Britannia Refined Metals

Proposed E-Scrap Facility, Manor Way, Northfleet

Flood Risk Assessment

WSP Environment & Infrastructure Solutions UK Limited – March 2023

Report for

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Document revisions

No.	Details	Date
P01	Draft FRA	22/08/22
P01.2	Draft FRA updated with receipt of EA modelling data	11/10/22
P01.3	Final	29/03/2023

Executive summary

Purpose of this report

Wood Environment & Infrastructure Solutions UK ('Wood') has been commissioned by Brittania Refined Metals (BRM) to provide a Flood Risk Assessment (FRA) and drainage strategy to support their planning application for the construction of an electronic scrap (E-Scrap) sampling facility at their Northfleet site, Kent. The objective of the plant is to accurately and effectively sample E-Scrap and supply feed material to Glencore smelters globally. All potential risks of flooding to the Site have been assessed and relevant flood management and mitigation measures have been recommended where necessary. A summary of the FRA is provided below.

Flood Risk Assessment Summary

Item	Summary
Flood Zone	The majority of the site is situated within Flood Zone 3, with the remainder being in Flood Zone 2. The site is mapped as being in an area benefitting from flood defences. The EA Flood Zones show 'undefended' risk (assume no flood defences in place), and therefore they do not account for the formal flood defences along the River Thames.
Detailed Tidal Flood Risk	Detailed tidal flood levels have been sourced from the TE2100 modelling study results supplied by the EA to inform the risk of tidal overtopping to the site. Breach modelling results have been used from the Thames Estuary Breach Assessment (undertaken in 2018) to assess the residual risk of tidal flooding to the site and determine the design flood level.
Other Sources of Risk	Flood risk to the Site has been considered from surface water, groundwater, sewer and artificial sources. The primary source of flood risk to the Site is tidal flooding associated with the Thames estuary, and the overall risk from other sources is considered to be low.
Vulnerability Classification	The Proposed Development is classified as 'More Vulnerable' based on the NPPF, considering the potentially hazardous waste housed in the main building.
Flood Zone Compatibility	More Vulnerable development is subject to the Sequential and Exception Tests within Flood Zones 2 and 3.
Exception Test	The Exception Test aims to demonstrate the need for the development in that location and plans to mitigate flood risk. The Exception Test is considered to be passed, given that the Proposed Development would deliver wider community benefits and the fact that it is shown to be resilient to flooding throughout the lifetime of its development, without impacting flood risk elsewhere.
Flood Risk to Development	Modelled tidal levels indicate that the Site is currently defended by tidal flood defences offering a standard of protection (SoP) exceeding the 0.1% AEP event. Within the lifetime of the project, the flood defences will require upgrading to continue to offer the required SoP. Breach modelling results from the Thames tidal downriver breach inundation modelling study have been used to inform the residual risk of flooding to the development.

Item	Summary
Impact on Flood Risk Elsewhere	There are no surface water flow paths running onto the Site and the drainage strategy has demonstrated how surface water runoff from the development will be effectively managed.
Mitigation	The key mitigation required for the Proposed Development is to manage the environmental risk of potentially hazardous waste entering the water environment. Mitigation in the form of raised perimeter walls and plant plinths will be incorporated to the design flood level.
Surface Water Management	A Drainage Strategy has been prepared by to demonstrate how surface water will be managed across the Site. The proposed drainage layout is to discharge to the existing drainage swale on the southern perimeter of the site at an unrestricted rate, based on agreement with Kent County Council (KCC). The proposed drainage scheme has been assessed under tide-locked conditions, and the existing ditch is envisaged to provide sufficient attenuation volume to accommodate runoff.

Contents

1. Introduction

1.1 Purpose

This Flood Risk Assessment (FRA) has been prepared to support Britannia Refined Metals (BRM) in their planning application for the construction of an electronic scrap (E-Scrap) sampling facility at their Northfleet site, Kent. The objective of the plant is to accurately and effectively sample E-Scrap and supply feed material to Glencore smelters globally.

The FRA has been prepared to assess flood risk from all potential sources to the site. A drainage strategy has been prepared and summarised in this document to outline how surface water generated within the site boundary should be managed to ensure there is no detrimental impact to flood risk elsewhere.

1.2 Structure

The report is structured as follows:

- Section 2 – Site description: development proposals;
- Section 3 - Planning considerations;
- Section 4 – Flood risk appraisal;
- Section 5 – Flood risk management;
- Section 6 – Drainage strategy;
- Section 7 – Exception Test; and
- Section 8 – Conclusions and recommendations.

The figures are embedded within the main body of the report while various supporting documents are included as appendices. In total there are four appendices, as follows:

- Appendix A – Site photographs;
- Appendix B – Proposed development drawings;
- Appendix C – TE2100 tidal model results; and
- Appendix D – Drainage strategy.

1.3 Terminology

In this report, the probability of a flood occurring is expressed in terms of Annual Exceedance Probability (AEP), which is the inverse of the annual maximum return period. For example, the 100 year flood can be expressed as the 1% AEP flood, i.e. a flood that has a 1% chance of being exceeded in any year.

Table 1.1 is provided to clarify the use of the AEP terminology as well a description of the Flood Zone definitions as set out in the NPPF, Flood risk and coastal change guidance.

Table 1.1 Flood Zone definitions and associated Annual Exceedance Probability

Flood Zones	Probability of flooding	AEP	Definition
Flood Zone 1	Low Probability	<0.1% AEP of river or sea flooding	Land with less than 1 in 1,000 probability of flooding from rivers or the sea, in any given year
Flood Zone 2	Medium Probability	1% to 0.1% AEP of river flooding 0.5% to 0.1% AEP of sea flooding	Land with between a 1 in 100 and 1 in 1,000 of river flooding; or land having between a 1 in 200 and 1 in 1,000 probability of sea flooding
Flood Zone 3a	High Probability	>1% AEP of river flooding >0.5% AEP of sea flooding	Land having a 1 in 100 or greater probability of river flooding in any year; or Land having a 1 in 200 probability or greater of sea flooding in any year.
Flood Zone 3b	Functional Floodplain	>5% AEP of river or sea flooding; or a designated area designed to flood	Land having a 1 in 20 or greater probability of river of sea flooding in any year.

1.4 Sources of data and information

The sources of information contained in **Table 1.2** were consulted and reviewed as part of this FRA.

Table 1.2 Sources of data and information

Data	Source	Purpose
LiDAR	Environment Agency, LiDAR DTM 1m https://data.gov.uk/ accessed June 2022	Topography of the development site
Statutory main river map	Environment Agency, Statutory Main River Map https://data.gov.uk/ accessed June 2022	Definition of watercourses in relation to site
OS Open Rivers	Ordnance Survey Open Rivers https://www.ordnancesurvey.co.uk/business-government/products/open-map-rivers accessed June 2022	Definition of ordinary watercourses in relation to the site
Flood map for planning	https://flood-map-for-planning.service.gov.uk/ accessed June 2022	For assessment of fluvial and tidal flood risk
Risk of Flooding from Surface Water (RoFSW) Mapping	https://flood-warning-information.service.gov.uk/long-term-flood-risk/map accessed June 2022	For assessment of surface water flood risk

Data	Source	Purpose
AIMS asset data	Environment Agency AIMS flood defence asset data https://environment.data.gov.uk/dataset/8e5be50f-d465-11e4-ba9a-f0def148f590 accessed June 2022	To characterise the adjacent flood defence asset data
Geological Mapping	https://mapapps.bgs.ac.uk/geologyofbritain/home.html accessed June 2022	To characterise the underlying geology and inform the assessment of groundwater flood risk.
Soils mapping	http://www.landis.org.uk/soilscapes/ accessed June 2022	To characterise the underlying soil type
Groundwater vulnerability and Groundwater Source Protection Zone Mapping	https://magic.defra.gov.uk/magicmap.aspx accessed June 2022	To characterise the groundwater vulnerability of the Site and its location relative to Groundwater Protection Zones
Thames Estuary 2100 (TE2100) modelling study reports	Environment Agency - Thames Estuary 2100 – Phase 3 Set 2 Estuary Wide Options Hydraulic Modelling (2008) [1] - Thames Estuary 2100 – Design water levels and future defence crest levels (2015) [2] (Supplied August 2022)	Lower Thames 1D ISIS (now Flood Modeller) in-channel model results to inform tidal overtopping risk to the site and flood defence criteria.
Thames tidal downriver breach inundation modelling study reports and outputs	Environment Agency - Thames Estuary Breach Assessment – Thames Barrier to Gravesend and Linford Methodology Report (2018) [3] (Supplied August 2022)	Breach modelling results for the Lower Thames, to inform the residual risk to the site associated with a breach of the defences.

1.5 Consultation

Environment Agency

The EA were contacted on 22nd June 2022 to provide the relevant River Thames hydraulic model results (to inform the tidal risk of flooding to the site), and to provide guidance on the flood design

[1] HR Wallingford (2008). Thames Estuary 2100 – Phase 3 Set 2 Estuary Wide Options Hydraulic Modelling. Environment Agency – TE2100.

[2] HR Wallingford (2015). Thames Estuary 2100 – Design Water Levels and Future Defence Crest Level. Environment Agency.

3 Atkins (2018). Thames Estuary Breach Assessment – Thames Barrier to Gravesend and Linford Methodology Report. Environment Agency.

level and any information on historic flooding at the site, under the Freedom of Information Act 2000.

The EA responded 31st August 2022 and supplied the TE2100 modelling study results and Thames tidal downriver breach inundation modelling results (as outlined in **Table 1.2**) to inform tidal flood risk to the site. The EA further advised to use the 0.5% AEP breach inundation results for the 2115 epoch to inform the flood design level and provided additional information regarding the 1953 historic flood event.

A series of meetings with the EA were held over late 2022 into early 2023, and the finalised approach to flood risk management for the Proposed Development reflects the outcomes of these discussions.

Lead Local Flood Authority

A meeting was held on-site on 27th June 2022 with representatives of Kent County Council (KCC), who act as the Lead Local Flood Authority (LLFA) for the Site. KCC provided pre-application advice relating to the surface water attenuation and Sustainable Urban Drainage (SuDS) requirements on-site.

2. Site description and development proposals

2.1 Site description

Site Location

The site of the proposed E-scrap facility comprises ~1.25ha of land, which is located immediately north of the existing operational Britannia Refined Metals (BRM) Ltd plant off Manor Way, Northfleet, Gravesend DA11 9BG (referred to hereafter as 'the Site'). It is situated on the western edge of Gravesham Borough close to the administrative boundary of Dartford Borough. A site location plan is provided as **Figure 2.1**.

Figure 2.1 Site overview

The proposed development site is under the ownership of BRM and is largely vacant. There is some limited concrete hardstanding and a small building (**Photograph 8, Appendix A**), with the remainder of the site being covered by scrub planting. It is understood that the site has been subject to a third-party lease based on a one month rolling contract, though has been unoccupied since early 2022. Previously, a transport business operated out of the northern half of the site and a marine piling business out of the southern half. A reclaimed wharf exists immediately east of the site, between the River Thames floodwall and the River Thames itself.

Existing access to the site is via three separate gates in the north-west, midway along the west boundary and in the south-west. These accesses were for the transportation business and reclaimed wharf area, the marine piling business and the defunct BRM battery processing plant via the weighbridge, respectively.

Photographs of the existing site are provided in **Appendix A**.

Hydrological setting

The site is bounded to the east by the tidal River Thames and to the south by the wider operational BRM facility, which extends approximately 350m southwards - beyond that is the industrial Seacon Terminals Ltd freight facility. To the west (and on the opposite side of Manor Way), is the freshwater Botany Marsh (**Photograph 1, Appendix A**), which comprises a network of drainage ditches, ponds, former grazing marsh, rough grassland and scrub. The marsh is partly owned by BRM and the company has a management plan in place to maintain the environmental value of the land owned by BRM. The marsh was recently notified by Natural England as a nationally significant Site of Special Scientific Interest (SSSI).

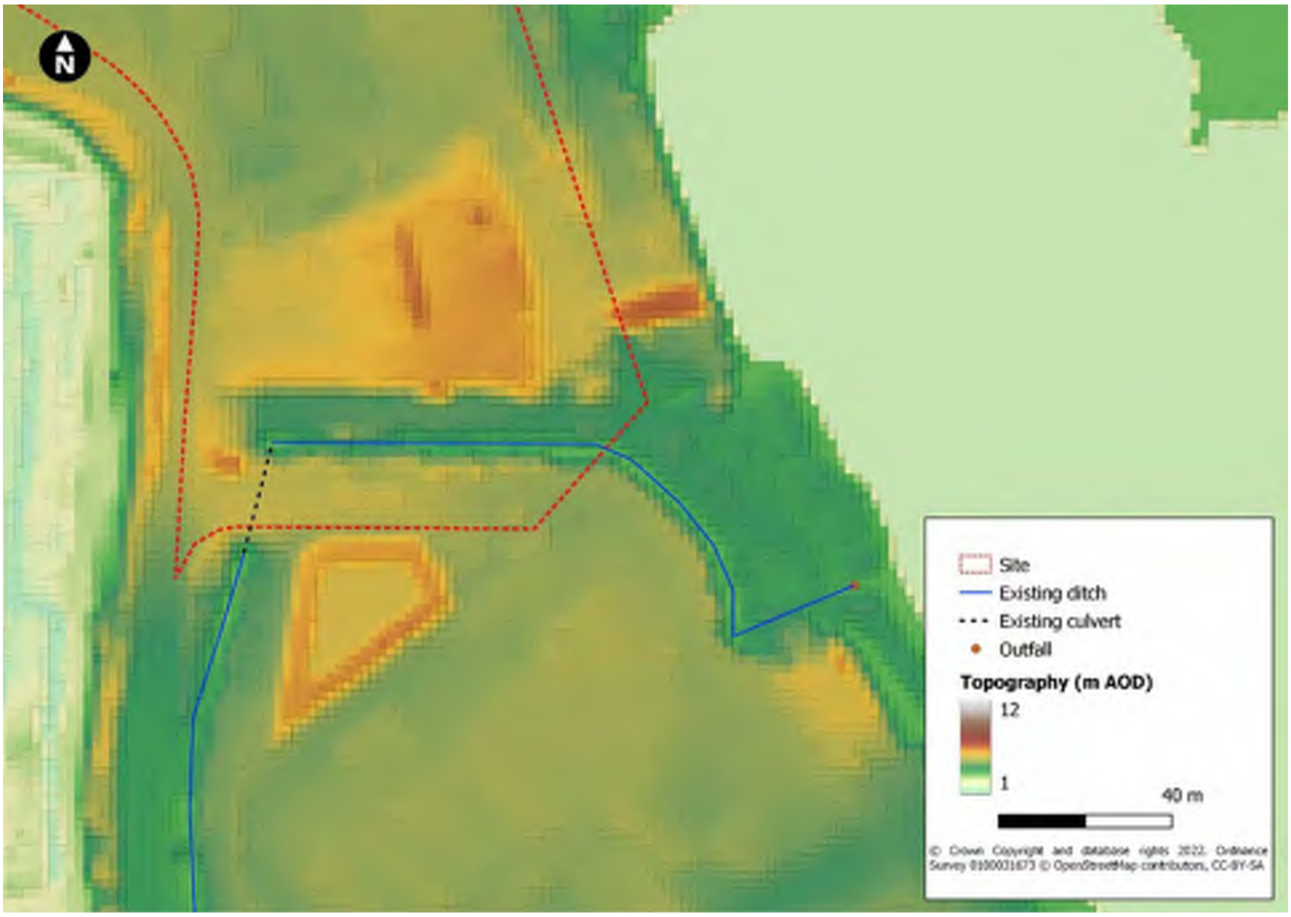
The nearest EA designated main river to the site is within Botany Marshes to the west (as shown in **Figure 2.2**), referred to hereafter as the Swanscombe Channel. The watercourse is understood to be fed from discharge from Eastern Quarry, dewatering of HS1 and local runoff, and drains to the River Thames under a combined gravity and pump driven outfall.

Figure 2.2 Hydrological setting

An existing drainage swale runs along the southern boundary of the site, draining from the south (running along the western perimeter of the existing BRM site) before turning east and towards an its outfall to the tidal River Thames (**Photograph 7**, **Appendix A**). The outfall is understood to be an EA asset, as shown in **Figure 2.5** and discussed further in the drainage strategy, **Appendix D**.

The swale is classified as a linear drainage feature as opposed to an ordinary watercourse which have been defined based on the Ordnance Survey Open Rivers dataset. Hence, the swale not mapped in the above **Figure 2.2** and is understood to drain the local BRM site only, though the exact contributing catchment is subject to further investigation. There is no connection beneath Botany Road to the ordinary watercourses within Botany Marsh to the west. The ditch is visible within the topography as mapped in **Figure 2.3** below, and photos of the ditch are provided in **Appendix A**. The bed elevation of the swale is approximately 3.5m AOD (Above Ordnance Datum) as represented by the EA LiDAR data, and there is no evident gradient along the swale.

Figure 2.3 Southern boundary swale

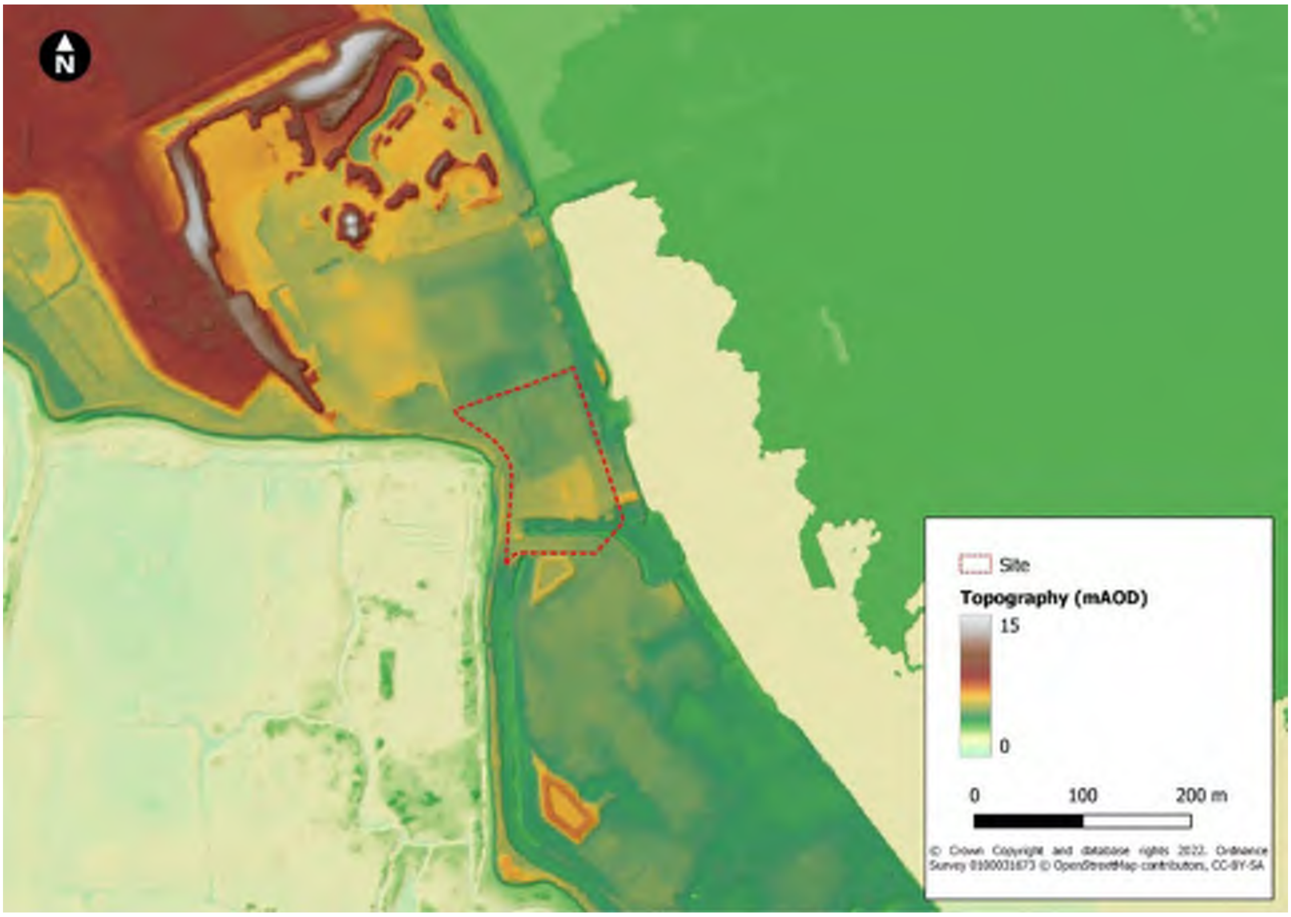


Topography

Topography of the site and surrounding area has been defined by the EA Digital Terrain Model (DTM) data, as shown in **Figure 2.4**. The site is relatively flat, situated at elevations between 4.5m to 6.5m AOD. The southern, vegetated portion of the site lies on a slightly elevated platform with elevations of 5.5m to 6.5m AOD, and dropping down to around 4m AOD at the southern boundary of the site into the existing drainage ditch.

The site is bounded by an elevated, discontinuous bund to the west of the site which runs along the perimeter of Botany Marshes, with a crest elevation typically between 5.5m to 6.0m AOD. Elevations within the marshes drop to 1.5m AOD.

Figure 2.4 Topography



Soils, geology and hydrogeology

Assessment of the British Geological Survey (BGS) Geology of Britain Viewer data shows that the Site is underlain by sedimentary bedrock, consisting of the Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) - Chalk. The entire site is underlain by superficial deposits of alluvium - clay, silt, sand and peat.

LandIS Soilscapes mapping indicates that the Site is underlain by Loamy and clayey soils of coastal flats with naturally high groundwater.

The bedrock geology beneath the site is classified as a Principal aquifer, comprising permeable layers that have high intergranular and/or fracture permeability, meaning they usually provide a high level of water storage and transmission. Principal aquifers provide significant quantities of drinking water, and may also support rivers, lakes and wetlands. The superficial Alluvium deposits across the Site is classified as a Secondary undifferentiated aquifer, where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type.

Owing to the geology, the bedrock layers are likely to harbour large volumes of groundwater, and the groundwater level is likely to be close to the surface.

Flood defence assets

The site is bordered by existing flood defences that run along the eastern perimeter to the tidal River Thames. These consist primarily of a flood wall (shown in **Photographs 3** to **5**, **Appendix A**), in addition to a series of flood gates and outfalls, as shown in **Figure 2.5**. Only a short section (approximately 30m) of the eastern perimeter floodwall is included within the Flood Map for Planning (FMfP). This is typically as the Environment Agency either do not hold full, sufficient detail on the defence condition and Standard of Protection (SoP) or these do not meet minimum requirements. The EA acknowledge that there is ongoing data improvement and review of these datasets.

The area is though mapped as benefitting from flood defences indicting a degree of confidence in defence performance. The spatial flood defence data indicates that the perimeter flood walls have a SoP of 0.1% AEP (1-in-1000 year). Crest elevations vary between 6.67m AOD to 6.95m AOD immediately adjacent to the site, though the lowest crest elevation along the wall within the wider vicinity of the site is 6.32m AOD. EA inspection records indicate that the existing flood defences are in ‘Fair’ (rated 3) to ‘Good’ (rated 2) condition.

There are two flood gates that run along the eastern perimeter flood wall of the site, photos of these are included in **Photograph 2** and **Photograph 6**, **Appendix A**. Each of these gates are indicated (by EA inspection records) to be in ‘Good’ (rated 2) condition.

There are three outfalls indicated within the EA’s AIMS structures dataset within the wider surrounding area, the closest of which is situated approximately 60m southeast of the site boundary (asset ID: 263586) and is the outfall for the existing drainage swale serving the BRM site. Detailed design drawings for the outfall are included in Appendix F of the Drainage Strategy (see **Appendix D**). The EA dataset indicates this outfall as being privately owned and thought to be decommissioned, though this is incorrect given its current use to drain the BRM Site.

Figure 2.5 Title here – this is an auto-numbering Quick Part – F then F3

Further information regarding the responsibility for flood defences are summarised in **Section 3.4**.

2.2 Development proposals

The development proposals consist of a small facility to sample and process waste electronics material (also known as an E-scrap facility) to the north of their site off Manor Way, Northfleet. This process involves the shredding of E-scrap to allow material laboratory analysis.

E-scrap comprises discarded, shredded electronic materials from computers, mobile phones, circuit boards, hard-drives, etc. It contains a complex and heterogenous mix of product types and materials, some of which are potentially hazardous (including cadmium, lead, mercury and certain flame retardants). Hazardous waste is defined (in England) within the Hazardous Waste (England and Wales) Regulations 2005 as *"any waste with hazardous properties that may make it harmful to human health and the environment"*.

An indicative site layout is set out in attached drawing 808678-WOOD-ZZ-XX-DR-Z-00001 (**Appendix B).** As can be seen from this layout, the development essentially comprises:

- A proposed main building of steel framed structure approximately (~) 90m (at its longest side, ~81m on its shorter side) x~ 65m wide x ~17.7m high to the top of the pitch.
- A firewater tank of ~7.9m diameter and 9m high and associated adjacent pump house at ~3m x 5m x 4.7m high.
- Dust extraction infrastructure ~5m x 25m x 7.0m high.
- An electrical switchgear/ motor control centre (MCC) and data room ~5m x 25m x3.5m high.
- An electrical sub-station ~5m x 5m x5m high.
- A welfare building ~9m x 6m x 4m high.
- Areas of asphalt (~250m^2 for footways) and concrete hardstanding (~4,650m2).
- Swales and an interceptor for drainage of surface water.
- A new sheet piled flood wall at a height of 8.0m AOD (see drawing in **Appendix B**) and at a distance of 12m from the proposed steel framed building, to be constructed the full eastern length of the proposed development site on the seaward side of an existing flood wall, which will be removed upon completion of the new wall. The new sea wall would also include construction of a flood gate at its northern end to facilitate access to an existing safeguarded wharf area.
- Associated site fencing and landscaping.

The proposed E-scrap facility would have a maximum throughput of 25,000 tonnes per annum (tpa), with up to approximately 4 weeks covered on-site storage equating to ~2,500 tonnes of E-scrap. The site would receive deliveries of up to 125 tonnes per day of E-scrap via 5 HGVs (each with a 25-tonne payload). Deliveries would be made over five days each week (Monday to Friday) and all deliveries would be made within daytime hours. In terms of despatch of the shredded and bagged E-scrap, it is envisaged that the loaded containers would be transported via road to a proximate shipping container terminal via road on an average of five 25 tonne payload HGVs per day. Access and egress from the site would be via an existing access point off Manor Way (utilising an existing gatehouse, wheel-wash and weighbridge in the BRM site).

The proposed design life of the facility is 25-years, which is in accordance with other BRM facilities.

In accordance with discussions with the EA over late 2022 into early 2023, and the Thames Estuary 2100 plan (TE2100) outlined below in **Section 3.3**, the proposed development will incorporate a new 8.0m flood wall to replace the existing flood wall (for drawing, see **Appendix B**). This will provide a SoP exceeding the 0.1% AEP event throughout the development lifetime.

3. Planning considerations

3.1 National Planning Policy Framework (2021)

NPPF states (paragraph 167, footnote 55) that a Site-specific Flood Risk Assessment (FRA) is required for development proposals of 1 hectare (ha) or greater in Flood Zone 1, all proposals for new development located in Flood Zones 2 and 3, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency); and where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding. A FRA has been prepared given the Site area exceeding 1 ha.

3.2 Sequential Test and Exception Test

Sequential Test

The NPPF and the accompanying Flood risk and coastal change guidance document describe the principles of the Sequential Test[4], which aims to steer new development to areas with the lowest probability of flooding (NPPF, 2021. Para 162). The Sequential Test is a decision-making tool designed to promote sites at the lowest risk of flooding in preference to sites in areas of higher risk.

The proposed main building, in NPPF terms, is considered to be 'More Vulnerable' (Waste treatment facilities for hazardous waste) as given in Table 2 in the NPPF Flood risk and coastal change Guidance[5]. The associated welfare building is considered to be 'Less Vulnerable'.

As the main building constitutes a 'More Vulnerable' development and is within Flood Zone 3, the Sequential Test is required.

The site is considered to be a suitable location for the facility given that the area is already under ownership of BRM and borders the existing BRM facility immediately south of the site. The site is adjacent to the Seacon terminal from which the E-Scrap would be exported to Germany. The site also has well-established access via Botany Road to the A226. The entire wider surrounding area around the site is situated within Flood Zones 2 and 3, and hence, any potential sites within Flood Zone 1 would be at a minimum of 900m south of the proposed site. As outlined in **Section 3.4,** there is considerable support within the Gravesham Local Plan for further development and retention of industrial activities in the area. Therefore, the Sequential Test is considered to be passed.

Exception Test

The Exception Test, as set out in paragraph 163 of the NPPF, is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.

Table 3.1, reproduced from the NPPF online flood risk matrix, indicates that, for *'More Vulnerable'* development within Flood Zone 3a the Exception Test need to be applied.

[4] National Planning Policy Framework (publishing.service.gov.uk) (accessed June 2022)
[5] https://www.gov.uk/guidance/national-planning-policy-framework/annex-3-flood-risk-vulnerability-classification (accessed June 2022)

Table 3.1 Flood Zone definitions and associated annual exceedance probability

Flood Risk Vulnerability Classification	Essential Infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Flood Zone 1	✓	✓	✓	✓	✓
Flood Zone 2	✓	Exception Test required	✓	✓	✓
Flood Zone 3a	Exception Test required*	✗	Exception Test required	✓	✓
Flood Zone 3b	Exception Test required**	✗	✗	✗	✓**

✓ Development is appropriate
✗ Development should not be permitted
*In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.
** In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to remain operational and safe for users in times of flood; result in no net loss of floodplain storage; not impede water flows and not increase flood risk elsewhere.

Paragraph 164 of the NPPF outlines the requirements of the Exception Test:

"To pass the exception test it should be demonstrated that:

a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and

b) the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall."

Both elements of the Exception Test should be satisfied for development to be allocated or permitted.

Given the Site is previously developed and currently comprises an operational facility, plus is landward of a flood defence, it is not considered to be situated within Flood Zone 3b (functional floodplain). In addition, the Site is bordered by existing operational sites of similar nature to the proposed Site, and it is recognised with the Gravesham Local Plan Core Strategy (as summarised in **Section 3.4**) that there is considerable support for further development and retention of industrial activities in the area.

The proposed land use is similar to the existing and surrounding use (albeit for more hazardous material) and avoids the need to site the facility in a less suitable location elsewhere. The redevelopment of previously developed land and its use for recycling electronic waste brings wider sustainability benefits to the community. The facility would contribute, in line with the overall UK government policy and the Kent Waste Disposal Strategy (2017-2035) [6], by managing waste as high up the waste hierarchy as possible: considering waste as a resource from which to recover some value and looking to disposal as the last option. It is therefore demonstrated that the first requirement of the Exception Test is satisfied.

[6] https://www.kent.gov.uk/__data/assets/pdf_file/0008/67094/Kent-Waste-Disposal-Strategy-Evidence-Base.pdf (Accessed June 2022)

To meet the second requirement of the Exception Test this FRA demonstrates that the development will be safe over its lifetime, taking into account the vulnerability of its users and without increasing flood risk elsewhere. Part 2 of the Exception Test is discussed further in **Section 7**.

3.3 Regional Planning Context

Thames Estuary 2100 Plan

The Thames Estuary 2100 (TE2100) Plan (November 2012) [7] sets out the Environment Agency's recommendations for the management of flood risk in London and the Thames Estuary to the end of the century and beyond.

The site is situated within the Swanscombe and Northfleet policy unit, identified in Action Zone 5 with the recommended flood risk management policy P4. The unit is identified to be at risk from tidal, fluvial, local drainage (and groundwater in Swanscombe & Northfleet) sources of flooding.

The TE2100 Plan and supporting documents defines the level the River Thames tidal flood defences must be raised at certain dates in the future in order to accommodate rising flood levels caused by climate change. Adjacent to the site, it is noted in the TE2100 modelling study**Error! Bookmark not defined.** that flood defence levels will need to be raised to 8.00m AOD to continue to provide the required SoP for the 0.1% AEP flood level (accounting for uncertainties), for the period 2070 to 2170. This is the most conservative level required assuming option 3.2 (discussed further below) is taken forward.

The TE2100 Plan states that the Thames Barrier is expected to continue to protect London to its current standard up until 2070. The Plan indicates that there are currently three options for improving tidal defences in the River Thames as follows:

- Option 1.4: Upgrade the existing Thames Barrier;
- Option 3.1: Construct a new barrier at Tilbury, and;
- Option 3.2: Construct a new barrier at Long Reach.

The TE2100 is an adaptive plan and as such, the final preferred option is unlikely to be made until closer to 2050.

3.4 Local Planning Context

Kent Thameside Strategic Flood Risk Assessment (2005 and as updated in 2009)

The Kent Thameside SFRA has been carried out in three stages. The Stage 1 SFRA[8] report provides a review of the baseline date obtained for the purposes of carrying out the SFRA. The Stage 2 SFRA report was prepared to identify:

- Areas and principal development sites that are at risk of flooding;
- Variations in flood risk within Flood Zone 3, including the presence and standard of any flood defences;

[7]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/322061/LIT7540_43858f.pdf (accessed June 2022)

[8] http://windmz.dartford.gov.uk/media/Eb53%20SFRAReport.pdf (accessed June 2022)

- The effect of flood defence failure by breaches in the flood defences, and;
- The effect of the increase in surface water run-off from Proposed Development.

The Stage 3 SFRA[9] report provides an assessment of the residual risk to development areas following the modelling and flood risk mapping carried out in Stage 2.

The primary flood risk to Kent Thameside (and to the Proposed Development) is from a tidal surge in the River Thames, either through overtopping or failure of the existing flood defences along the riverbank. The focus of the SFRA is therefore on the consequences of the defences being overtopped by an extreme high tide and of the failure of the defences resulting in a breach event.

The SFRA provides commentary on the responsibility for flood defences and the laws in place that require works undertaken close to defences as summarised below:

"…the responsibility for provision, maintenance and improvement of flood defences rests with the riparian owner. The Environment Agency (EA) has no statutory duty to do this work, it does, however, have permissive powers to undertake flood defence works."

Kent County Council, Preliminary Flood Risk Assessment (2011)

The Kent County Council, Preliminary Flood Risk Assessment (PFRA) (2011) [10] has been prepared to identify areas in which the risk of surface water and groundwater flooding is significant and warrants further examination through the production of maps and management plans. The document identifies surface water flooding and groundwater flooding as being sources of high risk to properties in Kent. Kent has the greatest number of properties at risk from surface water flooding than any other LLFA in the UK.

Figure 4[11] included within the PFRA indicates that the Site is outside of any are of historic sewer flooding, and there are no records of any other recorded flood events at the Site or within the immediate vicinity. Three historic incidents are mapped approximately 700m south of the Site. Figure 6[12] indicates that the Site is within a region of 'Low' groundwater flood risk.

Kent County Council Draft Local Flood Risk Management Strategy (2017)

The Kent County Council Local Flood Risk Management Strategy (2017) [13] presents a strategy for managing risk for the period 2017 – 2023. This document is an update to the KCC local strategy developed in 2013 for the period 2013 – 2017. The document identifies six geographical areas as focus areas for local flood risk management. The Project Site is not included in any of these areas.

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[9] https://geosmartinfo.co.uk/wp-content/uploads/2020/03/Strategic_Flood_Risk_Assessment_Update.pdf (accessed June 2022)

[10] https://www.kent.gov.uk/__data/assets/pdf_file/0013/12091/Preliminary-flood-risk-assessment.pdf (accessed June 2022)

[11] fig4-floodevents1.pdf (kent.gov.uk) (accessed June 2022)

[12] fig6-groundwater1.pdf (kent.gov.uk) (accessed June 2022)

[13] https://www.kent.gov.uk/__data/assets/pdf_file/0010/79453/Local-Flood-Risk-Management-Strategy-2017-2023.pdf (accessed June 2022)

Kent County Council Thameside Stage 1 Surface Water Management Plan (2013)

The Kent County Council Thameside Stage 1 Surface Water Management Plan (SWMP) (2013) [14] study area combines both Gravesham and Dartford, located southeast of London and west of Medway. This study area includes the Project Site.

The SWMP indicates that tidal flooding occurred in 1953 as a result of defences being breached and impacting 180 properties adjacent to Botany Marshes. The SWMP also identifies the Site as within a Zone III Source Protection Zone (SPZ).

Gravesham Water and Flood Risk Background Paper (2020)

The Gravesham water and flood risk background paper[15] provides context for draft policies to be adopted through the emerging Local Plan. The paper includes a review of strategic policies to guide development and management policies to address what needs to be considered in planning applications.

The paper aims to provide a current baseline review of flood risk local to Gravesham and provides a summary of the council's understanding of future defence upgrades. Specific to the project site, it is likely that defences will need to be raised by circa 0.3m by 2040, associated with the new north-south defence to be built to the east of Gravesend, with further upgrades anticipated in 2070 and 2120. The paper outlines a number of implications regarding flood defence upgrades and future development, stating that developments on the waterfront will need to address long term flood defence issues by either providing upgraded defences or by coming to some form of accommodation with the EA to deliver upgrades through partnership working.

Gravesham Local Plan Core Strategy (adopted 2014)

The Gravesham Local Plan Core Strategy is the main document in the Gravesham Local Plan (a collection of planning documents that will be used to plan the future of Gravesham Borough and to determine individual planning applications) and represents the overarching strategic document[16]. The site is situated entirely within the Gravesham Borough Council.

The Gravesham Local Plan Core Strategy sets out a vision for Gravesham which includes reinventing and regenerating the borough from an area with predominantly heavy riverside industry to one that offers a more diverse range of employment and housing. The site is situated within the Swanscombe Peninsula East Riverside Industrial Area, part of the wider Northfleet Embankment and Swanscombe Peninsula East opportunity area. The strategy states that retention and expansion of industrial and port related employment in this area will be supported, and there is significant planning policy support for development in this location. Support for development in this location is outlined in the below text:

- **Policy CS02 (Scale and Distribution of Development)** – *"Priority will be given to developing in the urban area, which will be achieved by (amongst other things) by promoting regeneration by prioritising the redevelopment and recycling of underused, derelict and previously developed land in the urban area. This will be principally through redevelopment of former industrial sites in the Opportunity Areas of Northfleet Embankment and Swanscombe Peninsula East, and Gravesend Riverside East and*

[14] https://www.kent.gov.uk/__data/assets/pdf_file/0010/50023/Thameside-Stage-1-SWMP-Report.pdf (accessed June 2022)

[15] https://localplan.gravesham.gov.uk/gf2.ti/f/1210690/83697125.1/PDF/-/Gravesham_Water_and_Flood_Risk_Background_Paper.pdf (accessed August 2022)

[16] https://drive.google.com/file/d/1bJTgQLmhbzjqZFibl-5WFb2tbvixXpLk/view (accessed June 2022)

Northeast Gravesend to create new residential neighbourhoods and employment areas.”

- **Policy CS03 (Northfleet Embankment and Swanscombe Peninsula East Opportunity Area)** – *“The Northfleet Embankment and Swanscombe Peninsula East Opportunity Area is a substantial opportunity for major riverside regeneration in Gravesham. Development will bring significant benefits to existing adjoining residential communities and the Borough as a whole through the delivery of new housing and jobs whilst achieving environmental improvement, especially in air quality, and a high standard of design.”*

The plan goes on to state that the Swanscombe Peninsula East Riverside Industrial Area, Kimberly Clark Site and Imperial Business Estate will be retained in employment use and that the Council will support proposals which expand and support their operation. In respect of the wider Opportunity Area, the Plan states at paragraph 4.4.1:

“There are clear opportunities in this location to make more efficient use of the land, facilitate river-related activity, accommodate new development and secure environmental improvement as part of the wider regeneration of the area.”

Specifically, in respect of the sub-divided Swanscombe Peninsula East Riverside Industrial Area, the Plan states at paragraph 4.4.5 that:

“Swanscombe Peninsula East Riverside Industrial Area (sub-area 1.2) comprises mainly industrial and port-related uses that sit behind the existing tidal flood defences. Access to this area is from the junction with the A226 at Galley Hill Road and a narrow privately maintained road. It is anticipated that this area will remain in active employment uses over the plan period. The retention and expansion of industrial and port related employment in this area will be supported.”

4. Flood Risk Appraisal

4.1 Flood Risk Appraisal Methodology

For this flood risk appraisal, the following methodology has been applied:

- The general context of the proposal, local hydrological context and relevant planning have been set out in **Sections 1, 2** and **3**. For the flood risk appraisal, the available data has been used to undertake an initial screening, which is presented in **Table 4.1**.
- The key sources of flood risk identified by this screening are then assessed further against all available information in the remainder of this report section. Where additional reports on an aspect of flood risk are available (i.e. a council investigation into surface water flood risk), these are referenced within the relevant section.

4.2 Design criteria

The Standard of Protection (SoP) for the Proposed Development varies based on the vulnerability and lifetime of the development proposals. The proposed lifetime of the project is 25-years, however, this is contrary to the NPPF and Planning Practice Guidance[17] which suggests using a 75-year design life for non-residential development as a starting point. Therefore, a 75-year design life has been assumed, to provide a conservative approach.

The following criteria forms the basis of the flood risk management strategy:

- All development across the site protected to the year 2100 as a minimum, considering an assumed project lifespan of 75-years;
- Safe access and egress from buildings; and
- Formal flood defences to have a SoP for the 0.1% AEP tidal event in the future.

Based on the EA sea level rise projections, the year 2100 has been used to estimate the flood risk for the 75-year design life. The design flood event has subsequently been identified as follows:

- 0.5% AEP tidal overtopping event for 2100, using the Upper End allowance (considering the More Vulnerable development classification); and
- 0.5% AEP breach flood event for 2100, using the Upper End allowance (considering the More Vulnerable development classification).

4.3 Historic flood records

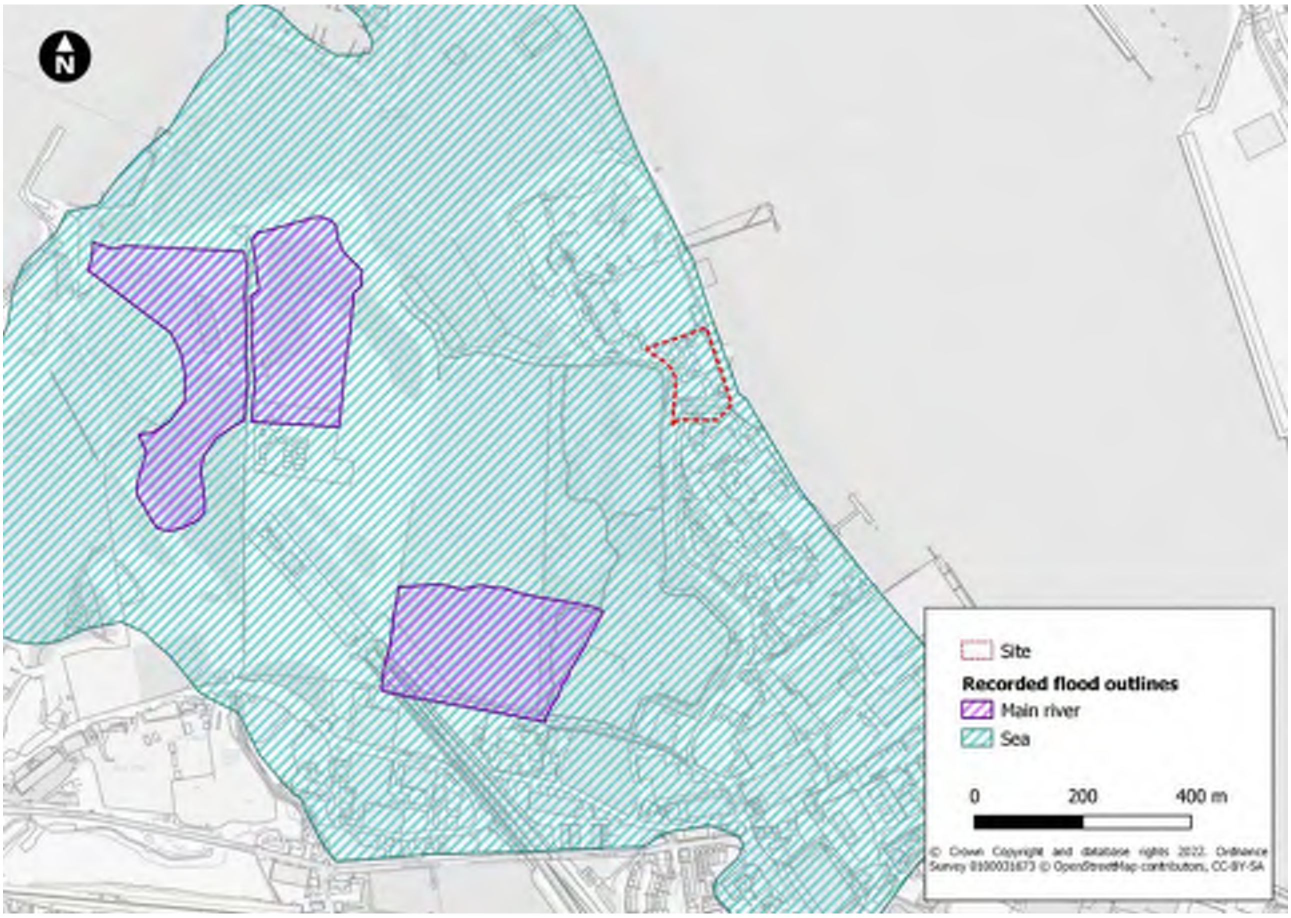
The most significant historical event that has impacted the Site was the 1953 North Sea Flood. An extreme extratropical cyclone moved south along the east coast of the UK and coincided with high spring tides, producing a storm surge that flooded significant areas of the east coast. The approximate return period of the event was estimated as 200-years, with an estimated level in the River Thames of 4.90m AOD, as advised by the EA. The tidal event coincided with a relatively low fluvial flow of 74m^3/s. In general, defence crest levels were raised by around 1m immediately after the 1953 event[1]. As shown in **Figure 4.1**, the flood event extended across the entire Site. The Botany Marshes to the west of the Site have been historically subject to fluvial (main river) flooding,

[17] https://www.gov.uk/guidance/flood-risk-and-coastal-change#para6 (accessed September 2022)

with recorded flood outlines mapped for the 1968 rainfall event ('The Great Flood of 1968'). However, flood outlines for this event are confined to the low-lying marshes only.

No records of local surface water flooding within the vicinity of the Site have been communicated by KCC.

Figure 4.1 EA recorded flood outlines



4.4 Flood risk screening

All potential sources of flooding have been considered and an initial screening undertaken to determine those requiring further consideration in the sub-sections below, as summarised in **Table 4.1**.

Table 4.1 Screening

Source	Comments	Screened in?
Fluvial	The EA Flood Map for Planning (FMfP) indicates that the Site is located within Flood Zone 2 and 3, and within an area benefitting from flood defences. The River Thames adjacent to the site is not considered as a designated EA main river, and therefore assessment of flood risk to the Site from the River Thames is considered as tidal flood risk, discussed in the sub-section 4.5 below. There are no additional watercourses within the vicinity of the Site that could pose a fluvial flood risk to the Site.	No

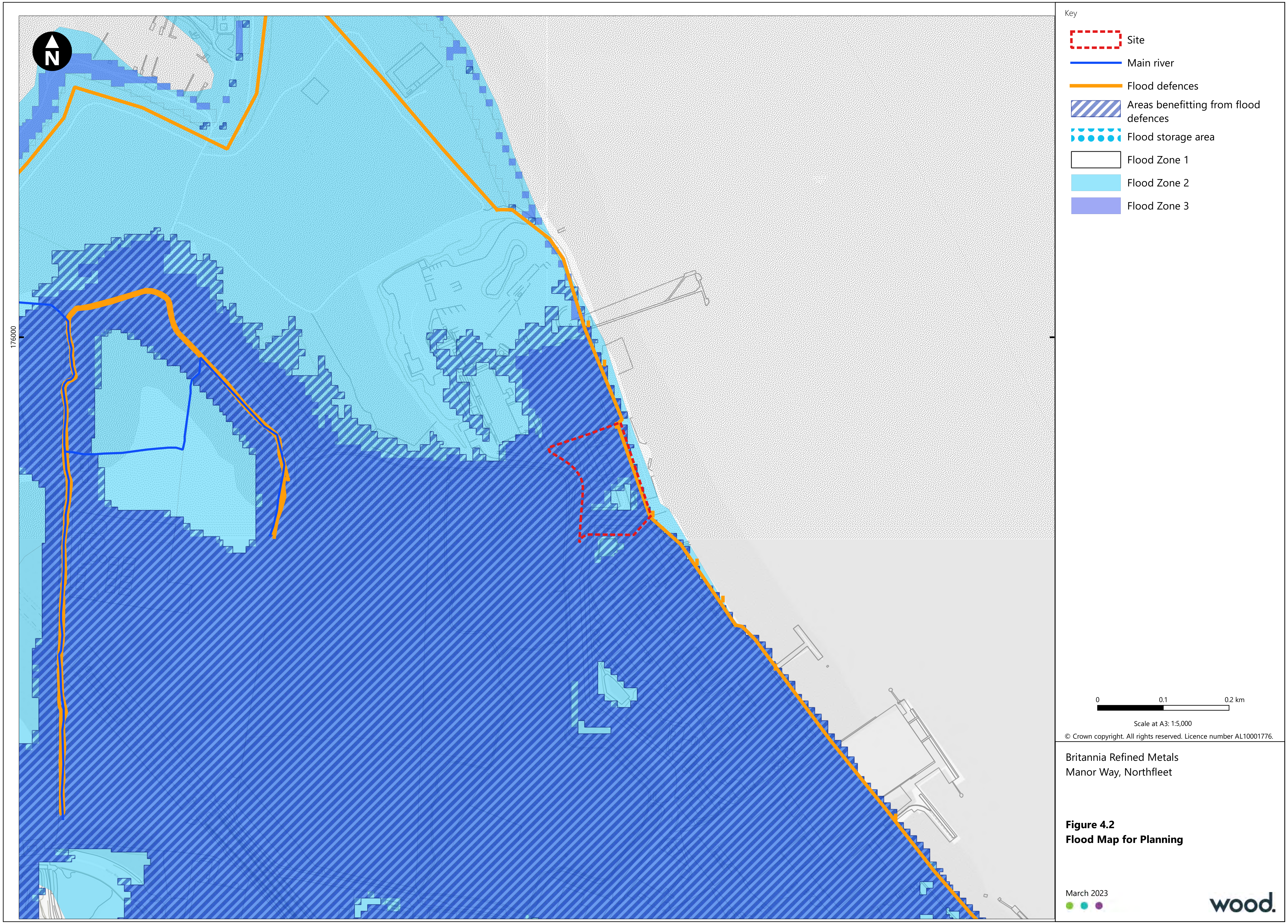
Source	Comments	Screened in?
Tidal	The Site is situated on the southern bank of the tidal River Thames and within Flood Zones 2 and 3. In addition, the Site is indicated as being within the 1953 historic flood extent, associated with a failure of the tidal defences. Therefore, the risk of tidal flooding to the Site is considered further in the sub-section 4.5 below.	Yes
Surface Water Flood Risk	The Site is primarily at Very Low risk of surface water flooding, as mapped within the EA Risk of Flooding from Surface Water (RoFSW). Some isolated regions of Low (1% AEP to 0.1% AEP) and Medium (3.33% AEP to 1% AEP) risk are mapped in the northern portion of the Site coincident with minor topographic depressions. Surface water flood risk is considered for further assessment in sub-section 4.6 below.	Yes
Groundwater	The Site is underlain by Chalk, classified as a Principal Aquifer with high intergranular and/or fracture permeability with an elevated risk of groundwater flooding issues. The Site is mapped as within a 'Low' region groundwater flood risk as indicated in the KCC PFRA[12], however, it is understood that groundwater levels within the region are kept artificially low as a result of dewatering activities at Eastern Quarry[9]. Therefore, groundwater flood risk to the site has been considered further in sub-section 4.7 below.	Yes
Artificial flooding	The Site is situated outside of the EA mapped risk of flooding from reservoirs dataset. Review of aerial imagery suggest that there are no additional raised waterbodies within the vicinity of the Site that could pose a risk of flooding in the event of a failure. As a consequence, the risk of flooding from artificial sources has not been considered for further assessment.	No
Sewer flooding	The 2011 PFRA[11] indicates that there are no mapped incidents of sewer flooding within the vicinity of the Site. As a consequence, the risk of flooding from sewers to the Site has not been considered further.	No

4.5 Tidal flood risk

Overtopping

The main flood risk to the site is via tidal flood risk, an element of which is from the overtopping of the existing EA defences that run along the eastern perimeter of the site. **Figure 4.2** shows that the site is entirely within Flood Zone 2, and the vast majority is within Flood Zone 3 in an area benefitting from flood defences. The flood wall running along the northeast perimeter of the site has crest elevations of between 6.67m AOD to 6.95m AOD immediately adjacent to the site, though the lowest crest elevation along the wall within the wider vicinity of the site is 6.32m AOD approximately 300m north of the site. Based on review of topographic levels, it is anticipated that overtopping of this section of wall would impact the site, and therefore this level is considered to be the threshold level for overtopping flooding mechanisms to the site.

Figure 4.2 Flood Map for Planning



Britannia Refined Metals
Manor Way, Northfleet

Figure 4.2
Flood Map for Planning

March 2023

wood.

TE2100 model results

The EA have provided in-channel design water levels output from the TE2100 1D ISIS model for the 0.1% AEP event, indicated in Table A.5 of the design water levels and future defence crest levels report[2] and reproduced in **Appendix C**. These model results have been used to assess the risk of tidal flooding to the site via overtopping of the flood defences.

The site is situated between nodes at 'Grays' (node reference '3.22') and Tilbury (node reference '3.23'). The Grays model node provides the most conservative estimate of flood risk and has therefore been used for this assessment.

The associated extreme tidal levels are generated based on a 2005 baseline year, and therefore need to be uplifted to inform the present-day risk. Flood levels have been uplifted based on the latest EA sea level rise allowances[18] for the Thames River Basin District and using the 'Upper End' allowance assuming the most conservative approach, reflective of the vulnerability of the development. The levels have also been uplifted to provide the future climate change levels for 2100, assuming a 75-year design life as shown in **Table 4.2**.

Table 4.2 TE2100 model in channel extreme tidal levels

	2005		**2022 (Upper End)**		**2100 (Upper End)[1]**	
AEP	Grays (3.22)	Grays (3.22)	Grays (3.22)	Tilbury (3.23)	Grays (3.22)	Tilbury (3.23)
0.1% AEP	5.86	5.85	5.98	5.97	6.93	6.92

[1]Flood levels in red are above the lowest adjacent flood wall crest level of 6.32m AOD, and therefore flooding would be anticipated on site under these events.

Based on review of the tidal flood levels and crest elevations of the flood walls within the vicinity of the site, the site is currently defended to a SoP exceeding the 0.1% AEP event. The current risk of tidal overtopping to the site is therefore considered to be low. However, assuming no change to the existing defences, the site and proposed development will be at risk of tidal overtopping in the future (within the lifetime of the development). Therefore, and as outlined in **Section 2.2**, the flood wall will be increased to 8.0m AOD as part of the development to provide a SoP exceeding the 0.1% AEP event throughout the development lifetime.

The risk of tidal overtopping to the current and future site is therefore considered to be low.

Breach

The entire site is within a region benefitting from flood defences. Therefore, there remains a residual flood risk to the site via breach or failure of defences, which may include structural failure or simple human failure (for example, failing to close a flood gate during an extreme event). The probability of a breach event occurring is deemed to be extremely low, though the potential consequence is high. The residual risk to the site is marked as High – Very High in Figure 7.3 of the Kent Thameside SFRA[8].

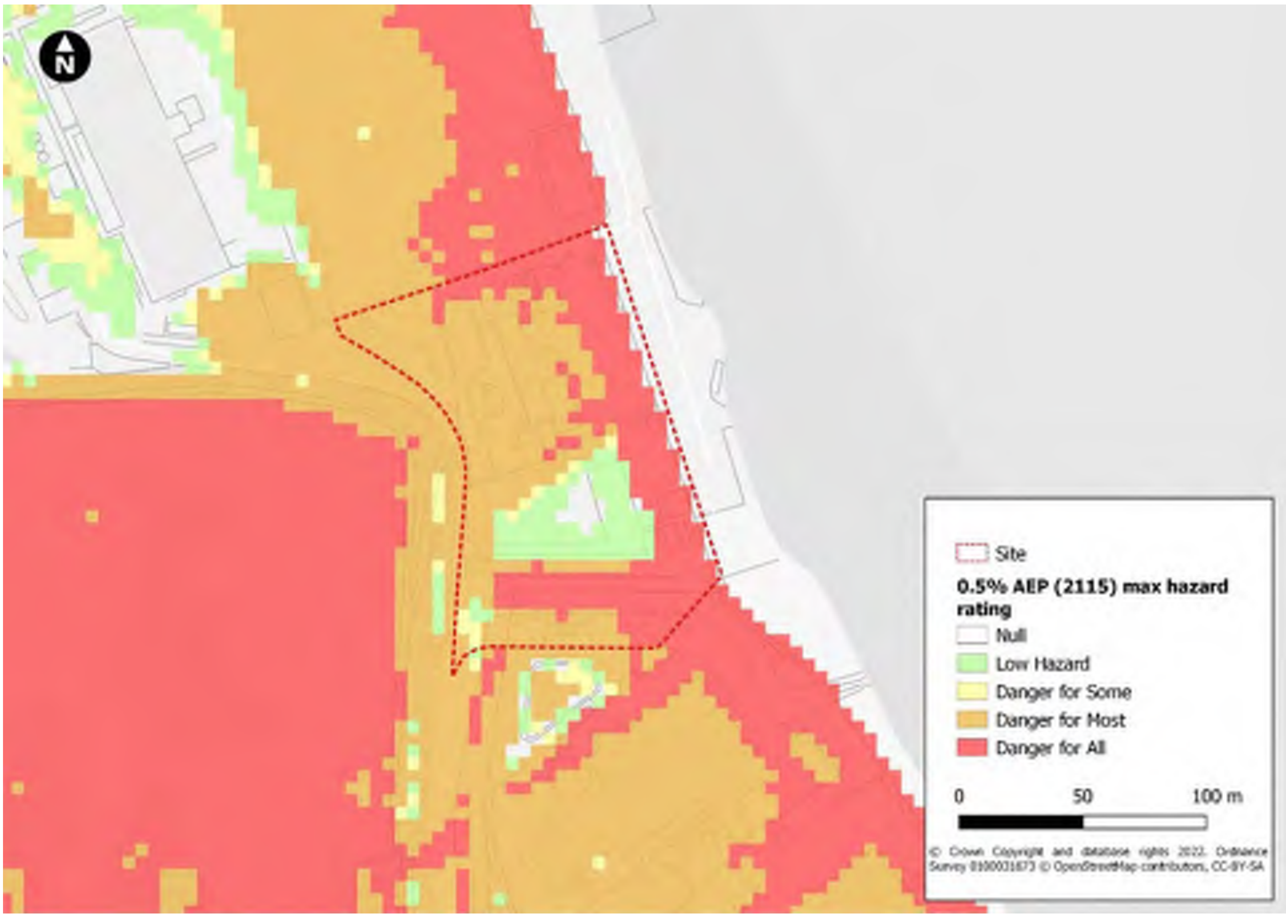
[18] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances (accessed August 2022)

Thames Estuary Breach Assessment

The EA have provided model outputs from the Thames Estuary Breach Assessment study undertaken in 2018 by Atkins, on behalf of the EA[3]. The study aims to quantify the results of flood defence breaches at key locations along the Thames defences, simulating return periods of 0.5% AEP and 0.1% AEP for the 2005 epoch and 2115 epoch. The individual breach output results have been combined to form composite outputs, to provide the most conservative estimate of residual risk within the defended floodplain. The composite max hazard results for the 0.5% AEP 2115 event are shown in **Figure 4.3**.

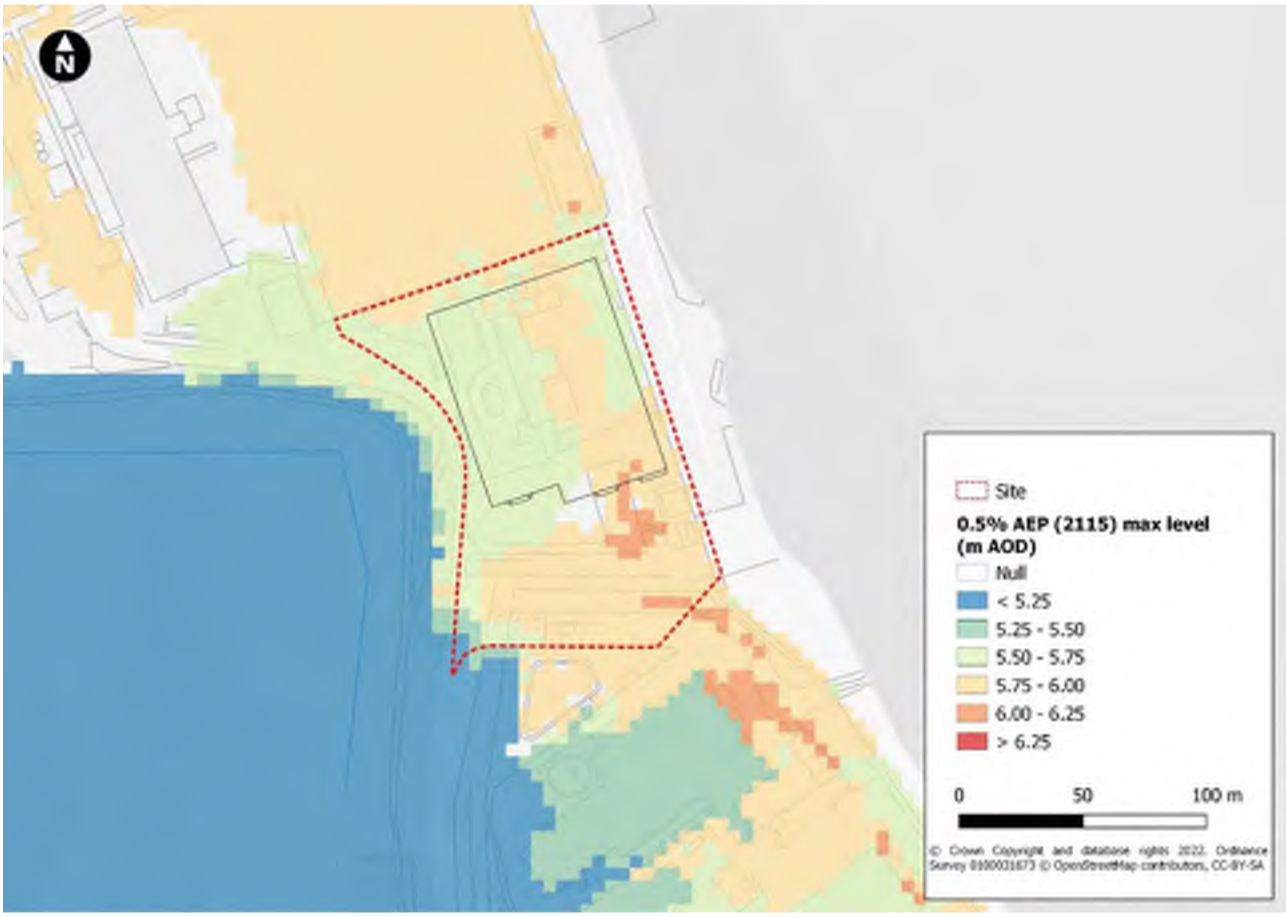
The EA have advised to use this event to determine the design flood event for the development. It is acknowledged that this is a conservative approach given the proposed development lifetime of 25 years (end of design life 2050). However, this is contrary to the NPPF Planning Practice Guidance which suggests using a 75-year design life for non-residential development as a starting point, and hence the 2115 epoch results have been used as the basis for this assessment.

Figure 4.3 Thames Estuary Breach Assessment – 0.5% AEP 2115 max hazard



The majority of the site is at considerable risk in the event of a breach, with associated hazard ratings predominantly moderate (Danger for Most) to high (Danger for All). Peak flood levels across the site for this event are shown in **Figure 4.4**. Peak levels are predominantly between 5.7m AOD and 6.0m AOD across the site, with a maximum flood level of 6.05m AOD. The maximum level has been taken forwards given the development's proximity to the defence.

Figure 4.4 Thames Estuary Breach Assessment – 0.5% AEP 2115 max level



The peak flood level of 6.05m AOD has been incorporated with a freeboard allowance of 600mm, in accordance with the TE2100 design water level guidance[2] for floodplain development, to account for the inherent uncertainty in the data and associated modelling. This provides a conservative **design flood level of 6.65m AOD**.

4.6 Surface water flood risk

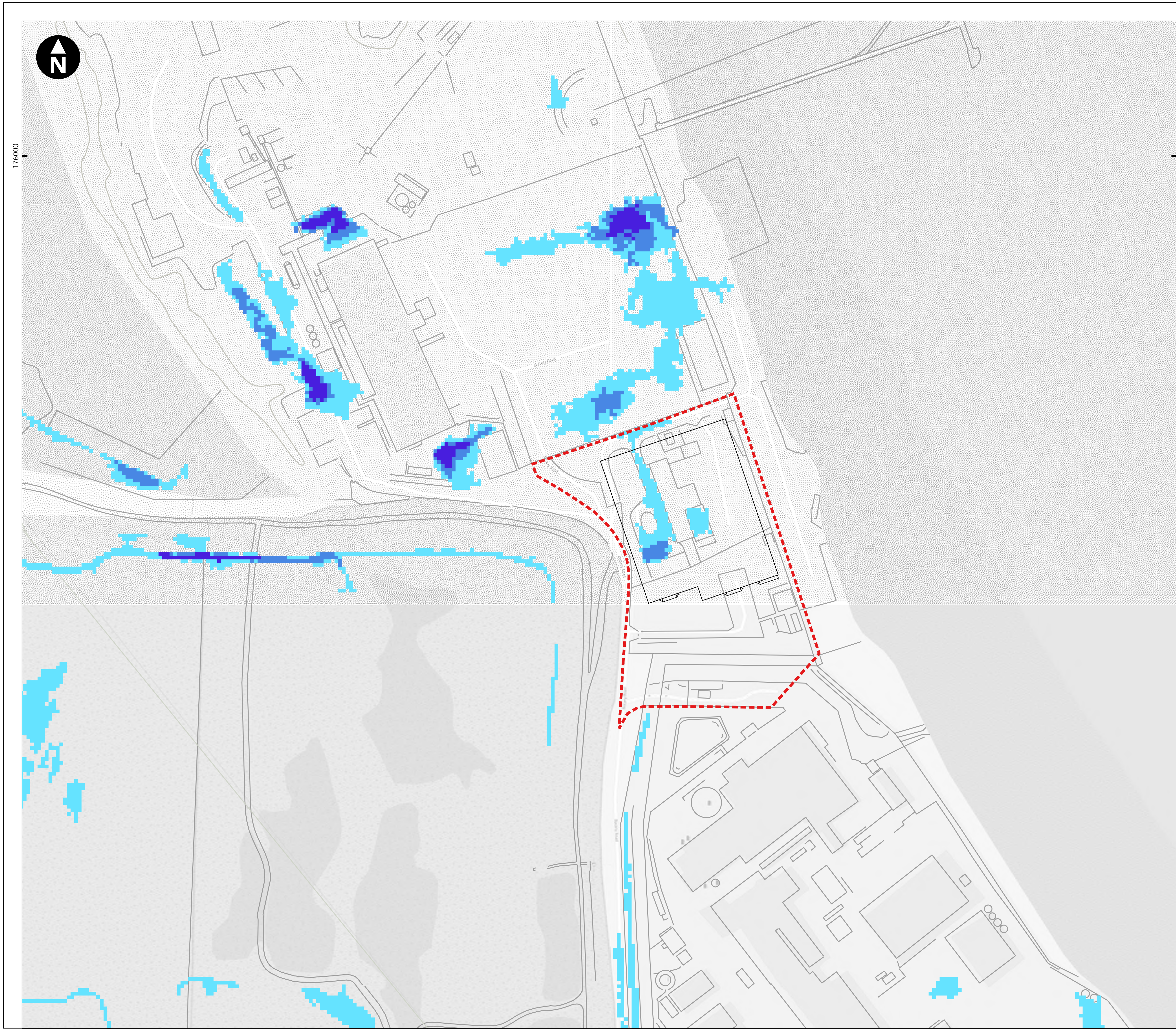
The EA Risk of Flooding from Surface Water (RoFSW) mapping is shown in **Figure 4.5**. The majority of the site is mapped as 'Very Low' (less than 0.1% AEP) risk, though there is some mapped 'Low' (1% AEP to 0.1% AEP) and 'Medium' (3.33% to 1% AEP) risk within the centre of the Site. This appears to be coincident with minor topographic depressions rather than a surface water flowpath, and is therefore of low concern.

However, it is noted that there are limitations with the RoFSW dataset, given that it is a national dataset and derived from relatively coarse 2D-only modelling approaches (no representation of sub-surface drainage networks). At the site the mapping shows minimal surface water accumulation, with some flooding mapped within the existing drainage swale that runs along the southern perimeter of the Site. The contributing catchment to the swale is understood to be minor (serving the local BRM site only), however, it is likely that the associated surface water flood risk is somewhat underestimated within the swale.

The capacity of the drainage swale has been considered in further detail within the Drainage Strategy, as summarised in **Section 6** and is understood to be substantial. Results of the tide-locking scenario indicate that there is sufficient attenuation capacity within the existing swale and 'no man's land' (the region of undeveloped land surrounding the swale, situated between the site and existing BRM site to the south) alone to attenuate flood water for the 1% AEP plus 40%

climate change event and assuming a conservative 3-hour storm duration. Therefore, the existing surface water flood risk associated with the swale is considered to be negligible.

Figure 4.5 Risk of flooding from surface water



Key

Site

Risk of Flooding from Surface Water: Risk Category

High

Medium

Low

0 0.05 0.1 km

Scale at A3: 1:2,000

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Manor Way, Northfleet

Figure 4.3
Risk of Flooding from Surface Water

March 2023

wood.

4.7 Groundwater flood risk

Groundwater flooding occurs when the level of water stored within the underlying rock or soil underground rises (known as the water table) above the surface. Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rocks, and therefore there is the potential for groundwater flooding to impact the Site.

As indicated within the KCC SFRA[8], development of the Swanscombe Peninsula is a primary concern, given that groundwater levels could be directly affected by the cessation of dewatering activities at Easter Quarry (approximately 3km southwest of the site). Cessation of dewatering activities is estimated to cause groundwater levels at Eastern Quarry to recover at least 5 to 8m AOD, and result in the initiation of flow through the River Ebbsfleet. The low-lying areas of Swanscombe Peninsula (between 0 and 4m AOD) would be at greater risk of groundwater flooding due to high connectivity through the underlying chalk.

However, as mapped within the KCC PFRA[12], the site is situated within a region of mapped low groundwater flood risk (understood to be the Areas Susceptible to Groundwater Flooding (AStGWF) dataset). The site is situated on raised ground, approximately 3 to 4m above the ground levels within the low-lying Botany Marshes to the west. Any groundwater emergence is likely to be confined to the Botany Marshes, and not impact the Site given the elevation difference.

5. Flood risk management

5.1 Principles of the Flood Risk Management Strategy

The overall approach to flood risk management is to ensure that the site is defended in accordance with the requirements of the local and regional policy, and that the development will not result in a detrimental impact to flood risk elsewhere. The key principles are summarised below:

- Ensure the Proposed Development is resilient to flood risk throughout the lifetime of the development (accounting for climate change);
- Ensure that the Proposed Development does not increase flood risk to adjacent sites;
- Manage existing overland surface water runoff and drainage minimise the impact of surface water run-off; and
- Develop appropriate mitigation measures to manage flood risk, utilising passive measures wherever possible to minimise the risk of mismanagement or failure.

5.2 Mitigation strategy

The following sub-sections outline the required mitigation measures in order provide the required flood risk resilience and negate any detrimental impact elsewhere.

Tidal

Flood risk has been considered from all sources, and tidal flood risk is considered to be the key risk to the site.

Formal flood defences

The site is indicated as being currently defended from tidal defences offering a present-day SoP exceeding the 0.1% AEP event. However, within the lifetime of the project, the SoP provided by the existing defences will decline as a result of future sea level rise. Therefore, the existing flood wall will be raised to 8.00m AOD (see drawing **Appendix B**) to continue to provide a 0.1% AEP SoP for the period 2070 to 2170 in accordance with the TE2100 plan (Section 3.3) and advice received from the EA during discussions on the project held between late 2022 and early 2023.

Incorporated flood resilient measures

Even with the current and future improved formal defences protecting the site, there remains a residual of flooding to the site via breach of the formal defences. This may occur due to factors such as ship collision, failure to close the flood gates (in effect creating a ‘breach’) or from structural failure of the defence.

To ensure that the waste material within the main building of the Proposed Development remains dry in the event of a flood (to avoid potentially harmful release of hazardous waste to the wider water environment), it is recommended that the building perimeter wall and associated plant plinths and flood gates are designed to the **design level of 6.65m AOD or above**. This will be accommodated for the main building with a finished floor level (FFL) of 6.35m AOD, threshold (‘sleeping policeman’ access ramp) at 6.44mAOD, with the floodwall around the remainder of the building perimeter wall being set with crest level of 6.65m AOD, as seen in **Appendix B**. The

6.44m AOD still constitutes the 0.5% AEP 2115 maximum breach level taken from the main building footprint and a 390mm allowance for freeboard. It is recognised that this level is marginally below the design level of 6.65m AOD.

With regards to the associated elements of the development: UKPN substation, switch/data room, and the firewater pump a FFL of 6.65m AOD is proposed (see drawings in **Appendix B**). For the Welfare building, a slab level of 6.35m AOD, with FFL of 6.50m AOD is proposed.

It is considered acceptable that some elements ('sleeping policeman' ramp at entrances to the main building, FFL of the welfare building) are below, but near to the 6.65m AOD design level given that the breach results are relevant for 2115 (beyond the 2100 end of development lifetime) and considering that the breach levels at the main building entrances / welfare building are approximately 150mm lower than the maximum level of 6.05m AOD modelled for land to the east of the main building adjacent to the flood defence. Whilst it can never be excluded, the installation of the brand new section of flood wall along the Thames as part of the development does further limit the risk of a breach.

The weighbridge and gatehouse at the entrance to the site has a threshold level of 5.54m AOD (see drawings in **Appendix B**). It is recognised that this level is below the design level of 6.65m AOD as stated above. However, this is considered acceptable as a) these are a minor part of the Proposed Development, and b) given that the proposed improvements to the Thames flood wall (crest level of 8.0m AOD).

Given that the development is situated on the landward side of the existing Thames flood defence walls, and considering that the main risk to the site is via tidal sources rather than fluvial, no floodplain compensation is required to address the raised proposed ground levels, as confirmed with the EA during discussions between late 2022 and early 2023.

Further flood resilient measures are recommended on site where infrastructure is not situated above the design flood level, to ensure that buildings can return and function soon after a flood event occurs. These may include measures such as the following:

- Water compatible internal walls;
- Water compatible flooring;
- Water compatible fittings;
- Sump and pump systems; and
- Raised electrics.

Flood evacuation and management plan

The site is at risk of tidal flooding via overtopping and breaching of the existing flood defences. The impact of inundation is likely to be quick across the site, with little time to react. However, overtopping or breaching of defences is likely to occur during an extreme event, which typically come with prior warning. The site is situated within the EA Gravesend and Northfleet flood warning area, and it is therefore recommended that the site manager signs up to the EA flood warning alert system[19] and Met Office weather forecasts, which will allow the site to be notified before a flood event impacts the site. In the event of a flood alert, operatives should be informed and lock up the site and install any relevant food resilient measures, before safely evacuating the site. Both pedestrian and vehicular evacuation should be via the existing site access on Botany Road south, towards the A226. This access route would allow operatives to safely egress in the event of a flood alert.

[19] https://www.gov.uk/sign-up-for-flood-warnings (accessed June 2022)

Proposed measures will be further developed as part of the Flood Evacuation and Management Plan in consultation with local authority's emergency planners.

Surface Water

The EA RoFSW dataset indicates that the risk of surface water flooding across the site is typically low. Risks associated with surface water flooding with relation to the Proposed Development have been considered in the Drainage Strategy, which is summarised in **Section 6** below. The existing drainage swale that runs along the southern perimeter of the site is indicates as being of sufficient capacity to accommodate runoff from the site.

Groundwater

The Proposed Development will be capped with an impermeable layer to prevent the mobilisation of contaminants through infiltration. There are no basement excavations proposed, and hence, the risk of groundwater flooding to the Proposed Development is considered low.

5.3 Flood Risk Activity Permit

Given that the Proposed Development is within 16m of a tidal flood defence, a Flood Risk Activity Permit (FRAP) will be applied for from the EA to ensure that construction works are regulated and permitted.

6. Surface Water Drainage

6.1 Development of the Drainage Strategy

National Planning Policy Framework

The NPPF requires that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development (unless specific off-site arrangements are made and result in the same net effect). Wherever possible, rainfall should be retained on site and allowed to infiltrate into the ground. Typically, run-off volumes generated during a storm will have to be stored for the duration of the storm and released slowly afterwards to meet the required discharge rate.

The NPPF further advises that planning authorities should promote the use of Sustainable Drainage System (SUDS) principles in the management of surface-water run-off from new developments. There is a presumption for the use of SUDS within any development, except in rare instances that it can be demonstrated that SUDS principles cannot feasibly be incorporated within a development, as agreed with the planning authority.

6.2 Drainage Strategy

The Drainage Strategy supporting the planning application is included in **Appendix D**, covering surface water, spent firewater and foul water. A summary of the surface water element of the Drainage Strategy is provided in the sub-sections below.

Existing drainage arrangements

The existing site impermeable area comprises a single-storey, flat-roof office building, auxiliary buildings and asphalt road from the entrance. In recent years, the two businesses in the north and south of the site have regularly laid down hardcore aggregate to create a running track for plant and transport vehicles. Compaction of this has created a semi-permeable area that is subject to ponding until the lower permeability ground allows rainfall to infiltrate. **Figure 6.1** below shows the existing site impermeable and semi-permeable catchment areas.

Figure 6.1 Existing site impermeable areas (Taken from Warner Surveys LT/222/0010/O/001, March 2022)

Surface water from the office building roof is discharged via downpipes to the asphalt area to the west, which in turn conveys to a series of side channels built into kerbs around the driveway and parking areas. In a number of locations, the side channels have become blocked due to silt and debris. This build-up anecdotally causes extensive flooding during heavy rain.

Within the semi-impermeable areas of the site, there is also regular pooling of water caused by laying and compaction of aggregate material over many years. Standing water eventually percolates to ground but anecdotally, it remains through much of the winter.

The swale constructed in the southern portion of the site does not appear to be used for surface water drainage from the north. However, a 300mm diameter pipe headwall is situated towards the eastern end. Further investigation of the catchment area serviced by this outfall will be undertaken during the pre-construction demolition contract. The catchment areas for the BRM-owned swale will be further investigated, however, the size of this is anticipated to be minimal.

The swale has a nominal fall from west to east within the proposed site. It is currently heavily vegetated with reeds and grasses. At the eastern end, the swale outfalls into a penstock chamber before discharging via an 825mm concrete pipe to the River Thames headwall fitted with a cast iron flap valve. The average bed level along the swale within the site boundary is 3.15m AOD and the River Thames outfall invert is 2.43m AOD.

The foul drainage system is shown in Appendix E of the Drainage Strategy. A 150mm pipe discharge from the office WC to a below ground cess tank located in the north-west. A further cess tank exists in the south-east of the site to service the removed welfare cabins. No other drainage information has been made available for this area.

All existing below ground drainage systems will be removed and contamination remediated prior to installation of the proposed drainage systems.

Proposed site layout and design

The development will require the construction of a large steel-frame building to house processing equipment and storage bunkers. To facilitate the movement of vehicles around the site, a large, impermeable hardstanding area is proposed to surround the processing facility. This will include kerbing around the full perimeter to form a contained apron for collection of surface water. Asphalt footways will provide pedestrian access to the main building and welfare crossing the reinforced concrete hardstanding at safe locations.

The existing site is approximately 25% impermeable and will become approximately 75% impermeable post-construction (see **Figure 6.2** below).

Figure 6.2 Proposed impermeable area

Requirements of the drainage system

In accordance with KCC and Environment Agency standards, the system has been designed using MicroDrainage 2018 Network software and has been sized to collect all surface water runoff for storm events up to and including the 1% AEP plus 40% climate change. Conservatively the surface water systems have been designed to the upper end climate change allowances for a development with a lifetime beyond 2100.

In addition, any piped drainage system provided as part of the development will need to be designed to cope with the 100% AEP storm event without surcharging. Surcharging of surface water pipes and structures is acceptable only in events of 3.33% AEP plus 35% climate change and greater.

The drainage system will also need to demonstrate sufficient attenuation volume under tide-locked conditions, in accordance with the KCC pre-application advice. The tide-locked scenarios assessed are outlined in **Table 6.1**.

Table 6.1 Tide locked scenarios

Rainfall Event	River Water Levels		
	No restriction (low tide)	MHWS	1:200 year water level 2090 Higher Central (HC) allowance
1 in 1 year	Yes	Yes	Yes
1 in 30 year +35%CC	Yes	Yes	No
1 in 100 year +40%CC	Yes	Yes	No

Given that the downstream outfall is to the tidal River Thames, there is no requirement for attenuation to restrict discharge rates. This is reflective of the KCC Non-Statutory Technical Standards for Sustainable Drainage S1 status and pre-application advice received.

Proposed strategy

A surface water drainage scheme has been designed to collect rainfall from roof, concrete and asphalt hardstanding, ultimately discharging to the tidal River Thames.

The strategy consists of two separate piped systems on the east and west of the building each discharging to precast concrete headwalls to the northern embankment of the existing drainage swale. The system will rely on gravitational flow by shallow gradient from north to south with the difference in upstream and downstream invert level being approximately 700mm for both.

Resulting flow rates and velocities for the west and east piped systems have been assessed in MicroDrainage and are shown in **Table 6.2**. The MicroDrainage network analysis indicates that a small volume of flooding is to be anticipated in the 1% AEP plus 40% climate change event within the east network which can easily be accommodated within the hardstanding along the kerb invert of the northern road.

Table 6.2 Flow rates and velocities for proposed surface water drainage system

Network	Rainfall event	Critical storm duration flow rate (l/s)	Velocity (m/s) at outfall
East	100%AEP	71.6	0.43
	3.3%AEP+35%CC	286.1	1.44
	1%AEP+40%CC	373.8	1.79
West	100%AEP	75.6	0.45
	3.3%AEP+35%CC	227.0	1.76
	1%AEP+40%CC	312.3	2.30

Due to the large flow velocities at the headwall outfalls, erosion protection and minimal maintenance of the existing swale vegetation is proposed (in accordance with pre-application advice received from KCC). Reno mattresses will be installed to the headwalls, and HDPE flap-valves will be fitted to the face of headwall units to prevent back-flow up the surface water systems.

Assessment of the tidal levels against the River Thames outfall invert level indicate a maximum tide-locked period of up to 2.4-hours for the 0.5% AEP plus climate change event. The results of the tide-locked scenario indicate that there is sufficient attenuation capacity within the existing swale and 'no man's land' alone to attenuate flood water for the 1% AEP plus 40% climate change event and assuming a conservative 3-hour storm duration.

7. Passing the Exception Test

Part 2 of the Exception Test requires that the Proposed Development would be safe, without increasing flood risk elsewhere and, where possible, would reduce flood risk overall. Part 2 of the Exception Test is considered passed, without the need for any additional mitigation on the basis that:

- The Proposed Development is considered to be ‘safe’ for its lifetime;
- The residual risk to the Site can be mitigated. The mitigation measures as outlined in **Section 5** would ensure that flood risk to the Site is manageable, and there is likely to be sufficient warning to evacuate (during construction and operation) and shutdown before the Site is impacted;
- The Proposed Development would not increase flood risk elsewhere due to the potential loss of floodplain storage, given that the Site is at risk from coastal flooding (as opposed to fluvial flooding) which are level-driven; and
- The Proposed Development would not increase flood risk elsewhere due to potential increase in surface runoff from the Site. The drainage strategy, as summarised in **Section 6**, demonstrates that the proposed drainage scheme will accommodate all runoff from the Site and discharge to the tidal River Thames.

8. Conclusions and Recommendations

8.1 Conclusions

The following conclusions can be made:

- Flood risk has been considered from all sources to the Site. The risk of flooding from fluvial, surface water, groundwater, sewer and artificial sources is considered to be low;
- The key risk to the Site is from tidal flood risk associated with the tidal River Thames. The entire Site is situated within Flood Zone 2, and the majority of the Site within Flood Zone 3;
- The majority of the Site is within an EA area benefitting from flood defences, owing to the flood wall that runs along the eastern perimeter of the Site which have associated crest elevations of between 6.32m to 6.95m AOD. The existing site elevations vary between 4.5m AOD and 6.5m AOD;
- The site is currently protected by formal flood defences offering a present day SoP exceeding the 0.1% AEP event. Flood defence upgrades are proposed as part of the development to continue to provide the required SoP;
- There is a residual risk of flooding to the site associated with a breach of the EA flood defences. The probability of any breach event is considered to be very low, though the potential consequence is high. The Thames Estuary breach assessment (2018) modelling results have been provided by the EA and used to determine a design level of **6.65m AOD**, taking the max water level within the main building footprint from the 0.5% AEP (2115) results and incorporating a 600mm freeboard;
- The proposed main building, in NPPF terms, is considered to be 'More Vulnerable', and the welfare building is considered to be 'Less Vulnerable';
- As 'More Vulnerable' development within Flood Zone 3, the proposed development is subject to the Sequential and Exception Tests;
    - The Sequential Test is considered to be passed, on the basis that any alternative sites would need to be situated over 900m south of the site to avoid flood zone interaction, and given the benefits of siting the development immediately north of the existing BRM site;
    - The Exception Test is considered to be passed, given that this FRA has demonstrated that the Proposed Development would deliver wider sustainability benefits, and will be resilient to flooding throughout its lifetime;
- A surface water drainage strategy has been prepared to demonstrate how surface water will be managed across the site. The proposed drainage strategy will discharge to the existing drainage swale running along the southern boundary of the site at an unrestricted rate, as agreed with KCC;
- The proposed surface water drainage scheme is shown to be resilient to conservative tide-locked scenarios, considering a 1% AEP event plus 40% climate change and a MHWS, and a 100% AEP event and 0.5% AEP (2090 Upper End) tide level. There is sufficient attenuation storage provided within the existing drainage swale, and;

- The drainage scheme results in no flooding in the 1% AEP plus 40% climate change design event. In addition, the scheme has been designed to ensure no surcharging occurs in the 100% AEP event or 3.33% AEP plus 35% climate change events.

8.2 Recommendations

The following recommendations are made:

- The Proposed Development should incorporate flood resilience measures to a **design flood level of 6.65m AOD**. These could be in the form of a building perimeter wall, plant plinths and flood gates. This is to account for the residual risk of breach flooding to the site;
- A flood evacuation and management plan should be incorporated into the construction and operational phases of the project, which will be the responsibility of the site manager. The plan should be further developed to incorporate specific measures in consultation with the LLFA, and;
- Erosion protection and sympathetic maintenance of the existing swale vegetation is recommended as part of the drainage scheme due to the calculated high discharge velocities from the drainage system. Reno mattresses should be installed to the headwalls, and HDPE flap-valves will be fitted to the face of headwall units to prevent back-flow up the surface water systems.

Appendix A
Site photographs

Photograph 1 Botany Marshes

Photograph 2 EA flood gate (Asset ID: 330355)

Photograph 3 Existing site and floodwall, looking south (a)

Photograph 4 Existing site and floodwall, looking south (b)

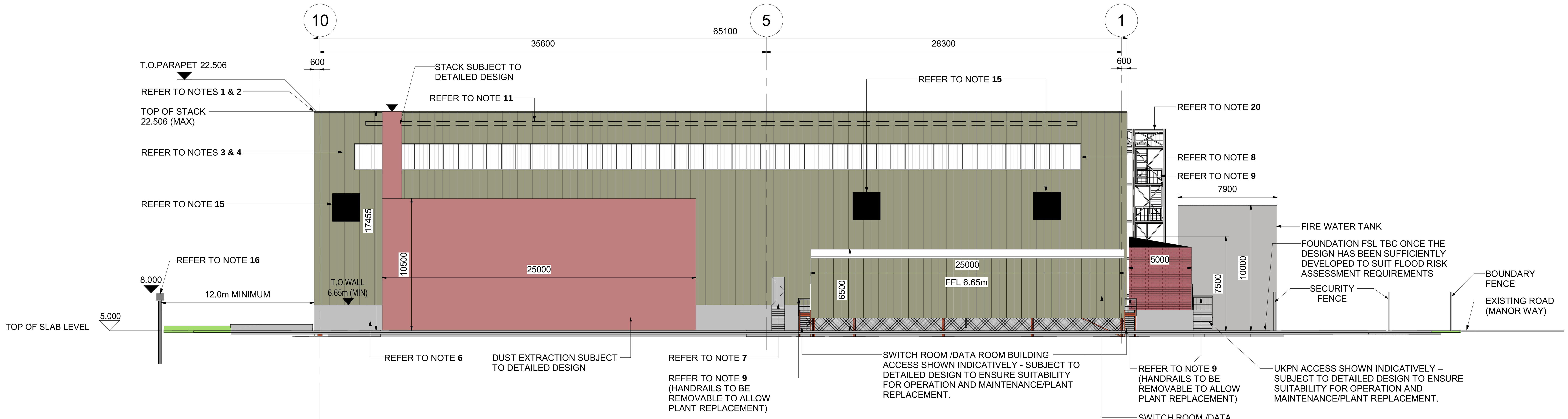
Photograph 5 Existing site and floodwall, looking north

Photograph 6 EA flood gate (Asset ID: 330356)

Photograph 7 Existing drainage swale

Photograph 8 Existing building

Appendix B
Proposed Development drawing



North Elevation - Planning

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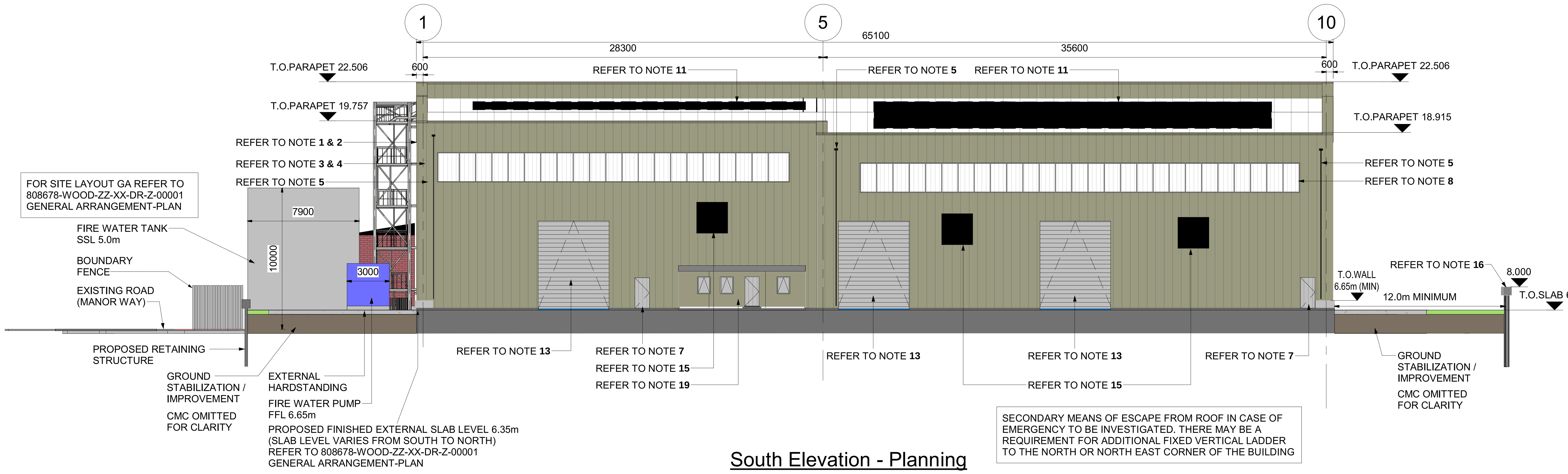

South Elevation - Planning

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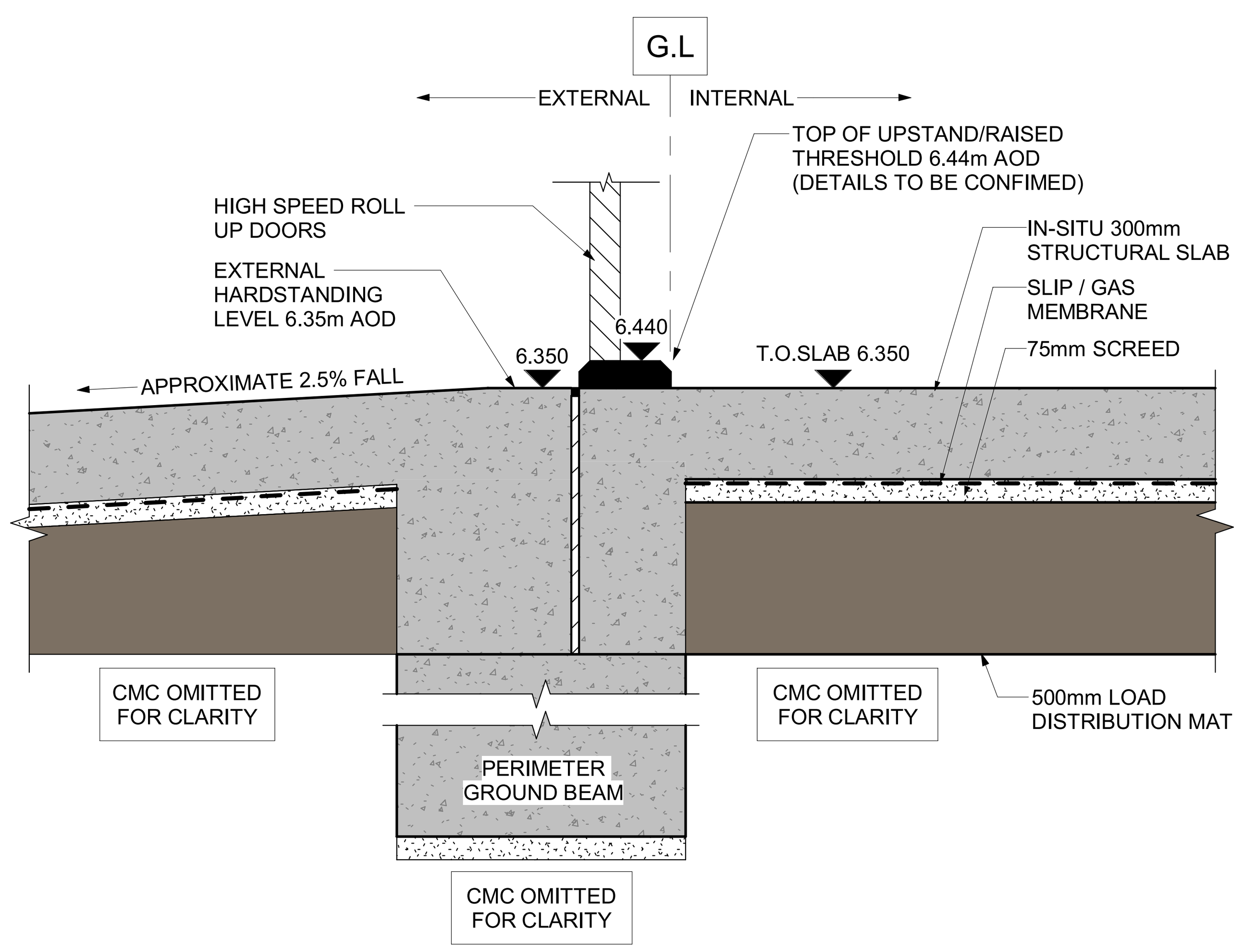
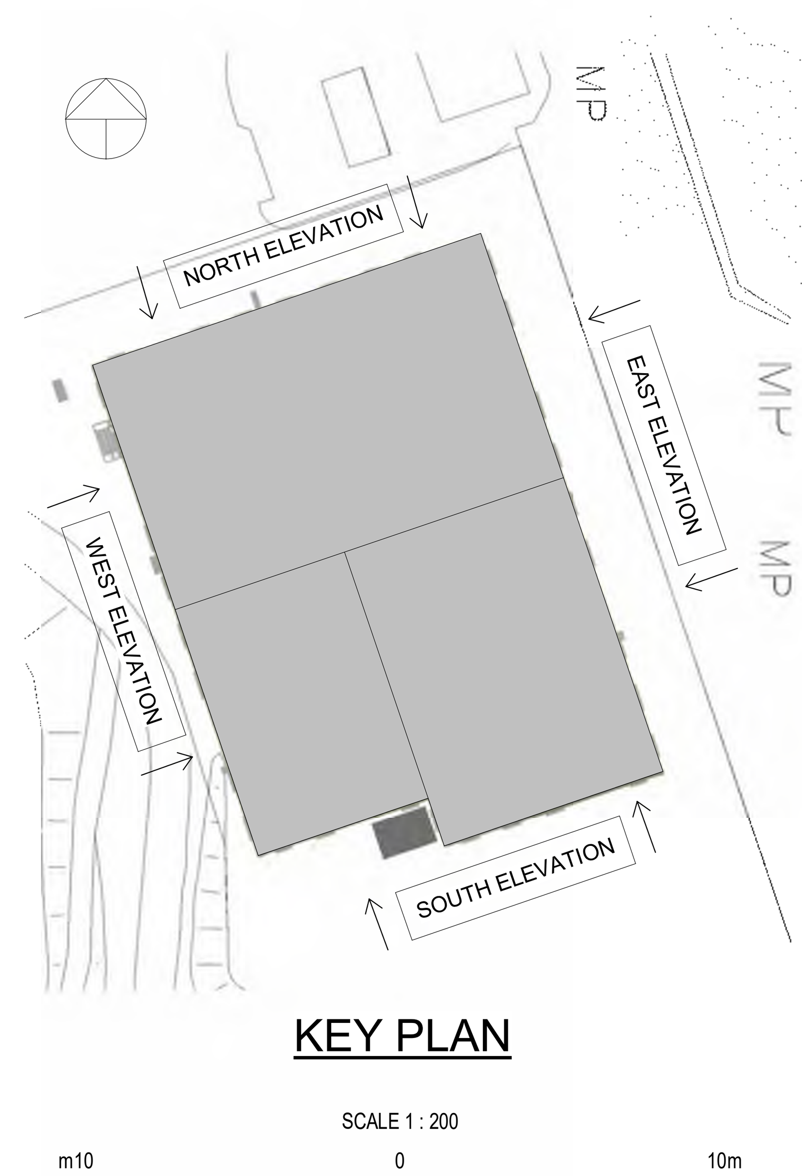


TYPICAL THRESHOLD DETAIL

SCALE:- 1 : 20



KEY PLAN

SCALE 1 : 200

NOTES:

EXTERNAL MATERIALS

1. ROOF - BUILT-UP METAL ROOFING SYSTEM OR COMPOSITE ROOF PANEL WITH TRAPEZOIDAL PROFILE TO ALLOW DIRECT FIXING OF PV PANEL SUBFRAME, ALUMINIUM OUTER SHEETING, COLOUR GREY, ROOF PITCH 6 DEGREES.
2. ROOF FLASHING - FLASHING AT RIDGE, EAVES & VERGE IN PRESSED STEEL COATED WITH COLORCOAT HPS200 ULTRA PLASTISOL, COLOUR GREY
3. WALL CLADDING - BUILT-UP METAL WALLING SYSTEM OR COMPOSITE WALL PANELS WITH TRAPEZOIDAL PROFILE COMPOSITE WALL CLADDING PANELS, LAID VERTICALLY OR HORIZONTALLY DEPENDENT ON THE DETAILED DESIGN. OUTER SHEETING COATED WITH COLORCOAT HPS200 ULTRA PLASTISOL, COLOUR GREY. ALL EXTERNAL WALLS AND ELEMENTS WITHIN TO BE RATED TO 30 MINUTES FIRE RESISTANCE UNLESS CONFIRMED OTHERWISE BY FIRE ENGINEER.
4. WALL FLASHINGS - CORNER FLASHINGS, FLASHING FORMING DRIPS AND OPENING SURROUNDS IN COLOUR TO MATCH ADJACENT CLADDING.
5. RAINWATER HOPPER & RAINWATER PIPES - RAINWATER HOPPER COLOUR TBC. RAINWATER DOWNPIPE STANDARD COLOUR TO MATCH ADJACENT CLADDING. NOTE - GUTTERS & DOWNPIPE SIZES, NUMBERS AND LOCATIONS INDICATIVE ONLY AND TBC FOLLOWING SPECIALIST INPUT/DESIGN.
6. CONCRETE WALL - TO THE FULL PERIMETER OF THE BUILDING WITH TOP OF WALL AT MINIMUM 6.65m AOD. COLOUR NATURAL COLOUR OF CONCRETE LIGHT GREY/WHITE NOTE - HEIGHT OF THE CONCRETE WALL WILL BE IN COMPLIANCE WITH THE RECOMMENDATION OF FLOOD RISK ASSESSMENT.
7. PERSONNEL DOORS - 30 MINUTE FIRE RESISTENCE UNLESS CONFIRMED OTHERWISE. FIRE RESISTANCE STEEL DOORSTEPS IN POWER COATED FINISH, COLOUR GREY. FIRE EXIT LANDINGS IN-SITU CONCRETE LAID TO FALL AWAY FROM THRESHOLD. NUMBERS AND LOCATIONS TBC, ALL TO FIRE ENGINEER REQUIREMENTS.
8. WINDOWS - NOT USED
9. HANDRAILS - EXTERNAL GALVANIZED STEELWORK HANDRAILS IN GALVANISED FINISH. LOCATIONS TBC ONCE THE DESIGN HAS BEEN SUFFICIENTLY DEVELOPED.
10. VEHICLE BARRIERS - ARMCO VEHICLE BARRIER OR SIMILAR APPROVED, IN GALVANISED FINISH.
11. PV PANELS - ROOF MOUNTED PV PANELS BEYOND PARAPET - EXTEND AND LOCATIONS INDICATIVE ONLY AND TBC FOLLOWING SPECIALIST INPUT/DESIGN.
12. PV INVERTER - WALL MOUNTED PV INVERTER - NUMBERS AND LOCATIONS TBC FOLLOWING SPECIALIST INPUT/DESIGN.
13. SERVICE DOORS - DYNACO REINFORCED PVC HIGH SPEED ROLL UP DOORS OR SIMILAR APPROVED. COLOUR TBC.
14. FLOOD BARRIERS - FLOOD BARRIERS TYPE, NUMBERS AND LOCATIONS TBC ONCE FRA HAS BEEN COMPLETED AND FOLLOWING SPECIALIST INPUT/DESIGN.
15. LOUVRES, GRILLS & OPENINGS - POWER COATED ALUMINIUM , COLOUR GREY. NUMBERS AND LOCATIONS TBC. ALL TO M & E REQUIREMENTS/DETAILS
16. NEW FLOOD WALL - NEW SHEET PILED FLOOD WALL AND GATE. (T.O.W LEVEL 8.0m AOD) TO REPLACE EXISTING SHEET PILED FLOOD WALL AND GATE.
17. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS STATED OTHERWISE
18. ALL LEVELS ARE IN METRES AND RELATE TO THE ORDNANCE DATUM
19. WELFARE FACILITY - MODULAR CONTAINERISED WELFARE FACILITY. LAYOUT AND EXACT SIZE AND HEIGHT TBC ONCE THE DESIGN HAS BEEN SUFFICIENTLY DEVELOPED. COLOUR TBC
20. EXTERNAL STEEL STAIR - GALVANISED STEEL STAIR TO PROVIDE SAFE ACCESS TO THE ROOF FOR MAINTENANCE OF PLANT AND VISUAL INSPECTION

P02	24/03 2023	FOR INFORMATION	LD	HM	CB
REV	DATE		DWN	CHK	APP

REVISIONS

REV	DATE		DWN	CHK	APP
P01	17/08 2022	FIRST ISSUE	EGT		

SCALE: As indicated

DRAWING STATUS: S2 - FOR INFORMATION

PROJECT TITLE:
BRM
E-SCRAP
FACILITY

DRAWING TITLE:
BRM E-SCRAP FACILITY
NORTH & SOUTH ELEVATIONS
PLANNING DRAWINGS - FIGURE 3.2

CLIENT:
BRITANNIA REFINED METALS LTD.
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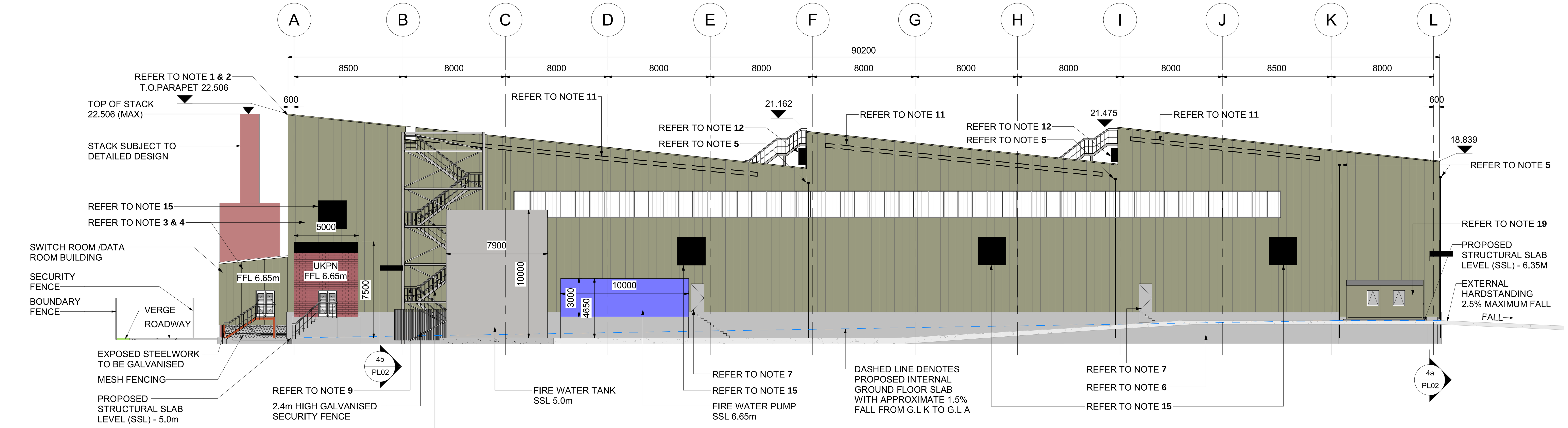
BRM DWG No. 808678-WOD-ZZ-XX-DR-Z-00002-P01 REV. P02

ADVISER / CONTRACTOR DWG No. 808678-WOD-ZZ-XX-DR-S- PL01



West Elevation - Planning

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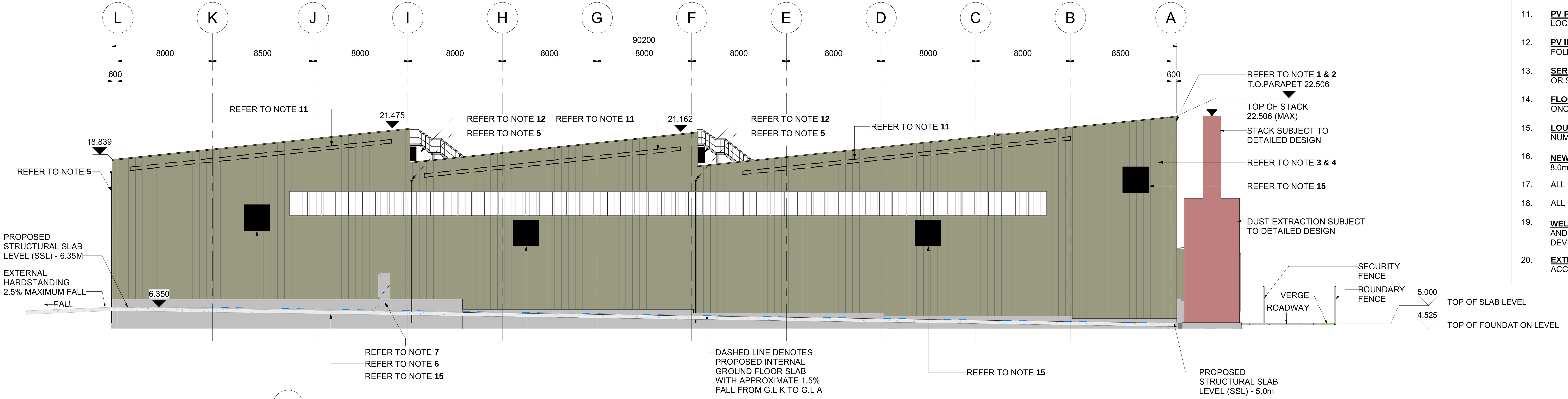

East Elevation - Planning

SCALE:- 1 : 200

NOTES:

EXTERNAL MATERIALS

1. **ROOF** - BUILT-UP METAL ROOFING SYSTEM OR COMPOSITE ROOF PANEL WITH TRAPEZOIDAL PROFILE TO ALLOW DIRECT FIXING OF PV PANEL SUBFRAME, ALUMINIUM OUTER SHEETING, COLOUR GREY, ROOF PITCH 6 DEGREES.
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8. **WINDOWS** - NOT USED
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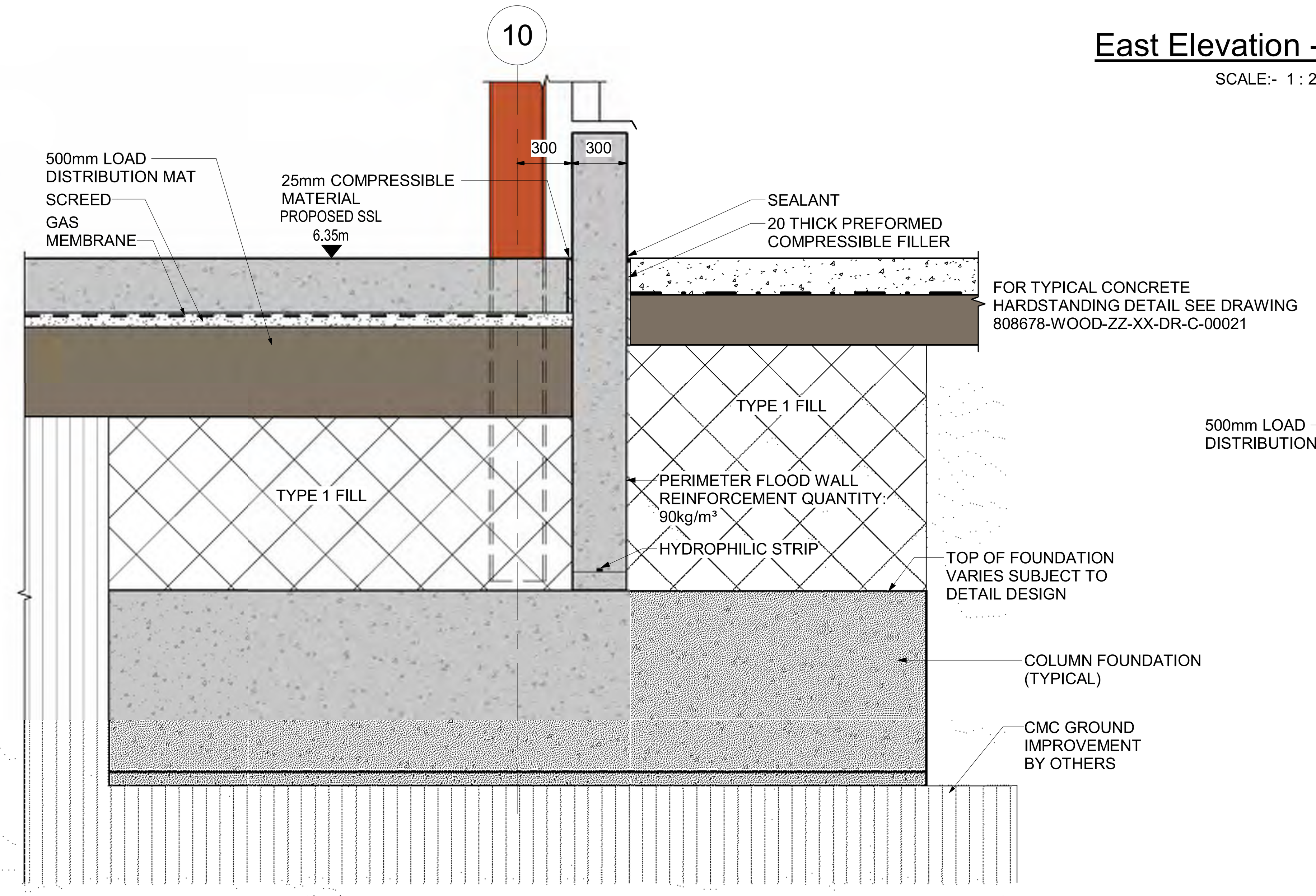
20. **EXTERNAL STEEL STAIR** - GALVANISED STEEL STAIR TO PROVIDE SAFE ACCESS TO THE ROOF FOR MAINTENANCE OF PLANT AND VISUAL INSPECTION



DETAIL 4a INDICATIVE WATER RETAINING WALL (MAX)

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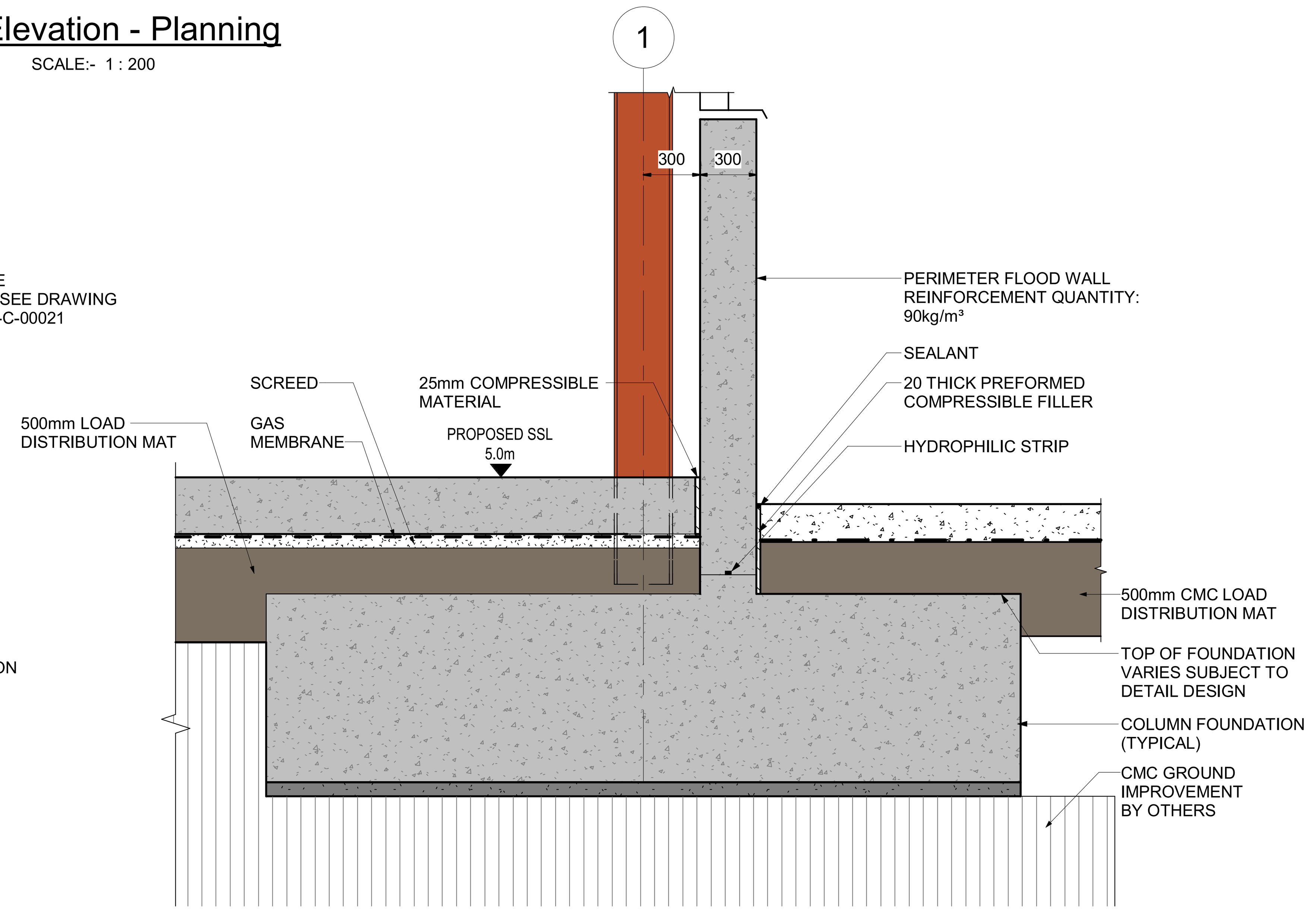

DETAIL 4b INDICATGIVE WATER RETAINING WALL (MIN)

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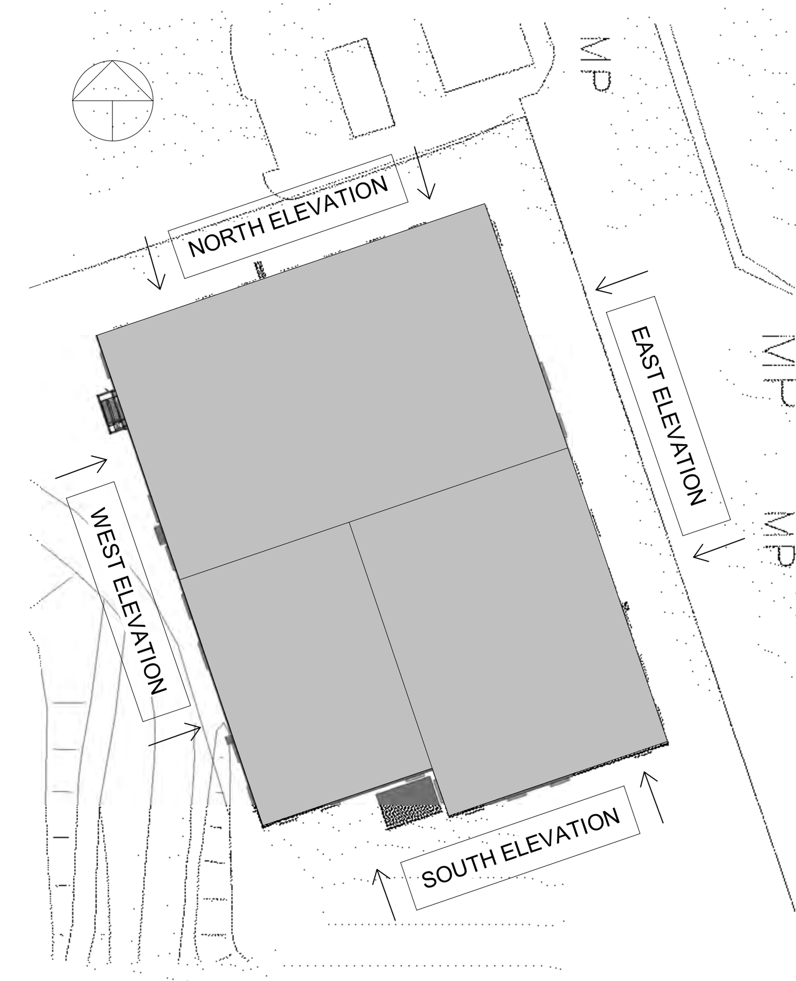

KEY PLAN

SCALE 1 : 200

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P02	24/03 2023	FOR INFORMATION	LD	HM	CB
		REVISIONS			
P01	17/08 2022	FIRST ISSUE	EGT		

SCALE: As indicated

DRAWING STATUS: S2 - FOR INFORMATION

PROJECT TITLE:
BRM
E-SCRAP
FACILITY

DRAWING TITLE:
BRM E-SCRAP FACILITY
EAST & WEST ELEVATIONS
PLANNING DRAWINGS - FIGURE 3.3

CLIENT:
BRITANNIA REFINED METALS LTD.
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FLOOR 3,
11 WESTFERRY CIRCUS,
LONDON
E14 4HD
TEL: (0203) 2151700
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wsp

BRM DWG No. 808678-WOD-ZZ-XX-DR-Z-00003-P01 REV. P02

ADVISER / CONTRACTOR DWG No. 808678-WOD-ZZ-XX-DR-S- PL02

Original Drawing Size - A0 DO NOT SCALE

NOTES:

- RED LINE BOUNDARY
- HB2 PRECAST KERB
- ACO HB305 DRAINAGE KERB
- TRIEF GST2A HIGH CONTAINMENT PRECAST KERB
- PRECAST CONCRETE EF EDGING KERB
- TIMBER FENCE LINE
- SECURITY FENCE
- PROPOSED PEDESTRIAN FOOTWAY SEE 808678-WOOD-ZZ-XX-DR-C-00019
- PROPOSED REINFORCED CONCRETE SLAB HARDSTANDING SEE 808678-WOOD-ZZ-XX-DR-C-00019
- EXISTING REINFORCED CONCRETE SLAB HARDSTANDING
- PROPOSED LANDSCAPED AREAS. 300mm SUBSOIL LAID ON GEOTEXTILE LAYER WITH LANDSCAPING TO 808678-WOOD-ZZ-XX-DR-L-00001
- PROPOSED E-SCRAP FACILITY BUILDING (SEE ARCHITECTURAL AND STRUCTURAL DRAWINGS FOR DESIGN DETAILS)

1. ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE
2. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
3. FULL PLANNING APPROVAL SHOULD BE OBTAINED PRIOR TO THE COMMENCEMENT OF WORKS ON SITE, AND ANY WORKS CARRIED OUT PRIOR TO THIS ARE UNDERTAKEN AT THE CLIENT'S/CONTRACTOR'S OWN RISK.
4. TOPOGRAPHIC SURVEY DATA TAKEN FROM WARNER SURVEYS DRAWINGS LT/222/0010/P/0001 AND 0002
5. PROPOSED LAYOUT SUBJECT TO CHANGE UPON PLANNING AND PERMITTING APPROVAL

REV	DATE		DWN	CHK	APP
P03	15/03/2023	UPDATES FOR SECOND PLANNING SUBMISSION	SD	HM	JC
P02	05/10/2022	UPDATES FOR ITT	SD	HM	JC

REVISIONS

CLIENT:

BRITANNIA REFINED METALS LTD.
Botany Road, Northfleet, Kent. DA11 9BG.

PROJECT TITLE:
BRM
E-SCRAP
FACILITY

SCALES: 1:250

REV	DATE		DWN	CHK	APP
P01	15/08 2022	FIRST ISSUE	SD	JC	CB

DRAWING STATUS: SUITABLE FOR REVIEW & COMMENT - S3

DRAWING TITLE:
PROPOSED SITE LAYOUT

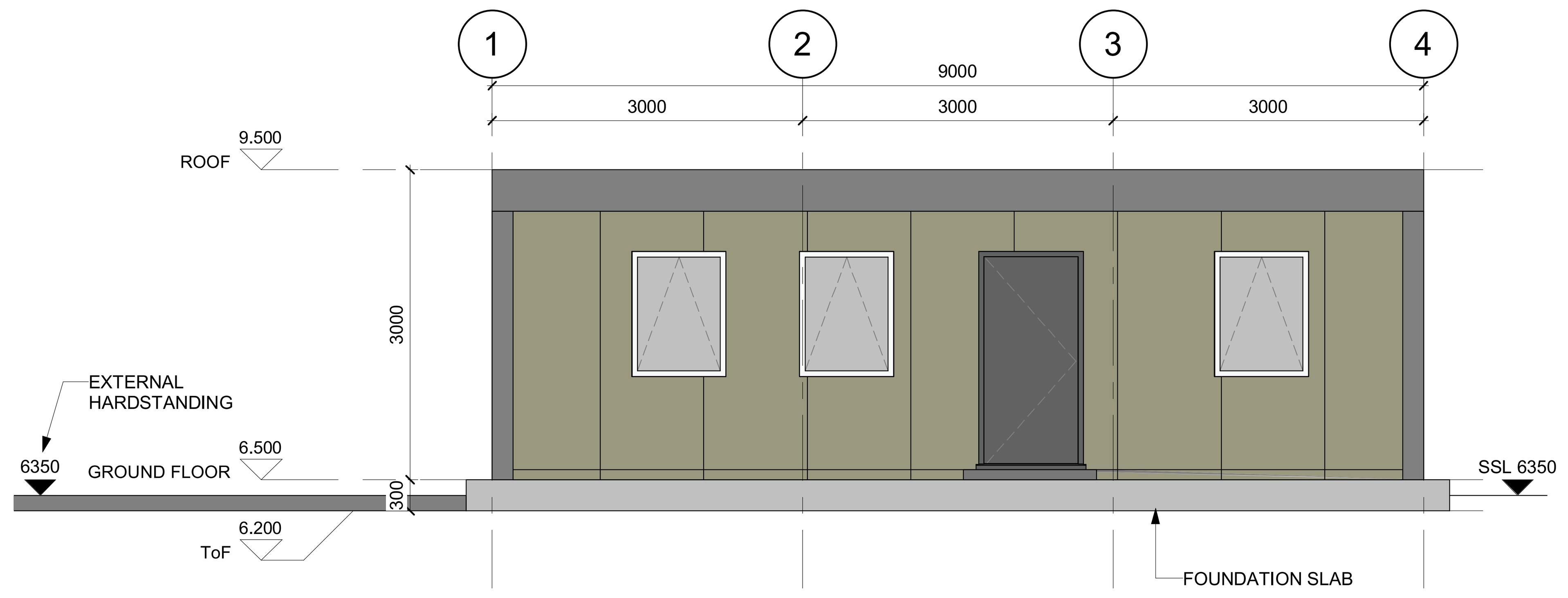
GENERAL ARRANGEMENT

FLOOR 3,
11 WESTFERRY CIRCUS,
LONDON
E14 4HD
TEL: (0203) 2151700
FAX: (0203) 2151701

BRM DRAWING No.
XXXXX-XXXX-XX-XX_XX-XX-XX-0001

REV.
P03

ADVISER / CONTRACTOR DRAWING No.
808678-WOOD-ZZ-XX-DR-Z-00001



SOUTH ELEVATION

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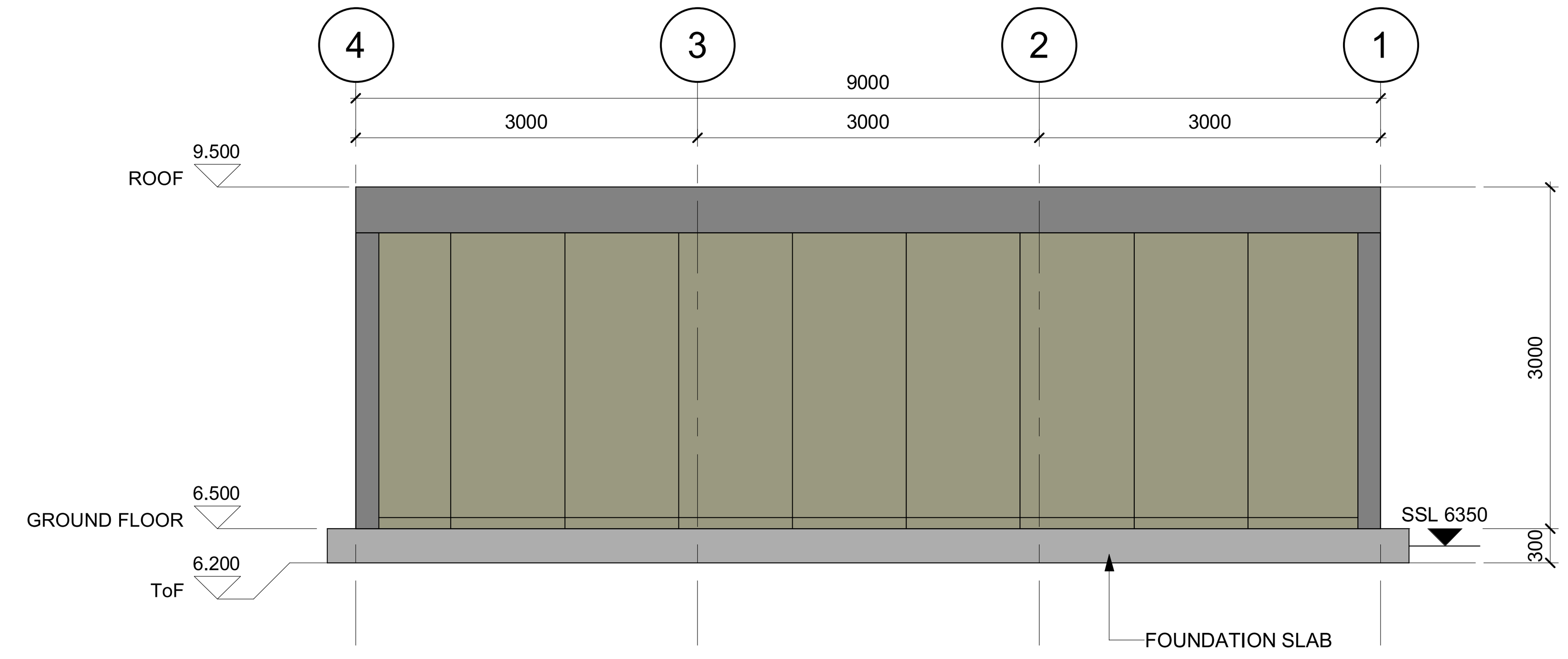

NORTH ELEVATION

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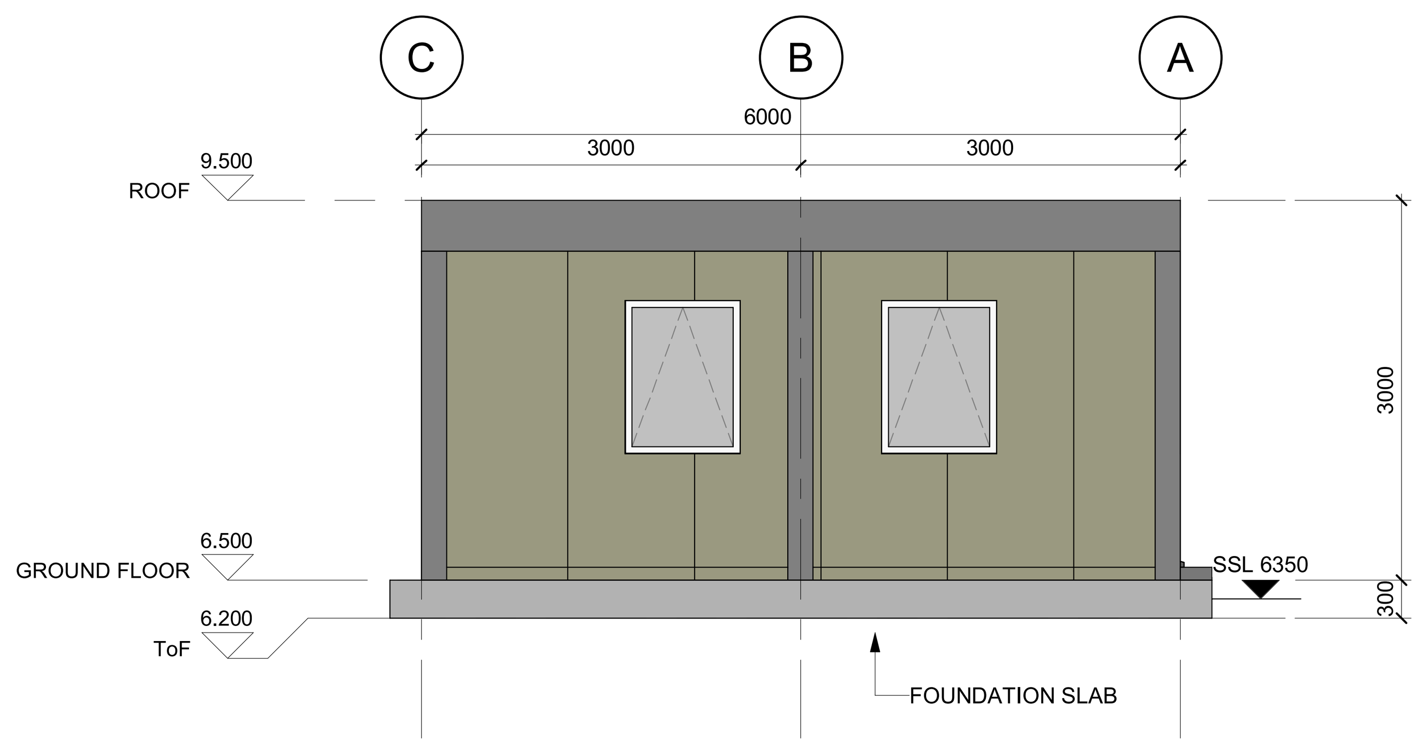

WEST ELEVATION

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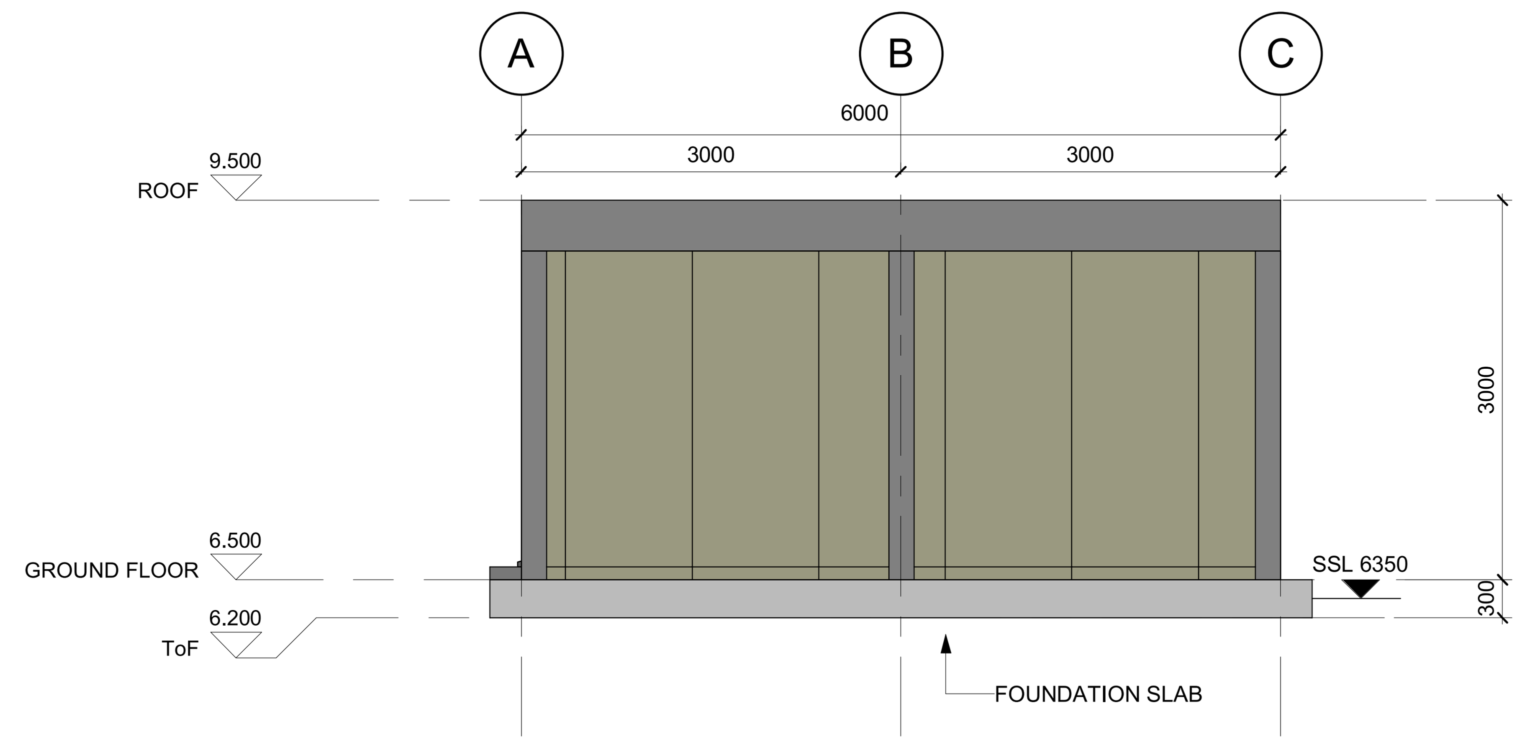


EAST ELEVATION

SCALE:- 1 : 50

NOTES:

1. THE WELFARE FACILITY SHALL BE A MODULAR CONTAINERISED UNIT THAT COULD POTENTIALLY BE HIRED/BOUGHT FROM A SUPPLIER FOR THE BRM FACILITY. THE LAYOUT ON THE DRAWING INCLUDES OFFICE SPACE, MEETING ROOMS AND STAFF WELFARE FACILITIES AS PER REQUIREMENTS CONFIRMED BY THE BRM TEAM.
2. THE WELFARE FACILITIES AND OFFICES ARE REQUIRED TO BE DESIGNED IN ACCORDANCE WITH THE WORKPLACE (HEALTH, SAFETY AND WELFARE) REGULATIONS 1992 AND BUILDING CONTROL.
3. TOILETS AND WASHING FACILITIES ARE IN ACCORDANCE WITH REGULATION 21 OF THE WORKPLACE (HEALTH, SAFETY AND WELFARE) REGULATIONS 1992. THE BUILDING HAS BEEN DESIGNED TO PROVIDE WELFARE AND OFFICE FACILITIES ON THE BRM SITE ONLY ALONE ASSUMING STAGGERED USE OF CANTEEN SPACE BY PERSONNEL ON BRM SITE.

REV	DATE		DWN	CHK	APP
P02	20/03 2023	FOR INFORMATION	LD	HM	CB
P01	16/09 2022	FIRST ISSUE	EDG	HM	CB

REVISIONS

SCALE: 1 : 50

DRAWING STATUS: S2 - FOR INFORMATION

PROJECT TITLE:
BRM
E-SCRAP
FACILITY

DRAWING TITLE:

BRM E-SCRAP FACILITY

INDICATIVE WELFARE ELEVATIONS
PLANNING DRAWING - FIGURE 3.5

CLIENT:

BRITANNIA REFINED METALS LTD.

Botany Road, Northfleet, Kent, DA11 9BG.

FLOOR 3,
11 WESTFERRY CIRCUS,
LONDON
E14 4HD
TEL: (0203) 2151700
FAX: (0203) 2151701

BRM DWG No.: BRM-DRAWING-NUMBER

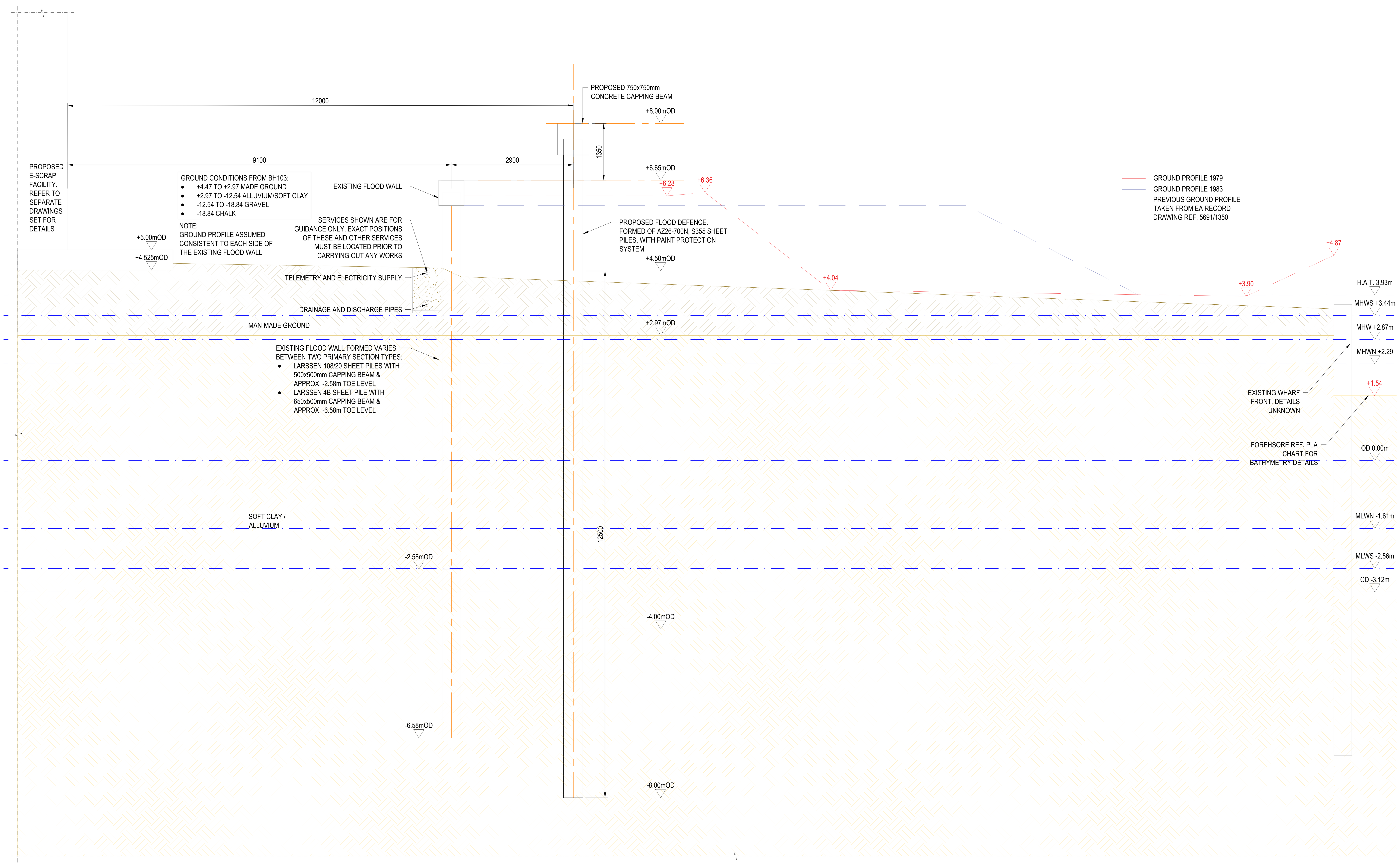
REV.: P01

ADVISER / CONTRACTOR DWG No.: 808678-WOOD-ZZ-XX-DR-Z-00007

DO NOT SCALE OFF THIS DRAWING

NOTES

1. Do not scale from this drawing.
2. All dimensions are in meters above ordnance datum (mAoD), unless stated otherwise.
3. This drawing is to be read in conjunction with Drg. 5856002-RWC-PLA-BNOFL-S-DR-100001 and all other relevant drawings.



1-1
0100
SECTION 1-1
SCALE 1:50

PROPOSED FLOOD WALL SECTION
(PRLIMINARY SUBJECT TO DETAILED DESIGN)
WSP DRAWING NO.
808678-WOD-ZZ-XX-DR-XXXXX_P01.3
PLANNING DRAWING - FIGURE 3.8

Scale 1:50 @ A1 - 1:100 @ A3
1m 0 1m 2m 3m 4m 5m

LEGEND

Indicates a residual risk warning

Revision History

Rev	Comment	By	Chkd	Appr	Date
P01.2	ISSUE FOR COMMENTS	IF	SH	RK	22/03/2023
P01.1	ISSUE FOR COMMENTS	IF	SH	RK	15/03/2023

Current Revision

P01.3	ISSUE FOR COMMENTS	IF	SH	RK	23/03/2023

PLANNING APPLICATION

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Project
BRITANNIA REFINED METALS - NORTHFLEET- FLOOD DEFENCE

Drawing Title
EXISTING SITE
GENERAL ARRANGEMENT

RWCL Internal Register reference: 5856 -002 Scales @ A1

5856002-RWC-PLA-BNOFL-S-DR-100200 -P01.3

Appendix C
TE2100 tidal model results

Table A.5 Design water levels downriver of the barrier:

0.1% annual probability (1 in 1,000 years)

ISIS Model Node		Chainage	1000-year design water levels					
		Km from barrier	2005	2040	2070	2100	2120	2170
Barrier	3.1	0.0	6.04	6.25	6.44	6.76	6.97	7.49
	3.2	1.1	6.03	6.24	6.44	6.75	6.96	7.49
	3.3	2.2	6.02	6.23	6.42	6.74	6.95	7.49
	3.4	3.4	6.01	6.22	6.42	6.74	6.95	7.48
Roding	3.5	4.5	6.00	6.21	6.42	6.74	6.95	7.48
	3.6	4.7	6.01	6.22	6.42	6.75	6.96	7.47
	3.7	6.1	6.01	6.22	6.42	6.75	6.95	7.46
	3.8	7.6	6.01	6.22	6.41	6.74	6.94	7.44
Beam River	3.9	8.8	6.00	6.21	6.40	6.72	6.92	7.42
	3.10	9.9	5.98	6.19	6.37	6.7	6.90	7.40
	3.11	11.0	5.97	6.18	6.37	6.7	6.90	7.39
	3.12	12.0	5.97	6.18	6.36	6.7	6.89	7.38
	3.13	13.0	5.97	6.18	6.35	6.69	6.88	7.37
	3.14	14.0	5.98	6.19	6.34	6.67	6.87	7.35
Darent	3.15	15.1	5.97	6.18	6.33	6.65	6.85	7.33
	3.16	16.2	5.95	6.16	6.31	6.63	6.82	7.31
	3.17	17.3	5.94	6.15	6.30	6.62	6.81	7.28
QEII bridge	3.18	18.5	5.94	6.15	6.29	6.6	6.79	7.25
	3.19	19.6	5.92	6.13	6.28	6.6	6.78	7.23
	3.20	20.8	5.90	6.11	6.27	6.58	6.76	7.22
Grays	3.21	22.6	5.89	6.10	6.24	6.55	6.74	7.21
	3.22	24.2	5.86	6.07	6.24	6.54	6.73	7.19
	3.23	25.5	5.85	6.06	6.22	6.52	6.71	7.18
Tilbury lock	3.24	26.2	5.83	6.04	6.19	6.49	6.69	7.18
	3.25	27.8	5.81	6.02	6.17	6.47	6.67	7.19
Gravesend	3.26	29.0	5.78	5.99	6.14	6.44	6.65	7.19
	3.27	30.6	5.71	5.92	6.08	6.38	6.61	7.19
	3.28	32.2	5.64	5.85	6.01	6.32	6.56	7.17
	3.29	34.2	5.58	5.79	5.93	6.25	6.51	7.15
	3.30	36.4	5.54	5.75	5.89	6.19	6.46	7.13
Mucking	3.31	38.8	5.49	5.70	5.86	6.18	6.45	7.12
	3.32	41.3	5.41	5.62	5.81	6.16	6.43	7.11
	3.33	43.6	5.33	5.54	5.76	6.14	6.41	7.09
	3.34	46.2	5.28	5.49	5.70	6.09	6.37	7.08
Canvey	3.35	48.4	5.22	5.43	5.66	6.05	6.34	7.07
	3.36	51.2	5.14	5.35	5.63	6.02	6.31	7.04
	3.37	54.0	5.06	5.27	5.60	5.99	6.28	7.02
Southend	3.38	56.4	5.03	5.24	5.55	5.95	6.25	7.00

Appendix D
Drainage strategy

Proposed E-Scrap Sampling Plant at Britannia Refined Metals, Manor Way, Northfleet

Drainage Strategy

WSP Environment & Infrastructure Solutions UK Limited – March 2023

Report for

Diego Garcia-Arenal
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Management systems

This document has been produced by WSP E&IS UK Limited in full compliance with our management systems, which have been certified to ISO 9001, ISO 14001 and ISO 45001 by Lloyd's Register.

Document revisions

No.	Details	Date
P01	First Issue	22/08/2022
P02	Updated for second submission	25/03/2023

1. Executive summary

This report has been produced for the purpose of describing the proposed surface, spent fire and foul water drainage strategy relating to the proposed E-Scrap development at Land off Manor Way, Northfleet as commissioned by Britannia Refined Metals (BRM). This report has been produced by Wood Environment & Infrastructure Solutions UK Limited to accompany the detailed planning application documentation submitted for approval by Kent County Council.

The report describes how the development will manage surface, foul and spent fire water in a sustainable and operationally effective manner. This will be achieved by conveying surface water to the adjacent River Thames, containing spent fire water within the development and retaining foul water for off-site disposal.

Surface water will be discharged to the Thames Estuary which is covered by S1 of the Non-Statutory Technical Standards for Sustainable Drainage: Practice Guidance. This allows uncontrolled flows to coastal or estuarine waters which can accommodate and, therefore, is exempt from the requirements of S2 to S6 of the same standard. To discharge to the Thames, two separate, traditional piped systems will discharge to the existing swale feature in the south of the Site and then outfall to an existing 825mm diameter headwall. In accordance with Kent County Council (KCC) requirements, the systems have been analysed against 100%AEP, 33.3%AEP+35% Climate Change (CC) and 1%AEP+40%CC. No flooding of the surface water system at the 3.3%AEP has been shown, with no flooding of the proposed buildings at 1%AEP.

Various tide-locked scenarios have also been analysed to ensure that the swale has sufficient attenuation capacity when the tide level prevents discharge to the Thames. Filtration of sediment and fuels is provided using silt sumps, catchpits, bypass oil interceptors and the SuDS-compliant swale. Prevention of major contamination to the swale, River Thames and ground will be provided by automatic shut-off valves installed to each of the catchpits immediately upstream of the swale headwalls.

The foul water strategy will be to discharge to a dedicated cess tank with capacity suitable for the maximum four persons that will be on site at any one time. 20,000l of foul water storage has been provided for via a SPEL Tankstor Series 300 unit. This has been sized based on one month storage for a population of 4 people using 100litres/person/day. The cesspools will require regular emptying via tankers and will be monitored via sensors and alarms which are fed to the main site facilities manager.

A total of 410m^3 of fire water is required for worst-case fire events. Due to the metal-processing activities undertaken, robust systems preventing spent fire water from entering the surface water systems have been developed. The primary prevention method is through physically containing spent fire water within the northern section of the building, with secondary containment provided by storage within the external impermeable reinforced concrete hardstanding. During a fire or large-scale fuel spill, the surface water systems will be shut off at catchpits directly upstream of outfalls into the swale, therefore, containing any contaminated surface water for disposal and processing off site.

2. Contents

1. Introduction

1.1 Background

1.1.1 Britannia Refined Metals (BRM) Ltd (a subsidiary of Glencore plc), is seeking to develop a facility to process waste electronics material (also known as an E-scrap) on a site immediately adjacent to and north of their existing facility on Botany Road/ Manor Way, Northfleet DA11 9BG.

1.1.2 'The Site' is located adjacent to the existing operational BRM facility in the south, an Environment Agency flood defence wall running along the western bank of the tidal River Thames in the east, a cement manufacturing plant to the north and Botany Marsh on the opposite side of Manor Way to the west.

1.1.3 The red line boundary of the site is approximately 1.25ha in size with the proposed development being within the ~1.10ha area to the north of a swale and 'no-man's land' security buffer running along the southern part of the site.

1.1.4 The Site is currently unoccupied with tenancies terminated in late 2021. Previously, a transport business operated out of the northern half and a marine piling business out of the southern half of the site (plus the quay to the east of the site). A reclaimed wharf exists to the east Ground investigation is being undertaken in Late July and August 2022 to gain factual geotechnical and geo-environmental information.

1.1.5 The area of the existing site north of 'no-man's land' consists of a single-storey, masonry office building, a single masonry garage, a small amount of asphalt hardstanding, semi-permeable aggregate running courses with the remainder covered in scrub vegetation. To the south of the swale and 'no-man's' land' there is an area of concrete hardstanding, a redundant weighbridge and associated office (it is proposed that this infrastructure will be brought back into services as part of this project).

1.1.6 Existing access to the Site is via three separate gates in the north-west, midway along the west boundary and in the south-west. These accesses were for the transportation business and reclaimed wharf area, the marine piling business and the defunct BRM battery processing plant via the weighbridge, respectively. Figure 1.1 aerial imagery below shows the layout of the existing site.

1.1.7 The Site is accessed from Lower Road leading into Manor Way from the south and is shared with users of the cement plant in the north. The road is privately owned by BRM with a Third-Party lease to the operators of the cement plant.

1.1.8 This report is specifically related to the drainage strategy for surface, spent fire and foul water for the development of the E-Scrap facility. It will outline how the proposed strategy is in compliance with Kent County Council, as Lead Local Flood Authority (LLFA), sustainable drainage policies.

1.1.9 Pre-application drainage advice has been sought from the LLFA with an on-site meeting taking place on the 27th June 2022. Confirmation letters outlining discussions during this site visit are included within Appendix A.

Figure 1.1 Proposed E-Scrap facility site location

1.2 Development proposal

1.2.1 The proposed development consists of a facility to sample and process waste electronics material (also known as an E-scrap sampling plant). The processing involves the shredding of E-scrap to allow material laboratory analysis on a portion of the waste stream. This in turn allows BRM to identify the most appropriate destination for the waste stream from which the sample was derived.

1.2.2 The development will require the construction of a large steel-frame building to house processing equipment and storage bunkers. Auxiliary structures including a motor control centre (MCC), welfare facility, fire water tank and dust extraction unit will sit outside the building. It is anticipated that a 5-tonne electric back-hoe loader and standard weight forklifts will operate from within the building. Deliveries and collections would be made over 5 days each week (Monday-Friday) and all would be made within daytime hours.

1.2.3 The site will be serviced by maximum UK legal limit articulated lorries at a rate of five deliveries and five collections per day. Lorries will enter and leave the building for disposal and collection of material during each visit. The proposed E-scrap facility would have a maximum throughput of 25,000 tonnes per annum (tpa), with up to approximately 4 weeks covered on-site storage equating to ~2,500 tonnes of E-scrap. In terms of despatch of the shredded and bagged E-scrap, it is envisaged that the loaded containers would be transported via road to a proximate shipping container terminal via road on an average of five 25 tonne payload HGVs per day.

1.2.4 To facilitate the movement of vehicles around the Site a large, impermeable hardstanding area is proposed primarily to the southern elevation of the processing facility. This will include kerbing around the site perimeter to form a contained apron for collection of surface water. Asphalt footways will provide pedestrian access to the main building and welfare crossing the reinforced concrete hardstanding at safe locations. To the south of 'no man's land' the existing entrance to the decommissioned battery processing plant will be utilised for access to the site. This is formed in reinforced concrete slab and includes a weighbridge with associated gatehouse which will be refurbished to be brought back into operation. No upgrading of the existing drainage strategy for the existing access is proposed. A reinforced concrete precast box culvert will be installed to cross the existing 'no man's land' and swale. This will be sized to match the existing ditch cross-sectional area and have a reinforced concrete carriageway, asphalt footways and verge over with embankments at a 1 in 3 slope.

1.2.5 A general arrangement of the site can be found in drawing 808678-WOOD-ZZ-XX-DR-Z-00001. In summary the proposal includes the following:

- A proposed main building of steel framed structure approximately (~) 90m x 72m x 17.5m high (to apex). Area = ~6,480m^2
- A firewater tank of ~12m diameter and 5m high and associated adjacent pump house at ~3m x 15m x 3m high.
- Dust extraction infrastructure housed in a unit ~10.5m x 2m x 6.5m high.
- A welfare building ~9m x 12m x 3m high. Area = 108m^2
- Areas of proposed concrete hardstanding = ~4,450m^2
- Areas of proposed landscaping = ~1,000m^2
- Areas of asphalt footways = ~250m^2

2. Baseline information

2.1 Topography

2.1.1 The main site is relatively flat, situated at elevations between 4.5m to 6.0m AOD (Above Ordnance Datum). The southern, vegetated portion of the site lies on a slightly elevated platform with elevations of 5.5m to 6.5m AOD and dropping down to 4m AOD at the southern boundary of the site into the existing drainage swale which has a channel bed at a level of between 3.0 and 3.5m AOD.

2.1.2 The site is bounded by an elevated, discontinuous bund to the west of the site which runs along the perimeter of Botany Marshes, with a crest elevation typically between 5.5m to 6m AOD. Elevations within the marshes drop to 1.5m AOD. Manor Way, running along the west boundary of the site, crossfalls to the west to a ditch running along the east side of the bund. The levels along the western side of the Environment Agency flood defence in the east vary from 4.5 to 5.5m AOD.

2.1.3 The surface proposed drainage strategy has been designed to minimise the change in level along the eastern flood defence and tie into the road and fence line to the west and north, respectively. A platform finished floor level for the proposed steel frame building reduces the potential for longitudinal falls around the building, therefore, alternative solutions to traditional gully collection are proposed.

2.2 Hydrology

2.2.1 The hydrological setting is described in section 2.2 of the Flood Risk Assessment. Within the site there is an existing drainage ditch in the south which has been classified as a swale during liaison with the LLFA. The swale is connected via culvert to a drainage ditch that runs along the western side of the main BRM site east of Manor Way. Below Figure 2.1 shows the approximate channel bed levels for the ditch running alongside Manor Way. The level at the northern end, at the location of the culverted crossing is 3.500mAOD and at the southern end, where it terminates, is 3.484mAOD. Levels between these locations vary between 3.4 and 3.8mAOD, therefore, based on LiDAR data the ditch can be considered an attenuation basin rather than a conveyance swale.

2.2.2 The catchment area for the Manor Way attenuation ditch has not been confirmed but LiDAR shows that Manor Way crossfalls east to the ditch. BRM systems do not allow discharge of surface water catchment to surface water systems or ground, so surface water volumes from east of the ditch should be negligible. This will be confirmed from details of the BRM main site surface water drainage systems.

2.2.3 Historically the drainage ditch crossed west to east to the south of the former battery processing plant but was diverted in the early 1990's to facilitate growth of the BRM site. Appendix C shows the design drawing produced by Evans and Langford Ltd. As part of the construction a 900mm diameter culvert was installed below the existing entrance to the battery processing plant.

Figure 2.1 Existing Manor way ditch bed levels (mAOD). Taken from EA LiDAR data.

2.3 Geology and Hydrogeology

2.3.1 Ground investigation has been undertaken for the site including boreholes and window samples to gather geotechnical and geo-environmental factual information. This was completed August 2022.

2.3.2 The geological setting is as described in section 2.1 of the FRA. In addition, a July 2017 Amec Foster Wheeler Ground Investigation report focused on the main BRM site (Appendix D) has been reviewed to better understand the likely ground strata encountered in the current ground investigation. The approximate stratigraphy is shown in table 2.1 below.

Table 2.1 Existing BRM ground investigation stratigraphy

Strata	Made ground	Alluvium	Boyn Hill Terrace Gravel	Seaford/Newhaven Chalk
Depth to base of stratum (mBGL)	1.0-2.8	12.5-15.0	18.0 – 20.0	>

This Table has been reproduced from data within *General Soil Conditions, Mchallams, 2005* and *Water Storage Tank & Silver Plant Baghouse Development Ground Investigation Report, Amec Foster Wheeler, 2017*

2.3.3 The hydrogeological setting is as described in section 2.1 of the FRA. The bedrock geology below the proposed development site classed as a Principal Aquifer with the alluvium layer shown in table 2.1 listed as an undifferentiated aquifer where groundwater is likely to be encountered. The 2017 Ground Investigation Report by Amec Foster Wheeler recorded groundwater levels encountered between 0.46 and 1.87m below ground level. The high-water level is expected due to the geology of the site and the significant hydraulic barrier provided by the flood defence on running between the site and the River Thames.

2.3.4 Given the anticipated high ground water level and the soft clay alluvium within the proposed development site, zero infiltration has been assumed for any unlined attenuation features within the surface water drainage strategy. Rain falling within the small, proposed areas of landscaping and retained, shrub vegetation will be considered to infiltrate to ground due to the small volumes and more permeable Made Ground.

2.4 Contamination

2.4.1 Geo-environmental investigation was completed in August 2022. The existing site is classed as brownfield, having previously been subject to industrial uses. The 2017 Ground Investigation Report by Amec Foster Wheeler identified a number of historic and current potential sources of contamination, predominantly relating to industrial land uses on and in close proximity to the site, together with the presence of Made Ground associated with general uncontrolled infilling within and in the vicinity of the BRM site boundaries. The types of contamination likely to be encountered during the Ground Investigation and subsequent construction include heavy metals (particularly lead), methane, carbon dioxide, hydrocarbons and slag deposits.

2.4.2 E-scrap comprises discarded, shredded electronic materials from computers, mobile phones, circuit boards, hard-drives, etc. It contains a complex and heterogenous mix of product types and materials, some of which are potentially hazardous (including cadmium, lead, mercury and certain flame retardants). Hazardous waste is defined (in England) within the Hazardous Waste (England and Wales) Regulations 2005 as 'any waste with hazardous properties that may make it harmful to human health and the environment'.

2.5 Existing site drainage

2.5.1 The existing site impermeable area comprises a single-storey, flat-roof office building, auxiliary buildings and asphalt road from the entrance. In recent years, the two businesses in the north and south of the site have regularly laid down hardcore aggregate to create a running track for plant and transport vehicles. Compaction of this has created a semi-permeable area that is subject to ponding until the lower permeability ground allows rainfall to infiltrate. Figure 2.2 below shows the existing site impermeable and semi-permeable catchment areas.

Figure 2.2 Existing site impermeable areas (Taken from Warner Surveys LT/222/0010/P/0001, March 2022)

2.5.2 The impermeable area surrounding and constituting the existing office building in the northern half of the site has a surface water drainage system as shown in Appendix E. Surface water from the office building roof is discharged via downpipes to the asphalt area to the west, which in turn conveys to a series of side channels built into kerbs around the driveway and parking areas. In a number of locations, the side channels have become blocked due to silt and debris as seen in figure 2.3 below. Thames Water were commissioned to undertake a CCTV survey of the systems conveying surface water from the impermeable areas to the marshes as shown in Appendix E, however, they were not able to get a full survey due to the silt and debris build up. This build-up anecdotally causes extensive flooding during heavy rain.

Figure 2.3 Blocked existing drainage channel

2.5.3 Within the semi-impermeable areas of the site, there is also regular pooling of water caused by laying and compaction of aggregate material over many years (See Figure 2.4 below). Standing water eventually percolates to ground but anecdotally, it remains through much of the winter.

Figure 2.4 Standing flood water in semi-impermeable hardstanding

2.5.4 The swale constructed in the southern portion of the site does not appear to be used for surface water drainage from the north. However, as seen in Appendix E, a 300mm diameter pipe headwall is situated towards the eastern end. Further investigation of the catchment area serviced by this outfall will be undertaken during the pre-construction demolition contract. As discussed in section 2.2, the catchment areas for the BRM-owned swale will be further investigated, however, the size of this is anticipated to be minimal.

2.5.5 The swale has a nominal fall from west to east within the proposed site. It is currently heavily vegetated with reeds and grasses. At the eastern end, the swale outfalls into a penstock chamber before discharging via 825mm concrete pipe to the River Thames headwall fitted with cast iron flap valve (see Appendix F for details). The average bed level along the swale within the site boundary is 3.146mAOD and the River Thames outfall invert is 2.430mAOD.

2.5.6 Appendix E also shows the location of the onsite foul water drainage system. A 150mm pipe discharge from the office WC to a below ground cess tank located in the north-west. Anecdotally, this cess tank surcharges causing effluent to pool in the area. It is not clear if this is due to high ground water or tank damage. A further cess tank exists in the south-east of the site to service the removed welfare cabins. No drainage information has been made available for this area.

2.5.7 All existing below ground drainage systems will be removed and contamination remediated prior to installation of the proposed drainage systems.

3. Surface Water Drainage Strategy

3.1 Surface Water System overview

3.1.1 A surface water drainage scheme has been designed to collect rainfall from roof, concrete and asphalt hardstanding, ultimately discharge to the River Thames. The Site is currently, approximately 25% impermeable and will become approximately 75% impermeable post-construction (See figure 3.1 below).

Figure 3.1 Proposed impermeable area

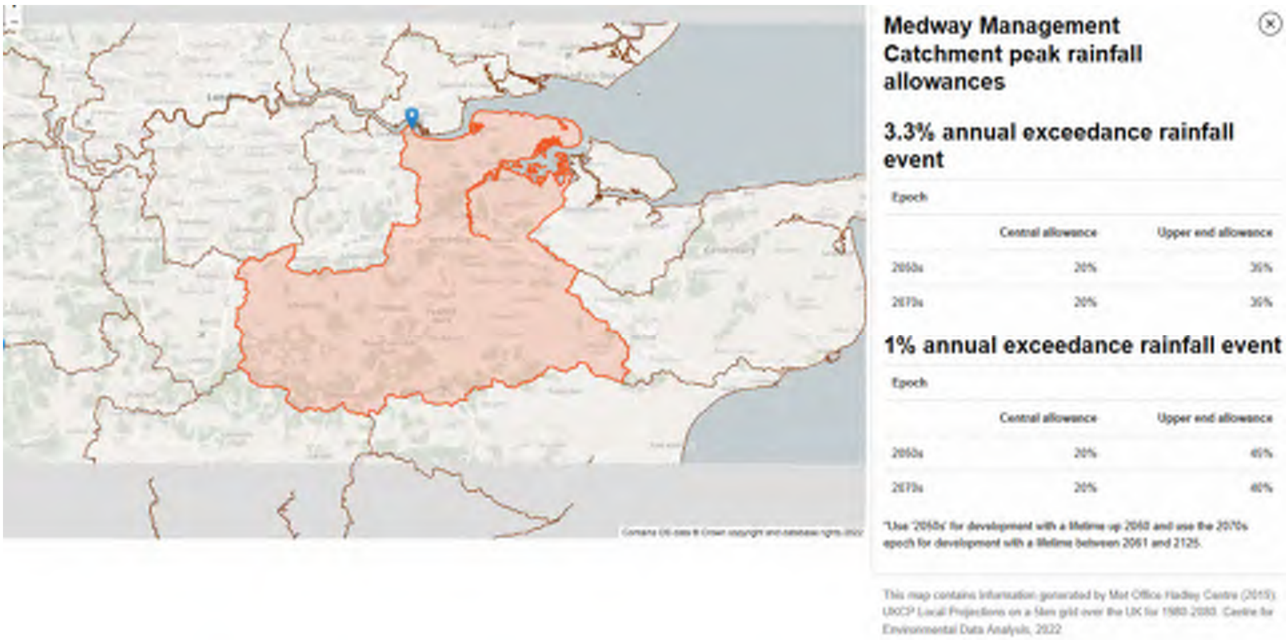
3.1.2 The site levels have been designed to direct surface water from hardstanding and roofs to the edges of pavements and designated low points for collection by surface water drainage systems. In accordance with KCC and Environment Agency standards, the system has been designed using

Microdrainage 2018 Network software and has been sized to collect all surface water runoff for storm events up to and including the 1 in 100year (1% AEP) + 40% climate change events as below. The expected lifespan of the proposed development is 25 years, however, conservatively the surface water systems have been designed to the upper end climate change allowances for a development with a lifetime beyond 2100 as seen in Figure 3.3 below.

Table 3.1 Rainfall storm events analysed

Annual Exceedance Probability (%)	Climate change (%)	Flood risk
100	0	No flood risk
33.3	35	Surcharge of surface water pipes and structures only
1	40	Development is safe from flooding and no flooding elsewhere outside site

Figure 3.2 Environment Agency climate change allowances for DA11 9BB, Kent



3.1.3 Analysis has been undertaken with FEH rainfall data from 2013 for the 3.3%AEP and 1%AEP storm events and FEH data from 1999 for the 100%AEP event. Run off coefficients (Cv) of 0.750 summer and 0.840 winter have been used for all storm events. All storm events have been analysed for a storm duration from 15 minutes to 7 days in accordance with standard procedure.

3.1.4 The surface water collection system comprises Aco HB305 drainage kerbs to the east and west of the proposed E-scrap building, Aco Qmax 350 slot drains to the north and south of the building and symphonic gutter drainage to building roof (See appendices J and K for details). All systems will discharge to a traditional concrete pipe, manhole and catchpit system collecting from north to south. Appendix G shows the catchment areas for each of the systems as well as the proposed surface water drainage strategy plans.

3.1.5 The strategy includes two separate piped systems on the east and west of the building each discharging to precast concrete headwalls to the northern embankment of the existing drainage swale. The system will rely on gravitational flow by shallow gradient from north to south with the difference in upstream and downstream invert level being approximately 700mm for both. Due to the frequently shallow depth of concrete pipes on both east and west runs, bedding will be type Z with Flexcell filler sheet fully surrounding at all pipe joints less than 600mm below finished ground level.

3.1.6 Appendix H contains the MicroDrainage 2018 analysis of the piped surface water systems with unrestricted discharge to the swale. Table 3.2 below summarises the resulting flow rates and velocities at the two outfalls to the drainage swale.

Table 3.2 Flow rates and velocities for proposed surface water drainage system

Network	Rainfall event	Critical storm duration flow rate (l/s)	Velocity (m/s) at outfall
East	100%AEP	71.6	0.36
	3.3%AEP+35%CC	286.1	1.46
	1%AEP+40%CC	373.8	1.90
West	100%AEP	75.6	0.48
	3.3%AEP+35%CC	227.0	1.43
	1%AEP+40%CC	312.3	1.96

3.1.7 Due to the large flow velocities at the Althon precast headwall outfalls, erosion protection and sympathetic maintenance of the existing swale vegetation is proposed. Reno mattresses will be installed to the headwalls similar to the example image in figure 3.3 below. To prevent back flow up both surface water systems, Althon HDPE flap-valves to suit 450mm and 500mm diameter pipes will be factory-fitted to the face of headwall units.

Figure 3.3 Example Reno mattress to headwall

3.1.8 The MicroDrainage network analysis has been undertaken to achieve no flooding at the 3.3%AEP+35%CC and flooding that will not flood proposed structures or cause flooding elsewhere outside the site boundary at the 1%AEP+40%CC event. The proposed west network does not flood at 1%AEP+40%CC. There is a $6.6m^3$ flooded volume for the same storm event in the East Network Pipe 1.000, ACO S Range S300. This is shown to be safely contained in a plan and section at the end of the Microdrainage analysis calculations showing $18.78m^3$ of available exceedance volume.

3.1.9 The downstream outfall will be to the River Thames utilising the existing penstock chambers, 825mm diameter reinforced concrete pipe and cast-iron flap valve headwall as shown within Appendix F. Prior to the development of the Site, a detailed CCTV survey will be undertaken on the length of the existing outfall arrangement to ensure it is in fully operational order.

3.2 SuDS Compliance

3.2.1 In accordance with LASOO Non-Statutory Technical Standards for Sustainable Drainage S1 status and pre-application advice received, there is no requirement for attenuation to restrict discharge rates due to the downstream outfall being to the River Thames. Therefore, no attenuation systems are proposed for the surface water drainage strategy upstream of the BRM-owned swale.

3.2.2 In accordance with pre-application advice from KCC SuDS officer, the surface water drainage strategy has been designed to achieve the high pollution hazard level indices of table 26.2 of the C753 CIRIA SuDS Manual below. This can be achieved through installation of SPEL ESR80/C1 Stormceptor ESR bypass interceptors to each surface water network and utilising the existing on-site swale. Interceptors have mitigation indices of 0.8, 0.6 and 0.9 against the pollutions listed below, whilst a SuDS swale achieves 0.5, 0.6 and 0.6, giving a total of 1.3, 1.2 and 1.5.

Figure 3.4 Mitigation indices taken from C753 CIRIA SuDS Manual 2015

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways[1]	High	0.8[2]	0.8[2]	0.9[2]

3.2.3 SPEL bypass interceptors have been specified to manage treatment of up to 80l/s which covers storm events up to 100%AEP. Interceptors will also treat first flush even when storms exceed 100%AEP. Alarm systems for both interceptors will be installed to warn when interceptors are approaching pollutant capacity. Due to the nature of the Site, a Draintector shut off system for both surface water systems has also been specified to the catchpits immediately upstream of the outfalls. This will automatically prevent serious contamination events conveying to the swale and to the River Thames outfall. The strategy in section 4 details the primary and secondary physical barrier systems that will prevent spent fire water from entering the surface water systems. Therefore, the automatic shut-off systems will act as a tertiary system, unlikely to be required in any fire event.

3.2.4 Despite not being subject to a discharge consent, BRM currently undertake monthly water quality at the River Thames outfall detailed in Appendix F. This is done manually using a 300ml water sample bottle to analyse the below constituents.

- Arsenic
- Cadmium
- Lead
- Nickel
- Silver
- Zinc
- Suspended Solids
- pH
- Oil or Grease

- Copper

To ensure the efficient operation of the SuDS measures listed, continued monitoring of the outfall will be undertaken by BRM with any exceedance of Environment Agency-designated values requiring the closure of the surface water system by ToggleBlok at catchpits CP2 and CP3. A similar monitoring regime is proposed at both headwall outfalls to the BRM-owned drainage swale.

3.3 Tidal locking of River Thames outfall

3.3.1 In accordance with KCC pre-application advice, sufficient attenuation volume during tide-locking of the outfall to the River Thames has been analysed. Figure 3.5 below shows the tide-locked scenarios analysed using Microdrainage 2018 Source Control.

Figure 3.5 Tide-locked scenarios for outfall to the River Thames

Rainfall Event	River Water Levels		
	No restriction (low tide)	MHWS	1:200 year water level 2090 Higher Central (HC) allowance
1 in 1 year	Yes	Yes	Yes
1 in 30 year +35%CC	Yes	Yes	No
1 in 100 year +40%CC	Yes	Yes	No

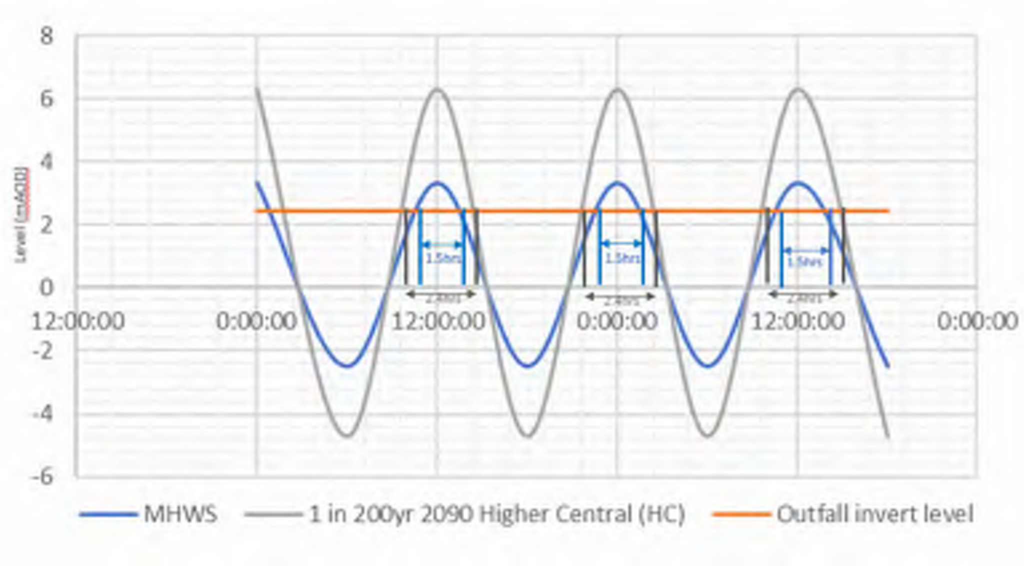
The MHWS and 1 in 200-year 2090 Higher Central allowance tide levels are as shown below in figure 3.6.

Figure 3.6 Tide-levels for tide-locked scenarios

Year	Tidal Event	In channel (node 3.20/3.23)	West Swanscombe Peninsula		East Swanscombe Peninsula	
			Overtopping	Breach	Overtopping	Breach
Lowest existing flood defence crest level			6.31		6.32	
Current day	MHWS	3.33	-	-	-	-
	HAT	3.77	-	-	-	-
2090	1 in 200yr HC	6.15/6.3	0	5.59	1.44	3.4
	1 in 200yr UE	6.65/6.54	3.08	5.89	2.34	4.12
	1 in 1000yr HC	6.64/6.6	3.16	5.91	2.40	4.15
	1 in 1000yr UE	6.9/6.75	3.61	6.18	2.65	4.76
2100	1 in 200yr H++	7.2/7.2	6.54	7.20	6.57	6.19
	1 in 1000yr H++	7.4/7.4	7.40	7.32	7.46	7.23
2125	MHWS	4.35	-	-	-	-
	HAT	4.79	-	-	-	-
	1 in 200yr HC	6.81/6.8	3.50	6.21	2.60	4.74
	1 in 200yr UE	7.1/7.0	5.10	6.73	4.32	5.48

Matching the above tide levels against the River Thames outfall invert level of 2.43mAOD, the Figure 3.7 tide cycles below show the length of time each tide is above the invert level. This is a conservative estimation as the existing flap valve will become unlocked before the tide level gets below the invert level as the head of water within the headwall will be greater than within the River Thames.

Figure 3.7 MHWS and 1 in 200-year 2090 HC tide levels corresponding to outfall invert level



3.3.2 Appendix I contains Source Control analysis of the figure 3.5 scenarios up to 180-minute storm duration. The attenuation volume required has conservatively been taken as that for a three-hour storm rather than the 1.5 and 2.4 hours required above. Within Appendix I, a flood map and sections have been produced showing the required area and depth for the critical 1%AEP+40%CC storm event over 3 hours which produces a flooded volume of 895.1m^3. This shows that during the worst-case tide-locked event, there is sufficient volume to attenuate flood water in the existing swale and 'no-mans land' security buffer without impacting buildings, critical infrastructure or causing flooding elsewhere.

3.4 Culvert Crossing

3.4.1 To allow access to the proposed development, the existing entrance to the redundant battery processing plant facility to the south will be used. To facilitate this a culvert crossing of the existing swale is needed at the location shown within Appendix G. During KCC pre-application advice, it was agreed that the culvert crossing will have no adverse effect on the hydraulics of the swale by matching the proposed cross-sectional area to the existing top of bank to top of bank cross sectional area of the swale channel. As shown in figure 3.8 below, the existing channel cross section along the centreline of the proposed culvert is 3.146m^2. Figure 3.9, also below, shows the proposed box culvert section to be installed to the existing swale. This has an internal cross-sectional area of 3.53m2 > 3.416m2. The culvert will have a 'V' shaped channel along the centre of the bed and a flow capacity of 5.61m3/s.

Figure 3.8 Existing drainage swale cross-sectional area at proposed entrance crossing

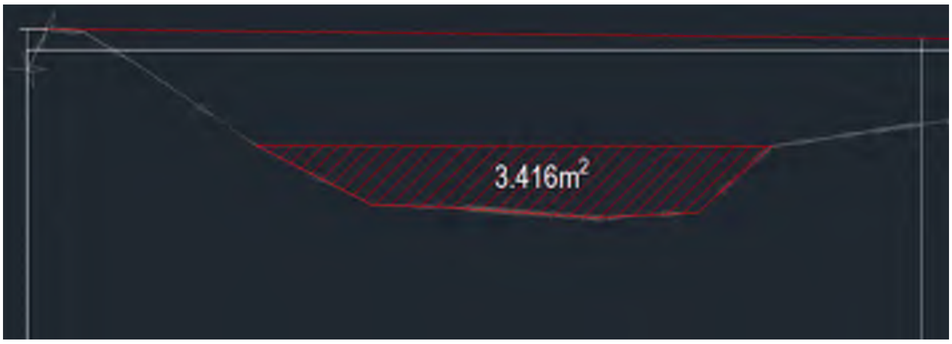


Figure 3.9 Proposed box culvert to be used in construction of entrance crossing

Key: Flow area m^2 / Discharge rate m^3/sec

Internal height mm	Width mm (internal span)											
	1000	1200	1500	1800	2100	2400	2700	3000	3300	3600	3900	4200
500	0.40 / 0.40	0.56 / 0.51	0.71 / 0.67	0.86 / 0.84	1.01 / 1.00	-	-	-	-	-	-	-
600	0.56 / 0.53	0.68 / 0.67	0.86 / 0.89	1.04 / 1.11	1.22 / 1.33	-	-	-	-	-	-	-
650	0.61 / 0.60	0.74 / 0.76	0.93 / 1.00	1.13 / 1.25	1.32 / 1.50	1.52 / 1.75	1.71 / 2.00	-	-	-	-	-
800	0.76 / 0.81	0.92 / 1.03	1.13 / 1.33	1.37 / 1.67	1.61 / 2.01	1.85 / 2.36	2.09 / 2.71	2.33 / 3.06	2.57 / 3.42	2.81 / 3.77	3.05 / 4.12	-
1000	0.95 / 1.10	1.16 / 1.40	1.43 / 1.84	1.73 / 2.32	2.03 / 2.80	2.33 / 3.29	2.63 / 3.79	2.93 / 4.29	3.23 / 4.79	3.53 / 5.30	3.83 / 5.80	4.13 / 6.30
1200	-	1.37 / 1.76	1.73 / 2.37	2.09 / 3.00	2.45 / 3.64	2.81 / 4.29	3.17 / 4.95	3.53 / 5.61	3.89 / 6.28	4.25 / 6.95	4.61 / 7.62	4.97 / 8.29
1500	-	-	2.18 / 3.21	2.63 / 4.09	3.08 / 4.98	3.53 / 5.89	3.98 / 6.81	4.43 / 7.74	4.88 / 8.68	5.33 / 9.62	5.78 / 10.57	6.23 / 11.52
1800	-	-	-	3.17 / 5.21	3.71 / 6.38	4.25 / 7.57	4.79 / 8.78	5.33 / 10.00	5.87 / 11.24	6.41 / 12.48	6.95 / 13.74	7.49 / 15.00
2100	-	-	-	-	4.34 / 7.83	4.97 / 9.31	5.60 / 10.83	6.23 / 12.36	6.86 / 13.92	7.49 / 15.49	8.12 / 17.07	8.75 / 18.67

3.5 Maintenance regime

BRM will be responsible for the maintenance of the surface water drainage network in accordance with their current regime including clearing of collection systems and checking for network blockages from within catchpits and manholes. Currently, BRM undertake a 3-monthly maintenance schedule on the existing sluice gate outfall to the River Thames. This includes checks on whether the gate will fully close, open and is free to operate. The SuDS maintenance schedule within figure 3.10 will be added to this regime to ensure full operability and efficiency of the surface water drainage systems.

Figure 3.10 SuDS features maintenance regime

Feature	Maintenance Regime	Task
Drainage Swale	3-monthly	Remove litter and debris, grass cutting access routes, inspection of inlets, outlets, banksides for blockages.
	6 Months to Annually	Tidy dead growth, remove sediment from inlets/outlets.
	As required	Reseed areas of poor vegetation growth, repair erosion or other damage by reseeding and/or fixing Reno mattressing.
SPEL ESR Separator	3-monthly	The primary chamber should be checked every 3 months to determine the depth of silt and retained pollutants. An alarm system is proposed to warn site operatives when emptying will be required.

4. Spent fire water drainage strategy

4.1.1 This section describes the proposed drainage strategy for spent fire water which will require on-site containment and subsequent removal to a registered processing facility. Firewater containment is the process of containing the run-off from fighting fires. Spent firewater contains many hazardous substances, largely by-products of combustion, which can transform safe materials into toxic, polluting, and environmentally damaging substances.

4.1.2 As per CIRIA 736 (Containment systems for the prevention of pollution: Secondary, tertiary, and other measures for industrial and commercial premises [2014]), contaminants, contaminated water and associated wastes should be contained either at the scene (for example, in a holding tank and/or by blocking drains), or remotely off site (for example, in a stormwater tank), until testing can be carried out and the firewater disposed of.

4.1.3 Within the proposed site fire strategy, the firefighting water volume has been calculated as 410m^3 based on a required demand of 3420 litres per minute over 120 minutes. This will be provided in an above-ground water tank with adjacent GRP-clad pumping station similar to that shown in figure 4.1 below.

Figure 4.1 Example image of above-ground fire water tank and GRP pumping station building

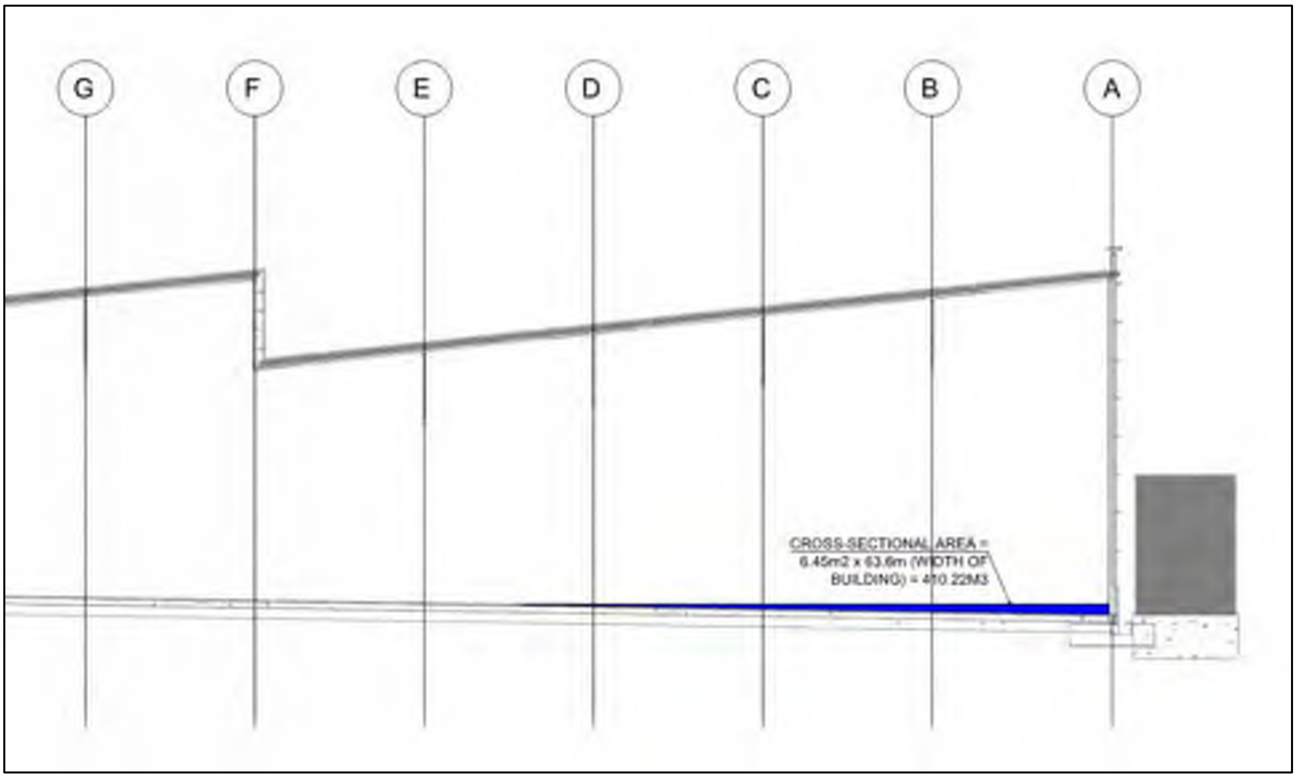
4.1.4 A fire water drainage strategy has been developed whereby spent firewater will be accommodated within the following elements of the building/site:

- Primary containment – stored within the building structure (RC walls and raised level threshold along southern elevation). The building has been designed so that internal drainage is contained within the building withno external drainage connections.
- Secondary containment – stored within the external hardstanding (kerbs).
- Tertiary containment – stored within a closed surface water system by engaging Togglebloks installed within catchpits CP2 and CP3 at the downstream end of the east and west surface water networks.

4.1.5 The associated flood risk assessment for the proposed development has indicated that the design breach flood level for the site is 6.35mAOD. Therefore, the building must be completely protected from flood waters to this level. As shown in the associated elevations, it is proposed to raise the southern operational area to an FSL of 6.35mAOD with the internal floor sloping at a gradient of 1.5% from south to north. To protect the north, east and west sides of the building it is proposed to include an uninterrupted reinforced concrete wall to a height of 6.35mAOD which will prevent flood waters from entering.

4.1.6 The proposed primary containment method for spent firewater is storage within the E-scrap building structure. To facilitate this, the internal floor, with a 1.5% fall from the southern elevation to the northern elevation, will convey water internally to the northern 1.35m high flood protection wall. To capture the spent firewater a series of below ground sumps will be incorporated into the northern area of the building, within which pumps can be dropped to collect water and any material mixed to be processed off site. Figure 4.2 below shows a cross section through the centre of the building from north to south within which the 410m3 volume is easily contained.

Figure 4.2 South to north cross section through building showing 410m3 spent fire water volume.



4.1.7 Due to the unlikely event of a leak from inside the building during or after a fire, secondary containment will be provided on the external hardstanding. The external hardstanding has an approximate area of 4500m^2 (see figure 4.3 below) with a minimum kerbed upstand of 125mm, providing a minimum total volume of 563m^3.

4.1.8 To allow for externally stored volume of spent fire water, a tertiary containment measure is required within downstream catchpits CP2 and CP3 in the form of ToggleBlok isolation devices to the outlet. When a fire event happens, either the operations team will initiate the shut-off system or it will be linked directly to the fire systems to automatically shut-off as soon as sprinkler systems are enabled. This will completely prevent spent fire water from entering the drainage swale after which the system will be jetted to each catchpit and the additional water collected for processing off-site.

Figure 4.3 Area of proposed secondary spent fire water containment on hardstanding apron

4.1.9 After a fire event, spent fire water will be sent for off-site processing. There are several companies in the Kent/East London area who specialise in the removal, treatment, and disposal of contaminated firewater, many of whom can respond to a call out on the same day, sometimes within 2 hours. The facility operating procedures will also include a clean-up regime for post-fire events which will ensure no residual contamination will be able to enter the drainage swale through the surface water drainage systems.

5. Foul water drainage strategy

5.1.1 The number of staff based at the E-scrap facility is anticipated to be a maximum of 4. A welfare facility has been provided for these staff to use whilst on shift. Staff will continue to use the main BRM canteen facility due to health and safety protocol.

For those staff, the welfare facility will offer the following welfare facilities creating wastewater:

- Toilets and wash basins;
- Break-out room with sink and basic kitchen facilities.

5.1.2 To design the system to accept wastewater generation from these activities, an allowance of 100litres/person/day has been allowed based on the UK Water design guidelines for an open industrial site. Conservatively this includes a canteen which the on-site welfare will not contain.

Table 5.1 Calculated foul water loading and storage

Worker population	Consumption rate (l/h/d)	Infiltration (%)	Storage time (days)	DWF (m^3/d)	Storage volume req. (m^3)	Storage volume provided (m^3)
4	100	0	50 days	0.4	20	20

5.1.3 To contain the wastewater a SPEL 300 series Tankstor cess stank has been specified to be connected to the welfare unit via 150mm dia. PVC pipe. The tank will be installed with an alarm system relaying to the welfare unit to warn when it is 75% and 90% full. As above it is anticipated that a register waste carrier will be required to empty the tank approximately every 2 months.

Appendix A
Drainage pre-application advice letters

Flood and Water Management
Invicta House
Maidstone
Kent
ME14 1XX
Website: www.kent.gov.uk/flooding
Email: flood@kent.gov.uk
Tel: 03000 41 41 41
Our Ref: NON/2022/090533
Date 01/07/2022

Britannia Refined Metals
(Site 4)
Manor Way
Northfleet
DA11 9BG

Location: Site 4, Land off Manor Way, Northfleet, DA11 9BB
Proposal: Pre App site meeting to determine status of swale under S.23 LDA 1991

Dear Sam Davy and Jack Park

Thank you for consulting with the Flood and Water Management Team with regards to pre-application advice.

I attended site and met with you on 27/06/2022 and can confirm that the swales on site as indicated on the map below does not appear to have any connection to the wider land drainage / ordinary watercourse network in the area and appears to have been installed to control surface water flows within that parcel of land, with the main site being north of the most northern swale shown below.

Channels Viewed and checked for connection

As such, these swales do not require consent under S.23 of the Land Drainage Act 1991 for any changes to flow. We would always advise that open channels should be incorporated into the new site design (which you confirmed was the case on site)

Other items discussed was the current condition of the ordinary watercourse, as a crossing is due to be installed, we would recommend that sympathetic maintenance is carried out to remove vegetation growth from within the channel. It was also observed that there appeared to be various types of litter and inappropriate materials from the site having been unused for an amount of time and this should also be removed.

The crossing that is proposed on the northern swale to allow access to the site should match the cross section of the swale where possible. Given the channel is of considerable width a box culvert may be the most efficient method of achieving this.

We would discourage maintenance activities that remove all vegetation from the banks and channels as this can cause instability should fast flows occur shortly after clearance and can also cause damage to local ecology and wildlife relying on the channel as a wildlife corridor. I would also recommend that an ecological survey is undertaken prior to any maintenance or construction work to ensure that any no protected species are harmed if they are present and that the works proposed are suitable for the channel.

Should you have any further queries with regards to this response please feel free to contact me.

Yours Sincerely,

Emma Burdett
Land Drainage Engineer
Flood and Water Management

PRE-APPLICATION MEETING

Meeting Notes

Date/Time : 27/06/2022
Location : Britannia Refined Metals (Site 4) Manor Way, Northfleet, DA11 9BG

Attendees: Sam Davy - Wood PLC
Jack Park - Wood PLC

KCC - Daniel Hoare
KCC - Emma Burdett
KCC - Emily Neale

Site Location: Land off Manor Way, Northfleet DA11 9BB
LPA District reference: Pre-application advice (outside of planning process)
KCC reference: NON/2022/090533

During the onsite meeting, a number of items were discussed in regards to future surface water management for the development. The below is a summary of those discussions for record:

Wood PLC informed the LLFA that the overarching surface water strategy designed to serve the new processing facility at site 4 would consist of capturing runoff from the impermeable surfaces (access road and roof area) and direct this to an existing swale/ ditch on site. The existing swale feature currently also receive runoff from the adjacent site and outfalls via gravity into the River Thames.

Discharge Limitations:

Wood PLC sought clarification in regard to any off-site discharge rate limitations that would be required. The LLFA applies the Non-Statutory Technical Standards guidance, of which Paragraph S1 states:

"Where the drainage system discharges to a surface water body that can accommodate uncontrolled surface water discharges without any impact on flood risk from that surface water body (e.g. the sea or a large estuary) the peak flow control standards (S2 and S3 below) and volume control technical standards (S4 and S6 below) need not apply"

In this instance, the LLFA would view that applying discharge rates and volume do not apply to this development due to the nature of the receiving watercourse (River Thames).

Continued use of the existing swale:

Wood PLC requested confirmation that the existing swale feature on site could continue to be used to manage runoff from the new development. The LLFA would agree that it is desirable to continue using the swale and we would regard this feature as a drainage asset that can be used to provide attenuation/ conveyance. It was confirmed during the meeting that the swale system is not connected to the adjacent marshes/ wetland and only receives contributions form site 4 itself and part of the current premises to the south.

Wood PLC confirmed that modelling was being undertaken to better understand the contributions to this feature and simulate this against varying storm events. This is approach is agreeable to the LLFA but we would advise that consideration is applied to a tide locking scenario (discharge via gravity). This is to understand the implications on the swale and site.

The LLFA acting as the authority for watercourse regulation in this area confirmed that the existing swale does not form part of an ordinary watercourse as there is no connection to the wider ditch network. As such works to alter the swale are exempt from consent under S.23 Land Drainage Act 1991. A formal letter from the land drainage engineer has been attached for your records. Should you have any further questions relating to watercourses in this area please contact our Land Drainage Engineer Emma Burdett directly.

Water Quality/ Treatment:

Wood PLC queried our requirements in regard to water quality and treatment requirements, prior to offsite discharge to the Thames. The LLFA requests for all developments to adhere to the guidance stipulated within the CIRIA SuDS Manual (2015) Part E Section 26. This section within the manual contains details of treatment levels and anticipated pollution from different land uses.

The LLFA understand that a combination of petrol interceptors and the swale are to be utilised to maximise treatment. It is anticipated that the incorporation of petrol interceptors would likely meet the required treatment levels detailed within the SuDS Manual.

It is further understood that heavily contaminated water from any refining/ recycling process would not enter the drainage network and would instead be stored within a below ground tank for removal. Upon development of the future Flood Risk Assessment and Drainage Strategy Report, we would request that this is appropriately evidenced.

Climate Change Guidance:
As of the 10th of May 2022, the Environment Agency's climate change allowances have have been updated. As part of this update, revisions have been made to the 'Peak Rainfall Intensity Allowances' that are used in applying climate change percentages to new drainage schemes. The LLFA would now seek the 'upper end' allowance is designed for both the 30 (3.3%) and 100 (1%) year storm scenarios. The latest information on the allowances and map can be found at the following link:
https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

As part of the pre-application process provided by KCC, the LLFA are open to further discussions following the outcome of the modelling.

Kind Regards,

Daniel Hoare
Flood Risk Officer
Flood and Water Management Team

Appendix B
Completed KCC drainage strategy checklist form

Appendix C. Drainage Strategy Summary Form

Drainage Strategy Summary

1. Site details				
Site/development name	BRM E-Scrap facility			
Address including post code	Land off Manor Way, Northfleet, Kent. DA11 9BB			
Grid reference	E 561220		N 175782	
LPA reference	N/A			
Type of application	Outline	☐	Full	☒
	Discharge of Conditions	☐	Other	☐
Has pre-application advice been sought from KCC?	Yes ☒		No ☐	
If so, KCC Reference Number: NON/2022/090533				
Pre-application Meeting Date: 27/06/22				
Site condition	Greenfield ☐		Brownfield ☒	

2. Existing drainage			Document/Plan where information is stated:
Total site area (ha)	1.54		
Impermeable area (ha)	0.356		
Final discharge location	Infiltration ☐ Watercourse ☐ Sewer ☐ Tidal reach/sea ☒		
Where applicable specify catchment runoff rates:	Greenfield runoff rates (l/s)	Existing brownfield runoff rates (l/s)	
QBAR (l/s)	N/A	N/A	
1 in 1 year (l/s)	N/A	N/A	
1 in 30 year (l/s)	N/A	N/A	
1 in 100 year (l/s)	N/A	N/A	

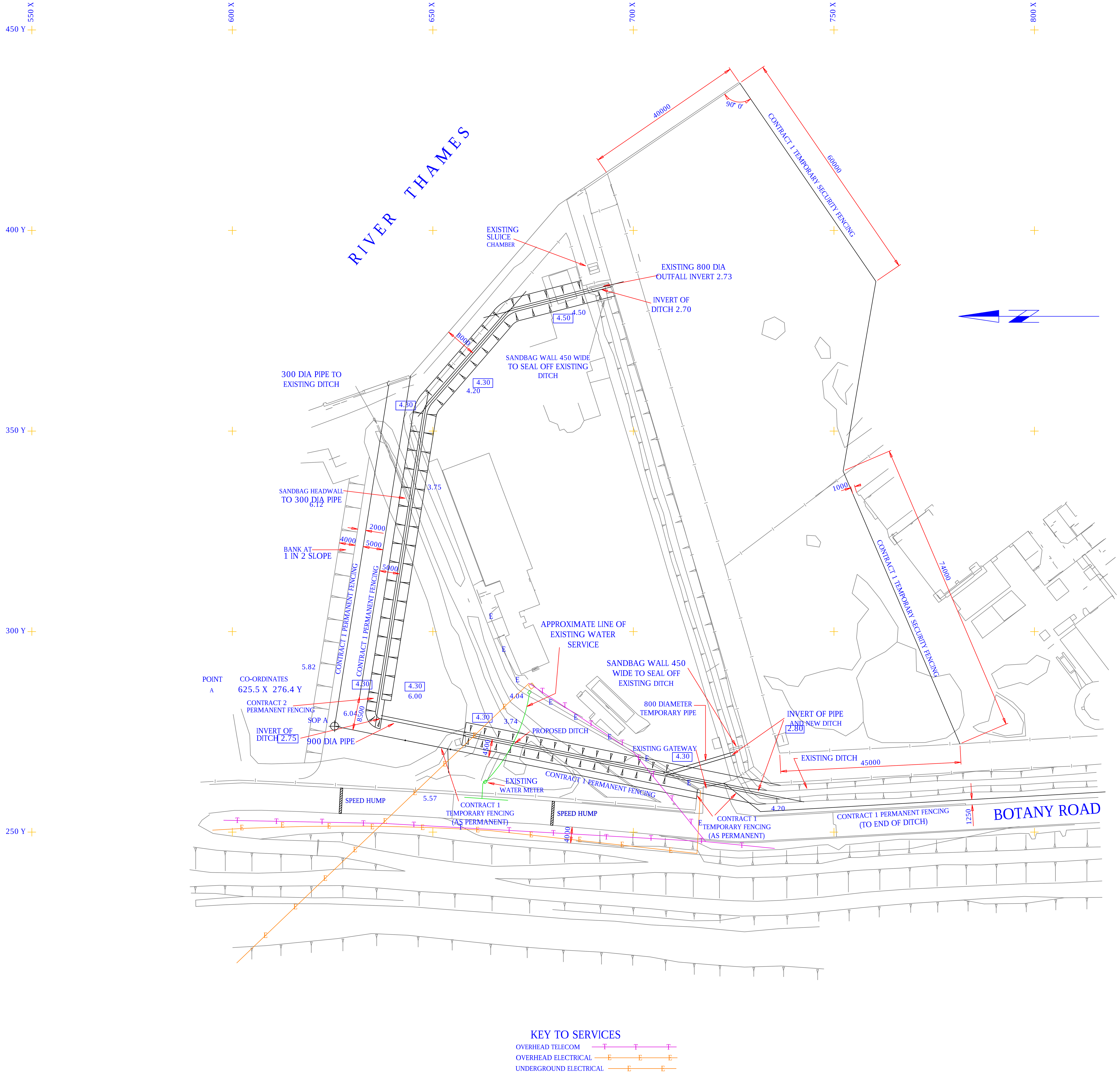
3. Proposed drainage areas			Document/Plan where information is stated:
Impermeable area (ha)	Roof	0.600	808678-WOD-ZZ-XX-RP-C-00002 Figure 2.3
	Highway/road	0.436	
	Other paved areas		
	Total	1.036	
Permeable area (ha)	Open space	0.230	
	Other permeable areas		
	Total	0.230	
Final discharge location	Infiltration ☐ Infiltration rate ____________m/s Watercourse ☐ Sewer ☐ Tidal reach/sea ☒		Appendix F - Existing outfall

Climate change allowance included in design	20% ☐ 30% ☐ 40% ☒ @ 1%AEP		35% CC ALLOWANCE FOR 3.3%AEP
4. Post-Development Discharge rates, with mitigation			**Document/Plan where information is stated:**
Describe development drainage strategy in general terms:			Drainage kerb and Qmax collection to piped drainage system, headwall outfalls to existing BRM-owned swale discharging to River Thames
(a) Soil type and discharge	Permeable ☐ No off-site discharge i.e. infiltration ☐	Semi-permeable ☐ Infiltration maximised, QBAR off-site ☐	Impermeable ☒ Staged discharge ☐
(b) Controlled developed discharge rates (l/s)	1 in 1 year	147.2	808678-WOD-ZZ-XX-CA-C-00001 - Surface Water Network Analysis
	1 in 30 year	509.3	
	1 in 100 year	513.1	
	1 in 100 year + CC	686.1	
5. Discharge Volumes			**Document/Plan where information is stated:**
	Existing volume (m^3)	Proposed volume (m^3)	808678-WOD-ZZ-XX-CA-C-00001 - Surface Water Network Analysis
1 in 1 year	N/A	81.5	
1 in 30 year	N/A	297.8	
1 in 100 year	N/A	N/A	
1 in 100 year + CC	N/A	402.7	
6. Plans/Drawings			**Document/Plan where information is stated:**
A schematic of the drainage strategy has been included? Yes ☒ No ☐			808678-WOD-ZZ-XX-DR-C-00001 - Drainage Plan
A schematic of the drainage network model has been included? Yes ☒ No ☐			808678-WOD-ZZ-XX-CA-C-00001 - Surface Water Network Analysis

All information presented above should be contained within the attached Flood Risk Assessment, Drainage Strategy or Statement and be substantiated through plans and appropriate calculations.

Form completed by	SAM DAVY
Qualifications	CEng MICE
Company	WOOD PLC
Telephone	07974214108
Email	SAM.DAVY@WOODPLC.COM
On behalf of (client's details)	BRITANNIA REFINED METALS
Date	23/03/23

Appendix C
BRM-owned swale diversion design



AutoCAD

Do Not Scale, If in Doubt Ask

Date	Drawing Status	By
16/08/2021	FOR COMMENTS-APPROVAL	E&L

BRITANNIA REFINED METALS LTD.
Botany Road, Northfleet, Kent. DA11 9BG.

PLAN VIEW

Britannia Site

DRAWN	E&L	DATE	01/05/1990	SCALE (A1 ONLY)	1: 500

DRG No BRM 01561 A

Appendix D
Existing BRM main site Ground investigation report

Britannia Refined Metals Limited

Water Storage Tank & Silver Plant Baghouse Development

Ground Investigation Report

July 2017

Amec Foster Wheeler Environment
& Infrastructure UK Limited

Report for

Paul Odendaal

Britannia Refined Metals
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Document revisions

No.	Details	Date
1	First Draft	June 2017
2	Final	July 2017

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1. Introduction

1.1 Background

Amec Foster Wheeler Environment and Infrastructure UK Ltd (Amec Foster Wheeler) was commissioned by Britannia Refined Metals Limited (BRM) to provide geotechnical support to assist the design and development of a new water storage tank and silver plant (also known as the Ag Baghouse) with an associated Cyclone Unit at their site in Botany Road, Northfleet, near Gravesend in Kent. A Site location plan is presented as Figure 1, in Appendix A.

A Desk Study has been carried out by Amec Foster Wheeler (Ref. 39166R005i2, dated May 2017), which revealed that although records of previous investigations exist elsewhere within the BRM site, no geotechnical information exists at the proposed facilities locations. As a result, that additional ground investigation has been recommended to provide information on the ground and groundwater conditions at the proposed facilities development sites.

The scoping, planning, procurement, execution, site supervision and interpretation of this ground investigation form part of this commission.

Furthermore, assessment of the suitability of re-using existing piles to support the new water storage tank was undertaken as part of the Desk Study. Whilst testing data for a preliminary load test pile was provided, no design, as-built information or testing of working piles could be found. Therefore, an outline testing programme was scheduled and executed during the same time as the proposed additional ground investigation (GI).

This report summarises interpretation of the additional investigation and provides engineering recommendations for consideration in the design and construction of ground and foundation works, including the suitability of re-using the existing piles as a foundation option to support the proposed new Water Tank Structure.

1.2 Proposed Development

As indicated in Section 1.1 above, the proposed development comprises the construction of a new Water Storage Tank and a Silver Plant Baghouse with a Cyclone Unit. The development layout is shown on Figure 2, presented in Appendix A.

The new Water Storage Tank is expected to have 1,000 m^3 capacity and be circular with a diameter of 16 m and a height of 5.5 m. The Feasibility Study (Amec Foster Wheeler 37124-01-D-LON-REP-015, July 2016) recommended that the new Water Tank be constructed at the former CX Battery breaking plant area, near the northern end of the BRM site. The new Water Tank will be constructed in a disused storage bay area adjacent to the main CX plant building. The Feasibility Study also recommended the re-use of the existing piled-foundations currently supporting the CX Battery Plant, to support the new Water Tank if found suitable after assessment and testing to determine their actual conditions and capacities.

The construction of a new Ag Baghouse, to extract and process emissions from the existing Silver Plant near the southern end of the site, will replace the existing baghouse which is reaching the end of its asset life. The proposed plant is envisaged to occupy a plan area of 150 m^2, with an associated Cyclone Unit occupying a plan area of approximately 5 m^2.

To limit differential settlements between existing and new structures, the Feasibility Study also recommended that the new Ag Baghouse and Cyclone Unit be supported on piled foundations.

1.3 Scope of Work

Amec Foster Wheeler scope of work for the required intrusive GI comprised the following:

- Scope, procure, manage and supervise an intrusive geotechnical investigation, schedule laboratory testing and review Factual Reports;
- Interpret the factual information to determine site specific ground and groundwater conditions and derive geotechnical characteristic parameters necessary for design;
- Identify geotechnical and environmental risks and hazards and associated mitigation measures for their management during the next phases of the projects; and
- Provide engineering recommendations for design and construction, including assessment of re-using the existing piled-foundations at the CX Shed to support the proposed new Water Storage Tank to be constructed at the same location;

1.4 Geotechnical Category of the Project

No very large or unusual structures are proposed and no abnormal risks are envisaged at the site. The key issue of concern for this project is the consideration for re-using the existing piled foundations at the Battery Plant area to support the proposed new Water Tank.

The foundation design for these proposed facilities will require collection and interpretation of the additional geotechnical information, assessment of the pile testing results, undertaken as part of this investigation, to determine suitability of re-using the existing piled-foundation at the CX Shed, thus, ensure that fundamental design and construction requirements are satisfied. As such and in accordance with Eurocode 7 (BS EN 1997-1; 2004), the proposed development works have been classified as Geotechnical Category 2.

1.5 Regulatory Context (Contaminated Land)

No conditions relating to contamination need to be discharged in advance of the proposed development. Therefore, this GIR is not intended to be utilised as part of the planning process. However, the site will need to be assessed for possible harm of future users throughout the operational life of the proposed development.

Further, it has to be noted that the risk assessment in Section 7 of this report does not consider risks to site construction workers on the basis that risk to workers will be dealt with under the Health and Safety at Work Act (1974) and regulations made under the Act.

2. Site Conditions

2.1 Site Location and Description

The BRM site is located on Botany Road, Northfleet, Gravesend, Kent DA11 9BG, at approximate National Grid Reference 561404, 175446 (see Figure 1, in Appendix A).

The proposed development facilities are located within the BRM site, which is approximately 3.0 km north-west of Gravesend town centre and covers an area of approximately 10 Ha.

The BRM site is bounded to the east by the River Thames, to the west by open grassland, to the north by a quayside storage facility and to the south by a series of industrial and commercial units.

The proposed location of the new Water Tank is a reclaimed storage bay area outside the disused battery breaking plant building (CX Shed), close to the northern end of the site. The area is covered by a canopy extending outwards from the main shed building. It is understood that this canopy will be demolished to allow the construction of the new Water Tank although the main shed building will be retained.

The Ag Baghouse proposed location is to the west of the existing silver plant and is situated close to the site access road at the southern end of the site, with an associated Cyclone Unit to be situated to the east of the Ag Baghouse, close to the southern side of the silver plant.

2.2 Services

A composite utility drawing (Drawing No 06686 Rev G – Master Site Plan – Services), dated 08/11/2010, was provided by BRM during the Desk Study. A review of this drawing revealed the presence of fire mains, water pipelines and mains in the vicinity of the proposed new Water Tank location. It also revealed that the proposed locations of the Cyclone Unit and the silver plant Ag Baghouse are in an area of congested services including fire mains, drains, water pipes, electricity and communications cables. A copy of the utilities drawing is presented in Appendix B.

Due to the risks posed by the presence of these services and potential presence of unrecorded services, BRM requested that all borehole locations were to be checked and cleared by them, and that a permit to dig is obtained prior to the drilling of any of the boreholes.

2.3 Unexploded Ordnance

As part of the Desk Study, Amec Foster Wheeler procured an Unexploded Ordnance survey, which was carried out by Macc International Limited in 2017. The purpose of the survey was to determine the likelihood of an encounter with UXO and recommend any precautionary measures to be taken during the execution of any intrusive investigations and ground and foundation works.

The survey concluded that the BRM site is located within an area that has been worked post-war with the risk of encountering UXO during intrusive investigation and foundation works classified as LOW. As a result, no special requirements were made for consideration during any intrusive works.

2.4 Site History Summary

A detailed review of the historical development of the site is presented in the Desk Study report. This indicated that the BRM facility has been present since the 1930's and underwent an expansion northwards in stages until the completion of the ISAsmelt plant and CX battery breaking plant (the location of the water tank) in the 1990's. The study found that the ISAsmelt area is underlain by dense slag material, which may have been placed to raise the level of the former marsh in this area, to allow the site to be further developed. Anecdotal evidence also indicates that a Victorian dumping ground had formerly existed in the centre of the site. Therefore, the potential for variable depths and composition of Made Ground could not be discounted, particularly in the area of the proposed Water Tank.

2.5 Geology

The review of the available geotechnical information during the Desk Study stage proved that whilst previous ground investigations had been carried out within the wider BRM site, none had been undertaken at or around the proposed locations for the new Water Tank and the Ag Baghouse and Cyclone Unit. Additional ground investigation was therefore recommended to obtain information on the ground and groundwater conditions at each of the proposed facilities locations.

A review of the available GI information within the wider BRM site revealed the following stratigraphy:

- Made Ground to variable depths between 1.0m and 2.8m below existing ground level (bgl);
- Alluvium (soft clay and silt with localised peat bands) of thickness ranging between 11.1m and 13.8m;
- Dense sand and Gravel (Boyn Hill Terrace Gravels) of thickness ranging between 6.0m and 9.4m;
- Seaford / Newhaven Chalk (undifferentiated).

2.6 Hydrogeology

The Desk Study review revealed that the BRM facility and neighbouring sites are currently protected by flood defences on their northern boundaries adjacent to the River Thames. The defence measures comprise concrete/steel sheet piles installed at least to a depth of 12.5m bgl and up to a maximum depth of 20m bgl, along the entire length of the BRM facility and further beyond. Hence, the flood defence acts locally as a substantial hydraulic barrier between the Site and the River Thames. Despite this, continued monitoring of groundwater indicated a general flow towards the River Thames, with no rise in groundwater levels beneath the site. This would therefore indicate that groundwater is finding a pathway away from the site and towards the river but the details of this are not known at this stage. The depth to groundwater was reported to vary between 0.46m and 1.87m bgl (levels between 2.20m and 3.79m AOD) (ERM 2017 - Ref 0374319 SPMP: 2016 Groundwater Monitoring).

In addition to the above, the aquifers below are noted to exit beneath the site boundaries.

2.6.1 Superficial Aquifer Designation

Superficial deposits on site (Alluvium and Boyn Hill Terrace Gravel) are classified as a Secondary (undifferentiated) Aquifer. These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers (Environment Agency, 2015).

2.6.2 Bedrock Aquifer Designation

The underlying Chalk, is indicated as a Principal aquifer. These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale (Environment Agency, 2015).

2.6.3 Source Protection Zones

The site is located within a total catchment (zone 3) groundwater source protection zone (Environmental Agency, 2015).

2.7 Hydrology

The River Thames is adjacent to the eastern boundary of the BRM site, and flows in a south - easterly direction before turning eastwards at approximately 1 km south of the site.

2.8 Radon Gas

The site is located in an area of potential elevated radon, the maximum radon potential across the site is between 1 – 3%.

2.9 Environmental Risk

The Desk Study identified a number of historic and current potential sources of contamination, predominantly relating to industrial land uses on and in close proximity to the site, together with the presence of Made Ground associated with general uncontrolled infilling within and in the vicinity of the BRM site boundaries.

The Desk Study also indicated that annual monitoring and analysis of the groundwater and gas wells identified the following:

i. Elevated concentrations of heavy metals which ranged from non-detectable to moderately high levels. It was thought that the majority of the heavy metals within the soils have not become soluble in the groundwater due to the neutral to slightly alkaline conditions prevalent across the site

ii. Significantly elevated concentrations of methane and carbon dioxide have been measured each year. However, it is understood that the proposed development does not include for any enclosed buildings and therefore the hazardous ground gases are not considered an issue.

iii. Groundwater monitoring report states that the ongoing annual monitoring indicates that there is no source of on-going contamination and that the concentration of metals detected in the groundwater are likely to reflect the presence of historically buried materials, including slag.

Furthermore, as indicated during the Desk Study, the main concern will be to reduce any impact on the environment with regards to the underlying chalk aquifer if a piled solution is to be used, which may penetrate this aquifer. If this is the case, a foundation risk assessment should be requested and any special requirements specified by the relevant authorities, like the EA, shall be considered in the construction methodology to be developed for ground and foundation works.

With regard to hazards during construction, this will be dealt with under the Health and Safety at Work Act (1974) and regulations made under the Act (Section 1.5 referred).

3. Ground Investigation

3.1 Ground Investigation (GI) Scope

An intrusive GI was scoped, procured, supervised and managed by Amec Foster Wheeler, including scheduling of laboratory testing and review of the Factual reports. CC Ground Investigation Limited executed the GI works between 3rd and 26th April 2017, and the factual information is included in Factual report C5617 dated May 2017, presented in Appendix C.

The GI scope comprised the following:

- 4No cable percussion holes (BH01-BH04) with rotary cored follow on at two Locations (BH01 and BH04) to a maximum depth of 30.0m bgl;
- 3Nos Dynamic probes to refusal within the Terrace Gravel;
- Geotechnical in situ testing;
- Sampling for geotechnical and geochemical testing;
- Geotechnical and chemical laboratory testing;
- Installation of gas / groundwater monitoring wells in selected boreholes and monitoring;
- Factual reporting.

The exploratory holes locations plan is presented as Figure 3, in Appendix A.

The fieldworks were supervised full time by Amec Foster Wheeler and were completed in accordance with the Contractor's Health and Safety Plan, approved by Amec Foster Wheeler. The Plan was prepared in full adherence to the notified CDM Regulations.

3.2 Services and UXO Clearance

3.2.1 Services

Due to the potential risks posed by the presence of both recorded and unrecorded services within and the vicinity of the proposed facilities locations, each borehole location was checked and cleared by BRM prior to excavation and drilling (Section 2.2). BRM also appointed a Concrete Coring Contractor to core through any surface hardstanding. A Permit to dig was issued on a daily basis for each of the boreholes and these were retained by BRM, who were Principal Contractor for the works.

3.2.2 UXO Clearance

As the risk of encountering UXO during intrusive investigation and piling works was classified as being low, there was no requirement to appoint a UXO engineer to carry out a watching brief during the ground investigation.

3.3 Exploratory Holes

3.3.1 Cable Percussion and Rotary cored Boreholes

The programme of borehole drilling is summarised in Table 3.1 below:

Table 3.1 Borehole Drilling Schedule

Borehole No.	Depth of Borehole (m bgl)	Depth of Borehole (m AOD)
BH01	30	(-)25.1
BH02	25	(-)21.3
BH03	1.6*	2.9*
BH04	30	(-)25.6

Note: * terminated due to hitting concrete obstruction

In granular materials, *in* situ Standard penetration tests (SPT) were undertaken at 1m intervals in the top 10 m, and at 1.5m intervals thereafter. In Cohesive materials, alternating SPT's and UT100 undisturbed samples were taken at 1m intervals in the top 10m, and at 1.5m intervals thereafter.

3.3.2 Dynamic Probing

Three dynamic probe tests were performed, using a track mounted terrier rig. The testing was performed in accordance with BS EN ISO 22476: Part 2 (2005), using a sacrificial cone and a DPSH-B configuration to depths of 15.1m (DP01), 14.59m (DP02) and 16.4m (DP03) bgl. All three probes were terminated when the blow count attained 50 blows for 100 mm penetration, defined as a refusal. All probes were performed within the footprint of the proposed new Water Tank.

3.4 Instrumentation

As directed by Amec Foster Wheeler, combined gas and groundwater standpipes were installed, in BH02 and BH04, to depths of 13.0m and 22.5m bgl respectively. The response zone in BH2 was within the alluvial deposits between 2.0m and 13.0m bgl; in BH04 the response zone was predominantly within the Boyn Hill Gravel deposits between 15.20m and 22.10m bgl, extending slightly into the chalk to a depth of 22.5 m bgl.

No instrumentation was installed in BH01.

3.5 Geotechnical Laboratory Testing

In addition to the *in situ* testing during borehole drilling, geotechnical laboratory testing was scheduled by Amec Foster Wheeler on representative soil samples. The laboratory testing results are included in the Factual Report, prepared by CC Ground Investigation Limited, and presented as Appendix C. Laboratory testing included the following tests:

i. Classification Tests:
   - Moisture Content and Atterberg Limits
   - Particle Size Distribution (PSD)
   - Dry density and saturation moisture content of chalk;

ii. Chemical Testing
   - Ground Aggressivity BRE Suite

iii. Strength and Compressibility Testing
   - One dimensional consolidation testing
   - Single Stage quick undrained triaxial compression testing undertaken on 100m samples

4. Ground and Groundwater Conditions

4.1 Geotechnical Conditions

The strata described below were encountered in the exploratory holes. Geological cross-sections are provided as Figures 4.1 and 4.2, in Appendix A.

4.1.1 Obstructions

Due to the prevalence of hardstanding and potential obstructions on the site, BRM supplied a concrete coring crew to advance the borehole through concrete slabs. A concrete slab was recorded at the ground surface in BH02 and BH04, with a thickness of 0.69m and 0.39m respectively. In BH03 a slab was recorded between ground level and 0.60m bgl, with a second slab being encountered at 1.20m bgl. This was penetrated to a depth of 1.6m bgl, by a combination of concrete coring and chiselling. At 1.60m bgl the borehole was abandoned as further progress was not possible.

4.1.2 Made Ground

Made Ground was reported in all of the exploratory holes locations. The base of the Made Ground was proven to depths of between 1.7m and 3.4m bgl (1.05m to 2.10m AOD), in all boreholes.

Made Ground is generally described as medium dense to dense sandy gravel or gravelly cobbles of brick, concrete and clinker. In BH02, the location of the Ag Baghouse, the Made Ground comprised very soft greyish brown silty sandy gravelly clay, which may indicate reworked alluvium.

4.1.3 Alluvium

Underlying the Made Ground, Alluvium was encountered in all the exploratory holes that penetrated the base of Made Ground. The top of the alluvium was not clearly discernible in the dynamic probes, due to the variability of the Made Ground. The base of the alluvium was proved in the exploratory holes at depths of between 13.1m and 15.2m bgl (8.4m to 10.75m AOD). The alluvium was observed to be between 11.0m and 11.8m thick.

The alluvium was generally described as very soft, locally soft, occasionally locally firm silty, locally sandy, locally gravelly clay with occasional organic remains and bands of peat.

4.1.4 Boyn Hill Gravel

Immediately below the Alluvium, the Boyn Hill Gravel formation was encountered in all the boreholes. In BH02 a band of firm brown sandy slightly gravelly clay was encountered between 18.0m and 19.2m bgl. As this clay was firm and is 4.8m below the base of the alluvium this would appear to be a localised zone within the gravel. The top of the stratum was identified in the dynamic probes, within the footprint of the proposed new water tank, by a sharp and sustained increase in blow counts. The base of the gravel deposit was proved in the boreholes at depths of between 22.1m and 22.5m bgl (17.6m to 18.53m below OD). The thickness of the deposit varied from 6.9m to 9.1m, with the greater thicknesses being recorded in the north (BH01, drilled at the proposed new water tank footprint) and west (BH02 – Ag Baghouse).

The Boyn Hill Gravel is described as medium dense to dense, locally very loose and locally very dense silty sandy gravel or gravelly sand.

4.1.5 Chalk

Chalk from the Seaford and Newhaven chalk formations was encountered below the Boyn Hill Gravel in all the boreholes. The material is described as structureless chalk recovered as slightly sandy silty GRAVEL (Grade Dc) passing into compacted off white sandy gravelly silt with depth in BH01 and BH04 (Grade Dm).

The clasts are described as very weak to weak, low to medium density off-white with black speckling, and the matrix is described as off-white to yellowish orange.

4.1.6 Typical Ground Models

The typical ground models for each facility are presented below, in Tables 4.1 and 4.2:

Table 4.1 Typical Ground Model – Proposed New Water Tank Location

Stratum	Depth to Base (m bgl)	Depth to Base (m AOD)	Thickness (m)
Made Ground	2.80	2.0	2.8
Alluvium	13.80	-8.9	11
Boyn Hill Gravel	21.50	-16.6	7.7
Seaford / Newhaven Chalk	>30	below -25.1	>8.5

Table 4.2 Typical Ground Model - Proposed Ag Baghouse and Cyclone Unit Location

Stratum	Depth to base (m bgl)	Depth to base (m AOD)	Depth to base (m bgl)
Made Ground	1.7 – 3.4	1.1- 2.0	1.7 – 3.4
Alluvium	13.1 to 15.2	-9.3 to -10.2	11.4 to 11.8
Boyn Hill Gravel	22.1 to 22.2	-17.7 to -18.5	6.9 to 9.1
Seaford / Newhaven Chalk	>30	below -25.6	>7.9

4.2 Groundwater Conditions

Perched groundwater was encountered within the Made Ground at a depth of 2.0m bgl in BH04 (2.45m AOD). Groundwater was also encountered within the alluvium in BH02, at a depth of 8.0m bgl (4.33m below OD). Further, groundwater was encountered within the Boyn Hill Gravel deposit in BH01, at a depth of 13.08m bgl (8.18m below OD).

Due to the sporadic nature of the groundwater strikes, it is not clear whether the boreholes have encountered a piezometric surface, or only isolated water bodies. The strike within BH04 is within the range of water levels recorded by ERM in their monitoring reports, but this strike was quickly sealed off and did not appear to be in hydraulic continuity with a piezometric surface.

Based on the above, design groundwater levels should consider the continuous monitoring results obtained by ERM.

5. Geotechnical Properties

5.1 Granular Made Ground

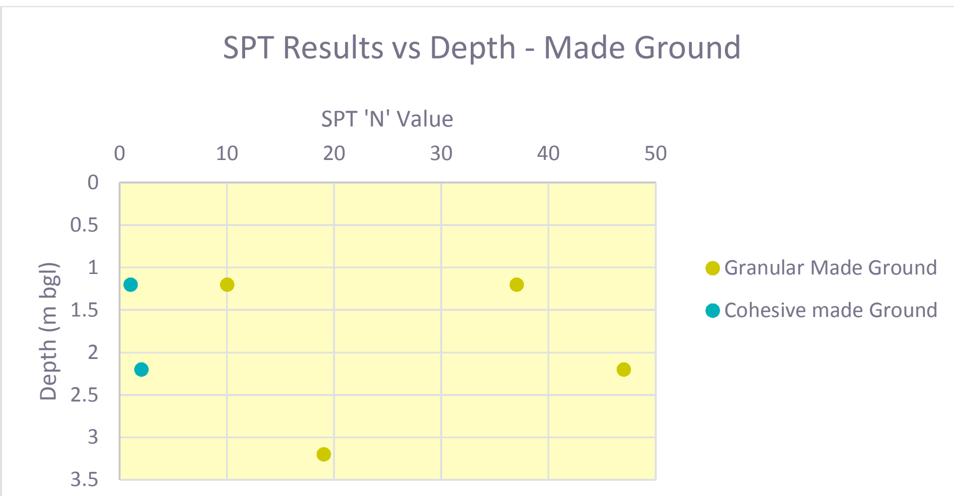
The composition of the Made Ground varies across the site and includes both granular and cohesive soils. Granular materials within the Made Ground is generally described as medium dense to dense sandy gravel or gravelly cobbles of brick, concrete and clinker.

5.1.1 In-situ Standard Penetration Tests (SPT)

Four SPTs were undertaken in the granular materials of Made Ground from depths of between 1.2m and 3.2m bgl, recording uncorrected SPT 'N' values of between 10 and 47. The tests indicate no discernible trend with depth, as shown in Figure 5.1. A review of the SPT N-values versus elevation indicates that the granular materials within the Made Ground has variable consistency

In addition, corrected N60 values of between 11 and 49 have therefore been calculated based on a rig energy ratio of 63%, following the method set out in BS EN ISO 22476-3:2005.

Figure 5.1 SPT N-values versus depth – Made Ground



5.1.2 Density

Based on the characteristic density of soils suggested in BS 8004:2015 Code of Practice for Foundations, a density value of 19kN/m^3 can be adopted for design corresponding to a medium dense to dense granular soil.

5.1.3 Angle of Shearing Resistance

Based on the corrected N_{60} values, an equivalent angle of shearing resistance of 30° to 40° was derived from the relationship between N values and angle of shearing resistance, after Peck et al (1967).

A conservative effective angle of shearing resistance of 32° is recommended for design, representing a medium dense granular soils within the Made Ground.

5.1.4 Drained Stiffness Modulus

The effective drained modulus has been determined from the relationship, E' = 2 x N_{60}. As a result, an E' value of 22 – 94MN/m^2 has been derived.

Due to the significant variation in the composition of the granular soils within the Made Ground and in conjunction with literature recommendations, a characteristic design E' value of 30MN/m^2 is recommended.

5.2 Cohesive Made Ground

Cohesive materials within the Made Ground was only encountered in BH02, the proposed Ag Baghouse location, the extent of this sub-type of Made Ground is not known. These materials are generally described as very soft Clay.

5.2.1 In-situ Standard Penetration Tests (SPT)

Two in-situ SPT tests were recorded in cohesive Made Ground, giving 'N' values of 1 and 2, as shown in Figure 5.1. This limited results indicate the cohesive Made Ground to have a very soft consistency, which is in general agreement with borehole description.

5.2.2 Density

Based on the characteristic density of soils suggested in BS 8004:2015 Code of Practice for Foundations, a density value of 16kN/m^3 can be adopted for design corresponding to a very soft soil.

5.2.3 Angle of Shearing Resistance

An approximate value for the drained angle of shearing resistance of 20° has been derived based on very low SPT N values of 1 and 2.

5.2.4 Undrained Shear Strength

The undrained shear strength values of 4.5 kN/m^2 and 9 kN/m^2 of cohesive materials within the Made Ground have been derived from a correlation with SPT N-values, where C_u = 4.5N, recommended by Stroud (Stroud, 1975), representing very soft clay with extremely low strength.

A conservative C_u value of 5kN/m^2 is considered appropriate, representing very soft clay within the Made Ground.

5.2.5 Modulus of Volume Compressibility

One-dimensional Consolidation testing was not performed on any of the cohesive Made Ground samples. In the absence of this information, the modulus of volume compressibility (m_v) has been derived based on the correlation with SPT N-values, m_v = 1 / 0.45N (or 10 / C_u), recommended by Stroud (1975). A characteristic design value of m_v = 2 m^2/MN is therefore considered appropriate.

5.2.6 Undrained Stiffness Modulus

For cohesive materials within the Made Ground, the undrained modulus (E_u) has been derived from the relationships recommended by Jamiolkowski et al (1979), E_u =400xC_u resulting in a value of E_u = 2 MN/m^2.

5.2.7 Drained Stiffness Modulus

The effective drained modulus has been determined from the relationship; E' = 0.6E_u. As a result, an E' value of 1.2 MN/m^2 has been derived.

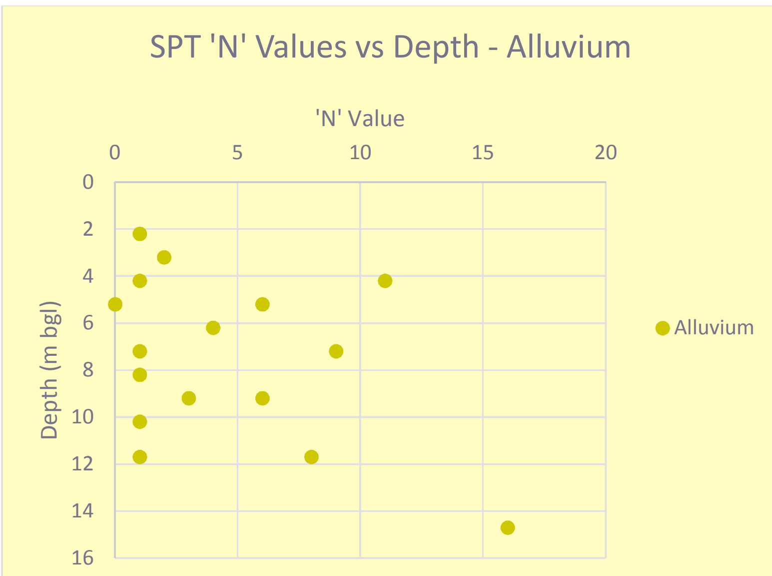
5.3 Alluvium

The Alluvium was typically described as very soft to soft Clay and Silt.

5.3.1 In-situ Standard Penetration Tests (SPT)

In-situ SPT testing was undertaken at intervals through the strata with N-Values ranging from a minimum of 0 to a maximum of 16 with the majority of results being 4 or less (see Figure 5.2 below). This indicates that the Alluvium is generally of very soft to soft consistency.

Figure 5.2 SPT N-values versus depth – Alluvium



5.3.2 Classification Tests

Laboratory testing was carried out on a number of alluvium samples. Thirty-eight moisture content tests gave a range of moisture content values between 18% and 385%, with the highest values being recorded in bands of peat encountered between 7.7m and 10.6m bgl in BH01 (the highest value recorded in clay was 198%). A plot of moisture content versus depth indicates that the moisture content increases to a point approximating the mid-point of the layer and then begins to once again decrease to the point where it contacts the Boyn Hill Gravel, as shown in Figure 5.3 below. This peak moisture content level corresponds well with the presence of peat in BH01, and organic clay in BH02, perhaps indicating an increase in moisture content due to the increased organic content at this level.

Twenty-two samples were tested to determine the Atterberg Limits for the alluvium. The tests returned Liquid Limits of 43% to 206% (median 96%, mean 102%), plastic limits of 16% to 149% (median 49%, mean 53%) and Plasticity index values of 27% to 71% (median and mean 49%). The results, when plotted on plasticity chart, indicate clay and silt of very high to extremely high plasticity, as shown in Figure 5.4.

5.3.3 Density

Density testing on 15 samples of Alluvium ranging from 12.7 Mg/m^3 to 20.7 Mg/m^3 for the Clay and Silt, and 10.8 Mg/m^3 to 12.4 Mg/m^3) for the Peat within this stratum.

Based on the test results, a density value of 16 kN/m^3 is recommended for the Alluvium of soft to very soft Silty and Clay. For the localised Peat materials, a density value of 11 kN/m^3 is recommended.

Figure 5.3 Moisture Content versus Depth - Alluvium

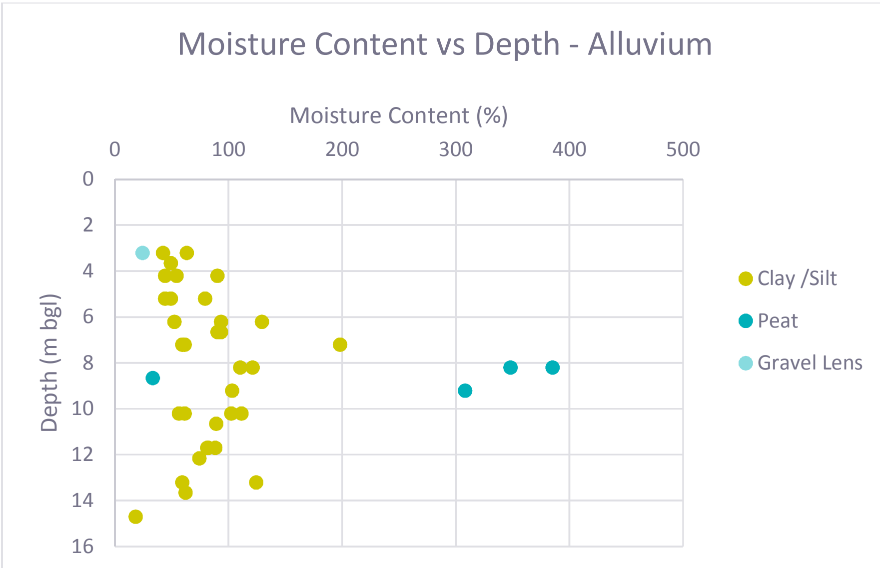
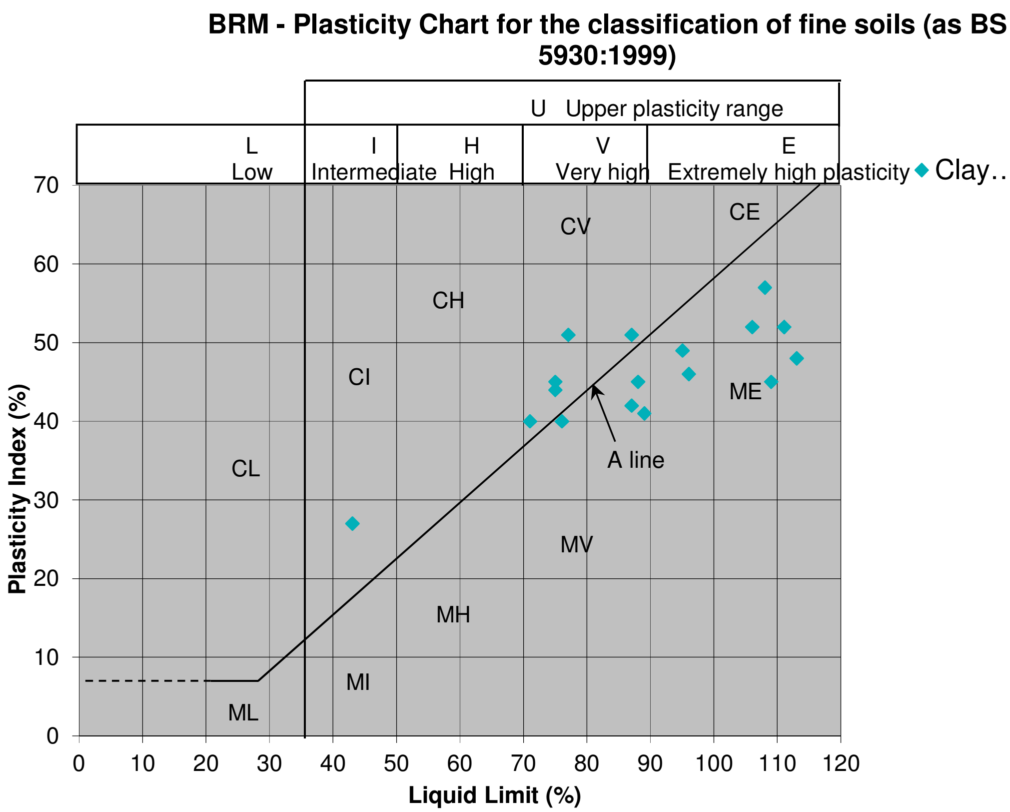


Figure 5.4 Plasticity Chart for Alluvium



5.3.4 Drained Angle of Shearing Resistance

Based on a mean PI value of 49%, BS 8002:1994 Code of Practice for Earth Retaining Structures indicates an approximate value for the drained angle of shearing resistance of 21°. In addition, for the localised Peat within the Alluvium, Warburton et al (2003) recommend an effective angle of friction equating to 21.6°.

Due to the limited data for this stratum an angle of shearing resistance of 21° is recommended for design.

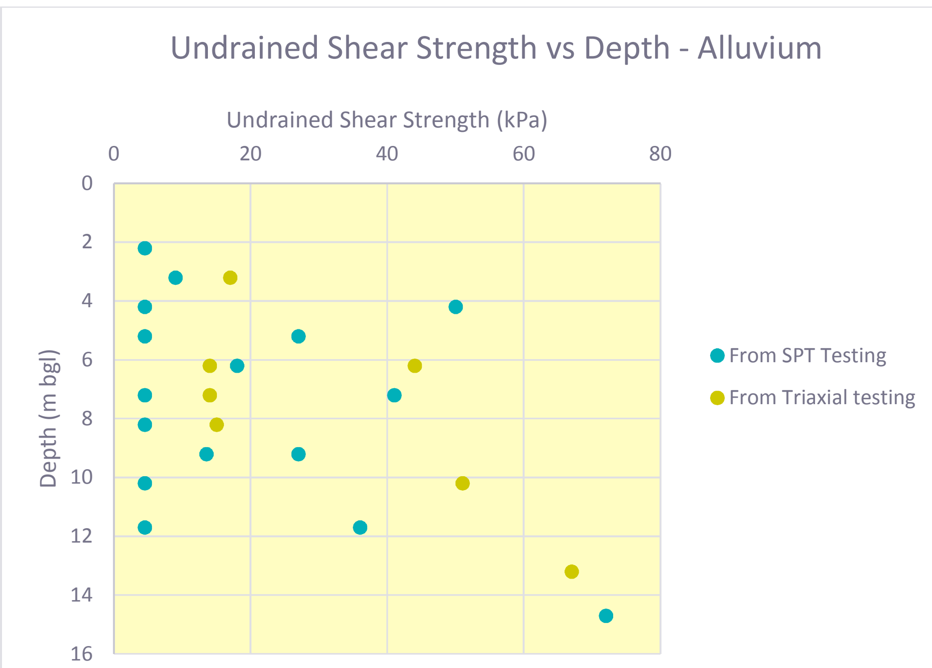
5.3.5 Undrained Shear Strength

The undrained shear strength of the Alluvium has been derived from an assessment of undrained laboratory triaxial tests and correlation with SPT N-values. An illustration of this assessment is provided in Figure 5.5 below.

The strength versus depth plot indicates a general increase in strength with depth, although there is a degree of variability.

A C_u value of 15kN/m^2 is recommended for design, representing very soft to soft Clay and Silt with localised Peat within the Alluvium.

Figure 5.5 Undrained Shear Strength versus depth for Alluvium



5.3.6 Modulus of Volume Compressibility

One-dimensional Consolidation testing was carried out on four samples of Alluvium. The tests indicated highly compressible material, with values of the co-efficient of volume compressibility (m_v) of between 0.43 m^2/MN to 1.40 m^2/MN Values for the co-efficient of consolidation (c_v) of between 0.23m^2/yr. and 1.9 m^2/yr were obtained.

Design values of 1.0 m^2/MN and 1.0m^2/yr are recommended for the m_v and c_v respectively.

5.3.7 Undrained Stiffness Modulus

The undrained modulus (E_u) has been derived from the relationships recommended by Jamiolkowski et al (1979), E_u =400xC_u resulting in a value of E_u = 6 MN/m^2, representing very soft to soft Alluvium

5.3.8 Drained Stiffness Modulus

The effective drained modulus has been determined from the relationship; $E' = 0.6E_u$. As a result, an E' value of 3.6 MN/m² has been derived.

5.4 Boyn Hill Gravel

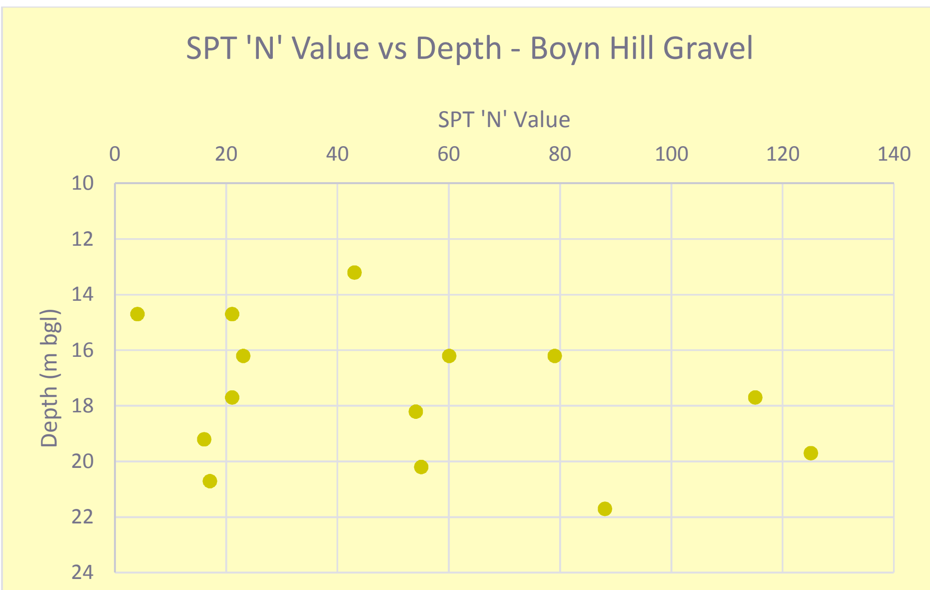
The Boyn Hill Gravel formation was described as medium dense to dense Sand and Gravel.

5.4.1 In Situ Standard Penetration Test

Fourteen *in situ* SPT tests were carried out with N-Values ranging from a minimum of 4 to a maximum of 125. The value of 4 seems rather spurious, given that the next lowest value is 16. The results broadly indicate a medium dense to very dense material, with the mean falling in the dense range. The results appear to indicate a general increase in 'N' value with depth, as seen in Figure 5.6.

In addition, corrected N60 values of between 4 and 131 have therefore been calculated based on a rig energy ratio of 63%, following the method set out in BS EN ISO 22476-3:2005.

Figure 5.6 SPT N-values versus depth – Boyn Hill Gravel



5.4.2 Classification Tests

Particle size distribution tests were carried out in order to determine the relative proportions of the primary and secondary constituents of the material recovered. The Gravel generally consists of 21 % – 85 % gravel with 67% - 13 % sand and 2 % - 15 % silt and clay.

The PSD results confirm the description given in the borehole logs for the Boyn Hill Gravel.

5.4.3 Density

Based on the characteristic density of soils suggested in BS 8004:2015 Code of Practice for Foundations, a density value of 19kN/m³ can be adopted for design, corresponding to a medium dense to dense granular soil.

5.4.4 Angle of Shearing Resistance

Based on the corrected N_{60} values, an equivalent angle of shearing resistance of 32 to over 40° was derived from the relationship between N values and angle of shearing resistance, after Peck et al (1967).

A characteristic effective angle of shearing resistance of 33° is recommended for design, representing a medium dense granular soil.

5.4.5 Stiffness Modulus

In accordance with CIRIA Report 143, an approximation of the drained stiffness can be established using the relationship E' = 2.N, where N_{60} is the SPT N-value ranging from a minimum of 17 to over 50. This results in a drained soil stiffness ranging from 34 MN/m^2 to over 100 MN/m^2. A characteristic value for the drained modulus of 40MN/m^2 is therefore recommended for design based on a characteristic N_{60} of 20, representing medium dense granular soil.

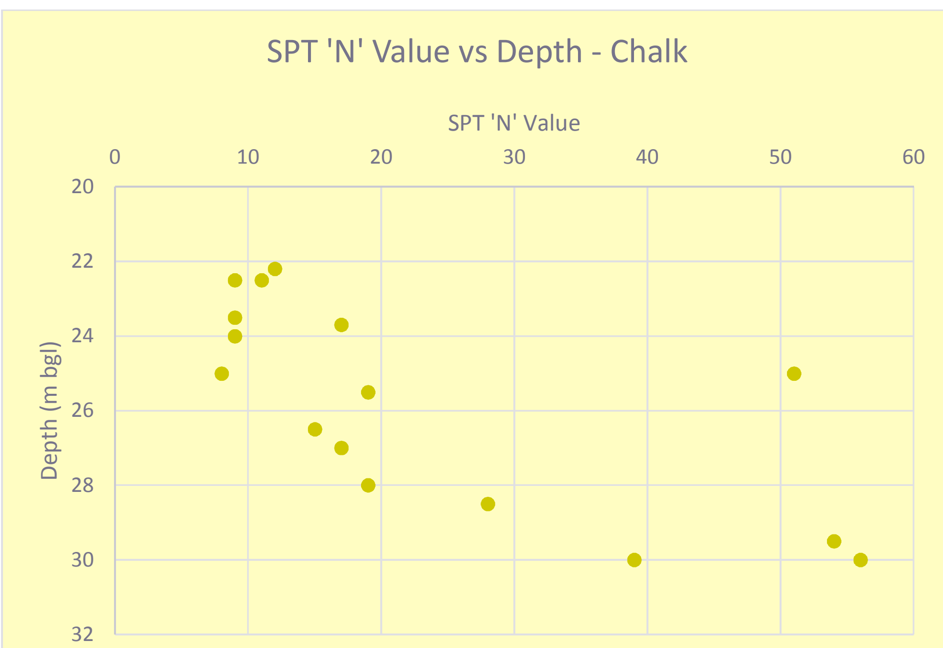
5.5 Chalk

The uppermost 1m to 3m of this stratum is recorded as being highly to completely weathered Chalk (structureless), below which the Chalk materials are less weathered.

5.5.1 In Situ Standard Penetration Test

Sixteen SPT tests in chalk gave SPT 'N' values of between 8 and 56. The results broadly indicate an increase in 'N' value with depth, as seen in Figure 5.7. Within the first 3m depth (approximately 22m – 25m bgl), N values of less than 10 were recorded, whereas below 25m bgl, the minimum SPT N value is 15. In addition, recorded N values are all over 25 at depths below 28m bgl.

Figure 5.7 Plot of SPT versus depth - Chalk



5.5.2 Saturate Moisture Content

Six samples of chalk were subjected to Saturation Moisture Content testing and returned results of between 37% and 45%. According to the CIRIA C574 (2002) classification, this indicates low density chalk.

5.5.3 Density

Ten chalk samples were recovered and subjected to density testing. The results returned bulk density values of $15kN/m^3$ to $20.9kN/m^3$. The results for dry density ranged from $15.2kN/m^3$ to $16.5kN/m^3$.

5.5.4 Classification

Based on the recorded density and saturated moisture content, the Chalk is generally classified as low density in accordance with Table 3.2 of CIRIA Report 574 (2002).

Based on the N values, the chalk bedrock underlying the site would be classed as extremely weak (UCS 0.6 to 1 MPa, N = 6-25 at the site) in Grade Dc Chalk down to about 28m bgl, and very weak in possibly Grade B and C (1 to 5 MPa, N = 28 – 56 at the site) below 28m bgl.

5.5.5 Geotechnical Properties

It is understood from the desk study review that existing pile foundations within the BRM Site are founded in the Boyn Hill Gravel. If there is a requirement for the foundation piles to penetrate the Chalk formation, the appropriate pile shaft and end bearing resistance may be derived from the recorded SPT N values, taking into considerations the determined chalk properties following the guidance in Section 8 of CIRIA Report 574 (2002).

5.6 Ground Aggressivity

Results of water soluble sulphate (2:1), determined from the testing of eleven soil samples (2 No. Made Ground and 9 No. Alluvium) ranged from 20 mg/l to 30 mg/l, with pH values ranging between 7.7 and 8.3. Additional tests of total sulphur and total sulphate on the same samples indicated the estimated oxidisable sulphide values to be all less than 0.3%, all of which suggests that the site is unlikely to be a pyritic ground.

The above results indicate that the sulphate class is DS-1 and the Aggressive Chemical Environment for Concrete (ACEC) is AC-1 for the soils at the site. This, in turn, suggests that the site is 'clean' and that the aggressivity risk is negligible. The findings are inconsistent with the site history and current gas monitoring results. Moreover, historical testing data contained in previous ground investigations on the BRM site revealed high levels of Sulphate (SO_3) contents, thus, leading to the recommendation of adopting a design AC-4 class for the ACEC.

6. Conclusions and Recommendations

6.1 Ground Conditions

The ground conditions at the proposed development site were determined from interpretation of exploratory holes information, field observations and testing. The ground models were developed to consider the conditions revealed at the proposed location of each facility, as summarised in Tables 4.1 and 4.2. These models are recommended for design, as applicable.

6.2 Characteristic Geotechnical Parameters

The soil parameters detailed in Table 6.1 are characteristic values recommended for design. These were derived from interpretation of borehole information, in-situ and laboratory testing results in conjunction with experience and literature recommendations.

Table 6.1 Summary of Characteristic Geotechnical Design Parameters Recommended for Design

Strata	Bulk Density, γ_b, (kN/m^3)	Undrained Shear Strength, C_u (kN/m^2)	Effective Internal angle of frictional resistance, φ' (degs)	Undrained soil stiffness, E_u (MN/m^2)	Effective soil Stiffness, E' (MN/m^2)
Made Ground	16 (cohesive) 19 (granular)	5 (cohesive only)	20 (cohesive) 32 (granular)	2 (cohesive)	1.2 (cohesive) 30 (granular)
Alluvium	16 (11 for Peat)	15	21	6	3.6
Boyn Hill Gravel	19	-	33	-	40
Seaford/Newhaven Chalk	17.5 (15.5 dry density)	-	-	-	-

6.3 Foundation Design Considerations

6.3.1 Proposed New Water Tank

The proposed new water tank is expected to be constructed at the location of the existing battery breaking Plant, which is currently founded on piles. The canopy is expected to be demolished and the concrete hardstanding broken out, with the proposed new water tank to be constructed in its location. The Feasibility Study recommended that the new Water Tank be founded on the existing piled-foundations at that location if assessment of their conditions and capacity are found to be suitable for re-use.

Preliminary assessment of the suitability of re-using the existing piles foundations to support the proposed new Water Tank was assessed during the Desk Study. The assessment included the following information:

- Review of available as-built drawings, specification and testing information;
- Breaking of the existing concrete hardstanding to expose the top 1.0m or so of a limited number of piles at the proposed new Water Tank location, for inspection of pile geometry and conditions.

The review concluded the following:

i. West piles, having 440mm were specified in the technical specification, which was prepared for construction of piles in other areas of the site;

ii. Pile design calculations and assumptions were not available;

iii. There are no as-built drawings of the installed piles at the proposed new Water Tank location;

iv. Results of only one preliminary static load test were available. These were for a 440mm diameter driven piles into the Terrace Gravel. A review of the testing results revealed that the settlement at a vertical Design Working Load (DWL) of 750kN, which included allowance for a 150kN load for negative friction from the fill, has been only marginally less than the specified maximum criteria of 5mm and to have exceeded it during the reloading cycle;

v. There are no records of testing of working piles;

vi. The exposed piles appear to be a driven cast in-situ concrete piles of 370 mm diameter (Plate 6.1 in Appendix E). These are different from the West Piles specified in the specification.

Because of the discrepancy between exposed in-situ piles, those specified in the specification and the details of the preliminary static load test pile, a further outline testing programme was scheduled. The testing comprised the following;

- Integrity testing of a selected number of existing piles that have been exposed to enable assessment of pile type, geometry and surface conditions, where possible;
- A maintained Static load test on one existing pile that was selected from those exposed within the proposed area for the new Water Tank and taking in consideration access for testing plant and equipment. The testing was performed into 2 cycles, with the first performed to a vertical load of 600kN and the second to a maximum load of 900kN. The applied load of 600kN was agreed with BRM who confirmed that this is the vertical DWL per pile being adopted for structural design.

Van Elle were selected as the Specialist Piling Contractor for undertaking the outline testing programme. It is understood that the piles to be exposed and tested were selected by BRM and Van Elle, taking in consideration access issues and plant and equipment to be mobilised for testing. It is also understood that BRM were responsible for breakage of hardstanding concrete and exposure of the existing piles to be tested.

The locations of the existing piles that were tested are shown on Figure 6, in Appendix A. The results of the integrity testing and the static pile load test (Plate 6.2 in Appendix E) are summarised in Tables 6.2 and 6.3 below respectively. Detailed testing results are included in Appendix D.

Table 6.2 Summary of Integrity Test Results

Pile Ref No.	Pile Length (m)	Comments
20	15.0	No evidence of any pile defects observed in test.
223	15.0	No evidence of any pile defects observed in test.
224	15.0	No evidence of any pile defects observed in test.
241	15.0	No evidence of any pile defects observed in test.
242	15.0	No evidence of any pile defects observed in test.

Table 6.3 Summary of static pile load test results

Test Cycle	Load (kN)	Settlement (mm)
1	600	2.99
2	900	5.49

Surface inspection and above testing results of the exposed piles at the proposed new Water Tank location indicated the following:

1. Inspection of the exposed piles suggest that the constructed piles appear to be the alternative option proposed by tenderers during the tendering stage, which is the driven cast in-situ piles with different dimensions to those specified. This is further supported by the confirmation, at the time of writing, that exposure of all the other existing piles at the proposed location of the new Water Tank are found to be of the same type and condition.

2. Surface inspection of the pile heads suggest that the piles are generally in good conditions. However, this does not include any potential impact on the conditions further down due to the demolition activities;

3. From integrity testing results, the tested piles showed no defects but were assessed to be only 15m long, which is a minimum of 1.0m less than specified in the specification. This could be due to breaking of the hardstanding slab to expose the selected piles and the preparation of the pile heads for testing. Another reason could be that the specified driving set has been achieved earlier. However, the latter cannot be verified, as pile design calculations were not available for both the specified pile and the as-constructed alternative. As point 1 above, it is understood that all existing piles at the proposed location have now been exposed. It is recommended that integrity testing be performed on all the exposed piles at the area of the proposed new Water tank to confirm their length and assess their conditions with respect to any defects.

4. The applied vertical load of 600kN for the maintained static load test, and assumed as the vertical DWL for structural design, does not consider the 150kN from negative skin friction. It can be assumed that the long term consolidation of the fill has taken place. However, any soil disturbance during the demolition activities of the existing hardstanding and any other structural elements, and construction of the new pile cap must be assessed and rectified during construction.

5. During maintained static load testing, the measured settlement at DWL of 600kN is below the 5mm specified in the original specification. The measured settlement values must be measured against the tolerable criteria set for the new Water Tank, taking in consideration the achieved magnitude to date and thus the cumulative based on previous and future serviceability conditions of the existing piles.

Notwithstanding the above conclusions and recommendations, the following must be noted and considered in the design and construction stages of the new Water Tank.

- The above assessment relates to the geotechnical capacity of the piles only and does not take account of any structural aspects such as concrete durability and corrosion of the steel reinforcement. Assessment of the structural integrity of the existing piles is required for a more complete assessment of the suitability of re-using them to support the new structure

- The above assessment does not consider the potential requirements for additional piles to supplement existing piles. For this case, differential settlements between existing and new piles should be assessed, taking in consideration sensitivity of the Water tank to such settlements, particularly for the empty/full tank case.

- The pile capacity assessment is limited to the testing of one existing pile to withstand a vertical load of 600kN, assumed to be the DWL considered for structural design. Assessment of the existing piles capacity to withstand other loading conditions such as cyclic due to full/empty tank, abnormal loads due to wind and other weather conditions loads (location of site close to the River Thames) and capacity to resisting any lateral loads must be checked and satisfied, as applicable, in the overall design of the new Water Tank structure.

- Settlement criteria to be satisfied are unknown at this stage. The setting of such criteria must consider the sensitivity of the new Water Tank structure to differential settlements, particularly between existing and new piles, as discussed above, noting that any creep settlements allowed for in the previous design life may have already occurred, thus, leaving little allowance for the new design life.

In summary, surface inspection and limited testing of the existing piles suggests that the as-constructed piles appear generally in good conditions and that, based on geotechnical assessment, a working vertical design load of 600kN appears reasonable for use in the structural design of the water tank. However, residual risks associated with the structural integrity of the existing piles and any impact at depth from the demolition works and exposure of piles, other unknown loading conditions and settlement criteria, potential for additional piles requirements and variation of the ground conditions should the proposed location change must be revised, mitigated and managed during the next stages of the project. The highlighted risks are summarised in the Geotechnical Risk Register, presented in Appendix F.

6.3.2 Proposed Ag Baghouse and Cyclone Unit

The Ag Baghouse and cyclone units are to be constructed in close proximity to existing facilities, which are likely to be supported on piles. To limit differential settlements between the proposed facilities and the existing structures, piled-foundations were recommended in the Feasibility Study.

The Ground Model at the Ag Baghouse and Cyclone Unit show Made Ground and Alluvium over Terrace Gravel and Chalk. Both the Made Ground and the Alluvium are considered unsuitable as foundation strata due to the variable nature the former in depth and consistency and the susceptibility of the latter to settlement. Hence, a piled foundation option is considered the most suitable option to support the proposed Ag Baghouse and Cyclone Unit structures. This is consistent with the recommendation of the feasibility Study that piled-foundation are adopted as the suitable foundation solution at this location. Due to the restrictions related to the Chalk as a protected aquifer, piles should terminate within the Terrace Gravel.

6.4 Excavations

Excavations into the Made Ground and natural soil should generally be achievable by means of normal hydraulic excavating plant.

Adequate lateral support should be provided for all excavations in accordance with current Health and Safety guidelines, should man entry be required, where excavations are in close proximity to structures or services or where personnel or machinery are working in the vicinity. All excavation support should be designed in accordance with CIRIA Report 97 and current Health and Safety regulations.

6.5 Groundwater Control

Perched groundwater was encountered in the boreholes, although no clearly discernible piezometric surface was observed. The ERM groundwater monitoring report which was reviewed as part of the Desk Study indicated that groundwater is typically present within the Made Ground, at depths of less than 2.0m bgl. Therefore the possibility of groundwater being encountered in shallow excavation work cannot be discounted. It should also be noted that the site is adjacent to the River Thames and the underlying natural alluvium and Boyn Hill gravels are highly likely to be in hydraulic continuity with this and therefore the level of the deeper groundwater has the potential to rise during times of heavy and prolonged rainfall, this change in level could have significant implications on any proposed deep excavations and foundation resistance. It is considered that groundwater monitoring is continued to understand the seasonal variations in groundwater levels, in abeyance of this, a design groundwater level of 1.0m below ground level is recommended.

6.6 Services

The proposed facilities are to be constructed at areas where congested services are known to exist (see Drawing in Appendix A and referred to in Section 2.2). During the ground investigation BRM operated a permit to dig system where they checked and verified each exploratory holes position prior to commencement. It is recommended that the same approach be adopted during excavation and construction of foundations.

As it is proposed to re-use existing piles to support the new water tank structure, it is unlikely that intrusive work would exceed the clearance of hardstanding to expose piles for testing and capping. Therefore, the use of a permit to dig system managed by BRM should be sufficient.

However, the construction of the Ag baghouse and cyclone plant will require the installation of a number of piles, and the risk of service strikes is increased. In close proximity to the developments are a number of services, including electricity and telephone cabling, fire mains, water service mains, and drains. It is recommended that services are accurately mapped as far as possible prior to works, and if necessary, services diverted and/or exposed and protected to prevent any damage to them during foundation construction.

6.7 UXO

As discussed in Section 2.3 the UXO level at the site is classified as LOW with respect to piling works. Furthermore, extensive development has already taken place on and round the proposed development sites, which included piling works.

On this basis, no specific strategy, such as further UXO studies or the attendance of a UXO engineer, is required during excavation and foundation construction.

6.8 Concrete Design

Based on the results of the BRE suite testing outlined in Section 5.5, the design sulphate class for concrete is assessed to be DS-1 and the Aggressive Chemical Environment for Concrete (ACEC) is classified as AC-1, assuming mobile groundwater conditions or AC-1s for static groundwater conditions. The classification, however, suggested that the soil at the proposed development facilities is “clean ground”. This is inconsistent with the site history which includes uncontrolled tipping and current levels of gas monitoring. Moreover, historical testing data contained in previous ground investigations on the BRM site revealed high levels of Sulphate (SO_3) contents, thus, leading to the recommendation of adopting a design AC-4 class for the ACEC. .

Given the above inconsistencies, further soil and water sampling and chemical testing is recommended. If this is not possible, however, and to be prudent, adopting a minimum design Class of DS-3, with an associated ACEC classification of AC-3 is recommended.

7. Geotechnical Risk Assessment

A geotechnical risk assessment has been undertaken for the site to identify geotechnical and geo-environmental hazards that may impact the design and construction. The aim of the assessment is to identify the risks and hazards, quantify them in relation to the proposed works and the site conditions and provide mitigation measures to help eliminate or reduce them.

The risk assessment has been given in Appendix F.

8. References

The following documents have been referred to during preparation of this report:

1) British Standard 10175:2011, Investigation of Potentially Contaminated Sites – Code of Practice, 2011;
2) British Standard 5930:1999+A2:2010, Code of Practice for Site Investigations (Amendment 2). British Standards Institution;
3) British Standard EN 1997-1:2004+A1:2013 Eurocode 7: Geotechnical Design – Part 1: General rules, 2013;
4) Bjerrum, L., Problems of Soil Mechanics and Construction on Soft Clays and Structurally Unstable Soils, General Report, in Proceedings of the 8th International Conference of Soil Mechanics, Moscow, 1973, Vol 3, 111 – 159;
5) Butler F. G., General report and state of the art review – Section 3, in proceedings of the 'Conference on Settlement of Structures- Cambridge 1974, Page 531 – 578, London 1975;
6) BS 8004 Code of Practice for Foundations, 2015;
7) BRE Special Digest 1:2005 Concrete in Aggressive Ground, 2005;
8) BRE BR 424 Building on fill: geotechnical aspects, 2nd edition, 2001
9) British Geological Survey On line Geological Mapping, 2016;
10) CIRIA Report 143 The Standard Penetration Test (SPT): methods and use;
11) CIRIA Special Publication 27, Settlement of Structures on Clay Soils, 1983;
12) CIRIA C574, Engineering in Chalk, 2002;
13) Das, Principles of Foundation Engineering , 3rd edition, 1995;
14) Peck et al. Foundation Engineering, 2nd edition, John Wiley, New York, 1967;
15) Stroud M.A. "The Standard Penetration Test in Insensitive Clays and Soft Rocks", Proceedings of the European Symposium on Penetration Testing, 2, 367-375, 1975;
16) Tomlinson M. J. Foundation Design and Construction, 7th edition, Longman, Singapore, 2001.

Appendix A
Figures

Appendix B
Drawings

Appendix C
Ground Investigation Factual Report

Appendix D
Pile Testing Results

Appendix E
Plates

Plate 6.1 Exposed pile head and reinforcement

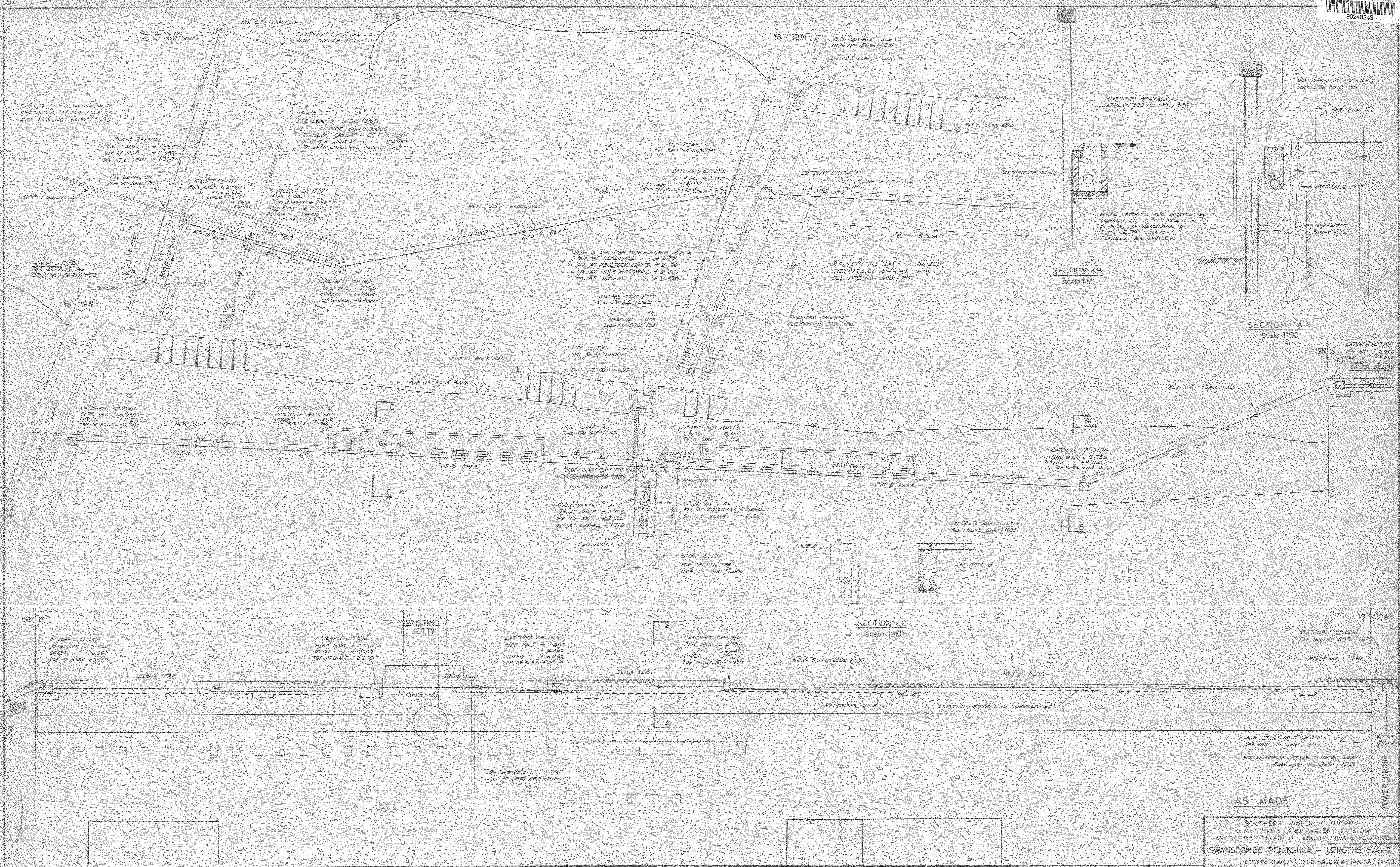
Plate 6.2 Static load test set up

Appendix F Geotechnical Risk Assessment

July 2017
Doc Ref. 39166R06i02

Appendix E
Existing site drainage drawing

Appendix F
Existing Environment Agency River Thames outfall drawing



NOTES

1. ALL LEVELS RELATED TO ORDNANCE DATUM (NEWLYN).
2. ALL DIMENSIONS IN MILLIMETRES.
3. FOR DETAILS OF TYPICAL CATCHPIT SEE DRG. NO. 5691/1520.
4. NEW SURFACE WATER DRAINAGE (PERFORATED PIPES, CATCHPITS, ETC.) MODIFIED TO SUIT SITE CONDITIONS.
5. 'HEPSEAL' AND CONCRETE PIPES WERE LAID ON AND SURROUNDED BY
5. contd. 150 mm. MIN. THICKNESS (825 ϕ – 300 MIN) OF APPROVED FINE GRANULAR MATERIAL OF 10 mm MAX. SIZE.
6. FOR TYPICAL SECTION OF PERFORATED PIPE DRAIN. SEE DRG. NO. 5691/1520.
7. CONCRETE PIPES ARE TO BS. 556 : PART 2 – REINFORCED EXTRA STRENGTH CLASS H WITH APPROVED FLEXIBLE JOINTS.

SOUTHERN WATER AUTHORITY
KENT RIVER AND WATER DIVISION
THAMES TIDAL FLOOD DEFENCES PRIVATE FRONTAGES

SWANSCOMBE PENINSULA – LENGTHS 5/4–7

TITLE OF DRAWING	SECTIONS 3 AND 4 – CORY HALL & BRITANNIA LEAD. FRONTAGES 17 18 19N and 19 DRAINAGE DETAILS
SCALE	1:200 or as noted

SIR BRUCE WHITE, WOLFE BARRY AND PARTNERS

DRAWING No. 5691/1380

Appendix G
Proposed drainage design drawings

Original Drawing Size - A1 DO NOT SCALE

MANHOLE SCHEDULE

MANHOLE REF.	INTERNAL DIMENSIONS	CONNECTIONS DETAILS	INLET CONNECTION (A,B,ETC.) DIAMETER (mm)	INLET CONNECTION (A,B,ETC.) INVERT LEVEL (mAOD)
CP1	1,500mm DIAMETER		A = 150mm PVCu B = 150mm PVCu C = 150mm PVCu	A = 3.684 B = 3.864 C = 3.864
MH1	1,500mm DIAMETER		A = 450mm TW B = 150mm PVCu C = 150mm PVCu	A = 3.603 B = 3.803 C = 3.803
MH2	1,500mm DIAMETER		A = 450mm TW B = 150mm PVCu	A = 3.406 B = 3.406
CP2	1,500mm DIAMETER		A = 450mm TW B = 300mm TW B = 150mm PVCu	A = 3.364 B = 3.364 B = 3.364
MH3	1,800mm DIAMETER		A = 225mm TW B =150mm PVCu	A = 3.796 B = 3.846
MH4	1,800mm DIAMETER		A = 500mm TW B = 150mm PVCu	A = 3.578
CP3	1,800mm DIAMETER		A = 500mm TW B = 300mm TW	A = 3.292 B = 3.292 C = 3.292
MH6	1,800mm DIAMETER		A = 500mm TW	A = 3.126

REF.	COVER LEVELS	OUTLET CONNECTION (X,Y, Etc.) DIAMETER (mm)	OUTLET CONNECTION (X,Y, Etc.) INVERT LEVEL (mAOD)	COMMENTS
CP1	4.904m	X = 450mm TW	X = 3.684	PRECAST CONCRETE CHAMBER. REFER TO DRAWING 0011 FOR DETAILS
MH1	4.966	X = 450mm TW	X = 3.603	PRECAST CONCRETE CHAMBER. REFER TO DRAWING 0011 FOR DETAILS TO RECEIVE FLOWS FROM SIPHONIC DRAINAGE SYSTEM.
MH2	4.954	X = 450mm TW	X = 3.406	PRECAST CONCRETE CHAMBER. REFER TO DRAWING 0011 FOR DETAILS TO RECEIVE FLOWS FROM SIPHONIC DRAINAGE SYSTEM.
CP2	4.763	X = 450mm TW	X = 3.684	PRECAST CONCRETE CHAMBER. REFER TO DRAWING 0011 FOR DETAILS TO RECEIVE FLOWS FROM ACO QMAX DRAINAGE SYSTEM.
MH3	4.932	X = 500mm TW	X = 3.796	PRECAST CONCRETE CHAMBER. REFER TO DRAWING 0011 FOR DETAILS
MH4	4.934	X = 500mm TW	X = 3.578	PRECAST CONCRETE CHAMBER. REFER TO DRAWING 0011 FOR DETAILS TO RECEIVE FLOWS FROM SIPHONIC DRAINAGE SYSTEM.
CP3	4.763	X = 500mm TW	X = 3.292	PRECAST CONCRETE CHAMBER. REFER TO DRAWING 0011 FOR DETAILS TO RECEIVE FLOWS FROM ACO QMAX DRAINAGE SYSTEM.
MH6	4.056	X = 500mm TW	X = 3.126	PRECAST CONCRETE CHAMBER. REFER TO DRAWING 0011 FOR DETAILS

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS STATED OTHERWISE.
2. ALL LEVELS ARE IN METRES UNLESS STATED OTHERWISE.
3. DRAINAGE SYSTEMS AND LEVELS SHOWN ARE PRELIMINARY, SUBJECT TO FINAL DESIGN.
4. INFORMATION RELATING TO THE EXISTING SURFACE WATER OUTFALL TO THE RIVER THAMES HAS BEEN TAKEN FROM ENVIRONMENT AGENCY SUPPLIED RECORDS AND SHALL BE CONFIRMED ON SITE VIA SURVEY.
5. ALL MANHOLES AND CATCHPITS TO BE OF CONCRETE CONSTRUCTION
6. THE EXTENT OF CMC INSTALLATION SHALL BE SUCH THE DRAINAGE NETWORK IS SUBJECT TO GROUND IMPROVEMENT ALONG ITS FULL LENGTH.
7. THE CONTRACTOR SHALL TRIM THE TOP SECTIONS OF CMC TO ALLOW FOR THE INSTALLATION OF PIPE BEDDING/SURROUND IN ACCORDANCE WITH DRAWING 808678-WOOD-ZZ-XX-DR-C-00027.
8. ALL SURFACE WATER PIPES WITH A DEPTH TO CROWN GREATER THAN 600mm TO BE TWINWALL WITH A TYPE S BEDDING IN ACCORDANCE WITH THE DETAILS SHOWN ON 808678-WOOD-ZZ-XX-DR-C-00027.
9. ALL SURFACE WATER PIPES WITH A DEPTH TO CROWN LESS THAN 600mm TO BE TWINWALL WITH A TYPE Z BEDDING IN ACCORDANCE WITH THE DETAILS SHOWN ON 808678-WOOD-ZZ-XX-DR-C-00027.
10. PLEASE REFER TO DRAWING 808678-WOOD-ZZ-XX-DR-C-0002 FOR THE MANHOLE SCHEDULE.
11. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE FOLLOWING DRAWINGS:

- 808678-WOOD-ZZ-XX-DR-C-0002 - DRAINAGE LAYOUT SHEET 2 of 2.

HB305 DRAINAGE KERB
HB305 DRAINABLE DROP KERB UNITS
HB305 DRAINABLE CENTRE STONE
DRAINAGE KERB OUTFALL UNIT
PROPOSED KERBLINE
BUILDING OUTLINE
150mm PVCu CONNECTION TO SURFACE WATER SYSTEM
SLOT/CHANNEL DRAIN (AS NOTED)
SURFACE WATER SEWER (PIPE DIA. AS NOTED)
SURFACE WATER MANHOLE/CATCHPIT (AS NOTED)
FOUL WATER SEWER
ROOF GUTTERING AND FLOW DIRECTION
DOWNPIPE LOCATIONS

REV	DATE		DWN	CHK	APP
P03	20/03 2023	TO ALIGN WITH LATEST PLANNING LAYOUT	SD	JC	JC
P02	04/10 2022	ADDITION OF S RANGE CHANNEL DRAINAGE	SM	SD	JC

REVISIONS

REV	DATE		DWN	CHK	APP
P01	11/08 2022	FIRST ISSUE	SM	SD	JC

SCALES: 1:250

DRAWING STATUS: SUITABLE FOR REVIEW & COMMENT - S3

PROJECT TITLE:
BRM
E-SCRAP
FACILITY

DRAWING TITLE:
SW DRAINAGE PLAN SHEET 1 of 2

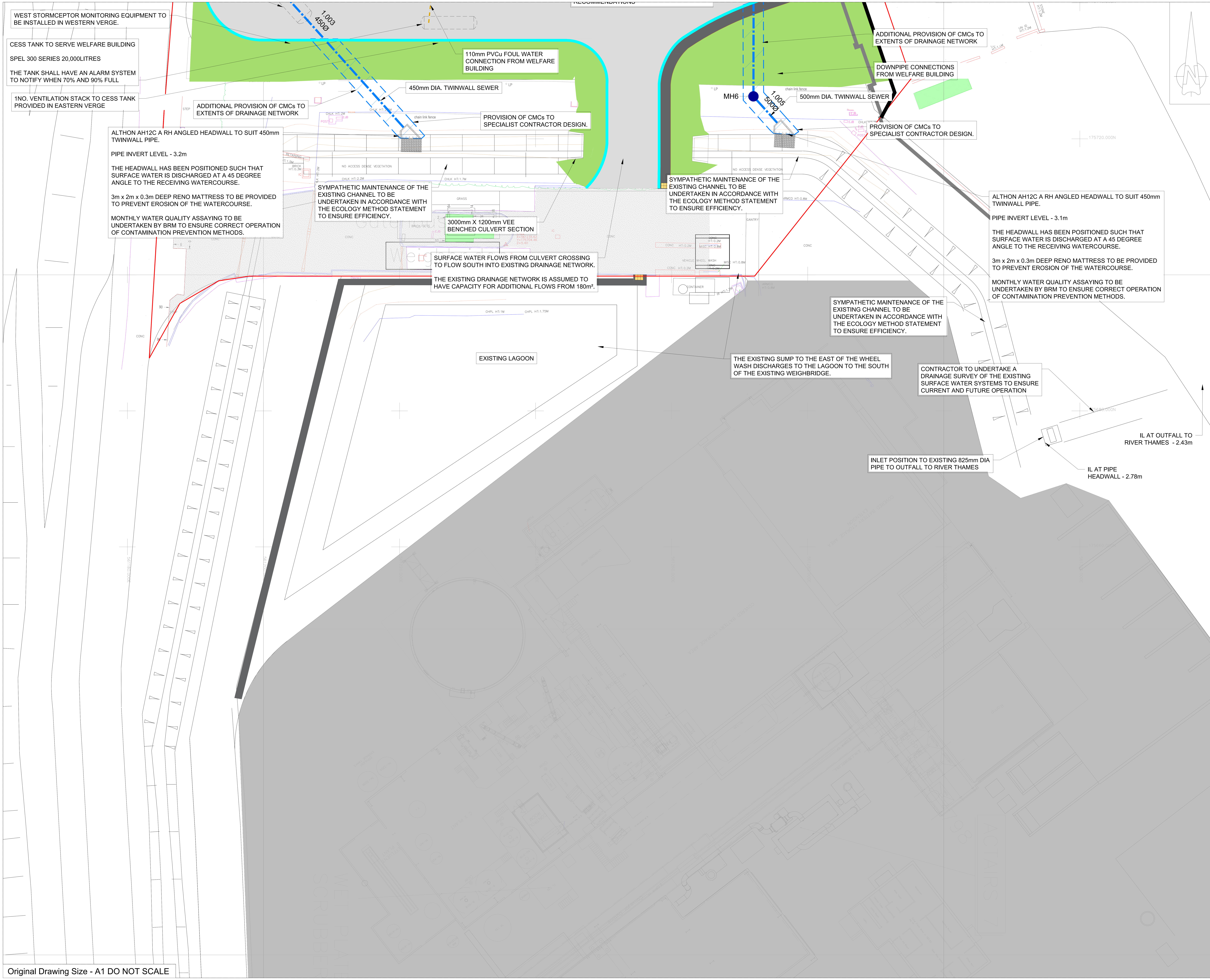
- SURFACE WATER DRAINAGE

CLIENT:
BRITANNIA REFINED METALS LTD.
Botany Road, Northfleet, Kent. DA11 9BG.

FLOOR 3,
11 WESTFERRY CIRCUS,
LONDON
E14 4HD
TEL: (0203) 2151700
FAX: (0203) 2151701

BRM DWG No. BRM_MERIDIAN_DWG_NO
REV. P03

ADVISER / CONTRACTOR DWG No.
808678-WOD-ZZ-XX-DR-C-00001



Original Drawing Size - A1 DO NOT SCALE

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS STATED OTHERWISE.
2. ALL LEVELS ARE IN METRES UNLESS STATED OTHERWISE.
3. DRAINAGE SYSTEMS AND LEVELS SHOWN ARE PRELIMINARY, SUBJECT TO FINAL DESIGN.
4. INFORMATION RELATING TO THE EXISTING SURFACE WATER OUTFALL TO THE RIVER THAMES HAS BEEN TAKEN FROM ENVIRONMENT AGENCY SUPPLIED RECORDS AND SHALL BE CONFIRMED ON SITE VIA SURVEY.
5. ALL MANHOLES AND CATCHPITS TO BE OF CONCRETE CONSTRUCTION
6. THE EXTENT OF CMC INSTALLATION SHALL BE SUCH THE DRAINAGE NETWORK IS SUBJECT TO GROUND IMPROVEMENT ALONG ITS FULL LENGTH.
7. THE CONTRACTOR SHALL TRIM THE TOP SECTIONS OF CMC TO ALLOW FOR THE INSTALLATION OF PIPE BEDDING/SURROUND IN ACCORDANCE WITH DRAWING 808678-WOOD-ZZ-XX-DR-C-00027.
8. ALL SURFACE WATER PIPES WITH A DEPTH TO CROWN GREATER THAN 600mm TO BE TWINWALL WITH A TYPE S BEDDING IN ACCORDANCE WITH THE DETAILS SHOWN ON 808678-WOOD-ZZ-XX-DR-C-00027.
9. ALL SURFACE WATER PIPES WITH A DEPTH TO CROWN LESS THAN 600mm TO BE TWINWALL WITH A TYPE Z BEDDING IN ACCORDANCE WITH THE DETAILS SHOWN ON 808678-WOOD-ZZ-XX-DR-C-00027.
10. PLEASE REFER TO DRAWING 808678-WOOD-ZZ-XX-DR-C-0002 FOR THE MANHOLE SCHEDULE.
11. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE FOLLOWING DRAWINGS:

- 808678-WOOD-ZZ-XX-DR-C-0002 - DRAINAGE LAYOUT SHEET 1 of 2.

HB305 DRAINAGE KERB
HB305 DRAINABLE DROP KERB UNITS
HB305 DRAINABLE CENTRE STONE
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BUILDING OUTLINE
150mm PVCu CONNECTION TO SURFACE WATER SYSTEM
SLOT/CHANNEL DRAIN (AS NOTED)
SURFACE WATER SEWER (PIPE DIA. AS NOTED)
SURFACE WATER MANHOLE/CATCHPIT (AS NOTED)
FOUL WATER SEWER
ROOF GUTTERING AND FLOW DIRECTION
DOWNPIPE LOCATIONS
0.000 EXISTING DITCH CHANNEL LEVELS

REV	DATE		DWN	CHK	APP
P03	20/03 2023	TO ALIGN WITH LATEST PLANNING LAYOUT	SD	JC	JC
P02	04/10 2022	ADDITION OF S RANGE CHANNEL DRAINAGE	SM	SD	JC

REVISIONS

REV	DATE		DWN	CHK	APP
P01	11/08 2022	FIRST ISSUE	SM	SD	JC

SCALES: 1:250

DRAWING STATUS: SUITABLE FOR REVIEW & COMMENT - S3

PROJECT TITLE:
BRM
E-SCRAP
FACILITY

DRAWING TITLE:
SW DRAINAGE PLAN SHEET 2 of 2

- SURFACE WATER DRAINAGE

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wsp

BRM DWG No.
BRM_MERIDIAN_DWG_NO

REV.
P03

ADVISER / CONTRACTOR DWG No.
808678-WOOD-ZZ-XX-DR-C-00002

Appendix H
East and west surface water network analysis

WSPE&IS UK LIMITED

Drainage Strategy Design – Calculation Sheet

Calculation No.:	**808678-WOD-ZZ-XX-CA-C-00001**	Revision:	P03	Date:	**March 2023**

Project Title: **BRM E-Scrap Facility** Project No. **808678**

Description: **Drainage Strategy- Surface Water Microdrainage Analysis**

Work Type: **Planning Approval** No. of pages: **20**

Designer:

Design by: **Sam Davy** Signed:

Date: 20/03/23

Designers Comments:

Checker:

Checked By: **Jeff Colson** Signed:

Date:

Checkers Comments

Authorised By: **John Coats**

Signature of Approver: Date:

SURFACE WATER IMPERMEABLE AREAS
PER PIPE RUN
(NTS)

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for PR East SW Network

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	10	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	40
Ratio R	0.438	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for PR East SW Network

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
P1.000	85.808	0.001	85808.0	0.096	5.00	0.0	0.600	o	370	Pipe/Conduit	🔒
P1.001	10.795	0.172	62.8	0.003	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
P1.002	44.299	0.218	203.2	0.025	0.00	0.0	0.600	o	500	Pipe/Conduit	🔒
P1.003	45.750	0.229	199.8	0.153	0.00	0.0	0.600	o	500	Pipe/Conduit	🔒
P1.004	44.578	0.057	782.1	0.308	0.00	0.0	0.600	o	500	Pipe/Conduit	🔒
P1.005	5.226	0.026	201.0	0.000	0.00	0.0	0.600	o	500	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
P1.000	39.32	30.00	4.283	0.096	0.0	0.0	4.1	0.05	5.8«	14.3
P1.001	39.32	30.00	3.968	0.099	0.0	0.0	4.2	1.65	65.8	14.8
P1.002	39.32	30.00	3.798	0.124	0.0	0.0	5.3	1.52	298.5	18.5
P1.003	39.32	30.00	3.578	0.277	0.0	0.0	11.8	1.53	301.1	41.3
P1.004	39.32	30.00	3.349	0.585	0.0	0.0	24.9	0.77	151.0	87.2
P1.005	39.32	30.00	3.126	0.585	0.0	0.0	24.9	1.53	300.1	87.2

PIPELINE SCHEDULES for PR East SW Network

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
P1.000	o	370	M1	4.679	4.283	0.026	Open Manhole	1200
P1.001	o	225	M2	4.679	3.968	0.486	Open Manhole	1200
P1.002	o	500	M3	4.932	3.798	0.634	Open Manhole	1800
P1.003	o	500	M4	5.950	3.578	1.872	Open Manhole	1800
P1.004	o	500	M5	6.125	3.349	2.276	Open Manhole	1800
P1.005	o	500	M7	4.057	3.126	0.431	Open Manhole	1800

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
P1.000	85.808	85808.0	M2	4.679	4.282	0.027	Open Manhole	1200
P1.001	10.795	62.8	M3	4.932	3.796	0.911	Open Manhole	1800
P1.002	44.299	203.2	M4	5.950	3.580	1.870	Open Manhole	1800
P1.003	45.750	199.8	M5	6.125	3.349	2.276	Open Manhole	1800
P1.004	44.578	782.1	M7	4.057	3.292	0.265	Open Manhole	1800
P1.005	5.226	201.0	M	3.900	3.100	0.300	Open Manhole	0

Area Summary for PR East SW Network

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.096	0.096	0.096
1.001	-	-	100	0.003	0.003	0.003
1.002	-	-	100	0.025	0.025	0.025
1.003	-	-	100	0.153	0.153	0.153
1.004	-	-	100	0.308	0.308	0.308
1.005	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.585	0.585	0.585

Simulation Criteria for PR East SW Network

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	0.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.439		

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for PR East SW Network

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 0.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 0
Number of Online Controls 0 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 561300 175650 TQ 61300 75650
Data Type	Catchment
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	30, 100
Climate Change (%)	35, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
P1.000	M1	15 Winter	30	+35%	100/15 Summer	100/15 Summer		
P1.001	M2	15 Winter	30	+35%	30/15 Summer			
P1.002	M3	15 Winter	30	+35%	100/15 Summer			
P1.003	M4	15 Winter	30	+35%	30/15 Summer			
P1.004	M5	15 Winter	30	+35%	30/15 Summer			
P1.005	M7	15 Winter	30	+35%	30/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
P1.000	M1	4.575	-0.078	0.000	0.98		56.3	FLOOD RISK	3
P1.001	M2	4.298	0.105	0.000	1.08		59.5	SURCHARGED	
P1.002	M3	4.149	-0.149	0.000	0.27		71.5	OK	
P1.003	M4	4.126	0.048	0.000	0.54		144.6	SURCHARGED	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for PR East SW Network

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
P1.004	M5	4.070	0.221	0.000	2.12		284.4	SURCHARGED	
P1.005	M7	3.745	0.119	0.000	1.74		286.1	SURCHARGED	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for PR East SW Network

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 0.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 0
Number of Online Controls 0 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 561300 175650 TQ 61300 75650
Data Type	Catchment
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	30, 100
Climate Change (%)	35, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
P1.000	M1	15 Winter	100	+40%	100/15 Summer	100/15 Summer		
P1.001	M2	15 Winter	100	+40%	30/15 Summer			
P1.002	M3	15 Winter	100	+40%	100/15 Summer			
P1.003	M4	15 Winter	100	+40%	30/15 Summer			
P1.004	M5	15 Winter	100	+40%	30/15 Summer			
P1.005	M7	15 Winter	100	+40%	30/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
P1.000	M1	4.686	0.033	6.584	0.79		45.4	FLOOD	3
P1.001	M2	4.496	0.303	0.000	1.35		74.5	FLOOD RISK	
P1.002	M3	4.464	0.166	0.000	0.32		84.5	SURCHARGED	
P1.003	M4	4.457	0.379	0.000	0.59		159.0	SURCHARGED	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for PR East SW Network

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
P1.004	M5	4.387	0.538	0.000	2.81		376.5	SURCHARGED	
P1.005	M7	3.865	0.239	0.000	2.27		373.8	FLOOD RISK	

STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for PR East SW Network

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
P1.000	85.808	0.001	85808.0	0.096	5.00	0.0	0.600	o	370	Pipe/Conduit	🔒
P1.001	10.795	0.172	62.8	0.003	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
P1.002	44.299	0.218	203.2	0.025	0.00	0.0	0.600	o	500	Pipe/Conduit	🔒
P1.003	45.750	0.229	199.8	0.153	0.00	0.0	0.600	o	500	Pipe/Conduit	🔒
P1.004	44.578	0.057	782.1	0.308	0.00	0.0	0.600	o	500	Pipe/Conduit	🔒
P1.005	5.226	0.026	201.0	0.000	0.00	0.0	0.600	o	500	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
P1.000	39.32	30.00	4.283	0.096	0.0	0.0	4.1	0.05	5.8«	14.3
P1.001	39.32	30.00	3.968	0.099	0.0	0.0	4.2	1.65	65.8	14.8
P1.002	39.32	30.00	3.798	0.124	0.0	0.0	5.3	1.52	298.5	18.5
P1.003	39.32	30.00	3.578	0.277	0.0	0.0	11.8	1.53	301.1	41.3
P1.004	39.32	30.00	3.349	0.585	0.0	0.0	24.9	0.77	151.0	87.2
P1.005	39.32	30.00	3.126	0.585	0.0	0.0	24.9	1.53	300.1	87.2

PIPELINE SCHEDULES for PR East SW Network

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
P1.000	o	370	M1	4.679	4.283	0.026	Open Manhole	1200
P1.001	o	225	M2	4.679	3.968	0.486	Open Manhole	1200
P1.002	o	500	M3	4.932	3.798	0.634	Open Manhole	1800
P1.003	o	500	M4	5.950	3.578	1.872	Open Manhole	1800
P1.004	o	500	M5	6.125	3.349	2.276	Open Manhole	1800
P1.005	o	500	M7	4.057	3.126	0.431	Open Manhole	1800

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
P1.000	85.808	85808.0	M2	4.679	4.282	0.027	Open Manhole	1200
P1.001	10.795	62.8	M3	4.932	3.796	0.911	Open Manhole	1800
P1.002	44.299	203.2	M4	5.950	3.580	1.870	Open Manhole	1800
P1.003	45.750	199.8	M5	6.125	3.349	2.276	Open Manhole	1800
P1.004	44.578	782.1	M7	4.057	3.292	0.265	Open Manhole	1800
P1.005	5.226	201.0	M	3.900	3.100	0.300	Open Manhole	0

Area Summary for PR East SW Network

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.096	0.096	0.096
1.001	-	-	100	0.003	0.003	0.003
1.002	-	-	100	0.025	0.025	0.025
1.003	-	-	100	0.153	0.153	0.153
1.004	-	-	100	0.308	0.308	0.308
1.005	-	-	100	0.000	0.000	0.000
				Total 0.585	Total 0.585	Total 0.585

Simulation Criteria for PR East SW Network

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	0.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.439		

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for PR East SW Network

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	0.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 561300 175650 TQ 61300 75650
C (1km)	-0.027
D1 (1km)	0.255
D2 (1km)	0.422
D3 (1km)	0.250
E (1km)	0.326
F (1km)	2.536
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1
Climate Change (%)	0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
P1.000	M1	15 Winter	1	+0%					4.413
P1.001	M2	15 Winter	1	+0%					4.049
P1.002	M3	15 Winter	1	+0%					3.885
P1.003	M4	15 Winter	1	+0%					3.705
P1.004	M5	15 Winter	1	+0%					3.612
P1.005	M7	15 Winter	1	+0%					3.356

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for PR East SW Network

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
P1.000	M1	-0.240	0.000	0.27		15.4	FLOOD RISK	
P1.001	M2	-0.144	0.000	0.28		15.6	OK	
P1.002	M3	-0.413	0.000	0.07		18.3	OK	
P1.003	M4	-0.373	0.000	0.13		35.8	OK	
P1.004	M5	-0.237	0.000	0.53		71.7	OK	
P1.005	M7	-0.270	0.000	0.44		71.6	OK	

STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for PR West SW Network

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	16.091	0.081	198.7	0.055	2.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S1.001	39.434	0.197	200.2	0.128	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S1.002	8.322	0.042	198.1	0.118	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S1.003	32.866	0.164	200.4	0.098	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	2.29	3.904	0.055	0.0	0.0	3.0	0.92	36.7	10.4
S1.001	50.00	2.75	3.603	0.183	0.0	0.0	9.9	1.43	228.0	34.7
S1.002	50.00	2.85	3.406	0.301	0.0	0.0	16.3	1.44	229.1	57.1
S1.003	50.00	3.23	3.364	0.399	0.0	0.0	21.6	1.43	227.8	75.6

PIPELINE SCHEDULES for PR West SW Network

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	225	S1	4.904	3.904	0.775	Open Manhole	1500
S1.001	o	450	S2	4.966	3.603	0.913	Open Manhole	1500
S1.002	o	450	S3	6.350	3.406	2.494	Open Manhole	1500
S1.003	o	450	S4	6.200	3.364	2.386	Open Manhole	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	16.091	198.7	S2	4.966	3.823	0.918	Open Manhole	1500
S1.001	39.434	200.2	S3	6.350	3.406	2.494	Open Manhole	1500
S1.002	8.322	198.1	S4	6.200	3.364	2.386	Open Manhole	1500
S1.003	32.866	200.4	S	4.250	3.200	0.600	Open Manhole	0

Area Summary for PR West SW Network

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.055	0.055	0.055
1.001	-	-	100	0.128	0.128	0.128
1.002	-	-	100	0.118	0.118	0.118
1.003	-	-	100	0.098	0.098	0.098
				Total	Total	Total
				0.399	0.399	0.399

Simulation Criteria for PR West SW Network

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	0.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.439		

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for PR West SW Network

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 0.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 0
Number of Online Controls 0 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 561300 175650 TQ 61300 75650
Data Type	Catchment
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	30, 100
Climate Change (%)	35, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Summer	30	+35%	30/15 Summer				4.179
S1.001	S2	15 Winter	30	+35%	100/15 Summer				4.012
S1.002	S3	15 Summer	30	+35%	30/15 Summer				3.958
S1.003	S4	15 Summer	30	+35%	30/15 Summer				3.859

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.050	0.000	1.32		43.0	SURCHARGED	
S1.001	S2	-0.041	0.000	0.54		109.2	OK	
S1.002	S3	0.102	0.000	1.14		172.8	SURCHARGED	
S1.003	S4	0.045	0.000	1.15		227.0	SURCHARGED	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for PR West SW Network

Simulation Criteria

Areal Reduction Factor 1.000   Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0   MADD Factor * 10m³/ha Storage 0.000
Hot Start Level (mm) 0   Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500   Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0   Number of Storage Structures 0
Number of Online Controls 0   Number of Time/Area Diagrams 0
Number of Offline Controls 0   Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 561300 175650 TQ 61300 75650
Data Type	Catchment
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0   DVD Status OFF
Analysis Timestep Fine   Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	30, 100
Climate Change (%)	35, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Summer	100	+40%	30/15 Summer				4.510
S1.001	S2	15 Winter	100	+40%	100/15 Summer				4.374
S1.002	S3	15 Winter	100	+40%	30/15 Summer				4.269
S1.003	S4	15 Summer	100	+40%	30/15 Summer				4.078

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.381	0.000	1.63		53.1	SURCHARGED	
S1.001	S2	0.321	0.000	0.72		145.2	SURCHARGED	
S1.002	S3	0.413	0.000	1.59		241.5	SURCHARGED	
S1.003	S4	0.264	0.000	1.58		312.3	SURCHARGED	

STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for PR West SW Network

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	16.091	0.081	198.7	0.055	2.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	39.434	0.197	200.2	0.128	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.002	8.322	0.042	198.1	0.118	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.003	32.866	0.164	200.4	0.098	0.00	0.0	0.600	o	450	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	2.29	3.904	0.055	0.0	0.0	3.0	0.92	36.7	10.4
S1.001	50.00	2.75	3.603	0.183	0.0	0.0	9.9	1.43	228.0	34.7
S1.002	50.00	2.85	3.406	0.301	0.0	0.0	16.3	1.44	229.1	57.1
S1.003	50.00	3.23	3.364	0.399	0.0	0.0	21.6	1.43	227.8	75.6

PIPELINE SCHEDULES for PR West SW Network

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	225	S1	4.904	3.904	0.775	Open Manhole	1500
S1.001	o	450	S2	4.966	3.603	0.913	Open Manhole	1500
S1.002	o	450	S3	6.350	3.406	2.494	Open Manhole	1500
S1.003	o	450	S4	6.200	3.364	2.386	Open Manhole	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	16.091	198.7	S2	4.966	3.823	0.918	Open Manhole	1500
S1.001	39.434	200.2	S3	6.350	3.406	2.494	Open Manhole	1500
S1.002	8.322	198.1	S4	6.200	3.364	2.386	Open Manhole	1500
S1.003	32.866	200.4	S	4.250	3.200	0.600	Open Manhole	0

Area Summary for PR West SW Network

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.055	0.055	0.055
1.001	-	-	100	0.128	0.128	0.128
1.002	-	-	100	0.118	0.118	0.118
1.003	-	-	100	0.098	0.098	0.098
				Total	Total	Total
				0.399	0.399	0.399

Simulation Criteria for PR West SW Network

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	0.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.439		

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for PR West SW Network

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	0.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 561300 175650 TQ 61300 75650
C (1km)	-0.027
D1 (1km)	0.255
D2 (1km)	0.422
D3 (1km)	0.250
E (1km)	0.326
F (1km)	2.536
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1
Climate Change (%)	0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Summer	1	+0%					3.997
S1.001	S2	15 Summer	1	+0%					3.713
S1.002	S3	15 Winter	1	+0%					3.569
S1.003	S4	15 Winter	1	+0%					3.527

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.132	0.000	0.36		11.8	OK	

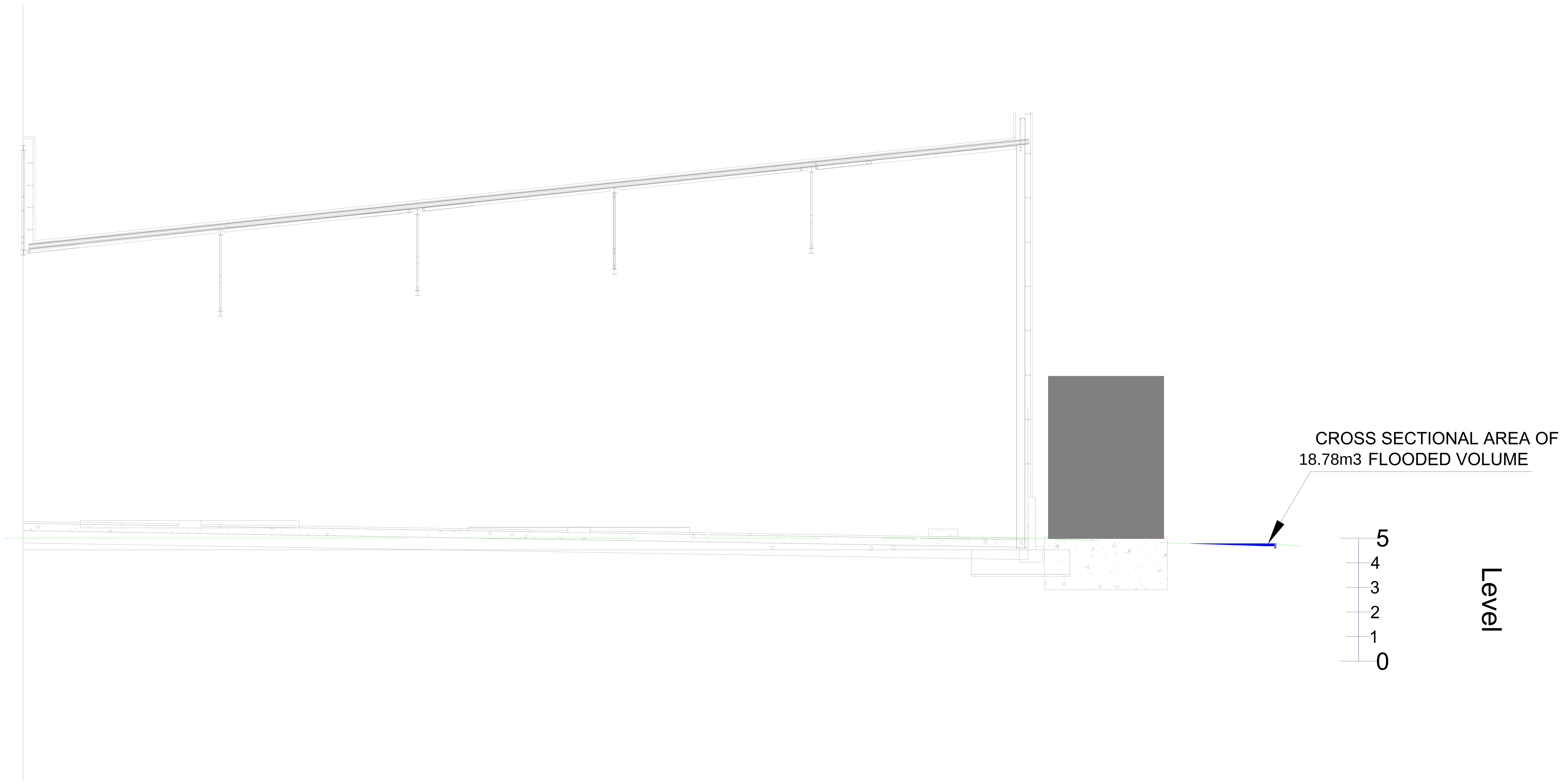
1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for PR West SW Network

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.001	S2	-0.340	0.000	0.13		27.1	OK	
S1.002	S3	-0.287	0.000	0.28		42.5	OK	
S1.003	S4	-0.287	0.000	0.28		55.7	OK	

Cut/Fill Summary

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
Volume between top of kerb level (4.780mAOD) and FGL	**1.000**	**1.000**	333.144sq.m	0.042 Cu. M.	18.784 Cu. M.	18.743 Cu. M.<Fill>
Totals			333.144sq.m	0.042 Cu. M.	18.784 Cu. M.	18.743 Cu. M.<Fill>

PLAN ON EXCEEDANCE FLOOD VOLUME TO NORTHERN ROAD
(1:250)



SECTION AA – FLOODED VOLUME
SCALE: H 1:200,V 1:200. DATUM: 0.000

Appendix I
Tide-locked outfall attenuation analysis

Summary of Results for 1 year Return Period (+40%)

Half Drain Time exceeds 7 days.

Critical storm may not be identified, please run longer storm durations.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	99.102	0.102	0.0	102.4	O K
30 min Summer	99.122	0.122	0.0	122.2	O K
60 min Summer	99.146	0.146	0.0	145.9	O K
120 min Summer	99.174	0.174	0.0	174.1	O K
180 min Summer	99.193	0.193	0.0	193.0	O K
15 min Winter	99.115	0.115	0.0	114.7	O K
30 min Winter	99.137	0.137	0.0	136.9	O K
60 min Winter	99.163	0.163	0.0	163.4	O K
120 min Winter	99.195	0.195	0.0	195.0	O K
180 min Winter	99.216	0.216	0.0	216.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	49.663	0.0	23
30 min Summer	29.632	0.0	38
60 min Summer	17.681	0.0	68
120 min Summer	10.549	0.0	128
180 min Summer	7.799	0.0	188
15 min Winter	49.663	0.0	23
30 min Winter	29.632	0.0	38
60 min Winter	17.681	0.0	68
120 min Winter	10.549	0.0	128
180 min Winter	7.799	0.0	188

Rainfall Details

Rainfall Model	FEH
Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 561300 175650 TQ 61300 75650
C (1km)	-0.027
D1 (1km)	0.255
D2 (1km)	0.422
D3 (1km)	0.250
E (1km)	0.326
F (1km)	2.536
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	180
Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.100

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.550	4	8	0.550

Model Details

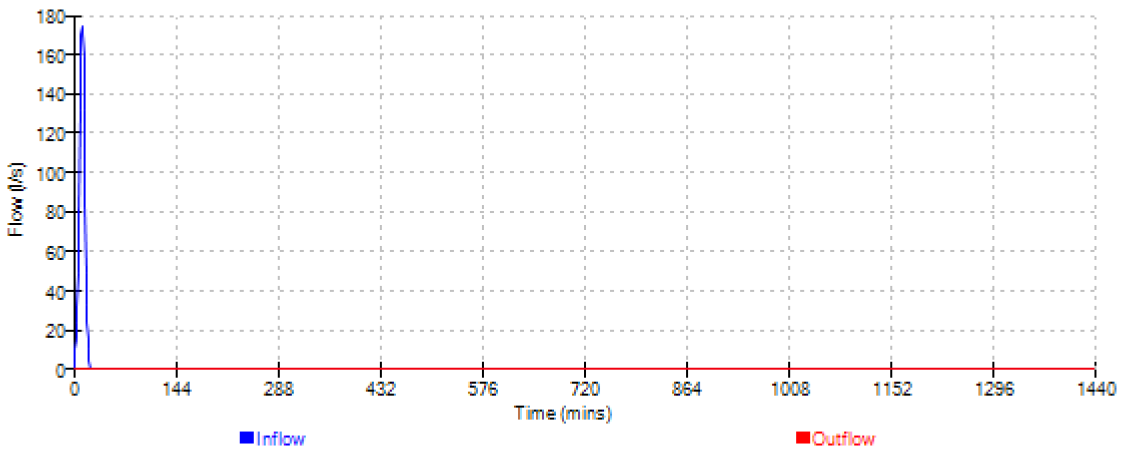
Storage is Online Cover Level (m) 100.000

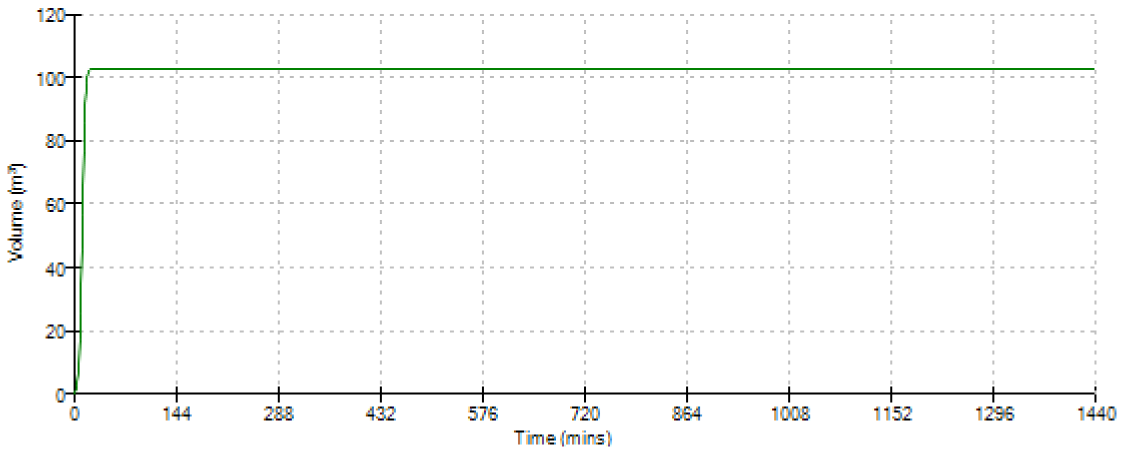
Infiltration Basin Structure

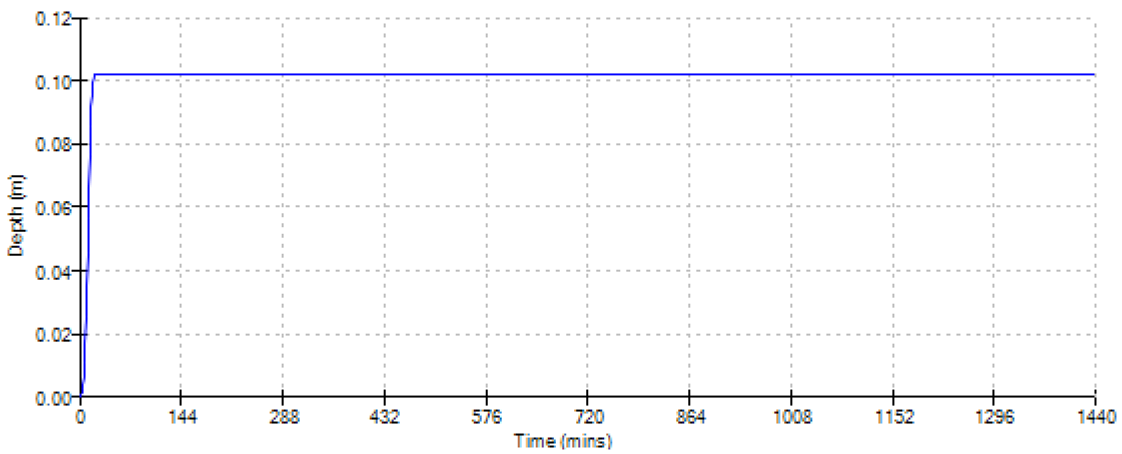
Invert Level (m) 99.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	1000.0	1.000	1000.0

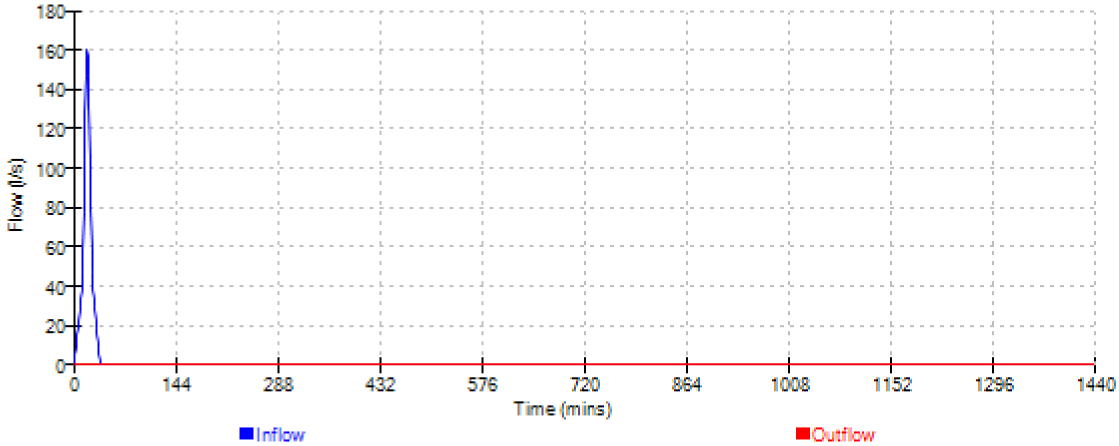
Event: 15 min Summer

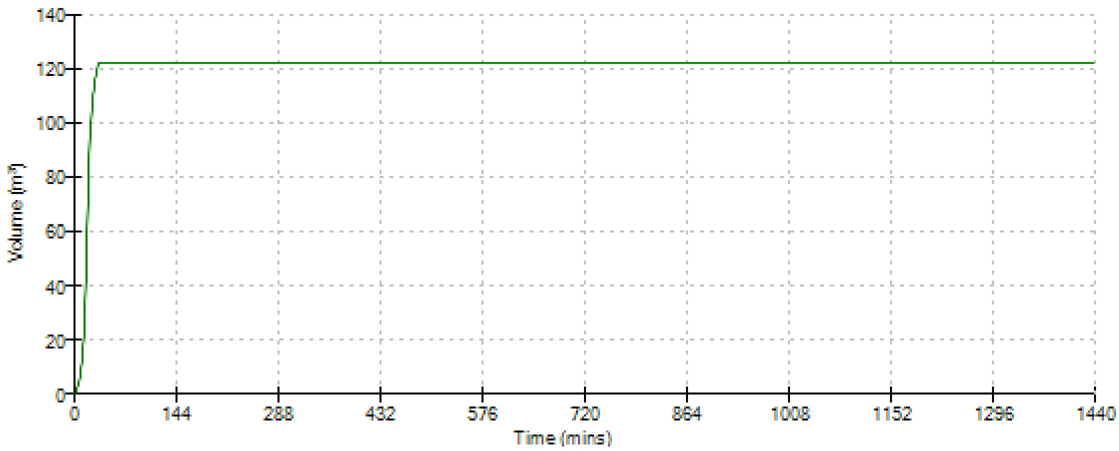


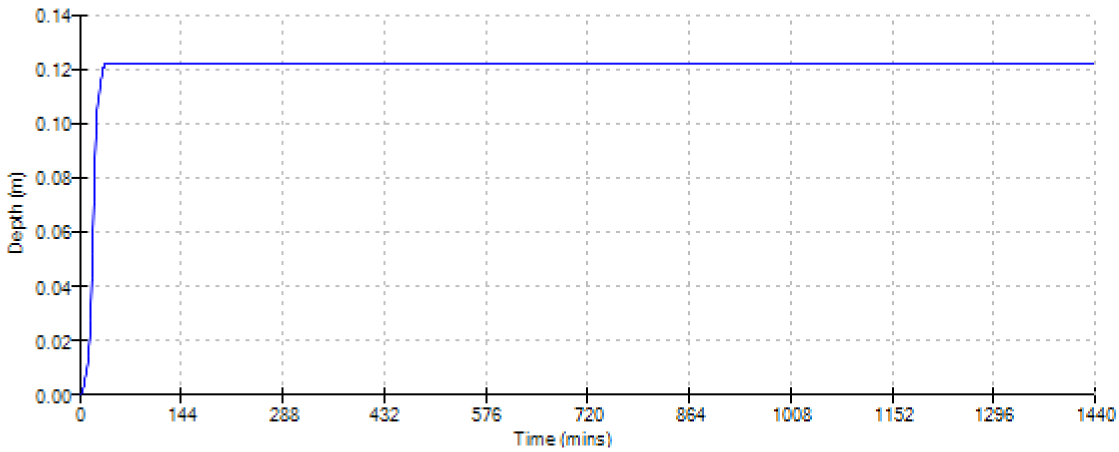




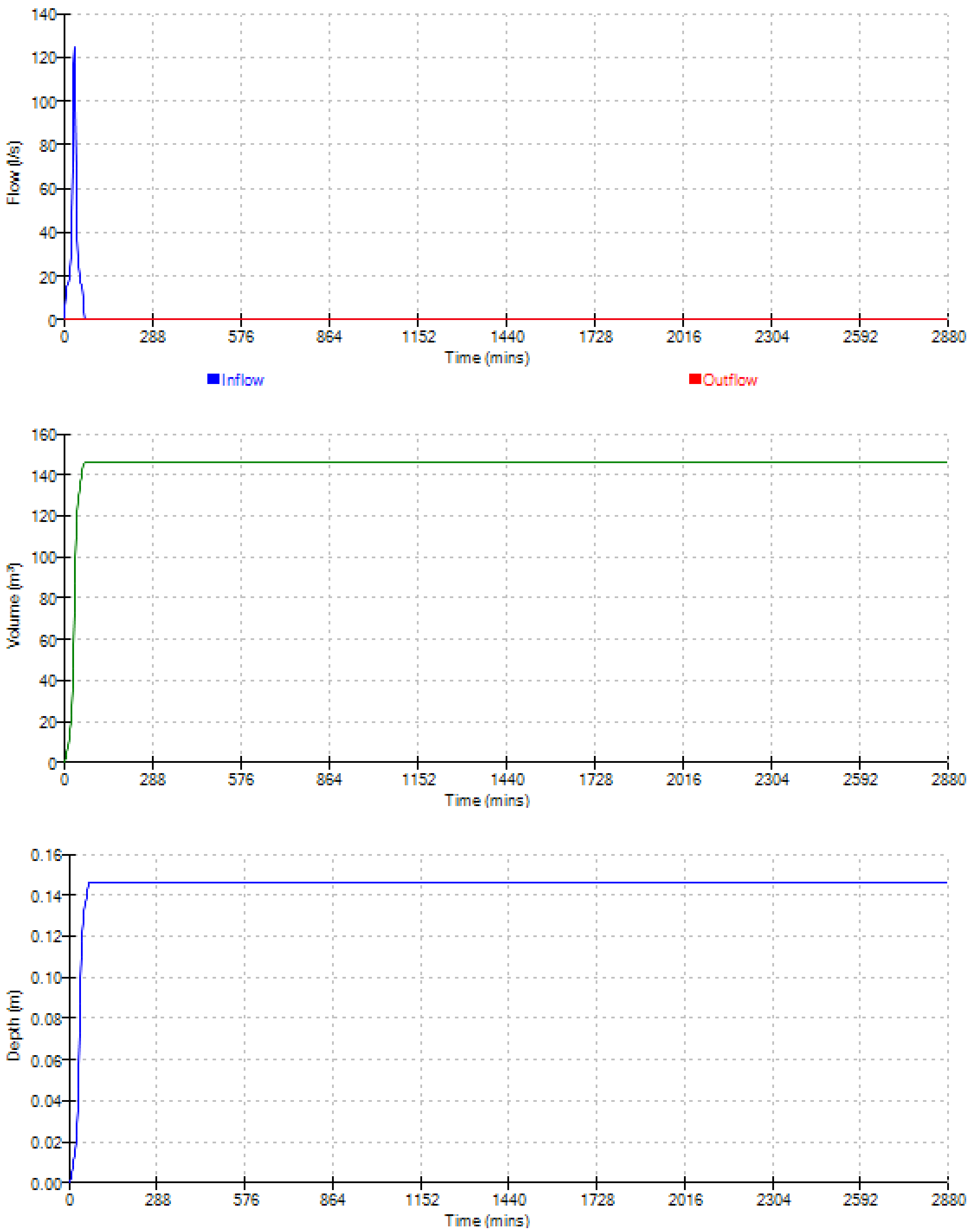
Event: 30 min Summer



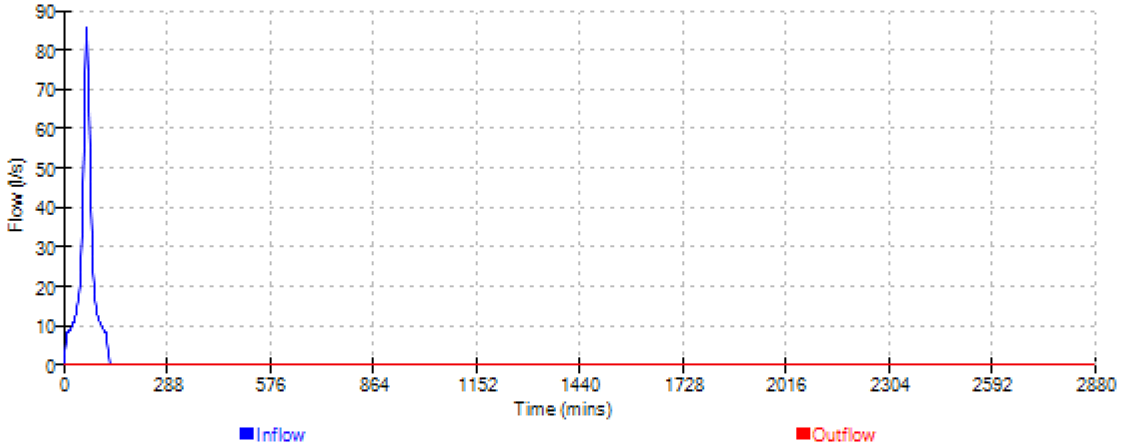


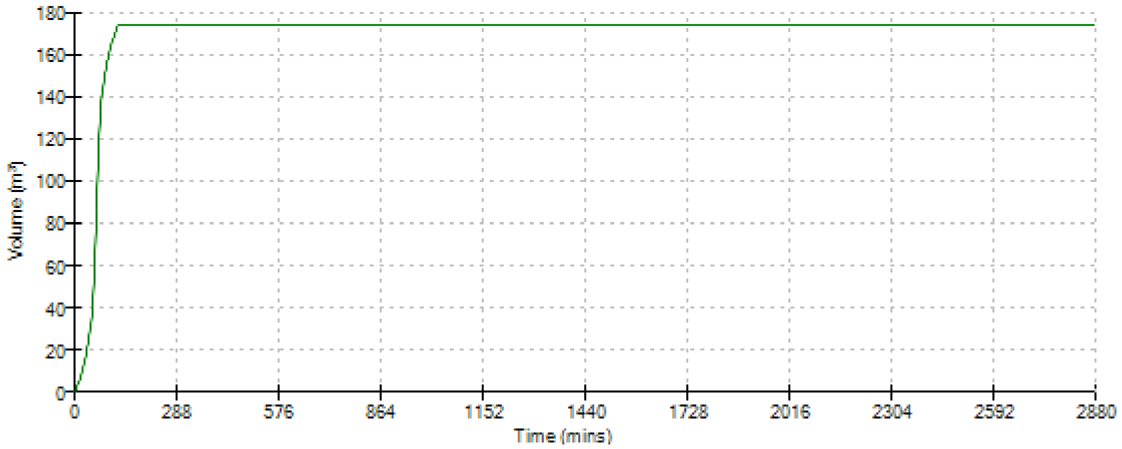


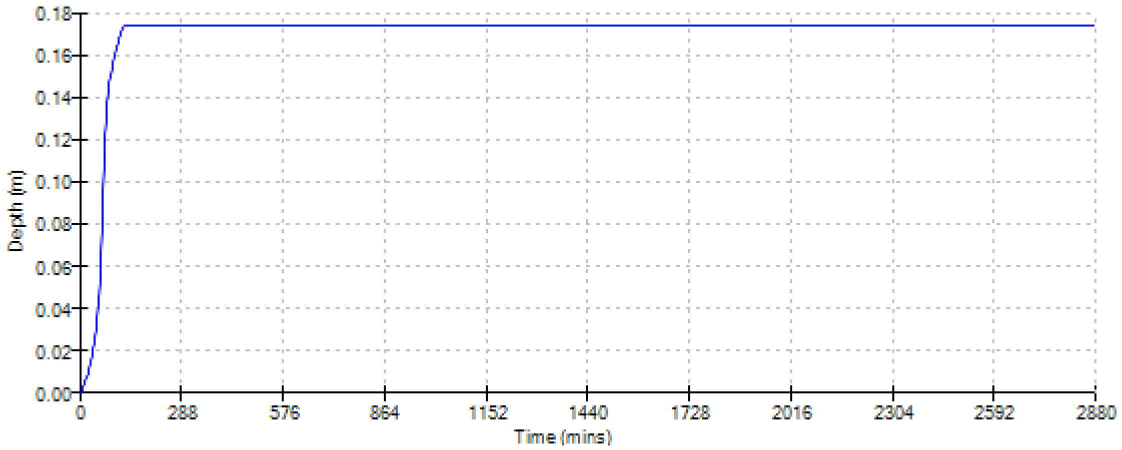
Event: 60 min Summer



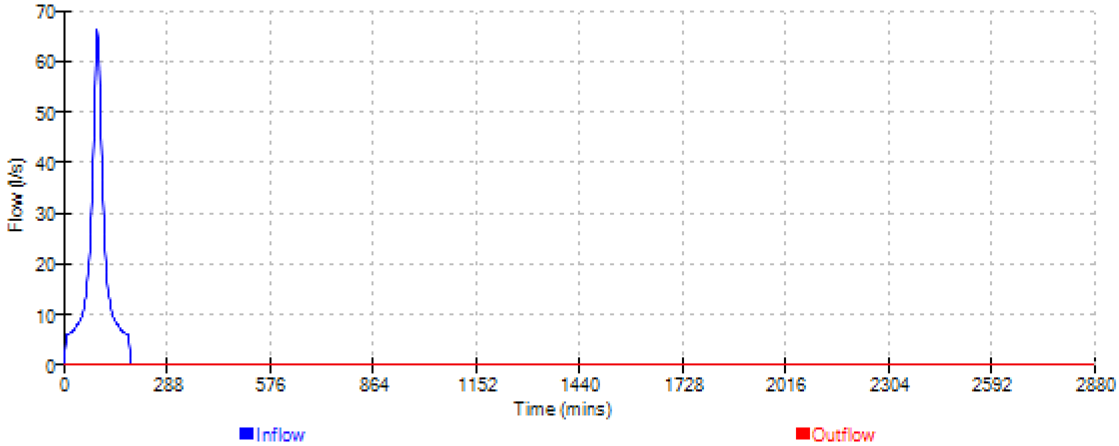
Event: 120 min Summer

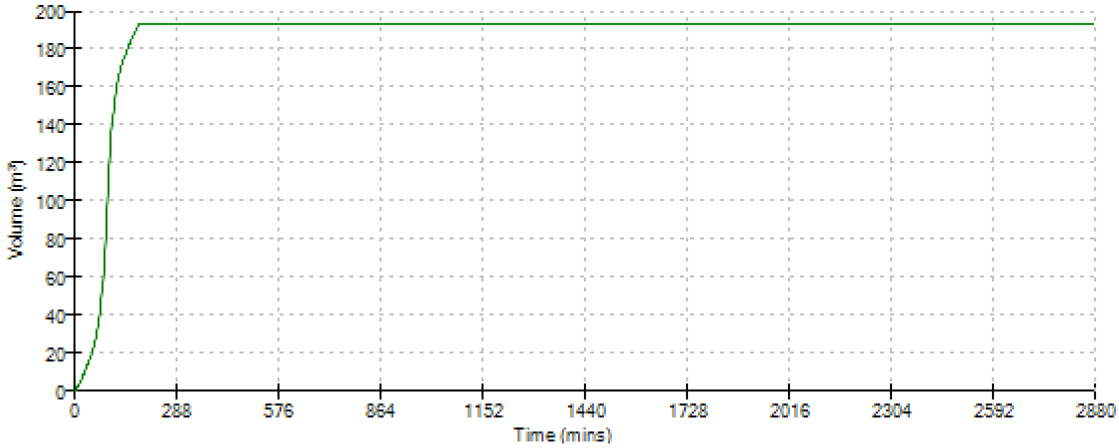


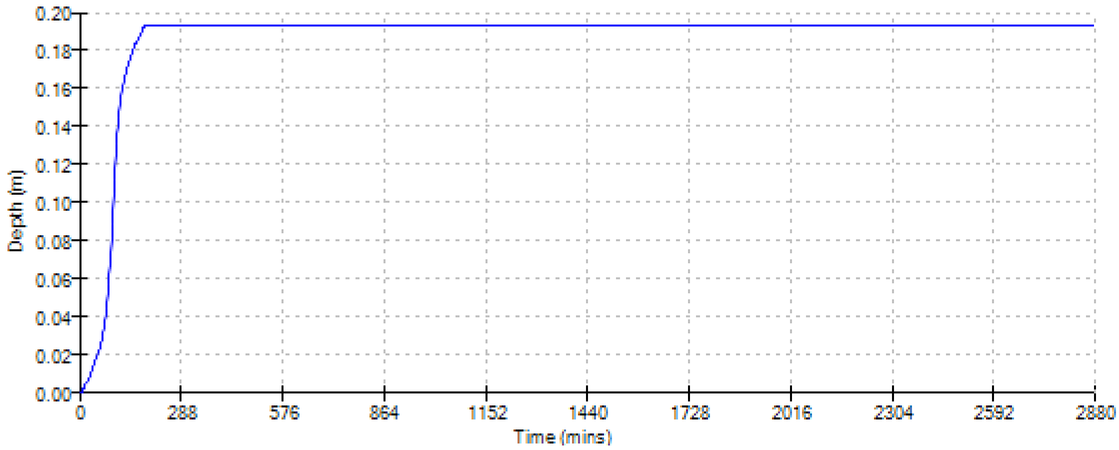




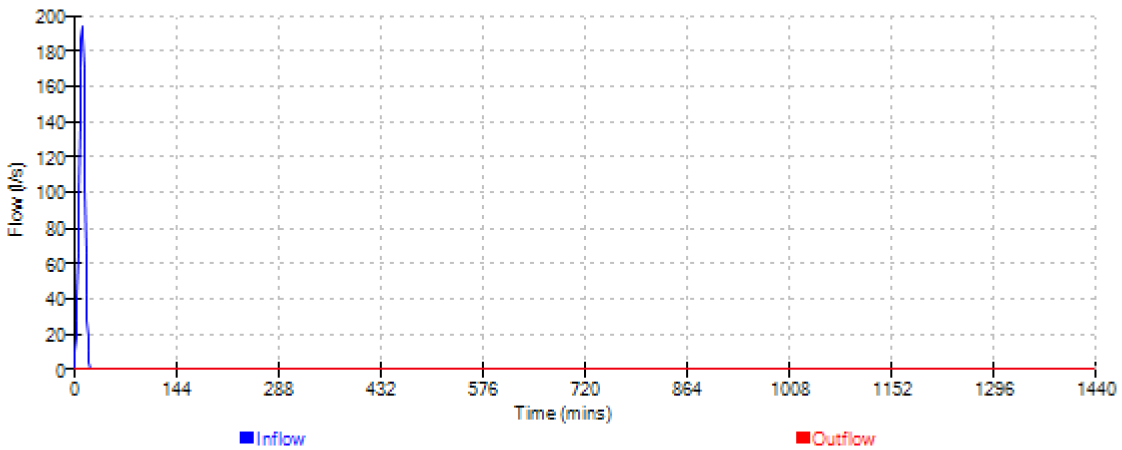
Event: 180 min Summer

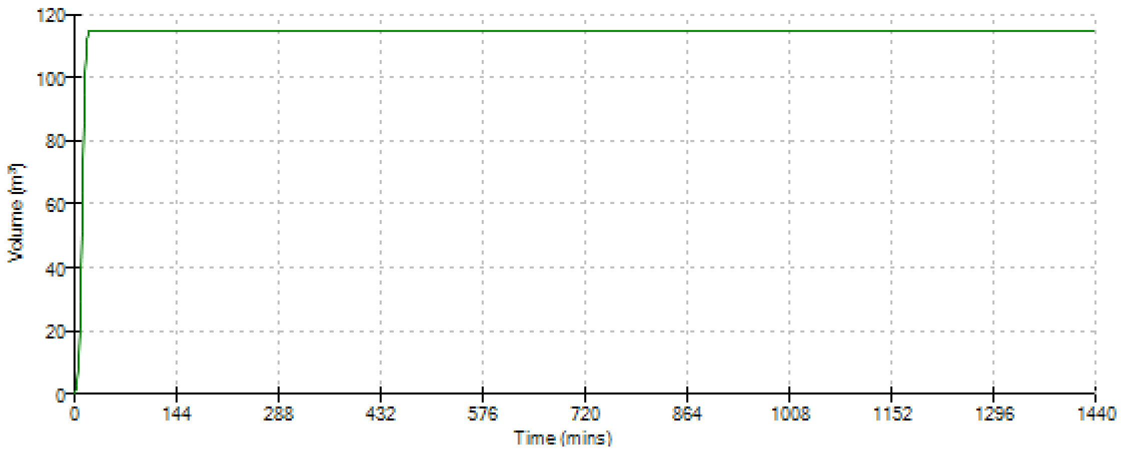


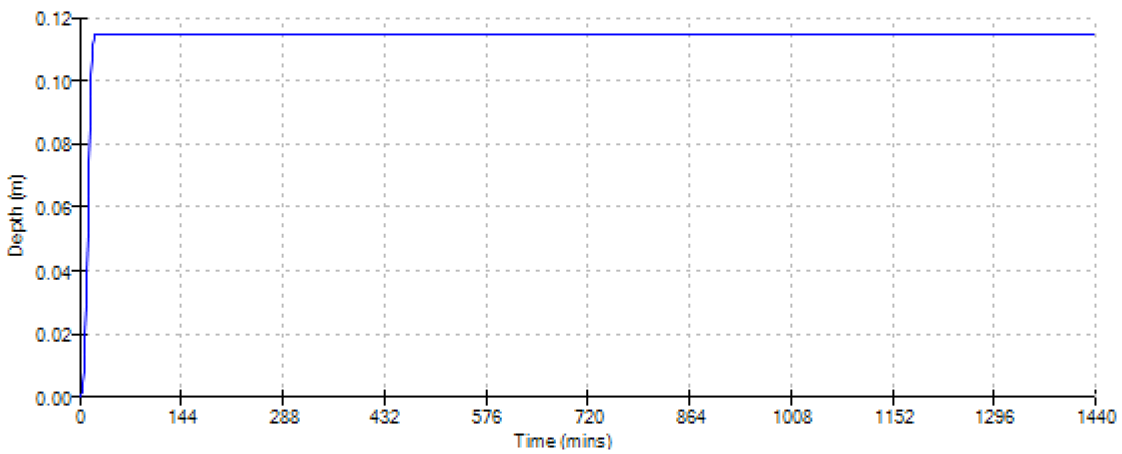




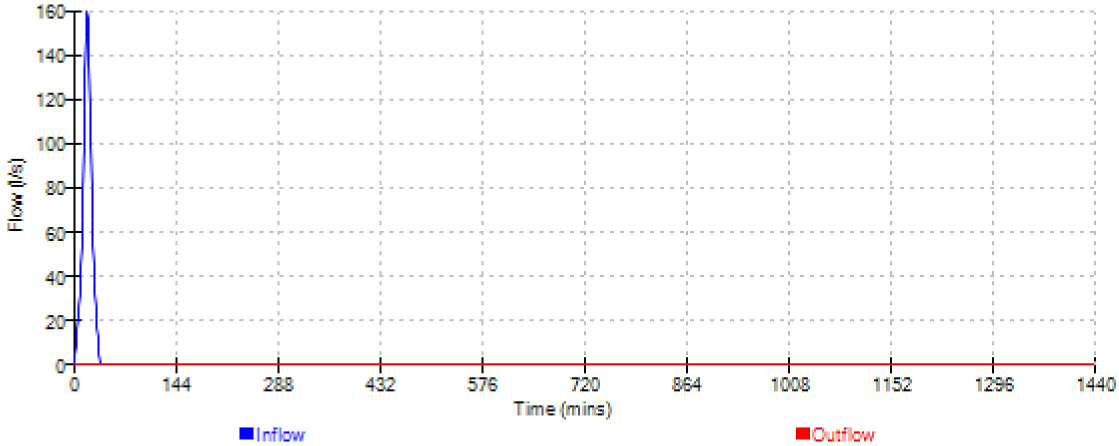
Event: 15 min Winter

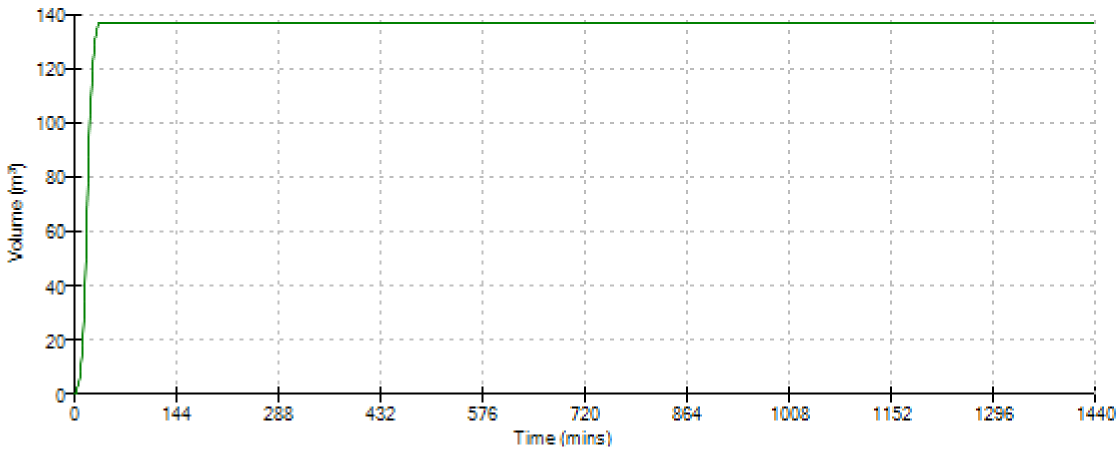


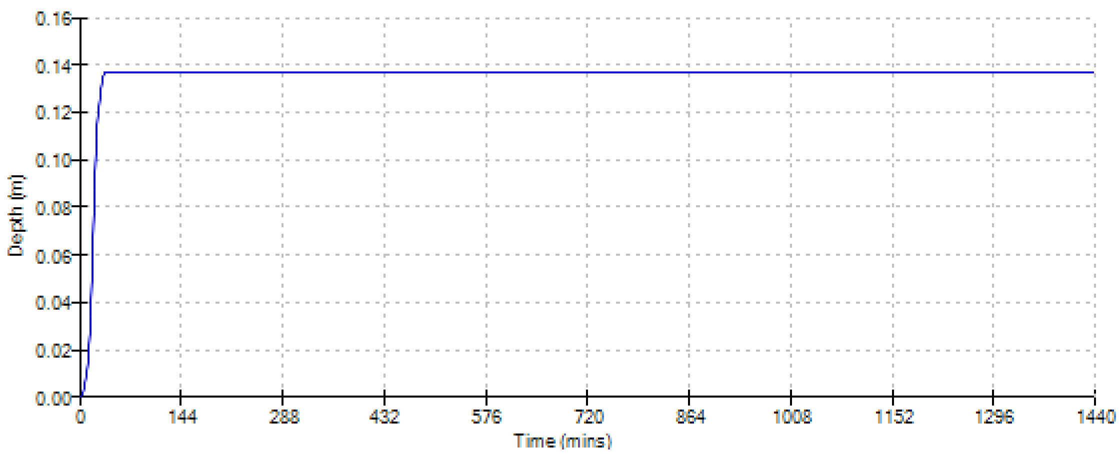




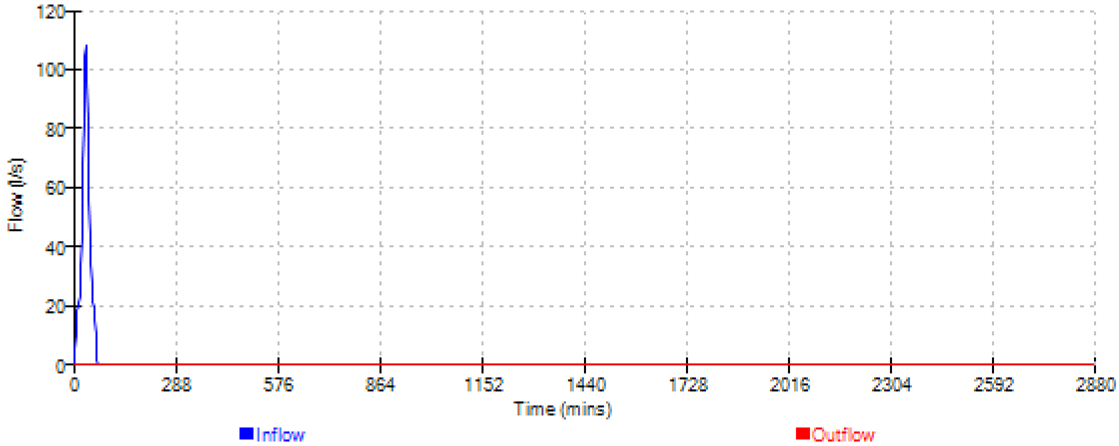
Event: 30 min Winter

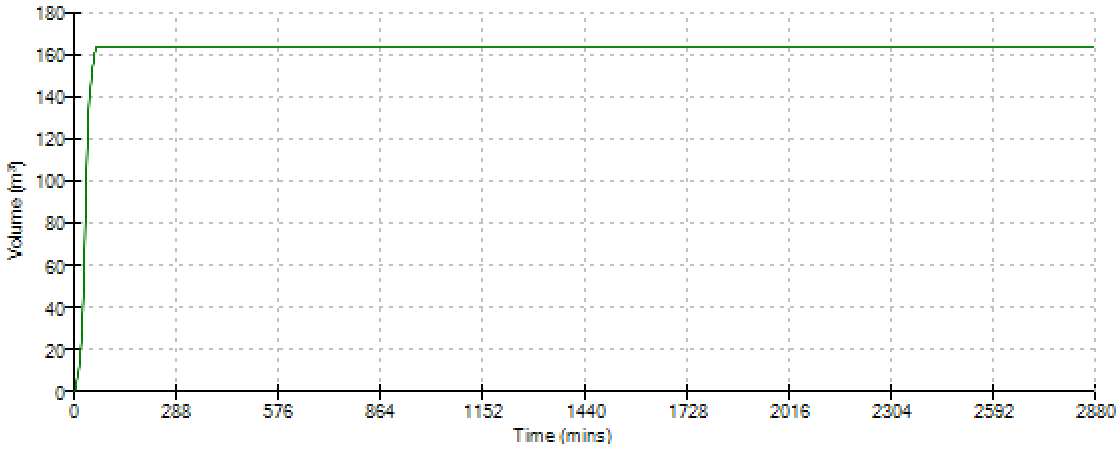


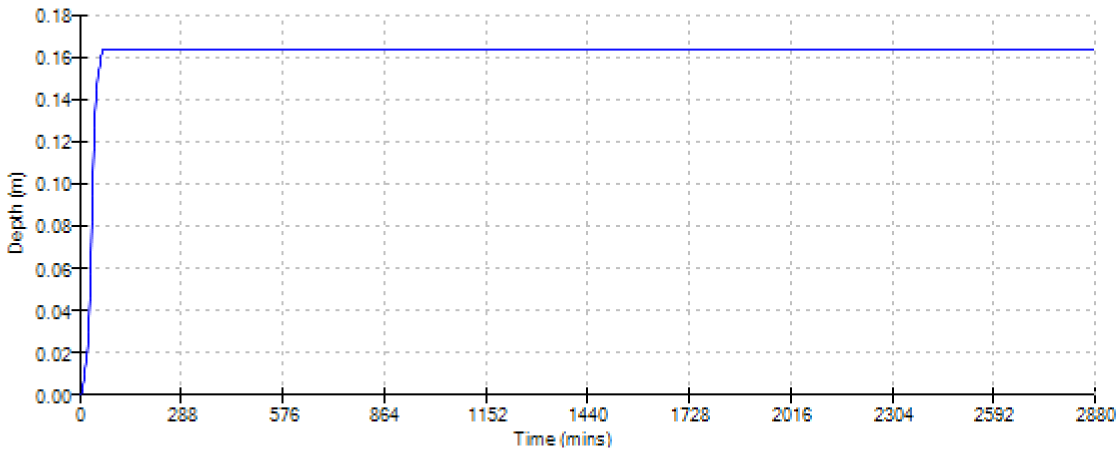




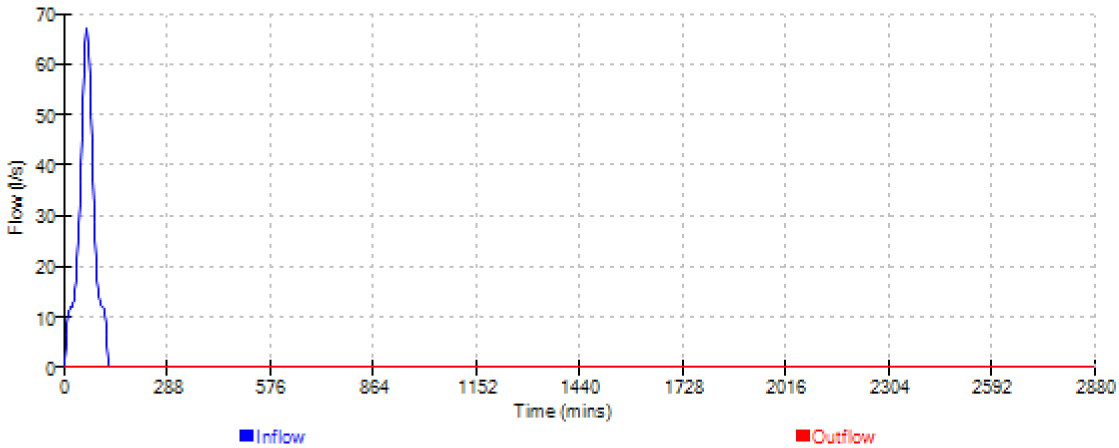
Event: 60 min Winter

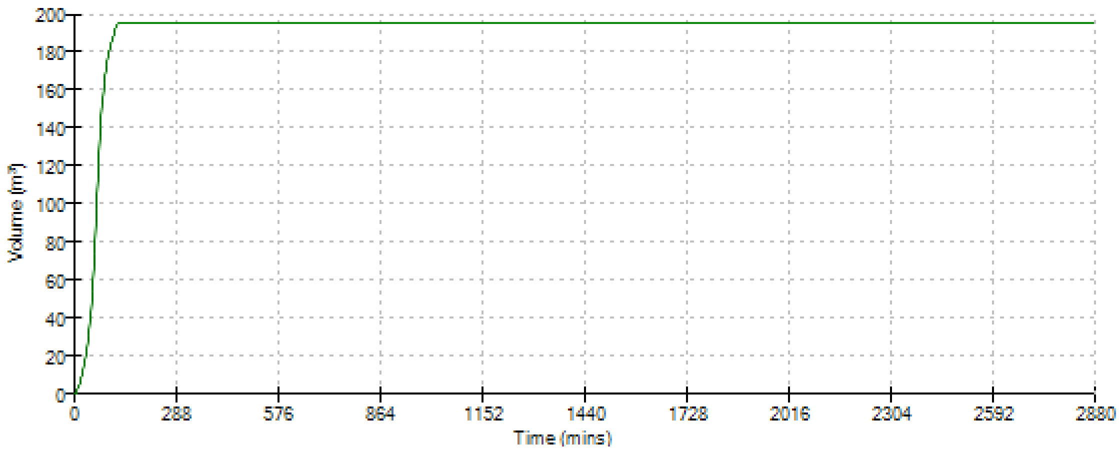


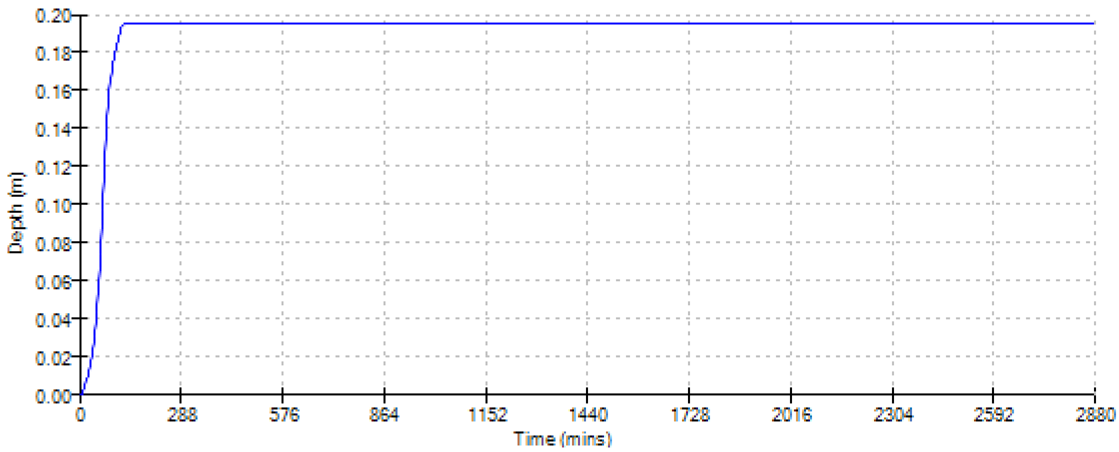




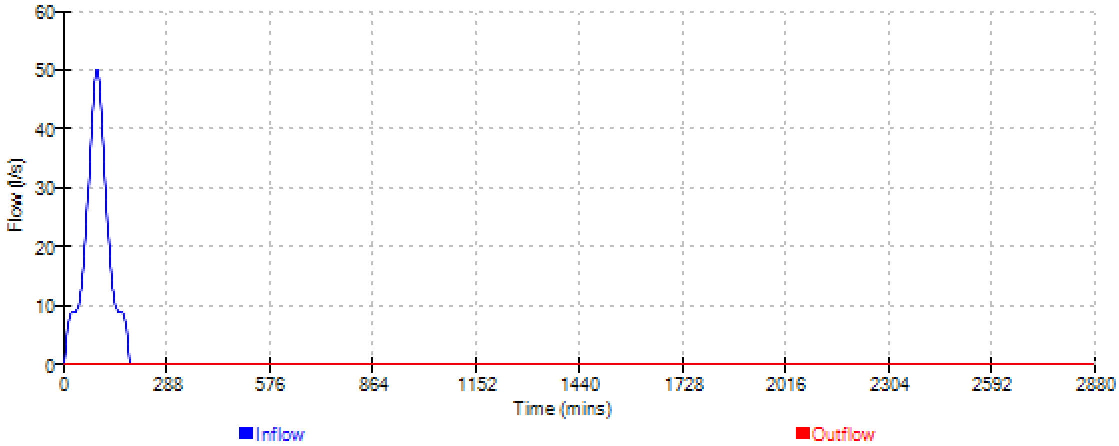
Event: 120 min Winter

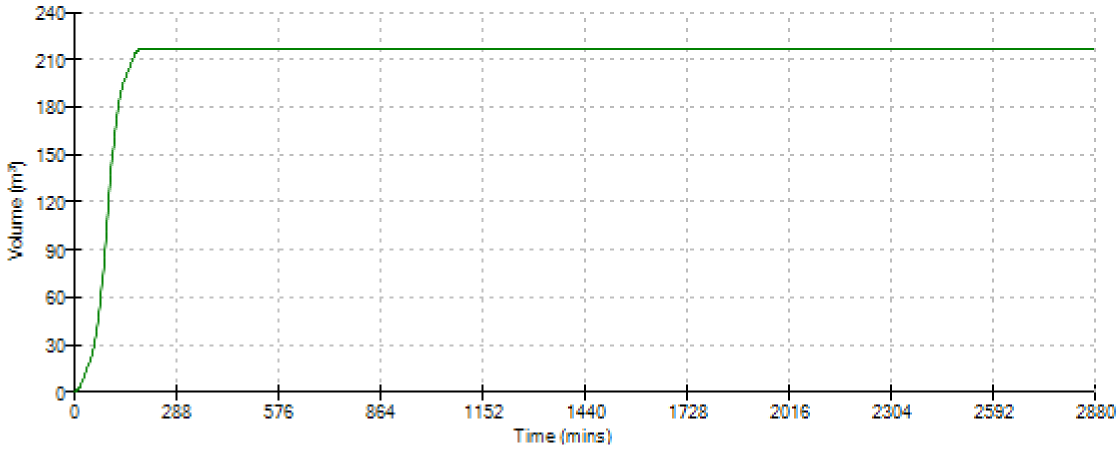


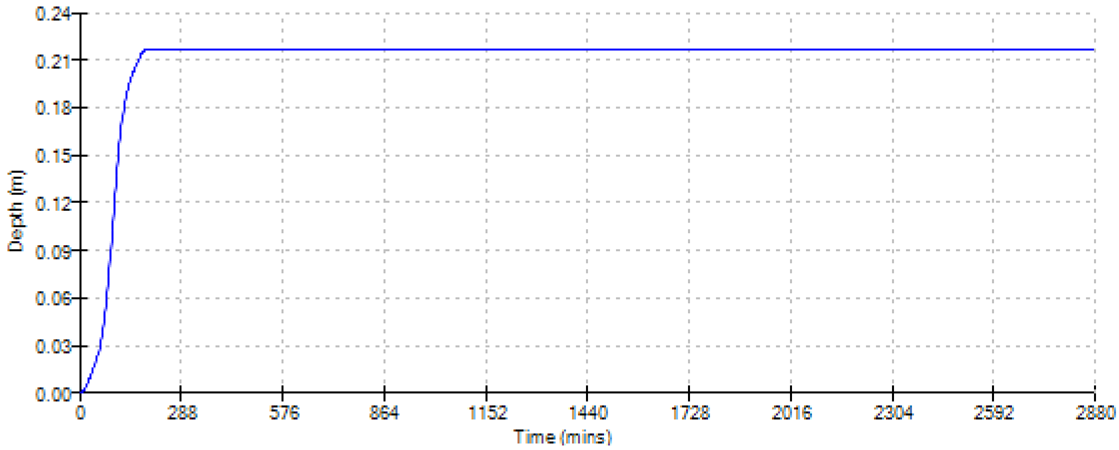




Event: 180 min Winter







Summary of Results for 30 year Return Period (+35%)

Half Drain Time exceeds 7 days.

Critical storm may not be identified, please run longer storm durations.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	99.267	0.267	0.0	267.3	O K
30 min Summer	99.342	0.342	0.0	342.4	O K
60 min Summer	99.419	0.419	0.0	418.6	O K
120 min Summer	99.515	0.515	0.0	514.8	O K
180 min Summer	99.571	0.571	0.0	571.3	O K
15 min Winter	99.299	0.299	0.0	299.4	O K
30 min Winter	99.383	0.383	0.0	383.4	O K
60 min Winter	99.469	0.469	0.0	468.8	O K
120 min Winter	99.577	0.577	0.0	576.5	O K
180 min Winter	99.640	0.640	0.0	639.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	129.605	0.0	23
30 min Summer	82.995	0.0	38
60 min Summer	50.733	0.0	68
120 min Summer	31.197	0.0	128
180 min Summer	23.081	0.0	188
15 min Winter	129.605	0.0	23
30 min Winter	82.995	0.0	38
60 min Winter	50.733	0.0	68
120 min Winter	31.197	0.0	128
180 min Winter	23.081	0.0	188

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	2013
Site Location	GB 561300 175650 TQ 61300 75650
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	180
Climate Change %	+35

Time Area Diagram

Total Area (ha) 1.100

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.550	4	8	0.550

Model Details

Storage is Online Cover Level (m) 100.000

Infiltration Basin Structure

Invert Level (m) 99.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1000.0	1.000	1000.0

Summary of Results for 100 year Return Period (+40%)

Half Drain Time exceeds 7 days.

Critical storm may not be identified, please run longer storm durations.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	99.362	0.362	0.0	361.5	O K
30 min Summer	99.469	0.469	0.0	468.9	O K
60 min Summer	99.579	0.579	0.0	578.7	O K
120 min Summer	99.715	0.715	0.0	714.9	O K
180 min Summer	99.799	0.799	0.0	799.2	O K
15 min Winter	99.405	0.405	0.0	404.9	O K
30 min Winter	99.525	0.525	0.0	525.2	O K
60 min Winter	99.648	0.648	0.0	648.1	O K
120 min Winter	99.801	0.801	0.0	800.7	O K
180 min Winter	99.895	0.895	0.0	895.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	175.280	0.0	23
30 min Summer	113.680	0.0	38
60 min Summer	70.140	0.0	68
120 min Summer	43.330	0.0	128
180 min Summer	32.292	0.0	188
15 min Winter	175.280	0.0	23
30 min Winter	113.680	0.0	38
60 min Winter	70.140	0.0	68
120 min Winter	43.330	0.0	128
180 min Winter	32.292	0.0	188

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 561300 175650 TQ 61300 75650
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	180
Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.550	4	8	0.550

Model Details

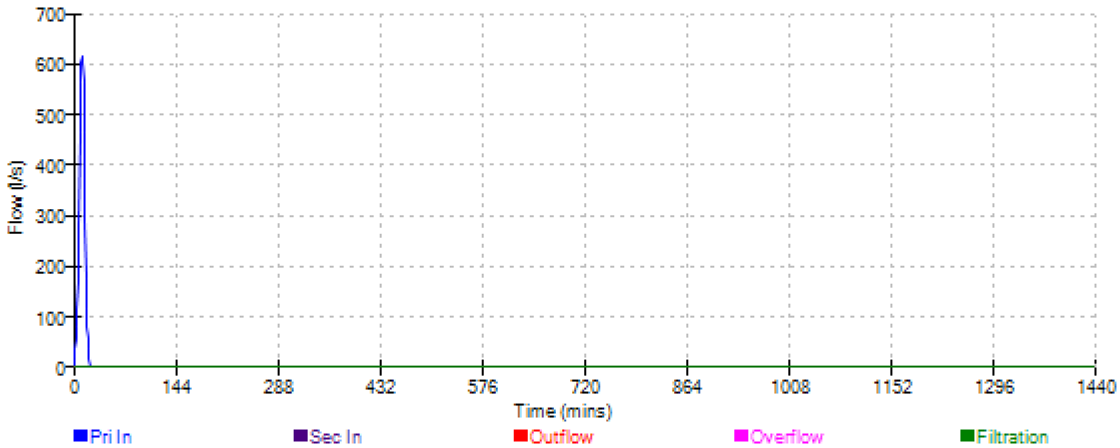
Storage is Online Cover Level (m) 100.000

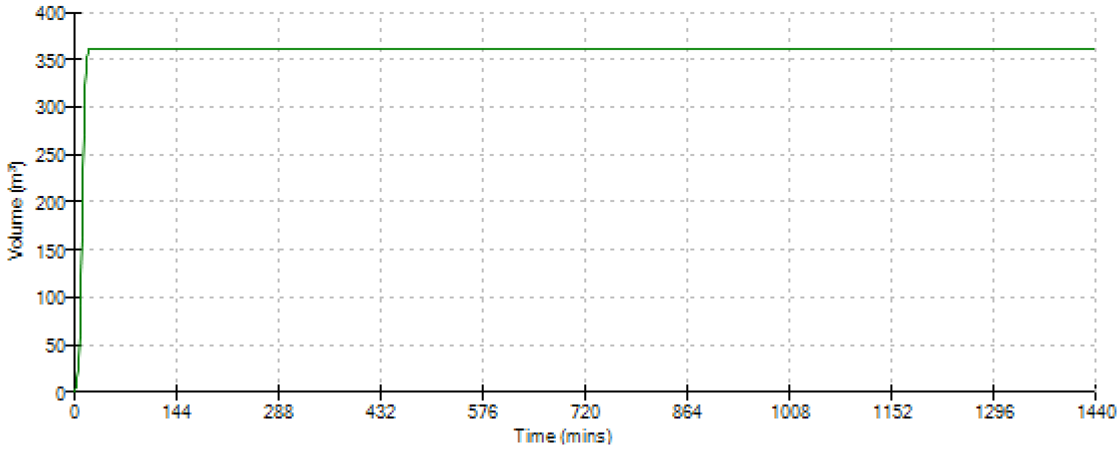
Infiltration Basin Structure

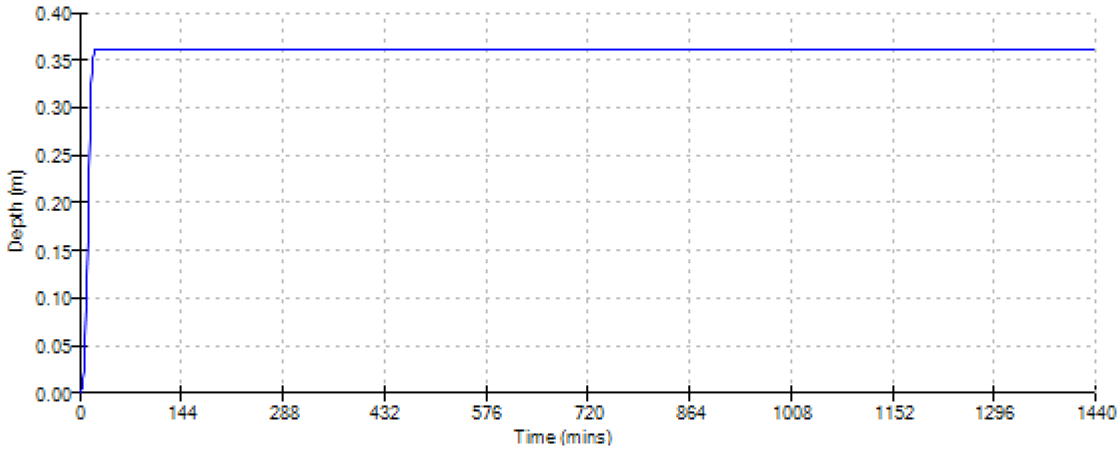
Invert Level (m) 99.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	1000.0	1.000	1000.0

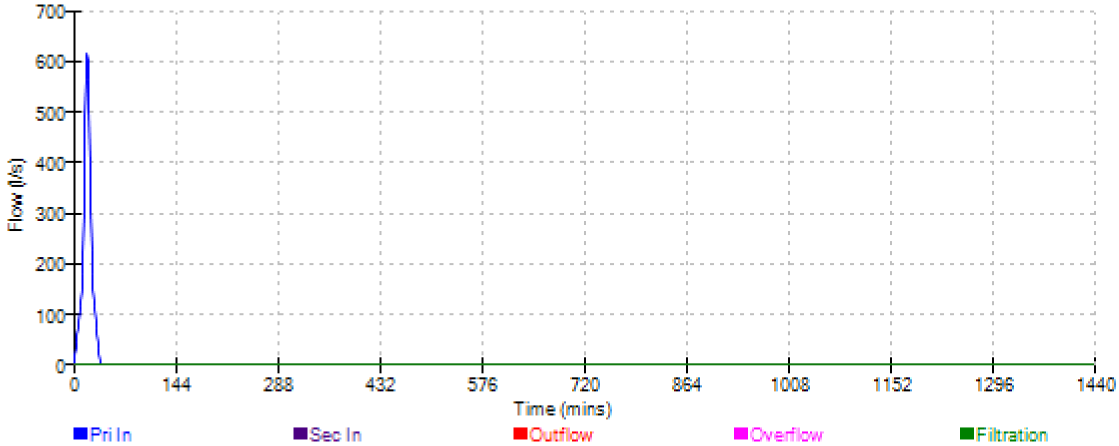
Event: 15 min Summer

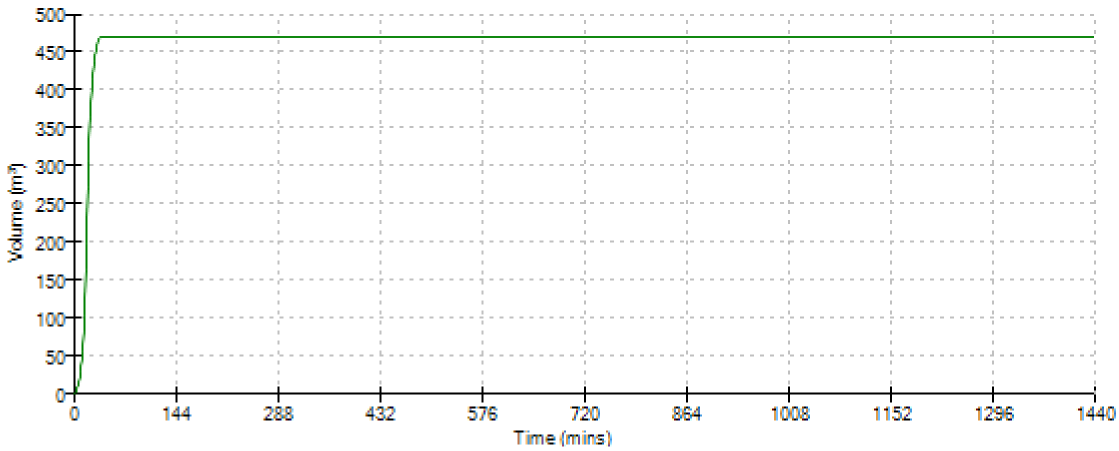


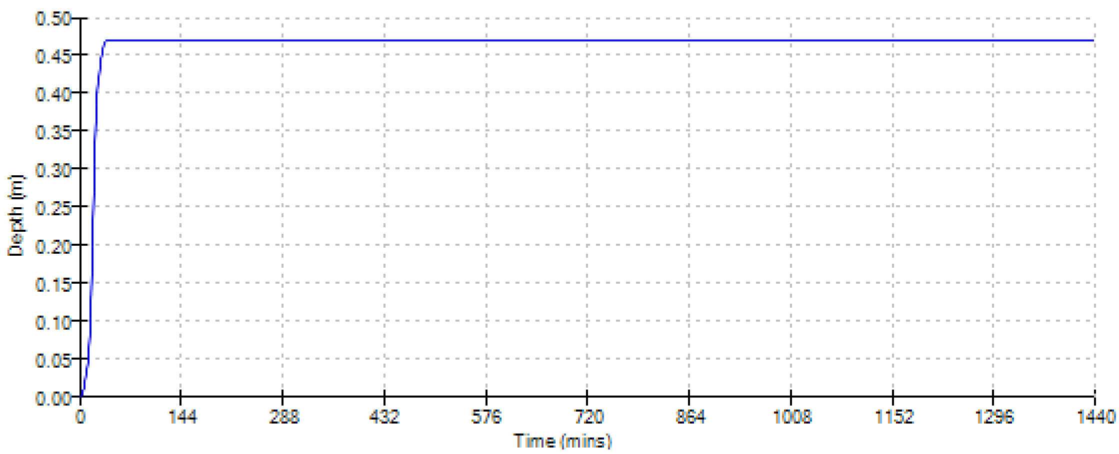




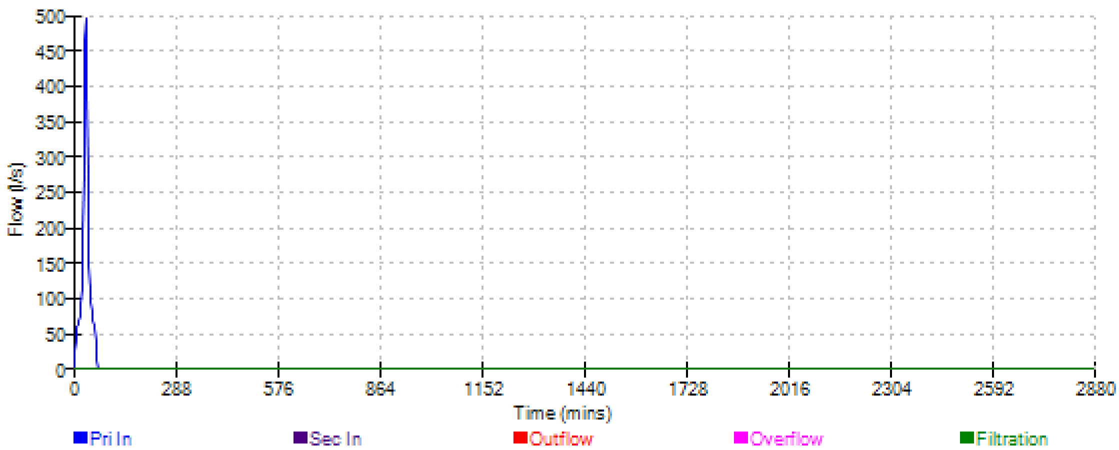
Event: 30 min Summer

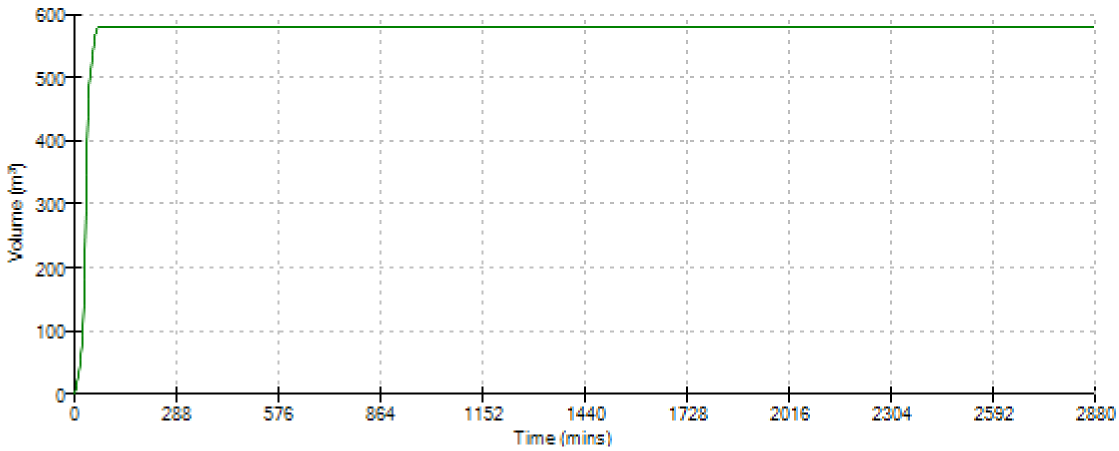


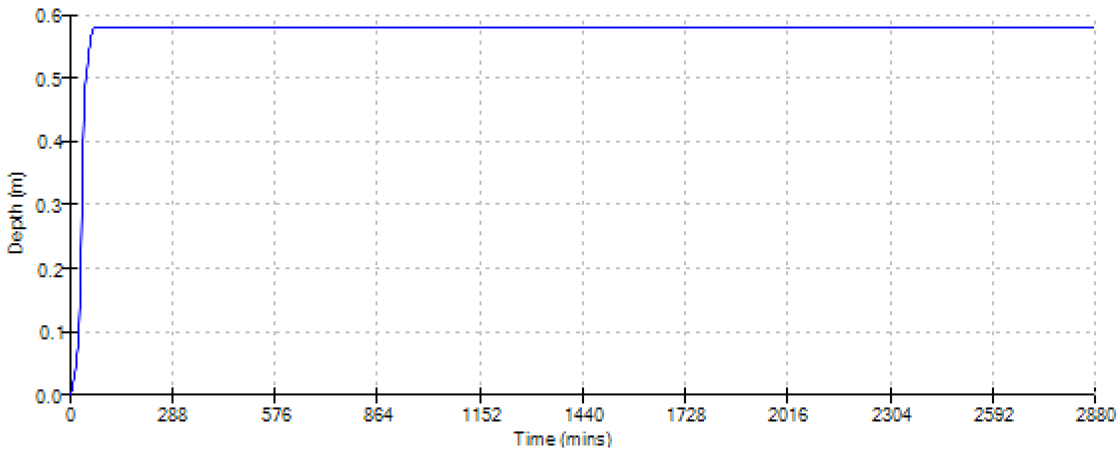




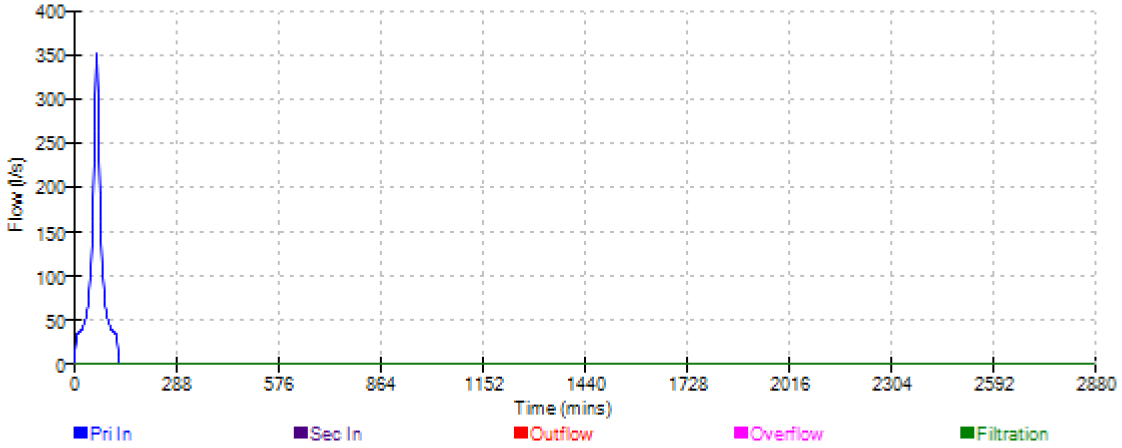
Event: 60 min Summer

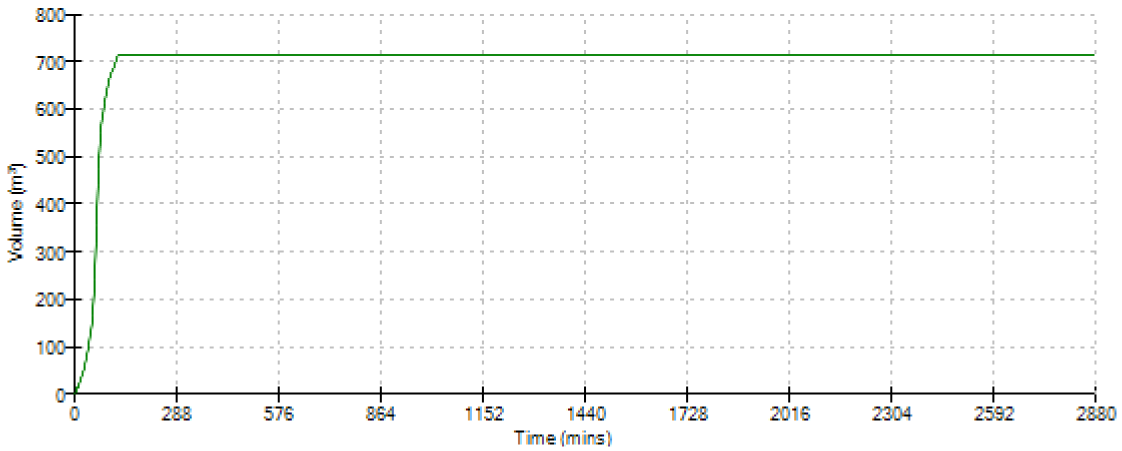


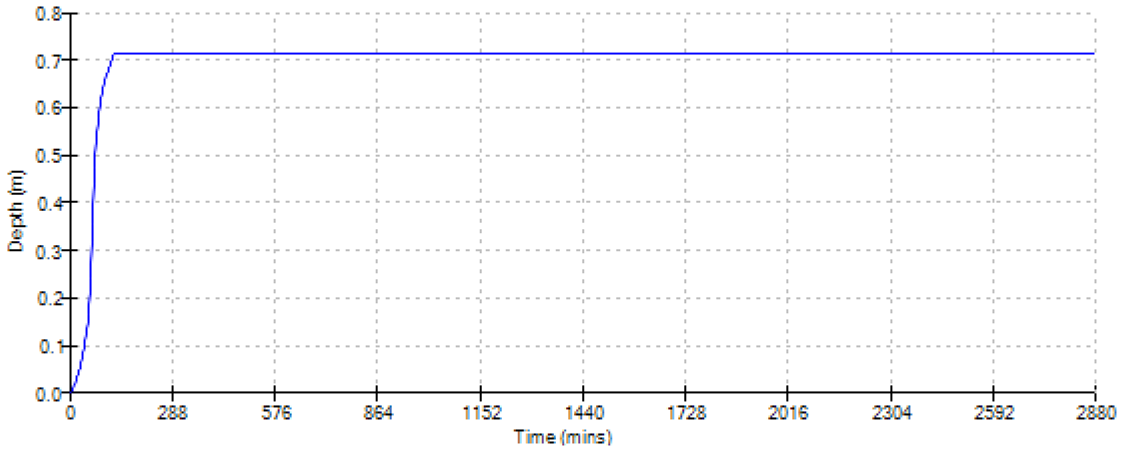




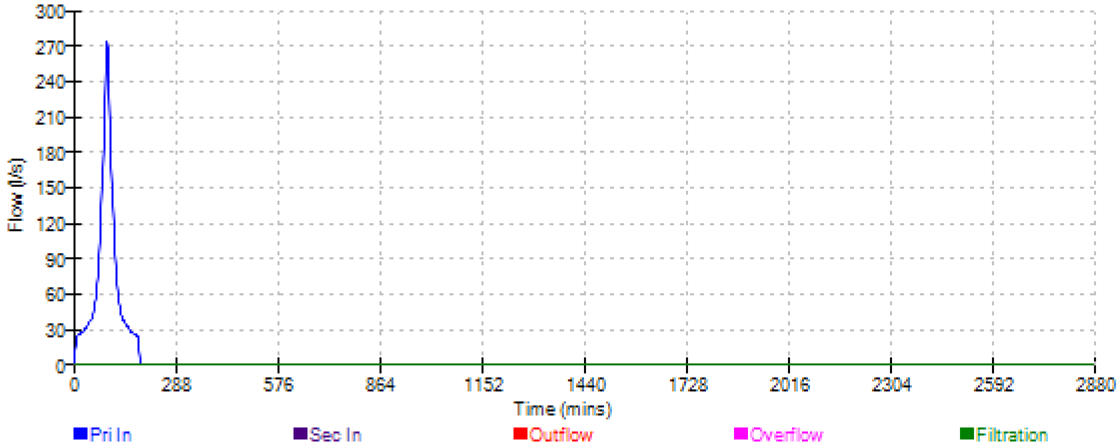
Event: 120 min Summer

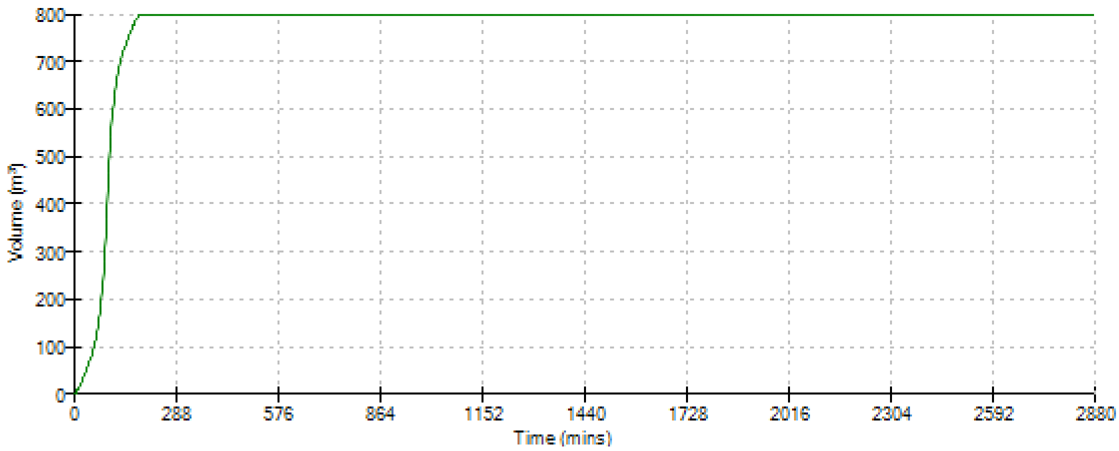


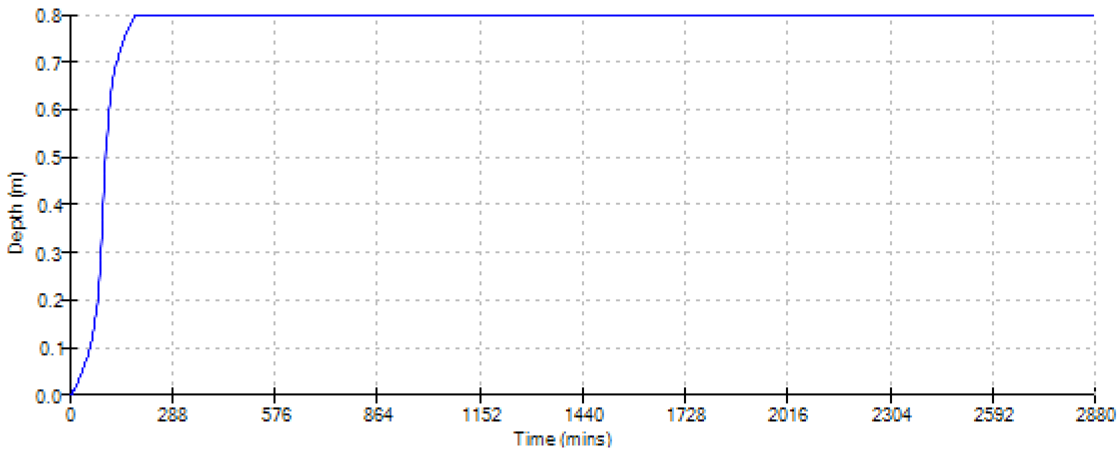




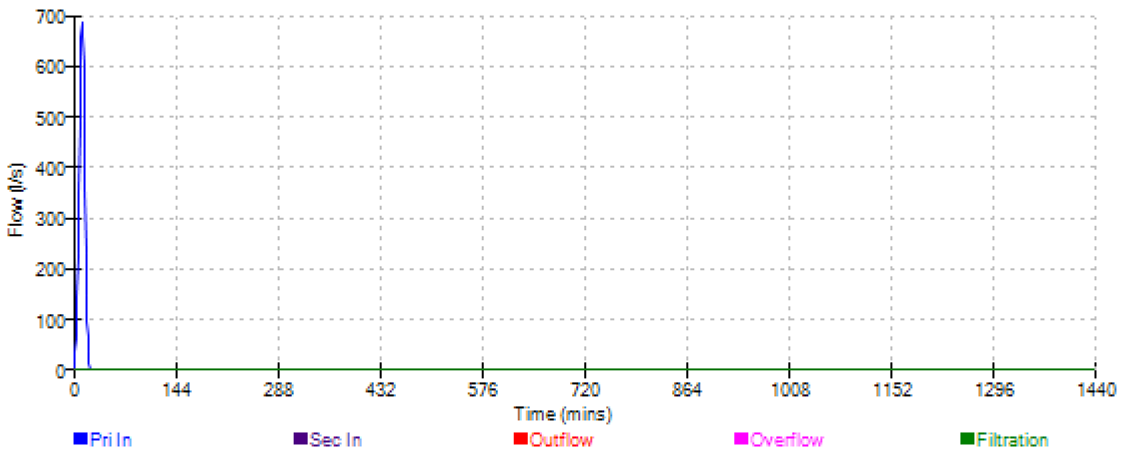
Event: 180 min Summer

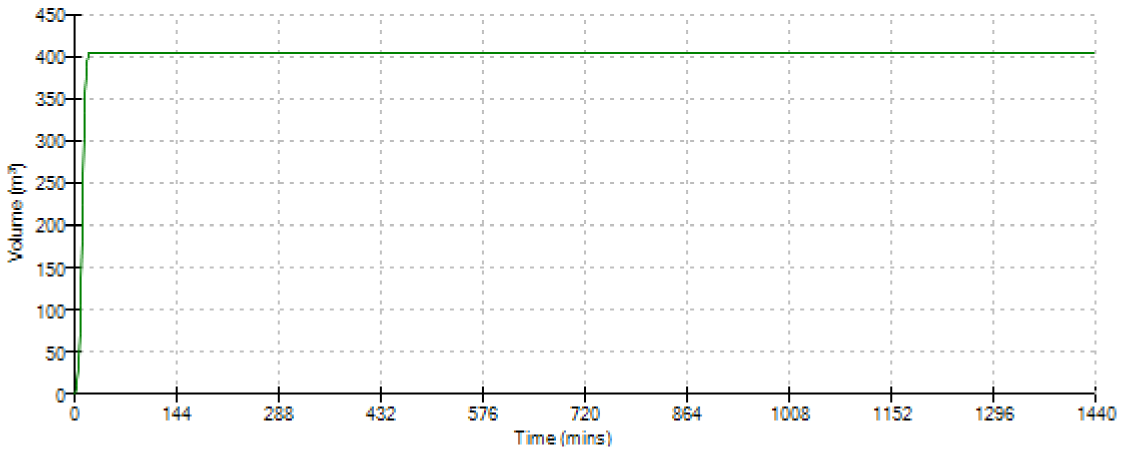


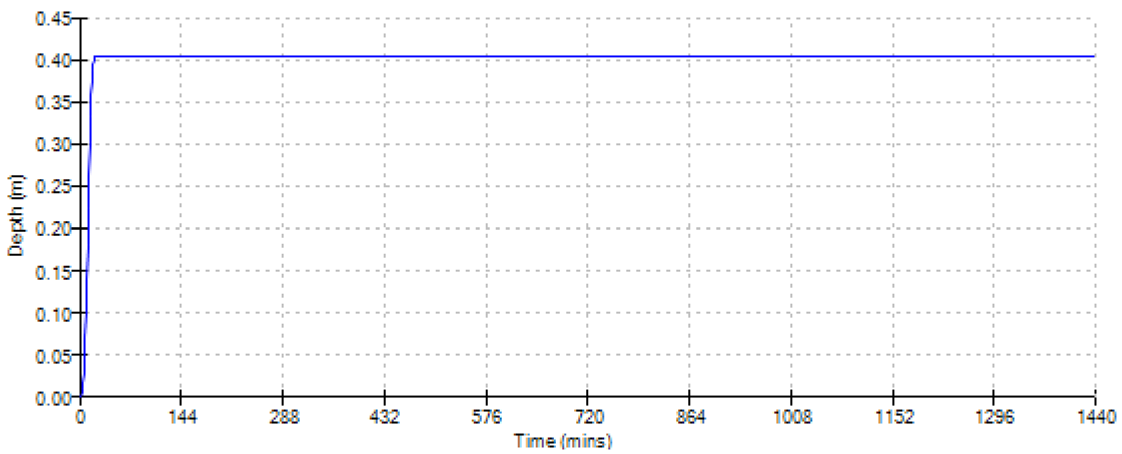




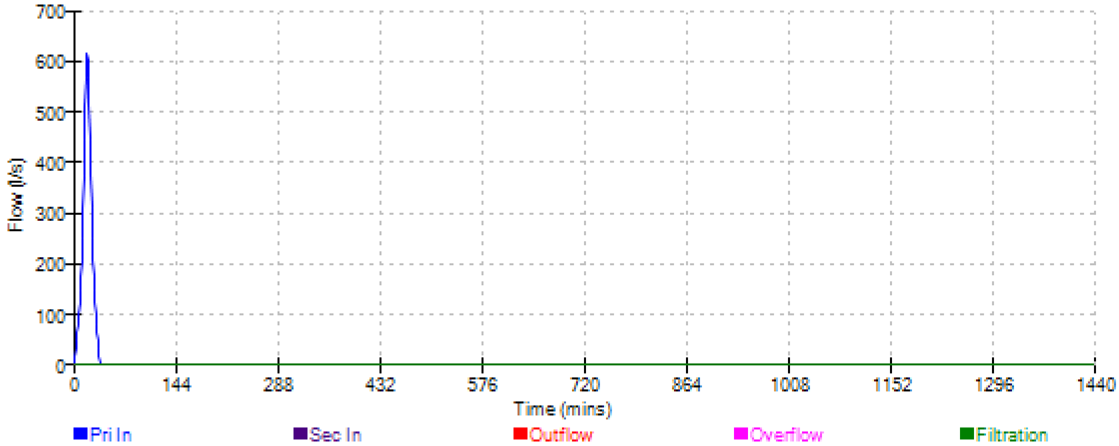
Event: 15 min Winter

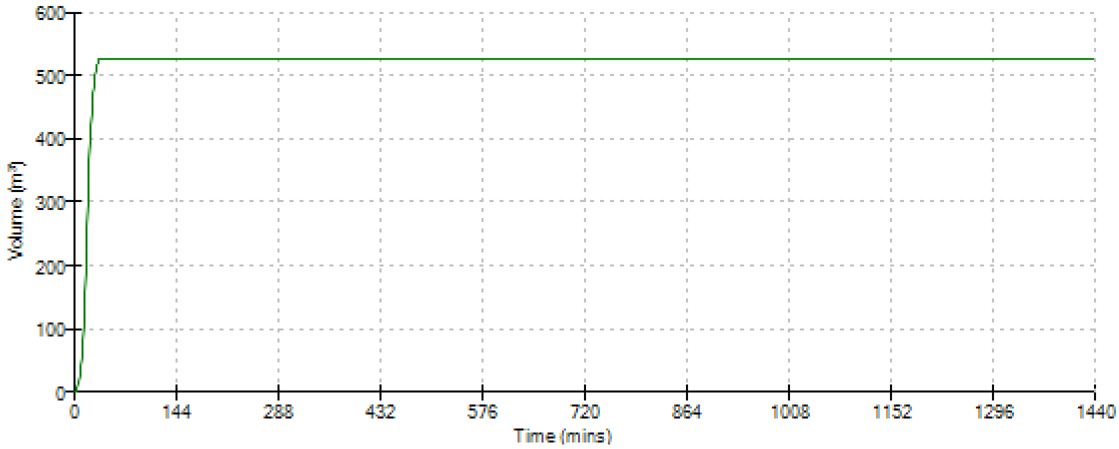


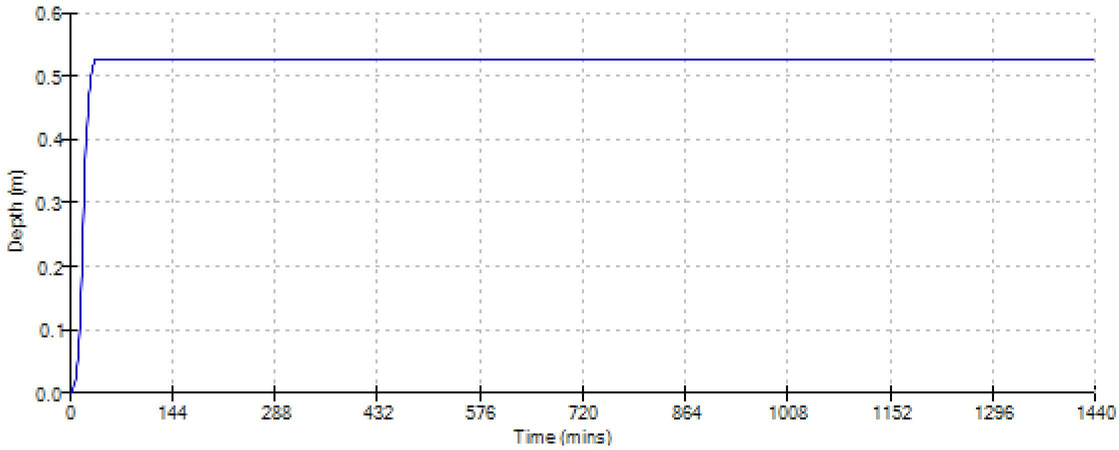




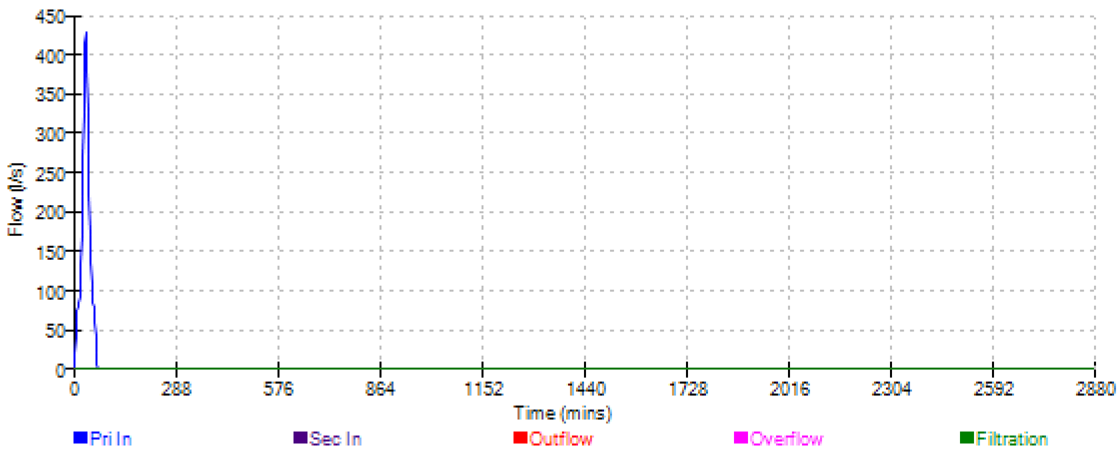
Event: 30 min Winter

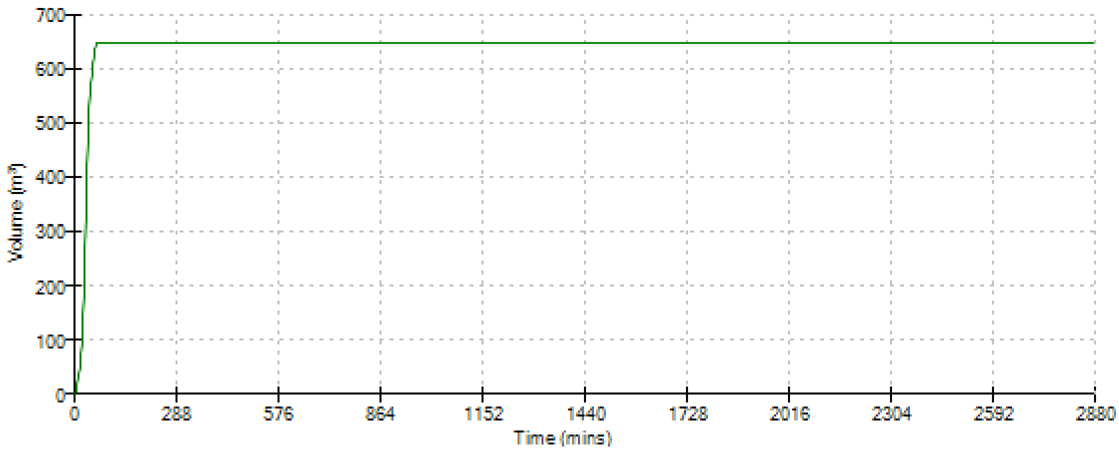


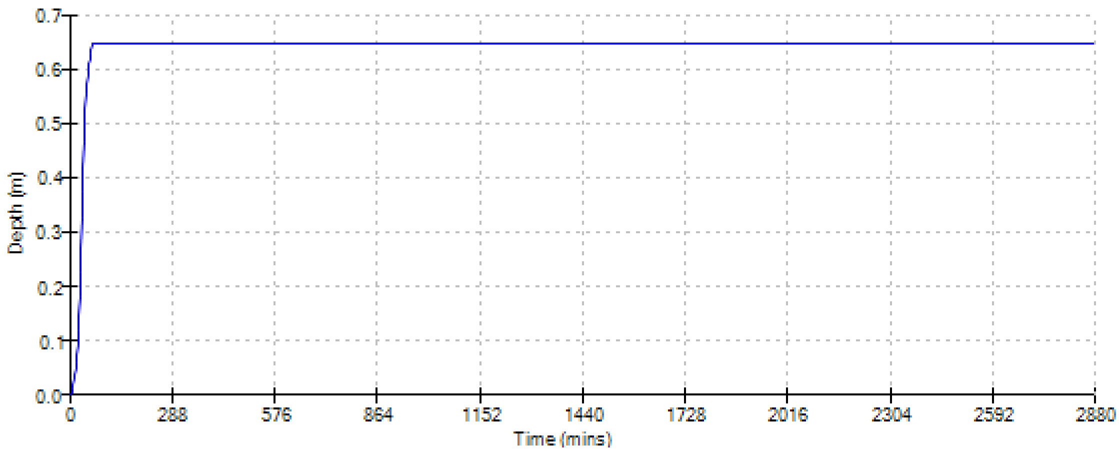




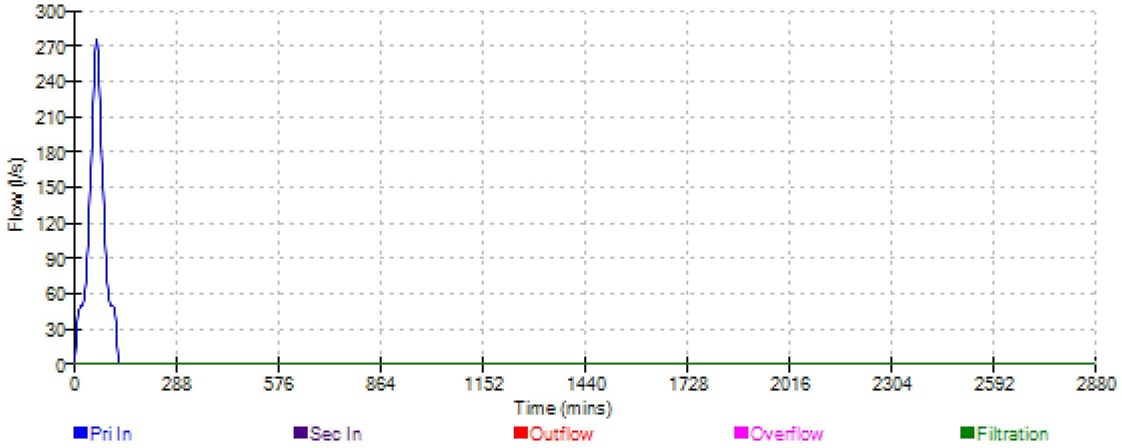
Event: 60 min Winter

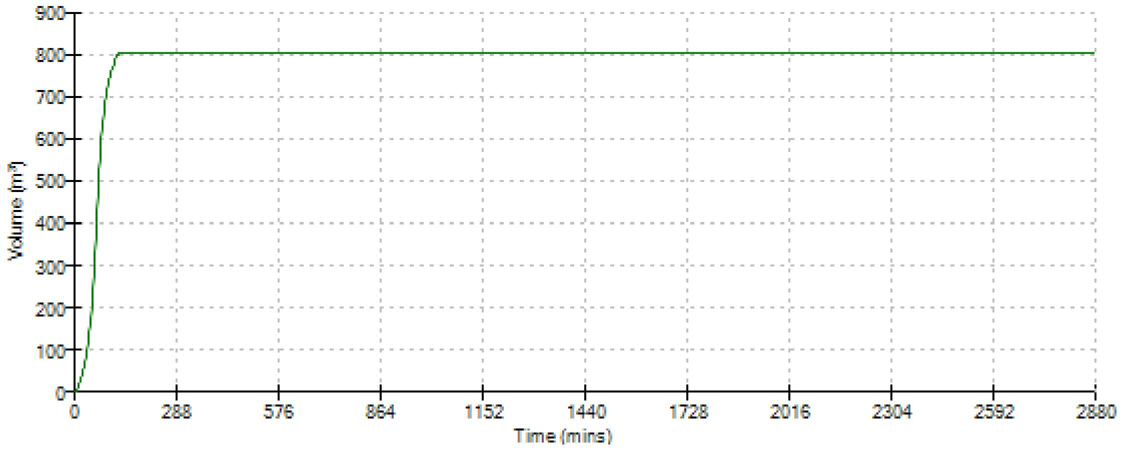


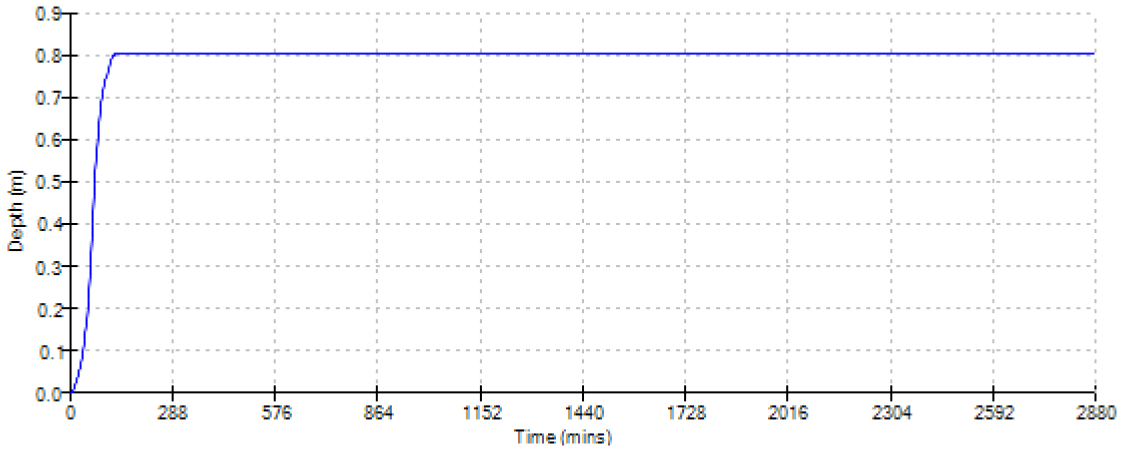




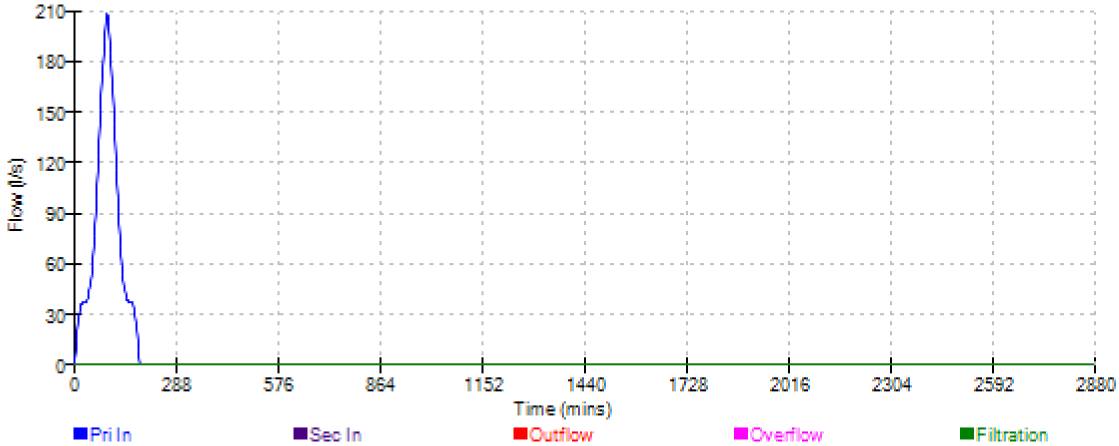
Event: 120 min Winter

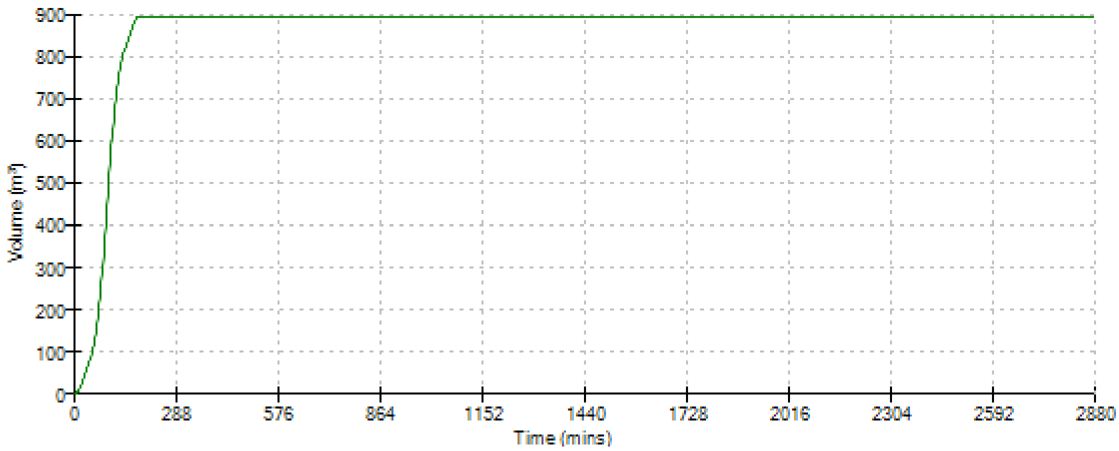


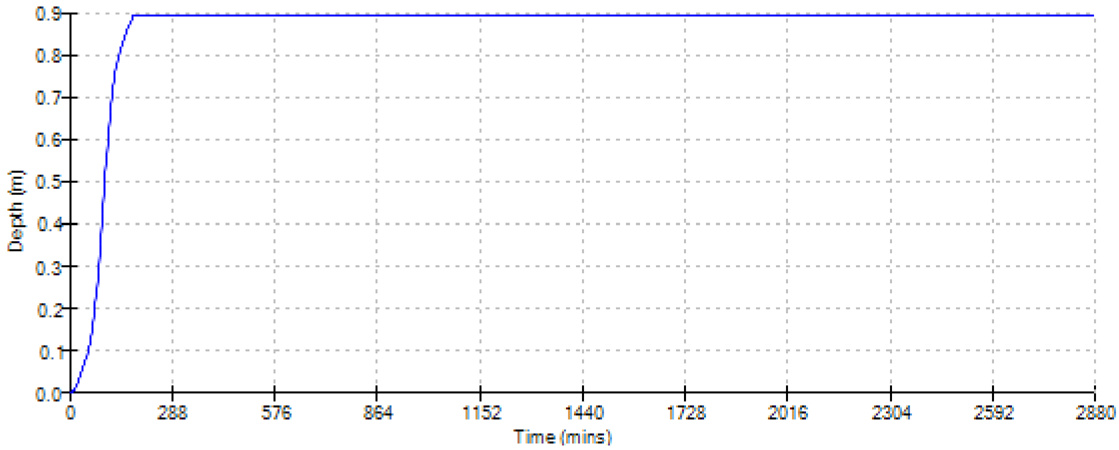




Event: 180 min Winter







NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS STATED OTHERWISE.
2. ALL LEVELS ARE IN METRES UNLESS STATED OTHERWISE.
3. DRAINAGE SYSTEMS AND LEVELS SHOWN ARE PRELIMINARY, SUBJECT TO FINAL DESIGN.
4. INFORMATION RELATING TO THE EXISTING SURFACE WATER OUTFALL TO THE RIVER THAMES HAS BEEN TAKEN FROM ENVIRONMENT AGENCY SUPPLIED RECORDS AND SHALL BE CONFIRMED ON SITE VIA SURVEY.
5. PLEASE REFER TO FLOOD STORAGE SECTIONS ON DRAWINGS 808678-WOD-ZZ-XX-DR-C-0004

LEGEND:

- 0.5m CONTOURS
- 0.1m CONTOURS
- FLOOD STORAGE AREA

REV	DATE		DWN	CHK	APP
P02	23/03 2023	WELFARE UNIT MOVED	SD	JC	JC

REVISIONS

REV	DATE		DWN	CHK	APP
P01	11/08 2022	FIRST ISSUE	SM	SD	JC

SCALES: 1:250

DRAWING STATUS: SUITABLE FOR INFORMATION - S2

PROJECT TITLE:

BRM
E-SCRAP
FACILITY

DRAWING TITLE:

FLOOD STORAGE PLAN

-
- SURFACE WATER DRAINAGE

CLIENT:

BRITANNIA REFINED METALS LTD.
Botany Road, Northfleet, Kent. DA11 9BG.

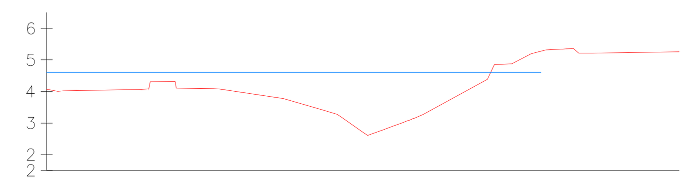
FLOOR 3,
11 WESTFERRY CIRCUS,
LONDON
E14 4HD
TEL: (0203) 2151700
FAX: (0203) 2151701

wsp

BRM DWG No.: BRM_MERIDIAN_DWG_NO

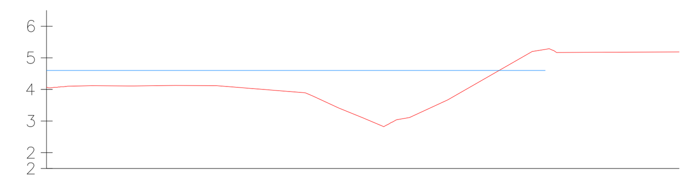
REV.: P02

ADVISER / CONTRACTOR DWG No.: 808678-WOD-ZZ-XX-DR-C-00004



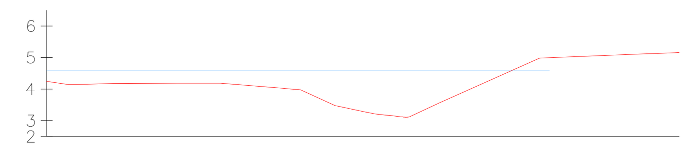
Chainage 10.000

PROPOSED LEVELS	4.068	4.028	4.048	4.069	4.315	4.091	4.000	3.851	3.628	3.334	2.71	2.916	3.325	3.874	4.526	5.027	5.325	5.217	5.228	5.242	5.256



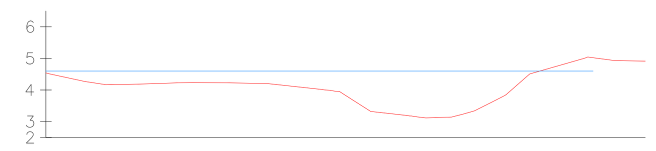
Chainage 20.000

PROPOSED LEVELS	4.068	4.105	4.111	4.111	4.126	4.117	4.063	3.984	3.906	3.515	3.10	3.003	3.355	3.852	4.423	4.994	5.235	5.172	5.175	5.179	5.183



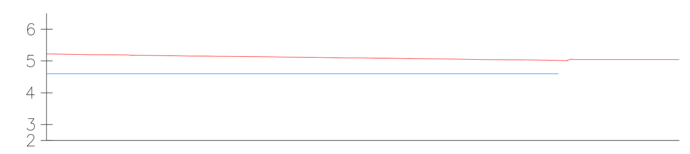
Chainage 30.000

PROPOSED LEVELS	4.249	4.149	4.181	4.186	4.188	4.188	4.146	4.066	3.982	3.536	3.29	3.146	3.372	3.826	4.274	4.723	5.004	5.043	5.082	5.122	5.164



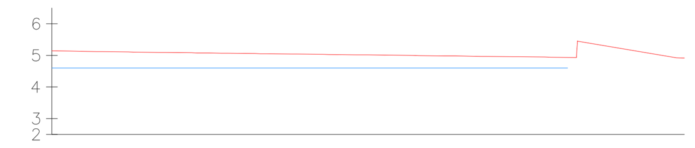
Chainage 40.000

PROPOSED LEVELS	4.476	4.267	4.175	4.198	4.226	4.231	4.220	4.179	4.069	3.949	3.329	3.21	3.128	3.259	3.702	4.478	4.786



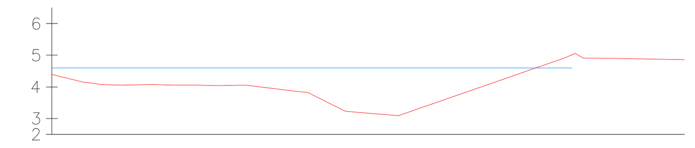
Chainage 50.000

PROPOSED LEVELS	5.221	5.208	5.194	5.181	5.167	5.154	5.142	5.130	5.118	5.106	5.09	5.082	5.070	5.058	5.046	5.034	5.022	5.047	5.047	5.047	5.047



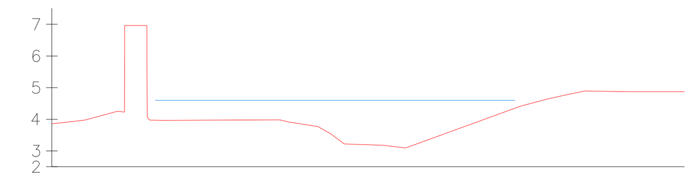
Chainage 60.000

PROPOSED LEVELS	5.140	5.126	5.113	5.100	5.086	5.073	5.061	5.049	5.037	5.025	5.01	5.001	4.989	4.977	4.965	4.953	4.941	5.385	5.216	5.047	4.919



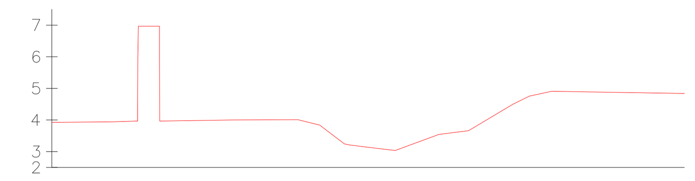
Chainage 70.000

PROPOSED LEVELS	4.395	4.151	4.061	4.069	4.053	4.042	4.050	3.945	3.836	3.367	3.17	3.103	3.452	3.800	4.148	4.496	4.844	4.913	4.901	4.881	4.861



Chainage 90.000

PROPOSED LEVELS	3.857	3.964	4.232	6.960	3.965	3.971	3.976	3.982	3.834	3.400	3.19	3.115	3.390	3.754	4.117	4.462	4.710	4.891	4.875	4.870	4.865



Chainage 95.000

PROPOSED LEVELS	3.919	3.932	3.946	6.960	3.973	3.986	3.998	4.003	3.953	3.434	3.14	3.089	3.453	3.640	4.154	4.709	4.903	4.887	4.870	4.854	4.837

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS STATED OTHERWISE.
2. ALL LEVELS ARE IN METRES UNLESS STATED OTHERWISE.
3. DRAINAGE SYSTEMS AND LEVELS SHOWN ARE PRELIMINARY, SUBJECT TO FINAL DESIGN.
4. INFORMATION RELATING TO THE EXISTING SURFACE WATER OUTFALL TO THE RIVER THAMES HAS BEEN TAKEN FROM ENVIRONMENT AGENCY SUPPLIED RECORDS AND SHALL BE CONFIRMED ON SITE VIA SURVEY.

LEGEND:

4.6m FLOOD LEVEL

PROPOSED LEVELS

REV	DATE		DWN	CHK	APP
P02	23/03 2023	WELFARE MOVED	SD	JC	JC

REVISIONS

REV	DATE		DWN	CHK	APP
P01	11/08 2022	FIRST ISSUE	SM	SD	JC

SCALES: 1:200

DRAWING STATUS: SUITABLE FOR INFORMATION - S2

PROJECT TITLE:

BRM
E-SCRAP
FACILITY

DRAWING TITLE:

FLOOD WATER STORAGE SECTIONS

-

- SURFACE WATER DRAINAGE

CLIENT:

BRITANNIA REFINED METALS LTD.
Botany Road, Northfleet, Kent. DA11 9BG.

FLOOR 3,
11 WESTFERRY CIRCUS,
LONDON
E14 4HD
TEL: (0203) 2151700
FAX: (0203) 2151701

BRM DWG No. BRM_MERIDIAN_DWG_NO

REV. P02

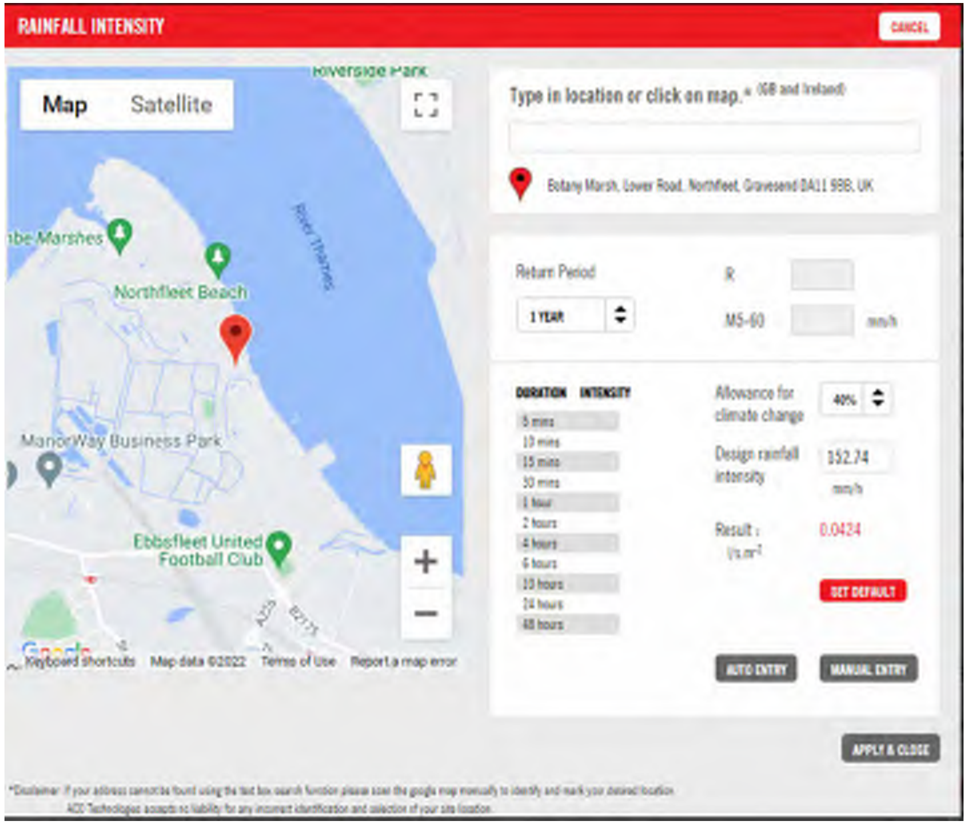
ADVISER / CONTRACTOR DWG No. 808678-WOD-ZZ-XX-DR-C-00005

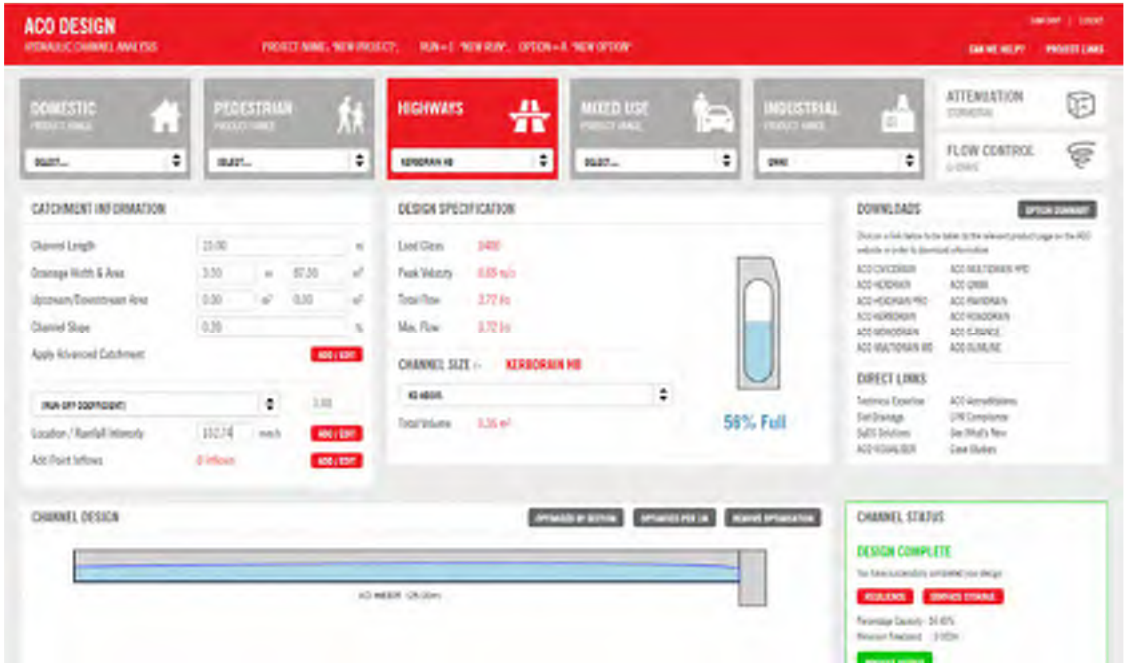
Original Drawing Size - A1 DO NOT SCALE

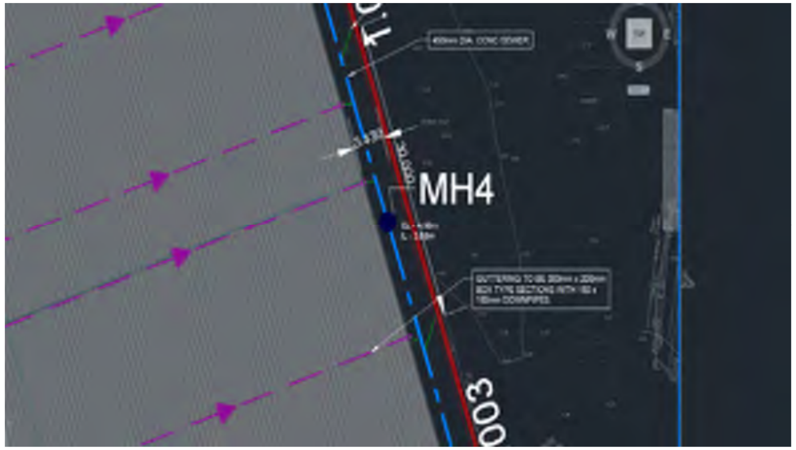
Appendix J
ACO and Syphonc Drainage surface water collection systems calculations


ACO DESIGN
DOMESTIC
PEDESTRIAN
HIGHWAYS
INDUSTRIAL
ATTENUATION
FLOW CONTROL
CATCHMENT INFORMATION
DESIGN SPECIFICATION
DOWNLOADS
CHANNEL DESIGN
CHANNEL STATUS
DESIGN COMPLETE


2400m2


RAINFALL INTENSITY
CANCEL
Map
Satellite
Riverside Park
Northfleet Beach
River Thames
Manor Way Business Park
Ebbsfleet United Football Club
Keyboard shortcuts
Map data ©2022
Terms of Use
Report a map error
Type in location or click on map.* (GB and Ireland)
Botany Marsh, Lower Road, Northfleet, Gravesend DA11 9BB, UK
Return Period
1 YEAR
R
M5-60
mm/h
DURATION
INTENSITY
5 mins
10 mins
15 mins
30 mins
1 hour
2 hours
4 hours
6 hours
10 hours
24 hours
48 hours
Allowance for climate change
40%
Design rainfall intensity
152.74
mm/h
Result :
l/s.m²
0.0424
SET DEFAULT
AUTO ENTRY
MANUAL ENTRY
APPLY & CLOSE
*Disclaimer: If your address cannot be found using the text box search function please scan the google map manually to identify and mark your desired location.
ACO Technologies accepts no liability for any incorrect identification and selection of your site location.


ACO DESIGN
DOMESTIC
PEDESTRIAN
HIGHWAYS
MIXED USE
INDUSTRIAL
ATTENUATION
FLOW CONTROL
CATCHMENT INFORMATION
DESIGN SPECIFICATION
DOWNLOADS
DIRECT LINKS
CHANNEL SIZE
KERBDRAIN HB
56% Full
CHANNEL DESIGN
CHANNEL STATUS
DESIGN COMPLETE


MH4

COLLECTOR PIPE LOAD TABLE

Collector Pipe Diameter	Pipework Load (kg) Per L Bracket	Total Weight (kg/m)
Ø75mm	12.85kg	5.56kg
Ø90mm	16.72kg	7.51kg
Ø110mm	23kg	10.66kg
Ø125mm	28.52kg	13.42kg
Ø160mm	44.22kg	21.47kg
Ø200mm	66.71kg	33.09kg
Ø250mm	103kg	50.76kg
Ø315mm	156kg	79.62kg

Collector pipework supports (L-brackets) to be fixed to purlins at maximum 2m centres for Ø63, Ø75, Ø90, Ø110, Ø125, & Ø160, and at 1.5m centres for Ø200, Ø250 & Ø315 pipework

PIPE SUPPORT BRACKET SPACING

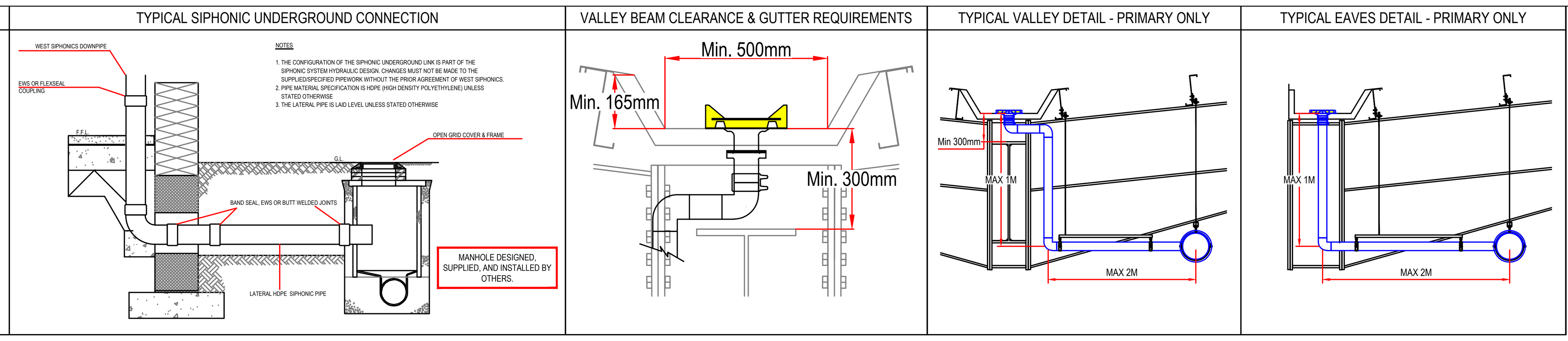
CLIPS @ MAX 1000mm SPACING FOR Ø63, Ø75, & Ø90 PIPE (7 NR CLIPS PER LENGTH)

CLIPS @ MAX 1500mm SPACING FOR Ø110, Ø125 & Ø160 PIPE (5 NR CLIPS PER LENGTH)

CLIPS @ MAX 2000mm SPACING FOR Ø200, Ø250, & Ø315 PIPE (4 NR CLIPS PER LENGTH)

DROP RODS TO BE SPACED AT MAX 2000mm CENTRES EXCEPT Ø200, Ø250 & Ø315 WHICH SHOULD BE MAX 1500mm CENTRES

TYPICAL SIPHONIC UNDERGROUND CONNECTION | VALLEY BEAM CLEARANCE & GUTTER REQUIREMENTS | TYPICAL VALLEY DETAIL - PRIMARY ONLY | TYPICAL EAVES DETAIL - PRIMARY ONLY



KEY

- Ø75 PRIMARY OUTLET
- Ø75 SECONDARY OUTLET
- Ø110 PRIMARY OUTLET
- PIPE REDUCER / INCREASER
- PRIMARY DOWNPIPE
- PRIMARY DROPPER
- SECONDARY DROPPER
- DROP IN PIPE

SCAN HERE FOR OUR OUTLET DETAILS

NOTES

BUILDING LIFE:- 25 Years
CATEGORY OF RISK:- 3
RETURN PERIOD:- 112.5 Years
DRI PRIMARY:- 0.061 L/S/M2 - 219.6 mm/hr
DRI SECONDARY:- n/a L/S/M2 - n/a mm/hr
OUTLET TYPE:- TBC
OUTLET Qty:- TBC
SECONDARY UPSTAND QUANTITY AND HEIGHTS
TOTAL:- n/a OFF - n/a mm HIGH
INSULATION REQUIREMENTS:-
TAILPIPES: N/A
OFFICE AREAS: N/A
ALL INTERNAL PIPEWORK: N/A

WEST SIPHONICS RECOMMEND THAT THE UNDERGROUND PIPE POP-UP SHOULD BE AT LEAST TWO PIPE SIZES LARGER THAN OUR DISCHARGE PIPE AT POINT OF CONNECTION

FOLLOWING ISSUE OF "APPROVAL" DRAWINGS IT IS DEEMED THAT THEY ARE APPROVED FOR INSTALLATION IF NO COMMENTS ARE RECEIVED WITHIN 2 WEEKS OF THE DATE OF ISSUE

DESIGN AND INSTALLATIONS ARE COMPLIANT WITH BSEN12056-3:2000 AND BS8490:2007

ALL PIPEWORK IS BLACK HDPE MANUFACTURED IN ACCORDANCE WITH EN1519

ALL DIMENSIONS MUST BE CHECKED ON SITE AND NOT SCALED FROM THIS DRAWING

WEIR / EMERGENCY OVERFLOWS ARE TO BE PROVIDED AS PART OF THE GUTTER CONSTRUCTION, BY OTHERS

REV	DESCRIPTION	DATE	BY	CKD
T02	RFI increased to suit Cat 3 risk factor.	08.09.22	MB	MD
T01	TENDER ISSUE	02.09.22	MD	MB

WEST SIPHONICS SYSTEMS LTD
COKE LANE
ROTHERHAM
S60 2JS
TEL : 01709 382 346

WEST SIPHONICS LTD
94 BROWNS STREET
NEWMILNS
AYRSHIRE
KA16 9BP
TEL : 01560 321 111

www.westsiphonics.co.uk
e-mail : design@westsiphonics.co.uk

DRAWING TITLE
SIPHONIC DRAINAGE LAYOUT

PURPOSE OF ISSUE: TENDER ISSUE

CLIENT: n/a

PROJECT LOCATION: NORTHFLEET

PROJECT TITLE: Electronic Scrap Facility

PROJECT NUMBER	DRAWN BY	CHECKED BY	DATE	SCALE (@ A1)
S-3577	MD	MB	02.09.22	1:250

DRAWING NUMBER

PROJECT	ISSUER	AREA	LEVEL	TYPE	TRADE	SEQUENCE	REVISION
-	WES	ZZ	ZZ	DR	Y	357701	T02

West Siphonics Systems Ltd
Coke Lane, Rotherham, S60 2JS
Tel: 01709 382 346
Email: design@westsiphonics.co.uk
Web: www.westsiphonics.co.uk

Project Reference: S-3577 -2

Date: 08 September 2022

Client: Wood PLC

For the attention of: Sam Davy

Re: NORTHFLEET Electronic Scrap Facility

Clients Reference: n/a

We thank you for your valued enquiry and have pleasure in confirming our all-inclusive quotation for the design, manufacture, supply, and installation of West Siphonics Systems Ltd rainwater management systems, as described within, and as laid out in the attached terms and conditions. All prices are quoted Nett ex Vat.

SIPHONIC RAINWATER DRAINAGE SYSTEMS		
Unit Siphonic Rainwater Drainage Systems	£	19,483.00
INSULATION, OPTIONS, AND ALLOWANCES		
Telehandler for Self-sufficient Distribution of Materials Across Site		Included

1.0 SCOPE OF WORKS AND DESIGN CRITERIA:

1.01	West Siphonics Systems Ltd (appended) drawing number:	WES-ZZ-ZZ-DR-Y-357701-T01	
1.02	A proposed start on site date for the siphonic installation TBC.		
1.03	An estimated siphonic install duration of (approx.) *1*	weeks, based on one two-person install team.	
1.04	An estimated design period of 3-4 weeks and 6-8 weeks for manufacture and procurement.		
1.05	Gutter size assumed as a minimum of 500mm sole x 165mm deep. Gutter to be installed level.		
1.06	A total rainfall intensity of :	219.6	mm/hr/m2
	or	0.061	l/s/m2
1.07	A building design life of :	25	years
1.08	A category of risk of:	3	
1.09	A storm return period of:	112.5	years
1.10	Supply of *18* No. gutter outlets (approx), issued to the roofing contractor for installation in to the gutters.		
1.11	Primary only drainage systems.		
1.12	Foil faced insulation options as quoted above (additional install time required).		
1.13	Supply of siphonic undergrounds, assumed to be 1m vertical x 6m horizontal without additional bends or offset, to the Primary drainage systems only. Free issued for installation by others.		
1.14	Receiving manhole to be fitted with an open grid manhole cover and suitably sized to accept the discharge rate advised on our appended drawings. Siphonic pipe to enter the manhole as close to cover level as possible to minimize the risk of surcharging.		

2.0 INCLUSIONS:

2.01 West Hydrostorm Siphonic Outlets (supplied to the roofing contractor for installation in to the gutters).

2.02 Provision of Access/Plant:
MEWPS for installation of siphonic pipework within the building.
Mobile scaffold tower up to a maximum working height of 4m.
Telehandler for self-sufficient distribution of materials across site.

2.03 An engineered pipework support rail system secured to a single suitably designed purlin. Bracketry and metalwork support system supplied in mild steel, BZP coated or pre-galvanised finish, unless stated otherwise.

2.04 Pipe and associated fittings - black HDPE manufactured in accordance with EN1519.

2.05 Production of 2D design drawings following receipt of relevant electronic copy "other trades" drawings, namely steelwork, gutter details, underground drainage and architect GA's.

2.06 Production of gutter and system calculations, made available to the client upon request.
2.07 Production of electronic As Built drawings and Operations and Maintenance manuals to be issued to the Principal Contractor / our client, in our own standard format.
2.08 Designs based on the recommendations and guidance set out in BS EN 12056-3:2000 and BS 8490:2007
2.09 Works carried out within one visit to site, following the installation of the gutter outlets and clear of any roof nets. Additional visits will be charged at £940.00 per additional visit and subject to a four week notice period. If return visits are required then our agreed duration on site shall be extended accordingly.
2.10 Practical Completion certificates to be issued following testing of systems installed. Systems to be tested by means of running water test if used as temporary drainage throughout the build phase, or air pressure tests if the systems have remained "dry" during construction.
2.11 Site storage if required.
2.12 Task lighting.
2.13 Clearance of debris to a central point for removal by others. No allowance has been made for contributions towards skip hire or cleaning.
2.14 Site clearance by West Siphonics Systems Ltd of our own surplus re-usable materials.
2.15 Generated power (if required) for the use of hand tools.

3.0 EXCLUSIONS:

3.01 Fire protection: fire collars and fire sleeves should be provided and installed by a fire protection specialist.
3.02 The removal of, or re-instatement of, any safety netting.
3.03 Pipe sleeves through the building structure.
3.04 Any builder's works, including holes or making good to cladding, sheeting or brick work.
3.05 Draining to rainwater harvesting tanks. If applicable, all connections to RWH tanks / valves / filters / tank overflows are to be provided by the tank supplier/others.
3.06 Rodding eyes / access hatches. These are not permitted in siphonic drainage systems.
3.07 Boxing out of gutters i.e. gutter boxes.
3.08 3D Revit models. These can be provided at an additional cost TBA.
3.09 No additional visits have been included for the installation of Secondary downpipe spitters (if applicable) through the wall cladding. It is assumed that the wall cladding will be in-situ prior to the installation of our pipework. Return visit costs will be incurred if this sequence is not achievable.
3.10 Splash pads beneath Secondary discharge pipes.
3.11 No allowance has been made for any pipework insulation unless quoted on page one.
3.12 Vermin guards or gravel guards to gutter outlets. Our outlets are fitted with a HydroStorm air baffle / leaf guard as standard.
3.13 Purlin spans.
3.14 Trace heating.
3.15 Outlet installation or cutting / marking holes in gutters to receive our outlets.
3.16 Rope access and fixed scaffolding.
3.17 Hydraulic water test.
3.18 Painting of pipework, metalwork, or outlets.
3.19 Downpipes in materials other than HDPE.
3.20 Gravity underground drainage pipework from the termination of our siphonic system to the receiving manhole chamber.
3.21 Pipework identification tape.
3.22 Co-ordination with other services.
3.23 Temporary drainage: West Siphonics Systems Ltd accept no responsibility for water damage occurring through unauthorised use of an incomplete siphonic drainage system. Temporary drainage can be provided at an additional cost TBA, if the requirements are advised to us.
3.24 Weir overflows in gutters / parapets, or emergency overflows.
3.25 Supply of membrane patches to the gutter outlets.
3.26 Performance Bond / Parent Company Guarantees.

4.0 ITEMS TO BE PROVIDED FREE OF CHARGE BY THE PRINCIPAL CONTRACTOR / OUR CLIENT:

4.01 Copies of the Main Contract and Sub-Contract documents (sensitive financial information can be re-dacted). Without this information our quotation is based on this document only, is not contractually binding, and may be withdrawn.
4.02 Copies of the project HSE Construction Phase Plan and F10 form.
4.03 Copies of the latest construction programme and construction maps.
4.04 Clear, level, and stable ground conditions around the building to undertake the whole installation without obstructions affecting installation.
4.05 Standard welfare facilities, including first aid provision.
4.06 Safety lighting and water supplies.
4.07 Use of hoists or standing scaffold if available.
4.08 Lay-down area for cabins (if required) and 6m long pipe stillages.
4.09 On-site car parking and access for our vehicles.
4.10 Off-loading of underground hockey sticks (if applicable).
4.11 Access to site / supervision as necessary during site hours – assumed 7.30am-5.30pm Monday-Friday.

5.0 ADDITIONAL TERMS AND CONDITIONS:

5.01 Acceptance of any contract conditions or collateral warranty wording would be discussed at the time of the contract award.

5.02 Notices can / will be issued and received by email.

5.03 The attached drawings are the property of West Siphonics Systems Limited and must not be used, loaned, reproduced or disclosed in whole or part to third parties without the company's written permission.

5.04 Due to volatility of material prices we can hold this price open for one week only, after which time we can provide up to date price checks for your reference. This will continue until material prices stabilize.

5.05 Payments terms are 30 days from month end.

5.06 For orders received with a total value of less than £20,000.00 retention will be 0%.
For orders received with a total value in excess of £20,000.01: The rectification period is 12 months and retention will be held at 3% until Sub-Contract practical completion whereby it will be reduced to 1.5% on application. The final 1.5% will be released on application at the end of the rectification / defects period

5.07 Liquidated and ascertained damages (LADs or LDs) are to be set at £0 per unit, per week, or part therof for two weeks following completion date. A maximum of 0.5% of the Sub-Contract value per week or pro rata thereafter but capped at 10% of the Sub-Contract value in the aggregate.

5.08 Our insurance cover is as follows:
Professional Indemnity at £15 million in the aggregate.
Public Liability at £10 million each and every insured event or series of insured events arising from an originating cause.
Employers Liability at £10 million any one claim or series of claims including costs and expenses arising out of one cause.
Products Libility at £10 million each and every insured event or series of insured events arising in the period of insurance.
Contractors All Risk at £300 thousand.

5.09 A Letter of Intent (LOI) can be issued to cover the cost of design work only, at a value of £3,000.00 or 10% of the total order value, whichever is higher. This sum to be claimed for and paid upon the issue of our Construction status drawings.

5.10 The acceptance of an LOI does not constitute a contract for the project. A full order document must be agreed upon and signed by both parties prior to procurement of materials, or a start on site.

5.11 Monies will be claimed in applications for materials on site, and gutter outlets issued to roofing contractors.

5.12 Any variations to the design laid out in our design drawings which are appended to this quotation, which results in the need for additional labour, and / or materials, will be chargeable based on a variation specific price that will be issued for approval before the alterations can be incorporated.

5.13 Any delays not caused by West Siphonics Systems Ltd which result in standing time for our labour, will be chargeable at a rate of £69.21 per hour for a two-person team. Any such delays will be notified to the Project Team by our Project Manager. The total amount of standing time to be added on to the previously agreed total duration of our on site works.

We trust this offer has interpreted your requirements correctly. Should you require further information or any points of clairification, please do not hesitate to contact us.

Yours faithfully

For and On Behalf of West Siphonics Systems Ltd

M. Barraclough

Michael Barraclough
T: 01709 382 346
M: 07841 581 386