J840 – STC IED Containment

Bracknell STC – Containment Options Report

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Contents

1. Executive Summary

Thames Water is required by the Environment Agency to provide secondary containment to their sludge treatment centres to satisfy provisions of the Industrial Emissions Directive (IED) and to safeguard the operation of the adjacent sewage treatments works. Twenty-five sludge treatment centres have been identified where containment proposals are required. This report deals with the proposals for Bracknell Sewage Treatment Works (STW).

Bracknell STW serves a population equivalent of 87,300 taking in sewage from the catchment of Cranbourne, Winkfield, Newell Green, Popeswood and Bracknell and Bracknell New Town. The sludge treatment centre shares the same site as the sewage treatment works.

CIRIA Report 736 – Containment systems for the prevention of pollution sets out principles and direction for the design, and construction of secondary containment systems. This report sets out options to apply the CIRIA 736 principles within the accepted constraints of a retrofitted solution.

There are 17 tanks at Bracknell which fall under the IED regulations, 5 of which are below ground and therefore do not require containment. The remaining 12 tanks requiring containment have individual volumes varying between 82 and 544m^3.

Due to the nature of the site, the tanks were initially grouped into 3 separate containment areas with a single option was developed for containment of each area.

The contained spill modelling retains the tank contents and associated rainfall within the site boundary, allowing the flows to be managed by TW operations for return to treatment. The volume for containment is driven by rainfall and largest tank volumes for Areas 1 and 3B while for Area 4 it is the 25% rule. A combined containment volume of 2138m^3 is required to be stored in Area 1 (721m^3), Area 3A (363m^3) and Area 4 (1054m^3).

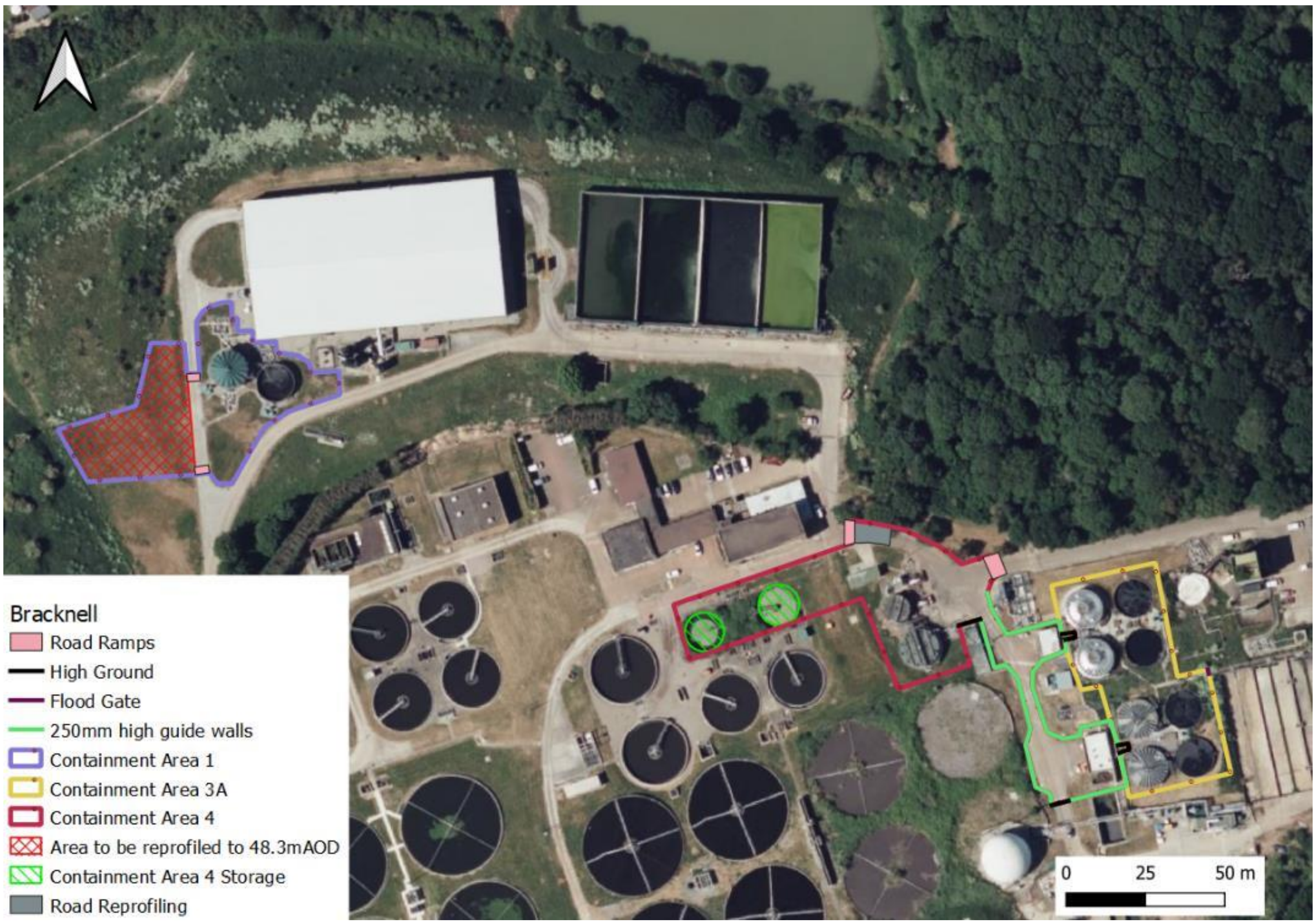
The preferred containment option includes 3 bunded containment areas, requiring the construction of 1018m of bund walls (250 - 1220mm high), four ramps at road crossings and three floodgates across all three containment areas. Additionally, in Area 1, ground will be reprofiled to locally provide the required storage and in Area 4 additional storage will be provided by two disused humus tanks. The option minimises costs provides high operational flexibility and has minimal impact to site access routes.

In addition to the creation of bunds, which due to space constraints are likely to be formed from concrete, existing grass or gravelled areas will be replaced with a bound impermeable material (high cement replacement concrete) to provide a surface that can be cleared of sludge to meet a 3-4 day recovery period. Vehicular access into the containment areas where frequent access is required is by ramps (speed humps) restricted to nom 300mm in height; where traffic movements are expected to be less frequent and the threshold for ramps is exceeded, permanent flood gates were proposed. Whilst the site is identified as requiring Class 2 containment (impermeable soil with a liner), the proposed solution is intending to concrete (with no liner) on the basis of the impermeability of the concrete, inherent strength and long-term mechanical resistance.

Bund heights are being set to provide freeboard considering both static conditions when the containment has been filled and during the transient condition at initial failure. There is the potential for some flow to overtop the access ramps during the conditions of the initial burst which is addressed by conveyance to the site drainage system which eventually discharges to the head of the works.

Isolation of the site drainage system linked to the containment area will also be required to mitigate the risk of unmanaged flows impacting the sewage treatment works.

General Layout of Preferred Option



2. Background

Following initial audits by the Environment Agency (EA) in 2019 that examined the primary, secondary, and tertiary containment provisions for Thames Water's anaerobic digestion (AD) process and associated tanks, the EA reported *"there is no provision of secondary containment for the AD process at any of Thames Water's sites. Catastrophic tank failure may impact nearby receptors and the operation of adjacent sewage treatment activities".* Jacobs were appointed to assess site risks and outline the options available for providing remote secondary containment of a catastrophic tank or digester failure across 25 Thames Water sites. Based on CIRIA C736 and The Anaerobic Digestion and Bioresources Association (ADBA) risk assessment tools, this containment report addresses the site-specific risks at Bracknell and outlines the options available for providing remote secondary containment in the event of a catastrophic tank or digester failure.

The current assessment identified gaps between the existing conditions of the sludge assets in Sewage Treatment Works (STW) and the requirements to meet the industrial standard (i.e., CIRIA C736 and ADBA). Site-specific risks, credible failure scenarios and design containment volume for the Bracknell STW were identified through a desktop study, Light Detection and Ranging Analysis (LiDAR) analysis and a site visit.

Bracknell STW (Figure 1 and Figure 2) is located within a rural area, outside of the village of Binfield and approximately 2.7 km to the north of the town of Bracknell, Berkshire. There are fields and woodland surrounding the STW. The nearest sensitive receptors are domestic properties, located approximately 85 m to the northwest of the site with further residential and commercial properties within 250 m of the site to the north and west. The STW serves a Population Equivalent (PE) of 87,300 from the catchment of Cranbourne, Winkfield, Newell Green, Popeswood and Bracknell and Bracknell New Town. The site is located within the boundaries of a Source Protection Zone (SPZ) Zone 3.

Figure 3 shows the boundary of the permitted IED area and the assets contained within Bracknell STW.

Figure 1: Satellite view of Bracknell Sewage Treatment Works

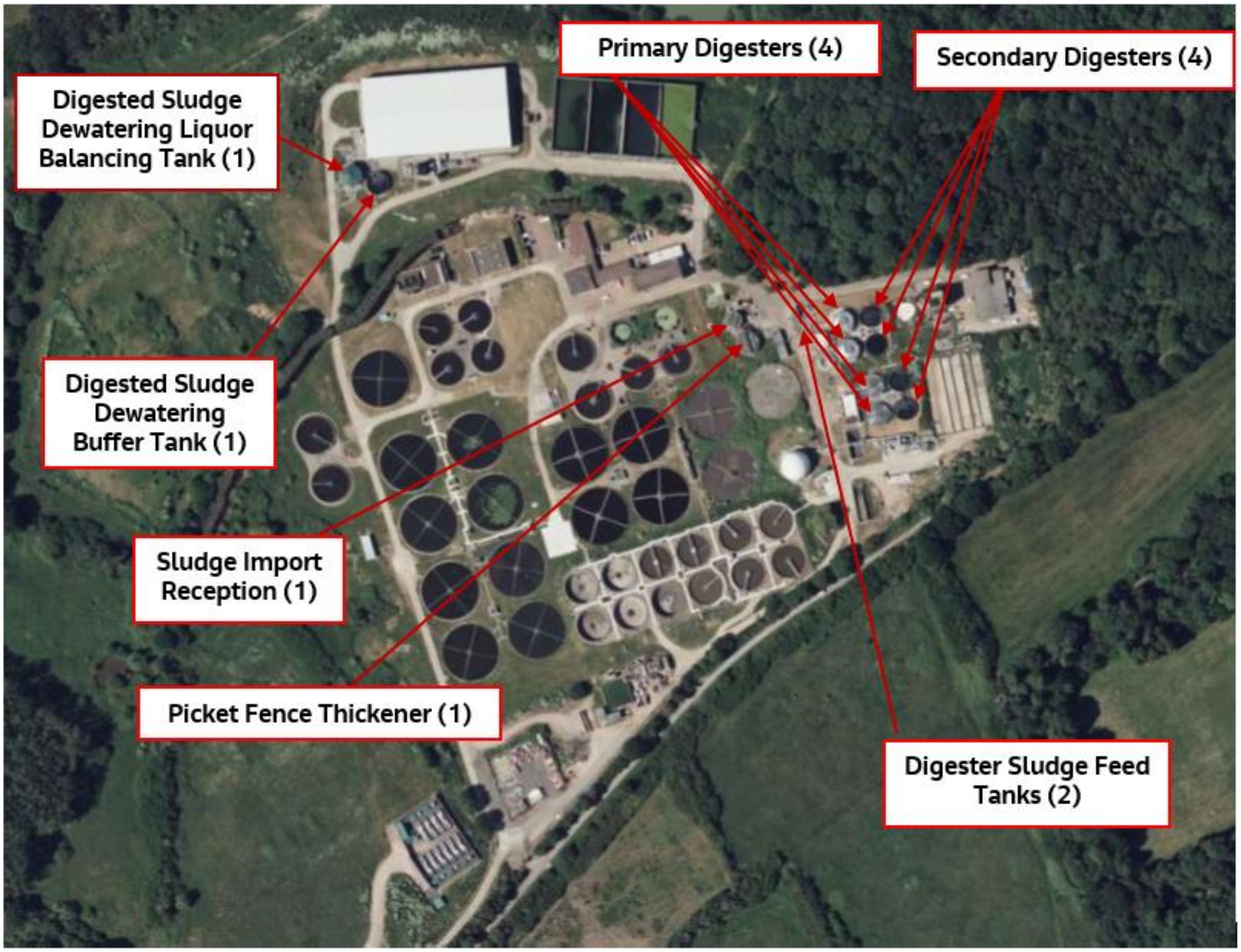


Figure 2: Bracknell Sewage Treatment Works (with sludge tanks labelled)

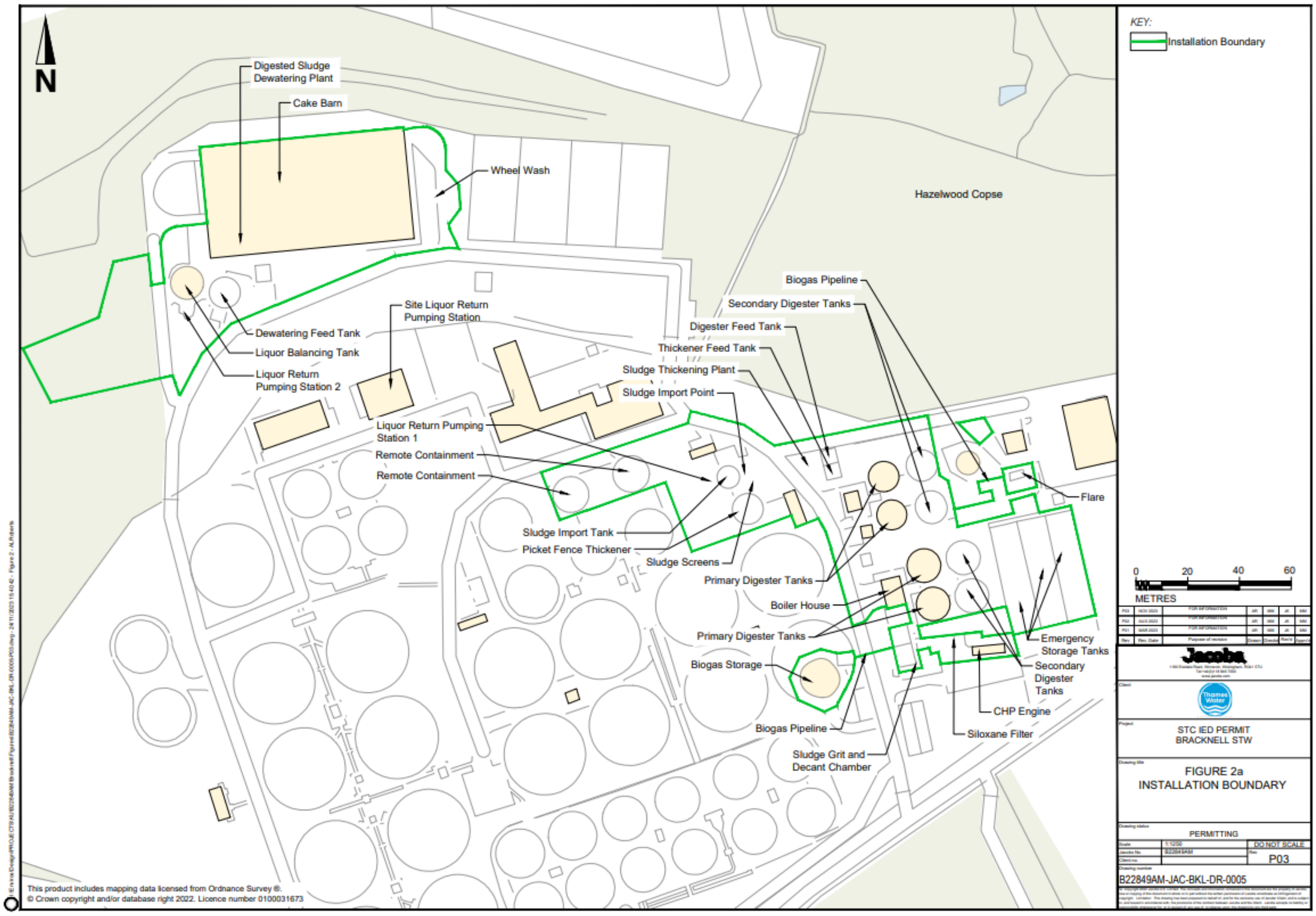


Figure 3: Boundary of Permitted IED area and assets contained within Bracknell STW

3. Proposed Containment at Bracknell STW

3.1 CIRIA C736

This containment option report has been prepared using CIRIA C736 as the basis of design and guidelines. Where a deviation from C736 has been recommended it is highlighted in the text.

CIRIA guidance document C736 *(Containment systems for the prevention of pollution – Secondary, tertiary, and other measures for industrial and commercial premises, 2014)* describes various options for containment of spillages from a credible failure scenario. It refers to a key plan, reproduced in Figure 4 below.

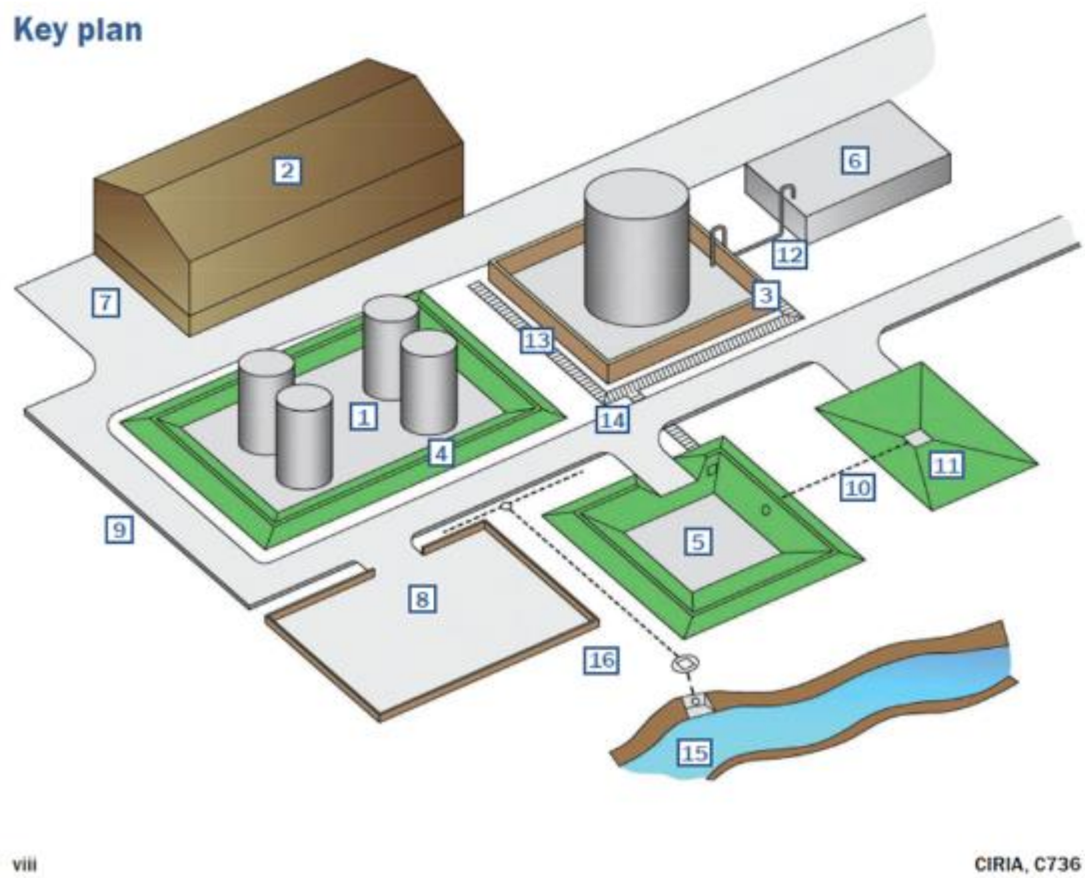


Figure 4: Diagram of primary, secondary and tertiary containment examples

-**Primary containment** is provided by the actual tank or vessel [1]

-**Secondary containment** is provided by a bund immediately surrounding the primary vessel e.g. [3] and [4], or by a lagoon [5] or tank [6]. If containment is provided away from the primary vessels this is known as **remote containment** and may be considered as either **remote secondary** or **tertiary containment**.

-**Tertiary containment** can be provided by a number of means including lagoons [5], or impermeable areas such car parks [8]. Roadways with high kerbing of sufficient height [9] can also form part of a tertiary containment system, or the **transfer system** to the remote containment.

The distinction between *remote secondary* and *tertiary* containment is not always clear but, if properly designed, a combined system can be provided that is capable of providing the necessary degree of environmental protection. The overriding concern is not the terminology but the robustness and reliability of the system which depends on a number of factors such as;

- Its complexity – the more there is to go wrong, the greater the risk. Passive systems relying solely on gravity are more reliable than pumped.
- Whether manual intervention is relied on to make the system work or whether the system can be automated to include fail-safes and interlocks.
- The ease of maintenance and monitoring of the system's integrity, and repair of any defects.

During and after an incident any rainfall runoff from the remote secondary storage areas, from the spillage catchment areas and from the transfer systems must also be prevented from reaching any outfall(s) to surface water by closure of control valve(s).

3.2 Objectives of remote secondary containment

The objectives of the remote secondary containment measures proposed in this report are to safely contain spillages from credible failure scenarios and prevent them from:

- escaping off site
- entering surface waters
- percolating into groundwater
- being pumped back to the inlet of the sewage works in an uncontrolled manner.

The remote secondary containment will be provided by maximising the use of existing impermeable surfaced areas to provide a fail-safe passive system that relies on gravity rather than pumps. A means of leak detection that will automatically trigger isolation valves at key locations in the drainage system is also proposed. A development opportunity may allow select pumping stations discharging back to head of the works to be inhibited.

3.2.1 Uncontained Spill modelling

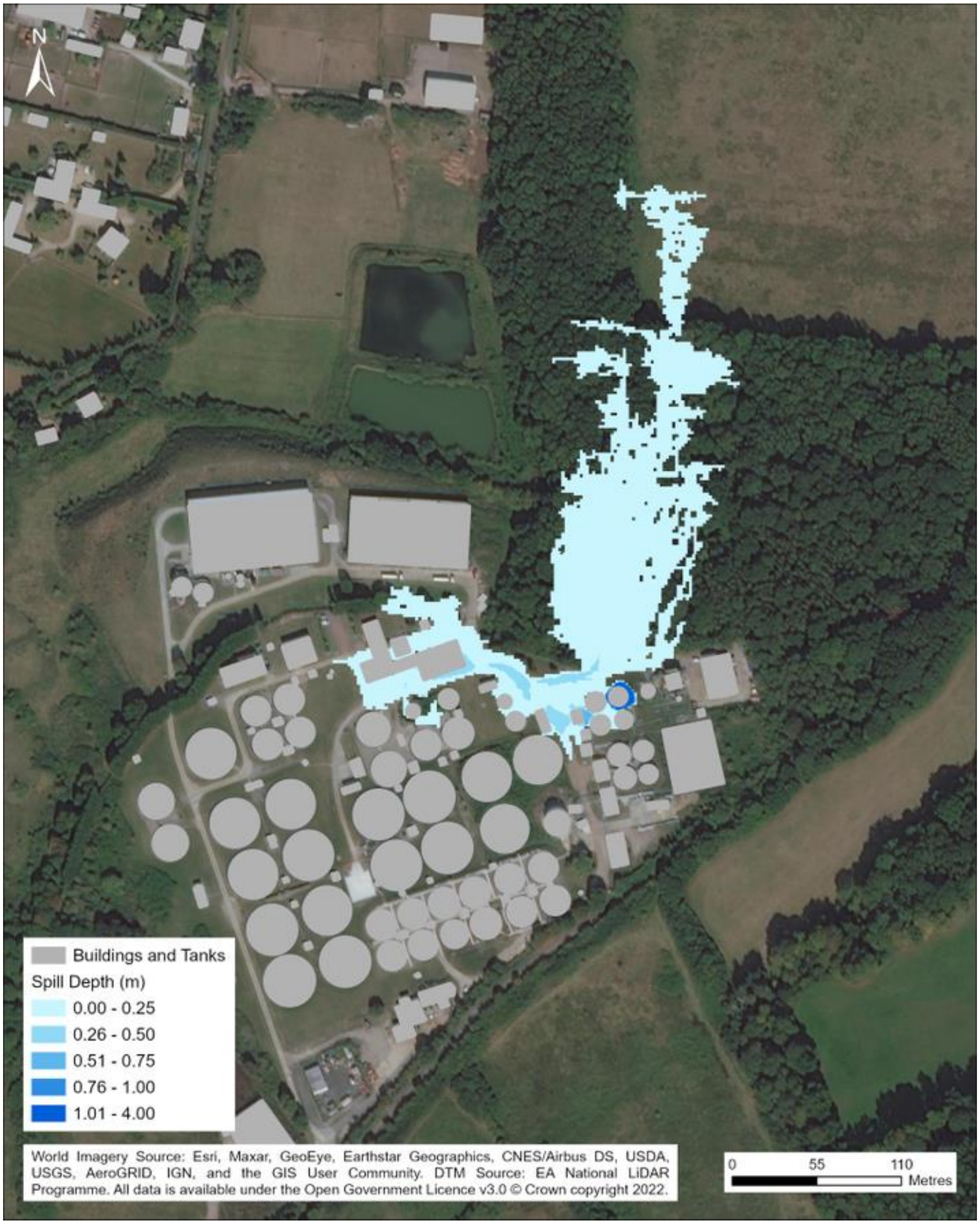


Figure 5: Uncontained Spill Model Results

As seen from Figure 5, the sludge spill mapping of an uncontained event at Bracknell STW showed that a potential sludge spill from one of the digesters will not be self-contained within the site and therefore passive containment needs to be implemented to safeguard the nearby receptors. According to the model the spill will leave the site boundary (in the north-east site boundary) in approximately 47 minutes following failure of one of the digesters. The spilled content will leave the site at the north boundary and will then into the adjacent Hazelwood Copse and will continue flowing through the wooded area and into adjacent farmland. Within the STW, sludge will travel past the sludge import day tank and picket fence thickener and surround the standby generator.

3.3 Site Classification Bracknell STW

Based on the use of the ADBA risk assessment, considering the source, pathway and receptor risks, Bracknell site hazard rating is deemed to be High. When considering the mitigated likelihood as low, a Class 2 secondary containment is required.

Source Risk	Pathway Risk	Receptor Risk	Site Hazard Rating	Likelihood	Overall Site Risk Rating
High	**High**	**High**	**High**	**Low**	**Medium (Class 2)**

Refer to Appendix 1 for summary of the ADBA risk assessment tool.

3.4 Bracknell STW Summary of Assets and Secondary Containment Requirements

There are two components that contribute to the required capacity of secondary containment, the source spill volume requiring containment and rainfall. Section 4 of CIRIA 736 forms the basis of this assessment. Section 4.2 of the guidance reviews current industry practice relating to source spill volume, Section 4.2.8 then summarises current industry practice relating to source spill volume in a tabular form. It can be seen from Section 4.2.8 of the CIRIA guidance that sewage sludges and associated regulations / guidance are not listed.

Within Section 4.2.1 there is detailed reference to the use of 110% of the largest tank or 25% of the total tank inventory volume, whichever is greater, and the rationale for this. CIRIA recognises that this approach is not quantitative or based on a risk assessment and are arbitrary methods. Sections 4.3 and 4.4 of CIRIA 736 provide guidance on a quantitative risk assessment methodology and this is what is being used for the calculation of the required capacity for containment in this report.

3.4.1 Assets for Containment

The tanks for which containment is required are summarised below:

Table 3-1: List of Tanks

Tanks Requiring Containment	Number of Tanks	Individual Operational Tank Volume m^3	Total Operational Tank Volume m^3	Material	Below/ Above/ Partially in ground
Picket Fence Thickener	1	464	464	Steel	Above
Sludge Import Tank	1	147	147	Steel	Above
Thickener Feed Tank	1	82	82	Concrete	Below
Digester Feed Tank	1	82	82	Concrete	Below
Primary Digester Tanks	2	487	974	Steel	Partial
	2	487	974	Concrete	Partial
Secondary Digester Tanks	2	487	974	Concrete	Partial
	2	340	680	Concrete	Partial
Emergency Storage Tanks	3	800	2400	Concrete	Below
Dewatering Feed Tank	1	235	235	Steel	Above
Liquor Balancing Tank	1	544	544	Steel	Above
Note: the tanks wholly below ground do not require containment. 17 tanks total, 5 below ground.					

3.4.2 Design allowance for rainfall

The containment volume, when not dictated by the 110% or 25% containment rules includes an extra allowance for rainfall that may accumulate within the contained area before and after an incident has been made. The CIRIA guidance recommends that the containment volume should include an allowance for the total rainfall accumulated in response to a 1 in 10-year return period events for the 24 hours preceding an incident and for an eight-day period following an incident or other time period as dictated by site specific assessment. Thames Water has indicated that the clean-up and return to operation is feasible in 3 to 4 days. Therefore, a three-day period following an incident has been allowed for in the design allowance for rainfall following the incident. The arising average rainfall depths for a 1 in 10-year storm over the event period for Bracknell is 75mm. It should be noted that the rainfall depths for Bracknell have been estimated using the depth-duration-frequency rainfall model contained in the *Flood Estimation Handbook* (FEH), which provides location specific rainfall totals for given durations and return periods.

3.5 Identified Constraints

3.5.1 Operational constraints

Below are the key operational constraints that have been identified during the development of the proposed containment areas at Bracknell STW.

- Ground surface of the containment area will need to be easy to clear of sludge. The existing ground surface is a mix of concrete, grass and gravel. TW operations have stated that it would be difficult to clean up sludge from gravel areas as the gravel would also sucked up with the sludge. The grass and gravel areas will need to be replaced with impermeable surface e.g. concrete from which sludge can be cleared up easily.

- The time to recovery and return site back to operation has been set at 3-4 days following direction by Thames Water. The containment volume, when not dictated by the 110% or 25% containment rules allows for three days of rain during the recovery period and one day of rain immediately preceding an event.

- Access is to be maintained where the proposed containment boundary crosses access roads. This could be achieved using road ramps (speed bumps), flood gates etc.

- Where access into buildings and operation areas are impacted by the containment boundary, access is to be maintained or an alternative access arrangement is to be provided (e.g. steps, flood gate, alternative route etc.)

- In some areas there are significant amount of above ground pipework and cabling which may need to be temporary diverted if it is not possible to excavate and install the concrete containment in these areas.

3.5.2 Geotechnical and Environmental constraints

Existing ground conditions are unknown, however, this will need to be considered during excavating and backfilling activities.

Regarding the construction works, there are no significant environmental constraints as these will all be completed within a Thames Water site.

The existing shrubbery within the containment area shall be removed and area infilled with concrete. To compensate for the loss of shrubbery, alternative areas shall be identified onsite for compensation planting or planting containers installed onsite.

3.5.3 Topographical Constraints

The digital terrain model (Figure 6) indicates low areas of the site are located in the north-east and the east of the STW. Any spills on the site are likely to leave the site via these areas without any containment.

Figure 6: Digital Terrain Model of Bracknell STW

3.5.4 Other constraints

None identified

4. Secondary Containment

The constituent parts of secondary containment are;

- The contained area itself.
- The transfer system.
- Isolation of the drainage from both the contained area and from the transfer system.

For Bracknell, where possible, existing features of the site (e.g., building structures and impermeable surfaces) are used as much as possible to provide the remote secondary containment to reduce cost. The options considered, modifications and their functionality at Bracknell STW are listed below:

- Bund/walls to contain liquid. The heights of bund/walls given in Section 4.1 are the minimum heights required such that that top of the bund/wall is equal to the top water level plus a 250mm freeboard consideration for potential surge (to reflect the planned use of concrete walls with a recurved profile to return flow back on itself) in accordance with CIRIA. Containment ramps provide a barrier for the liquid on roads that still need to be accessible to vehicles for site operation. The maximum height of these will be 300mm to avoid issues with vehicle passage. The risk of spill at the ramps is mitigated by conveyance of the flow to site drainage and return to the head of the works.
- Local infill of grass/gravel to create an impermeable surface and facilitate containment and conveyance.
- Reuse of redundant tanks to provide containment storage after a spill event.
- Raised kerbs on high ground to guide spill to the remote containment area.
- All buildings within the containment and transfer areas must either have doors that lie above the top water levels detailed in Section 4.1 or any equipment inside must be raised off the ground to level above the top water level.

4.1 Containment Option 1

Due to the nature of the site, the tanks were initially grouped into 3 separate areas (Figure 7 below). Only a single option was developed for containment of each area.

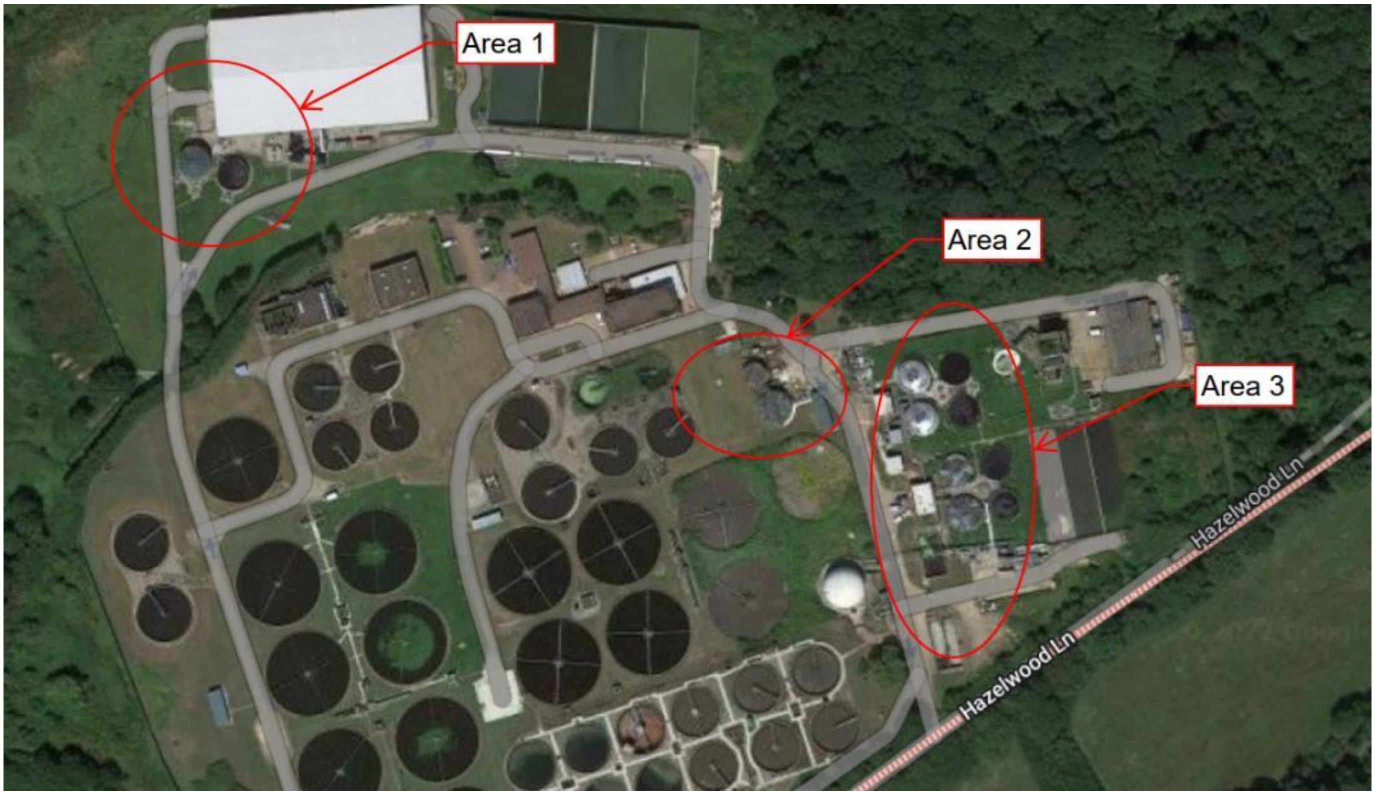


Figure 7: Tank Areas

4.1.1 Containment Area 1

This containment area will contain any spills from the Digested Sludge Dewatering Liquor Balancing Tank and the Digested Sludge Buffer Tank. This containment area consists of low bund walls along with reprofiling of high ground to the west of the tanks to provide additional containment storage. The containment area is approximately 2375m^2, but the actual available containment area will be 2178m^2 as areas such as the tanks and the adjacent buildings will not be included in the storage volume.
The reprofiled area of approx. 1085m^2, will need the ground level to be lowered to 48.30mAOD in order to minimise sludge level in the containment area.

4.1.1.1 Total Spill Volumes

The containment volume for Area 1 was checked against the 110 and 25% rule as well as the largest tank plus total rainfall. The largest tank plus rainfall was found to apply.

The total design contained volume is 721m^3 (largest single tank failure of 544m^3 and 177m^3 rainfall from FEH over catchment area). Table 4-1 summarises the check of the total design containment volume against the 110 and 25% rules as well as the largest tank plus rainfall.

Table 4-1: Area 1 Design Spill Volume Summary

Design Spill Volume Summary	
Rainfall (mm)	75
Catchment Area (m^2)	2375
Total Rainfall (m^3)	177
Largest Tank plus Rainfall (m^3)	721
110% of Largest Tank within Containment Area (m^3)	598
25% of All Tanks within Containment Area (m^3)	195
Design Spill Volume	**721**

4.1.1.2 Contained Model

The contained model output for Area 1 is shown in Figure 8 and Figure 9. The containment model shows that when total design spill volume of 721m^3 is contained in this area, the top water level will settle at 48.76mAOD uniformly across the containment area. Therefore, allowing for 250mm freeboard on the bund wall the bund height will vary between 0.36 – 0.97m with the higher bund wall along the northern and western sides of the containment area.

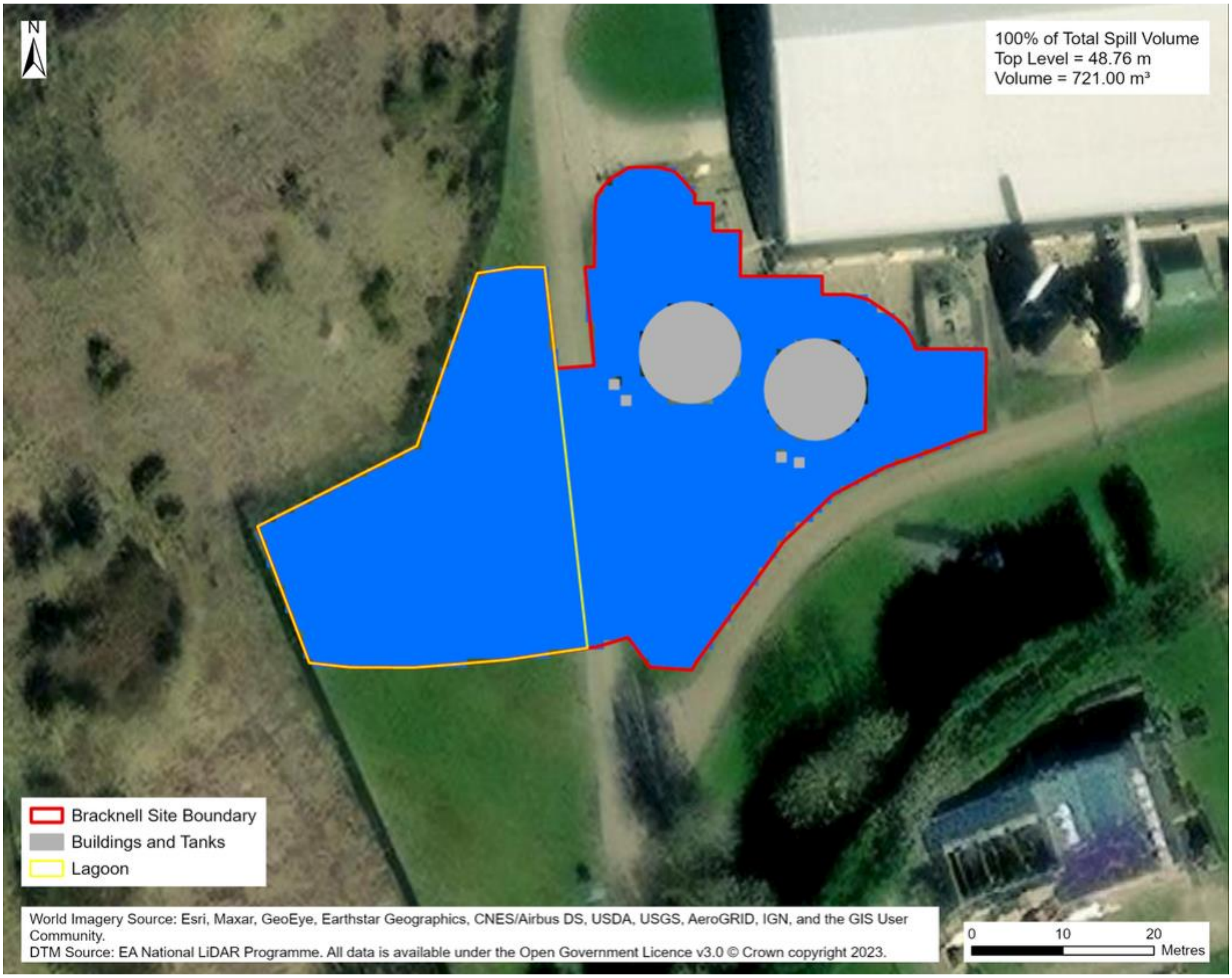


Figure 8: Area 1 Containment Spill Model Output

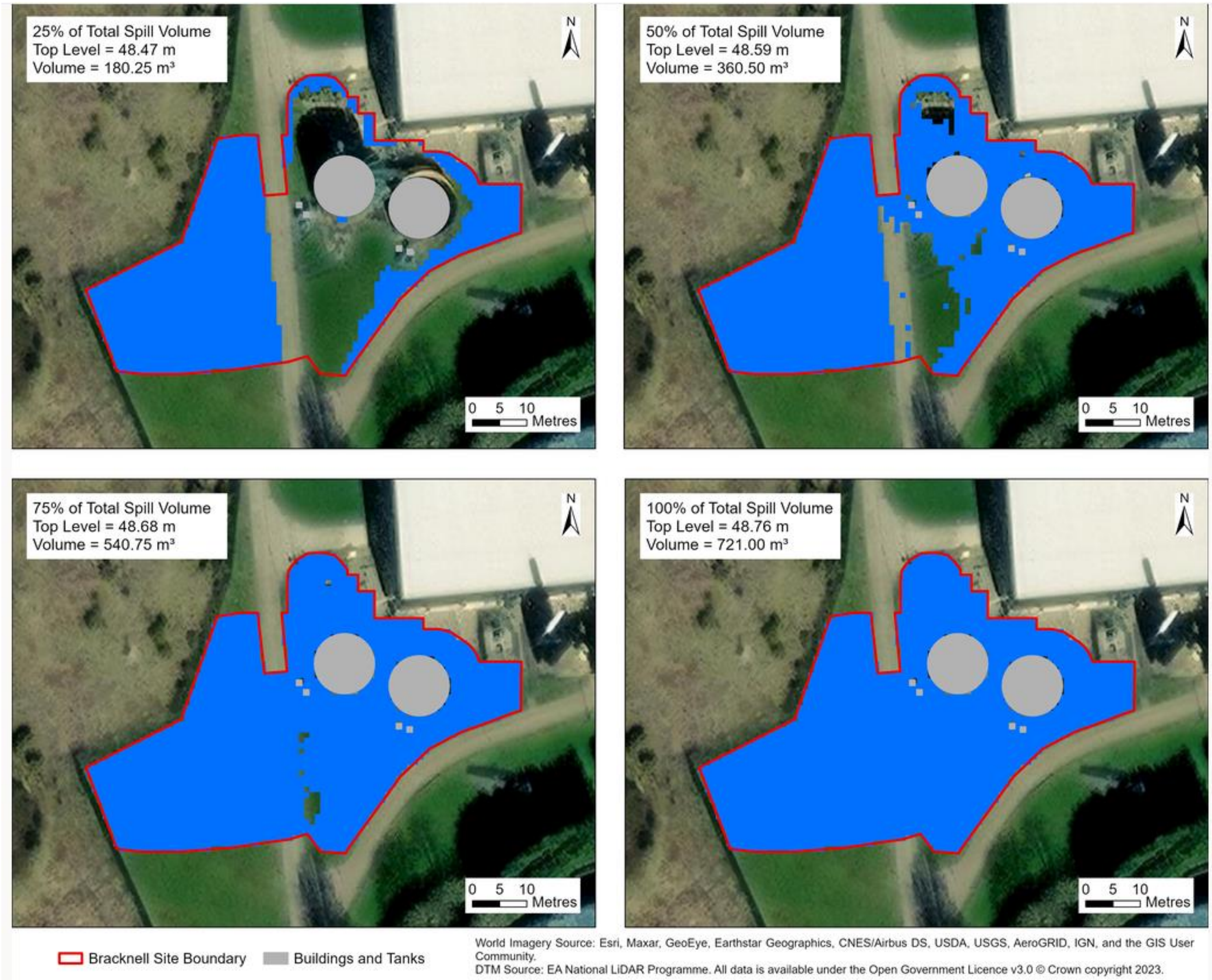


Figure 9: Area 1 Containment Spill Model Output at 25%, 50%, 75% and 100% Volumes.

Figure 10 (below) shows the spot levels along the containment boundary. Where the containment area crosses access road, ramps are proposed as the expected depths less than 300mm and suitable for ramps.

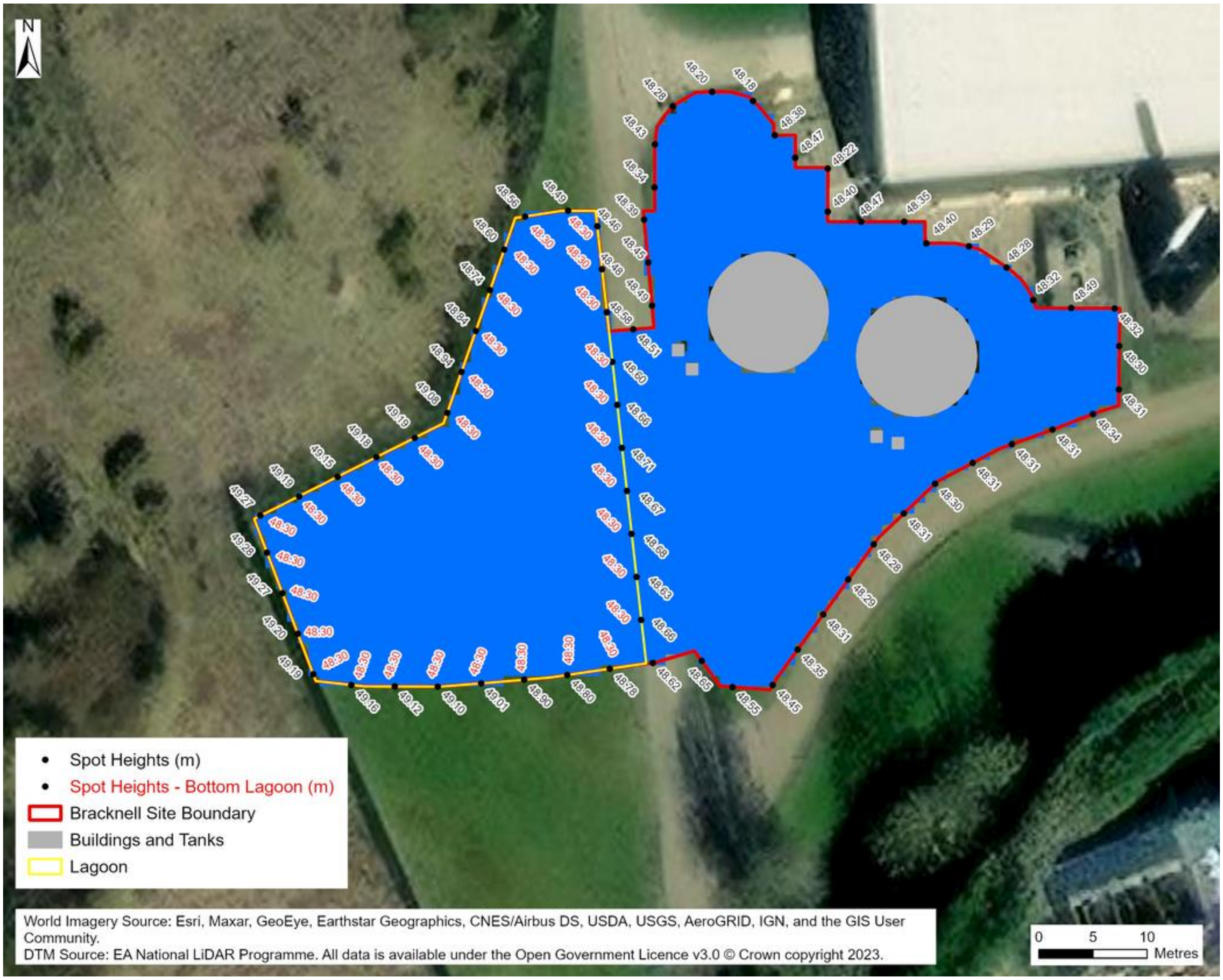


Figure 10: Spot Levels along Area 1 Containment Boundary

Summary of Containment Area 1 is described below and shown in Figure 11.

- Approximately 275m of concrete bund wall ranging between 0.36m and 0.97m high with an average height of 650mm. The foundation for the bund wall will extend 300mm below ground level. 65m of the proposed wall will be topped with fencing along the western boundary of the containment area.

- All grass and gravel areas will be excavated and resurfaced with concrete to mitigate seepage into the local ground and soil. This also aids cleaning procedures following a spill.

- 2no. high road ramps across existing access to maintain access (250mm and 140mm high).

- To minimise the bund heights and facilitate the use of road ramps to maintain vehicular access approximately 1085m^2 of ground to the west of the tanks needs to be reprofiled.

- There is the potential for some flow to overtop the access ramps during the conditions of the initial burst which is addressed by conveyance to the site drainage system which eventually discharges to the head of the works.

Figure 11 - Containment Area 1

4.1.2 Containment Area 2

Containment Area 2 includes the Picket Fence Thickener and the Import Sludge Tank. Due the proximity of this area to Containment Area 3B, it has been combined with Area 3 to form a new Area, Area 4. This approach will make efficient use of the space available for containment storage during a spill event. Refer to Section 4.1.4 for further details.

4.1.3 Containment Area 3

Containment Area 3 incorporates the four primary digester tanks and the four secondary digester tanks. The tanks are located within a reinforced concrete structure which is surround by an earth bund. The top of the tanks is between 0.6m and 1.6m above the top of the earth bund. The reinforced concrete structure is accessible by entrances at road level, while the top of the earth bund is accessible by steps up the side of the bund.
Any spills between the top of the tank and the top of the earth bund will need to be contained. In addition, any spills from the tanks within the reinforced concrete structure will also need to be contained as the structure is open at ground level.

To accommodate these possible spill scenarios, Containment Area 3 has been spilt into the 2 sub-areas below:

- Containment Area 3A – to contain any spills between the top of the earth bund and the top of the tanks
- Containment Area 3B – to contain any spills between the top of the road level and the top of the tanks.

As noted in Section 4.1.2, Containment Areas 2 and 3B have been combined due the proximity of the areas and to make efficient use of the available space.

Containment Area 3B is a close containment area around the tanks at the top of the earth bund. This approach minimises the impact of any spill event across the site. The containment area is approximately 2433m^2, but the actual available containment area will be less than this as areas such as the tanks will not be included in the storage volume.

4.1.3.1 Total Spill Volumes

Both the primary and secondary digesters in Containment Area 3A are partially below ground. To take this into account, only the section of the tanks that sits above the top of the earth bund was considered for the spill volume. It was assumed the sludge levels in the four primary digesters and two of the secondary digesters were maximum 1.6m above the top of the earth bund and the other two secondary digesters had a maximum sludge level of 600mm above the top of the earth bund.

The containment volume for Area 3A has been checked against the 110 and 25% rule as well as the largest tank plus total rainfall. The largest tank plus rainfall was found to apply.

The total design contained volume is 363m^3 (largest single tank failure of 181m^3 and 182m^3 rainfall from FEH over catchment area). Table 4-2 summarises the check of the total design containment volume against the 110 and 25% rules as well as the largest tank plus rainfall.

Table 4-2: Area 3A Design Spill Volume Summary

Design Spill Volume Summary	
Rainfall (mm)	75
Catchment Area (m^2)	2433
Total Rainfall (m^3)	182
Largest Tank plus Rainfall (m^3)	363
110% of Largest Tank within Containment Area (m^3)	199
25% of All Tanks within Containment Area (m^3)	305
Design Spill Volume	**363**

4.1.3.2 Contained Model

The contained model output for Area 3A is shown in Figure 12 and Figure 13. The containment model shows that when total design spill volume of 363m^3 is contained in this area, the top water level will settle at 51.58mAOD around the high ground. Therefore, allowing for 250mm freeboard on the bund wall the bund height will vary between 0.47 – 0.96m with the higher bund walls along the northern and western sides of the containment area.

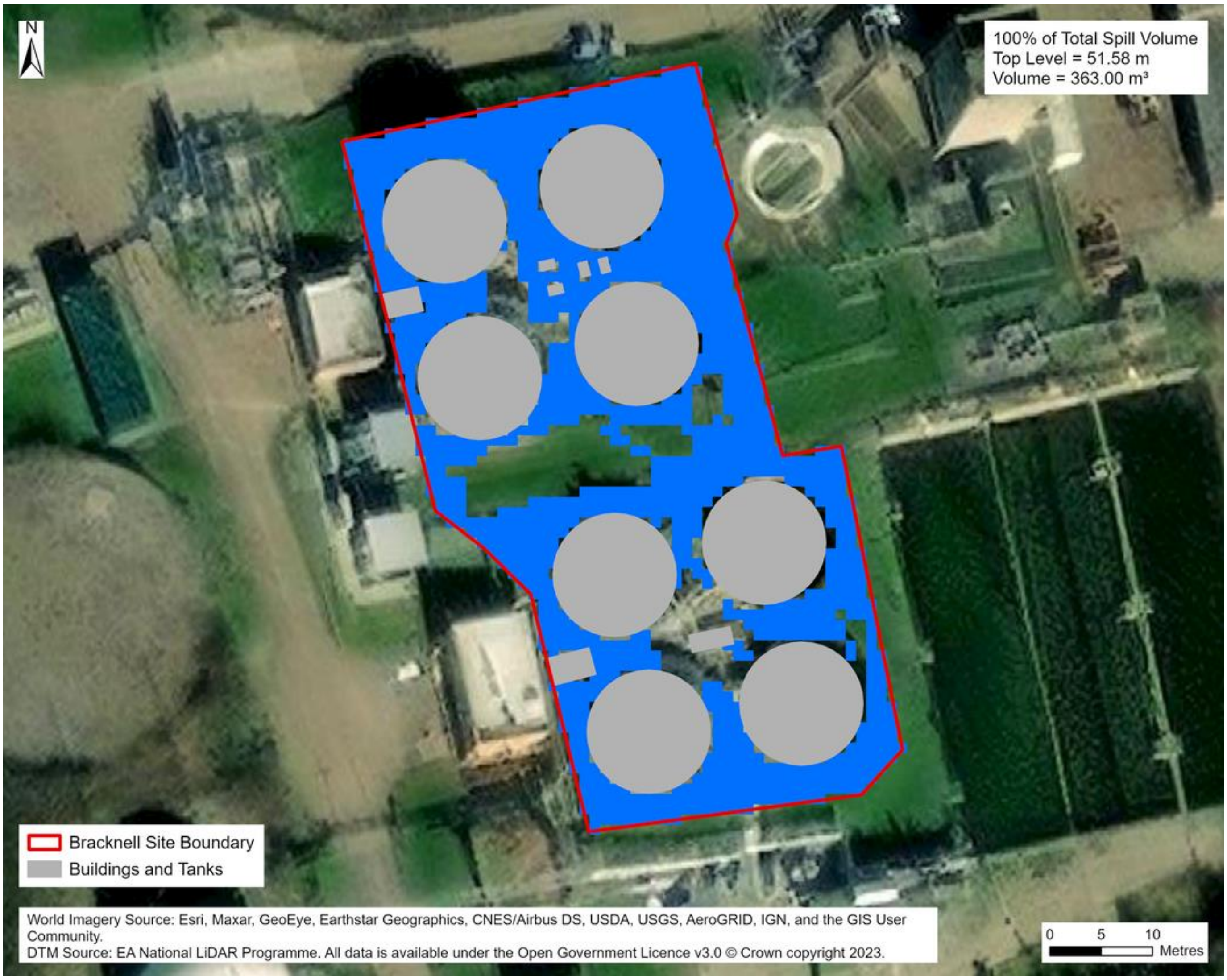


Figure 12: Area 3A Containment Spill Model Output

Figure 13: Area 3A Containment Spill Model Output at 25%, 50%, 75% and 100% Volumes.

Figure 14 shows the spot levels along the containment boundary where the spill reaches the edge of the containment boundary. The potential depths at the access points to the containment area will require the use of floodgates to maintain access due to the height of the contained spills.

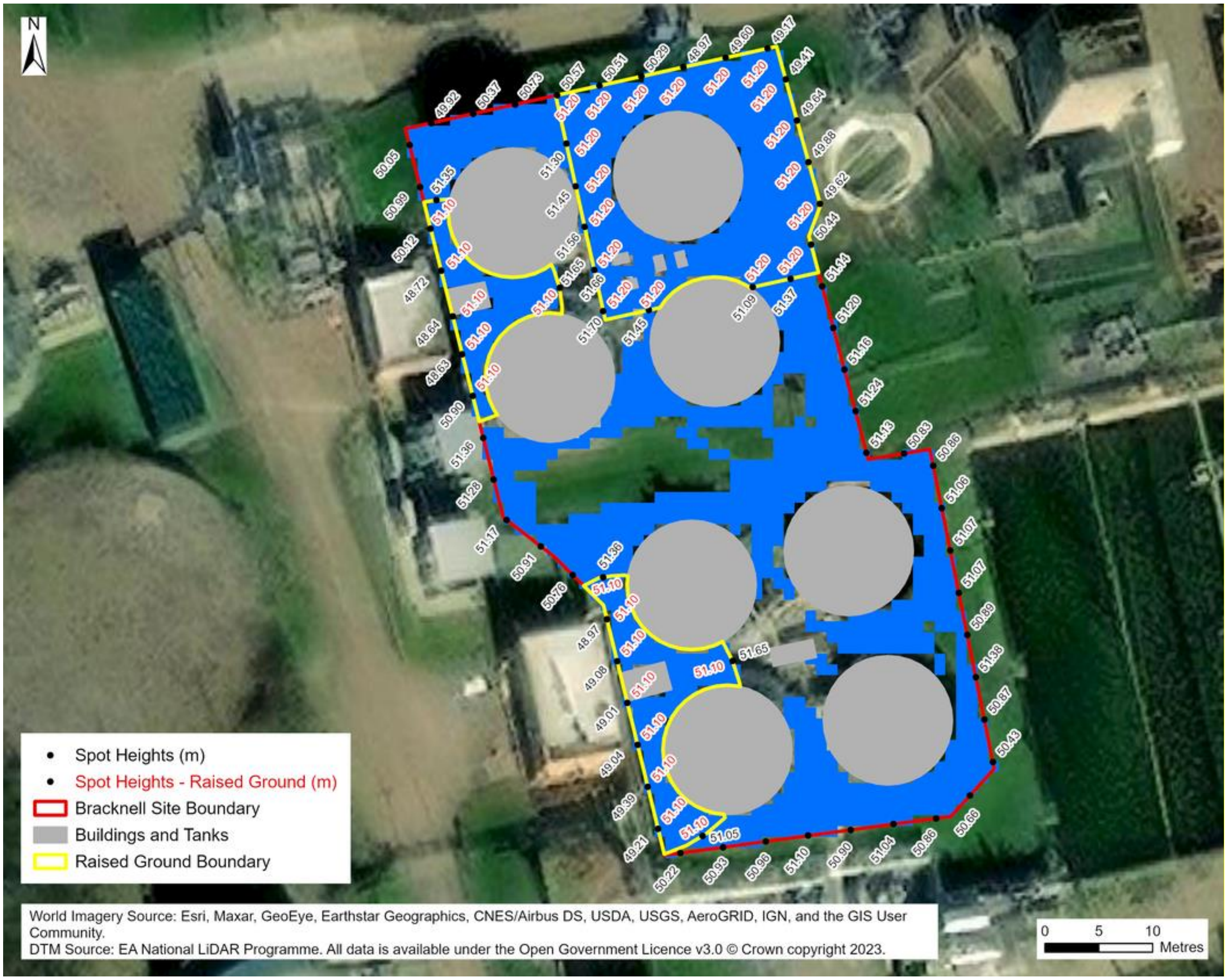


Figure 14: Area 3A Spot Levels along Containment Boundary

Summary of Containment Area 3A is described below and shown in Figure 15.

- Approximately 236m of low concrete bund wall ranging between 0.47m and 0.96m high with an average height of 750m. The foundation for the bund wall will extend 300mm below ground level.
- All grass and gravel areas will be excavated and resurfaced with concrete to mitigate seepage into the local ground and soil. This also aids cleaning procedures following a spill.
- 3no. flood gates to maintain pedestrian access to the top of the earth bund and to the tanks.

Figure 15 - Containment Area 3A – Close Containment Area

4.1.4 Containment Area 4

Containment Area 4 combines Area 2 and Area 3B. It includes the Picket Fence Thickener, Sludge Import Tank, the four Primary Digesters and the four Secondary Digesters. As noted in Section 4.1.3 above, the Primary and Secondary Digesters are located within a reinforced concrete structure which is surround by an earth bund. Containment Area 3B will contain any spills from the tanks between road level and the top of the tanks. This is estimated to be between 3.01m and 4.31m high.
Containment Area 4 is a wide containment area around the 10 tanks. It also utilises two disused Humus tanks to provide storage during a spill event. Combining Areas 2 and 3B minimises the land used for storage during a spill event. The containment area is approximately 6128m^2, but the actual available containment area will be less than this as areas such as the tanks will not be included in the storage volume.

4.1.4.1 Total Spill Volumes

As discussed in Section 4.1.3.1, both the Primary and Secondary Digesters are partially below ground. For Area 4, this is taken into account by only including the volume of the tank that sits above road surface at the entrance to the reinforced concrete structure. It was assumed the sludge levels in the four Primary

Digesters and two of the Secondary Digesters were maximum 4.31m above the top of the road surface and the other two Secondary Digesters had a maximum sludge level of 3.01m above the road surface.

The containment volume for Area 4 has been checked against the 110 and 25% rule as well as the largest tank plus total rainfall. The 25% rule was found to apply.

The total design contained volume is 1054m^3 (25% rule). Table 4-3 summarises the check of the total design containment volume against the 110 and 25% rules as well as the largest tank plus rainfall.

Table 4-3: Area 4 Design Spill Volume Summary

Design Spill Volume Summary	
Rainfall (mm)	75
Catchment Area (m^2)	6128
Total Rainfall (m^3)	460
Largest Tank plus Rainfall (m^3)	945
110% of Largest Tank within Containment Area (m^3)	536
25% of All Tanks within Containment Area (m^3)	1054
Design Spill Volume	**1054**

4.1.4.2 Contained Model

The contained model output for Area 4 is shown in Figure 16 and Figure 17. This shows the total design spill volume will be contained in the low areas located in the north-western side of the containment area. It also shows that when total design spill volume of 1054m^3 is contained in this area, the top water level will settle at 48.28mAOD. Therefore, allowing for 250mm freeboard on the bund wall the bund height will vary between 0.25 – 1.22m with the higher walls located along the containment boundary to the south of the disused humus tanks.

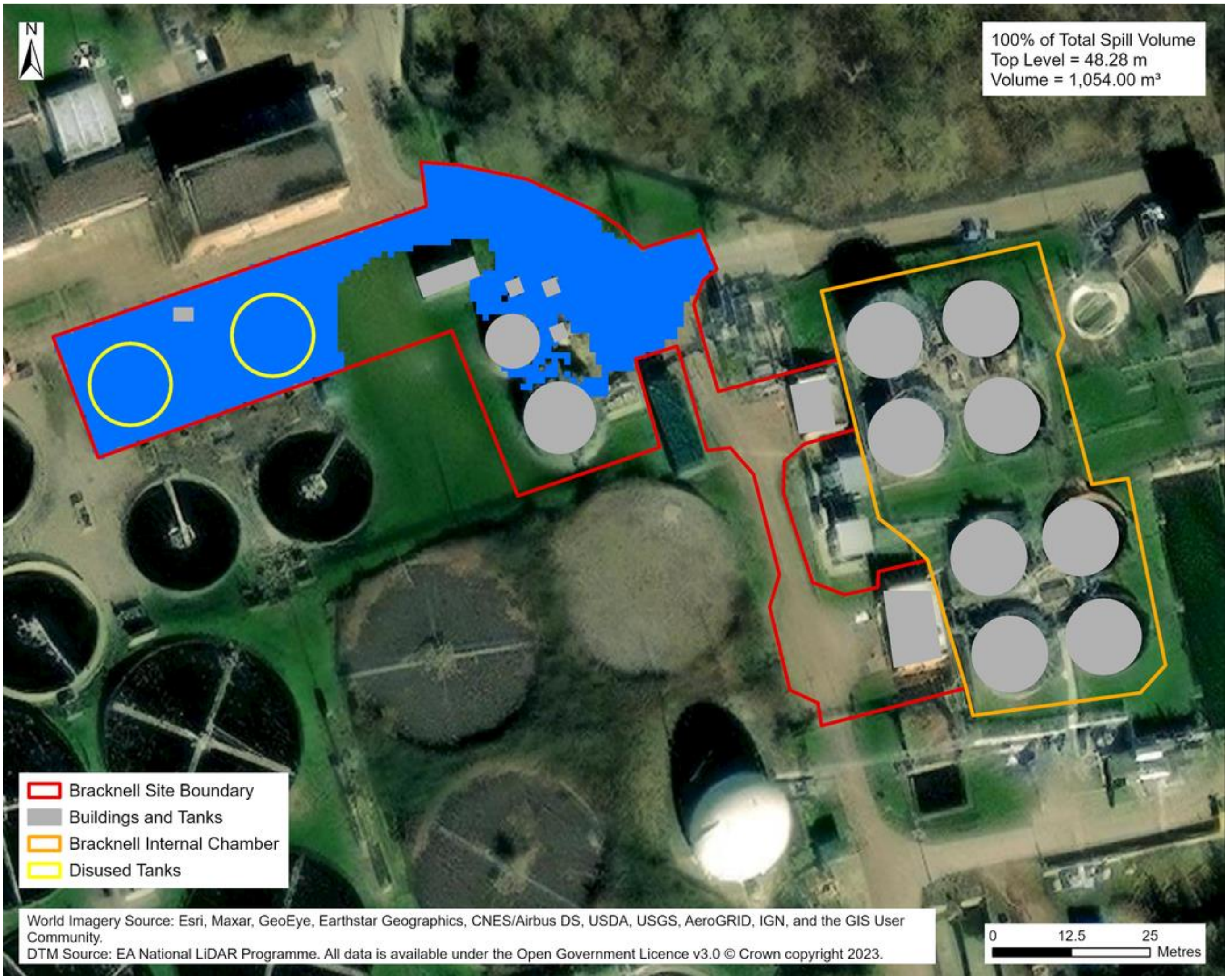


Figure 16: Area 4 Containment Spill Model Output

Figure 17: Area 4 Containment Spill Model Output at 25%, 50%, 75% and 100% Volumes.

Figure 18 shows the spot levels along the containment boundary where the spill reaches the edge of the containment boundary. The potential depths at the access points to the containment area will require nominal reprofile of the road to ensure the access ramps can be used to maintain vehicular access across the site, as this area includes the main access road through the site.

Figure 18: Area 4 Spot Levels along Containment Boundary

Summary of Containment Area 4 is described below and shown in Figure 19

- Approximately 507m of concrete bund wall ranging between 0.25m and 1.22m high with an average height of 375mm. The foundation for the bund wall will extend 300mm below ground level.
- All grass and gravel areas will be excavated and resurfaced with concrete to mitigate seepage into the local ground and soil. This also aids cleaning procedures following a spill.
- 2no. high road ramps across existing access to maintain access (300mm and 190mm high).

- Local reprofiling of access road to allow access ramps to be 300mm maximum.

- Cleaning and re-using currently disused humus tanks as storage during a spill event.

- There is the potential for some flow to overtop the access ramps during the conditions of the initial burst which is addressed by conveyance to the site drainage system which eventually discharges to the head of the works.

Figure 19 - Containment Area 4 – Wide Containment Area

4.1.5 Tertiary Containment Option

No tertiary containment is provided at Bracknell STW.

4.2 Mitigation of Site-Specific Risks

4.2.1 Jetting and Surge Flows

The potential for failure through jetting is minimised by ensuring that the minimum distance from the tank to the bund wall is in accordance with Box 6.1 of CIRIA 736.

The likelihood of jetting occurring however is deemed low as failure is more likely to begin with major seeping from the tanks which would be spotted during routine site walkabout tours each day.

The natural topography of the site and the distance to the boundaries of the containment area results in a low risk of surge overwhelming the containment.

4.2.2 Flooding

According to the UK Government's Flood Map for Planning the sludge areas of the site is largely situated in Flood Zone 1, see Figure 20 below.

Areas situated in flood zone 1 have a low probability of flooding and have an annual probability of river flooding of less than 0.1%.

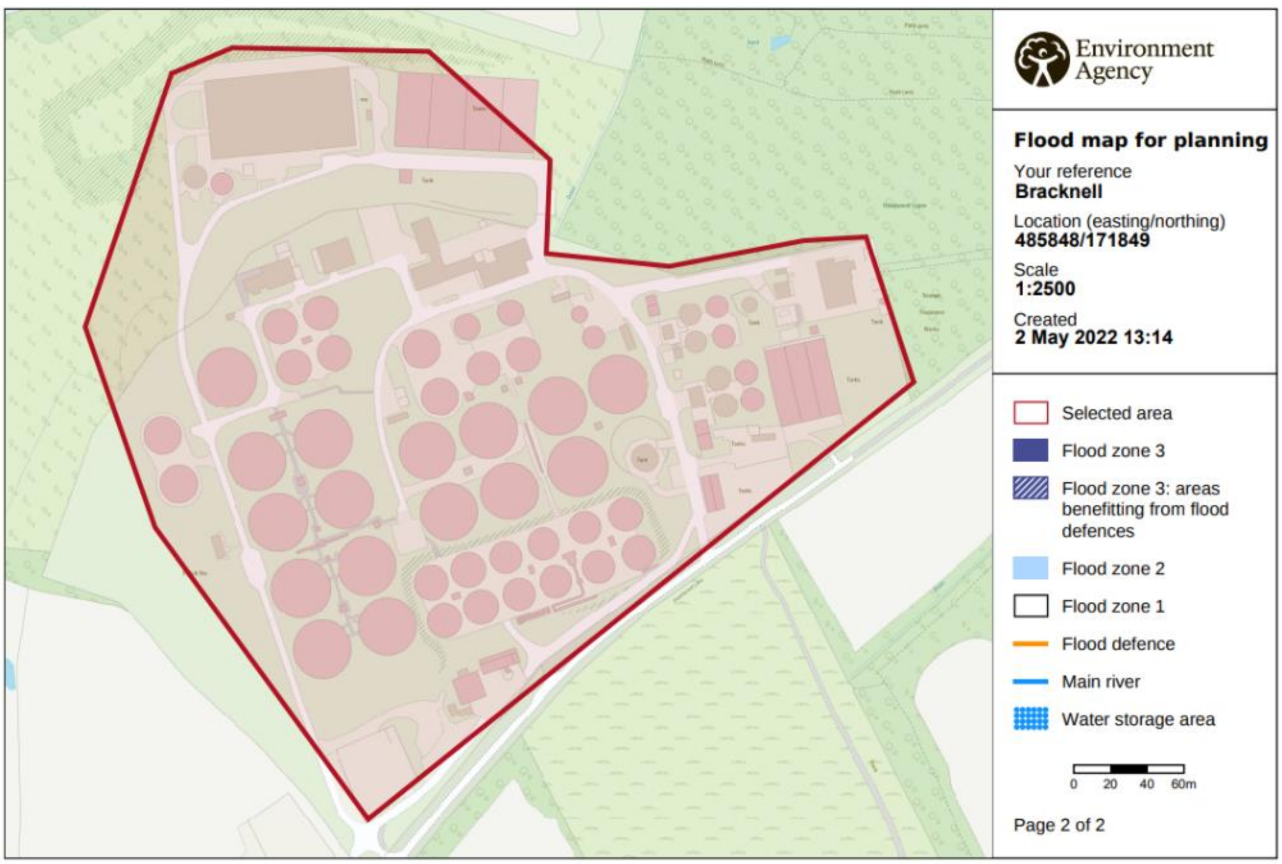


Figure 20: Flood Map for Planning

4.3 Identification of Preferred Option

The preferred containment option is Option 1 which includes three bunded containment areas with reprofiling in Area 1 and in Area 4 provision of storage in two of the currently disuse humus tanks. The option minimises costs provides high operational flexibility and has minimal impact to site access routes.

Alternatives options were initially discussed with Thames Water for Areas 2 and 3B however, these were discounted as combining Areas 2 and 3B provided a more efficient solution.

4.3.1 H&S and CDM risks

- Flood gates not suitable for areas of high traffic movement
- Sealing of cable ducts and fibre ducts to mitigate issue of acting as conduit to transport sludge around site.
- Confirm that the containment walls do not impact the existing DSEAR equipment rating.

5. Site Drainage and liquor returns

5.1 Process flow diagram

The Process Flow Diagram for the Bracknell STW will be included after review and acceptance by Thames Water.

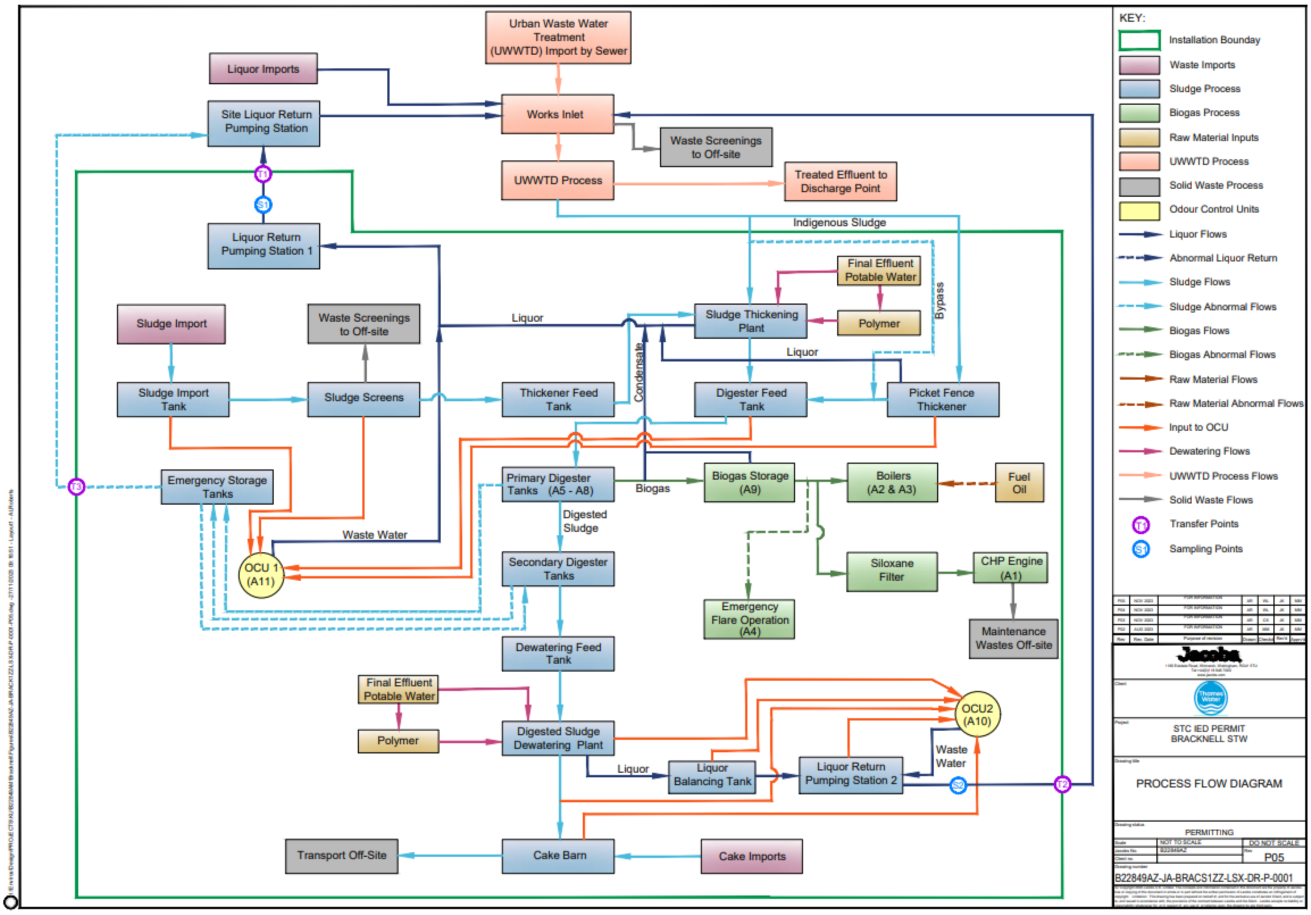


Figure 21: Process Flow Diagram

5.2 Foul, Process and Effluent Drainage

Site drainage assessments are based on Bracknell STW Drainage Plan Drawing Number BRACS1ZZ-DPL-001. This drawing is dated July 2012 and it is likely that there have been modifications\ upgrade during this time. Therefore, a drainage survey is required, and the drainage plans updated to suit.

The Drainage Plan for Bracknell shows very little details on the discharge point of the surface water pipes noted, however, these are thought to be sent back to the head of the works. Figure 22 shows the available drainage information which is limited to Containment Area 1. In the event of sludge entering the head of the works, the shock load could adversely impact the sewage works treatment process. Therefore, in the event of a catastrophic loss of containment, the drainage line should be isolated.

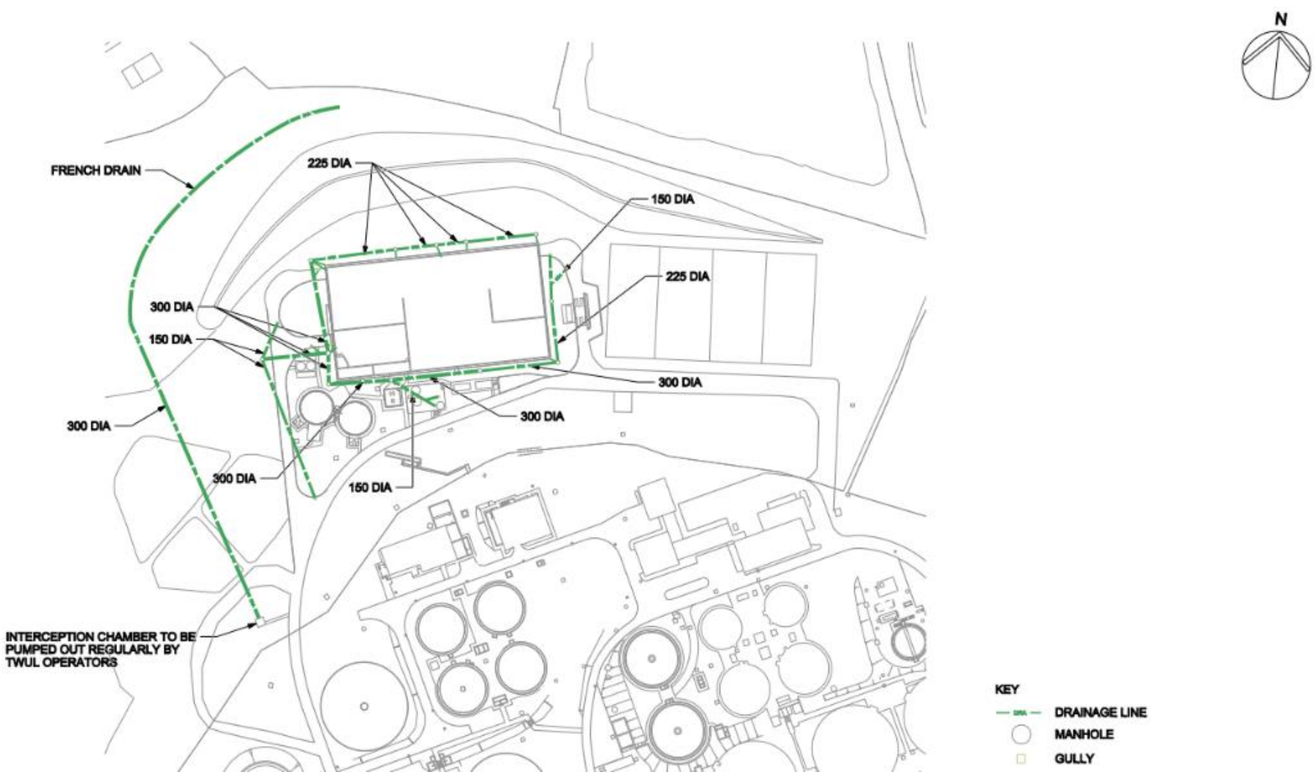


Figure 22: Drainage Plan

5.3 Liquor Returns

The existing liquor return system is not being altered by the containment system, other than the control modifications proposed in 5.4.

Details of the liquor returns sampling are being developed outside of this report for incorporation within the permit submission.

5.4 Automatic Isolation Valves

For the catastrophic loss of containment scenarios for the sludge areas discussed, such a loss could be automatically detected by the level sensors in the tanks. A catastrophic failure would be identified by the rate of change in tank level being larger than expected at normal operation. The signal from the sensors would be used to automatically prevent any adverse impact on sewage treatment.

In the event of a catastrophic sludge spill, flows entering the head of the works via the drainage pipes could adversely impact the sewage works treatment process. Therefore, in the event of a catastrophic loss of containment, the drainage lines within the containment area should be isolated.

It is recommended that float operated isolation valves are installed on all outgoing drainage lines from the containment area. These valves will remain normally open but will close when high levels in the existing drainage system are encountered. This drainage configuration will have the following impacts:

- In heavy or intense rain events these drainage isolation valves may be triggered, and operators onsite will need to manual operate these valves to release flows into the existing drainage network.
- In minor or slow flow tank spill events, the sludge spill will flow into the exiting drainage network (and into the head of the works) unless operators intervene to isolate the drainage networks. Minor spill flows are unlikely to adversely impact the process as they will be small compared to the flow to full treatment at the works.
- In most locations, to accommodate the new isolation valves, new manholes need to be constructed over the existing drainage lines.

6. Conclusions

This section summarises the findings of the containment assessment options report for Bracknell Sewage Treatment Works.

Based upon the Anaerobic Digestion Bioresources Association (ADBA) containment assessment tool; the site carries an overall site risk rating of Medium meaning that Class 2 containment is needed.

The assessment focuses on site-specific risks and outlines the options available for providing secondary containment of a catastrophic tank or digester failure.

The preferred containment option is Option 1 which includes three bunded containment areas with reprofiling in Area 1 and in Area 4 provision of storage in two of the currently disuse humus tanks. The option minimises costs provides high operational flexibility and has minimal impact to site access routes.

This option will require the construction of 1018m of bund walls (250 - 1220mm high) across all three containment areas, four ramps at road crossings and three floodgates to maintain access. In Area 1, ground will be reprofiled to locally provide the required storage and in Area 4 additional storage will be provided by two disused humus tanks.

In addition to the containment elements, isolation of the site drainage system linked to the containment area will be required to mitigate the risk of unmanaged flows impacting the sewage treatment works. Existing gravelled and grass areas within the containment will be replaced with concrete.

The contained spill modelling retains the tank contents and associated rainfall within the site boundary and the flows can be managed by TW operations for return to treatment. The volume for containment is driven by rainfall and largest tank volumes for Areas 1 and 3B while for Area 4 it is the 25% rule.

Freeboard allowances and the profile of the containment bund wall provides mitigation against surge effects. Jetting escape is mitigated due to the location of the tanks being remote to the containment boundary.

Appendix 1 ADBA Site Hazard Risk assessment summary – Bracknell

ADBA Industry Guidance and CIRIA C736 state how the site hazard rating of the site risk and classification are to be calculated. A summary of the hazard risks for Bracknell STW are as follows:

Source – There are two sources that have been identified:

1. Digestate is stored within the tanks
2. Polyelectrolyte chemicals for sludge thickening.

The Source Hazard rating was determined as High.

Pathway – There are four pathways that have been identified:

1. The process and site drains take both process and surface water to the head of the works which would negatively impact the process stability on site and would eventually impact on the receiving watercourse
2. Groundwater: There are several areas where a sludge spill could pass over permeable ground.
3. The Cut River runs approximately 500m to the northwest of the site.
4. Topography of the site is such that spills will be directed to the adjacent Hazelwood Copse

Consequently, the Pathway Hazard rating was determined as High.

Receptor – There are several potential receptors which have been identified:

1. The site sits within a Source Protection Zone 3, however, Groundwater vulnerability is ranked as “Low” to the north of the site
2. The Sludge Treatment Centre is less than 250m away from residential dwellings
3. The Cut River runs approximately 500m to the northwest of the site.
4. Hazelwood Copse woodland directly northeast of the STW.

The Receptor Hazard rating was determined as High

Likelihood – The mitigated likelihood is **low**, which reflects the use of materials, the tank systems do not have a history of failure, the tanks are designed to British Standards and installed by competent contractors and Thames Water undertake regular site tours giving the opportunity to identify early indications of potential issues.

Based on the information above the overall site risk rating was calculated to be **Medium** which means that **Class 2 secondary containment** is required.