

Mansfield Digesters and Sludge Tanks
IED Containment Assessment-Risk Identification Report

April 2022

Severn Trent Water Limited

Jacobs

Project No: B19589CT
 Document Title: Mansfield – IED Containment Assessment-Risk Identification Report

Document No.: B19589CT-DOC-021
 Revision: 1.1
 Date: 20 April 23
 Client Name: Severn Trent Water Limited
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 File Name: B19589CT- DOC-021-Mansfield Report (Risks)

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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
1.0	17/12/21	Draft	RW	SG	SG	RB
1.1	15/03/23	Final Report for Issue	HR	WL	CS	KC

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i. Background

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 was 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. This report details the site-specific risks at Mansfield Sewage Treatment Works (STW), the illustration of the uncontained spill event and the containment classification.

Mansfield STW is located 1 mile north-east of the centre of Mansfield, the River Maun lies to the east of the site. The entire West and North of the site are bordered by an industrial estate, to the South-west is a secondary School The Brunts Academy, to East there is River Maun and housing. Figure i an aerial view of the site in the context of its nearby surroundings. An initial visit to Mansfield Sewage Treatment Works occurred for the purpose of site assessment and data collection.

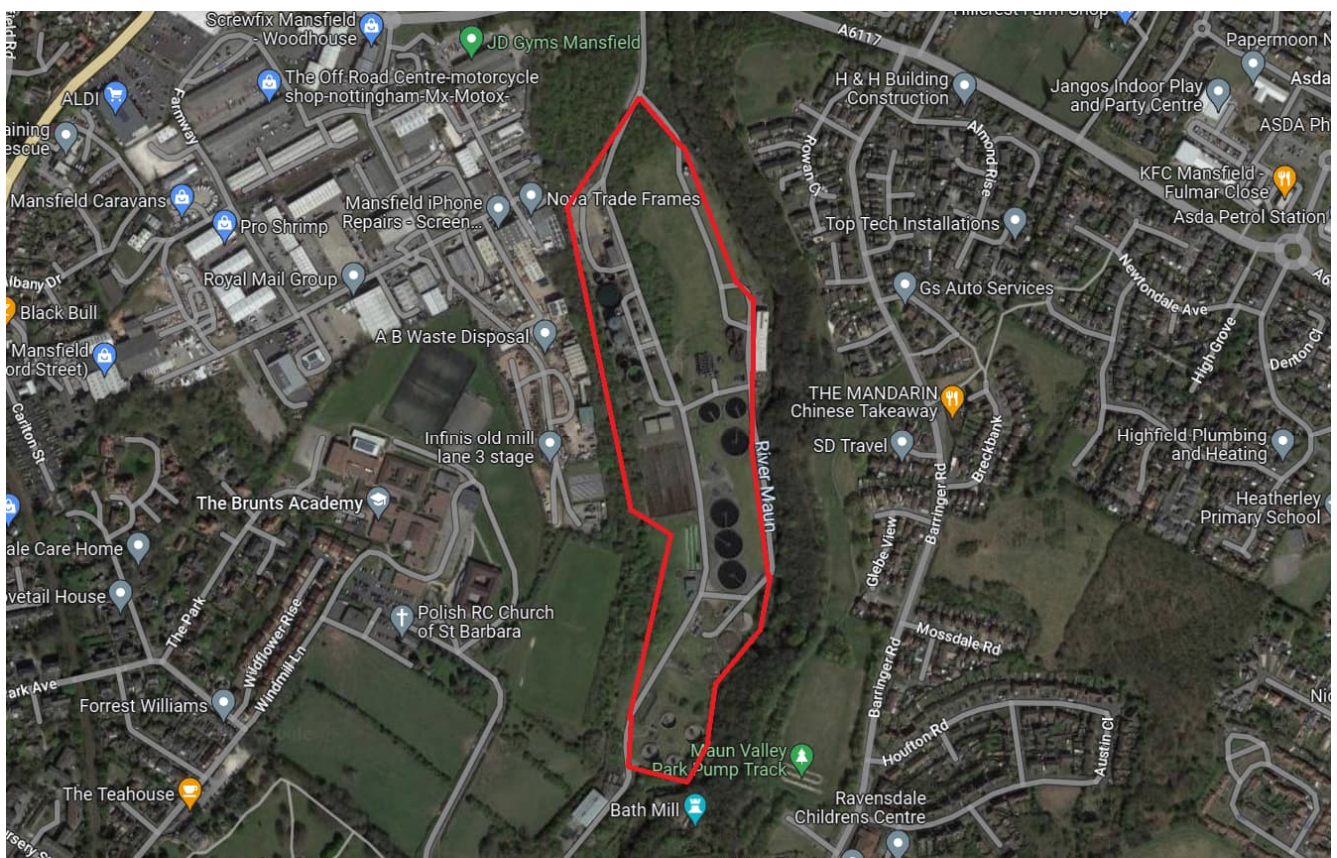


Figure i Satellite view of Mansfield Sewage Treatment Works

This document precedes ‘Mansfield STW Digesters and Sludge Tanks, IED Containment Assessment- Option and Recommendations Report, revision 1.1’ and informs the containment classification required. This report outlines the options to contain a spill from the tanks within the IED permit boundary.

Chapter 1 outlines the site-specific risks at Mansfield for sludge holding and digestion assets and the Containment Classification Assessment for the site.

Chapter 2 describes the site contouring, derivation of overland flow paths and any significant sludge holding tanks.

Chapter 3 determines the design containment volume based on a credible failure scenario and including pre- and post-event rainfall.

Chapter 4 analyses the spill mapping for the Sludge Area investigated on site achieved using ArcGIS and ArcPy coding of LiDAR data and digital topographic imagery. The spill mapping shows where flows accumulate, the volume of accumulated liquid and the top water level for any given volume, in mAOD.

Chapter 5 discusses the risks to the site from external flooding. The Sludge Area has less than 1 in 10000 annual probability of flooding therefore the risk posed is extremely low.

Chapter 6 presents the main conclusions of the containment assessment.

1. Site specific risks at Mansfield STW

To model the event of a credible and catastrophic tank failure resulting in loss of containment of sludge at Mansfield STW, the assets on site must be evaluated to identify the most hazardous failure events.

The principal sludge holding and digestion tank at Mansfield STW is as detailed below

- Three thickening tanks of steel construction of 120 m³ with a total capacity of 360 m³.
- Two digesters of concrete construction of 1975 m³ with steel jacket with total capacity of 3950 m³.
- Two Pre digestion storage tanks with steel construction of 267 m³ with total capacity of 534 m³, hydraulically linked.
- Two Post-digestion storage tanks of steel construction of 300 m³ with total capacity of 600m³.

For clarity, in each case the capacities given above are the total tank capacity, i.e., the maximum volume that a particular tank could hold. In practice the operational volumes are less due to freeboard and headspace, but the maximum volume is used to represent worst case scenario.

The plan in Figure 1.1 below indicates the boundary of the permitted IED area and the assets contained within.

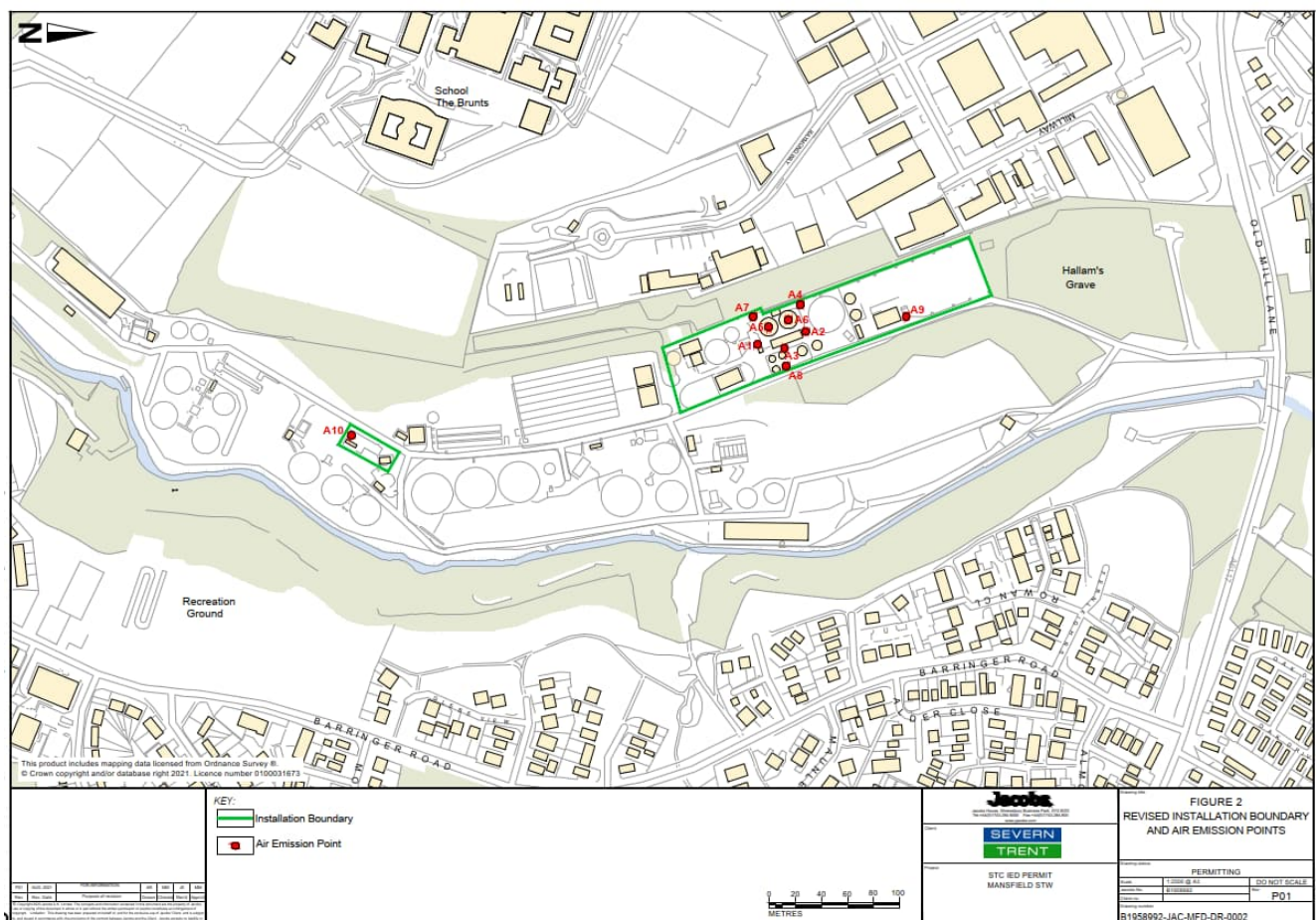


Figure 1.1 Boundary of the permitted IED area and the assets contained in Mansfield STW.

The site-specific risk factors that were identified at Mansfield STW are as follows:

- The total digester volume onsite and the number of large tanks and their individual tank capacities.
- Groundwater vulnerability is ranked as “High”, information retrieved from Ground Water Vulnerability Map.
- The River Maun is situated along the east boundary of the site which then later discharges to the River Severn tributary. The distance between the IED permitted area and River Maun is within 115m in the east direction of the site.
- Proximity to Old Mill Lane A6117 – the site is within 115m of this road.
- Proximity to Industrial Area and the Brunts Academy secondary school – site is within 120m of this area
- There are residential dwellings within 240m of the site to the east and 360m to the west.
- Ravensdale is a site of Local Nature Reserves which is located within 60m to the east of the site.

Table 1.1 Designated site review

Site Name	Designation	Distance	Direction
Ravensdale	LNR	60m (closest)	East
Maun Valley Park	LNR	560m	East
Oak Tree Heath	LNR	3300m	South- East
Quarry Lane	LNR	2800m	South
Oakham	LNR	3500m	South
The Hermitage	LNR	4000m	South
Pleasley Vale	LNR	3330m	North-East
Pleasley Vale Railway	SSSI	4150m	North-East

Abbreviations: LNR – Local Nature Reserves. SSSI – Site of Specific Scientific Interest

(Table 1.1 Reference: MAGIC.gov.uk website, accessed in March 2023)

For habitat sites, the relevant distance for consideration are: International designations (SAC, MPA, SPA and Ramsar - 10km); National designations (SSSI, LNR – 2km); Nature reserves and ancient woodland (2km). (Reference: Environment Agency pre-application conservation and screening report issued February 2023).

1.1 Containment Classification Assessment

CIRIA C736 states how the site hazard rating and, the site risk and classification are to be calculated. The ADBA risk assessment tool was used and is attached in Appendix 1. A summary of the hazard risks for Mansfield STW are as follows:

Source – There are two sources that have been identified:

1. Domestic and trade effluent Wastewater sludges, both in a raw, semi treated and treated state.
2. Polyelectrolyte chemicals for sludge thickening, but no other chemicals are identified to be present at this site

The Source Hazard rating was determined as High.

Pathway – There are four pathways that have been identified:

1. The process and site drains take any liquid to the head of the works which would negatively impact the process stability on site and would eventually impact on the receiving watercourse.
2. The River Maun is adjacent to the boundary of the site; the topography of the site runs west to east and consequently any spill will gravitate towards and into the river.
3. There are a number of areas where a sludge spill could pass over permeable ground.
4. Sludge would cross the site boundary and reach River Maun within 4 minutes.

The Pathway Hazard rating was determined as High.

Receptor – There are four receptors that have been identified:

1. The site drainage system and the head of the works.
2. The River Maun located on the Eastern boundary of the site.
3. There is a principal aquifer present in this location with a watercourse/ river near the site.
4. There is a commercial/industrial park to the west of the STW.

The Receptor Hazard rating was determined as High.

Likelihood

A review was completed with Severn Trent Bioresources staff and the likelihood for mitigated and unmitigated risks were calculated. The probabilities outlined in CIRIA C736 section 2.5, table 2.3 were used. Scoring was completed on the basis of a loss of containment which was not necessarily a total loss through a catastrophic failure but could in fact be a partial loss through a leak of minor spillage.

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

Following the implementation of post-mitigation measures the risk was scored as Low.

The final Likelihood Hazard rating was determined as Low.

Based on the information above the overall site risk rating was calculated to be high which means that class 2 secondary containment is required.

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

2. Flow Paths

2.1 Site Characterisation

To understand the topography of the site, open source LiDAR (Light detection and ranging) imaging data from the Environment Agency (EA) National LiDAR Programme, was utilised. This dataset was captured aerially and used to accurately measure the terrain or objects on the surface using a series of laser pulses on 1m pulse laser beam intervals and 1km grid tiles across the whole site. ArcGIS 10.8.1 modelling software was used to analyse LiDAR Digital Surface Model (DSM)/Digital Terrain Model (DTM) and formulate coloured hill shading and contour models. There are several products available as part of this programme, this project has utilised the DSM (Digital Surface Model) and DTM (Digital Terrain Model) alongside aerial imagery. The DSM was used with aerial imagery to locate any buildings or tanks within the site so these could be removed from the process. The 1m resolution DTM uses the last return of the LiDAR pulse, classified as the ground, and as part of the EA National Programme has been manually filtered to improve accuracy of the ground model.

The DTM was observed for the entire site as shown in Figure 2.1. DTM model for Mansfield STW shows that the site gradually slopes from west to east. Higher elevation is to the north and north-west of the site, reaching 90.03 m. The central area and south side of the site is relatively around 80.0m to 85.0m high, the east boundary of the site reaches varies from 80m to 77.04m and north-east side of the site reaches 77.04m.

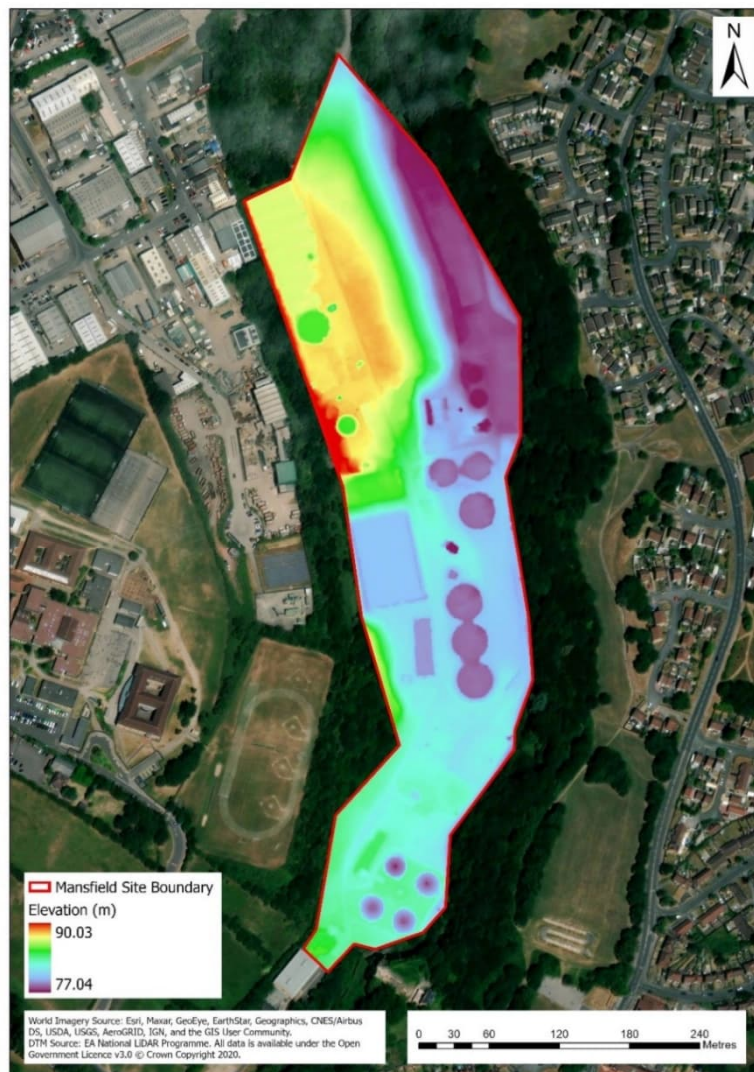


Figure 2.1 DEM/DTM Hill shade model of Mansfield Sewage Treatment Works Site

2.2 Uncontained spill mapping and flow paths

In order to demonstrate the location of the flow paths and the area sludge is deposited to following the catastrophic failure of sludge tank(s) onsite, uncontained flood mapping has been completed utilising Flood modeller software.

This modelling has been completed using a spill volume of 2088 m³, which is 110% of the largest sludge asset volume onsite. This value is larger than 25% of all above ground sludge assets in the containment area.

Modelling limitations

The software models the spill using a single density, a modelling tool is not available that can model all the variables associated with sludge storage and sludge spill i.e. Sludge density in the tank will vary from day to day, sludge density will be different at different levels in the tank and again different every day, it is likely that solids separation will occur in the area closest to the spill, but again this is variable depending upon the velocity of the liquid and the variability of the surface the sludge is travelling over.

Hydraulic modelling has been used to assess the uncontained spill following a catastrophic failure of the largest digester tank within the site. The 2D model generated uses the TUFLOW software package (Version 2020-10-AC), which can be used for simulating depth-averaged, one and two-dimensional free-surface flows exhibited with floods and tides. TUFLOW's implicit 2D solver, solves the full two-dimensional, depth averaged, momentum and continuity equations for free-surface flow using a 2nd order semi-implicit matrix over a regular grid of square elements. Furthermore, it includes the viscosity or sub-grid scale turbulence term that other mainstream software omit.

The DTM used in the model was of 1m resolution and the footprints of buildings and tanks were omitted from the model. The dimensions of the tank were used to calculate a constant flow of liquid in all directions from the circumference until it was emptied. Areas with different roughness coefficients were delineated using aerial imagery e.g., liquid would flow more easily over roads and paths as opposed to vegetated ground. The model outputs are 2m resolution with a timestep of one second. The model was run until the liquid front was no longer moving. Default parameters were used in the simulation and the model was stable with a mass balance error below the acceptable 1%.



Figure 2.2 Uncontrolled spill of Mansfield Sewage Treatment Works

2.3 Assets impacted by the spill

In the event of losing the full contents of the largest tank on site, the following assets will be impacted;

- 3 Thickening tanks, 2 Digesters, 2 pre-digestion storage tank, 2 post- digestion storage tanks, and 8 sludge tanks together with associated chambers and pumping stations.
- Cake pad area.
- Boiler House
- Offices
- Inlet Works
- Site Entrance
- Gas holder, and main power incomer / sub-station building.
- A large area of site access roads and associated drainage.

In addition to the Severn Trent assets, the uncontained sludge spill will leave the site boundaries to the east and will end up in the River Maun the spill will impact Severn Trent Assets on the south-east side.

Spill modelling demonstrates that no housing receives any of the spill contents, with the exception of sludge entering the return Pumping Station and then subsequent flow through the works and outfall to the River Maun.

Figure 2.3 shows the site annotated with principal sludge holding and digestion tanks, significant buildings and the IED area.

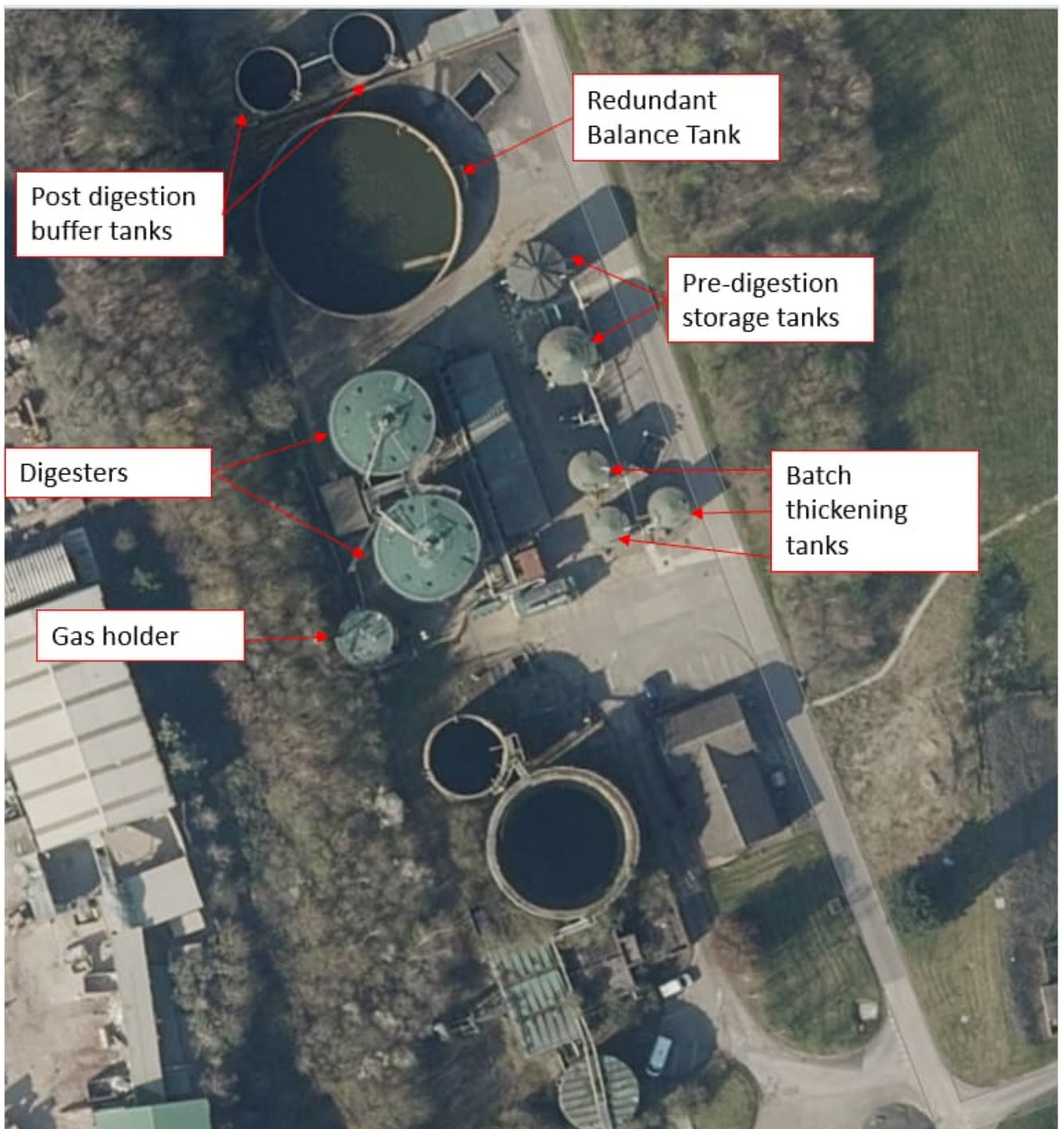


Figure 2.3 Labelled image of Mansfield Sewage Treatment Works

3. Spill through Jetting

3.1 Jetting and surge flows

In addition to analysis of spill maps for the areas, jetting effects should also be considered to understand flow paths for a potential spill. Jetting is the phenomenon whereby the failure of a tank through rupture or corrosion results in the escape of a jet of liquid with sufficient force causing projection out of the tank.

In the instance that tanks lie near the boundary of the containment areas discussed in the chapter, jetting may have implications on where spills accumulate. The surrounding area of the tanks, where the spill could accumulate is the impermeable area, if the sludge assembles outside the bund the sludge will penetrate the permeable area. Both the digesters and containment tanks lie near the area boundaries.

Figure 3.1 below details the method for determining the necessary height and distance of a bund wall from a given tank to prevent jetting.

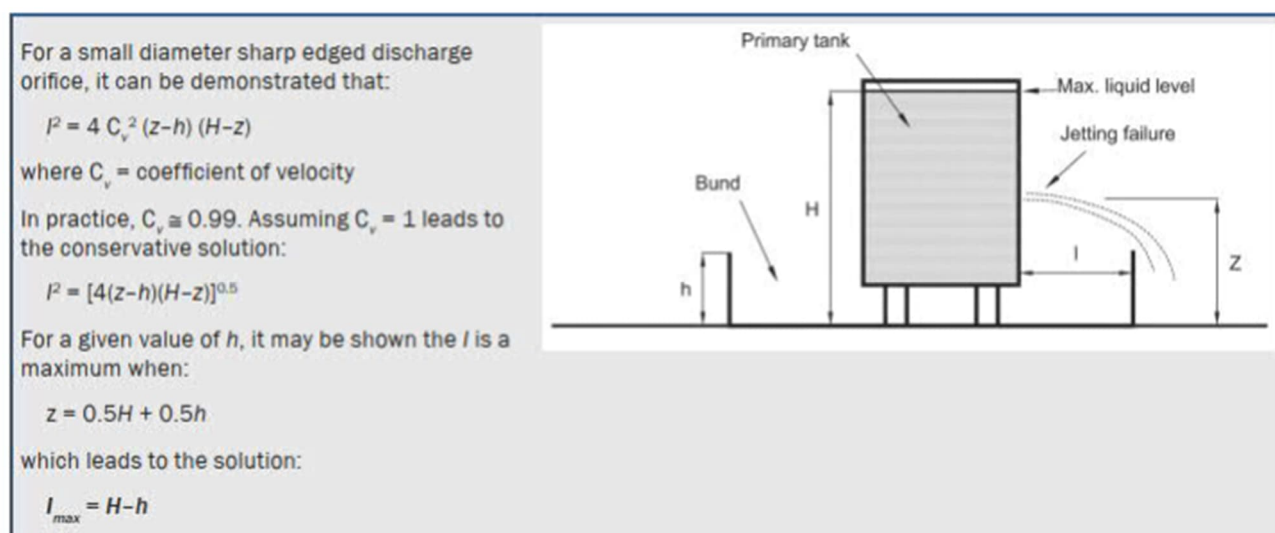


Figure 3.1 Extract for tank jetting consideration, *CIRIA guidance document C736 (Containment systems for the prevention of pollution – Secondary, tertiary, and other measures for industrial and commercial premises, 2014)*

3.2 Surge Flows

Surge effects of a catastrophic failure of the primary storage vessel will be considered in the design of the containment solution. This will consider the distance of the tanks from the bund walls and also the profile of the bund structure.

The surge allowance requirements (in the absence of detailed analysis) for different type of bund/containment structure are detailed in Table 4.7 of CIRIA C736.

- In situ reinforced concrete and blockwork bunds – 250mm surge allowance.
- Secondary containment tanks – 250mm surge allowance.
- Earthwork bunds – 750mm surge allowance.

4. Flooding

According to the UK Government's Flood Map for Planning, Mansfield STW is not within any potential flooding zone (Flood Zone 2) to the east boundary whereas the IED permitted area of Mansfield is in flood Zone 1 as shown in Figure 4.1. The Flood Zone definitions listed in Table 4.1 provide additional detail of the areas of concern, which in the case of Mansfield STW, have less than 1 in 1000 annual probability of river flooding for the IED permitted area. The eastern boundary have an annual probability of river flooding between 1 in 100 and 1 in 1000. Given that the probability of flooding in the area is low, further mitigation measures are not required. 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.

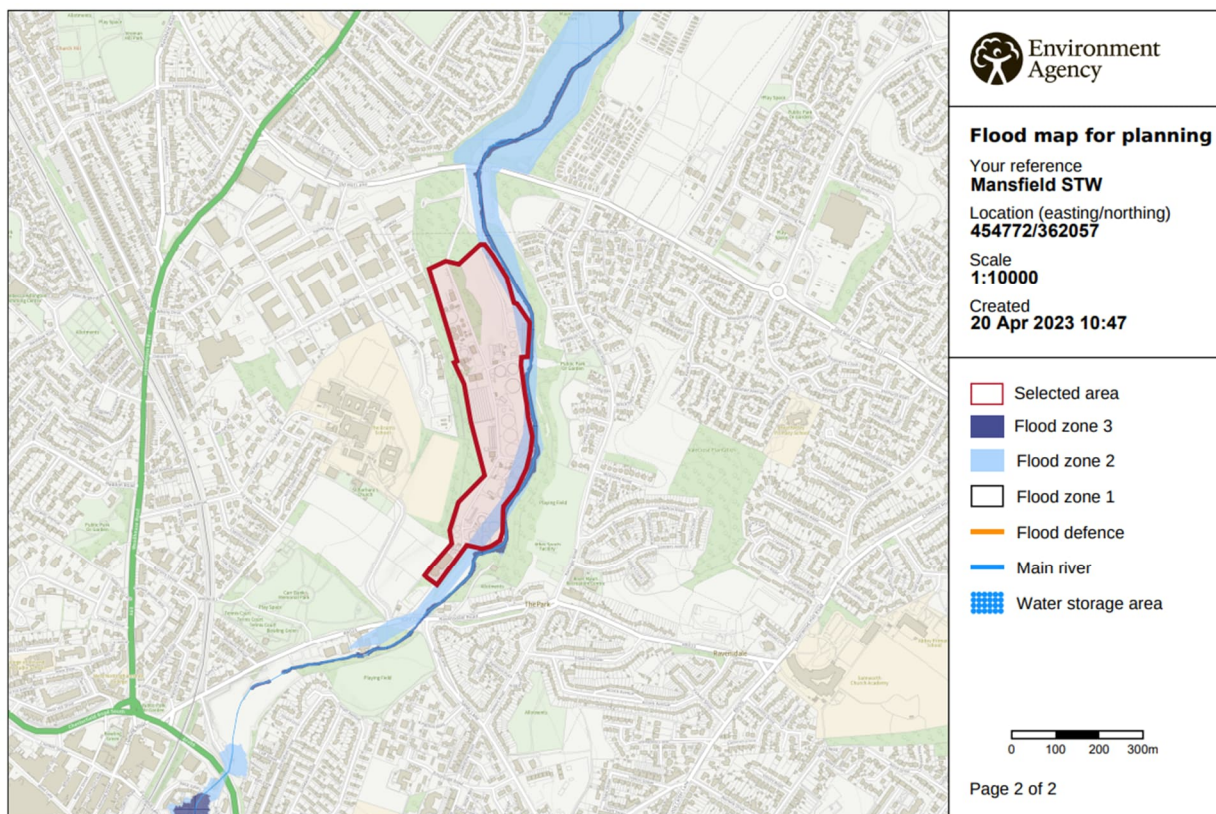


Figure 4.1 Extent of Fluvial flooding due to extreme weather events

Table 4.1 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)

5. Potential Options

There are several options which need to be considered as part of the optioneering to deliver containment at the Sludge Treatment Centre. This optioneering has not yet been carried out and hence some of the proposed options may not be appropriate for the site on a cost, engineering, space or practicality basis.

Some of these options are applicable across a number of sites, while others are site and location specific. It is possible that more than option may be appropriate at a single site, on an asset specific basis, rather than using a single concept at the site.

If any of the incoming power supply and combustion assets are impacted by a potential spill which would impact on their ability to function, Severn Trent will seek to either re-locate or protect them with a specific containment solution

The high-level containment options are tabulated below, followed by an overview of some of the options, with regards to their practicality at the specific site. Some options may not relate to specific tanks, but involve the movement of other assets such as pumps, pipework or the biogas systems to minimise the risk of damage to these in the event of a spill. This may involve relocating assets or raising them above their current level, which may alter available volumes close to tanks impacting upon bunding requirements with regards to location and height.

Table 5.1 Potential Option of containment

High Level Option	Details	Scope	Applicability
Replacement of tanks	Existing tanks replaced by assets which are double skinned or integrally banded.	May apply to all tanks or a subset of tanks	Will depend upon the assessed current asset lifespan. Integral bunding practicality may be influenced by tank volume
Resizing of tanks	Resizing of existing tanks to reduce either the overall number of tanks, or potential volume in a containment failure scenario	May apply to all tanks or a subset of tanks	Will depend upon the assessed current asset lifespan. May increase overall number of tanks on site. May reduce site resilience due to reduced storage volumes
Installation of tank farm bunding	Bunding of tanks on either an individual basis or for a group of closely spaced tanks	May apply to all tanks or a subset of all tanks	May be used on all tanks, however, likely to involve changes to existing pipeworks and pumping requirements, to reduce the requirement for bund penetrations by pipes. May impact on access to individual tanks For some assets, may lead to potential confined space or DSEAR concerns
Use of Tertiary containment	Remote bunding of tanks, which may include use of	May apply to all tanks or a subset of all tanks	Likely to be applicable to all sites. However, may

High Level Option	Details	Scope	Applicability
	existing assets to capture spillages, such as roadways or open space		lead to increased requirement for impermeable surfacing to reduce infiltration in designated spill containment areas. Will depend on existing site infrastructure and may lead to land sterilisation issues
Installation of increased diameter drains and wet wells	Installation of increased diameter drainage locally to capture more of a spillage, linked to wet wells to hold spillages, prior to return to works inlet	May be possible for some tanks but will depending on existing drainage infrastructure.	May be applicable for single or multiple tanks, but the larger the covered area, the greater the potential volume needed to account for rainwater May be limited in use due to ground conditions and subsurface asset locations May have carbon related impacts due to increase in pumping requirements
Construction of sumps	Construction of engineered, sealed, sumps, to increase storage capacity locally in the event of a loss of containment	May be possible for some tanks, but likely to only have potential for a limited storage volume	Likely to be applicable mainly for smaller tanks May be limited in use due to ground conditions and subsurface asset locations May create confined spaces or raise DSEAR concerns.
Tank construction	Change to asset standards to reduce the potential risk of tank failure	May apply to tanks if they are being replaced	Will not remove need for containment, but may alter the failure mode, impacting on the speed of a spillage occurring and volume involved. Potential carbon related impacts
Process changes	Changes to process technology and techniques to reduce the requirement for post digestion storage duration to achieve the required pathogen kill level	Applicable to sites without advanced digestion techniques	May reduce to the overall volume of sludge stored reducing containment requirements. However, may increase dewatering requirements and associated storage volumes May have wider impact on works, such as changes to

High Level Option	Details	Scope	Applicability
			gas yield or requirement for liquor treatment
Movement or raising of ancillary assets	Movement of assets such as pumps, pipework and the biogas system in order to raise it above the potential spill level local to those assets.	All assets which may be impacted by a sludge spillage within the spill mapped area	Applicable to all assets which may be impacted by a loss of containment. May involve raising levels locally through installation of plinths or similar, altering the existing spill mapping. May have carbon related impacts due to increase in pumping requirements
Site closure	Closure of sludge assets, with transfer of sludge to alternative treatment location	Would apply to all permitted assets. Likely to only be applicable at treatment centres with lower throughputs	Will depend upon the assessed current asset lifespan. Requires sufficient capacity at alternative treatment location. Potential for carbon impact due to transfer of sludge

6. Conclusions

This section summarises the findings of the site assessment at Mansfield STW for event of a credible failure of a sludge holding tank.

Sludge spill mapping was undertaken for an event of an uncontained sludge spill which showed that the spill self-contained within the site. According to the model the spill would run into the River Maun within 4 minutes.

A hazard risk assessment was carried out for the site. A site hazard rating was calculated to be high, with the likelihood of a spillage being classed as low. Based on these risks an overall site risk rating was determined to be medium, meaning that class 2 containment is required.

In addition to analysis of spill maps for the areas, jetting effects should also be considered to understand flow paths for a potential spill. In the instance that tanks lie near the boundary of the containment areas, jetting may have implications on where spills accumulate.

The site is in Flood Zone 2 according to the UK Government's Flood Map for Planning, the IED permitted area at Mansfield STW is in Flood Zone 1 and therefore additional measures for flooding are not required.

Digital terrain models generated show the topography of the site and identify low point where sludge spills would collect on site, or flow to River Maun. The Digester and Consolidation Tanks were subsequently identified as areas of interest to perform spill mapping. The uncontained sludge spill modelling shows that a potential digester failure spill will leave the site boundaries and impact on the adjacent commercial / industrial park.

In the instance of a credible failure scenario at Mansfield STW, to prevent sludge from spreading into the adjacent commercial/industrial area, and to prevent sludge possibly entering the ground water, the provision of a secondary containment system should be considered.

Appendix A. ADBA Site Hazard Risk assessment for Mansfield STW

Site Name	Mansfield STW Containment Classification Assessment					
Revision	Date	Description	Author	Checked	Reviewed	Approved
1.0	1/31/2022	Draft	B. Brown			
1.1	4/20/2023	Final Draft	H. Rani	W. Liu	C.Sfynia	

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	Two Digesters, Three Thickening Tanks, Two Predigestion Blending Tanks and Two Post - Digestion Storage Tanks with total capacity of 5290m3.
Additives and site chemicals									
Ferric Chloride	Liquid	1	IVC	IVC	Not flammable	No	Low	L	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
							Sources Overall Hazard Rating	H	Justification: Digesters, thickening tanks, predigestion blending tanks and post digestion storage 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 River Maun within 4 minutes.
If any of the site inventory has a runoff time of a few hours....	L	Not Applicable
If any of the site inventory has a runoff time of a few days...	L	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 West to East therefore the site is raised above River Maun.
Chalk	L	According to the British Geological Survey the site is not in the chalk aquifer zone
Fractured chalk	L	Not applicable
Principal Aquifer	H	Principal Aquifer is present at the site
Groundwater protection zone 1	H	Groundwater Vulnerability is 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: it is unclear where site drainage goes to Mansfield Bath Lane STW Treatment Works Layout Plan Drawing Number DT7173/ Mansfield STW/001. Assume high risk in lack of information.
Climatic conditions		
Annual rainfall < 1000 mm	M	Annual rainfall within 715.57 mm - 809.89 mm
Annual rainfall > 1000 mm	L	Not Applicable
Snow accumulation is possible	M	Yes
Fire Fighting Water		
Inflammable materials normally present on site in large quantities?	L	Not Present
Location		
Site is in a flood plain	M	The Mansfield STW site is in Flood Zone 2 whereas the IED permitted area is in Flood Zone 1.
Site is at bottom of a hill	H	The site inclines from West to East, towards the river
Site is connected to a sewage treatment works	H	Area IED permitted is connected to sewage treatment works
	Site Considerations Overall Rating	H
		Justification: IED permitted area is connected to sewage treatment works.
	Pathway Overall Hazard Rating	H
		Justification: The site inclines from West to East, towards the river

Receptors	Within	units					Environmental hazard rating	Notes	
Watercourses and bodies									
Rivers above potable water supplies	100	m					H	The River Maun is within 30m from the east side of the IED permit Area.	
Aquifers used for public supply	150	m					H	Principal Aquifer is present at the site	
High quality waters	1000	m					L	Not found	
Agricultural abstraction points	50	m					L	No Agricultural abstraction identified via desktop analysis	
High value ecosystems	1000	m					H	SSSI and LNR sites are near the IED permitted area	
Recreational waters	50	m					L	Not applicable	
Small treatment works	50	m					H	A B Waste disposal is within 50m from the Sewage Treatment site	
None of the above							L	Not applicable	
							Water Overall Rating	H	Justification: The River Maun is within 30m
Habitation									
Dwelling	250	m					H	Housing is within 240m from the site	
Workplace	250	m					H	Workplace is within 170m of the IED site. Secondary School The Brunts Academy is within 260m.	
None of the above							L	Not applicable	
							Habitation Overall Rating	H	Justification: There is an industrial estate on the west boundary of the site
Other									
SSSI/SPA/SAC	1000	m					H	Ravensdale LNR east 60m; Maun Valley Park LNR east 560m; Oak Tree Heath LNR South-East 3300m; Quarry Lane LNR South 2800m; Oakham LNR South 3500m ; The Hermitage LNR South 4000m; Pleasley Vale LNR North- East 3330m ; Pleasley Vale Railway SSSI North-East 4150m.	
RAMSAR Site	1000	m					L	Not present	
None of the above							L	Not applicable	
							Other Overall Rating	H	Justification: SSSI and LNR sites are present nearby the site.
							Receptors Overall Hazard Rating	H	Justification: SSSI and LNR sites are present nearby 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
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

Low

**Site Overall
Likelihood**

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