

# Technical Note

**Project title** Yorkshire Water IED  
**Job number** 293261  
**File reference** IED\_CLD-ARP-TRT-ZZ-TN-Z-0001  
**cc**  
**Prepared by** Andy Pittam  
**Date** 05 April 2024  
**Subject** Caldervale Flow Modelling - Supporting Note

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## 1. Introduction

A detailed assessment using TufLOW© modelling software has been undertaken to simulate potential spill scenarios at the Caldervale site. These model results have then been assessed to determine appropriate defence elevations for the proposed bunds, resurfacing and extents of the containment design.

This technical note outlines the modelling process that has been undertaken, any key assumptions, the model results and how these have been used to inform the secondary containment design at Caldervale. Outputs from the TufLOW modelling are included in Appendix A.

## 2. Modelling Process

A TUFLOW model was produced to simulate breaches in each of the tanks. Breaches were applied in turn, at the following tanks:

| Spill Model Reference Number | Primary Containment Tanks      |
|------------------------------|--------------------------------|
| 1                            | Sludge Reception Tank          |
| 2                            | Thickener Feed Tank 1          |
| 3                            | Thickener Feed Tank 2          |
| 4                            | SAS Tank                       |
| 5                            | Digester Feed Tank 2           |
| 6                            | Digester Feed Tank 1           |
| 7                            | Anaerobic Digester 1           |
| 8                            | Anaerobic Digester 2           |
| 9                            | Digested Sludge Holding Tank 1 |
| 10                           | Digested Sludge Holding Tank 2 |
| 11                           | Digested Sludge Holding Tank 3 |

This was achieved by calculating a maximum water level within each tank based on known above-ground capacities and dimensions of the tanks. This level was applied spatially at the location of the

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tank as an Initial Water Level (IWL) within the software. When the model simulation commences, this level spills onto an applied LiDAR level obtained from DEFRA, following the flow path that the contents of the tank would take should a breach occur.

Additionally, known rainfall depths for a 1 in 10-year return period (10% AEP) was applied simultaneously to each spill scenario, to give an indication of the combined depths of rainfall and the contents of each breached tank. Rainfall is based on the sum of a 1 in 10-year 24-hour and 8-day storm event, as per the Ciria C736 guidance.

The outputs of this modelling exercise will be used to inform the design of suitable works to contain the flow, be it bunds, walls, kerbs or similar, to be determined on a case-by-case basis.

### 3. Modelling Assumptions

A limitation of the below method is that the modelling assumes the contents of the tanks have the same physical properties of water, and will propagate across the site in the same manner as water would. This results in a worse-case scenario for the initial surge maximum depths that if the spills were to be modelled using effluent. However, the impact on the settled results is negligible, as consistent rainfall would mix with the effluent, resulting in similar material properties to water.

Additionally, in using IWL's to simulate the breach, it assumes all sides of the tanks instantaneously burst. Therefore, maximum spill depths around the tanks immediately after breach are excessively conservative.

### 4. Results

Two sets of results have been produced as part of the TufLOW modelling and included within Appendix A:

1. **The maximum spill depths** – these plans show the maximum spill depths recorded within the modelled area, across the full duration of the simulated storm and spill, for each tank. This data shows the dynamic impacts of an instantaneous spill.
2. **The final spill depths** – these plans show the spill depths of at the end of the spill event, i.e. on the completion of the simulated storm and once the spill inventory has dissipated and settled within the contained area to the final depths.

Typically, the final spill depths equate to the maximum spill depths across the site. Where there are instances that the maximum spill depths are greater than the final spill depth, this highlights a risk of surge effects from the spill influencing the containment depths.

In designing the containment defences, both sets of results have been used with the following approach:

- Minimum defence heights across the site have been set based on the final spill depths.
- Where the final spill depth is greater than 0m above existing ground level and the maximum spill depths are greater than the final spill depths, a surge freeboard has been added to the minimum defence heights.

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- Surge freeboard has been based on the Ciria C736 guidance, see (below).

| Type of structure (see Part 3)                         | Allowance |
|--|-----------|
| <i>In situ</i> reinforced concrete and blockwork bunds | 250 mm    |
| Secondary containment tanks                            | 250 mm    |
| Earthwork bunds  | 750 mm    |

**Figure 1 Surge Allowance Extract from CIRIA 736**

- Where the maximum spill depths are equal to the final spill depths, freeboard has not been included. This is because the TufLOW modelling has not identified a risk of surge impacts at these locations.




The results show part of the spill collecting in an area east of the thickener feed tanks. This is because the LiDAR data shows this as a low spot. However, visual site inspections show that this is not the case and that the ground level is equal to or higher than the ground around it. Consequently, it is assumed that no spill occurs in this area and that this is a result of incorrect LiDAR data.

A summary plan of the minimum defence height requirements, based on the above methodology, is included in Appendix B.

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## DOCUMENT CHECKING

|           | Prepared by   | Checked by  | Approved by   |
|-----------|---|---|---|
| Name      | Andy Pittam   | Andy Pittam   | Niall Bourke  |
| Signature |  |  |  |

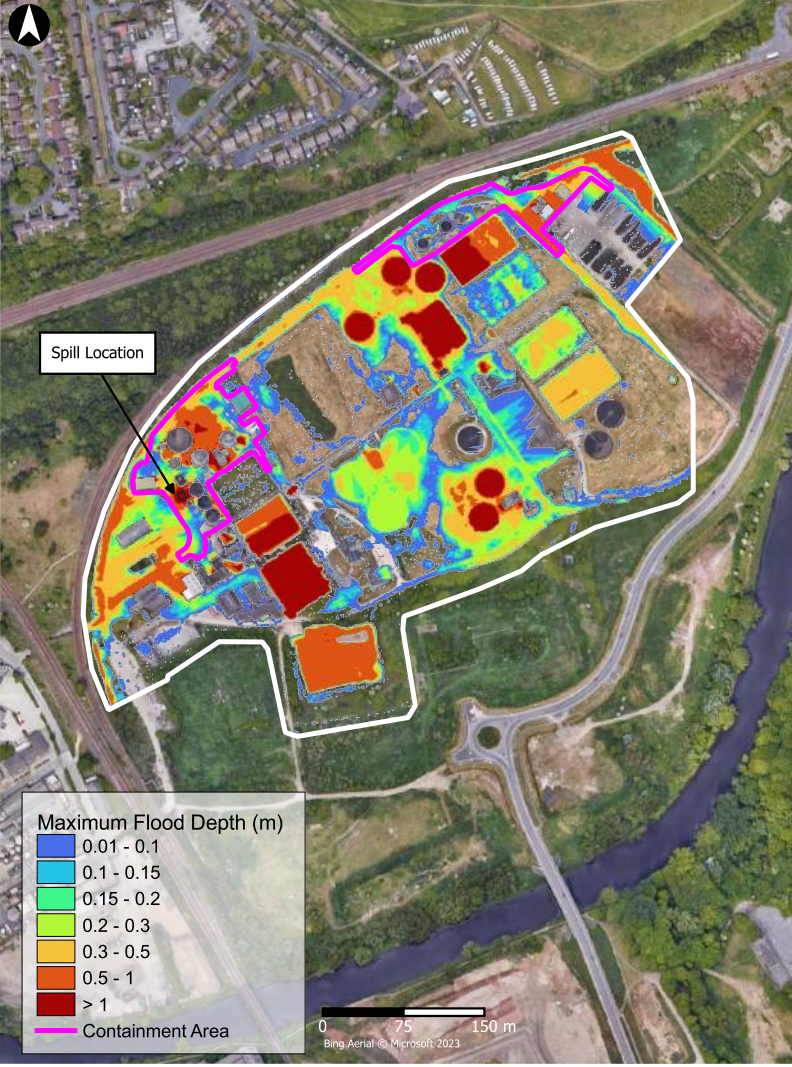
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## Appendix A – Tuflow Modelling Results

# Tank 1 Spill Results

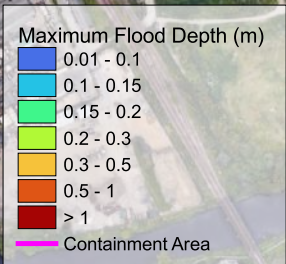


# Tank 2 Spill Results

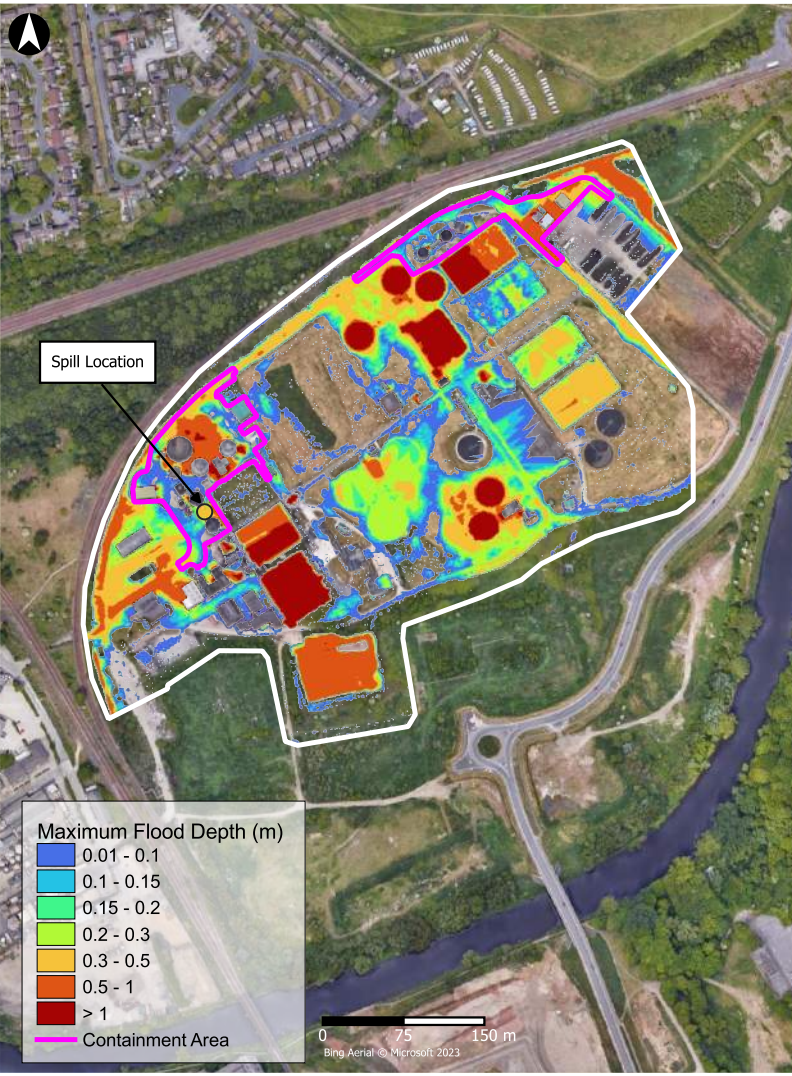
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Spill Location



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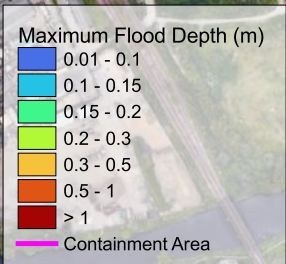


# Tank 3 Spill Results

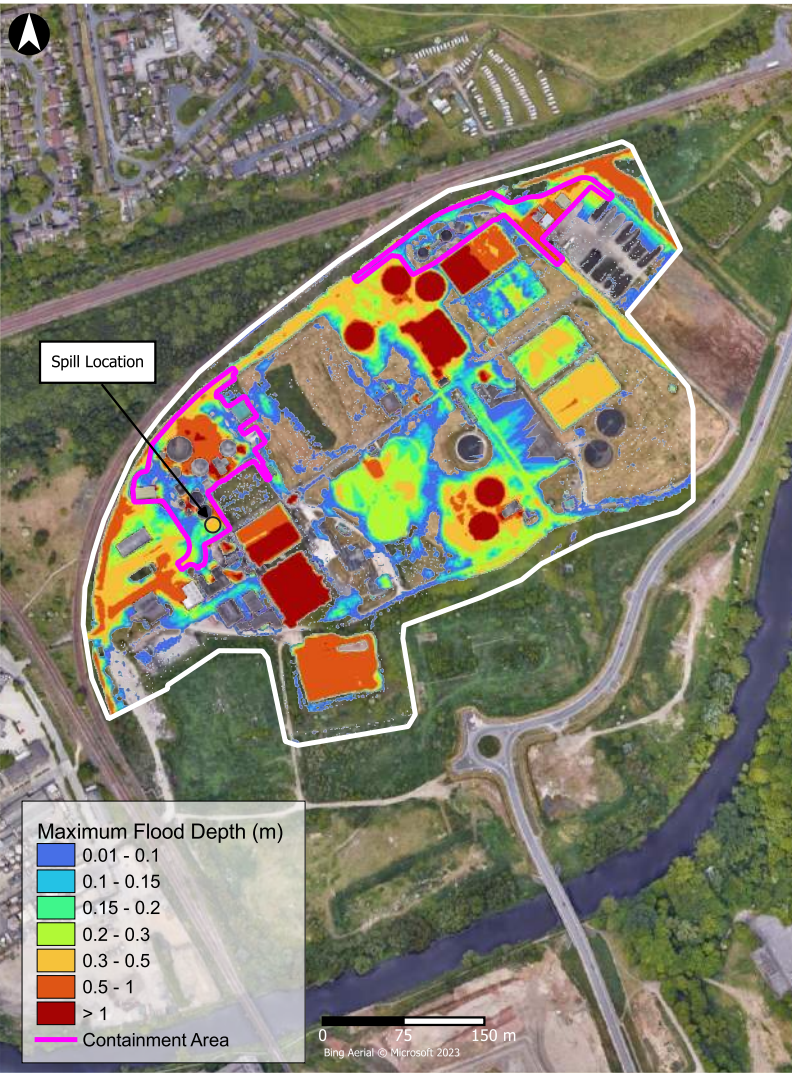
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Spill Location



Bing Aerial © Microsoft 2023



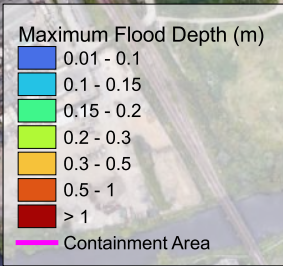


# Tank 4 Spill Results

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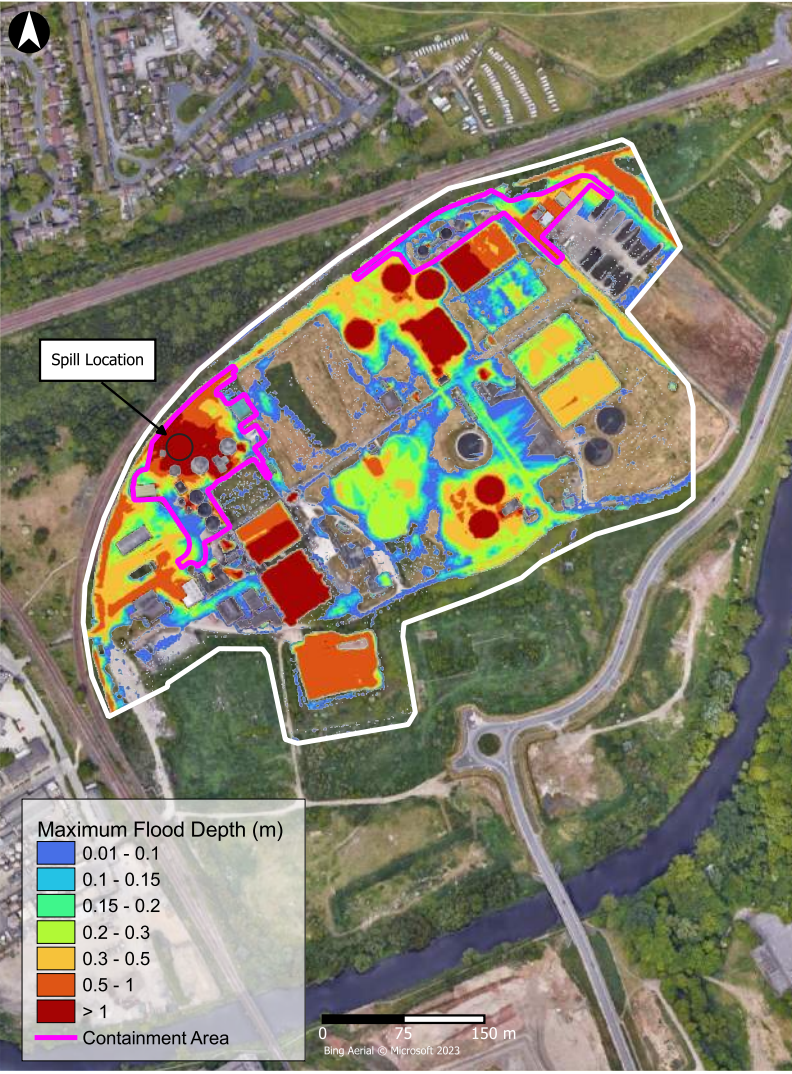


Spill Location



0 75 150 m

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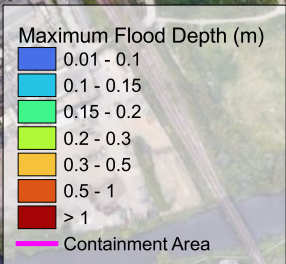


# Tank 5 Spill Results

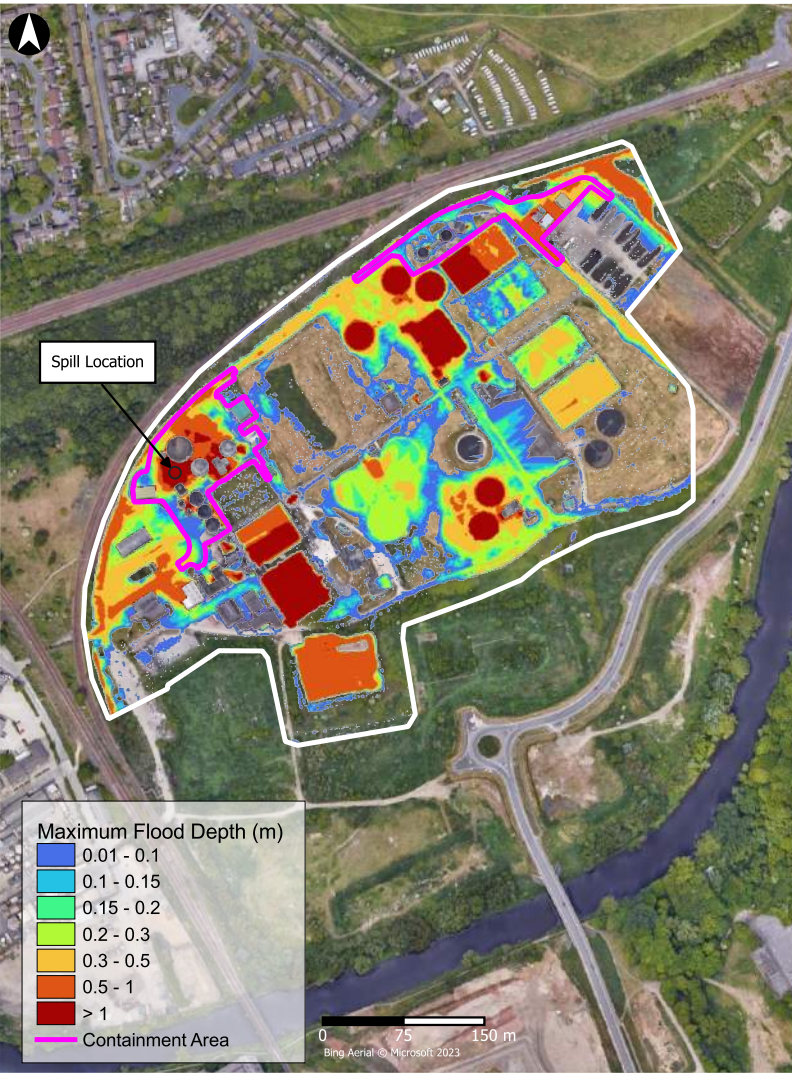
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Spill Location



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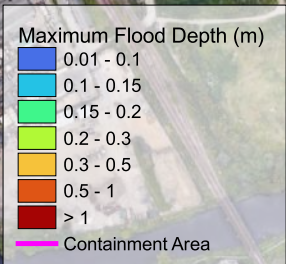


# Tank 6 Spill Results

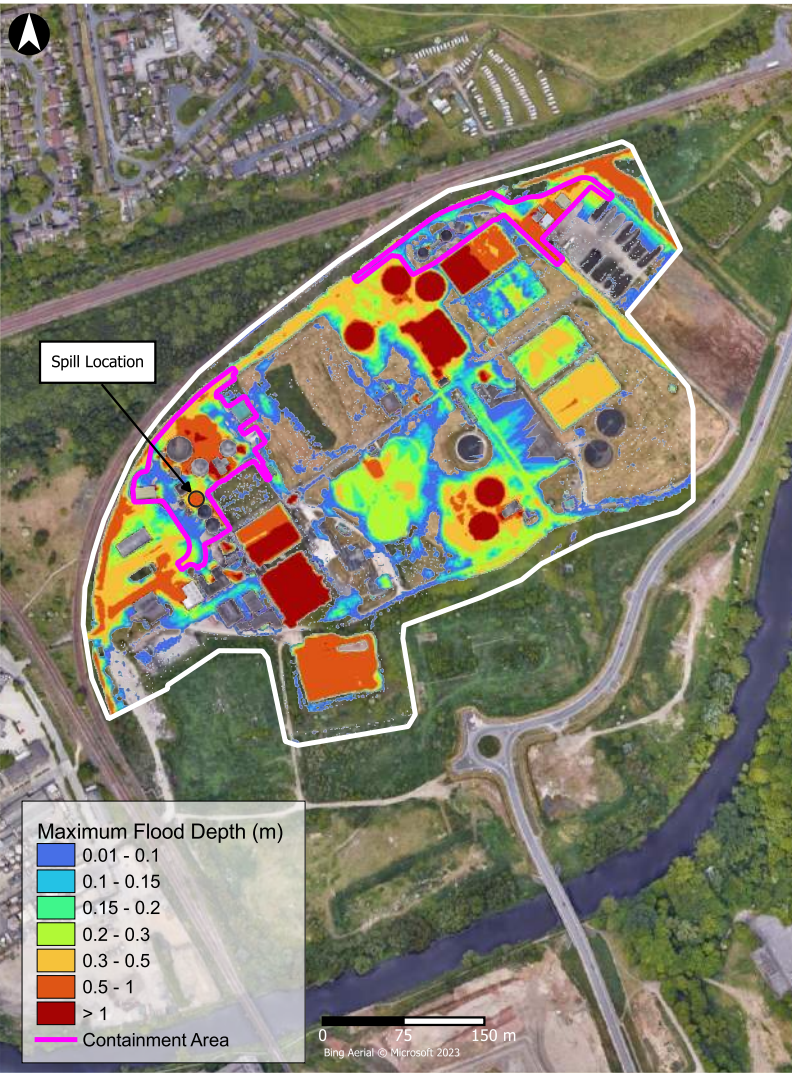
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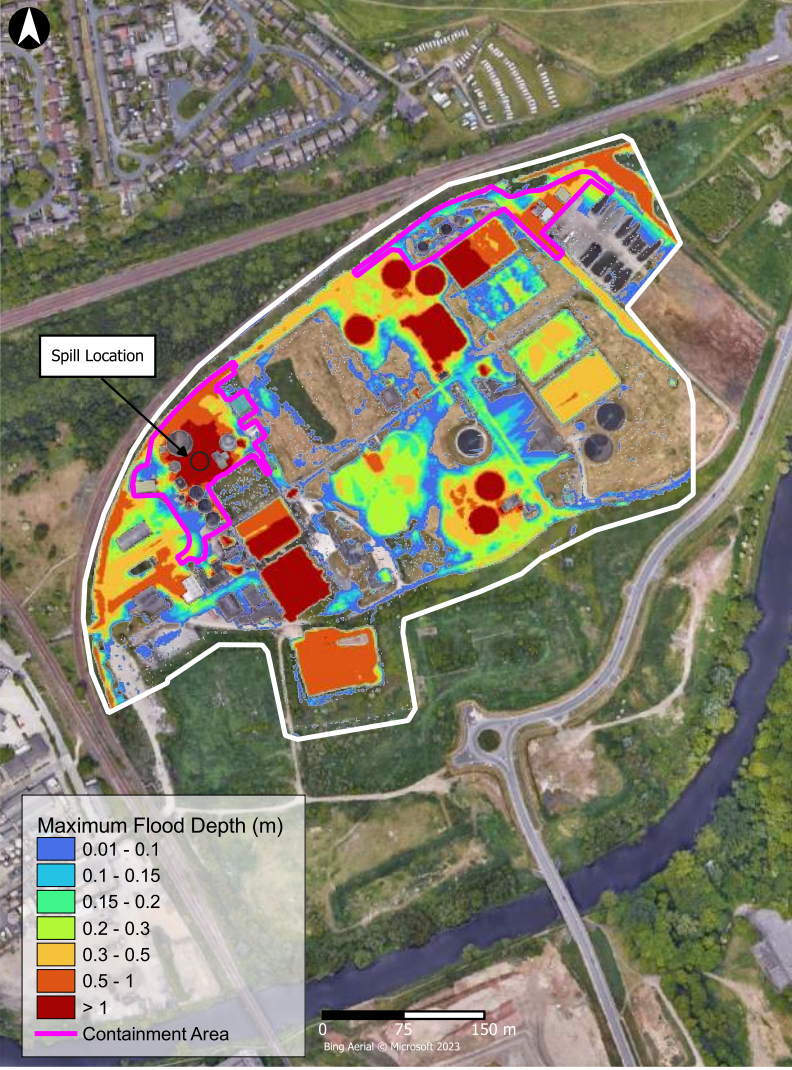
Spill Location



Bing Aerial © Microsoft 2023



# Tank 7 Spill Results



Spill Location

| Maximum Flood Depth (m) |                  |
|-------------------------|------------------|
| Blue                    | 0.01 - 0.1       |
| Cyan                    | 0.1 - 0.15       |
| Green                   | 0.15 - 0.2       |
| Light Green             | 0.2 - 0.3        |
| Yellow                  | 0.3 - 0.5        |
| Orange                  | 0.5 - 1          |
| Red                     | > 1              |
| Pink line               | Containment Area |

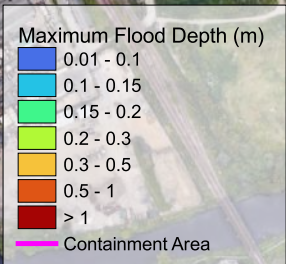
0 75 150 m  
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# Tank 8 Spill Results

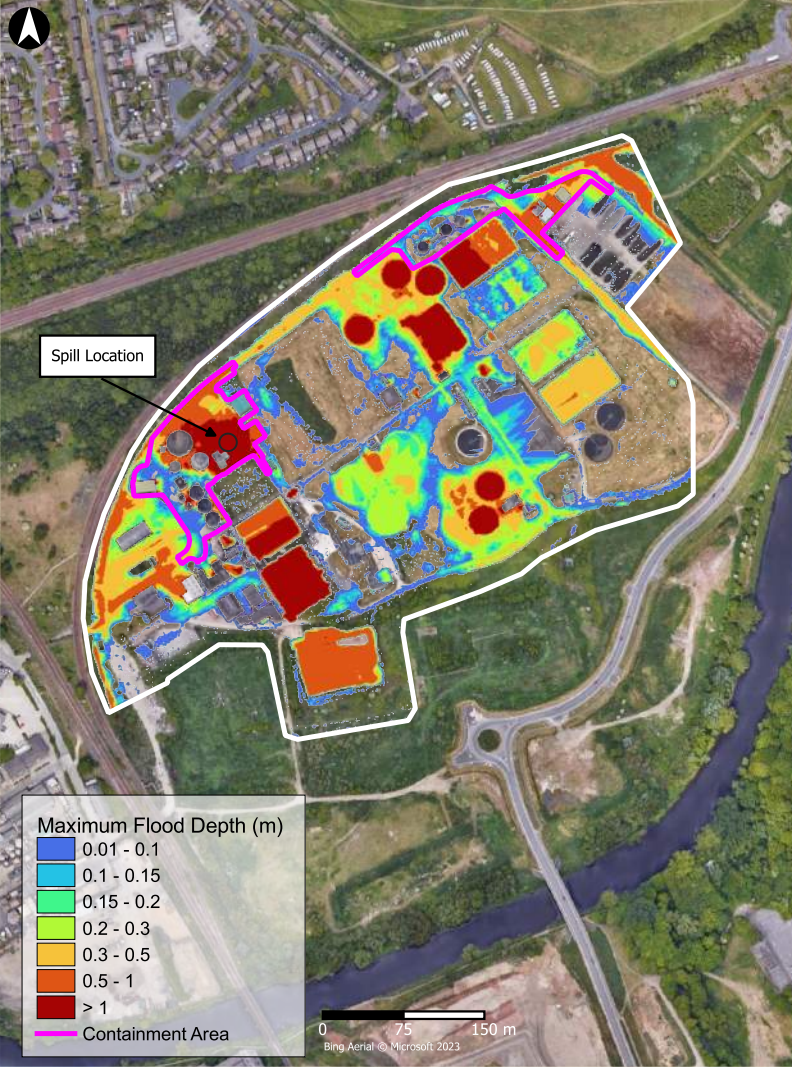
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Spill Location



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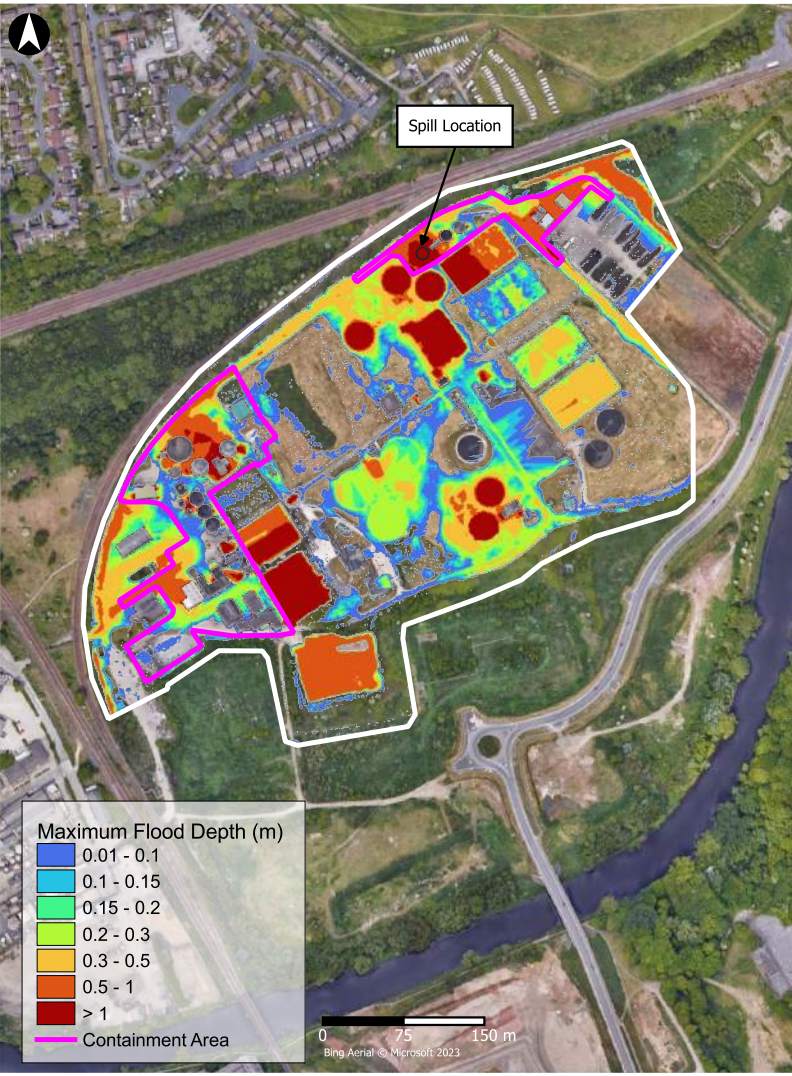


# Tank 9 Spill Results

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Spill Location



Maximum Flood Depth (m)

- 0.01 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- > 1

Containment Area

0 75 150 m

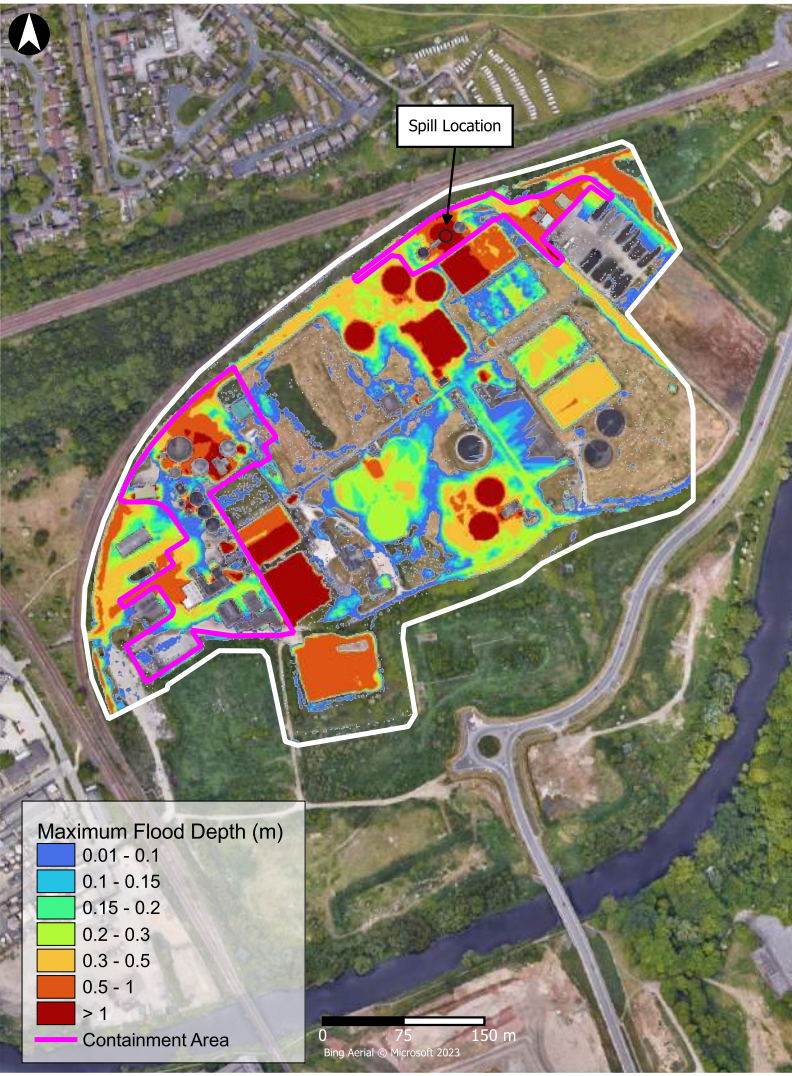
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# Tank 10 Spill Results

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Spill Location



Maximum Flood Depth (m)

- 0.01 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- > 1
- Containment Area

0 75 150 m

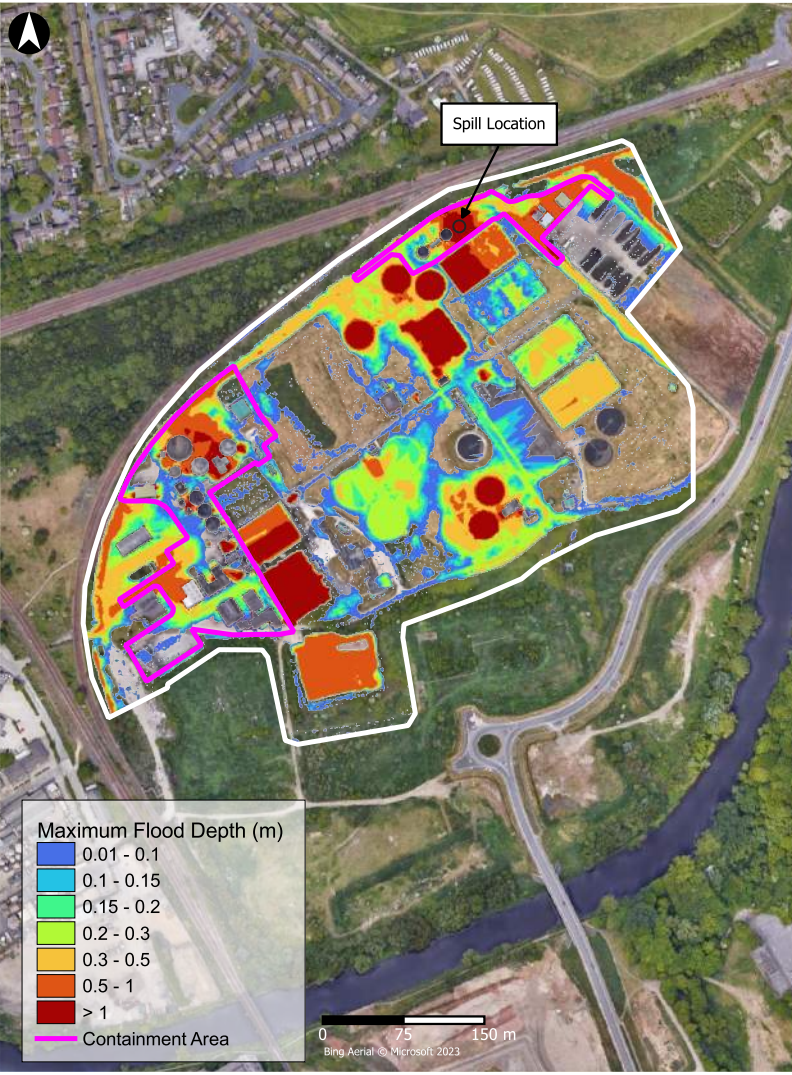
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# Tank 11 Spill Results

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Spill Location



Maximum Flood Depth (m)

- 0.01 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- > 1
- Containment Area

0 75 150 m

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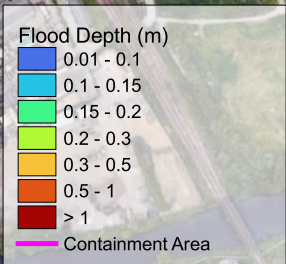


# Tank 1 Spill Results - Final Depths

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Spill Location



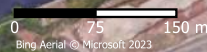
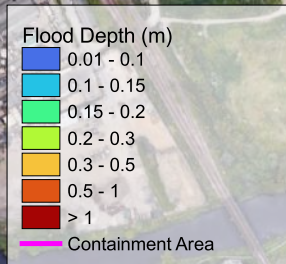
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# Tank 2 Spill Results - Final Depths

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Spill Location

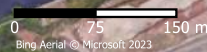
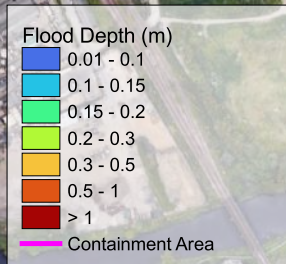


# Tank 3 Spill Results - Final Depths

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Spill Location

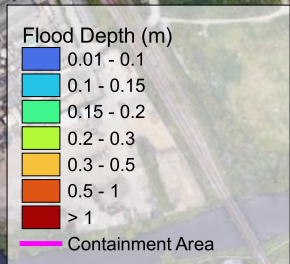


# Tank 4 Spill Results - Final Depths

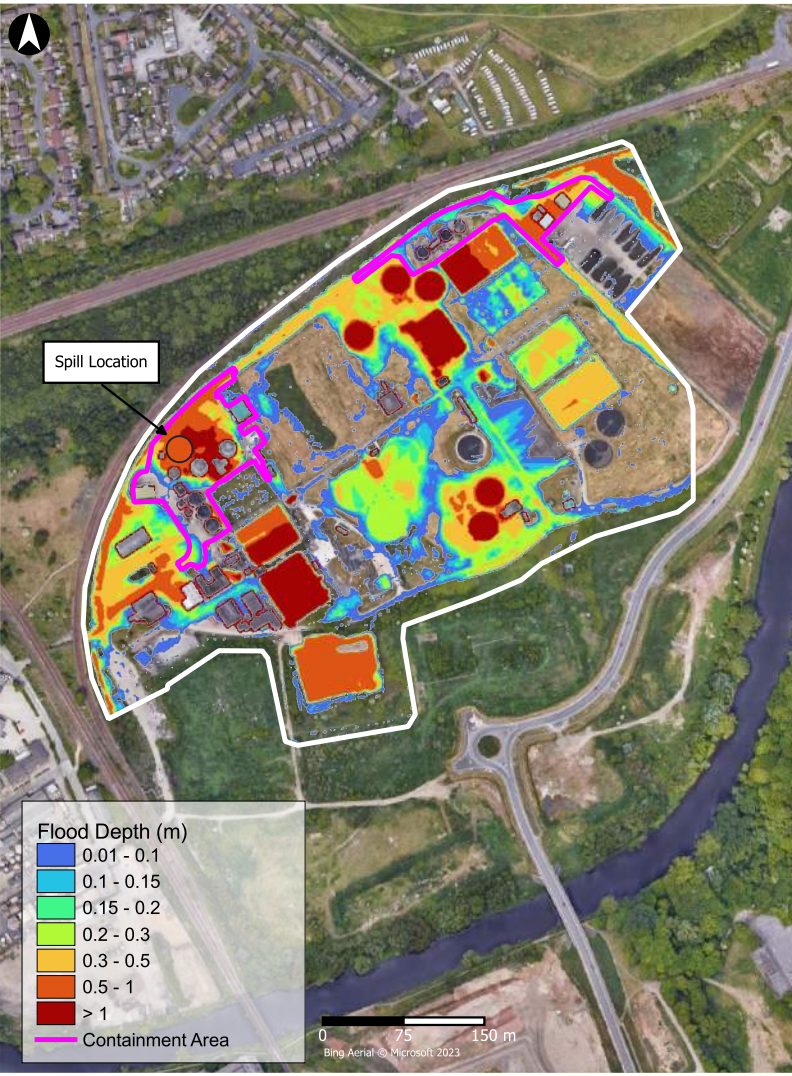
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Spill Location

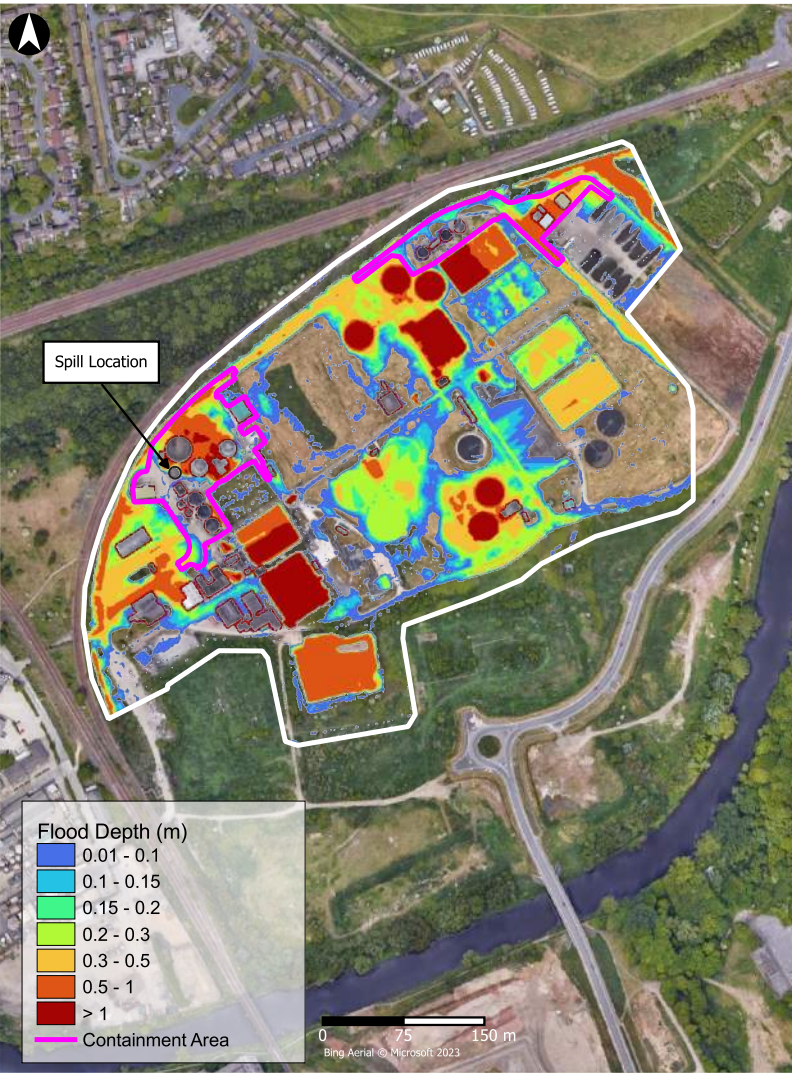


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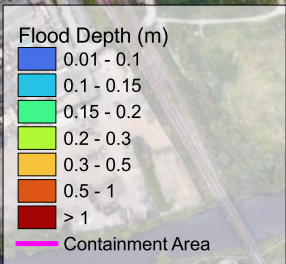


# Tank 5 Spill Results - Final Depths

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Spill Location



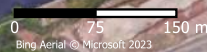
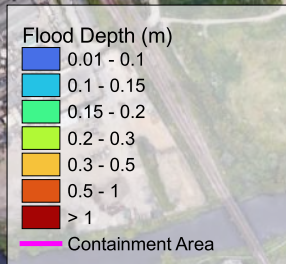
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# Tank 6 Spill Results - Final Depths

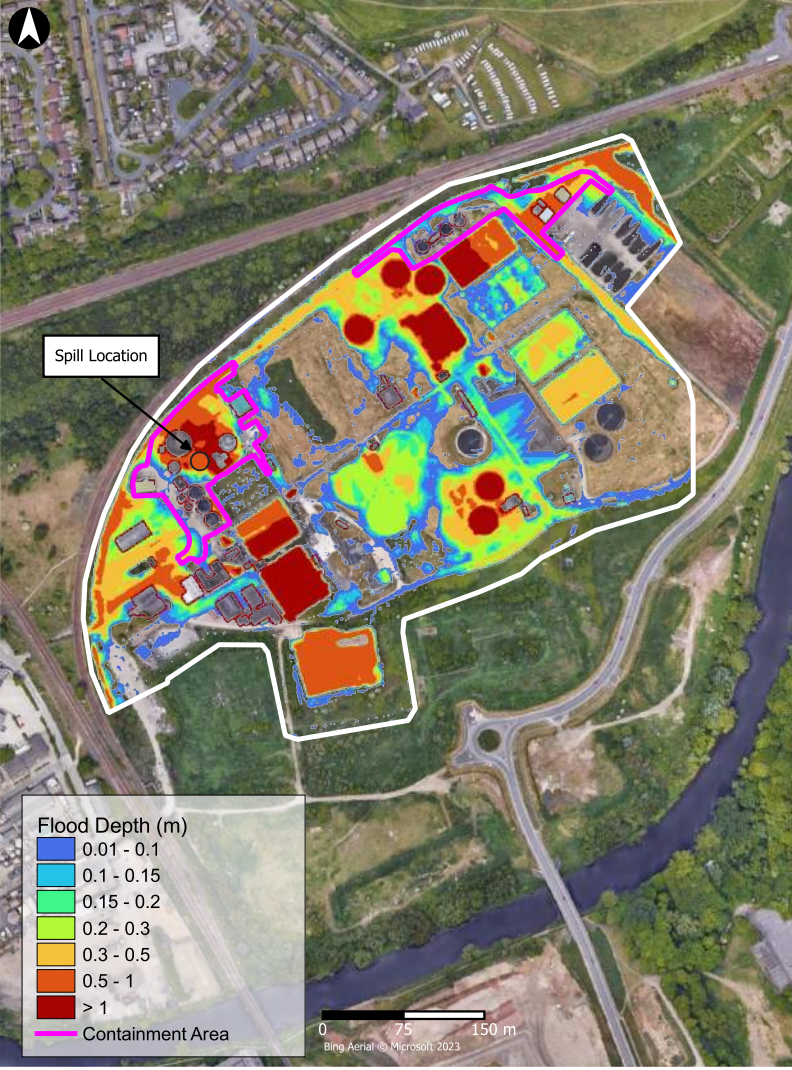
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Spill Location



# Tank 7 Spill Results - Final Depths

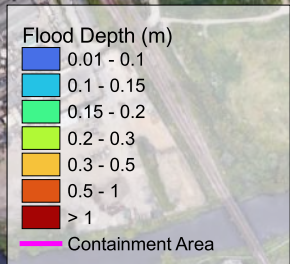


# Tank 8 Spill Results - Final Depths

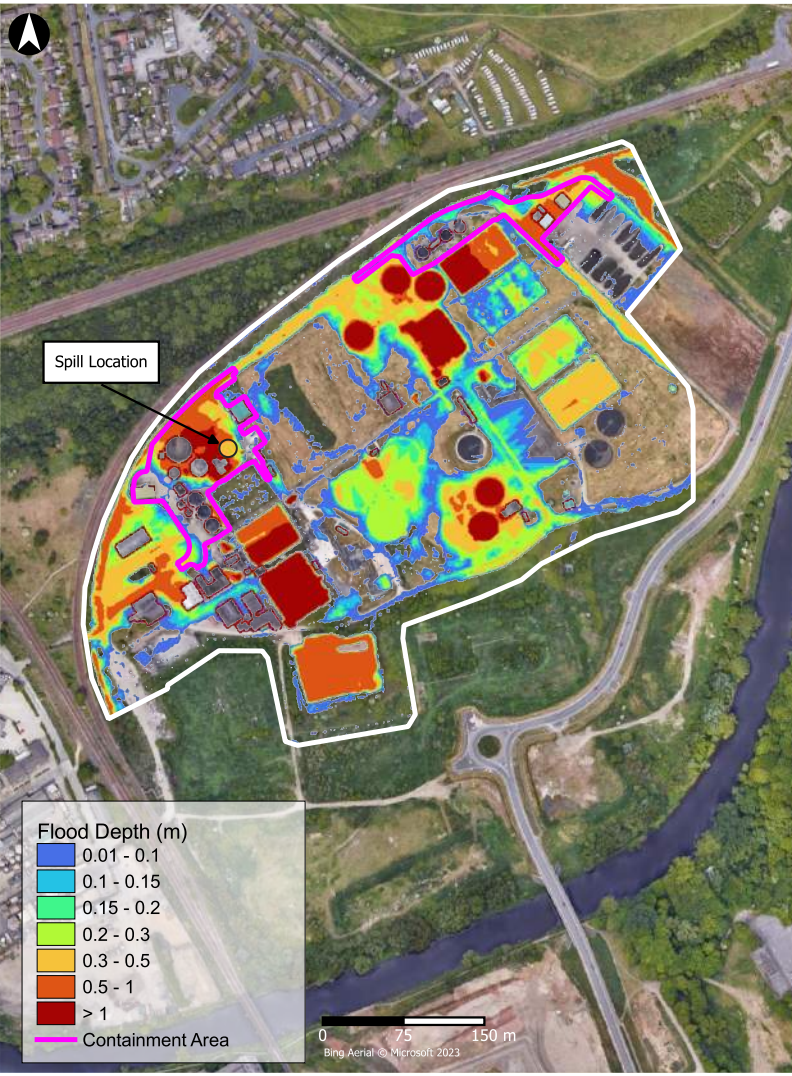
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Spill Location



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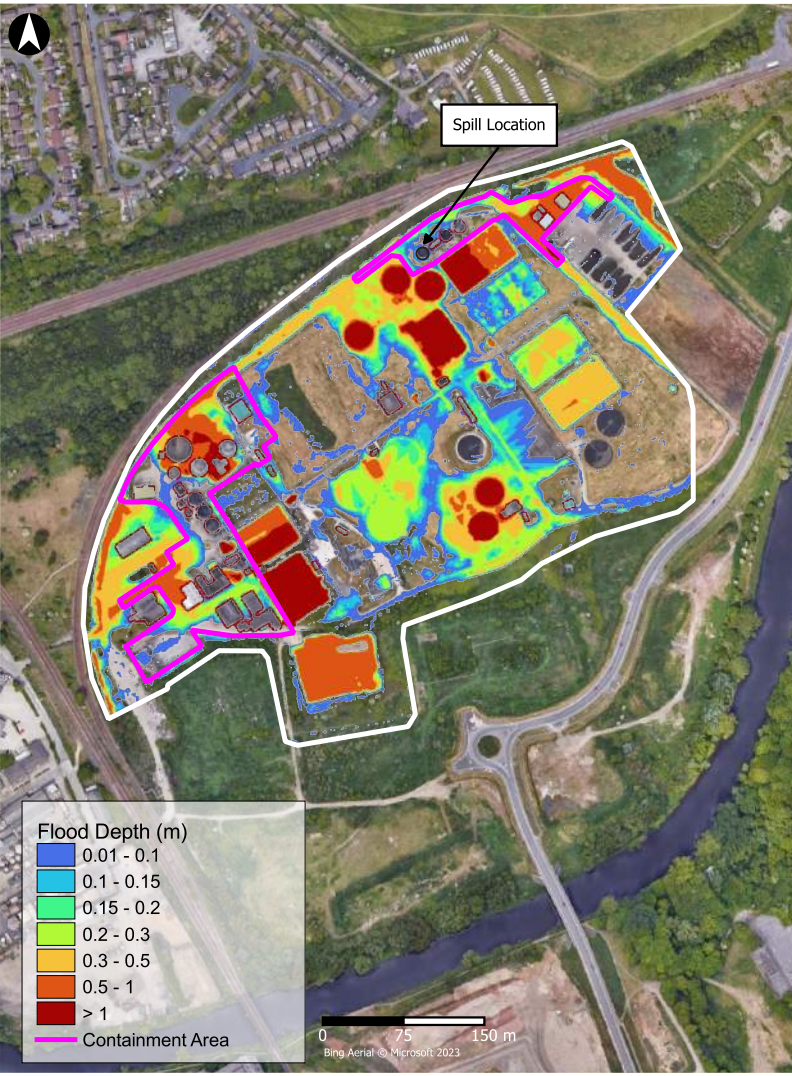


# Tank 9 Spill Results - Final Depths

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Spill Location



## Flood Depth (m)

- 0.01 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- > 1
- Containment Area



Bing Aerial © Microsoft 2023

# Tank 10 Spill Results - Final Depths

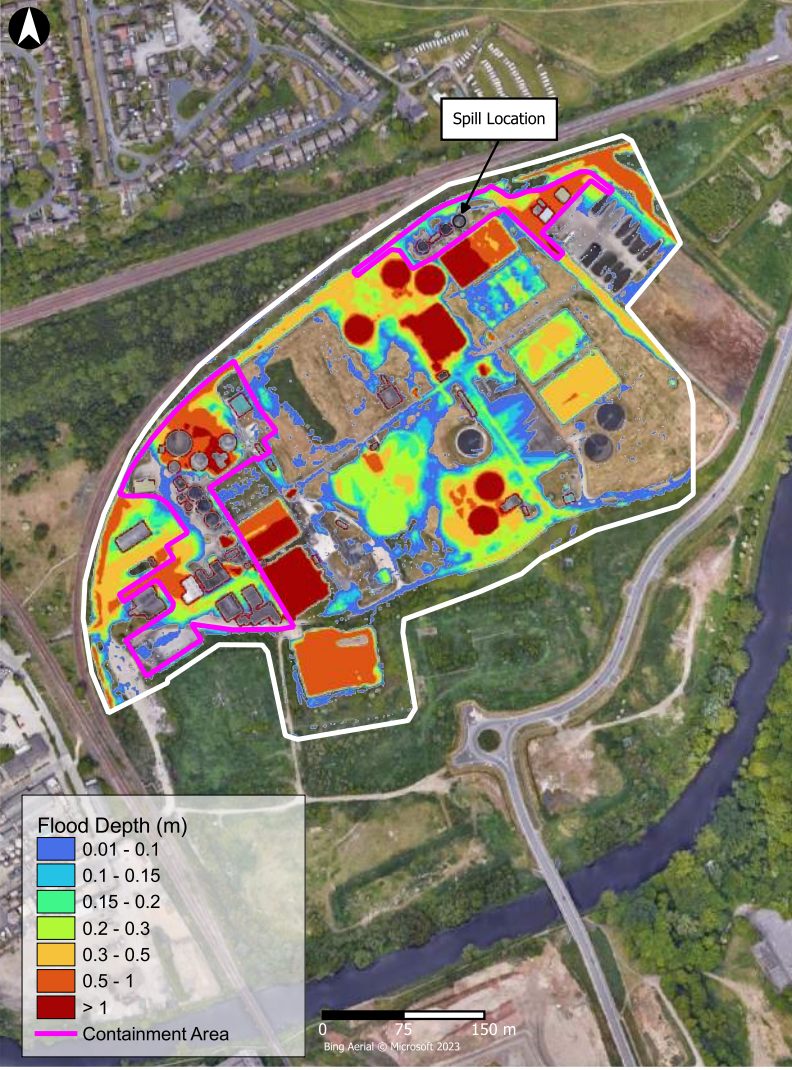
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Spill Location



# Tank 11 Spill Results - Final Depths



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## Appendix B – Defence Design Markup based on Tuflow Modelling

