

Havant Thicket Reservoir

Construction Phase Flood Risk & Drainage Plan

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1. Introduction

1.1. Scheme Overview

General

The proposed Havant Thicket Reservoir (HTR) will be a new reservoir to be built in Havant, which is approximately 10km north of Portsmouth.

The operating capacity of the reservoir is 8,700 ML, including borrow pits but not including water below the lowest draw off level or retained in the wetland. The top water level (TWL) is 39.5 m AOD, and the lowest operating level is 29.0 m AOD. The lowest 20% of the total volume is considered dead storage, i.e. the minimum level before the reservoir operationally fails. General arrangement of the key elements of the design are contained in Appendix 1.

Document Scope

This Construction Phase Flood Risk & Drainage Plan is intended to set out how the scheme is to be carried out in accordance with the submitted flood risk assessment (ref HTR-ATK-XX-XX-RP-Z-0042, titled A15.2 Flood Risk Assessment Report, compiled by Atkins on behalf of Portsmouth Water Ltd dated 01/09/20). The report details the mitigation measures implemented by Future Water during the construction of Phases 2 & 3.

The Construction Phase Flood Risk & Drainage Plan is intended to address the requirements of Condition 32 in relation to phases 2 & 3, as well as summarising the flood risk impact as a result of the proposals for the construction phase of Havant Thicket Reservoir. This report addresses the flood risk concerns detailed in the flood risk assessment (ref HTR-ATK-XX-XX-RP-Z-0042) by providing a summary (Section 2) related to the study sections and confirming there is no increase in flood risk as a result of the proposals.

- o A detailed drainage management plan that details the management of drainage associated with phases 2-3 is provided in section 3.0
- o Detailed information surrounding the number of permanent structural elements including the proposed dimensions and height of the embankment, associated spillway, control house and wetland retaining structure (including the proposed piped controls) is provided in section 1.2
- o Detailed information including the long-term maintenance scheduled for the proposed development is provided in section 4.0

The information provided in this report applies to Phases 2 to 8 of the development. Details of localised drainage systems for future phases 4-8 will be subject to further revision of drainage management plan. Where these elements affect the overall drainage strategy, the information provided with the outline permission flood risk assessment have been assumed.

The elements of Condition 32 related to the location and access to the visitor centre will be addressed separated as part of Phase 9 of the development.

1.2. Key details

Main reservoir embankment

The main reservoir embankment is 2,850 m long with a height of 20 m at an embankment crest level of 40.5 m AOD. This is 1 m above the top water level and therefore the reservoir has 1 m of freeboard as required by the Reservoir Flood Study (HTR-ATK-RZ-RE-RP-Z-0006). The embankment consists of a zoned earthen embankment with the following zones:

- a central, low permeability core as the main water retention zone (Zone 1)
- chimney filter and blanket filter/drain to control seepage through the embankment (Zone 2)
- upstream and downstream shoulders to support the core and maintain stability (Zone 3)

The upstream and downstream shoulders are sloped at 1V:9H where the height of the embankment is greater than 10m (except adjacent to Staunton Country Park where the slopes will vary from 1V:8H to 1V:9H), and 1V:8H where the height of the embankment is less than 10m. The crest is protected with a gravel pavement for vehicle access.

The spillway is at 39.5 m AOD, consisting of a 3 m long weir, with a 700 mm diameter pipe, which gives a 1.3 m³/s discharge at a head of 0.4 m. The 700 mm diameter pipe will discharge into Riders Lane Stream downstream of the dam toe. The details of the spillway and pipeline were granted full planning permission by the hybrid planning permissions and will be constructed as Phase 7 of the development.

The embankment will have a toe drain around its entire downstream edge, which will collect the surface water run-off from the embankment and channel it into either the Riders Lane Stream or Durrants Stream (to the River Lavant). A small section of the Riders Lane Stream catchment (0.03 km²) may be diverted out of the catchment and into the Lavant Headwaters by the toe drain. The Lavant Headwaters catchment area is still reduced, however, as the embankment will intercept a proportion of the baseline catchment, reducing the overall area from approximately 0.50 km² to 0.38 km².

Further detail is provided in Table 1.

Wetland structure

The wetland comprises two embankments, the Wetland Retaining Structure (WRS) and Wetland Retaining Bund (WRB). The WRS encircles three compartments (numbered 2 to 4) that capture the three main streamlines into the reservoir. The WRB extends from the WRS to create Compartment 1. The WRS has a length of approximately 1075 m and the WRB a length of 375 m along the northern shoreline at an average distance 60-80 m away from where the TWL would cover.

This is planned to facilitate wetland habitat development, provide resilience to seasonal reservoir level changes and to ensure viable habitat that meets biodiversity net gain requirements.

The crest level of the WRS and WRB that separates the wetlands from the main reservoir is set at 40.0 m AOD. At TWL (39.5 m AOD) the wetland area will be approximately 10 ha, however at retained water level (38.8 m AOD) it will be approximately 6.2 ha. The retained wetland level is the level at which the retaining structure starts to hold back water within the wetland area as reservoir levels fall.

The water level in the wetland will be actively managed through the provision of piped controls at strategic locations along the retention structure, which connect the retained wetland to the main body of the reservoir at naturally occurring low points in the topography. These outlet structures consist of DN900 conduits in each compartment with a penstock control on the wetlands side to allow the flow of water both ways in operation. Further detail is provided in Table 2.

The wetlands is programmed to be completed before the end of the main reservoir embankment. Flood control during construction is obtained by the maintaining the outlet structures open to pass any inflows and completion of the overbank, rock lined spillways. The flood risk is lower after the construction of

the main reservoir embankment and so the overbank spillways completed for construction are adequate to maintain sufficient flood capacity. Five overbank spillways to the main reservoir exist along the WRS and WRB crest, consisting of a lowering in the crest level to the spillway crest level of 38.8 mAOD. Rock lining is placed on the flow path over the embankment material to prevent erosion from occurring in flood.

Culvert and outlet pipe

A reinforced concrete culvert passes through the embankment that is 5.1 m wide and 3.75 m high internally. The dimensions of the culvert have been designed to allow installation of all the necessary internal pipework and fittings in construction and if required to be replaced in the embankment's operational life. Access to the culvert is through the control building and valve tower.

The culvert includes two pipelines; a DN1400/DN1600 diameter pipeline to provide a common outlet, and drawdown main, plus an independent 300mm diameter scour/compensation main. The outlet pipe consists of a DN1400 opening in the bulkhead at the base of the valve tower and stays as a DN1400 pipe through the main guard valves. The outlet pipe then enlarges to DN1600 through the downstream culvert before reducing to DN1400 at the bi-furcate to the emergency drawdown pipe. The outlet pipe continues as a DN1400 to the interface pit for the main Bedhampton Pipeline, before reducing to a DN1200 on the route to Bedhampton. The DN1400 emergency drawdown pipe is regulated by a submersible valve that releases the flow into an open channel Riders Lane Stream. Further detail is provided in Table 1.

The outlet and scour pipework passes through the embankment in a reinforced concrete culvert that is 5.1 m wide and 3.75 m high internally. The dimensions of the culvert have been designed to allow installation of all the internal pipework and fittings in construction and if required to be replaced in the dam's operational life. Access to the culvert is through the valve tower and control building.

1.3. Key details

A summary of the key features of the main reservoir is given below in Table 1 and the wetland structure in Table 2.

Table 1 Main reservoir key details

Feature	Description
Dam Embankment	
Embankment type:	Zoned earthfill with central core, chimney filter and blanket filter with finger drains
Embankment slopes:	1V:9H upstream / downstream where height greater than 10m (except adjacent to Staunton Country Park where the slopes will vary from 1V:8H to 1V:9H) 1V:8H upstream / downstream where height lower than 10m.
Design Crest Level (DCL)	40.5 mAOD
Embankment height (above D/S Toe):	20.0 m
Build height (above lowest foundation level):	23.0 m (above lowest foundation – estimated)
Embankment length	2850 m
Reservoir	
Top Water Level (TWL)	39.5 mAOD
Minimum Operating Level (MOL)	29.0 mAOD
Lowest level of reservoir	~22.0 mAOD

Feature	Description
Storage at TWL	9000 ML
Operation storage at TWL	7200 ML
Drawdown from FSL to MDL (with no inflow)	133 days
Surface Area (FSL)	105 ha
Catchment Area	2.0 km ²
Spillway	
Location	CH 910 (Approx)
Spillway type	Concrete inlet structure with 3m crest directing flows to ND700 pipe to Riders Lane Stream
Crest level	39.5 mAOD
Spillway pipe length	450 m
Spillway capacity (a head of 0.4 m)	1.3 m3/s
Outlet Works	
Location	CH 1365
Outlet type	Concrete valve tower with upper draw-off located within the upstream shoulder of the embankment. Upstream culvert from upstream toe directing water to middle draw-off at bulkhead in the base of the tower. Downstream culvert to control house at downstream toe of the reservoir.
Valve Tower	8 m internal diameter concrete tower for upper draw-off. Internal access stairs and platforms over full height
Upstream and downstream culvert	Horseshoe / "D" shape concrete, cut and cover type culvert. Internal height 3.75m and base width 5.1m. Design grade of 1% to downstream with drainage chase to collect and transport seepage downstream to Control House.
Draw-off invert levels	High draw-off: 34.0 mAOD Low draw-off: 27.7 mAOD
Outlet pipe size	High draw-off: ND700 mm diameter ductile iron pipe in tower connecting to main ND1400 mm outlet Middle draw-off: ND1400/1600 mm diameter ductile iron pipe to bi-furcation for emergency drawdown and Bedhampton Pipeline Interface. Then ND1200 mm diameter to Bedhampton Pumping Station
Emergency Discharge size	ND 1400 mm to submersible valve in Control House
Guard valves	1 x 700 mm diameter – gate valve 1 x 700 mm diameter – butterfly valve 1 x 1400 mm diameter – gate valve 1 x 1400 mm diameter – butterfly valve
Scour pipe size	ND 300 mm diameter ductile iron pipe from bulkhead to downstream toe of embankment

Table 2 Wetland structure key details

Feature	Description
General	
Wetlands Minimum Operating Level (WMOL) / Spillway Crest Levels	38.8 m AOD
Main Reservoir Top Water Level (TWL)	39.5 m AOD
General	
Wetlands Minimum Operating Level (WMOL) / Spillway Crest Levels	38.8 m AOD
Main Reservoir Top Water Level (TWL)	39.5 m AOD
Design Crest Level (DCL)	40.0 m AOD
Compartments	4
Intercompartment Spillway Crest Level	38.7 mAOD (38.8 mAOD between Compartment ½)
Catchment Area	0.861 km ²
TWL Storage Volume @39.5mAOD	155.0 ML
TWL Storage Area @39.5mAOD	90,034m ²
Compartment 1	
Height (Max.)	2.5 m
Penstock Inlet Invert	37.5 m AOD
WMOL Volume / TWL Volume	7.2 ML / 17.2 ML
TWL Area	12,081m ²
Compartment 2	
Height (Max.)	6.4 m
Penstock Inlet Invert	34.6 m AOD
WMOL Volume / TWL Volume	32.6 ML / 55.7 ML
TWL Area	31,028m ²
Compartment 3	
Height (Max.)	4.9 m
Penstock Inlet Invert	35.1 m AOD
WMOL Volume / TWL Volume	30.6 ML / 49.3 ML
TWL Area	22,323m ²
Compartment 4	
Height (Max.)	4.0 m
Penstock Inlet Invert	36.0 m AOD
WMOL Volume / TWL Volume	15.2 ML / 32.7 ML
TWL Area	24,602m ²

1.4. Key features comparison with original proposal FRA

Table 3 summarises key changes from the outline FRA that have been assessed in this Construction Phase Flood Risk & Drainage Plan.

Table 3 Key feature comparison

Feature	Change	Reason
Main reservoir embankment	Change in embankment alignment	To allow sufficient room at the downstream embankment toe for road and drainage works and not encroach into root protection zone.
	Slope change from 1V:7H / 1V:5H to 1V:9H / 1V:8H	Foundation shear strength reduced due to presence of low strength structure (relict shears)
	Reduction in overall reservoir capacity from 9,200 ML to 8,700 ML.	Flattening of slope as per above resulted in change in reservoir capacity. However, key operational requirement of 8,700 ML is maintained.
	Increase in area of the embankment footprint	Due to flattening of slope
	Change in borrow pit arrangement from three pits to two	Flattening of slope requires an increase in embankment fill material requiring borrow pits to be enlarged.
	Possible removal of bentonite cement cutoff in Bognor Sands formation	To be confirmed, contractor may elect to excavate all Bognor Sands material beneath the embankment and construct a deeper Zone 1 core cut-off into the foundation.
Outlet Works / Valve Tower	Valve tower has moved 35 m upstream away from the edge of the embankment crest	The valve tower penetrated into the embankment core which effectively reduces width of the core increasing the risk of increased seepage and initiation of internal erosion.
Outlet Works / Culvert	ND1200 Inlet/Outlet and ND1400 Emergency Discharge rationalise to single ND1400/ND1600 Multiple Purpose pipe	Twin pipes rationalised to a single pipe as the different operational uses never required at same time. Pipe size increased to ND1600 in downstream culvert to maintain emergency discharge requirements.
	ND1400 removed from upstream culvert	Pipe redundant within culvert and only creates additional maintenance requirements. Removal of pipe requires a concrete intake structure to be added so as water is drawn from the reservoir at the same level as the original pipe intake.
	ND300 scour extended through upstream culvert to reservoir	Removal of ND1400 from upstream culvert and addition of intake structure requires scour to be extended to a new intake directly to the reservoir.
	Downstream culvert internal geometry changed from 6m wide x 4m high to 5.1m wide x 3.75m high.	Minimising size of culvert to reduce potential risk to the dam.

Feature	Change	Reason
	Culvert shape change from rectangular to arched roof	Arched roof is more effective design in regards to concrete volume and minimises potential of differential settlement of the embankment fill adjacent the culvert that can lead to the initiation of internal erosion/"piping" and excessive seepage.
	Overall culvert length increased from 160m to 230m	Flattening of slope has resulted in an increase in culvert length
	Culvert horizontal alignment change.	To allow sufficient room at the downstream embankment toe for pipework to remain out of the root protection zone.
	Culvert vertical alignment change	Base of culvert lowered to level of embankment core cut-off so on more uniform foundation and minimise differential settlement.
Control House	Courtyard length increased from 20m to 50m	To maintain control house dimensions and keep partially buried within embankment, flattened embankment slopes resulted in increased length of courtyard.
Inlet Pipe	New ND800 inlet pipe added from site boundary, following line of overflow spillway (up and over south east embankment corner), running along the bed of the reservoir terminating in the north west of the reservoir.	Added to improve resilience to system and allow inflow and outflow to occur simultaneously when required. Improves mixing of inlet flows in reservoir.
Destratification System	Air pipe running up and over embankment from control room (buried) to res floor (tied down, buoyant pipes) – pipe from control room bifurcates in valve pit near crest of embankment, each pipe run in res terminating in borrow pits	Removes need for high pressure air lines within culvert.
Wetland Embankment	Slope change from 1V:3H / 1V:4H to 1V:5.5H to 1V:10H	Foundation shear strength reduced due to presence of low strength structure (relict shears)
	Manhole with penstock included on wetlands side of crest for water level control	Height off embankments required manhole arrangement for ease of access to operation personnel

1.5. Site overview

Within the study area there are two Environment Agency defined main rivers, the Hermitage Stream and the Riders Lane Stream, as shown on Figure 1.

Main rivers are usually larger rivers and streams, on which, the Environment Agency are responsible for carrying out maintenance and improvement works. Smaller rivers are referred to as Ordinary Watercourses, and the flood risk management of these watercourses is carried out by Lead Local Flood Authorities (LLFAs) and / or District Councils.

The Hermitage Stream has an approximate catchment size of 20 km², however 4.5 km² of that area is attributed to the Riders Lane Stream catchment. The upper catchment of the Riders Lane Stream

includes five ordinary watercourses, which are intermittent or temporal streams. The Riders Lane Stream also has a pond feature called 'Upper Lake' at National Grid Reference (NGR) SU 7142110030.

To the west of the reservoir site are the headwaters of Park Lane Stream (part of the Hermitage Stream catchment). The Park Lane Stream is classed as Ordinary Watercourse until it is culverted under the urban area, where it becomes a main river. The confluence of the Park Lane Stream with the Hermitage Stream is just upstream of the confluence of the Hermitage Stream with the Riders Lane Stream.

Within the reservoir footprint (considered the area within the top water level of the reservoir at the upstream extent and the embankment toe and the downstream extent), towards the eastern edge, there are some small unnamed watercourses. These are mainly ditch-like still-water headwaters that drain eastwards into Durrants Stream to the River Lavant.

The Nominal Tidal Limit (NTL) is at NGR SU 70511 06237 on the Hermitage Stream, just south of Meyrick Road. The Hermitage Stream flows over a weir at this point, after which it becomes a transitional waterbody, Langstone Harbour.

Figure 1 also shows the location of two National River Flow Archive (NRFA) gauges; Hermitage Stream at Havant (NRFA no. 42017) and Lavant Stream at Leigh Park (NRFA no. 42025).



1.6. Study sections

The study sections adopted in flood risk analyses completed for the Environmental Statement Volume 4 – Appendix 15.2 Flood Risk Assessment Report (HTR-ATK-XX-XX-RP-Z-0042) are again used for reference. The study sections are described in Table 4 and Figure 2 (reproduced from HTR-ATK-XX-XX-RP-Z-0042).

Table 4 Study sections used for flood risk analysis (HTR-ATK-XX-XX-RP-Z-0042)

Study Section	Description	Grid reference – upstream	Grid reference – downstream
1	Headwater Streams 1, 2 and 3 up to Reservoir footprint	HS1 – SU 71178 10789 HS2 – SU 71520 11000 HS3 – SU 71743 10398	HS1 – SU 71160 10368 HS2 – SU 71421 10346 HS3 – SU 71713 10253
2	Headwater Streams 1, 2, 3, 4, 5, Upper Lake and short section of Riders Lane Stream (RLS) all under Reservoir footprint	HS1 – SU 71160 10368 HS2 – SU 71421 10346 HS3 – SU 71713 10253 HS4 – SU 71828 09793 HS5 – SU 71621 09697 RLS – SU 71314 09436	HS1 – SU 71314 09436 HS2 – SU 71537 09816 HS3 – SU 71537 09816 HS4 – SU 71621 09697 HS5 – SU 71475 09570 RLS – SU 71319 09440
3	RLS between Reservoir footprint up to Hermitage Stream confluence. The Lake Stream (TLS) joining Riders Lane Stream from Leigh Lake.	RLS – SU 71319 09440 TLS – SU 71836 09095	RLS – SU 71007 07503 TLS – SU 71747 08787
4	Hermitage Stream – between A3(M) and confluence with Riders Lane Stream	SU 69631 09096	SU 71007 07503
5	Hermitage Stream – between confluence with Riders Lane Stream and Nominal Tidal Limit (NTL)	SU 71007 07503	SU 70511 06237
6	Langstone Harbour	SU 70511 06237	SU 68652 00138
7	Headwater Streams draining east towards River Lavant	SU 71947 09871	SU 72613 09497
8	Park Lane Stream	SU 70563 10531	SU 70513 09001

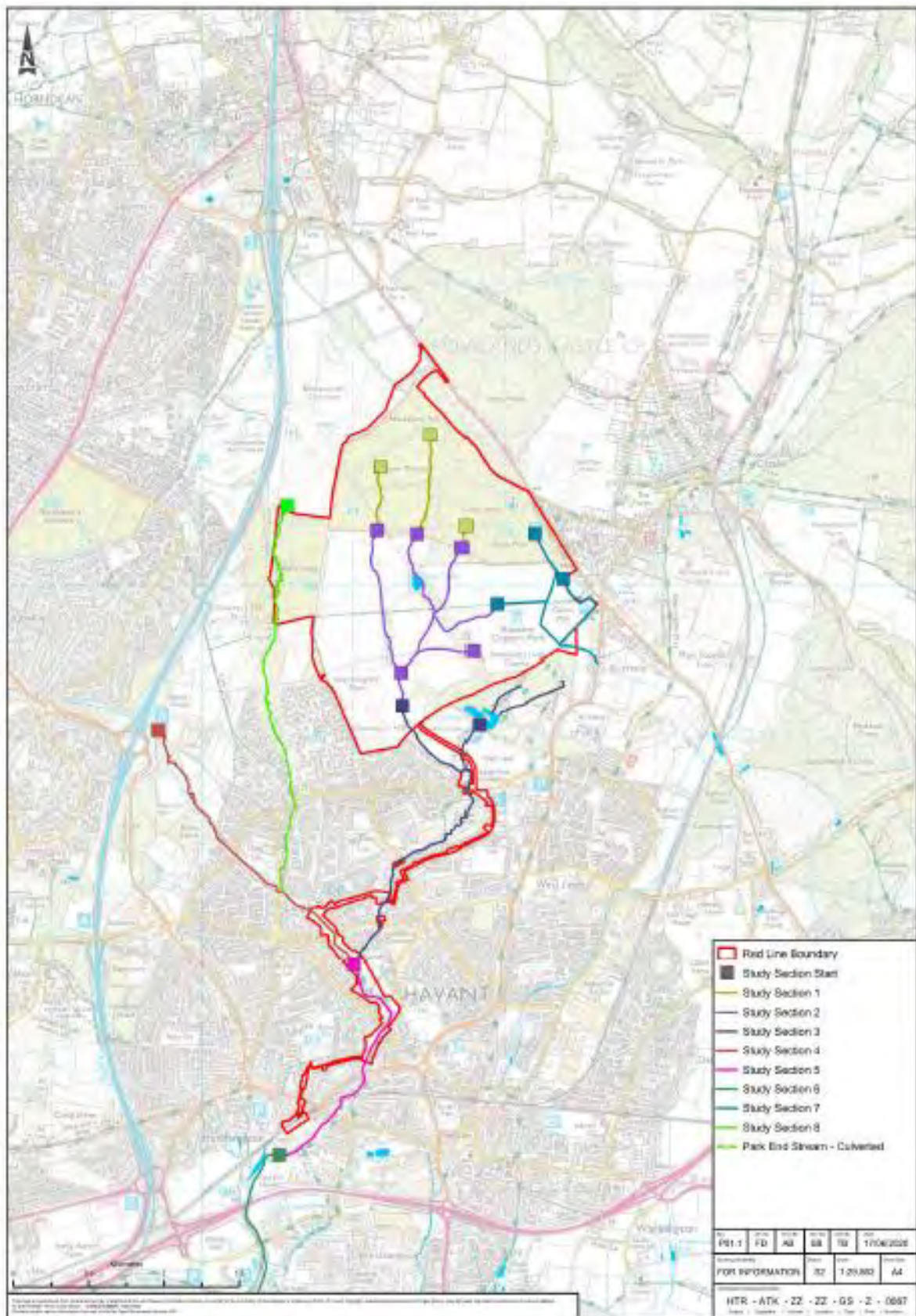


Figure 2 Map showing Study Sections (HTR-ATK-XX-XX-RP-Z-0042)

2. Flood Risk Management

2.1. Scope requirements

2.1.1. Main reservoir embankment

The functional requirements of the main reservoir spillway as outlined in the Scope Support Document (HTR-ATK-RZ-RE-SP-Z-0001) are “to provide sufficient freeboard to contain the reservoir flood rise, prevent overtopping by waves for the Design Flood and include an allowance for long-term settlement (after construction) of the foundation and embankment”. The performance parameters & requirements set out in the outline application, to be met during the detailed design of the spillway are:

- Provision of a spillway weir at the TWL of 39.5m AOD (designed to accommodate future adjustments for settlement) and associated pipework, chambers and structures to pass the Design Flood and Safety Check Flood.
- Spillway weir comprising a drop-box inlet connected to a concrete pipe crossing the embankment crest and running beyond the reservoir embankment mitre/toe to drain into Riders Lane Stream.
- To avoid debris entering the spillway system, a trash screen shall be installed in front of the spillway weir. This screen shall be detailed to allow manual cleaning and be designed in accordance with C786 Culvert, screen and outfall manual (CIRIA, 2019).
- The spillway shall be based on a flood study for the catchment defined by the proposed embankment alignment. The reservoir inflow hydrographs for the Design Flood (10,000 year flood) and Safety Check Flood (Probable Maximum Flood) shall be derived following the methodologies recommended in Floods and Reservoir Safety (ICE, 2015). The reservoir routing to assess the outflows and flood rise shall take into account the attenuation effect provided by the reservoir surface area. The spillway capacity shall be such that the overflow head affords the required flood freeboard.
- The reservoir flood rise for the SCF flood shall be below the top of the clay core of the embankment.
- The maximum reservoir flood rise shall be used in the calculation of the mean overtopping discharges for the DF and SCF.
- The hydraulic design of the spillway shall show that the weir will not become drowned and that the drainage pipe will operate in free flow conditions up to the SCF peak outflow discharge.

2.1.2. Wetlands retaining structure

The wetlands functional requirement is to “allow flood flows from the catchment to be safely conveyed into the reservoir”. The performance parameters & requirements set out in the outline application of the spillway for the wetlands is:

- The wetland shall be designed as a reservoir in its own right, and which is separate to the Havant Thicket reservoir and certified by the Construction Engineer (under the Reservoirs Act 1975), considering the risk and consequence of failure during construction and being designed and constructed to accommodate appropriate design flood and safety check floods with provision made for managing seepage (including surveillance measures) and affecting drawdown in an emergency. The design provided for outline planning permission assumes that once the main reservoir embankment is constructed the wetland shall cease from being a high risk reservoir in its own right and shall form part of the whole reservoir. This philosophy is maintained through detailed design.

Within the performance requirements for the wetlands are also details of the arrangement of the spillways.

2.1.3. Culvert and pipework

The key requirements being met by the design of the culvert and pipework is summarised in Table 5.

Table 5 Culvert & Pipework – Functional Requirements

Element	Parameter	Element Type	Performance Criteria
Reservoir capacity	At least 9,600ML maximum capacity, including borrow pits volume, above low-level outlet up to at Top Water Level (TWL of 39.5m AOD)	Total capacity not including water below lowest draw off level or retained in wetland	To exceed minimum required total capacity of 8,700ML
Supply rate to Farlington DAF (via Bedhampton booster pumps)	25MI / day	Inlet / outlet pipeline, varying 1.2m to 0.7m diameter	25 MI / day over the reservoir operational envelope. Flow rate measured at reservoir control house and Bedhampton Pumping Station
Filling rate of the reservoir (via Bedhampton reservoir fill pumps)	40MI / day	Inlet / outlet pipeline, varying 1.2m to 0.7m diameter	
Embankment	Crest level 40.5m	Cohesive fill, with zoned clay core and outer shoulders, granular chimney filter and drainage element	
Top Water Level (TWL)	39.5m AOD	Overflow level	Freeboard (from TWL to embankment crest) to contain flood rise due to Design Flood and wave action and consider long term settlement.
Lowest operating level	29.0m AOD	Top of lowest 20% of storage volume	Lowest 20% to be considered dead storage, minimum level before reservoir operationally fails.
Emergency drawdown facility	Outline planning application design Discharge capacity of 10.9 m³/s Reservoir can be lowered by 1/3 of water depth in 6 days	Outline planning application: 1.4m dia scour pipe and submerged discharge valve discharging into Riders Lane Stream at control house; 1.2m dia inlet /outlet pipe discharging into the Hermitage Stream 3km	Installed drawdown rate following Environment Agency guidance to be 0.85m in first 24 hours (5% of reservoir depth) Time to lower 1/3 of the water depth.

2.2. Design criteria

Design of the spillways and embankments are required to satisfy ICE (2015). ICE (2015) provides guidance on the design of a dam for flood, wind and waves based on the assessed hazard of the dam to downstream populations. Two approaches are recommended: the standards-based approach and risk-based approach. As a new reservoir, ICE (2015) recommends the dam be designed using both standards-based and risk-based approaches.

The standards-based approach gives guidance on recommended flood, wind and wave conditions for design based on the assessed hazard (consequences) of a dam failure. The ICE (2015) standards are

reproduced in Table 6. ICE (2015) defines two flood conditions for the assessment of the overflow capacity and freeboard; the 'Design Flood' (DF) and 'Safety Check Flood' (SCF). The Design Flood must be discharged under normal conditions with a safety margin provided by an accepted freeboard limit. The Safety Check Flood is defined as the flood beyond which the safety of the dam cannot be assured.

Risk-based assessments quantitatively calculates a probability of failure and determines the acceptability of risk to life based on societal and individual risk criteria (EA, 2013). Where risks are not deemed to be unacceptable, the need for further risk reduction is decided based on the As Low As Reasonably Practicable (ALARP) principal.

Table 6 ICE (2015) Flood, wind and wave protection standards

Dam Category	Potential effect of a dam breach	Initial reservoir condition standard	Safety check flood conditions		Design flood conditions	
			Reservoir flood inflow	Concurrent wind speed for assessing wave overtopping	Reservoir flood inflow	Concurrent wind speed for assessing the freeboard required to contain wave overtopping or min. flood freeboard provision (whichever is greater)
A	Where a breach could endanger lives in a community	Just full (i.e. no spill)	Probable Maximum Flood (PMF)	Mean annual maximum hourly wind speed	10,000-year flood	Mean annual maximum hourly wind speed, with minimum flood freeboard of 0.6m
B	Where a breach could (i) endanger lives not in a community or (ii) could result in extensive damage		10,000-year flood		1000-year flood	Mean annual maximum hourly wind speed, with minimum flood freeboard of 0.6m
C	Where a breach would pose negligible risk to life and cause limited damage		1000-year flood		150-year flood	Mean annual maximum hourly wind speed, with minimum flood freeboard of 0.4m
D	Special cases where no loss of life can be foreseen as a result of a breach and very limited additional flood damage would be caused		150-year flood		150-year flood	Mean annual maximum hourly wind speed, with minimum flood freeboard of 0.3m

2.3. Main reservoir embankment flood design

2.3.1. General

The detailed design of the spillway to provide flood protection to the main embankment will be carried out in line with the full planning permission parameters. To date FUW have reviewed the Reservoir Flood Studies (HTR-ATK-RZ-RE-RP-Z-0006) completed for the outline planning application design and these were found to be generally in accordance with good practice. Failure of the embankment is still considered likely to endanger lives in a community as previously assumed in the outline design. Therefore, no significant changes to the functional requirements of the main reservoir spillway as outlined in Section 2.1.1 are expected. Given this, the impacts of flooding from the other proposed changes to the project as outlined in Section 1.4 are discussed below.

2.3.2. Fluvial flooding

There is no change in the fluvial flood risk detailed in the Environmental Statement Volume 4 – Appendix 15.2 Flood Risk Assessment Report (HTR-ATK-XX-XX-RP-Z-0042). The change in alignment and embankment slope angles has resulted in a minor decrease in the area upstream of the embankment crest to capture rainfall and rainfall run-off into the reservoir. However, the minor changes do not alter the fluvial flood risk as reported in HTR-ATK-XX-XX-RP-Z-0042, reproduced below in Table 7.

Table 7 Summary of change in fluvial flood risk as a result of the embankment and wetland retaining structure

Study Section	Summary of change in fluvial flood risk
1	There is no change in flood risk in Study Section 1 as it is upstream of the reservoir.
2	Post construction, within Study Section 2, the intermittent or temporal streams will be replaced by a wide expanse of stored water. The watercourses in this study area have been replaced with the reservoir. The visitor centre is built within the wetland, and is therefore at risk of flooding resulting in a rise in the water level of the reservoir. The visitor centre is classified as “Less Vulnerable” development, and as such should be designed with a finished floor level above the 1% (1 in 100 year) AP event, plus an allowance for climate change (35% and 45% for the “central” and “higher central” estimates respectively). The 1% (1 in 100 year) AP event gives reservoir peak water levels of 39.65 m AOD and 39.67 m AOD for the “central” and “higher central” estimates. When an allowance for wave height is included (0.1m, due to the limited fetch distance from the wetland retaining structure) and freeboard (0.3 m), the recommended finished floor level for the visitor centre is 40.1 m AOD. The southern access road is within Study Section 2 and crosses into the Park Lane Stream catchment (Study Section 8). The northern access road does not cross into any other waterbody areas. The areas of construction are not within Flood Zone 2 or 3 and therefore neither access road is expected to alter fluvial flood risk.
3	Directly downstream of the reservoir. During a 1% AP flood, there is a reduction in peak flow of 3.64 m³/s and a reduction in peak level of 0.64 m at the upstream end, and 3.37 m³/s and 0.15 m at the downstream end. Across the Study Section the flood extent for this event is reduced by 0.03 km², which is an 87% reduction. During a 0.1% AP, there is a reduction in peak flow of 5.99 m³/s and a reduction in peak level of 0.66 m at the upstream end, and 2.82 m³/s and 0.10 m at the downstream end. Across the Study Section the flood extent for this event is reduced by 0.04 km², which is an 82% reduction. There is no predicted change in flood risk to The Lake Stream. A small section of the embankment will drain to the Riders Lane Stream via a toe drain, however, this will not increase fluvial flows compared to baseline levels. The location of the control house is not within Flood Zone 2 or 3 and during normal operation of the reservoir the, will not be at risk of flooding. If the reservoir were to breach, then the Control House would be at risk of flooding. This will be discussed in Section 8.

Study Section	Summary of change in fluvial flood risk
4	The operation of the reservoir and embankment is not predicted to have any impact on fluvial flood risk in Study section 4 as it is upstream of the confluence with the Riders Lane Stream
5	During a 1% AP, there is a reduction in peak flow of 3.50 m³/s and a reduction in peak level of 0.16 m at the upstream node, and 3.20 m³/s and 0.07 m at the downstream node. Between the two nodes the floodplain extent has reduced by 0.01 km², which is a 25% reduction. During a 0.1% AP, there is a reduction in peak flow of 4.48 m³/s and a reduction in peak level of 0.09 m at the upstream node, and 3.87 m³/s and 0.07 m at the downstream node. Between the two nodes the floodplain extent has reduced by 0.01 km², which is a 13% reduction.
6	During a 1% AP, there is a reduction in peak flow of 3.20 m³/s and a reduction in peak level of 0.07 m at the upstream node, and 2.78 m³/s and 0 m at the downstream node. Between the two nodes there is no change in the floodplain extent. During a 0.1% AP, there is a reduction in peak flow of 3.87 m³/s and a reduction in peak level of 0.07 m at the upstream node, and 3.95 m³/s and 0 m at the downstream node. Between the two nodes there is no change in the floodplain extent. The effect of the tidal influence reduces the impact of a reduction in flood level and extent.
7	As discussed in previous sections, the Lavant Headwaters will be intercepted by the new embankment. This reduces the catchment area from 0.50 km² to 0.31 km² (38%). This will result in a decrease in flow and level within the Lavant, thereby reducing flood risk. The embankment drains into a toe drain around the southern perimeter, some of which flows into the Lavant. This has been included in the reduction of catchment area calculation and will be discussed further in the surface water section.
8	The southern access road is within Study Section 2 and crosses into the Park Lane Stream catchment (Study Section 8). At this point it is an Ordinary Watercourse. The areas of construction are not within Flood Zones 2 nor 3 and are not expected to alter fluvial flood risk. There is therefore no change expected for the Park Lane Stream.

2.3.3. Tidal flooding

There is no change in the tidal flood risk as detailed in the Flood Risk Assessment Report (HTR-ATK-XX-XX-RP-Z-0042). Therefore, the results as summarised in the Flood Risk Assessment Report (HTR-ATK-XX-XX-RP-Z-0042) below are unchanged:

There is no change in extent between the baseline and with-scheme results under the current climate or with inclusion of climate change. The construction of the scheme therefore does not affect tidal flood risk.

2.3.4. Surface water flooding

The changes in surface water flood risk are described qualitatively in Table 8, referenced to each study section.

Table 8 Summary of change in surface water flood risk as a result of the embankment and wetland retaining structure

Study Section	Surface Water Flooding
1	There is no change in flood risk in the headwater streams upstream of the reservoir. The surface water flow routes will discharge into the existing streams and into the wetland and / or reservoir.
2 & 3	The main embankment captures direct rainfall on the reservoir, from the wetland area and from headwater streams upstream of the wetland / reservoir. There is no surface water flood risk due to the embankment or wetland retaining structure downstream of the reservoir along Riders Lane Stream due to the reduction in peak water levels and flow rates caused by the capture and attenuation of rainfall in the reservoir. The visitor centre will increase the area of hardstanding with a corresponding increase in surface water runoff rates and volumes. Both the southern access road and the northern access road will increase hardstanding. Surface water drainage systems at the toe of the embankment and from

Study Section	Surface Water Flooding
	seepage collections systems within the embankment will be directed back to existing water courses downstream of the embankment. The design of the drainage is to be finalised at the detailed design stage and included in the hard landscaping reserved matters submission. As part of the design, surface water management techniques will be incorporated, for example, Sustainable Drainage Systems (SuDS). SuDS principles will be adopted where possible and the drainage design will follow the local and national guidance and best practice documents. The design criteria and agreement with stakeholders will be detailed in the Drainage Management Plan to be completed as part of these works. It is assumed that the net increase from the reservoir site will not increase surface water runoff and downstream flood risk.
4	There are no changes in surface water flood risk in the Hermitage Stream section from the A3(M) and the confluence of Riders Lane Stream.
5	There is no predicted change in surface water flow routes as a result of the reservoir. Localised surface water flood risk, however, is likely to reduce due to the reduction in peak levels and flow within the watercourse providing more capacity for the surface water network to discharge into the channel.
6	There is no predicted change in surface water flow routes as a result of the reservoir. The tidal influence in this section reduces the benefit of reduced flows and levels in the channel having a beneficial effect on the discharge of urban surface water.
7	As discussed in relation to fluvial risk, the Lavant Headwaters catchment is reduced by 38%. This calculation includes the surface water drainage from the embankment which is routed into the toe drain and into the River Lavant. There is therefore a reduction in surface water flood risk for Study Section 7.
8	No significant impacts assumed, to be revised in Drainage Management Plan to be completed as part of these works.

2.4. Wetlands flood design

Details of the spillway geometry are given in the scope requirements. These requirements have been met in the detailed design. However, a check of these designs to ensure they meet the requirements of ICE (2015) was also completed.

As the wetlands embankment is proposed to be constructed prior to the main embankment, two scenarios were reviewed:

- Temporary: Prior to completion of the main embankment where an uncontrolled dam breach will impact construction workers and proceed downstream into Riders Lane Stream.
- Permanent: An uncontrolled dam breach will flow directly into the main reservoir body.

Based on the calculated outflow from the wetland embankment, it is likely that the downstream population would be affected during construction if a breach was to occur when the wetlands were full and before the main reservoir embankment is high enough to trap the released water. A consequence assessment was not completed to determine quantitatively the number of people or infrastructure affected from such a breach, so conservatively it has been assumed that the wetlands embankment is required to pass the PMF event during construction.

After the main embankment is completed, the risk to the main embankment and the public is insignificant as a breach of the wetlands will result in a marginal rise in the main reservoir. The spillway was therefore judged required to meet the requirements of Dam Category D as per ICE (2015) in normal operation. However, the spillways have been designed to pass the 1 in 1000-year flood.

To pass the probable maximum flood (PMF) event in construction, the sequencing of the wetlands will include openings in the embankment such that flows from events greater than a 1 in 30-year event will be able to pass through the structure. The openings would not allow the wetlands to fill to a depth of more than 300mm over the permanent spillway crest level (39.1m AOD), which is consistent with the

design in normal operation of a 1 in 1000-year event reaching a maximum 300mm depth of water over the spillways with the opening closed.

2.5. Flood Modelling

Royal Haskoning DHV (RHDHV) was commissioned by Future Water to undertake a numerical hydraulic flood modelling and mapping study of Havant Thicket based on the design development since the outline planning permission was granted in 2021. The aim of the study was to demonstrate that there would be no uncontrolled release of surface water runoff from the site during at least a 3.3% AEP storm event (1:30 year storm) which is consistent with the 2020 FRA (ref HTR-ATK-XX-XX-RP-Z-0042).

The detailed flood model “2024-05-13 Hydraulic Model” modelling project has run 4 different simulation, looking at the performance of the reservoir during construction (Surface Water Flood Model) and once construction of the reservoir embankment has been completed. The model was issued for interpretation to the Environment Agency in May 2024. A copy of the Hydraulic Modelling report can be found in Appendix 4.

Drainage Management

2.6. Scope requirements

The Contractor's design responsibility for surface drainage through construction requires the following:

305.7.q.v. temporary diversion works to manage surface water inflows into the reservoir during construction, up to the 1 in 30 year return period flood,

FUW is also required to meet the conditions of the Register of Environmental Actions and Commitments (REAC), which is also contained in Appendix A of the Scope Support Document (HTR-ATK-RZ-RE-SP-Z-0001). A REAC condition also requires that "Flows from the construction site should not increase flood risk or cause watercourse scouring. Up to 1:30 rainfall scenario will be attenuated."

The REAC also requires the Contractor to develop a Drainage Management Plan that includes the following detail as a minimum on the drainage design and management:

- Design standards – any areas of surface or foul water drainage affected by the works should be identified and each section of affected drainage should be briefly described, and a proposed solution provided.
- Pollution control/interception – any interceptor solutions should be identified on discipline specific drawings and reviewed during the relevant design stages. For example, any new car parks and associated access roads or haulage routes will incorporate treatment and are transferred to site drainage system.
- Outfalls – known outfalls should be identified and where possible any drainage should tie in with the existing outfalls. Where no existing drainage outfalls are present/known, SuDS principles should be considered to ensure that the discharge rate and volume is suitable. The designing of new drainage catchments should include consideration of any potential attenuation sites. High-level drainage catchment assessments should be undertaken to determine the potential attenuation requirements. It is assumed that drainage scenarios which replicate the current un-attenuated drainage system will remain with no requirement to provide additional water storage.
- Earthworks – a review of existing earthworks and drainage provision should be undertaken to assess the required interventions to be developed at subsequent design stages. Areas are to be identified which currently do not have any drainage but is required.
- Access Roads and Haulage Routes –the development of drainage from the access roads and haulage routes including the modification/re-alignment, connection into or new access road / haulage road infrastructure will be included. Construction mitigation is likely to include but not be limited to measures within the PPGs, e.g., to attenuate and treat polluted runoff. Haul roads will be unpaved and covered in hard core or gravel. Surface water run-off will be collected and treated prior to discharge.
- Third Party Land – drainage interventions to support the reservoir may affect third party land. Assessment of drainage interventions should account for the following scenarios but not limited to:
 - third party land drainage which currently affects the infrastructure;
 - drainage interventions required for the Scheme which may affect third party land; and,
 - outfall required for drainage which is located within third party land.
- Stakeholder engagement and consultation should be undertaken at subsequent design stages when required drainage proposals are further defined. Continued stakeholder engagement will be necessary to obtain consents.
- Surface Water Drains – With particular relevance for the pipeline corridor, detail on the surface water networks in the vicinity of the pipeline construction areas which may transfer pollutants to the nearby river.

- Ecology – Key ecological features to be considered as part of the construction work, including where EcoW may be required.

2.7. Construction drainage

The wetland retaining structure will be constructed in the first phase of construction immediately prior or at the same time as the start of the main embankment construction. Construction of the wetland will require the outlets to be constructed adjacent but isolated from the natural stream course at the stream bed level or a diversion channel to be dug while they are constructed. On completion of the outlet, the natural channel will be diverted through the outlet and then released back into the natural channel downstream of the new embankment. This will allow the wetland embankments to be constructed and the natural flow maintained.

Immediately downstream of the wetland embankments a temporary drainage system has been installed in accordance with the approved Ordinary Water Course Consents (OWC) application, refer to Appendix 2 for the OWC application and Appendix 3 for the OWC decision notice. The temporary drainage system will control the outflow from the wetlands retaining structure through the main reservoir construction area to Riders Lane Stream. The temporary drainage system has been designed to pass up to a 1 in 30 year return period flood as required by the scope and described in Section 2.6. Figure 3 shows the location of the outlets in the wetlands and how they maintain the flow in the natural channel until it is diverted by the temporary drainage system. Details of the outlets in the wetlands retaining structure are shown in Figure 4.

The penstocks in the wetlands structure will remain open through the construction of the main reservoir embankment to allow inflows to pass through and be captured in the temporary drainage system in the works area. As the wetlands reservoir is not large, only minor attenuation is expected of any floods through this structure, however the fluvial flood risk downstream of the wetlands as described in Section 2.3.2 will still be marginally lower after its construction. As described in Section 2.4, the outlets have been designed to pass the PMF, which is far in excess of the 1 in 30 year return period flood requirement. As the construction progresses, any overflow from the wetlands will begin to be captured in the borrow areas within the reservoir area that are the source of embankment fill material. These borrow areas will gain substantial volume to store flood waters with time and help attenuate any flood flows.

In a 1 in 30 year event, with all penstocks remaining open, the entrapped water in the wetlands compartments reaches peak levels of around 1.5m. If a dam breach was to occur at this peak level at the deepest section (in compartment 2), the maximum discharge leaving this location is 1.26m³/s (conveyed in the breach opening). The total peak flow downstream of the wetland structure remains much less than the Riders Lane Stream capacity and does not threaten permanent residences.

The wetlands structure will be finished at least two years prior to the completion of the main reservoir embankment. The first stage of the main reservoir embankment construction is to complete the reinforced concrete outlet culvert and valve tower base away from the natural streamlines and temporary drainage channels. On completion of the outlet culvert and tower base, flow along Riders Lane Stream will be blocked by the main embankment construction. Flow in the temporary drainage system within the reservoir area for events greater than 1 in 30 year will then be diverted through the outlet culvert and downstream discharge channel back to Riders Lane Stream. The equivalent 5.1 m internal diameter culvert has a discharge capacity far in excess of that required to pass a PMF flood in construction. The size of the culvert will also provide a minor attenuation of any floods through this structure, therefore lowering the fluvial flood risk downstream of the main reservoir embankment marginally.

On completion of the main reservoir embankment and spillway, a permanent reinforced concrete bulkhead will be constructed immediately upstream of the valve tower in the culvert to block flows down the culvert and commence impoundment of the reservoir for normal operation.

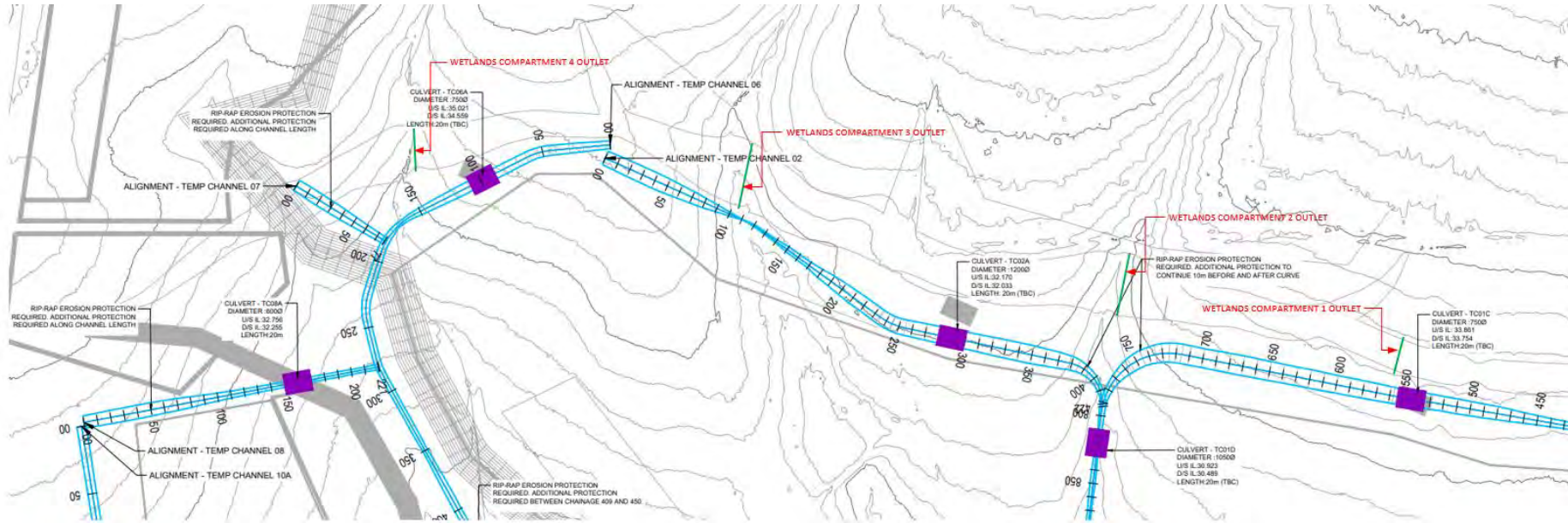


Figure 3 Extract of temporary drainage plan (B038779-TTE-00-XX-DR-C-0501) showing location of outlets to divert water through drainage system

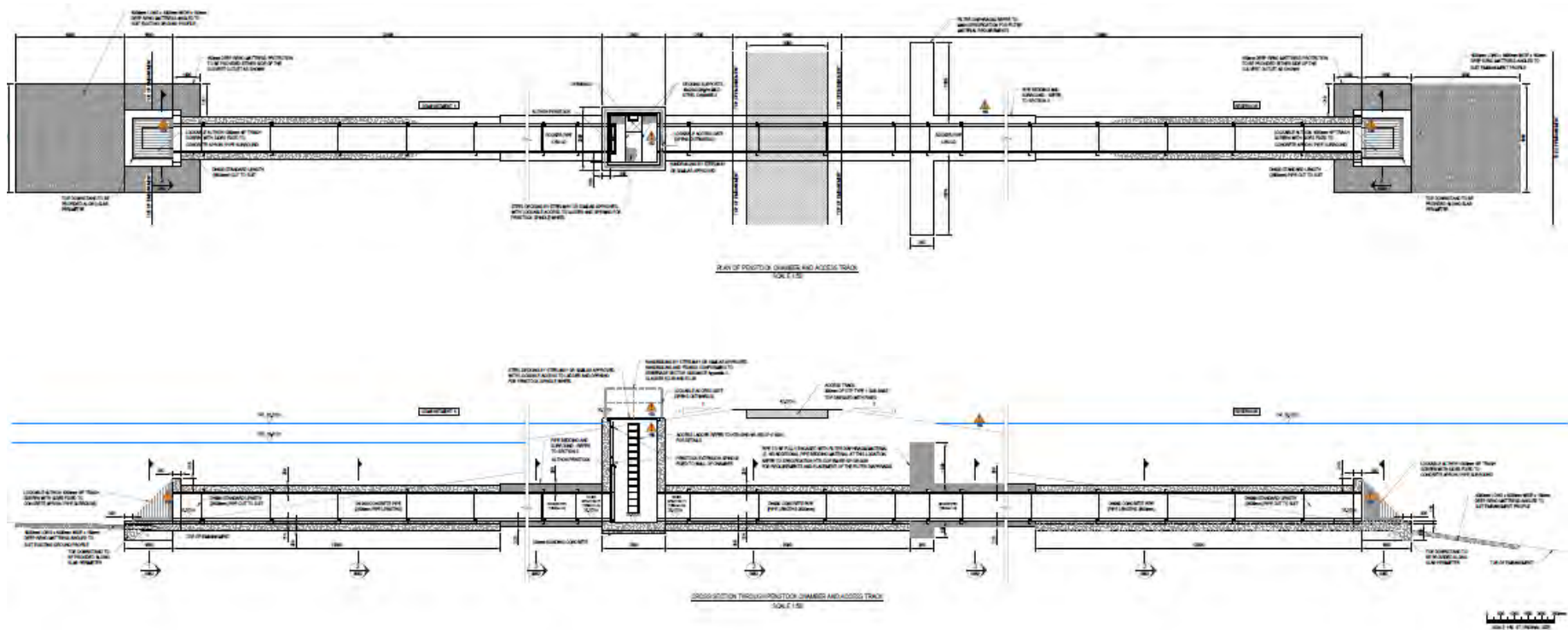


Figure 4 Extract from HTR-GHD-WC-ZZ-DR-L-0064 showing plan and section of outlet through Compartment 2

2.8. Permanent drainage

A Drainage Management Plan is being prepared for the scheme prior to the submission of reserved matters for hard landscaping (Phase 8) as required by the REAC, refer to Section 2.6.

This will include details on the permanent drainage system around the reservoir such as design standards, pollution control/interception, outfall locations, access roads and surface water drains. It will also include details of how increased surface water runoff from new areas of hardstanding (i.e. access roads, visitor centre, car parks etc) and areas of steeply sloped grass (i.e. embankment) will be managed to ensure no increase in flood risk.

The principle for the permanent drainage is to collect runoff from the embankment, paved tracks and surfaces, and convey them south towards the outlet at Riders Lane Stream or Durrants Stream. Without the use of attenuation measures, the runoff from hard surfaces and steep slopes could result in an overall increase in peak flows downstream. To manage these potential increases, measures such as filter drains, which provide both attenuation volume and treatment of surface water runoff, will be used to collect and convey flows downstream. Excess flow will be attenuated in further SuDS features, such as an open pond or basin, which also provides further opportunities for water quality improvements prior to discharging to the watercourse.

The total discharge rate to Riders Lane Stream and Durrants Stream from the drainage systems will be limited to the equivalent greenfield Q_{bar} rate. For the outlet to Riders Lane Stream, this will include an allowance for the compensation flow from the main reservoir.

The LLFA were consulted (October 2023) about the design requirements of the drainage for the reservoir embankment and new hard standing areas. It was agreed in principle that:

- Discharge of surface water runoff will be restricted to the equivalent Q_{bar} rate for all storm events up to and including the 1% AEP rainfall event, plus a 45% uplift for climate change.
- The outfall location will be downstream of the embankment. The primary outfall will be to Riders Lane Stream, but a second outfall to Durrants Stream will also be used for the equivalent area of the site already draining to this watercourse.
- Default runoff co-efficients (C_v values) typically used within the industry standard software for drainage design, is not appropriate for modelling runoff from the reservoir embankment given its slope angle and material composition. For these areas, a C_v value of 0.4 will be used. Elsewhere, flat grassed areas will have a C_v value of 0.3, whereas generally flat gravel tracks and tarmac roads will have values of 0.8 and 0.9 respectively.
- Rainfall data will be based on the FSR data included in the Innovyze InfoDrainage software based on the location of the outfall.
- Water quality will be considered, and evidence provided, that sufficient water treatment has been achieved in accordance with the methodology in the CIRIA SuDS Manual, using the Simple index Criteria (Box 26.2).

The LLFA also requested that consideration be given for those rainfall events in excess of the design criteria. For these scenarios, the drainage design for the scheme will need to make allowances for excess flows to be directed safely to suitable points of discharge, or stored locally until such time the drainage system can convey them, without overflowing to new locations.

Elsewhere, away from the main embankment and associated infrastructure, no new formal drainage is anticipated. Existing access tracks, like the Forestry England route to the north of the wetlands, will continue to discharge via the network of ditches and drains currently serving it. Where required, these will be locally altered to suit any interface issues with the wetland infrastructure, but no further networks are currently required. This will discharge to the wetland and then on to the main reservoir, and so no additional conveyance or attenuation features will be required. The wetlands embankments will also not

require any dedicated drainage network, and so runoff will discharge informally to the wetland or the main reservoir to be attenuated within those structures.

The permanent drainage design for the reservoir site is currently being developed in line with the agreements already in place with the LLFA. The drainage design will follow the best practice principles set out in The SuDS Manual (CIRIA C753, 2015) and guidance from Hampshire County Council Surface Water Checklist Guidance, where relevant.

3. Operation and Maintenance

3.1. During Construction

Maintenance requirements for the temporary drainage system is outlined in the Ordinary Water Course Consents (OWC) application, refer to Appendix 2.

3.2. Completed Reservoir

3.2.1. Dam safety

Havant Thicket reservoir will be regulated under the Reservoirs Act 1975 as amended by the Flood and Water Management Act 2010, which was set to promote the safety of large reservoirs.

As required by the legislation, the reservoir is being designed and will be constructed under the supervision of an All Reservoirs Panel Engineer (as the Construction Engineer) and during operation a Supervising Engineer will do regular visits (twice a year typically) and prepare an annual statement. An Inspection Engineer will inspect the reservoir at least every 10 years, or when requested by the Supervising Engineer. Following the inspection, the Inspection Engineer in his report can identify “measures in the interests of safety” which must be addressed by Portsmouth Water.

Testing of the emergency discharge valves will be undertaken twice per year, in line with the requirements of the Reservoirs Act (1975), and the Environment Agency Guidance for Drawdown Capacity (Environment Agency, 2017). The configuration of the control and submerged valves permits testing of each under full head, without a discharge at design capacity. This regular maintenance and testing is required to ensure the continued safe operation of the reservoir and Emergency Drawdown Strategy.

Full testing of the ‘emergency drawdown’ system, up to the capacity of the watercourses, will be tested on commissioning of the reservoir.

3.2.2. Main reservoir maintenance

The following tables list some of the recurring maintenance tasks that are to be completed at the main reservoir on completion.

Table 9 Main reservoir embankment maintenance tasks

Task No.	Basic Task	Key Points	Freq.
1	Remove debris and vegetation from upstream face.		1 month
2	Maintain surface drains to ensure free flow of water.		1 month
3	Cut grass and strimming of embankment slopes	Maintain low grass height to aid visual inspection of the embankment for seepage, movement etc.	As needed
4	Clear all trees and non-ornamental shrubs from the embankment.	This protects the embankment from invasive roots that may threaten the dam safety.	6 months
5	Repair to erosion areas.	Remove loose materials and replace with compacted fill. Replace surface material (gravel, rock or grass) to prevent further erosion.	6 months

Task No.	Basic Task	Key Points	Freq.
		If required provide diversion drains around eroded area to prevent future erosion.	
6	Maintain upstream slope protection.	Repair beaching of riprap by re-grading the slope to the original lines and replacing bedding material and riprap. Repair voids in the riprap by adding or moving riprap.	1 year
7	Maintain crest and berm roads.	The crest should be kept well gravelled and graded at the designed crossfall so that it drains properly. The crest should be kept clear of vegetation.	1 year
8	Maintain guard rails and fencing	Replace all damaged sections	As needed

Table 10 Culvert and tower maintenance tasks

Task No.	Basic Task	Key Points	Freq.
1	Clean outlet culvert, including: Pipework Valves Drains	Hose down tunnel floor to remove silt and sludge build up. Remove any rubbish.	1 month
2	Remove buildup and deposits from concrete surfaces.		1 month
3	Remove mineral deposits from metal pipework and protect from seepage.	Divert seepage to drain or loosely cover metalwork.	1 month
4	Remove mineral deposits from electrical equipment (culvert lights and cables) and protect from seepage.	Divert seepage to drain or loosely cover metalwork.	1 month
5	Repair concrete surfaces and joints.	Note: Record and report all problems before making repair as they may be an indication of a serious safety problem.	As needed
6	Clean High Level Intake Screen	Clean more frequently when required.	3 month
7	Clean Low Level Intake Screen	Clean if reduction in water quality associated with this draw off. Requires reservoir drawdown and/or use of divers.	As needed

Table 11 Valve and actuator maintenance tasks

Task No.	Basic Task	Key Points	Freq.
1	Exercise valves	Operate through full travel with dam off line and balanced heads where possible.	6 month
2	Mechanical service of valves		1 year

Table 12 Spillway maintenance tasks

Task No.	Basic Task	Key Points	Freq.
1	Remove obstructions from spillway.	For example large rocks, debris, vegetation, etc.	1 month
2	Remove obstructions within the discharge channel.		1 month
3	Keep concrete joints and surfaces free of vegetation.		6 months
4	Repair concrete surfaces and joints.	Note: Record and report all problems before making repair as they may be an indication of a serious safety problem.	As needed

3.2.3. Wetlands maintenance

The following tables list some of the recurring maintenance tasks that are to be completed at the wetlands structure on completion.

Table 13 Wetlands maintenance tasks

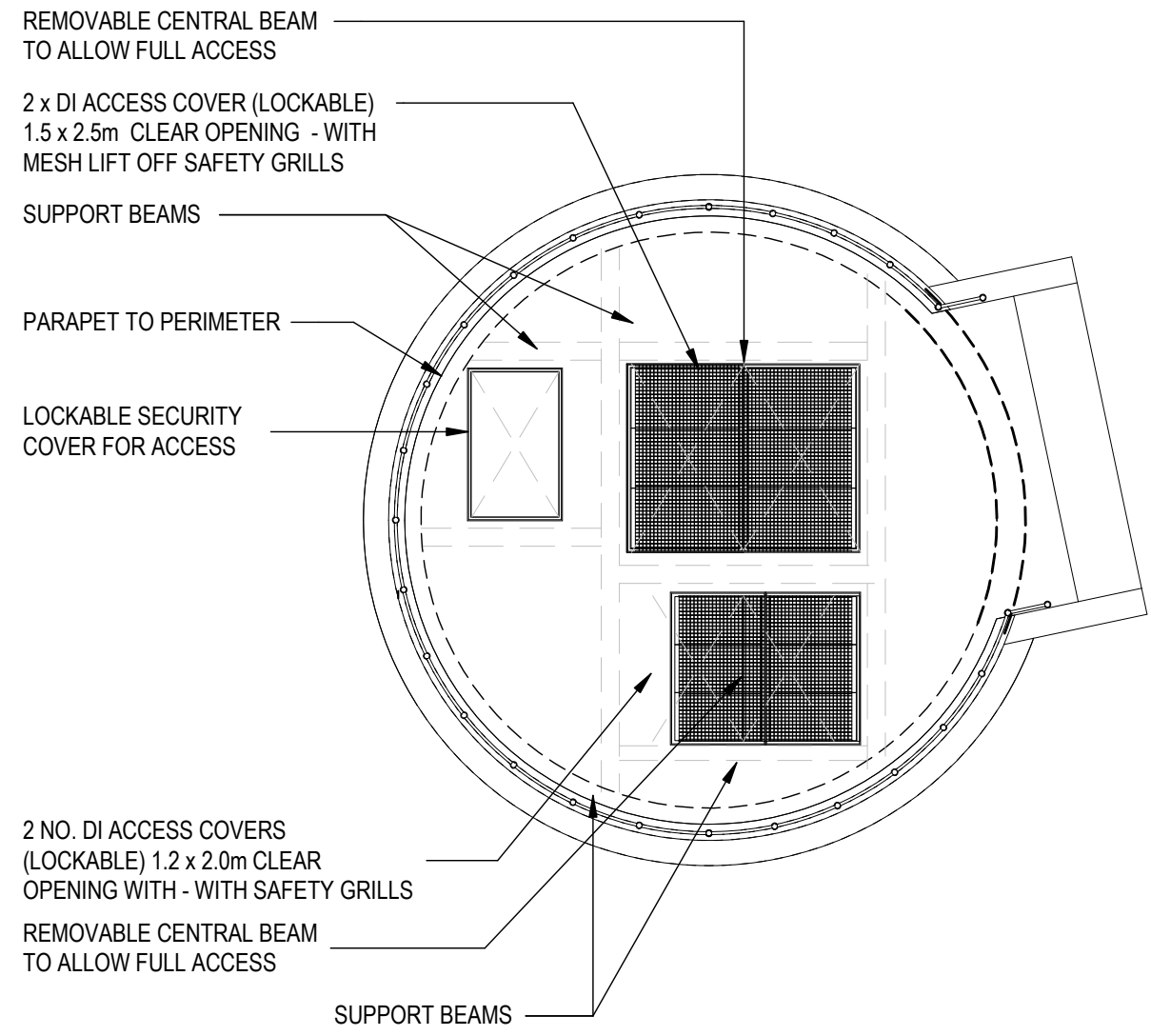
Task No.	Basic Task	Key Points	Freq.
1	Clean intake screens and obstructions on spillways	Clean more frequently when required.	3 months
2	Clear all invasive trees and non-ornamental shrubs from the embankment.	This protects the embankment from invasive roots that may threaten the dam safety.	6 months
3	Repair to erosion areas.	Remove loose materials and replace with compacted fill. Replace surface material (gravel, rock or grass) to prevent further erosion. If required provide diversion drains around eroded area to prevent future erosion.	6 months
4	Maintain outlet pipe and spillway rock protection.	Repair beaching of riprap by re-grading the slope to the original lines and replacing bedding material and riprap where required. Repair voids in the riprap by adding or moving riprap.	1 year
5	Maintain crest road.	The crest access should be kept well gravelled and graded at the designed crossfall so that it drains properly. The crest road should be kept clear of vegetation.	1 year
6	Inspection of internal pipework	CCTV inspection between chambers	5 years
7	Maintain fencing and signage	Replace all damaged or lost sections	As needed

Table 14 *Valve and actuator maintenance tasks*

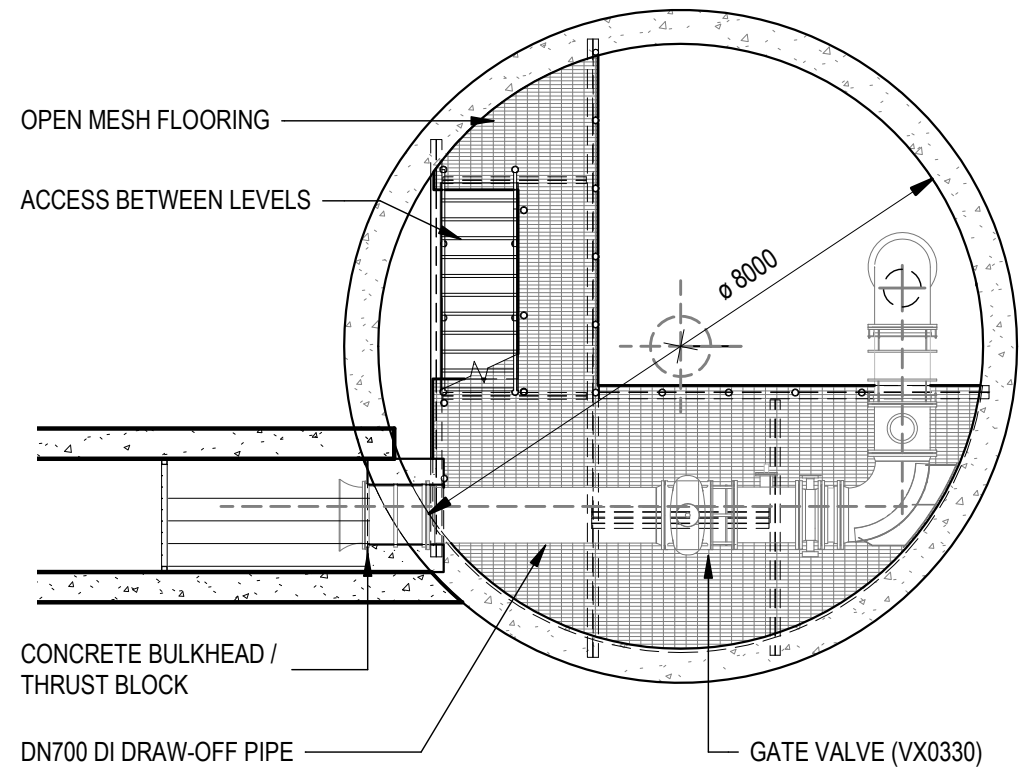
Task No.	Basic Task	Key Points	Freq.
1	Exercise valves	Operate through full travel with dam off line and balanced heads where possible.	6 month
2	Mechanical service of valves		1 year

Appendices

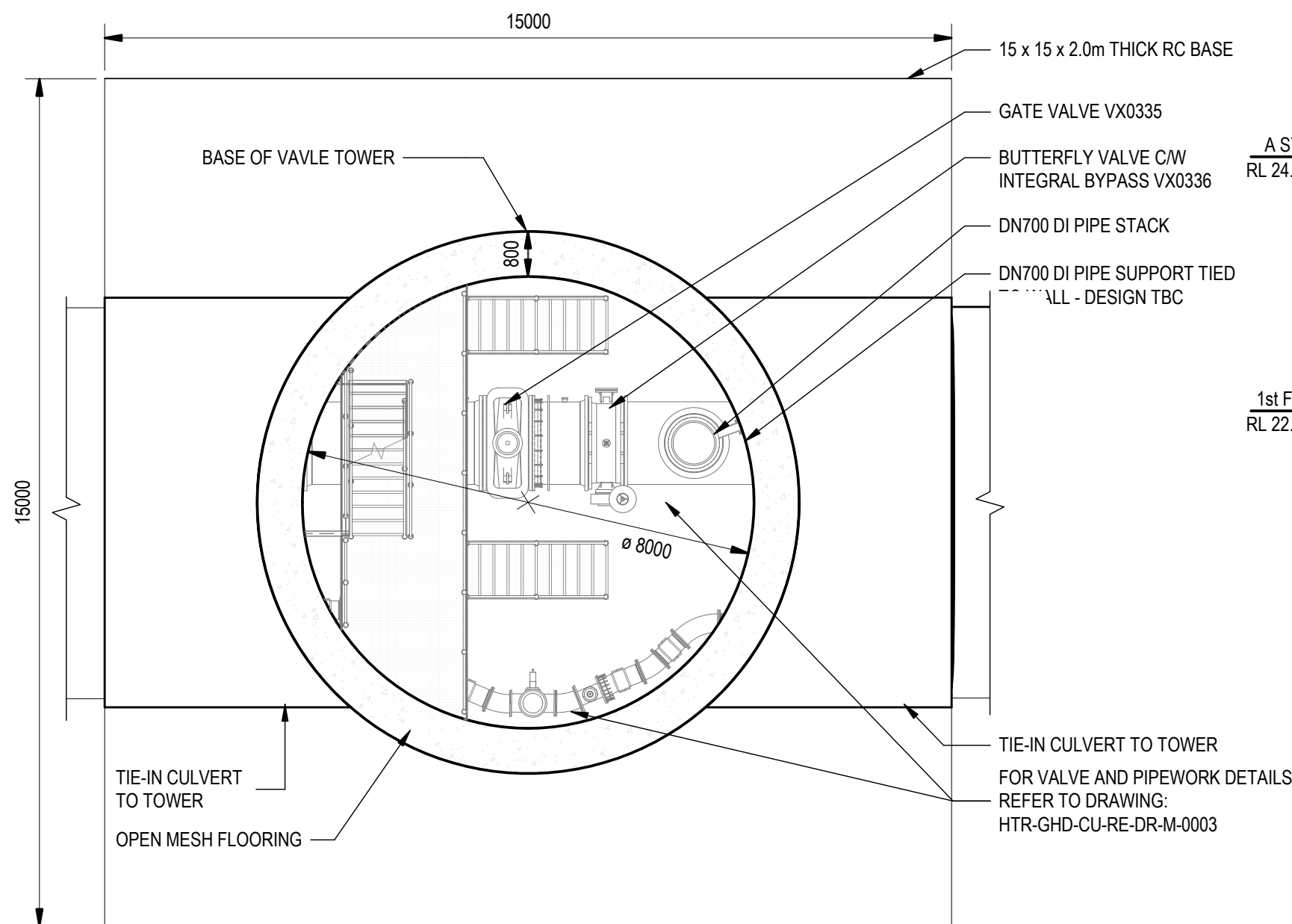
Appendix 1 General Arrangement Drawings



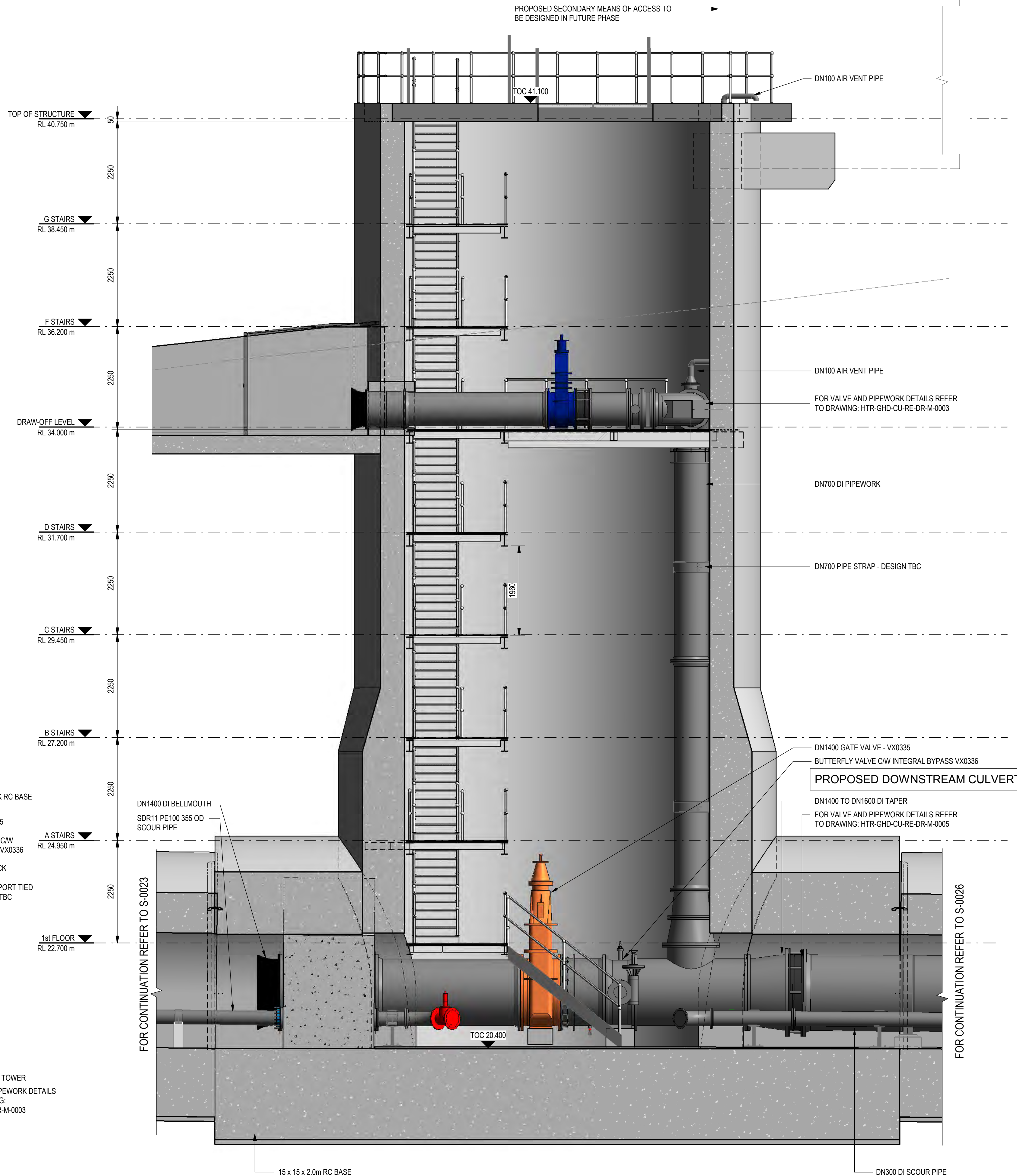
PLAN: TOP OF TOWER
SCALE 1:100



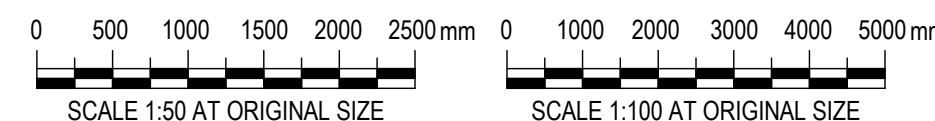
PLAN: DRAW OFF VALVE LEVEL
SCALE 1:100



PLAN: BASE OF TOWER LEVEL
SCALE 1:100



TOWER SECTION
SCALE 1:50



GENERAL NOTES

1. ALL DIMENSIONS RELEVANT TO SETTING OUT AND OFF-SITE WORK SHALL BE VERIFIED BY THE CONTRACTOR.
2. WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH THE LATEST EUROCODES AND CODES OF PRACTICE AND ALL RELEVANT CURRENT STATUTORY AUTHORITY REQUIREMENTS.
3. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE SPECIFICATIONS, AND ALL RELEVANT ENGINEERING PROJECT DOCUMENTATION.
4. EXCEPT WHERE OTHERWISE DESCRIBED BELOW, EXECUTION SHALL BE IN COMPLIANCE WITH THE FOLLOWING STANDARDS:
CONCRETE STRUCTURES: BS EN 13670:2009
5. ALL PROPRIETARY PRODUCTS TO BE USED STRICTLY IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.
6. ALL EQUIPMENT PROVIDED SHALL BE SUITABLE FOR USE IN A POTABLE WATER.
7. ALL PIPELINE MATERIALS SHALL HAVE DWI APPROVAL.
8. DENSO TYPE TAPE WRAP (OR SIMILAR APPROVED) SHALL BE FIXED AROUND ALL BURIED FLANGE JOINTS/FITTINGS.

LEVELS AND DIMENSIONS

1. ALL LEVELS SHOWN ARE FINAL DESIGN LEVELS, FOR CONSTRUCTION LAYOUT REFER TO HTR-GHD-CU-RE-DR-S-0020.
2. DIMENSIONS ARE NOT TO BE SCALED.
3. ALL DIMENSIONS ARE SHOWN IN MILLIMETRES UNLESS NOTED OTHERWISE.
4. ALL LEVELS ARE SHOWN IN METRES ABOVE ORDNANCE (mAOD)
5. ALL COORDINATES ARE IN METRES TO OS GRID.
6. ALL EXISTING DIMENSIONS AND LEVELS ARE TO BE CONFIRMED ON SITE.
7. FOR ALL CONTRACTION JOINT DETAILS REFER TO DRAWING:
HTR-GHD-CU-RE-DR-S-0052 & HTR-GHD-CU-RE-DR-S-0053

REFERENCE DRAWINGS:

CULVERT AND TOWER DRAWINGS LIST

HTR-GHD-ZZ-RE-DR-Z-0020 - COVER SHEET SITE LOCATION PLAN & DRAWING LIST

HTR-GHD-ZZ-RE-DR-Z-0021 - GENERAL NOTES - SHT 1 OF 2

HTR-GHD-ZZ-RE-DR-Z-0022 - GENERAL NOTES - SHT 2 OF 2

HTR-GHD-CU-RE-DR-S-0030 - CULVERT & VALVE TOWER SETTING OUT PLAN

HTR-GHD-CU-RE-DR-S-0020 - OUTLET CULVERT EXCAVATION PLAN & SECTION

HTR-GHD-CU-RE-DR-S-0021 - OVERALL GENERAL ARRANGEMENT PLAN & SECTION

HTR-GHD-CU-RE-DR-S-0023 - UPSTREAM CULVERT PLAN & SECTION

HTR-GHD-CU-RE-DR-S-0052 - UPSTREAM CULVERT CONCRETE DETAILS - PLAN & SECTIONS

HTR-GHD-CU-RE-DR-S-0026 - DOWNSTREAM CULVERT PLAN & SECTION - SHT 1 OF 2

HTR-GHD-CU-RE-DR-S-0027 - DOWNSTREAM CULVERT PLAN & SECTION - SHT 2 OF 2

HTR-GHD-CU-RE-DR-S-0053 - DOWNSTREAM CULVERT CONCRETE DETAILS - PLAN & SECTIONS

HTR-GHD-CU-RE-DR-S-0040 - VALVE TOWER GENERAL ARRANGEMENT - SHT 1 OF 2

HTR-GHD-CU-RE-DR-S-0043 - VALVE TOWER GENERAL ARRANGEMENT - SHT 2 OF 2

HTR-GHD-CU-RE-DR-S-0050 - VALVE TOWER CONCRETE DETAILS - PLAN & SECTIONS SHEET 1 OF 2

HTR-GHD-CU-RE-DR-S-0051 - VALVE TOWER CONCRETE DETAILS - PLAN & SECTIONS SHEET 2 OF 2

MECHANICAL

HTR-GHD-CU-RE-DR-M-0001 - PROCESS & INSTRUMENTATION DIAGRAM

HTR-GHD-CU-RE-DR-M-0002 - VALVE TOWER

HTR-GHD-CU-RE-DR-M-0003 - DOWNSTREAM CULVERT

HTR-GHD-CU-RE-DR-M-0004 - CONTROL ROOM

HTR-GHD-CU-RE-DR-M-0005 - CONTROL ROOM COURTYARD

HTR-GHD-CU-RE-DR-M-0006 - COMPENSATION FLOW LINE

HTR-GHD-CU-RE-DR-M-0007 - SCOUR PIPEWORK UPSTREAM CULVERT

HTR-GHD-CU-RE-DR-M-0008 - SCOUR PIPEWORK DOWNSTREAM CULVERT

HTR-GHD-CU-RE-DR-M-0009 - SCOUR PIPEWORK CONTROL ROOM & COURTYARD

HTR-GHD-CU-RE-DR-M-0010 - VALVE SCHEDULE

P05	FOR PLANNING	AH	JR	09/02/24
P04	FOR PLANNING	JR	KNG	08/12/23
P03	FOR REVIEW AND COMMENT	AP	JR	20/10/23
P02	FOR PLANNING	JR	JR	12/10/23
P01	FOR PLANNING	IA	KN	28/09/23
-	WIP	WIP	WIP	WIP

Rev	Description	Checked	Approved	Date
Author	WIP	Drafting Check	WIP	Reg No.
Designer	WIP	Design Check	WIP	Date

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Project No.
HTR

Client **PORTSMOUTH WATER**

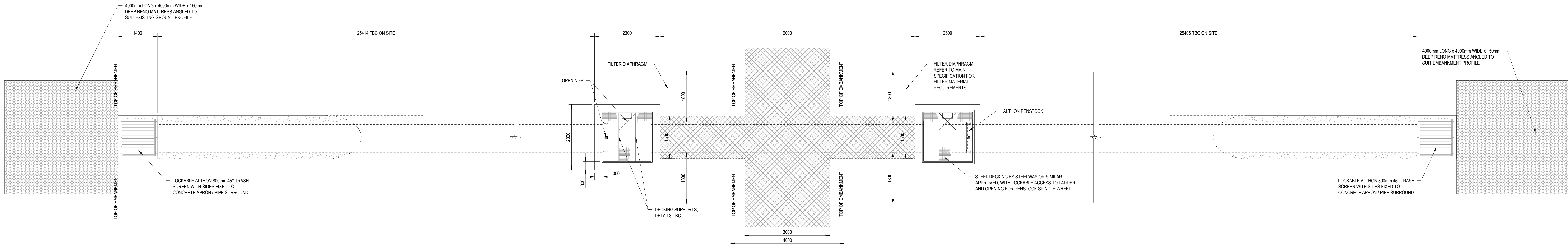
Project **HAVANT THICKET RESERVOIR**

Status **FOR PLANNING**

Drawing Title **VALVE TOWER
GENERAL ARRANGEMENT
SHEET 2 OF 2**

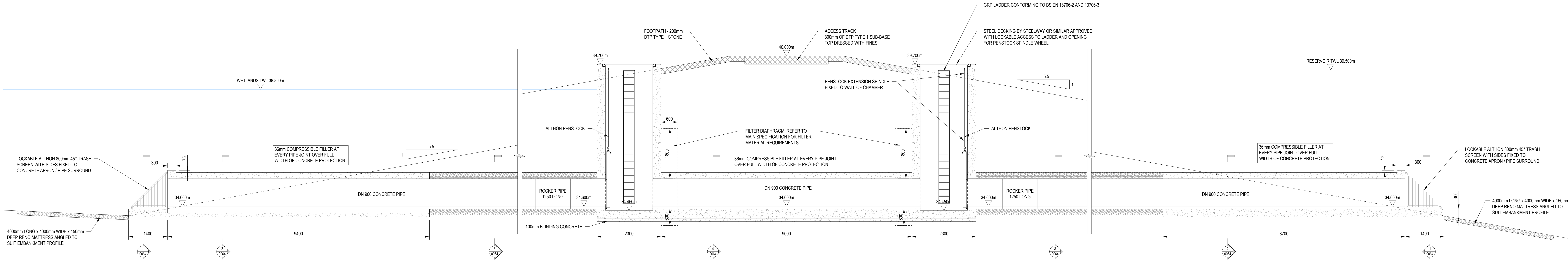
Size
A1

Drawing No. **HTR-GHD-CU-RE-DR-S-0043**
Rev **P05**

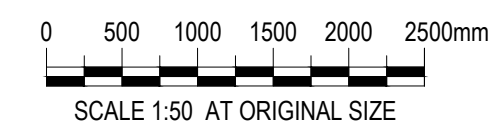


PLAN OF PENSTOCK CHAMBERS AND ACCESS TRACK BUND.
SCALE 1:50

REINFORCEMENT REQUIREMENTS
FOR PENSTOCK CHAMBERS AND
CONCRETE PROTECTION TO
PIPEWORK TO BE CONFIRMED.



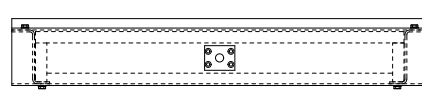
CROSS SECTION THROUGH PENSTOCK CHAMBERS AND ACCESS TRACK BUND.
SCALE 1:50



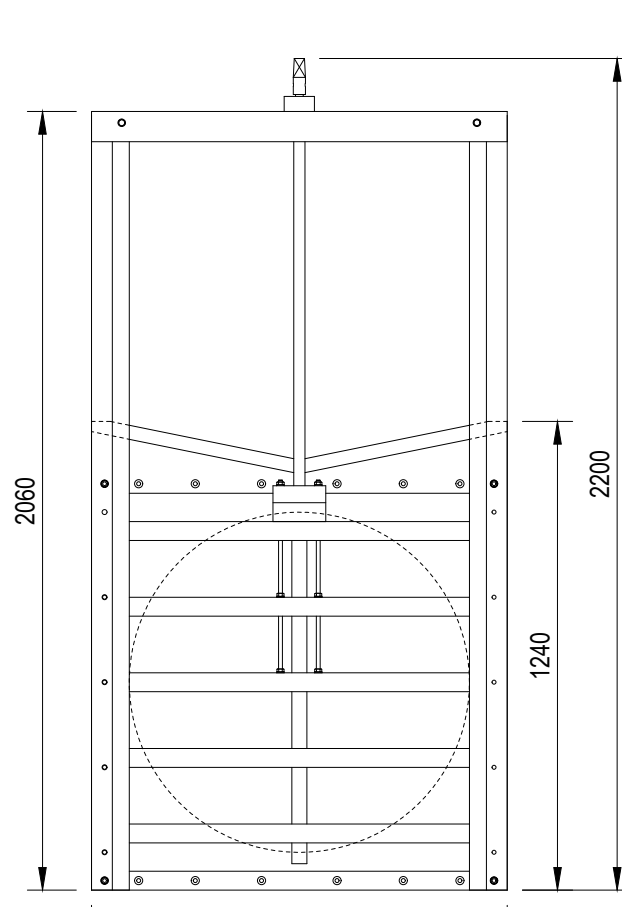
ALTHON PRA-G 900 HDPE/SS PENSTOCK SPECIFICATION
INFORMATION

- THE PENSTOCK HAS A NON-RISING SPINDLE AS STANDARD
- WITH AN O.G. SPINDLE BEARING AND AN HOPE BACK PLATE
- WITH AN HOPE MOVING PLATE PROVIDED WITH RV5316, STIFFENERS WITH POM SPINDLE BLOCK
- THE MOUNTING MATERIAL AND THE SPINDLE ARE MADE OF SS316
- THE SEAL BETWEEN THE MOVING AND BACK PLATE CONSISTS OF AN INTEGRAL EPDM LIP SEAL, WHICH DOES NOT REQUIRE ANY ADJUSTMENT AFTER INSTALLATION

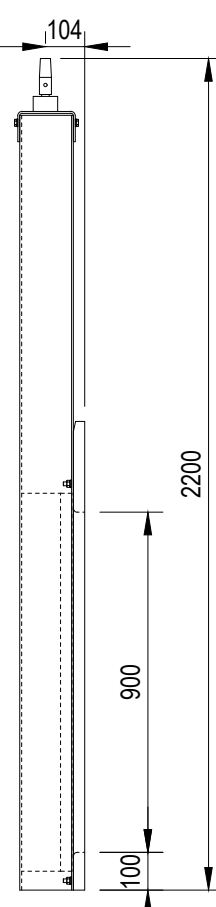
MATERIAL: HDPE, SS316, EPDM AND POM
MAX. LOAD (ON/OFF SEATING): 5.8kN FROM BOTTOM INVERT LEVEL (B.I.L.)
NUMBER OF CHEMICAL ANCHORS: M8 18PCS
SHAFT: 600mm
CONICAL SQUARE SOCKET REMOVED WHEN USING SPINDLE EXTENSION



PLAN.

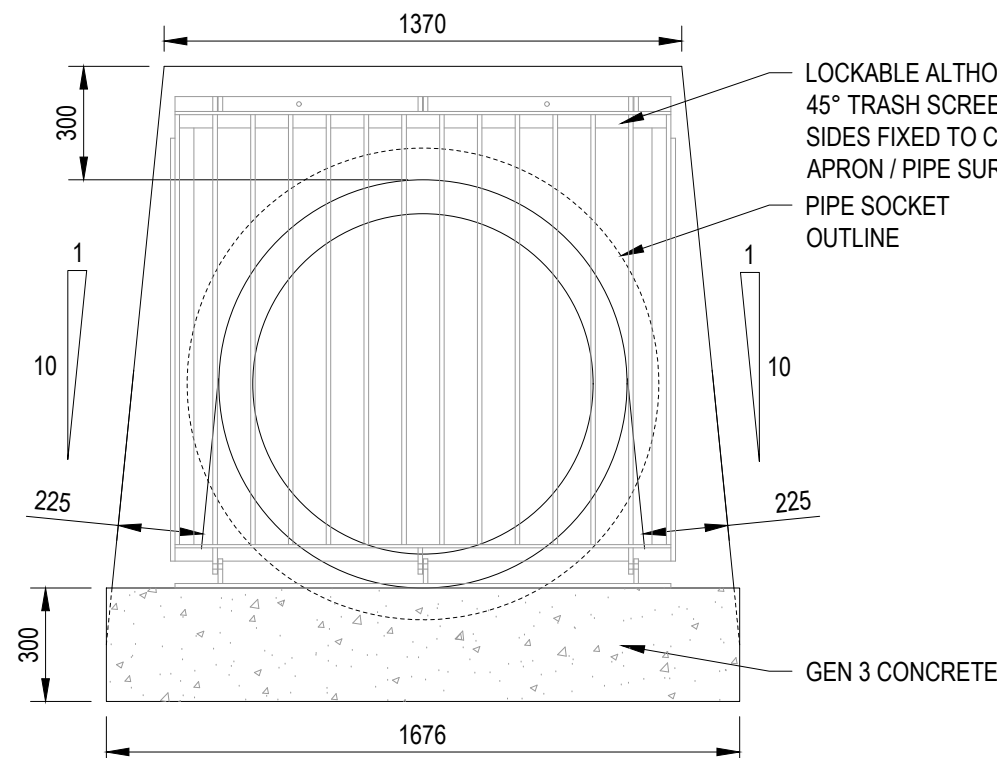


ELEVATION.

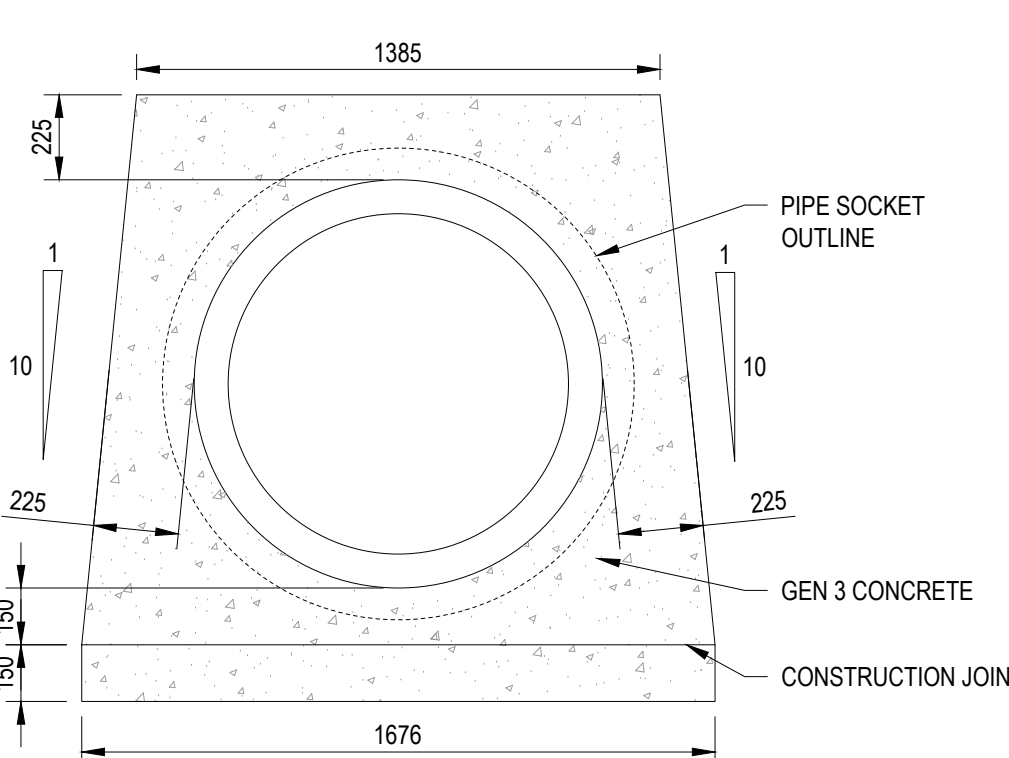


SECTION.

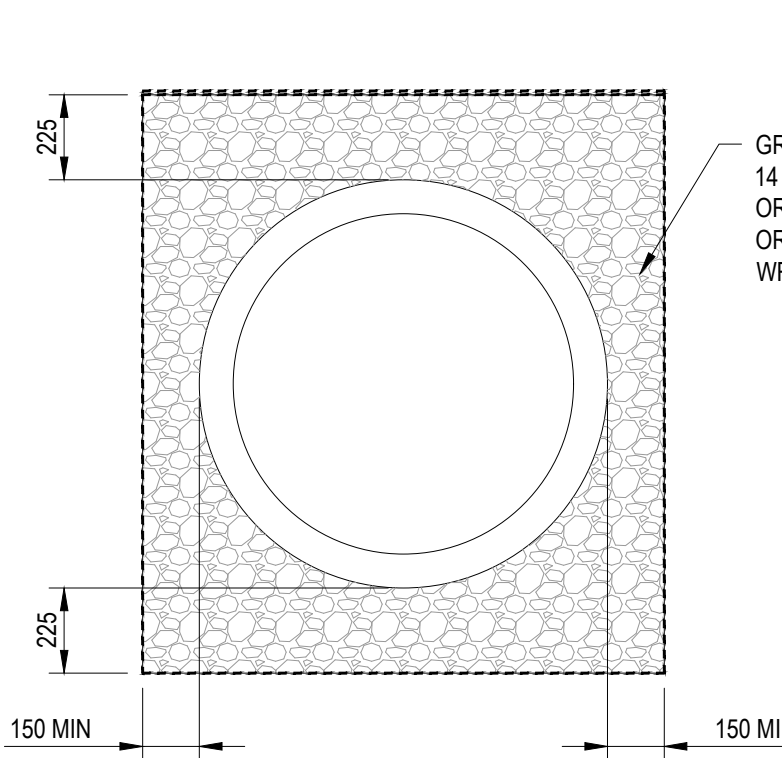
ALTHON 900mm HDPE PENSTOCK.
SCALE 1:20



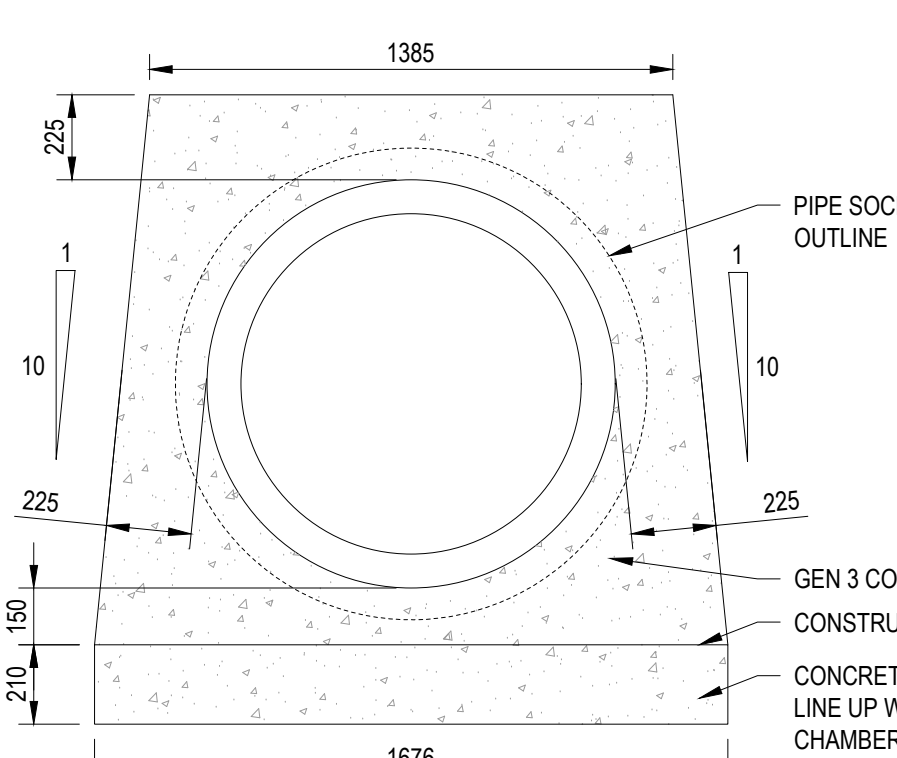
SECTION 1 - TRASH SCREEN APRON.
SCALE 1:20



SECTION 2 - CONCRETE PROTECTION TO PIPE.
SCALE 1:20



SECTION 3 - CLASS S BEDDING
DETAIL FOR 900mm DIA PIPE.
SCALE 1:20



SECTION 4 - CONCRETE PROTECTION TO PIPE
BETWEEN PENSTOCK CHAMBERS.
SCALE 1:20

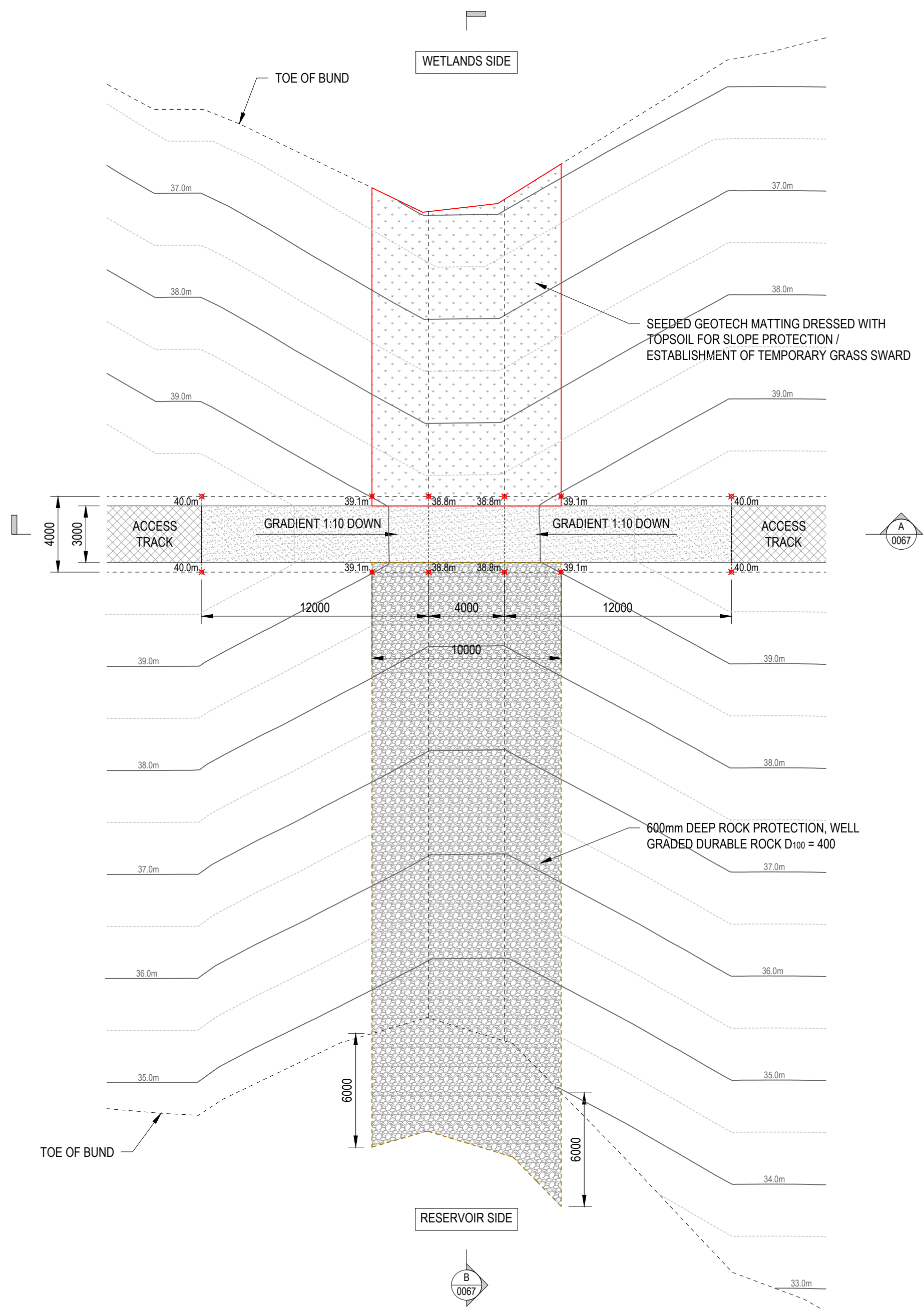


NOTES

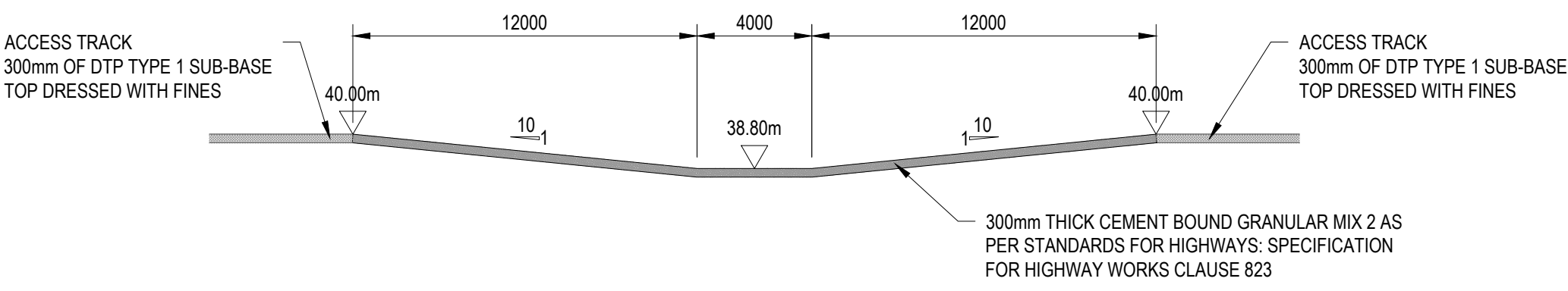
- ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE (UNO).
- ALL LEVELS ARE IN METRES TO ORDNANCE DATUM UNO.
- DO NOT SCALE FROM THIS DRAWING. IF IN DOUBT, CONSULT THE ENGINEER.
- ALL CO-ORDINATES ARE RELATIVE TO OS NATIONAL GRID.

P03	UPDATED FOLLOWING INTERNAL REVIEW	LIG	JR	23.10.23
P02	REVIEW 167 COMMENTS - UPDATED BUND PROFILE	LIG	JR	20.09.23
P01	ISSUED FOR COMMENT	LIG	JR	24.08.23

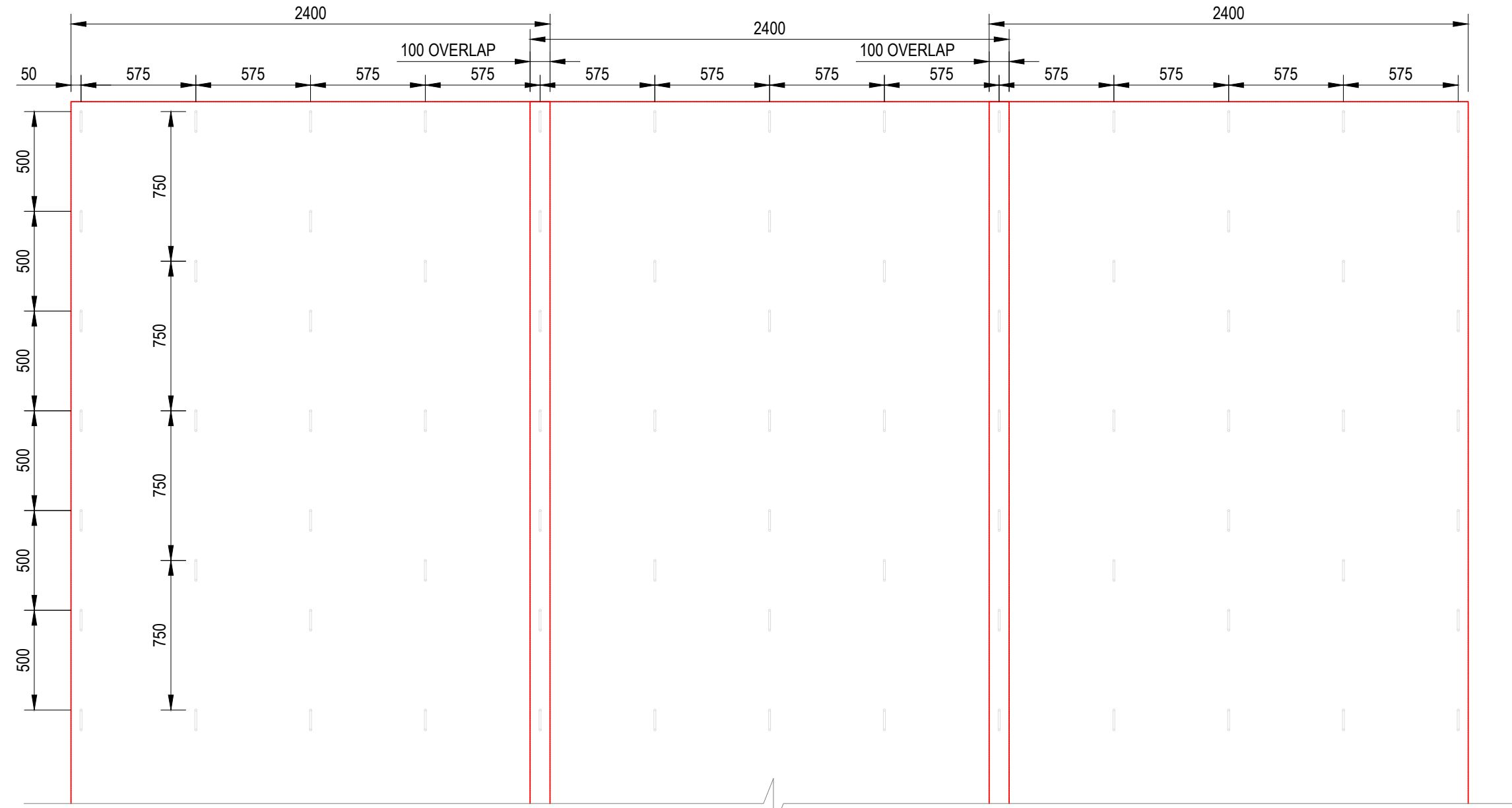
Rev	Description	Checked	Approved	Date
Author	PAR	Drafting Check	LIG	
Designer	PAR / LIG	Design Check	LIG	



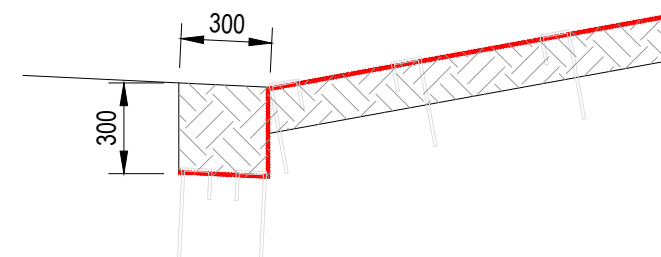
PLAN OF SPILLWAY
SCALE 1:200



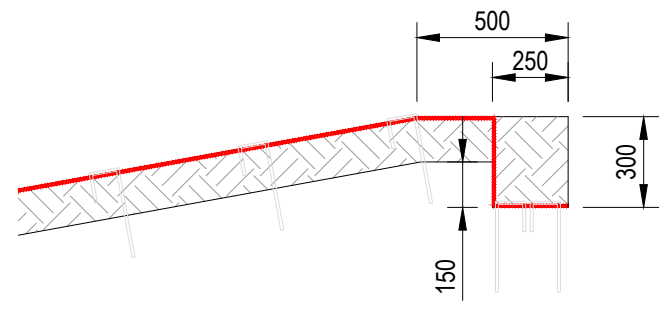
SECTION A - A.
SCALE 1:200



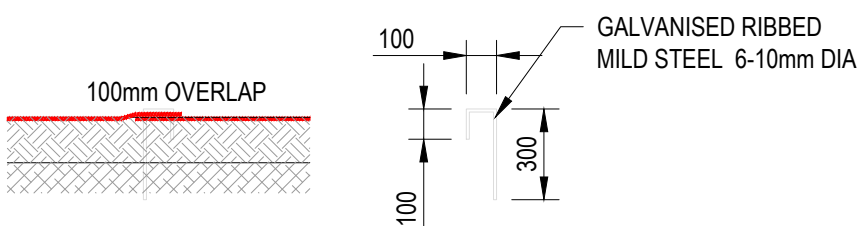
TYPICAL PIN FIXING LAYOUT FOR SEEDED GEOTECH MATTING.
(REFER TO MANUFACTURES SPECIFICATION)
SCALE 1:25



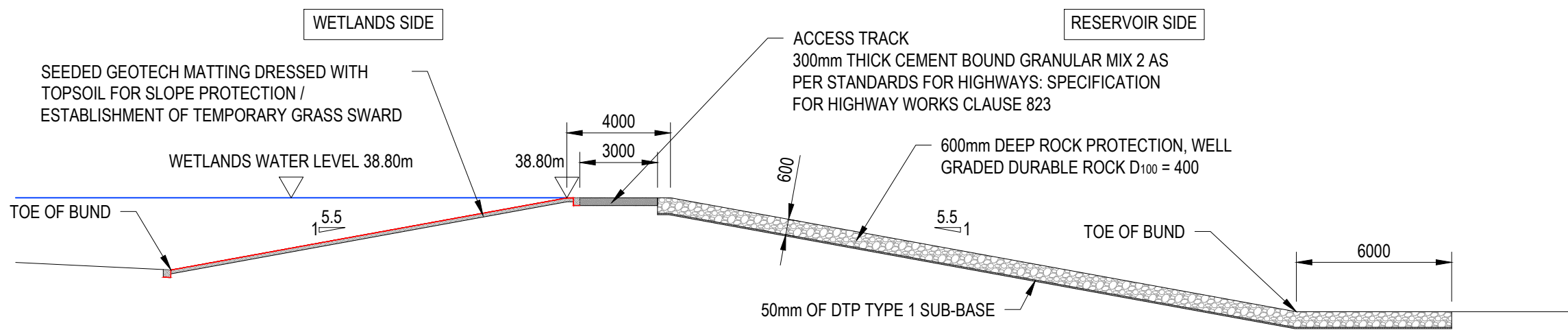
TYPICAL FIXING AT TOE OF BUND.
SCALE 1:25



TYPICAL FIXING AT TOP OF BUND.
SCALE 1:25



FIXING PIN DETAIL.
SCALE 1:25



SECTION B - B.
SCALE 1:200



- NOTES.
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE (UNO).
 2. ALL LEVELS ARE IN METRES TO ORDNANCE DATUM UNO.
 3. DO NOT SCALE FROM THIS DRAWING. IF IN DOUBT, CONSULT THE ENGINEER.
 4. ALL CO-ORDINATES ARE RELATIVE TO OS NATIONAL GRID.

REFERENCE DOCUMENTS AND DRAWINGS

PLEASE REFER TO THE BELOW DRAWINGS:
HTR-GHD-WC-ZZ-DR-L-0005 - WETLAND EMBANKMENT SPILLWAY DETAIL WITH TRACK

P03	FOR APPROVAL	LJG	JR	31.10.23
P02	FOR COMMENT	LJG	JR	11.10.23
P01	FOR COMMENT	LJG	JR	09.10.23

Rev	Description	Checked	Approved	Date
Author	PAR		Drafting Check	LJG
Designer	PAR		Design Check	LJG

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Project No.
12547181

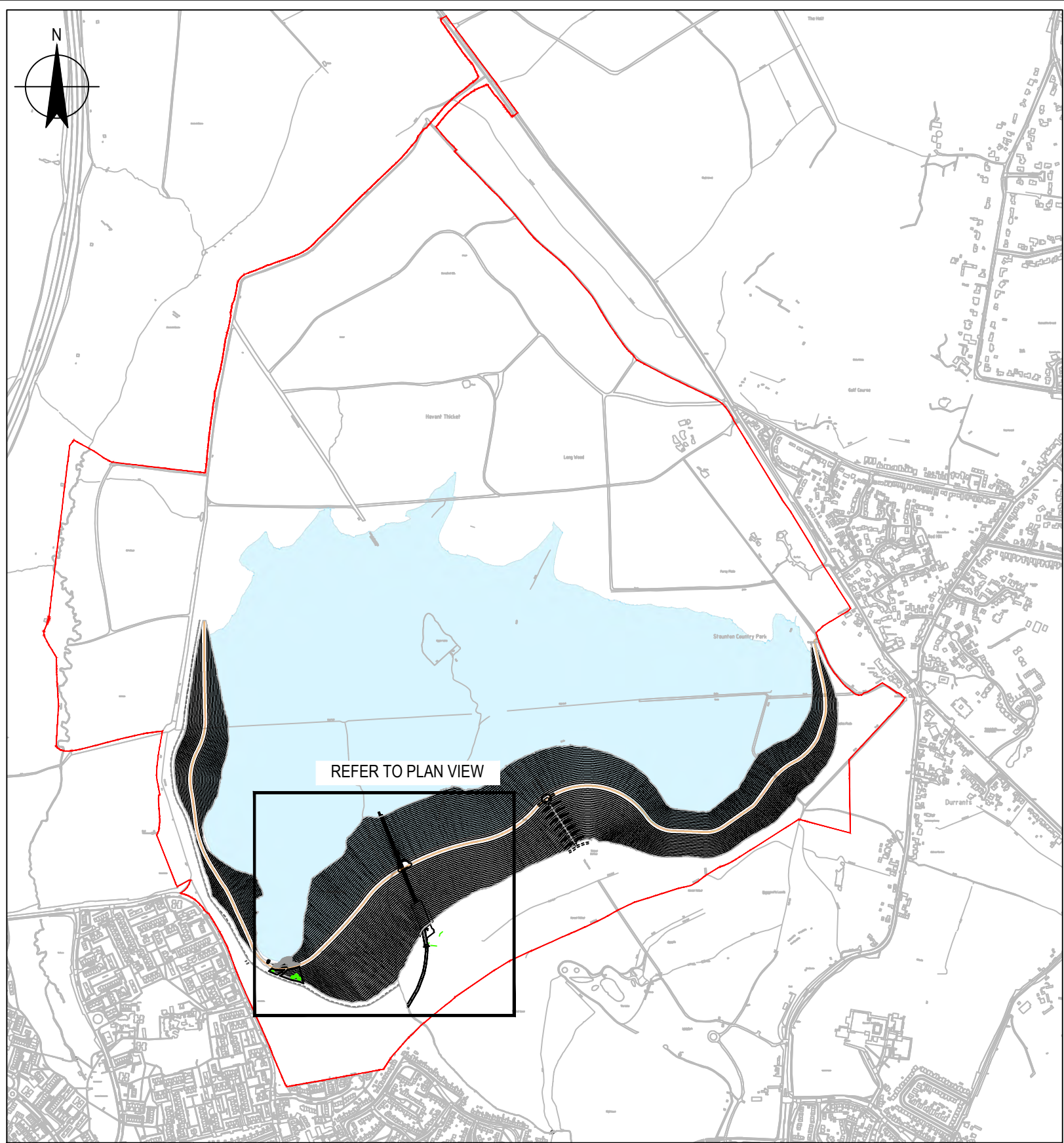
Client PORTSMOUTH WATER

Project HAVANT THICKET RESERVOIR

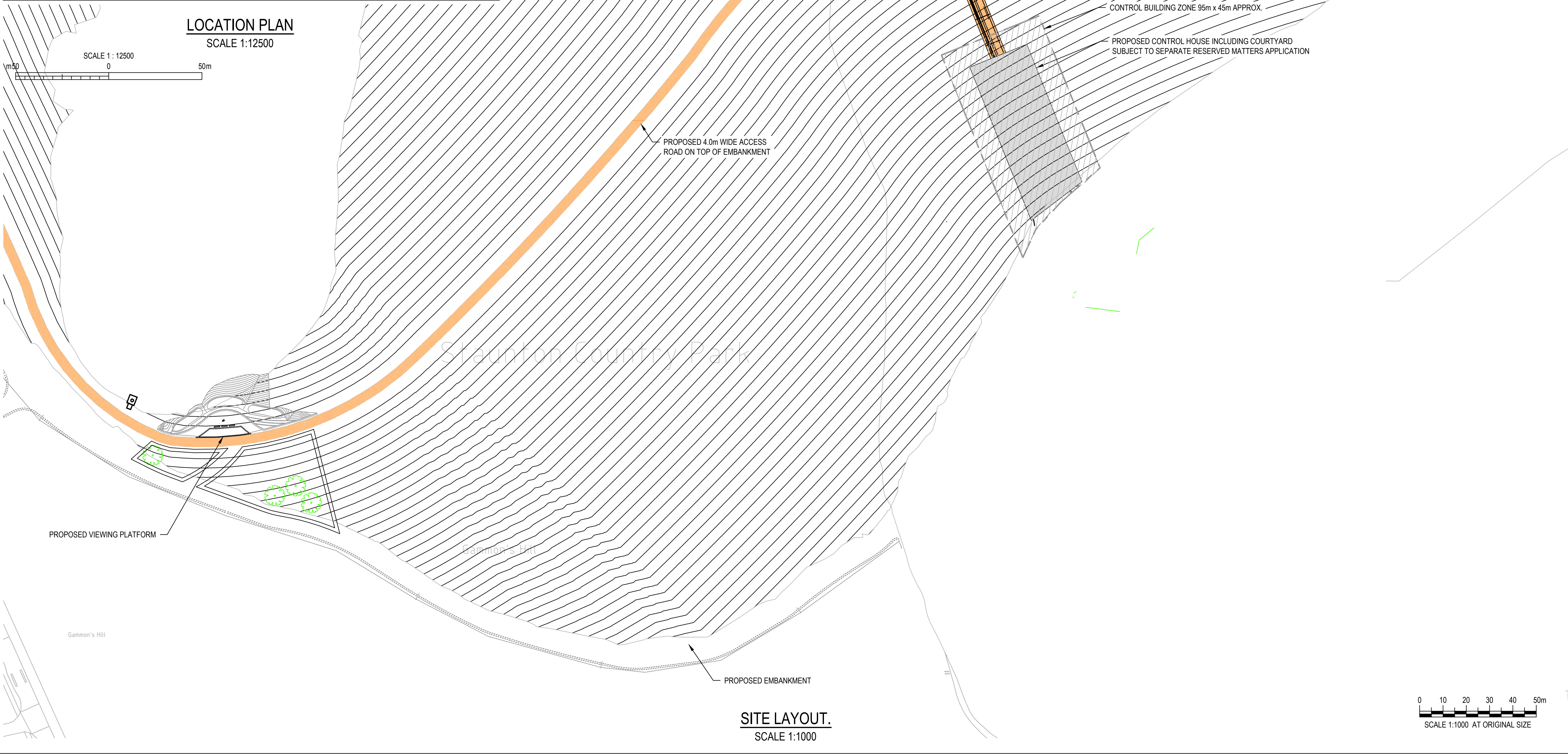
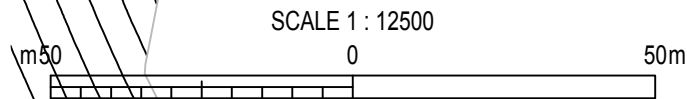
Status FOR APPROVAL Status Code S4

Drawing Title WETLANDS SPILLWAY (VEHICULAR ACCESS) PLAN AND SECTIONS

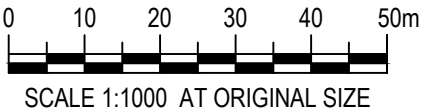
HTR-GHD-WC-ZZ-DR-L-0067 Drawing No. Rev P03



LOCATION PLAN
SCALE 1:12500



SITE LAYOUT.
SCALE 1:1000



NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS (mm) & ALL LEVELS ARE IN METERS (m) AOD, UNLESS STATED OTHERWISE.
2. ALL LEVELS SHOWN ARE RELATIVE TO ORDNANCE DATUM.

LEGEND

- PLANNING APPLICATION BOUNDARY
- RESERVOIR AREA
- PROPOSED BELOW GROUND CULVERT
- PROPOSED ACCESS TRACK (TOP OF EMBANKMENT)

P03	FOR APPROVAL	SG	TG	16.04.24
P02	DESIGN AMENDMENTS	SG	TG	12.04.24
P01	FOR COMMENT	SG	TG	09.04.24

Rev	Description	Checked	Approved	Date
Author	I Ahmed			
Designer	AP			
Drafting Check	AP			
Design Check	JR			

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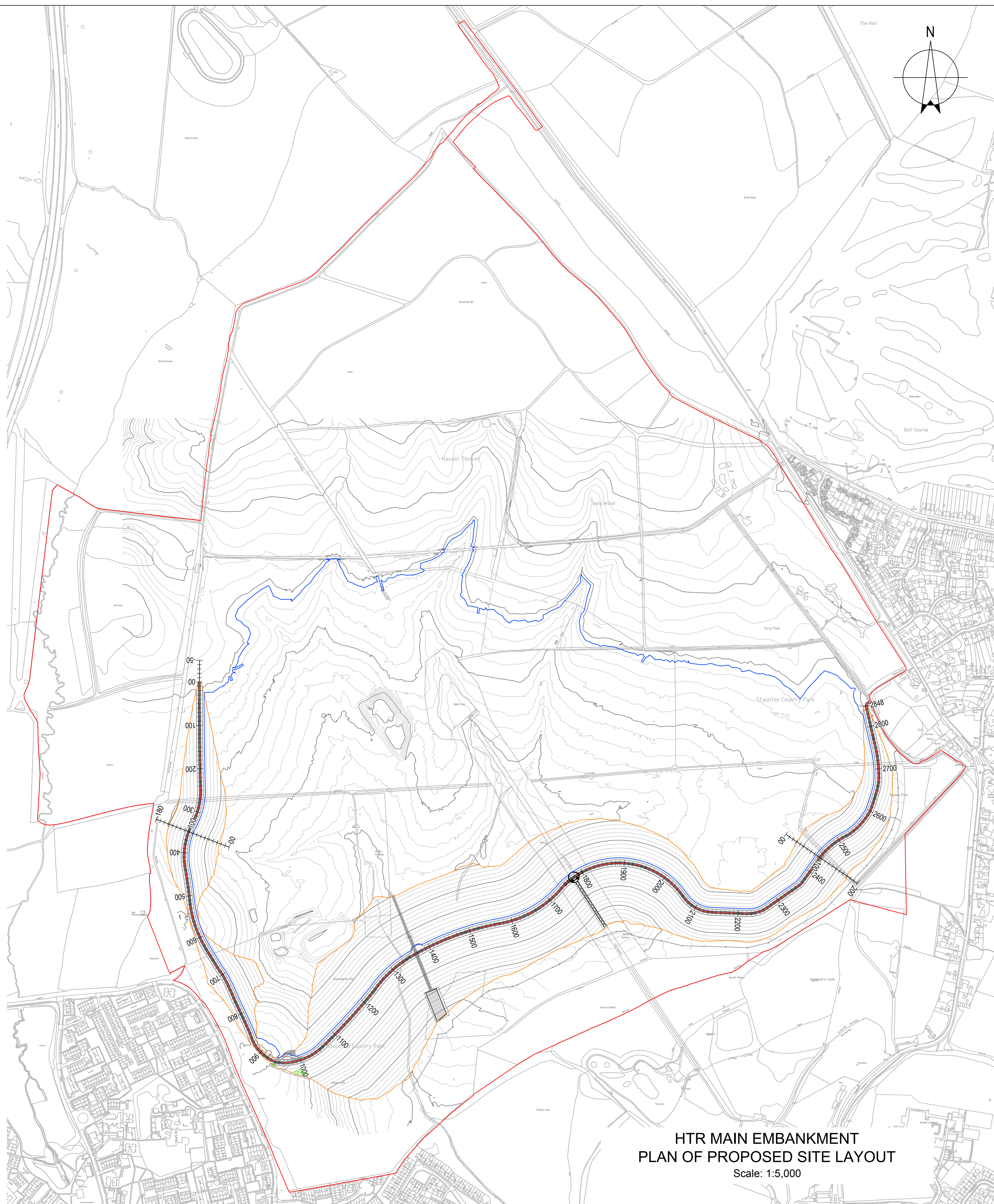
Client PORTSMOUTH WATER

Project HAVANT THICKET RESERVOIR

Status FOR PLANNING Status Code. S4

Drawing Title PROPOSED CULVERT AND VALVE TOWER SITE LAYOUT Size

Drawing No. HTR-GHD-ZZ-ZZ-DR-T-0013 Rev P03



NOTES:

1. ALL DIMENSIONS AND LEVELS ARE IN METRES UNLESS NOTED OTHERWISE (UNO).
2. ALL LEVELS ARE RELATIVE TO ORDNANCE DATUM.
3. ALL GREYED OUT PROPOSED COMPONENTS TO BE CONFIRMED IN FUTURE PLANNING PHASES.

LEGEND

	MAIN EMBANKMENT DAM
	RESERVOIR AT TOP WATER LEVEL (39.5m AOD)
	EXTENT OF BORROW PITS
	MAJOR CONTOUR (5.0m)
	MINOR CONTOUR (1.0m)
	HTR PLANNING APPLICATION BOUNDARY

Rev	Description	Checked	Approved	Date
Author	JDP	Drafting Check	EB	
Designer	EB	Design Check	PC	17/04/2024

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Project No.
3586AC

Client **PORTSMOUTH WATER**

Project HAVANT THICKET RESERVOIR

Status **PLANNING APPLICATION**

S4

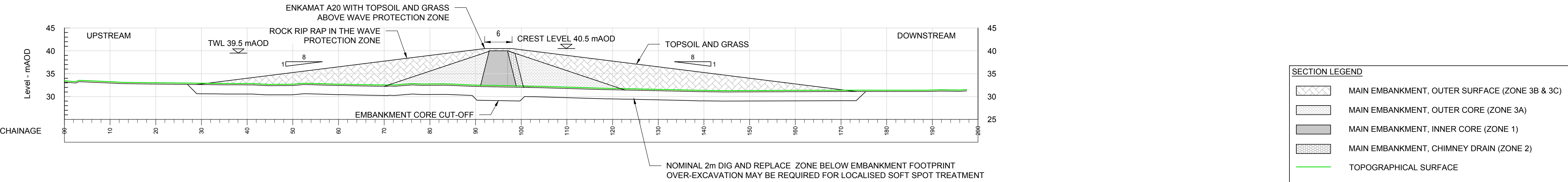
Drawing Title	MAIN EMBANKMENT PROPOSED SITE LAYOUT
---------------	---

1

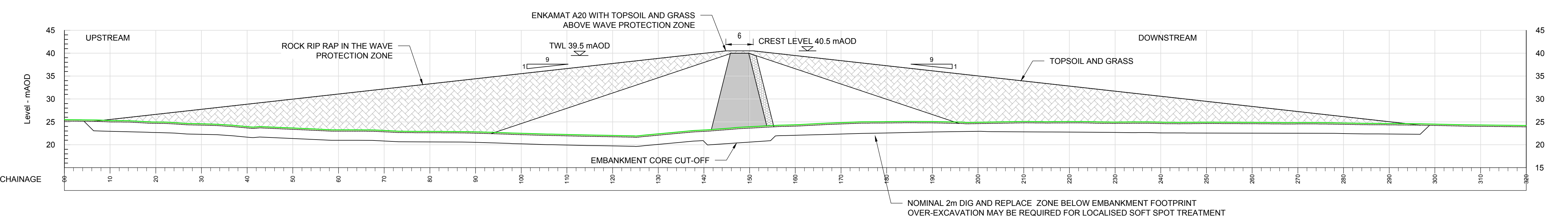
Drawing No.
HTR-COF-EM-RE-DR-GE-4002

01

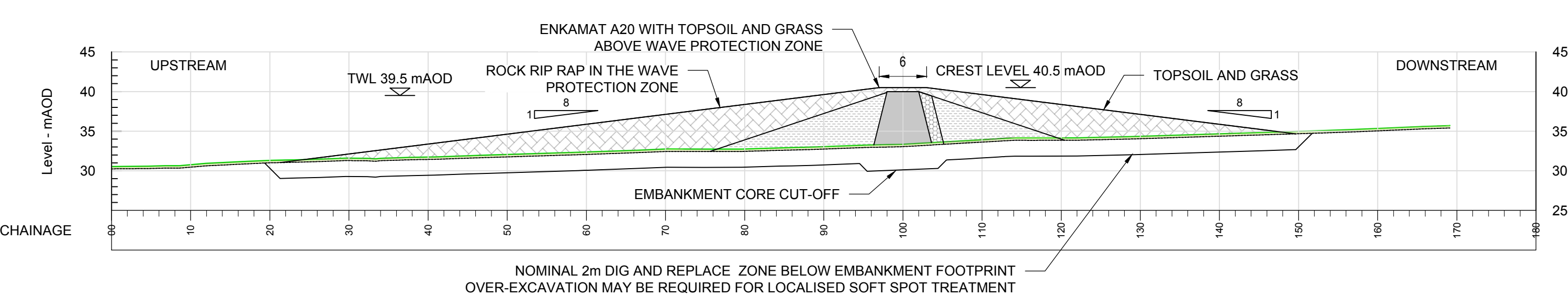
DAM CROSS SECTION AT CHAINAGE 2450



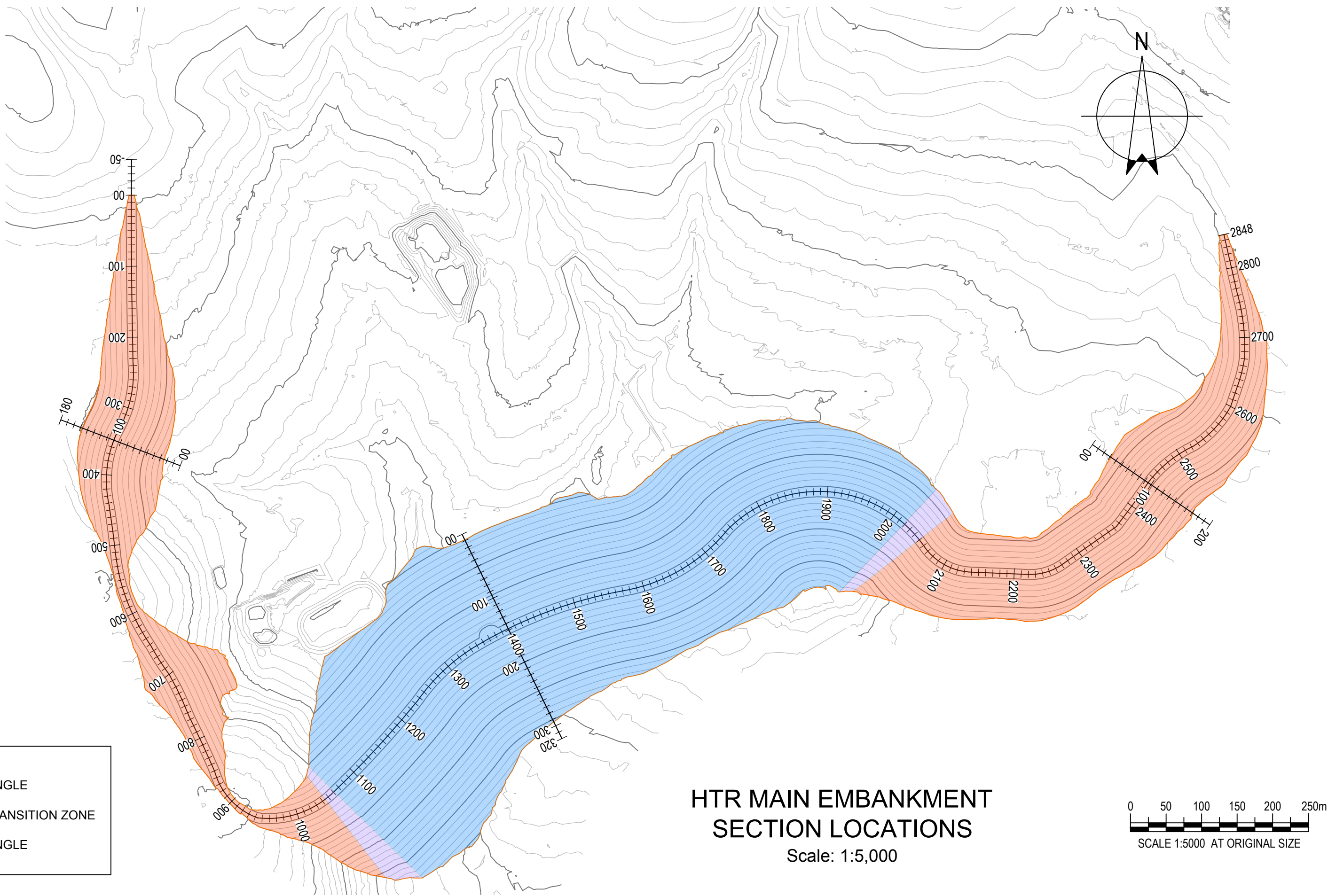
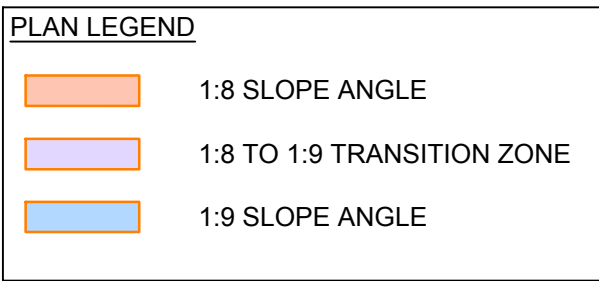
DAM CROSS SECTION AT CHAINAGE 1400



DAM CROSS SECTION AT CHAINAGE 350



- NOTES:
- ALL DIMENSIONS AND LEVELS ARE IN METRES UNLESS NOTED OTHERWISE (UNO).
 - ALL LEVELS ARE RELATIVE TO ORDNANCE DATUM



Rev	Description	Checked	Approved	Date
Author	JDP	Drafting Check	EB	
Designer	EB	Design Check	PC	15/04/2024

REFERENCE DOCUMENTS AND DRAWINGS

DOCUMENT REFERENCES	DOCUMENT TITLES

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Project No:
03586AC

Client PORTSMOUTH WATER
Project HAVANT THICKET RESERVOIR
Status PLANNING APPLICATION

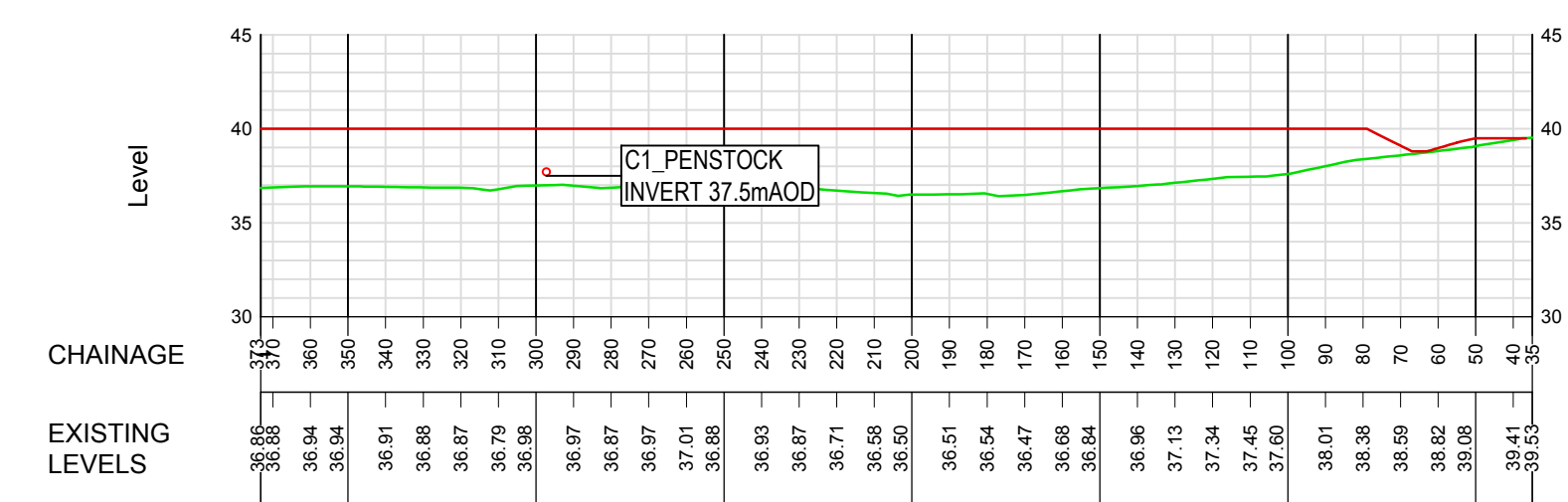
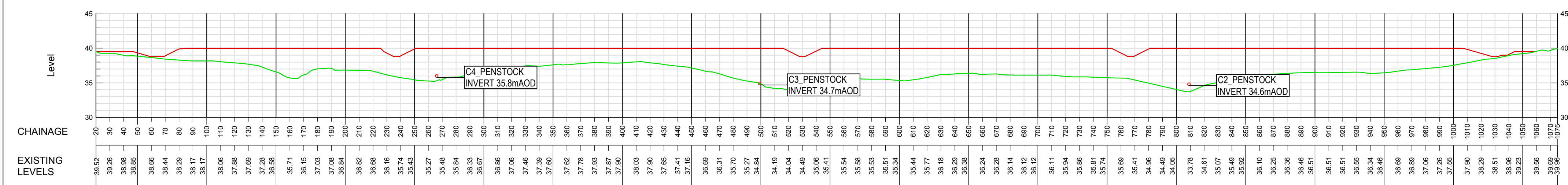
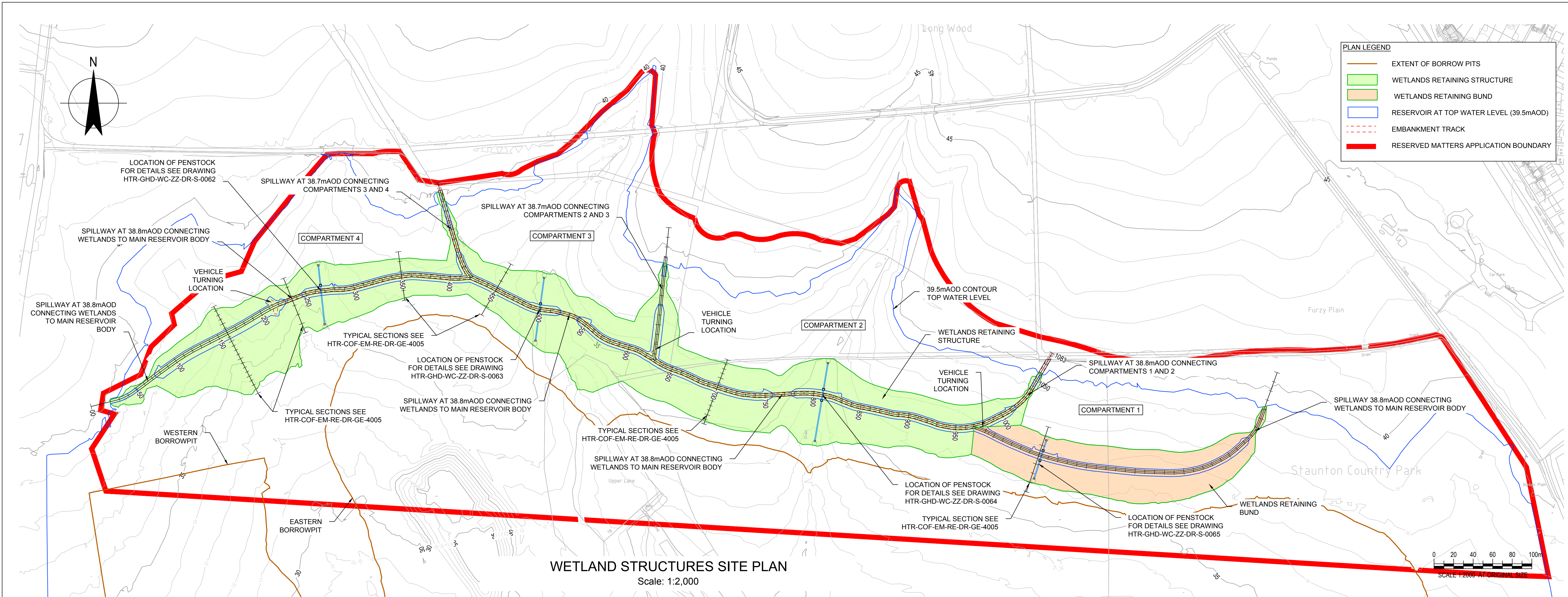
Drawing Title
MAIN EMBANKMENT
CROSS-SECTIONS

Status Code
S4

HTR-COF-EM-RE-DR-GE-4003

Size
A1

Rev
P01



WETLANDS RETAINING BUND
LONG SECTION - COMPARTMENT 1
Scale: 1:2,000 (5 x VERTICAL EXAGGERATION)

NOTES:

- ALL DIMENSIONS AND LEVELS ARE IN METRES UNLESS NOTED OTHERWISE (UNO).
- ALL LEVELS ARE RELATIVE TO ORDNANCE SURVEY DATUM.
- VISITOR CENTRE IS SUBJECT TO SEPARATE RESERVED MATTERS APPLICATION.

Rev	Description	Checked	Approved	Date
Author	JDP	Drafting Check	EB	
Designer	EB	Design Check	PC	04/03/2024

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REGISTERED IN ENGLAND No. 2536455



Project No:
03586AC

Client PORTSMOUTH WATER
Project HAVANT THICKET RESERVOIR
Status PLANNING APPLICATION

Drawing Title
PLANNING DRAWING
WETLANDS
STRUCTURES
PROPOSED SITE LAYOUT

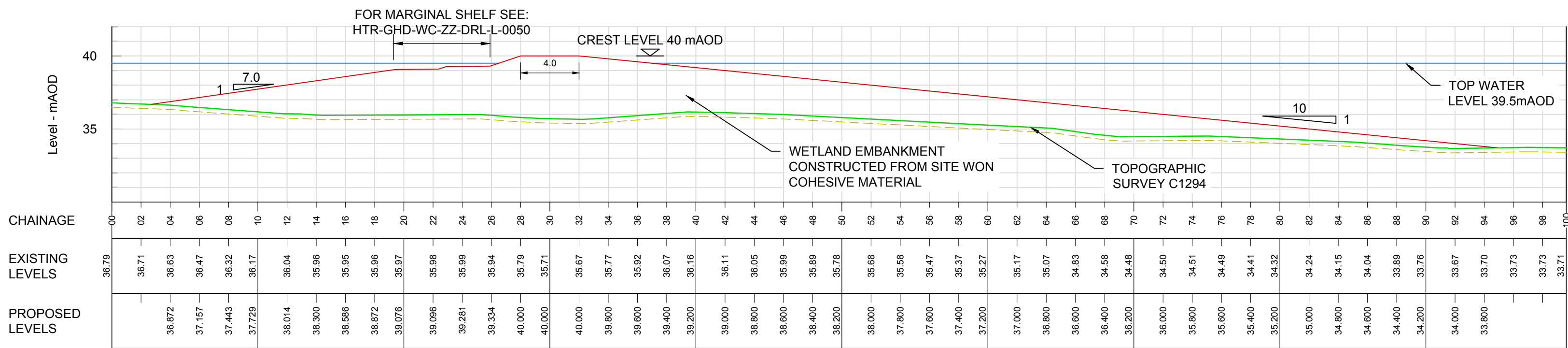
Status Code
S4

HTR-COF-EM-RE-DR-GE-4004

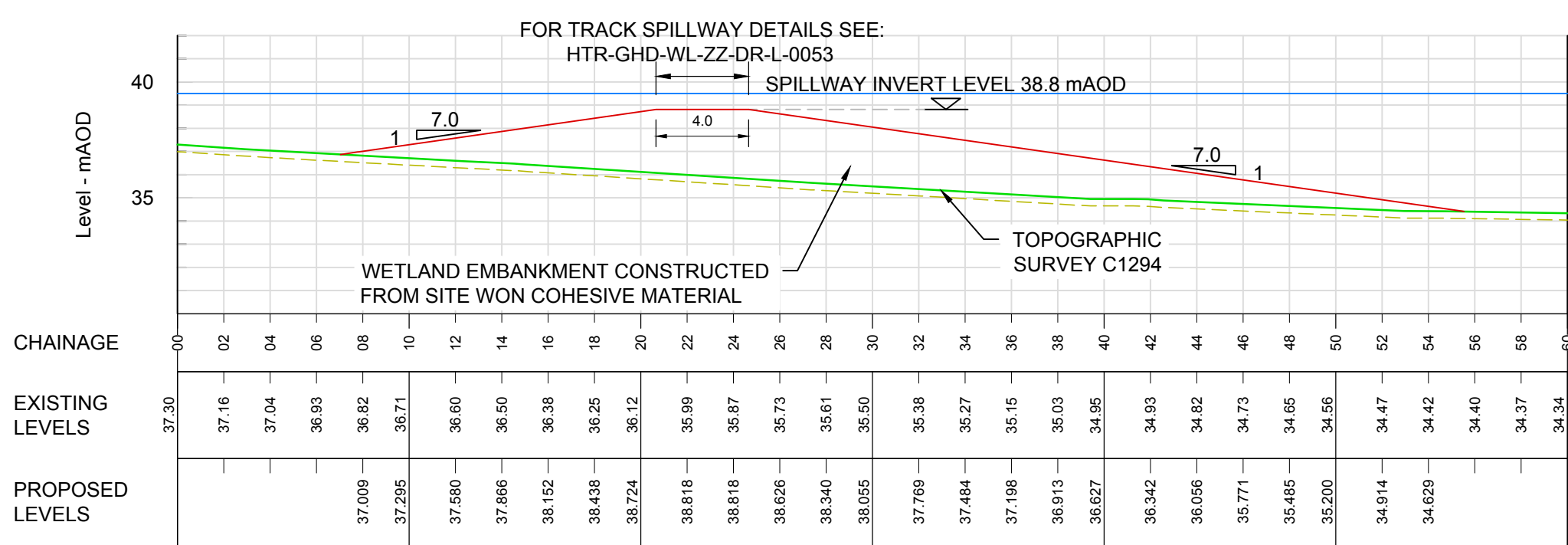
Size
A1

Rev
P01

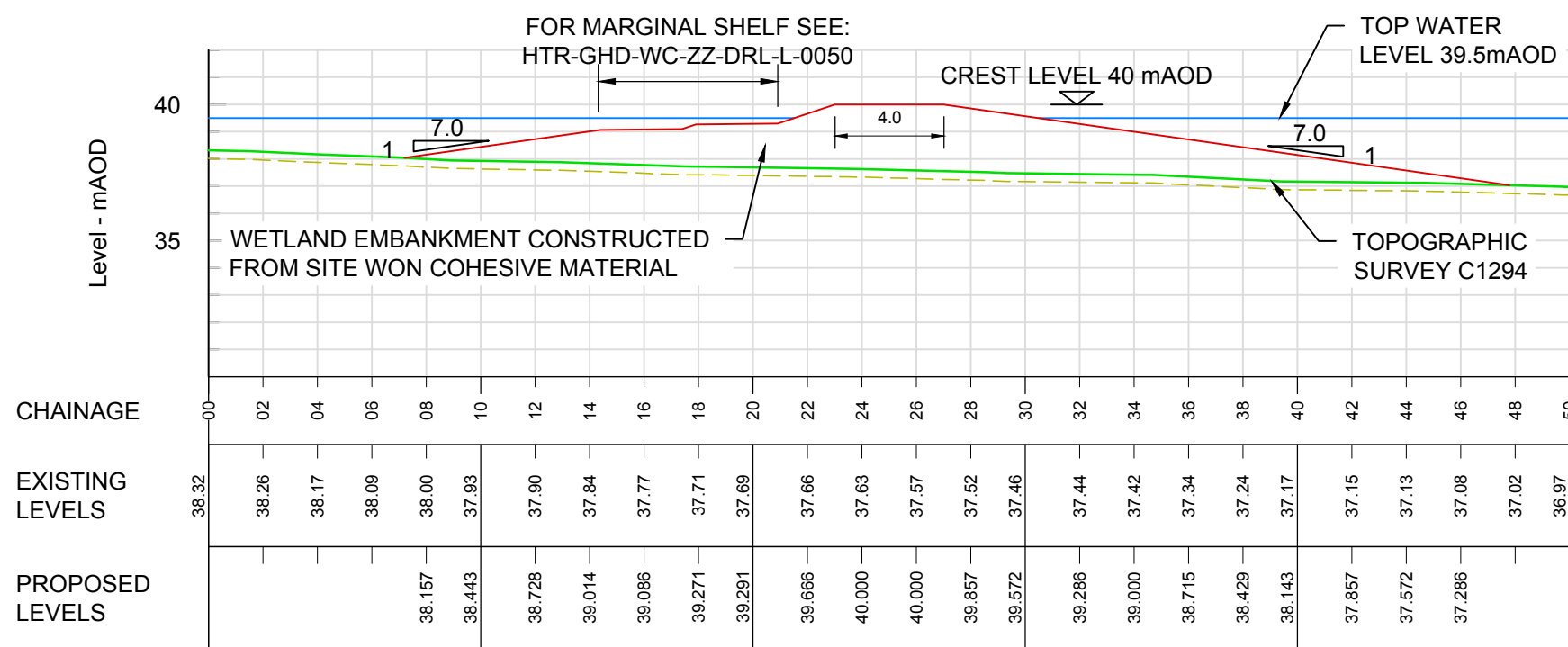
CROSS SECTION AT CH160 OF RETAINING STRUCTURE
Scale 1:250



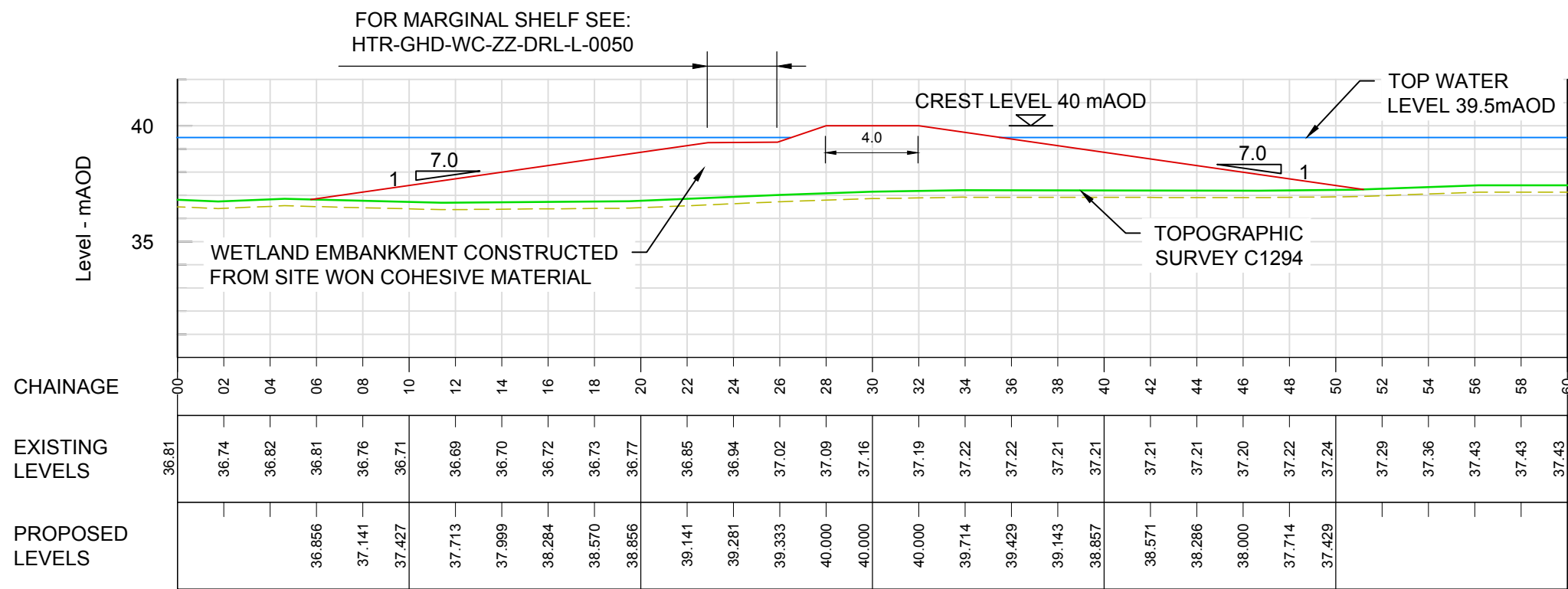
CROSS SECTION AT CH235 OF RETAINING STRUCTURE
Scale 1:250



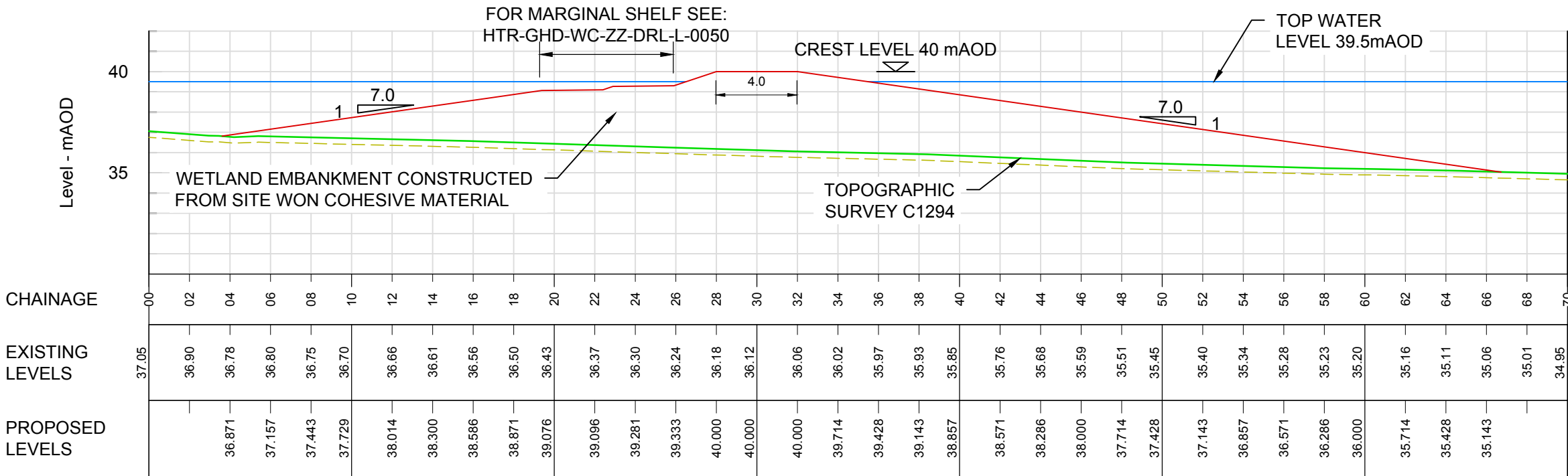
CROSS SECTION AT CH350 OF RETAINING STRUCTURE
Scale 1:250



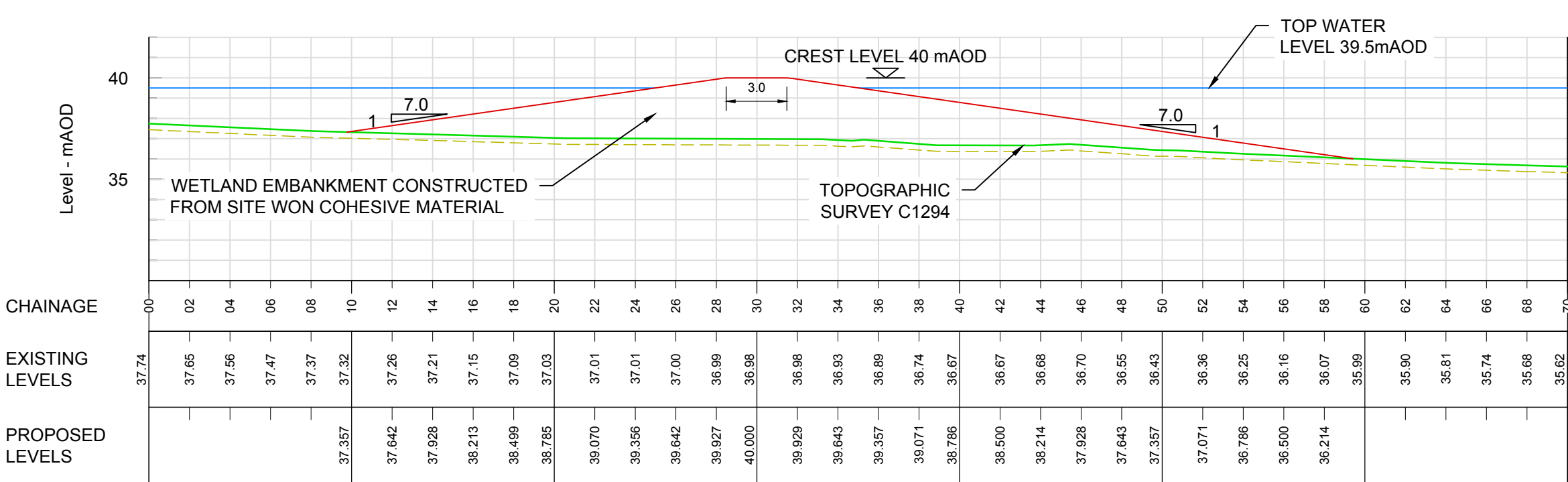
CROSS SECTION AT CH450 OF RETAINING STRUCTURE
Scale 1:250



CROSS SECTION AT CH700 OF RETAINING STRUCTURE
Scale 1:250



CROSS SECTION AT CH300 OF RETAINING BUND
Scale 1:250



SECTION LEGEND

- PROFILE OF EMBANKMENT TOP
- PROFILE OF EXISTING TOPOGRAPHY
- PROFILE OF TOPSOIL STRIP (-300mm)
- TOP WATER LEVEL AT 39.5mAOD

NOTES:

- ALL DIMENSIONS AND LEVELS ARE IN METRES UNLESS NOTED OTHERWISE (UNO).
- ALL LEVELS ARE RELATIVE TO ORDNANCE DATUM.

Rev	Description	Checked	Approved	Date
Author	JDP	Drafting Check	EB	
Designer	EB	Design Check	PC	16/02/2024

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REGISTERED IN ENGLAND No. 2536455



Project No:
03586AC

Client PORTSMOUTH WATER
Project HAVANT THICKET RESERVOIR
Status PLANNING APPLICATION

Drawing Title
PLANNING DRAWING
WETLANDS
EMBANKMENTS
DESIGN CROSS SECTIONS

Status Code
S4

HTR-COF-EM-RE-DR-GE-4005

Size
A1

Rev
P01