Spernal Digesters and Sludge Tank IED Containment Assessment - Proposed Options Report

Document no: B19589CT - DOC – 040
Version: 1.0

Severn Trent Water

Severn Trent IED Containment Studies
8 September 2023

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Client name:	Severn Trent Water		
Project name:	Severn Trent IED Containment Studies		
Project no:	B19589CT		
Document no:	B19589CT - DOC – 040	**Project manager:**	Karen Chiu
Version:	1.0	**Prepared by:**	James Kelly
Date:	8 September 2023	**File name:**	B19589CT-DOC-040 Spernal Report (solutions) Rev1.0

Document history and status

Version	Date	Description	Author	Checked	Reviewed	Approved
1.0	08/09/23	Final Report for Issue	JK	SMNS	SMNS	KC

Jacobs U.K. Limited

7th Floor, 2 Colmore Square
38 Colmore Circus, Queensway
Birmingham, B4 6BN
United Kingdom

T +44 (0)121 237 4000
www.jacobs.com

Executive summary

Spernal Sewage Treatment Works is some 5km to the south east of Redditch and lies to the north of the village of Spernal. The River Arrow lies to the east side of the site. The site is otherwise surrounded by fields, which act as the site boundaries Figure i shows an aerial view of the site in the context of its nearby surroundings. An initial visit to Spernal Sewage Treatment Works occurred for the purpose of site assessment and data collection.

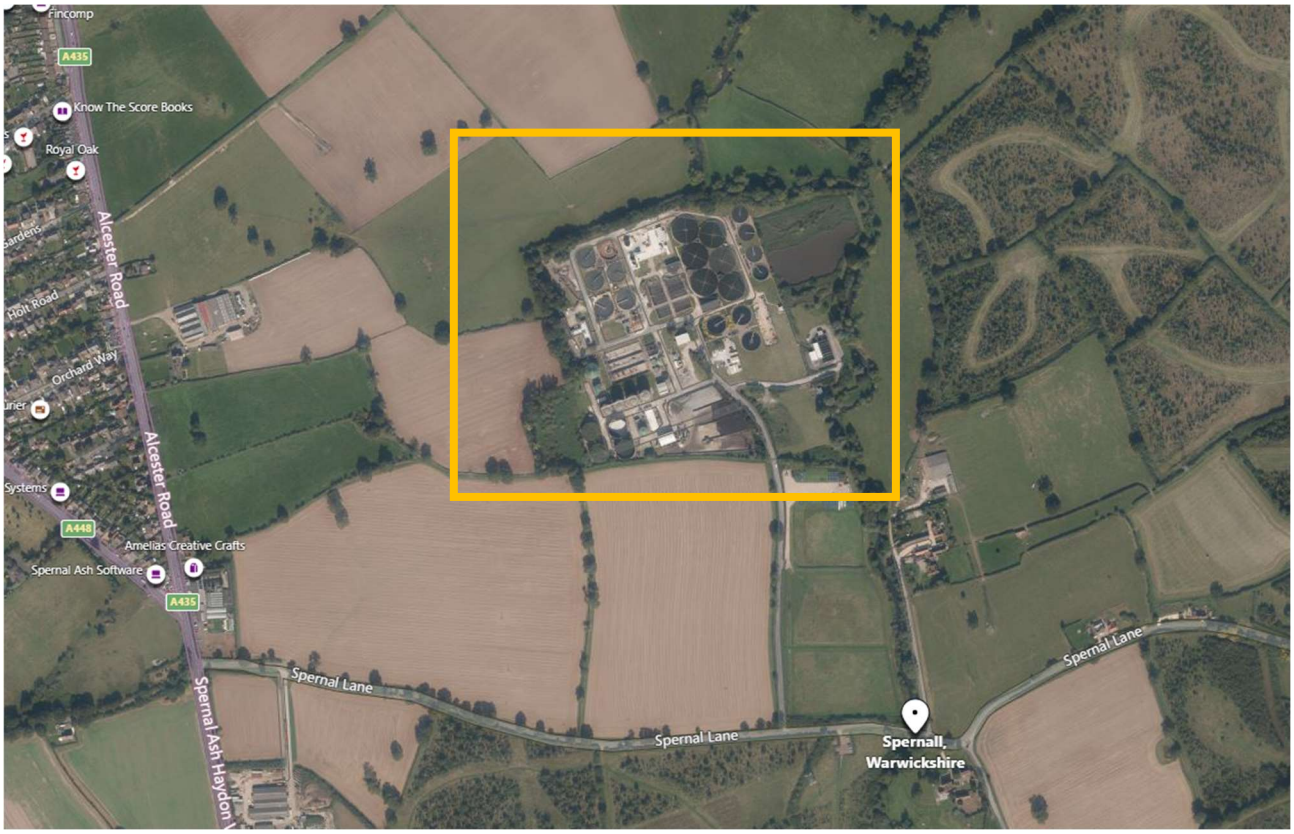

Figure i Satellite view of Spernal Sewage Treatment Works

The secondary containment solution has been based on the following design parameters:

- Risk Report has identified that class 2 containment is required.
- The required containment volume for area 1 is 5,368 m^3 and is the point of spill plus rainfall ('credible spill').
- The required containment volume for area 2 is 3,708m^3 and is the point of spill plus rainfall ('credible spill').
- The required containment volume for area 3 is 284m^3 and is the point of spill plus rainfall ('credible spill').
- The containment recovery period is 48 hours, a 3 day 1 in 10-year event has been used for rainfall.

The solution for the PKT and pre-digester area (area 1) uses bund walls, kerbing, flood gates and ramps to create the secondary containment area. This has been selected as the preferred technical solution as there is less impact on day-to-day site operations, due to the practical height of the ramps. (See figure ii overleaf).

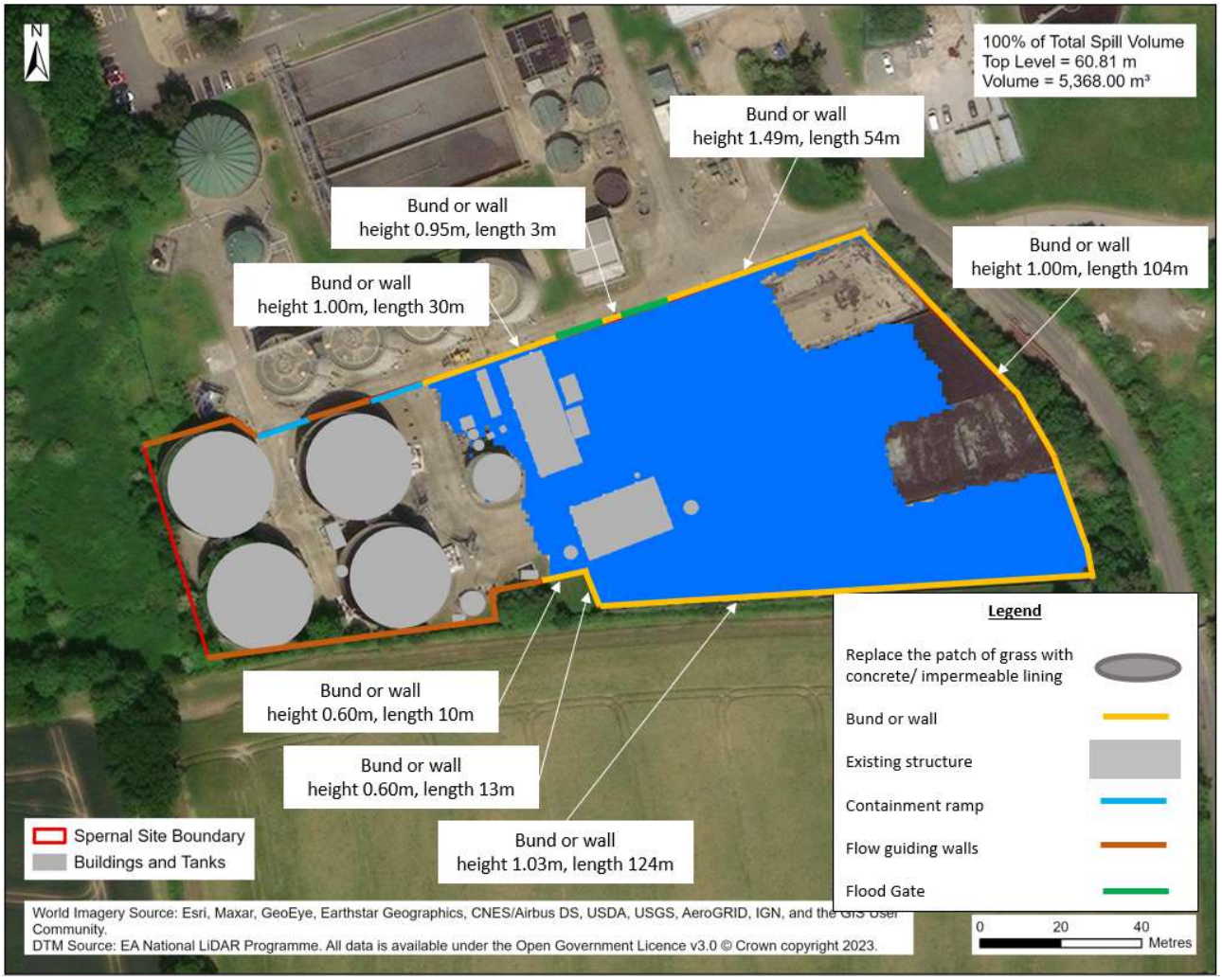

Figure ii – Plan showing recommended solution (Area 1)

The preferred technical solutions for the centrate and digester tank area is to use kerbs to guide flows to a drainage point before flows are transfer to secondary containment area 1 via a drainage pipe. (Figure iii).

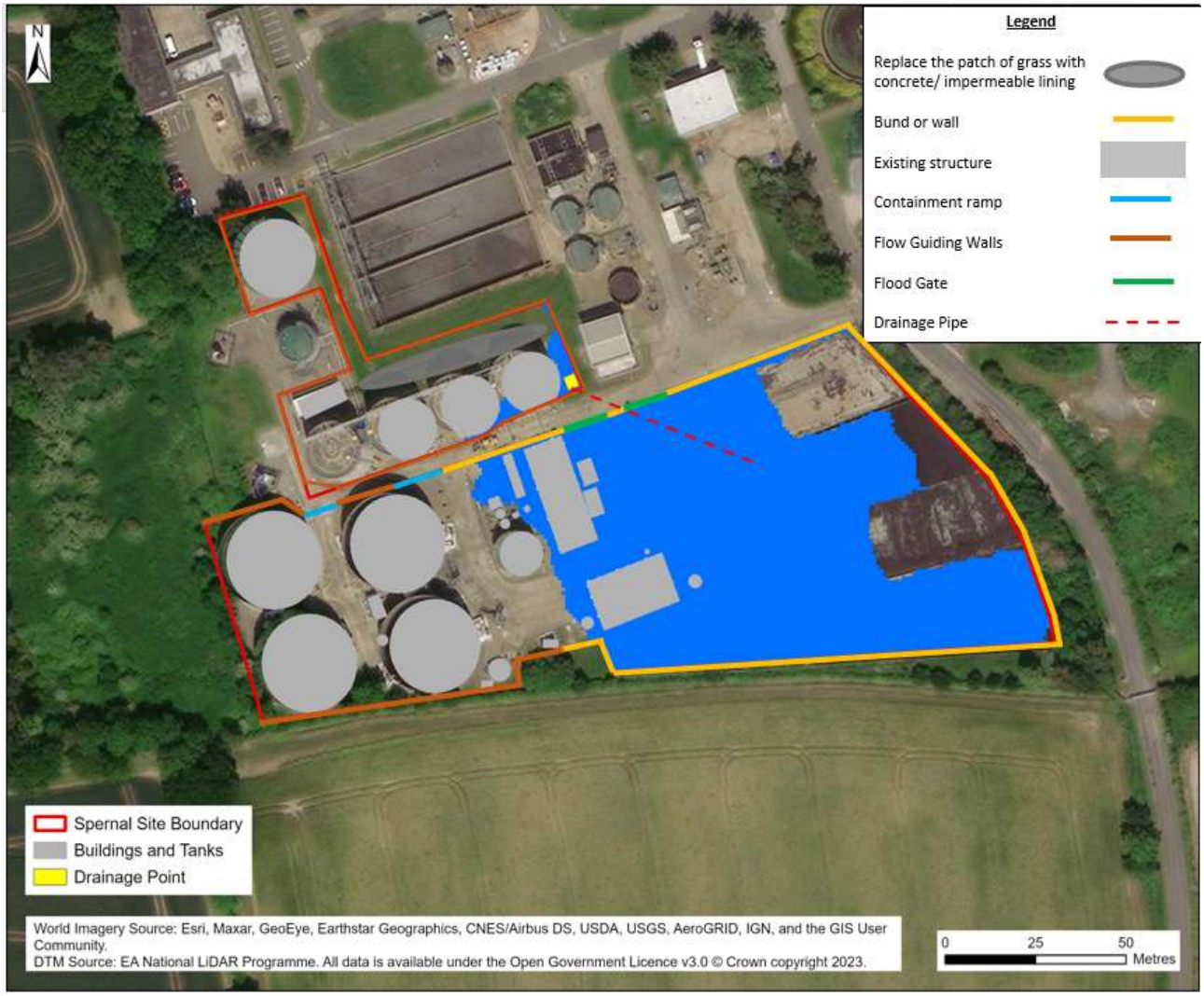

Figure iii – Plan showing recommended solution (Area 2)

The preferred technical solutions for the batch/consolidation tank area is to use kerbs, bund walls and ramps to guide and contain flows. The position of walls/bunds will be finalised during detailed design, ensuring storage footprint is not compromised and the bund walls compliant to site operations and other considerations (i.e. services). (Figure iv)

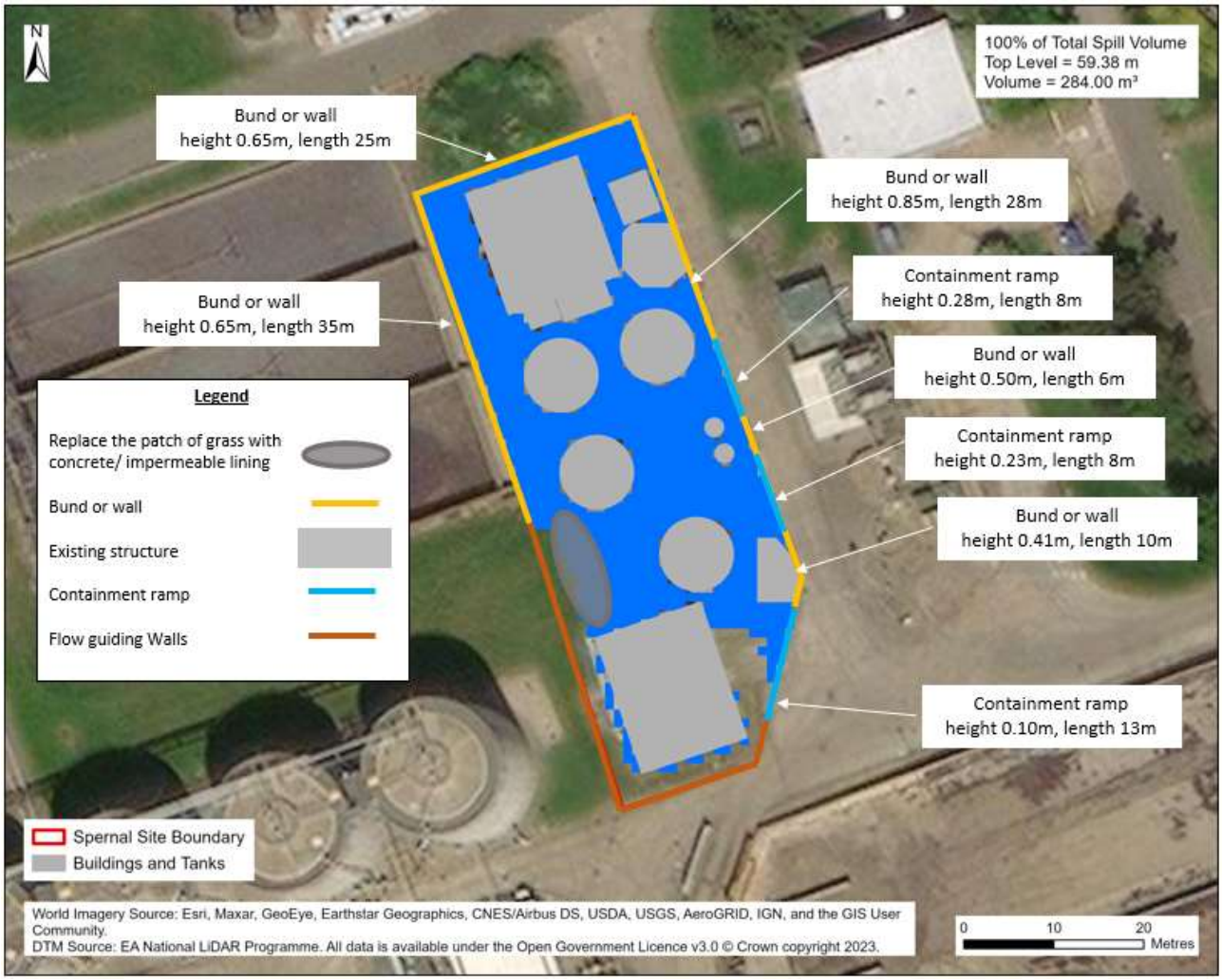

Figure iv – Plan showing recommended solution (Area 3)

Following initial audits by the Environment Agency (EA) in 2019 that examined the primary, secondary, and tertiary containment provisions for Severn Trent'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 Severn Trent'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 multiple Severn Trent sites. Based on CIRIA C736 and ADBA risk assessment tools this containment report addresses the site-specific risks at Spernal Sewage Treatment Works (STW) and outlines the options available for providing remote secondary containment in the event of a catastrophic tank or digester failure.

This document follows 'Spernal Digesters and Sludge Tanks, IED Containment Assessment-Risk Report, revision 2.0' which outlines the impact of an uncontained spill and the risk assessment completed and contains a complete tank list inventory for the IED permit area.

Chapter 1 provides an overview of the differing options for containment as outlined in CIRIA guidance document C736 (Containment systems for the prevention of pollution – Secondary, tertiary, and other measures for industrial and commercial premises, 2014) and the importance of this work at Spernal.

Chapter 2 details the loss of stock and rainfall components to identify the containment volume required

Chapter 3 details the recommended options to provide remote secondary containment considering containment and transfer areas for each area investigated and discusses the optimal option at the Spernal site.

Chapter 4 evaluates the surface water site drainage. Automated isolation valves linked to level indicators in the tanks are discussed to prevent shock loadings from being returned to the head of the works or sludge discharging into the river in the event of sludge tank failure.

Chapter 5 addresses the site-specific risks identified in Spernal IED Containment Assessment- Risk Identification Report, namely jetting and fluvial flooding.

Chapter 6 presents the main conclusions of the containment assessment.

Appendix A presents the ADBA site hazard risk assessment completed for this site.

Appendix B presents the Site Surfacing Plan for this site.

Contents

Appendices

1. Proposed Containment at Spernal

1.1 CIRIA C736

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:

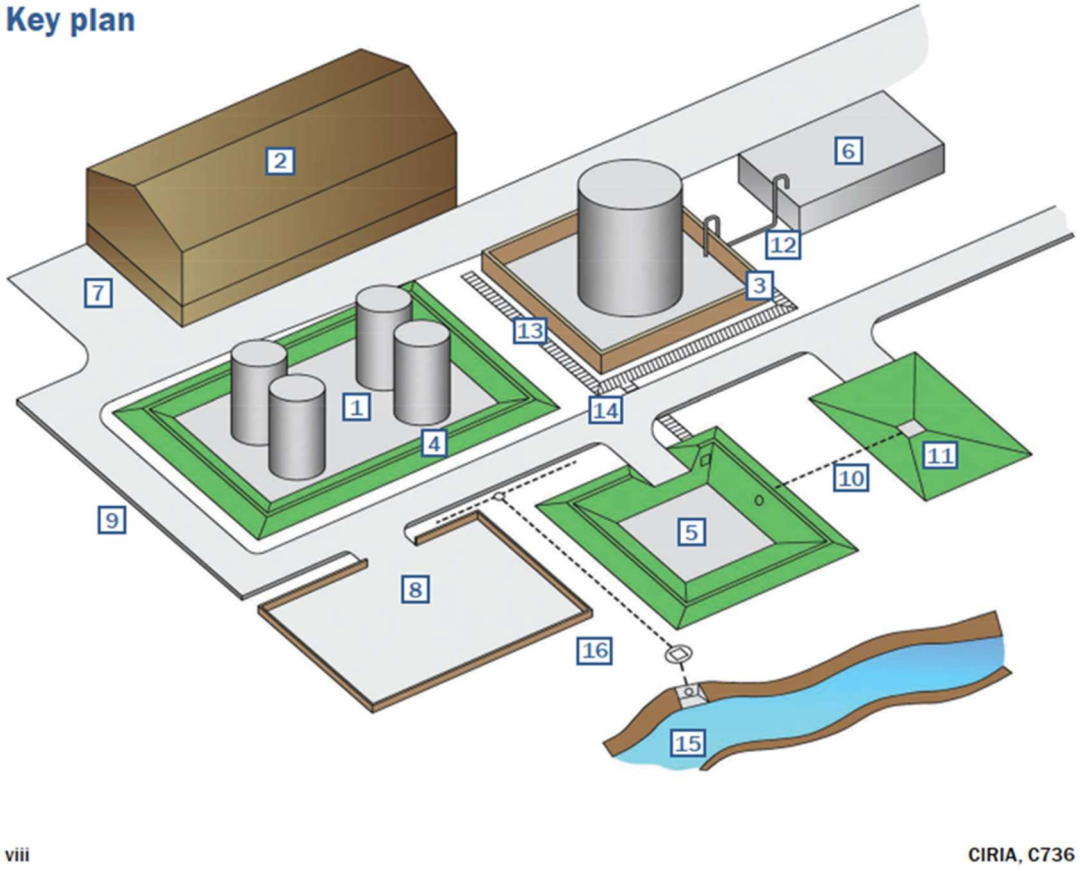

Figure 1.1 - Diagram of primary, secondary, and tertiary containment examples

-**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).

1.2 Site specific risks at Spernal STW

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

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

1.3 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.

2. Loss of Stock from Failure Scenario

In the Schedule 5 Notice dated Nov 2022, the EA has provided guidance on the failure scenarios to be modelled to assess the impact of catastrophic failure of sludge asset(s) within the IED permit boundary. The guidance stated, 'assessment of the impact of spill volumes using 110% of the largest tank or 25% of all tanks within a bunded area (whichever is greater)'. Contained spill volumes for containment areas have therefore been selected as the greater of 110% of the largest tank or 25% of all tanks within a bunded area or a credible spill volume (largest tank volume plus rainfall).

It was also later clarified with the EA that the total volume of sludge assets to be considered includes only above ground volumes of the assets.

2.1 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, *or other time periods as dictated by a site-specific assessment*. Given that Spernal STW is a large, manned wastewater works with ready access to pumps and tankers, and with a (controlled) disposal route via the wastewater treatment system being available, it is considered unlikely that even a catastrophic spillage would take more than 48 hours to be pumped and drained away, therefore a 3-day event period has been selected. The average 72 hours rainfall depths for a 1 in 10-year storm for Spernal STW is 63 mm. It should be noted that the rainfall depths for Spernal STW have been estimated using the depth-duration-frequency rainfall model contained on the *Flood Estimation Handbook* (FEH 13), which provides location specific rainfall totals for given durations and return periods.

2.2 Total Design Containment Volume

For the pathogen kill and pre-digestion tank – area 1, a 14,325 m^2 catchment with 63 mm rainwater depth, the total design containment volume comprises 4,462 m^3 from catastrophic tank failure, and 906 m^3 from the rainfall event, giving a total volume of 5,368 m^3. The containment volume is a credible spill, which is greater than both 25% (4629m^3) of the volume of all sludge assets in this area and 110% (4908m^3) of the largest tank in this area.

For the centrate and digester tank area – area 2, a 17,335 m^2 catchment area with 63 mm rainwater depth, the total design containment volume comprises 2,612 m^3 from catastrophic tank failure, and 1,096 m^3 from the rainfall event, giving a total volume of 3,708 m^3. The containment volume is a credible spill, which is greater than both 25% (3,112m^3) of the volume of all sludge assets in this area and 110% (2,873m^3) of the largest tank in this area.

For the batch tank and consolidation tank area – area 3, a 1,803 m^2 catchment area with 63 mm rainwater depth, the total design containment volume comprises 170 m^3 from catastrophic tank failure, and 114 m^3 from the rainfall event, giving a total volume of 284 m^3. The containment volume is a credible spill, which is greater than both 25% (182m^3) of the volume of all sludge assets in this area and 110% (187m^3) of the largest tank in this area.

3. Remote Secondary Containment

3.1 The Containment Area

3.1.1 Topography

Figure 3.1 shows the topography of the area containing the sludge assets at Spernal. The highest ground is shown with the pink contours. The lowest elevations are shown with the blue contours. The site is fairly level with a slight slope to the north.

Figure 3.1 – DTM of the sludge assets showing contours at 10cm intervals

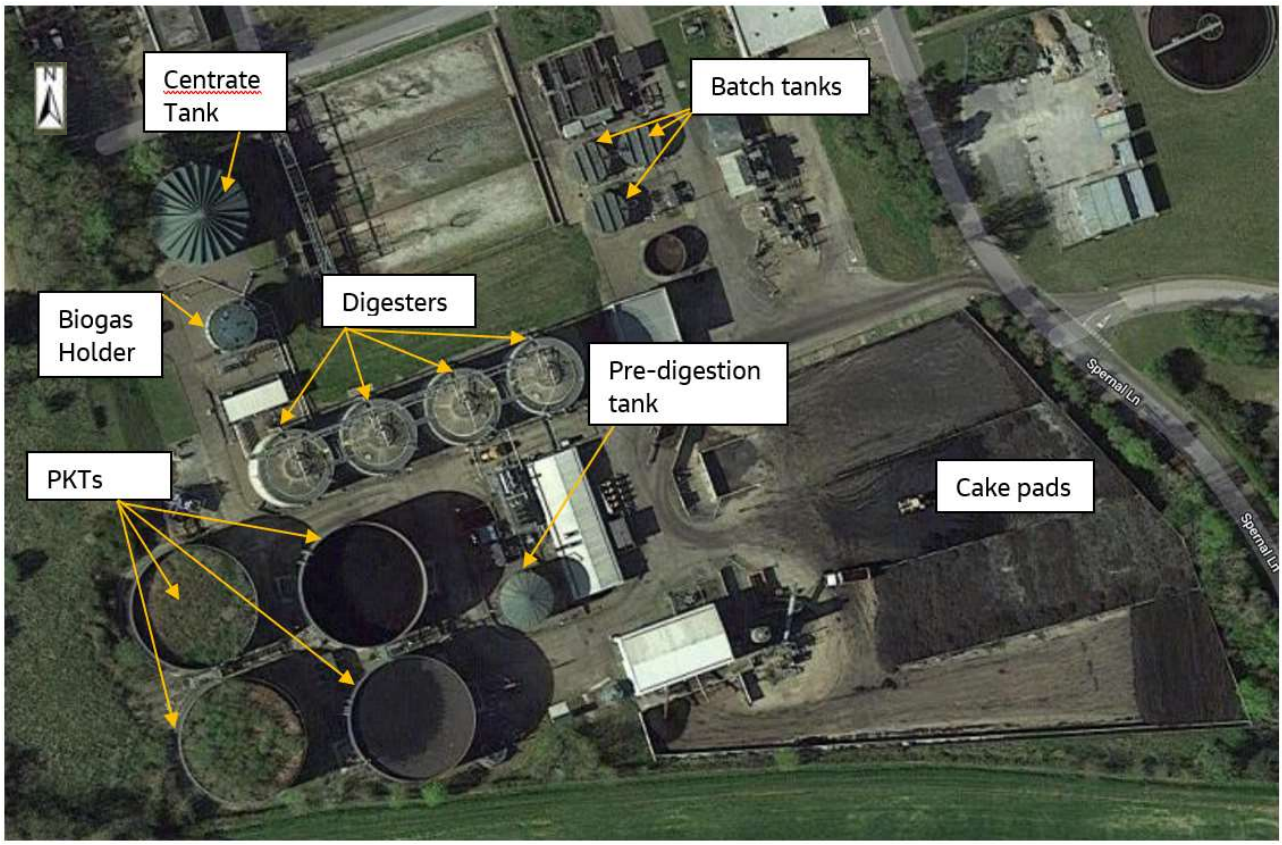

Figure 3.2 - Labelled site plan at Spernal STW

3.1.2 Containment Solution

3.1.2.1 Containment area 1

To provide sufficient secondary containment for the pathogen kill tank (PKT) and pre digestion tank area, the total design containment volume of 5,368m^3 needs to be securely contained. LiDAR spill modelling predicted the top water level (TWL) when 5,368 m^3 is contained in this area to be at 60.81 m AOD. Figure 3.3 shows the works necessary to convert the sludge asset area into a secure remote secondary containment facility. Installation of flow guiding walls, containment ramps, flood gates and construction of bund/wall structures create a secondary containment area.

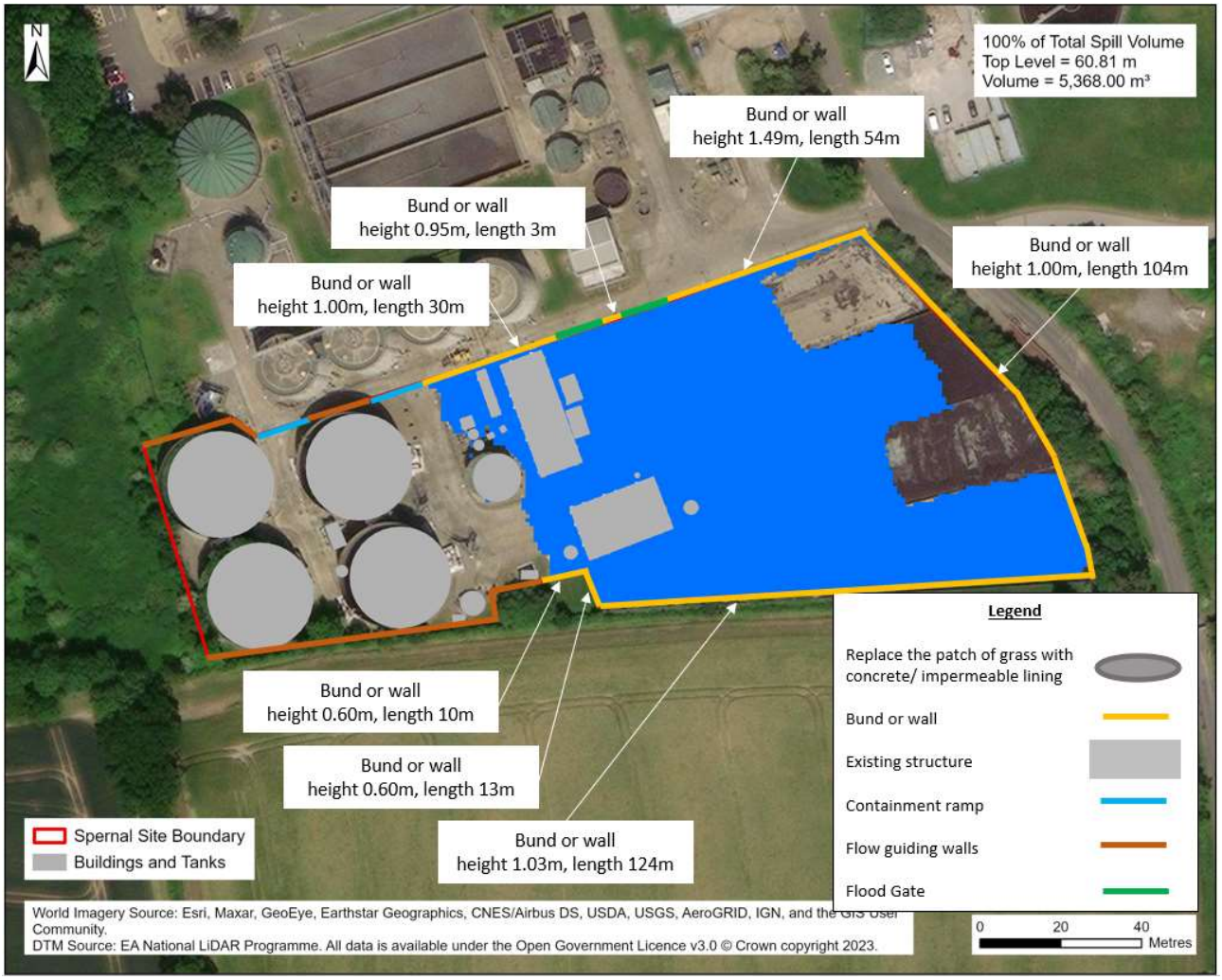

Figure 3.3 - recommended modifications to provide secondary containment for Area 1

The position of bund walls will be finalised during detailed design ensuring the storage footprint is not compromised, and bund walls are compliant with site operations and other considerations (e.g. services). No cake pad assessment has been undertaken due to approximately 75% of the cake pad being modelled as full due to the LiDAR information for this STW.

3.1.2.2 Containment area 2

To provide sufficient secondary containment for the centrate and digester tank area (area 2), the total design containment volume of 3,708 m^3 needs to be securely contained. LiDAR spill modelling predicted the top water level (TWL) when 3,708 m^3 is contained in this area to be at 60.57m AOD. Figure 3.4 show the works necessary to convert the sludge asset area into a secure remote secondary containment facility. Installation of flow guiding walls will direct flows into a drain. Piping will transfer flows in containment area 1. The pipe will require a non-return valve to be installed. Detail of the containment area 1 is detailed above.

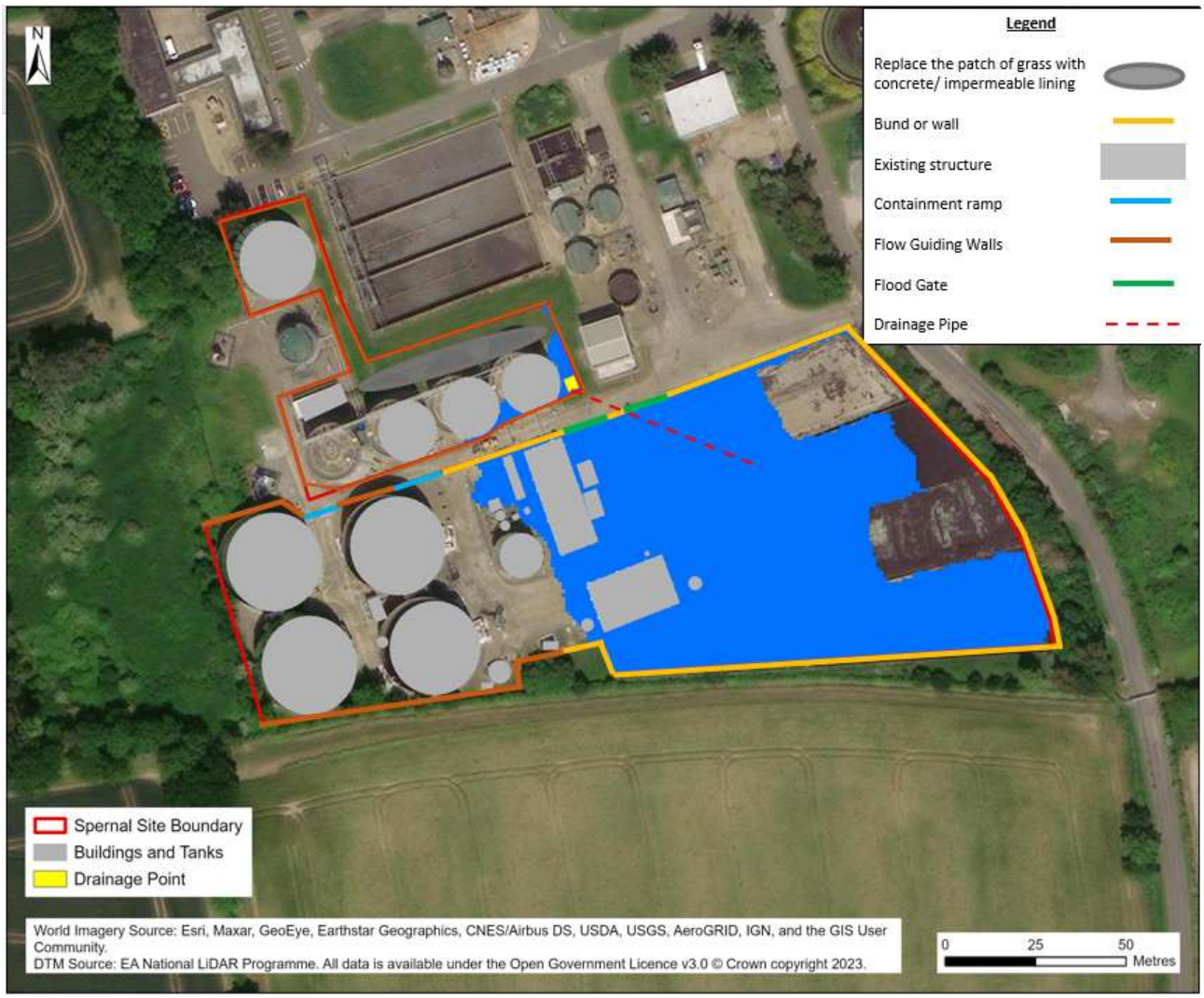

Figure 3.4 – recommended modifications to provide remote secondary containment for area 2

3.1.2.3 Containment area 3

To provide sufficient secondary containment for the batch/consolidation tank area, the total design containment volume of 284 m^3 needs to be securely contained. LiDAR spill modelling predicted the top water level (TWL) when 284 m^3 is contained in this area to be at 59.38m AOD. Figure 3.5 shows the works necessary to convert the sludge asset area into a secure remote secondary containment facility. Installation of flow guiding walls, containment ramps and construction of bund/wall structures create a secondary containment area.

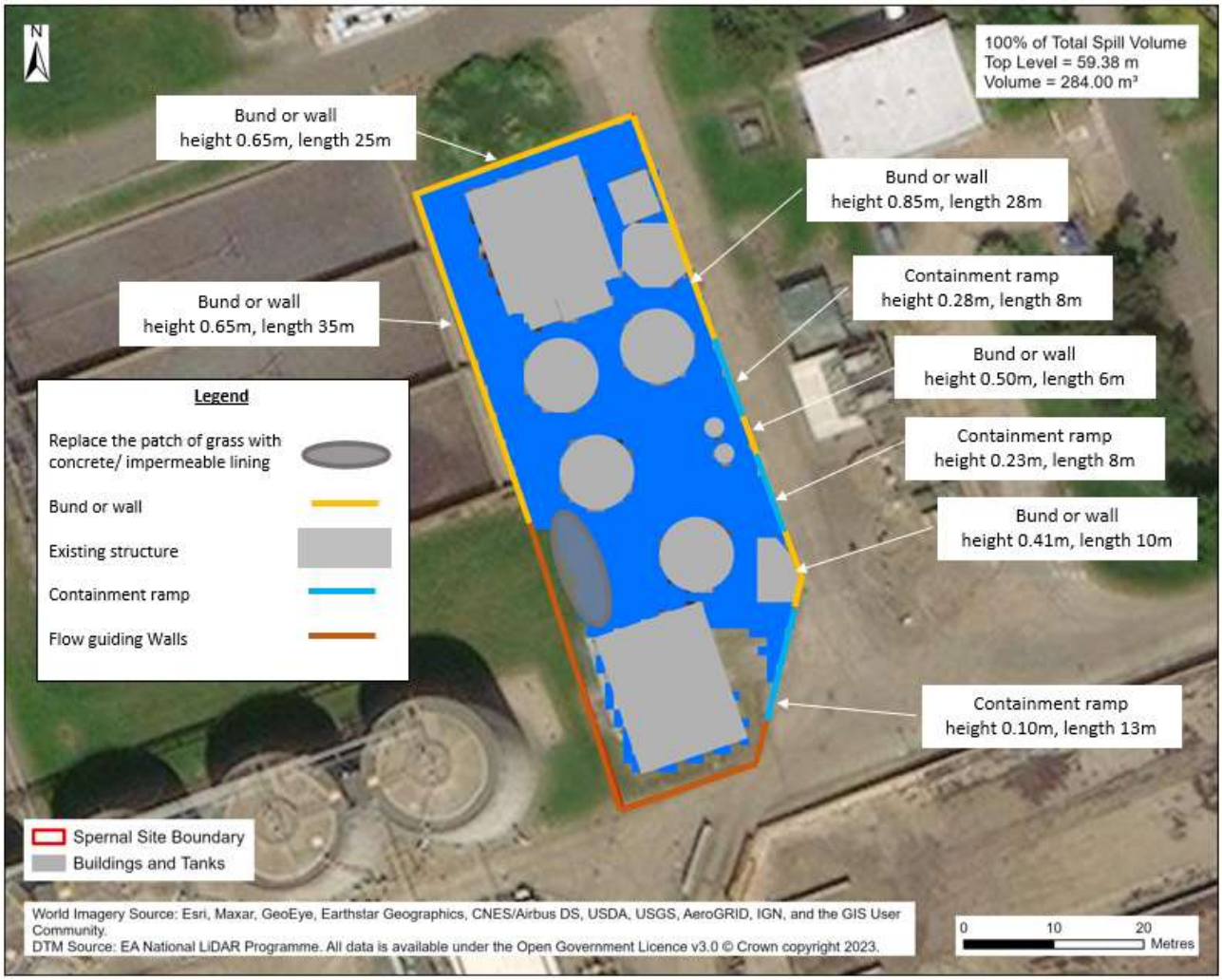

Figure 3.5 – recommended modifications to provide remote secondary containment for area 3

The position of bund walls will be finalised during detailed design ensuring the storage footprint is not compromised, and bund walls are compliant with site operations and other considerations (e.g. services)

3.2 The Transfer System

Due to the topography of the site the transfer of liquid to the remote secondary containment occurs under gravity.

The site surfacing plan for Spernal STW, shown in Appendix B, details the current impermeable and permeable surfacing in the containment areas. The grass areas around the transfer system and tanks should be lined for the eventuality of sludge collecting on them, either through jetting from the tanks or pipework, or spillages over kerbing.

3.3 Remote Secondary Containment Summary

A summary of the recommended containment for Spernal STW are listed below.

Table 3.1 - Summary of Recommended Site Modifications (Area 1)

	Impermeable Lining /m2	Walls/ Barriers	Ramps/Flood gates	Other (Isolation Valves/Building Protection/ local infill)
Containment Area 1	N/A	7 sections: • Max height 1.00m length 30m • Max Height 0.95m length 3m • Max height 1.49m length 54m • Max height 1.00m length 104m • Max height 1.03m length 124m • Max height 0.60m length 13m • Max height 0.60m length 10m Kerbing for flow guiding to be raised to 400 mm above road level to direct and contain spillages and protect buildings.	Two flood gates to contain flows. Two containment ramps to guide flows	Isolation of drainage system to prevent it heading to the head of the works.

Table 3.2 - Summary of Recommended Site Modifications (Area 2)

	Impermeable Lining /m2	Walls/ Barriers	Ramps	Other (Isolation Valves/Building Protection/ local infill)
Containment Area 2	Approximately 850m^2 require impermeable lining	350m of HGV kerbing Kerbing for flow guiding to be raised to 400 mm above road level to direct and contain spillages and protect buildings.	N/A	40m of pipework to take flows to the containment area 1

Table 3.3 - Summary of Recommended Site Modifications (Area 3)

	Impermeable Lining /m2	Walls/ Barriers	Ramps	Other (Isolation Valves/Building Protection/ local infill)
Containment Area 3	Approximately 132m^2 require impermeable lining	5 sections: • Max height 0.65m Length 35m • Max height 0.65m Length 25m • Max height 0.85m Length 28m • Max height 0.50m Length 6m • Max height 0.41m Length 10m Kerbing for flow guiding to be raised to 400 mm above road level to direct and contain spillages and protect buildings.	3 Containment ramps for flow guiding/containing.	Isolation of drainage system to prevent it heading to the head of the works.

4. Site Drainage

Site drainage assessments are based on Spernal Sewage Works Layout Plan Drawing Number R803/001.

4.1 Foul Process and Effluent Drainage

The Sewage Works Layout Plan for Spernal shows all Foul/ Combined/ Process/ Effluent drainage pipes, indicated by red lines, either go to the head of the works, or into the River Arrow. If sludge were to enter the head of the works, the shock load could adversely impact the sewage works treatment process. The release of sludge into the River Arrow would be hazardous to the environment and breach EA regulations. These lines (circled purple) should therefore be isolated with float actuated valves in the event of a catastrophic loss of containment. Manholes circled green will required watertight covers to be fitted and any chambers in the flood area will require closed covers fitted (Figure 4.1 & 4.2).

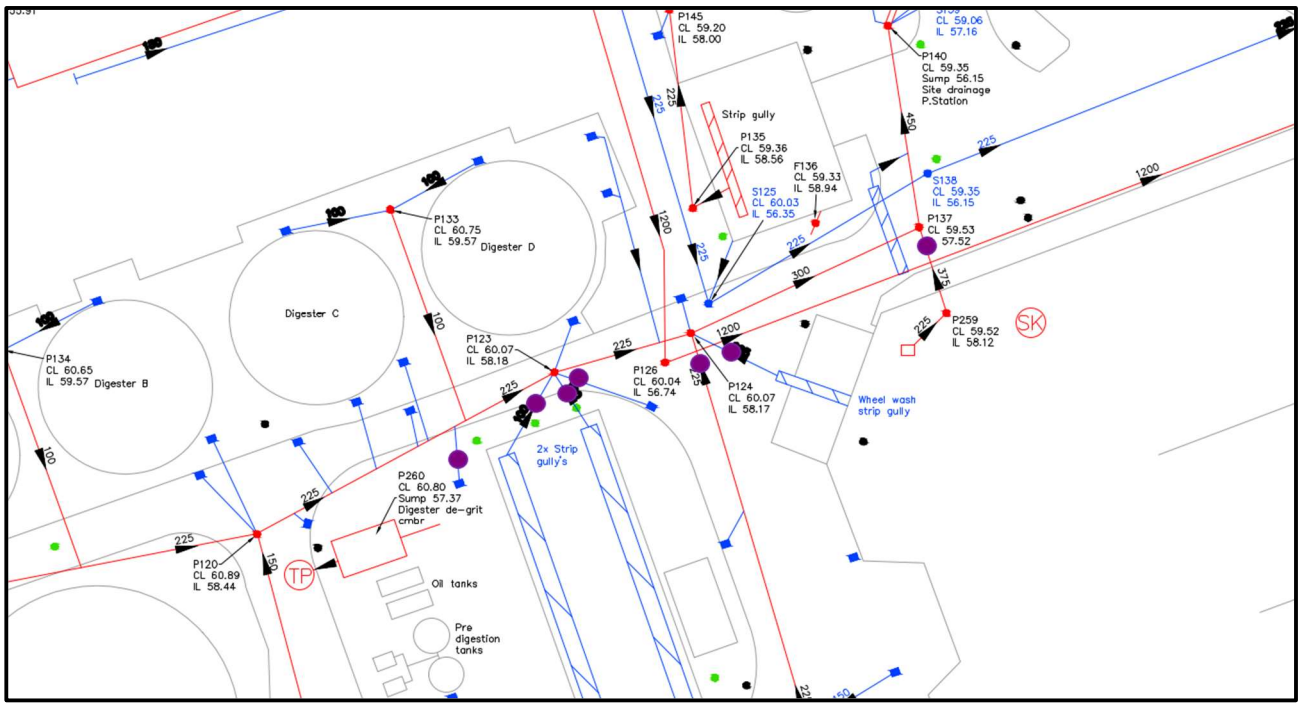

Figure 4.1 – Site drainage outfall pipes into head of the works that require isolation.

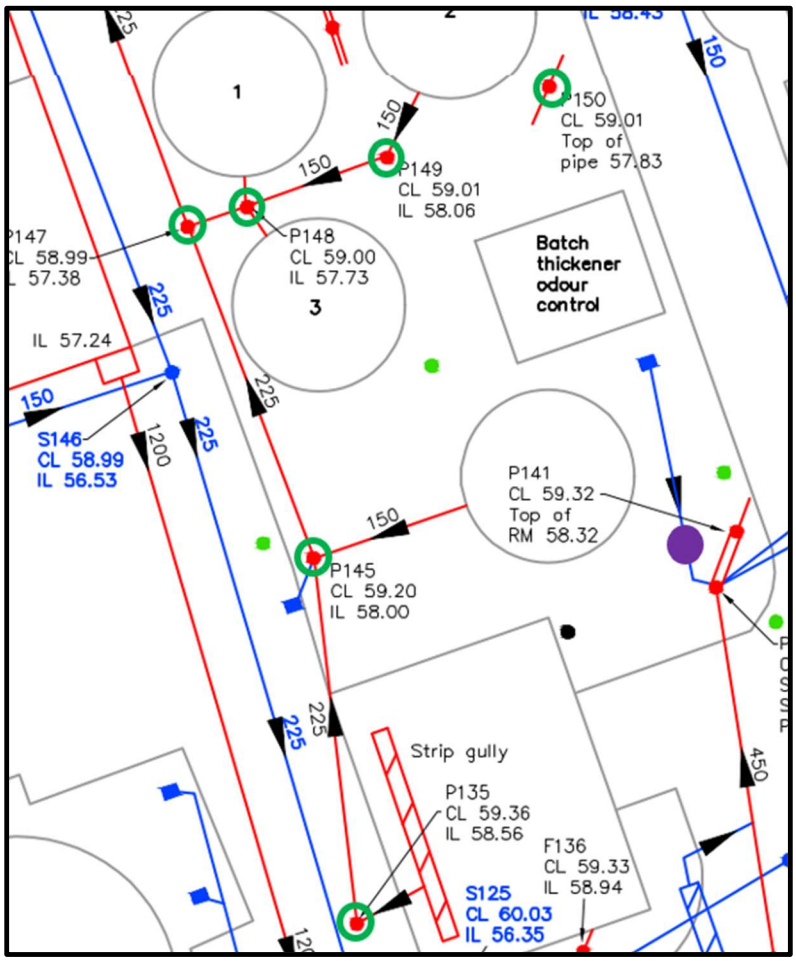

Figure 4.2 – Site drainage outfall pipes and manholes into head of the works that require isolation.

4.2 Surface Water Drainage

Surface water drainage, shown by blue lines on the sewage works layout plan for Spernal, drains into the River Arrow. For the loss of containment events explored in this report, any of the surface water manholes within the containment areas that are below the top water levels would send sludge into the river. These lines should therefore be isolated in the event of a catastrophic loss of containment. There are no surface water manholes within the three containment areas and therefore no isolations are required.

4.3 Automatic Isolation Valves

For the catastrophic loss of containment scenarios for 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 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 manually operate these valves to release flows into the existing drainage network

- In minor or slow flow tank spills, 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 Spernal 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.

5. Mitigation of Site-Specific Risks

5.1 Jetting and Surge Flows

No additional walls should be required to be constructed around any of the vessels with the containment parameters detailed in this report, as all tanks included in this assessment are sufficiently far away from the containment boundary for jetting to be of concern.

5.2 Flooding

According to the UK Governments Flood Map for Planning, Spernal STW is not within any potential flooding zone as shown in **Error! Reference source not found.** therefore no modifications need to be made to Spernal STW to accommodate risk.

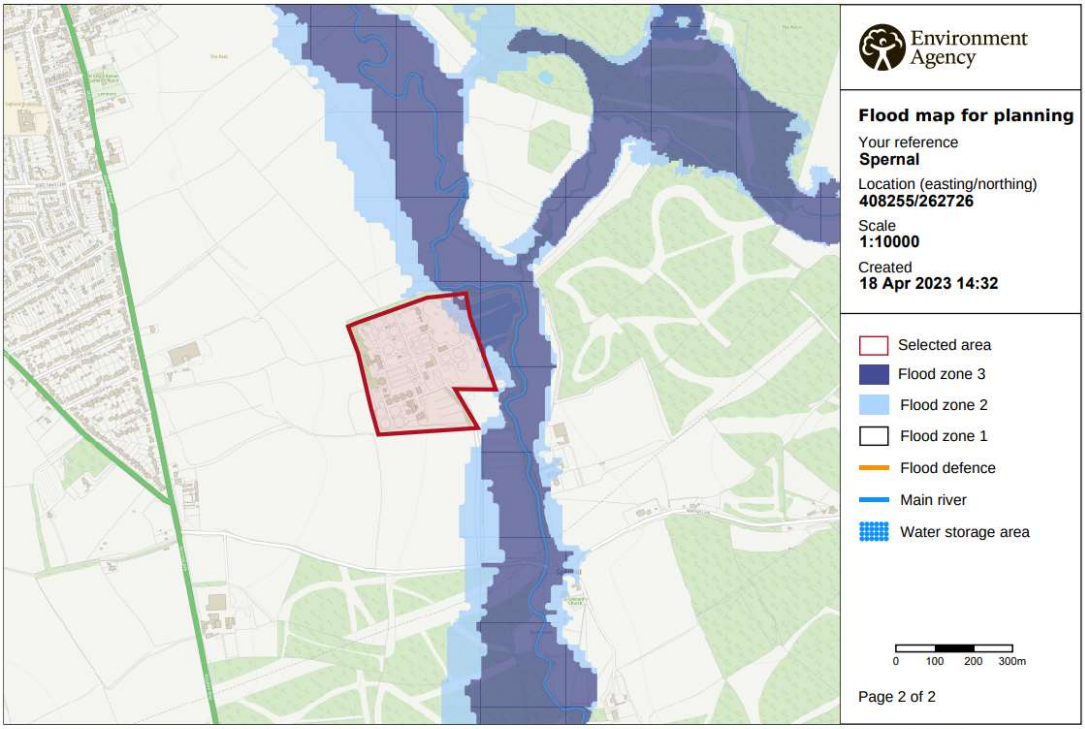

Figure 5.1 - UK Government's Flood Map for Planning

6. Conclusions

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

In the Risk Identification Report for Spernal STW a containment classification report was carried out. An overall site risk rating of medium was determined meaning that class 2 containment is needed. The detailed requirements for class 2 containment have been outlined in the Risk Identification Report in section 1.1.

The assessment focusses on site -specific risks and outlines the options available for providing remote secondary containment of a catastrophic tank or digester failure. A technical option has been developed for the containment of spills within the three sludge areas.

The solution for the PKT and pre-digester area (area 1) uses bund walls, kerbing, flood gates and ramps to create the secondary containment area.

The preferred technical solutions for the centrate and digester tank area is to use kerbs to guide flows to a drainage point before flows are transfer to secondary containment area 1 via a drainage pipe.

Finally, the preferred technical solutions for the batch/consolidation tank area is to use flow guiding walls, bund walls and ramps to guide and contain flows. The position of walls/bunds will be finalised during detailed design, ensuring storage footprint is not compromised and the bund walls compliant to site operations and other considerations (i.e. services).

These solutions have been selected as the preferred technical solution as there is less impact on day-to-day site operations, due to the practical height of the ramps.

The effect of Jetting and surge flows were also assessed and found to pose no issues in the containment areas.

Appendix A. ADBA Site Hazard Risk Assessment for Spernal STW

Material	Physical properties	Quantity	units	Storage	Flammability	Corrosive	Ecotoxicity (based on LD and quantity)	Environmental hazard rating	Justification
Process									
Digestate (fermenter)	Liquid	< 1000	m3	Covered Tank or lagoon				H	Based on latest aquatic toxicity results from REA
	Liquid	1000 < X < 5000	m3	Covered Tank or lagoon				H	Based on latest aquatic toxicity results from REA
Separated digestate solids	Cake			Concrete pad				M	Largely immobile therefore presents only a medium risk.
Separated digestate liquid	Liquid			Covered tank				H	
							Process Overall Rating	H	Justification: 4 Digesters, 4 Pathogen Kill tanks, 2 Consolidation tanks, 3 batch tanks, 1 Centrate tank, 1 blending tank with total capacity of 32,124 m3.
Additives and site chemicals									
Ferric Chloride	Liquid	1	IVC	IVC	Not flammable	No	Low	M	Not present
Glycol	Liquid	1	IVC	IVC	Not flammable	No	Low	L	Not present
Cleaning products	Liquid	1	IVC	Consumables container	Not flammable	No	Low	L	Not present
Lab consumables	Liquid	20	litres	Consumables container	Not flammable	No	Low	L	Not present
							Chemicals Overall Rating	L	Section not relevant
Fire fighting agents and cooling water spillages									
Fire Fighting Agents harmful in their own right or contaminated by inventory	Liquid	>25	m3	NA	Not flammable	No	Low	L	Not present
Fire fighting and cooling water contaminated by inventory	Liquid	>25	m3	NA	Not flammable	No	Low	L	Not present
							Spillages Overall Rating	L	All the hazards are "Low" therefore the overall rating is low

Pathway - the route from primary containment to receptor		Environmental hazard rating	Notes
Site layout and drainage			
If any of the site inventory has a runoff time of a few minutes…		H	Sludge will cross the site boundary within 1 minute.
If any of the site inventory has a runoff time of a few hours….		H	Not Applicable
If any of the site inventory has a runoff time of a few days…		M	Not Applicable
If any of the site inventory has a runoff time of a few weeks…		L	Not Applicable
Topography, geology and hydrology			
Site is raised above a nearby receptor		H	Site slopes from South-West to North-East therefore is raised above the River Arrow.
Chalk		H	According to the British Geological Survey the site is not in the chalk aquifer area.
Fractured chalk		H	Not Applicable
Principal Aquifer		H	Aquifer at this location in of Secondary type B.
Groundwater protection zone 1		H	Groundwater Vulnerability is Medium-High according to Ground Water Vulnerability Map.
Mitigation - do these apply?			
If a secondary containment system is present…		L	Not present at the moment
If the rain water drainage system in the secondary containment fails safe…		L	Not applicable
	Path & Mitigation Overall Rating	H	Justification: sludge inventory have runoff time of 1 minute.
Climatic conditions			
Annual rainfall < 1000 mm		L	Annual Rainfall within 647.01 mm - 809.9 mm
Annual rainfall > 1000 mm		M	Not Applicable
Snow accumulation is possible		M	Yes
Fire Fighting Water			
Inflammable materials normally present on site in large quantities?		M	Not Applicable
Location			
Site is in a flood plain		H	IED permitted Area is Flood Zone 1 (north-east site boundary is in Flood Zone 2)
Site is at bottom of a hill		M	The site inclines from South West to North East, towards River Arrow.
Site is connected to a sewage treatment works		M	The sludge treatment center is integral with the sewage treatment works
	Site Considerations Overall Rating	M	Justification: Area IED permitted is integral with the sewage treatment works.
	Pathway Overall Hazard Rating	**H**	Justification: In the case of a spill, sludge will cross the site boundary within 1 minute.

Receptors	Within	units						Environmental hazard rating	Notes
Watercourses and bodies									
Rivers above potable water supplies	100	m						H	River Arrow is within 95m, located north from the Sewage Treatment site.
Aquifers used for public supply	150	m						M	Aquifer present are secondary B type.
High quality waters	1000	m						H	Not applicable
Agricultural abstraction points	50	m						M	No Agricultural abstraction identified via desktop analysis
High value ecosystems	1000	m						M	SSSI and LNR sites are identified near the IED permitted area.
Recreational waters	50	m						M	Not applicable
Small treatment works	50	m						M	Not applicable
None of the above								L	Not applicable
							Water Overall Rating	H	Justification: River Arrow is within 95 m from the site
Habitation									
Dwelling	250	m						H	Not applicable
Dwelling	251-500	m						M	Spernal Hall Farm is within 260m from the site to the east
Workplace	250	m						M	Former church of St Leonard's is 530m away to the south of the site
None of the above								L	Not applicable
							Habitation Overall Rating	M	Justification: Farmhouse is within 260m from the site
Other									
SSSI/SPA/SAC	1000	m						M	Bannam's Wood SSSI 3100m East; Rough Hill SSSI 2700m West; Wirehill Woods SSSI 2700m West;
RAMSAR Site	1000	m						M	None
None of the above								L	
							Other Overall Rating	L	Justification: Nearest SSSI site is 2700m to the west of the site.
							Receptors Overall Hazard Rating	**H**	Justification: River Arrow is within 95 m from the site

Calculated hazard ratings:			
Source	Pathway	Receptor	**Site Hazard Rating**
H	H	H	**High**

Possible Combination			Site Hazard Rating
L	L	L	Low
M	M	L	Low
H	L	L	Low
M	M	M	Medium
H	M	L	Medium
H	H	L	Medium
H	M	M	High
H	H	M	High
H	H	H	High

Risk #	Description of Risk	UNMITIGATED LIKELIHOOD	Mitigation applied	MITIGATED LIKELIHOOD	Low	Site Overall Likelihood
1	Operational failures, such as failure of plant, or human failure by operators	H	Annual HAZOPs and operator training	L		
2	Shortfalls in design – lack of alarms and fail-safe devices	M	Pre-construction HAZOP identified measures - see P&IDs	L		
3	Structural failure – materials, components, detailing, corrosion or when exposed to heat and flame	M	Inspection of vessels, asset management	L		
4	Abuse – inappropriate change of use or other misuse	L		L		
5	Impact, eg from a vehicle	L	Armco barriers and concrete bollards installed	L		
6	Vandalism, terrorism, force majeure etc	L		L		
7	Fire or explosion	L		L		
8	Geological factors -subsidence etc	L		L		
9	Ageing or deteriorating assets/sub-components.	M	Inspection of vessels, asset management	L		
10	Lightning strike	L		L		

Site Hazard Rating	Likelihood	Overall Site Risk Rating	Indicated Class of Secondary Containment Required
High	Low	**Medium**	**Class 2**

Appendix B. Spernal STW Site Surfacing Plan