J840 – STC IED Containment

Rye Meads STC – Containment Options Report

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Thames Water

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4.0	12/11/2024	Update after EA comment	CR	SMNS	SC	HG

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 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 Rye Meads.

Rye Meads STW is located south of the A414, to the east of the town of Hoddesdon and approximately 10 km north of the Junction 26 of the M25 and serves a population equivalent of 412,000 for the areas of North and East Hertfordshire. 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. This report sets out options to apply the CIRIA 736 principles within the accepted constraints of a retrofitted solution.

There are 17 tanks containing sludge with a total operational sludge volume of approximately 60,700m^3, and individual operational volumes varying between 50 to 6,227m^3, refer to section 3.4.1 for details on tanks and volumes. The site is generally low lying and flat. There are two containment volumes to consider at Rye Meads:

Containment Area	Volume	Rule
Primary digester area	5,843m^3	Largest tank + Rainfall rule
Secondary digester area	9,341m^3	25% rule

An initial review, together with TW Site Operations, was carried out to confirm that the working of the sewage treatment work would not be compromised by any proposal. In the review closed containment and wide containment options were discussed.

Within the discussions the failure of a secondary digester tank (largest spilled tank) was addressed in two ways:

1. Separate containment areas with bunding that diverts spillage to a lagoon shared between the areas.

2. Adopting a wide containment area using bunding to contain spillage over the site.

The lagoon option is recommended, due to its slightly smaller footprint within the working area of the treatment works, and that the lagoon will prevent pooling of spillage around the site therefore allowing continued access to the sludge treatment works. Refer to Section 4.1 for details on the options reviewed and Section 4.3 for the preferred option.

It must be noted that the location and orientation of the lagoon will be dependent on the decisions taken for the location of gas bags planned to be installed as part of an AMP7 project relating to the fixing down of the primary digester roofs. At the time of writing the gas bags could be placed on either the existing cake pad or above the old sludge lagoons. Two similar lagoon options (O1a and O1b) based on the preliminary lagoon concept have therefore been suggested, final layout is selected once the proposed AMP7 project confirms the gas bag location. The replacement of the primary digester roofs is reported to be adopting a flexible roof system that avoids the need for gas bags, which allows the adoption of Option O1a.

Below a summary of the preferred option(s):

Containment Area	Description of containment
Lagoon Option **(O1a & O1b)**	• Two containment areas using low bunding to divert flow to pipework that conveys any spillage to a purpose-built lagoon. The lagoon is excavated to a depth of 0.75m and a below ground volume of some 8,800m^3. Bunding allows mobilisation of the surface area to achieve the 9,341m^3 total volume required and provides the freeboard. • Lagoon volume addresses largest spill volume. The two containment areas are some 150m apart mitigating the potential for a single event to trigger simultaneous failure in both areas • The lagoon construction will incorporate lining of the lagoon either using concrete or a recognised impermeable lining material. The lining system detail will ensure that the liner is stable when the lagoon is empty and will protect the underlying groundwater below the site should the lagoon be used to contain a spillage. • Small pump station to be built in order to divert rainwater to surface water network and back to head of works. • 9 x Ramps will be built where vehicular access is required in order to prevent spilled sludge exiting the containment boundary.

Float valves will also be installed onto surface water drains to prevent spilled sludge from returning immediately to the head of the works.

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 tertiary containment and conveyance to the site drainage system which discharges to the inlet works.

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 either a liner system or a bound impermeable material (high cement replacement concrete) to provide a surface that can be cleared of sludge to meet an eight-day recovery period. Vehicular access into the containment areas is by ramps (speed humps) restricted to nom 250-300mm in height; traffic movements on site make the use of permanent flood gates impracticable. Whilst the site is identified as requiring Class 2 containment (impermeable soil with a liner), the proposed solution is intending to apply high-cement replacement concrete (with no liner) on the basis of the impermeability of the concrete, inherent strength, and long-term mechanical resistance. The general layout of the proposed solution is presented on the next page:

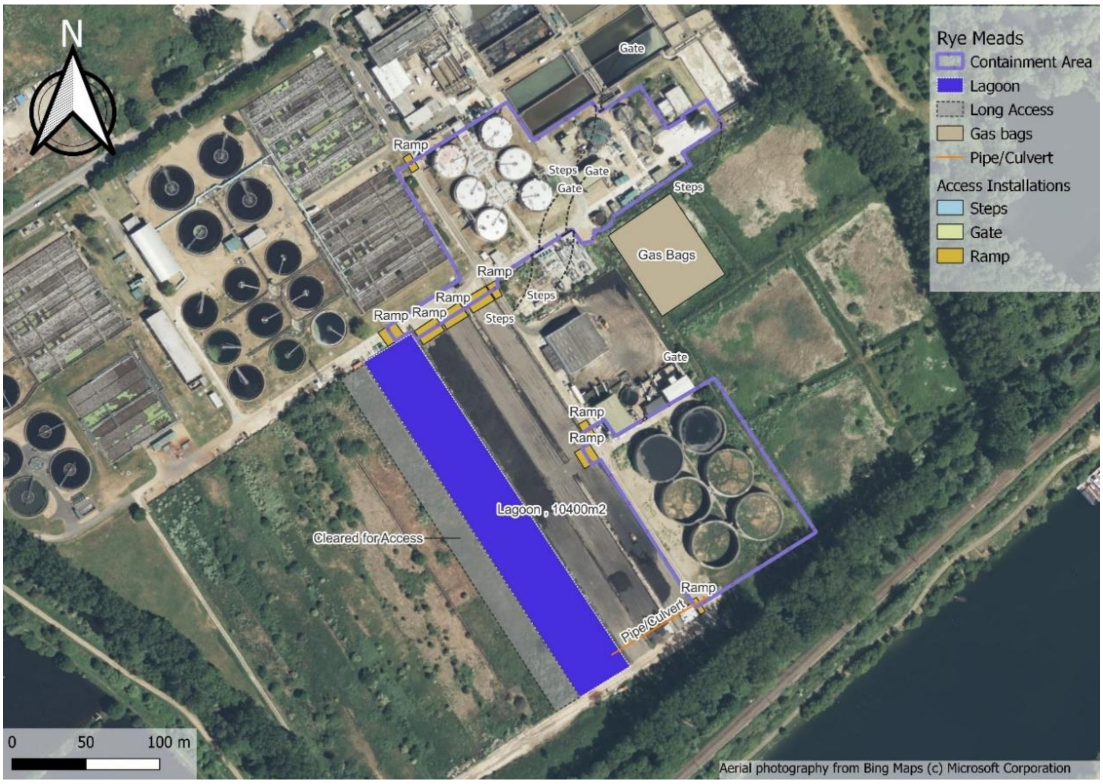

Figure 1-1 General layout of containment for Rye Meads STW - if future gas bags on old sludge lagoons (Option 1a)

Figure 1-2 General layout of containment for Rye Meads STW if future gas bags on old sludge drying beds (Option 1b)

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 28 Thames Water sites. Based on CIRIA C736 and ADBA risk assessment tools this containment report addresses the site-specific risks at Rye Meads 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 Rye Meads STW and the requirements to meet the industrial standard (i.e., CIRIA C736 and The Anaerobic Digestion and Bioresources Association Limited (ADBA)). Site-specific risks, credible failure scenario and design containment volume for the Rye Meads STW were identified through a desktop study, Light Detection and Ranging Analysis (LiDAR) analysis and a site visit.

Rye Meads STC, contained within Rye Meads Sewage Treatment Works (Figure 2-1) Rye Meads STW is located south of the A414, to the east of the town of Hoddesdon and approximately 10 km north of the Junction 26 of the M25. The site is immediately bounded to the north by Rye Meads Nature Reserve and is bounded to the east by agricultural land and a lake formed from the River Stort. The Southern boundary of the site is contained by the Greater Anglia train line, the River Stort and the Roydon Mill Marina.

Figure 2-1 Location of Rye Meads STW

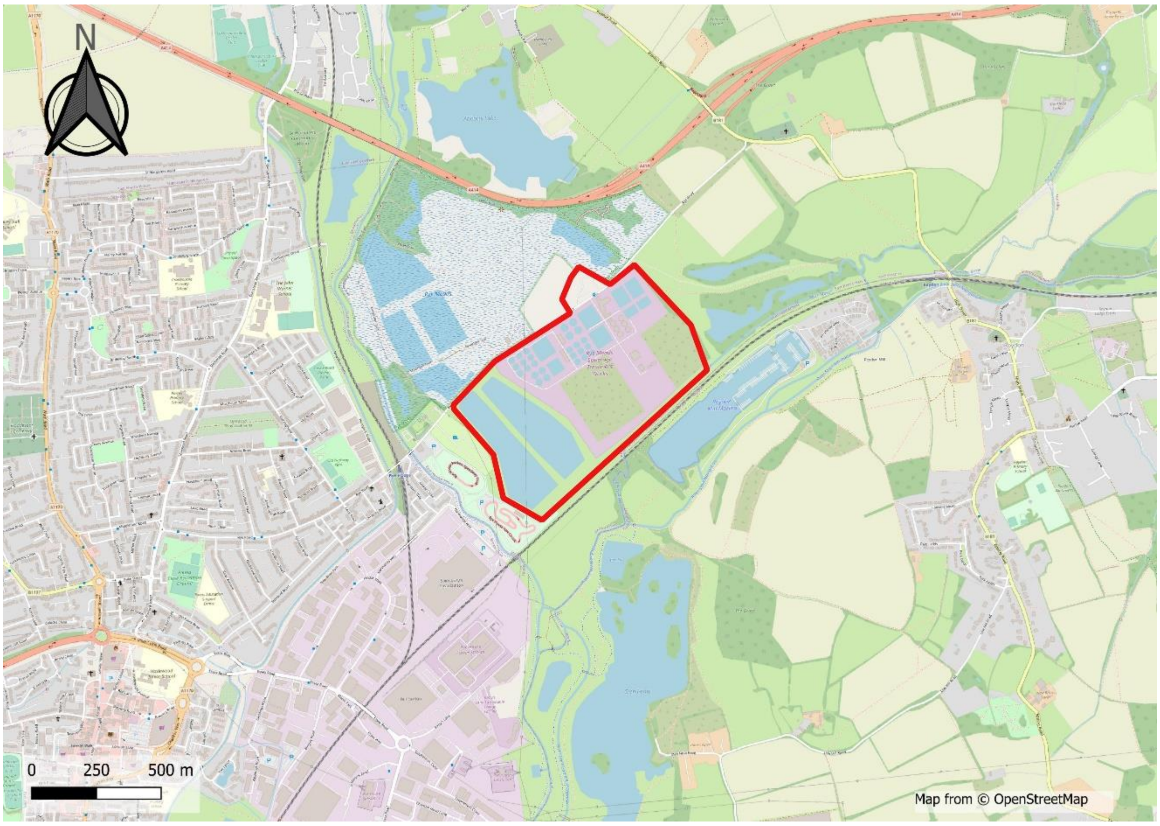

Figure 2-2 Satellite image of Rye Meads STW location

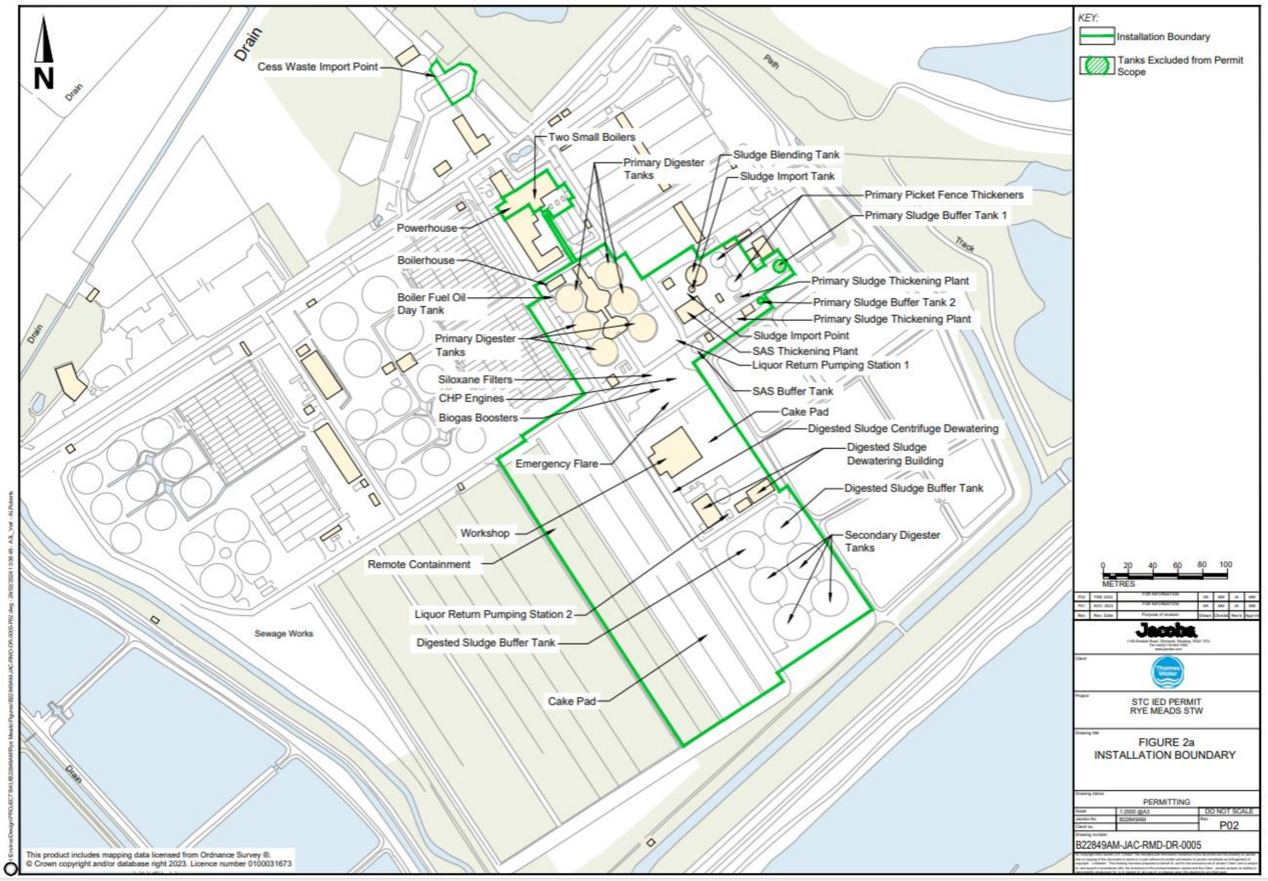

Figure 2-3 Boundary of permitted IED area and the assets

3. Proposed Containment at Rye Meads 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 makes reference to a key plan, reproduced below;

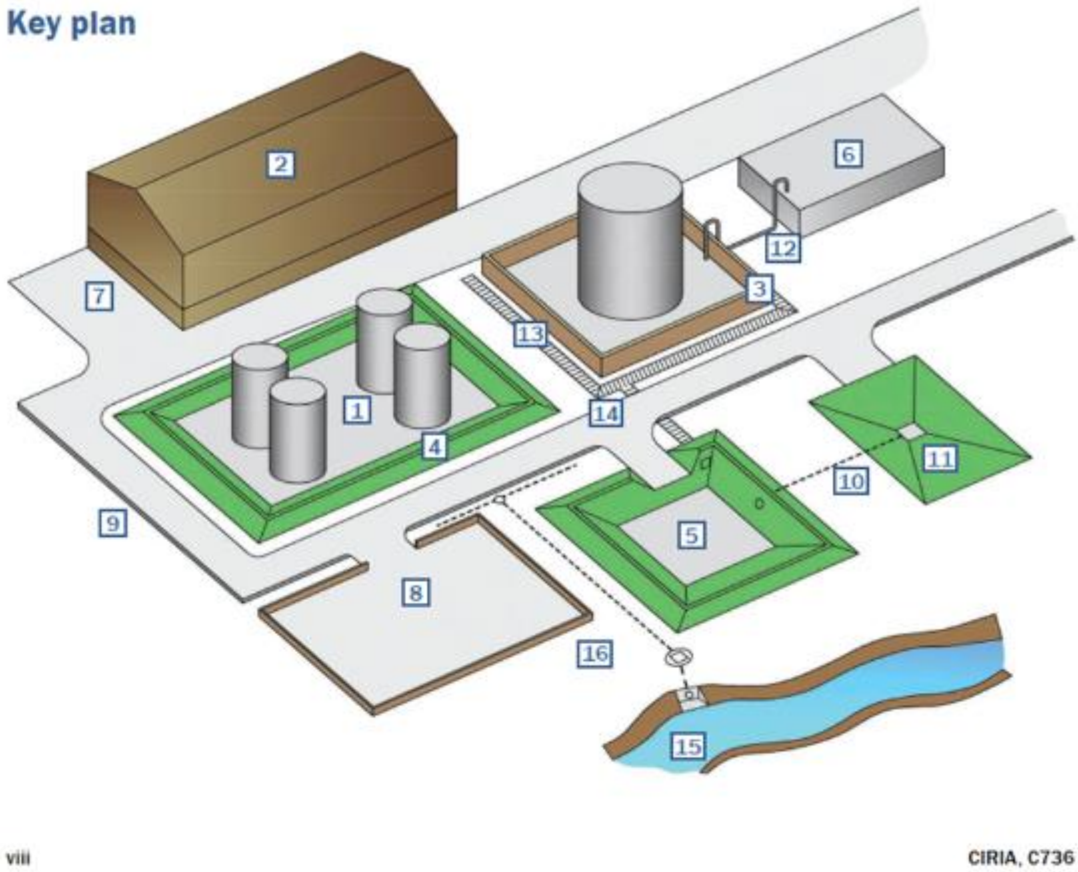

Figure 3-1 Diagram of primary, secondary and tertiary containment examples

-**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.

3.2.1 Uncontained Spill modelling

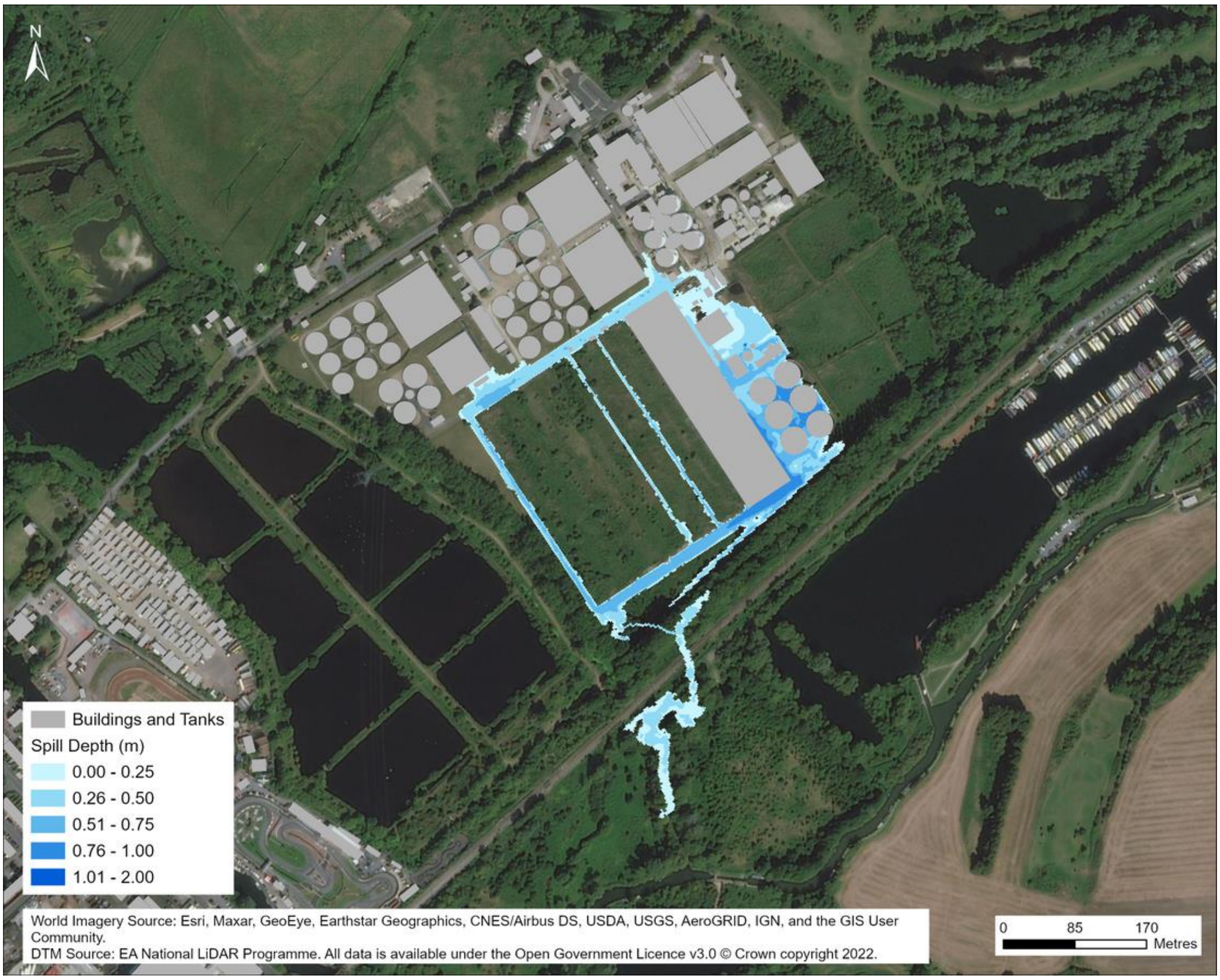

Figure 3-2 Uncontained Spill Model Results

Figure 3-2 shows the sludge spill mapping of an uncontained event in Rye Meads STC. The modelling results showed that a potential sludge spill from one of the Secondary 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, sludge will first flow and cover the area where the Secondary Digesters are located and be directed to the west against the sludge storage area. The north-western spill of the digesters will surround the sludge holding tanks, digested sludge dewatering building, cake pad, emergency flare, gas boosters, CHP engines, siloxane filters and then loop around southwest resulting in a square loop around the west and south boundary. The spill will flow marginally northwards from the Secondary Digesters but will predominantly leave the site boundary in the southern boundary corner, in approximately 2 minutes after the failure of one of the digesters.

The spilled content will eventually travel south bound and flow into the works discharge point, the Tollhouse Stream. The sludge will then travel downstream where it will reach the River Stort, a Thames tributary.

3.3 Site Classification Rye Meads

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

Table 1 Risk rating

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.

3.3.1 Spill Volume Summary

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 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 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. Section 4.3 and 4.4 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.

3.3.2 Total Spill Volumes

For each containment area, the containment volume has been checked against the largest tank + rainfall, the 110% and 25% rule and for each the 25% rule applies.

The total design contained volumes comprise:

1. Primary digester area: 5,843m^3
2. Secondary digester area: 9,341m3

Primary digester area		
25% Rule	**5,503m^3**	
110% Rule	**3,599m^3**	
Largest + rainfall	**5,843m^3**	**Emerging critical case**
Secondary digester area		
25% Rule	**9,341m3**	**Emerging critical case**
110% Rule	**6,850m^3**	
Largest + rainfall	**8,790m^3**	

Table 2 Estimating critical spill volumes

3.4 Rye Meads STW Summary of Containment volumes and assets

3.4.1 Assets for Containment

The tanks for which containment is required are summarised below. There are two containment areas, the Primary Digesters Area (PDA) and the Secondary Digesters Area (SDA).

Tank Purpose	No.	Operational Volume (m^3)	Total Operational Volume (m^3)	Material	Site Area
Primary Picket Fence Thickeners	2	904	1808	Concrete	PDA
SAS Buffer Tank	1	238	238	Steel	PDA
Sludge Blending Tank	1	800	800	Steel	PDA
Sludge Import Tank	1	50	50	Concrete	PDA
Primary Digester Tanks	6	3,400	20,400	Concrete	PDA
Secondary Digester Tanks	4	6,227	24,908	Concrete	SDA
Digested Sludge Buffer Tanks	2	6227	12,454	Concrete	SDA

Table 3 List of tanks and volumes

3.4.2 Digital Terrain Model

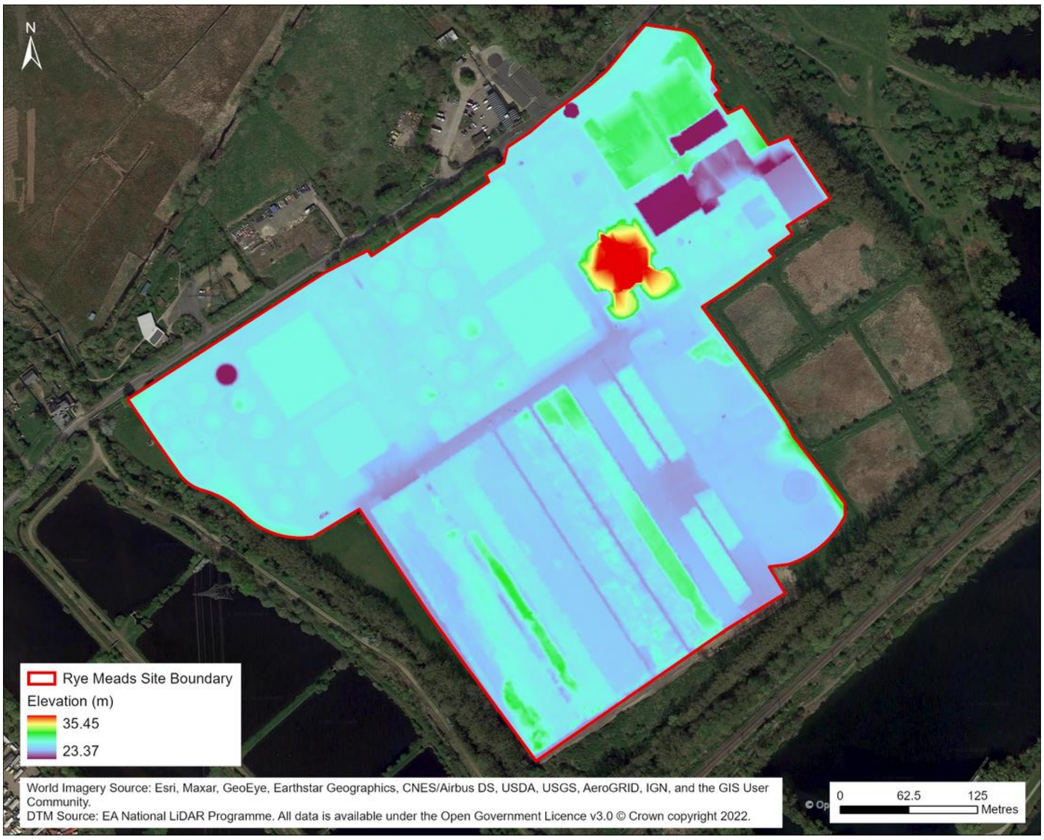

Figure 3-3 Digital Terrain Model of Rye Meads Sewage Treatment Works

The STW effluent channel (Figure 3-3), which is discharging to Tollhouse Stream, is located directly on the central southern boundary of the works. Considering the topography of the sludge area, the high-resolution contouring revealed that the site is generally flat with the Secondary Digesters on very slight elevated ground. To the east of the digesters there are areas of higher elevation which in the event of catastrophic failure of one of the secondary digesters would act as a natural barrier to prevent flows spreading east of the site. The Primary Digesters are located to the north of the secondary digesters on an elevated area therefore, in the event of catastrophic failure of one of the secondary digesters, the primary digesters could act as a means of bund to prevent the sludge from spreading further. However, in the event of failure of one of the Primary Digesters, sludge would be expected to spread further than intended due to the tanks located on a high elevated area. The sludge storage area, located to the west of the Secondary Digesters would also form a barrier to prevent sludge passing through in the event of a spill.

3.5 Contained Model Output and Contour Maps

For Rye Meads, two viable options were modelled and three methods of failure. These are shown in table 4 below.

The first option considers the construction of a lagoon, which via low bunding, will receive a spillage from the primary digester area and the secondary digester area. Two distinct critical spill vol. for the two zones were modelled for this option to confirm the pooling depths in the smaller containment boundaries and the flow into the lagoon. As can be seen from Figure 3-4 all sludge from the digester areas flows to the lagoon and none is left to pool within the containment areas around the tanks. For the 25%-rule volumes, some of the spill ponds on access road. However, for the more credible case of largest tank+rainfall, all flows are held within the lagoon. This means main access roads will be kept clear, allowing activity to continue within the site for all but the most unlikely spill event.

The second option, a wide containment area, considers the cleaning and concreting of the old sludge drying beds to create an impermeable surface over which the spilt sludge may flow and pool. As there are no boundaries between the primary digester and secondary digester areas, the critical spill vol. of the total area was used to understand the pooling of the spillage over the containment area. spilled sludge will spread around the site with some water depths reaching up to 800mm, some profiling of the old sludge drying beds would be necessary to make use of the area so that a spillage will not pool along the main access road.

Option	Model	Method of failure	Figures
1	Lagoon Option	Primary Digester Failure	Figure 3-4
		Secondary Digester Failure	Figure 3 5
2	Wide containment Area	Secondary Digester Failure – 25% Rule	Figure 3-6

Table 4 Contained model options and method of failure

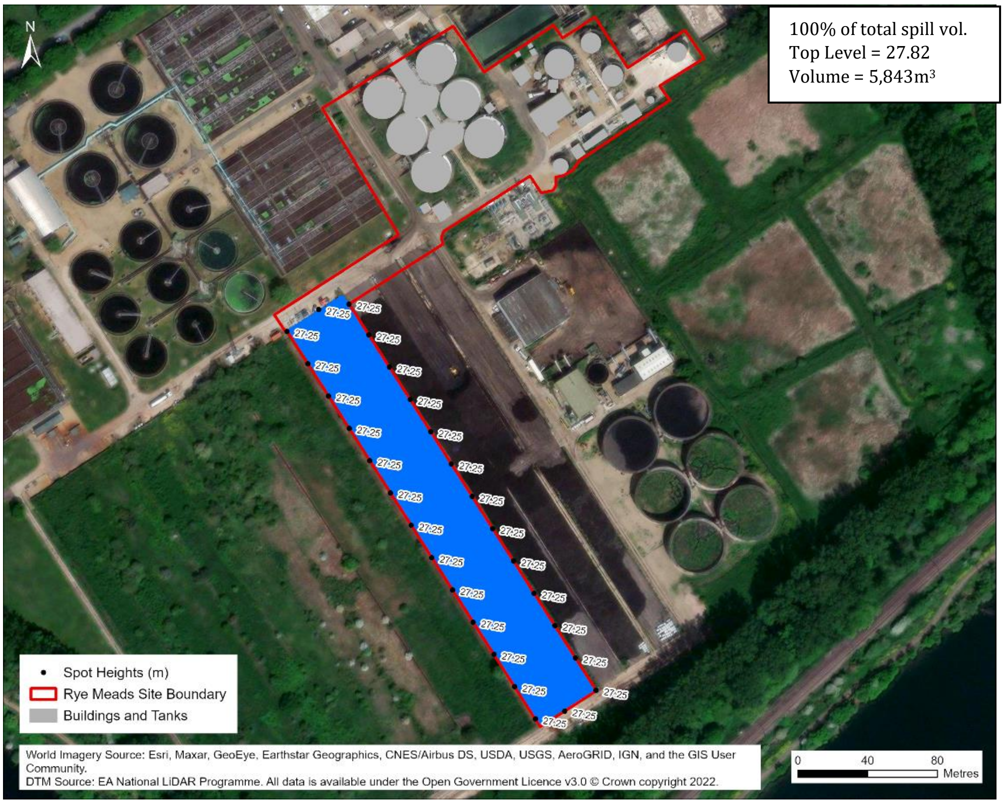

Figure 3-4 Contained model output for lagoon option showing spillage in the primary digester area, TWL of liquid at 28.82mAOD and spot levels

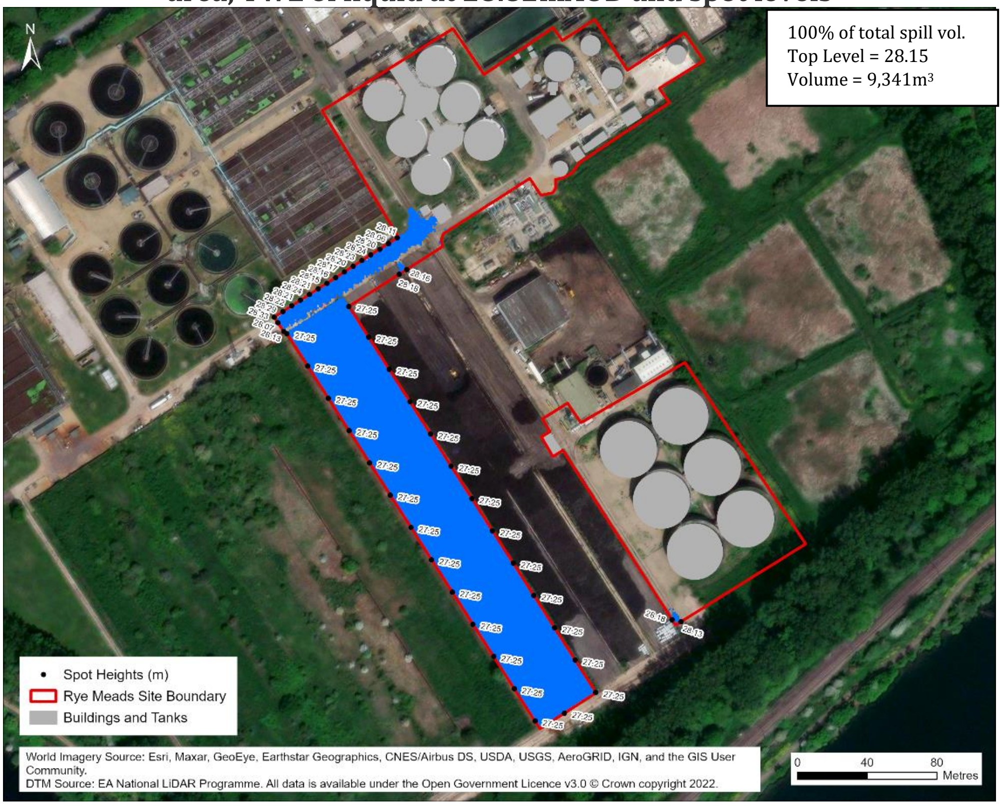

Figure 3-5 Contained model output for lagoon option showing spillage in the secondary digester area, TWL of liquid at 28.15mAOD and spot levels

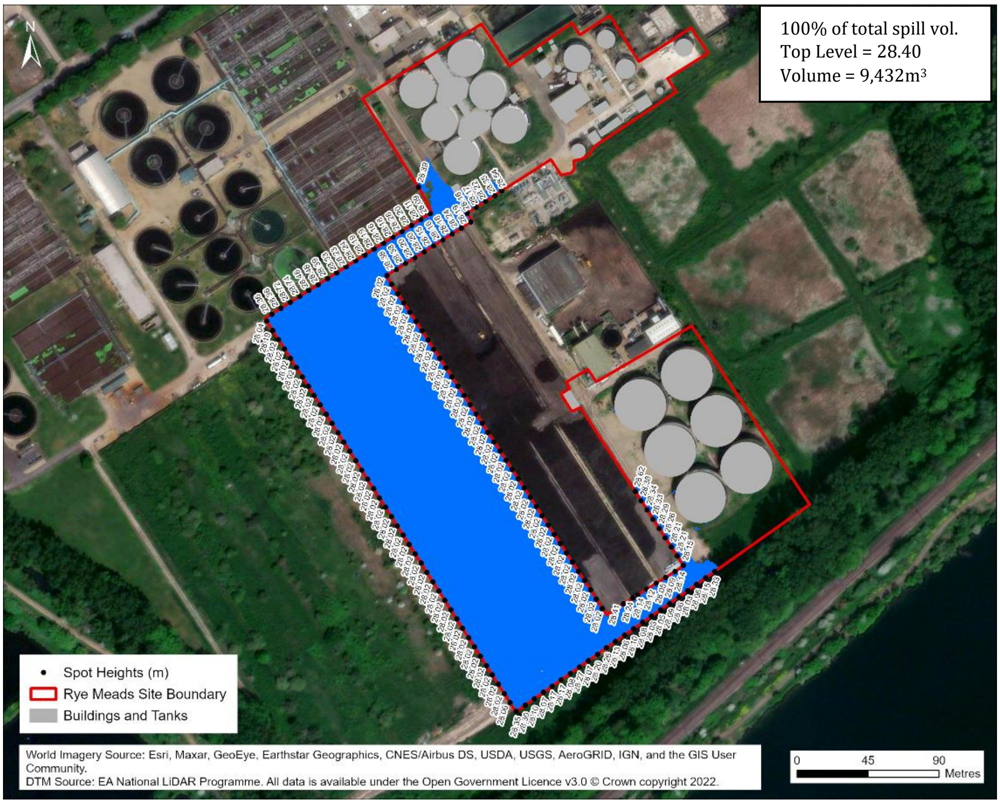

Figure 3-6 Contained model output for old sludge drying beds as containment showing spillage within wide containment area TWL of liquid at 28.40mAOD and spot levels

3.6 Identified Constraints

3.6.1 Operational constraints

3.6.1.1 Clean-up time

The time to recovery and return site back to operation has been set at 3 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.

3.6.1.2 Surface cleaning

The existing ground surfaces around the sludge treatment tanks consist mainly of grass and gravel that will need to be replaced with an impermeable surface, such as concrete, to facilitate the cleanup. The impermeable surface will be gently sloped to aid with the sludge spill flow path towards the drainage network.

It is noted that concreting these areas may slow emergency access to underground surfaces and there is a trade-off between the advantages of digging up existing surfaces (in grass or gravel) vs. decreasing the clean-up effort required in the event of a sludge spill.

Whilst the site is identified as requiring Class 2 containment (impermeable soil with a liner and leakage detection system), the proposed solution is intending to use concrete (with no liner) based on the impermeability of the concrete, inherent strength, and long-term mechanical resistance. Remedial works to existing concrete slabs/roads will be undertaken to ensure that they provide a competent surface, for example resealing of joints.

3.6.1.3 Access and Traffic Thoroughfare

Vehicular access through the flow guiding walls will be via ramps (speed humps) restricted to nom 300mm in height and 1:15 slope.

Flood gates have been included at the proposed entry points into containment areas around the secondary and primary digesters to serve non-frequent access and where geometry precludes the use of ramps.

To allow access on foot, steps with handrails will be constructed to allow workers to traverse the walls.

3.6.1.4 Existing Services

Several above ground pipes can be seen from aerial images which may need to be relocated during construction/excavation.

3.6.2 Geotechnical and Environmental constraints

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.

3.6.3 Other constraints

None

3.7 Design allowance for rainfall

In addition to the maximum volume arising from a credible failure scenario, 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 for the 24 hours preceding an incident and for the duration of the incident and recovery. Thames Water has confirmed a three-day period for the incident and recovery. The arising average rainfall depths for a 1 in 10-year storm over the event period for Rye Meads is 67.89 mm. It should be noted that the rainfall depths for Rye Meads have been estimated using the depth-duration-frequency rainfall model contained on the *Flood Estimation Handbook* (FEH), which provides location specific rainfall totals for given durations and return periods.

3.8 Planned Site Upgrade

Thames Water Operations noted that major upgrades to the site are proposed including installing coverings on the primary digesters, installing additional gas storage capacity and removing redundant equipment and instrumentation from the SCADA system.

- Containment construction as part of the preferred option may interfere with planned upgrades and connections.

- The planned construction of major storage assets could potentially be combined or repurposed with sludge containment construction for a more cost-effective solution, but at this point the containment proposals seek to avoid sterilising areas with potential to accommodate new construction.

- Communication amongst different Thames Water teams and consultants is necessary to ensure the old sludge drying beds are repurposed in an efficient way.

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 Rye Meads, 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 Rye Meads 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 to 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. Dependent on timing of the works these ramps may be pre-cast to allow shorter installation times and to allow works to continue on the site along the main access road.
- Local infill of grass/gravel to create an impermeable surface and facilitate containment and conveyance.
- Steps will provide a containment barrier and allow access in and out of the containment area where foot traffic is high, but vehicular access is not needed. These steps will have handrails to facilitate safe passage over them.
- Flood gates to installed where areas with foot traffic are low, but where vehicular access may be necessary.
- Remote secondary containment through the construction of a lagoon to store spilled sludge.

4.1 Containment Options

Three options were investigated and developed with operations:

Option	Description
O1a	Considers two separate containment areas that drain into a shared lagoon that fills the full length of the old sludge drying beds, Figure 4-1
O1b	Considers a squarer lagoon located on the southern end of the old drying beds, Figure 4-2
O2	Considers 1 wide containment area by concreting over 4 lanes of the old sludge drying beds, Figure 4-3.

The main features of the options are summarised in tabulated form below.

Containment Option	Description of containment
Lagoon Option (O1a & O1b)	• Two containment areas using low bunding to divert flow to pipework that conveys any spillage to a purpose-built lagoon. The lagoon is excavated to a depth of 0.75m and a below ground volume of some 8,800m^3. Bunding allows mobilisation of the surface area to achieve the 9,341m^3 total volume required and provides the freeboard. • Lagoon volume addresses largest spill volume. The two containment areas are some 150m apart mitigating the potential for a single event to trigger simultaneous failure in both areas • The lagoon construction will incorporate lining of the lagoon either using concrete or a recognised impermeable lining material. The lining system detail will ensure that the liner is stable when the lagoon is empty and will protect the underlying groundwater below the site should the lagoon be used to contain a spillage. • Small pump station to be built in order to divert rainwater to surface water network and back to head of works. • 9 x Ramps will be built where vehicular access is required in order to prevent spilled sludge exiting the containment boundary.
Wide containment area (O2)	• Wide containment area using low bunding to contain spilled sludge, old sludge drying beds to be cleaned and concreted over to provide extra containment area. • 12 x Ramps will be built where vehicular access is required in order to prevent spilled sludge exiting the containment boundary.
Summary	• O1 has a smaller concrete footprint and keeps access available for vehicles on the southern side of the cake pad • O1 Lagoon acts as separator to the current cake pad and potential future pad area, that could allow isolation of cake does not meet required standards. • O2 includes large area that would be attractive to be used as emergency cake storage. • For O2 if a catastrophic spill was to happen cake stored in emergency storage could be ruined.

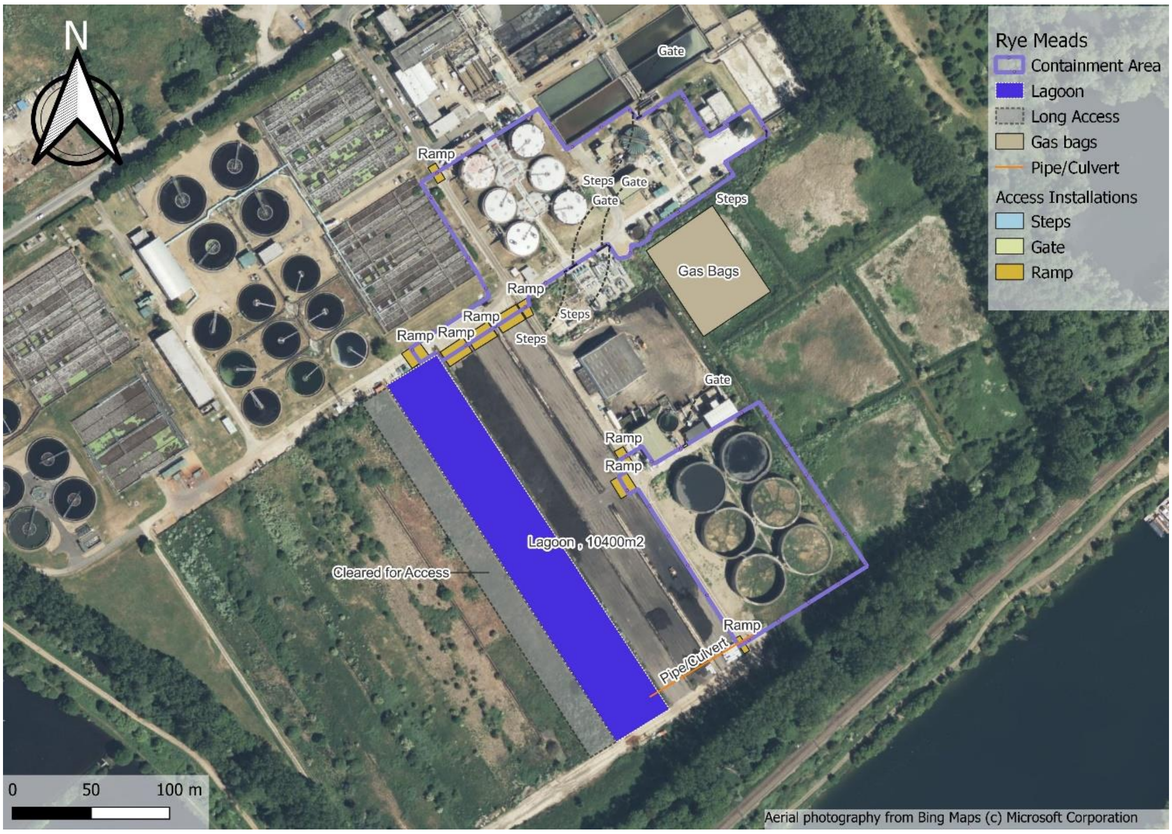

Figure 4-1 - O1a – Lagoon Option – If future gas bags on old sludge lagoons

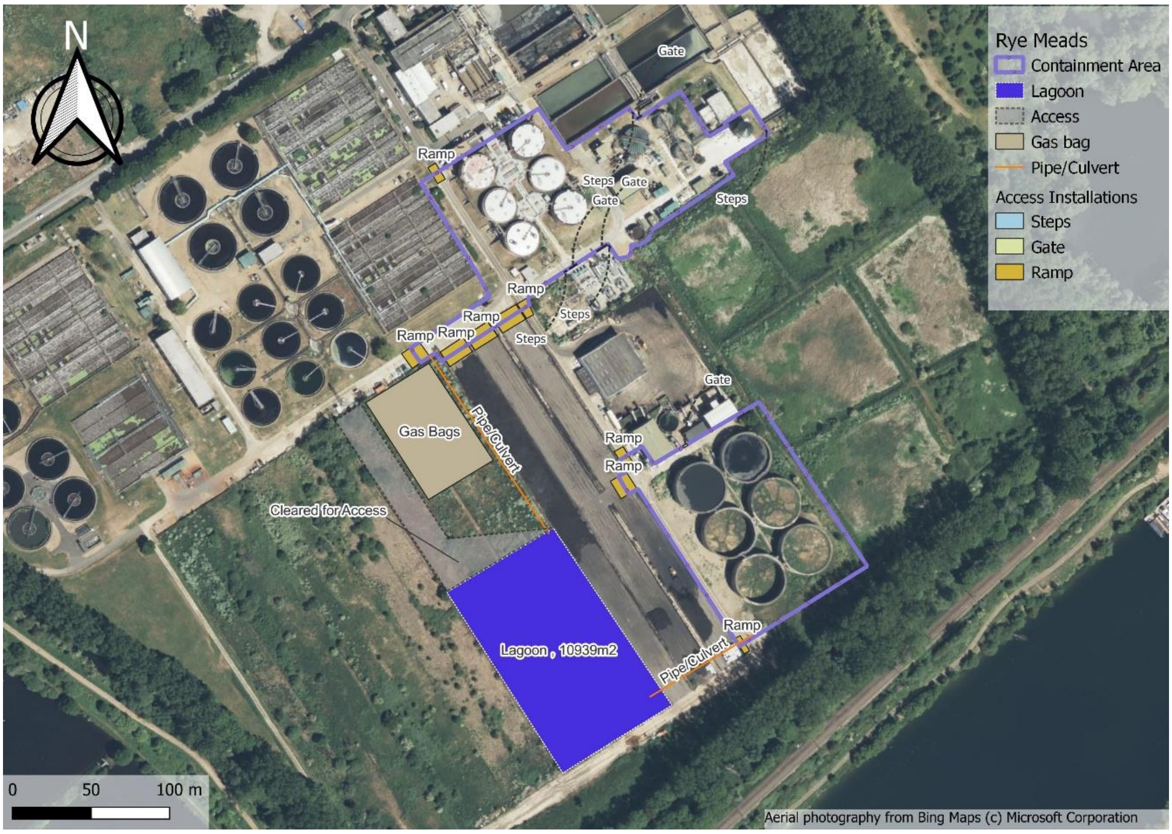

Figure 4-2 O1b - Lagoon Option – If future gas bags on old sludge drying beds

Figure 4-3 – O2 - single wide containment area with shallow storage on old drying beds

4.1.1 Options O1a and O1b – Lagoon Option

Both of these options consider the use of a Lagoon which is the preferred conceptual option for Rye Meads. Any spill will eventually be contained completely within the lagoon, allowing works to continue around the site. An area will need to be cleaned to allow access to this lagoon which may also be used as an emergency store for sludge that does not meet required standards.

The main difference between O1a and O1b is the amount of area that will need to be cleared for access which would eventually mean less area for emergency storage of sludge. Option O1a also requires less pipework, as there will be no need to convey any spill from the access road to the north of the lagoon, via a culvert or pipe.

Option O1a is the preferred option leaving option O1b to be selected only if new gas bag projects prevent the construction of a lagoon running the full length of the old sludge drying beds.

4.1.2 Option 2 – Single wide containment area

The second option considers a single wide containment area and the repurposing of old sludge drying beds into a containment area shown in Figure 4-3.

A variation to this layout which allowed the cake pad to fall within the containment area was considered briefly, however the larger concrete footprint and operational issues relating to the potential inundation of the cake storage area saw it rejected.

4.2 Mitigation of Site-Specific Risks

4.2.1 Jetting and Surge Flows

There is the potential for wo of the primary and secondary digesters to jet over the containment boundary. It is noted that the jetting risk does not result in flow passing over the site boundary into the wider environment. This on-site risk is mitigated by the operation of the site's road drainage providing a conveyance pathway to the head of the works.

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 and addressed before becoming a major issue.

The natural topography of the site, freeboard 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 area is in Flood Zone 3, as shown in Figure 4-4. The Flood Zone definitions listed in Figure 4-4 provide additional detail of the areas of concern, which in the case of Rye Meads STW, have a 1-in-100 or less probability of river flooding.

The area for the proposed lagoon has longstanding material bunded on the drying beds, the construction of the lagoon will cause no detriment to the effective flood storage volume as a result. The bund walls for the lagoon will be set to be above the 1-in-100-year flood event level.

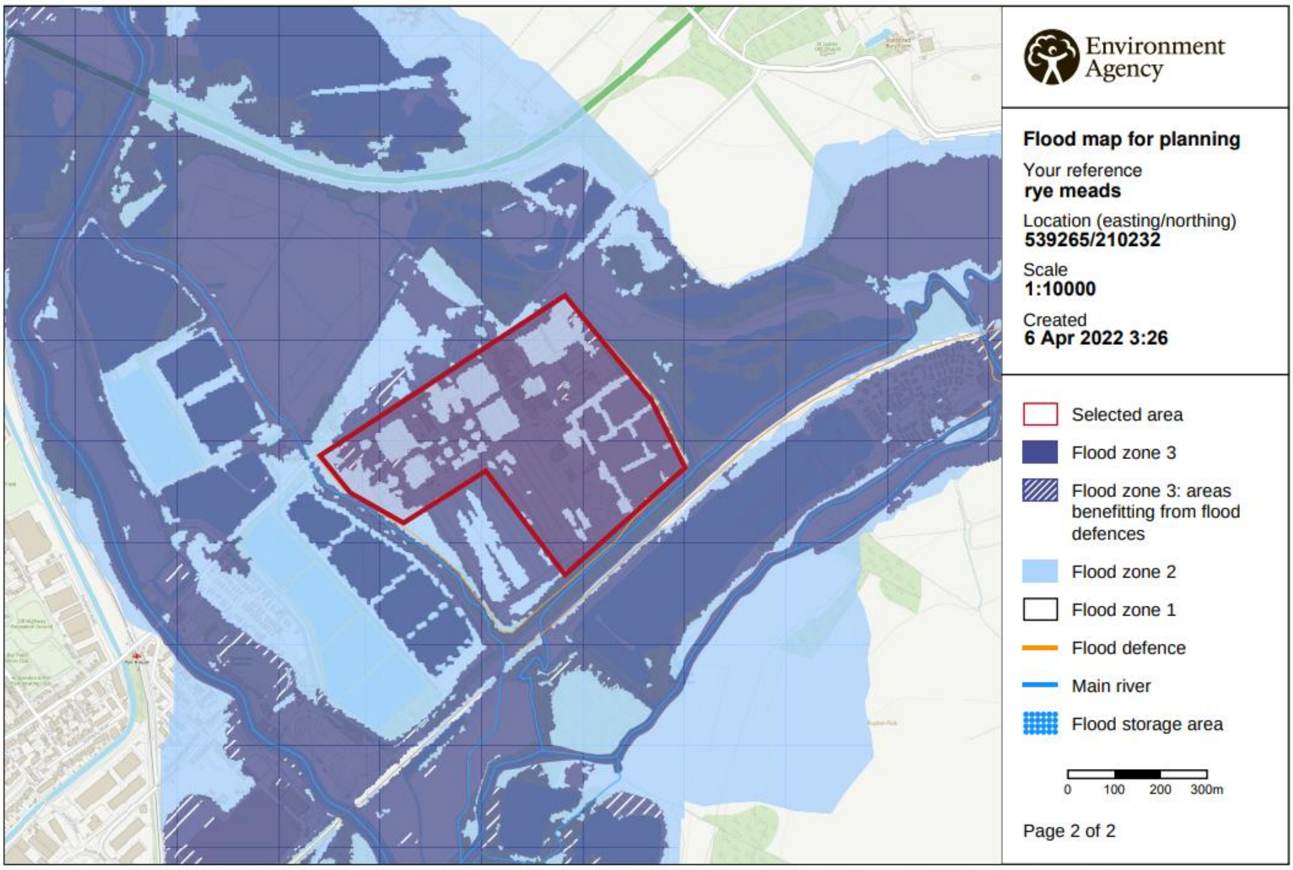

Figure 4-4 Extent of Fluvial flooding in Rye Meads due to extreme weather events

4.3 Identification of Preferred Option

The preferred containment proposal is O1a which considers the following advantages:

- Efficient use of assets/space (using roads and elevated areas to act as natural bunding)
- Practicality of installation (lower containment bund construction required)
- A lower bund wall will minimise long term site operational impacts including line of sight and ease of access.
- Access road operation simplified by use of ramps to cross containment lines rather than by the use of floodgates. With access possible into containment areas following catastrophic spill as spillage flows to lagoon.

Option O1b would only progressed should O1a not be possible due to the outcome of the AMP7 gas bag project.

Recent feedback indicates that the digesters roof replacement project will adopt a flexible roof system that incorporates gas storage. Should this be completed then Option 01a can be progressed.

H&S and CDM risks

- Flood gates not suitable for areas of high traffic movement
- Cable ducts and fibre ducts act as conduit to transport sludge around site.
- Confirm that the containment walls do not impact the existing DSEAR equipment rating.
- Maintenance of a new large non-process asset for the operations team.
- Security around the lagoon important to prevent wildlife entering.

5. Site Drainage and liquor returns

5.1 Process flow diagram

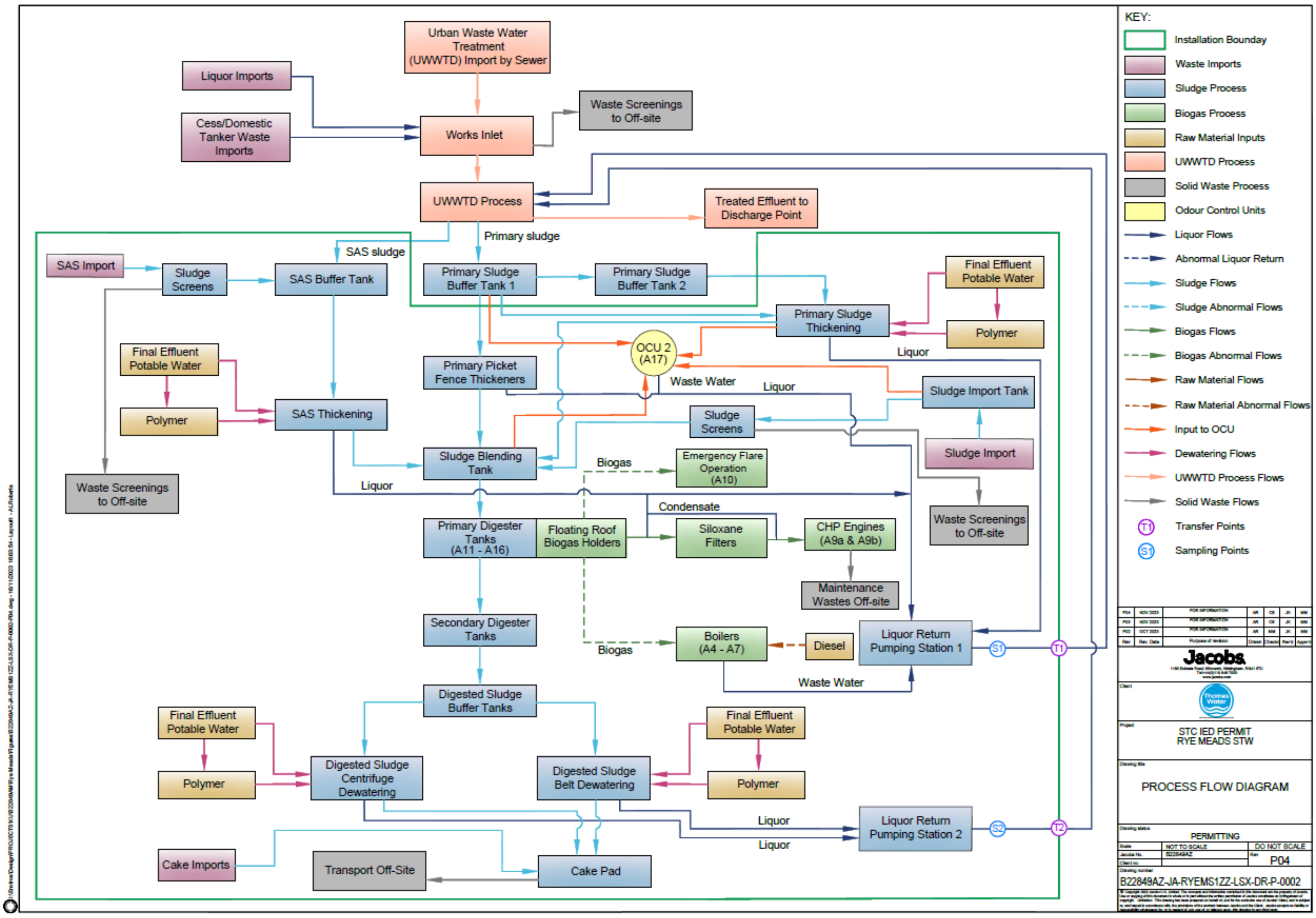

Figure 5-1 Process flow diagram for STW

5.2 Foul Process and Effluent Drainage

There are no existing site drainage plans. From site visits it has been indicated that the site drains fully to the works inlet. Supplementary survey work has been undertaken to confirm the discharge at Rye Meads.

Containment options onsite involve replacing existing impervious areas with concrete. This will result in a small increase in site surface waters, which are likely to have a negligible additional effect on the head of the works given the scale of flow to full treatment at Rye Meads.

5.3 Liquor Returns

The existing liquor return system is not being altered by the containment system, other than the control modifications proposed in Section 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 digester area 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 generate an alarm.

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, this line 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 existing drainage network (and into the head of the works) unless operators intervene to isolate the drainage networks. Due to the flow to full treatment at Rye Meads being large, minor spill flows will not adversely impact the process.

- 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 Rye Meads Sewage Treatment Works.

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

The total contained volumes comprise:

Containment Area	Volume	Rule
Primary digester area	5,834m^3	Largest Tank + Rainfall
Secondary digester area	9,341m^3	25% rule

A lagoon-based solution is recommended as offers advantage over the wide containment area. Two variations for the lagoon configuration have been considered and the selection will depend on the outcome of the current AMP7 gas bag project, these are options 01a and 01b, described below:

Containment Area	Description of containment
Lagoon Option **(01a & 01b)**	• Two containment areas using low bunding to divert flow to pipework that conveys any spillage to a purpose-built lagoon. The lagoon is excavated to a depth of 0.75m and a below ground volume of some 8,800m^3. Bunding allows mobilisation of the surface area to achieve the 9,341m^3 total volume required and provides the freeboard. • Lagoon volume addresses largest spill volume. The two containment areas are some 150m apart mitigating the potential for a single event to trigger simultaneous failure in both areas • The lagoon construction will incorporate lining of the lagoon either using concrete or a recognised impermeable lining material. The lining system detail will ensure that the liner is stable when the lagoon is empty and will protect the underlying groundwater below the site should the lagoon be used to contain a spillage. • Small pump station to be built in order to divert rainwater to surface water network and back to head of works. • 9 x Ramps will be built where vehicular access is required in order to prevent spilled sludge exiting the containment boundary.

Option 01a will be adopted if the primary digesters roof replacement works complete with the reported adoption of a flexible roof system that incorporates gas storage.

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.

Existing gravelled and grass areas within the containment will be replaced with concrete. Elements of the site roads will be replaced/repaired to allow them to present an impermeable surface.

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.

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 and flow being conveyed to the proposed lagoon.

Appendix 1 ADBA Site Hazard Risk assessment summary for Rye Meads STW

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 Rye Meads STW are as follows:

Source – There is one main source that has been identified:

1. Sludge digestate

The Source Hazard rating was determined as **High**.

Pathway – There are two pathways that have been identified:

1. The site is in a zone 3 flood plain
2. Sludge treatment centre is integrated with large sewage works; as a consequence,

The Pathway Hazard rating was determined as **High**.

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

1. River Stort and Lea Navigation are less than 100m from the site boundary.
2. There are SSSI, SPA and RAMSAR sites within 1000m of the site.

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.