J840 – STC IED Containment

Slough STC – Containment Options Report

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Thames Water

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6.0	28/06/2023	Updated App 2/Permit Plan	MH	SMNS	SC	HG

Contents

1. Executive Summary

Thames Water is required by the Environment Agency to provide secondary containment to their sludge treatment centres (STC) 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 Slough.

Slough serves a population equivalent of some 226,000 receiving flows from the 13 areas around Slough. 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.

Slough has the potential for some 25,569m^3 of liquid to escape from the sludge treatment centre in the event of tanks failure. The liquid sludge is stored in 16 tanks with individual volumes varying between 254-3197m^3, refer to section 3.4.1 for details on tanks and volumes. The majority of the tanks are concrete, the site is manned and subject to regular tours by operations staff. The site is generally reasonably flat with the primary digester area being at a slightly lower elevation to the rest of the site.

Within this report, failure of a digester or sludge tank has been addressed by three independent containment areas due to their disparate locations on site. Options for these three areas have been identified and reviewed with Operations to confirm that the working of the sewage treatment works is not compromised by proposals, refer to section 4.1 for details of the options and section 4.3 for preferred option.

1. For the primary digesters (south-west) area, the installation of a close containment area is proposed. To keep the bund wall to a practicable height, the footprint of two old primary digesters has been mobilised as storage within the closed containment area. These tanks are being taken out of service by Operations, the roof is being removed and the low-level access hatch is being replaced with a grille to allow ventilation of the tank shell, which allows flows to access the tank. Access to the containment area is by a flood gate which is normally closed (with alarm to SCADA when not closed), and the area is subject to a low frequency of movement which complements the flood gates remaining normally closed. Containment volume dictated by largest-tank-plus-site-specific-rainfall, which exceeds the 110% and 25%-rules.

2. For the primary digesters (north-east) area, the installation of a close containment area is proposed. To keep the bund wall low to allow the use of access ramps, the proposed solution incorporates the construction of a storage lagoon where the disused sludge drying beds are located. Containment volume dictated by largest-tank-plus-site-specific-rainfall, which exceeds the 110% and 25%-rules.

3. For the secondary digesters area, installation of a close containment area using taller bund walls to this group of tanks is proposed. Tall walls are constructed on three sides to mitigate the risk of jetting (externally to the south, into the storm tanks to the east and onto the cake pad to the west). The fourth side is lower to aid ventilation and maintain visibility into the area from the site access road. Access to the containment area is by a flood gate which is normally closed (with alarm to SCADA when not closed), and the area is subject to a low frequency of movement which

complements the flood gates remaining normally closed. The residual risk of jetting may be mitigated by the installation of a 2m high screen. Containment volume dictated by largest-tank-plus-site-specific-rainfall, which exceeds the 110% and 25%-rules.

It is recommended that the above solution is progressed as it meets the TW Operations constraints relating to maintaining access around the site for normal operation whilst incorporating long-term containment. This solution allows the containment areas to remain separate from the UWWTD plant.

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. The nature of the flow and the size of the works mitigates the impact of such flows upon the treatment process.

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 day recovery period. Vehicular access into the containment areas where frequent access is required is by ramps (speed humps) restricted to nominal 300mm in height; where traffic movements are expected to be less frequent and the threshold for ramps is exceeded, permanent flood gates were proposed. The flood gates will be to the EA specification. 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.

General layouts of the proposed solutions are presented overleaf.

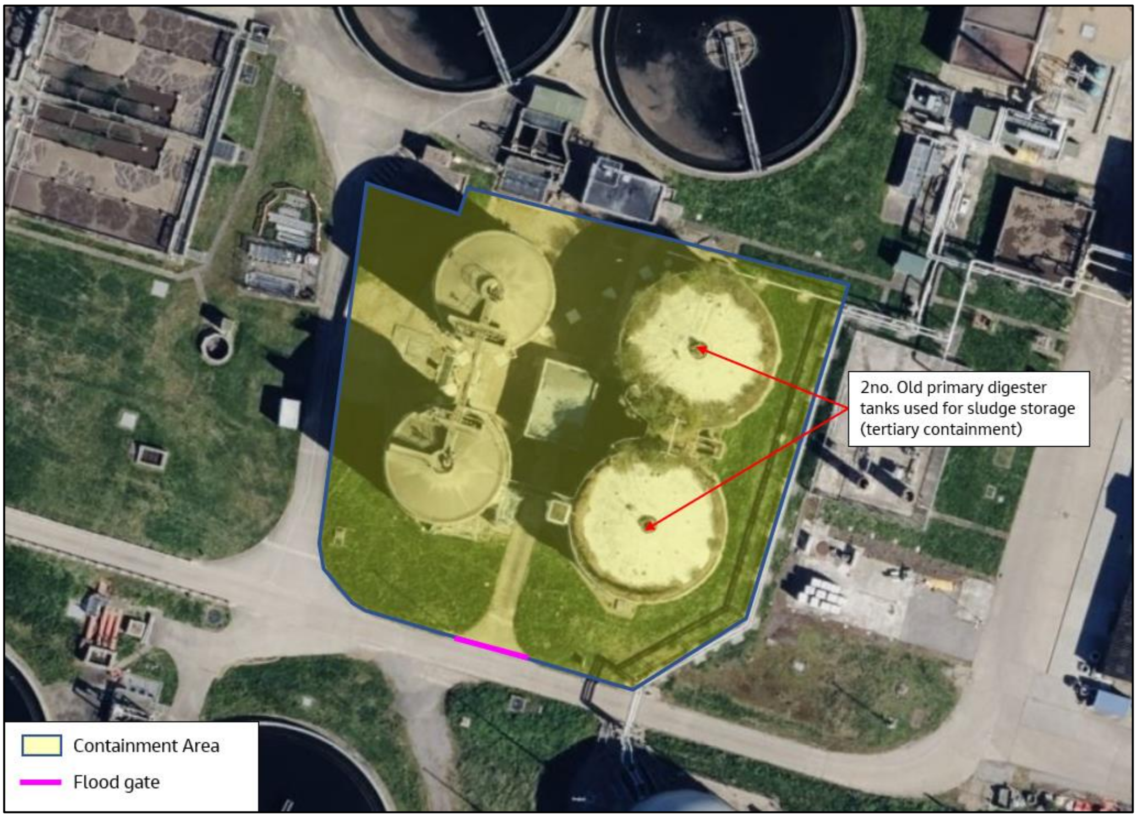

Figure 1-1 – Primary Digesters (south-west) Area – Containment layout

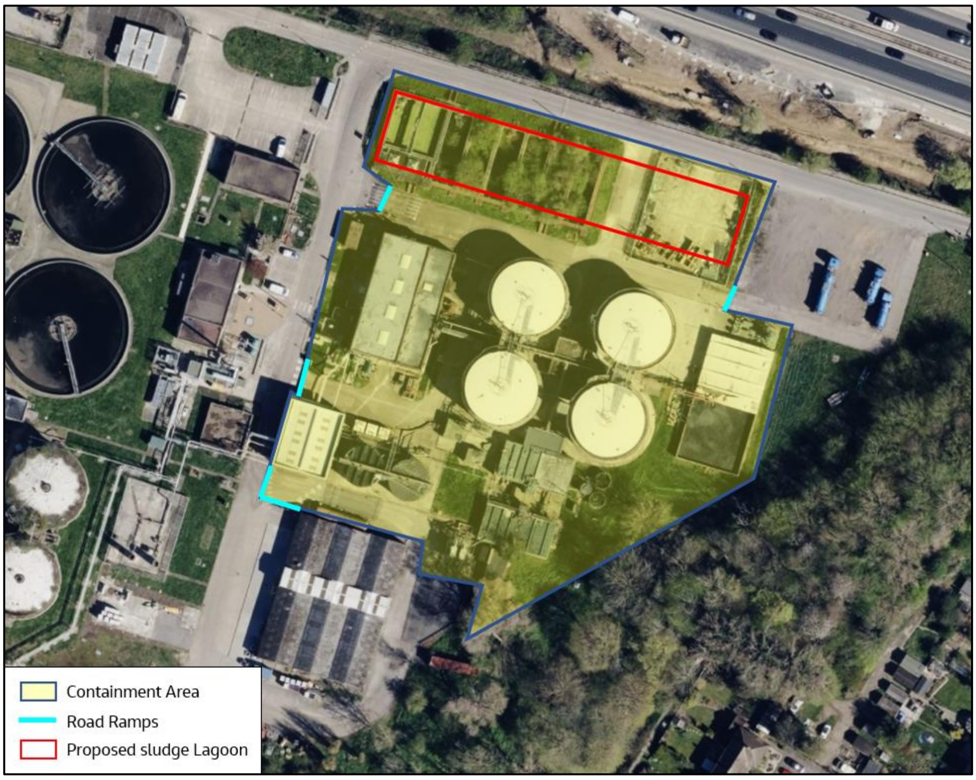

Figure 1-2 – Primary Digesters (north-east) Area – Containment layout

Figure 1-3 – Secondary Digesters Area – Containment layout

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".* 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 ABDA risk assessment tools this containment report addresses the site-specific risks at Slough 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 The Anaerobic Digestion and Bioresources Association Limited (ADBA)). Site-specific risks, credible failure scenarios and design containment volume for the Slough STW were identified through a desktop study, Light Detection and Ranging Analysis (LiDAR) analysis and a site visit.

Slough STC, contained within Slough Sewage Treatment Works (Figures 2-1 – 2-4), is located a mile west of central Slough, with the M4 to the north, beyond which resides a large housing development. South and east are rural areas, with Dorney to the southwest, and Eton Wick to the south, both within a mile of site boundary. Slough STW serves a population equivalent of 226,000 from 13 areas around Slough.

Figure 2-4 shows the Boundary of the permitted IED area and the assets contained within Slough STW.

This document should be read in conjunction with Slough STW, Risk Identification and Containment Assessment Report, revision 0A dated 11/04/2022 which outlines the impact of an uncontained spill with the associated risk assessment completed.

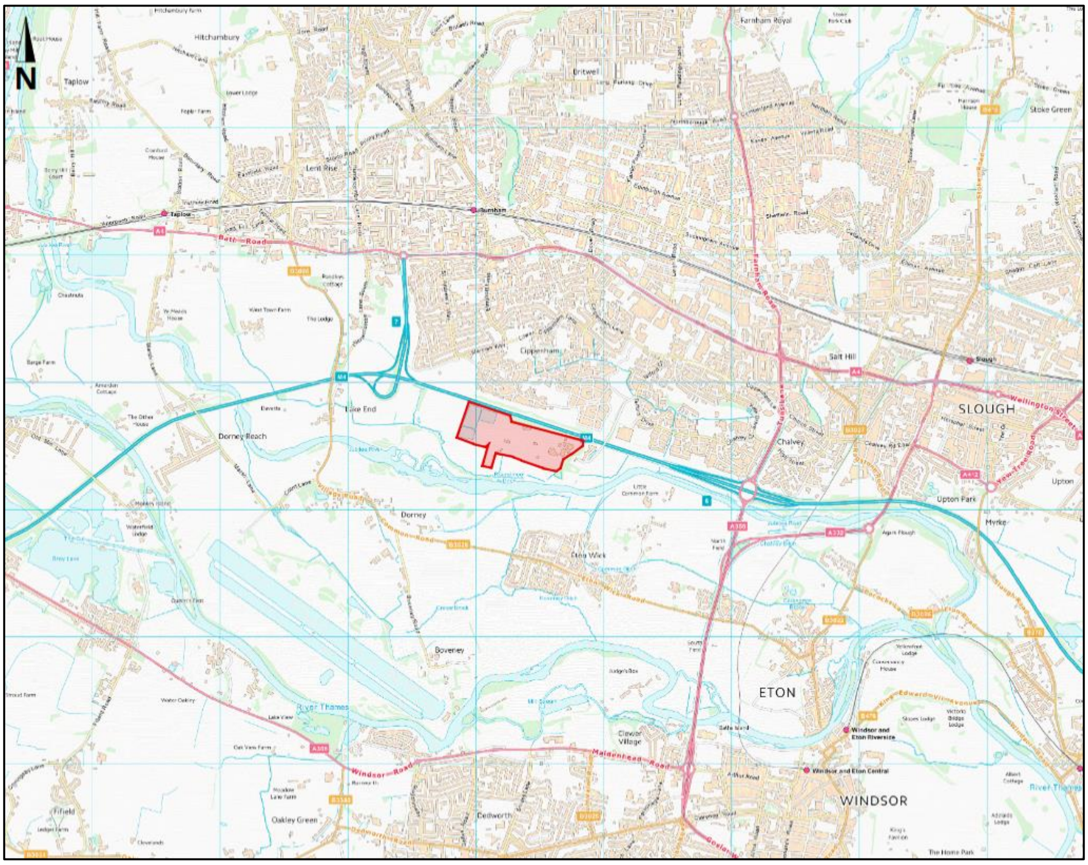

Figure 2-1 – Location Plan Slough Sewage Treatment Works


Figure 2-2 – Satellite view of Slough Sewage Treatment Works

Figure 2-3 – Labelled image of the STC elements within Slough Sewage Treatment Works

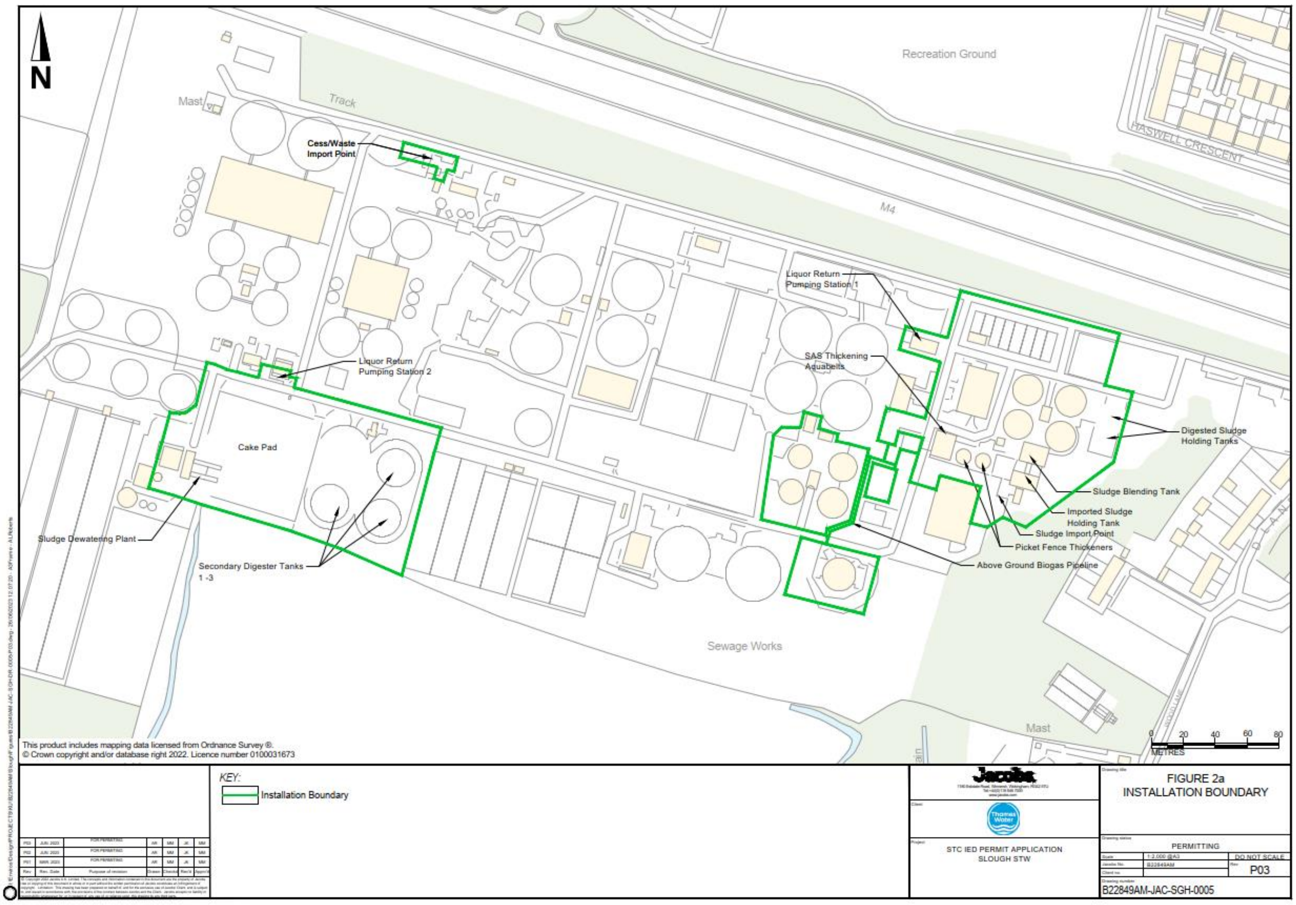

Figure 2-4 – Boundary of the permitted IED area and the assets contained within Slough STW

3. Proposed Containment at Slough

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;

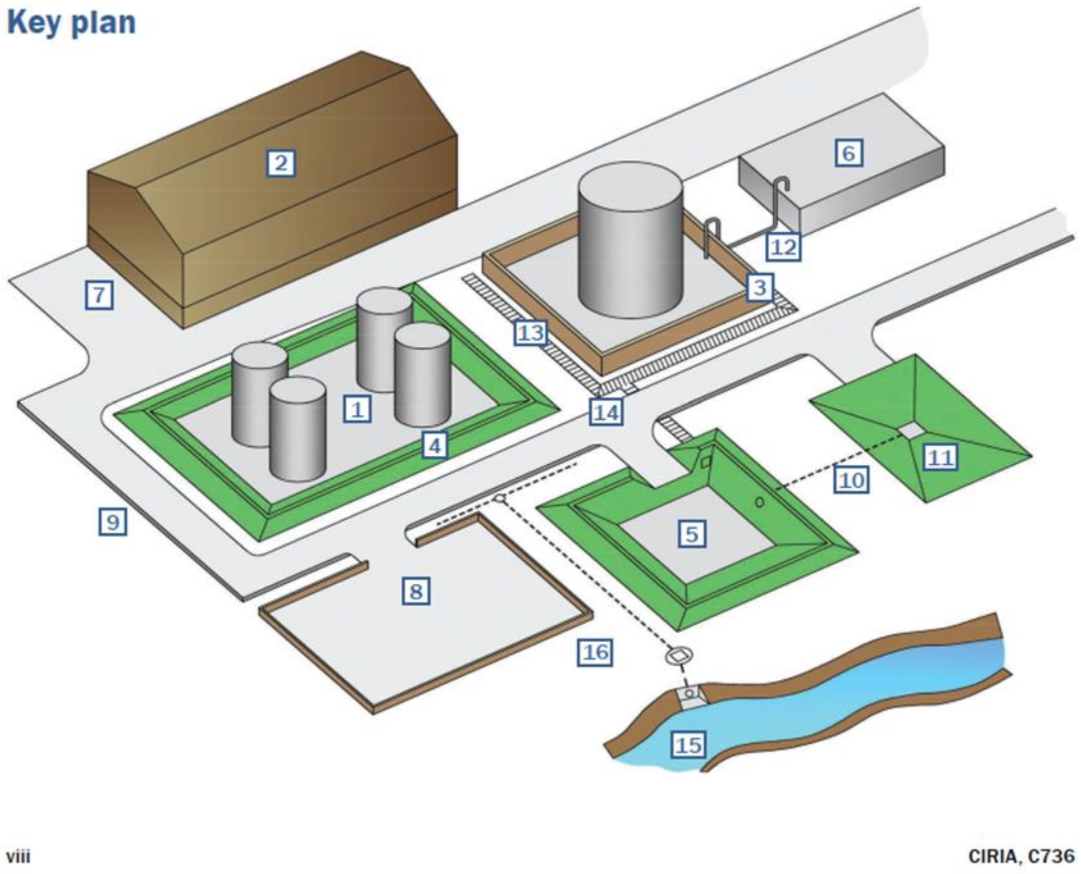

Figure 3-1 – Diagram of primary, secondary and tertiary containment examples

-**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 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 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

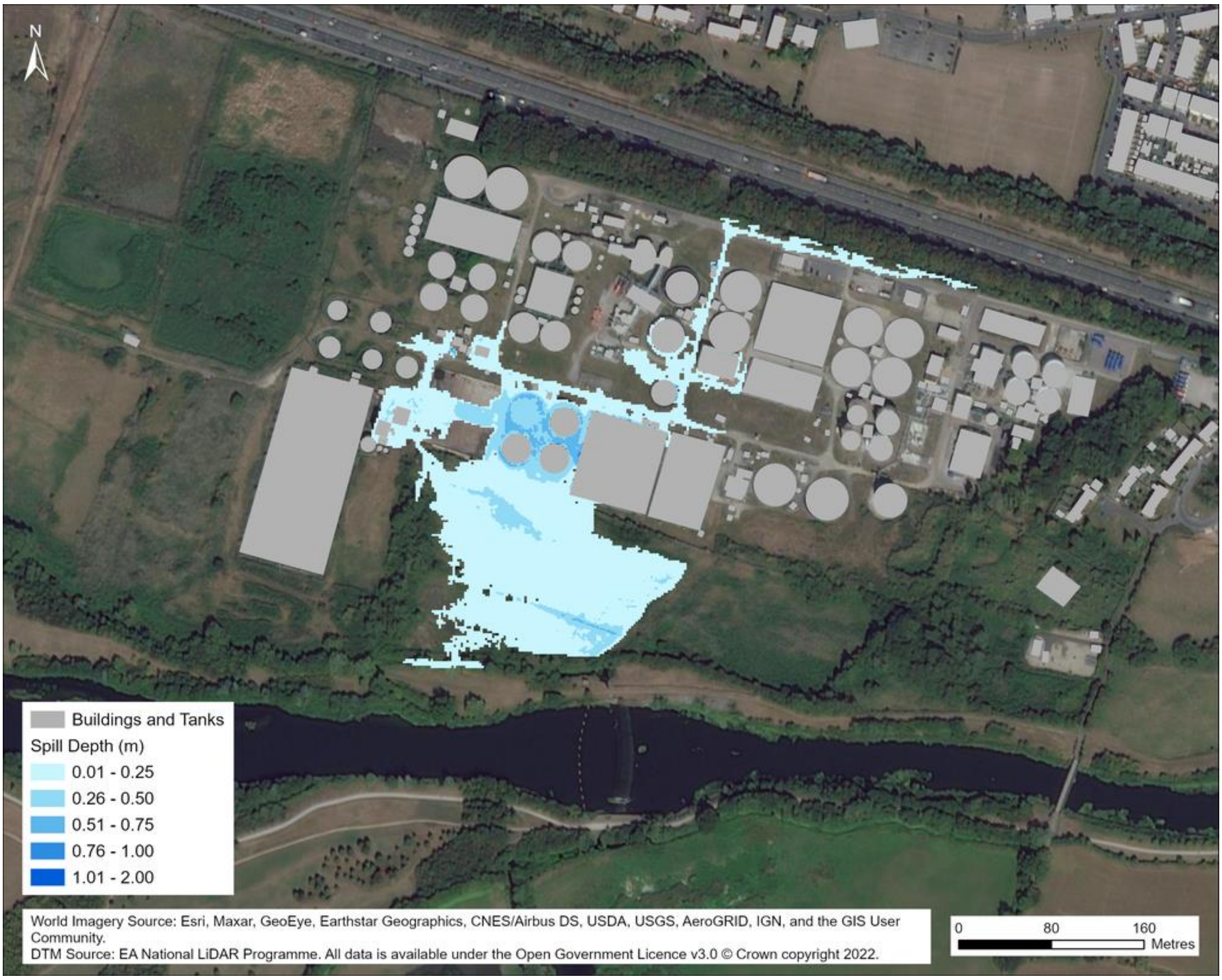

Figure 3-2 – Uncontained Spill Model Results at Slough STW

As seen from Figure 3-2, the sludge spill mapping of an uncontrolled event in Slough 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 approximately 1 minute after the failure of one of the digesters.

Assuming the spilled sludge originate from the failure of one of the Secondary Digesters on site. The bulk of the sludge travels southward leaving the site boundary towards Roundmoor Ditch, pooling around the area near the Manor Farm Weir. A small part of the sludge will travel along internal roads inside the STW first east then north ward. Reaching the north boundary of the site closest to the M4.

It should be also noted that the Roundmoor ditch to the north of the Jubilee River, forms a natural barrier for the uncontained release and in the event of catastrophic sludge failure on site, it could become contaminated with the uncontained release which is estimated to be around 150m from the river.

3.3 Site Classification Slough STW

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

Table 3-1 – Site Risk Rating for Slough STW

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

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

3.4 Slough 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 3-2 – List of Tanks Requiring Containment

Tanks Requiring Containment	Number of Tanks	Individual Effective Tank Volume m^3	Total Effective Tanks Volume m^3	Material	Below/ Above/ Partially in ground
Picket Fence Thickeners	2	314	628	Steel	above
Pre-Digestion Sludge Blending Tank	1	450	450	Steel	above
Primary Digesters	4	2282	9128	Concrete	above
Primary Digesters	2	2118	4236	Concrete	above
Imported Sludge Mixing Tanks	2	254	508	Steel	above
Digested Sludge Holding Tanks	2	514	1028	Concrete	above
Secondary Digesters	3	3197	9591	Steel	above
Total	**16**	**n/a**	**25569**	n/a	above

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 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 four-day event period (1 day prior plus 3 day recovery) for Slough is 75 mm. It should be noted that the rainfall depths for Slough 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.

3.5 Identified Constraints

3.5.1 Operational constraints

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

- The existing ground surfaces within the containment area that are grass and gravel and will need to be replaced with an impermeable surface e.g. concrete from which sludge can be cleared up easily.

- 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 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.

- The sludge cake barn has not been included in the proposed containment area. This is because any spills onto the dried sludge cake would be difficult to clean up and take a long time, the sludge cake would need to be passed through a centrifuge again to dry it and re-thicken it or sent back to the head of the works.

3.5.2 Geotechnical and Environmental constraints

Ground conditions need to be considered during excavating and backfilling activities. Soil types and ground water levels are not reported to present abnormal risks to the proposed works.

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

3.5.3 Topographical Constraints

The digital terrain model (Figure 3-3) shows a gentle gradient across the primary digesters area from south to north (towards the M4). It also shows the area around the secondary digesters to be more uniform. The grassed areas around the road show a small increase in elevation.

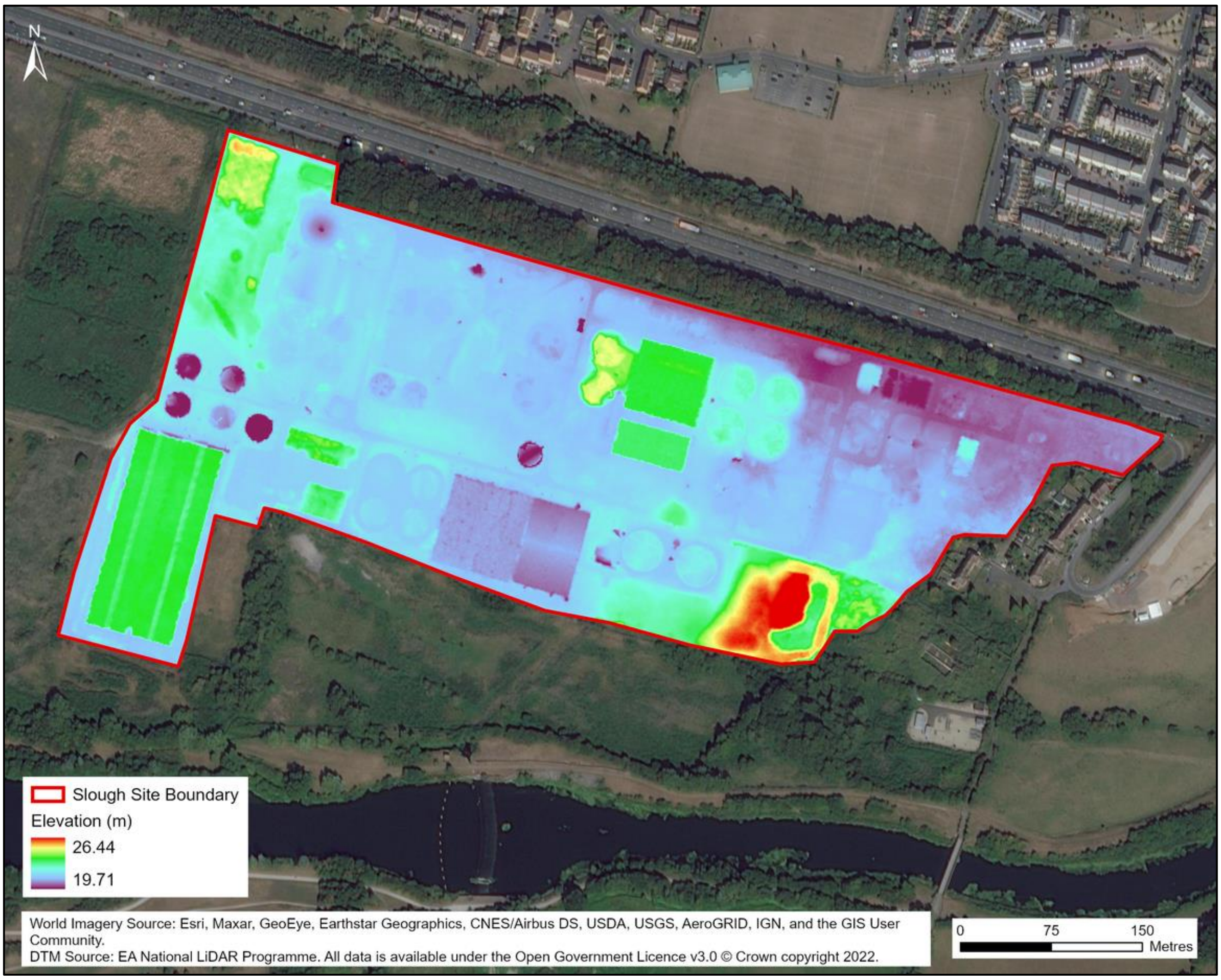

Figure 3-3 – Digital Terrain Model of Slough STW

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 Slough, 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 Slough 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 250-300mm 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.
- Raised kerbs on roadways to channel 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 do not contain sensitive equipment below the anticipated the top water level.
- Keeping containment areas separate from UWWTD asset area.

4.1 Containment Options

4.1.1 Primary Digesters (south-west) Area

Containment for the primary digesters located to the south-west considers a closed containment solution, including the old primary digesters which are out of service for the long term and act as tertiary containment, providing additional storage volume. The total containment area within the bunding is approximately 4,698m^2. The containment area is identified in Figure 4-4.

4.1.1.1 Total Spill Volumes

The total design contained volume comprises 2,118m^3 from catastrophic Primary Digesters failure, and 352m^3 from the 1 in 10-year rainfall falling on the catchment area of 4,698m^2 during the clean-up period of 3 days, giving a total nominal containment volume of 2,472m^3.

The containment volume has been checked against the 110 and 25% rule and exceeds both due to the rainfall influence.

Table 4-1 – Primary Digesters (south-west) Area – Design Spill Volume Summary

Design Spill Volume Summary		
Rainfall (mm)	75	
Catchment Area (m^2)	4698	
Total Rainfall (m^3)	352	
Tanks within Containment Area	**No. of Tanks**	**Volume (m^3)**
Primary Digester Tanks	2	2,118
Total Effective Volume (m3)	**2**	**2,118**
Largest Tank plus Rainfall (m^3)	2472	
110% of Largest Tank within Containment Area (m^3)	2330	
25% of All Tanks within Containment Area (m^3)	1059	
Design Spill Volume	**2472**	

4.1.1.2 Contained Model

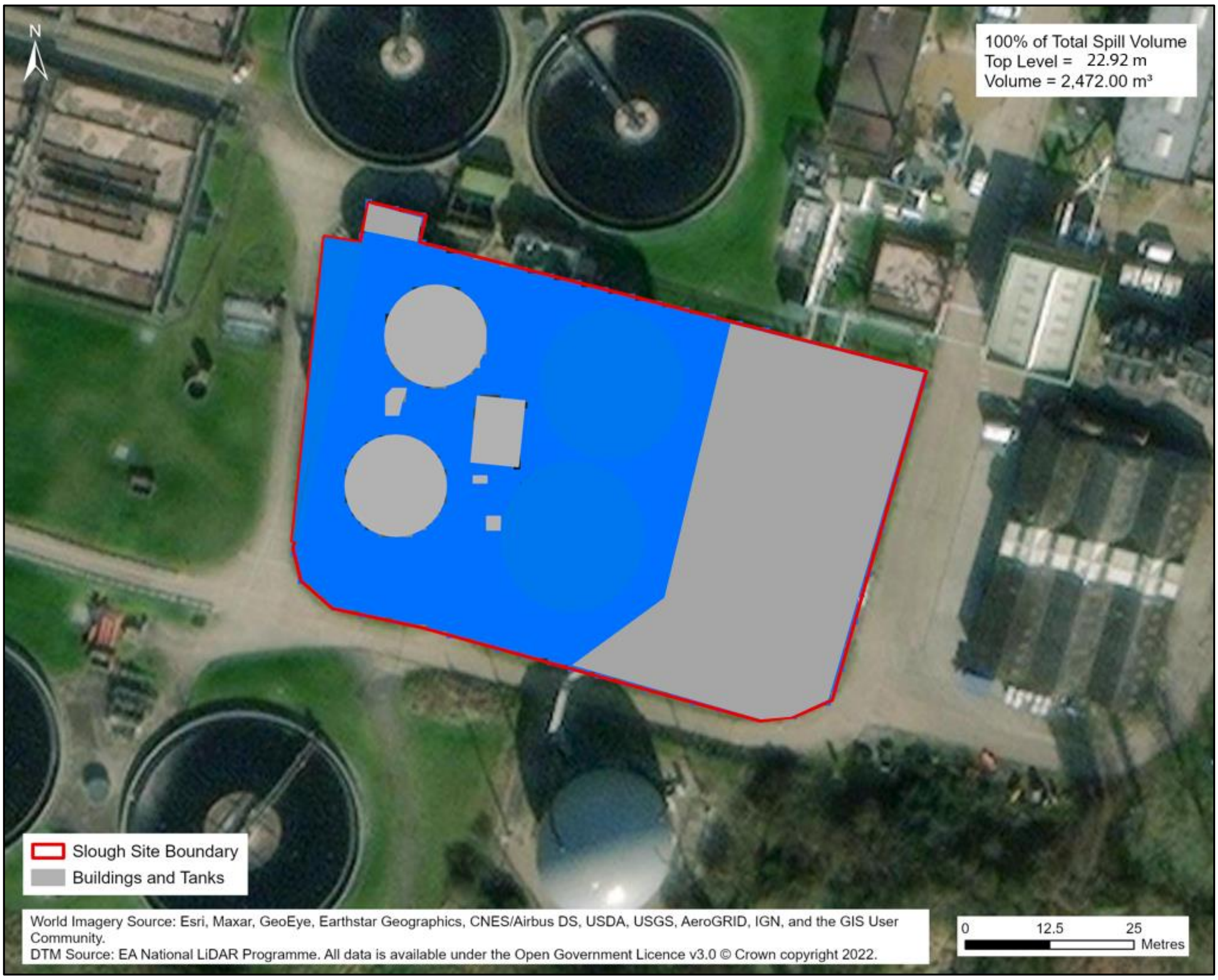

Figure 4-1 – Primary Digesters (south-west) Area – Containment Spill Model Output

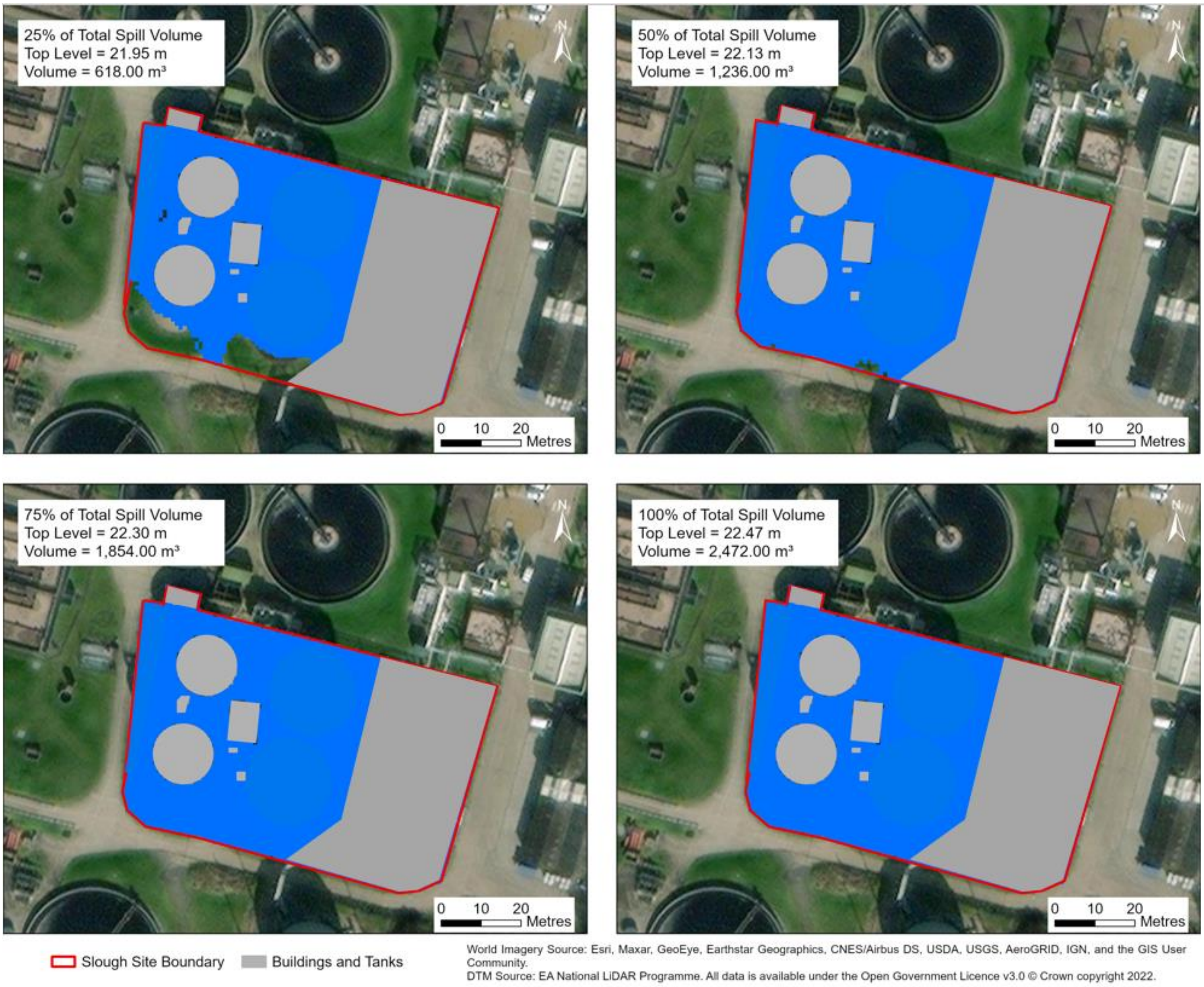

Figure 4-2 – Primary Digesters (south-west) Area – Containment Spill Model Output at 25%, 50%, 75% and 100% Volumes

The contained model outputs are shown in Figures 4-1 and 4-2. This identifies that the flows will fill in the containment area completely. The top water level (standing stored level) for the tank and rainfall volume is 22.92mAOD. After consultation with TW Operations team it has been identified that the area located to the east of the old digesters needs to be excluded from the containment area as it is preferable to leave the waste gas burners dry. In this case, the two old digesters have been included as tertiary containment within the containment solution.

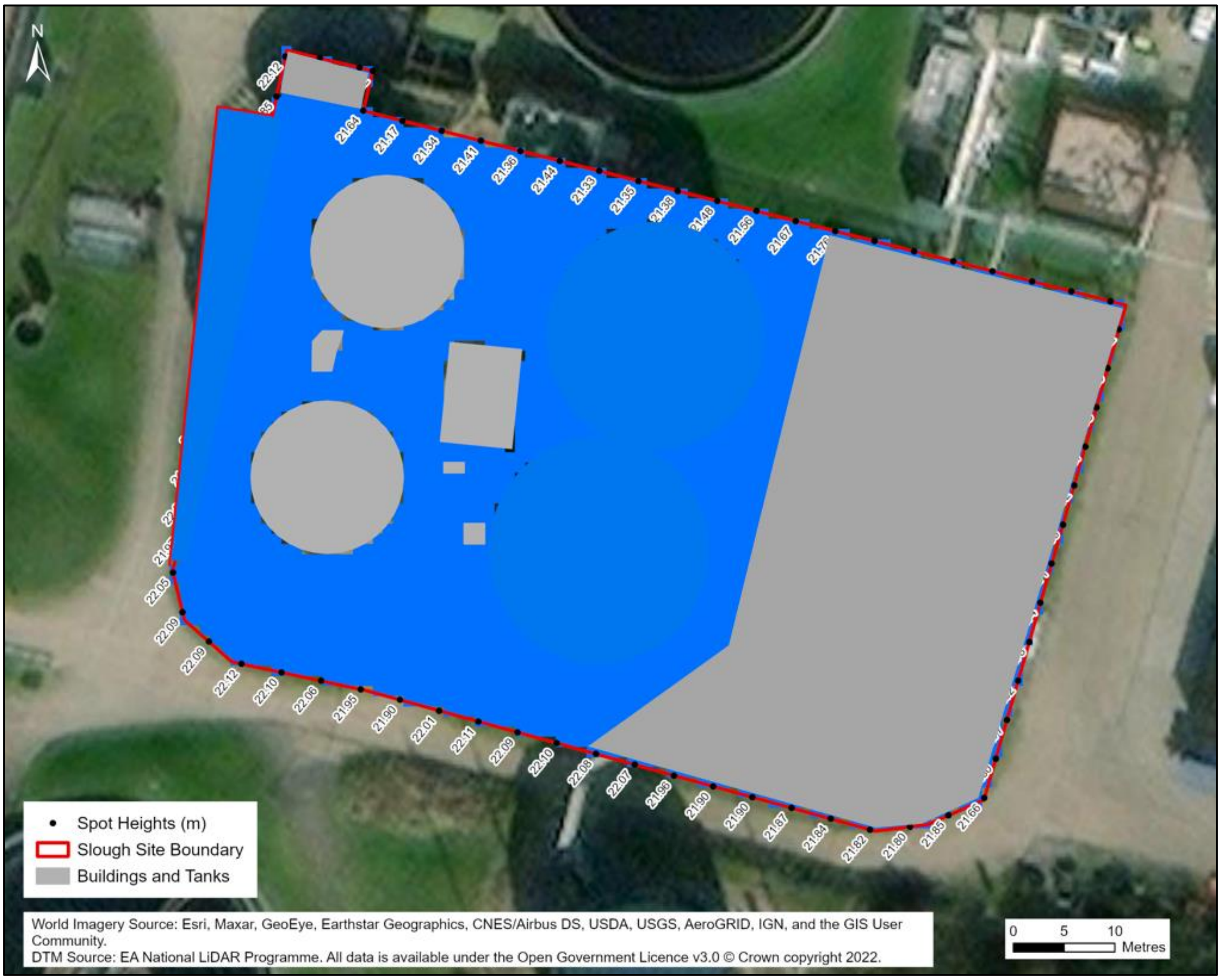

Figure 4-3 – Primary Digesters (south-west) Area – Spot Levels along Containment Boundary

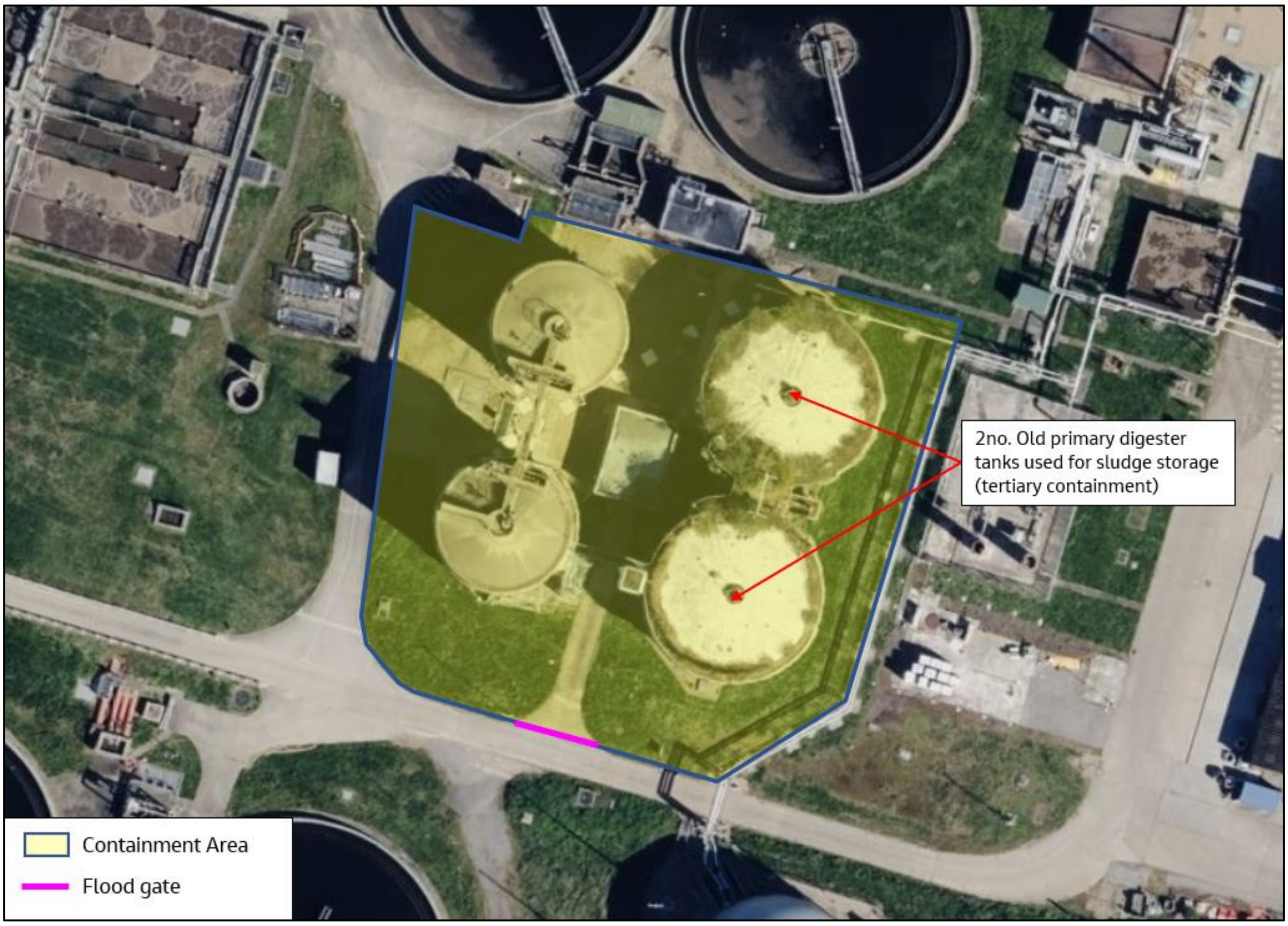

Figure 4-4 – Primary Digesters (south-west) Area – Containment Solution

Summary of the recommended containment for sludge area is described below and shown in Figure 11.

- Approximately 217m of low concrete bund wall ranging between with an average height of 1.5m. 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.
- 1no. 1500mm high flood gate across existing access to maintain access.
- 2no. old primary digesters as tertiary containment with a total sludge storage volume of 1257m^3 approximately.

4.1.2 Primary Digesters (north-east) Area

Containment for the primary digesters located to the north-east considers a closed containment solution, including other STC assets as listed in Table 4. The total containment area within the bunding is approximately 11,126m^2. The containment area is identified in Figure 4-8.

4.1.2.1 Total Spill Volumes

The total design contained volume comprises 2,282m^3 from catastrophic Primary Digesters failure, and 834m^3 from the 1 in 10 year rainfall falling on the catchment area of 11,126m^2 during the clean-up period of 3 days, giving a total nominal containment volume of 3,119m^3.

The containment volume has been checked against the 110 and 25% rule and exceeds both due to the rainfall influence.

Table 4-2 – Primary Digesters (north-east) Area – Design Spill Volume Summary

Design Spill Volume Summary		
Rainfall (mm)	75	
Catchment Area (m^2)	11,126	
Total Rainfall (m^3)	834	
Tanks within Containment Area	**No. of Tanks**	**Volume (m^3)**
Primary Digester Tanks	4	2,282
Picket Fence Thickeners	2	314
Pre-Digestion Sludge Blending Tank	1	450
Imported Sludge Mixing Tanks	2	254
Digested Sludge Holding Tanks	2	514
Total Effective Volume (m3)	**11**	**11,742**
Largest Tank plus Rainfall (m^3)	3,119	
110% of Largest Tank within Containment Area (m^3)	2,510	
25% of All Tanks within Containment Area (m^3)	2,936	
Design Spill Volume	3,119	

4.1.2.2 Contained Model

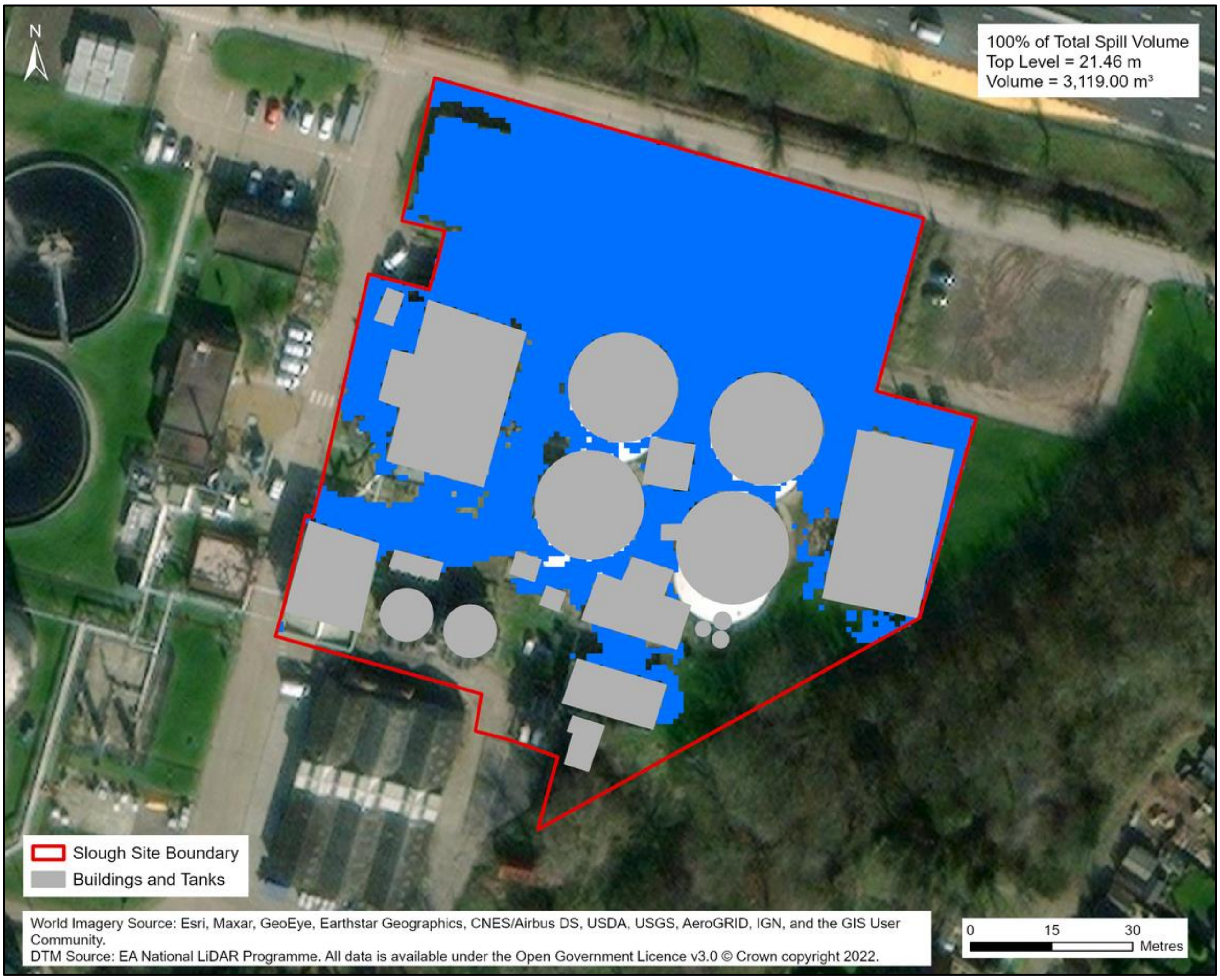

Figure 4-5 – Primary Digesters (north-east) Area – Containment Spill Model Output

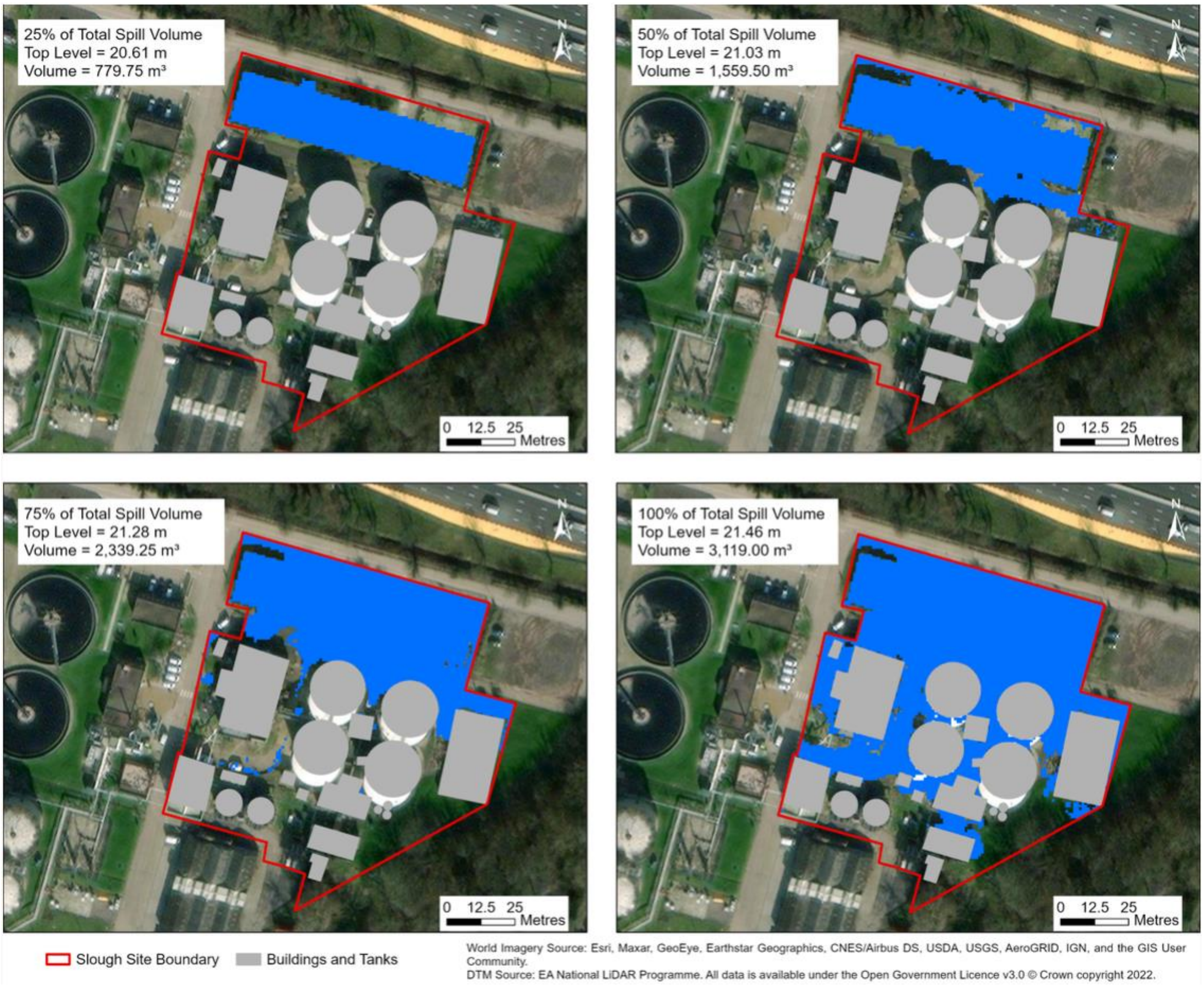

Figure 4-6 – Primary Digesters (north-east) Area – Containment Spill Model Output at 25%, 50%, 75% and 100% Volumes

The contained model output is shown in Figures 4-5 and 4-6. The top water level (standing stored level) for the tank and rainfall volume is 21.46mAOD. The natural topography enables the flows to fill in the northern side of the containment area with the proposed storage lagoon. At 50% of the total spill volume, the lagoon is completely full, and the flows start spreading to the south side of the containment area. Any jetting from the primary digesters would be captured within the closed containment area.

Figure 4-7 – Primary Digesters (north-east) Area – Spot Levels along Containment Boundary

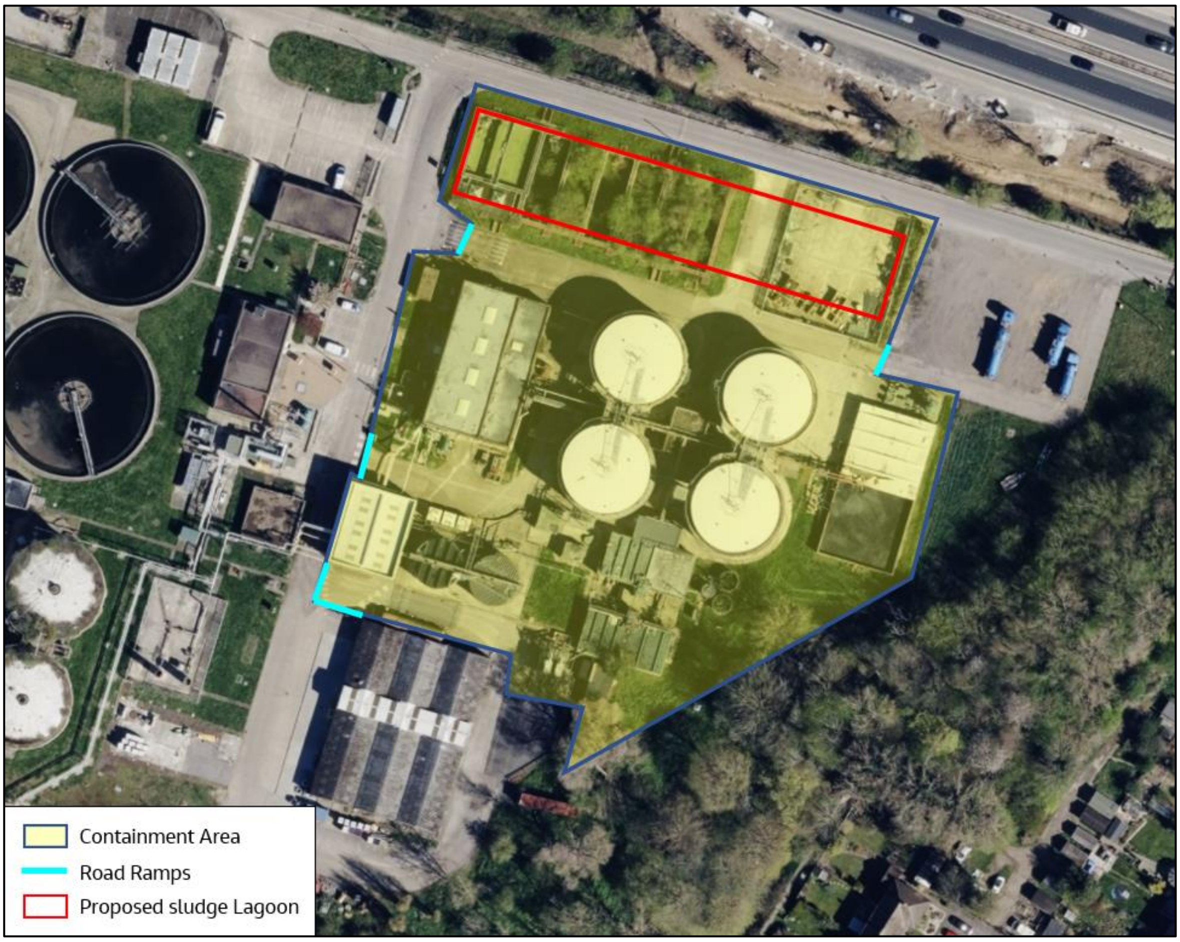

Figure 4-8 – Primary Digesters (north-east) Area – Containment Solution

The containment solution is shown in Figure 4-8. At locations where the bunding will cross an access road, a ramp will be installed at a maximum height of 300mm to enable full site access. Any permeable area which is mostly the grass areas within the containment boundary will be excavated and filled with bound concrete. Operations are then able to clean the containment area in a practicable way.

The area in the north-east (the area adjacent to the storage lagoon) has not been included within the containment boundary as this area has been reserved for the future planned development of the new site entrance and security facilities.

Summary of the recommended containment for sludge area is described below and shown in Figure 4-8.

- Approximately 468m of low concrete bund wall ranging between 250mm and 850mm high with an average height of 590mm. 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.

- 5no. 300mm high road ramps across existing access roads to maintain access.

- Proposed storage lagoon at the footprint of the disused sludge drying beds with an area of 1,705m^2 and depth of 1m.

4.1.3 Secondary Digesters Area

Containment for the secondary digesters area considers a closed containment solution. The total containment area within the bunding is approximately 4,701m^2. The containment area is identified in Figure 4.11.

4.1.3.1 Total Spill Volumes

The containment volume has been checked against the 110 and 25% rule and exceeds both due to the rainfall influence.

Table 4-3 – Secondary Digesters Area – Design Spill Volume Summary

Design Spill Volume Summary		
Rainfall (mm)	75	
Catchment Area (m^2)	4,701	
Total Rainfall (m^3)	353	
Tanks within Containment Area	**No. of Tanks**	**Volume (m^3)**
Secondary Digester Tanks	3	9,591
Total Effective Volume (m3)	**3**	**9,591**
Largest Tank plus Rainfall (m^3)	3,551	
110% of Largest Tank within Containment Area (m^3)	3,517	
25% of All Tanks within Containment Area (m^3)	2,398	
Design Spill Volume	**3,551**	

4.1.3.2 Contained Model

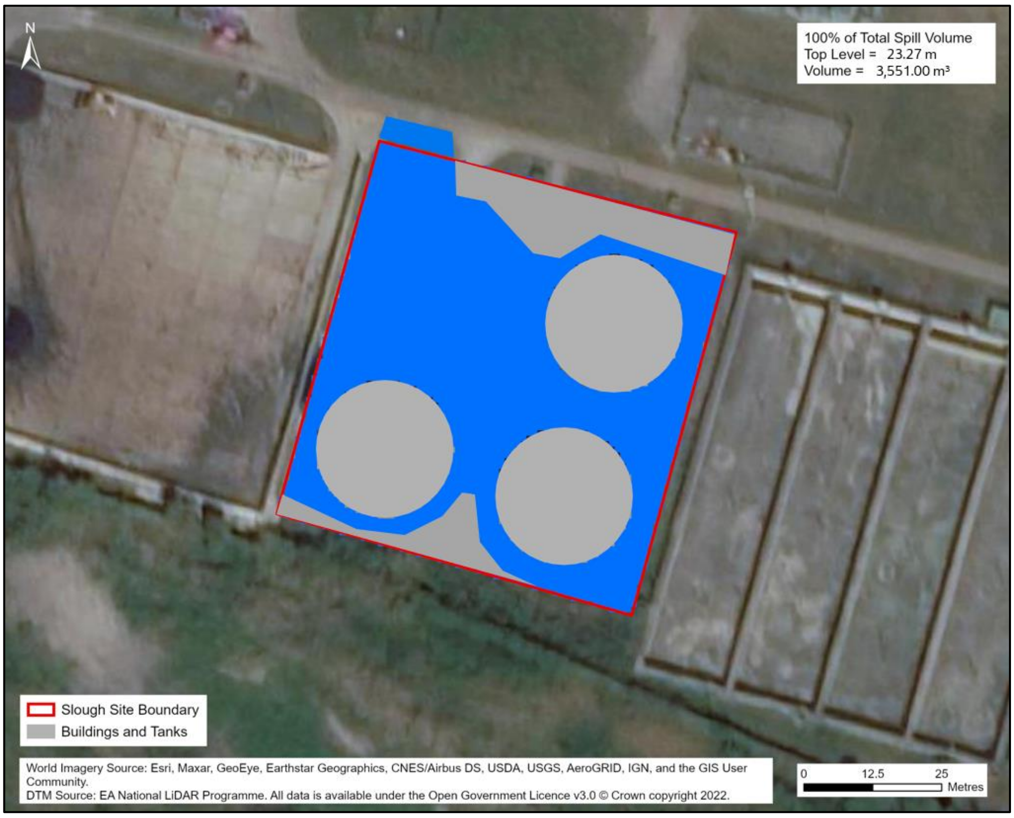

Figure 4-9 – Secondary Digesters Area – Containment Spill Model Output

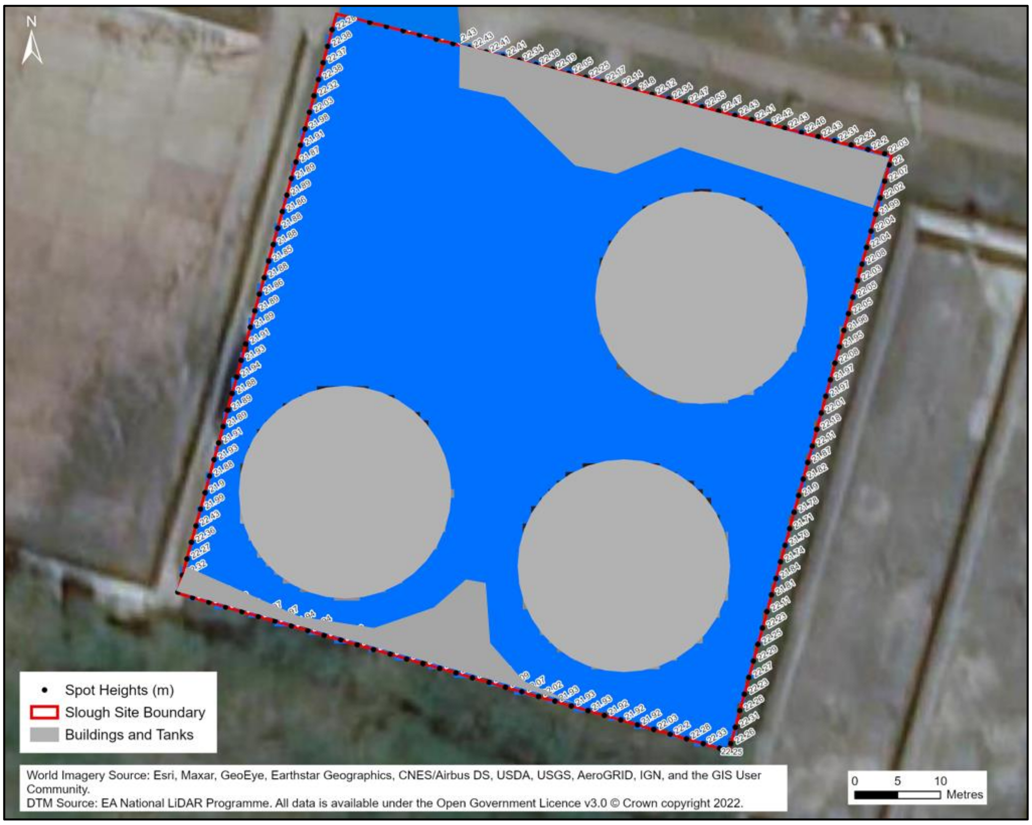

Figure 4-10 – Secondary Digesters Area – Spot Levels along Containment Boundary

Figure 4-11 – Secondary Digesters Area – Containment Solution

This option comprises the installation of high walls to surround the tanks. The west, south and east sides of the walls will consist of 2m high reinforced concrete with 2m high Perspex screen fitted onto of the concrete. The north wall, the roadside wall, is 1.5m high reinforced concrete to aid ventilation of the area and maintain visibility of the working area. The reduced height complements the installation of a flood gate of 1.5m height to allow access for operations. The flood gate will be normally closed (with position indication and alarm should the gate not be closed) and this area is not subject to high levels of movements.

Summary of the recommended containment for sludge area is described below and shown in Figure 4-11.

- Approximately 302m of low concrete bund wall ranging between with an average height of 2m. The foundation for the bund wall will extend 300mm below ground level. The concrete containment bund will be completed with a 2m high Perspex screen on top of concrete for preventing any jetting spillages to escape 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.

- 1no. 1500mm high flood gate across existing access to maintain access.

4.1.4 Tertiary Containment Option

Tertiary containment is provided at Slough STW for the Primary Digesters (north-east) Area, with installation of a sludge storage lagoon; and for the Primary Digesters (south-west) with the mobilisation of the footprint of the old primary digesters resulting from their being taken out of service (roof removal and grille across the low level inspection hatch to allow ventilation of the tank shell, which also allows flow to enter these tanks).

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. For the primary digester (both north-east and south-west) this has been achieved.

In addition, 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. Also, the majority of the digester tanks are concrete construction, for which catastrophic failure is deemed to be less of an issue.

For the secondary digesters there is a risk of contamination through jetting due to the proximity of the secondary digesters to the boundary of the site and a jetting barrier has been provided to mitigate the risk of sludge escaping from the secondary containment area due to jetting.

Surge effects have been mitigated by the bund profile (recurved to return flows back on itself) and the distance of the bund wall to the tanks.

4.2.2 Flooding

According to the UK Government's Flood Map for Planning, the proposed containment areas at Slough STW are situated in Flood Zone 1 as shown in Figure 4-12. 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%, therefore, no modifications need to be made to Slough STW to accommodate this risk.

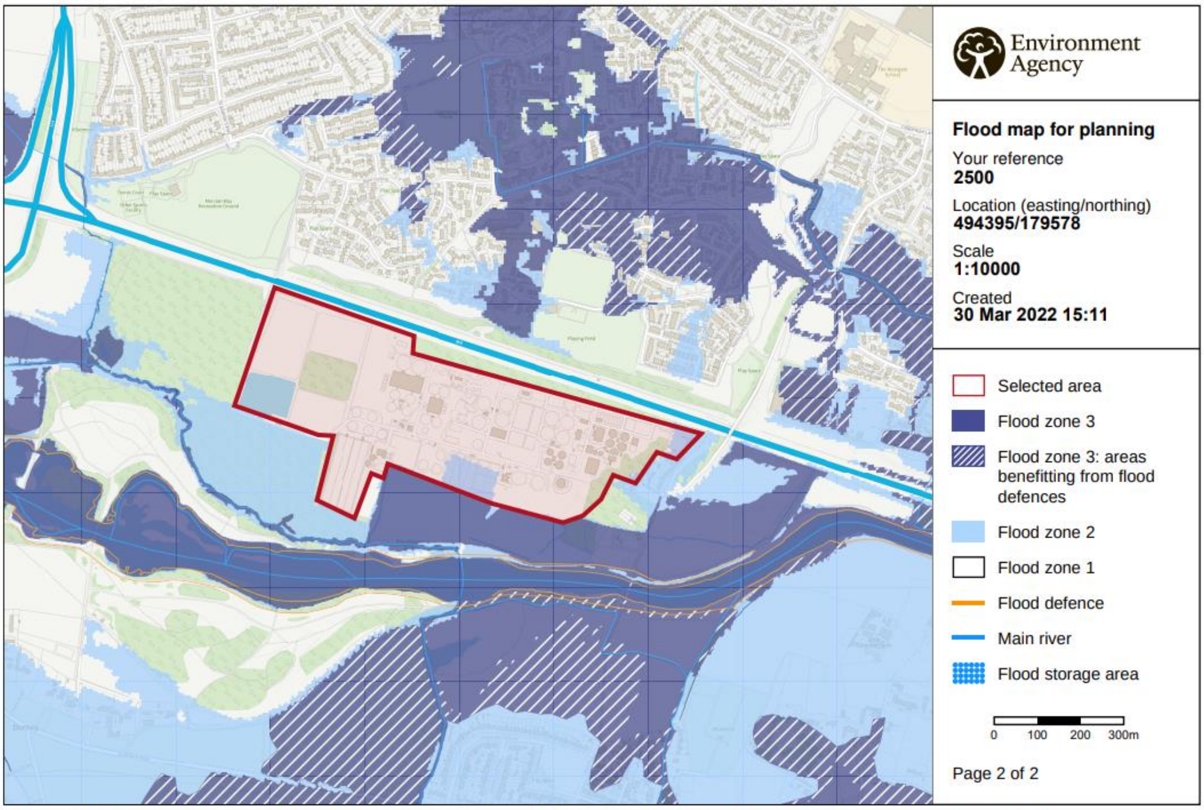

Figure 4-12 – Flood Map for Planning

4.3 Identification of Preferred Option

The preferred option is the installation of three closed containment areas as presented in Section 4.2. The basis reflects practicality of installation and operation. This option has been consulted with TW Operations team, as a wide containment area was previously rejected.

4.3.1 H&S and CDM risks

- Detail design to consider potential effects of taller containment walls and mitigations
- Cable ducts act as potential conduit to transport sludge around site.
- Impermeable membrane with gravel on top not supported by operations as difficult to clean up sludge.
- Covering secondary sludge digesters – potential explosive risk is generated requiring management.

5. Site Drainage and liquor returns

5.1 Process flow diagram

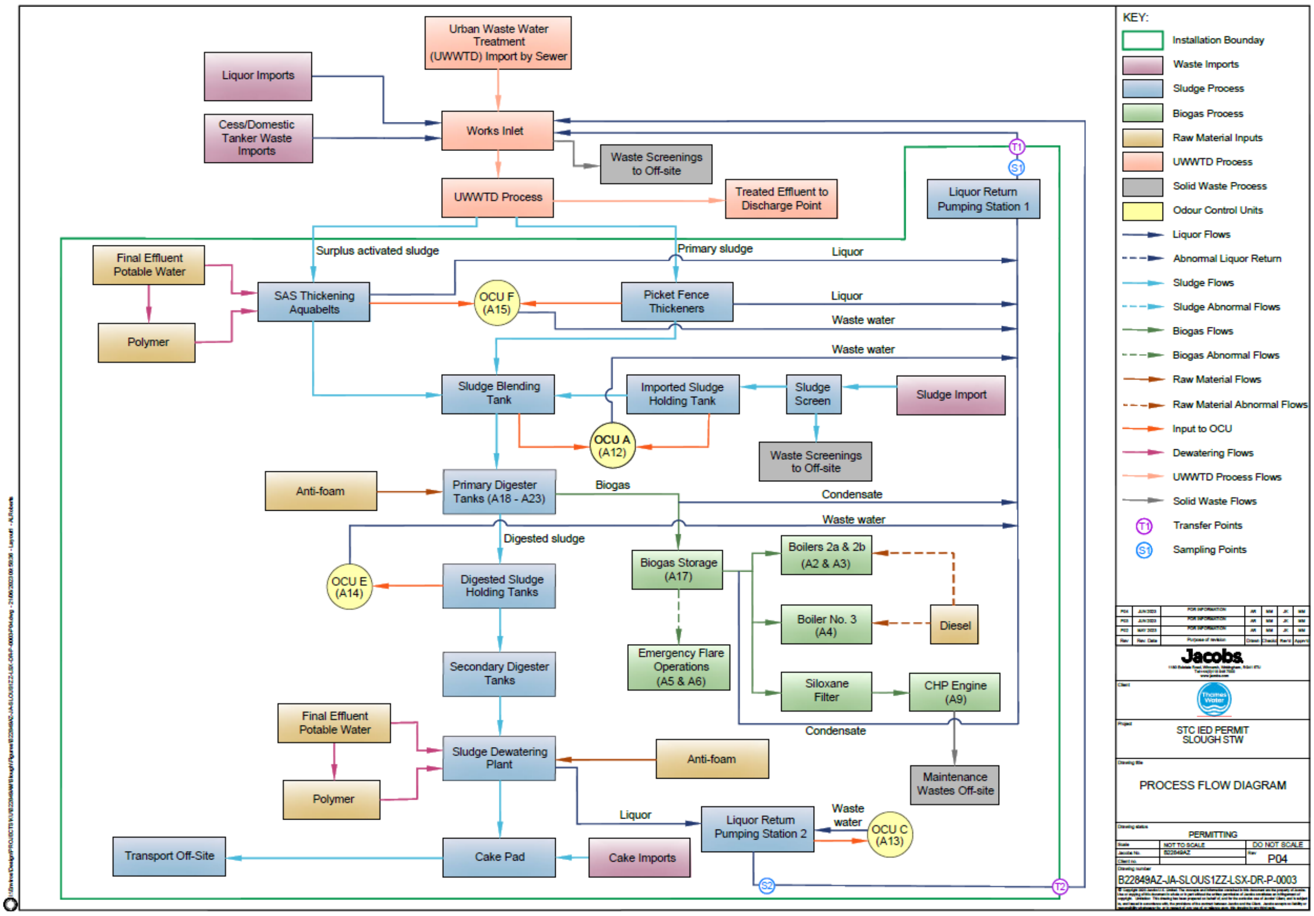

Figure 5-1 – Process Flow Diagram

5.2 Foul, Process and Effluent Drainage

Site drainage assessments are based on Slough Sewage Works Layout Plan Drawing Numbers SLOUZZ-DPL-001, 002 and 005.

The Sewage Works Layout Plan for Slough shows all Combined/ Process/ Effluent drainage pipes, indicated by the blue lines, go back to the head of the works via pumping stations as shown in Figures 5.2 - 5.4. 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, these lines should be isolated. The option of inhibiting the pumping stations is less practicable as there is potential to cause disruption to the main process stream due to impact upon desludging operations.

The surface water drains, shown as the dark green lines, are also mixed with the process drains and go to the head of the works. As both systems combine, the surface water drains have been reviewed as part of this section.

Figure 5-2 – Drainage Plan

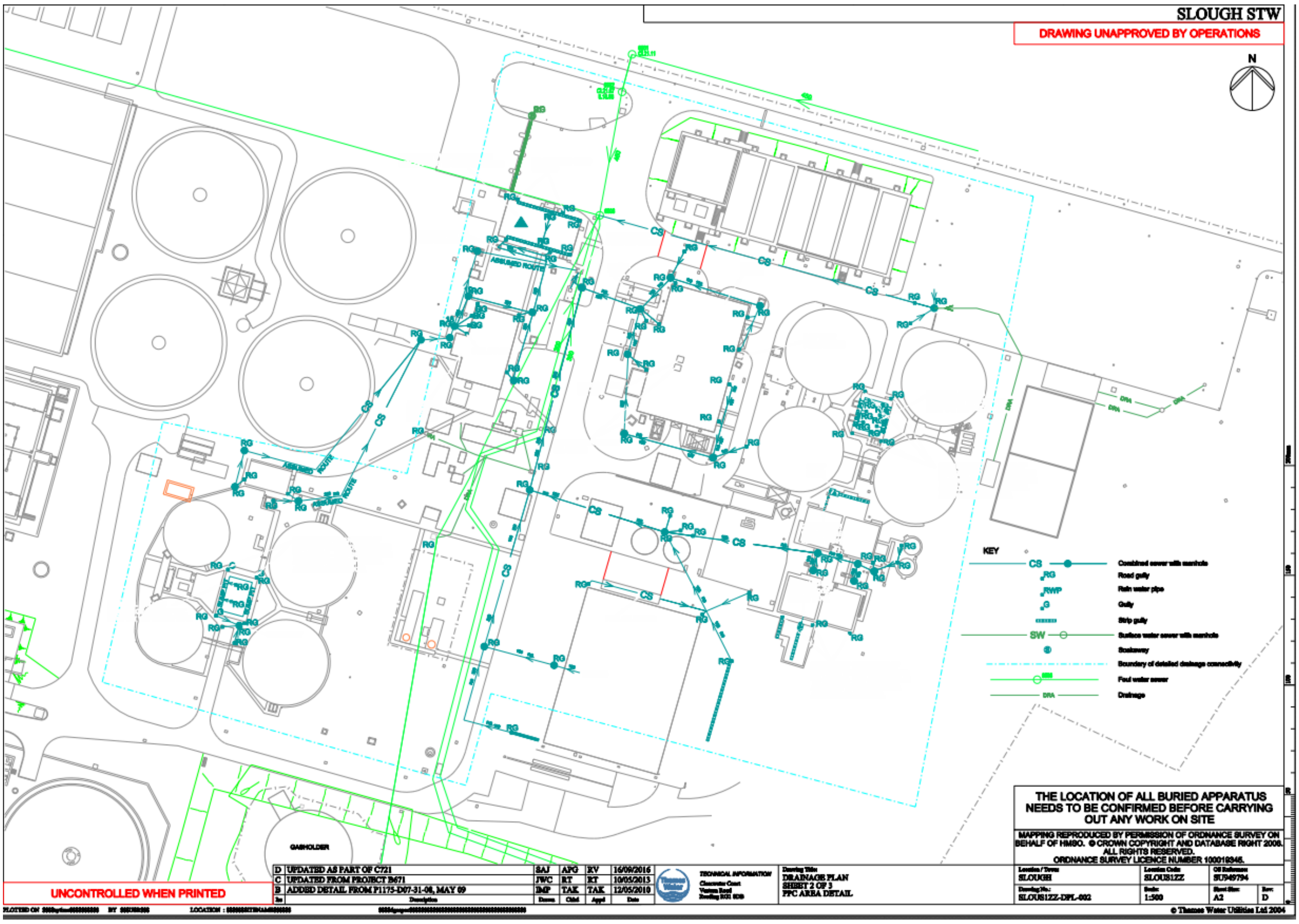

Figure 5-3 – PPC Area – Drainage Plan sheet 2 – Primary Digesters area

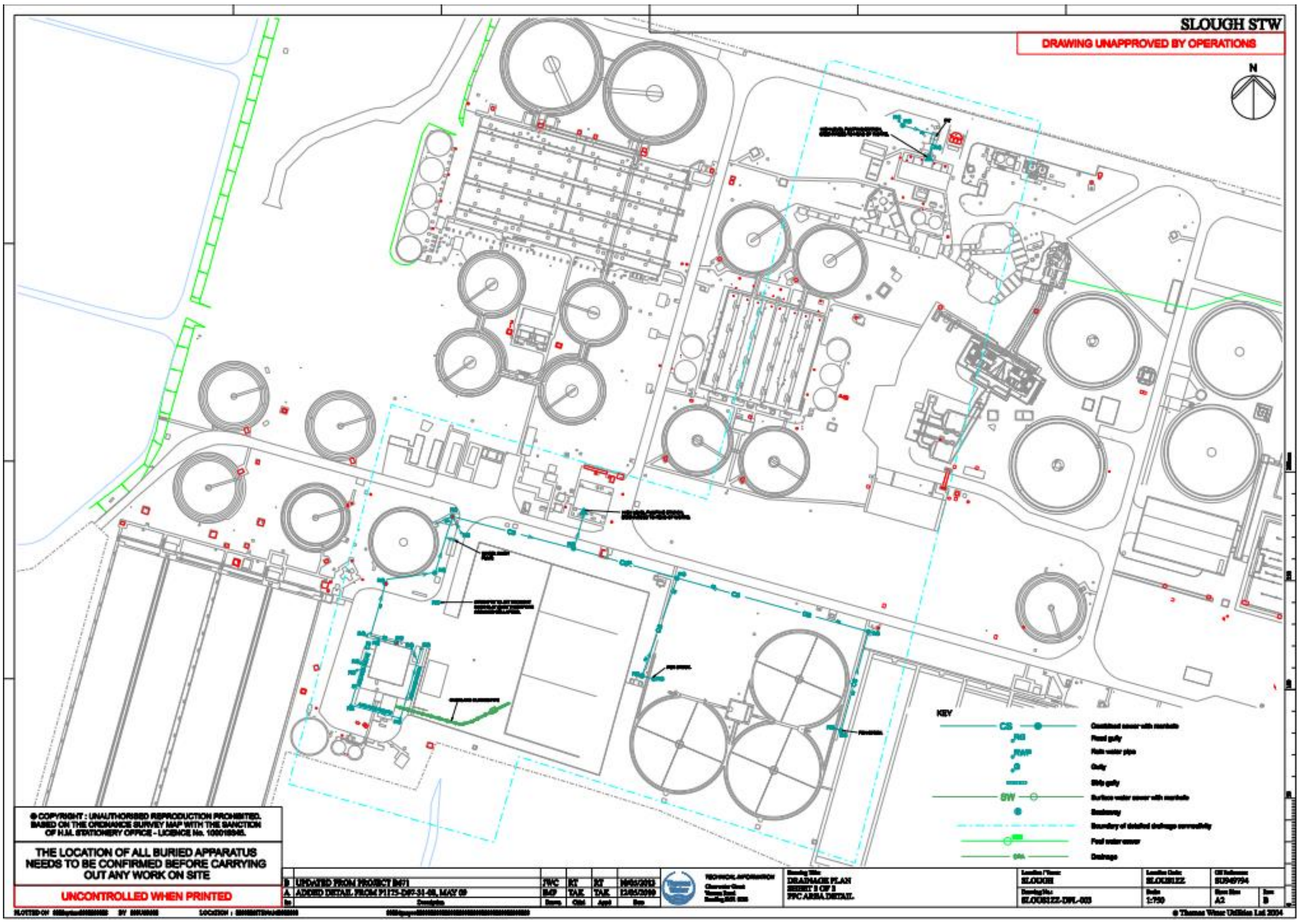

Figure 5-4 – PPC Area – Drainage Plan sheet 3 – Secondary Digesters and cake pad area

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.

There is a small site drainage pumping station within the containment boundary for the secondary digesters. This pumping station receives flows from the adjacent cake storage area. A flap-valve/non-return valve will need to be fitted to the drainage line from the cake storage area. This is to prevent backflow from the containment area discharging via the sump and the drainage pipework into the cake storage area.

5.4 Automatic Isolation Valves

For the catastrophic loss of containment scenarios for the sludge 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 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. Due to the flow to full treatment at Slough 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.

Once the spillage has been stopped and contained, any sludge in the drainage system can be released back into the head of the work in a controlled manner therefore, not creating adverse effects at the inlet.

6. Conclusions

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

In the Risk Identification Report for Slough a containment classification report was carried out. An overall site risk rating of medium was determined meaning that Class 2 containment is needed.

The assessment focuses on site-specific risks and outlines the options available for providing secondary containment to mitigate the risk of a catastrophic tank or digester failure. Slough has three separate areas for containment.

The preferred option for the primary digester area is to install two closed containment areas, with less area being used for sludge containment. To allow the resulting areas to be bunded with walls with practicable height, two tertiary containment systems have been put in place. For the primary digesters located to the south-west, the two old primary digesters have been included as storage to the closed containment area. For the Primary Digesters located to the north-east, it has been proposed to construct a storage lagoon where the disused sludge drying beds are located.

The preferred option for the secondary digester area is to install taller bund walls to this discrete group of tanks. Tall walls are constructed on three sides to mitigate the risk of jetting. The fourth side is lower to aid ventilation and maintain visibility into the area in line with CIRIA guidance. Access is by a flood gate which is normally-closed, linked to SCADA to allow alarm to be generated if the gate is not in the closed position and the area is subject to fewer movements.

The results of the uncontained spill mapping show that a catastrophic spill will not be contained within the site. The contained spill modelling shows that the tank contents and associated rainfall are retained within the site boundary and the flows can be managed by TW operations for return to treatment.

The containment volumes have been checked against the 110% and 25% rules. In the three proposed areas, the containment volume exceeds these due to the impact of rainfall; the containment is set by the largest tank plus the rainfall.

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, except for the potential for one secondary digester which subject to planning could been mitigated by the use of a screen extension to the containment wall.

Appendix 1 ADBA Site Hazard Risk Assessment Summary for Slough STW

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

Source – There are two sources that have been identified:

1. Sludge digestate – this carries the dominant hazard rating
2. Polyelectrolyte chemicals (and Ferric Sulphate) for sludge thickening.

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

Pathway – There are three pathways that have been identified:

1. The process and site drains take any liquid to the head of the works which would negatively impact the process stability on site and would eventually impact on the receiving watercourse.
2. The Roundmoor Ditch and Jubilee River to the south side of the site, the topography from the site runs north to south and consequently any spill will gravitate across fields towards and into the river. Distance to these rivers is outside the risk trigger.
3. There are several areas where a sludge spill could pass over permeable ground. These are mitigated by containment and management of the drainage system interface. However, the location of the STC being integral with the STW attracts a medium rating.

Consequently, the Pathway Hazard rating was determined as **Medium.**

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

1. The Jubilee River directly to the south and at lower elevation to Slough STW. The Roundmoor ditch prior to the Jubilee River receptor. Both are outside of the risk trigger distances.
2. Part of the site is on the outer boundary of the Eton borehole protection zone.
3. Habitation nearby, the largest of which is directly across the M4. But is outside of the risk trigger distance. However, the dwellings in Wood Lane are within the trigger distance.

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.

Appendix 2 Tank Covering initial review

Thames Water commits to covering permitted open top tanks at the facility in accordance with the IED and BAT 14. Thames Water will take a risk-based approach, including use of PAS110, to determine our approach to abatement if required for individual tanks at Slough. Thames Water confirm that our approach to abatement includes use of a biogas system if required. Engineering design assessment may result in replacement of tanks or reduction in number of applicable tanks. Our programme of delivery will need to be phased so that for each location a minimum number of existing AD tanks are always in continued operation to ensure process requirements are met. Thames Water will use PAS110 to determine whether individual tanks are biologically active. Non-biologically active tanks will be considered in accordance with the guidance Covering Slurry Lagoons (publishing.service.gov.uk).