



SWL24-380-01-DDR-02

Point of Ayr Gas Terminal,

Liverpool Bay:



Dewatering Design Report

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P02	20.11.2025	Updated as per client's comments	James Pettengell	Mark Pickett

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- Appendix 1:** Pumping Test Analysis Graphs
- Appendix 1:** Dewatering Engineering Calculations
- Appendix 2:** Indicative Dewatering Well Designs

1. Introduction and Scope of this Report

This Dewatering Design Report has been prepared by Stuart Wells Limited (Stuart Wells) at the instruction of Saipem Ltd (the Client). This report summarises a review of the temporary works groundwater control requirements for the proposed works at the Point of Ayr Gas Terminal, Liverpool Bay, Talacre, Holywell CH8 9RD (the Site). Following this introduction, the report is structured as follows:

- Section 2: Information reviewed;
- Section 3: Structures for which groundwater control is required;
- Section 4: Conceptual Ground Model;
- Section 5: Groundwater control requirements;
- Section 6: Indicative Groundwater Control Designs;
- Section 7: Risk and uncertainty;
- Section 8: Regulatory considerations;
- Section 9: Summary and recommendations; and
- Section 10: References.

1.1. Exclusions from the Scope of this Report

The following aspects are not addressed in detail in the current report (although they may be highlighted briefly where relevant to groundwater control matters):

- i. Geotechnical assessment of the stability of any excavations;
- ii. Any permanent works groundwater control requirements or impacts;
- iii. Control of surface water (e.g., from precipitation, construction processes and run-off from adjacent areas);
- iv. Assessment of the potential for dewatering related settlement;
- v. Monitoring specifically related to environmental impacts; and
- vi. Assessment of external impacts from temporary works groundwater control.

1.2. Relevant Standards

This report has been carried out in accordance with UK good practice for dewatering projects, based on Eurocode 7 (BS EN 1997-1: 2004) and CIRIA Report C750 Groundwater Control: Design and Practice, 2nd Edition (Preene *et al.*, 2016).

2. Information Reviewed

The principal information used in this report is summarised below. Public domain information used is given in the reference section at the end of this report.

Ground Investigation Information

- Fugro-McCelland Limited (1992) Geotechnical Investigation, Hamilton Field Landfill and Terminal Facilities Volume 1: Factual Data, 91/2126-1 Rev 03, February 1992.
- Soil Engineering (2025) Report on a Ground Investigation for LBA CSS Project – WP3 Point of Ayr Gas Plant, TA8701 Rev 02, April 2025.
- Stuart Wells Limited (2025) Point of Ayr Gas Terminal, Liverpool Bay Pumping Test Factual Report, SWL24-380-01-PT-02, September 2025.

Construction Information

- Saipem (2025) Point of Ayr Gas Plant, Overall Plot Plan (Point of Ayr) 102700TDG60005 Rev 02, August 2025.

3. Structures for which Groundwater Control is Required

3.1. Site Location

The Site is located to the west of the Dee Estuary and south of the Irish Sea. The land surrounding the Site is predominantly agricultural, with a holiday park situated to the north of the Site. The Site location is shown in Figure 1.



Figure 1: Site Location Map.

3.2. Proposed Excavations

A series of excavations are required to be made as part of the demolition works at the Site. The proposed excavations are shown in Figure 2. The cooling tower, pig receiver and gas inlet facility are relatively small structures which are close together; these areas have been grouped together and referred to as the 'Inlet and Metering Unit' in Figure 2, however, these areas are shown in more detail in Figure 10 in Section 6.2 of this report. Approximate excavation dimensions are given in Table 1.

Table 1: Excavations summary.

Proposed Excavations	Excavation length	Excavation width	Excavation Formation Level	
	(m)*	(m)*	(mAOD)**	(mbgl)
Cooling tower	21	17	2.25	2.25
Pig receiver	11	5	2.0	2.5
Gas inlet facility	33	32	2.0	2.5
Knock Out drums	70	9	1.5	3.0
Propane Tank	24	9	1.5	3.0
Compression station***	47	40	1.5	3.0
Oily water collection tank	29	11	1.5	3.0

Notes: *Excavation footprints not given; dimensions measured from (Saipem, 2025).

**Excavation formation given in mbgl only; assumed ground level of 4.5 mAOD utilised.

***Excavation split into 3 equally sized areas; dimensions given are per area

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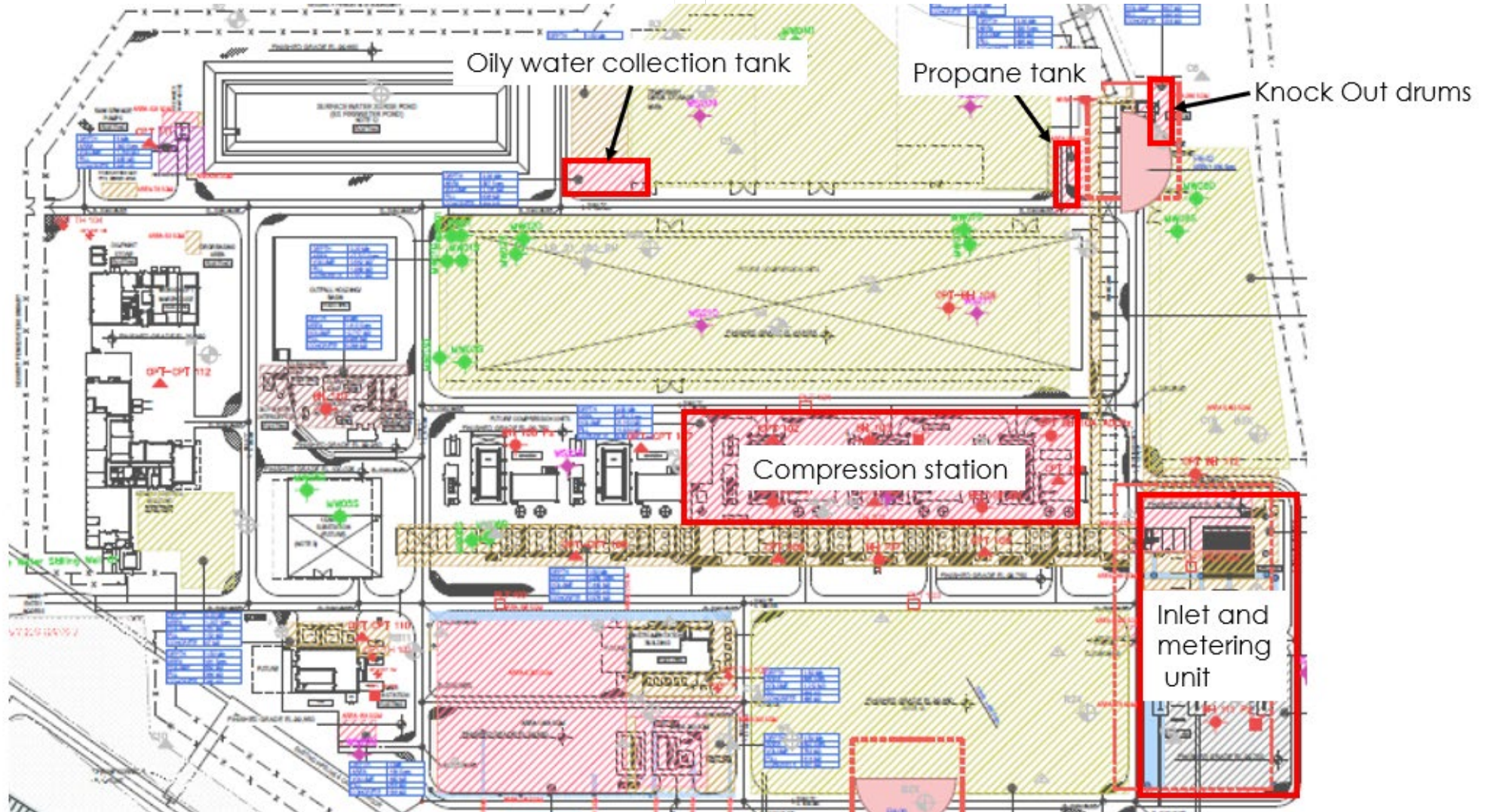


Figure 2: Earthworks Layout plan (after Saipem, 2025).

4. Conceptual Ground Model

The ground conditions have been assessed based on public domain British Geological Survey (BGS, 2025) mapping and project-specific ground investigation data listed in Section 2.

4.1. Ground and Groundwater Conditions

4.1.1. Mapped Geology

Public domain mapping by the British Geological Survey (BGS, 2025) indicate that superficial deposits at the Site are Tidal Flat Deposits comprising clay, silt and sand. BGS mapping indicates the bedrock geology at the Site comprises the Pennine Lower Coal Measures Formation (mudstone, siltstone and sandstone). Superficial and bedrock geology maps are presented in Figures 3 and 4, respectively.

4.1.2. Site Investigation

Several ground investigations have been undertaken at the Site (Stuart Wells, 2025, Soil Engineering, 2025 and Fugro, 1992). There are some discrepancies as to what geological formations parts of the superficial deposits fall under (whether the upper portion of the superficial deposits are Tidal Flat Deposits or part of the Saltmarsh Formation). All the investigations report the same geotechnical properties of these deposits and therefore for the purposes of this report, the superficial deposits where these discrepancies occur are to be referred to as Tidal Flat Deposits. A general sequence of strata following a review of this ground investigation data is presented in Table 2.

Table 2: General sequence of strata.

Unit	Level of Top of Stratum (mAOD)	Description
Made Ground	Ground Level (Approximately 45.5)	Variable sandy gravel and sandy gravelly clay with geotextile membrane present
Tidal Flat Deposits	4.4 to 2.9	Slightly sandy slightly gravelly CALY, silty SAND and slightly sandy coarse GRAVEL
Glacial Till	-14.2 to -18.6	Stiff slightly sandy slightly gravelly CLAY
Pennine Lower Coal Measures Formation	-28.1 to -39.9	Mudstone, siltstone and sandstone

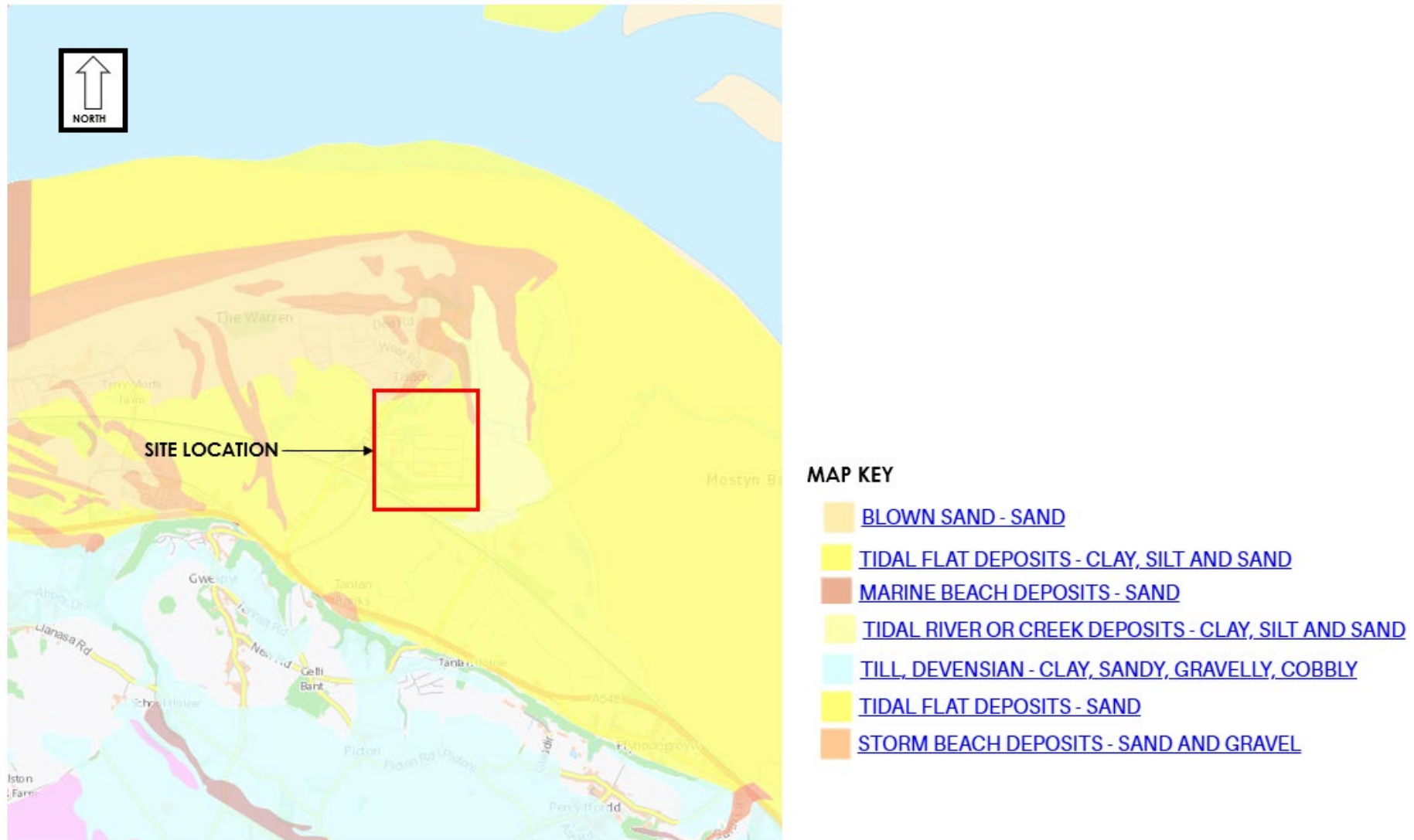


Figure 3: Superficial geology map (contains British Geological Survey Materials Copyright NERC September 2025).

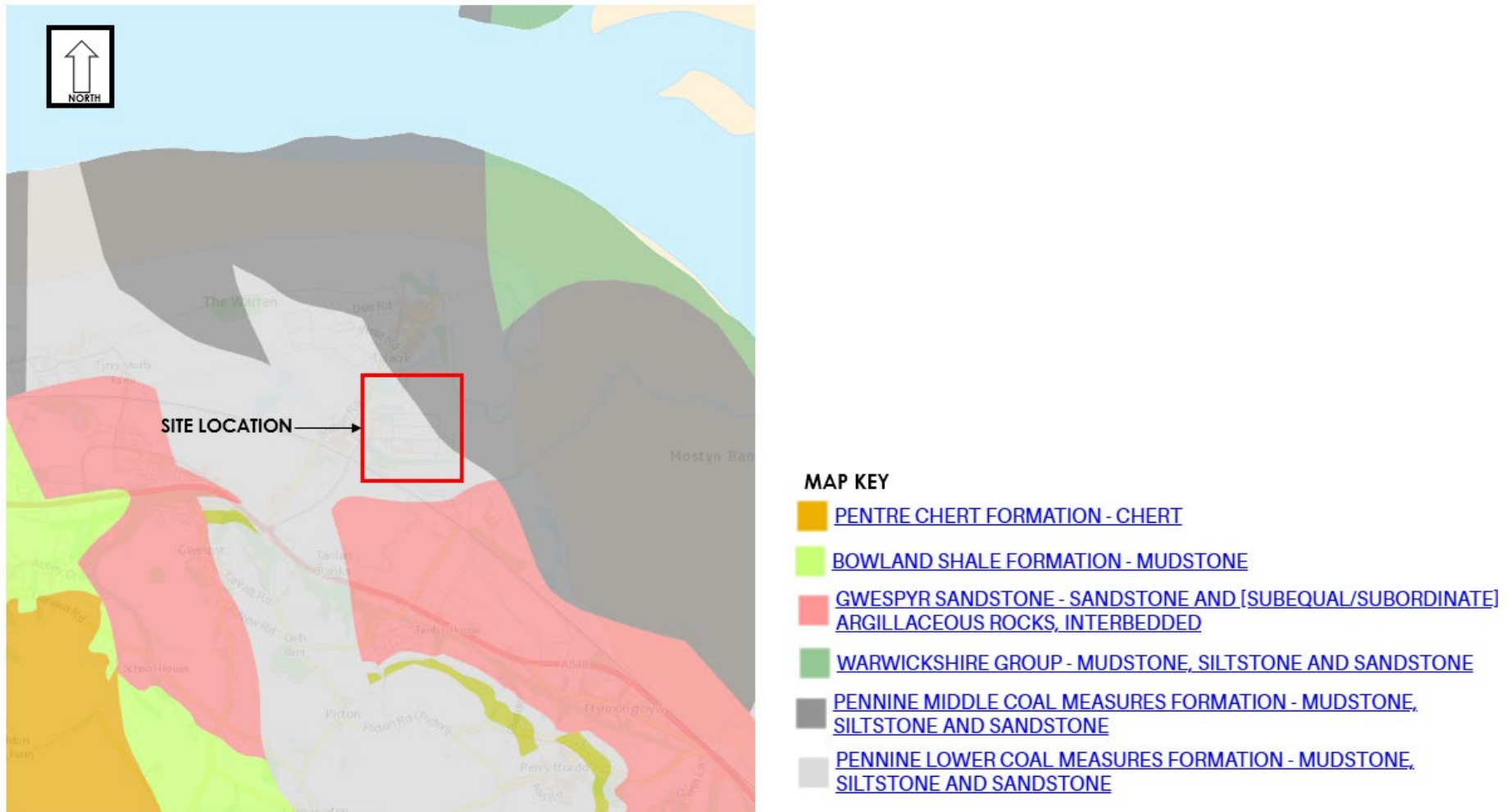


Figure 4: Bedrock geology (contains British Geological Survey Materials Copyright NERC September 2025).

4.1.3. Groundwater Monitoring Data

Groundwater monitoring was undertaken within the Tidal Flat Deposits at the Site during the Soil Engineering (2025) ground investigation between December 2024 and February 2025. These data are presented graphically in Figure 5, which shows groundwater levels range between 1.0 and 1.5 mAOD.

Baseline groundwater monitoring was also undertaken in August 2025 during the pre-test monitoring phase of the Stuart Wells (2025) pumping test (herein referred to as 'the pumping test'). The pumping test is discussed further in Section 4.1.4, however, the pumping test time-hydrograph presented in Figure 6 shows resting groundwater levels in the Tidal Flat Deposits were monitored between 2.75 and 3.20 mAOD.

Level logger data from the pumping test also indicated that the groundwater within the Tidal Flat Deposits are tidally influenced, however, the degree of tidal influence was observed to be minimal, with a tidal range of up to 0.2 m.

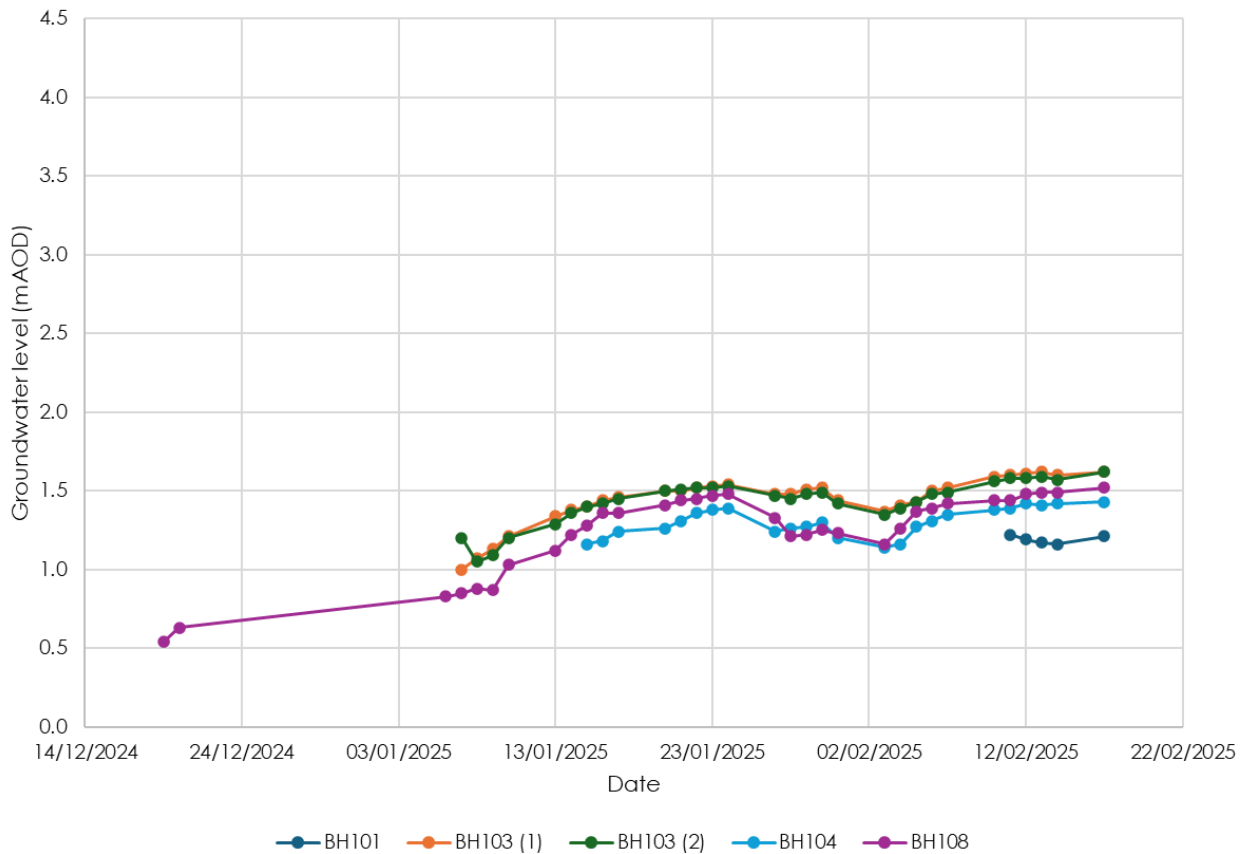


Figure 5: Soil Engineering (2025) groundwater monitoring data.

4.1.4. Groundwater encountered during drilling

Groundwater was encountered during drilling within the Soil Engineering (2025) ground investigation. Drilling strikes and subsequent rises from this investigation are summarised in Table 3.

Table 3: Summary of groundwater encountered during drilling in the Soil Engineering (2025) Ground Investigation.

BH no.	Groundwater Strike (mbgl)	Groundwater rise (mbgl)	Stratum
BH101	2.60	2.15	Tidal Flat Deposits
BH102	2.70	2.39	Tidal Flat Deposits
BH103	3.80	2.90	Tidal Flat Deposits
BH107	4.65	2.80	Tidal Flat Deposits
BH109	4.95	4.50	Tidal Flat Deposits
BH110	4.00	3.00	Tidal Flat Deposits
BH112	3.30	2.60	Tidal Flat Deposits
BH201	1.50	1.00	Tidal Flat Deposits

4.1.5. Commentary on available groundwater monitoring data

The available groundwater monitoring data and groundwater encountered during drilling suggest resting groundwater levels in the Tidal Flat Deposits on Site range between 1.0 and 3.2 mAOD. While groundwater in the Tidal Flat Deposits was observed to be tidal during the pumping test, the tidal range was observed to be relatively insignificant; up to 0.2 m. A design groundwater level of 3.2 mAOD is assessed to be representative and conservative for the purposes of this report.

The drilling strikes and subsequent rises observed during the Soil Engineering (2025) ground investigation suggest confined groundwater conditions are present at the Site. These conditions are assessed to be present due to the variable nature of the Tidal Flat Deposits where granular material is overlain by lower permeability, cohesive layers. These conditions are not present throughout the whole Site however, and, while these locally confined conditions appear to exist, the aquifer as a whole is assessed to behave as an unconfined aquifer.

4.1.6. Groundwater Quality

Per- and Polyfluoroalkyl Substances (PFAS) were found to be present in the groundwater at the Site. As a result, it is recommended that a detailed groundwater risk assessment be undertaken, which is outside the scope of this report.

4.2. Aquifer Hydrogeological Properties

The aquifer in consideration at the Site is the shallow Tidal Flat Deposits. In August 2025, Stuart Wells undertook a pumping test in the Tidal Flat Deposits at the Site to allow the hydrogeological properties to be better understood. The pumping test time-hydrograph is presented in Figure 6. The test comprised utilising an electric submersible borehole pump installed in the pumping well, and abstracted groundwater during the was discharged to the firewater pond on-site. The constant rate test was undertaken at an average flow rate of 5.3 l/s between the 13 and 19 August 2025.

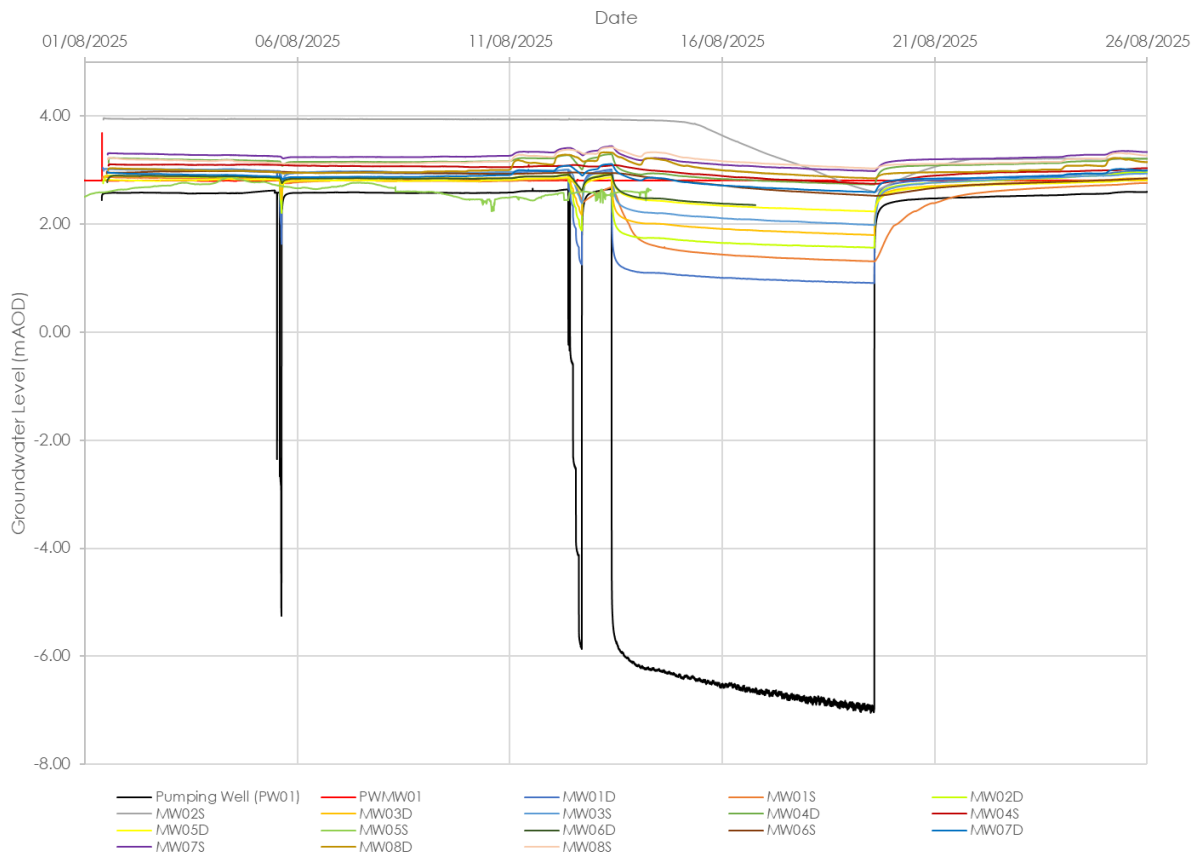


Figure 6: Pumping test time-hydrograph (SWL, 2025).

The Cooper Jacob's (1946) methods can be used to estimate transmissivity using the pumping test data. The methods of Cooper Jacob are applicable in confined aquifers where flow is directly proportional to drawdown, however, in unconfined aquifers, this proportionality does not exist due to changes in aquifer thickness during pumping. Jacob (1940) developed a 'corrected drawdown' method to account for this, the equation for which is presented in Equation 1.

$$s' = s - \frac{s^2}{2b} \quad (1)$$

Where: s' is corrected drawdown, s is observed drawdown and b is aquifer thickness.

The corrected drawdown data can then be used to undertake the Cooper Jacob's distance drawdown analysis using Equation 2 and Cooper Jacob's time drawdown analysis using Equation 3.

$$T = \frac{2.3 * Q}{4\pi * \Delta s} \quad (2)$$

$$T = \frac{2.3 * Q}{2\pi * \Delta s} \quad (3)$$

Where: T is transmissivity, Q is flow rate and Δs is drawdown per logarithmic cycle.

The semi-logarithmic distance drawdown graph from the pumping test is presented in Figure 7, while an example of an analysed semi-logarithmic time drawdown graph is presented in Figure 8. All time drawdown graphs are presented in Appendix 1.

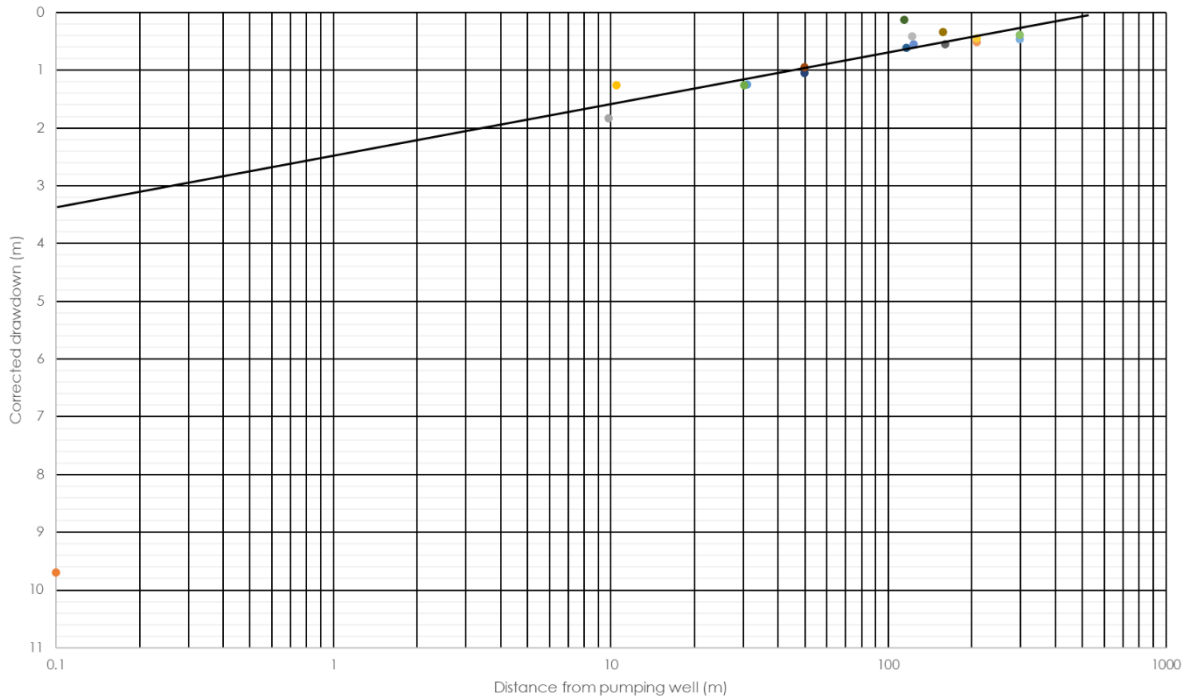


Figure 7: Semi-logarithmic distance drawdown graph (SWL, 2025).

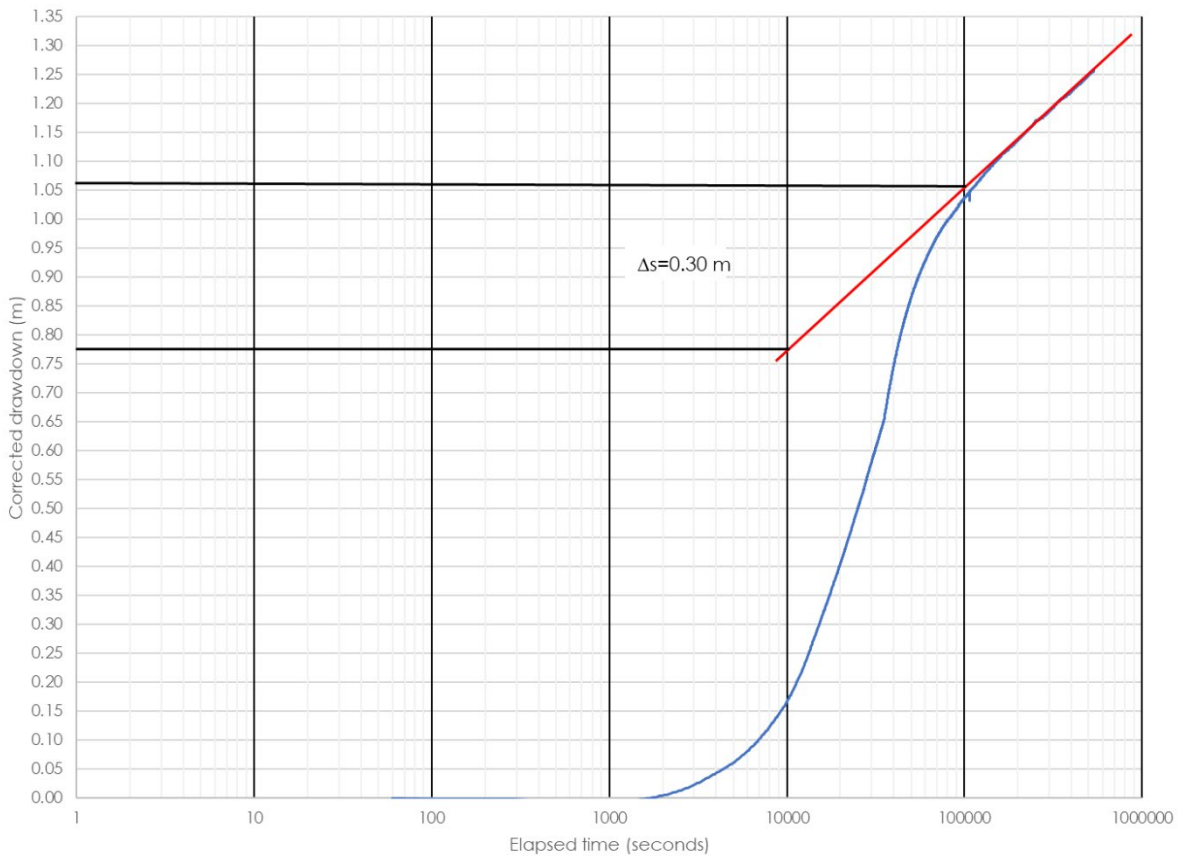


Figure 8: Semi-logarithmic time drawdown graph (SWL, 2025).

Estimated transmissivity values utilising the Cooper Jacob's distance drawdown and time drawdown analysis are summarised in Table 4. Permeability is then calculated by dividing the transmissivity by aquifer thickness. In this case, an average aquifer thickness of 20 m has been utilised.

Table 4: Summary of Cooper Jacob's pumping test analysis.

Analysis type	Well ID	Calculated Transmissivity (m ² /s)	Calculated Permeability (m/s)
Distance drawdown	n/a	2.2 x 10 ⁻³	1.1 x 10 ⁻⁴
Time drawdown	MW01d	4.9 x 10 ⁻³	2.4 x 10 ⁻⁴
Time drawdown	MW01s	3.3 x 10 ⁻³	1.6 x 10 ⁻⁴
Time drawdown	MW02s	3.8 x 10 ⁻⁴	1.9 x 10 ⁻⁵
Time drawdown	MW02d	4.9 x 10 ⁻³	2.4 x 10 ⁻⁴
Time drawdown	MW03d	3.9 x 10 ⁻³	2.0 x 10 ⁻⁴
Time drawdown	MW03s	3.5 x 10 ⁻³	1.7 x 10 ⁻⁴
Time drawdown	MW04d	3.6 x 10 ⁻³	1.8 x 10 ⁻⁴
Time drawdown	MW04s	2.7 x 10 ⁻³	1.4 x 10 ⁻⁴
Time drawdown	MW05d	3.8 x 10 ⁻³	1.9 x 10 ⁻⁴
Time drawdown	MW06d	3.9 x 10 ⁻³	2.0 x 10 ⁻⁴
Time drawdown	MW06s	2.0 x 10 ⁻³	1.0 x 10 ⁻⁴
Time drawdown	MW07d	3.1 x 10 ⁻³	1.5 x 10 ⁻⁴
Time drawdown	MW07s	3.3 x 10 ⁻³	1.6 x 10 ⁻⁴
Time drawdown	MW08d	2.4 x 10 ⁻³	1.2 x 10 ⁻⁴

The results of the analysis show the permeability of the Tidal Flat Deposits ranges from between 1.1 x 10⁻⁴ and 2.4 x 10⁻⁴ m/s. A permeability of 1.9 x 10⁻⁵ m/s was calculated for MW02s in the time drawdown analysis; however, this value is assessed to be an anomaly as the rest of the data is all within a relatively concise range. For the purposes of design, a permeability range of 1.0 x 10⁻⁴ to 2.5 x 10⁻⁴ m/s is to be utilised.

4.3. Hydrogeological Conceptual Model Relevant to Dewatering

The available information has been used to develop the following conceptual model (relevant to dewatering) which is used for our dewatering design.

Ground conditions: Made Ground is present at the Site atop the natural superficial deposits and was found to comprise variable sandy gravel and sandy gravelly clay. The superficial deposits at the Site comprise Tidal Flat Deposits (Slightly sandy slightly gravelly CLAY, silty SAND and slightly sandy coarse GRAVEL) underlain by Glacial Till (Stiff slightly sandy slightly gravelly CLAY). These superficial deposits are underlain by the Pennine Lower Coal Formation bedrock, which comprises mudstone, siltstone and sandstone.

Aquifer Conditions: There is one aquifer of consideration at the Site; the Tidal Flat Deposits. While locally confined conditions were found to be present in this aquifer at the Site, the aquifer is assessed to behave as an unconfined aquifer overall. Aquifer parameters that are to be utilised as part of this analysis are summarised in Table 5.

Groundwater Quality: Per- and Polyfluoroalkyl Substances (PFAS) were found to be present in the groundwater at the Site. As a result, it is recommended that a detailed groundwater risk assessment be undertaken, which is outside the scope of this report.

Table 5: Summary of Predominant Aquifer Conditions.

Aquifer Property	Superficial Deposits
Aquifer behaviour	Unconfined
Permeability	1.0 x 10 ⁻⁴ to 2.5 x 10 ⁻⁴ m/s
Groundwater Level	3.20 mAOD

5. Groundwater Control Requirements

5.1. Dewatering (excavation) Area Dimensions

Based on the reviewed information and the proposed excavation depths, it is assessed that specialist dewatering is required for all excavations presented in Table 1 to allow the works to be undertaken in dry and stable conditions.

It has been assumed that all other excavations are to be open cut with a batter angle of 45 degrees. The excavations presented in Table 1 are for the base of the excavations only and do not include slope batters. Details of the proposed excavations with dimensions from the top of the slope batters given are presented in Table 6.

Table 6: Summary of excavation details including slope batters.

Proposed Excavations	Excavation length	Excavation width	Excavation Formation Level	
	(m)*	(m)*	(mAOD)**	(mbgl)
Cooling tower	29	25	2.25	2.25
Pig receiver	19	13	2.0	2.5
Gas inlet facility	41	40	2.0	2.5
Knock Out drums	30	15	1.5	3.0
Propane Tank	30	15	1.5	3.0
Compression station***	53	46	1.5	3.0
Oily water collection tank	35	17	1.5	3.0

Notes: *Excavation footprints not given; dimensions measured from (Saipem (2025)).

**Excavation formation given in mbgl only; assumed ground level of 4.5 mAOD utilised.

*** Excavation split into 3 equally sized areas; dimensions given are per area

5.2. Estimated dewatering flow rates

Dewatering flow rates have been estimated based upon the findings of the pumping test (SWL, 2025) using the methods of CIRIA C750 (Section 5.2.1) and by utilising the principle of superposition (Section 5.2.2). It should be noted that the analysis undertaken assumes that only one structure would be dewatered at any given time, and there is no positive impact on the dewatering of surrounding structures on dewatering flow rates.

The analysis undertaken also assumes a worst-case groundwater level of 3.2 mAOD; it should be noted however, that groundwater monitoring suggests that groundwater levels at the Site range between 1.0 and 3.2 mAOD. Lower groundwater levels at the time of dewatering may reduce required dewatering flow rates, with some shallower structures no longer requiring dewatering altogether. It is therefore recommended that continuous groundwater monitoring be undertaken at the Site to further inform dewatering requirements.

It should also be noted that, due to the variability of the Tidal Flat Deposits at the Site and the relatively shallow depth the proposed excavations are to extend to, some excavations may be entirely founded in cohesive material, reducing the groundwater control requirements. For the purposes of this report, worst-case ground conditions have been assumed to be conservative.

5.2.1. Estimated dewatering flow rates (CIRIA C750)

To estimate the dewatering flow rates, the methods of CIRIA C750 have been utilised using an equivalent well analysis. The results of this analysis are summarised in Table 7. Full calculations are presented in Appendix 2.

Table 7: Anticipated dewatering flow rates using the methods of CIRIA C750.

Proposed Excavation	Drawdown required (m)*	Anticipated dewatering flow rate (l/s)		
		1.0 x 10 ⁻⁴ m/s	2.0 x 10 ⁻⁴ m/s	2.5 x 10 ⁻⁴ m/s
Cooling tower	1.5	4.3	7.1	8.4
Pig receiver	1.7	3.5	6.0	7.2
Gas inlet facility	1.7	5.8	9.5	11.2
Knock Out drums	2.2	4.7	8.0	9.6
Propane Tank	2.2	4.7	8.0	9.6
Compression station**	2.2	7.2	11.8	13.9
Oily water collection tank	2.2	5.0	8.6	10.2

NOTES: *Allowing for a 0.5 m contingency below the excavation formation level.

** Excavation split into 3 equally sized areas; flow rates given are per area

5.2.2. Estimated dewatering flow rates (principle of superposition)

The required dewatering flow rates have also been estimated by the principle of superposition. For this approach, the semi-logarithmic distance drawdown plot was utilised from the pumping test and specific drawdown was calculated by dividing the drawdown by the corresponding pumping flow rate. This represents the drawdown at a given distance that will be achieved by pumping at 1 l/s.

The approach is usually utilised for confined aquifers where drawdown is directly proportional to saturated aquifer thickness (as saturated aquifer thickness remains constant), however, the approach can be utilised for unconfined aquifers given that the drawdown factor is set to 0.6 (Cashman and Preene, 2021). Results of this analysis are presented in Table 8.

Table 8: Anticipated dewatering flow rates using the principle of superposition.

Proposed Excavation	Drawdown required (m)*	Anticipated dewatering flow rate (l/s)
Cooling tower	1.5	10.0
Pig receiver	1.7	9.6
Gas inlet facility	1.7	13.2
Knock Out drums	2.2	15.0
Propane Tank	2.2	15.0
Compression station**	2.2	17.6
Oily water collection tank	2.2	15.0

Notes: * Allowing for a 0.5 m contingency below the excavation formation level.

** Excavation split into 3 equally sized areas; flow rates given are per area

6. Indicative Groundwater Control Designs

6.1. Surface Water Control

The design and management of surface water control systems is outside the scope of this report. However, if any low permeability strata are exposed in the base of the excavations, or any direct precipitation or run-off reaching the excavation will tend to pond at low points within the base of the excavation. It is considered that conventional sump pumping techniques would be appropriate, most likely with the aid of collection ditches that would direct surface water to sumps, from where water can be pumped away.

It is likely that surface water discharged from sump pumps would be laden with suspended solids. It is good practice to pass the discharge water through a settlement tank(s) to allow the situation to be monitored and remove those solids that settle in the tank.

6.2. Deepwell Dewatering

Wellpoint dewatering, while potentially a cheaper dewatering option, is assessed to be more sensitive to pumping failure due to the reliance on a vacuum being maintained. In an active demolition environment, the most appropriate method of groundwater control is therefore assessed to be via deepwells which will lower groundwater levels within the Tidal Flat Deposits to allow the excavation works on Site to be undertaken in dry and stable conditions.

Indicative dewatering designs for each excavation are summarised in Table 9. All wells are to be installed 1 m back from the crest of the slope batters. An indicative dewatering layout is shown in Figure 9 with indicative well designs given in Appendix 3. In Figure 9, due to the proximity of the cooling tower, pig receiver and gas inlet facility, these are all grouped together and referred to as the 'Inlet and Metering Unit'. These smaller structures and the proposed dewatering wells are shown in more detail in Figure 10. As some of the excavations are in close proximity to one another, it may be possible to incorporate multiple excavations in one dewatering system, however, as details of excavation sequences or slope batter arrangements have not been provided at this stage, each excavation has been treated independently.

Table 9: Indicative dewatering design summary.

Proposed Excavation	Number of Pumping wells	Number of monitoring/contingency wells	Approximate Well Spacing (m)	Well Depth (m)	Well Bore Diameter (mm)
Cooling tower	4	0	20	8	300
Pig receiver	3	0	20	8	300
Gas inlet facility	4	0	20	8	300
Knock Out drums	6	1	15	8	300
Propane Tank	6	1	15	8	300
Compression station*	10	1	20	8	300
Oily water collection tank	6	1	20	8	300

Notes: Excavation split into 3 equally sized areas; number of wells given are per area, however, anticipated 4 wells can be shared between each area

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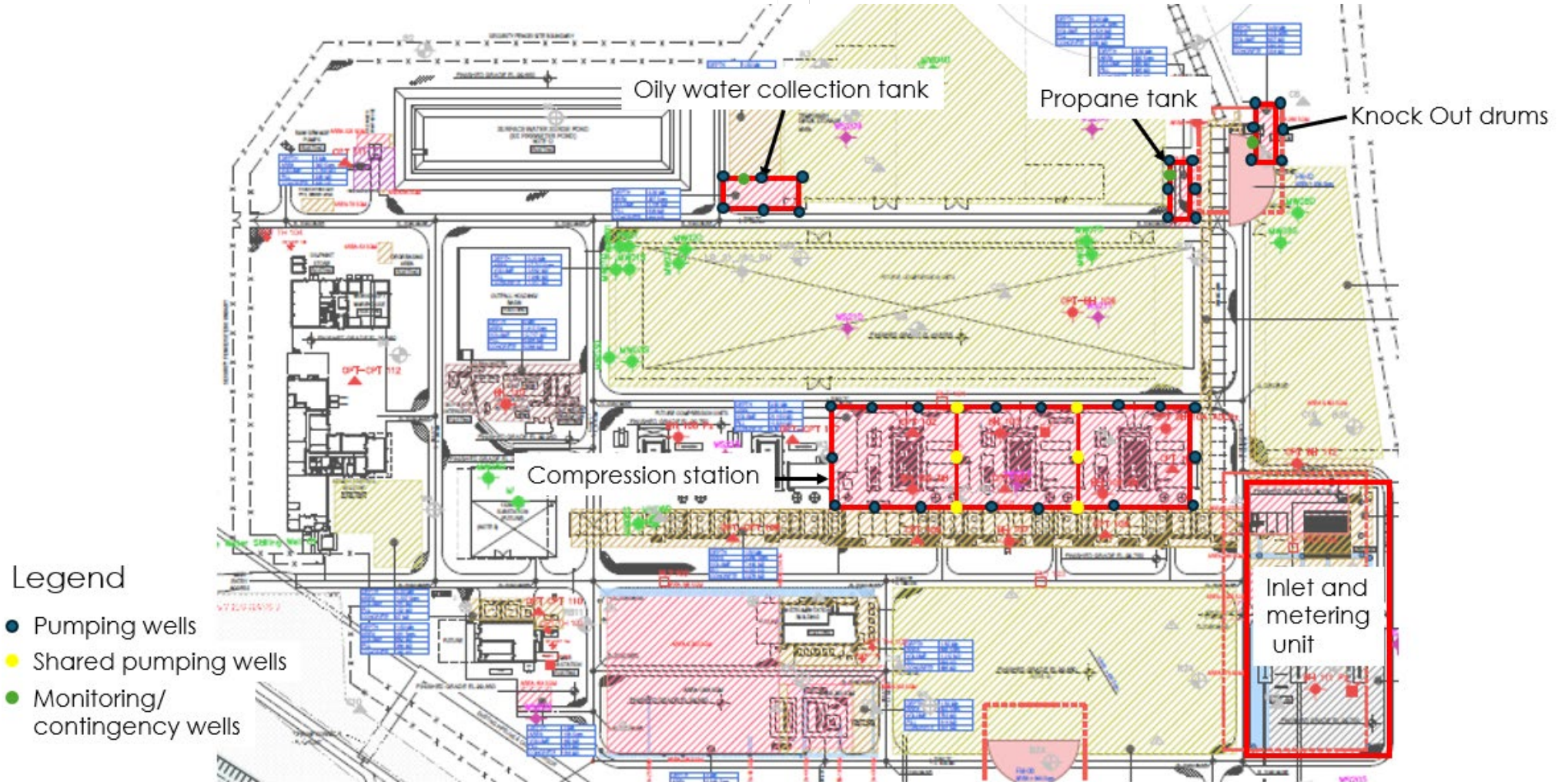


Figure 9: Indicative dewatering layout map (after Saipem, 2025).

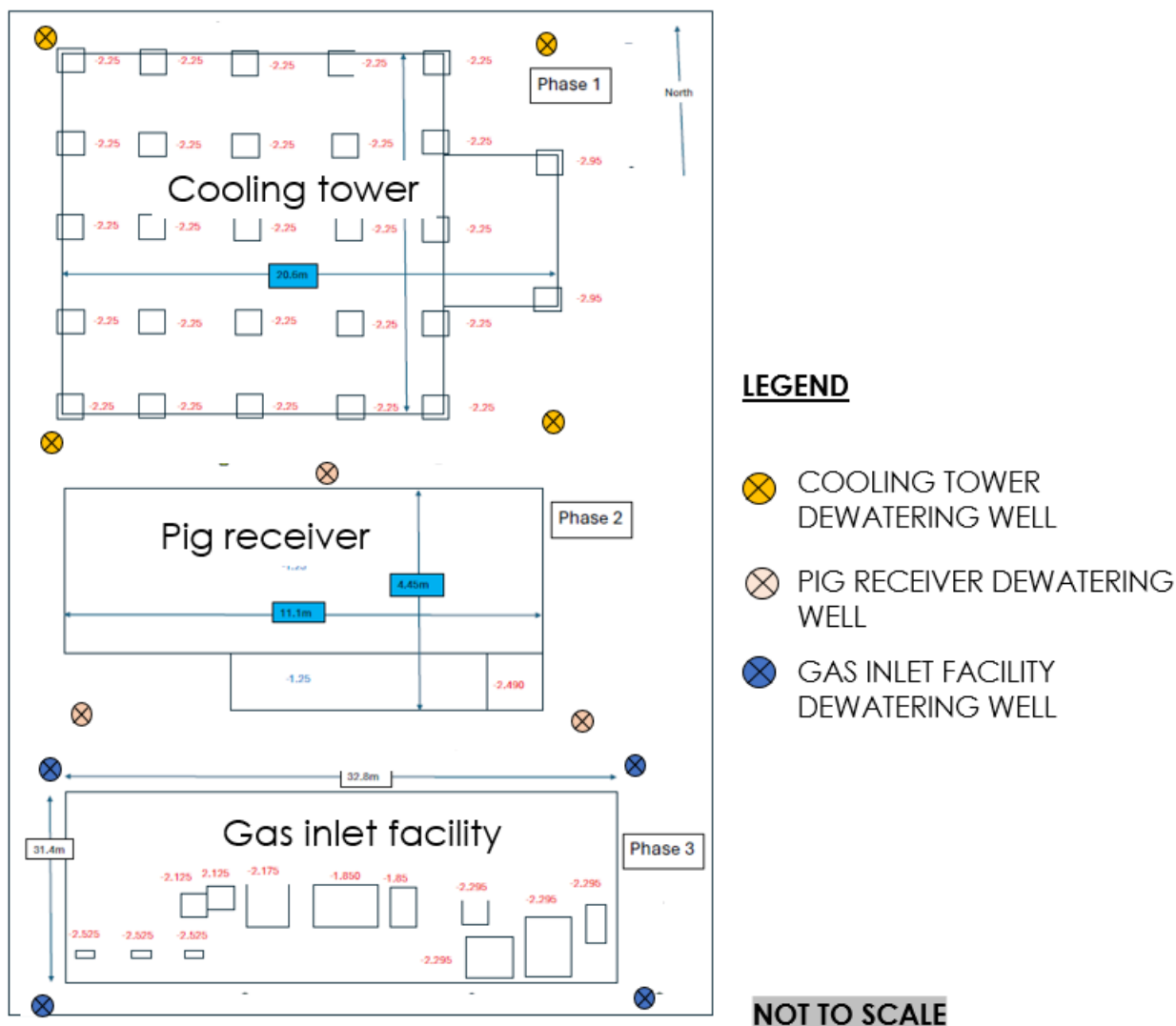


Figure 10: Indicative dewatering layout map for structures within the Inlet and Metering Unit.

The key elements of the Dewatering Design comprise:

- All wells drilled by cable percussion methods at 300 mm bore diameter to the depths specified in Table 9.
- Wells to be installed with an end cap, 165 mm OD x 155 mm ID x 0.5 mm slot perforated well liner and 165 mm OD x 155 mm ID plain casing, backfilled from base to 1 m above the top of the slotted well liner with 0.5 to 1.0 mm filter sand and thereafter to ground level with a bentonite seal and bentonite cement cap. Lengths of well liner type (plain and slotted) for each well depth are specified in Appendix 3.
- Dewatering wells will be developed by airlifting to remove any drilling residue, and to allow the wells to pump clear water (after the end of development) free of suspended solids.
- Dewatering wells shall be installed with individual submersible electric borehole pumps with a capacity of up to 10 l/s, riser pipe and a wellhead that connect onto a 4" BSP flanged wellhead, that ultimately connects to a 150 mm collector main.

To mitigate the risk of groundwater 'overbleed' at the interface between cohesive and granular layers, it is recommended that the deepwell dewatering systems are supplemented by sump pumping.

6.3. Groundwater Discharge

It is understood that abstracted groundwater is to be discharged to the on-site Firewater Pond. It should be ensured that all required permits are in place prior to discharge.

7. Risk and Uncertainty

Dewatering designs, like any geotechnical analysis, involve uncertainty, deriving in part from the natural variability of the ground conditions and from the fact that any ground investigation can only sample or test a small proportion of the ground. The key to a robust design is that critical uncertainties are identified and addressed, for example by using conservative parameters in design and/or monitoring.

7.1. Groundwater Related Considerations

Key groundwater related considerations are summarised below:

- 1) Clogging and damage to dewatering system:** The dewatering systems are to be installed within proximity to the earthworks at the Site; there is a risk that the earthworks activities on Site have the potential to damage to pumps and/or pipework. This could potentially cause interruption to pumping. Measures should be taken to mark out well locations and protect wellpoints, pumps and pipework throughout the main works.
- 2) Dewatering related settlement:** The reduction of groundwater levels results in an increase in effective stress which can lead to surface settlement. An assessment into dewatering related settlement is out of the scope of this report.
- 3) High flow rates:** This assessment has been undertaken based on an analysis of the pumping test, however, due to the size of the Site, there is a risk that the permeability of the Tidal Flat Deposits could be higher in areas than anticipated, which could result in higher dewatering flow rates.

8. Regulatory Considerations

Since January 2018, the general position for dewatering systems in England and Wales is that if pumping rates are more than 20 m³/d (0.23 l/s) a formal license to abstract groundwater is required. The licensing process is controlled by National Resources Wales (NRW) in Wales. In Stuart Wells experience, this process can take several months.

The dewatering flow rates on this project will exceed 20 m³/day and will fall under the abstraction licensing regime.

8.1. Abstraction Licensing

The regulatory position on groundwater abstraction from wells requires an abstraction/transfer license from NRW.

This is in addition to, and not to be confused with, any discharge permits for the project. Pumping legally cannot commence until all required permits are in place. Therefore, it is important that you notify the Site owner of this risk and leave sufficient time to obtain the required permits.

For your information there are three types of abstraction permits:

- A **temporary license**, which only lasts 28 days and cannot be renewed. For longer abstraction periods you will require **either**:
- A **transfer licence** with transfer of groundwater from one environmental source or another without intervening use (stream/ditch etc.). Should there be restrictions it may be possible to use soakaways as a means of discharge.
- A **full abstraction licence**, with discharge direct to utility outfall.

8.2. Discharge Licensing

Abstracted groundwater from temporary dewatering is classed as a trade effluent by NRW, and the discharge of trade effluent to either groundwater, surface water or utility outfall is regulated. As a result, there will be a requirement to acquire a permit to discharge, unless either of the following conditions are met:

- It is viable to recharge abstracted water directly back to aquifer via soakaway within an abstraction transfer licence arrangement, without intervening use it should not require a separate discharge permit.
- If the conditions of RSP261 - Temporary dewatering from excavations to surface water can be met it is possible to discharge for up to 3 months without a separate discharge permit
- Any discharge to outfall needs to have agreement with the asset owner. There may already be a discharge permit or conditions in place for the works area that can be used. If the discharge point is outside the works a trade effluent discharge permit will need to be applied for.

9. Summary and Recommendations

The ground conditions at the Site comprise Made Ground underlain by Tidal Flat Deposits, which are underlain by Glacial Till. The bedrock geology at the Site comprises the Pennine Lower Coal Measures Formation.

Groundwater monitoring undertaken during a pumping test at the Site (SWL, 2025) indicates groundwater within the Tidal Flat Deposits is tidally influenced at the Site, however, the tidal range was found to be relatively insignificant; up to 0.2 m. Groundwater monitoring (Soil Engineering, 2025, and SWL, 2025) suggests groundwater levels range from between 1.0 and 3.2 mAOD (approximately 1.3 and 3.5 mBGL) in the Tidal Flat Deposits. Although localised confined aquifer conditions were found to be present within these deposits due to the presence of low permeability cohesive material, the aquifer as a whole is assessed to behave as an unconfined aquifer.

Based on the available information, it is assessed that to allow the proposed excavation works to be undertaken in dry and stable conditions, groundwater control is required in the Tidal Flat Deposits. An analysis has been undertaken on the pumping test data to estimate the hydrogeological conditions of these deposits at the Site. This analysis found the permeability of the Tidal Flat Deposits to be in the range of 1.0×10^{-4} to 2.5×10^{-4} m/s.

It is understood that all excavations for the demolition works are to be open-cut. Details of slope batters have not been provided at this stage, however it has been assumed all slope batters are to be 45 degrees.

Wellpoint dewatering, while potentially a cheaper dewatering option, is assessed to be more sensitive to pumping failure due to the reliance on a vacuum being maintained. In an active demolition environment, the most appropriate method of groundwater control is therefore assessed to be via deepwells. It is proposed that for all open-cut excavations, deepwells are installed at the crest of slope batters around the excavation perimeter. Deepwell dewatering should be supplemented with conventional sump pumping to reduce the risk of groundwater 'overbleed' at the interface of cohesive and granular layers within the Tidal Flat Deposits.

Per- and Polyfluoroalkyl Substances (PFAS) were found to be present in the groundwater at the Site. As a result, it is recommended that a detailed groundwater risk assessment be undertaken, which is currently outside the scope of this report.

10. References

Cooper, H and Jacob, C E. (1946). A generalised graphical method for evaluating formation constants and summarising well field history. Transactions of the American Geophysical Union, 27, pp526–534.

Preene, M. Roberts, T.O.L. and Powrie, W. (2016). Groundwater Control – Design and Practice, 2nd Edition. Construction Industry Research and Information Association, CIRIA Report C750, London.

Cashman, P.M. and Preene, M. (2021). *Groundwater Lowering in Construction: A Practical Guide to Dewatering, third edition*. CRC Press.

Appendix 1:
Pumping Test Analysis Graphs

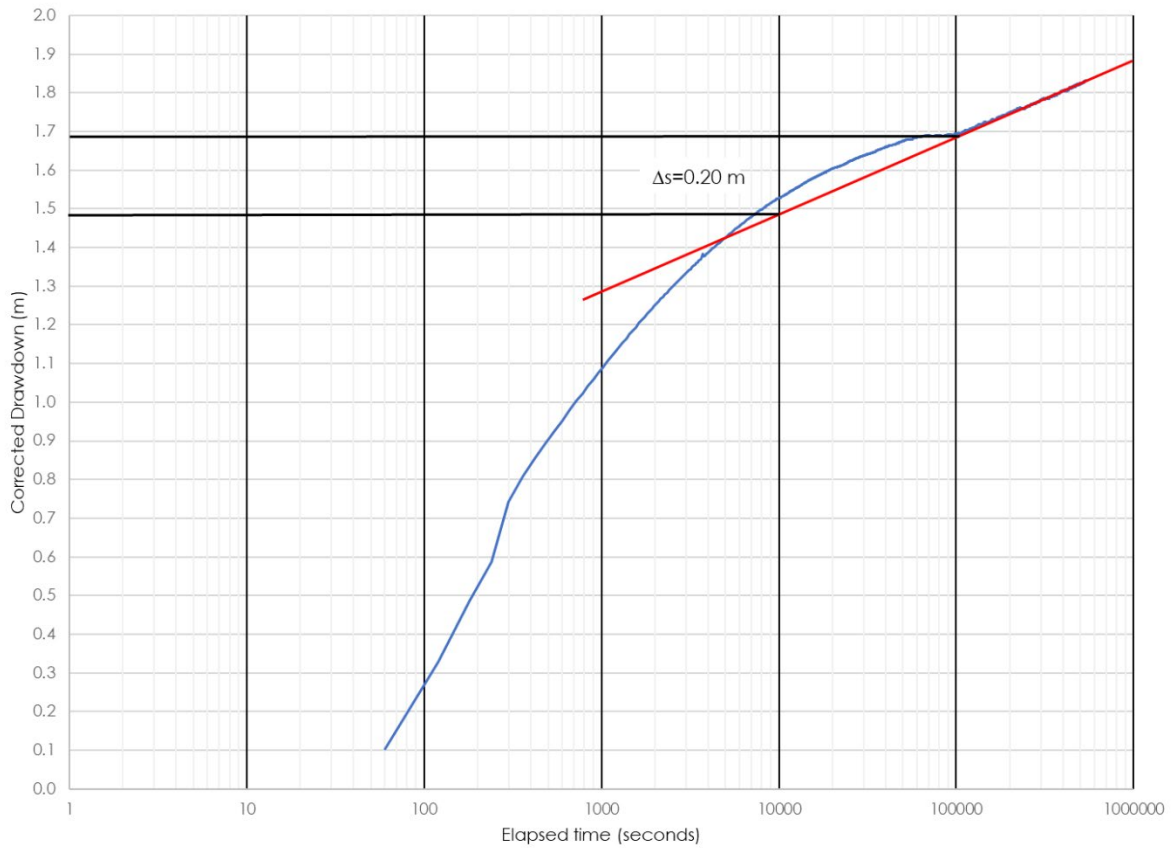


Figure A 1: MW01D time drawdown graph

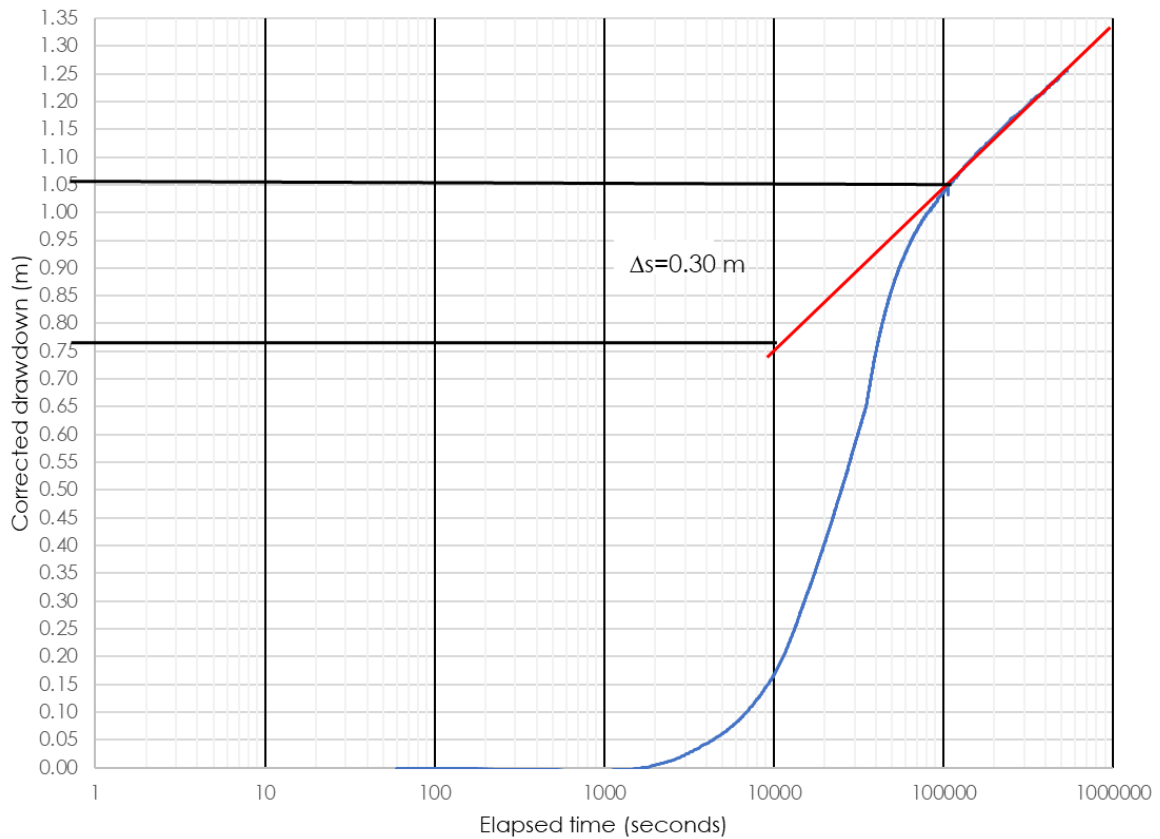


Figure A 2: MW01S time drawdown graph

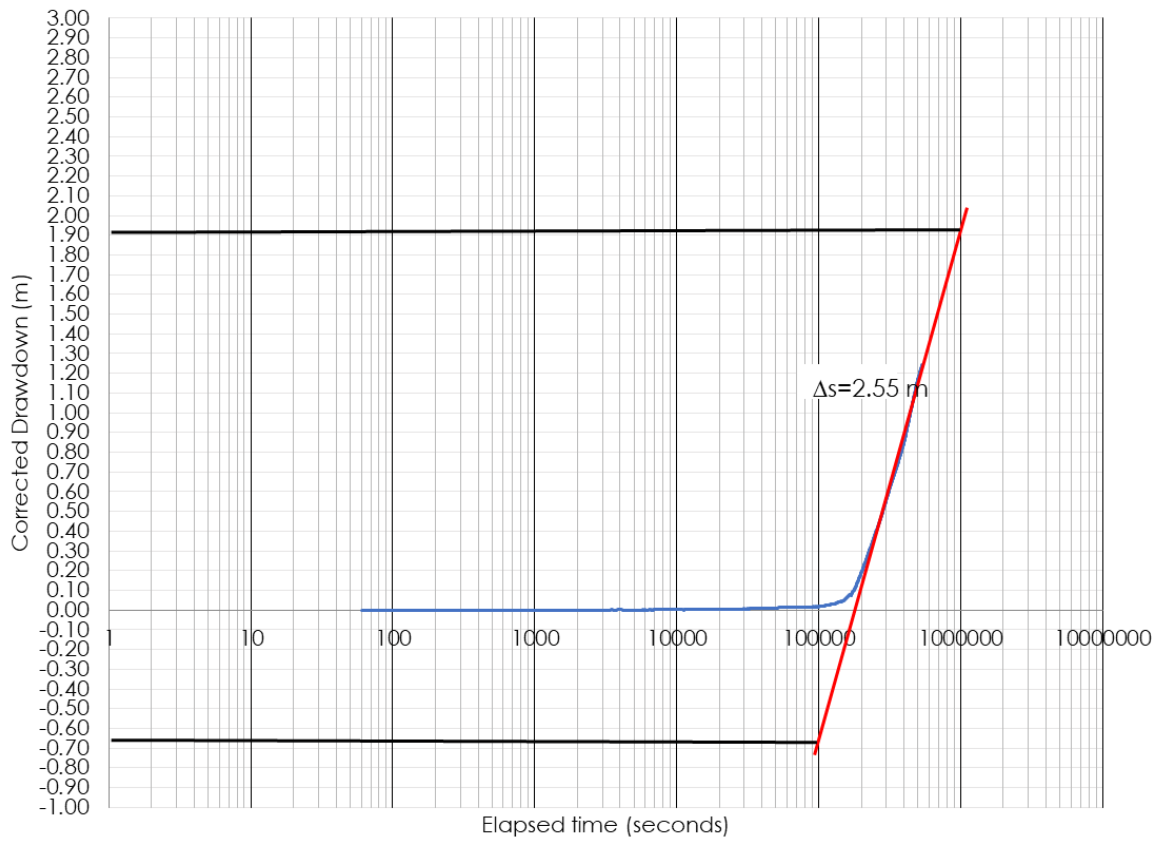


Figure A 3: MW02S time drawdown graph

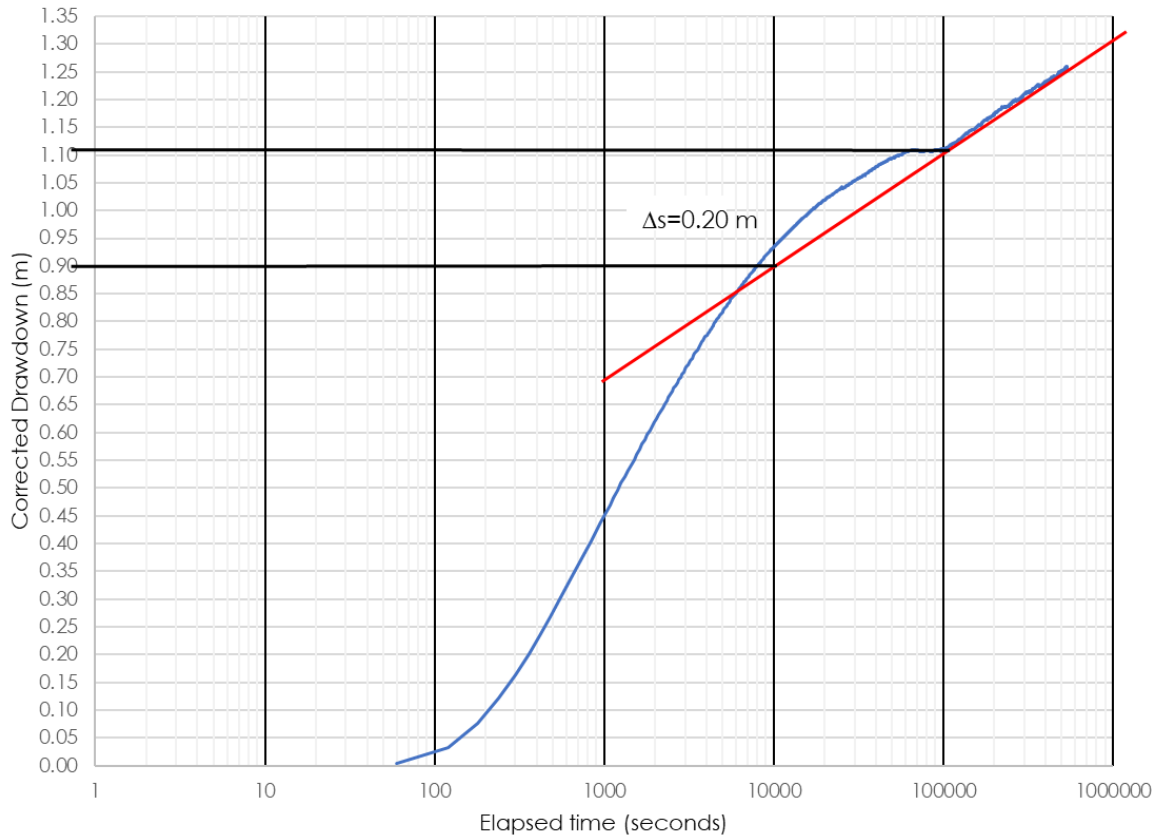


Figure A 4: MW02D time drawdown graph

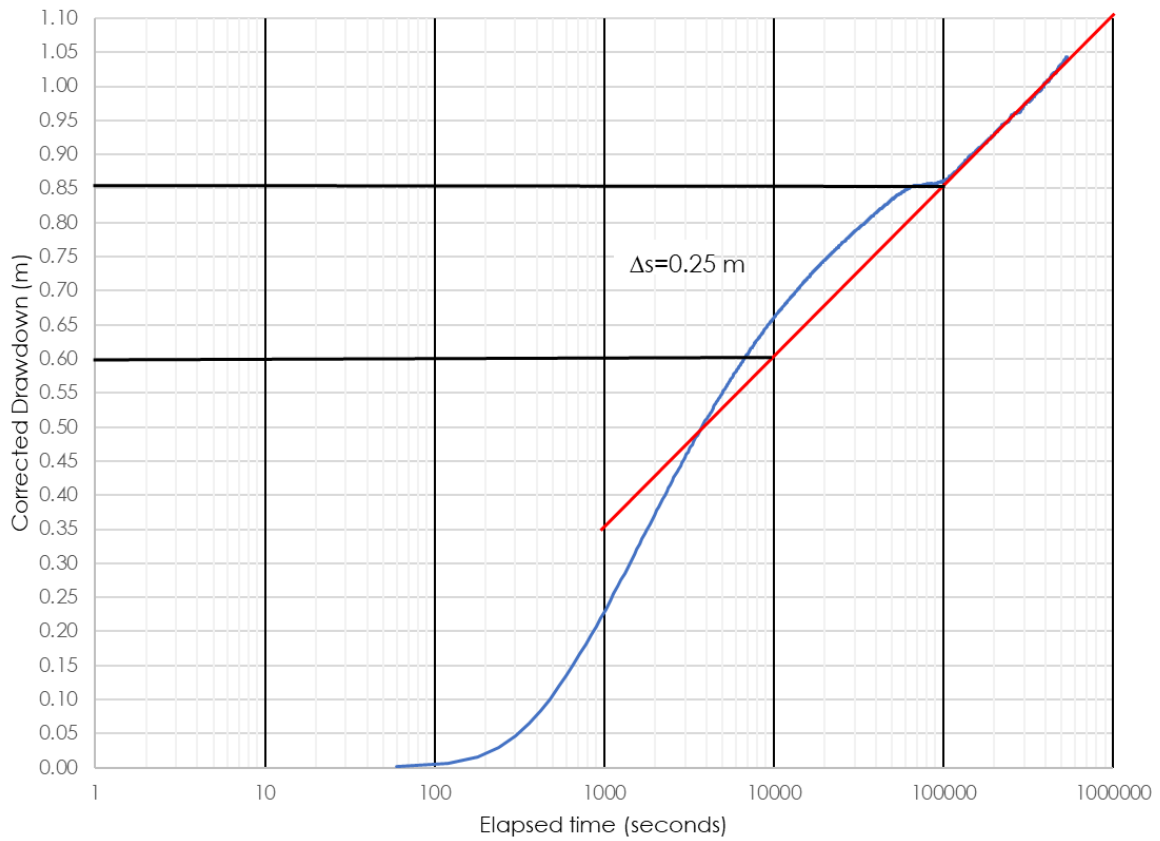


Figure A 5: MW03D time drawdown graph

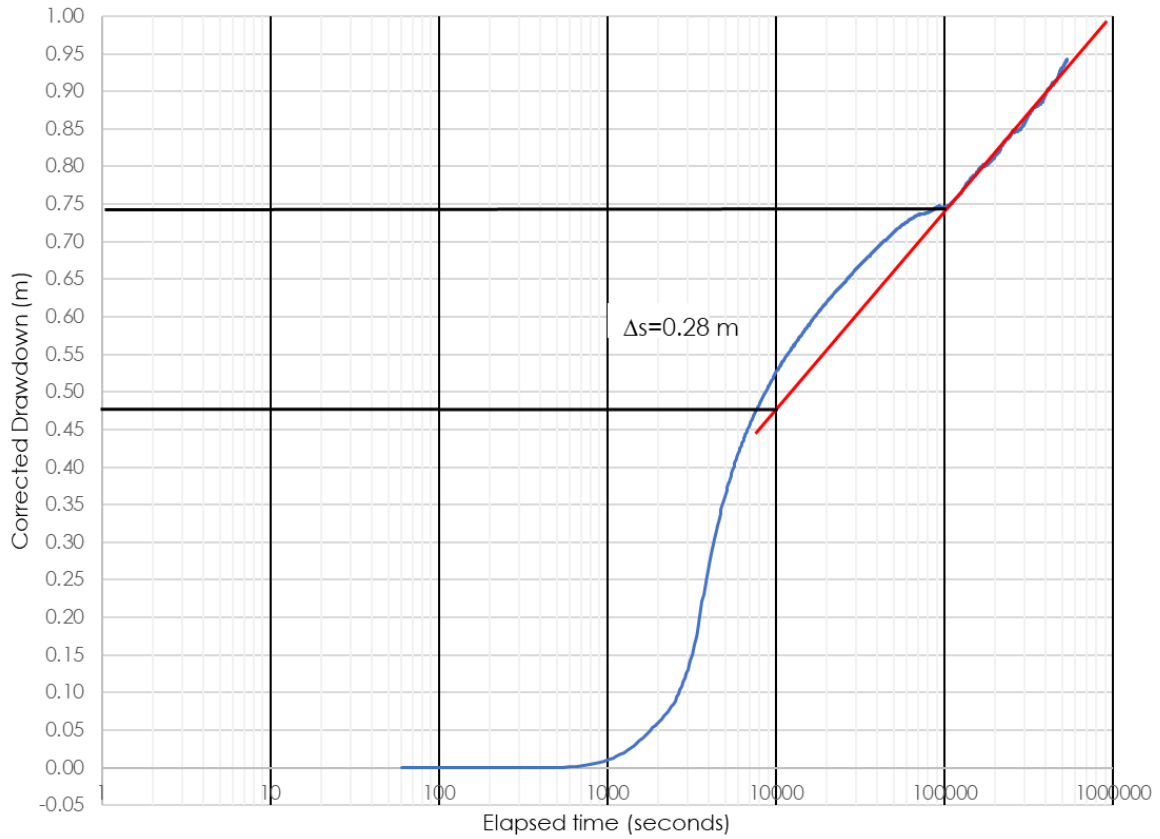


Figure A 6: MW03S time drawdown graph

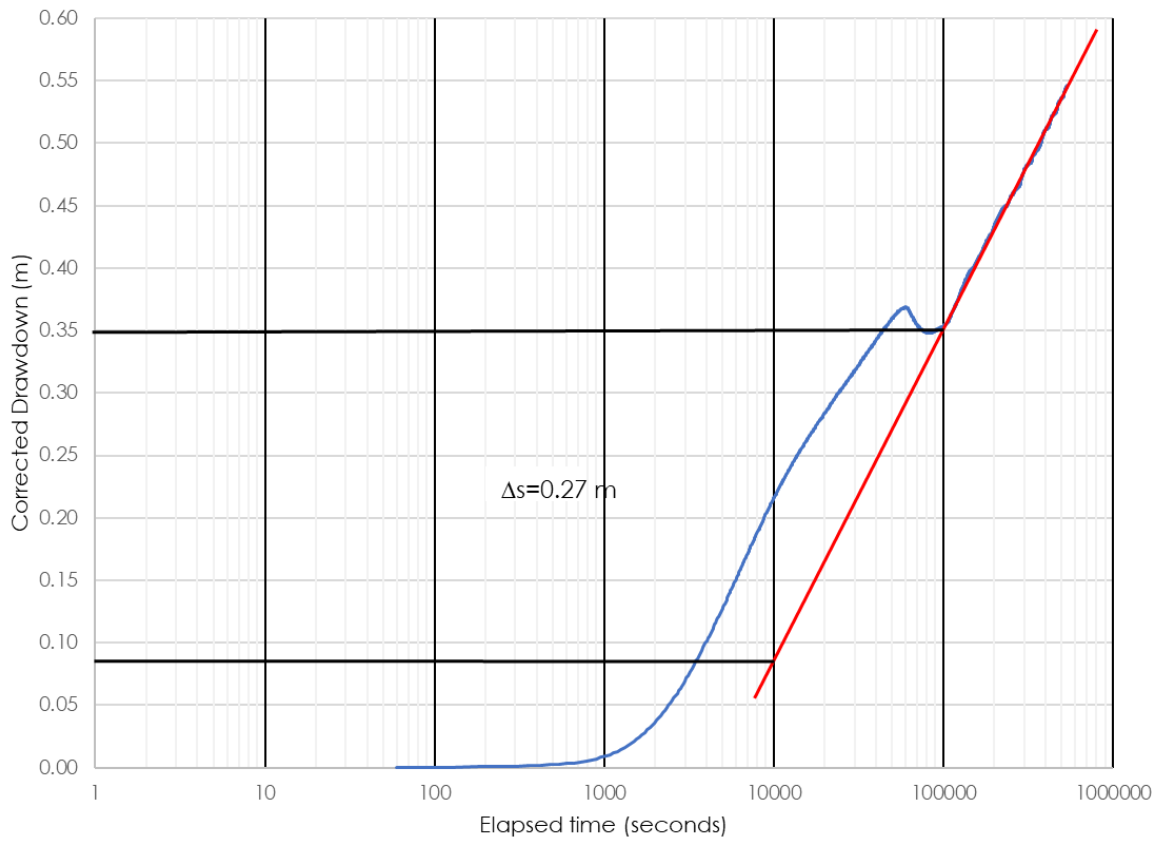


Figure A 7: MW04D time drawdown graph

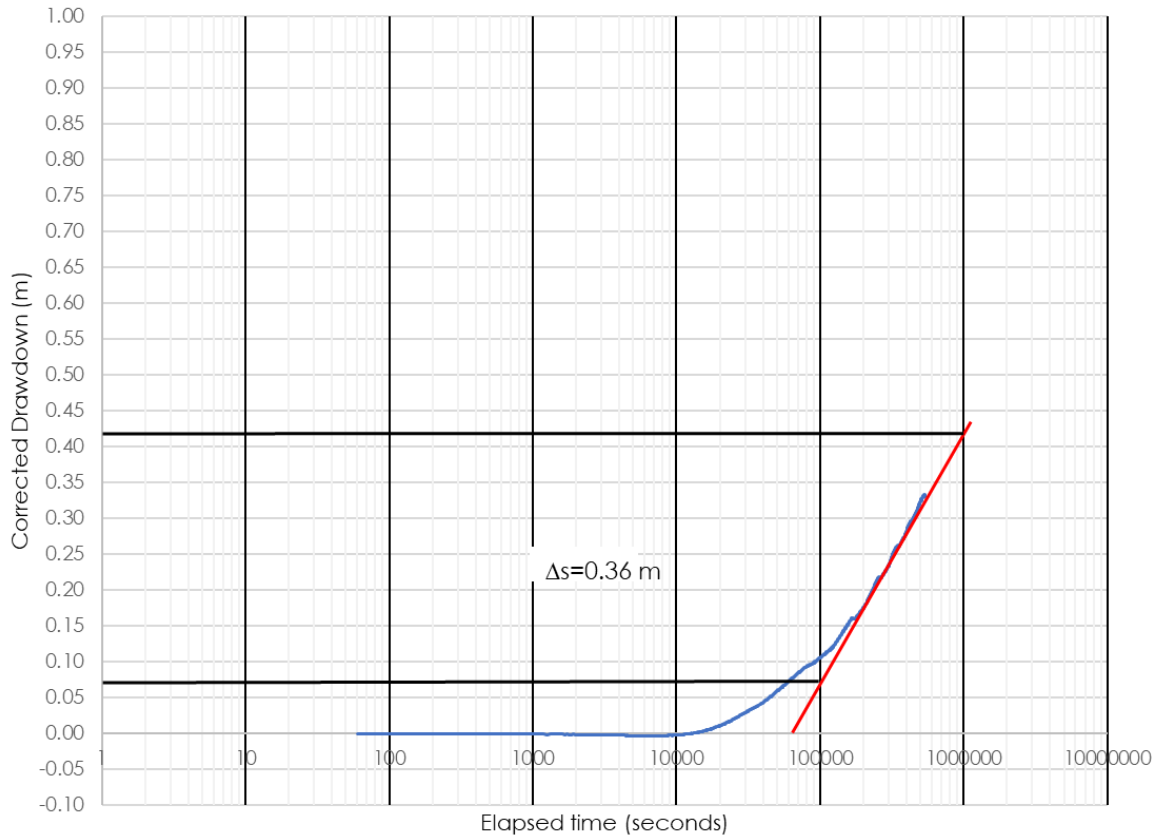


Figure A 8: MW04S time drawdown graph

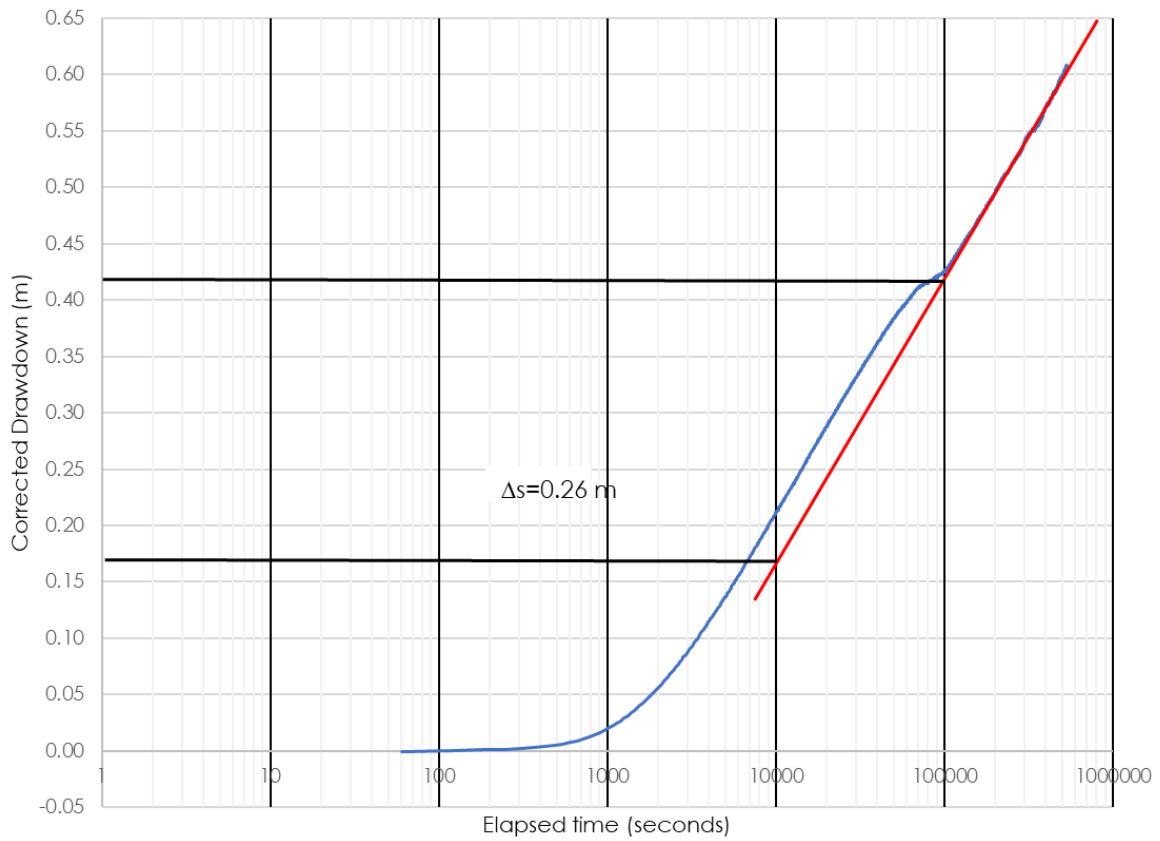


Figure A 9: MW05D time drawdown graph

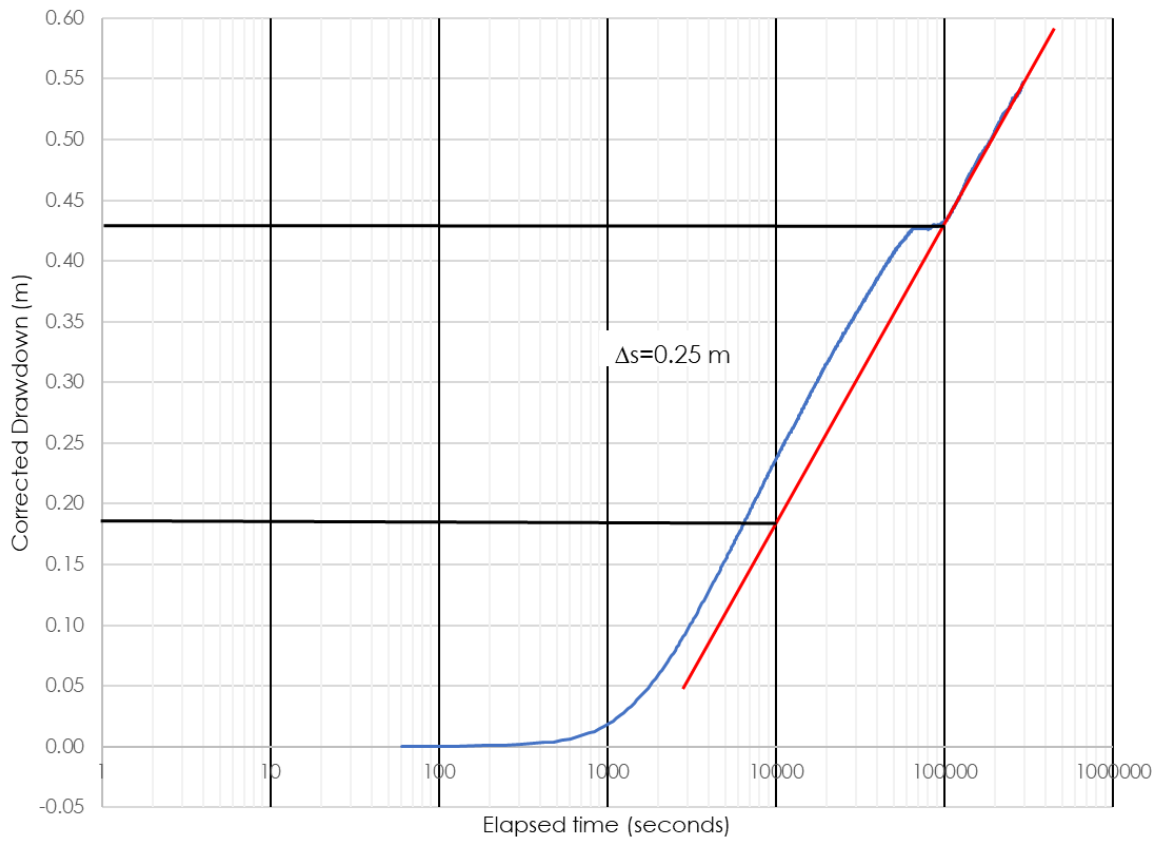


Figure A 10: MW06D time drawdown graph

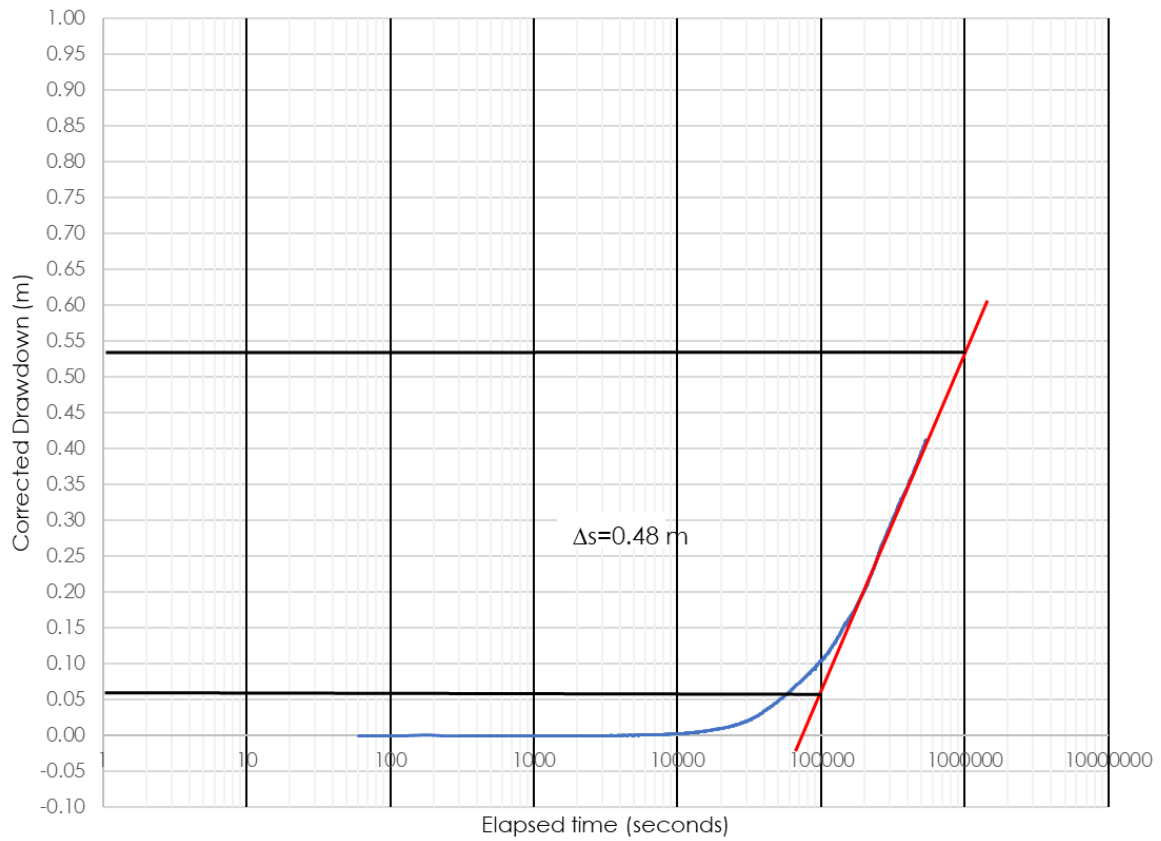


Figure A 11: MW06S time drawdown graph

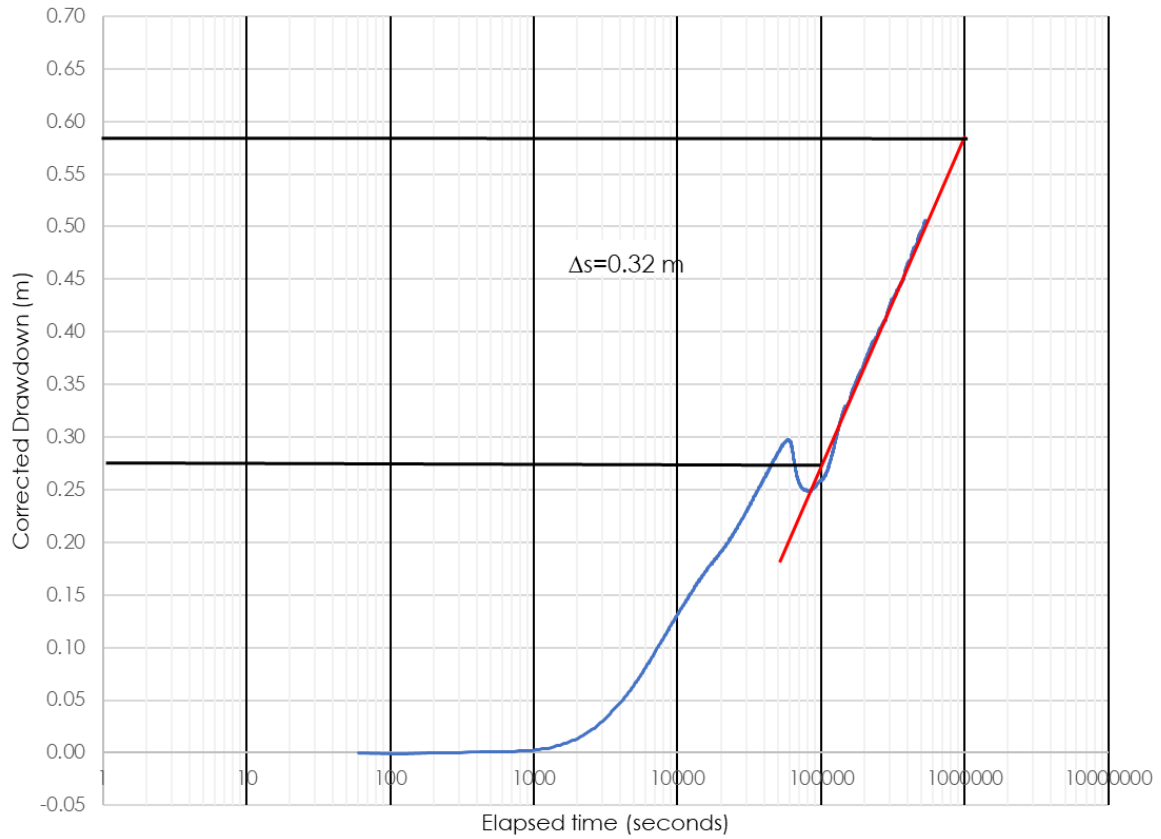


Figure A 12: MW07D time drawdown graph

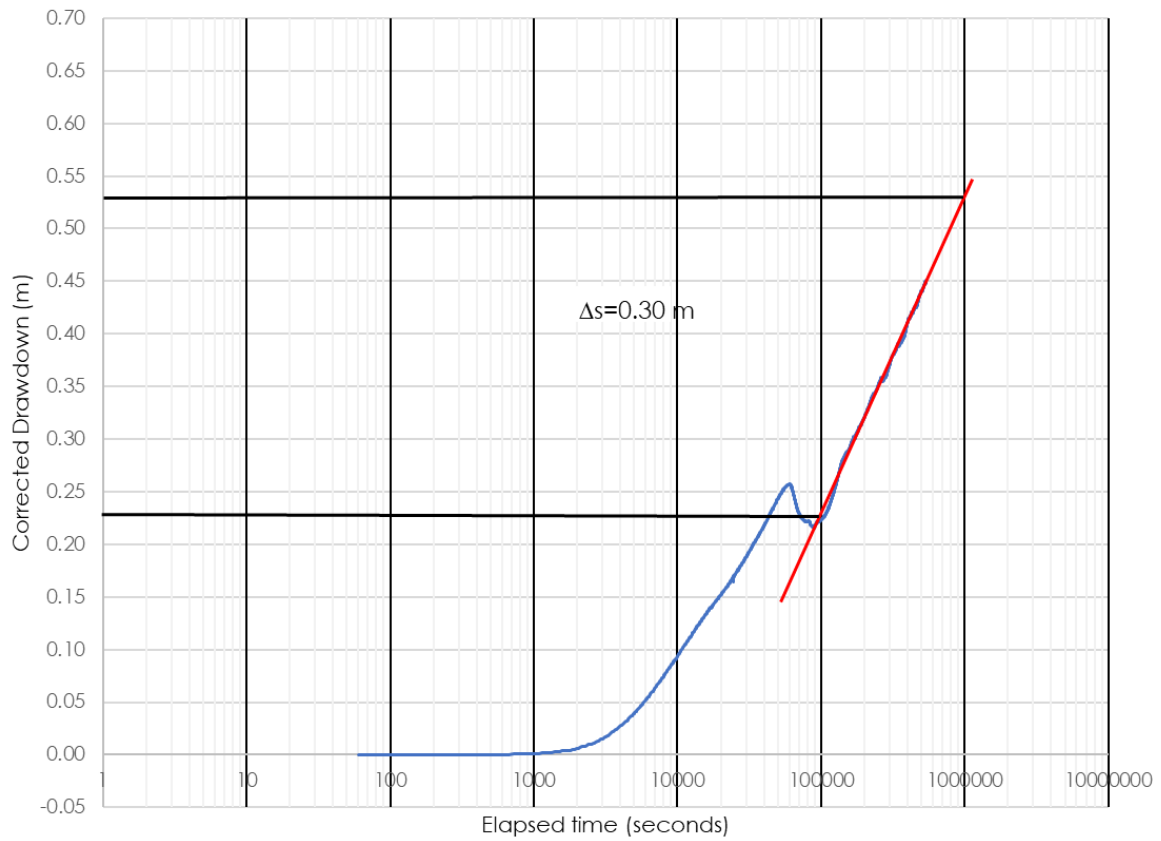


Figure A 13: MW07S time drawdown graph

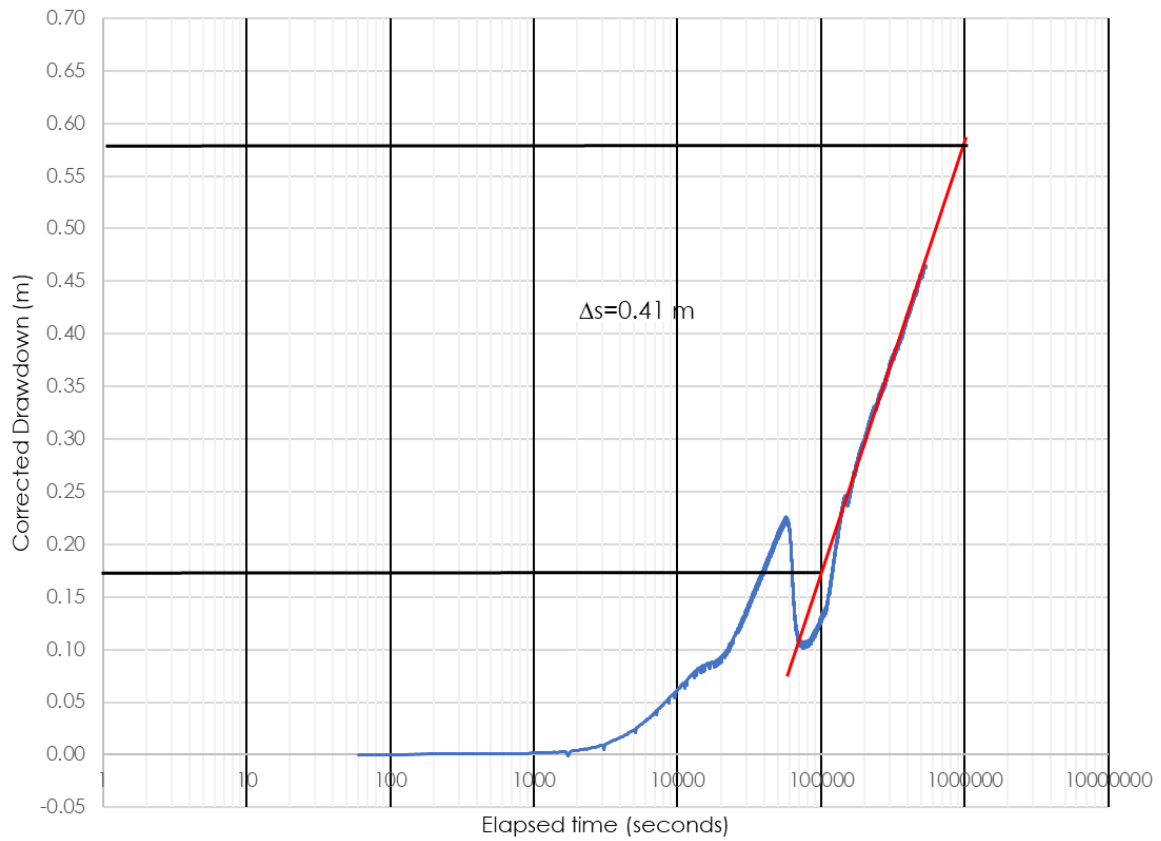


Figure A 14 MW08D time drawdown graph

Appendix 2:
Dewatering Engineering Calculations



Project:	24-380
Type of Calculation:	Radial Unconfined Aquifer Dewatering Flow Rate Estimates (Cooling tower)
Prepared by:	JP
Checked by:	MP
Date:	14/11/2025

Calculation Details			
Ground level (mAOD)	4.50	4.50	4.50
Length of Excavation (m)	28.60	28.60	28.60
Width of Excavation (m)	25.20	25.20	25.20
Initial Groundwater Level (mAOD)	3.20	3.20	3.20
Target Groundwater Level (mAOD)	1.75	1.75	1.75
Drawdown (m)	1.45	1.45	1.45
Strata being Dewatered	Tidal Flat Deposits		
Permeability Range of Dewatered Strata (m/s)	1.00E-04	2.00E-04	2.50E-04
Base of Aquifer (mAOD)	-17.00	-17.00	-17.00
H (m)	20.20	20.20	20.20
hw (m)	18.8	18.8	18.8
(H-hw) (m)	1.45	1.45	1.45
Radius of Equivalent Well re (m)	17.13	17.13	17.13
B (Partial Penetration Factor)	0.31	0.31	0.31
Ro by Sichardts formula (m)	60.63	78.64	85.90

Estimated Required Dewatering Flow Rates			
Total Estimated Dewatering Flow Rate (l/s)	4.3	7.1	8.4
Total Estimated Dewatering Flow Rate (m3/day)	372	617	729

NOTES ON CALCULATIONS:

Calculations are undertaken in accordance with CIRIA C750 Groundwater control: design and practice, second edition (2016).

Radial Confined calculations undertaken as per :

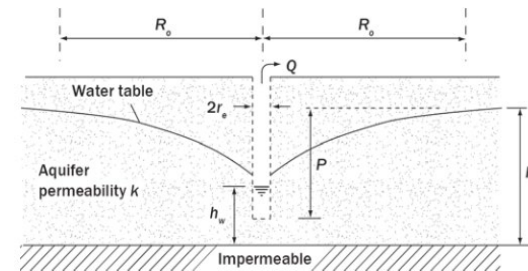
Radius of Equivalent Well (CIRIA C750 Equation 6.6) $r_e = (a + b)/\pi$

Partial Penetration Factor (CIRIA C750 6.7 and 6.10) Unconfined conditions: $Q = \frac{\pi k(H^2 - h_w^2)}{\ln[R_e/r_e]}$

$Q_{pp} = BQ_p$

Ro by Sichards Formula (CIRIA C750 6.9)

Radial flow: $R_o = C(H - h_w)\sqrt{k}$



Extracted from CIRIA C750 (Figure 6.8 B)



Project:	24-380
Type of Calculation:	Radial Unconfined Aquifer Dewatering Flow Rate Estimates (Pig Receiver)
Prepared by:	JP
Checked by:	MP
Date:	14/11/2025

Calculation Details			
Ground level (mAOD)	4.50	4.50	4.50
Length of Excavation (m)	19.10	19.10	19.10
Width of Excavation (m)	12.45	12.45	12.45
Initial Groundwater Level (mAOD)	3.20	3.20	3.20
Target Groundwater Level (mAOD)	1.51	1.51	1.51
Drawdown (m)	1.69	1.69	1.69
Strata being Dewatered	Tidal Flat Deposits		
Permeability Range of Dewatered Strata (m/s)	1.00E-04	2.00E-04	2.50E-04
Base of Aquifer (mAOD)	-17.00	-17.00	-17.00
H (m)	20.20	20.20	20.20
hw (m)	18.5	18.5	18.5
(H-hw) (m)	1.69	1.69	1.69
Radius of Equivalent Well re (m)	10.04	10.04	10.04
B (Partial Penetration Factor)	0.31	0.31	0.31
Ro by Sichardts formula (m)	60.74	81.74	90.21

Estimated Required Dewatering Flow Rates			
Total Estimated Dewatering Flow Rate (l/s)	3.5	6.0	7.2
Total Estimated Dewatering Flow Rate (m3/day)	303	520	621

NOTES ON CALCULATIONS:

Calculations are undertaken in accordance with CIRIA C750 Groundwater control: design and practice, second edition (2016).

Radial Confined calculations undertaken as per :

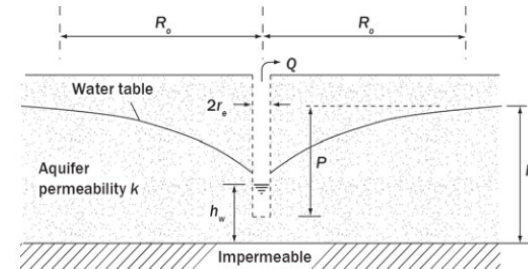
Radius of Equivalent Well (CIRIA C750 Equation 6.6) $r_e = (a + b)/\pi$

Partial Penetration Factor (CIRIA C750 6.7 and 6.10) Unconfined conditions: $Q = \frac{\pi k(H^2 - h_w^2)}{\ln[R_e/r_e]}$

$Q_{pp} = BQ_p$

Ro by Sichards Formula (CIRIA C750 6.9)

Radial flow: $R_o = C(H - h_w)\sqrt{k}$



Extracted from CIRIA C750 (Figure 6.8 B)



Project:	24-380
Type of Calculation:	Radial Unconfined Aquifer Dewatering Flow Rate Estimates (Gas Inlet Facility)
Prepared by:	JP
Checked by:	MP
Date:	14/11/2025

Calculation Details			
Ground level (mAOD)	4.50	4.50	4.50
Length of Excavation (m)	40.80	40.80	40.80
Width of Excavation (m)	39.40	39.40	39.40
Initial Groundwater Level (mAOD)	3.20	3.20	3.20
Target Groundwater Level (mAOD)	1.48	1.48	1.48
Drawdown (m)	1.73	1.73	1.73
Strata being Dewatered	Tidal Flat Deposits		
Permeability Range of Dewatered Strata (m/s)	1.00E-04	2.00E-04	2.50E-04
Base of Aquifer (mAOD)	-17.00	-17.00	-17.00
H (m)	20.20	20.20	20.20
hw (m)	18.5	18.5	18.5
(H-hw) (m)	1.725	1.725	1.725
Radius of Equivalent Well re (m)	25.53	25.53	25.53
B (Partial Penetration Factor)	0.31	0.31	0.31
Ro by Sichardts formula (m)	77.28	98.71	107.35

Estimated Required Dewatering Flow Rates			
Total Estimated Dewatering Flow Rate (l/s)	5.8	9.5	11.2
Total Estimated Dewatering Flow Rate (m3/day)	502	822	968

NOTES ON CALCULATIONS:

Calculations are undertaken in accordance with CIRIA C750 Groundwater control: design and practice, second edition (2016).

Radial Confined calculations undertaken as per :

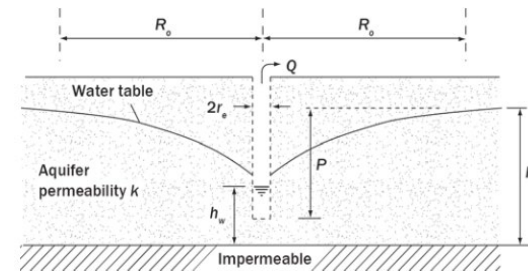
Radius of Equivalent Well (CIRIA C750 Equation 6.6) $r_e = (a + b)/\pi$

Partial Penetration Factor (CIRIA C750 6.7 and 6.10) Unconfined conditions: $Q = \frac{\pi k(H^2 - h_w^2)}{\ln[R_e/r_e]}$

$Q_{pp} = BQ_p$

Ro by Sichards Formula (CIRIA C750 6.9)

Radial flow: $R_o = C(H - h_w)\sqrt{k}$



Extracted from CIRIA C750 (Figure 6.8 B)



Project:	24-380
Type of Calculation:	Radial Unconfined Aquifer Dewatering Flow Rate Estimates (Knock Out drums)
Prepared by:	JP
Checked by:	MP
Date:	14/11/2025

Calculation Details			
Ground level (mAOD)	4.50	4.50	4.50
Length of Excavation (m)	30.00	30.00	30.00
Width of Excavation (m)	15.00	15.00	15.00
Initial Groundwater Level (mAOD)	3.20	3.20	3.20
Target Groundwater Level (mAOD)	1.00	1.00	1.00
Drawdown (m)	2.20	2.20	2.20
Strata being Dewatered	Tidal Flat Deposits		
Permeability Range of Dewatered Strata (m/s)	1.00E-04	2.00E-04	2.50E-04
Base of Aquifer (mAOD)	-17.00	-17.00	-17.00
H (m)	20.20	20.20	20.20
hw (m)	18.0	18.0	18.0
(H-hw) (m)	2.2	2.2	2.2
Radius of Equivalent Well re (m)	14.32	14.32	14.32
B (Partial Penetration Factor)	0.31	0.31	0.31
Ro by Sichardts formula (m)	80.32	107.66	118.68

Estimated Required Dewatering Flow Rates			
Total Estimated Dewatering Flow Rate (l/s)	4.7	8.0	9.6
Total Estimated Dewatering Flow Rate (m3/day)	406	694	828

NOTES ON CALCULATIONS:

Calculations are undertaken in accordance with CIRIA C750 Groundwater control: design and practice, second edition (2016).

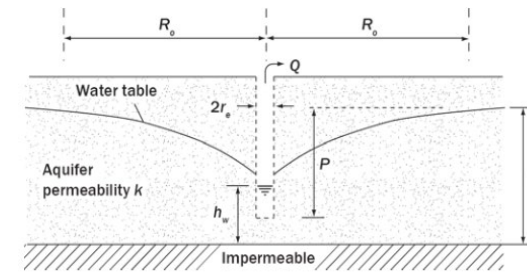
Radial Confined calculations undertaken as per :

Radius of Equivalent Well (CIRIA C750 Equation 6.6) $r_e = (a + b)/\pi$

Partial Penetration Factor (CIRIA C750 6.7 and 6.10) Unconfined conditions: $Q = \frac{\pi k(H^2 - h_w^2)}{\ln[R_o/r_e]}$

$Q_{pp} = BQ_{rp}$

Ro by Sichards Formula (CIRIA C750 6.9) Radial flow: $R_o = C(H - h_w)\sqrt{k}$



Extracted from CIRIA C750 (Figure 6.8 B)



Project:	24-380
Type of Calculation:	Radial Unconfined Aquifer Dewatering Flow Rate Estimates (Propane Tank)
Prepared by:	JP
Checked by:	MP
Date:	14/11/2025

Calculation Details			
Ground level (mAOD)	4.50	4.50	4.50
Length of Excavation (m)	30.00	30.00	30.00
Width of Excavation (m)	15.00	15.00	15.00
Initial Groundwater Level (mAOD)	3.20	3.20	3.20
Target Groundwater Level (mAOD)	1.00	1.00	1.00
Drawdown (m)	2.20	2.20	2.20
Strata being Dewatered	Tidal Flat Deposits		
Permeability Range of Dewatered Strata (m/s)	1.00E-04	2.00E-04	2.50E-04
Base of Aquifer (mAOD)	-17.00	-17.00	-17.00
H (m)	20.20	20.20	20.20
hw (m)	18.0	18.0	18.0
(H-hw) (m)	2.2	2.2	2.2
Radius of Equivalent Well re (m)	14.32	14.32	14.32
B (Partial Penetration Factor)	0.31	0.31	0.31
Ro by Sichardts formula (m)	80.32	107.66	118.68

Estimated Required Dewatering Flow Rates			
Total Estimated Dewatering Flow Rate (l/s)	4.7	8.0	9.6
Total Estimated Dewatering Flow Rate (m3/day)	406	694	828

NOTES ON CALCULATIONS:

Calculations are undertaken in accordance with CIRIA C750 Groundwater control: design and practice, second edition (2016).

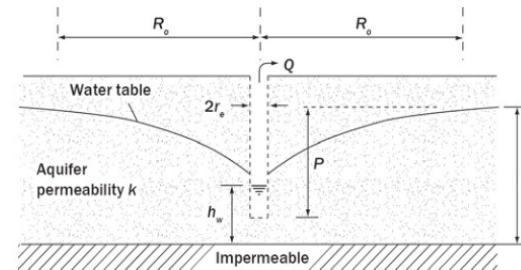
Radial Confined calculations undertaken as per :

Radius of Equivalent Well (CIRIA C750 Equation 6.6) $r_e = (a + b)/\pi$

Partial Penetration Factor (CIRIA C750 6.7 and 6.10) Unconfined conditions: $Q = \frac{\pi k(H^2 - h_w^2)}{\ln[R_o/r_e]}$

$Q_{pp} = BQ_p$

Ro by Sichardts Formula (CIRIA C750 6.9) Radial flow: $R_o = C(H - h_w)\sqrt{k}$



Extracted from CIRIA C750 (Figure 6.8 B)



Project:	24-380
Type of Calculation:	Radial Unconfined Aquifer Dewatering Flow Rate Estimates (Compression station per dewatering area)
Prepared by:	JP
Checked by:	MP
Date:	14/11/2025

Calculation Details			
Ground level (mAOD)	4.50	4.50	4.50
Length of Excavation (m)	53.00	53.00	53.00
Width of Excavation (m)	46.00	46.00	46.00
Initial Groundwater Level (mAOD)	3.20	3.20	3.20
Target Groundwater Level (mAOD)	1.00	1.00	1.00
Drawdown (m)	2.20	2.20	2.20
Strata being Dewatered	Tidal Flat Deposits		
Permeability Range of Dewatered Strata (m/s)	1.00E-04	2.00E-04	2.50E-04
Base of Aquifer (mAOD)	-17.00	-17.00	-17.00
H (m)	20.20	20.20	20.20
hw (m)	18.0	18.0	18.0
(H-hw) (m)	2.2	2.2	2.2
Radius of Equivalent Well re (m)	31.51	31.51	31.51
B (Partial Penetration Factor)	0.31	0.31	0.31
Ro by Sichardts formula (m)	97.51	124.85	135.87

Estimated Required Dewatering Flow Rates			
Total Estimated Dewatering Flow Rate (l/s)	7.2	11.8	13.9
Total Estimated Dewatering Flow Rate (m3/day)	620	1017	1198

NOTES ON CALCULATIONS:

Calculations are undertaken in accordance with CIRIA C750 Groundwater control: design and practice, second edition (2016).

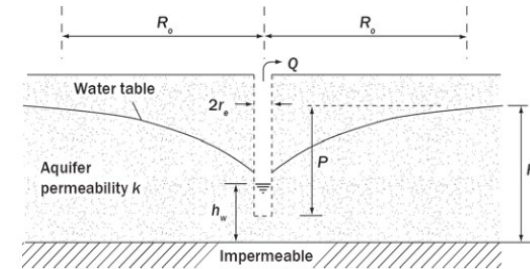
Radial Confined calculations undertaken as per :

Radius of Equivalent Well (CIRIA C750 Equation 6.6) $r_e = (a + b)/\pi$

Partial Penetration Factor (CIRIA C750 6.7 and 6.10) Unconfined conditions: $Q = \frac{\pi k(H^2 - h_w^2)}{\ln[R_e/r_e]}$

$Q_{pp} = BQ_{pp}$

Ro by Sichards Formula (CIRIA C750 6.9) Radial flow: $R_o = C(H - h_w)\sqrt{k}$



Extracted from CIRIA C750 (Figure 6.8 B)

Project:	24-380
Type of Calculation:	Radial Unconfined Aquifer Dewatering Flow Rate Estimates (Oily water collection tank)
Prepared by:	JP
Checked by:	MP
Date:	14/11/2025

Calculation Details			
Ground level (mAOD)	4.50	4.50	4.50
Length of Excavation (m)	35.00	35.00	35.00
Width of Excavation (m)	17.00	17.00	17.00
Initial Groundwater Level (mAOD)	3.20	3.20	3.20
Target Groundwater Level (mAOD)	1.00	1.00	1.00
Drawdown (m)	2.20	2.20	2.20
Strata being Dewatered	Tidal Flat Deposits		
Permeability Range of Dewatered Strata (m/s)	1.00E-04	2.00E-04	2.50E-04
Base of Aquifer (mAOD)	-17.00	-17.00	-17.00
H (m)	20.20	20.20	20.20
hw (m)	18.0	18.0	18.0
(H-hw) (m)	2.2	2.2	2.2
Radius of Equivalent Well re (m)	16.55	16.55	16.55
B (Partial Penetration Factor)	0.31	0.31	0.31
Ro by Sichards formula (m)	82.55	109.89	120.91

Estimated Required Dewatering Flow Rates			
Total Estimated Dewatering Flow Rate (l/s)	5.0	8.6	10.2
Total Estimated Dewatering Flow Rate (m3/day)	436	740	880

NOTES ON CALCULATIONS:

Calculations are undertaken in accordance with CIRIA C750 Groundwater control: design and practice, second edition (2016).

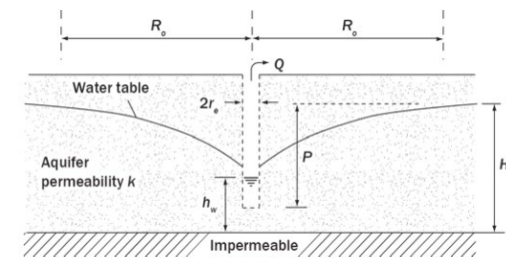
Radial Confined calculations undertaken as per :

Radius of Equivalent Well (CIRIA C750 Equation 6.6) $r_e = (a + b)/\pi$

Partial Penetration Factor (CIRIA C750 6.7 and 6.10) Unconfined conditions: $Q = \frac{\pi k(H^2 - h_w^2)}{\ln[R_o/r_e]}$

$Q_{pp} = BQ_p$

Ro by Sichards Formula (CIRIA C750 6.9) Radial flow: $R_o = C(H - h_w)\sqrt{k}$



Extracted from CIRIA C750 (Figure 6.8 B)

Appendix 3:
Indicative Dewatering Well Designs

Stuart Wells Limited

