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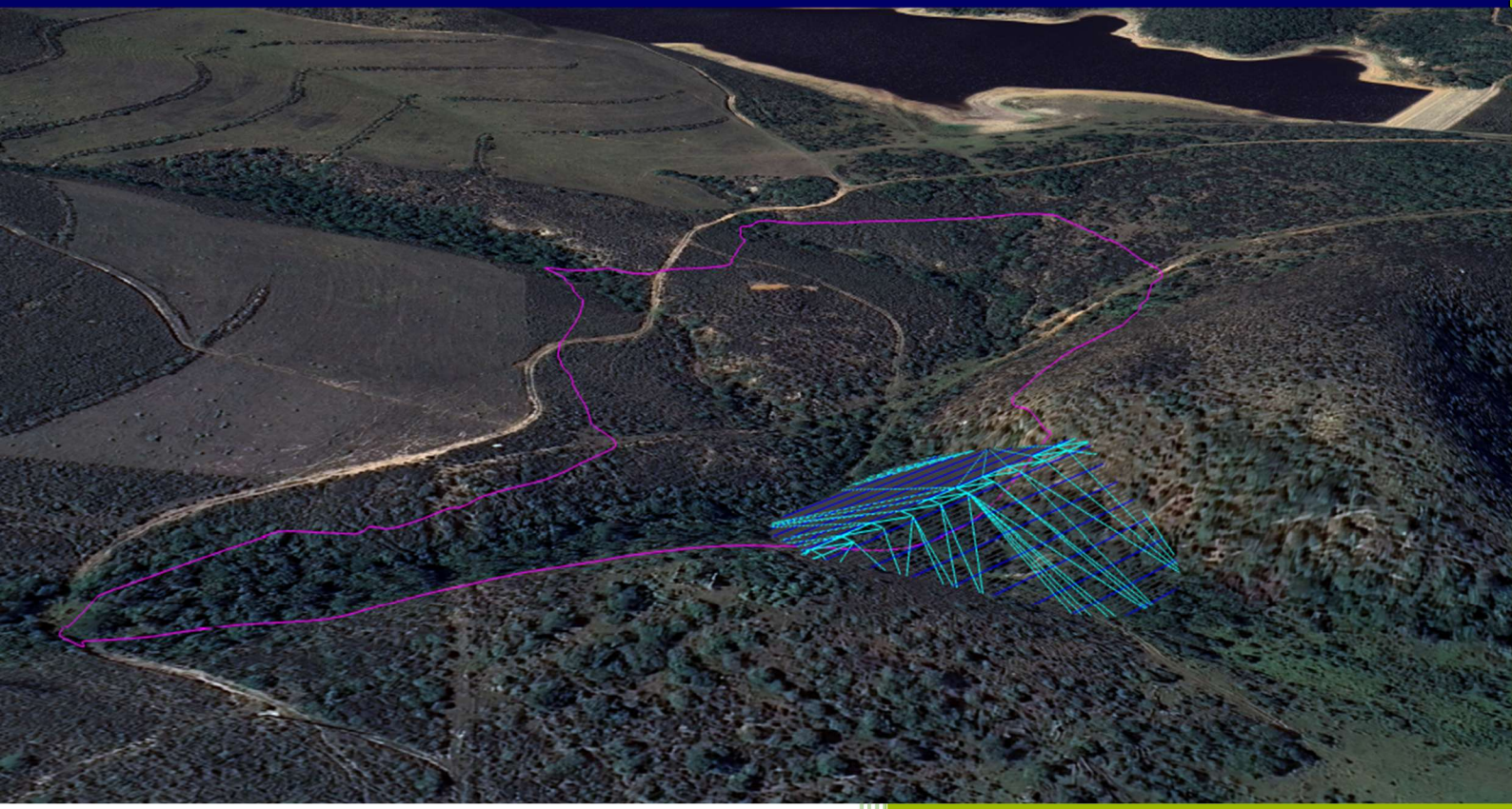
OUDRIFT DAM: CONCEPT DESIGN REPORT FOR ENVIRONMENTAL APPROVAL



KLIPHEUWEL TRUST

16 February 2026

Report No: DJH 337-01

Document prepared by:

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TABLE OF CONTENTS

1. Introduction 1
1.1 Background 1
1.2 Project Location 1
2. Review of original concept design 2
2.1 Geology 2
2.2 Embankment type and dimensions 3
2.3 Hydrology 5
2.4 Spillway 5
2.4.1 Spillway selection 5
2.4.2 Spillway capacity and reservoir levels 6
2.4.3 Energy dissipation 7
2.5 Freeboard 7
2.6 Outlet works 9
2.7 New gauging station 9
3. Construction methodology 10
3.1 Construction materials 10
3.2 Construction impact area 11
4. Conclusion 12
5. References 13
Appendix A 14

FIGURES

Figure 1-1: Locality map of Oudrift Dam 2
Figure 2-1: Regional Geology at Proposed Oudrift Dam (3322 Oudtshoorn) (RSA, 1973) 3
Figure 2-2: Typical earthfill embankment irrigation dam 4
Figure 2-3: Spillway discharge capacity 6
Figure 2-4: Typical image of USBR Type III stilling basin 7
Figure 2-5: Indication of the expected fetch in a north-western wind direction (Google Image) 8
Figure 2-6: Gauging station capacity 9

TABLES

Table 2-1: General embankment cross-section details 4
Table 2-2: Recommended flood peaks 5
Table 2-3: Flood peaks and reservoir water levels 7
Table 2-4: Calculated freeboard requirements summary 8
Table 3-1: Flood peaks and reservoir water levels 10

GLOSSARY OF TERMS

Term	Definition
AEP	Annual Exceedance Probability
APP	Approved Professional Person
Amsl	above mean sea level
Dia	diameter
DSER	Dam Safety Evaluation Report
DSO	Dam Safety Office
DWS	Department of Water and Sanitation
E	East
EPP	Emergency Preparedness Plan
FSL	Full Supply Level
H	Horizontal
H	height
$H_{2\%}$	2% exceedance wave height
Km	kilometre
km^2	square kilometres
ℓ/s	litres per second
M	metre
m/s	metres per second
m^3	cubic metres
m^3/s	cubic metres per second
Mm	millimetres
No.	number
NOC	Non-Overspill Crest
OMM	Operation and Maintenance Manual
PMF	Probable Maximum Flood
Pr Eng	Professional Engineer
R	Rand
$R_{2\%}$	2% exceedance wave run-up
RDD	Recommended Design Discharge
RDF	Recommended Design Flood
RI	Recurrence Interval
RL	Reduced Level
RMF	Regional Maximum Flood
S	South
SANCOLD	South African National Committee on Large Dams
SED	Safety Evaluation Discharge
SEF	Safety Evaluation Flood
V	Vertical
Yr	year

1. INTRODUCTION

1.1 BACKGROUND

Hagen Brink Consulting Engineers was appointed by Klipheuwel Trust to evaluate a concept design for a Water Use License Application compiled by Gorra Water (Mr Retief Kleynhans) in November 2021. The design by Gorra Water consisted of a concept design report, summary of calculations, and a set of drawings. The purpose of the evaluation of the Gorra Water report is to provide input for the relevant environmental approval processes to be followed for Oudrift dam.

The concept design is not suitable for further project phases such as the License to Construct application in terms of the Dam Safety Regulations or for any construction works.

1.2 PROJECT LOCATION

The proposed Oudrift dam is situated on the farm Klipheuvel (Farm No. 143 Portion 3) at 34º2'56.12''S and 22º8'15.04''E. The embankment of the dam is located on Farm No. 143, Remainder of portion 13, for which a servitude was registered.

Driving on the N2 from Hartenbos to Klein Brak River, take the R102 turn-off to Klein Brak River. At the intersection, turn left on the R102 and continue for approximately 400 m to the T-junction. At the T-junction, turn right towards Sorgfontein. Continue with this road for approximately 3 km and turn right (before crossing the Moordkuil River) to the Klipheuwel Dam (turn-off indicated by a blue asterisk). The proposed Oudrift dam site is located 520 m from the northern shore of the Klipheuwel Dam.

The site is not publicly accessible and visitors must be accompanied by the owner. See **Figure 1-1** below indicating the position of the Oudrift dam.

Figure 1-1: Locality map of Oudrift Dam

2. REVIEW OF ORIGINAL CONCEPT DESIGN

2.1 GEOLOGY

The regional geology map (3322 OUDTSHOORN, 1:250 000 series) (RSA, 1973) indicates that the site is underlain by Conglomerate, sandstone, siltstone and clay from the Enon and similar younger deposits formation (Ke) (refer to **Figure 2-1** below [dam position indicated by the green asterisk ✳]).

The previous report, however, indicates that the site is underlain by whitish-weathering quartz sandstone, medium to coarse-grained, quartzitic and massive of the Cape Supergroup, Table Mountain Sub-group and Peninsula formation (Op). From the image below, it can be seen that this is possible.

From close inspection, it was confirmed that the Oudrift Dam site is locally underlain by the Peninsula formation. Extensive rock outcrops are exposed outside the river section, with hillwash alluvial deposits occurring at the base of the lower flank slopes. Areas of rock and boulders can be observed on both the left and right flanks. These boulder zones are related to the underlying quartzitic sandstone lithology.

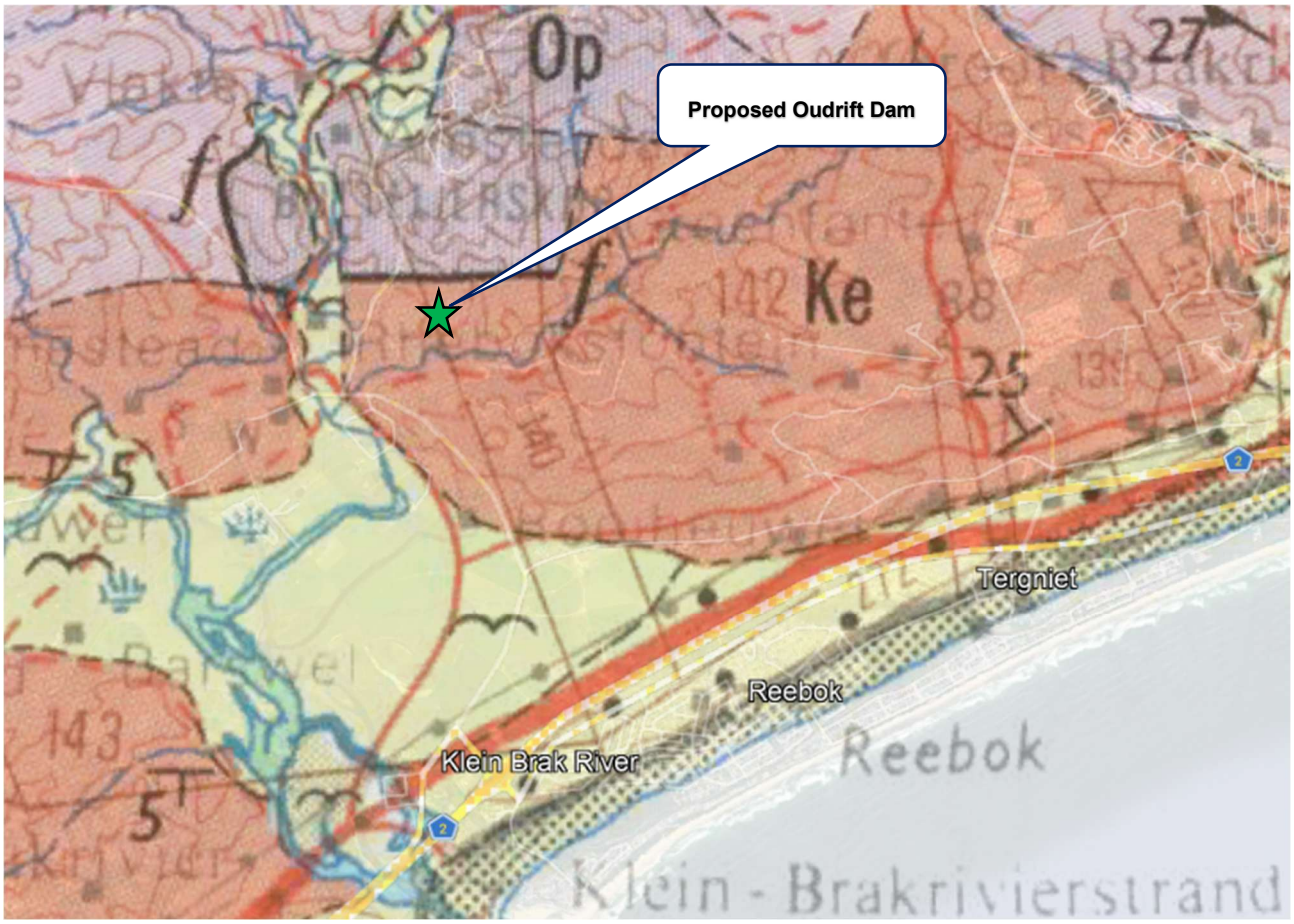

Figure 2-1: Regional Geology at Proposed Oudrift Dam (3322 Oudtshoorn) (RSA, 1973)

From an engineering perspective, the proposed site is geologically suited to a zoned earthfill embankment dam with a central clay core. The rock permeabilities are generally very low, and the majority of the rock mass can be considered to be nearly impervious. Contacts between the sandstone and sedimentary strata are generally open and fractured, and grouting is recommended to intersect all these contacts. The spillway could be accommodated at the natural valley line situated on the right bank of the dam.

Based on the test pits excavated for the previous report, excavation depths for the core trench might vary between 4 m at the left and right flanks and 5 m in the central section. For the outlet pipe, a 2.5 m excavation depth can be assumed for the installation of an outlet pipe encased in reinforced concrete.

2.2 EMBANKMENT TYPE AND DIMENSIONS

As mentioned in the previous section of the report, the proposed site is suitable for the construction of a zoned earthfill embankment dam. Although not feasible at the moment, the Client indicated that the design should accommodate the possible raising of the embankment crest level in future. The approach, therefore, was to design an embankment for the future scenario, but to omit the top section, to save costs. This will result in an overly conservative crest width. See the attributes of the proposed embankment below in **Table 2-1**.

Table 2-1: General embankment cross-section details

Cross-section details		Value
Crest width		15 m
Non-overspill level		25.5 m.a.s.l.
Crest length		112.2 m
Wall height		19.6 m
Upstream slope		1V:3H
Downstream slope		1V:2.5H
Core upstream slope		1V:1.75H
Core downstream slope		1V:0H (Vertical)
Core trench	**Depth**	4 m
	Side slopes	1V:1H
Filter thickness (Chimney and blanket)		0.6 m
Upstream wave protection thickness (rip rap)		0.5 m

Figure 2-2: Typical earthfill embankment irrigation dam

2.3 HYDROLOGY

The guidelines used for the selection and determination of suitable design floods are contained in the SANCOLD publication "*Guidelines on Safety in Relation to Floods*" (SANCOLD, 1991).

According to these guidelines, the design of flood selection is dependent on the dam size, class, and hazard rating as assigned by the Department of Water and Sanitation (DWS) in terms of the regulations relating to dam safety. The proposed Oudrift Dam will most likely be a Medium dam with a Significant hazard rating and would therefore be classified as a Category II dam.

A two-assessment level approach was followed. At the first assessment level, the recommended floods were based on the Regional Maximum Flood (RMF), and at the second assessment level, site-specific methods were used to determine the relevant floods.

As the concept of the RMF cannot be applied to the Oudrift Dam (a small catchment area of 0.54 km² < 10 km²), the second assessment level was used for evaluating the spillway capacity.

For the Oudrift Dam, the recommended minimum floods are the Recommended Design Flood (RDF), which should be the 1 in a 100-year flood, and the Safety Evaluation Flood (SEF) equal to the Probable Maximum Flood (PMF) multiplied by a factor, which is dependent on the RMF. Since the RMF concept is not considered applicable, it was decided to revert to the 1986 Guidelines (SANCOLD, 1986) to determine the SEF. The factor for a Medium dam with a Significant hazard rating according to the 1986 guidelines is 0.7.

It is important to mention the impact of the nearby Klipheuwel dam. Klipheuwel dam does not have a formal spillway. Flood discharge is through a natural saddle upstream of the right flank. Any flow through this saddle will discharge into the basin of Oudrift dam. Oudrift's spillway and freeboard must therefore also accommodate flows from Klipheuwel dam.

The RDF and SEF floods for Oudrift dam were calculated and combined with the routed RDF and SEF floods from Klipheuwel dam to determine the applicable incoming flood for Oudrift dam.

The incoming flood peaks were routed through the reservoir using the approximate equation of Görgens et al. (1990) to determine the water levels in the reservoir in order to evaluate the spillway capacity and ultimately the freeboard requirements.

See **Table 2-2** below, indicating the recommended total flood peaks for the proposed Oudrift dam.

Table 2-2: Recommended flood peaks

Flood category	Oudrift Dam	
	Flood peak inflow (m³/s)	Flood peak outflow (m³/s)
RDF – Combined	125.15	58.84
SEF – Combined	224.49	105.54

2.4 SPILLWAY

2.4.1 Spillway selection

The spillway is designed with the objective to discharge excess inflow in a controlled manner, safely and effectively, without endangering the dam itself, downstream inhabitants or the general public using downstream infrastructure and roads (N2 and R102).

The selection of spillway type was based on the ability of the spillway to deal with the relevant floods reported in Section 2.1 of this report. Various options were considered, but a conventional uncontrolled open channel spillway with a concrete sill was selected for the following reasons:

- Satisfied the design criteria;
- It is the most economical option, from the ones considered, and
- Best utilisation of the natural topography.

With the spillway constructed away from the earthfill embankment and in a natural valley, it is not foreseen that training walls will be required. Both the spillway and spillway return channel will have side slopes of 1V:1H to reduce the footprint required.

The spillway will consist of a 30 m-long reinforced concrete sill constructed on natural rock. The concrete sill will be 750 mm deep and 500 mm thick.

2.4.2 Spillway capacity and reservoir levels

The applicable flood peaks for the Oudrift dam calculated in **Section 2.3** were used to determine the spillway discharge capacity and relevant reservoir levels during these flood events.

The spillway discharge channel will be a trapezoidal-shaped open channel, which discharges into a natural stream downstream of the embankment. The maximum spillway discharge capacity was calculated using an approximate equation based on the effective width (base width of 40% of the difference between the base width and the top width) of the trapezoidal channel.

A 1.45 discharge coefficient was used, and the maximum spillway discharge capacity was calculated to be 183.4 m³/s at a proposed freeboard of 2.5 m. See the expected spillway capacity below in **Figure 2.2**.

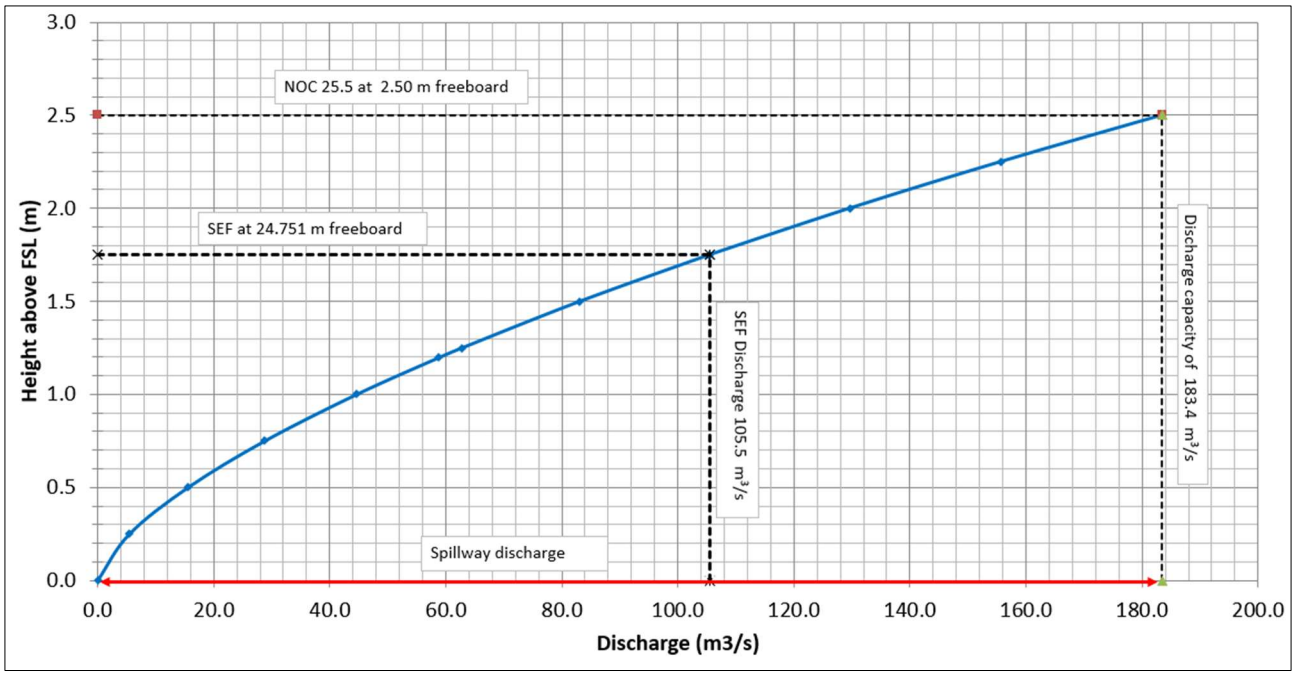

Figure 2-3: Spillway discharge capacity

See **Table 2-4** below, indicating the relevant flood peaks and water levels.

Table 2-3: Flood peaks and reservoir water levels

Flood Category	Flood peak outflow (m³/s)	Max Water level (m)	Height above Min FSL 23.00 (m)	Height above Min NOC of 25.50 (m)
RDF	58.8	24.197	1.197	-1.303
SEF	105.5	24.751	1.751	-0.749

2.4.3 Energy dissipation

Energy dissipation at the discharge point of the spillway return channel will be achieved with a USBR Type III or similar stilling basin. The actual size of the stilling basin will be determined during the detail design phase. The expected size of the stilling basin will be 10 m x 25 m (width x length), and it will be constructed with reinforced concrete, with a gabion mattress installed on the downstream end of the stilling basin.

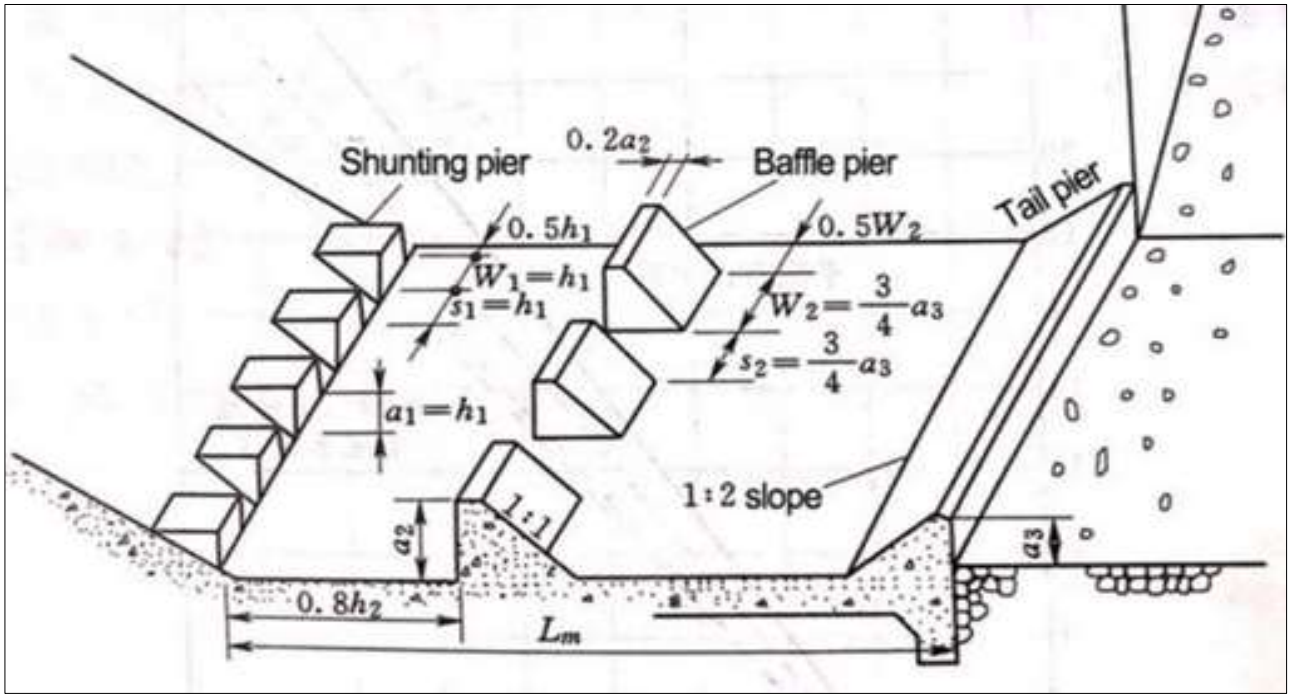

Figure 2-4: Typical image of USBR Type III stilling basin

2.5 FREEBOARD

The recommended combinations of conditions to determine the minimum recommended freeboard allowance were determined as prescribed in the Guidelines on Freeboard for Dams (SANCOLD, 2011). The required freeboard for a Medium dam, Category II, with Significant hazard rating, was determined according to the guidelines. The summary of the freeboard calculations is shown in **Table 2-4**.

The outcome of the freeboard calculation was compared with the proposed freeboard as presented in the previous report. The proposed freeboard of 2.5 m was adapted within the design and found to be sufficient for the proposed Oudrift dam, even though more conservative flood scenarios were used in the calculation.

Table 2-4: Calculated freeboard requirements summary

Aspect	Levels
Full Supply level (m)	23.0
Non-overspill Crest (m)	25.5
Maximum outflow head (RDF) above FSL (m)	1.20
Maximum outflow head (SEF) above FSL (m)	1.75
Wave water level (1:100 yr RI):	
Wave height, $H_{2\%}$ (m)	0.71
Wave Run-up (m)	0.59
Wind setup (m)	0.00
Minimum calculated freeboard required (RDF plus wave run-up, set-up and surges) (Second case)	1.79
Minimum calculated freeboard required (SEF) (Sixth case)	1.75
Freeboard provided [NOC – FSL] (m)	2.5

The approximate fetch length measured, which influences wave height and run-up, is shown in **Figure 2-4** below.

Figure 2-5: Indication of the expected fetch in a north-western wind direction (Google Image)

2.6 OUTLET WORKS

The outlet pipe for Oudrift dam will be a 250 mm dia. PE100 PN10 HDPE pipe encased in reinforced concrete installed underneath the embankment. The outlet pipe will be excavated into suitable founding material. The intake inside the dam basin will be fitted with an inlet sieve as per the project drawings attached as **Appendix A**.

Downstream of the embankment, the outlet pipe will be fitted with a 250 mm dia, flanged gate wedge valve (Class PN 10) to control flow out of the dam. Just upstream of this vale, a 250 mm x 200 mm T-Piece will be installed. The 200 mm leg will also be fitted with a 200 mm dia. flanged gate wedge valve (PN 10) to serve as a scour and emergency valve. See the project drawings attached in **Appendix A** for details of the outlet pipe.

2.7 NEW GAUGING STATION

The proposed Oudrift dam will be filled with an extension to an existing gravity pipeline. Minor runoff from the Klipheuwel dam catchment area will also be collected by thedam in case of the Klipheuwel dam overflowing. This rare, occasional run-off (none on record since the construction of the Klipheuwel Dam in 1980) needs to be measured and recorded with a gauging station to determine the volume of compensation water that needs to be released through the Oudrift dam outlet pipe. A structure combining a V-notch and sharp-crested weir is proposed as a gauging station as can be seen in the project drawings attached as **Appendix A**.

This gauging station will be situated outside of the full supply level area of the Oudrift dam at a level equal to the freeboard level, to enable measuring and recording of flows during flood conditions. See below the proposed concept design capacity in **Figure 2-5** below.

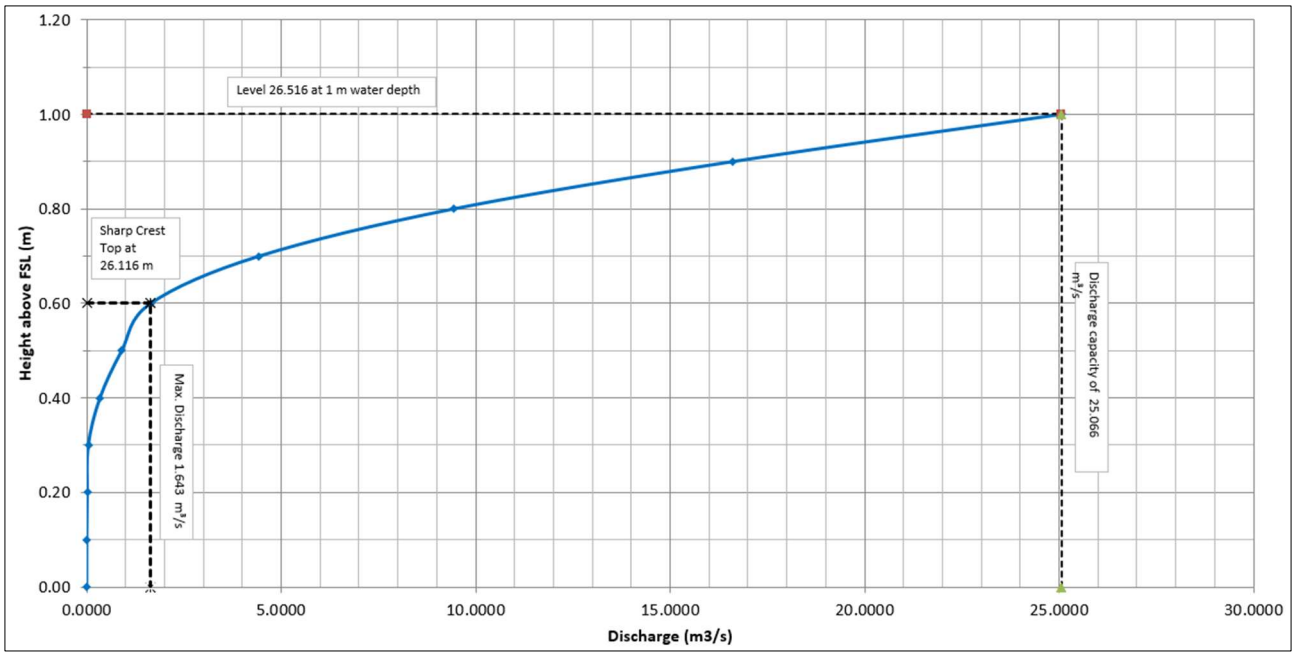

Figure 2-6: Gauging station capacity

3. CONSTRUCTION METHODOLOGY

3.1 CONSTRUCTION MATERIALS

It is foreseen that all material required for the construction of the zoned earthfill embankment will either be sourced from within the dam basin or from commercial sources. Excavation of the impervious material for the clay core, as well as the semi-pervious material for the selected and shell material, will be done within the dam basin under the proposed full supply level. Find attached in **Appendix A** the proposed section of the embankment indicating all zones and filter layers required. Also see **Table 3-1** below, indicating the estimated material quantities for the main items required for construction.

Table 3-1: Flood peaks and reservoir water levels

Description	Unit	Quantity
Total earthfill (core, selected and shell material)	m^3	79 060
Rip rap (rock for wave protection)	m^3	1 045
Chimney drain (sand)	m^3	725
Blanket drain (sand)	m^3	2 388
Toe drain (rock)	m^3	338
250 mm HDPE PE100 PN10 outlet pipe (encased)	m	117
Reinforced concrete encasing	m^3	66
Reinforced concrete sill (spillway)	m^3	11.25
Spillway return channel rip rap (rock)	m^3	365
Stilling basin – Concrete	m^3	160
Stilling basin – Rip-rap (rock)	m^3	70
250 mm HDPE PE100 PN10 irrigation supply pipe	m	550
250 mm HDPE PE100 PN10 pipe with concrete collars at river crossing	m	20
Gauging station – Brickwork	m^2	52
Gauging station – Concrete works	m^3	7.5

3.2 CONSTRUCTION IMPACT AREA

Find attached in **Appendix A** a layout drawing indicating the impact area of construction. The site establishment, stockpiling of material and all temporary construction roads will fall within this area. The total construction impact area will be 6.96 hectares.

4. CONCLUSION

From the review of the concept design, it can be concluded that from a technical point the proposed Oudrift Dam seems viable. Unless any fatal flaws are encountered during the environmental process or the detail design process, this project could go ahead, budget permitting.

5. REFERENCES

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The South African National Roads Agency, Drainage Manual, 6th Edition. 2013.

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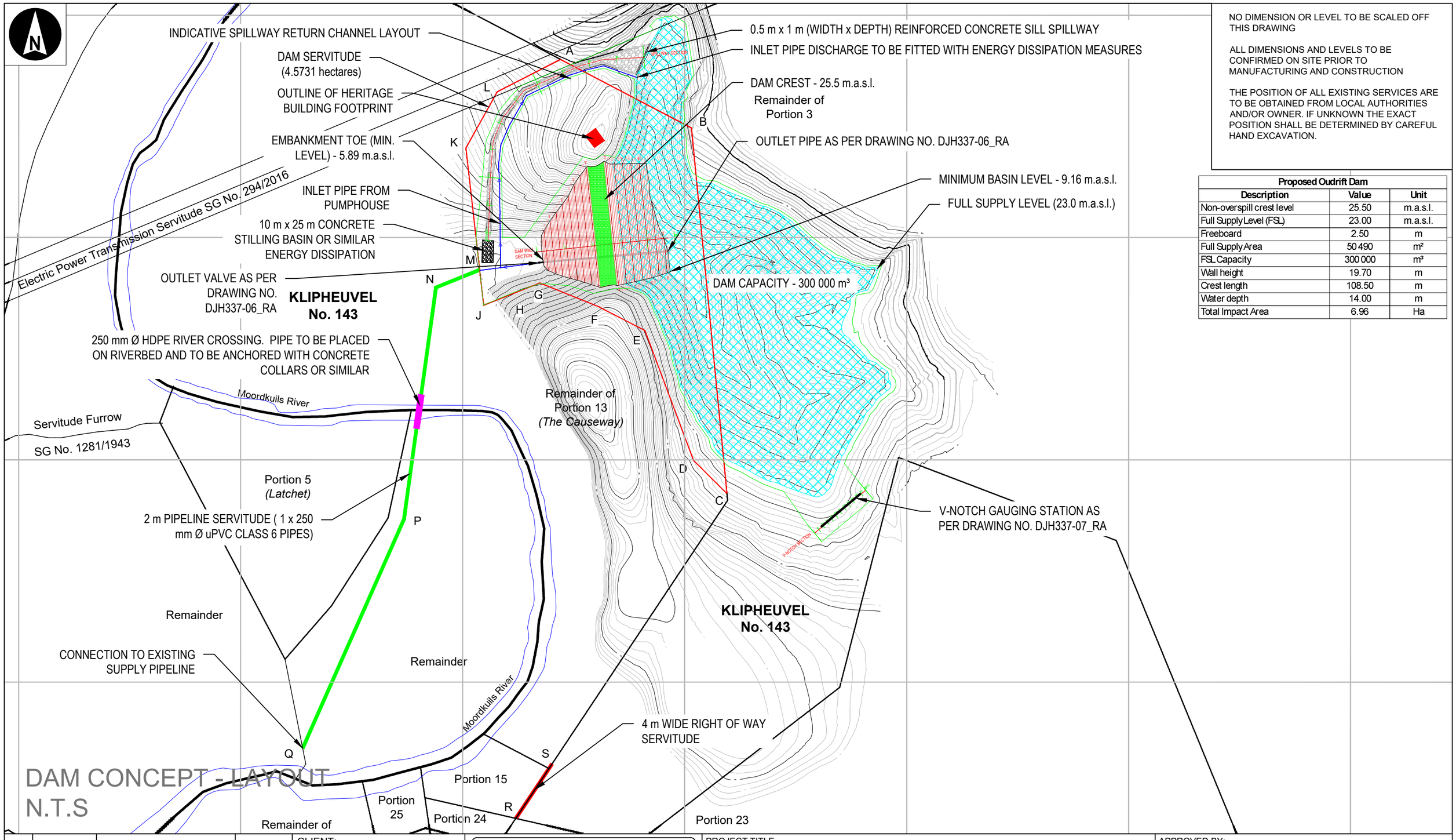
Appendix A

Project drawings



NO DIMENSION OR LEVEL TO BE SCALED OFF THIS DRAWING

ALL DIMENSIONS AND LEVELS TO BE CONFIRMED ON SITE PRIOR TO MANUFACTURING AND CONSTRUCTION

THE POSITION OF ALL EXISTING SERVICES ARE TO BE OBTAINED FROM LOCAL AUTHORITIES AND/OR OWNER. IF UNKNOWN THE EXACT POSITION SHALL BE DETERMINED BY CAREFUL HAND EXCAVATION.

Proposed Oudrift Dam		
Description	**Value**	**Unit**
Non-overspill crest level	25.50	m.a.s.l.
Full Supply Level (FSL)	23.00	m.a.s.l.
Freeboard	2.50	m
Full Supply Area	50 490	m²
FSL Capacity	300 000	m³
Wall height	19.70	m
Crest length	108.50	m
Water depth	14.00	m
Total Impact Area	6.96	Ha

DAM CONCEPT - LAYOUT
N.T.S

No.	DATE	REVISION DESCRIPTION	CONSULT. ENG.
D	28/01/2026	SPILLWAY CHANGED	HBCE
C	27/11/2025	CHANGED ROAD LAYOUT	HBCE
B	05/07/2025	ADDED SERVITUDES	HBCE
A	11/05/2025	FOR REPORT	HBCE

CLIENT:
KLIPHEUWEL TRUST

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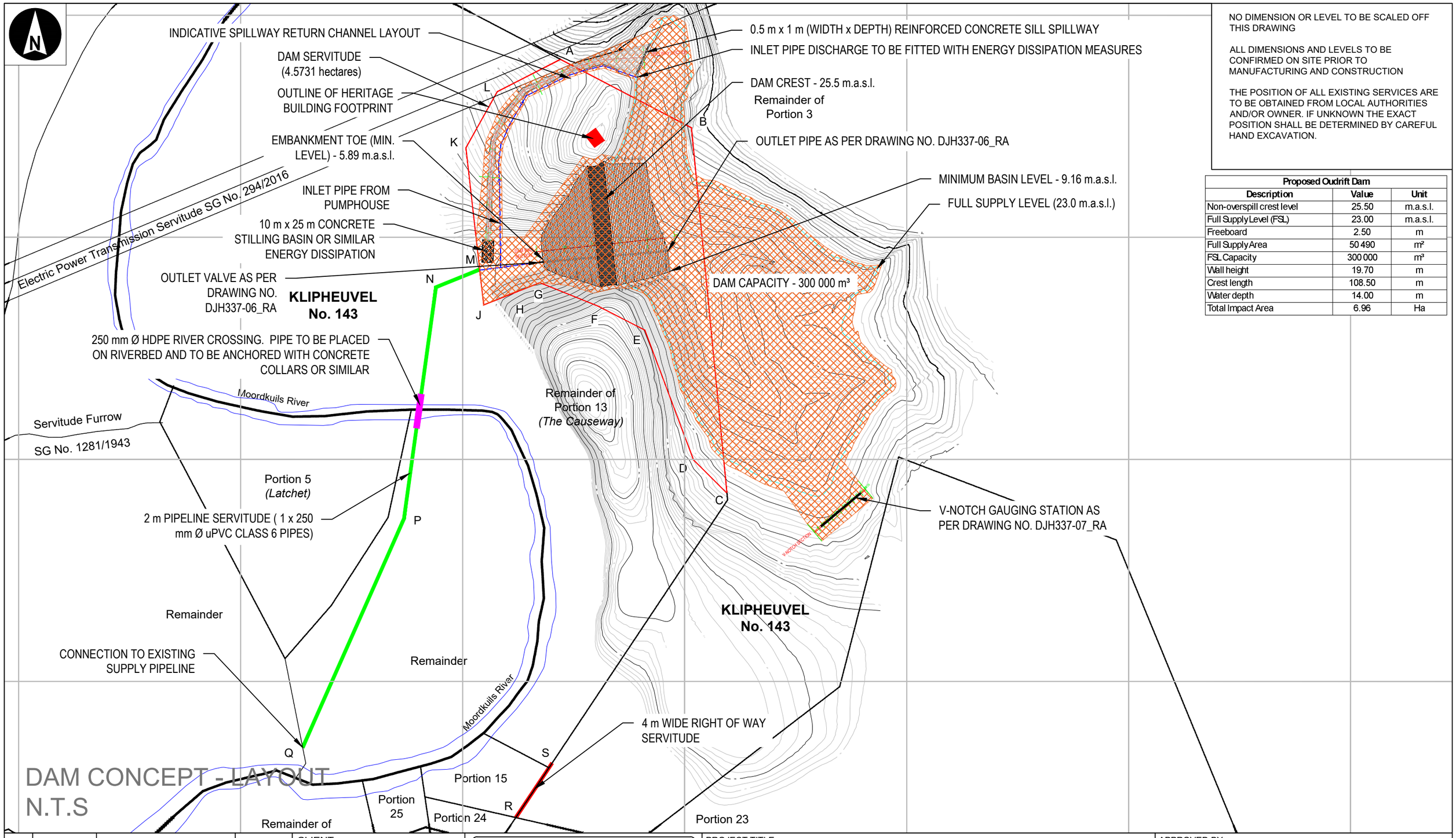
PROJECT TITLE
KLIPHEUWEL TRUST - OUDRIFT DAM

DRAWING TITLE
DAM CONCEPT - LAYOUT

SCALE : AS SHOWN | DRAWING SIZE : A3

APPROVED BY:		
20080228 (PR. ENG.)	(SIGNATURE)	05-07-2025 (DATE)
DESIGNED BY: JEAN DIPPENAAR	CHECKED BY: JAN BRINK	
DRAWN BY: JEAN DIPPENAAR	DATE: 05-07-2025	
PROJECT No: DJH337	DRG No: DJH337-01	REV No: D



DAM CONCEPT - LAYOUT
N.T.S

NO DIMENSION OR LEVEL TO BE SCALED OFF THIS DRAWING

ALL DIMENSIONS AND LEVELS TO BE CONFIRMED ON SITE PRIOR TO MANUFACTURING AND CONSTRUCTION

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CLIENT:
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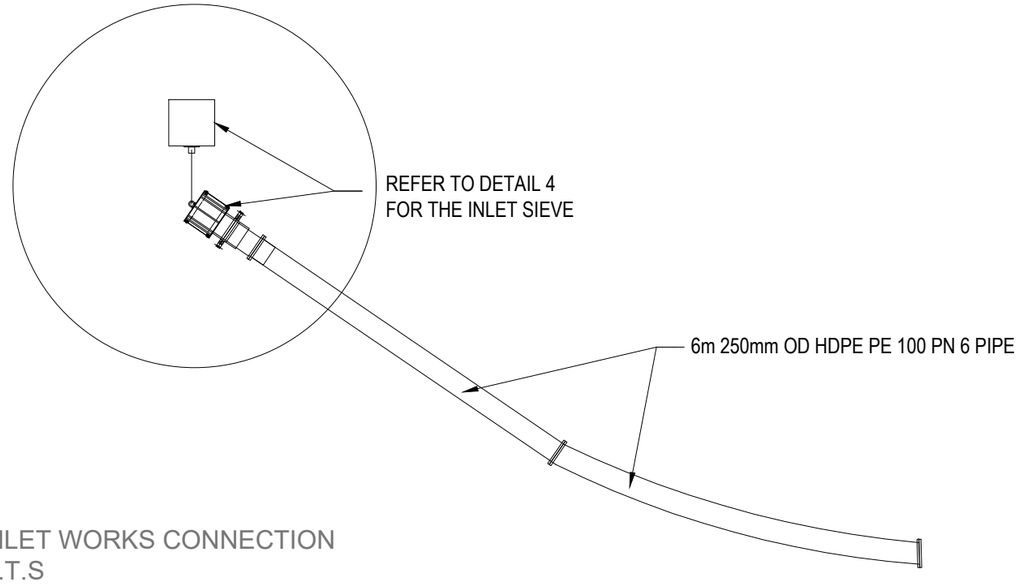
PROJECT TITLE
KLIPHEUWEL TRUST - OUDRIFT DAM

DRAWING TITLE
DAM CONCEPT - LAYOUT (IMPACT AREA)

SCALE : AS SHOWN | DRAWING SIZE : A3

APPROVED BY:		
20080228		05-07-2025
PR. ENG.	SIGNATURE	DATE

DESIGNED BY:	CHECKED BY:	
JEAN DIPPENAAR	JAN BRINK	
DRAWN BY: JEAN DIPPENAAR	DATE: 05-07-2025	
PROJECT No: DJH337	DRG No: DJH337-01	REV No: D



INLET WORKS CONNECTION
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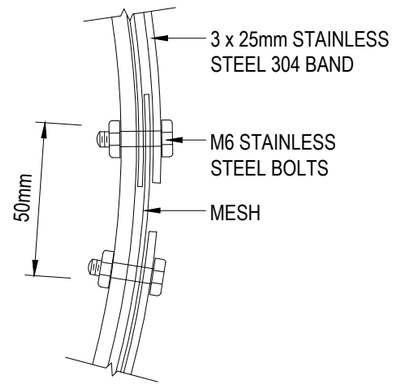
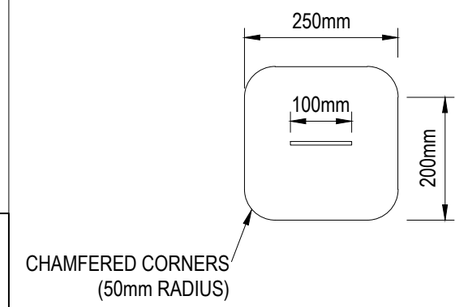


DETAIL 9: INLET SIEVE
N.T.S

INLET SIEVE

1. BARS TO BE WELDED TOP AND BOTTOM.
2. BARS TO BE WELDED ALONG THEIR FULL CIRCUMFERENCE WITH NO CREVICES.
3. ALL MATERIALS, INCLUDING M6 BOLTS, TO BE MADE FROM STAINLESS STEEL 316.
4. SIEVE FRAME MANUFACTURED FROM 6mm THICK STAINLESS STEEL 304 SHEETING AND 20mm STAINLESS STEEL 316 RODS.
5. ALL SHARP CORNERS MUST BE CHAMFERED TO AT LEAST 2mm RADIUS.

- **DIMENSIONS**
- A = 600 mm
- B = 500 mm
- C = 250 mm OD



DETAIL 8: INLET SIEVE BASE PLATE
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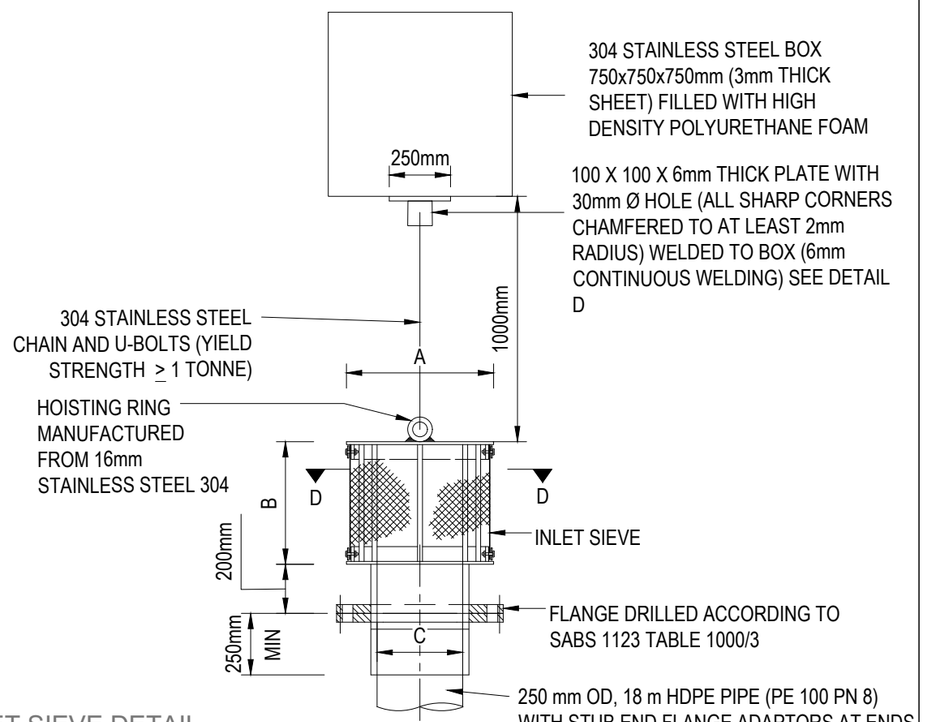
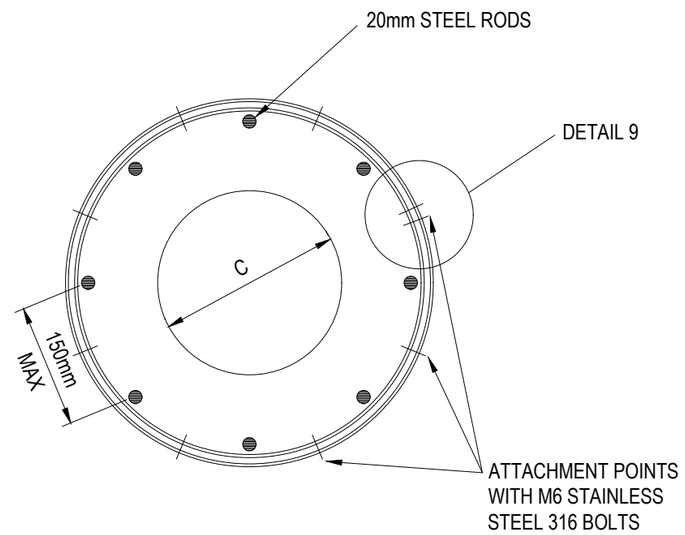


INLET SIEVE DETAIL
N.T.S



SECTION F-F: INLET SIEVE
N.T.S

DETAIL 7: INLET SIEVE
N.T.S

No.	DATE	REVISION DESCRIPTION	CONSULT. ENG.
A	05/02/2026	FOR REPORT	HBCE

CLIENT:

KLIPHEUWEL TRUST

HAGENBRINK CONSULTING ENGINEERS
PASSION | EXCELLENCE | INNOVATION

PROJECT TITLE

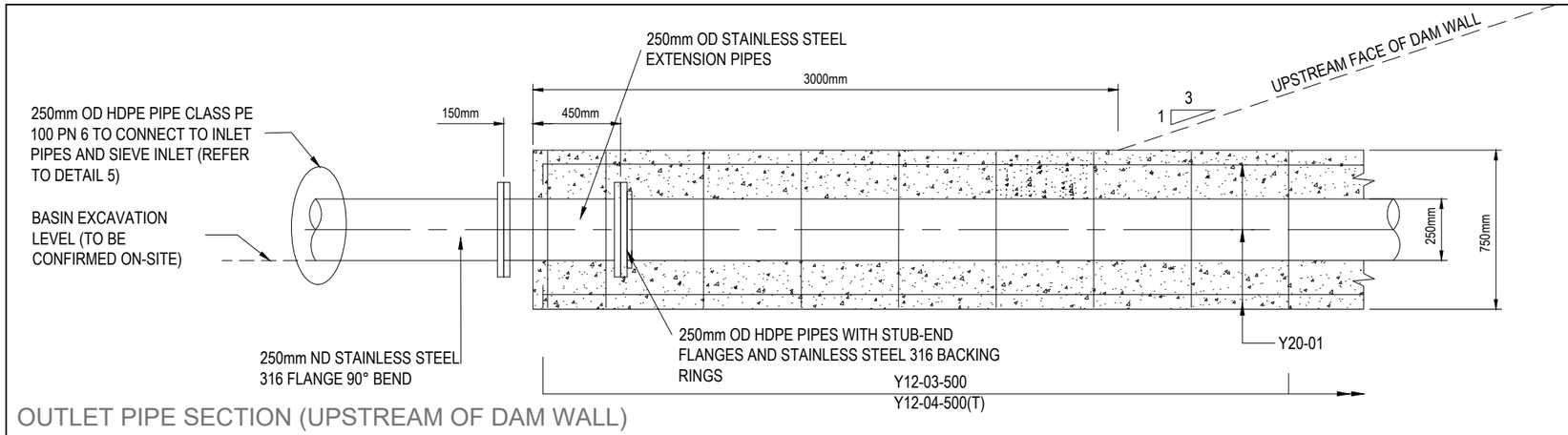
KLIPHEUWEL TRUST - OUDRIFT DAM

DRAWING TITLE

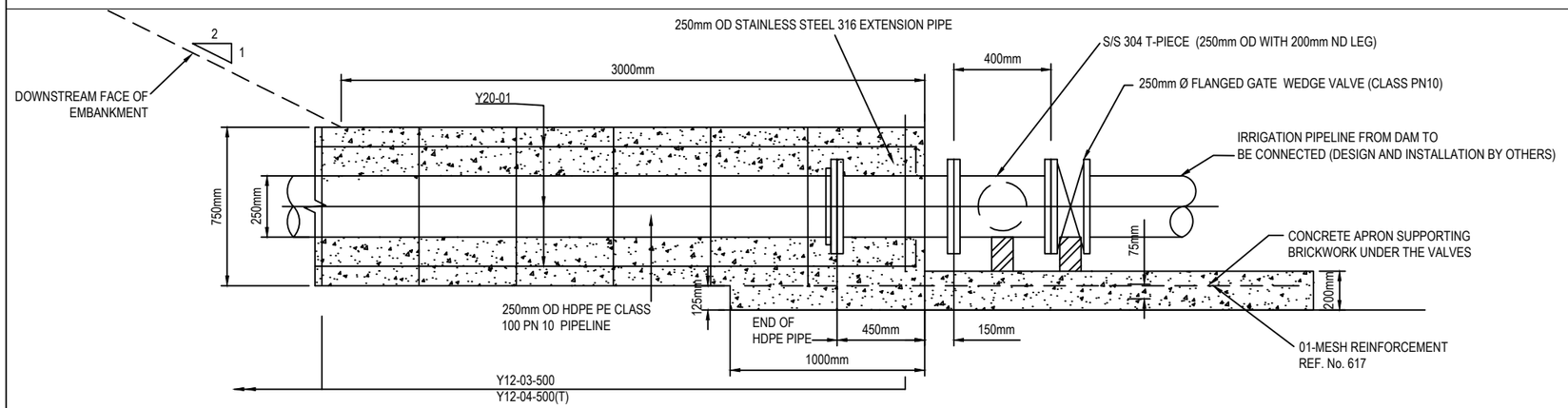
DETAILS OF INLET WORKS

SCALE : AS SHOWN | **DRAWING SIZE : A3**

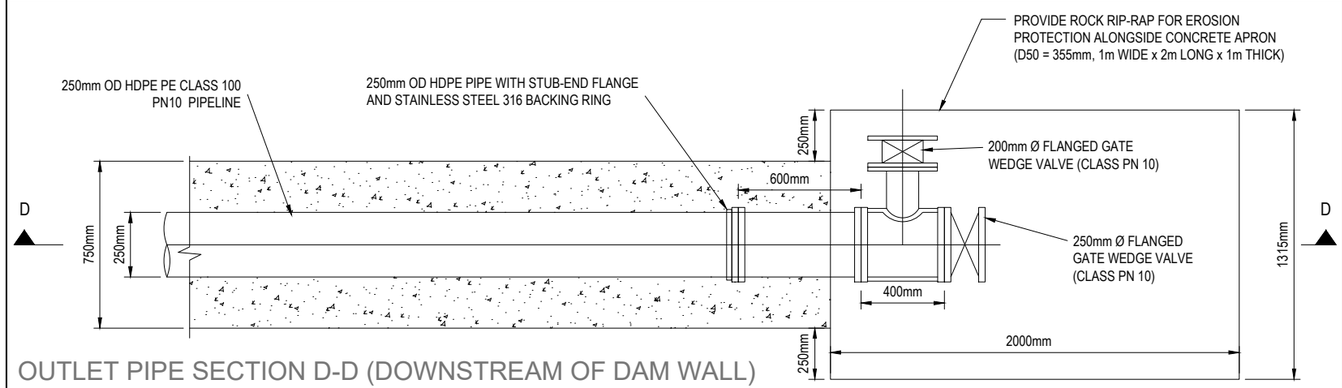
APPROVED BY:		
20080228		05-02-2026
PR. ENG.	SIGNATURE	DATE
DESIGNED BY: JEAN DIPPENAAR	CHECKED BY: JAN BRINK	
DRAWN BY: JEAN DIPPENAAR	DATE: 05-02-2026	
PROJECT No: DJH337	DRG No: DJH337-05	REV No: A



OUTLET PIPE SECTION (UPSTREAM OF DAM WALL)
N.T.S



OUTLET PIPE SECTION D-D (DOWNSTREAM OF DAM WALL)
N.T.S



OUTLET PIPE SECTION D-D (DOWNSTREAM OF DAM WALL)
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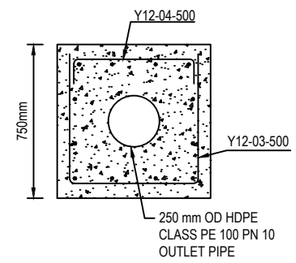
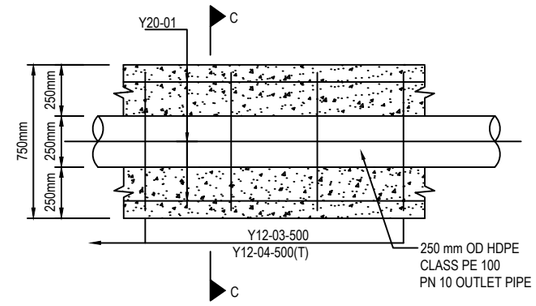


SECTION C-C: OUTLET PIPE
N.T.S



DETAIL 4
N.T.S

NOTES:

OUTLET WORKS

1. MINIMUM THICKNESS OF STEEL SPECIALS = 6 mm.
2. ALL CONCRETE EDGES CHAMFERED 20 x 20 (mm) WHERE CONCRETE IS EXPOSED.
3. RUBBER GASKETS TO BE PROVIDED BETWEEN ALL FLANGE CONNECTIONS.
4. ALL FLANGES AND FLANGE DRILLING TO BE ACCORDING TO TABLE 1000/3 (SANS 1123).
5. CONCRETE OF OUTLET WORKS TO BE 30/19 MPa WITH W/C RATIO OF 0.5.
7. MINIMUM COVER FOR STEEL REINFORCEMENT: 75 mm
8. ALL STEEL REINFORCEMENT MARKED 'Y' HAS A MINIMUM YIELD STRENGTH OF 450 MPa.
9. MINIMUM LAPS TO REINFORCEMENT - 50 x Ø
10. SURFACE PREPARATION TO BE APPROVED BY ENGINEER ON SITE PRIOR TO CASTING OF CONCRETE.

LEGEND: (T) - TOP
(Ø) - DIAMETER

OUTLET PIPE

11. INVERT LEVEL OF OUTLET PIPE INLET TO BE CONFIRMED ON SITE.
12. OUTLET PIPE THROUGH EMBANKMENT TO CONSIST OF OD 250 mm HPDE PIPE CLASS PE 100 PN 6 WITH 250 mm CONCRETE COVER AROUND THE PIPE.
13. CONCRETE ENCASEMENT LENGTH = 120 m
- 120 m OF HDPE PIPE (20 no x 6 m PIPE LENGTHS)

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PROJECT TITLE
KLIPHEUWEL TRUST - OUDRIFT DAM

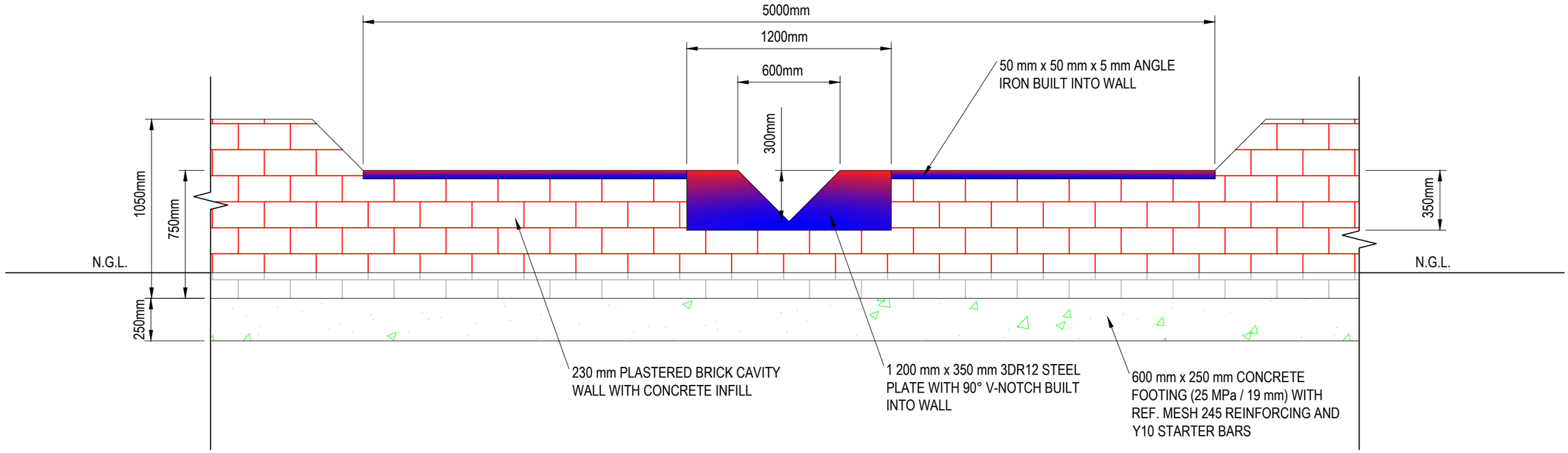
DRAWING TITLE
DETAILS OF OUTLET WORKS

SCALE : AS SHOWN | DRAWING SIZE : A3

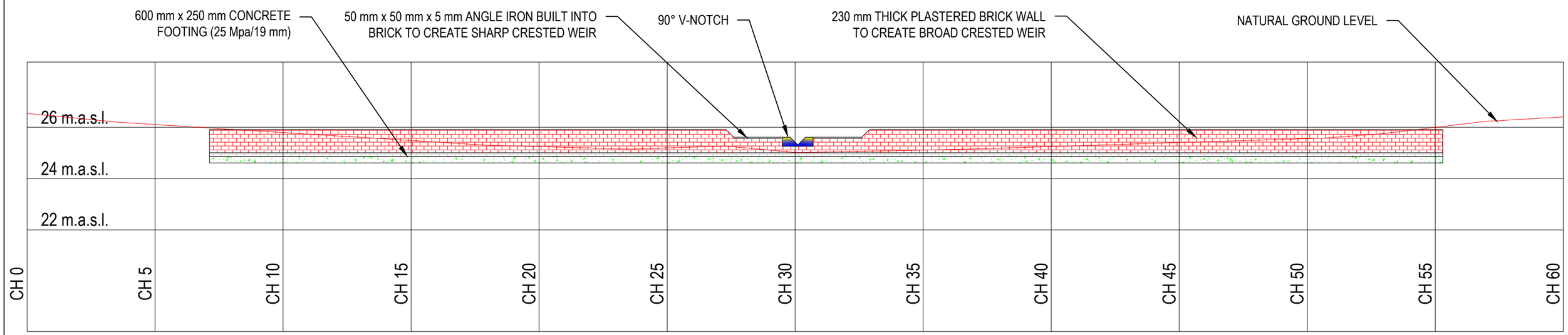
APPROVED BY:		
20080228		05-02-2026
PR. ENG.	SIGNATURE	DATE

DESIGNED BY:	CHECKED BY:
JEAN DIPPENAAR	JAN BRINK
DRAWN BY: JEAN DIPPENAAR	DATE: 05-02-2026

PROJECT No	DRG No	REV No
DJH337	DJH337-06	A



V-NOTCH DETAIL
N.T.S



V-NOTCH (SIDE VIEW)
N.T.S

No.	DATE	REVISION DESCRIPTION	CONSULT. ENG.
A	06/02/2026	FOR REPORT	HBCE

CLIENT:
KLIPHEUWEL TRUST

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PROJECT TITLE
KLIPHEUWEL TRUST - OUDRIFT DAM

DRAWING TITLE
V-NOTCH DETAILS

SCALE : AS SHOWN | DRAWING SIZE : A3

APPROVED BY:
20080228 (PR. ENG.) | SIGNATURE | 06-02-2026 (DATE)

DESIGNED BY:	CHECKED BY:
JEAN DIPPENAAR	JAN BRINK
DRAWN BY: JEAN DIPPENAAR	DATE: 06-02-2026

PROJECT No	DRG No	REV No
DJH337	DJH337-07	A

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