Material 2		14	Mohr-Coulomb	0	35	Water Surface	Constant
Material 3		20	Mohr-Coulomb	40	30	Water Surface	Constant
Material 4		20	Mohr-Coulomb	18	26	Water Surface	Constant
Material 5		20	Mohr-Coulomb	150	35	Water Surface	Constant

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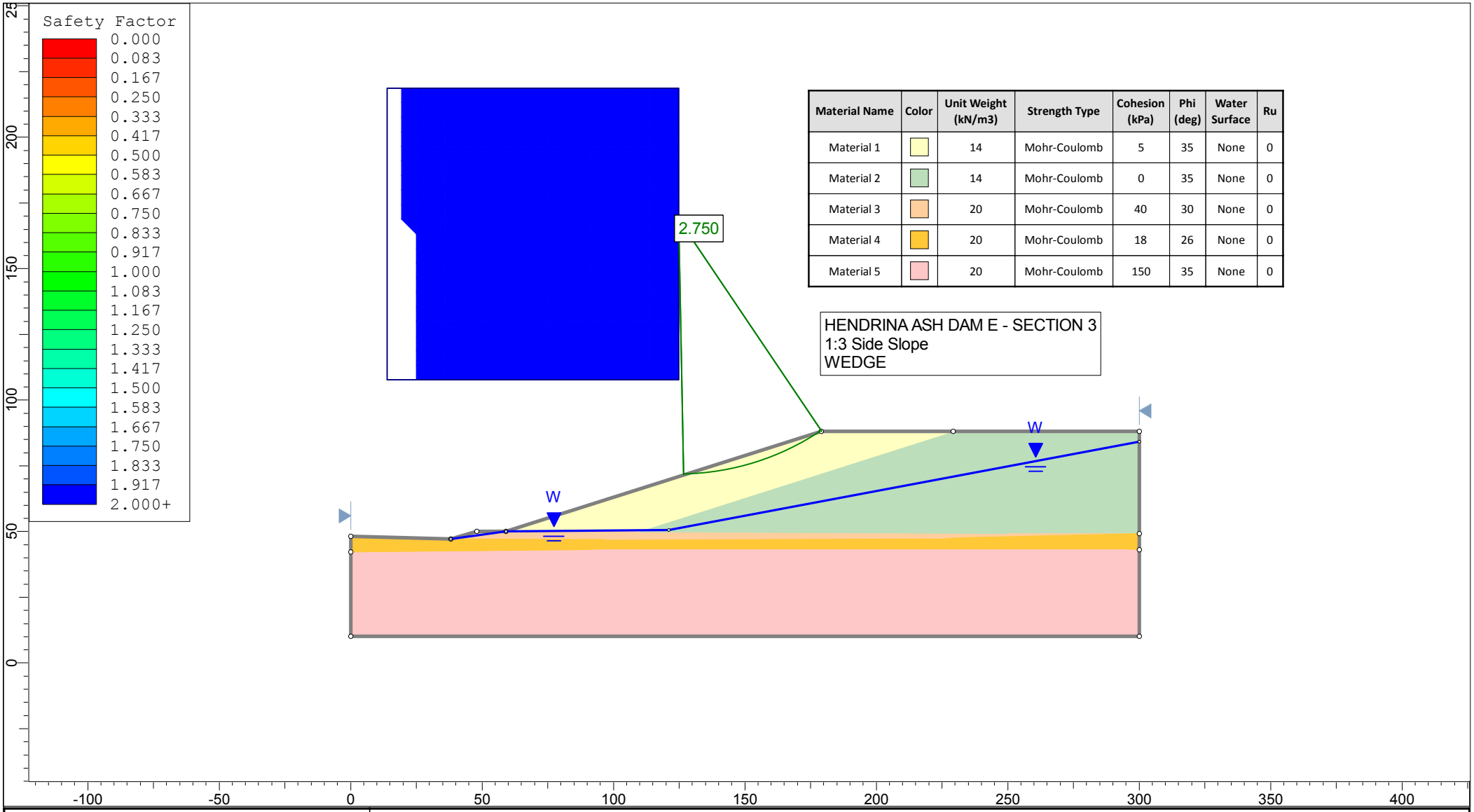
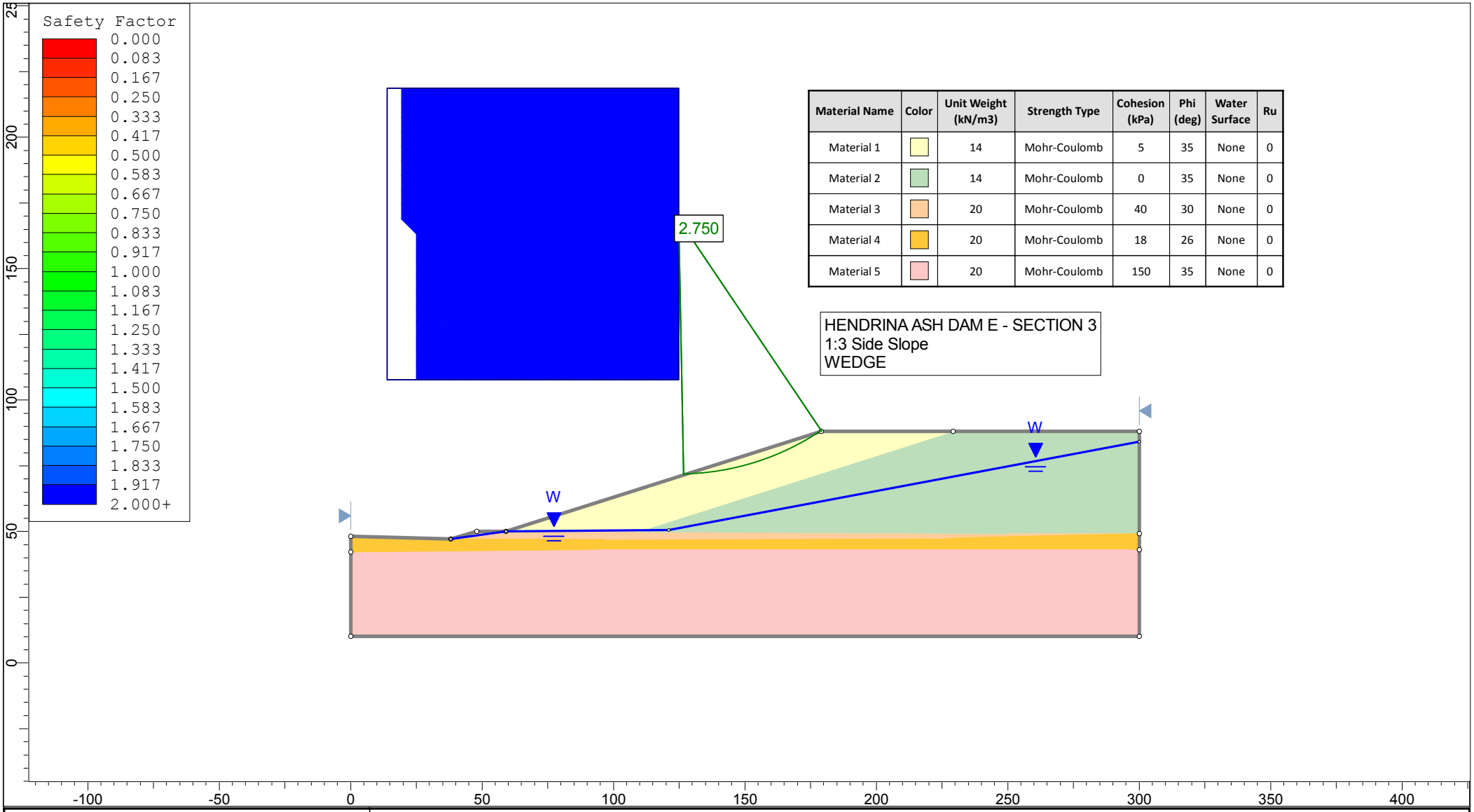
SLIDEINTERPRET 6.023

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description			
Drawn By		*Scale* 1:2591	*Company*
Date	2013/07/18, 12:49:13 PM		*File Name* Section 2 MOD WEDGE.slim



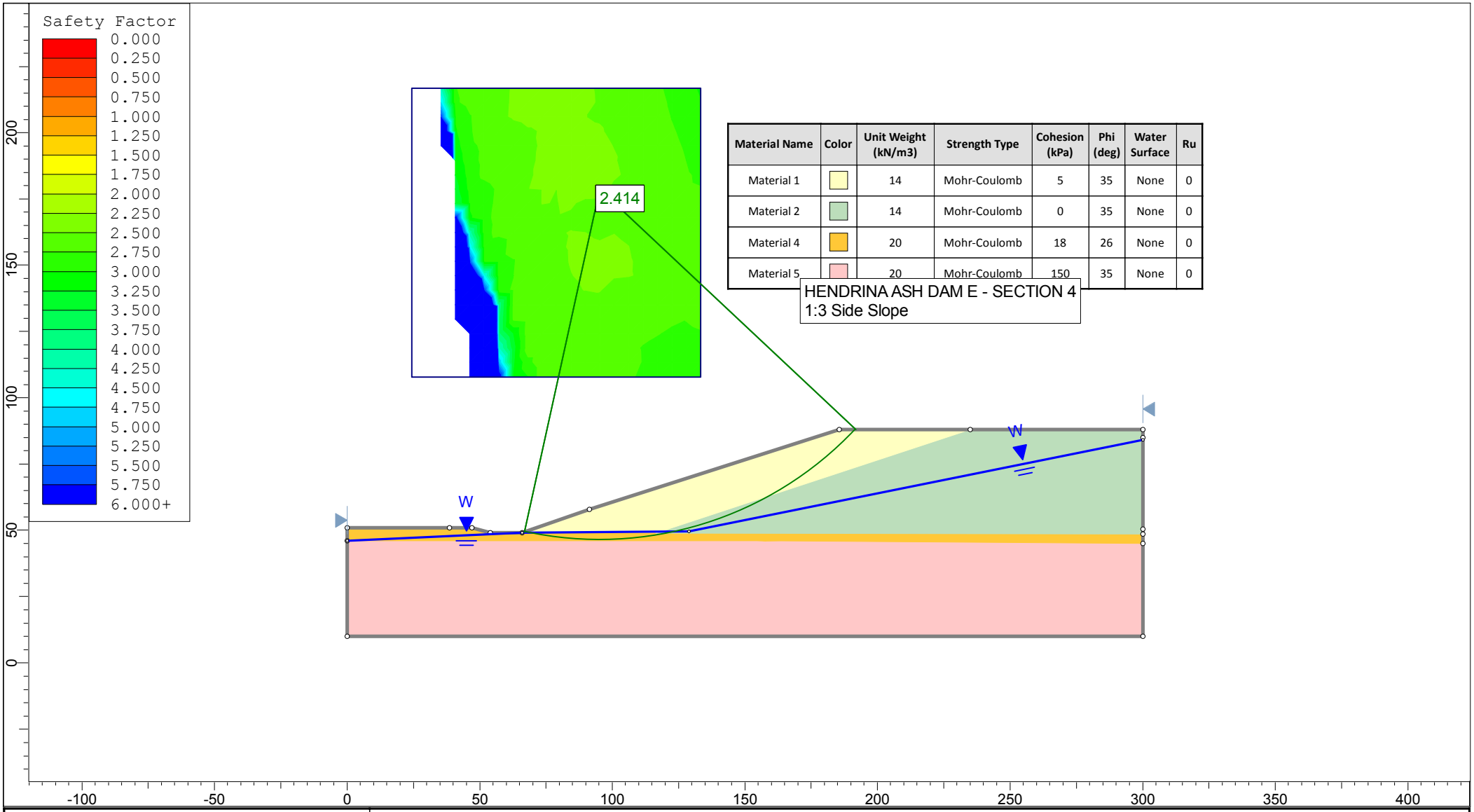
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Material 1		14	Mohr-Coulomb	5	35	None	0
Material 2		14	Mohr-Coulomb	0	35	None	0
Material 3		20	Mohr-Coulomb	40	30	None	0
Material 4		20	Mohr-Coulomb	18	26	None	0
Material 5		20	Mohr-Coulomb	150	35	None	0

rocscience	*Project* SLIDE - An Interactive Slope Stability Program		
	Analysis Description		
	Drawn By	*Scale* 1:2016	*Company*
SLIDEINTERPRET 6.023	*Date* 2013/07/19, 10:38:07 AM		*File Name* Section 3 MOD.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Material 1		14	Mohr-Coulomb	5	35	None	0
Material 2		14	Mohr-Coulomb	0	35	None	0
Material 3		20	Mohr-Coulomb	40	30	None	0
Material 4		20	Mohr-Coulomb	18	26	None	0
Material 5		20	Mohr-Coulomb	150	35	None	0

rocscience	*Project* SLIDE - An Interactive Slope Stability Program		
	Analysis Description		
	Drawn By	*Scale* 1:2016	*Company*
SLIDEINTERPRET 6.023	*Date* 2013/07/19, 10:38:07 AM		*File Name* Section 3 MOD.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Material 1		14	Mohr-Coulomb	5	35	None	0
Material 2		14	Mohr-Coulomb	0	35	None	0
Material 4		20	Mohr-Coulomb	18	26	None	0
Material 5		20	Mohr-Coulomb	150	35	None	0

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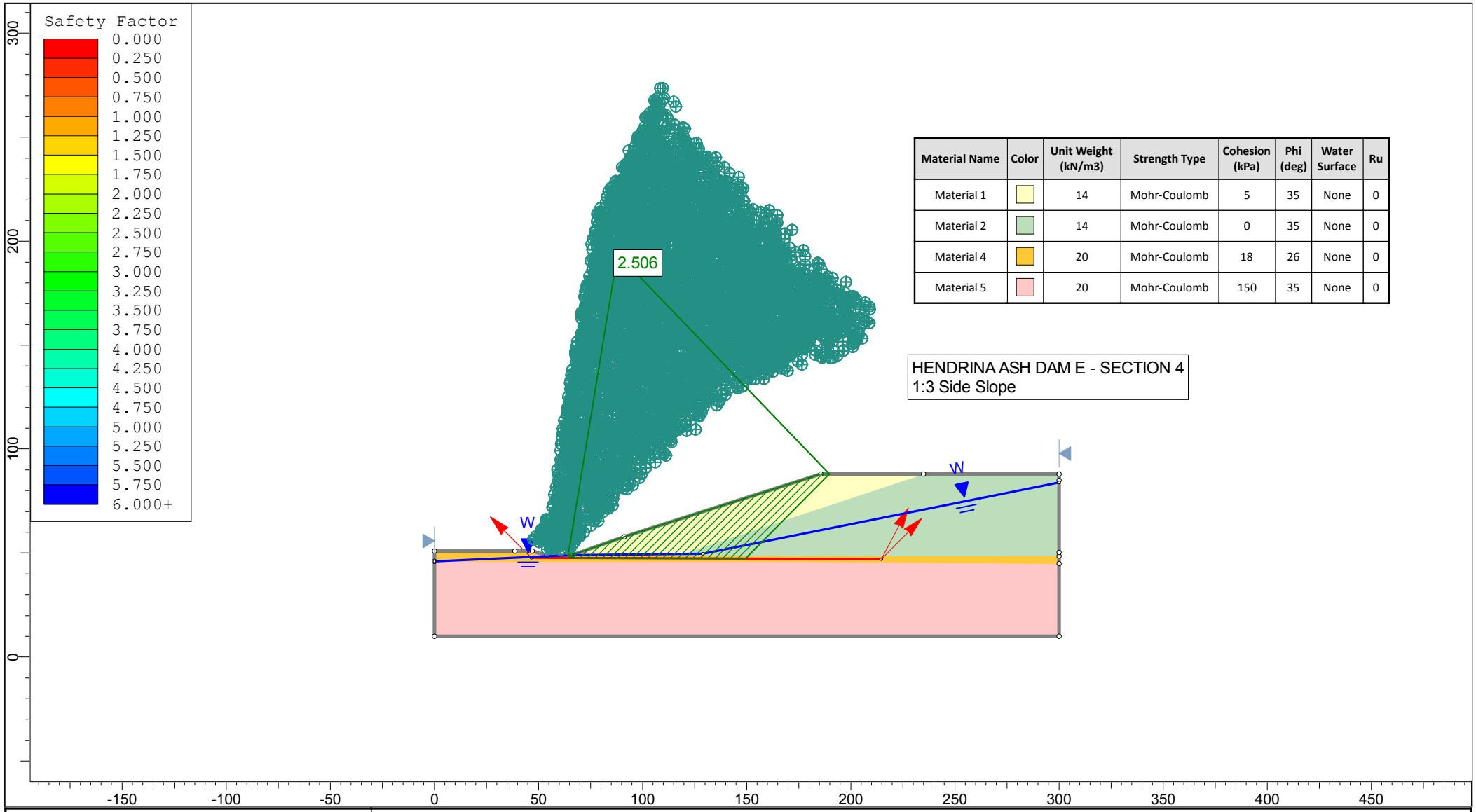
SLIDEINTERPRET 6.023

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description			
Drawn By	*Scale* 1:1998	*Company*	
Date 2013/07/19, 11:27:19 AM		*File Name*	Section 4.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Material 1		14	Mohr-Coulomb	5	35	None	0
Material 2		14	Mohr-Coulomb	0	35	None	0
Material 4		20	Mohr-Coulomb	18	26	None	0
Material 5		20	Mohr-Coulomb	150	35	None	0

SLIDEINTERPRET 6.023

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description			
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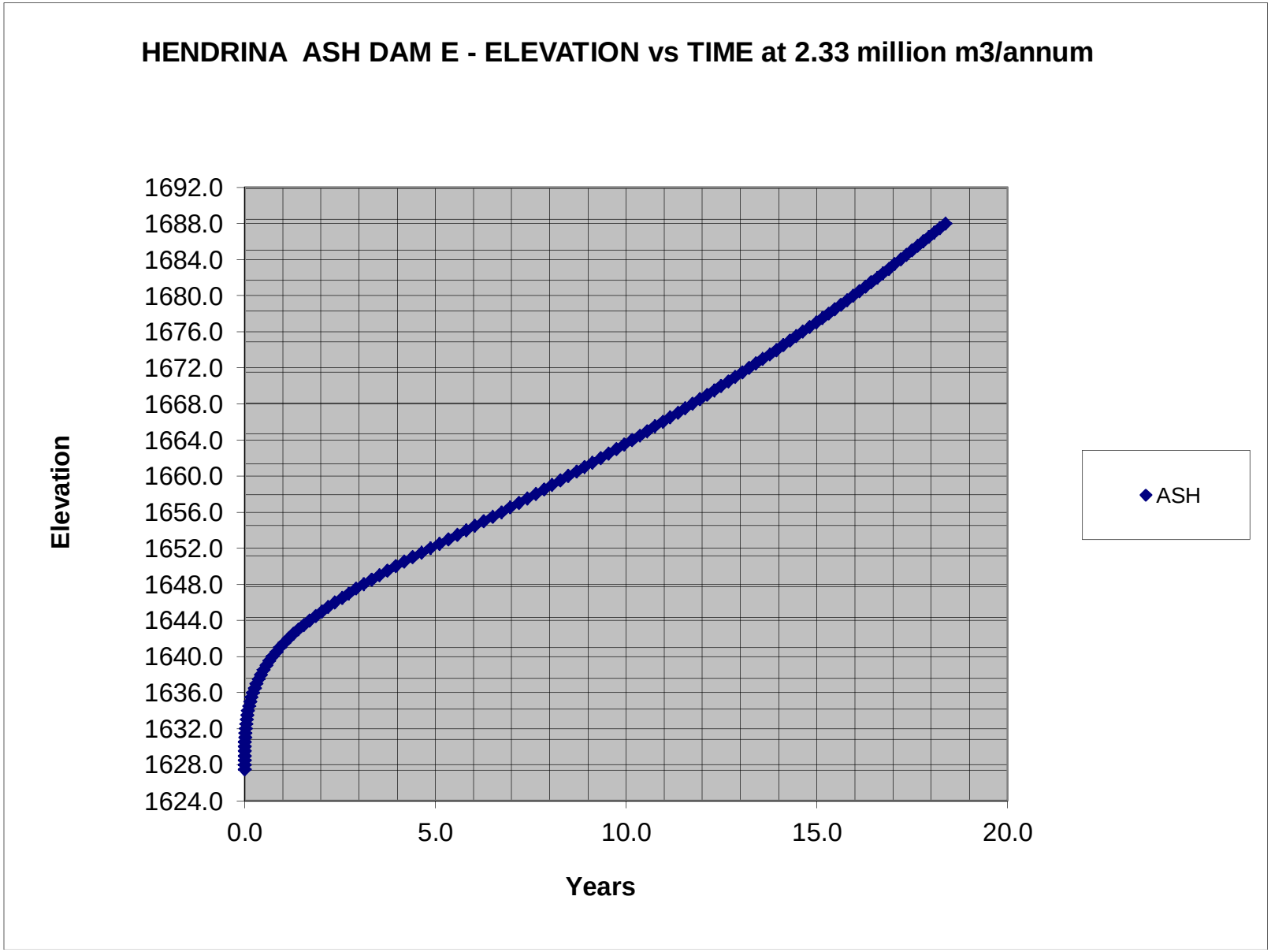
Date	2013/07/19, 11:27:19 AM	*File Name*	Section 4.slim


HENDRINA ASH DAM E - ELEVATION vs TIME at 2.33 million m3/annum
Elevation
1692.0
1688.0
1684.0
1680.0
1676.0
1672.0
1668.0
1664.0
1660.0
1656.0
1652.0
1648.0
1644.0
1640.0
1636.0
1632.0
1628.0
1624.0
0.0
5.0
10.0
15.0
20.0
Years
ASH

HENDRINA ASH DAM E - ROR vs ELEVATION at 2.33 million m3/annum