SW VILJOEN BOERDERY (PTY) LTD

CONSTRUCTION OF DASBERG DAM

PRELIMINARY DESIGN REPORT

J. VAN BREDA, Pr Eng
(Approved Professional Person)

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Date : February 2017
Ref : T650

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1. INTRODUCTION

1.1 General

The proposed Dasberg Dam is situated in the Sonderend River catchment on Ptn 5 of the farm Van Der Wattskraal 399, district of Swellendam ±13 km east of Riviersonderend in the Western Cape Province. The location plan is included in Appendix A. The dam provides water for irrigation. The dam serves as an instream storage dam for water pumped from the Sonderend River.

1.2 Purpose of report

The purpose of this report is to form part of the Environmental and Water Licence applications.

1.3 Water licence and Environmental Authority

Water licence include taking of 'new' water, transferral and storing of water – detail in WULA done by Sarel Bester Engineers. An **environmental authority** is also required.

1.4 Dam safety

The reservoir is subject to the dam safety legislation in terms of Chapter 12 of the National Water Act. The dam is likely to be classified as a Category II, medium size work with a significant hazard potential rating.

1.5 Design and construction team

Mr J van Breda, Pr Eng of Van Breda & Associates is the Approved Professional Person for the design and quality control during construction

The construction will be undertaken by a contractor.

1.6 Main features

Crest level of embankment	RL 63,5 m
Full supply level	RL 62,5 m
Lowest drawdown level	RL 47 m
Downstream river level	RL 44 m
Wall height	19,5 m
Length of crest	535 m
Width of crest	4 m
Upstream slope	1:3
Downstream slope	1:2
Storage capacity	625 000 m^3
Surface area at FSL	8,8 ha
Volume earthfill	168 000 m^3

Type of spillway	Uncontrolled open channel on the left bank
Spillway width	1 m
Spillway return channel	Excavated channel with a firm shale bed
Outlet works	A 315 mm dia uPVC pressure conduit under the embankment, cast in reinforced concrete and founded on firm formation
Downstream control	A 300 mm dia gate valve
Upstream control	Floating intake
Construction period	Q2 2018 to Q3 2018

The cross-sections and details are shown on the design drawings (Appendix B).

1.7 **Public Safety**

1.7.1 **Evaluation of existing development that can be affected by the dam**

There are no developments other than the N2 national road 1,6km d/s in the 2,7km reach below the dam before it joins the significant Sonderend Rivier (Appendix A).

1.7.2 Precautions and measures to ensure public safety

An Operation and Maintenance Manual and Emergency Plan will be compiled in conjunction with the Swellendam Municipality.

2 **EMBANKMENT**

2.1 **Geology**

The site is located on shale, mudstone and siltstone of the Bokkeveld Group.

2.2 **Foundation**

The site is covered by a thin layer of clayey gravelly topsoil (< 0,3 m thick), which lies directly on a horizon of up to 2m thick of decomposed in situ, residual clay derived from advanced weathering of the shale, which in turn grades down to decomposed Bokkeveld shale.

Ten trail holes were excavated along and near the centreline of the embankment. Refer to drawing V&A T650/1 (Appendix B). A generalized description of the materials based on the profiles and the expected core trench excavation line, are shown on drawing V&A T650/2 (Appendix B).

2.3 **Material**

Eight trial holes were dug in and around the basin at positions indicated on drawing V&A T650/1 (Appendix B). Samples were taken from these holes for analysis. The shell will be constructed with the coarse fraction. No strength parameter tests were carried out on the latter. The strength properties of this material were obtained from the publication *A guide to practical Geotechnical Engineering in Southern Africa*.

The Geo-Technical Laboratory Somerset West tested the material samples. A range of tests was carried out to determine the properties of the material and its suitability for earth fill. The properties of the different materials, as determined by the laboratory tests and the above-mentioned publication, are summarised in Table 2-1.

Table 2-1: Soil properties

	204	206 (O)	206 (B)	207	216	217
CLAY CONTENT (%<0,002)	6	16	13	16	4	20
LIQUID LIMIT (%)	32	18	NP	37	29	21
PLASTICITY INDEX (%)	9	3	NP	12	7	5
LINEAR SHRINKAGE (%)	6	3	NP	6,5	5,5	3,5
DISPERSIVITY: SCS (%)	81	54	60	41	54	43
PERMEABILITY (m/s) [%Proctor]	$1,3x10^{-6}$ [98]	$2,3x10^{-6}$ [98]	$2,6x10^{-7}$ [98]	$2,7x10^{-10}$ [98]	$2,3x10^{-9}$ [98]	$4,5x10^{-7}$ [98]
MAXIMUM DRY DENSITY (kg/m^3)	1745	2140	2100	1840	2005	1975
OPTIMUM MOISTURE (%)	16,0	8,0	8,2	14,0	10,2	9,4
COHESION (kPa)		0	0		0	0
ANGLE OF FRICTION (º)		35	35		35	35
TYPE	SHELL	SHELL	SHELL	CORE	CORE/ SHELL	SHELL

Suitable filter sand is available on the property. The gravel for the strip drains will be obtained from commercial sources.

2.4 **Drainage filters**

A 0,3m wide vertical chimney drain is provided between the core and the downstream shell to protect the core against any possible erosion damage, especially in the event of a concentrated leak as well as to improve the stability of the downstream slope.

Strip drains intercept the flow to minimize the possibility of saturated conditions at the downstream toe and at the lower parts of the embankment.

2.5 **Compaction**

Zone I (core) shall be compacted to a minimum of 98% to 100% of the Standard Proctor maximum dry density at optimum moisture content to counter any possibility of long term seepage. Zone I shall be compacted to a minimum of 98% of the Standard Proctor maximum dry density at optimum moisture content.

All filter material shall be compacted to at least 95% of the Proctor density at optimum moisture content.

2.6 **Slope stability analysis**

The slopes of the embankment were analysed. The factors of safety were evaluated for various possible slip surfaces applying the following load cases and combinations of soil properties:

- Downstream slope with reservoir at full supply level;
- Upstream slope with reservoir at full supply level; and
- Upstream slope after rapid drawdown from full supply to lowest drawdown level has taken place.

The results are listed in Table 2-2.

Table 2-2: Maximum Section: Results of slope stability analysis

Load Case	Factor of safety	
	Required	Achieved
D/S slope at FSL	1,5	1,5
U/S slope at FSL	1,5	2,2
U/S slope after rapid drawdown	1,2	1,6

2.7 **Slope protection**

The outer layer of the shell is formed of coarse general fill material to protect the slopes against erosion and the washing out of the fines fraction. Suitable rip-rap will be placed on the upstream slope as wave protection.

2.8 **Monitoring instruments**

No monitoring instruments will be installed inside the embankment. Settlement markers on the crest and a pressure gauge on the outlet pipe will be installed.

3. **OUTLET WORKS**

The reservoir is provided with a 315 mm dia class 6 uPVC outlet pipe. A floating intake will be fitted to the upstream end of the pipe. The outlet under the embankment is founded on firm formation and encased in reinforced concrete. The outlet terminates with a 300 mm gate valve on the downstream end. A scour for emptying the dam will be fitted to the valve.

4. **HYDROLOGY**

The catchment of the reservoir is limited to the local hills. The properties are as follow:

Location:	20º 02' 54,2" E 34º 07' 49,9" S
Area:	0,5 km^2
MAP:	350 mm
Time of concentration Tc:	0,11 hr (use 0,25 hr)
Francou-Rodier "K":	5

The flood calculations are based on TR137 (Kovacs, 1988) and HRU 1/72 (Midgley et al, 1972). The results are summarised in Table 2-1.

Table 4-1: Unrouted flood discharges (m^3/s)

Return Period (years)	TR137	HRU 1/72
100	-	4
RMF_5	n/a ($A<<10km^2$)	-
PMF	-	27

The HRU 1/72 results were accepted as the TR137 method is not suitable for small catchments. Based on the hazard potential of the dam, the recommended design discharge (RDD) is based on the one in hundred year flood of 4 m^3/s.

The safety evaluation discharge (SED) of 19 m^3/s is based on the PMF. A fraction of 0,7 is used.

5. SPILLWAY

An uncontrolled open channel emergency spillway 1 m wide is proposed on the left bank. The freeboard of the spillway is 1,0 m.

Flood retention is simulated with the dimensionless unit hydrograph theory according to HRU 1/72. The results are listed in Table 5-1 and the hydrographs are shown in Appendix D.

Table 5-1: Flood discharges Q (m^3/s)

Spillway properties		RDF (1:100)	SEF (0,7 PMF)	Max capacity
d=1,0m; w=1m & side slope Z=2	Q_{in}	4	19	58
	Q_{out}	0,04	0,54	3,7
	H	0,08	0,38	1,0

Limited scour of the firm shale bed of the spillway return channel can be expected.

6. QUALITY CONTROL

6.1 Earthworks

Quality control measures during the construction period consist of compaction control tests. The following tests will be carried out by the soil laboratory:

(a) Embankment (Zone I & II)
Compaction tests will be done on the materials of both zones for every 3 000 m^3 placed in layers of 300 mm.

(b) Concrete
Concrete quality control includes the approval of materials and mix designs.

6.2 Specifications

The following standardized specifications are applicable to the construction:

SABS 1200 AD	General (small dams)
SABS 1200 DE	Small Earth Dams

7. SUMMARY

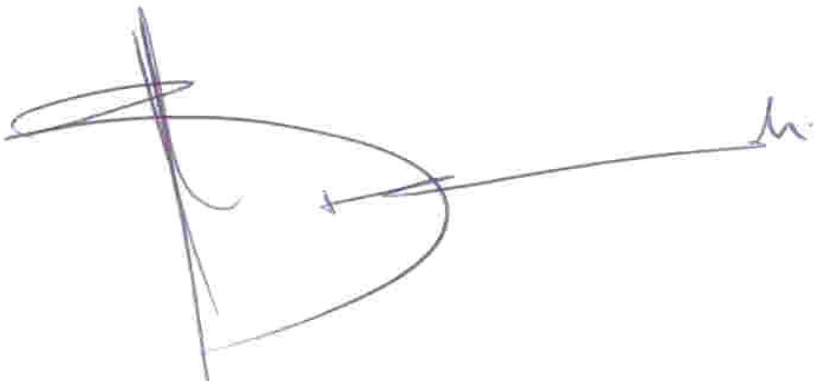
No major problems are expected during the construction of the embankment, outlet pipe and spillway.

8. LIST OF APPENDICES

Appendix A: Locality maps

Appendix B: Design drawings

Appendix C: Area Capacity Curve



J VAN BREDA Pr. Eng
Approved Professional Person

7 February 2017

APPENDIX A

LOCALITY MAPS

Garmap SA TOPO 2012.3 NT
Garmin SA Southern Africa Topo & Rec 2012.1

0 km 0.75 km 1.5 km 2.25 km 3 km

Weskus Toer 18-21Maart 2016

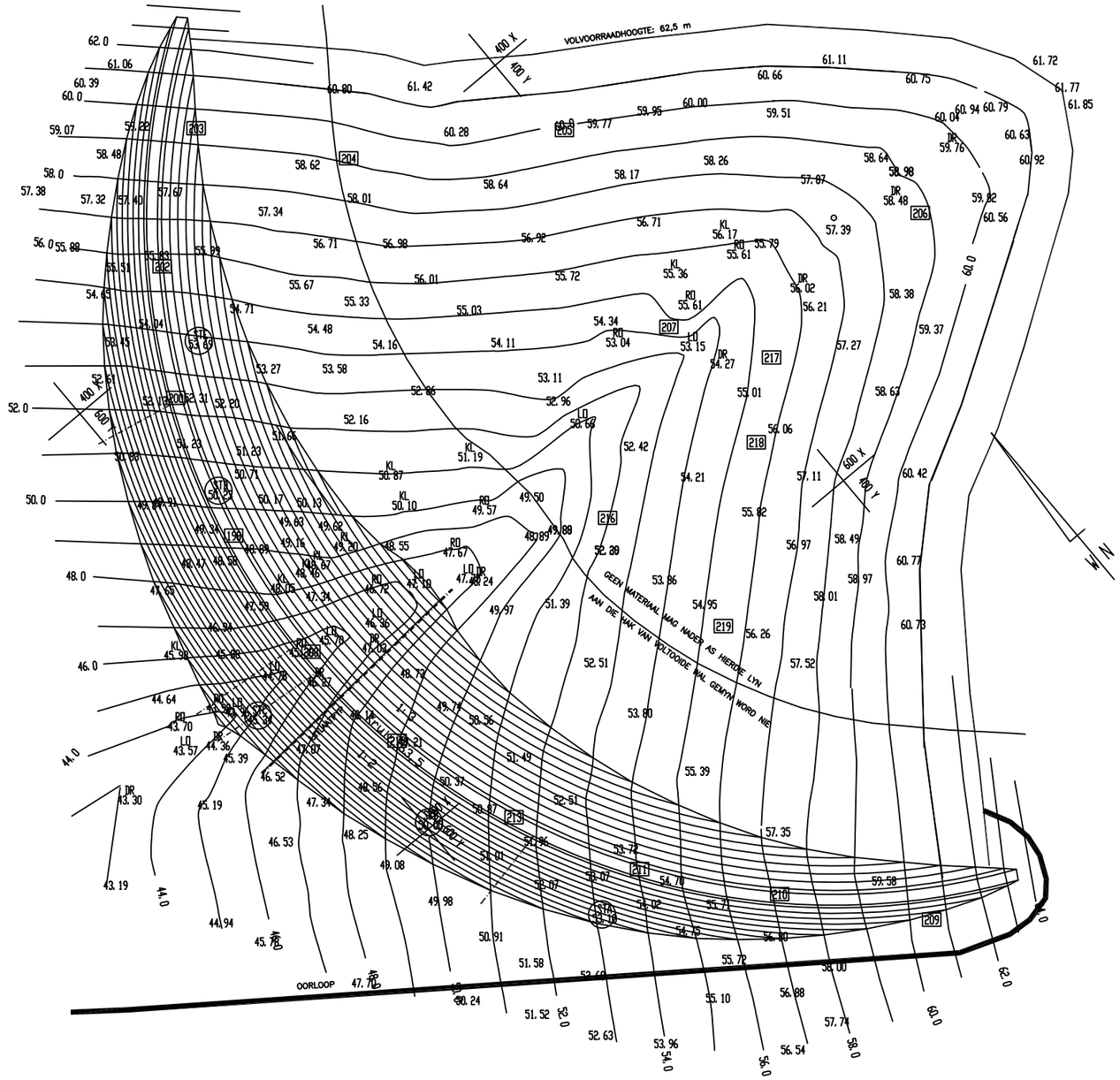
GARMIN.

APPENDIX B

DESIGN DRAWINGS

LIGGINGSPLAN

SKAAL 1 : 50 000



WALUITLEG

SKAAL 1 : 1000

225 Toetsgate

● Versakkingsbakens

Dreinuitlate

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RAADGEWENDE INGENIEURS
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SW VILJOEN BOERDERY (EDMS) BPK
DASBERG-DAM
Liggingsplan, Eienskappe
Kontoeropmeting en uitleg

INGENIEUR

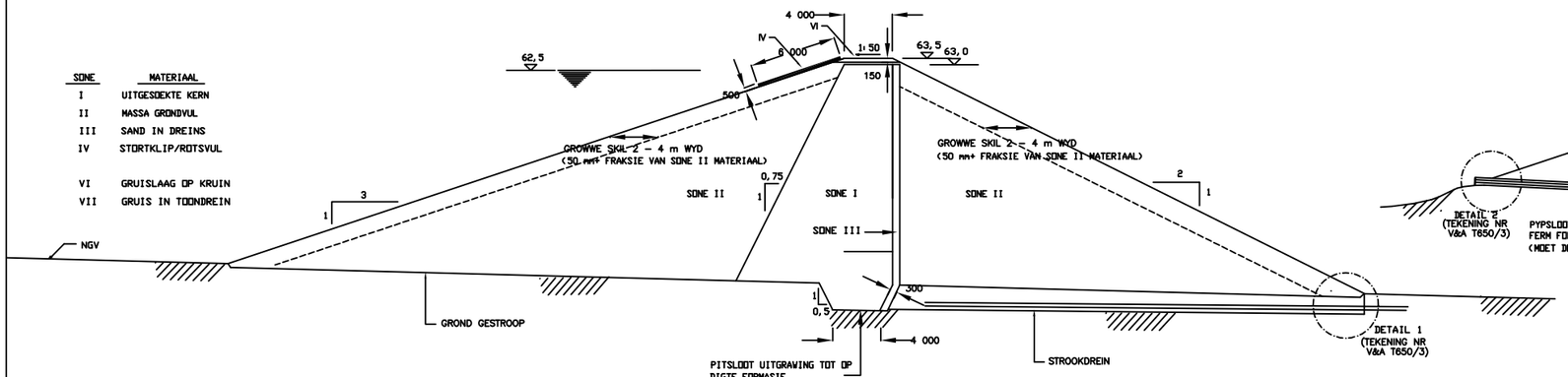
GOEDGEKEURDE PROFESSIONELE PERSOON

NR			
1	MR LISENSIE-DOELEINDES	JVB	1/2017
NR	VERBETERINGS	GOEDGEKEUR	DATUM

OPGEMEET BO	INDEX NR
GEPLOT	OPMETING NAGEGAAN
TEKENING JVB	TEKENING NAGEGAAN
ONTWERP JVB	ONTWERP NAGEGAAN
SKAAL : SOOS AANGEDUI	VEL 1 VAN 3

TEKENING NR V&A T650/1

SONE	MATERIAAL
I	UITGESDEKTE KERN
II	MASSA GRONDVUL
III	SAND IN DREINS
IV	STORTKLIP/ROTSVUL
VI	GRUISLAAG OP KRUIN
VII	GRUIS IN TOONDREIN



TIPIESE SNIT VAN WAL

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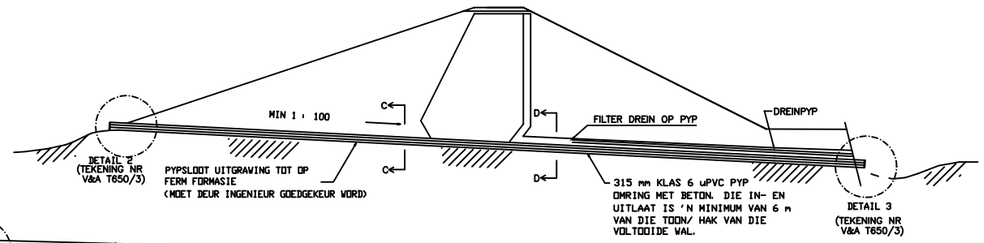

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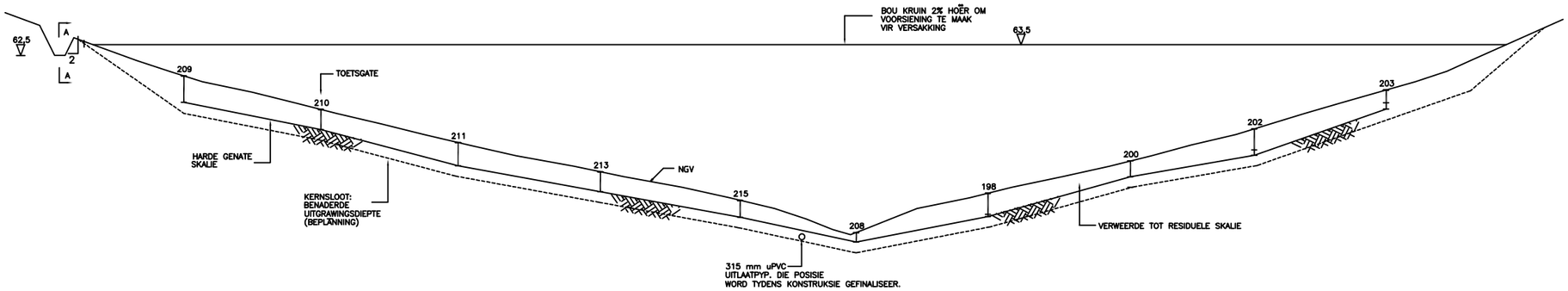
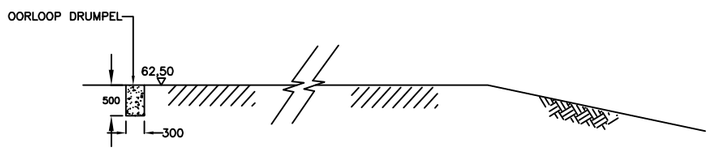
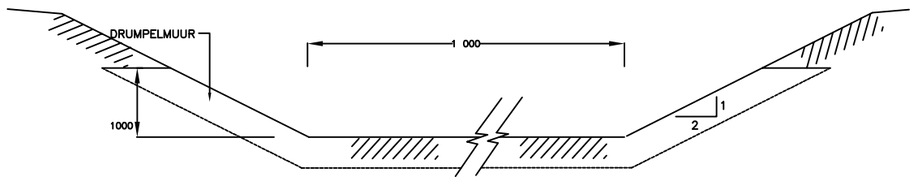


LENGTESNIT VAN DAMWAL LANGS S/O SKOUER VAN KRUIN (S/O AANSIG)

SKAAL HORS. 1 : 1 000 VERT. 1:250



SNIT A-A
AFSNYMURE EN BESKERMING
VAN OORLOOPKANAAL
NVS



DWARSSNIT VAN OORLOOPKANAAL

NVS

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Snitte van wal en oorloop

INGENIEUR

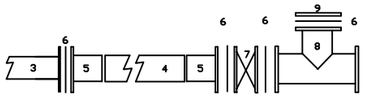
GOEDGEKEURDE PROFESSIONELE PERSOON

NR	VERBETERINGS	GOEDGEKEUR	DATUM
1	VIR LISENSIE-DOELEINDES	JVB	1/2017

OPGEMEET	BOEK NR
GEPLOT	OPMETING NAGEGAAN
TEKENING JVB	TEKENING NAGEGAAN
ONTWERP JVB	ONTWERP NAGEGAAN
SKAAL : SOOS AANGEDUI	VEL 2 VAN 3

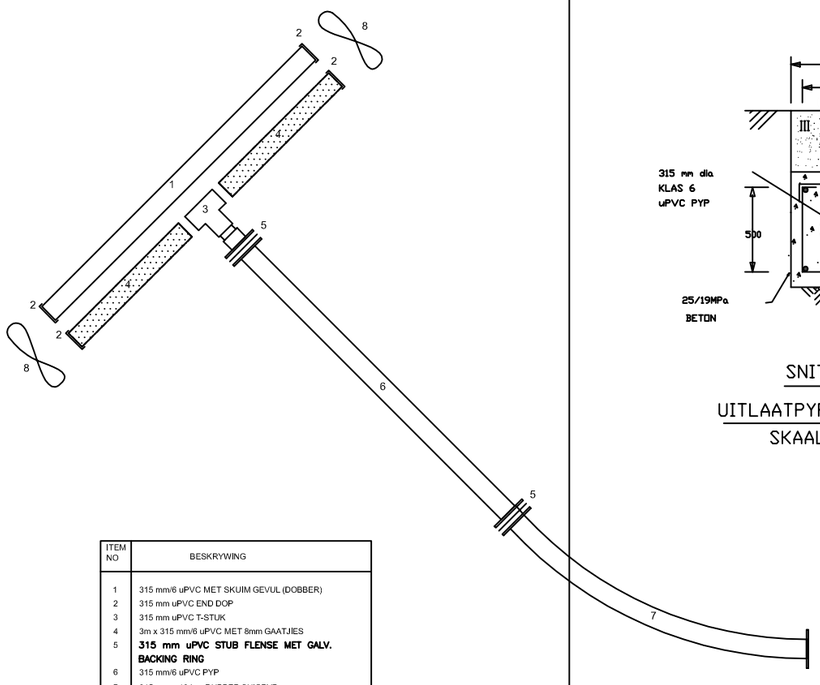
TEKENING NR V&A T650/2

ITEM NR	BESKRYWING
3	DRYWENDE INLAAT (SIEN SKETS HIERONDER)
4	315 mm KLAS 6 uPVC PYP
5	315 mm FLENSPASSTUK
6	315 mm PAKSTUK
7	315 mm GIETYSTER SKUIWERKLEP
8	315 mm GEFLENSDE GELYKE BEEN GEGALV. STAAL T-STUK
9	315 mm GEGALV. STAAL BLANKO FLENS



315 mm UITLAAPPYP ITEMS

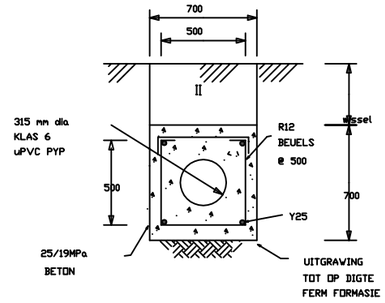
NIE VOLGENS SKAAL



ITEM NO	BESKRYWING
1	315 mm/6 uPVC MET SKUIM GEVUL (DOBBER)
2	315 mm uPVC END DOP
3	315 mm uPVC T-STUK
4	3m x 315 mm/6 uPVC MET 8mm GAATJIES
5	**315 mm uPVC STUB FLENSE MET GALV. BACKING RING**
6	315 mm/6 uPVC PYP
7	315 mm x 10 bar RUBBER SUIGPYP MET INGEBOUDE FLENSE
8	10mm VLEKVRYE STAAL KABEL x 2,5m LANK

DRYWENDE INLAAT ITEMS

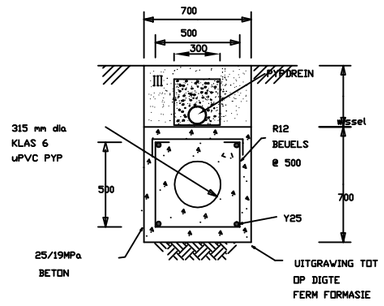
NIE VOLGENS SKAAL



SNIT C-C

UITLAATPYP IN SLOOT

SKAAL 1 : 20



SNIT D-D

UITLAATPYP IN SLOOT

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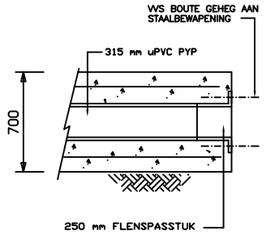

DETAIL 2 & 3

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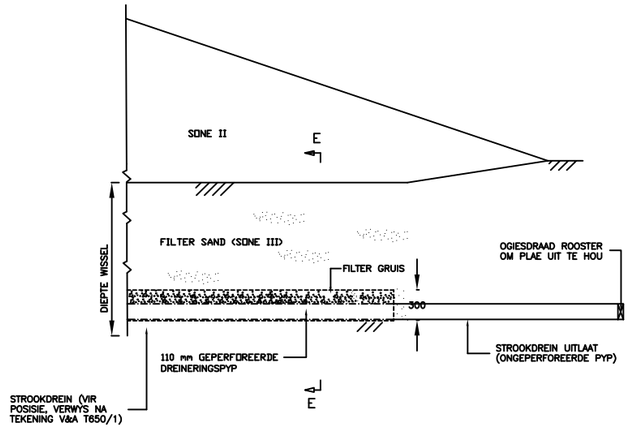

DETAIL 1

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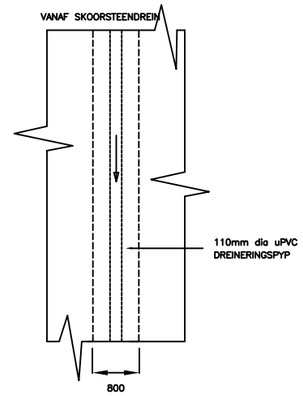
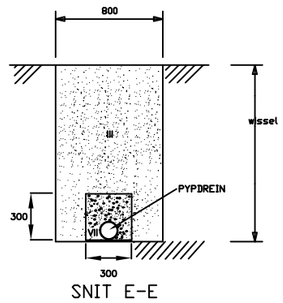


PLANAANSIG VAN

STROOKDREINUITLAAT

SKAAL 1 : 40



SNIT E-E

STROOKDREIN

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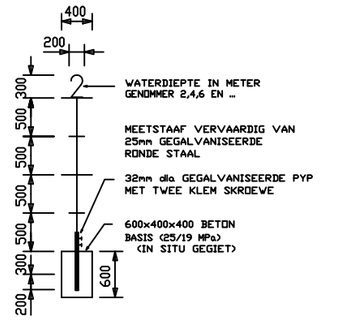

DIEPTEMERKER DETAIL

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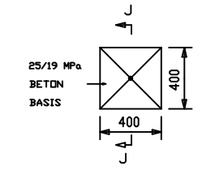

PLAN

VERSAKKINGSBAKEN DETAIL

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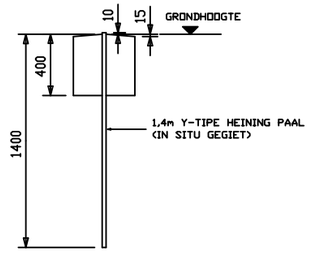

SNIT J - J

SKAAL 1 : 20

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DASBERG-DAM

Uitlaat, dreins en moniteringsitems

INGENIEUR

GOEDGEKEURDE PROFESSIONELE PERSOON

NR	VERBETERINGS	GOEDGEKEUR	DATUM
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ONTWERP JVB	ONTWERP NAGEGAAN
SKAAL : SOOS AANGEDUI	VEL 3 VAN 3

TEKENING NR V&A T650/3

APPENDIX C

AREA CAPACITY CURVE

T650: DASBERG

Dam Basin Properties (7-02-2017)