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

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Severn Trent Water

STW IED Containment Studies
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Hayden Digesters and Sludge Tank IED Containment Assessment - Proposed Options Report

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Executive summary

Hayden Sewage Treatment works is in the west region of Cheltenham. The Hatherley Brook watercourse lies on the south side of the site and the M5 lies on the west side. The boundary of the site has fields on the north and east sides and housing on the east side. Figure i shows an aerial view of the site in the context of its nearby surroundings. An initial visit to Hayden Sewage Treatment Works occurred for the purpose of site assessment and data collection.

Figure i – Aerial Image of Hayden STW

The secondary containment solution is based on the following design parameters:

- The Risk Report has identified that class 2 containment is required
- The required containment for the pathogen kill tank (PKT) and digester area is 5,473 m^3 and is derived from 25% of total tank inventory
- The required containment for the centrate balancing tank area is 591m^3 and is point of spill plus rainfall ('credible')
- The containment recovery period is 48 hours, a 3 day 1 in 10-year event has been used for rainfall
- Due to the size and location of the centrifuge buffer tank, it will be replaced with an integrally bunded tank of similar size

The solution for the PKT and digester area uses bund walls, kerbing and ramps to guide the flow to the secondary containment area, which is a storage 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).

The preferred technical solutions for the centrate balancing tanks 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 iii)

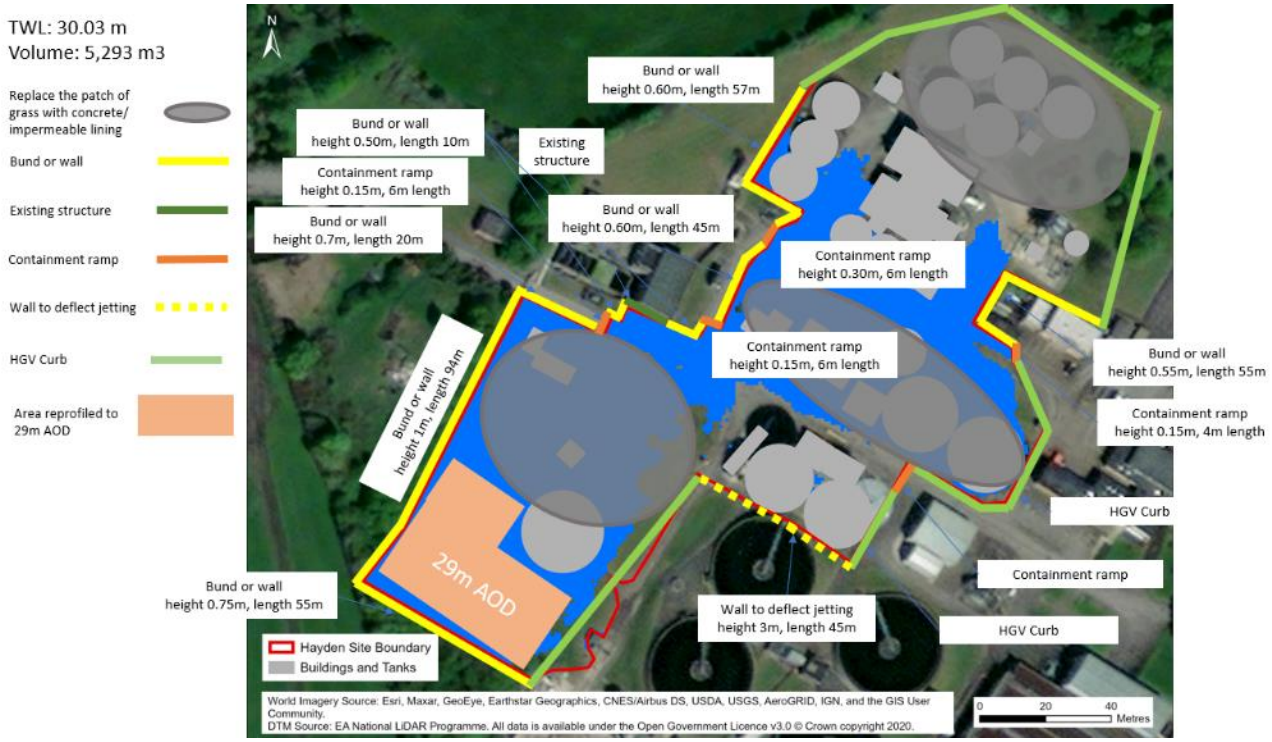

Figure ii – Plan showing recommended solution (PKTs and digester Area)

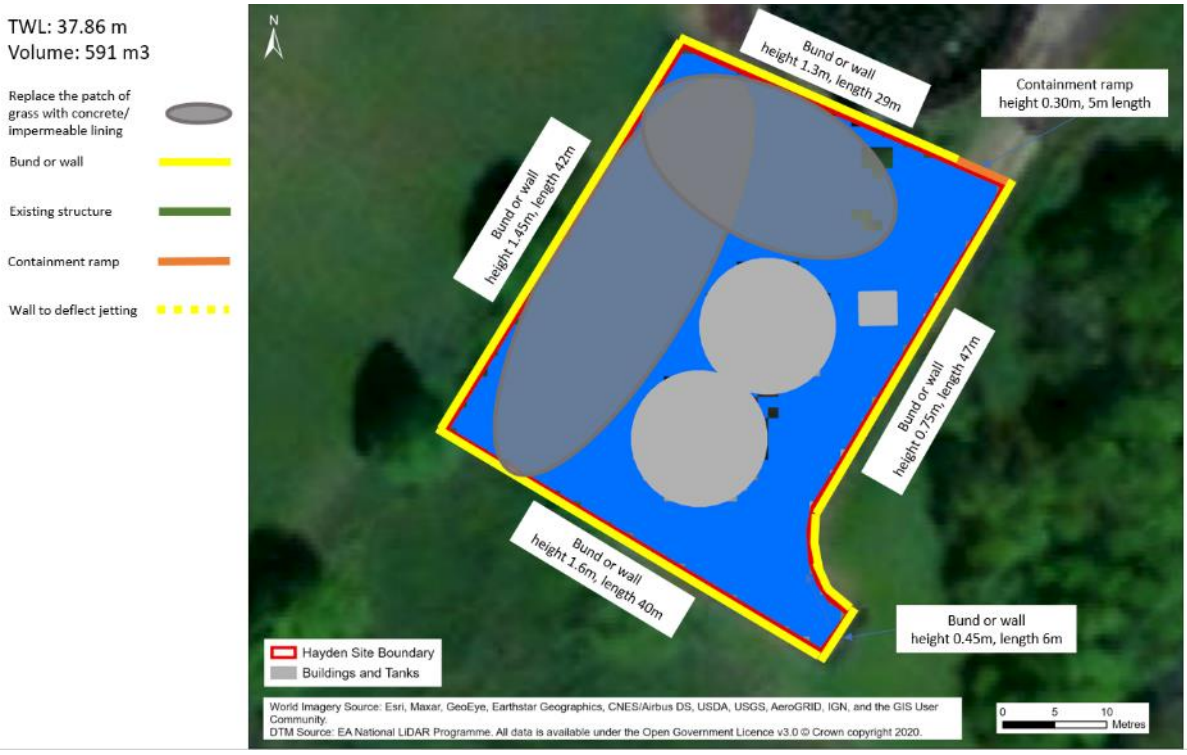

Figure iii – Plan showing recommended solution (Centrate balancing tank area)

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 Hayden 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 'Hayden Digesters and Sludge Tanks, IED Containment Assessment-Risk Report, revision 1.1' which outlines the impact of an uncontained spill and the risk assessment completed. The tank inventory list for the IED permitting area is contained within this report.

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 Hayden.

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 Hayden 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 Hayden 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 Hayden

1.1 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:

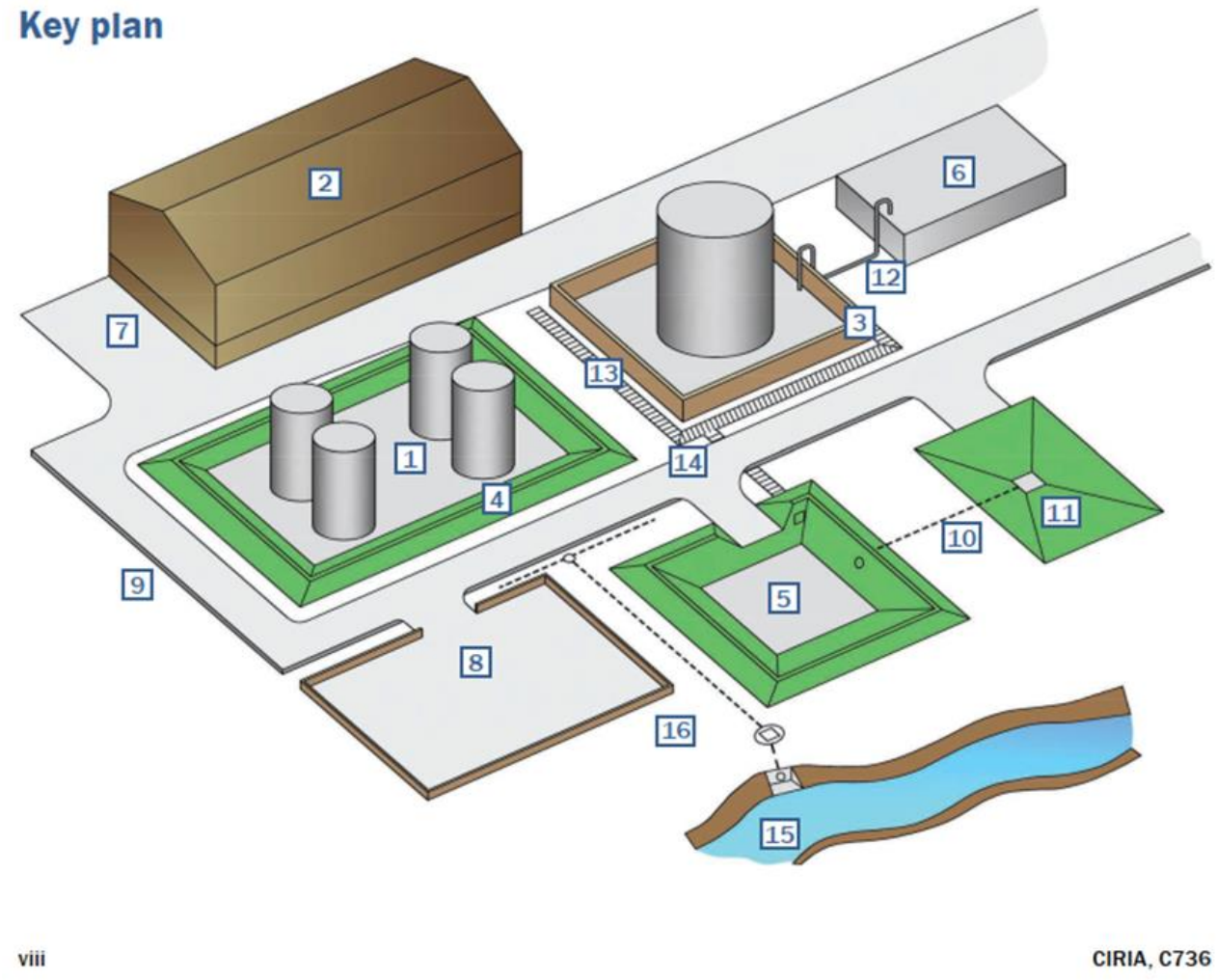

Figure 1.1 - Diagram of primary, secondary and tertiary containment examples

-**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 Hayden

Based on the use of the ADBA risk assessment, considering the source, pathway and receptor risk Hayden 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)

The detailed ADBA risk assessment tool is attached in Appendix A.

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 event the containment capacity must also make allowance for rainfall that may accumulate within the contained area before and after an incident. 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 event 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 Hayden is a sewage treatment facility with ready access to pumps and tankers, and with a (controlled) disposal route via the sewage 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 three-day rainfall period has been selected. The average three-day rainfall depths for a 1 in 10-year storm for Hayden is 58.7mm. It should be noted that the rainfall depths for Hayden 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.

2.2 Total Spill Volumes

The PKT and digester area considers a spill volume of 5,473m^3 – this is the 25% volume of the total tank inventory. This is larger than the credible spill volume 4,106m^3 (which considers a 19,868m^2 catchment with 58.7mm rainwater. The spill volume comprises of 2,940m^3 from a catastrophic tank failure and 1,116m^3 of rainfall), and larger than 110% of the largest tank (3,233m^3)

For the centrate balancing tank area, a 1,556 m^2 catchment area with 57.8 mm rainwater depth, the total design containment volume comprises 500 m^3 from catastrophic tank failure, and 91 m^3 from the rainfall event, giving a total volume of 591 m^3. The containment volume is a credible spill, which is greater than both 25% (250m^3) of the volume of all sludge assets in this area and 110% (550m^3) of the largest tank in this area.

3. Remote Secondary Containment

3.1 The Containment Area

3.1.1 Topography

Error! Reference source not found. shows the topography of the PKT and digester area containing the sludge assets at Hayden. The highest ground is shown with the pink contours to the northeast of the site. The lowest elevations are shown with the blue contours to the south-west of the site.

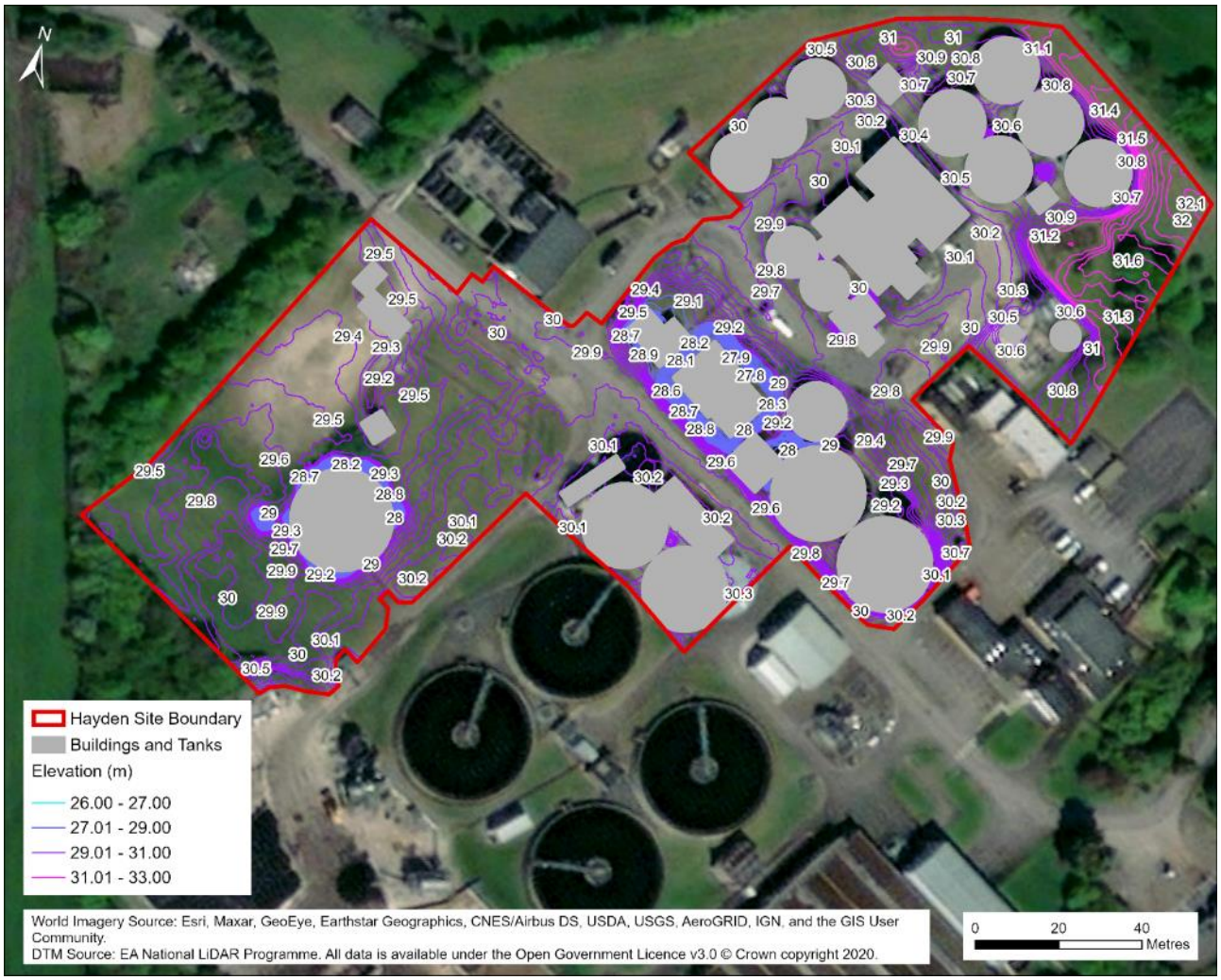

Figure 3.1 – PKT and Digester area topography at 10cm intervals

Error! Reference source not found.2 shows the topography of the centrate balancing tank area at Hayden. There is a slight fall from east to west at this location.

Figure 3.2 – Centrate balancing tank area topography at 10cm intervals

Figure 3.2 - Labelled site plan at Hayden STW

3.1.2 Containment Solutions

3.1.2.1 PKTs and Digester Area

To provide sufficient secondary containment for the PKTs and digester Area, the total design containment volume of 5,473m^3 needs to be securely contained. LiDAR spill modelling calculated the top water level (TWL) when 5,473m^3 is contained in this area to be at 30.03mAOD. Figure 3.4 shows the works necessary to convert the PKTs and digester Area into a secure remote secondary containment facility. The works consists of impermeable linings on the grass areas within the containment area, bund/wall structures on the south-west and east sides of the containment area, HGV curbs as well as cutting into the grassed area in the south-west of the area and levelling the area to 29m AOD to increase the area that can be used for storage. Five containment ramps will be required. The impact of jetting and the installation of a jetting barrier has also

been considered at the east boundary of the site, to prevent jetting from the digesters. There is approximately 5,700m^2 of grassed area that require the installation of impermeable area.

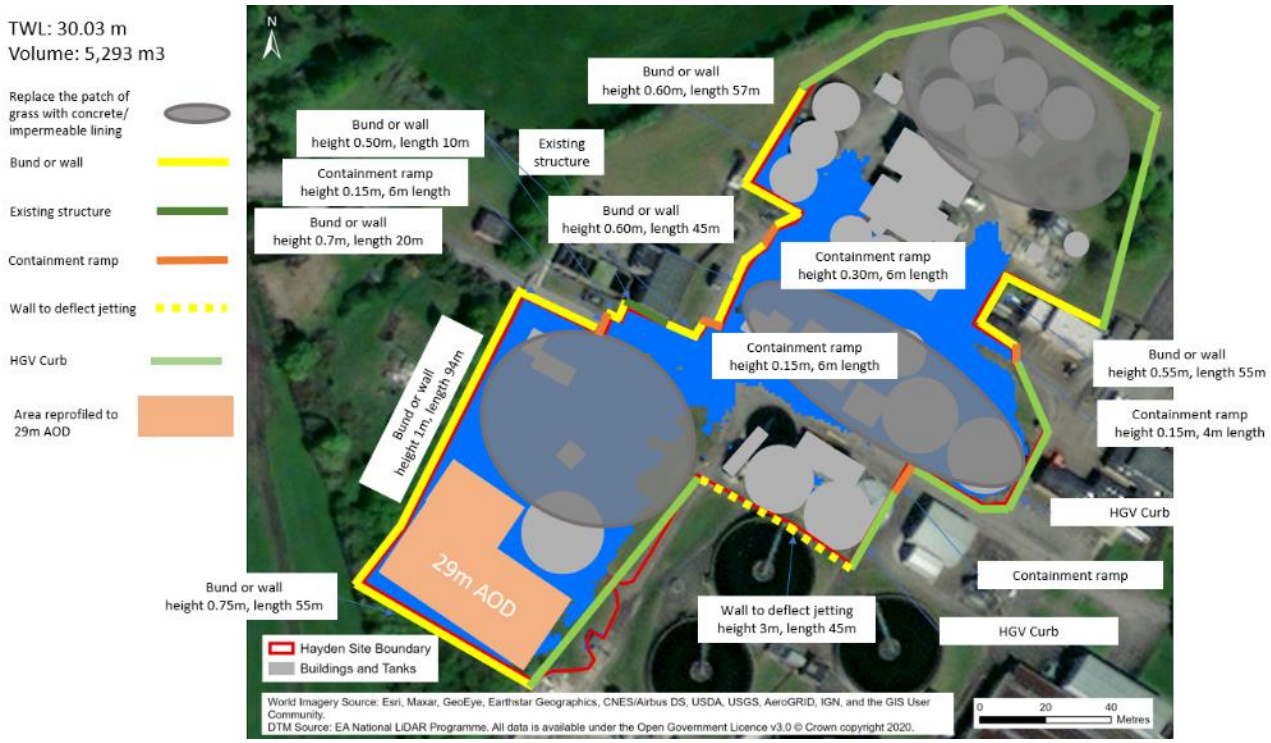

Figure 3.4 - Recommended site modifications to provide remote secondary containment for the PKTs and Digester Area

The position of bund walls will be determined by detailed design ensuring the storage footprint is not compromised, and the bund walls compliment site operations and other considerations (e.g. services).

3.1.2.2 Centrate Balancing Tanks Area

To provide sufficient secondary containment for the Centrate Balancing Tanks Area, the total design containment volume of 591m^3 needs to be securely contained. LiDAR spill modelling calculated the top water level (TWL) when 591m^3 is contained in this area to be at 37.86mAOD. Figure 3.5 shows the works necessary to convert the Centrate Balancing Tanks Area into a secure remote secondary containment facility, namely impermeable linings on the grass areas within the containment area, bund/wall structures on all the boundaries of the containment area and a containment ramp on the north-east side. There is approximately 670m^2 of grassed area that require the installation of impermeable area.

Figure 3.5 Recommended site modifications to provide remote secondary containment for Centrate Balancing Tanks Area

The position of bund walls will be determined by detailed design ensuring the storage footprint is not compromised, and the bund walls compliment 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 Hayden 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 the Hayden STW are tabulated overleaf.

Table 3.1 - Summary of Recommended Site Modifications

	Impermeable Lining /m^2	Walls/ Barriers	Ramps	Other (Isolation Valves/Building Protection/ local infill)
PKT & Digester Area	4 areas require impermeable lining (Total area of 5,700m^2)	8 sections Walls/Bunds: • Max height 0.75m Length 55m • Max height 1.00m Length 94m • Max height 0.7m, Length 45 m • Max height 0.5m Length 10m • Max height 0.5m Length 10m • Max height 0.6m Length 45m • Max height 0.6m Length 57m • Max height 0.55m Length 55m Wall to defect jetting: • Max height 3.0m Length 45m Kerbing to guide flows Length 235m	4 containment ramps • Height 0.15m Length 6m • Height 0.15m Length 6m • Height 0.30m Length 6m • Height 0.15m Length 4m 1 containment ramp for guiding flows	Isolation of drainage system to prevent it heading to head of works Reprofiling of 1,732m^2 area to 29m AOD for additional storage
Centrate Balancing Tanks Area	An area of 670m^2 requires impermeable lining	5 sections Walls/Bunds: • Max height 1.3m length 29m • Max height 1.45 m Length 42m • Max height 1.60m length 40 m • Max height 0.45m length 6 m • Max height 0.75m length 47m	1 containment ramp • Height 0.3m Length 5m	Isolation of drainage system to prevent it heading to head of works

4. Site Drainage

Site drainage assessments are based on Hayden Sewerage Works Layout Plan Drawing Number R790/001.

4.1 Foul, Process and Effluent Drainage

The Hayden Sewerage Works Layout Plan shows all Foul/ Combined/ Process/ Treated Effluent drainage pipes, indicated by red lines, go to the head of the works shown in Figure 4.1. If large quantities of sludge were to enter the head of the works, the shock load could adversely impact the sewage works treatment process. The release of untreated effluent and sludge would be hazardous to the environment and breach EA regulations. These lines should therefore be isolated in the event of a catastrophic loss of containment. As both systems combine, the surface water drains have been reviewed as part of this section. Four isolation points have been determined as shown in Figure 4.1 & 4.2. Isolation downstream of manhole P107 could potentially cause operational issues for the works (relating to centrate buffering) but is required to stop a shock load at the head of the works arising from sludge containment. Due to the lack of flooding in the sludge thickening tank area this line hasn't been isolated upstream of P87.

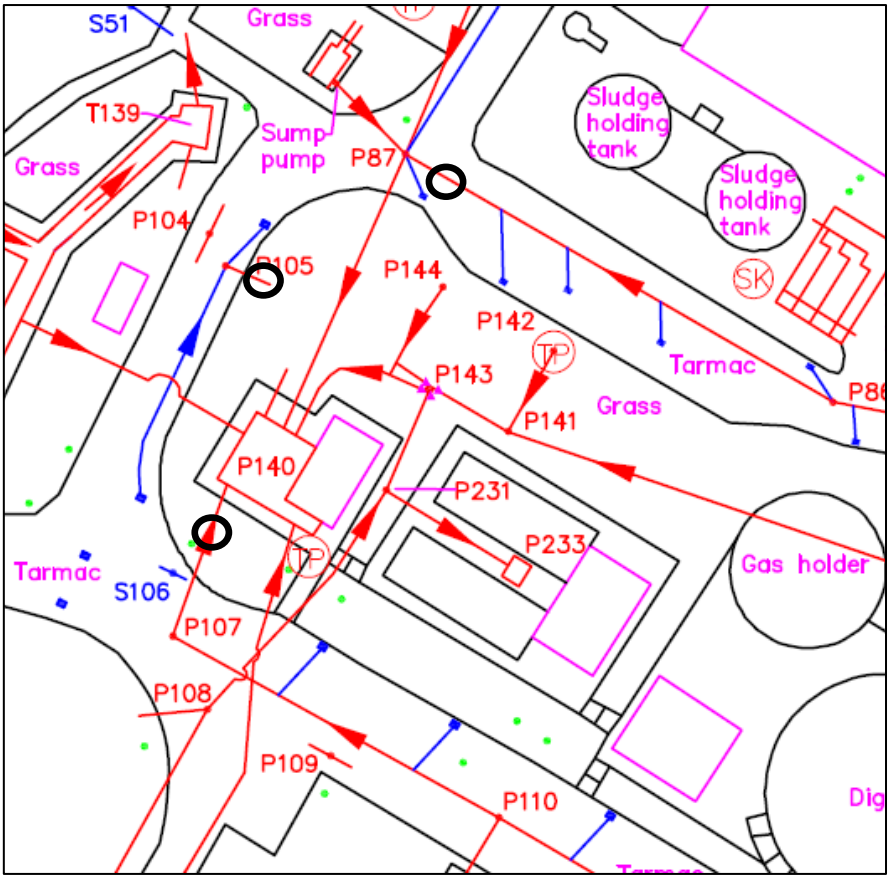

Figure 4.1 - Drainage line to head of works and suggested isolation points

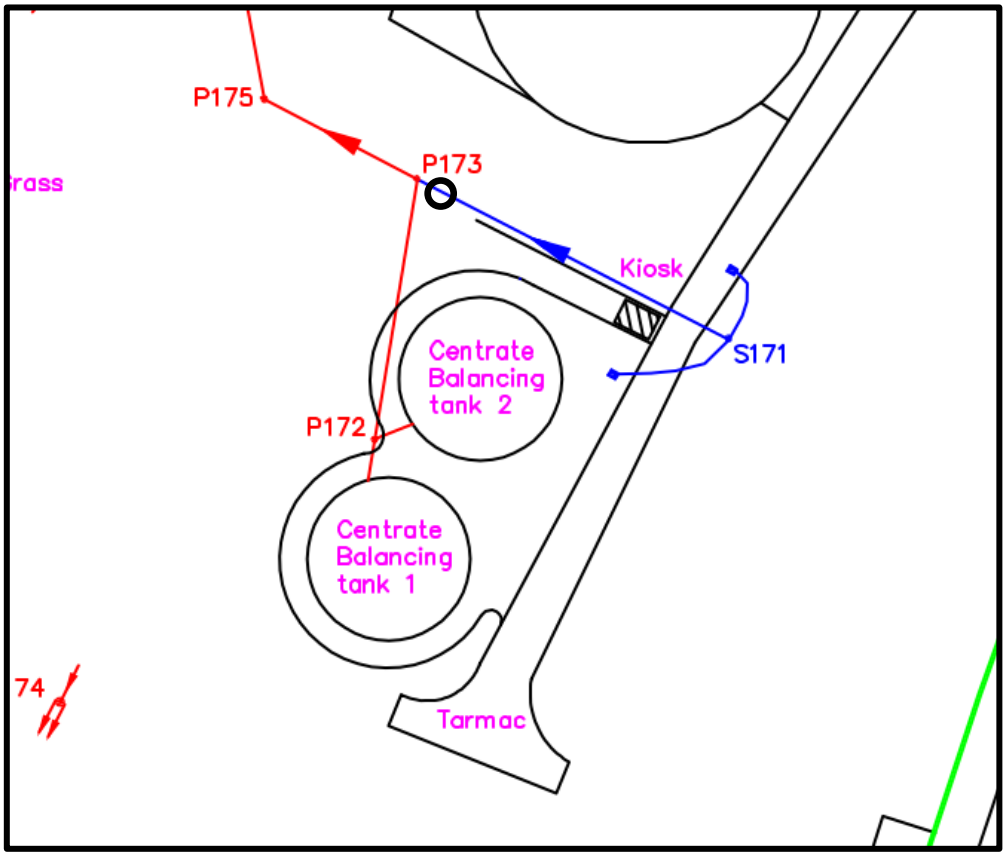

Figure 4.2 - Drainage line to head of works and suggested isolation point at centrate balancing tank area

4.2 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 Hayden 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. Mitigations of Site-Specific Risks

5.1 Jetting and Surge Flows

Jetting was identified as a risk in Hayden IED Containment Assessment Risk Identification Report due to the location of the Pathogen Kill Tanks, the digesters and the centrate balancing tanks. **Error! Reference source not found.**.1 below details the method for determining the necessary height and distance of a bund wall from a given tank to prevent jetting. Where it is not practical to locate a bund wall so as to contain jetting, baffle plates or suitably robust curtains can be installed.

Box 6.1 Method for calculating bund geometry to prevent jetting

For a small diameter sharp edged discharge orifice, it can be demonstrated that:

$l^2 = 4\,C_v^2\,(z-h)\,(H-z)$

where C_v = coefficient of velocity

In practice, $C_v \cong 0.99$. Assuming $C_v = 1$ leads to the conservative solution:

$l^2 = [4(z-h)(H-z)]^{0.5}$

For a given value of h, it may be shown the l is a maximum when:

$z = 0.5H + 0.5h$

which leads to the solution:

$l_{max} = H-h$

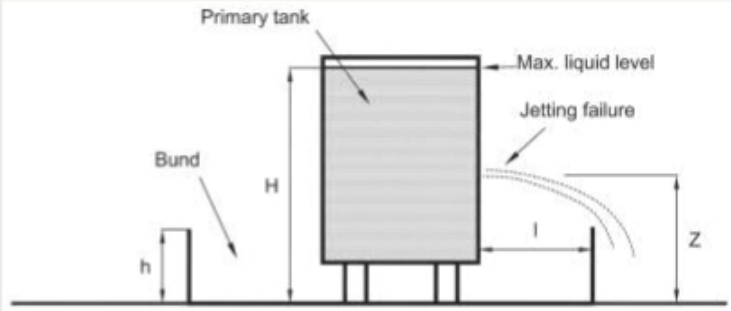

Figure 2.1 Extract for tank jetting consideration, *CIRIA guidance document C736 (Containment systems for the prevention of pollution – Secondary, tertiary and other measures for industrial and commercial premises, 2014)*

For the digester Area and pathogen Kill tank area, the spill mapping in Figure 3.3 shows jetting flows can be of concern for the digesters located in close proximity to the FSTs. Based on the equation in Figure 5.1 the required distance to contain jetting from a digester is 15m. The actual distance from the digesters to the boundary of the containment area is 6m. This means a jetting barrier of 45m length and 3m height located to the south of the digesters will be needed to contain the spill of the digesters.

For the Centrate Balancing Tanks Area, Figure 3.4 shows the two centrate balancing tanks are in proximity to the boundary of the containment area. Based on the equation in Figure 4.1 the required distance to contain jetting from a centrate balancing tank is 4.5m. The actual distance from the centrate balancing tanks to the boundary of the containment area is 12m therefore jetting is not an issue for these tanks as the distance from the centrate balancing tanks to the boundary is larger than the jetting distance calculated. However, the grass area surrounding the centrate balancing tanks should be impermeabilized to prevent sludge from entering the ground.

5.2 Flooding

According to the UK Governments Flood Map for Planning, Hayden STW is not within any potential flooding zone as shown in Figure 5.3 therefore the solution report doesn't accommodate the risk of flooding.

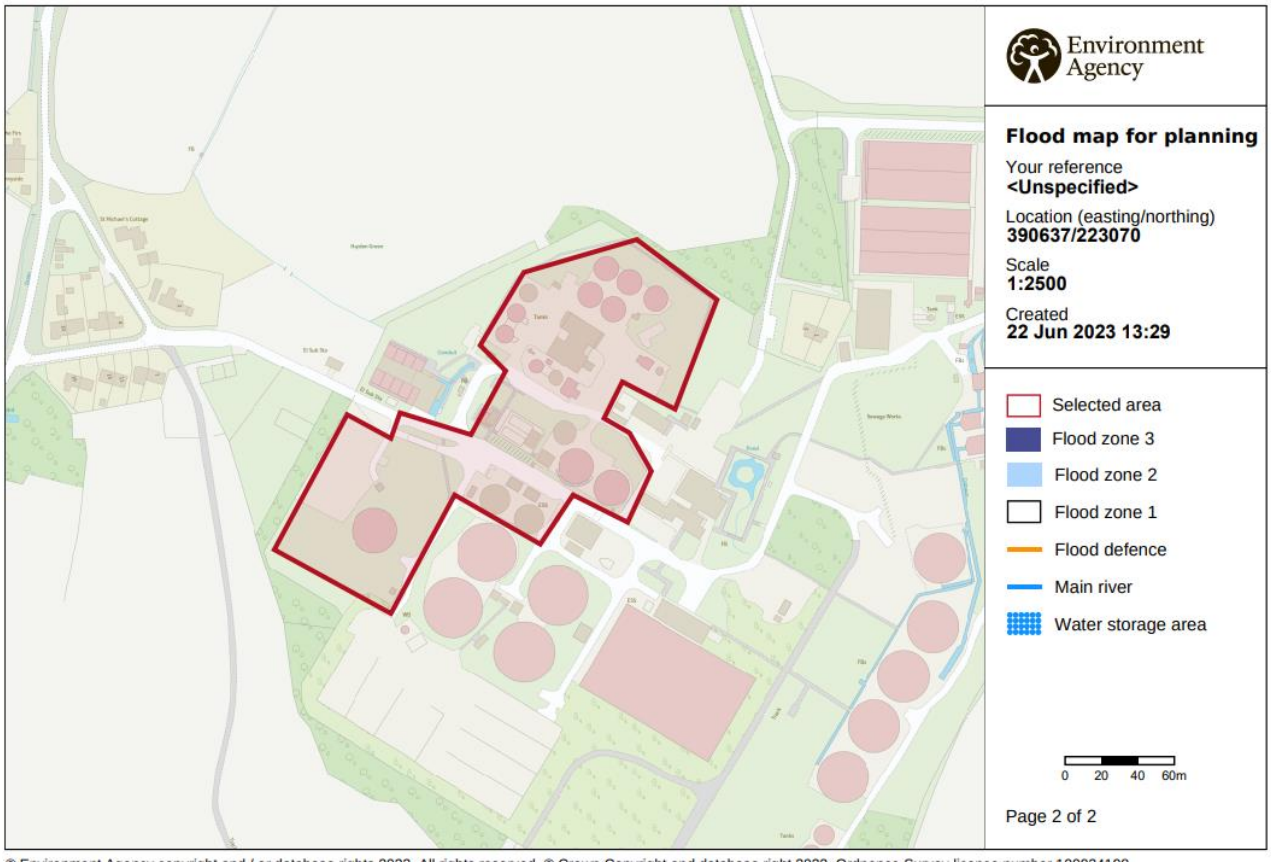

Figure 5.3 - Extent of Fluvial Flooding due to Extreme Weather

6. Conclusion

This section summarises the findings of the containment assessment at Sludge and bioresources areas, located at Hayden sewage treatment works.

In the Risk Identification Report for Hayden STW a containment report was carried out. An overall site risk rating of medium was determined meaning that class 2 containment is needed. The detailed requirements 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 two sludge areas.

The PKT & digester area uses walls/bunds, ramps and curbs to guide flows into a storage area to store the spills. Walls /Bunds and ramps are required to contain the flows at certain points of the boundary. This solution has been developed so that the impact of the site operations is not affected.

The 25% of total stock volume is the dominant rule at this site. This has increased the required storage volume by 1,187m^3 compared to the storage volume required for largest tank plus rainfall.

The centrate balancing tanks area uses walls/bunds and ramps to store the spills. Walls /Bunds and ramps are required to contain the flows within the boundary. This solution has been developed so that the impact of the site operations is not affected.

The effect of jetting and surge flows were also assessed and found to pose a risk within the PKT & digester area. A jetting barrier of 45m length and 3m height located to the south of the digesters will be needed to mitigate the risk from the digesters.

Appendix A. ADBA Site Hazard Risk Assessment for Hayden STW

Material	Physical properties	Quantity	Units	Storage	Flammability	Corrosive	Ecotoxicity (based on LD and quantity)	Environmental hazard rating	Justification
Feedstock 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	Present at this site.
							Process Overall Rating	H	Justification: Two digesters; Five Pathogen Kill Tanks; Two Sludge Storage Tanks; Two Centrate Balancing Tanks and three Primary sludge thickening tanks with a total capacity of 22842 m3.
Additives and site chemicals									
Ferric Chloride	Liquid	1	IBC	IBC	Not flammable	No	Medium	M	
Glycol	Liquid	1	IBC	IBC	Not flammable	No	Low	L	Not present
Cleaning products	Liquid	1	IBC	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	M	Polyelectrolyte chemicals for sludge thickening.
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
							Sources Overall Hazard Rating	**H**	Justification: Digesters; Pathogen Kill Tanks; Sludge Storage Tanks; Centrate Balancing Tanks and Primary sludge thickening tanks are present at this site.

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 would reach head of works within 4 minutes.
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 East to West, therefore raised above the near housing area.
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 present are secondary type (undifferentiated).
Groundwater protection zone 1		H	According to Ground Water Vulnerability Map, Groundwater Vulnerability is high risk with soluble rock.
None apply		L	Not applicable
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 would reach the head of work within 4 minutes. The site is raised above nearby receptors. The Groundwater Vulnerability is rated as High for this location.
Climatic conditions			
Annual rainfall < 1000 mm		L	Annual Rainfall within 809.9 mm - 867.2mm
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	Flooding from River is at low risk; Flooding from Surface water is medium- high risk
Site is at bottom of a hill		M	The site inclines from East to West, towards the residential area.
Site is connected to a sewage treatment works		M	IED permitted is connected to sewage treatment works.
	Site Considerations Overall Rating	M	Justification: IED permitted is connected to sewage treatment works.
	Pathway Overall Hazard Rating	H	Justification: Runoff time to the head of the work is less than a few minutes. The site is a sewage treatment work.

Receptors	Within	units						Environmental hazard rating	Notes
Watercourses and bodies									
Rivers above potable water supplies	100	m						H	River Severn is 6.49 km away from the site to the west, and Hatherley Brook is within 500m from the IED permitted area to the south.
Aquifers used for public supply	150	m						H	Aquifer present are secondary type (undifferentiated).
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	Local Nature Reserve is to the east of the site but more than 1000 m away.
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	L	Justification: The site is far from these Watercourses and bodies receptors.
Habitation									
Dwelling	Within 250	m						H	Housing is within 150m of the Sewage Treatment works.
Dwelling	251-500	m						M	Not applicable
Workplace	Within 250	m						M	The Firs, Cheltenham Spa is within 265m to the west of the site.
None of the above								L	Not applicable
							Habitation Overall Rating	H	Justification: housing is within 150m from the Sewage Treatment work.
Other									
SSSI/SPA/SAC	1000	m						M	Not found
RAMSAR Site	1000	m						M	Not found
None of the above								L	Griffiths Avenue is a LNR site 2250m to the site's east side.
							Other Overall Rating	L	Justification: There is a LNR site nearby that is not considered in this ADBA.
							Receptors Overall Hazard Rating	**H**	Justification: Housing is within 250m from the Sewage Treatment works.

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. Site Surfacing Plan