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CESA

PAST MEMBER

ESKOM TUTUKA

CONCEPTUAL DESIGN REPORT

ADF (ASH DISPOSAL FACILITY) EXTENSION

REV 4

Ref : 667 – Rev 4
Date: 13 February 2015

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Eskom

ESKOM TUTUKA
CONCEPTUAL DESIGN REPORT
ADF (ASH DISPOSAL FACILITY) EXTENSION
REV 4

CONTENTS

ESKOM TUTUKA
CONCEPTUAL DESIGN REPORT
ADF (ASH DISPOSAL FACILITY) EXTENSION
REV 4

EXECUTIVE SUMMARY

This report is to be read in conjunction with the one produced by DEMCOTECH dated 30 May 2011 Rev 1.TU 4797NN.

It supplements the DEMCOTECH report in that it takes the wetland and excluded areas into account, as well as allowing for the ADF to be HDPE lined.

The Conceptual Design has been carried out on the selected Site in order to accommodate 158 million tons of ash from the Tutuka Power Station.

The purpose of this report is to provide conceptual design information for the ash disposal facilities, and associated pollution control structures for the next 40 years of the operational life of the power station.

This report specifically covers the conceptual design of the dry Ash disposal facility, with AWRD'S and associated storm water control measures, taking into consideration the topographical and physical constraints.

With the depicted configuration, the ADF can accommodate 166 million m^3 with the existing equipment.

As part of the stormwater control measures on the site, an Ash Water Return Dam is required and the two existing Southern Dams, will be modified in shape, and upgraded for use as "store and release" facilities, with the clean water being diverted back in the river further south.

Due to property ownership constraints, the Valley west of the RRD2 will need to be backfilled to Contour Level 1599, to accommodate the new clean water canal, or alternatively a clean water dam could be constructed on the neighbours' property, with his permission, to improve the clean canal alignment.

The three Pollution Control Dams should be lined with 1,5 mm HDPE, to control seepage, and to contain all storm water runoff from the average rainfall, plus the 1:50 year 24 hour storm, with 0,8 m freeboard.

A cost estimate for the infrastructure will be prepared at the Basic Design stage to give some indication of the expected construction costs for the various facilities related to the ash handling.

-oOo-

ESKOM TUTUKA
CONCEPTUAL DESIGN REPORT
ADF (ASH DISPOSAL FACILITY) EXTENSION
REV 4

0. INTRODUCTION

Tutuka Power Station, a coal fired power generation facility commissioned between 1985 - 1990, is located 20km North of Standerton in the province of Mpumalanga. Tutuka Power Station currently disposes of burnt boiler ash in a dry format by means of conveyors, spreaders and a stacker system from the station terrace to the Ash Disposal Site. The Ash Disposal Site is located approximately 4km east of the station terrace.

The waste product is deposited on to the ADF by means of a Stacker, which handles some 85% of the total ash, whilst the remaining 15% is placed by a standby Spreader system.

This report is to be read in conjunction with the one produced by DEMCOTECH dated 30 May 2011 Rev 1.TU 4797NN.

It supplements the DEMCOTECH report in that it takes the wetland and excluded areas into account, as well as allowing for the ADF to be HDPE lined.

1. SCOPE OF WORK

The Conceptual Design has been carried out on the selected Site in order to accommodate 158 million tons of ash from the Tutuka Power Station.

The purpose of this report is to provide conceptual design information for the ash disposal facilities, and associated pollution control structures for the next 40 years of the operational life of the power station.

2. SITE SELECTION AND SIZING

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

- The assumption has been made that no mining licence or permits exist for the Eskom owned property but if this should change, revised pillar, spacing to accommodate the loadings, would be required. **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 to be used will be outside the 100m buffer of sensitive or pristine wetlands and associated flood plains.

3. DESIGN ASSUMPTIONS

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

a) The ADF height and overall slope is subject to review once the detailed 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 Basic Design Stage.

b) Design Parameters

- Final average ADF side Slope	1:5
- Max Facility height (m)	58m
- Storm Design Criteria	GN704
- Min. factor of safety	1,5
- Dry density of placed ash (t/m^3)	1,04
- ADF Capacity (x 10^6 tons)	166
- Ash production	34%

- All runoff from side slopes and rehab areas to be captured in RRD's (Release Retention Dam).

4. ASH DISPOSAL

The ash disposal area comprises various components, and the details are shown on the drawings for the following facilities, as listed on Page 13 of this Report:

- Location of existing and future AWRD and RRD's.
- Dry Ash Disposal facility
- Clean water diversion trench
- Dirty water drains/leachate interception and collection systems

4.1 Production Rates

The expected Ash production is 158million tons, over the coming 40 years, is based on the current Eskom estimates.

The final elevation, footprint and capacity will be decided after the Geotechnical information is available, and following discussions with the Eskom Design Team.

4.2 Construction of the disposal facility

The existing Main ADF stacker mechanical system is to be modified from a parallel shifting system to slewable operation system in order to build the ADF in a radialclockwise direction. An additional requirement is that the modified Main Stacker must be in operation for 60% of the time and the new Standby Stacker plant must be in operation for 40% of the time, or vice versa, and later back stacked by and additional 18m.

Construction of the Main ADF is achieved by a radial slewing conveyor system with ash dumped in a radial fashion (front-stacked) to the maximum height and later back-stacked by an additional 10m.

The ash is placed at a slope not exceeding 1:40 which could be "flattened" to accommodate the stacker. Civil works as described below need to proceed the advancing ADF involving topsoil stripping, the removal of unstable alluvial clays, construction of sub-surface drains and a network of surface "Dirty" and "Clean" water cut-off channels.

Temporary access roads will be constructed parallel to the temporary "Dirty" and "Clean" water cut-off channels, which facilitate the ease of maintenance of the cut-off channels and allows for the rehabilitation of the ADF with topsoil.

The drawings in Appendix A provide conceptual details of the proposed layout, which involves the following construction process.

- Phase I – Remove topsoil and subsoil to a depth of 700 mm, and stockpile separately
- Phase II – Carry out earthworks and compact in situ material beneath the ADF
- Phase III - Construct, interceptor drains to accept seepage, which will be directed into proposed AWRD.
- Phase IV – Dredge RRD's and construct AWRD.
- Phase V - Place 1,50 mm HDPE liner to PCD's.
- Phase VI - Place 1,50 mm double textured HDPE liner in sections and anchor
- Phase VII - Construct perimeter clean and dirty drains.
- Phase VIII – Commission Stackers, and deposit ash as described above.

Vibrating wire electronic Piezometers, should be installed **during construction** 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

5. HYDROLOGY

The site is not affected by floodlines as all the clean water has been directed in excavated channels. All Dams have been sized in terms of the criteria set out in the water balance report, from Ilanda, which is attached as Appendix B to this Report.

Drain sizing will form part of the Preliminary Design phase of the project.

Eskom has stated that in terms of their Water Licence it is stipulated that no effluent or dirty water may leave the site. If properly managed, the water from rehabilitated areas should be considered "clean" to be temporarily stored, and then released as Quality allows.

Further to this, it is now a requirement that all water from rehabilitated areas be stored in "store and release" dams. This water will be contained in RRD1 and spill into RRD2, for release as quality dictates.

6. DESIGN OF ASH DISPOSAL FACILITY

6.1 Water Balance

A water balance, detailed in the Ilanda Report attached as Appendix B, has been carried out to assess the water utilisation and to size the AWRD and RRD's. The interaction of the proposed ash disposal areas with this resource will be refined as part of the Basic Design.

The dump will be lined to prevent groundwater pollution, so the liner should mitigate any impacts of dust suppression water.

If the dump is not over irrigated, no infiltration will occur and all the dust suppression water will evaporate. However, the salts will be left behind and may infiltrate when rainfall dilutes them and infiltrated.

By implication, clean or fairly clean water may need to be used for dust suppression to limit pollution potential. The quality of the dirty runoff will need to be checked to ensure that it can be used for dust suppression.

We suggest that Eskom considers reducing their dust suppression when the dams levels are lower. The Eskom proposed 6mm/day is high although, at this rate it is useful when trying to make the dams as small as possible for GN704, but onerous when trying to find water during the dry season. We suggest perhaps 6mm/day when we are trying to get rid of water and 3mm/day or 4mm/day when there is a shortfall.

This approach will still not "find" water, if there is a shortfall, and a "bigger" study will be required if there are shortfalls – which is not part of this Brief.

6.2 Seepage Control

In order to collect seepage and prevent it from getting into the subsoils beneath the disposal area, under-drainage and a 1,5mm double textured HDPE liner will be provided to collect the leachate, which will then be led into the AWRD, from where it will be pumped back to the station for reuse. Details of this liner are given on the drawing in Appendix A, although the actual layer configuration and its effect on the ADF stability will form part of the Preliminary Design Stage.

6.3 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 and ADF.

The existing AWRD's may need to be supplemented and adapted to collect the dirty water seepage from the ash disposal facility, as well as rainfall runoff. The details of this are presented on the drawings and within the Ilanda Report, in Appendix B.

All dirty stormwater drains will be lined with concrete as detailed.

6.4 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 ash dam
- Gradual spreading of topsoil to cover shaped ash dam 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 shrubs.
- Aftercare of rehabilitated areas to ensure continued stability and eventual self sustainability
- The upkeep of a complete rehabilitation progress manual.

7. POLLUTION CONTROL DAMS

"The ash return water dams were sized to comply with Government Notice 704 of the South African National Water Act, Act 36 of 1998. The act specifies that the ash return water dam should spill once every fifty years on average. The dam must be lined.

The modelling showed that at final footprint development, the proposed new ash return water dam capacity must be 170 000m^3.

The existing Settling dam, Dirty water dam and Clean water dam should no longer be required once the proposed new ash water dam is operational, assuming that run-off from the rehabilitation areas of the existing and proposed dump extension is clean. All seepage water should be routed to the proposed new ash return water dam (ARWD)."

The following is an extract from the Ilanda Report attached :

Two scenarios were run to determine the worst-case dam capacities required. The two scenarios are:

- Early dump life: This scenario provides the worst case ash water return dam capacity. The scenario models the start of the deposition of the two dump extensions. A large catchment to the east of the current deposition cannot drain through a clean water system due to the deposition under the extendible conveyor. This storm water will be clean in the early stages of deposition, but will have to flow through a dirty area and therefore will become dirty. This storm water is managed as part of the dirty water system. This catchment is largest at the start of the dump extensions. The rehabilitated areas are at their smallest.

- End of dump life: This scenario provides the worst case rehab runoff dam capacity. The scenario models the end of the dump deposition. The rehabilitated areas are at their largest.

7.1 Ash Water Return Dams

All the dirty water run-off which accumulates on and around the ADF will be directed into one of the Ash Water Return Dam, via pipe lines or open channels.

Emergency 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 other sources, to create the required capacity, in a "cut and fill" operation, taking the ground water table level into account.

All PCD’s should be lined with a 1,5 mm HDPE liner in detailed on the drawings.

As part of the stormwater control measures on the site, an Ash Water Return Dam is required and the two existing Southern Dams, will be modified in shape and upgraded for use as “store and release” facilities, with the clean water being diverted back in the river further south.

7.2 Retention Release Dams

Due to property ownership constraints, the Valley west of the RRD2 will need to be backfilled to Contour Level 1599, to accommodate the new clean water canal, or alternatively a clean water dam could be constructed on the neighbours’ property, with his permission, to improve the clean canal alignment.

8. RECOMMENDATIONS

In order to progress from Conceptual Stage to Basic Design the following additional information is necessary

- Specialist Geotechnical investigation and evaluation of the underlying soil, affecting the stability of the ash disposal facility and AWRD.
- Evaluation of spillway sizes on the existing Valley Dams.
- Extensive testing of shear strength characteristics between soil and HDPE liner.
- Confirmation that site is not undermined.
- Evaluation of Conveyor alignment, drives, electrical and pumping infrastructure requirements should be carried out.
- Update J&W Report i.t.o the New Regulations.

9. CAPEX COSTING

A cost estimate for the various components of the infrastructure, will form part of the Basic Design stage.

10. RISK EVALUATION

10.1 Residue Characterisation

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 following is an extract from the Jones and Wagner Report JW123/13/D880 – Rev 01 dated December 2014.

"Lidwala approached Jones & Wagner Engineering and Environmental Consultants (J&W) to assess the coal derived ash from the Power Station in terms of the provisions of the National Environmental Management : Waste Act, Act 59 of 2008, as amended.

Assessment of the ash is required for two purposes :

- To correctly assess the new ash disposal facility for licensing purposes, and
- To develop an appropriate barrier design for the facility based on the outcome of the assessment of the ash in order to protect the water environment.

In terms of the DEA's water assessment regulations, the ash is assessed as a Type 3 (low risk waste), which requires disposal on a landfill of which the performance of the barrier system complies with that of a Class C landfill. The outcome of the assessment was the result of the leachable concentrations of boron and chromium VI, and the total concentrations of barium and copper in the ash.

Based on the findings of this study, it is recommended that :

- The extended Tutuka Power Station ash disposal facility should be licensed as a Class C landfill,

- The barrier system should comply with the performance requirements of a Class C landfill, and
- Human settlements are not to be allowed on the top of the ash disposal facilities either during operation or after closure.”

10.2 ADF Slope Stability 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 of the ADF during detailed design stage.

The initial conclusion is that the ADF has a low to medium Hazard Classification in terms of its slop stability and likely hood of its failure causing property damage.

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APPENDIX A
DRAWINGS

Drawing No.	Rev	Title
667/100	B	Key Plan Ash Extension
667/105	0	Release water berms and drains
667/110	A	South Section A-A
667/112	A	South Section B-B
667/114	A	South Section C-C
667/116	A	South Section D-D
667/122	A	East Section E-E
667/124	A	East Section F-F
667/126	A	East Section G-G
667/140	B	Typical AWRD safety details
667/150	0	AWRD 1 wall section
667/151	0	RRD1 wall section
667/152	0	RRD2 wall section
667/160	A	AWRD Armorflex spillway
667/170	B	Dump and AWRD barrier details
667/180	0	Energy dissipation structure and pipe crossing
667/190	0	HDPE liner details
667/220	B	Dry Ash stack arrangement
667/320	0	Ash Dam Typical Details (wall section)

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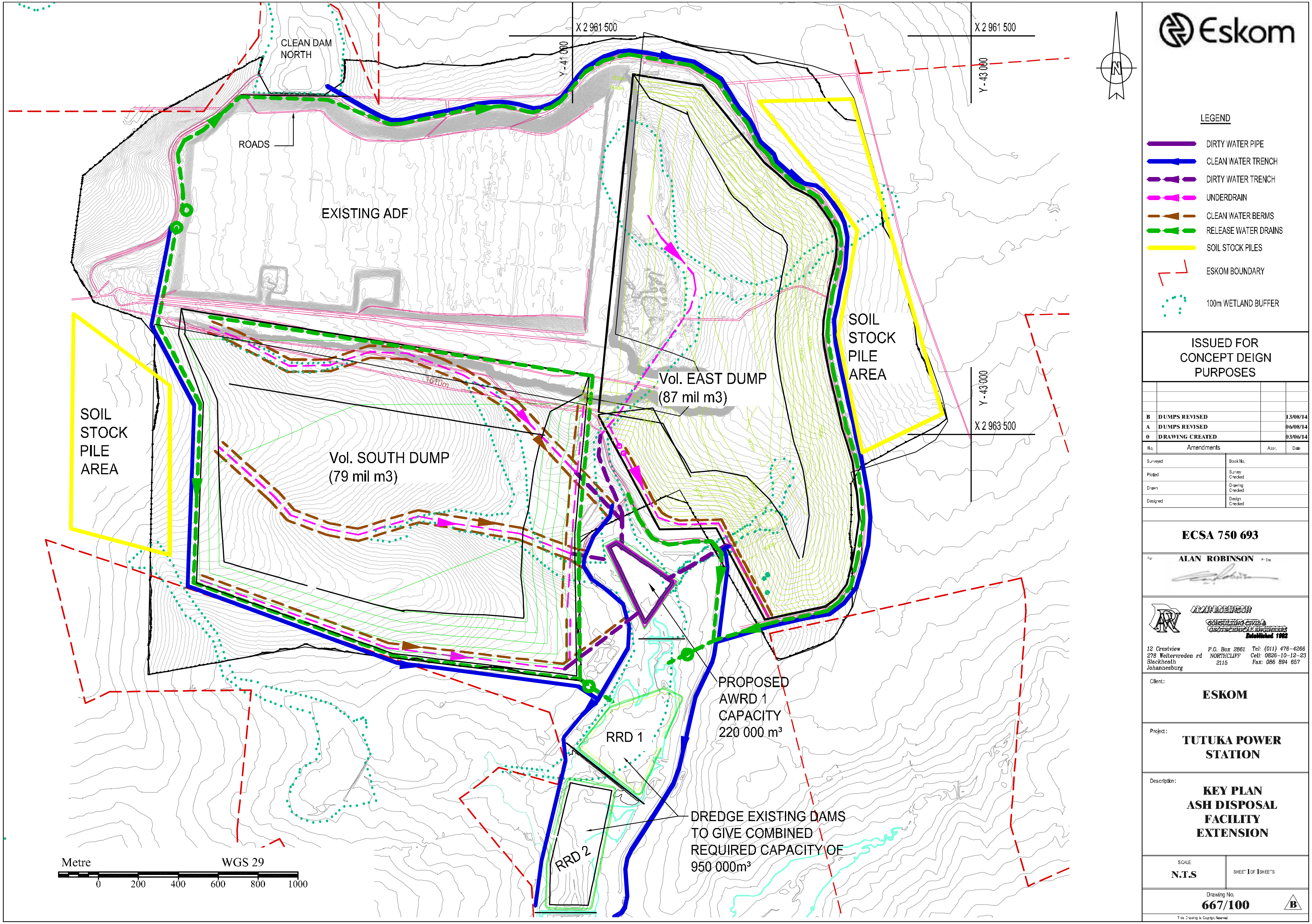

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LEGEND
DIRTY WATER PIPE
CLEAN WATER TRENCH
DIRTY WATER TRENCH
UNDERDRAIN
CLEAN WATER BERMS
RELEASE WATER DRAINS
SOIL STOCK PILES
ESKOM BOUNDARY
100m WETLAND BUFFER
ISSUED FOR CONCEPT DEIGN PURPOSES
B DUMPS REVISED 13/08/14
A DUMPS REVISED 06/08/14
0 DRAWING CREATED 03/06/14
No. Amendments Appr. Date
Surveyed
Book No.
Plotted
Survey Checked
Drawn
Drawing Checked
Designed
Design Checked
ECSA 750 693
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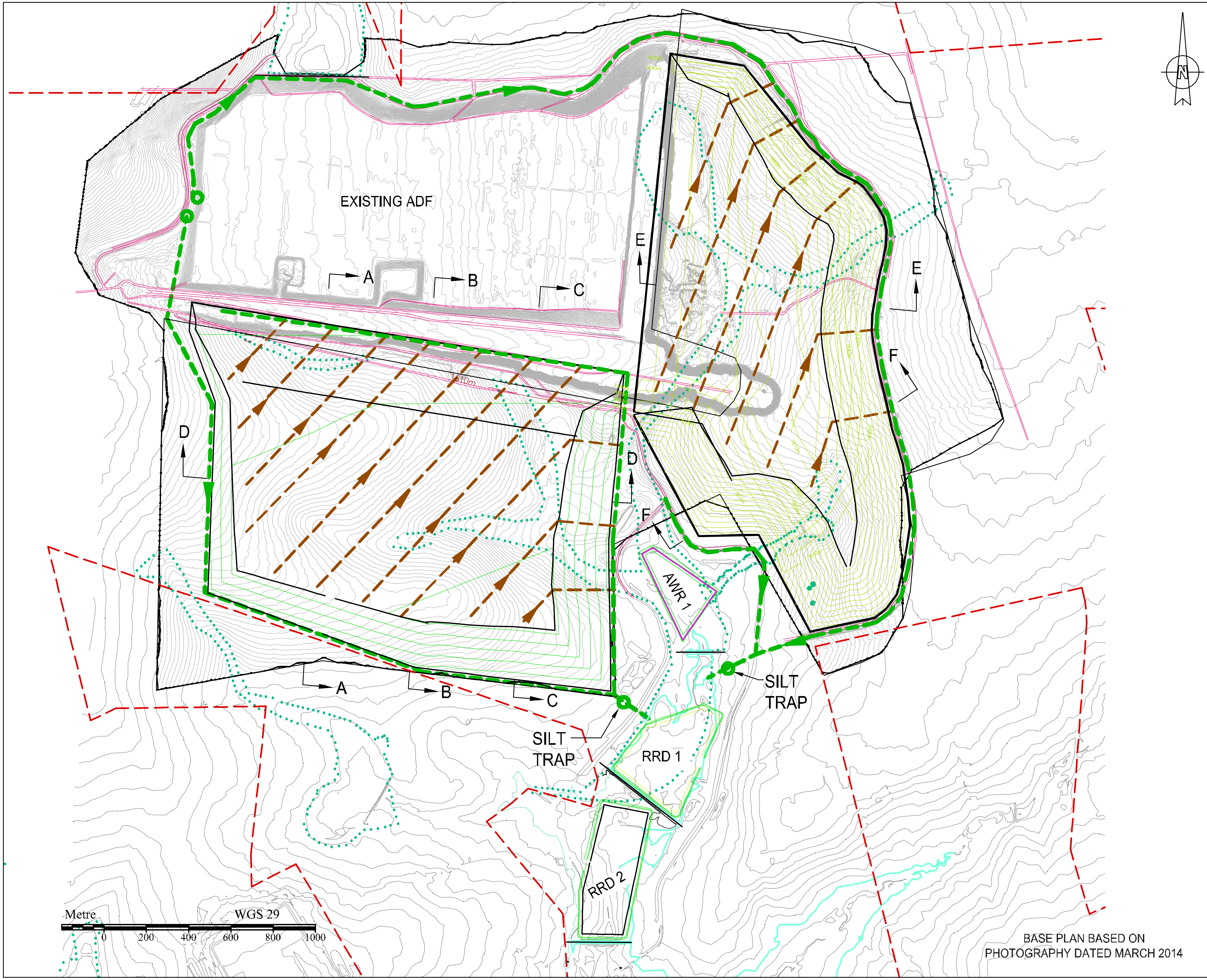
Client:
ESKOM
Project:
TUTUKA POWER STATION
Description:
KEY PLAN ASH DISPOSAL FACILITY EXTENSION
SCALE
N.T.S
SHEET 1 OF 1 SHEETS
Drawing No.
667/100
B
X 2 961 500
Y - 41 000
Y - 43 000
X 2 963 500
CLEAN DAM NORTH
ROADS
EXISTING ADF
SOIL STOCK PILE AREA
Vol. EAST DUMP (87 mil m3)
Vol. SOUTH DUMP (79 mil m3)
1610m
PROPOSED AWRD 1 CAPACITY 220 000 m³
RRD 1
RRD 2
DREDGE EXISTING DAMS TO GIVE COMBINED REQUIRED CAPACITY OF 950 000m³
Metre
WGS 29
0
200
400
600
800
1000



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LEGEND

- CLEAN WATER BERMS
- RELEASE WATER DRAINS
- BOUNDARY
- 100m WETLAND BUFFER

ISSUED FOR CONCEPT DEIGN PURPOSES

No.	Amendments	Appr.	Date
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Surveyed		Book No.	
Plotted		Survey Checked	
Drawn		Drawing Checked	
Designed		Design Checked	

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Client: ESKOM

Project: TUTUKA POWER STATION

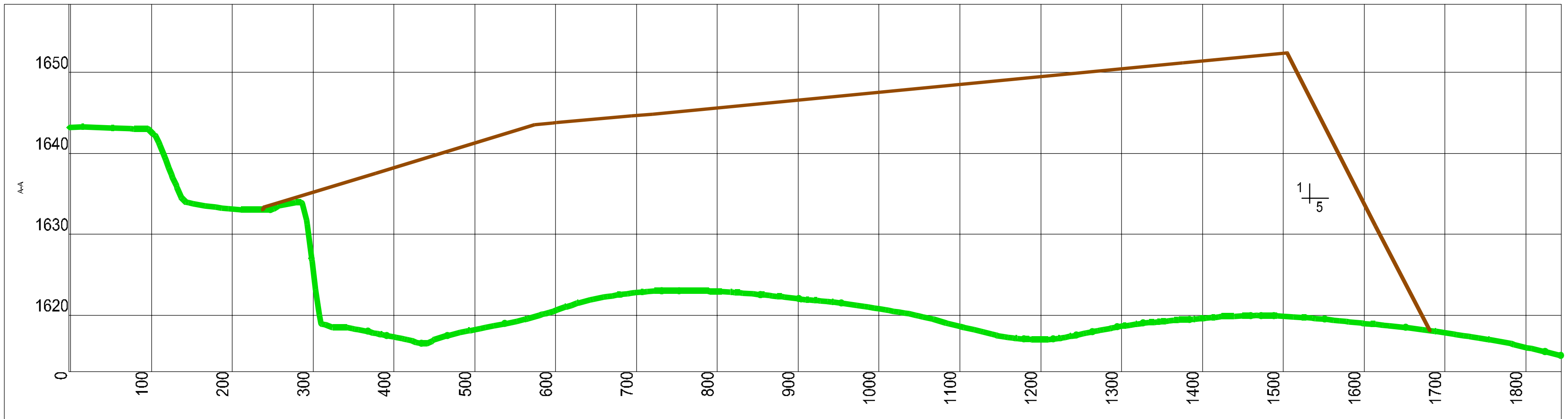
Description: RELEASE WATER BERMS & DRAINS

SCALE: N.T.S

SHEET 1 OF 1 SHEETS

Drawing No. 667/105

0



Distance	13.3	235.4	373.8	562.5	597.0	689.3	721.7	1371.0	1512.6	1613.7	1687.7	1843.3
OGL	1643.2	1633.0	1617.8	1619.5	1620.5	1622.7	1623.0	1619.4	1619.8	1618.9	1618.0	[illegible]

Distance	237.5	377.6	574.0	595.4	693.5	719.8	1376.1	1504.4	1614.3	1681.2
Dump Elevation	1633.0	1637.6	1643.6	1643.7	1644.6	1644.8	1651.2	1652.4	1631.1	1618.1

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No.	Amendments	Appr.	Date
A	DRAWING UPDATED		02/12/14
0	DRAWING CREATED		13/08/14

Surveyed	Book No.
Plotted	Survey Checked
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Designed	Design Checked

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Client: **ESKOM**

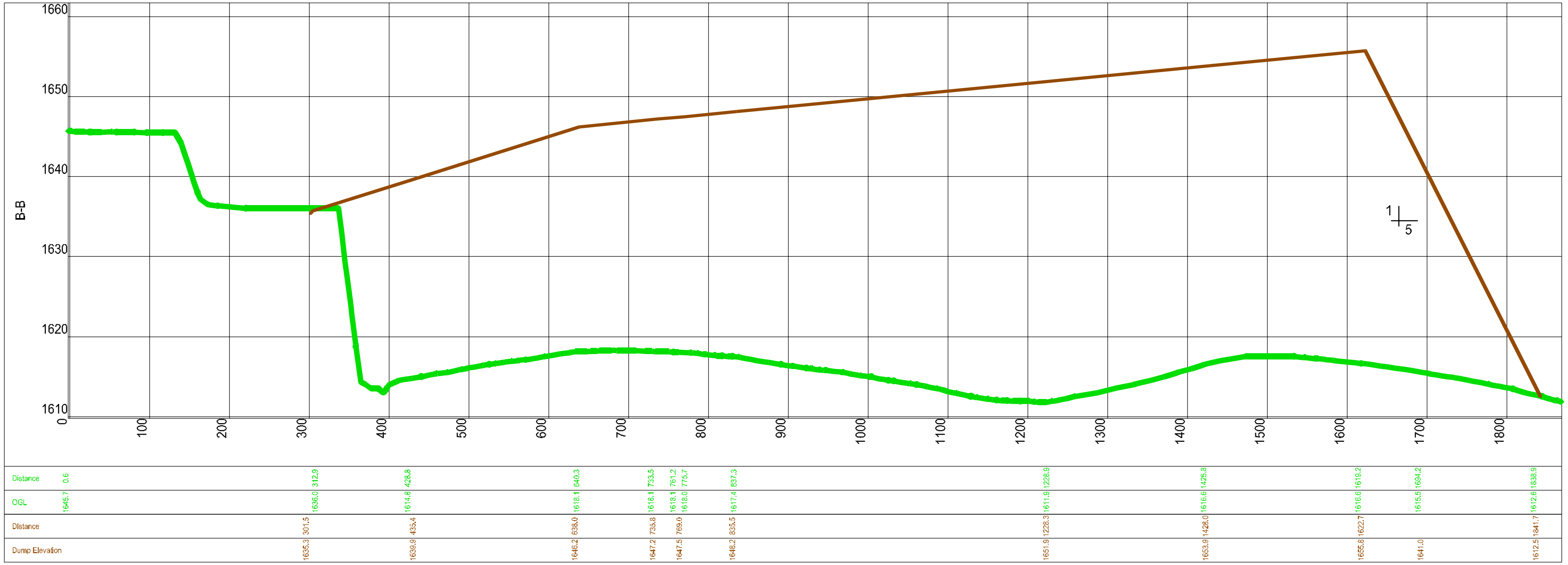
Project: **TUTUKA POWER STATION**

Description: **SOUTH DUMP SECTION A-A**

SCALE **N.T.S**

SHEET 1 OF 1 SHEETS

Drawing No. **667/110** A



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No.	Amendments	Appr.	Date
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Client:
ESKOM

Project:
TUTUKA POWER STATION

Description:
SOUTH DUMP SECTION B-B

SCALE
N.T.S

SHEET 1 OF 1 SHEETS

Drawing No.
667/112

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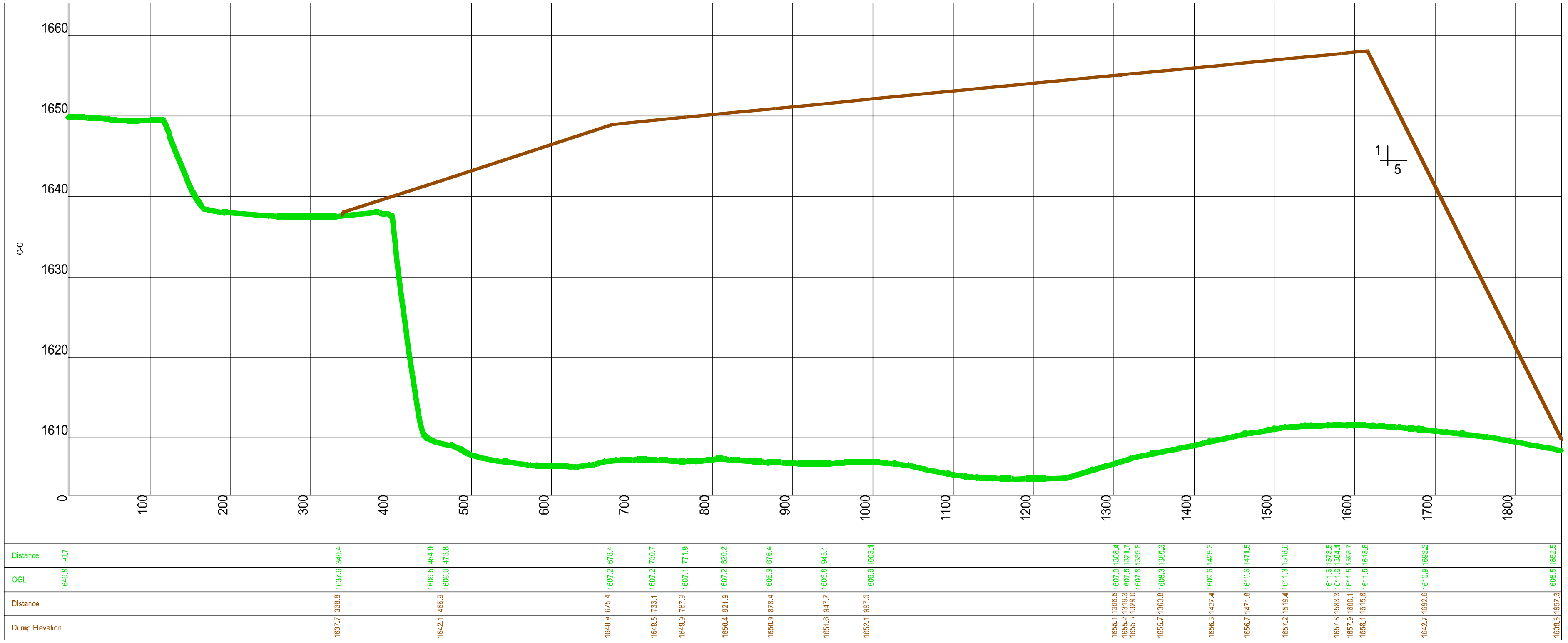

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Client:
ESKOM

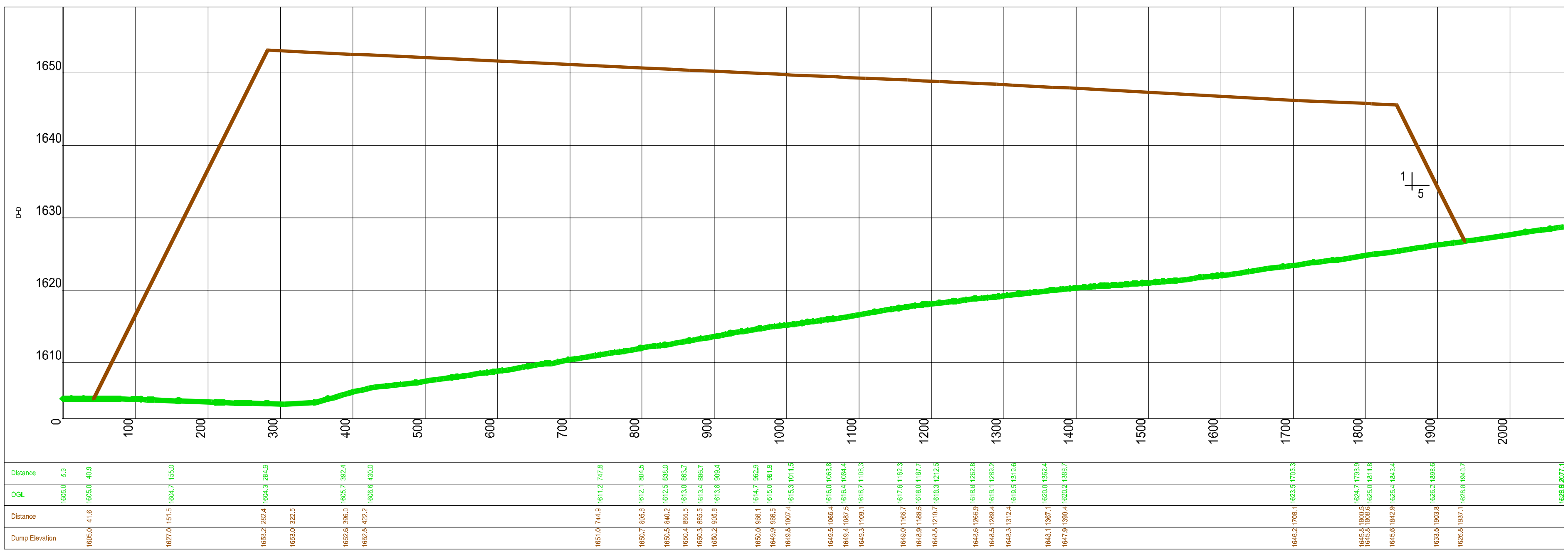
Project:
TUTUKA POWER STATION

Description:
SOUTH DUMP SECTION C-C

SCALE
N.T.S

SHEET 1 OF 1 SHEETS

Drawing No.
667/114 A



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Project:

TUTUKA POWER STATION

Description:

SOUTH DUMP SECTION D-D

SCALE
N.T.S

SHEET 1 OF 1 SHEETS

Drawing No.
667/116

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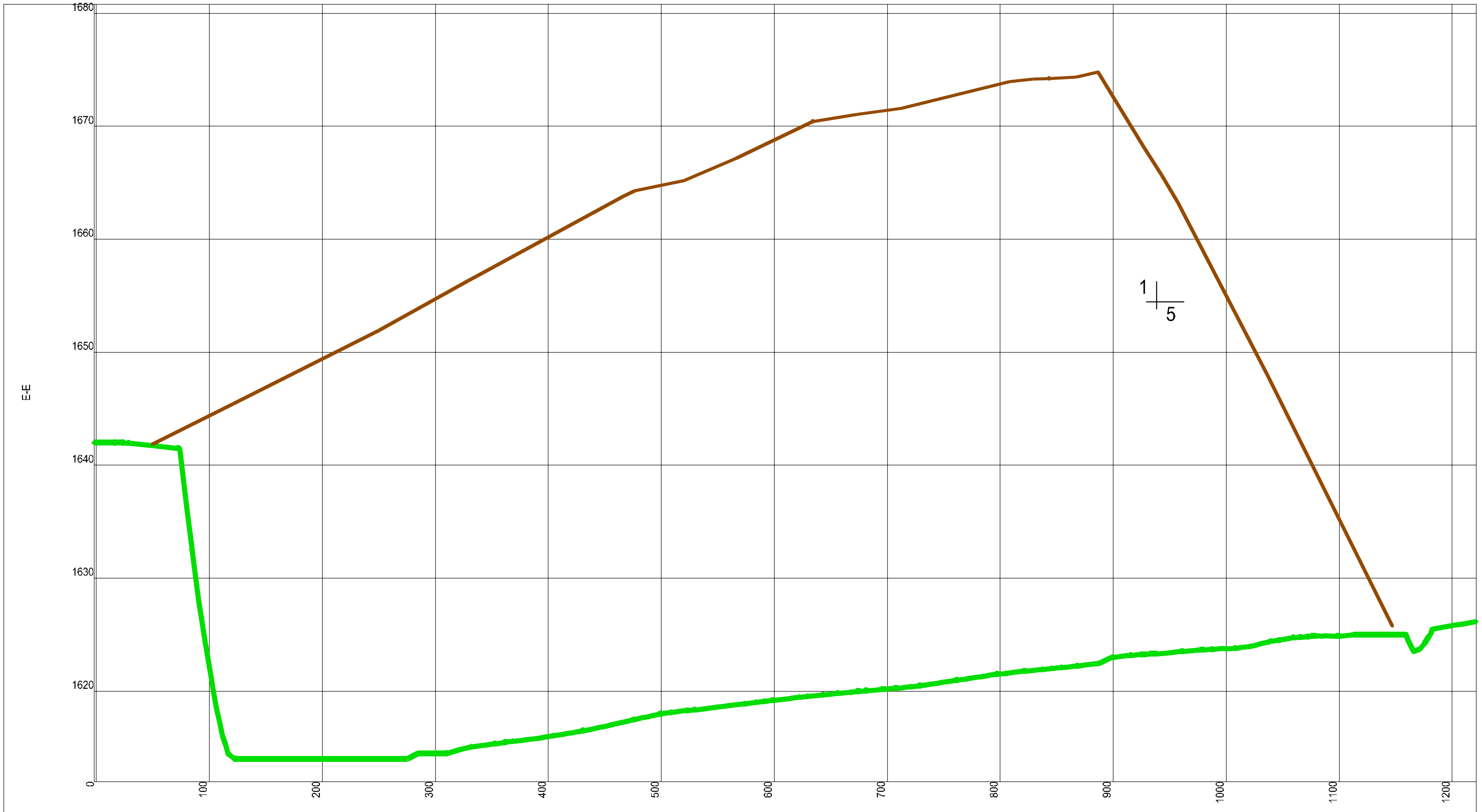

	Distance	OGL	Distance	Dump Elevation
	0.8	1642.0		
	51.9	1641.7	49.5	1641.8
	122.6	1614.0	120.7	1645.4
	242.7	1614.0	249.6	1651.9
	323.7	1614.9	329.2	1656.3
	331.6	1615.1	334.9	1656.6
	466.3	1617.3	466.5	1663.8
	474.1	1617.4	476.8	1664.3
	521.3	1618.3	520.2	1665.2
	567.3	1618.8	565.9	1667.2
	635.3	1619.6	633.8	1670.4
	673.8	1620.0	672.7	1671.0
	715.7	1620.3	712.1	1671.6
	804.2	1621.6	808.4	1673.9
	828.3	1621.8	828.7	1674.2
	844.9	1622.0	843.0	1674.2
	866.8	1622.2	867.1	1674.4
	886.2	1622.5	884.6	1674.8
	923.7	1623.2	926.5	1668.3
	935.1	1623.3	942.7	1665.7
	949.2	1623.4	957.3	1663.3
	959.4	1623.5		
	1039.1	1624.4	1036.2	1648.0
	1145.8	1625.0	1147.1	1625.8
	1158.9	1625.0		
	1167.5	1623.5		
	1171.8	1623.7		
	1179.6	1624.9		
	1202.1	1625.8		
	1212.0	1626.0		
	1218.6	1626.1		

Eskom

ISSUED FOR
CONCEPT DEIGN
PURPOSES

No.	Amendments	Appr.	Date
A	DRAWING UPDATED		02/12/14
0	DRAWING CREATED		13/08/14

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

ECSA 750 693

For ALAN ROBINSON Pr Eng

ALAN ROBINSON
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Fax: 086 894 657

Client: ESKOM

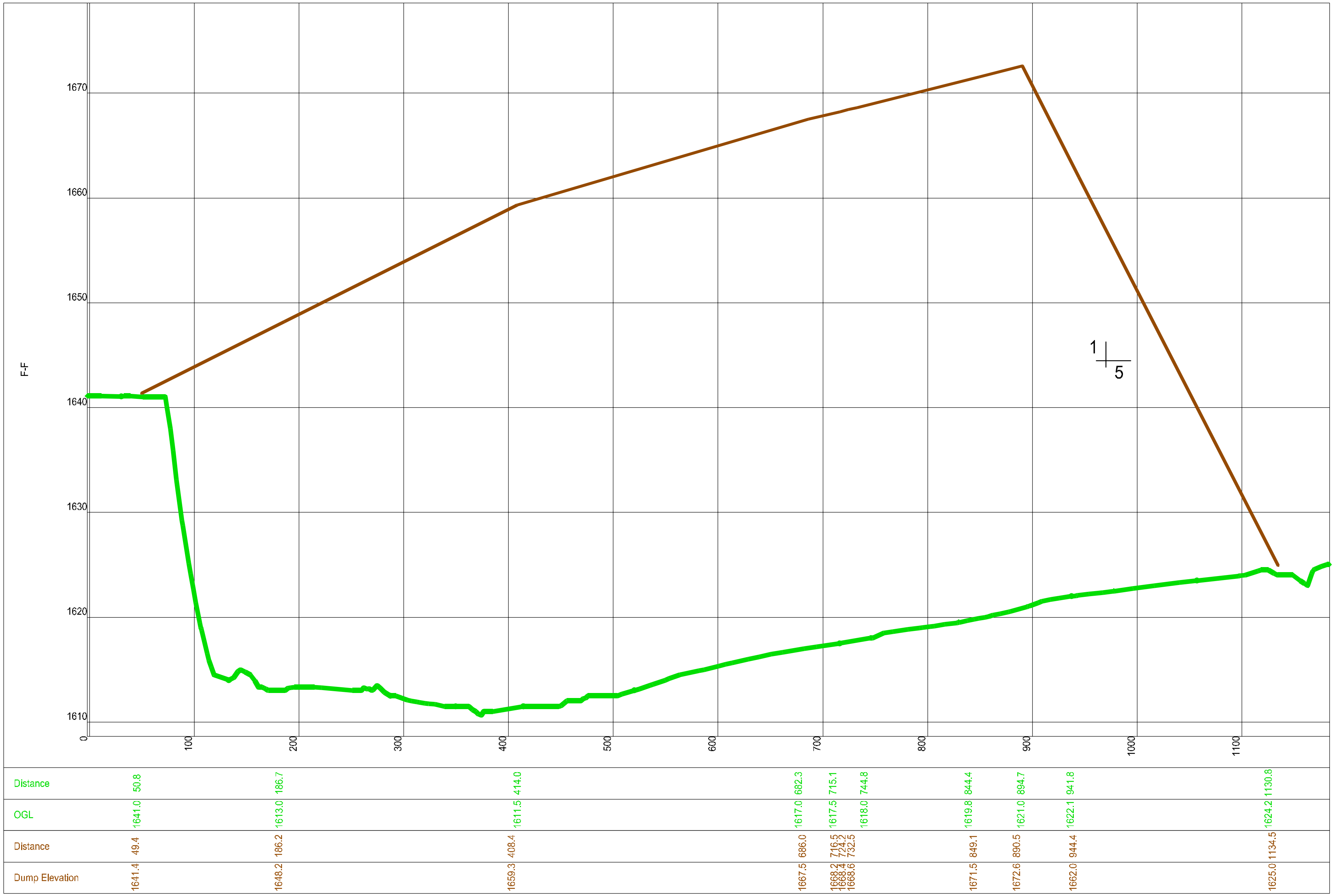
Project: TUTUKA POWER STATION

Description: EAST DUMP SECTION E-E

SCALE N.T.S

SHEET 1 OF 1 SHEETS

Drawing No. 667/122 A



Eskom

ISSUED FOR
CONCEPT DEIGN
PURPOSES

No.	Amendments	Appr.	Date
A	DRAWING UPDATED		02/12/14
0	DRAWING CREATED		13/08/14

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

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For ALAN ROBINSON Pr. Eng

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Fax: 086 894 657

Client:
ESKOM

Project:
TUTUKA POWER STATION

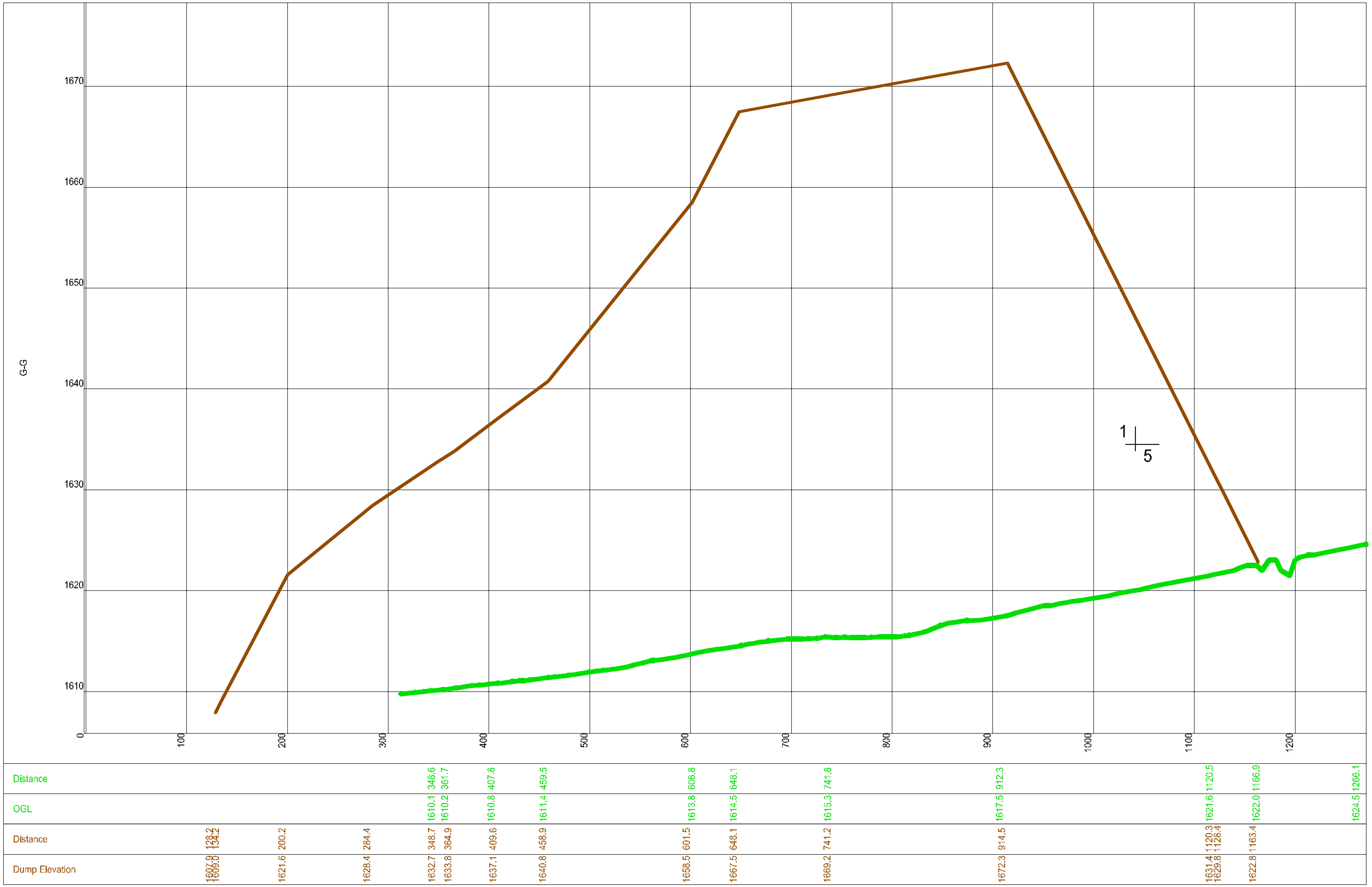
Description:
EAST DUMP SECTION F-F

SCALE
N.T.S

SHEET 1 OF 1 SHEETS

Drawing No.
667/124

A



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CONCEPT DEIGN
PURPOSES

No.	Amendments	Appr.	Date
A	DRAWING UPDATED		02/12/14
0	DRAWING CREATED		13/08/14

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:
ESKOM

Project:
TUTUKA POWER STATION

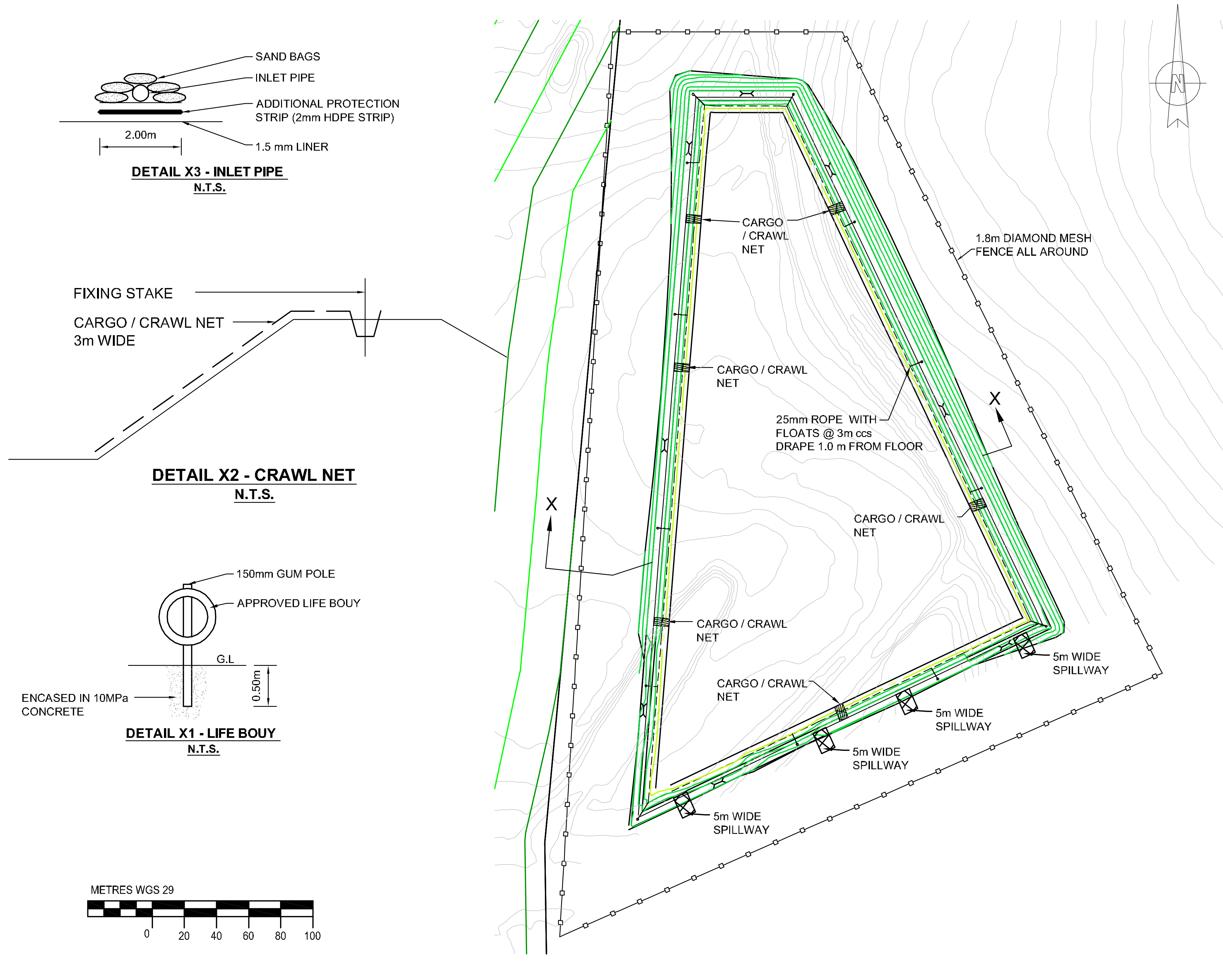
Description:
EAST DUMP SECTION G-G

SCALE N.T.S

SHEET 1 OF 1 SHEETS

Drawing No. 667/126

A



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

UNDERDRAIN (DETAIL F)

LIFE BOUY

ISSUED FOR CONCEPT DEIGN PURPOSES

No.	Amendments	Appr.	Date
B	DRAWING UPDATED		02/12/14
A	DRAWING UPDATED		13/11/14
0	DRAWING CREATED		03/06/14

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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Tel: (011) 476-4266 Cell: 0826-10-12-23 Fax: 086 894 657

Client: **ESKOM**

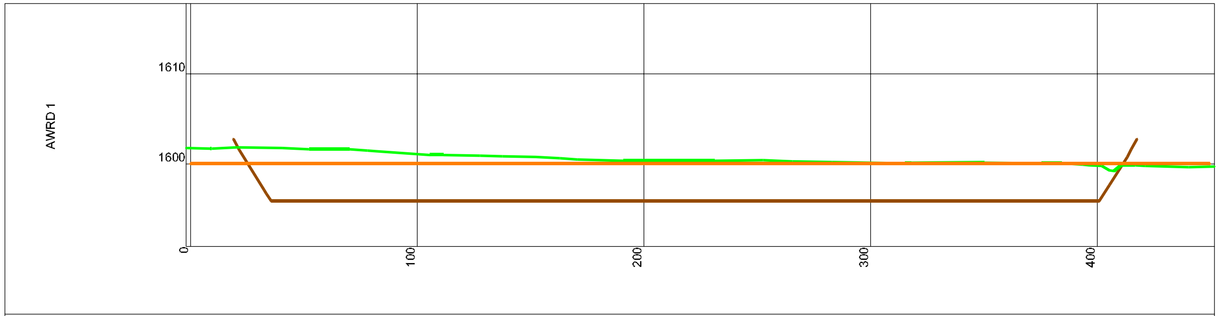
Project: **TUTUKA POWER STATION**

Description: **AWRD 1 PLAN & SAFETY DETAILS**

SCALE as shown

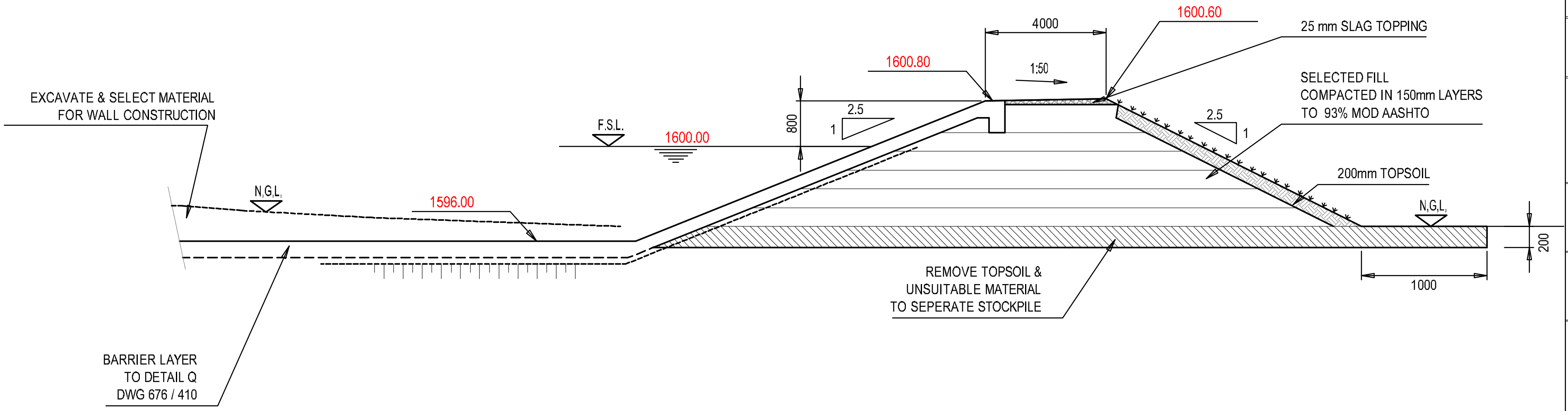
SHEET 1 OF 1 SHEETS

Drawing No. 667/140 B



Distance	0.0 449.9
WL	1600.0 1600.0
Description	PI1 PI1
Distance	-2.0 20.3 40.2 52.1 70.0 77.9 105.5 127.5 137.4 152.3 163.0 190.9 212.6 231.0 252.5 265.7 283.1 315.4 350.2 375.6 393.6 402.0 416.9 440.4 451.9
NGL	1601.8 1601.9 1601.8 1601.6 1601.6 1601.5 1601.0 1601.0 1600.9 1600.8 1600.7 1600.4 1600.4 1600.4 1600.5 1600.3 1600.2 1600.1 1600.2 1600.1 1600.0 1599.8 1599.9 1599.7 1599.7
Distance	18.8 32.4 52.3 65.4 94.4 115.6 142.2 164.9 190.2 213.9 238.3 262.6 286.5 380.9 400.8 413.4
AWRD 1 LEVELS	1602.8 1597.2 1595.9 1595.9 1595.9 1595.9 1595.9 1595.9 1595.9 1595.9 1595.9 1595.9 1595.9 1595.9 1595.9 1600.8

SECTION X-X



SECTION - PCD WALL (NTS)

Eskom

NOTE:
ALL WORK IS TO BE DONE
TO SABS 1200

ISSUED FOR
CONCEPT DEIGN
PURPOSES

No.	Amendments	Appr.	Date
0	DRAWING CREATED		03/06/14

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: ESKOM

Project: TUTUKA POWER STATION

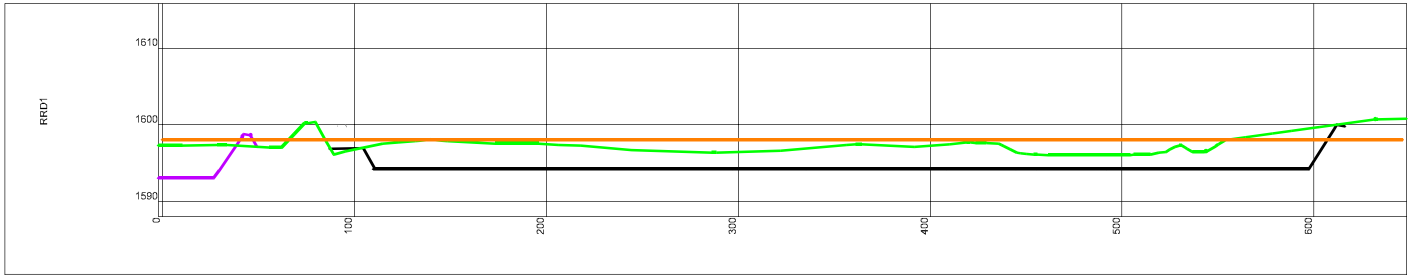
Description: AWRD 1 WALL SECTION

SCALE N.T.S

SHEET 1 OF 1 SHEETS

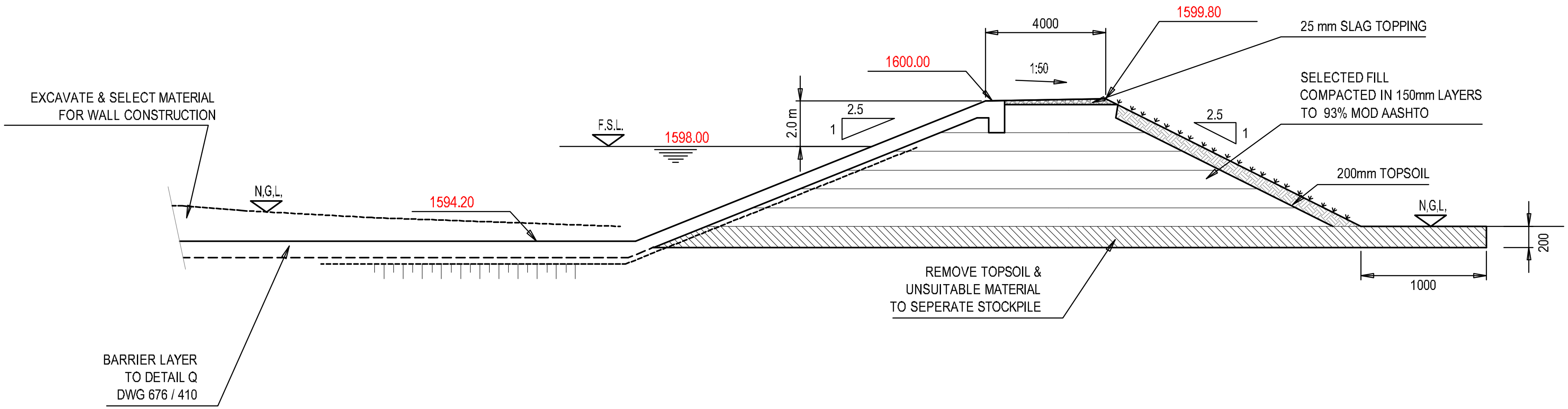
Drawing No. 667/150

0



Distance	0.0 646.3
FSL	1598.0 1598.0
Description	PI1 PI1
Distance	10.3 28.8 55.8 85.2 114.8 148.4 173.4 218.1 244.6 286.1 322.1 364.5 410.1 447.0 453.9 492.4 536.2 564.3 588.2 632.0 648.3
NGL	1597.3 1597.4 1597.0 1597.9 1597.6 1597.9 1597.5 1597.2 1596.7 1596.4 1596.6 1597.4 1597.5 1596.3 1596.1 1596.0 1596.5 1598.3 1599.2 1600.7 1600.8
Distance	91.5 110.0 160.4 183.9 217.5 285.5 297.2 335.6 362.0 408.6 444.9 455.3 492.0 501.9 539.3 556.1 588.0 616.1
RRD 1	1599.8 1594.2 1594.2 1594.2 1594.2 1594.2 1594.2 1594.2 1594.2 1594.2 1594.2 1594.2 1594.2 1594.2 1594.2 1594.2 1594.2 1599.8
Distance	12.9 24.1 41.6
RRD 2	1593.0 1593.0 1598.5

SECTION Y-Y



SECTION - PCD WALL (NTS)

Eskom

NOTE:
ALL WORK IS TO BE DONE
TO SABS 1200

ISSUED FOR
CONCEPT DEIGN
PURPOSES

No.	Amendments	Appr.	Date
0	DRAWING CREATED		02/12/14

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

ECSA 750 693

ALAN ROBINSON Pr Eng

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Client: ESKOM

Project: TUTUKA POWER STATION

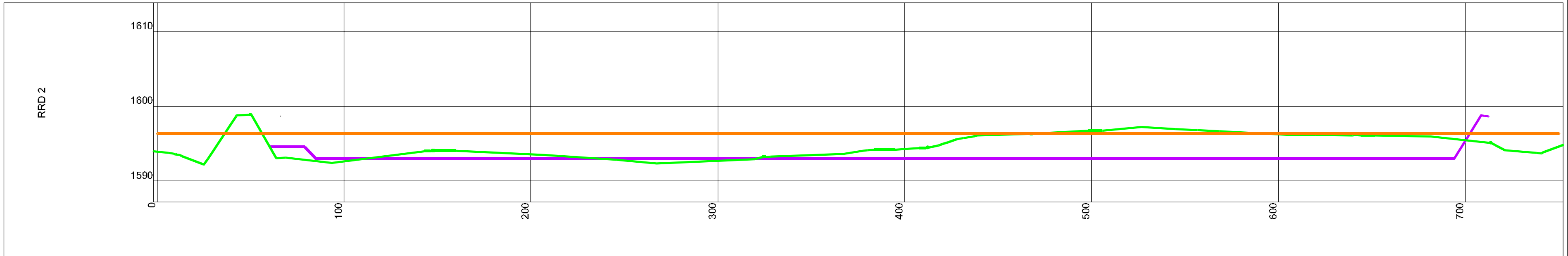
Description: RRD 1 WALL SECTION

SCALE N.T.S

SHEET 1 OF 1 SHEETS

Drawing No. 667/151

0

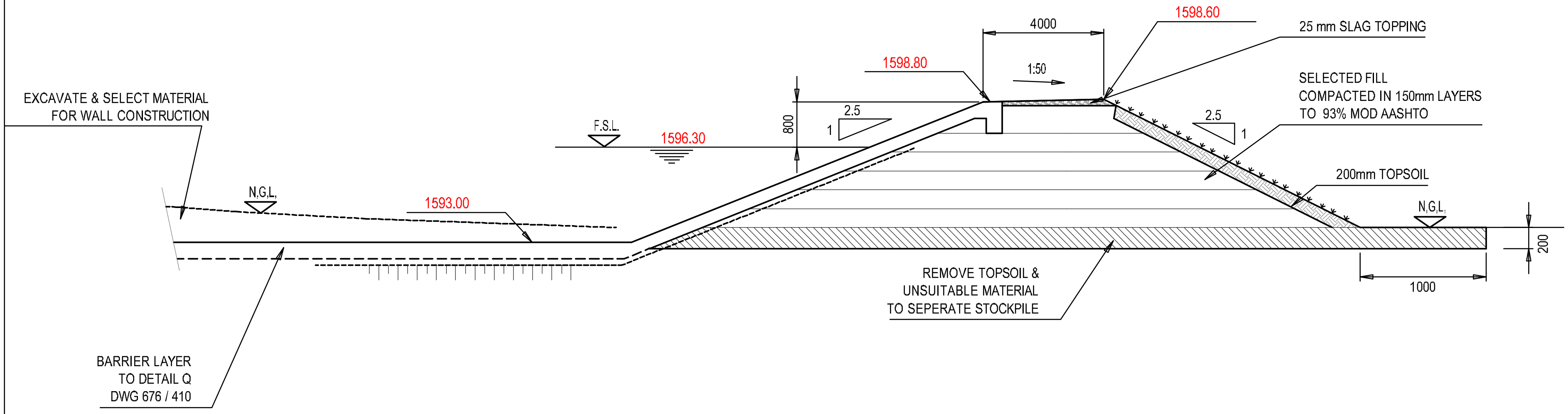


Distance	FSL	Description
0.0	1596.3	PI1
750.3	1596.3	PI1

Distance	NGL
6.4	1593.7
62.8	1593.4
93.4	1592.4
143.1	1594.0
159.6	1594.0
207.6	1593.5
245.8	1592.9
267.2	1592.3
325.9	1593.2
367.1	1593.6
383.5	1594.1
402.9	1594.3
431.5	1595.7
467.3	1596.3
498.0	1596.7
505.8	1596.8
526.8	1597.2
556.7	1596.8
605.7	1596.2
619.9	1596.2
639.6	1596.1
651.6	1596.1
681.5	1595.9
712.9	1595.1
721.1	1594.1
738.2	1593.8
752.3	1594.8

Distance	RRD 2 LEVELS
66.0	1598.6
84.8	1593.0
97.9	1593.0
109.5	1593.0
180.2	1593.0
210.2	1593.0
230.3	1593.0
259.3	1593.0
280.4	1593.0
310.8	1593.0
331.5	1593.0
360.9	1593.0
381.2	1593.0
404.6	1593.0
431.0	1593.0
461.3	1593.0
480.7	1593.0
511.5	1593.0
530.4	1593.0
561.7	1593.0
664.0	1593.0
675.7	1593.0
694.0	1593.0
708.5	1598.8

SECTION Z-Z



SECTION - PCD WALL (NTS)

Eskom

NOTE:
ALL WORK IS TO BE DONE
TO SABS 1200

ISSUED FOR
CONCEPT DEIGN
PURPOSES

No.	Amendments	Appr.	Date
0	DRAWING CREATED		02/12/14

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

ECSA 750 693

ALAN ROBINSON

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Client: ESKOM

Project: TUTUKA POWER STATION

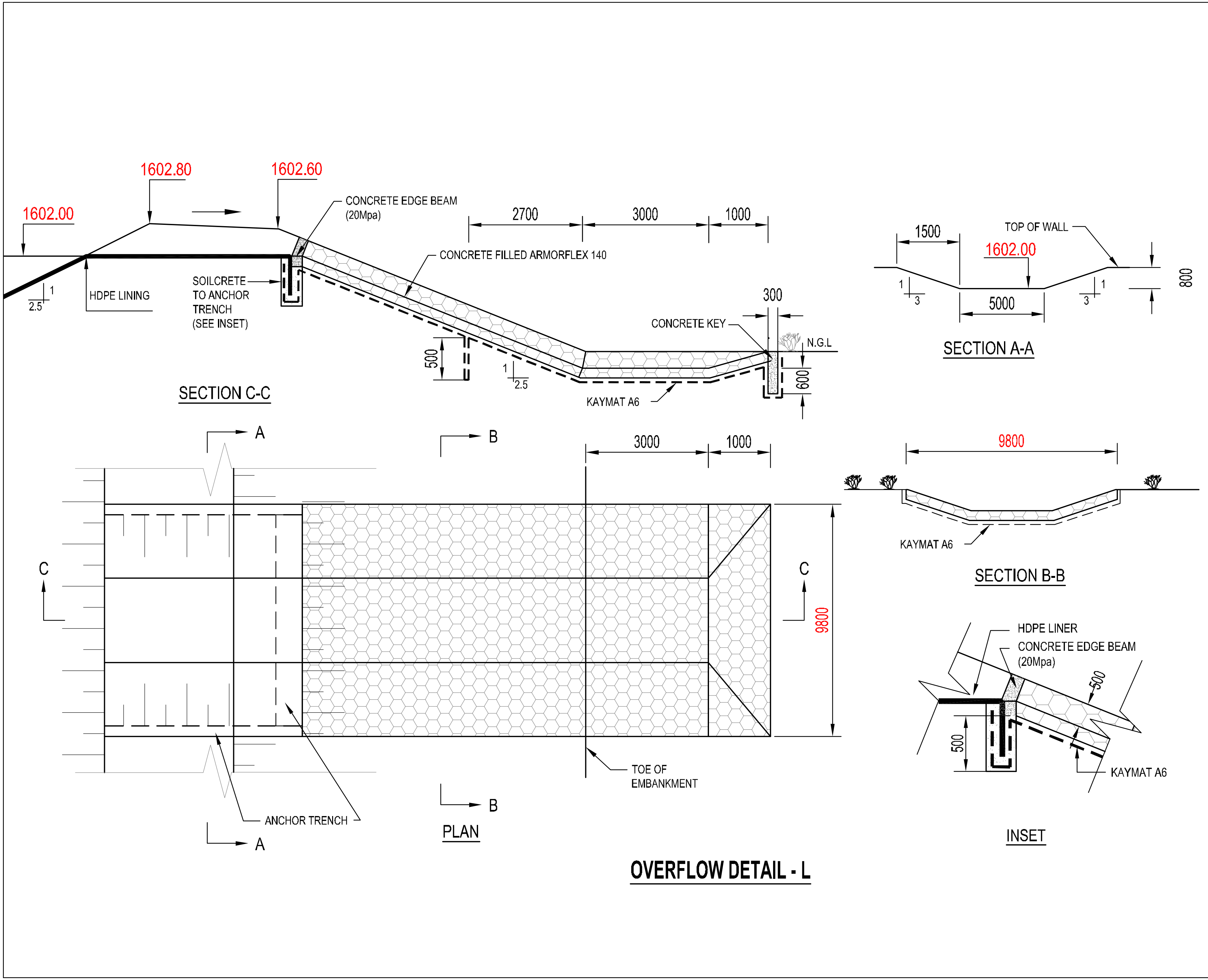
Description: RRD 2 WALL SECTION

SCALE N.T.S

SHEET 1 OF 1 SHEETS

Drawing No. 667/152

0



Eskom

ISSUED FOR CONCEPT DEIGN PURPOSES

No.	Amendments	Appr.	Date
A	DRAWING UPDATED		13/08/14
0	DRAWING CREATED		03/06/14

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

ECSA 750 693

For ALAN ROBINSON Pr. Eng

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Client: ESKOM

Project: TUTUKA POWER STATION

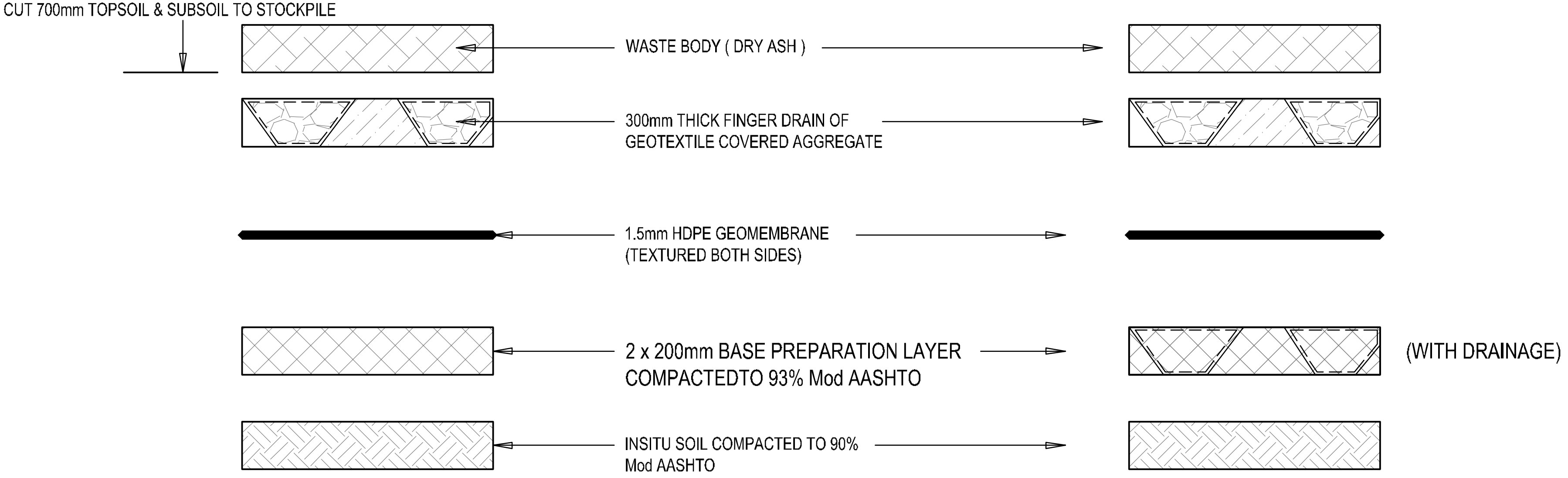
Description: ARWD 1 ARMORFLEX SPILLWAY (4 No.)

SCALE N.T.S

SHEET 1 OF 1 SHEETS

Drawing No. 667/160

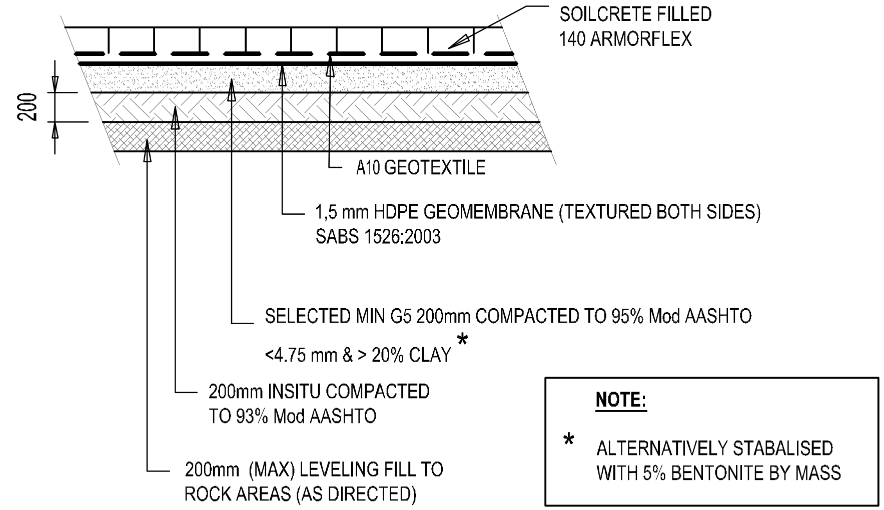
A



DETAIL (DRY ASH)
(TYPE C BARRIER) - DEEP W.T

DETAIL (DRY ASH)
(TYPE C BARRIER) - SHALLOW W.T

* NOTE : FILL BENEATH LINER
(MAXIMUM STONE SIZE 3.00mm) DEGREE
OF ACCURACY 50mm ON 3.0 m STRAIGHT EDGE.)

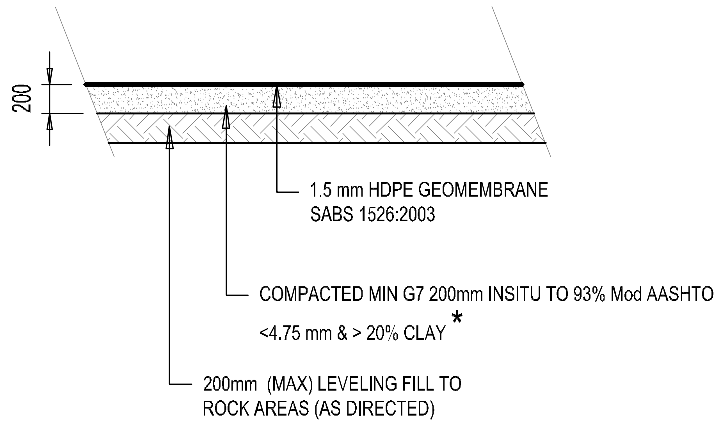


NOTE:

* ALTERNATIVELY STABALISED
WITH 5% BENTONITE BY MASS

DETAIL R (ARMORFLEX + HDPE)
SILT TRAP

* NOTE : FILL BENEATH LINER
(MAXIMUM STONE SIZE 3.00mm) DEGREE
OF ACCURACY 50mm ON 3.0 m STRAIGHT EDGE.)



DETAIL Q (TYPE C BARRIER)
AWRD

Eskom

ISSUED FOR
CONCEPT DEIGN
PURPOSES

No.	Amendments	Appr.	Date
B	DETAILS UPDATED		02/12/14
A	DETAILS UPDATED		07/07/14
0	DRAWING CREATED		26/05/14

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: 0826-10-12-23
Fax: 086 894 657

Client: ESKOM

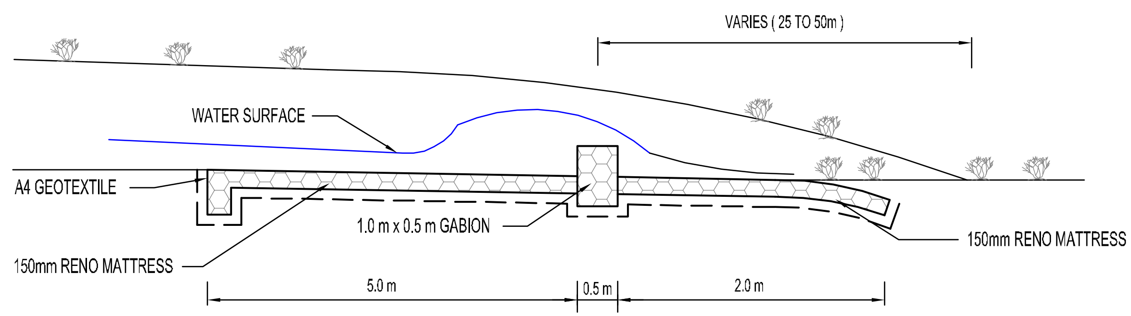
Project: TUTUKA POWER STATION

Description: DUMP & ARWD BARRIER DETAILS

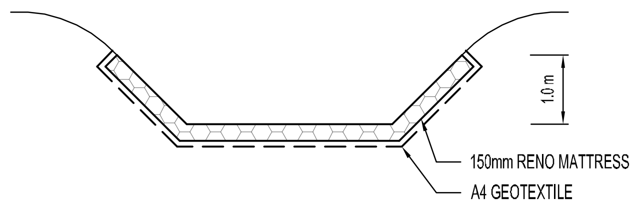
SCALE N.T.S

SHEET 1 OF 1 SHEETS

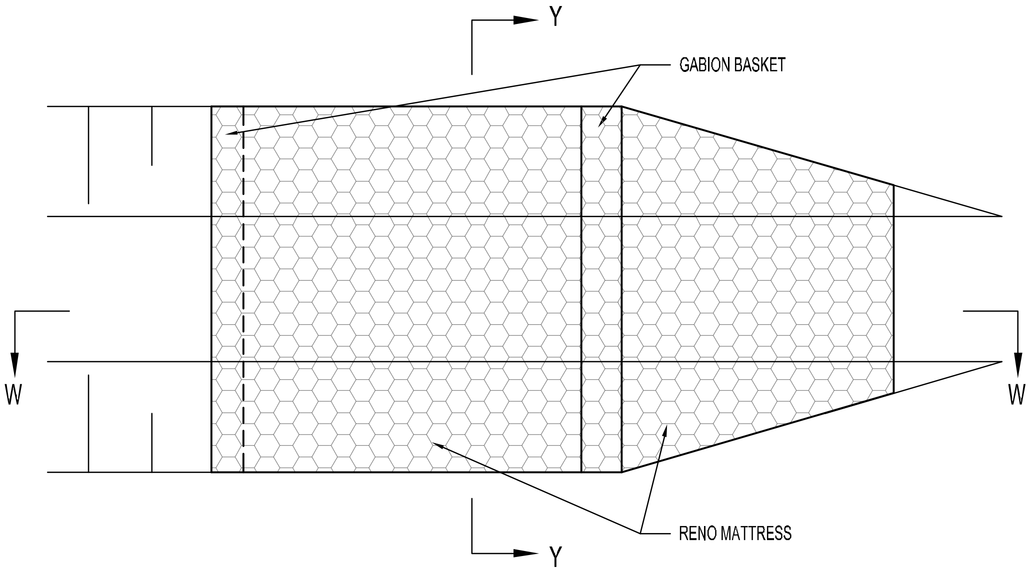
Drawing No. 667/170 B



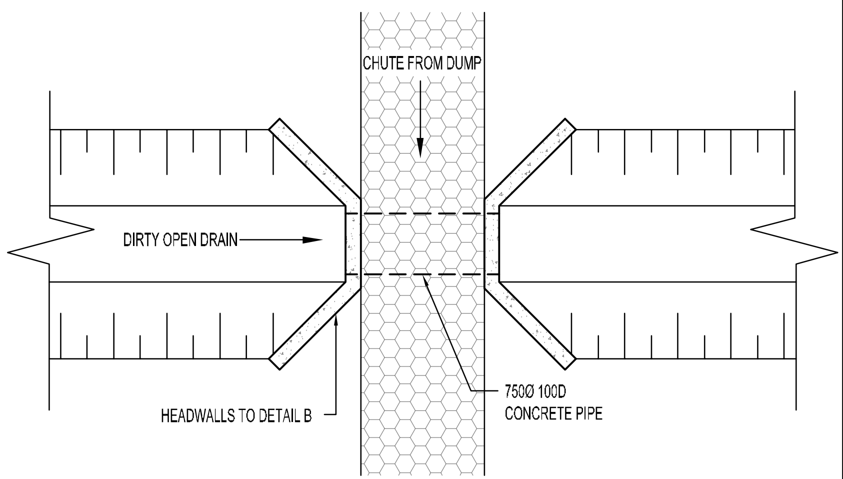
TYPICAL SECTION W-W



TYPICAL SECTION Y-Y



PLAN - OF OPEN CHANNEL



PIPE CROSSING - DETAIL B1

DETAIL - Z OPEN CHANNEL OUTLET

Eskom

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PURPOSES

No.	Amendments	Appr.	Date
0	DRAWING CREATED		03/06/14

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

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For ALAN ROBINSON Pr Eng

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Fax: 086 894 657

Client: ESKOM

Project: TUTUKA POWER STATION

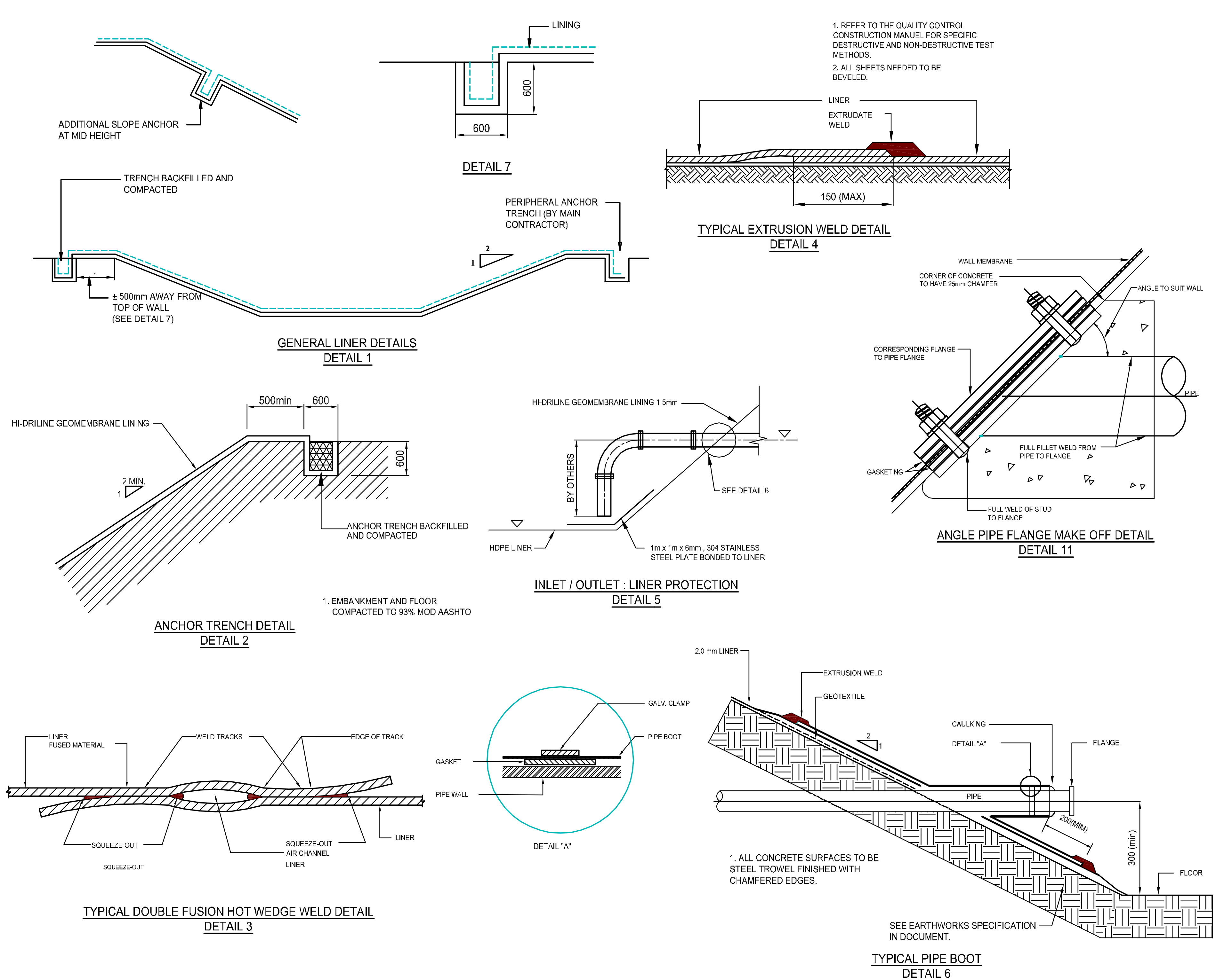
Description: ENERGY DISSIPATION STRUCTURE & PIPE CROSSING

SCALE N.T.S

SHEET 1 OF 1 SHEETS

Drawing No. 667/180

0



Eskom

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

ISSUED FOR CONCEPT DEIGN PURPOSES

No.	Amendments	Appr.	Date
0	DRAWING CREATED		03/06/14

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: **ESKOM**

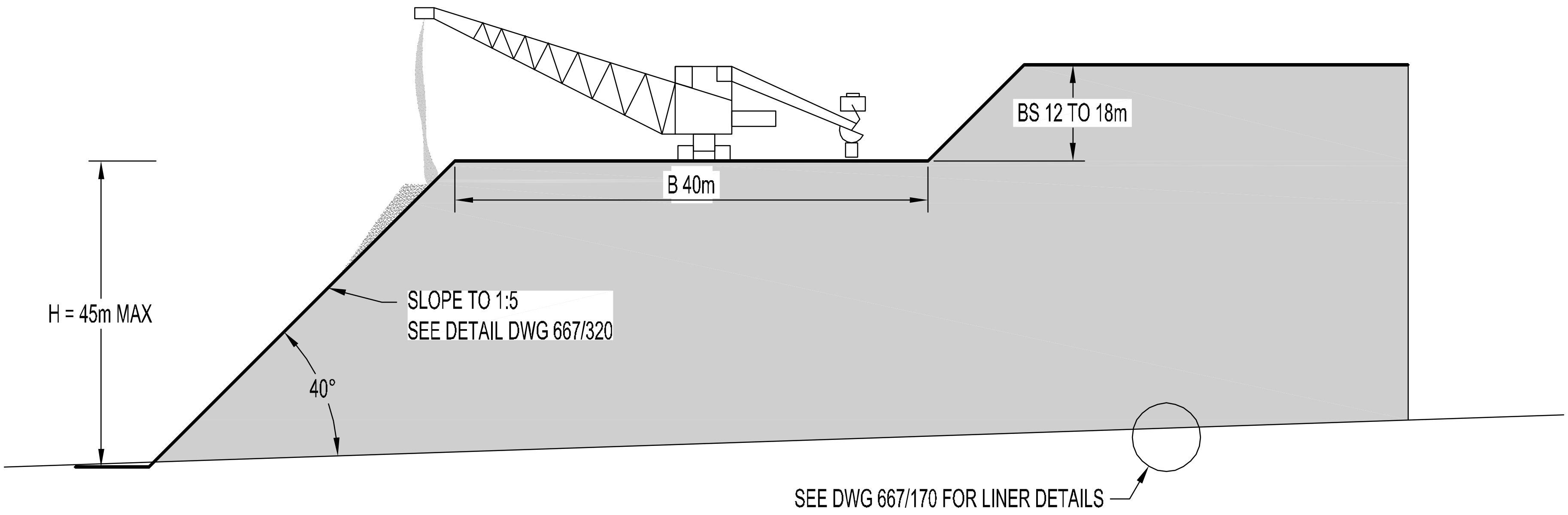
Project: **TUTUKA POWER STATION**

Description: **HDPE LINER DETAILS**

SCALE N.T.S

SHEET 1 OF SHEETS

Drawing No. **667/190** 0



BS - DENOTES BACK STACK
FS - DENOTES FRONT STACK
B - BENCH WIDTH

Eskom

ISSUED FOR CONCEPT DEIGN PURPOSES

No.	Amendments	Appr.	Date
B	DRAWING REVISED		13/08/14
A	DRAWING REVISED		10/07/14
0	DRAWING CREATED		03/06/14

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

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For ALAN ROBINSON Pr. Eng

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Fax: 086 894 657

Client: ESKOM

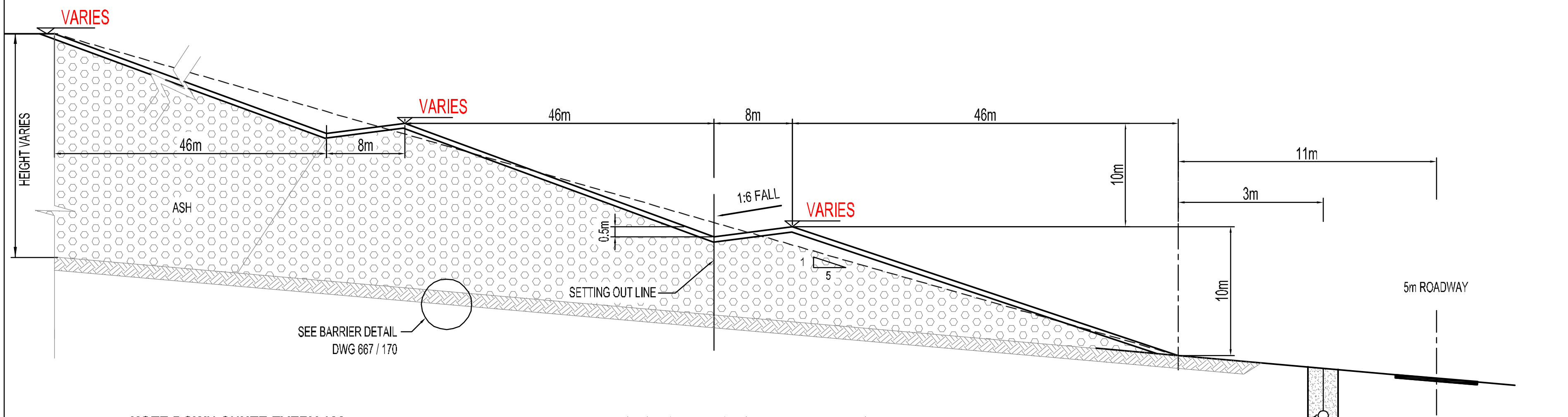
Project: TUTUKA POWER STATION

Description: DRY ASH STACK ARRANGEMENT

SCALE N.T.S

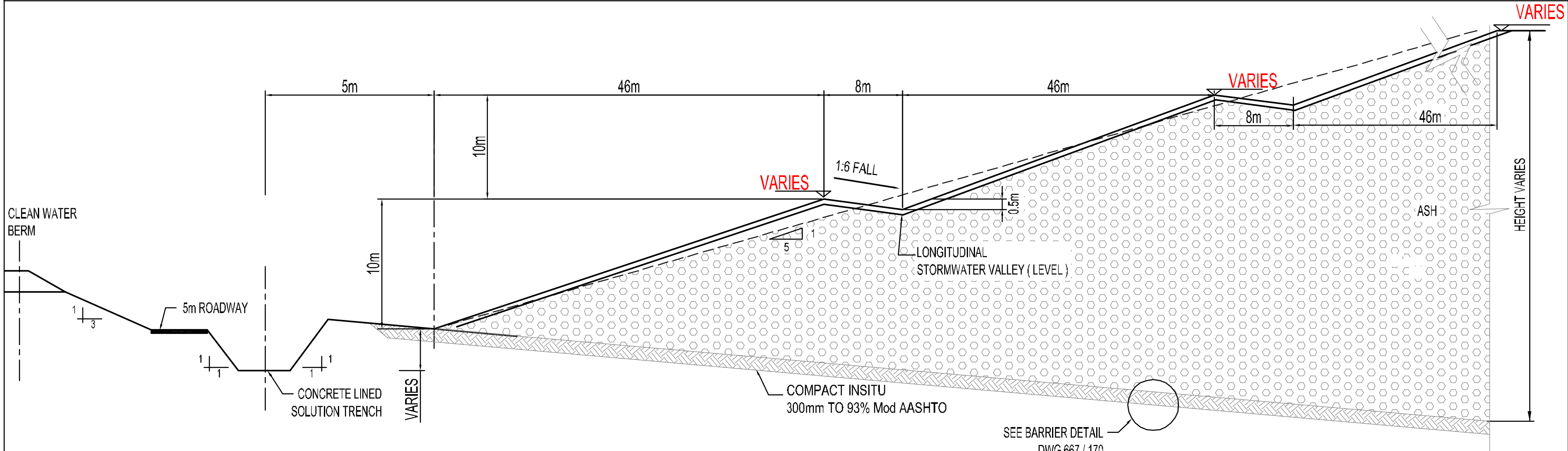
SHEET 1 OF 1 SHEETS

Drawing No. 667/220 B

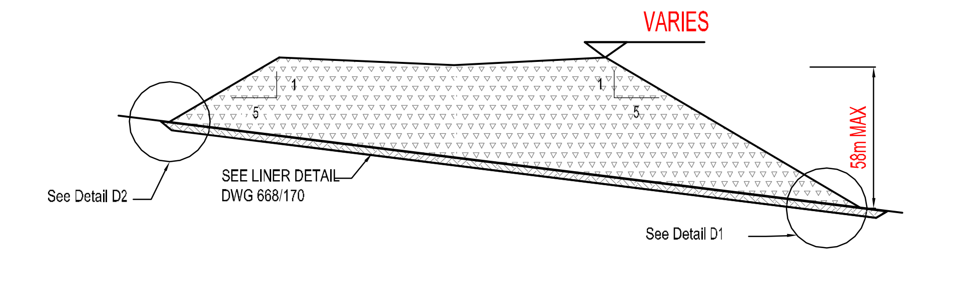


NOTE DOWN CHUTE EVERY 100m
(TO DETAIL E)

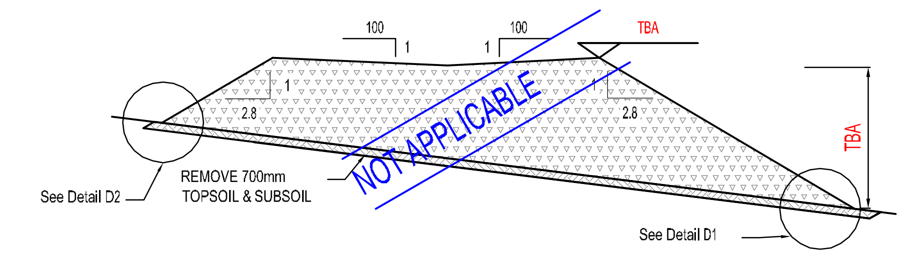
DETAIL D1 - SECTION THROUGH DAM (DAM UPSTREAM)



DETAIL D2 - SECTION THROUGH DAM (DAM DOWN STREAM)



DUMP E - DETAIL S1



DUMP 2 - DETAIL S2

Eskom

ISSUED FOR
CONCEPT DEIGN
PURPOSES

No.	Amendments	App.	Date
0	DRAWING CREATED		15/08/14

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

ECSA 750 693

For ALAN ROBINSON Pr Eng

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Project: TUTUKA POWER STATION

Description: ASH DAM TYPICAL DETAILS (WALL SECTION)

SCALE N.T.S

SHEET 1 OF 1 SHEETS

Drawing No. 667/320

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APPENDIX B
ILANDA WATER BALANCE REPORT

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REPORT ON

TUTUKA ASH WATER RETURN DAM SIZING

Report No : 0129-Rep-002 Rev 1

Submitted to:

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November 2014 0129

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REVISION TRACKING

Rev 0: Original document

Rev 1: Design changes incorporated

1 INTRODUCTION

Alan Robinson Consulting Civil & Geotechnical Engineers commissioned iLanda Water Services CC to calculate the water balance and required return water dam capacity for the extension to the existing ash dump at the Tutuka power station. This report details the results of the study, as well as recommendations coming from the work done.

1.1 Study Objectives

The study objectives are as follows:

- Size the ash water return dams for the extension to the existing ash dump
- Size the water return pumping system and the irrigation system
- Specify how the ash water return dam system is to be operated

1.2 Battery Limits

The battery limits for the water balance work include the existing ash dump and its ash water return dams, the proposed extension to the ash dump and the new ash water return dam. The station water balance is excluded but the total station feed to the ash dump is included. Brine water is pumped from the power station to the ash dams for dust suppression.

2 CLIMATE DATA SUMMARY

Rainfall data for the area was obtained from the CCWR (Computing Centre for Water Research, Natal University) database. Gauge number 0441523 (New Denmark) was used. Evaporation data and its monthly distribution were sourced from the Water Resources of South Africa Study data set, zone 13B (Midgley et al., 1990). Run-off factors were informed by average run-off for the quaternary catchment C11K, 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	627
Mean annual evaporation (S-Pan)	1 520

2.1 Storm Events

Peak rainfall data was sourced from Adamson's (Adamson, 1981) TR102 gauge 0441650 (Niekerksvlei). 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

3 WATER BALANCE METHODOLOGY

3.1 Ash Dump Complex

The ash dump complex consists of the existing ash dump and water dams, as well as the proposed ash dump extensions and additional return water dams and water management channels and pipes. Three types of water will be managed in three separate systems on and around the ash dump complex:

- Dirty water
  - storm water from the progressive ash deposition face
  - seepage water collected in the dumps' underdrainage systems
  - brine water sent to the ash dam complex from the power station
- Store and release water
  - storm water from rehabilitated areas of the dumps
- Clean water
  - clean storm water from upstream catchments

The clean water, store and release and dirty water systems are shown schematically in Figure 1. Some channels will be decommissioned during the life of the dump extensions. This is shown schematically in Figure 2 and Figure 3.

Dirty water will be collected in a dedicated ash water return dam and irrigated back onto the dump's exposed areas for dust suppression. Clean storm water will be diverted around the complex via two storm water diversion trenches. As per the requirements set out by Eskom, storm water from rehabilitated areas will be directed to a dedicated rehab runoff dam system. Channels will be constructed to capture this water and route it to the rehab runoff dams. The water quality of this water will be evaluated and released if the water quality is suitable. If the water quality is not suitable for release, it will be irrigated back onto the rehabilitated areas.

Rehabilitated areas of the current ash dump are should direct storm water away from the proposed dump extensions and into the store and release channel system. The current clean water diversion that runs along the northern and eastern side of the complex will be repurposed into a store and release channel and disconnected from the existing diversion dam. A new clean water diversion must be constructed on the outside of this channel and connected to the existing diversion dam. This should be a duplicate of the existing channel. The seepage through the existing dump is assumed to be split between deep seepage to groundwater and seepage that would emerge at the toe of the existing dump. The seepage that emerges at the toe of the existing dump was included in the water balance and assumed to report to the proposed new ash water return dam.

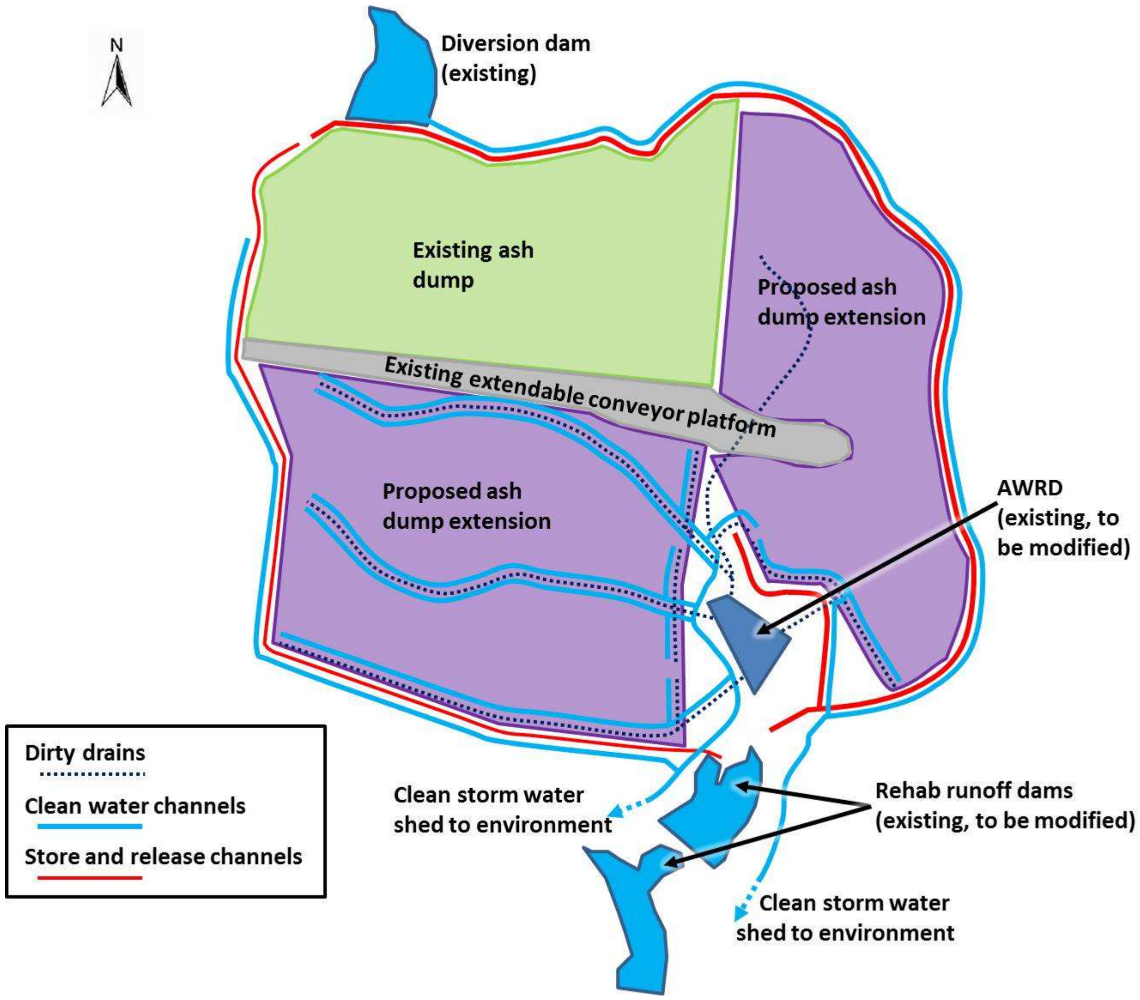

Figure 1: Schematic of the clean and store and release systems

The current operations appear to have about a 200 m wide working face, from the toe of the dump to the edge of the rehabilitation. It was assumed that this would be the case with the proposed extensions. The proposed extensions to the dump are in two directions – to the east and to the south. These are two separate extensions and both will be used simultaneously. The areas around the extendible conveyor (extendible conveyor platform) will also be dirty as these areas are currently not fully rehabilitated and ash spills will keep this area dirty. It was assumed that storm water from these areas will be dirty and must be managed as part of the dirty system. It is assumed that all moisture in the deposited ash will be evaporated.

This dirty deposition face and the extendible conveyor platform will generate dust if not managed properly. Up to 6 mm/day (subject to water availability) of dust suppression water is assumed to be irrigated onto these areas. Currently about 1 Ml/day and 1.5 Ml/day of brine is pumped from the power station to the ash dump for dust suppression during the wet and dry seasons respectively. This is accounted for in the modelling.

It was further assumed that the rest of the proposed extensions to the existing ash dump will be properly rehabilitated. This implies that storm water from the rehabilitated areas of the proposed extension to the existing ash dump may be clean and suitable for release. This water will be collected in the store and release system.

It was further assumed that the rest of the proposed extension to the existing ash dump will be properly rehabilitated. This implies that storm water will be shed from the dump and storm water generated on the dump's rehabilitated surface will be clean and suitable for release into the environment.

The proposed extensions to the ash dump are assumed to be lined with an HDPE liner or another lining method that has a similar permeability as HDPE liners. Seepage from the entire footprint of the ash dump extensions are assumed to be collected and must be accommodated in the proposed ash water return dam system.

3.2 Scenarios Run

Two scenarios were run to determine the worst-case dam capacities required. The two scenarios are:

- Early dump life: This scenario provides the worst case ash water return dam capacity. The scenario models the start of the deposition of the two dump extensions. A large catchment to the east of the current deposition cannot drain through a clean water system due to the deposition under the extendible conveyor. This storm water will be clean in the early stages of deposition, but will have to flow through a dirty area and therefore will become dirty. This storm water is managed as part of the dirty water system. This catchment is largest at the start of the dump extensions. The rehabilitated areas are at their smallest.
- End of dump life: This scenario provides the worst case rehab runoff dam capacity. The scenario models the end of the dump deposition. The rehabilitated areas are at their largest.

3.3 Water Balance Model

A water balance model was used to simulate storm water run-off from the dirty deposition face, percolation and resultant seepage from the existing ash dump and proposed ash dump extensions, ash water return dam storage and dust suppression demands on the ash water return dam. The water balance model consists of a mass-balance model that operates on a daily time step. The model is coded in Goldsim.

3.3.1 Climate data inputs

A 97-year continuous daily rainfall data set, described in section 2, was used as rainfall inputs into the model. In the absence of a long term daily evaporation data set, monthly average evaporation was used in the modelling.

3.3.2 Catchments

The catchments consist of a three-layer cascading soil moisture budgeting system and SCS-based moisture budget equations. This accounts for antecedent moisture conditions in the upper subsurface layers of the catchments. Run-off, infiltration and evaporation are dynamically adjusted to account for antecedent moisture conditions in the catchments.

The interflow and seepage to the dump drainage system is calculated using a non-linear decay function that is dependent on the volume of water that infiltrates into the sub-surface layers of the catchment.

3.3.3 Ash water return dam

The water balance around the ash water return dam is modelled in detail. The following hydrological interactions are modelled:

- Inflows
    - Direct rainfall
    - Seepage inflows
    - Storm water inflows from the dirty deposition face
- Outflows
    - Seepage losses (limited due to assumed HDPE lining)
    - Evaporation losses
    - Spillage losses in compliance with GN704 of the National Water Act
    - Dust suppression demands

Evaporation is calculated using the water surface area in the water return dam at the time of calculation. The area of the water return dam is defined by the area-storage relationship for the dam and is continuously adjusted as storage in the water return dam changes.

4 WATER BALANCE RESULTS

4.1 Ash Water return Dam Sizing and Management

The required dam capacities are summarised in Table 3

Table 3: Required dam capacities

Scenario	AWRD (dirty) capacity required	Rehab runoff dam capacity required
Early dump life	220 000 m^3	550 000 m^3
End of dump life	150 000 m^3	950 000 m^3

The ash water return dams were sized to comply with Government Notice 704 of the South African National Water Act, Act 36 of 1998. The act specifies that the ash water return dam should not spill more than once every fifty years on average. The dams must be lined.

The early dump life is shown schematically in Figure 2. The end of dump life is shown schematically in Figure 3.

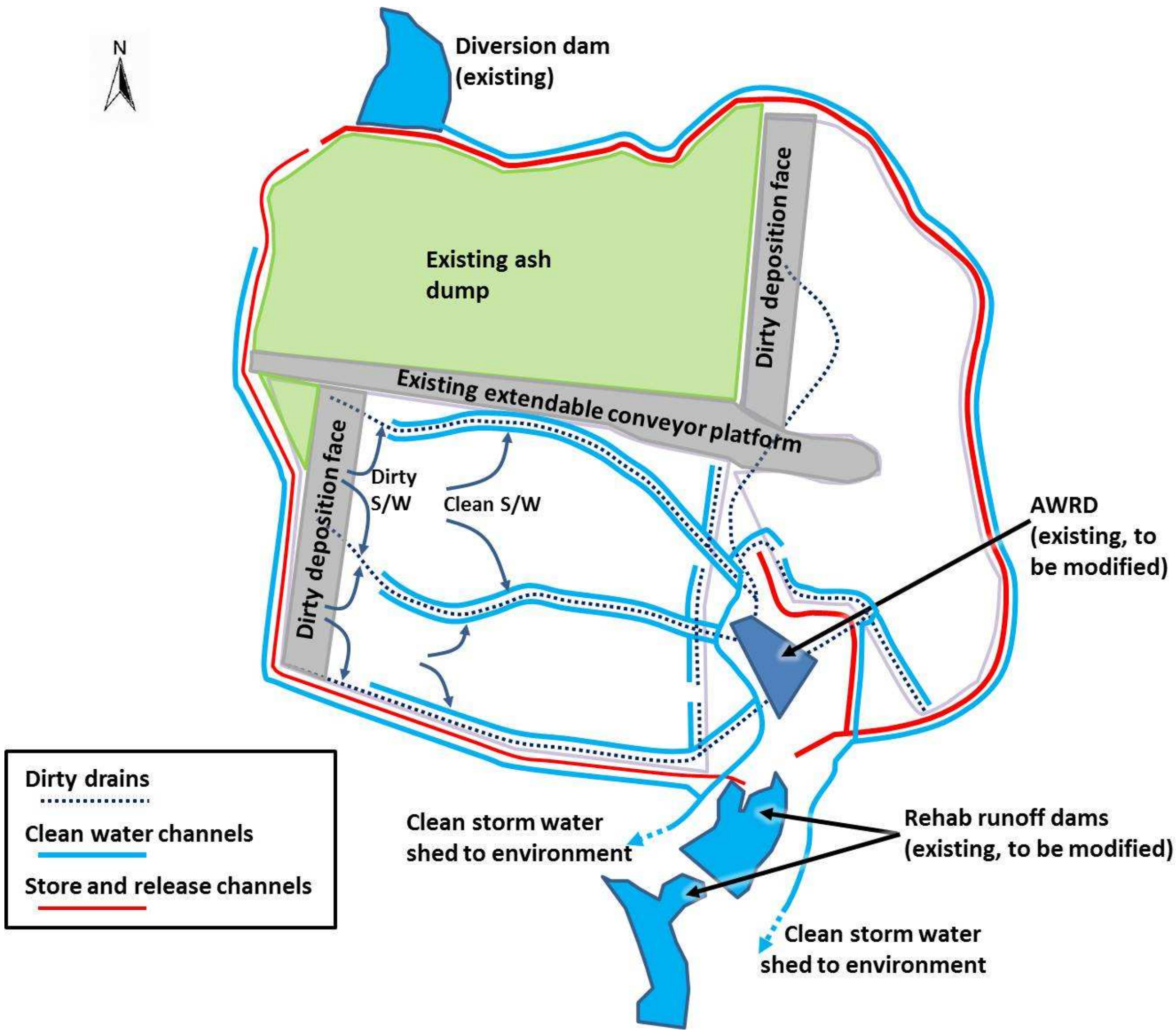

Figure 2: Early dump life

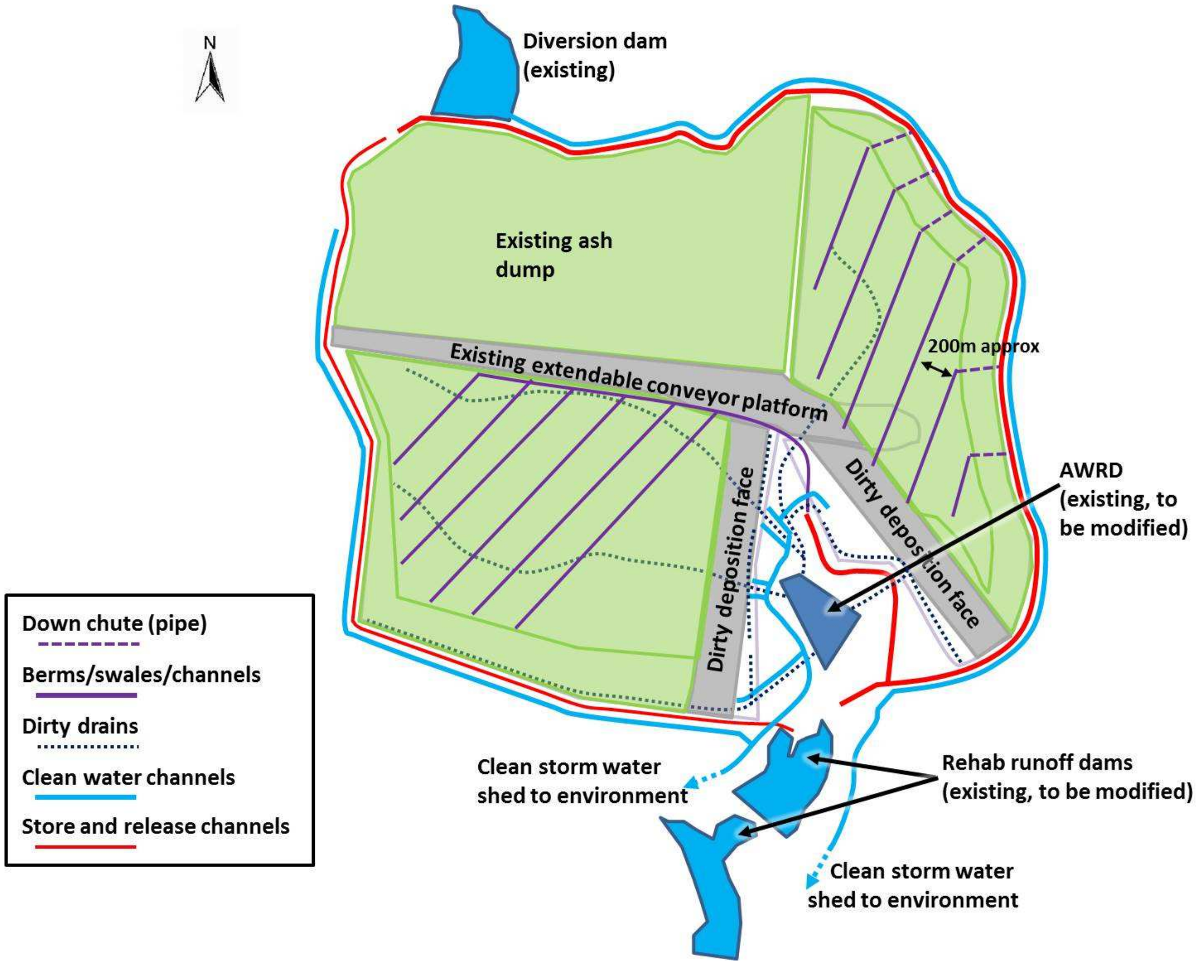

Figure 3: Late dump life

4.2 Dust Suppression and Rehabilitation

The required irrigation capacities are summarised in Table 4

Table 4: Required irrigation capacities

Scenario	AWRD (dirty) irrigation capacity required	Rehab runoff dam irrigation capacity required
Early dump life	6 450 m^3/day	3 150 m^3/day
End of dump life	5 500 m^3/day	8 200 m^3/day

Up to 6 mm per day of dirty water irrigation has been allowed for in the modelling, subject to water availability. This is based on the current dust suppression irrigation depths used on the current ash dump. The store and release irrigation has been throttled to limit the capacity of the irrigation system. This is to achieve a compromise between irrigation system capacity and required rehab runoff dam capacity.

Once the ash has been stacked to its full height, it should be rehabilitated. The rehabilitation should be sustainable in the long term such that storm water will be clean and will be shed from the rehabilitated areas to the store and release system. A 600 mm diameter HDPE pipe flowing full and pressurised will have a capacity of approximately 2 m^3/s. This is the 50-year design flow generated by approximately 1.4 ha of catchment. Down pipes should be located such that they drain approximately every 1.4 ha of the proposed ash dump extension. The pipe diameter can be reduced by temporarily attenuating storm water on the top surface of the dump before being transferred into smaller pipes.

The rehabilitation should limit infiltration to a minimum. This could be achieved through the use of a store and release cover, capping with a low permeability layer, shaping to shed storm water or a combination of these.

4.1 Spillway Sizing

The spillways on ash water return dam will need to cater for storm water generated from the dirty deposition face, as well as seepage that will flow into the dams. The seepage water flows are negligible when compared to the storm water flows and can be ignored. The ash water return dam spillways were sized for the early stages of dump development as this is the where dam will have the largest catchment. This is shown in Table 5. The existing rehab runoff dam spillways should be used. Their capacities should be confirmed in subsequent design stages.

Table 5: Spillway sizing (routing ignored)

Dam	50-yr flood peak	100-yr flood peak	Spillway width	No of spillways	50-yr flow depth	100-yr flow depth
AWRD	20.4 m^3/s	28.1 m^3/s	5 m	4	0.73 m	0.9 m

4.2 Water Balance Diagram

The water balance diagram is shown in Figure 4. It shows the water balance at the end of the life of the dump.

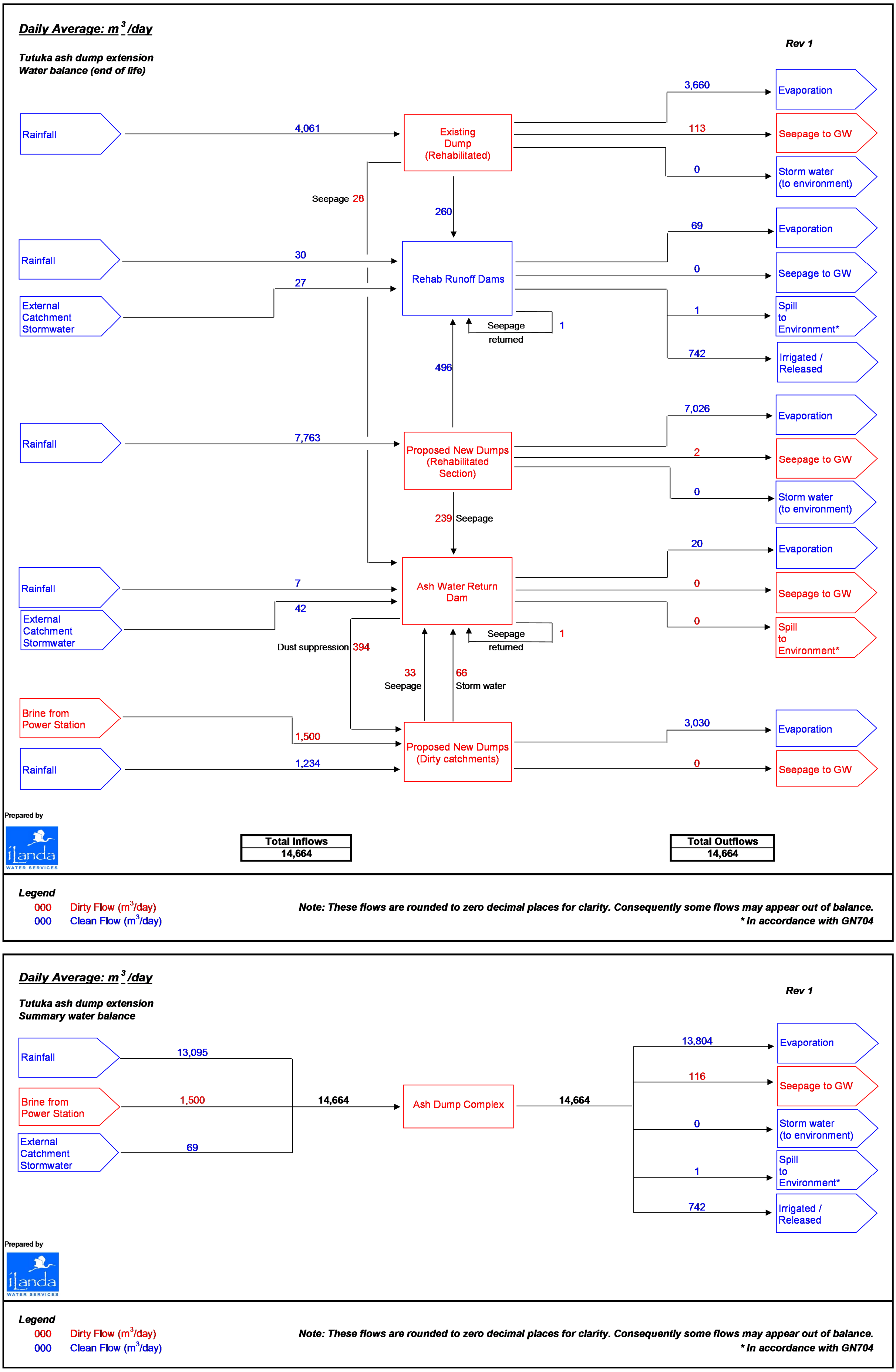

Figure 4: Water balance diagram (end of life)

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