Jacobs

J840 – STC IED Containment

Slough 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 (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 24,050m^3 of liquid to escape from the sludge treatment centre in the event of tanks failure. The liquid sludge is stored in 12 tanks with individual volumes varying between 450-3197m^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 primary and secondary digester tank has been addressed by two independent containment areas due to their disparate locations on site. Two options for both the primary and secondary 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. Primary digester area
   Wide area containment option whereby the primary digesters and sludge tanks are contained within a bunded boundary with sufficient area to generate shallow depth that does not deny emergency access to equipment when the spill has been contained. Access into the contained area is by ramps. Option selected due to practicality.

2. Secondary digester area
   The creation of a local containment area around the secondary digesters with high bund walls. The entry is by flood gates within a lower fourth wall. Localised low level bunding provides tertiary containment to direct any spill from jetting into a disused humus tank repurposed for storage. Option selected as lower fourth wall aids ventilation and visibility of operatives in the containment area.

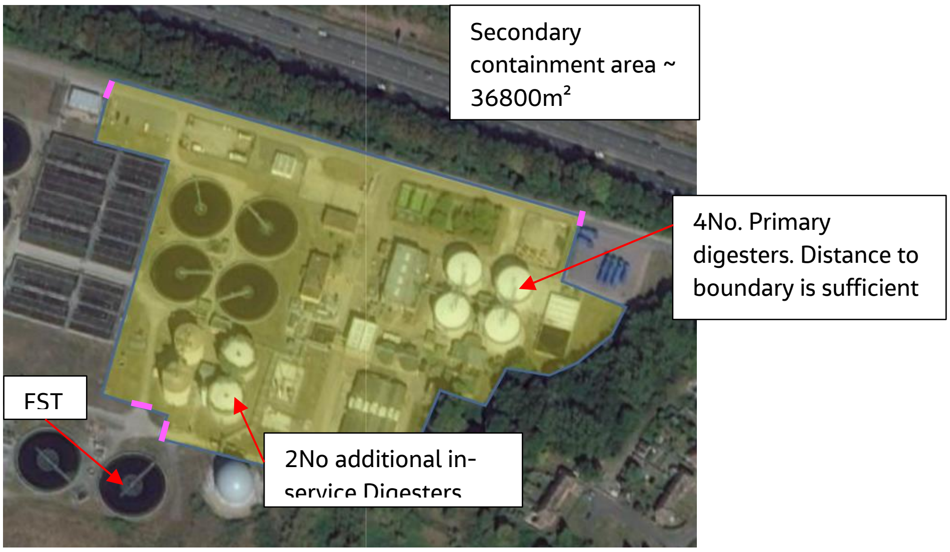
Bund heights are being set to provide freeboard considering both static conditions when the containment has been filled and during the transient condition at initial failure. The bunds have been identified to be concrete due to space constraints. The bund profile will facilitate turning the flow back on itself to mitigate the risk of overtopping during the initial failure.

In addition to the creation of bunds, 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 an eight-day recovery period. These new concrete areas with the existing concrete roads and slabs provide the impermeable base to the containment area as a whole. The site is identified as requiring Class 1 containment (impermeable soil with no liner), the proposed solution is intending to adopt concrete (with no liner) on the basis of the impermeability of the concrete, inherent strength and long-term mechanical resistance to cope with potential cleaning activity. Remedial works to existing concrete slabs/roads will be undertaken to ensure that they provide a competent surface, for example resealing of joints.

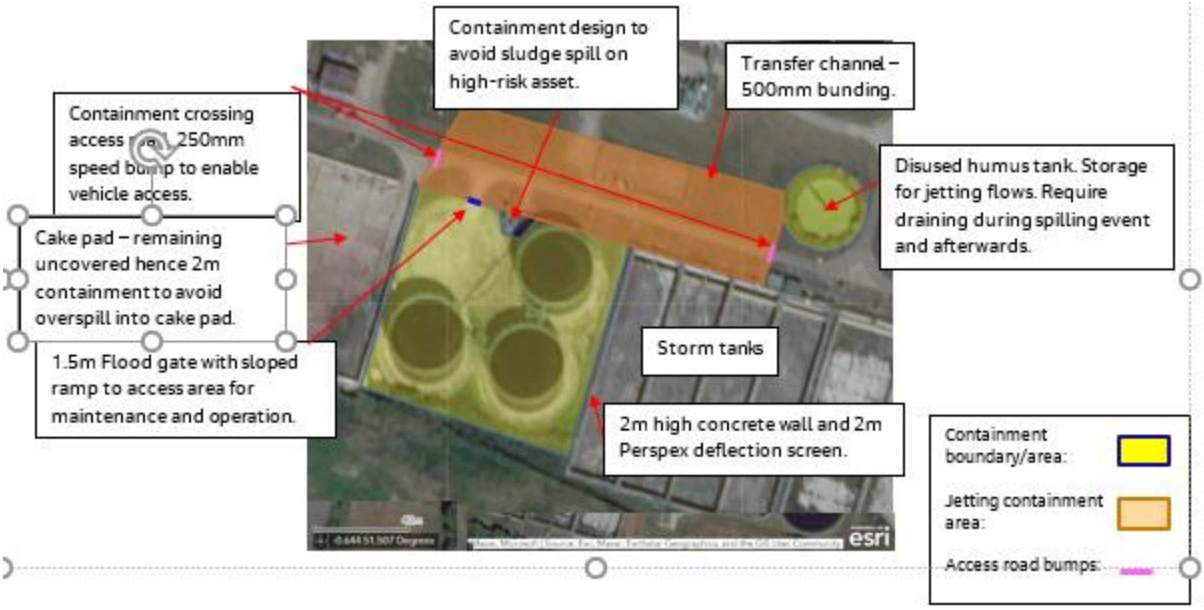
The containment volume identified reflects the potential escape volume from the tanks and the 1 in 10 year rainfall that could arrive during the clearing up period, which exceeds the 110/25%-rules.

General layouts of the proposed solutions are presented below.

Primary Digestion area



Secondary digester area



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 28 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.

Slough STC, contained within Slough Sewage Treatment Works (Figures i-iv), 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 for 13 areas around Slough.

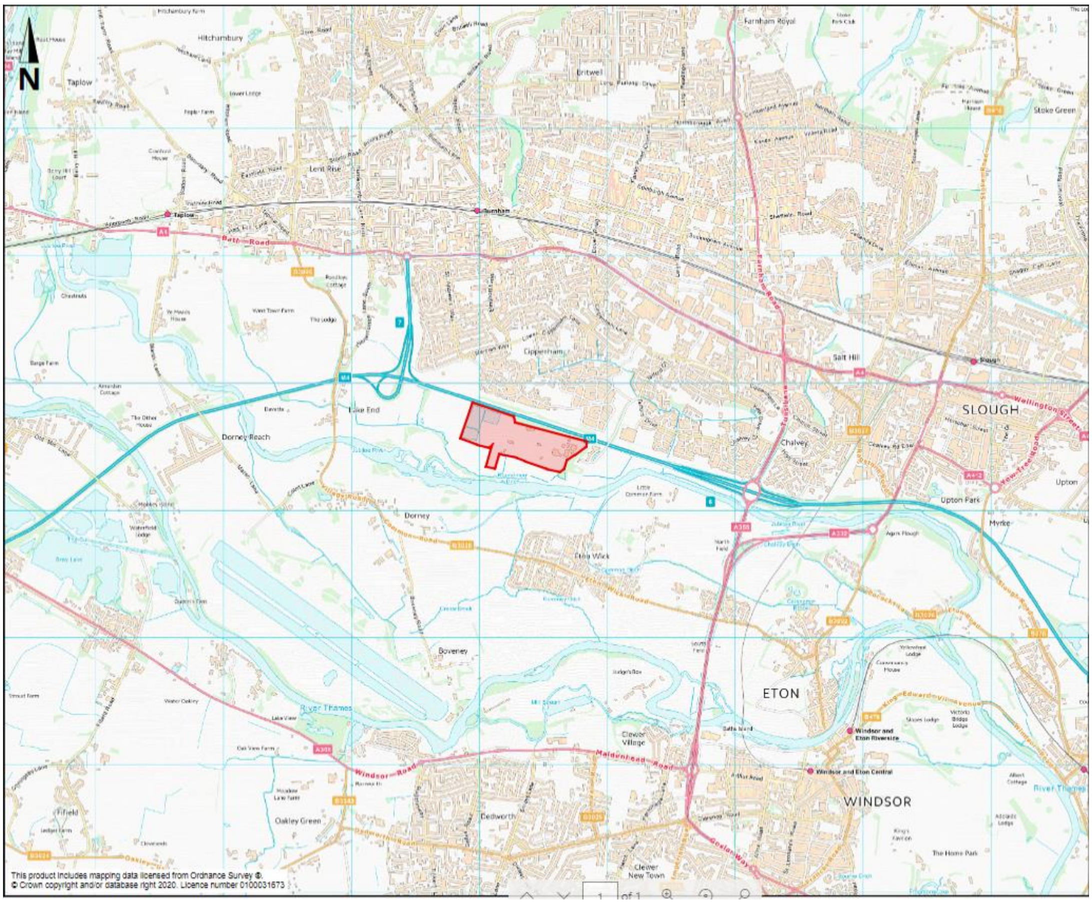


Figure i Location Plan Slough Sewage Treatment Works

Figure ii Satellite view of Slough Sewage Treatment Works

Figure iii Labelled image of the STC elements within Slough Sewage Treatment Works

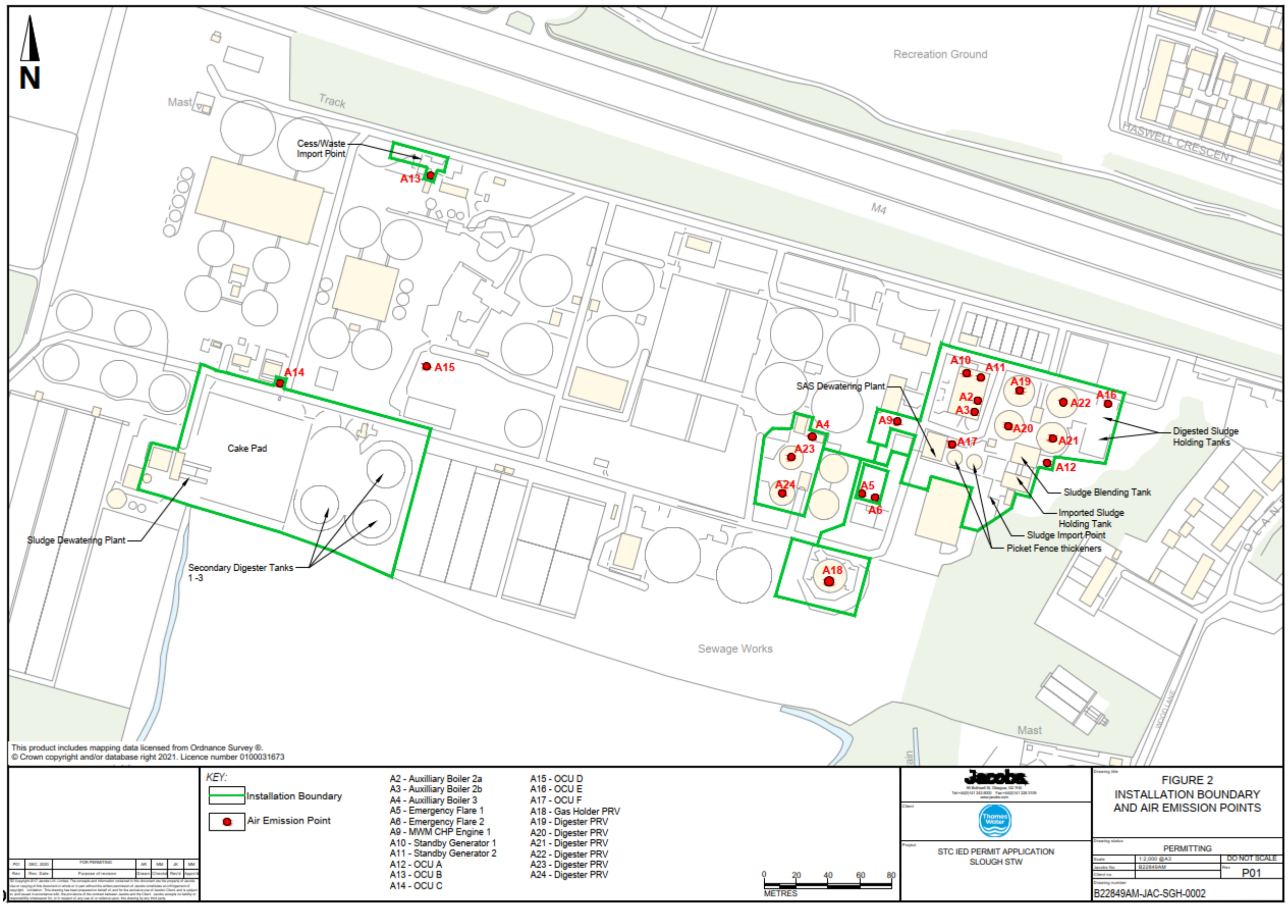


Figure iv Boundary of the permitted IED area and the assets contained within Slough STW

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

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;

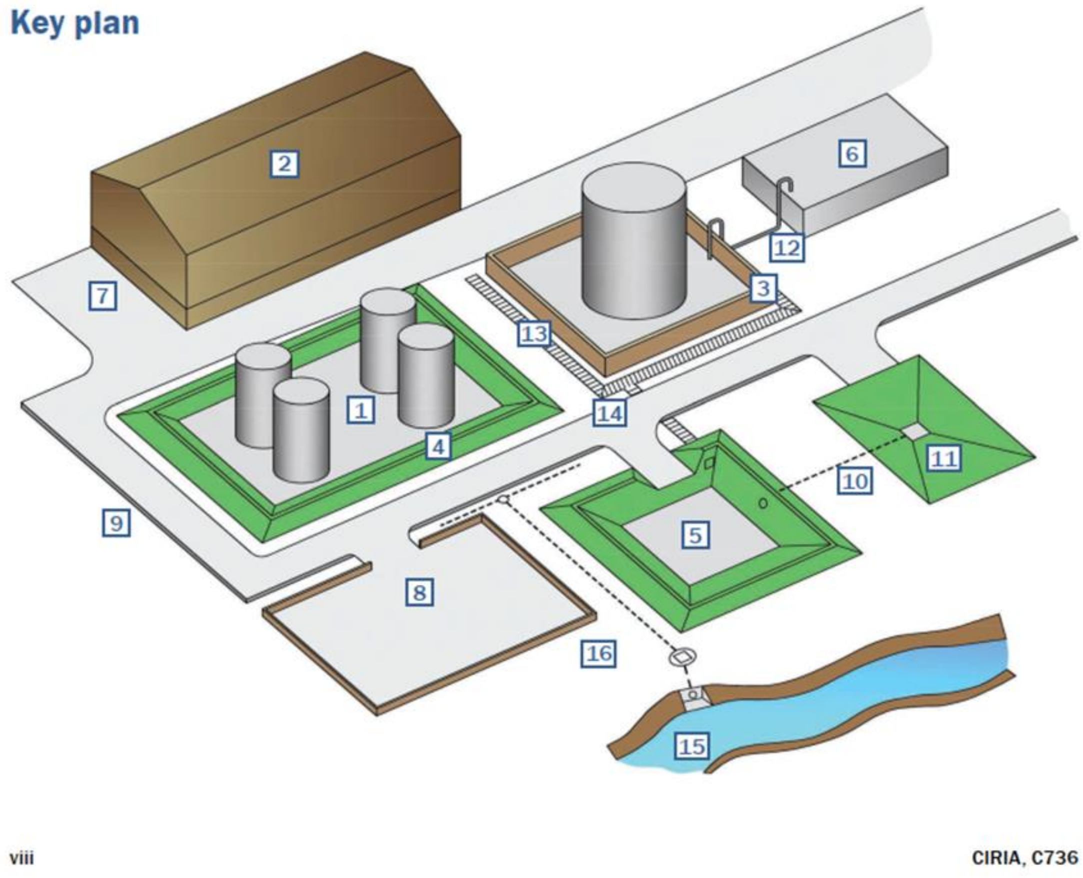


Figure 3-3.1 Diagram of primary, secondary and tertiary containment examples

-**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

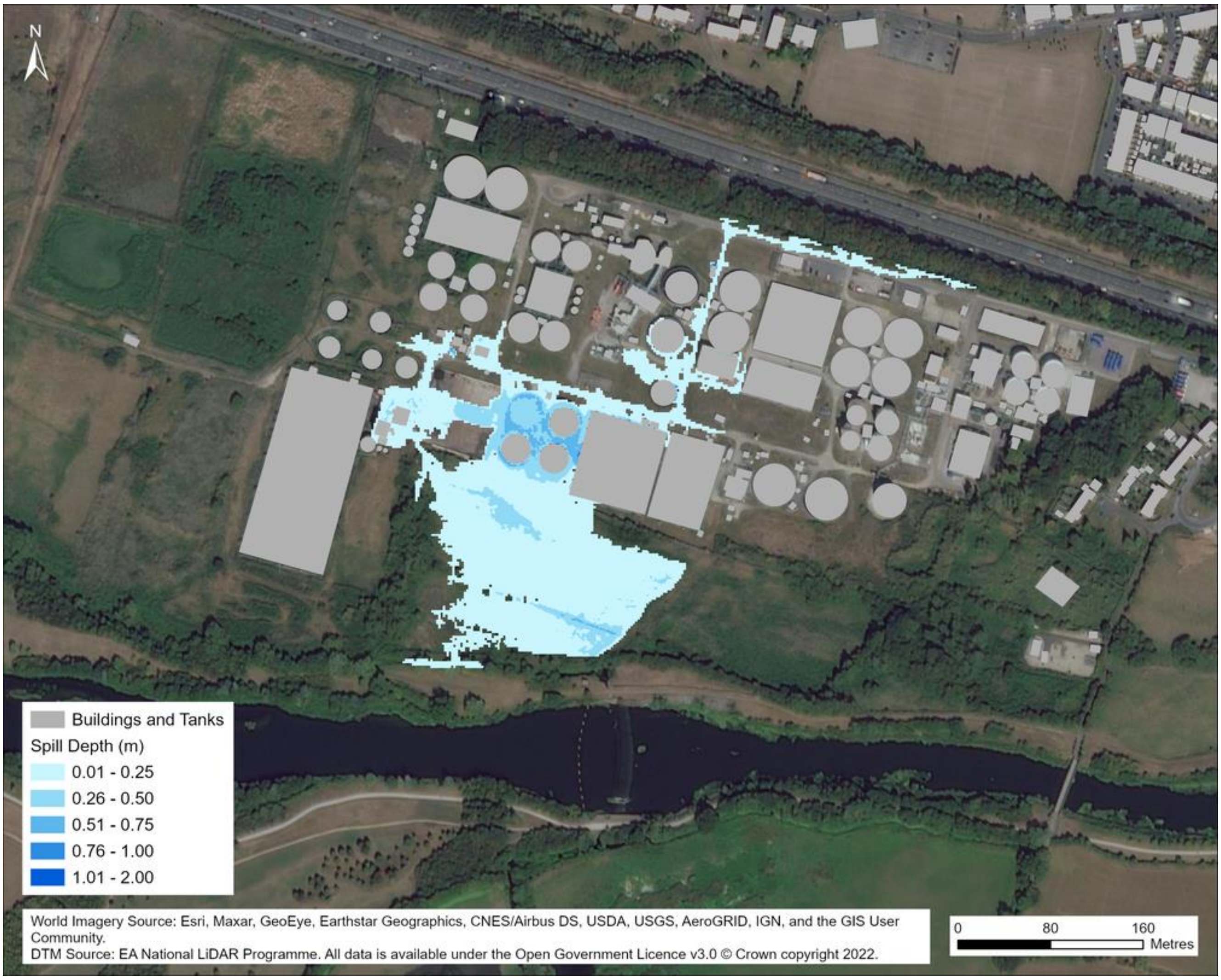


Figure 3.2 Map of Uncontained spill event at Slough STW

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. The Roundmoor ditch will be also affected at the southernmost point of the uncontained release.

Given that this area is in a flood zone 3, the private fields/land and Roundmoor ditch could carry the uncontained release further than anticipated during flooding.

3.3 Site Classification Slough

Based on the use of the ABDA risk assessment, considering the source, pathway and receptor risk Slough site hazard rating is deemed to be Medium. When considering the mitigated likelihood as low a class 1 secondary containment is required.

Source Risk	Pathway Risk	Receptor Risk	Site Hazard Rating	Likelihood	Overall Site Risk Rating
Medium	**Medium**	**Medium**	**Medium**	**Low**	**Low (Class 1)**

Refer to Appendix 1 for more detailed 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

Primary Digesters Area

The total design contained volume comprises 2,155m^3 from catastrophic Primary Digester failure, and 3,500m^3 from the 1 in 10 year rainfall falling on the catchment area of 36,900m^2 during the clean-up period of 8 days, giving a total nominal containment volume of 5,655m^3.

The containment volume has been checked against the 110 and 25% rule and exceeds both due to the rainfall influence. From the tank perspective alone, 25%-rule would be the controlling parameter.

Secondary Digesters Area

The total design contained volume comprises 3,200m^3 from catastrophic Secondary Digester failure, and 445m^3 from the 1 in 10 year rainfall falling on the catchment area of 4,700m^2 during the clean-up period of 8 days, giving a total nominal containment volume of 3,645m^3.

The containment volume has been checked against the 110 and 25% rule and exceeds both due to the rainfall influence. From the tank perspective alone, 110%-rule would be the controlling parameter.

3.4 Slough STW Summary of Containment volumes and assets

3.4.1 Assets for Containment

The tanks for containment are summarised below:

Tanks within Catchment Area 1	**No. of Tanks**	**Total Tank Volume**	
Picket Fence Thinkener Tank	2	628	m3
Pre-Digestion Sludge Blending Tank	1	450	m3
Primary Digesters	6	13364	m3
Totals	**9**	**14442**	**m3**
Tanks within Catchment Area 2	**No. of Tanks**	**Total Tank Volume**	
Secondary Digesters	3	9591	m3
Totals	**3**	**9591**	**m3**

3.4.2 Constrained Model Output – Primary Digesters Area

The terrain model (Figure 3.1) shows a gentle gradient across the primary digesters area from south to north (towards the M4)

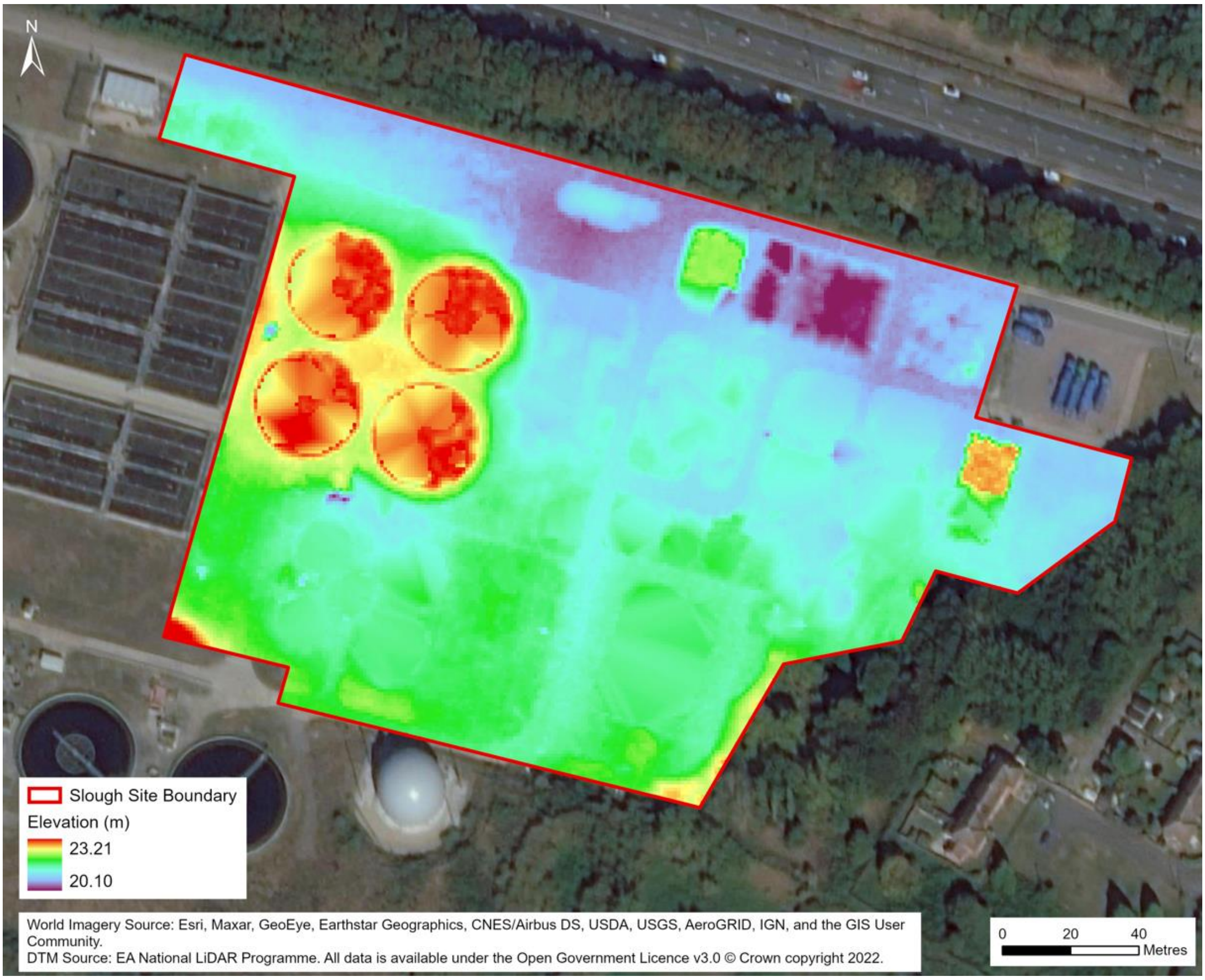


Figure 3.3 Digital Terrain Model of Slough Sewage Treatment Works

The contained model output is shown in Figure 3.4. This identifies that the flows will naturally seek to flow south to north. The top water level (standing stored level) for the tank and rainfall volume is 21.63mAOD. Two plots are provided, one for the full storage volume being mobilsed with the resulting top water level of 21.63mAOD, the other shows an intermediate stage when half of the tank volume has been utilised with a temporary water level of 21.40mAOD,

Figure 3.5 shows the contour plot for the containment area.

Some of the potential depths on the access road in the north are greater than ramps alone can address. Final design development of the bunded area will include replacement of existing grassed and gravel areas. This provides the ability to lower these areas to be flush with the existing roadways and mobilise these areas for storage rather than spill conveyance. A final development may require the ramps to be supplemented by flood gates. The ramps provide storage in the first instance allowing the gates to be closed. A further development could be to revisit the recovery time as the contribution from rainfall over an 8 day period is significant.

The area in the north east has not been included within the containment boundary as this area has been reserved for the development of the new site entrance and security facilities planned for later in 2022.

Figure 3.4 Constrained Spill Model – Full and Partial discharge of volume

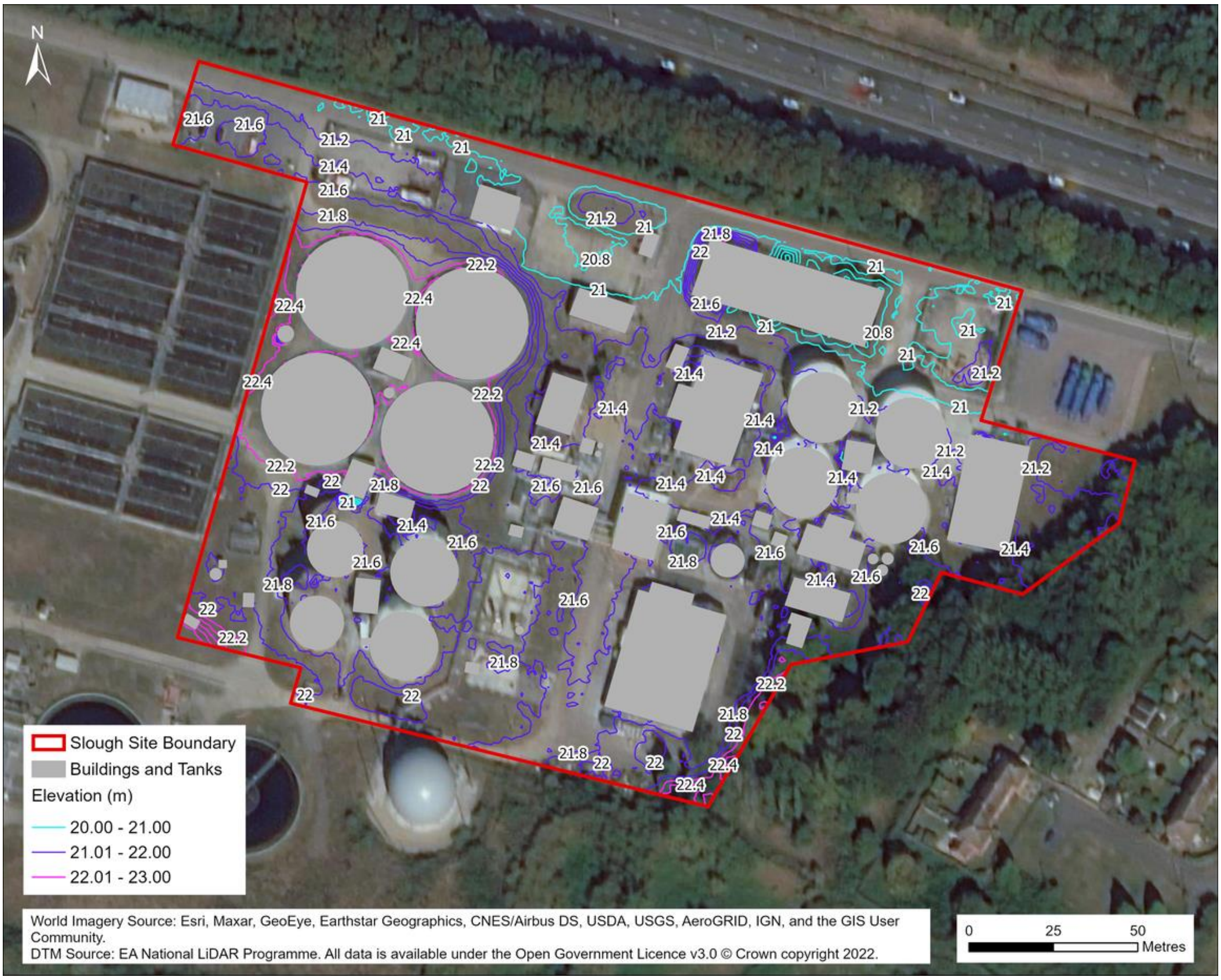


Figure 3.5 Contour Plot for the containment area

3.4.3 Constrained Model Output – Secondary Digesters Area

The terrain model (Figure 3.6) shows the area around the secondary digesters to be more uniform. The grassed areas around the road show a small increase in elevation.

Figure 3.6 Digital Terrain Model of Slough Sewage Treatment Works

The contained model output is shown in Figure 3.7. The top water level (standing stored level) for the tank and rainfall volume is 23.07mAOD. Jetting and splashing is captured by the tertiary containment area. The top wall level of the low wall on the north side is nom 23.4mAOD.

Figure 3.8 shows the contour plot for the containment area.

The tertiary treatment area complements the natural topography enabling flows that may have escaped the main secondary area to be captured and conveyed to the old humus tank repurposed for emergency storage.

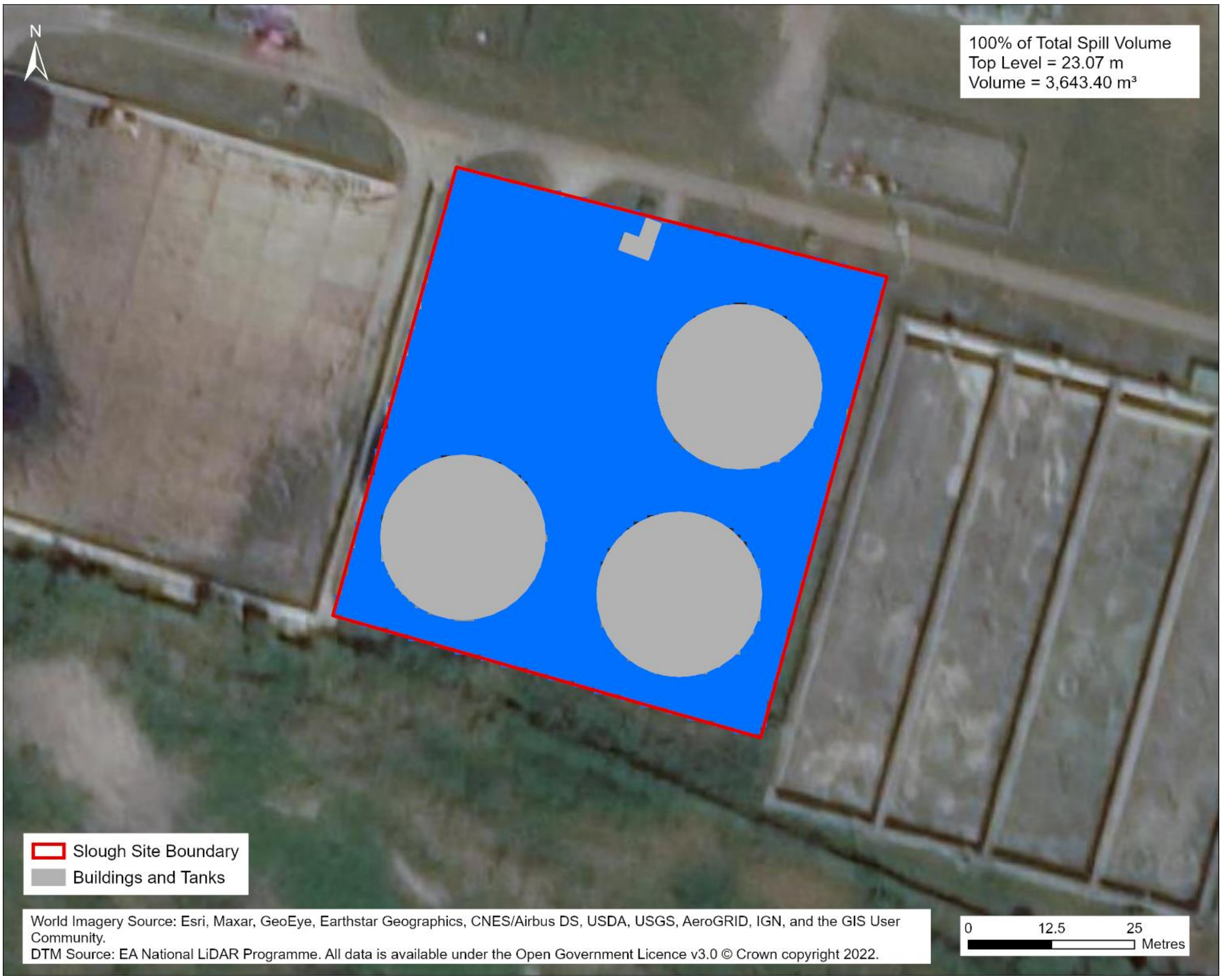


Figure 3.7 Constrained Spill Model

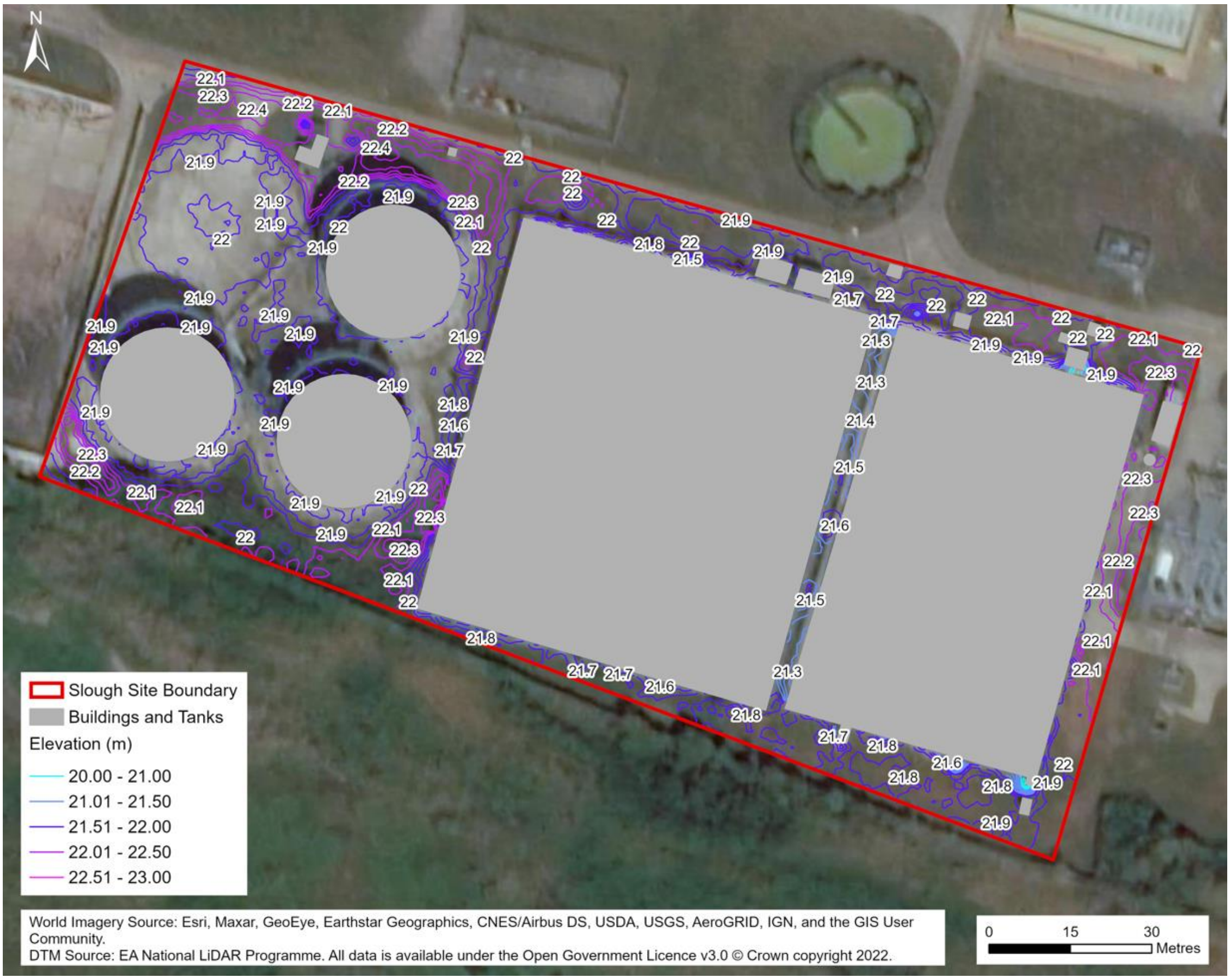


Figure 3.8 Contour Plot for the containment area

3.5 Identified Constraints

3.5.1 Operational constraints

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 8 days which aligns with the CIRIA guidance maximum as Thames Water operations state they cannot achieve this in a significantly shorter time, e.g. 48hrs

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 Other constraints

None identified

3.6 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 events for the 24 hours preceding an incident and for an eight-day period following an incident. The arising average rainfall depths for a 1 in 10-year storm over the event period for Slough is 95 mm. It should be noted that the rainfall depths for Slough 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.

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., suitable 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.

4.1 Containment Options

4.1.1 Primary digester area – wide area containment Option 1

Containment option 1 for the primary digester area considers a wide area containment solution. This helps reduce the bunding height to 250mm. The total containment area within the bunding is approximately 36,800m^2 . The containment area is identified in Figure 4.1

The total spill volume is nom 5653m^3. This comprises catastrophic failure of one of the Primary Digestor tanks, 2155m^3 and rainfall 3498m^3. LiDAR spill modelling calculates a top water level (TWL) 27.63 mAOD when 5653m^3 is contained in this area.

At locations where the bunding will cross an access road, a ramp will be installed at a maximum height of 250mm 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. Further analysis of risks to this work will need to be undertaken.

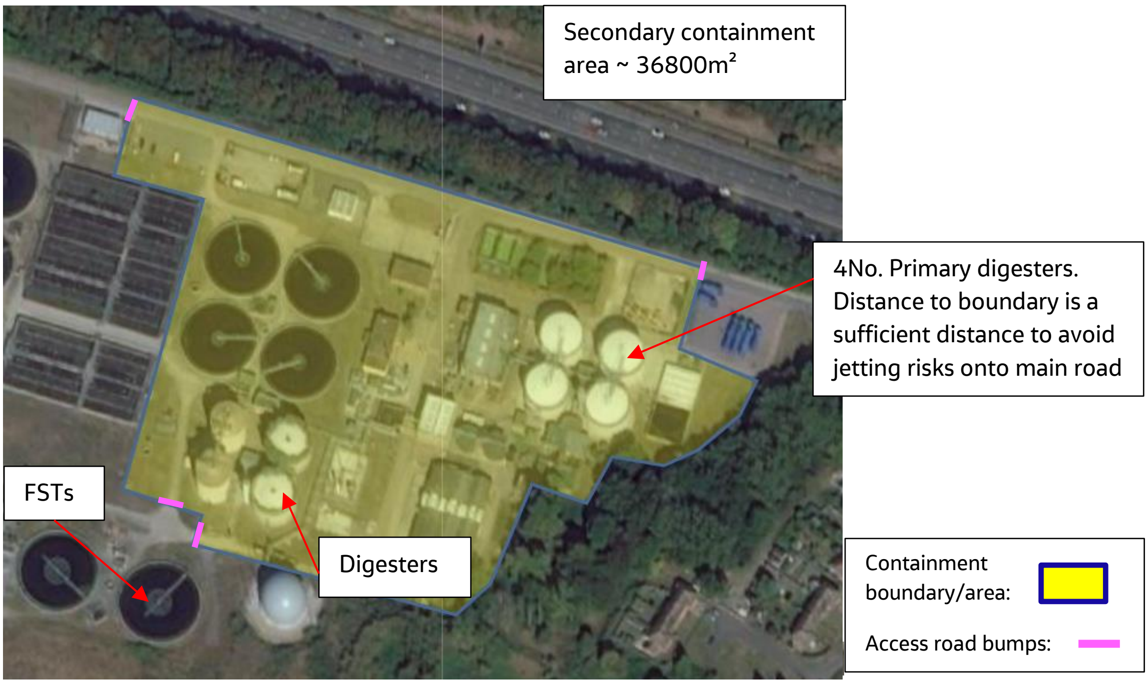


Figure 4.1 Primary digester area - containment option 1

4.1.2 Primary digester area - Containment Option 2 (not modelled)

Option 2 considers a wide area solution but a smaller footprint to reduce the sludge spill area across the site and the added management and clean-up. However, a smaller footprint will raise the bunding height to contain the sludge. The containment area, not including the area in orange which is available for jetting spills, equates to 12,000m^2. The containment area is identified in Figure 4.2

Therefore, to contain this volume of sludge, the bunding will be a height of 500mm which creates larger disruption to site operation, including difficulty tying the bunds into road ramps that fall in the containment area. The location of the bunds has the potential disrupt congested areas of the site. This is in comparison to the benefits of option 2 which consider a smaller clean-up area and less concrete to infill the grass areas.

Additionally, some provision for jetting is included in this option to mitigate the risk associated with the eastern primary digesters. However, there are still some unresolved issues with the wester primary digesters being too close to the secondary containment bund. There are potential issues due to the gentle slope of the area towards the north which will see ponding and likely increased depths in the containment area.

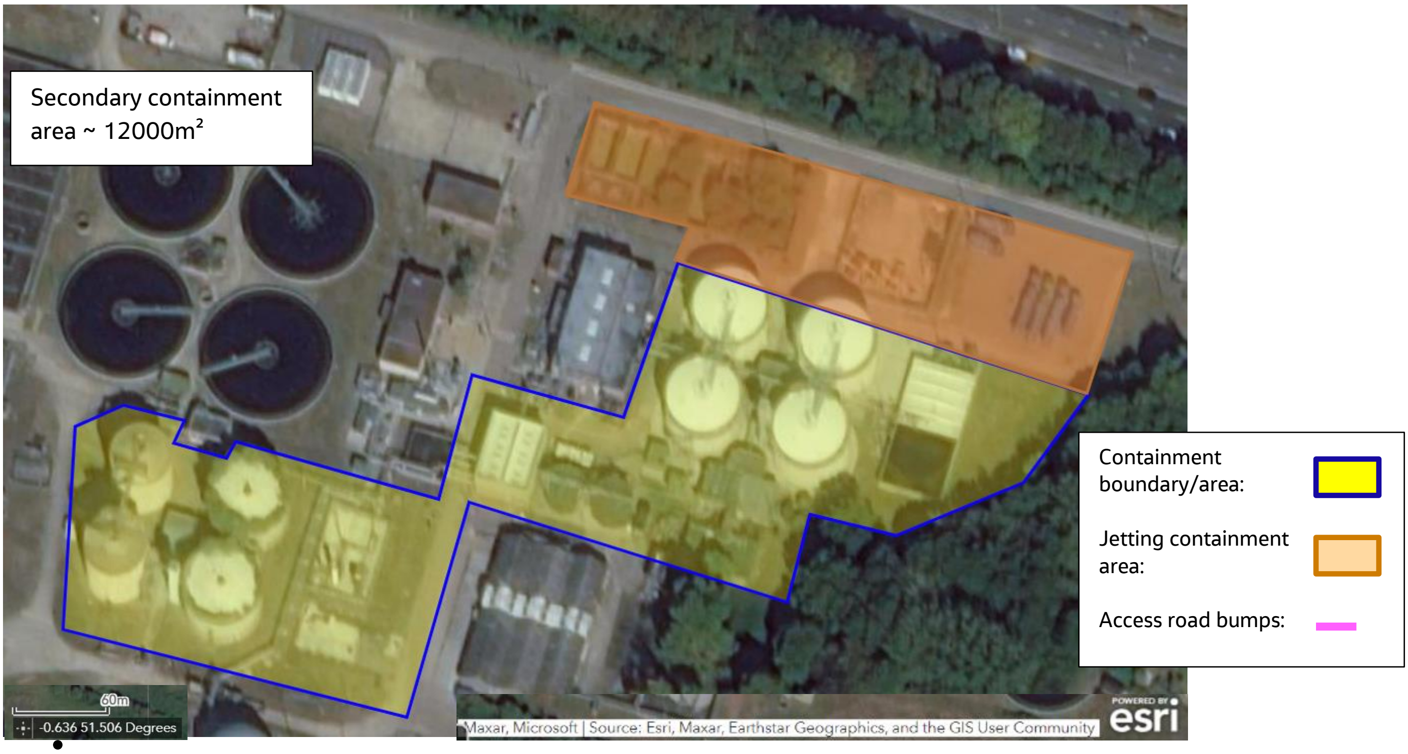


Figure 4.2 Primary digester area - containment option

4.1.3 Secondary digester area - Containment Option 1

Option 1 provides a hybrid solution between secondary containment and tertiary containment.

The total spill volume is nom 3,645m^3. This comprises catastrophic failure of one of the Secondary Digestor tanks, 3,200m^3 and rainfall 445m^3. LiDAR spill modelling calculates a top water level (TWL) 23.07mAOD when 3,645m^3 is contained in this area.

This option comprises the installation of 4 high walls to surround the tanks. Three of the walls will consist of 2m high reinforced concrete with 2m high Perspex screen fitted onto of the concrete. The fourth 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 and a ramp to allow access for operations. The flood gate will be normally closed and this area is not subject to high levels of movements.

Due to the wall being lower at the roadside, considerations are required for jetting and overtopping in the design. Beyond the roadside wall is a tertiary containment area with low bunding at 500mm and road ramps at 250mm on the east and west side where the channel crosses the road. This area will be connected to a disused humus tank that is being repurposed for storage. Flows reach and enter the tank by gravity. See Figure 2.1 below. Removal of rainwater from this tank will be a regular task for operations.

There are risks to be considered in detailed design in this transfer area with HV cables running north and south of the road. Any bunding constructed along the road will require sufficient distance from the overhead cables. To enable practicable access along the road, a maximum of 250mm high bund that is sufficient for frequent vehicle loading.

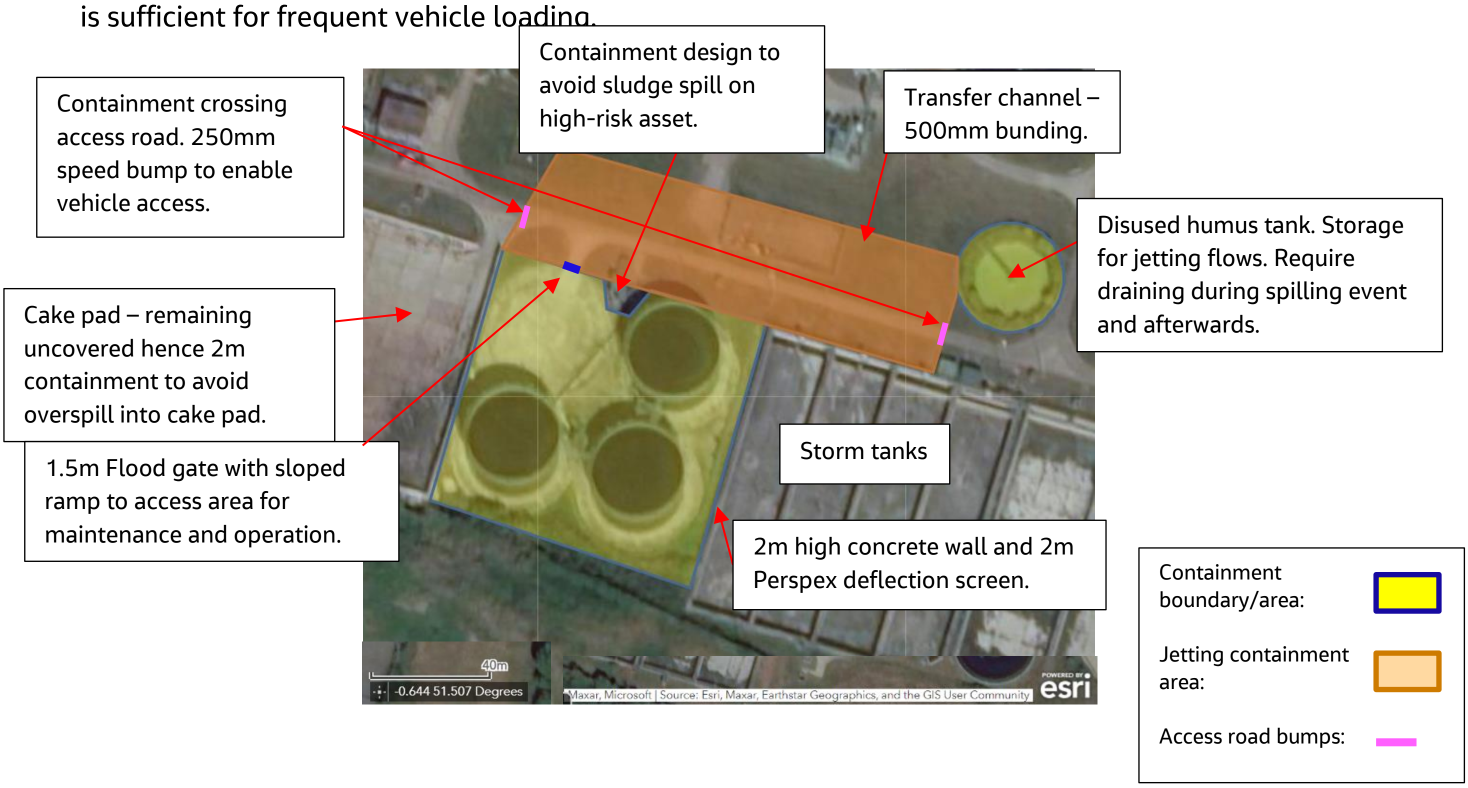


Figure 4.3 Secondary digester area - containment option 1

4.1.4 Secondary digester area - Containment Option 2 (not modelled)

This option is solely a close containment option that protects against risks of jetting flows from the tanks. Therefore, the containment walls must be significantly higher to account for this, including on the northern side where an access flood gate will be required.

The walls are designed at 4m high provided and contain a total area of approximately 4200m^2 . The 4m wall height will comprise of 2m of concrete and the additional 2m will be a Perspex screen with an angled top section to aid with deflection from jetting.

The nominal depth of sludge will be around 1.2m after a spill event. Therefore, the walls can contain the total volume but the additional 2.5m wall height is to account for jetting. Figure 4.2 shows the containment wall boundary extending to the north west corner for additional storage volume. However, with the HV cables running in parallel to the road on either side, this may not be feasible and containment boundary may be reduced.

Figure 4.4 Secondary digester area - containment option

4.2 Mitigation of Site Specific Risks

4.2.1 Jetting and Surge Flows

There is a low risk of jetting occurring at the primary digesters as the majority of the digester tanks are concrete construction, for which catastrophic failure is deemed to be less of an issue. Failure is more likely to begin with major seeping from the tanks which would be spotted during routine site walkabout tours each day.

For the secondary digesters there is a risk of contamination through jetting due to the proximity of the secondary digestors to the boundary of the site and containment area for which tertiary provision has been made.

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 not within any potential flooding zone as shown in Figure 4.5 therefore, no modifications need to be made to Slough STW to accommodate this risk.

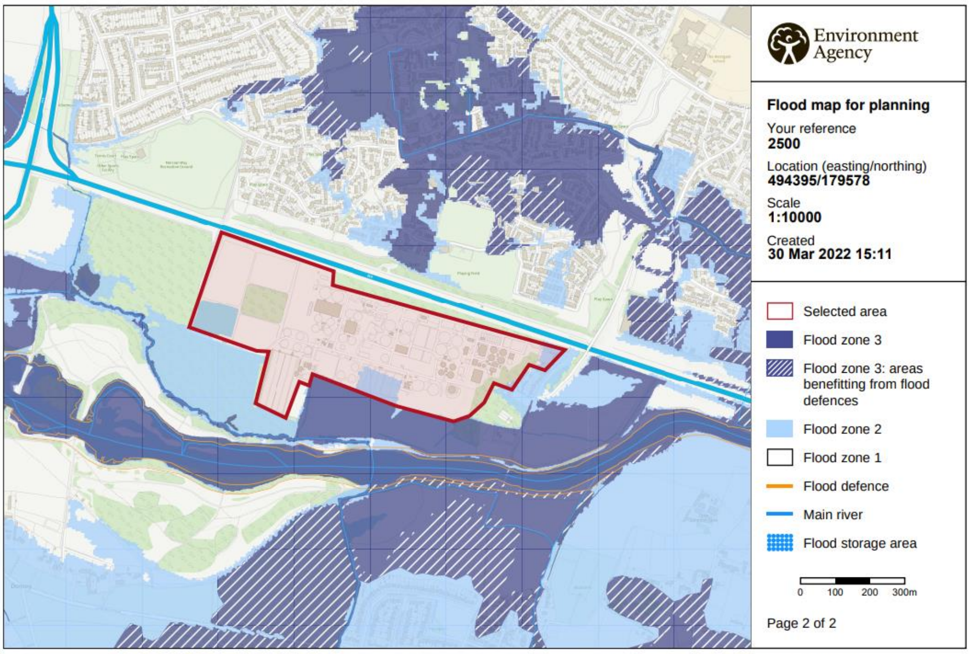


Figure 4.5 Extent of Fluvial flooding in Slough due to extreme weather events

4.3 Identification of Preferred Option

The preferred option for the primary digester area is option 1 and for the secondary digester area option 1.

The basis reflects practicality of installation and operation. The taller bund/wall heights associated with the rejected options present long-term access issues. In particular for secondary digesters area, the tall walls have the potential to obscure visibility of operatives working in that area.

4.3.1 H&S and CDM risks

- Flood gates where more frequent traffic movement not supported by Operations e,g main site roads
- Interconnecting pipework on secondary digestors and failure of one tank will cause some flow to be released from the other connected tanks
- Cable ducts and fibre ducts act as conduit to transport sludge around site.

- Impermeable membrane with gravel on top not supported by operations as difficult to clean up sludge
- Concern over covering secondary sludge digestors – potential explosive risk

5. Site Drainage and liquor returns

5.1 Process flow diagrams

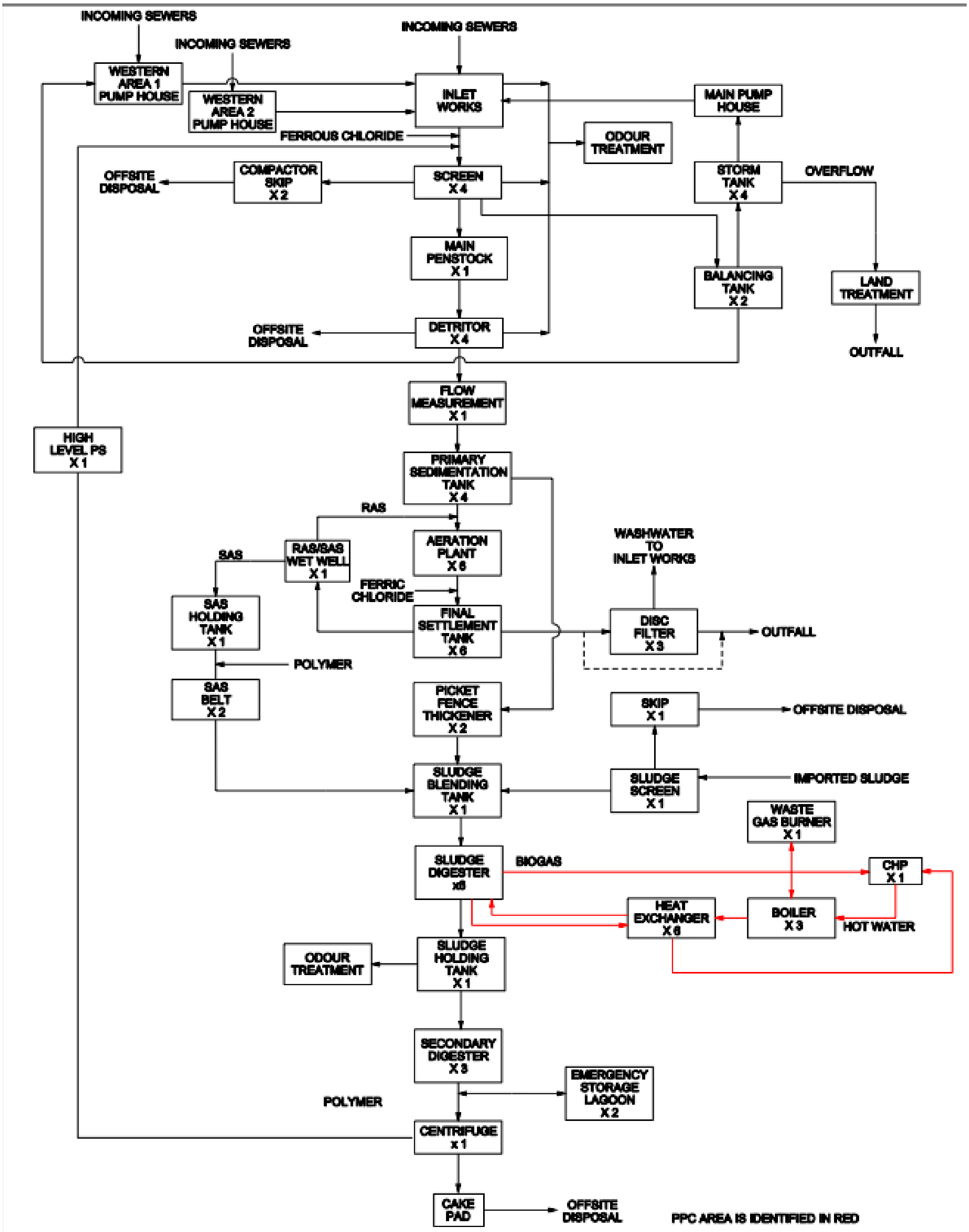


Figure 5.1 Process Flow Diagram

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 5.4- 5.6. 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, this line should be isolated or pumping should be inhibited.

The surface water drains, shown as the 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 5.4 – overall site drainage plan

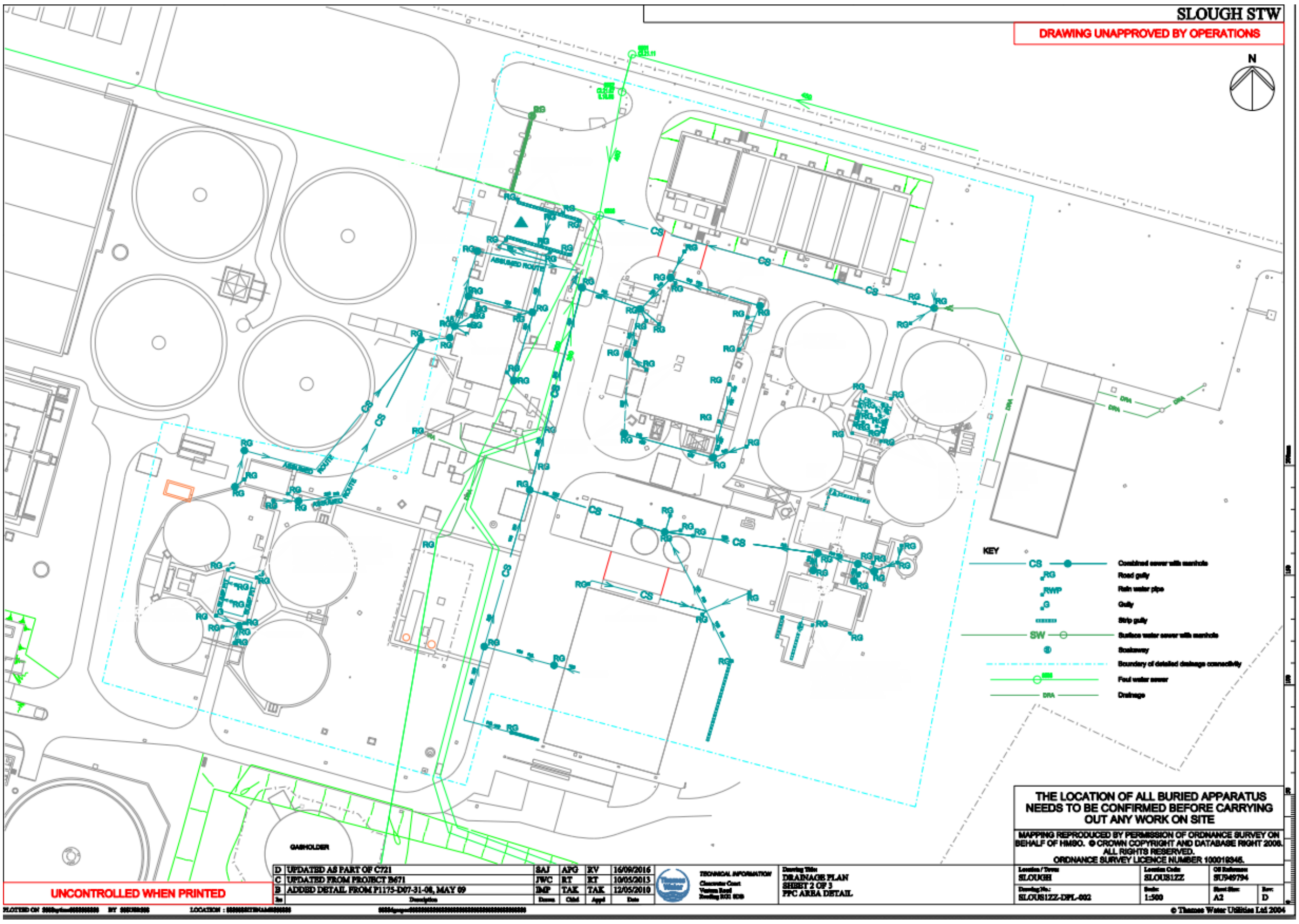


Figure 5.5 PPC Area - drainage plan sheet 2 – primary digester area

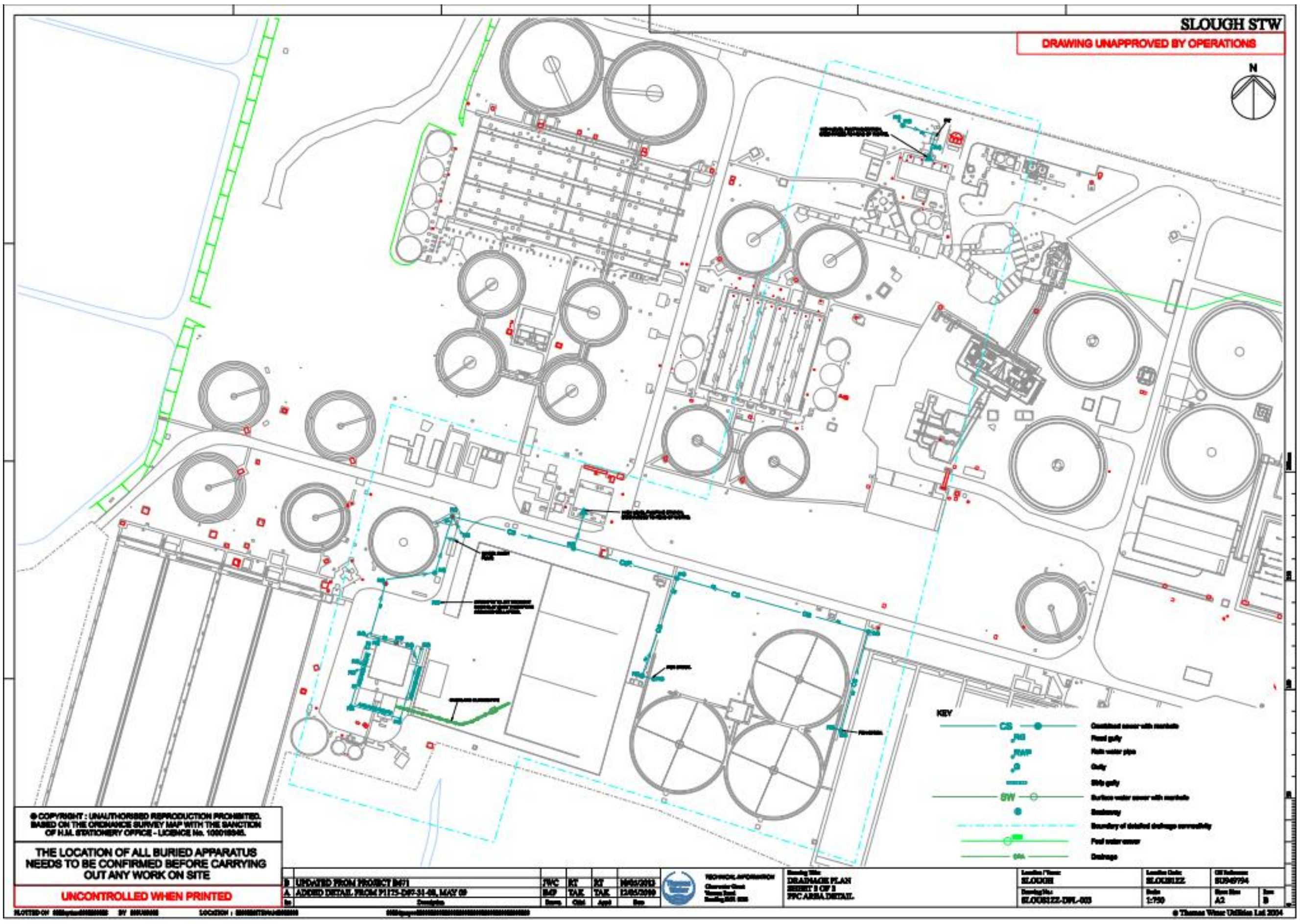


Figure 5.6 - PPC Area - drainage plan sheet 3 - Secondary digesters and cake pad area

5.3 Liquor Returns

The existing liquor return system is not being altered by the containment system, other than the control modifications proposed in 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 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 automatically prevent any adverse impact on sewage treatment. There are two options for this;

A. Level signal automatically isolates the at-risk pipes. This would prevent large flows of digestate from entering the drainage lines to the inlet channel or river. This option requires an automatically actuated isolation valve to be installed on each of these pipes.

B. Level signal automatically inhibits sludge being returned back to the head of the i.e., allow catastrophic spillages to enter the inlet channel but prevent it from being pumped back to the head of the works. This option requires no hardware or infrastructure, only software modifications.

Option B is cheaper and easier to implement as it will use current equipment and require only software modifications only. However, operators on site should be consulted to further understand the surface water drainage system to explore any automatic isolation solutions that involve software modifications only.

The option of the level sensor signal from an abnormal rate of change triggering an alarm system for an operator has been considered.

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 low was determined meaning that class 1 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 two separate areas for containment.

The preferred option for the primary digester area is option 1 which is an area wide bund. The resulting area allows shallower containment depths making long term access more practicable. The depths avoid the use of flood gates in a part of the site that is subject to high levels of vehicle movement.

The preferred option for the secondary digester area is option 1 which comprises 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. Access if by a flood gate which is normally closed and the area is subject to fewer movements. The risk of jetting into the site is mitigated by tertiary containment and direction of flows to a repurposed storage tank.

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 both areas, the containment volume exceeds these due to the impact of rainfall; the containment is set by the largest tank plus the rainfall.

Due to gradients across the site, water may pond particularly in the primary digestors area. Final design detailing will need to consider measures to reduce the risk of ponding on the roads. Such amendments may include reprofiling of areas when replacing grassed and gravelled areas with concrete. Alternatively, the recovery time of eight days may need to be reassessed to reduce the rainfall impact upon this area.

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 has been mitigated by the use of tertiary containment.

Appendix 1 ABDA 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. Domestic and trade effluent Wastewater sludges, both in a raw, semi treated and treated state.

2. Polyelectrolyte chemicals for sludge thickening.

The Source Hazard rating was determined as Medium.

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.

Consequently, the Pathway Hazard rating was determined as Medium.

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

1. The site drainage system and the head of the works.

2. Part of the site is on the outer boundary of the Eton borehole protection zone .

3. The M4 adjacent to the north of Slough STW.

4. The habitation of large populaces nearby, the nearest of which is directly across the M4. But these are outside of the risk trigger

5. The Jubilee River directly to the south and at lower elevation to Slough STW. The Roundmoor ditch prior to the Jubilee River receptor. But is outside of the risk trigger

The site is near a populated area across the motorway. The site is bordered by the M4. Spillage can potentially cause damages to these infrastructures leading to significant delays.

The Receptor Hazard rating was determined as Low.

Likelihood – For the purpose of this assessment the likelihood for mitigated and unmitigated risks was calculated based on the assumption that the likelihood hazard rating is low.

Pre-mitigation measures, operational failures were highlighted as a high risk, shortfalls in design (provision of alarms and monitoring) together with structural failure were highlighted as a medium risk.

Post-mitigation measures operational failures were re-scored as a medium risk. Therefore, the final Likelihood Hazard rating was determined as low.

Based on the information above the overall site risk rating was calculated to be low which means that class 1 secondary containment is required.

Appendix 2 Tank Covering initial review

There are a number of open top tanks within the permit boundary at Slough STC, including the secondary digesters.

It is acknowledged that there may be emissions of biomethane and / or odour from some of these tanks, and Thames Water is preparing a monitoring exercise to determine the nature of any emissions and their quantity. Based on these outputs, the requirement for covering the tanks will be assessed on a prioritsed basis, in accordance with the design of the existing tanks and HSE requirements around specialist equipment and DSEAR, in accordance with the applicability notes for BAT 14d.

As part of any tank cover design, the initial monitoring data will be necessary to determine if the correct routing of any gas from the tank headspace would be to the biogas utilisation system; to an OCU or another option. The quantification of tank emissions is needed to determine if the gas treatment assets also require upgrading, e.g. existing engine utilisation levels and gas storage system.

Due to the variability of air pressure underlying the potential release rate of gas from the tank contents, it is proposed that the monitoring exercise will consider a minimum number of sampling rounds during a 12 month period, to reflect emission levels at different ambient air temperatures and atmospheric pressures. Where multiple tanks for the same purpose are on a site (e.g. secondary digesters) it is proposed to monitor a representative tank rather than all of the same type.

Monitoring will be undertaken using appropriate methodology for the nature of the tank. Being open topped, monitoring falls outside of standard Environment Agency guidance such as M1 and M2. However, it is proposed to use an area sampling technique, similar to that proposed in the M9 document for bioaerosols, through use of a 1m square sampling hood, with an integral chimney which can be used for extractive sampling. This sampling will be undertaken by appropriately qualified contractors, preferably MCERTS certified.

As an illustration of the proposed technique, a minimum of two air samples will be taken from each sampling location, one for odour assessment and one for VOC measurement, at an appropriately MCERTS or UKAS accredited laboratory, as well as gas flow being measured when the sampling hood is in-situ. The measured concentrations will be assessed against UK government clean air values to determine the impact, if any, on air quality from the tank contents. These results will then feed into the design of any identified cover system to ensure that any emissions are appropriately handled.

Any proposed coverings will be subject to a cost benefit analysis, based upon the Environment Agency tool.

Appendix 3 Quantities of the preferred option

Primary digester area – option 1 (preferred)

Containment Area	Total Wall/Bund Lengths (m)	Wall/Bund Height (m)	Ramps*
Secondary containment	800	250	3
Additional (Flood Gates/Isolation Valves/Building Protection/ local infill)	**Location in containment area**	**Width (m)**	**Height (mm)**
Ramp	Northwest corner	7	250
Ramp	Northeast corner	7	250
Ramp	Southwest corner, adjacent to digesters	4	250
Ramp	Southwest corner adjacent to FSTs	4	250

Secondary digester area – option 1 (Preferred)

Containment Area/Asset	**Total Wall/Bund Lengths (m)**		**Wall/Bund Height (m)**	**No. Ramps*/Flood gates**
Secondary concrete	200		2	
Secondary perspex	200		2	
Secondary (North wall)	80		1.5	1
Secondary (North wall) perspex	80		1.5	
Tertiary Transfer Channel	300		0.5	2
Additional (Flood Gates/Isolation Valves/Building Protection/ local infill)	**Location**	**Width (m)**	**Height (mm)**	
Ramp	Western side, adjacent to cake pad.	12	250	
Ramp	Eastern side, next to old humus tank.	3	250	
Flood gate	Existing road entry to secondary digesters.	4	1500	
Other	**Description**	**Pump rate (l/s)**	**Duration**	
Pumping activity	Pumping out rainwater of disused humus tank			