

Flood Risk Assessment

Proposed New lead Storage Building at the BRM site in Northfleet, Gravesend, DA11 9BG

Britannia Refined Metals

Botany Road, Northfleet, Gravesend, DA11 9BG

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Revision Record

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Basis of Report

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Executive Summary

Britannia Refined Metals (BRM) has been advised to prepare a Flood Risk Assessment (FRA) to support a planning application for the development for a proposed New Lead Storage Building, situated at BRM, Botany Road, Northfleet, Gravesend, DA11 9BG. The New lead Storage building would be ancillary to the operation of site's current operations.

Subject	Element	Findings
Site	Name	New Lead Storage building.
Existing Site	Description	The Site is located within a metal processing facility operated by BRM on the south bank of the River Thames. It is part of a brownfield industrial estate that includes material processing plants and supporting infrastructure. To the west, the Site is adjacent to Swanscombe Peninsula, an undeveloped marshland designated as a Site of Special Scientific Interest (SSSI) and is owned by the applicant. To the south, is the Northfleet Industrial Park. Access to the Site is via Manor Way which then joins the A226, providing access to the broader national road network.
	Topography	The wider BRM facility is on leveled land raised above the River Thames at varied elevations. The Site is on a flat area at approximately 3.80m above Ordnance Datum (AoD). To the northeast, the area consists of foundations with ramp access, elevated between 4.00 – 4.35m AoD. There is a depression at 3.00m AoD immediately to the southwest of the Site.
	Geology & Hydrogeology	Bedrock geology is indicated to consist of Chalk (Lewes Nodular, Seaford and Newhaven) formations. Superficial deposits are indicated to comprise Alluvium consisting of silt and clay. Given the developed nature of the Site, significant made ground is likely present. The Site is overlain by impermeable concrete hard standing of 0.58m depth The EA Aquifer Designation mapping indicates the bedrock is classed as 'Principal' aquifer, with the superficial layers designated as 'Secondary (undifferentiated)' aquifer. The Site lies within a Source Protection Zone 2 (SPZ) and has 'medium - high' groundwater vulnerability.
	Hydrology	The Site is located 160m inland from the south bank of the tidal River Thames. To the west is the Swanscombe Peninsula, featuring marshlands including Botany Marsh adjacent the BRM facility, with surface water ponds, wetlands, and ditches.
	Drainage	The BRM facility surface water drainage system includes privately owned attenuation ponds, land drains, and surface water drainage networks. The EA Asset database indicates flood gates and pump stations along the south bank of the Thames. The facility is divided into 'Surface Water Contained' and 'Surface Water Outflow' catchments. 'Surface Water Outflow' discharges into the Southern Water foul sewer network offsite to Manor Way. 'Surface Water Contained' discharges rainwater into raised attenuation lagoons within the BRM facility, located 200m northwest and 390m north of the site. An open channel drain near the northwest lagoon runs around the

Subject	Element	Findings
		perimeter of the BRM facility, discharging into the River Thames.
Proposals	Description	The proposed lead storage building, designed for storage of by-products awaiting processing & products already processed. The building allows us to comply with improvement notices required to keep more of the product under covered storage & reduce site risks & carbon footprint. The proposed building will be 21.4m x 25.7m & have a single pitched roof to 13.4m. Total footprint expected to be 550m ²
	Lifetime	The proposed building has an expected 20-year lifetime up to 2044.
	Vulnerability	Flood risk vulnerability classification at PPG Annex 3, the development is considered to be 'Essential Infrastructure'.
Site Flood Risk	Fluvial	The River Thames is predominantly tidally influenced where it is adjacent the Site. As such, the primary flood risk to the Site is from tidal sources. On this basis the flood risk from River or Fluvial Flooding is assessed to be low.
	Tidal	The Site is located adjacent to the tidally influenced River Thames and falls within Flood Zone 3, indicating a high probability of tidal flooding if flood defenses were not present. However, the Site benefits from flood defenses directly adjacent the BRM facility's northeast boundary, including tidal walls with a crest level of 6.75m AoD, providing a 1 in 1000-year (0.1% AEP) standard of protection. Current flood level data indicates that a 1 in 200-year (0.5% AEP) flood level is 5.85m AoD. Uplifting peak flood levels by 0.22m for climate change up to 2044 equates to 6.07m AoD. With existing crest levels, defenses provide up to 0.68m of freeboard for the BRM facility. In line with TE2100 Policy 4, the site may benefit from raised defences with crest level of 7.00m AoD by 2040 In line with TE2100 Policy 4, the site may benefit from raised defenses with crest level of 7.00m AoD by 2040. The BRM facility is protected by a 3.0m high embankment from Botany Marsh, which is adjacent to the Swanscombe Peninsula. The peninsula itself is protected by a second earth embankment with a crest level of 8.8m AoD, providing additional flood protection from the River Thames. These defenses provide a 1 in 1000-year (0.1% AEP) standard of protection. The marshes are well drained through an extensive ditch and pond network leading to two open relief channels that
	Infrastructure Failure	The Site is located 150m from the nearest modelled breach to the northeast. In the event of a breach failure, the site would experience rapid inundation with water depths exceeding 1.32m, posing a significant hazard to site personnel. However, the BRM facility has a series of on-site flood gates and emergency procedures to protect 'Employee Work Areas,' ensuring safe refuge. The facility is regularly staffed, and defenses are routinely monitored for defects, making the likelihood of breach failure relatively low.

Subject	Element	Findings
	Surface Water	The Site is located on levelled hard standing, with surface water runoff flowing from the northeast to the southwest where it is collected by the existing drainage network. The Site is predominantly at 'low risk' of surface water flooding, Therefore, the flood risk from surface water is considered low and not considered further.
	Groundwater	BRM during the soil investigation process had some test boreholes drilled to aid in this. During this process groundwater was found to ingress the borehole at 1.70m rising to 1.50m after some time. Groundwater is limited to 1.5m depth below ground level (see soil investigation report DC2523 – Appendix B 16083X BRM New Lead Storage Area – SI Report – FINAL). The Site is overlain by impermeable 0.58m thick concrete hard standing and is not considered at risk of emergence.
	Sewers and Artificial Sources	The Site contains an existing drainage network. The Site is located primarily within the 'Surface Water Outflow' network which drains off-site to sewers under Manor Way. Upstream overland flow would move towards the Site. The potential for significant flood volumes inundating the Site is low. The upstream network receives no offsite flows. Flood risk is therefore considered low.
Planning Requirements	Sequential Test and Exception Test	The proposed development is a Lead Storage building in the existing BRM facility, comprising a total site area of 550m². The Lead Storage Building will be ancillary to and necessary to the efficient operation of the sites main processing plant. Due to the size and nature of the proposed development, it is exempt from sequential testing. The proposed Lead Storage Building will support the site's main operation, and it aligns with sustainable development goals and will aid the BRM site, a key local employer. Located on brownfield land within an established industrial site, the proposed development includes building only, with no habitable or welfare spaces. The site is considered to be at residual risk of flooding from tides or unlikely infrastructure failure. Close monitoring of assets and early flood warnings with contingency Evacuation Plans have suitably mitigated remaining risk. Both the sequential and exception test have therefore been passed.

Summary	Conclusion	Flood risk at the Site has been assessed according to BS8533, considering all potential sources, including fluvial, tidal, surface water, groundwater, sewer, reservoirs, canals, and infrastructure failure. The screening assessment concludes that the primary flood risk at the Site is from the tidally influenced reach of the River Thames. Modelled flood level data from the EA indicates that the Site is located within Flood Zone 3a and benefits from tidal flood defenses protecting against events up to 1 in 1000-year (0.1%
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Subject	Element	Findings
		AEP) event. In channel flood level data inclusive of climate uplifts accounting for climate change confirms the Site is currently safe from flooding from tidal sources. In addition to the 0.68m freeboard provided by existing defenses, residual tidal flood risk is additionally anticipated to be mitigated by raised flood defenses over the proposed 20-year lifetime of the development. TE2100 Policy 4 for Swanscombe and Northfleet state that defenses are to provide sufficient protection by 2040. It is anticipated that future tidal flood risk will remain acceptably low. Site-specific modelling indicates that, although infrastructure failure could pose significant risks to personnel, established early flood warning systems and Evacuation Plans effectively mitigate these risks. The TE2100 policy ensures ongoing monitoring and upgrades of defenses, securing the Site's safety for the proposed 20-year development lifespan. Overall, the development will be safe from all flood risks, with no adverse off-site impacts. The development includes flood gates on all Personnel & roller shutter door opening into the new building.

Table of Contents

Basis of Report	i
Executive Summary	ii
Acronyms and Abbreviations	x
1.0 Introduction	1
1.1 Terms of Reference	1
1.2 Administrative Context.....	1
1.3 Site Location	1
1.4 Background and Aims	2
2.0 Site Details.....	4
2.1 Existing Site Description	4
2.2 Topography	5
2.3 Hydrological Context	6
2.3.1 Local Hydrology.....	6
2.3.2 Site Drainage.....	6
2.4 Geological and Hydrogeological Context.....	6
2.4.1 Geology.....	6
2.4.2 Hydrogeology	7
3.0 Development Proposal.....	9
3.1 Proposed Development.....	9
3.2 Anticipated Lifetime of Development	9
3.3 Flood Risk Vulnerability.....	9
3.4 Planning Context.....	9
3.4.1 National Planning Policy.....	9
3.4.2 County Planning Policy.....	10
3.4.3 Local Planning Policy	11
3.4.4 Thames Estuary 2100	12
3.5 Flood Risk Compatibility	12
3.6 Sequential Test	12
3.7 Exception Test.....	13
4.0 Assessment of Flood Risk.....	14
4.1 Potential Sources of Flooding.....	14
4.1.1 Flooding from Sea or Tidal Flooding.....	14
4.1.2 Flooding from Rivers or Fluvial Flooding.....	16
4.1.3 Flooding from Infrastructure Failure.....	16
4.1.4 Flooding from Surface Water or Pluvial Flooding	18

4.1.5 Flooding from Groundwater	20
4.1.6 Flooding from Sewers.....	20
4.1.7 Flooding from Reservoirs, Canals and other Artificial Sources	21
4.2 Flood Risk Summary	21
4.3 Flood Zone	21
5.0 Climate Change	23
Sea Level Change.....	23
6.0 Conclusions	24
6.1 Flood Risk	24

Tables in Text

Table 2-1: BRM 2023 GIR borehole strata description summary	7
Table 3-1 Flood Risk Vulnerability and Flood Zone ‘Compatibility’	12
Table 4-1: Infrastructure Failure Sampled Point Data Summary for Flood Elevation, Depth and Velocity for 0.5% and 0.1% AEP.	18
Table 4-2: Groundwater Monitoring Data.....	20
Table 4-3: Potential Sources of Flooding	21
Table 5-1 Sea level allowances by river basin district for each epoch in mm for each year (based on a 1981 to 2000 baseline)	23

Figures in Text

Figure 1-1: Site Location Plan	2
Figure 1-2: Extract of the Environment Agency Flood Maps for Planning	3
Figure 2-1: Satellite Imagery	4
Figure 2-2: Digital Terrain Model at the Site	5
Figure 4-1: Environment Agency Infrastructure Failure Point Sample Locations.....	16
Figure 4-2: Environment Agency Surface Water Flood Risk Map	19

Appendices

Appendix A	BRM Facility Drainage Layout Plan
Appendix B	Development Layout Plan
Appendix C	Flood Gate Location Plan
Appendix D	Building Elevations
Appendix E	Groundwater Monitoring Borehole Location Plan
Appendix F	Sea Level Rise Calculations

Acronyms and Abbreviations

AEP	Annual Exceedance Probability
AoD	Above Ordnance Datum
BGL	Below Ground Level
BRM	Britannia Refined Metals
BS	British Standards
CIRIA	Construction Industry Research and Information Association
DS	Drainage Statement
EA	Environment Agency
FRA	Flood Risk Assessment
GBC	Gravesham Borough Council
GIS	Geographic Information System
LFWMS	Local Flood Water Management Strategy
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
MAGIC	Multi-Agency Geographic Information for the Countryside
NGR	National Grid Reference
NPPF	National Planning Policy Framework
PPG	Planning Practice Guidance
BRM	BRM Consulting Limited
SoP	Standard of Protection
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
TE2100	Thames Estuary 2100
WFD	Water Framework Directive

1.0 Introduction

1.1 Terms of Reference

Britannia Refined Metals (BRM) has been advised to prepare a Flood Risk Assessment (FRA) to support a planning application for the development of a proposed Lead Storage building, situated at BRM, Botany Road, Northfleet, Gravesend, DA11 9BG.

Reporting has been completed in accordance with guidance presented within the National Planning Policy Framework¹ (NPPF) and its associated Planning Practice Guidance² (PPG), taking due account of current best practice documents relating to assessment of flood risk published by the Construction Industry Research and Information Association (CIRIA)³, the British Standards Institution BS8533⁴ and the Environment Agency's (EA) National Standing Advice on Development and Flood Risk⁵.

1.2 Administrative Context

The Site falls under the planning jurisdiction of Gravesham Borough Council who are the Local Planning Authority (LPA) and Kent County Council who acts as the Lead Local Flood Authority (LLFA).

1.3 Site Location

The Site, which covers an area of approximately 550m², is situated within the south section of the wider BRM site and will be situated adjacent to the Silver Processing building. The application area is situated close to the site boundary between BRM & Seacon. The Site is centered at National Grid Reference (NGR) TQ 61401 75307, as shown in Figure 1-1.

1 National Planning Policy Framework: Communities and Local Government (Updated December 2023)

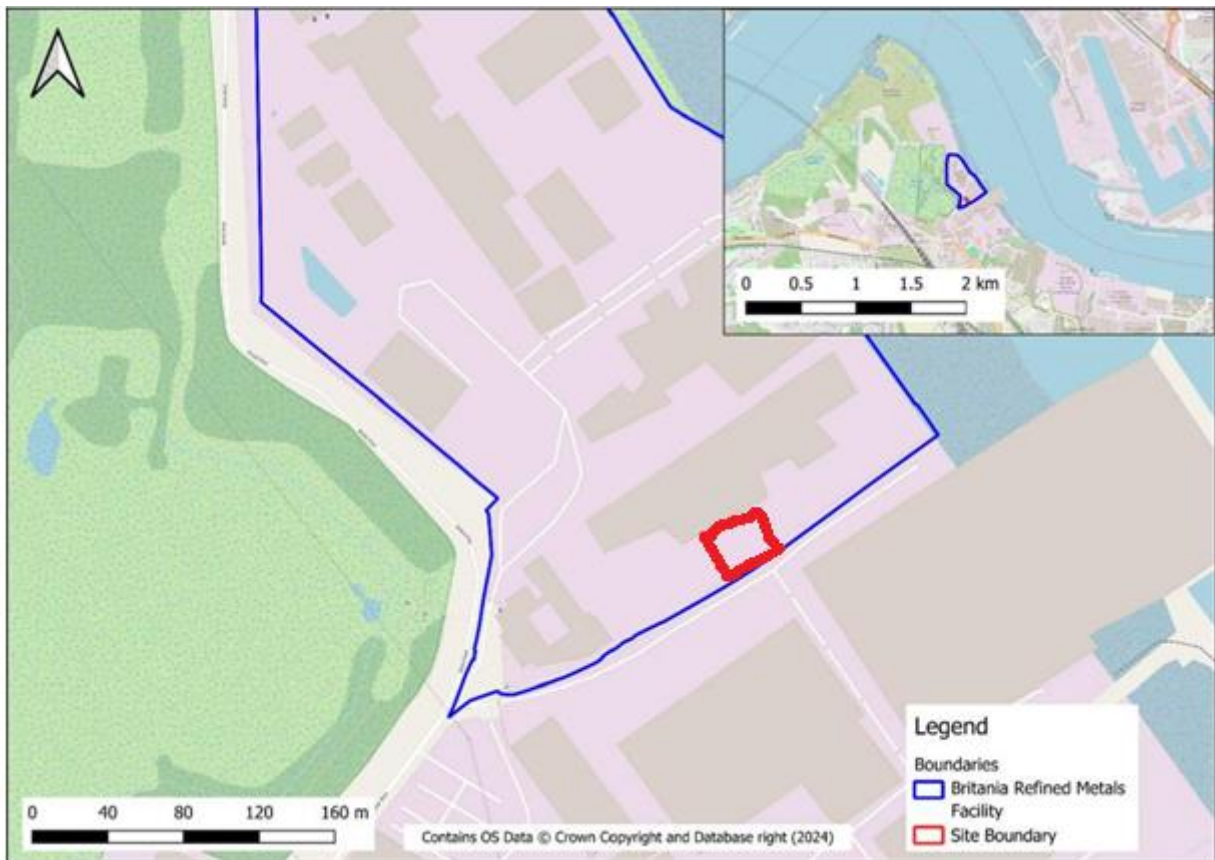
2 Planning Practice Guidance: Communities and Local Government (Updated July 2021)

3 CIRIA Report C624, Development and flood risk – guidance for the construction industry (October 2004)

4 BS8533:2017, Assessing and managing flood risk in development: Code of Practice (December 2017)

5 Department for Environment, Food & Rural Affairs and Environment Agency (2015). Flood risk assessment: local planning authorities, <https://www.gov.uk/guidance/flood-riskassessmentlocal-planning-authorities>

Figure 1-1: Site Location Plan

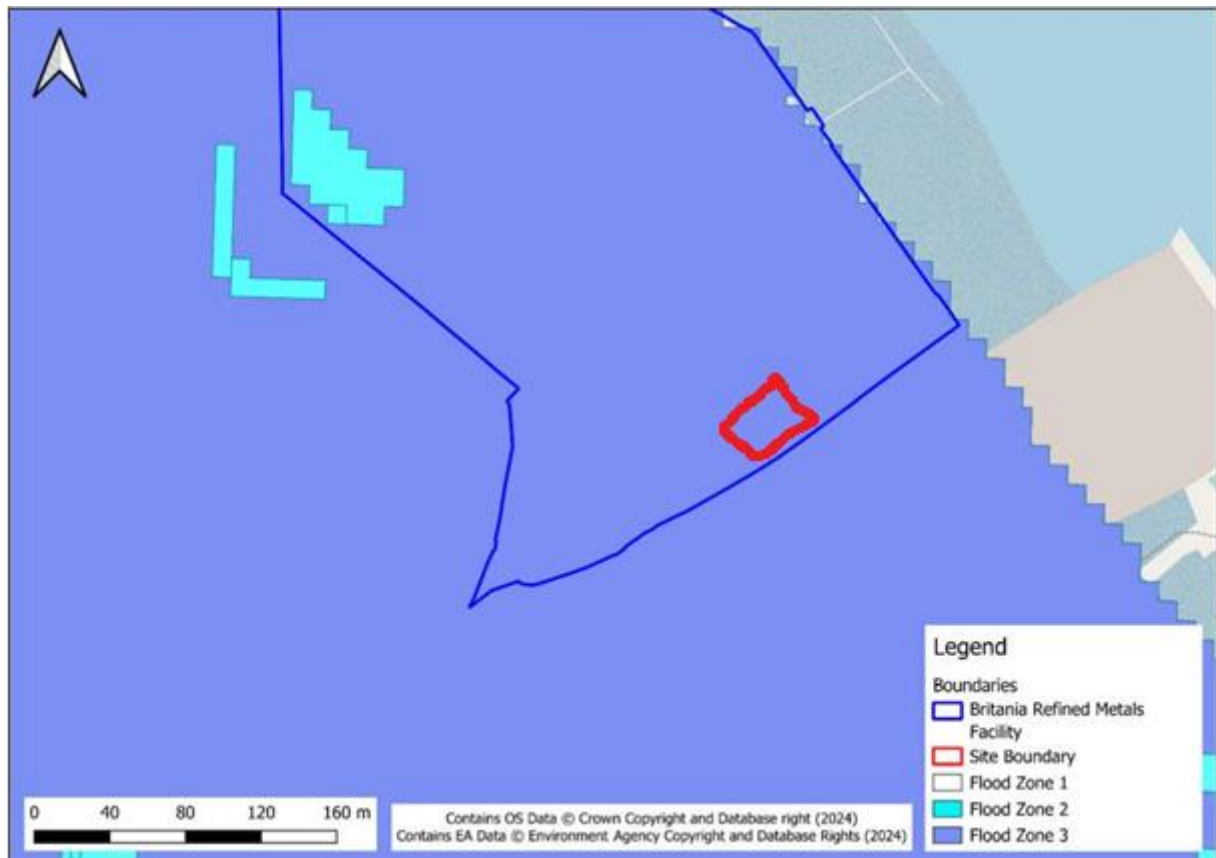


1.4 Background and Aims

With reference to the Environment Agency's *Long-Term Flood Risk*⁶, the Site lies within an area considered to be at risk of fluvial and/or tidal flooding. An extract of the Flood Map for Planning is provided by Figure 1-2.

6 Government Digital Service <https://flood-map-for-planning.service.gov.uk> (Accessed: 23 June 2024)

Figure 1-2: Extract of the Environment Agency Flood Maps for Planning



The Site is situated within Flood Zone 3, indicating that, without flood defenses, the annual probability of fluvial flooding is greater than 1% Annual Exceedance Percentage (AEP), while tidal flooding would be at least 1 in 200 or 0.5% AEP.

2.0 Site Details

2.1 Existing Site Description

The Site is situated within an existing metal processing facility operated by BRM on the south bank of the River Thames. The Site is a brownfield industrial estate comprising of material processing plants and ancillary infrastructure.

To the west of the Site lies undeveloped low laying marshland which is a designated Site of Special Scientific Interest (SSSI). There is another industrial estate consisting of warehouses and dockyards within the Northfleet Industrial Park to the south; other neighboring companies include sheet metal solutions; the London Bus Company; B & W Products; and Brett Aggregates & Brett Concrete.

The Site is accessed via Manor Way, which provides access to BRM and neighboring industrial areas to the north. Manor Way connects to Lower Road to the south, which then joins to the A226 which provides access to the wider national road network.

The area northeast of Manor Way is the working BRM metals recovery site, whilst the southwest includes an area of green space which is part of the wider Swanscombe Peninsula SSSI and under the ownership of the applicant.

Figure 2-1: Satellite Imagery



2.2 Topography

The EA have collected and compiled a Light Detection and Ranging (LiDAR) database for the UK⁷. LiDAR is an airborne mapping technique to measure distance between the land surface and the aircraft. The data has been used to generate 0.5m contours, as shown in Figure 2-2.

Figure 2-2: Digital Terrain Model at the Site



The wider BRM facility is located on a roughly levelled area of land raised above the River Thames at varied elevations. The Site is situated on a flat area at an approximate elevation of 3.80m above Ordinance Datum (AoD). The immediate area to the northeast consists of foundations with a ramp access, elevated to a range between 4.00 – 4.35m AoD. A depression exists at 3.00m AoD immediately to the southwest of the Site.

The data additionally highlights a raised embankment located on the west side of Manor Way. It is assessed that the embankment is raised by approximately 3.0m above nominal levels at the Swanscombe Peninsula to the west.

⁷ Environment Agency, LiDAR database, <http://environment.data.gov.uk> (Accessed 25 June 2024)

2.3 Hydrological Context

2.3.1 Local Hydrology

The Site is located 170m inland of the south bank of the River Thames, a designated EA Main River⁸, which is tidally influenced adjacent to the Site.

The large area of marshlands to the west of the BRM facility is located on the Swanscombe Peninsula and consists of an extensive network of surface water ponds, wetlands and ditches. The area is well drained through the Swanscombe Marsh Outfall operated and maintained by the EA. The outfall is outfitted with inspection chambers, control grates and non-return flap valves⁹.

The River Thames exerts a tidal influence on the area, leading to periodic inundation of the marshlands. Adjacent the BRM facility to the west is an area known as Botany Marshes.

2.3.2 Site Drainage

The existing BRM facility surface water drainage consists of a series of privately owned attenuation lagoons, land drains and surface water drainage networks. EA asset database information indicates that there are flood gates and pump stations along the south bank of the River Thames.

Existing surface water drainage plans, provided in Appendix A, indicate that the network conveys flows from a series of downpipes gullies. Due to runoff potentially mobilizing harmful contaminants, the facility is split into 'Surface Water Contained' and 'Surface Water Outflow' catchments.

'Surface Water Outflow' discharges into the Southern Water¹⁰ foul sewer network located offsite to the southwest within Manor Way.

'Surface Water Contained' discharges rainwater into raised attenuation lagoons located within the BRM facility 200m northwest and 390m to the north of the Site.

There is an open channel drain adjacent to the 200m northwest lagoon. This drain runs north around the western and northern perimeter of the BRM facility before it discharges to the River Thames.

2.4 Geological and Hydrogeological Context

2.4.1 Geology

Published British Geological Survey (BGS) online geology maps¹¹ indicate that the Site is situated upon superficial geology consisting of *Alluvium – Clay, Silt, Sand and Peat*. The bedrock geology consists primarily of sedimentary *Lewes Nodular Chalk Formation, Seaford*

8 Designation of 'main rivers': guidance to the Environment Agency (Accessed 24 June 2023), <https://www.gov.uk/government/publications/designation-of-main-rivers-guidance-to-the-environment-agency/designation-of-main-rivers-guidance-to-the-environment-agency>

9 Environment Agency, (2024). Asset Management (Updated March 2024). Available from: Item: /asset-management/id/asset (data.gov.uk) (Accessed: 8 July 2024)

10 Kent County Council, (May 2013) Thameside Stage 1 Surface Water Management Plan. (Accessed: 24 June 2024).

11 British Geological Survey, Geoindex (Accessed: 24 June 2024), <https://mapapps2.bgs.ac.uk/geoindex/home.html>

Chalk Formation And Newhaven Chalk Formation (Undifferentiated). The BGS mapping also indicates the presence of made ground at the site location.

A ground investigation report (GIR) has been completed by BRM in July 2023 to identify geological strata. Works included 2No. dynamic sampling boreholes with rotary follow on to 30.0m below ground level (bgl) boreholes. A summary of the encountered strata has been provided in Table 2-1.

Table 2-1: BRM 2023 GIR borehole strata description summary

Ground Type	Fomation and Description	Depth Range (m bgl)
Hardstanding	Concrete - Hardstanding with 1 – 2cm rebar	Ground level – 0.6
Made ground	Made Ground - Very soft to firm black/greyish brown/dark grey slightly gravelly sandy clay. Loose to medium dense dark grey sandy gravel, Anthropogenic slag, glass flint concrete, brick.	0.6 – 3.50
	Reworked Clay - Very soft to firm dark grey/brown clay	1.30- 3.50
Superficial deposits	Alluvium - Very soft to soft silty clay. Occasionally gravelly with flint. Occasionally with organic atter and wood.	3.50 – 13.50
	Peat - Soft dark brown spongey peat with frequent wood and organic matter.	6.50 – 12.80
	Boyn Hill Gravel Member - Very loose to very dense orangeish/yellowish/greyish brown, brown, multicoloured sandy gravel of flint / gravelly sand.	13.10 – 22.50
Solid Deposit	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) Structureless, weak, low to medium density.	21.70 – 30.0

2.4.2 Hydrogeology

A review of the online MAGIC mapping¹³ indicates that the bedrock at the Site is designated by the EA as 'Principal' aquifer, defined as: *'... units that are highly permeable and have significant water storage capacity. They can provide water on a large scale and are important for groundwater supply and base flow to rivers...'*

The Site falls within the West Kent Daren and Cray Chalk groundwater water body catchment under the Water Framework Directive (WFD).

Superficial geologies are classified as 'Secondary (undifferentiated)', defined as: *'... those that do not fall neatly into either the secondary A or B categories. These aquifers may consist of mixed lithologies with variable permeability. They are typically less productive than principal aquifers but can still provide useful amounts of groundwater locally.'*

¹³ Defra, MAGIC Map, <http://magic.defra.gov.uk/MagicMap.aspx> (Accessed: 24 June 2024)

The Site is situated within a Source Protection Zone (SPZ) 2. An SPZ 3 is located approximately 1.12km southeast of the Site. The groundwater within the bedrock strata is classified as medium - high vulnerability.

3.0 Development Proposal

3.1 Proposed Development

The proposed Lead Storage building would consist of a Covered storage building, situated adjacent to the Silver Preparation Building. The Silver Preparation Building houses furnaces and grinding/milling equipment, hence the need for the Lead Storage building. The proposed building will lie to the southeast of the Silver Preparation Building. A proposed development layout plan has been provided in Appendix B.

The footprint of the Lead Storage building would be 21.7m long by 25.4m wide, giving an area of 550m².

The Lead Storage Building will accommodate 4T blocks stacked 3 high across the bulk of the floor space. In order to allow a circular route around the main silver processing plant the building will have high-speed roller doors on either elevation to allow vehicular traffic to pass through as and when required. These doors will be protected by flood gates to be installed by a specialist company. The personnel doors will also be flood doors to prevent water ingress into the building causing damage to products & allow fine particles to be washed out into the effluent drain system.

3.2 Anticipated Lifetime of Development

The anticipated lifetime of the development is 20 years; therefore, the development has been assessed up to 2044.

3.3 Flood Risk Vulnerability

With reference NPPF¹: *Flood risk vulnerability classification* at PPG² Annex 3, Developments such as E – Waste Processing are classified as:

Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as ‘Essential Infrastructure’.)

The development is located within the BRM facility adjacent the River Thames and is in Flood Zone 3. The development is required to operate in this location which is considered a ‘water side location’ and is therefore classed as ‘*Essential Infrastructure*’.

3.4 Planning Context

3.4.1 National Planning Policy

This FRA report has been completed in accordance with the guidance presented in the NPPF¹ and with reference to PPG². The NPPF states that Local Plans should be supported by a Strategic Flood Risk Assessment (SFRA)¹⁴, and develop policies to manage flood risk

¹⁴ Gravesham Borough Council, (October 2020). GRAVESHAM WATER AND FLOOD RISK Background paper. (Accessed: 28 June 2024)

from all sources taking account of advice from the EA. It is crucial that Local Planning Authorities consider the risks posed by flooding within their boundary when determining planning applications.

3.4.2 County Planning Policy

Kent County Council, as the LLFA for the area, aims to ensure that new developments are planned with flood risk in mind, promoting sustainable flood risk management practices through their Local Flood Water Management Strategy¹⁵ (LFWMS).

The strategy focuses on improving the safety and well-being of Kent's residents, protecting the local economy from flooding impacts, and ensuring effective collaboration among authorities. It emphasizes the use of natural processes where appropriate and aims to make Kent more resilient to flooding through sustainable techniques and informed planning decisions. The strategy also aims to empower residents to understand and manage their own flood risks.

OBJECTIVE 1: UNDERSTANDING RISK

Risk management authorities have a clear understanding of flood risk.

Risk Management Authorities in Kent have a clear understanding of local flood risk mechanisms, risks and management opportunities and this understanding is shared with partners to create an evidence base for flood risk and how it can be managed to ensure we target resources where they are most effective.

OBJECTIVE 2: REDUCING THE RISK OF FLOODING People

and businesses in Kent are protected from flooding

To protect the people and businesses of Kent from flooding through the delivery of flood risk management projects and programmes using new or innovative techniques where appropriate

OBJECTIVE 3: RESILIENT PLANNING

Development planning in Kent contributes to effective flood risk management

Development and spatial planning in Kent take account of flood risk issues and plans to effectively manage any impacts.

OBJECTIVE 4: RESILIENT COMMUNITIES

Communities are supported to be resilient and empowered to take a proactive role in their flood risk management

Residents and businesses of Kent have access to appropriate data and information to understand flood risk in their area, how it is managed and by whom. Emergency plans are in place for flood vulnerable communities. Communities and individuals are empowered to act to protect themselves from flooding through individual efforts, partnerships and joint working

¹⁵ Kent County Council (2017), Kent Local Flood Risk Management Strategy, <https://documents.hants.gov.uk/flood-water-management/local-flood-water-management-strategy.pdf>

3.4.3 Local Planning Policy

The Gravesham Local Plan Core Strategy 2014¹⁶ sets out the planning framework for the borough to deliver sustainable development. The planning policies related to flood risk and drainage are considered in determination of planning application approval. The policies relating to flood risk and climate change are outlined below:

Policy CS18: Climate Change

Flood Risk

5.14.36 With the exception of the previously developed sites along the Thames Riverside (see Policies CS03, CS04 and CS05) and those other regeneration sites which have already been evaluated in accordance with the sequential and exception tests at the application stage, development will be directed sequentially to those areas at least risk of flooding.

5.14.37 Proposals in areas at risk of flooding must be accompanied by a Flood Risk Assessment (in accordance with national policy and Environment Agency standing guidance as appropriate) and a Flood Risk Management Plan (if required) to demonstrate that they are adequately defended and safe over their lifetime. Planning permission will be refused for schemes which do not pass the sequential and exceptional tests.

5.14.38 The Council will priorities the maintenance, improvement or replacement of flood defense infrastructure over other land uses where relevant. In addition to meeting their own flood defense and management needs, the Council will expect new development to take advantage of opportunities to reduce the causes and impacts of flooding from all sources where it is technically and financially feasible.

Water Quality

5.14.39 As part of its approach to climate change and environmental improvement, the Council will have regard to the delivery of the Water Framework Directive and associated Thames River Basin Management Plan objectives to support water bodies being progressively improved to “good” status over the plan period.

Sustainable Drainage and Surface Water Run-Off

5.14.40 The Council will seek to minimize the impact of drainage from new development on waste water systems. In particular, the Council will:

- Require that surface water run-off from all new development has, as a minimum,*
- No greater adverse impact than the existing use; and*
- Require the use of Sustainable Drainage Systems on all developments where*
- Technically and financially feasible.*

¹⁶ Gravesham Borough Council (2014) Gravesham Local Plan Core Strategy Local Plan Core Strategy. Available from: <https://www.gravesham.gov.uk/local-plan-policy/local-plan#Gravesham%20Local%20Plan%20CORE%20Strategy#:~:text=The%20Local%20Plan%20Core%20Strategy>

3.4.4 Thames Estuary 2100

Thames Estuary 2100 (TE2100), produced by the EA, is a long-term plan split into epochs to strategize climate adaptation of the Thames Estuary to protect people and property the following flood risks:

- High tides
- Storm surges
- Heavy rainfall

The Site falls under Swanscombe & Northfleet, Policy 4 (P4), defined: “*take further action to keep up with climate and land use change so that flood risk does not increase*”.

Updates to the TE2100 indicate that the delivery of the plan will incorporate more partners in the future, including developers.

3.5 Flood Risk Compatibility

As discussed at Section 3.3 the proposed development is classified as a ‘*Essential Infrastructure*’ and has been assessed to lie in Flood Zone 3a.

Therefore, with reference to *Table 2: Flood risk vulnerability and flood zone ‘incompatibility’* at PPG Paragraph 078 (reproduced as Table 3-1), the proposed development would be considered an ‘appropriate’ form of development.

Table 3-1 Flood Risk Vulnerability and Flood Zone ‘Compatibility’

Flood Risk Vulnerability Classification (PPG Table 2)		Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone (PPG Table 1)	Zone 1	I	I	I	I	I
	Zone 2	I	Exception Test Required	I	I	I
	Zone 3a	Exception Test Required	x	Exception Test Required	I	I
	Zone 3b (functional floodplain)	Exception Test Required	x	x	x	I

Key: I Development is appropriate x Development should not be permitted

3.6 Sequential Test

NPPF Paragraph 162 advises that the aim of the Sequential Test is to ‘*steer new development to areas with the lowest risk of flooding from any source*’. Furthermore, it states:

‘Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding.’

The *Flood Map for Planning (Rivers and Sea)*⁵ as seen in Figure 1-2 and the local flood risk modelling to provide the basis for applying this test. The Site is located entirely within Flood

Zone 3 (i.e., Land having a 1% or greater annual probability of river flooding; or Land having a 0.5% or greater annual probability of sea).

The proposed development is a Lead Storage building, on a total site area is 550m². The building will be ancillary to and essential to the efficient operation of the Silver Preparation Building.

As the proposed development falls within the definition of a 'non-major development' i.e. a small, non-domestic extension where the floor space created by the development does not exceed 550m², it is exempt from the sequential test. Furthermore, the proposed development is located within the Northfleet Embankment and Swanscombe Peninsula East Opportunity Area and is consistent with the site's allocated use i.e. the metal refinery.

It has therefore been deemed that the Sequential Test has passed.

3.7 Exception Test

The Exception Test is required to show that the sustainability benefits of the proposed development to the community outweigh the flood risk. The Exception Test must also show that the development will be safe for its lifetime and will not increase the flood risk elsewhere.

The NPPF¹ states that where it is not possible for a development to be in an area of lower flood risk, the Exception Test may have to be applied. The Flood Risk Vulnerability Classification set out in the NPPF confirms that essential infrastructure in flood zones 3a and 3b will need to pass the Exception Test.

The purpose of the proposed storage building is to house by-products awaiting processing and also to house some products awaiting shipping to clients after processing through the silver plant.

In addition to enabling BRM to meet their required Lead Storage standards, the proposed development is considered to be in accordance with the aim of achieving sustainable development, as it will contribute to the continuing, successful operation of the BRM site, which is a significant employer in this area.

In line with the NPPF, the proposed development would be located on a brownfield site, within a much larger, established industrial site, and will be ancillary to existing operations on that site. The proposed development comprises plant. There are no habitable or office spaces within the building, nor any welfare facilities.

In the event of residual flood risk from the River Thames, the BRM facility operates with an early flood warning system and Evacuation Plan which has been provided in Appendix C. Under extreme scenarios, flood gates will protect the development from inundation.

On this basis, it is deemed that the Exception Test has been passed.

4.0 Assessment of Flood Risk

This report has been prepared in accordance with the advice and requirements prescribed in current best practice documents relating to management of flood risk in development published by the Construction Industry Research and Information Association (CIRIA)¹⁷ and The British Standards Institution (BSI) BS8533⁴⁴.

A screening study has been completed to identify whether there are any potential sources of flooding at the Site which may warrant further consideration. If required any potential flooding issues identified in the screening study would then be considered in subsequent sections of the assessment.

4.1 Potential Sources of Flooding

There are a number of potential sources of flooding, and these include:

- Flooding from rivers or fluvial flooding;
- Flooding from the sea or tidal flooding;
- Flooding from surface water or pluvial flooding;
- Flooding from groundwater;
- Flooding from sewers;
- Flooding from reservoirs, canals, and other artificial sources; and
- Flooding from infrastructure failure.

The flood risk from each of these potential sources is discussed below.

4.1.1 Flooding from Sea or Tidal Flooding

The Site is located adjacent to the tidally influenced River Thames¹⁴, as confirmed by the EA in a data request provided in Appendix C. This information has been supplied in Geographic Information System (GIS) format from the TE2100 hydraulic modelling study. The data was analyzed concerning the development, alongside supporting information regarding coastal defenses and modelling parameters.

The EA flood mapping shown Figure 1-2 places the site in Flood Zone 3. This indicates that if flood defenses were not present, the annual probability of tidal flooding would be greater than 1 in 200 (0.5% AEP).

The Site is not located within EA TE2100 Designated Flood Storage Areas¹⁸.

4.1.1.1 Flood Defenses

Flood defenses maintained by the EA⁹ are present 170m northeast of the Site. These defenses are tidal walls providing standard of protection (SoP) for up to and including the 1

¹⁷ CIRIA Report C624, Development and flood risk: guidance for the construction industry

¹⁸ Environment Agency (June 2024) Thames Estuary 2100 Flood Storage areas.
<https://www.data.gov.uk/dataset/b25962d1-e8b7-4d2a-a287-106c300d7ac0/thames-estuary-2100-flood-storage-areas> (Accessed: 11 July 2024).

in 1000-year (0.1% AEP) event. The wall is raised to an effective crest level of 6.75 m AoD and is in 'fair' condition¹⁹.

The area falls within Policy 4 of the TE2100 which requires defenses to “*keep up with climate and land use change so that flood risk does not increase.*” Therefore, asset owners are required to work with the EA and LPA to have ensure sufficient SoP is provided by defenses by 2040.

Appendix C shows how defenses along the Thames Estuary are to respond to increasing tidal risk overtime because of climate change. In line with Policy 4 for Swanscombe and Northfleet, flood defenses by 2040 are expected to have provide effective crest levels of 7.00m so that flood risk at the Site does not increase when accounting for climate change.

4.1.1.2 Swanscombe Peninsula

It was assessed that the Swanscombe Peninsula, and by extension Botany Marshes, is a floodplain that has potential to be inundated by the River Thames during high tides. With reference to Section 2.2, the Site benefits from embankments raised c3.0m above the Botany Marshe ground levels which separating the BRM facility. It is not identified as a formal flood defense asset in the EA Asset database²⁰.

The Flood Map for Planning therefore overrepresents flood risk from the peninsula at the Site because the mapping does not account for existing defenses in the area and instead represents a natural floodplain extent. The peninsula has a perimeter earth embankment at a crest level of 8.8m AoD, providing a 1 in 1000-year (0.1% AEP) SoP from the Thames 750m to the northwest. By extension, this embankment offers protection to Botany Marshes.

EA asset mapping of Swanscombe Marsh identifies a 'Main Drain' and outfall to the Thames equipped with a penstock control gate. It is considered that the area is well-drained, and water levels are not expected to exceed 3m in depth where it may overtop the raised embankment and ingress the Site.

4.1.1.3 Flood Level Data

Flood level data taken at TE2100 Extreme Water Level²¹ node: 3.27 (NGR: TQ 62089 75409), a current day 1 in 200 annual probability (0.5% AEP) flood level of 5.85m AoD is anticipated.

The current day tide level for the 1 in 200 annual probability (0.5% AEP) flood is therefore lower than the current day crest of the wall adjacent the Site by 0.9m. As such direct over topping from tides is unlikely.

Additionally, flood risk from Botany Marshes is considered low due to the significant protection provided by two earth embankments from the Swanscombe Peninsula and Botany Marshes.

Therefore, Flood risk from this source is considered high but the development is protected by well-maintained flood defenses. Residual flood risk from this source would therefore occur under exceptional scenarios.

¹⁹ Environment Agency, (2024). Asset Management (Asset ID: Wall: 127260) (Updated March 2024). Available from: <https://environment.data.gov.uk/asset-management/id/asset/127260> (Accessed: 27 June 2024)

²⁰ Environment Agency, (2024). Asset Management (Updated March 2024). Available from: [Item: /asset-management/id/asset \(data.gov.uk\)](https://environment.data.gov.uk/asset-management/id/asset/127260) (Accessed: 8 July 2024)

²¹ Environment Agency, Thames Estuary 2100 Extreme Water Level nodes (updated June 2024) <https://www.data.gov.uk/dataset/69728968-613b-445d-9e6d-de854c0af461/thames-estuary-2100-extreme-water-level-nodes#licence-info> (Accessed: 8 July 2024)

4.1.2 Flooding from Rivers or Fluvial Flooding

The primary flood risk to the Site is from tidal sources as confirmed by the EA. The tidal reach of the River Thames extends to Teddington Weir, located 44km west of the Site where extreme tide surges are controlled up to the Thames Barrier 22km to the west.

The barrier serves to protect London from tidal surges from the North Sea. Its operation coordinates both upstream fluvial flow with tide surges to reduce coincidental extreme flood risk upstream and downstream.

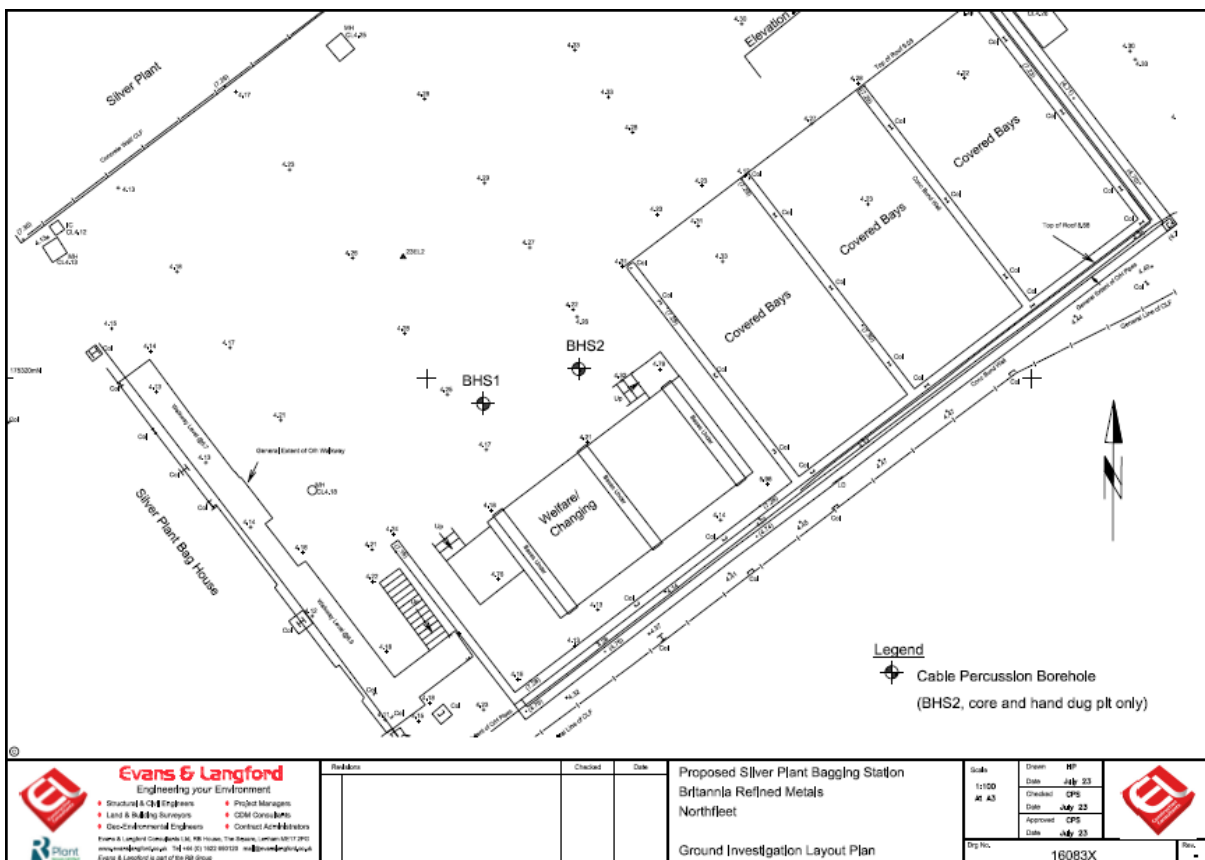
On this basis the flood risk from river or fluvial flooding is assessed to be low.

4.1.3 Flooding from Infrastructure Failure

During an extreme tidal flood event, over topping of the flood defenses is possible. Such overtopping would significantly increase the potential for scour and erosion of flood embankments, and this could result in major breaches through which significant quantities of flood water would enter the Site.

Model output data from the Thames Tidal Downriver Breach Inundation Modelling 2018²² was used to perform a detailed analysis of infrastructure failure at the Site in line with Product 6 guidance provided by the EA. Outputs were sampled using GIS software to derive hazard information at specific locations for the Site. Samples were taken from the points shown in Figure 4-1, with the results produced in Table 4-1.

Figure 4-1: Environment Agency Infrastructure Failure Point Sample Locations



²² Environment Agency (May 2018) Thames Estuary Breach Assessment Thames Barrier to Gravesend and Linford Methodology Report. [Accessed: 08 July 2024].

Table 4-1: Infrastructure Failure Sampled Point Data Summary for Flood Elevation, Depth and Velocity for 0.5% and 0.1% AEP.

Year	Sample		Node 1	Node 2
2115	Elevation (m AoD)	0.5% AEP	5.12	5.15
		0.1% AEP	5.60	5.60
	Depth (m)	0.5% AEP	1.32	1.43
		0.1% AEP	1.80	1.87
	Velocity (m/s)	0.5% AEP	0.63	0.61
		0.1% AEP	0.68	0.64
2005	Elevation (m AoD)	0.5% AEP	4.79	4.79
		0.1% AEP	4.92	4.93
	Depth (m)	0.5% AEP	0.993	1.06
		0.1% AEP	1.12	1.20
	Velocity (m/s)	0.5% AEP	0.62	0.61
		0.1% AEP	0.63	0.64

The Site is located 160m from the nearest modelled breach to the northeast. Should a breach failure occur, the site would be inundated quickly with depths that exceed 1.32m in year 2115. This reflects significant hazard to site personnel.

The BRM facility has a series of on-site flood gates and emergency procedures in the event of flood defense failure which protects 'Employee Work Areas' as shown in Appendix C. The development shall be incorporated into the existing arrangement to ensure safe refuge is immediately available for site personnel and flood gates mitigate risk of inundating sensitive assets.

The modelled data reflect a worst-case scenario where defenses fail suddenly. The BRM facility is regularly staffed where defenses are routinely monitored for defects. The likelihood of a breach failure is considered relatively low and effectively mitigated from existing emergency procedures in-place at the Site.

The probability of flood risk from this source is considered low due to ongoing maintenance and the condition of defenses. However, should failure occur the Site would be directly impacted.

4.1.4 Flooding from Surface Water or Pluvial Flooding

The Site is located on levelled hardstanding. Topographic data suggests that surface water runoff from the wider BRM facility would flow from the northeast to the southwest. Surface water runoff is anticipated to temporarily pond in nearby depressions adjacent the Site. The area immediately around the Site benefits from a surface water drainage network.

Appendix E shows the finished floor level of the development with the new flood gate positions shown. However, the drainage pathway is expected to flow around the development before continuing on its natural course.

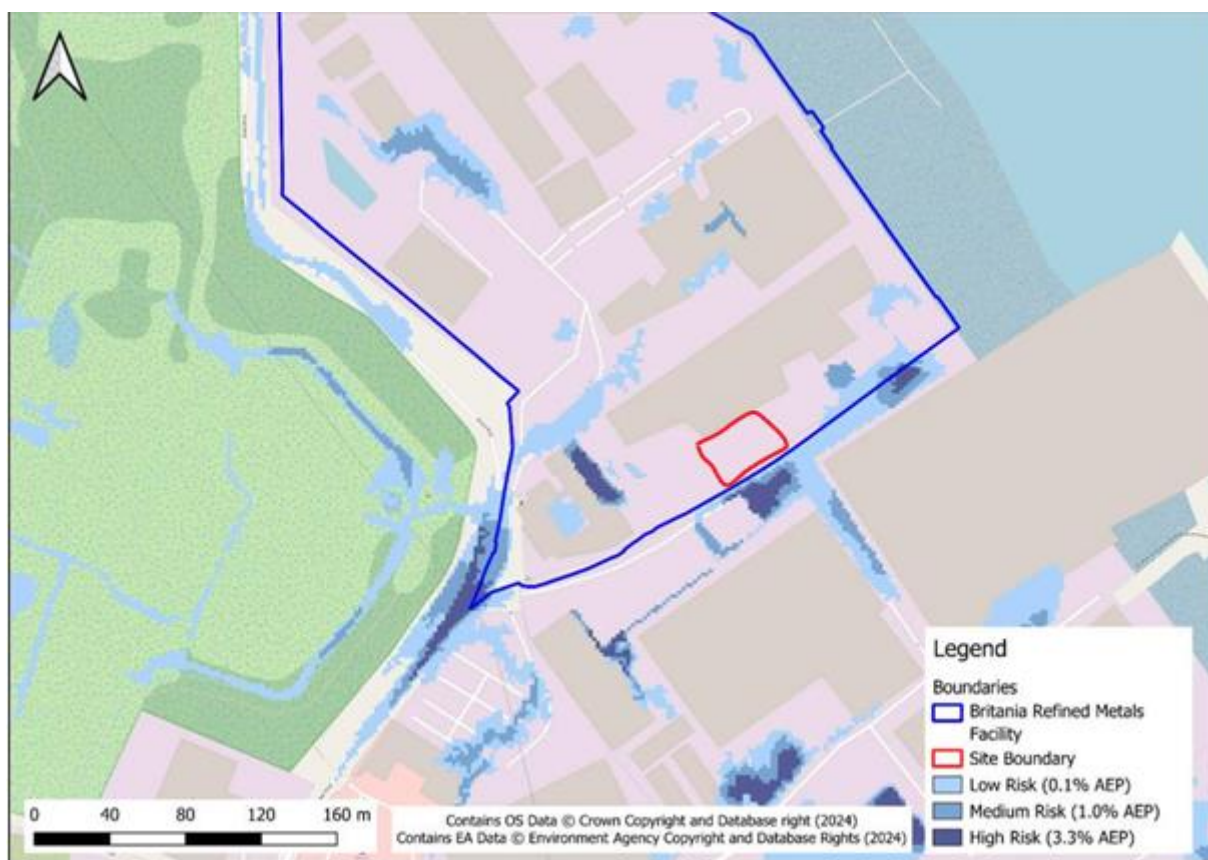
It is considered that there will be no significant loss of flood storage for the design 1.0% AEP event, and flood risk downstream is not expected to increase.

An extract from the *Long-Term Flood Risk Information*²³ mapping showing areas potentially at risk of flooding from surface water has been provided as Figure 4-2.

The surface water flood risk categories are defined as:

- **Very Low:** less than 1 in 1,000 (0.1% AEP) chance of flooding in any given year;
- **Low:** less than 1 in 100 (1% AEP) but greater than or equal to 1 in 1,000 (0.1% AEP) chance of flooding in any given year;
- **Medium:** between 1 in 100 (1% AEP) and 1 in 30 (3.3% AEP) chance of flooding in any given year; and
- **High:** greater than 1 in 30 (3.3% AEP) chance of flooding in any given year.

Figure 4-2: Environment Agency Surface Water Flood Risk Map



With reference to Figure 4-2, the Site is predominantly at a 'low risk' of surface water flooding. The conceptual understanding of the drainage arrangement was therefore confirmed as ponding is shown to occur to the southwest in the nearby depression. These areas are expected to drain via sewer networks or follow existing drainage pathways away from the Site to the southwest.

Flooding from surface water is therefore low and not considered further.

²³ Long Term Flood Risk, Government Digital Service (Accessed: 05 July 2024) <https://www.gov.uk/check-long-term-flood-risk>

4.1.5 Flooding from Groundwater

Groundwater flooding can occur where sites are located on permeable ground, particularly where there are significant variations in local topography and geology. After a prolonged period of rainfall and groundwater recharge, a considerable rise in the water table can result in this intersecting the ground surface, resulting in flooding. Due to the slow response of groundwater systems, any resulting flows and inundation could persist for an extended period.

BRM revisited the Site to undertake three rounds of winter groundwater monitoring in 2023¹². The 2No. wells measured the depth to groundwater; a summary of the data is shown in Table 4-1 below. The location of the boreholes is provided in Appendix F.

Table 4-2: Groundwater Monitoring Data

BH Ref	BH Elevation (m AoD)	Borehole Screen Interval (m bgl)	Date	Well Headspace (ppm)	Depth to Water (m)	Groundwater Elevation (m AoD)	Notes
BH2023-01S	3.85	0.5-1.5	20/09/2023	<1	0.83	3.02	Sampled
			02/10/2023	<1	0.83	3.02	
			06/10/2023	<1	0.93	2.92	
BH2023-01D	3.85	14.0-20.0	20/09/2023	<1	3.48	0.37	Sampled
			02/10/2023	<1	3.44	0.41	
			06/10/2023	<1	3.47	0.38	
BH2023-02S	3.79	1.0-3.0	20/09/2023	<1	Dry	-	
			02/10/2023	<1	Dry	-	
			06/10/2023	<1	Dry	-	
BH2023-02D	3.79	13.0-20.0	20/09/2023	<1	1.03	2.76	Sampled
			02/10/2023	<1	1.21	2.58	
			06/10/2023	<1	1.01	2.78	

The data shows that groundwater is limited to 0.83m depth below ground level. The Site is overlain by impermeable 0.58m thick concrete hardstanding and is not considered susceptible to groundwater emergence. The development does not include works that require installation of permanent below ground equipment that would be susceptible to flooding from groundwater.

Flooding from groundwater is therefore low and not considered further.

4.1.6 Flooding from Sewers

Sewer plans provided by the client indicate that there are existing sewers that service the BRM facility. Due to runoff potentially mobilizing harmful contaminants, the facility is split into 'Surface Water Contained' and 'Surface Water Outflow' which discharges into the Southern Water foul sewage network located offsite to the southwest. The drainage arrangements for the Site and BRM facility are included in Appendix A.

Should upstream sewers within the network to the northeast flood, overland flow would be conveyed down gradient towards the Site. Sewer flows are typically shallow and are expected to attenuate in depressions located near the Site.

It is considered that there is insufficient potential for significant flood volumes to risk inundating the Site. The network receives no additional offsite flows and, the final finished floor level of the development is raised by 0.55m above ground level.

Flooding from sewers is therefore low and not considered further.

4.1.7 Flooding from Reservoirs, Canals and other Artificial Sources

The EA's 'Flood Risk from Reservoirs' mapping indicates that the Site is not at risk of flooding in the event of multiple upstream reservoir failures.

The flood risk from these sources is therefore low and is not considered further.

4.2 Flood Risk Summary

A summary of the potential sources of flooding and the flood risk arising from them is presented in **Table 4-3**.

Table 4-3: Potential Sources of Flooding

Potential Source of flooding	Significant Flood Risk at the Site (Y/N)
Rivers or Fluvial Flooding	Low
Sea or Tidal Flooding	High
Surface Water or Pluvial Flooding	Low
Groundwater	Low
Sewers	Low
Reservoirs, Canals and other Artificial Sources	Low
Infrastructure Failure	Low

The Flood Risk Assessment confirms that the primary flood risks at Site are tidal from the adjacent River Thames.

4.3 Flood Zone

The definition of flood zones is provided by *Table 1: Flood zones* at PPG Paragraph 077 and is summarised below:

- *Zone 1 – low probability* (Flood Zone 1). Land having a less than 0.1% annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map for Planning – all land outside Zones 2, 3a and 3b)
- *Zone 2 – medium probability* (Flood Zone 2) Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding. (Land shown in light blue on the Flood Map)
- *Zone 3a – high probability* (Flood Zone 3a) Land having a 1% or greater annual probability of river flooding; or Land having a 0.5% or greater annual probability of sea. (Land shown in dark blue on the Flood Map)
- *Zone 3b – the functional floodplain* (Flood Zone 3b) This zone comprises land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise:
 - o land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or

- o land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding). Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency.

Based on the screening study, the entire site lies within Flood Zone 3. Although the Site benefits from existing defenses that provide a SoP for flood events up to the 1 in 1000-year (0.1% AEP) event from tidal sources, which is considered the primary risk at the Site.

5.0 Climate Change

In July 2021 the EA issued updated guidance on the impacts of climate change on flood risk in the UK²⁴ to support NPPF. This advice sets out that peak rainfall intensity, sea level, peak river flow are all expected to increase in the future as a result of climate change.

The PPG recommends that considerations for future climate change are included in FRAs for proposed developments. Given that the site has only been identified as being at risk of tidal flooding, only consideration of climate change in relation to sea level rise has been included herein.

Sea Level Change

Sea Level Allowances, published by the EA for the 'Thames Basin District' (Southeast), are presented in Table 5-1. This shows the estimated annual uplifts to mean sea level which increase over time.

Table 5-1 Sea level allowances by river basin district for each epoch in mm for each year (based on a 1981 to 2000 baseline)

Area of England	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)
Southeast	Higher Central	5.8 (200)	8.7 (261)	11.6 (348)	13.1 (393)	1.21
	Upper end	7.0 (242)	11.3 (339)	15.8 (474)	18.2 (546)	1.62

Using the baseline of 2018²⁵, the anticipated sea level rise throughout the 20-year anticipated lifetime of development, up until 2044, is 0.18m using the higher central allowance and up to 0.22m using the upper end allowance. A summary of these calculations is provided in Appendix G.

These uplifts are used to predict changes to sea level along coastlines which have been modelled through the EA's Coastal Design Sea Levels²⁶. Where available, the outputs of such modelling should be used in preference to simply uplift base day estimates of extreme flood levels. However, the data provided by the EA did not include defended tidal flood risk modelling for accurate assessment. Therefore, for conservatism, the 'Upper end' allowance has been used using level data provided in Section 4.1.1.3.

Assessing current day TE2100 Extreme Water Levels at 5.85m AoD and applying climate uplift up to 2044 gives an approximate level of 6.07m AoD. Should nearby defenses provide the existing crest level of 6.75m AoD during the 1 in 200 (0.5% AEP) event plus climate

²⁴ Environment Agency, February 2016 (updated October 2021). Flood risk assessments: climate change allowances (Accessed: 10 July 2024) <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

²⁵ Environment Agency, January 2012. (Updated June 2024) Thames Estuary 2100 Extreme Water Level nodes

²⁶ Environment Agency (2018) Coastal Design Sea Levels - Coastal Flood Boundary Extreme Sea Levels (2018) <https://www.data.gov.uk/dataset/73834283-7dc4-488a-9583-a920072d9a9d/coastal-design-sea-levels-coastal-flood-boundary-extreme-sea-levels-2018>

change, there would be a freeboard of 0.68m, which would not reflect significant risk to the Site.

6.0 Conclusions

Britannia Refined Metals (BRM) has been advised to prepare a Flood Risk Assessment (FRA) to support a planning application for the development for a proposed lead storage building, situated at BRM, Botany Road, Northfleet, Gravesend, DA11 9BG. The lead storage building would be ancillary to the operation of the silver Preparation Building.

6.1 Flood Risk

Flood risk has been assessed in line with BS8533⁴ taking account of national and local planning policy and guidance, and all potential sources of flooding to the site have been considered.

A screening assessment reviewed the flood risk posed by sources including fluvial, tidal, surface water, groundwater, sewer, reservoirs, canals and infrastructure failure. It is concluded that the Site is at risk of flooding from the tidally influenced River Thames. However, the Site benefits from the protection of flood defenses.

The Site is located within Flood Zone 3a as the Site benefits from tidal flood defenses for events up to 1 in 1000 (0.1% AEP). The development is classified as 'Essential Infrastructure' and subjected to both the Sequential and Exception Tests. It is concluded that the Site is suitable for development under NPPF and PPG requirements.

Modelling data has been provided by the EA which indicates in-channel flood levels along the River Thames which confirm that the Site will be safe up to 2044 including anticipated increases as a result of climate change.

Site specific infrastructure failure modelling has concluded that, in a highly unlikely event of a breach of the flood defenses, the risk to site personnel would be significant. However, there are already established early flood warning systems and Evacuation Plans for staff to mitigate significant risk. The flood defense assets are routinely monitored and maintained by the EA and BRM and are considered unlikely to fail.

The TE2100 policy zone for Swanscombe & Northfleet intends to monitor and upgrade defenses over time. The Site has therefore shown that it will be safe from flooding for the anticipated 20-year lifetime of the proposed redevelopment.

It is concluded that the development will be safe from all sources of flood risk. Additionally, there will be no adverse off-site impact with respect to flood risk.

Appendix A BRM Facility Drainage Layout Plan

Flood Risk Assessment

Proposed Lead Storage building, at the BRM site in Northfleet, Gravesend, DA11 9BG

Britannia Refined Metals

BRM Project No: 600433664 19

Sept 2024

Appendix B Development Layout Plan

Flood Risk Assessment

Proposed Lead Storage building, at the BRM site in Northfleet, Gravesend, DA11 9BG

Britannia Refined Metals

BRM Project No: 600433664 19

Sept 2024

Appendix C Flood Gate Location Plan

Flood Risk Assessment

Proposed Lead Storage building, at the BRM site in Northfleet, Gravesend, DA11
9BG

Britannia Refined Metals

BRM Project No: 600433664 19 Sept

2024

Britannia Refined Metals
Flood Risk Assessment

19 Sept 2024
BRM Project No: 600433664

Appendix D Building Elevations

Flood Risk Assessment

Proposed Lead Storage building, at the BRM site in Northfleet, Gravesend, DA11 9BG

Britannia Refined Metals

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Sept 2024

Appendix E Groundwater Monitoring Borehole Location Plan

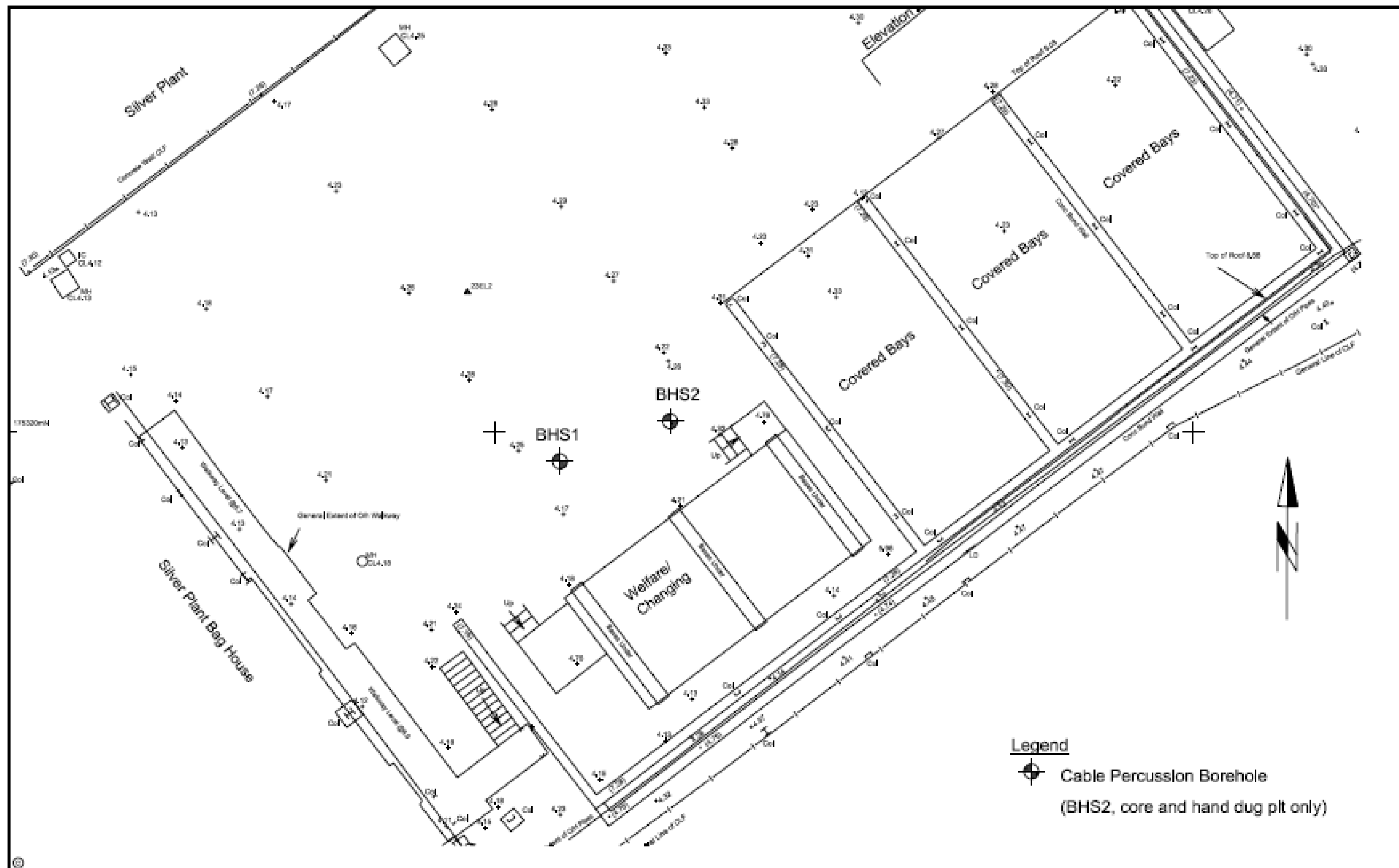
Flood Risk Assessment

Proposed Lead Storage building, at the BRM site in Northfleet, Gravesend, DA11 9BG

Britannia Refined Metals

BRM Project No: 600433664 19

Sept 202



 Evans & Langford Engineering your Environment ✦ Structural & Civil Engineers ✦ Land & Building Surveyors ✦ Geo-Environmental Engineers ✦ Project Managers ✦ CDM Consultants ✦ Contract Administrators  R&I Plant Engineering your Environment Evans & Langford Consultancy Ltd, 8th House, The Square, Lifford, Londonderry BT27 2PD evansandlangford.co.uk Tel: +44 (0) 1622 660122 mail@evansandlangford.co.uk Evans & Langford is part of the R&I Group	<table><tr><th>Revisions</th><th>Checked</th><th>Date</th></tr><tr><td> </td><td> </td><td> </td></tr></table>	Revisions	Checked	Date				Proposed Silver Plant Bagging Station Britannia Refined Metals Northfleet	<table><tr><td rowspan="5">Scale 1:100 At A3</td><td>Drawn</td><td>HP</td></tr><tr><td>Date</td><td>July 23</td></tr><tr><td>Checked</td><td>CPS</td></tr><tr><td>Date</td><td>July 23</td></tr><tr><td>Approved</td><td>CPS</td></tr><tr><td></td><td>Date</td><td>July 23</td></tr></table>	Scale 1:100 At A3	Drawn	HP	Date	July 23	Checked	CPS	Date	July 23	Approved	CPS		Date	July 23	
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Appendix F Sea Level Rise Calculations

Flood Risk Assessment

Proposed Lead Storage building, at the BRM site in Northfleet, Gravesend, DA11 9BG

Britannia Refined Metals

BRM Project No: 600433664 19

Sept 2024

PROJECTED UPLIFT SUMMARY				
	mm to m conversion			1000
CC Allowance Type	Higher Central (m)	Upper End (m)		
	0.18	0.22		

Extreme Sea Level Calculations				
	PPG Table higher central uplift (mm)	Calculated Outcome (mm)	PPG Table upper end uplift (mm)	Calculated Outcome (mm)
2018	N/A	0	N/A	0
2019		5.8	7	7
2020		5.8	7	14
2021		5.8	7	21
2022		5.8	7	28
2023		5.8	7	35
2024		5.8	7	42
2025		5.8	7	49
2026		5.8	7	56
2027		5.8	7	63
2028		5.8	7	70
2029		5.8	7	77
2030		5.8	7	84
2031		5.8	7	91
2032		5.8	7	98
2033		5.8	7	105
2034		5.8	7	112
2035		5.8	7	119
2036		8.7	11.3	130.3
2037		8.7	11.3	141.6
2038		8.7	11.3	152.9
2039		8.7	11.3	164.2
2040		8.7	11.3	175.5
2041		8.7	11.3	186.8
2042		8.7	11.3	198.1
2043		8.7	11.3	209.4
2044		8.7	11.3	220.7

