J840 – STC IED Containment

Banbury STC – Containment Options Report

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Thames Water

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1.0	24/03/2023	First Issue	CR	KG	SC	HG
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Contents

1. Executive Summary

Thames Water is required by the Environment Agency to provide secondary containment to their sludge treatment centres to satisfy provisions of the Industrial Emissions Directive 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 Banbury.

Banbury STW treats wastewater from Banbury town and surrounding villages such as Bodicote & Adderbury, Duns Tew and Deddington and cess waste from the neighbouring companies. The treatment works also serves as a regional sludge centre. 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 12 tanks in total containing sludge with a total operational sludge volume of approximately 8764m^3, most are constructed of steel, with individual tank volumes varying between 110 to 1408m^3. Refer to section 3.4.1 for details on tanks and volumes. The site is generally low lying and flat. There are four containment areas to consider at Banbury each set by the largest tank + rainfall rule as well as a lagoon that will act as secondary containment:

Containment Area	Volume	Rule
Primary digester area	1748m^3	Largest tank + rainfall
Secondary digester area	1094m^3	Largest tank + rainfall
Sludge import reception tank area	291m^3	Largest tank + rainfall
Picket fence thickener area	191m^3	Largest tank + rainfall
Lagoon	832m^3	n/a

Below a summary of the preferred option:

Containment Area	Description of containment
Primary digesters (System 1)	• Close containment boundary allowing nom 300mm depth of storage. Containment area sized to incorporate the proposed sludge buffer tank. Spillage will overflow once containment area full via pipe or covered open channel leading to the Secondary Digester Area.
Secondary digester Area (System 1)	• Close containment boundary allowing 300mm minimum height of storage. Overflow chamber within area, takes spillage via 525mm diameter underground pipe to new proposed lagoon.
Lagoon (System 1)	• 764m2 lagoon, 1.25m deep to act as remote secondary containment. Completely fenced with dedicated pumping station for rainfall.
Sludge import reception tank area	• Close containment boundary allowing nom 300mm depth of storage, spillage conveyed via underground pipe to Picket Fence Thickener (PFT’s)

Picket fence thickener area (PFT's)	• Close containment boundary allowing nom 300mm depth of storage. Containment area oversized to allow planned construction of 2 new PFT's.
Summary	• The option combines two distinct systems both using closed containment and conveyance routes. • System 1: Primary digesters area → Secondary digester area → Lagoon • System 2: Sludge import reception tank area → PFT area • Option reduces impact to operational access as no containment boundaries cross main access roads.

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. The review showed that the solution needed to work with the land topography. Failure of a primary digester tank (largest spilled tank) was addressed by adopting stepped closed area containments out falling to a remote lagoon for both the primary and secondary digesters. Failure of a PFT or Sludge Import Reception tanks were also addressed through close containment with an underground pipe connecting the two areas, using some of the natural slope of the ground around the PFT's as a containment boundary. These options will have a low impact on the daily operations of the site with minimal access installations. Refer to Section 4.1 for details on the options reviewed and Section 4.3 for the preferred option.

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. Float valves will also be installed onto surface water drains to prevent spilled sludge from returning immediately to the head of the 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 a bound impermeable material (high cement replacement concrete) to provide a surface that can be cleared of sludge to meet a four-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 use 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 below:

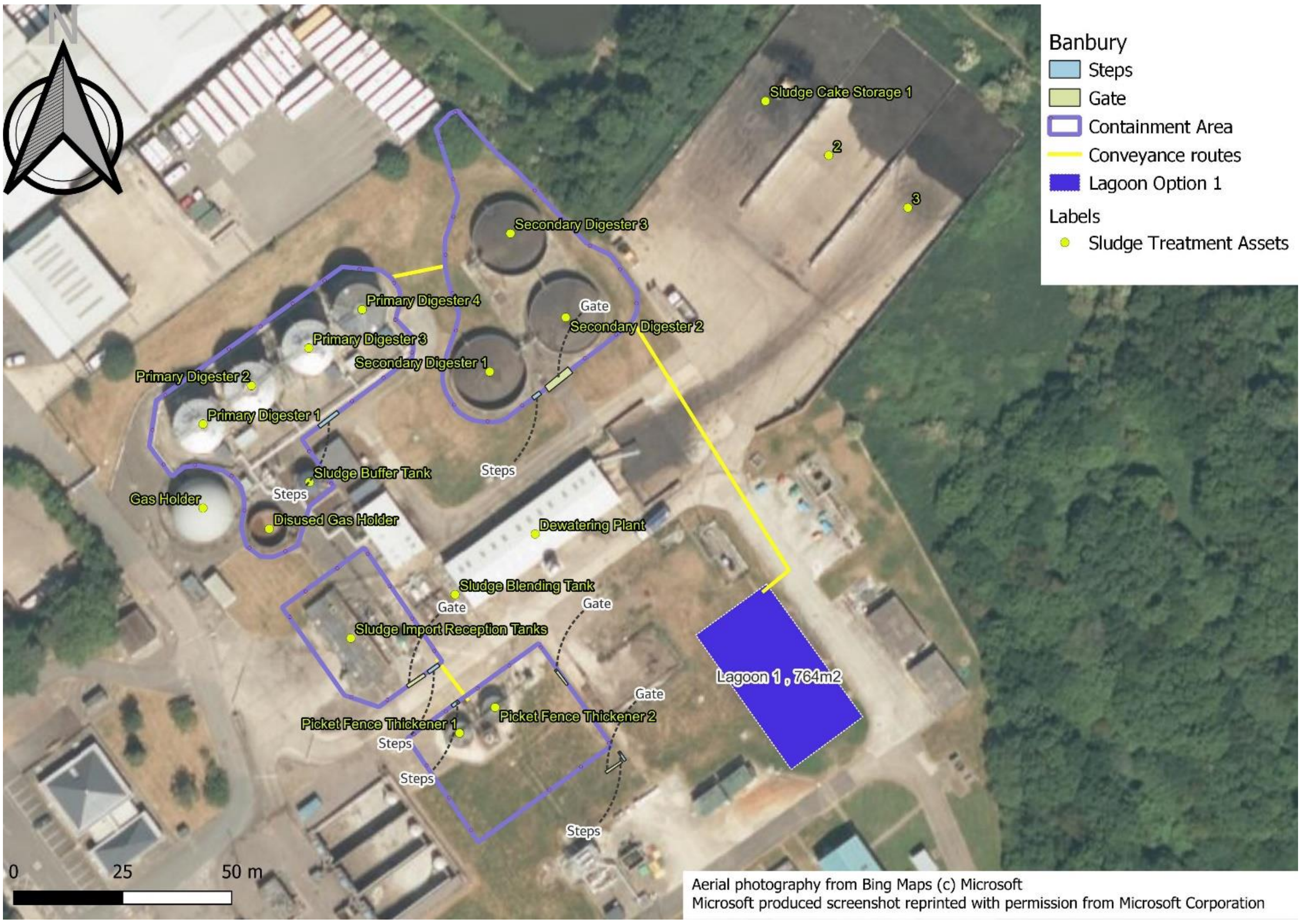


Figure 1-1 General layout of containment for Banbury STW

2. Background

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

Banbury STC is located approximately 1.5 km east of the town of Banbury, Oxfordshire. The site is towards the south of a large industrial estate, adjacent to a commercial waste transfer station. To the north are a number of industrial and commercial units forming areas of the industrial estate. To the east is an area of woodland and green space leading to a number of large industrial warehouses and the M40 motorway. To the south is further green space, in the form of agricultural fields along with further industrial warehouses. To the west is green space and a railway line.

Figure 2-1 Location of Banbury STW

Figure 2-2 Satellite image of Banbury STW location next to industrial estate

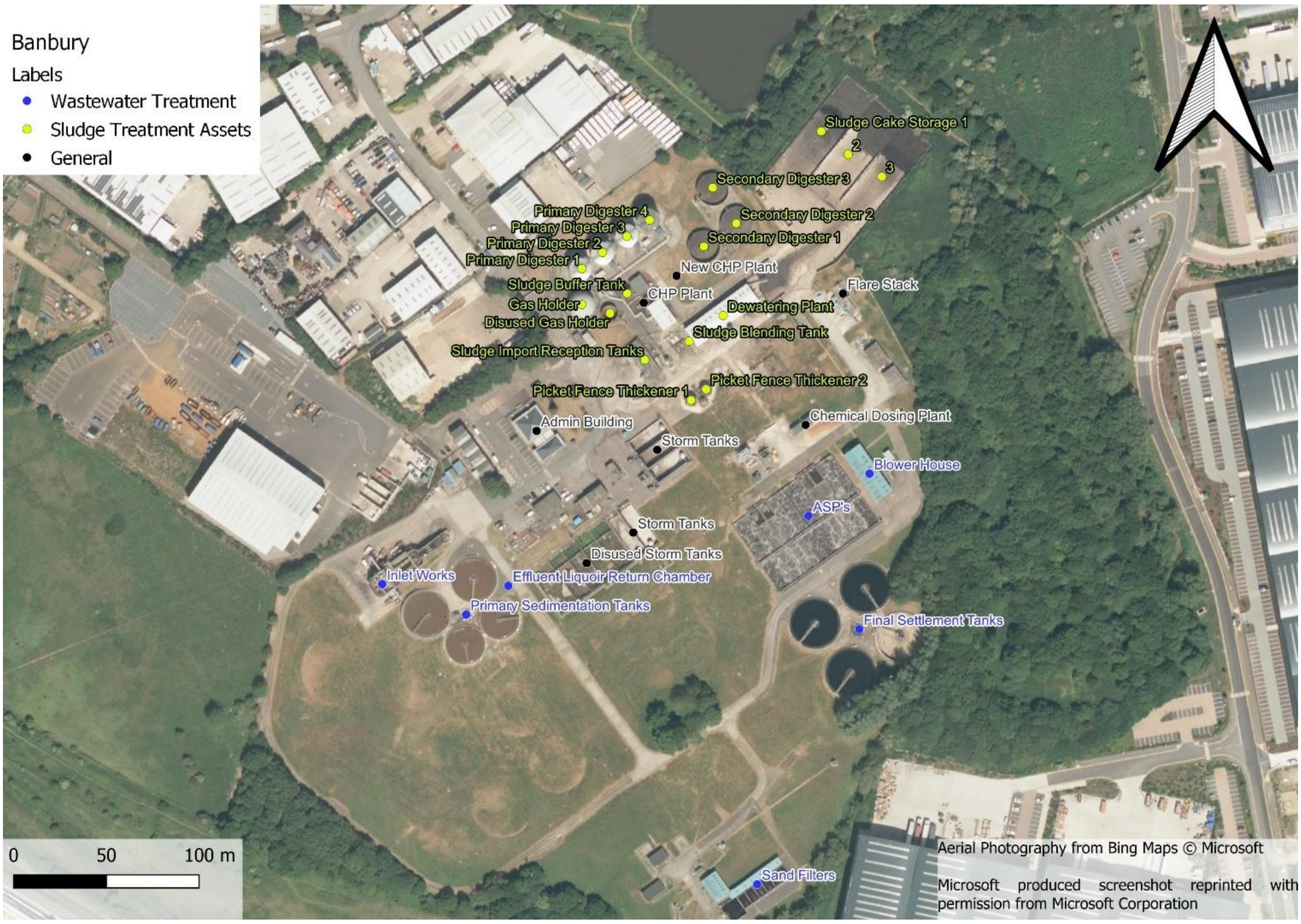


Figure 2-3 Labelled image of the assets within Banbury STW

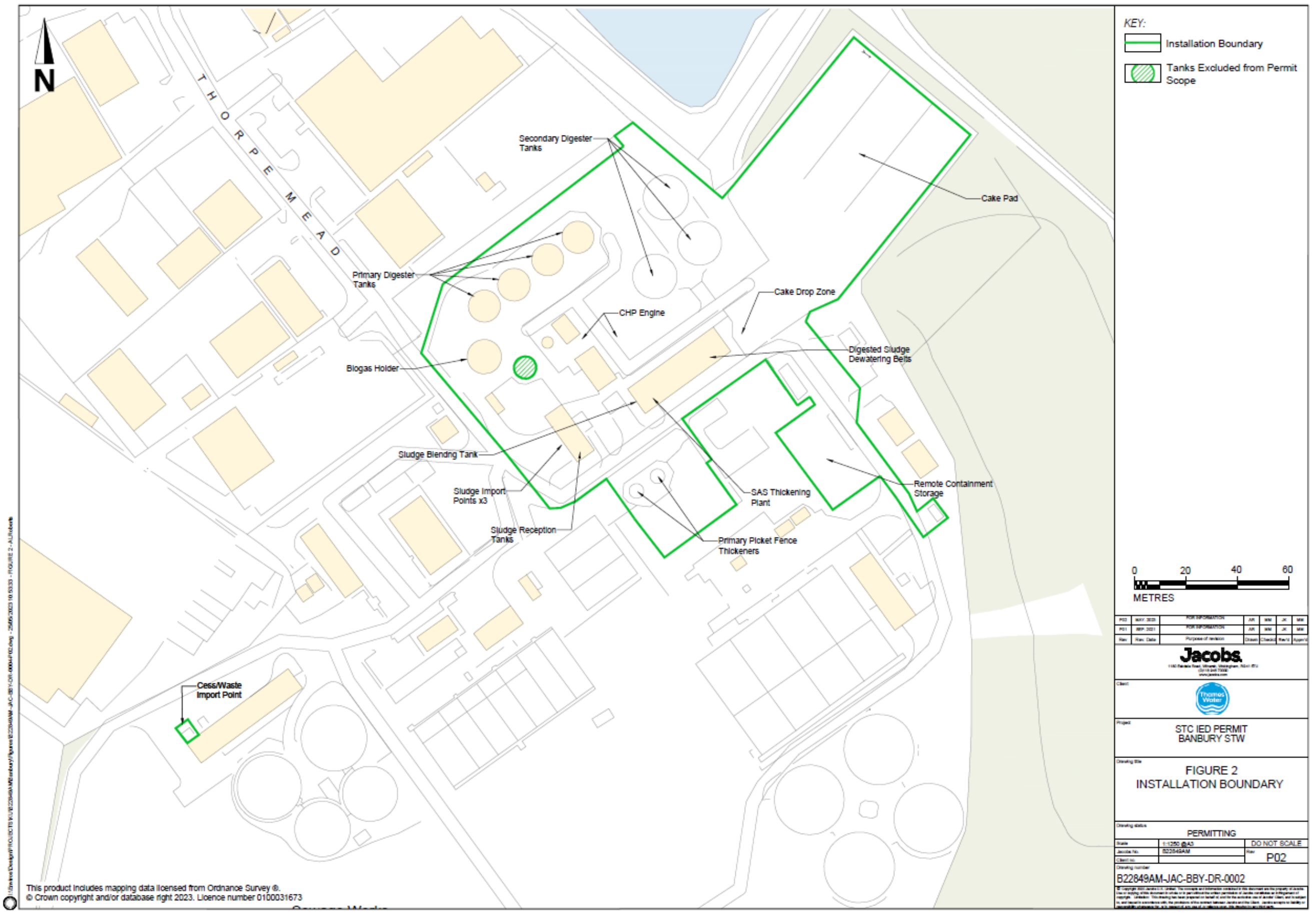


Figure 2-4 Boundary of permitted IED area and the assets

This document should be read in conjunction with; Banbury STW, Risk Identification and Containment Assessment Report, revision OA dated 14/04/2022. This report outlines the impact of an uncontained spill and the risk assessment completed.

3. Proposed Containment at Banbury 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;

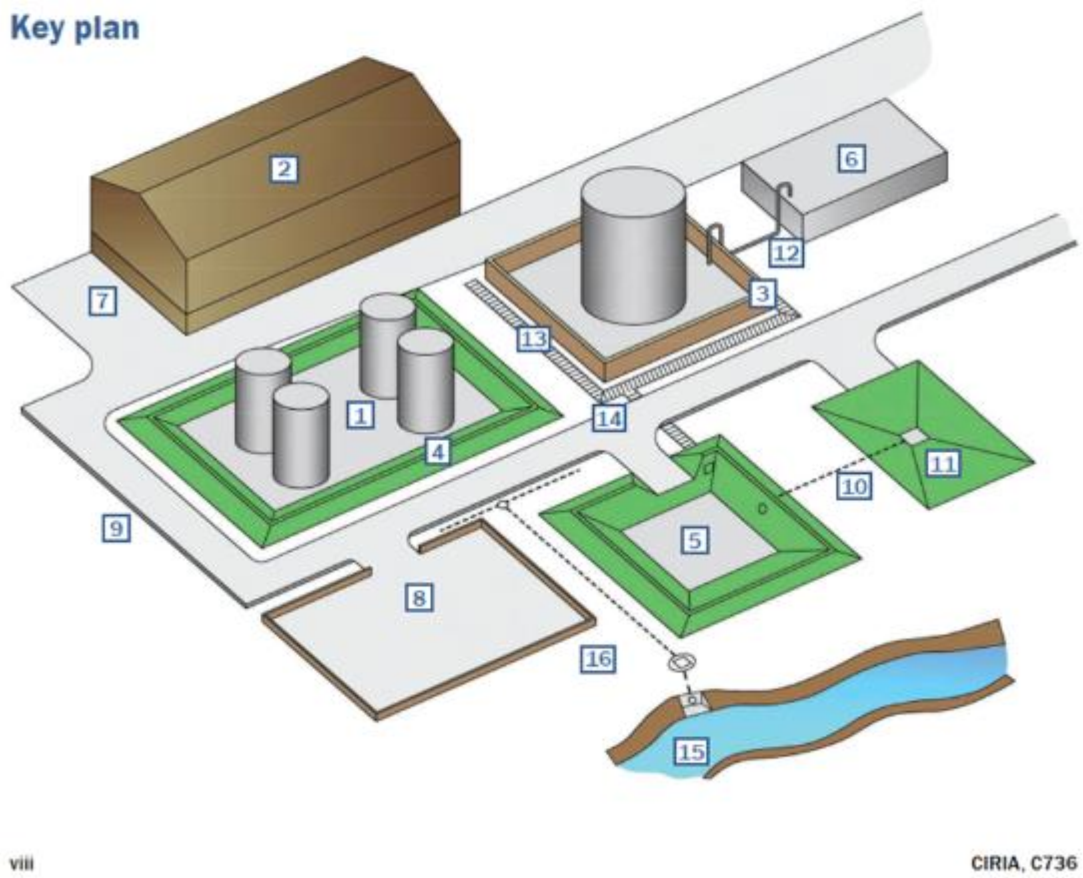


Figure 3-1 Diagram of primary, secondary and tertiary containment examples

- 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

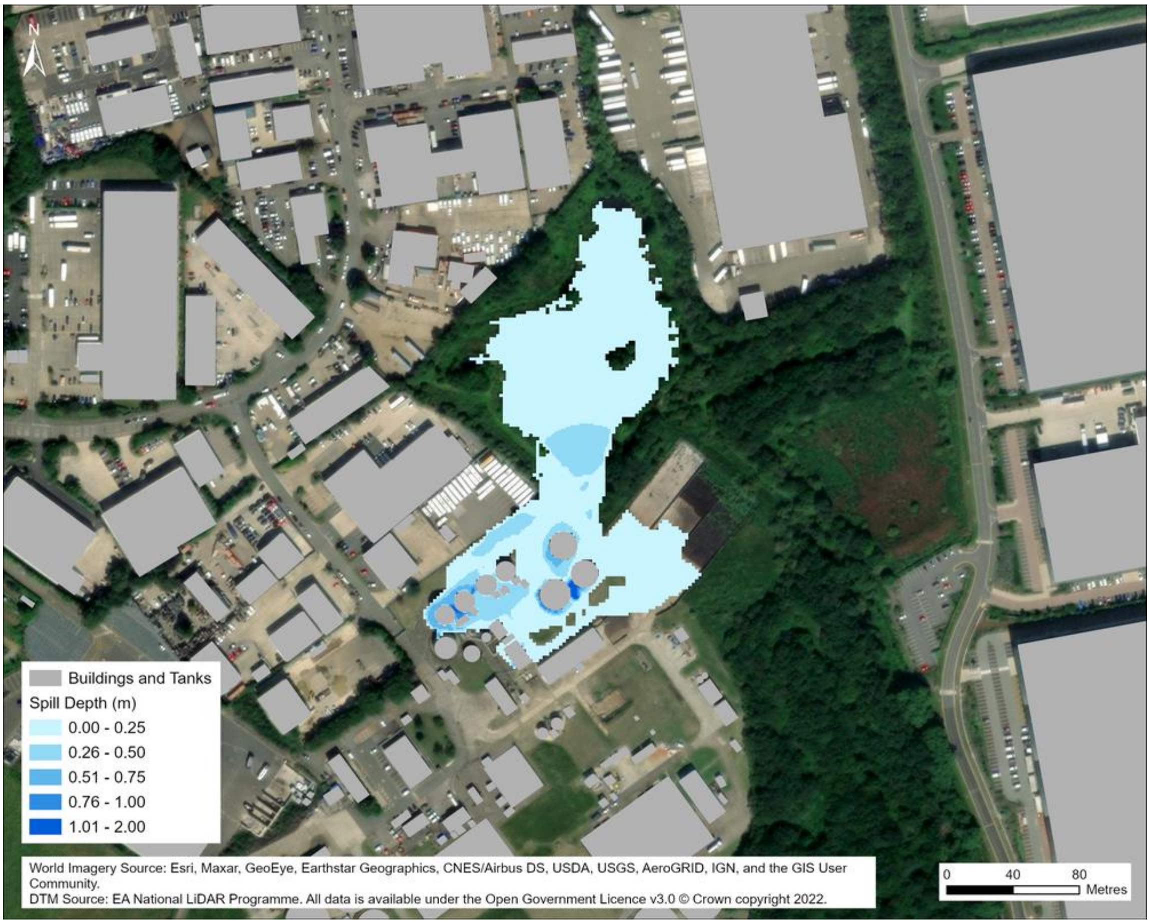


Figure 3-2 Uncontained Spill Model Results

Figure 3-2 shows that a potential sludge spill from the one of the digesters will not be self-contained within the site and therefore passive containment needs to be implemented to safeguard the nearby receptors. According to the model the spill will leave the site boundary (in the north-east site boundary) in approximately 2 minutes after the failure of one of the digesters.

Assuming the spilled sludge originate from the failure of one of the Primary Digester on site. The spilled content will travel north bound and empties into a tributary off the River Cherwell. The sludge will then travel downstream of the tributary, eventually reaching the River Cherwell, a Thames tributary.

3.3 Site Classification Banbury

Based on the use of the ADBA risk assessment, considering the source, pathway and receptor risk Banbury 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	Medium	Medium	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 largest tank + rainfall applies.

The total design contained volumes comprise:

1. Primary digester area: 1748m^3
2. Secondary digester area: 1094m^3
3. Sludge import reception tank area: 291m^3
4. Picket fence thickener area: 191m^3

Table 2 Estimating critical spill volumes

Primary digester area		
25% Rule	**1473**	
110% Rule	**1549**	
Largest + rainfall	**1748**	**Emerging critical case**
Secondary digester area		
25% Rule	**674**	
110% Rule	**989**	
Largest + rainfall	**1094**	**Emerging critical case**
Sludge import reception tank area		
25% Rule	**39**	
110% Rule	**173**	
Largest + rainfall	**291**	**Emerging critical case**
Picket fence thickener area		
25% Rule	**110**	
110% Rule	**121**	
Largest + rainfall	**191**	**Emerging critical case**

3.4 Banbury STW Summary of Containment volumes and Assets

3.4.1 Assets for Containment

Table 3 List of tanks and volumes

Tank Purpose	No.	Operational Volume (m^3)	Total Volume (m^3)	Material
Sludge Import Reception Tanks	1	157	157	Concrete
Picket Fence Thickeners	2	110	220	Steel
Sludge buffer tank	1	100	100	Steel
Primary Digester	3	1,408	5,591	Steel
	1	1,367		
Secondary Digester	3	899	2,697	Steel
		Overall Total	**8,765**	
Proposed new tanks				
PFT's	2	110	220	Steel
Sludge buffer tank	1	200	200	Steel
		Proposed New Total	**9,185**	

3.4.2 Digital Terrain Model

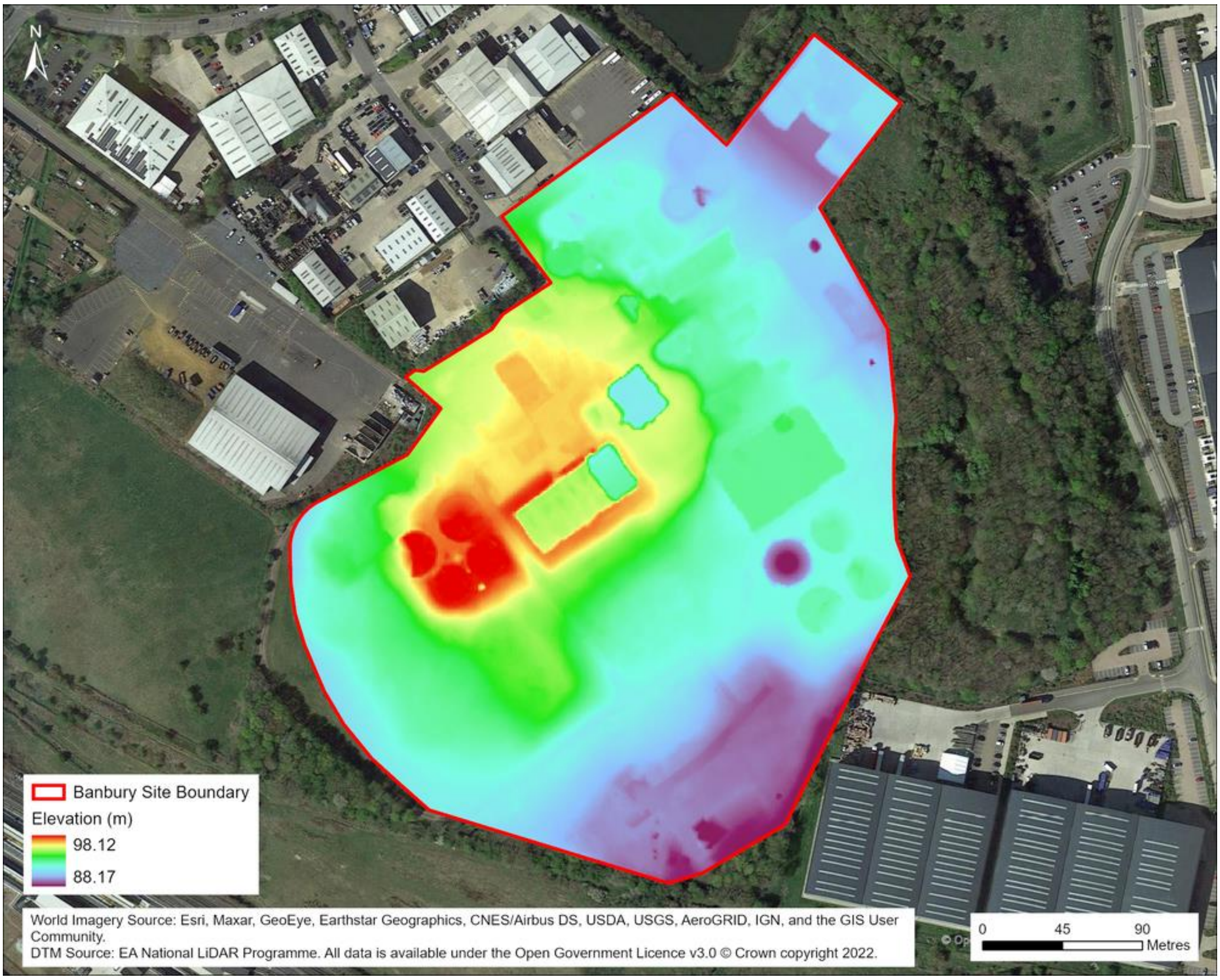


Figure 3-3 Digital Terrain Model of Banbury Sewage Treatment Works

The effluent channel for the STW, which is discharging to River Cherwell, is located 200 meters away in the southwest direction to the STW. Considering the topography of the sludge area, the high-resolution contouring revealed that the digesters are on lower ground relative to the west and on higher ground relative to its east, therefore the spilled sludge would flow towards the north and east direction.

3.5 Contained Model Output and Contour Maps

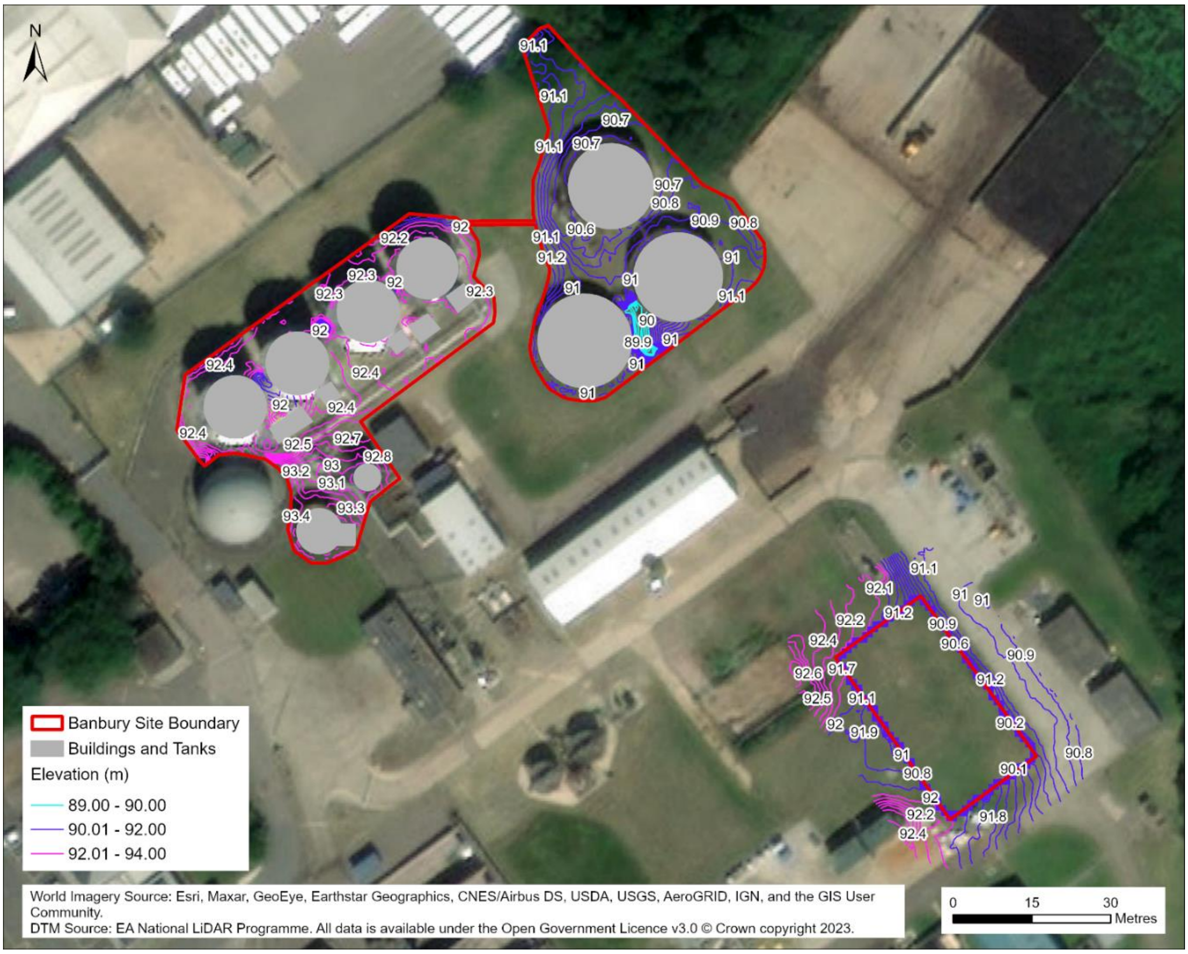


Figure 3-4 Contour lines within system 1, lagoon in bottom right modified to have flat base

The following images have been produced using open-source government LiDAR data and GIS modelling software. Worst case spill scenarios defined in section 3.3.2, proposed boundaries and ground profile modifications are combined to show spill depths over time and confirm the feasibility of the proposed boundaries. 3 output images are shown for the 2 different systems these are:

1. Contour lines within containment areas
2. Contained model output showing spillage area over time
3. Ground elevation at boundary walls

For systems 1 and 2 the results show feasibility for the proposed containment solutions to contain catastrophic spills from ruptured tanks. There also exists opportunity to reduce containment footprints such as in the case of the sludge import tank where the majority of flow, flows directly to the PFT area, or the PFT area where the sludge is contained with area to spare.

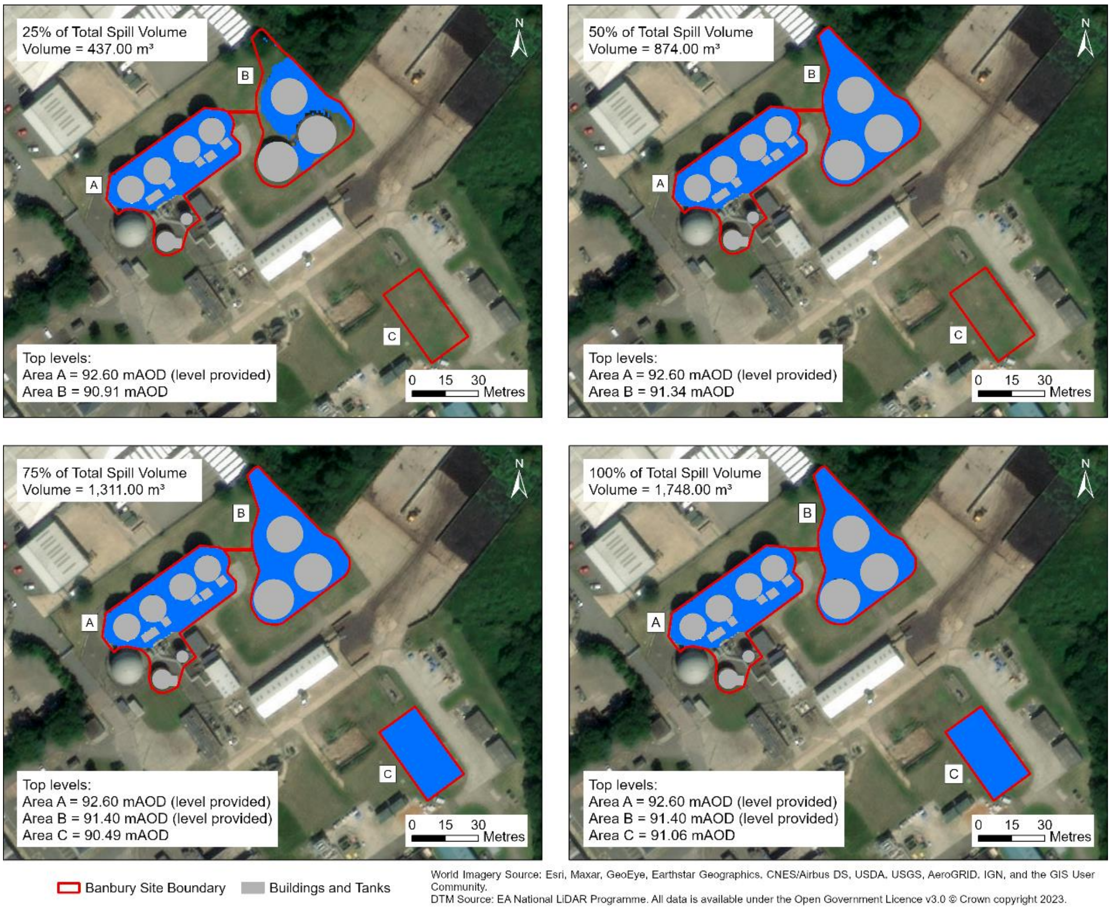


Figure 3-5 – Contained model output for area 1 showing spill routing from Primary Digesters to Lagoon

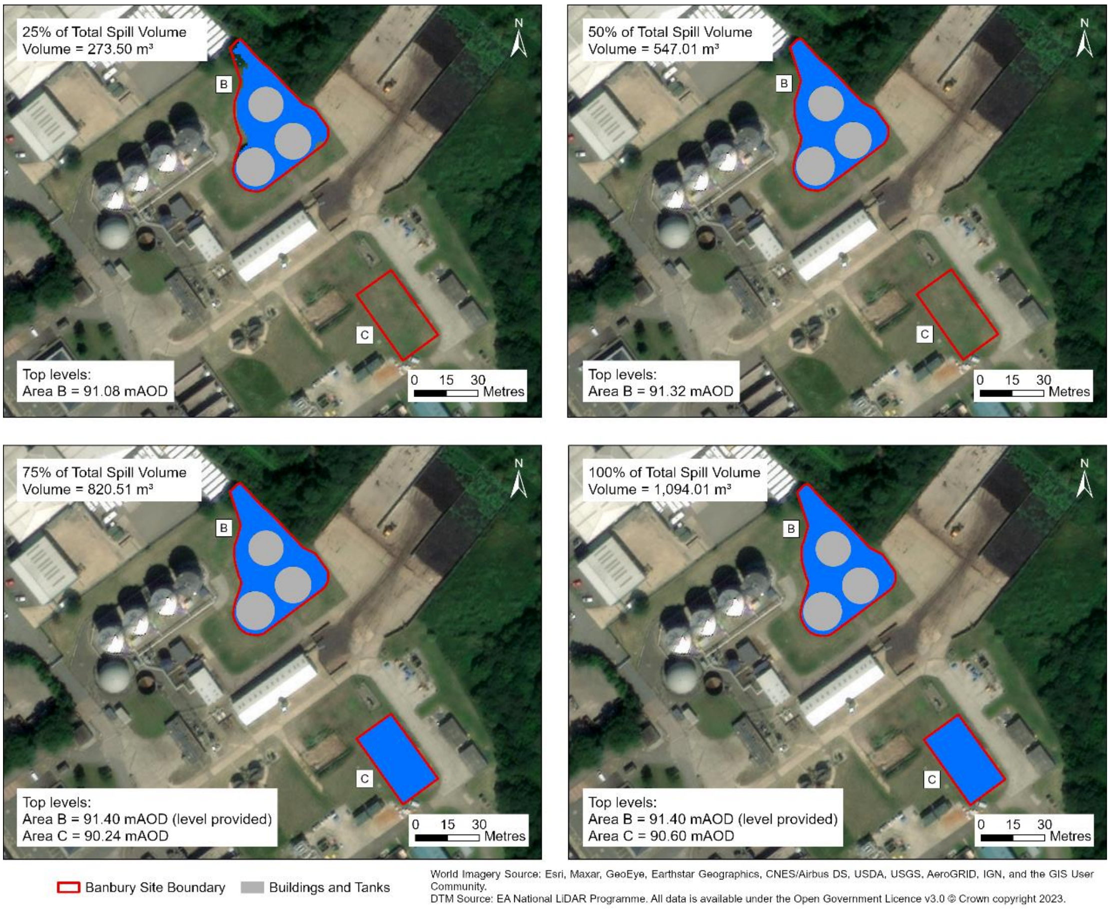


Figure 3-6 – Spillage in secondary digester area

Figure 3-7 - Contour lines within system 2, PFT area modified to include new PFT's and flatten area

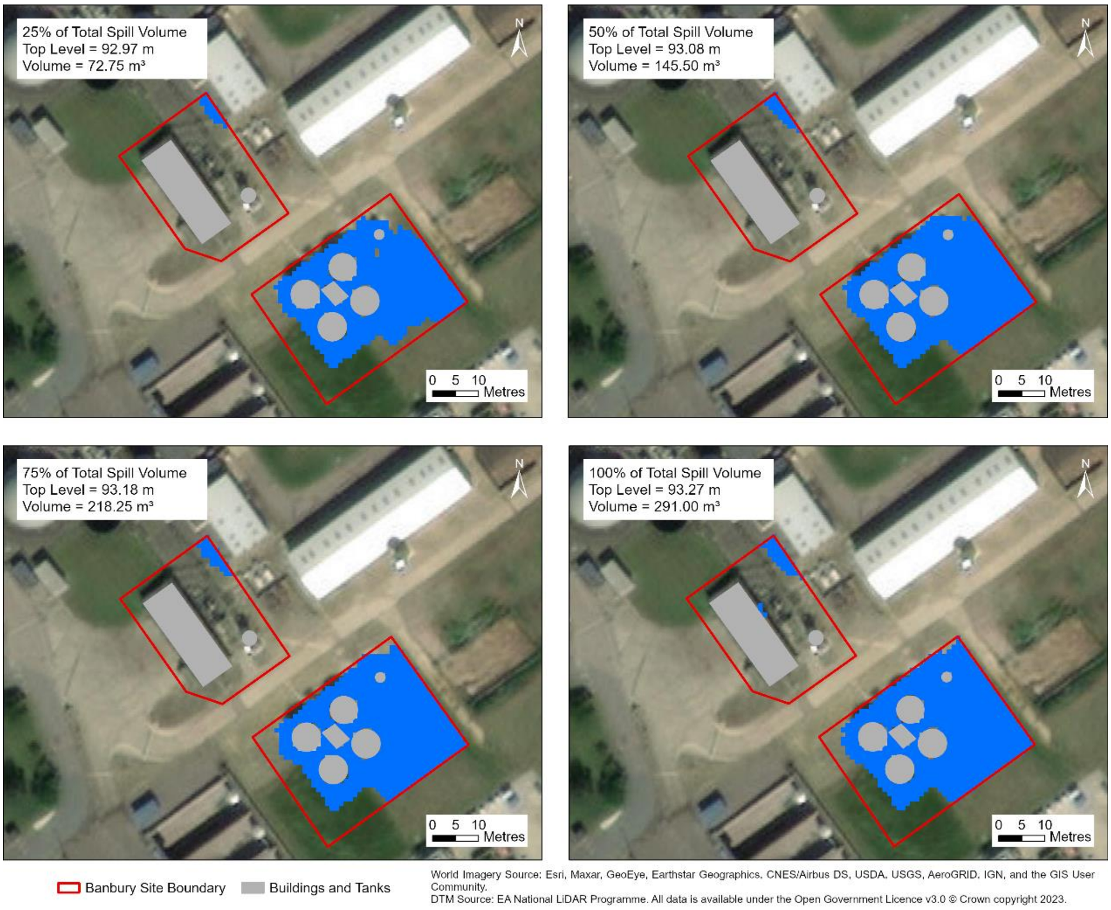


Figure 3-8 – Contained model output for area 3 showing spillage from sludge import reception tank

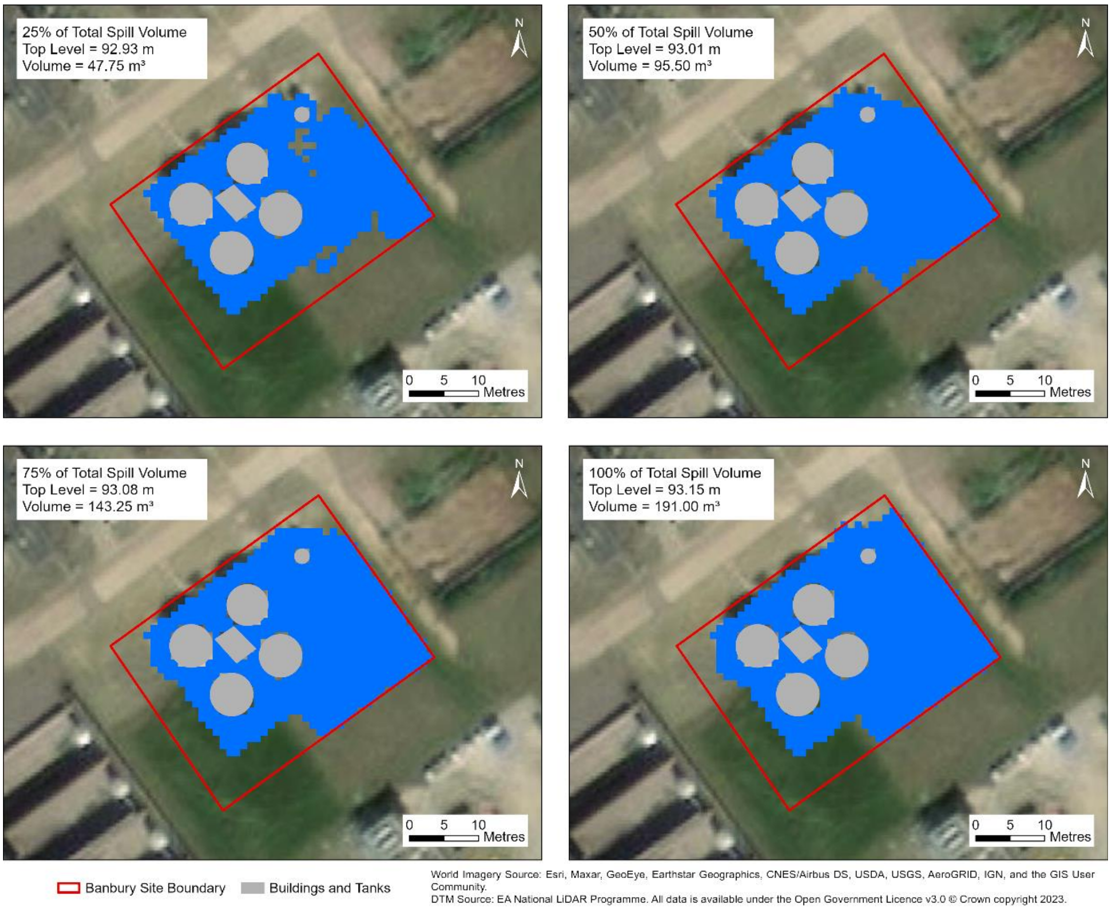


Figure 3-9 - Contained model output for area 3 showing top water level at 72.27mAOD

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 3-4 days following direction by Thames Water. The containment volume, when not dictated by the 110% or 25% containment rules allows for three days of rain during the recovery period and one day of rain immediately preceding an event.

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 the close containment areas around the primary digesters, secondary digesters and picket fence thickeners.

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

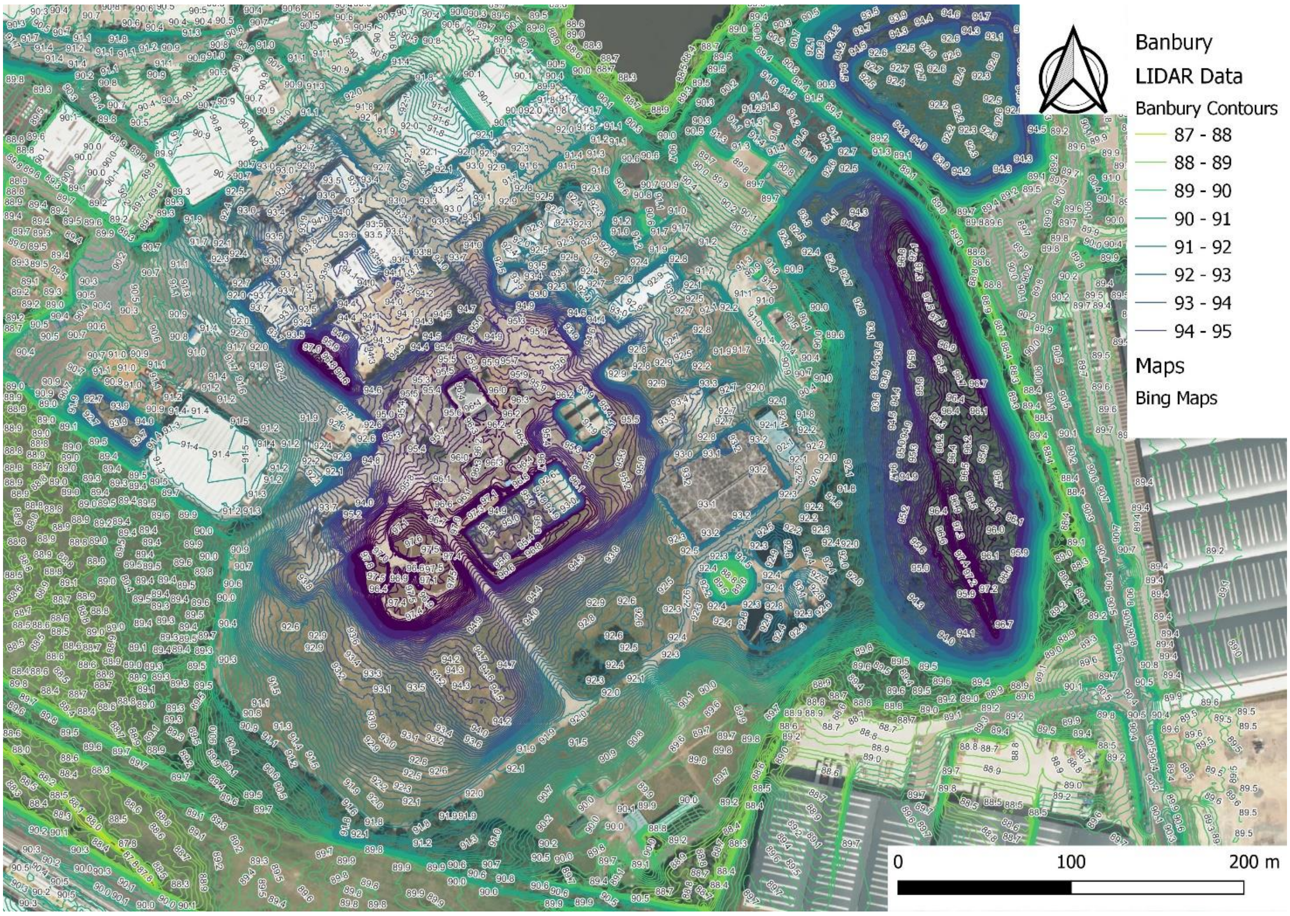


Figure 3-10 Map of Banbury STW showing contours

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 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 Banbury is 74.49 mm. It should be noted that the rainfall depths for Banbury 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

The interface with two proposed site upgrade works have been considered in the design of the containment solutions these include:

1. Construction of 2x new PFT's
2. Construction of new sludge buffer tank

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 Banbury, 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 Banbury 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 300-350mm 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.
- 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 and where infrequent vehicular access may be necessary.

4.1 Containment Option

Different options were investigated and developed with operations. The option that was further developed considers a close containment solution for 4 individual sludge tank areas with a lagoon as secondary containment. Table 4 provides a summary of the proposed option.

Table 4.1 – Summary of each containment area option

Containment Area	Description of containment
Primary digesters	• Close containment boundary allowing 300mm minimum height of storage. Spillage will overflow once containment area full via an open channel indicatively sized 500mm depth 1m width leading to the Secondary Digester Area. • Top level of containment at 92.60mAOD, bund walls typically 250mm-1100mm after reprofiling ground.
Secondary digester Area	• Close containment boundary allowing 300mm minimum height of storage. Overflow chamber within area, takes spillage via 525mm underground pipe to new proposed lagoon. • Top level of containment at 91.40, bund walls typically between 250mm – 1000mm after reprofiling ground • Access provided for infrequent vehicular access by large flood gates. Steps provided for pedestrian access to the area.
Lagoon (System 1)	• 764m2 lagoon, 1.25m deep to act as remote secondary containment. Completely fenced with dedicated pumping station for rainfall.
Sludge import reception tank area	• Close containment boundary allowing 300mm maximum height of storage, spillage connected via 350mm underground pipe to Picket Fence Thickener (PFT's). • Bunding walls typically 250mm - 500mm high.
Picket fence thickener area (PFT's)	• Close containment boundary allowing 300mm minimum height of storage. Containment area oversized to allow construction of 2 new PFT's. • Bunding Walls typically 250mm high.
Summary	• Two distinct systems both using closed containment and conveyance routes. • System 1: Primary digesters area → Secondary digester area → Lagoon • System 2: Sludge import reception tank area → PFT area • Option reduces impact to operational access as no containment boundaries cross main access roads. • Minimal conveyance routes that require regular and onerous maintenance.

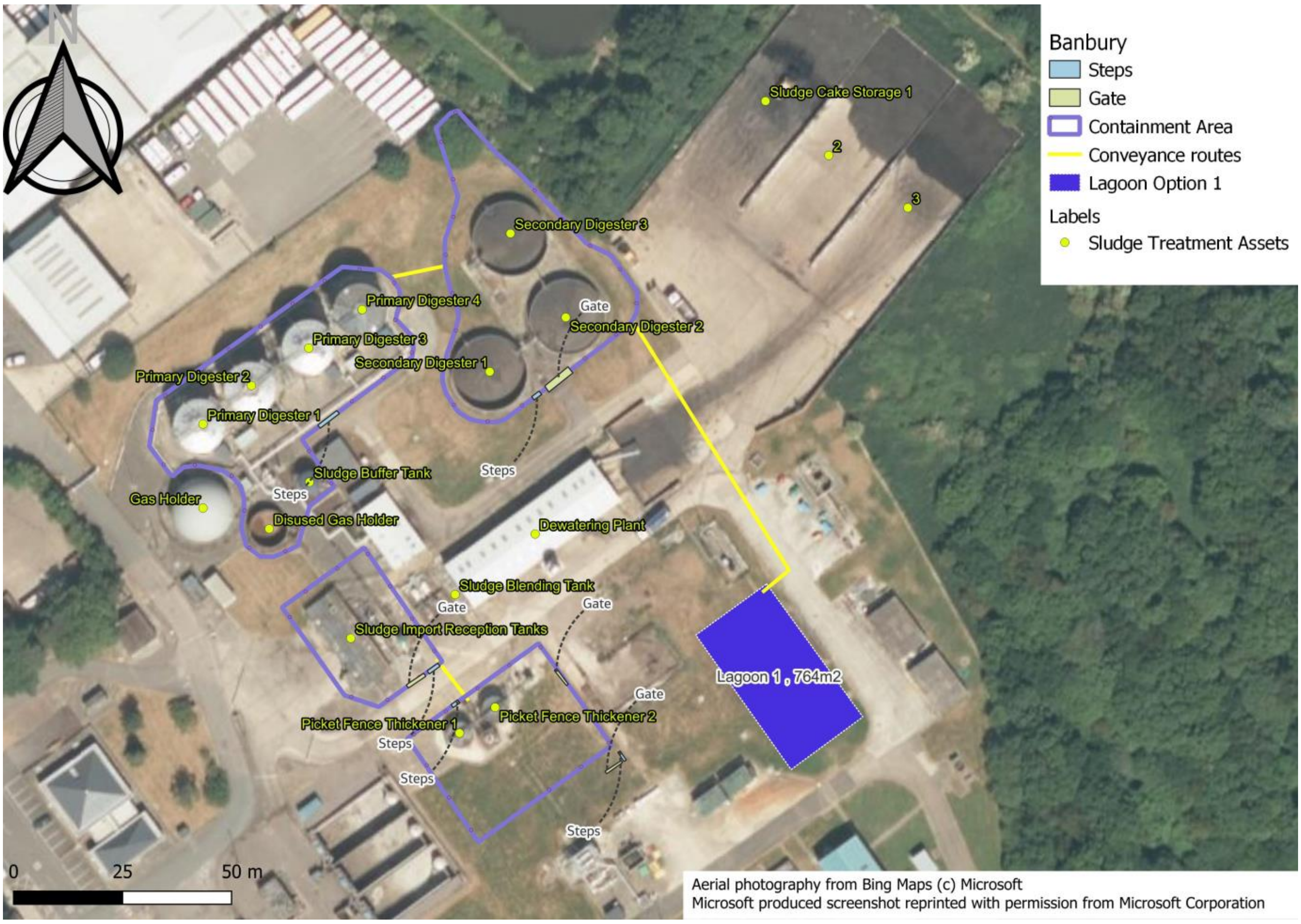


Figure 4-1 - Option 1 - Close containment areas and lagoon

A large containment area is prevented by the topography of the land, most sludge would spill into the cake pad area and high walls would be needed to prevent spillage from contaminating the drying sludge. The spill depth would also make it impractical for vehicles to traverse, limiting operations. For this reason, large containment areas were not further developed.

4.2 Mitigation of Site-Specific Risks

4.2.1 Jetting and Surge Flows

Due to the location of the tanks and their distance from the boundary of the containment area, there is a risk of contamination through jetting. Especially from the primary digesters which sit close the site boundary in areas. This will be mitigated through the installation of screen walls on top of the concrete bunding.

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

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

4.2.2 Flooding

According to the UK Government's Flood Map for Planning, the sludge area is in Flood Zone 1, as shown in Figure 4-2. The Flood Zone definitions listed in Appendix A provide additional detail of the areas of concern, which in the case of Banbury STW, have a 1 in 1000 or less probability of river flooding. Mitigation measures are not to be further for fluvial flooding given that the probability of flooding in the area is low.

Additionally, in the Flood Risk Vulnerability Classification sewage works are classified as 'less vulnerable', if adequate measures to control pollution and manage sewage during flooding events are in place.

The proposed containment areas for the sludge facilities fall within Zone 1 (low risk) as shown in Figure 4-2.

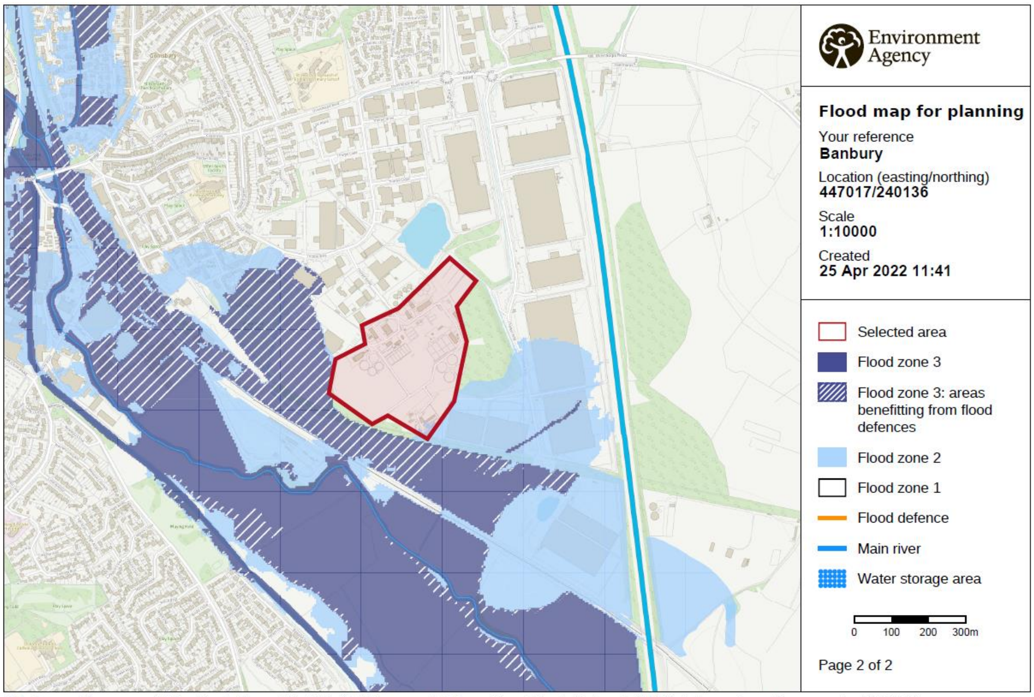


Figure 4-2 Extent of Fluvial flooding in Banbury due to extreme weather events

Table 4.2 Flood Zone Definitions from GOV.UK Flood Map for Planning

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding.(Land shown in dark blue on the Flood Map)

4.3 Identification of Preferred Option

The preferred containment proposal considers the following advantages:

- Efficient use of assets/space (using elevated areas to act as natural bunding)
- Using full volume of containment area to reduce size of remote secondary containment lagoon.
- 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.
- No need for ramps

H&S and CDM risks

- Cable ducts and fibre ducts act as a potential conduit to transport sludge around site and will require sealing.
- Confirm that the containment walls do not impact the existing DSEAR equipment rating.

5. Site Drainage and liquor returns

5.1 Process flow diagram

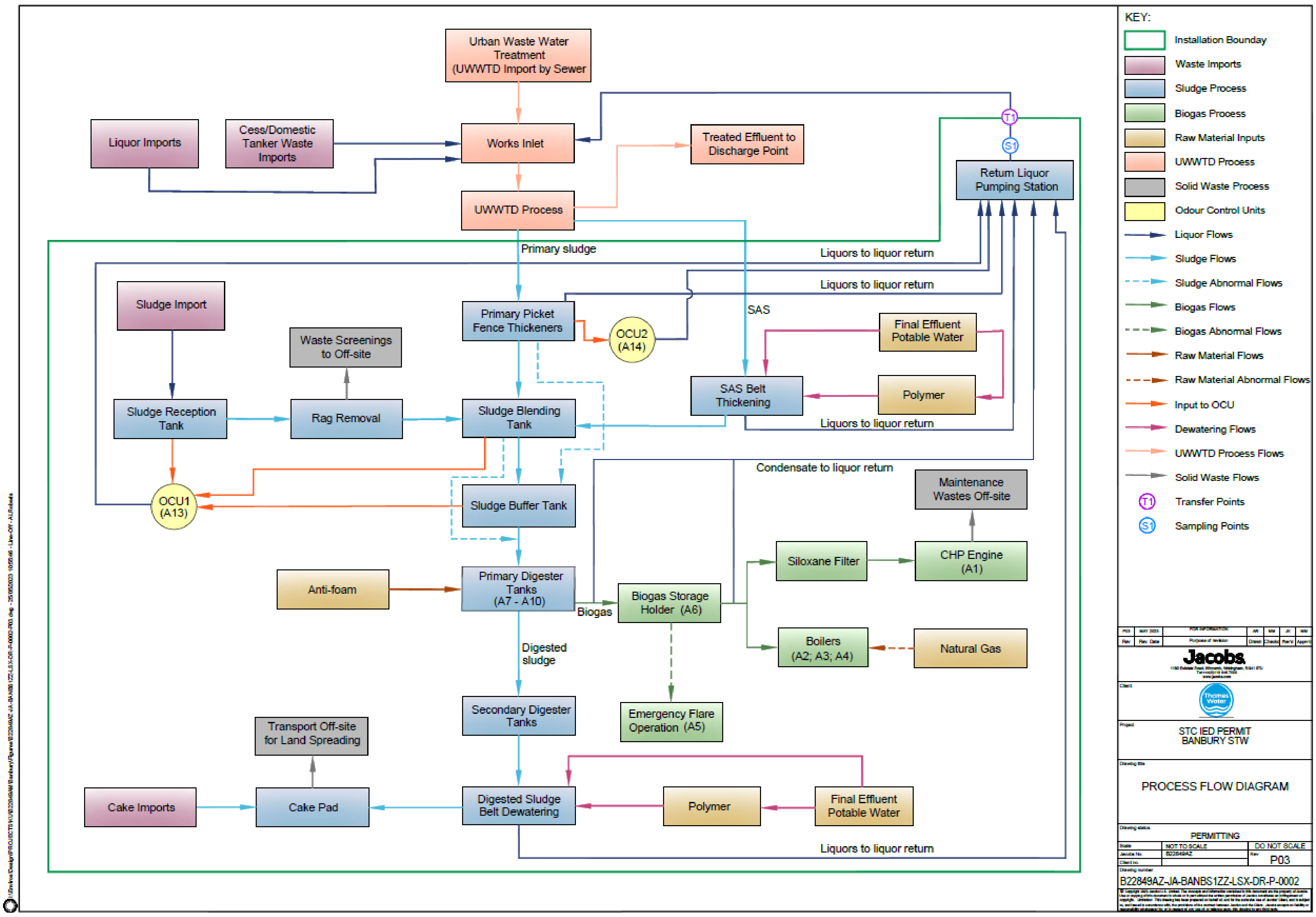
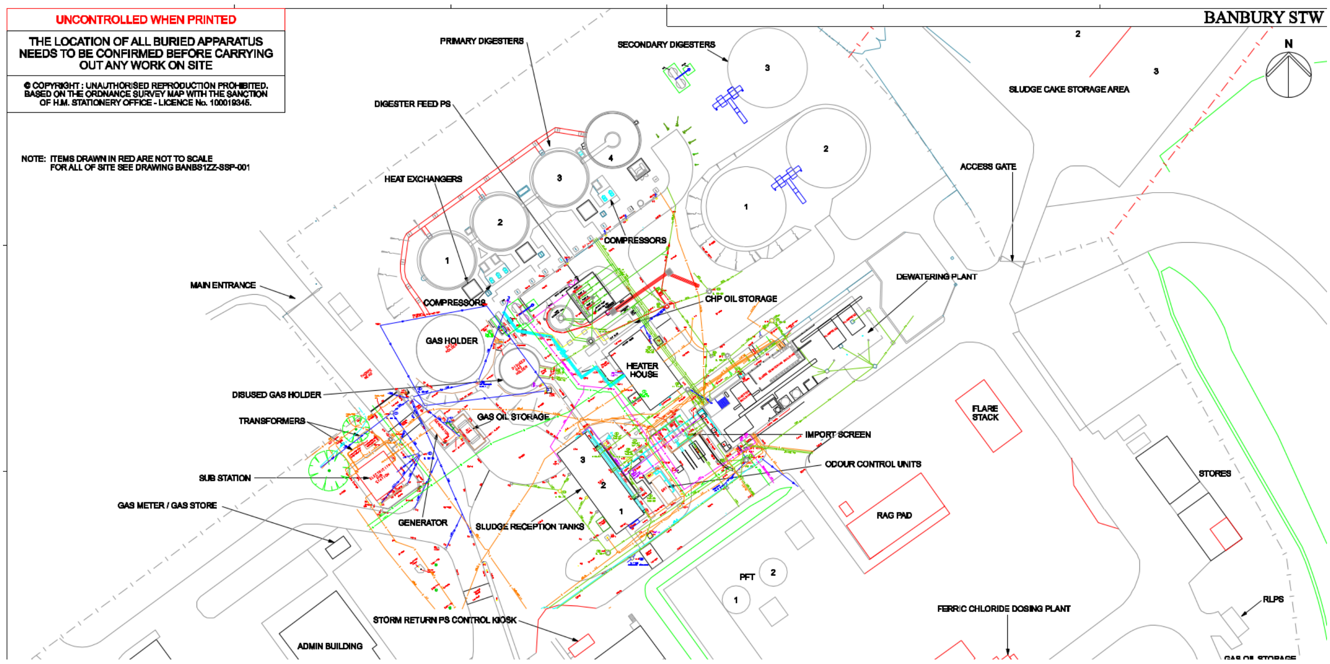


Figure 5-1 Process flow diagram Banbury STW

5.2 Foul Process and Effluent Drainage

The available drainage and site plans (BANBS1ZZ-SSP-001 and BANBS1ZZ-SSP-002) show detailed drainage information within the IED permit area. However, there is no information around the sludge holding tanks themselves. In addition, the plans were last updated in 2012 so there may have been modifications to the combined sewers, gully's, soakaways etc.



All captured surface water flows return to the Return Liquor Pumping Station. This consists of two submersible pumps. It is a key asset as it takes all the liquors from the sludge digestion plant, sludge storage pads, PFTs and FST scum and pumps them up to the PST feed chamber. Supplementary survey work has been undertaken to confirm the discharge at Banbury.

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 Banbury.

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 Banbury 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 Banbury Sewage Treatment Works.

An overall site risk rating of Medium was determined meaning that Class 2 containment is needed arising from the ABDA risk assessment process. The detailed requirements for Class 2 containment have been outlined in the Risk Identification Report in Section 3.3.

The containment solution has the tanks contained within four areas. The critical volume for each of the areas is identified below:

Containment Area	Volume	Rule
Primary digester area	1748m^3	Largest tank + rainfall
Secondary digester area	1094m^3	Largest tank + rainfall
Sludge import reception tank area	291m^3	Largest tank + rainfall
Picket fence thickener area	191m^3	Largest tank + rainfall

These areas work as a system and the main features are summarised below:

Containment Area	Description of containment
Primary digesters	• Close containment boundary allowing 300mm minimum height of storage. Spillage will overflow once containment area full via an open channel indicatively sized 500mm depth 1m width leading to the Secondary Digester Area. • Top level of containment at 92.60mAOD, bund walls typically 250mm-1100mm after reprofiling ground.
Secondary digester Area	• Close containment boundary allowing 300mm minimum height of storage. Overflow chamber within area, takes spillage via 525mm underground pipe to new proposed lagoon. • Top level of containment at 91.40, bund walls typically between 250mm – 1000mm after reprofiling ground • Access provided for infrequent vehicular access by large flood gates. Steps provided for pedestrian access to the area.
Lagoon (System 1)	• 764m2 lagoon, 1.25m deep to act as remote secondary containment. Completely fenced with dedicated pumping station for rainfall.
Sludge import reception tank area	• Close containment boundary allowing 300mm maximum height of storage, spillage connected via 350mm underground pipe to Picket Fence Thickener (PFT's). • Bunding walls typically 250mm - 500mm high.
Picket fence thickener area (PFT's)	• Close containment boundary allowing 300mm minimum height of storage. Containment area oversized to allow construction of 2 new PFT's. • Bunding Walls typically 250mm high.

Summary	• Two distinct systems both using closed containment and conveyance routes. • System 1: Primary digesters area → Secondary digester area → Lagoon • System 2: Sludge import reception tank area → PFT area • Option reduces impact to operational access as no containment boundaries cross main access roads. • Minimal conveyance routes that require regular and onerous maintenance.

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. A new lagoon will be built as remote secondary containment and it's maintenance should be considered by for TW operations. 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.

Appendix 1 ADBA Site Hazard Risk assessment summary for Banbury 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 Banbury 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 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 without mitigation. Mitigation measures being applied
2. The site is located in an area that has medium ground water vulnerability
3. Sludge treatment centre is integrated with large sewage works; as a consequence,

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

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

1. The site is within 300m of a populated area and situated to the west of a number of warehouses.
2. There is a recreational site (M40 Balance Pond) <50m southeast of the site

The Receptor Hazard rating was determined as **Medium**.

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 High Level Commitment

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 Banbury. 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).