SWECO

Deeside

Preliminary Dewatering Assessment

Sweco UK Limited	2888385
Project Name	Deeside Airfields - Raw Water Paper Mill Feasibility Report and Detailed Design
Project Number	65201386-001
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Change list

Ver	Date	Description of the change	Reviewed	Approved by
1	25/10/2023	For TA approval	KF	**CB**
2	03/11/2023	Revisions/ amendments made following TA review	KF	CB

Summary

Laying of a new raw water main and construction of a pump house is required for the proposed Industrie Cartarie Tronchetti (ICT) Paper Processing Mill in the Sealand area of Flintshire, North Wales. Temporary excavation works into the underlying permeable Tidal Flat Deposits (TFD) will require a groundwater abstraction licence. This document is in support of the abstraction licence application to National Resources Wales (NRW) and provides a Hydrogeological Impact Appraisal which includes development of a conceptual model and calculation of likely groundwater inflows to the temporary excavations. The works are being carried out on behalf of Dŵr Cymru Welsh Water (DCWW).

Site-specific permeabilities considered representative of the made ground and TFD, underlying the proposed route of the raw water main and pump house, were used to estimate a range of groundwater inflows to excavations.

The total length of the dewatered section for the raw main is 1100 metres. Dewatering will be carried out by a specialist dewatering contractor and the proposed methodology includes dewatering of three sections at a time. Each section is approximately 70 metres long, three metres wide and four metres deep, and will be dewatered using a single side well pointing method. The calculated inflows are between 171 and 622 m^3/day (2 and 7.2 l/s).

The excavation for the pump house is an approximately ten metres long, six metre wide and four-metre-deep foundation pad. The calculated inflows are between 83 and 318 m^3/day (0.96 to 3.68 l/s).

The radii of influence for both the trench and pump house foundation dewatering are estimated to be between 35 and 81 metres.

The raw water main will run from east to west, from the southern edge of the residential property “Greenfields” on Green Lane East, along the southern side of the daylighted section of the Northern Drain watercourse, towards the Old Marsh Farm Cottages. The raw water main continues westwards, along the southern boundary of the Old Marsh Farm Cottages, under the A548, A494 and B5441, continuing along the newly implemented road on the former RAF site.

The proposed arrangement for the abstracted groundwater is for it to be discharged to the Garden City Drain, via the implementation of surface water swales, as outlined in Appendix A. Subsequently, the Garden City Drain discharges to the river Dee, via the Dee estuary. A permit is being sought for this activity, as part of this application.

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1 Introduction

1.1 Background

1.1.1 Sweco was appointed by Dŵr Cymru Welsh Water (DCWW), to undertake the detailed design and construction of the new raw water main, for the proposed Industrie Cartarie Tronchetti (ICT) Paper Processing Mill in the Sealand area of Flintshire, North Wales; The extent of the entire raw water main is hereafter referred to as 'the site'. As part of the installation, only the section to the east of the A494 requires dewatering due to shallow groundwater levels. Figures 1-1 and 1-2 display the extent of 'the site' and extent of the area requiring dewatering.

1.1.2 The works involve the installation of approximately 2.3 km of high-density polyethylene (HDPE)/ steel raw water main, and associated supporting infrastructure, to the proposed Paper Mill site. This forms the continuation of an existing 27" raw water main located approximately 2 km to the east, south of the residential property called Greenfields, on Green Lane East.

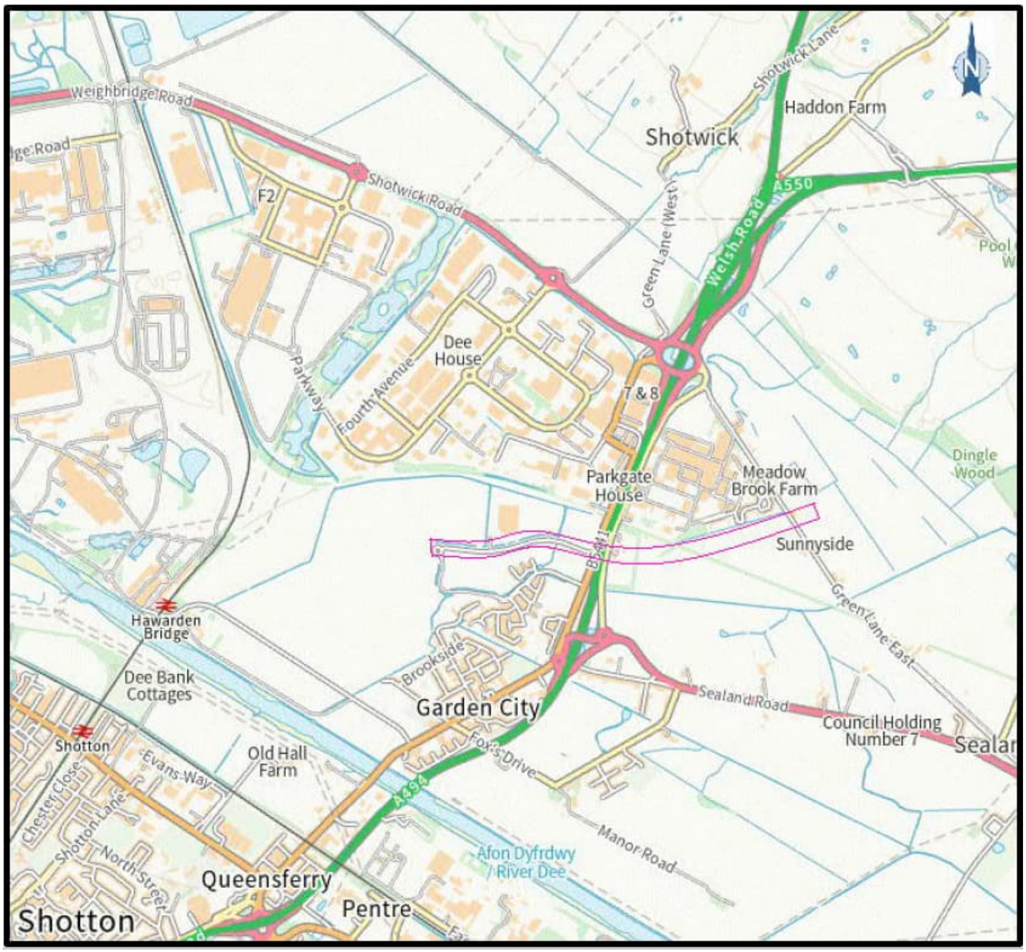


Figure 1-1: Site location and extent map

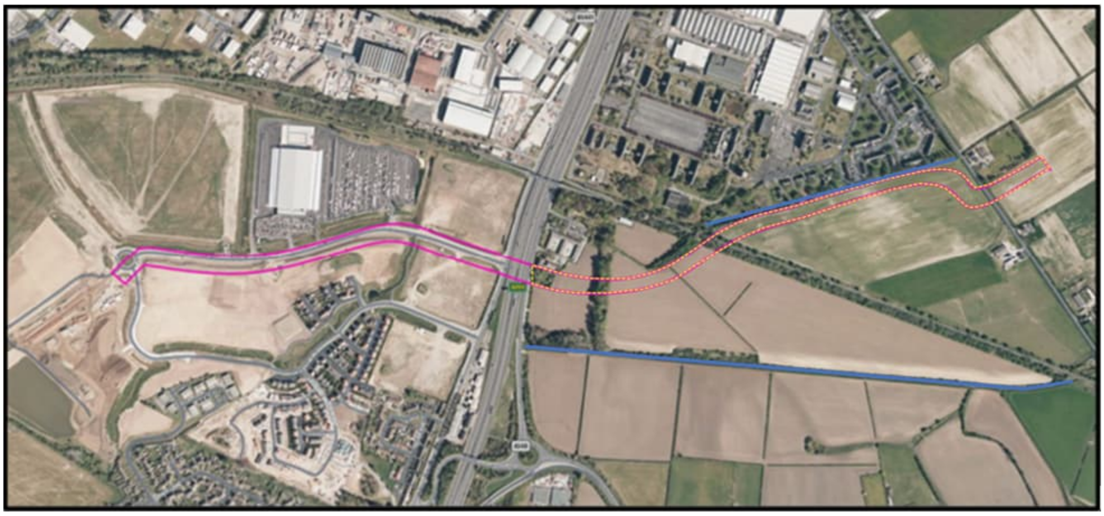


Figure 1-2: Full site (pink solid line) and required dewatering extents (red dashed line). (Sweco UK Ltd, 2023)

1.1.3 The total extent of the raw water main ('the site') is approximately 4.3 hectares, as delineated by the solid pink outline in Figure 1-2. Within 'the site', the section requiring dewatering, east of the A494, is approximately 2.2 hectares, and indicated by the red dashed line in Figure 1-2. The site comprises:

- Arable and agricultural land, contained in four separate fields.
- Two watercourses abound the northern (Northern Drain) and southern (Garden City Drain) extents of the site.
- A public foot path (Chester Millennium Greenway), which follows the path of the former London and North-eastern Railway line.

1.1.4 Ground elevation increases from west to east across the site and varies between 4 and 5m Above Ordnance Datum (AOD).

1.1.5 Due to the presence of shallow groundwater within an extensive sand aquifer beneath the site, an abstraction licence is required to enable temporary dewatering of excavation works. Excavations will be required for trench works and for the formation of a temporary abstraction pumping foundation slab pad, located adjacent to the eastern end of the trench, as indicated on Figure 1-2.

1.1.6 This document is in support of the application for a groundwater abstraction transfer licence for the temporary works.

1.1.7 A consent to discharge the abstracted groundwater is also being sought as part of this application.

1.1.8 A plan showing the surface water courses and proposed discharge locations is presented on a plan in Appendix A of this report.

1.1.9 During initial communications and discussions with Natural Resources Wales (NRW), it was established that the proposed discharge of abstracted groundwater, to the surrounding watercourses, would be exempt from the requirement to provide a Flood Risk Activity Permit (FRAP). A FRAP would normally be required to demonstrate no adverse increase in flood risk, but this project is exempt as the licence and permit holder Dŵr Cymru Welsh Water (DCWW) is a water undertaker.

1.2 Scope of works

1.2.1 This document presents a Preliminary Dewatering Assessment for the proposed dewatering abstractions, which considers the following elements:

- Section 1 outlines the information regarding the project initiation and timescale alongside the assessment methodology implemented to calculate the influence radii and groundwater inflow rates likely to occur within the excavations.
- Section 2 provides baseline information for the site and surrounding area, including information from the 2023 ground investigation (Sweco UK Ltd, 2023), details of potential receptors identified and a hydrogeological conceptual model.
- Section 3 provides preliminary dewatering estimates, and summarises abstraction licensing and discharge requirements, alongside the proposed mitigation methods and technical uncertainties.
- Section 4 contains the preliminary impact assessment outlining any likely risk and impact of the proposed dewatering activities on the identified potentially vulnerable groundwater receptors.
- Section 5 summarises the main conclusions and findings contained within the whole report, detailing the calculated inflows, influence radii, identified vulnerable receptors and associated mitigation methods.

1.2.2 Hydrogeological conditions have been established using data from ground investigations, as presented in the Sweco GI report (Sweco UK Ltd, 2023) and with reference to the assessment for the nearby sewer diversion works (Geotechnics Ltd, 2016).

1.2.3 All calculations presented in this document are preliminary, conservative estimates, that will be updated as an improved understanding of dewatering methodology and groundwater control measures is established.

1.2.4 References are provided at the end of the document.

1.3 Assessment methodology

1.3.1 Based on available site-specific hydrogeological information, estimation of groundwater inflows to excavations for the trench and foundation pad, have been estimated using the empirical Dupuit-Thiem equation for unconfined conditions (Preene et al., 2016). Additionally, the radii of influence (Ro) in relation to the proposed dewatering strategy, were calculated using the empirical Sichardt formula.

1.3.2 The empirical Sichardt equation is based on observational data and can underestimate the radius of influence, due to overestimating the hydraulic gradient and subsequently the inflow. Despite this, it is still used routinely to estimate a radius of influence for input to the analytical Dupuit-Thiem equation (Preene, et al., 2016). These are in accordance with CIRIA guidance (Preene, et al., 2016).

1.3.3 The likely zone of influence has been estimated to determine if ground and surface water receptors in the area may be potentially impacted by the dewatering.

1.3.4 Further details on the dewatering assessment methodology are provided in Section 3.2.

1.4 Project timescale

1.4.1 Site enabling works are projected to begin in January/ February 2024.

2 Baseline conditions

2.1.1 Desk based geological and hydrogeological information is provided in this section.

2.2 Information sources

2.2.1 The following sources have been used to obtain information:

- British Geological Survey [BGS] GeoIndex (onshore) online map (British Geological Survey, 2023).
- Department of Environment, Food and Rural Affairs MAGIC online map (DEFRA, 2023a) with the following datasets:

    - Sites of Special Scientific Interest [SSSI's] (Natural England, 2023b)
    - Special Areas of Conservation (Natural England, 2023c)
    - Local Nature Reserves (Natural England, 2023d)
    - National Nature Reserves (Natural England, 2023e)
    - Ramsar Sites (Natural England, 2023f)

- Natural Resources Wales (2023) DataMapWales online map viewer with the following datasets:
    - Licensed Water Abstractions (Natural Resources Wales, 2023c)
    - Permitted discharges to controlled waters with conditions (Natural Resources Wales, 2023d)
    - Sites of Special Scientific Interest [SSSI] (Natural Resources Wales, 2023e)
    - Special Areas of Conservation [SAC] (Natural Resources Wales, 2023f)
    - National Nature Reserves (Natural Resources Wales, 2023g)
    - Local Nature Reserves (Natural Resources Wales, 2023h)
    - Ramsar Wetlands of International Importance (Natural Resources Wales, 2023i)
- Department of Environment, Food and Rural Affairs, Catchment Data Explorer (DEFRA, 2023b).

2.2.2 Site-specific information pertaining to the geological setting within the site, was obtained by referring to the previous 2023 Ground Investigation Report (Sweco UK Ltd, 2023).

2.3 Consultation

2.3.1 A freedom of information (FOI) request was made to National Resources Wales (NRW), Flintshire Council and Cheshire West and Chester Council for the below information:

- Licenced and unlicensed groundwater abstractions within 1.5 kilometres of the site.
- Consented discharges within 1.5 kilometres of the site.
- Information on unlicenced private water supplies, within 1.5 kilometres of the site.
- Locations of any known landfills or locations of waste deposit, within 1.5 kilometres of the site.
- Any documented pollution incidents, within 1.5 kilometres of the site.

2.3.2 The FOI requests were submitted to NRW, Flintshire and Cheshire West and Chester councils on 24 August 2023.

2.3.3 Responses were received from Flintshire Council, National Resources Wales and Cheshire West and Chester councils, on 30, 24 August and 18 September 2023 respectively. Flintshire councils' response indicated that licensed abstractions and consented discharges information could be obtained from the NRW's DataMapWales online portal, whilst they had no information regarding unlicensed abstractions or consents. Cheshire West and Chester council's response indicated that there were no licensed or licensed abstractions or consented discharges within the requested 1.5km extent from the site, within their jurisdiction.

2.3.4 All of the obtained information is summarised within the baseline Hydrology (Section 2.5) and Hydrogeology (section 2.6) sections.

2.4 Ground investigation works summary

2.4.1 Information on ground conditions and groundwater monitoring data was collected as part of the ground investigation as summarised in Table 2-1. GI locations, borehole logs and trial pit logs are provided in Appendix B of this report (as extracted from the Sweco Ground Investigation Report).

Table 2-1 Summary of available site-specific hydrogeological data.

Data Source/ Type	Description
Sweco 2023 Ground Investigation Report	Ground investigation specified and managed by Sweco, conducted by Socotec Ltd, various contractors in 2023. This included three cable percussive boreholes (SWE-BH-01, SWE-BH-01B, SWE-BH-02), four windowless samples holes (WS02-05), five machine excavated trial pits (TP05-09) and 41 In situ SPT test were conducted. Groundwater monitoring wells were installed in two of the boreholes SWE-BH-01B and SWE-BH-02, and manually monitored over six consecutive weeks following installation (17 May – 20 June 2023).

2.4.2 Schematic conceptualized geological cross sections have been developed using the information from the exploratory boreholes installed during the 2023 GI, in addition to the historic borehole records held as part of the BGS GeoIndex (Onshore) database (UKRI – BGS, 2023d). These are discussed in detail within section 2.11 and presented within Appendix C.

2.4.3 Three separate longitudinal, east to west cross sections, extending between chainage sections 0-550, 500-1050 and 1000-1550 metres were created using the GI installed borehole, trial pits and window screening produced data. An additional southeast to northeast transverse cross section, displaying various strata thicknesses and interface depths was also created using both the GI collected data and historic borehole data from the BGS GeoIndex public database (UKRI – BGS, 2023d). The groundwater level strike and groundwater level data presented within these hydrogeological conceptual cross-sectional models is discussed further in Section 2.6.

Water Quality

2.4.4 Two of the boreholes implemented within the GI report, provided groundwater samples for geochemical compositional analysis. SWE-BH-01B and SWE-BH-02 were both sampled on 23 May 2023, from depths 2.15mbgl and 1.60 mbgl respectively.

2.4.5 Table 2-2 displays details of the full groundwater analysis testing suite conducted on both groundwater samples, whilst the resultant analysis data is tabulated in Table 2-3.

Table 2-2: Groundwater testing suite analysis breakdown (Sweco UK Ltd, 2023)

Testing Suite	No. of Samples	Suite Breakdown
Groundwater Suite	2	pH, Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Zinc, Boron, Cyanide (Free, Total and Complex), Sulphide, Total Sulphur as SO4, Chloride, Ammoniacal Nitrogen as N, NH4 and NH3, 16 PAHs, TPH CWG (C5 – C35) including GRO & BTEX, MTBE, Nitrate as NO3, Electrical Conductivity at 25°C and Low-Level Phenols

Table 2-3: Groundwater Geochemical Compositional Analysis

			Sample ID	
Analysis	**LOD**	**Unit**	**SWE-BH-01B**	**SWE-BH-02**
Ammoniacal Nitrogen as N	0.01	mg/l	<0.01	<0.01
Ammoniacal Nitrogen as NH3	0.02	mg/l	<0.02	<0.02
Ammoniacal Nitrogen as NH4	0.02	mg/l	<0.02	<0.02
>C6-C7 Aliphatic	0.1	mg/l	<0.100	<0.100
>C7-C8 Aliphatic	0.1	mg/l	<0.100	<0.100
>C7-C8 Aromatic	0.05	mg/l	<0.005	<0.005
>C8-C10 Aliphatic	0.1	mg/l	<0.100	<0.100
>C8-C10 Aromatic	0.02	mg/l	<0.020	<0.020
C5-C6 Aliphatic	0.1	mg/l	<0.100	<0.100
C5-C7 Aromatic	0.005	mg/l	<0.005	<0.005
Total GRO C5-C10	0.1	mg/l	<0.100	<0.100
Conductivity at 25°C	100	µS/cm	818	906
pH	1	pH units	8.3	8.4
Chloride as Cl	1	mg/l	24	71
Nitrate as NO3	0.9	mg/l	<0.9	0.9
Complex Cyanide	0.02	mg/l	<0.02	<0.02
Free Cyanide	0.02	mg/l	<0.02	<0.02
Sulphide as S	0.02	mg/l	<0.02	<0.02
Total Cyanide	0.02	mg/l	<0.02	<0.02
Arsenic as As	0.001	mg/l	0.002	0.001
Cadmium as Cd	0.00002	mg/l	<0.00002	<0.00002
Total Chromium as Cr	0.001	mg/l	<0.001	<0.001
Copper as Cu	0.001	mg/l	0.001	<0.001
Lead as Pb	0.001	mg/l	<0.001	<0.001
Mercury as Hg	0.00003	mg/l	<0.00003	<0.00003
Nickel as Ni	0.001	mg/l	0.002	0.002
Selenium as Se	0.001	mg/l	0.003	<0.001
Zinc as Zn	0.002	mg/l	<0.002	0.008
Boron as B	0.01	mg/l	0.07	0.08
Total Sulphur as SO4	3	mg/l	168	128
MTBE	10	µg/l	<10	<10
Benzene	5	µg/l	<5	<5
Ethylbenzene	5	µg/l	<5	<5
m/p-Xylene	10	µg/l	<10	<10
o-Xylene	5	µg/l	<5	<5
Toluene	5	µg/l	<5	<5
Acenaphthene	0.01	µg/l	<0.01	<0.01
Acenaphthylene	0.01	µg/l	<0.01	<0.01
Anthracene	0.01	µg/l	<0.01	<0.01
Benzo[a]anthracene	0.01	µg/l	<0.01	<0.01
Benzo[a]pyrene	0.01	µg/l	<0.01	<0.01
Benzo[b]fluoranthene	0.01	µg/l	<0.01	<0.01
Benzo[g,h,i]perylene	0.01	µg/l	<0.01	<0.01
Benzo[k]fluoranthene	0.01	µg/l	<0.01	<0.01
Chrysene	0.01	µg/l	<0.01	<0.01
Dibenzo[a,h]anthracene	0.01	µg/l	<0.01	<0.01
Fluoranthene	0.01	µg/l	<0.01	<0.01
Fluorene	0.01	µg/l	<0.01	<0.01
Indeno[1,2,3-cd]pyrene	0.01	µg/l	<0.01	<0.01
Napthalene	0.01	µg/l	<0.01	0.01
Phenanthrene	0.01	µg/l	<0.01	0.01
Pyrene	0.01	µg/l	<0.01	0.01
Total PAH 16	0.16	µg/l	<0.16	0.18
>C10-C12 (Aliphatic)	0.01	mg/l	<0.10	<0.01
>C12-C16 (Aliphatic)	0.01	mg/l	<0.10	<0.01

>C16-C21 (Aliphatic)	0.01	mg/l	0.12	<0.01
>C21-C35 (Aliphatic)	0.01	mg/l	0.42	0.02
Total TPH >C8-C40 (Aliphatic)	0.01	mg/l	0.93	0.05
>C10-C12 (Aromatic)	0.01	mg/l	<0.10	<0.01
>C12-C16 (Aromatic)	0.01	mg/l	0.10	<0.01
>C16-C21 (Aromatic)	0.01	mg/l	<0.01	<0.01
>C21-C35 (Aromatic)	0.01	mg/l	0.17	0.01
Total TPH >C8-C40 (Aromatic)	0.01	mg/l	0.58	0.04
Dimethylphenols	0.0005	mg/l	<0.0005	<0.0005
Methylphenols	0.0005	mg/l	<0.0005	<0.0005
Phenol	0.0005	mg/l	<0.0005	<0.0005
Total Phenol	0.002	mg/l	<0.0020	<0.0020
Trimethylphenols	0.0005	mg/l	<0.0005	<0.0005

2.4.6 As seen from the geochemical analysis, most of the concentrations of the analysed constituent chemicals were below the analytical limits of detection. Only arsenic, nickel, boron, total sulphur and >C21-C35, Total TPH >C8-C40 (both aliphatic) and >C21-C35 and Total TPH >C8-C40 (both aromatic) displayed concentrations greater than the limits of detection in both groundwater samples.

2.4.7 Additional concentrations exceeding the LODs in either of the samples include copper, selenium, C16-C21 aliphatic and C12-C16 aromatic (SWE-BH-01B-1-EW-2.15) and naphthalene, phenanthrene, pyrene and total PAH 16 (SWE-BH-02-1-EW-1.60). Despite this, the concentrations are comparatively low concentrations, with no further contamination risk identified within the initial GI report (Sweco UK Ltd, 2023).

Geology

Made Ground

2.4.8 Deposits of superficial made ground were encountered, at boreholes SWE-BH-01, SWE-BH-01B, SWE-WS-02, and trial pits TP05 to TP09, as reported within the 2023 GI, primarily located around the western extents of the proposed dewatering section. Made ground is likely associated with the former aeronautical and industrial nature of the former RAF Airfield on the site, as well as the presence of the former Great Central Railway line now present as the Chester Millennium Greenway. The encountered made ground deposits were located from ground level to a maximal depth of 2.5 metres below ground level (mbgl). Made ground composition also varied, with the light brown gravelly fine to coarse sand, with gravel that is angular to subrounded fine to coarse flint, quartzite, sandstone and occasional brick and limestone present at SWE-BH-01B, TP05 and TP08 being the most prevalent. Furthermore, the made ground present at SWE-BH-01B and TP05 were both underlying superficial macadam layers, and fill material. The made ground encountered in the other GI structures was notably different in composition, suggesting separate depositional events, further aligning with the varied industrial, aeronautical, and locomotive history across the site.

Topsoil

2.4.9 Topsoil was encountered at all exploratory locations, except SWE-BH-01, SWE-BH-01B, SWE-WS-02 and trial pits TP05 to TP09, from ground level to a maximum depth of 0.35m bGL. This was primarily located along the eastern extent of the area requiring dewatering. Topsoil present consisted of greyish brown (SWE-WS-03, 04 and 05) and brown (SWE-BH-02) sandy silts. This is very similar to the underlying Tidal Flat Deposits (TFD) and is hence hypothesized to be reworked natural soils.

Superficial Deposits

2.4.10 Consultation of the available superficial geological maps (UKRI – BGS, 2023b) indicates that the entire site is underlain by TFD comprising clay, silt, and sand deposits. The boreholes and trial pits installed as part of the Ground Investigation, were of insufficient depth to confirm the thickness of the TFD, however the TFD was encountered in all of the boreholes and trial pits installed within the GI, except TP06. Geoindex mapping indicates that regionally the TFD extend approximately 1km to the east of the site and 3km to the west and extend north to the Welsh Channel and south to Chester.

2.4.11 Historic borehole log from SJ36NW46, sourced from the British Geological Survey (BGS) GeoIndex (Onshore) mapping tool (UKRI – BGS, 2023d), indicated that the TFD have an increasing clay content with depth, with boulder clay deposits underlying them. These Boulder Clay deposits were found at depths of approximately 64mbgl at historical locations and not encountered during the GI.

2.4.12 It was noted that none of the implemented investigatory structures in the 2023 GI, identified a total thickness of the TFD, however from the historic borehole log SJ36NW46 (BGS, 2023) it was found to be at least approximately 20.3 metres in thickness.

2.4.13 A summary is presented in Table 2-4 below.

Table 2-4: Summary of site-wide superficial geology

Stratum	Typical Description	Typical Encountered Depths (mbgl)	Typical Proven Thickness (m)	Distribution
Made Ground	Variable mix of greyish brown gravelly fine to coarse silty sand with angular to subangular, fine to coarse gravel of flint with occasional fragments of brick and concrete	Ground level	0.2 to 1.30	Sporadic
Topsoil	Greyish brown sandy SILT	Ground level	0.2 to 0.35	Sporadic
Tidal Flat Deposits	Variable CLAY, SILT and SAND deposits	0.65 (0.2 to 1.3)	1.2 to 19.8	Present across the entirety of the site.

Bedrock Geology

2.4.14 The bedrock underlying most of the site, as indicated from the BGS online 1:50,000 geological map, is the Triassic Kinnerton Sandstone Formation. The southwestern extent of the site is also indicated to be close to Westphalian Etruria Formation and Pennine Middle Coal Measure Formation.

2.4.15 None of the boreholes installed during the 2023 GI, determined the full thickness of the TFD, hence identification and information on the underlying bedrock was obtained from alternative sources.

2.4.16 Historic borehole records indicated that the Kinnerton Sandstone Formation was of a depth of at least 79.8mbgl (UKRI – BGS, 2023d).

2.5 Hydrology

2.5.1 Surrounding the site are three surface watercourses, the Northern, the Garden City and the Manor drains, which all drain water to the river Dee estuary, which is located approximately 1.45km south of the site. Further field and land drainage is present which subsequently drains into the aforementioned surface water bodies within the region. An overview of the surface water bodies, including some field and land drainage is present as Appendix A.

2.5.2 The Garden City Drain, the designated main river within the Garden City Drain Water Body catchment, is approximately 1.92km in length, whilst the catchment itself is approximately 1448.23 hectares (Natural Resources Wales, 2023b). The heavily modified river is located approximately one hundred and thirty metres to the south of the planned excavation for the raw main, at its closest point. The Garden City Drain flows from east to west across the Garden City area, flowing beneath the A494, before turning southward and discharging into the river Dee.

2.5.3 The Manor drain is a highly modified watercourse which flows from east to west, roughly parallel to both the proposed water main route and Garden City Drain. The Manor drain is situated approximately six hundred and thirty meters south of the south of the site. Additionally, the Northern Drain is located running from east to west approximately twenty metres north of the proposed excavation. The watercourse is exposed as it flows from the eastern extent of the dewatering site at Green Lane East before being culverted beneath the Chester Millennium Greenway, a section of approximately 50 metres in length. The North Drain subsequently returns to being daylighted, and merges with field drainage running along the southern side of the Chester Millennium Greenway embankment, flowing northwest.

2.5.4 Each of the Northern, Garden City and Manor drains all ultimately discharge into the river Dee, at the Dee estuary, approximately 1.55km southwest of the site.

2.5.5 The site is located within the Dee Estuary Operational Catchment, and the Garden City Drain (GB111067056960) water body catchment of the Dee River Basin Management Plan (DEFRA, 2023b,c,d,e; Natural Resources Wales, 2023b). The Garden City Drain water body catchment was assigned an overall moderate ecological status in the WFD (Water Framework Directive) Cycle 3, 2019. The Garden City Drain was assigned a Fail chemical designation, with reasons for not achieving good (RNAG) stated as follows:

- Poor livestock management
- Urbanisation
- Poor soil management
- Riparian/ in-river activities (including bankside erosion)
- Farm/ site infrastructure

- Trade/ Industry discharge
- Private sewage treatment
- Physical modification
- Land drainage – operational management

2.6 Hydrogeology

2.6.1 The Kinnerton Sandstone Formation, underlying the site is part of the Dee Permo-Triassic Sandstone water body and Operational Catchment within the Dee River Basin Management Plan. The Kinnerton Sandstone Formation is also classified as a principal aquifer by NRW. The NRW have classified the Kinnerton Sandstone Formation as a principal aquifer, and it is part of the larger EA classified, Dee Permo-Triassic Sandstone groundwater body (Natural Resources Wales, 2023b, DEFRA, 2023 b,c,d,e).

2.6.2 During 2019 WFD Cycle three, the Dee Permo-Triassic Sandstone achieved an overall Poor status. This was due to the Poor chemical status, limited by the chemical status element, chemical drinking water protected area and general chemical test contributory components. There were no documented reasons for not achieving good status (RNAG's), however the poor overall status is likely due to changes made to the assessment methodology and increase in the EA evidence base, within the chemical status classification, during the 2019 cycle. As a result of these changes, all water bodies now fail the chemical status and the 2019 assessment data is not comparable to previous assessment cycle data (DEFRA, 2023 b,c,d,e).

2.6.3 Aquifer designations for the site's underlying superficial and bedrock geology, are summarised in Table 2-5 below (DEFRA, 2023a).

Table 2-5: Summary of aquifer designations

Geology Type	Stratum	Aquifer designation
Superficial Deposits	Made Ground	Unproductive strata
	Topsoil	
	Tidal Flat Deposits	Secondary (undifferentiated) aquifer
Bedrock	Kinnerton Sandstone Formation	Principal Aquifer

2.6.4 The site is not located within a groundwater Source Protection Zone (SPZ). The nearest SPZ located approximately 3.5 kilometres to the southeast, across the river Dee (DEFRA, 2023a).

Licenced abstractions and discharges

2.6.5 A list of licenced abstractions and discharges is presented in the table below, with locations presented in in Appendix D.

Table 2-6: Licensed abstractions and consented discharges

Name	Location	Type	NGR	Distance from dewatering (m) and direction	Permit/ Licence no.	Date
Greenfields	NE of Green Lane East – N of the site.	Consented Discharge - Domestic Groundwater Discharge	SJ 34308 69956	27	CG0445601	1 January – 31 December
19 Green Lane East	NE of Green Lane East – S of the site.	Consented Discharge - Unnamed ditch/ watercourse	SJ 34380 69784	243	CM0023801	1 January – 31 December
Garden City – British Legion	A494 northwards slip road at Drome Cor, Deeside	Consented Discharge - Combined Sewer Outflow	SJ 33126 69169	608 southwest	CM0166001	1 January – 31 December
Sealand Pumping Station	Between Leopard Moth Road and Dee Road	Consented Discharge - Sewerage Network – Pumping Station	SJ 32920 69290	627 southwest	CM0118001	1 January – 31 December
North Access Road Trade Drainage	South of Sealand Avenue	Consented Discharge - Trade Discharges – Site Drainage	SJ 32763 69561	755 southwest	AB3295HG	N/A
Maesgwyn Farm Consented Discharge	Unnamed road, off Green Lane East	Consented Discharge - Sewage non water undertaker/ tributary or the Garden City Drain.	SJ 34000 70418	691 north	CM0025301	1 January – 31 December
Queensferry WWTW Storm Tank Overflow	Southern bankside of river Dee, near Bypass Road.	Consented Discharge - Queensferry WWTW Storm Tank Overflow	SJ 32380 68530	1440 south	CM0082301	1 January – 31 December
Queensferry WWTW Sewage Discharges – Final/ Treated Effluent	Southern bankside of river Dee, near Bypass Road.	Consented Discharge – Queensferry WWTW Final/ Treated Effluent Discharge	SJ 32379 68522	1470 south	CM0082201	1 January – 31 December
PS 1 (Phase 2) Deeside Industrial Park Pumping Station 1	Tenth Avenue, Deeside Industrial Park	Consented Discharge - Sewerage Pumping Station – Storm overflow discharge	SJ 31900 71150	1485 northwest	CG0366901	1 January – 31 December
Ashgrove Pumping Station Shotton	Southern bankside of river Dee, South of Hawarden Bridge.	Consented Discharge – Water company sewerage discharge	SJ 31231 69211	1500 southwest	CM0165801	1 January – 31 December
TATA Steel UK groundwater extraction borehole 1A	Field abounded by Green Lane West, north of Welsh Road.	Licenced Abstraction – Borehole 1A TATA Steel UK	SJ 33670 71170	1317 north	24/67/10/0090	N/A

2.6.6 Documented pollution incidents, within the 1.5km of the site, are listed in Table 2-7 below. Pollution incident information was requested and collected to evaluate any potential risk to the groundwater quality encountered during dewatering.

Table 2-7: Pollution Incidents within 1.5km buffer.

Name	Location	NGR	Distance from dewatering (m) and direction	Permit/ License No.	Date
Garden City Residential Development Pollution Incident	Northwest of Leopard Moth Road	SJ3278569574	607 southwest	2104408	20 May 2021
Zone 1 Deeside Industrial Park Pollution Incident	Parkway Business Centre Deeside Industrial Park, Unit 103, Zone 1, Deeside CH5 2LR	SJ3309670265	610 northwest	2003726	28 May 2020

2.6.7 Within 1.5km of the proposed dewatering excavation area there is one licenced groundwater abstraction, and ten consented groundwater discharges. The consented discharges consist of domestic sewage soakaways, combined sewerage overflows (CSO's), trade waste discharges, sewerage network pumping stations and drainage ditch discharges.

2.6.8 Two pollution incidents were confirmed, within 1.5km of the excavation area, at 607 metres and 610 metres from the site.

2.6.9 In addition to the surface waterbodies, there were also fifteen listed historic water wells, within 1.5km of the site (UKRI – BGS, 2023c). Details of the purported historic water wells, within 1.5 km of the site are tabulated in Table 2-8 below. It should be noted that consultation with the local councils did not suggest any unlicensed abstractions in the area.

Table 2-8: Identified Historic Water Wells within 1.5 km of site.

Name	Location	NGR	Distance From Site (m)
Brook Farm	Brook Farm	SJ34450 69230	693m southeast
Sealand Bank Farm	Sealand Bank Farm	SJ32100 69200	1370m south
Sealand Exploration Company no.2 Borehole	North of Shotton Clocktower	SJ31940 697830	1430m west
Ghorst's Cottage	East of Meadow View	SJ33930 68550	1300m south
SJ36/5B	East of East Green	SJ 33850 68390	1440m south
Ferry Bank Farm	Ferry Bank Farm	SJ 32800 68730	1170m south
Williams & Robinson, Queens Ferry	East of Station Road, Queensferry	SJ 32100 68500	1390m south
SJ36/32	West of Station Road, Queensferry	SJ 31900 68500	1450m south
SJ36/28A	North of Hawarden Bridge railway station	SJ 31260 69890	1310m west
SJ36/28B	North of Hawarden Bridge railway station	SJ 31250 69560	1310m west
SJ37/52	Desside Fishery	SJ 32120 70840	1130m northwest
SJ37/23	Dee Marshes	SJ 33190 70830	1100m north
SJ37/35	BSC, Shotton No. 1A – TATA Steelworks	SJ 33680 71180	1420 m north
SJ37/5A	Shotton No.1 – TATA Steelworks	SJ 33800 71100	1370m north
SJ37/4	Shotwick Park House	SJ 35810 70280	1500m east

2.7 Designated sites

2.7.1 The river Dee/ Dee estuary is a designated Site of Special Scientific Interest (SSSI) and a Special Area of Conservation, is located 1.43 km south of the proposed excavation works (Natural England, 2023).

2.7.2 Within the river Dee/ Dee estuary, there are Ramsaar designated wetlands and saltmarsh approximately 1450m south west of the site, along the northern bank of the river Dee/ Dee estuary.

2.8 Groundwater levels

2.8.1 Groundwater strike information has been summarised and presented in Table 2-9. TP05 was installed on 26 April 2023, whilst the remaining boreholes and window sampling displayed in Table 2-9, were installed between 2 and 10 May 2023.

2.8.2 The Shallow groundwater was encountered at all boreholes, window sample locations and at one trial pit location TP05 (information extracted from the Sweco Ground Investigation Report). Groundwater was observed to rise, from the initial strike to the resting level in all of the boreholes and trial pits, except for TP05 and SWE-WS-05. The rise in groundwater level ranged from 0.6m (SWE-BH-01) to 0.1m (SWE-WS-02)

Table 2-9 Summary of Groundwater Strikes

Hole ID	Strike Depth (mbgl)	Strike Depth rising to (mbgl)	Description
SWE-BH-01	2.50	1.84	Fine SAND (Tidal Flat Deposits)
SWE-BH-01B	3.00	2.60	Slightly silty fine SAND (TFD)
SWE-BH-02	2.00	1.50	Fine SAND (TFD)
SWE-WS-02	1.20	1.10	Fine SAND (TFD)
SWE-WS-03	1.20	0.90	Fine SAND (TFD)
SWE-WS-04	1.20	1.00	Fine SAND (TFD)
SWE-WS-05	1.10	1.10	Fine SAND (TFD)
TP05	2.40	--	Fine SAND (TFD)

2.8.3 Two boreholes SWE-BH-01B and SWE-BH-02 were installed for monitoring groundwater. Manual groundwater dip levels were collected weekly between the 17 May 2023 and 20 June 2023. Locations of the groundwater monitoring boreholes can be viewed in Appendix B.

2.8.4 Both boreholes were screened to monitor groundwater within the Tidal Flat Deposits but monitored groundwater at different depths.

2.8.5 A summary of the groundwater level monitoring records is included in Table 2-10, with associated groundwater level monitoring hydrographs presented in Figure 2-1.

Table 2-10: Summary of groundwater monitoring

Hole ID	Response zone range		Depth to groundwater (mbgl)					
	(Depth mbgl)		17/05/23	23/05/23	31/05/23	06/06/23	12/06/23	20/06/23
SWE-BH-01B	3.0	6.0	2.02	2.14	2.19	2.19	2.16	1.97
SWE-BH-02	5.0	8.0	1.39	1.52	1.60	1.57	1.56	1.38

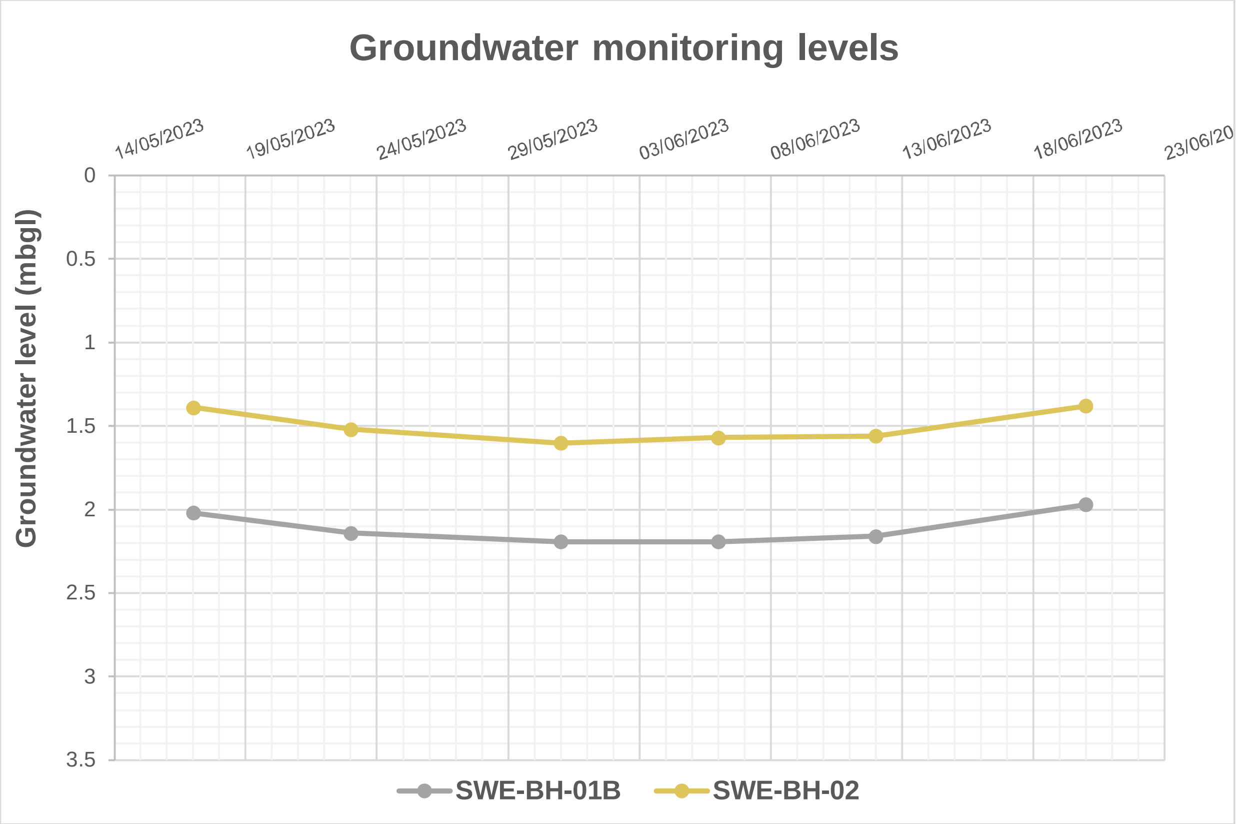


Figure 2-1: Groundwater hydrographs (May to June 2023)

2.8.6 The groundwater level monitoring data, presented in Table 2-10 and on Figure 2-1, is currently limited to May and June 2023. The hydrograph indicates very similar, near identical trends within the superficial targeted boreholes, confirming the presence of shallow groundwater, across the site. Comparison of the initial groundwater strike data and the groundwater monitoring level data indicates that the monitoring data is all above the initial groundwater strikes. Furthermore, the SWE-BH-01B monitoring groundwater levels are shallower than the resting groundwater levels encountered during the initial strike data.

2.8.7 These levels are representative of early summer conditions and the winter groundwater levels at SWE-BH-01B and SWE-BH-02, are expected to be higher.

2.8.8 The British Geological Survey's historic borehole records indicate that the encountered groundwater within the upper extent of the Tidal Flat Deposits are unlikely to be in hydraulic continuity with the underlying sandstone bedrock due to the presence of clay deposits overlying the bedrock. Separate groundwater strike (2.50mbgl) and groundwater seepage depths (1.20mbgl) were encountered within the Tidal Flat Deposits, within SWE-BH-01. This, in conjunction with the presence of the low permeability clay, suggests there may be encapsulated groundwater lenses within the clay-rich Tidal Flat Deposits.

2.9 Aquifer properties

2.9.1 Hydraulic conductivity rising and falling head tests were conducted on two monitoring boreholes installed during the 2023 GI; SWE-BH-02 and SWE-BH-01B. Hydraulic conductivity values were also derived from site specific Particle Size Distribution (PSD) analysis.

2.9.2 Hazen's approximation of hydraulic conductivity (K) is applicable to sand/gravel sediment samples within a d10 effective particle size of between 0.1-3.0mm (that is, the effective grain size relative to which 10% of the sample is finer is between 0.1-3.0mm). C is an empirical constant which in this case was set as 0.01. The formula applied is:

$$K = C * (d_{10})^2$$

2.9.3 The hydraulic conductivity values, calculated using the Hazen rule of approximation, ranged from 4.23 x 10^{-5} to 7.23 x 10^{-5} m/s.

2.9.4 Results are summarised in Table 2-11.

Table 2-11: Summary of hydraulic conductivity values (m/s)

Hazen's Rule						**Rising/Falling Head Test**		
Borehole	**Depth (mbgl)**	**C**	**Lithological Description**	**d_{10}**	**Hydraulic Conductivity**	**Interval (mbgl)**	**Lithological description**	**Hydraulic Conductivity**
SWE-BH-01	1	0.01	Tidal Flat Deposits – Sand	0.07	4.90×10^{-5}	N/A	N/A	N/A
SWE-BH-01B	3	0.01	Tidal Flat Deposits – fine Sand	0.065	4.23×10^{-5}	3.0 – 6.0	Sand	8.6×10^{-5} (Falling Head) 1.0×10^{-5} (Rising Head)
	4	0.01	Tidal Flat Deposits – fine Sand	0.08	6.40×10^{-5}	N/A	N/A	N/A
	11.5	0.01	Tidal Flat Deposits – fine and medium Sand	0.085	7.23×10^{-5}	N/A	N/A	N/A
SWE-BH-02	2	0.01	Tidal Flat Deposits – fine and medium Sand	0.068	4.62×10^{-5}	N/A	N/A	N/A
	4	0.01	Tidal Flat Deposits – fine and medium Sand	0.085	7.23×10^{-5}	4.8 – 8.0	Silty Sand	2.6×10^{-5} (Falling Head) 1.4×10^{-5} (Rising Head)
	7	0.01	Tidal Flat Deposits – fine and medium Sand	0.07	4.90×10^{-5}	N/A	N/A	N/A
SWE-WS-02	2	0.01	Tidal Flat Deposits – fine Sand	0.07	4.90×10^{-5}	N/A	N/A	N/A
SWE-WS-04	1.2	0.01	Tidal Flat Deposits – coarse Sand	0.07	4.90×10^{-5}	N/A	N/A	N/A
SWE-WS-05	1.2	0.01	Tidal Flat Deposits – coarse Sand	0.075	5.63×10^{-5}	N/A	N/A	N/A

2.9.5 The in-situ hydraulic conductivity test results indicate a range of 1.0 x 10^{-5} to 8.6 x 10^{-5} m/s. The values estimated using Hazen's Approximation Rule range from 4.6 x 10^{-5} and 7.2 x 10^{-5} m/s. These values are within the range for silty sands and at the lower end of the range for clean sands (Freeze and Cherry, 1979)

2.9.6 Results indicate a small variation in hydraulic conductivity with depth, and at SWE-BH-01B, an increase with depth is noted. This small variation in hydraulic conductivity is likely due to the presence of the medium sands identified at 11.5mbgl.

2.9.7 Hazen's Approximation Rule is applicable to granular and uniform geological materials. Consequently, derived hydraulic conductivities do not take account of the heterogeneous nature of the underlying deposits and the presence of less permeable material.

2.9.8 Hydraulic conductivity values derived through the application of Hazen's Rule may overestimate the hydraulic conductivity of the in-situ deposits, however given their similarity with in-situ values at this site, they are considered representative of these predominantly granular materials.

2.10 Receptors

2.10.1 A summary of the identified potential receptors, from the initial desk study within the initial 1.5km implemented Buffer Zone is tabulated in Table 2-12, whilst a graphical GIS representation of the identified potential receptors, their location and proximity to the proposed excavation requiring dewatering is presented in Appendix D.

Table 2-12: Potential Receptors within initial 1.5km buffer

Receptor Name	Location	Distance
Greenfields Consented Discharge – residential septic system	Greenfield residential property, Green Lane East	NGR: SJ 34308 69956; - Approximately 27 metres east of the site.
Bridge Farm Consented Discharge – unnamed stream/ drainage ditch	Bridge Farm, Green Lane East	NGR: SJ 34380 69784; - Approximately 243 metres southeast of the site.
Maesgwyn Farm Consented Discharge – unnamed stream/ drainage ditch.	Maesgwyn Farm, Green Lane East	NGR: SJ 34000 70418; - Approximately 691 metres north of the site.
Gateway to Wales Hotel site Consented Discharge – Storm overflow outlet.	Former Gateway to Wales Hotel Site – Welsh Road (B5441) Deeside	NGR: SJ 33126 69169; - Approximately 608 metres south of the site.
Pumping Station Consented Discharge	Between Dee Road and Leopard Moth Road, Deeside	NGR: SJ 32920 69290; - Approximately 627 metres southwest of the site.
Industrial Unit - Consented Discharge	Industrial unit on the Northern Access Road, Garden City, Deeside	NGR: 32763 69561; - Approximately 755 metres southwest of the site.
Queensferry WWTW Consented Discharge – Storm Tank Overflow	Southern shoreline of River Dee, north of industrial units on Riverside Way, Queensferry.	NGR: SJ 32380 68530; - Approximately 1440 metres south of the site.
Queensferry WWTW Consented Discharge – Treated Effluent Discharge	Southern shoreline of River Dee, north of industrial units on Riverside Way, Queensferry.	NGR SJ 32379 68522; - Approximately 1470 metres south of the site.
Pumping Station 1 – Consented Discharge	Tenth Avenue, Deeside Industrial Park	NGR: SJ 31900 71150; - Approximately 1485 metres northwest of the site
Ashgrove Pumping Station – Consented Discharge	Southern Bankside of River Dee, South of Hawarden Bridge, Shotton	NGR: SJ 31231 69211; - Approximately 1500 metres southwest of the site.
TATA Steel UK – Licensed Groundwater Abstraction Borehole 1A.	Field abounded by Green Lane West, north of Welsh Road	NGR: SJ 33670 71170; - approximately 1317 meters north.
Historic Brook Farm water well	Brook Farm, north of Sealand Road	NGR: SJ34450 69230; Approximately 693 metres south of the site.
Historic Sealand Bank Farm water well	Former Sealand Bank Farm, west of the end of Farm Road	NGR: SJ32100; 69200; approximately 1370m southwest of the site.
Historic Sealand Exploration Company No. 2 Borehole water well	Eastern side of the Shotwick Burn, west of the Garden City Industrial Estate.	NGR: SJ31940 697830; - approximately 1430m west.
Historic Ghorst's Cottage water well	North of Shotton Clocktower	NGR: SJ 31940 697830; approximately 1300 metres south of the site.
Historic SJ36/5B water well	East of East Green	NGR: SJ 33850 68390; approximately 1440 metres south of the site.
Historic Ferrybank Farm water well	Ferrybank Farm	NGR: SJ 32800 68730; approximately 1170 metres south of the site.
Historic Williams & Robinson, Queens Ferry water well	East of Station Road, Queensferry	NGR: SJ 32100 68500; approximately 1390 metres south of the site.
Historic SJ36/32 water well	West of Station Road, Queensferry	NGR: SJ 31900 68500; approximately 1450 metres south of the site.
Historic SJ36/28A water well	North of Hawarden Bridge railway station	NGR: SJ 31260 69890; approximately 1310 metres west of the site.
Historic SJ36/28B water well	North of Hawarden Bridge railway station	NGR: SJ 31250 69560; approximately 1310 metres west of the site.
Historic SJ37/23 water well	Deeside Fishery	NGR: SJ 32120 70840; approximately 1130 metres northwest of the site.
Historic SJ37/23 water well	Dee Marshes	NGR: SJ 33190 70830; approximately 1100 metres north of the site.
Historic SJ37/35 water well	BSC, Shotton No. 1A – TATA Steelworks.	NGR: SJ 33680 71180; approximately 1420 metres north of the site.
Historic SJ37/5A water well	Shotton No.1 – TATA Steelworks.	NGR: SJ 33800 71100; approximately 1370 metres north of the site.

Receptor Name	Location	Distance
Historic SJ37/4 water well	Shotwick Park House	NGR: SJ 35810 70280; approximately 1500 metres east of the site.
Northern Drain surface watercourse	Partially culverted, Northern Drain water course, flowing between Green Lane East and A548, flowing parallel to the proposed excavation.	Approximately 15 metres north of the site.
Garden City Drain surface watercourse	Garden City Drain watercourse flows east to west parallel to the excavation, between Green Lane East and the A548.	Approximately 130 metres south of the site.
Manor Drain surface watercourse	Manor Drain watercourse flows southeast to northwest, just south of Sealand Road, just after Villa Road.	Approximately 623 metres south of the site.
Shotwick Brook surface watercourse	Shotwick Brook Surface watercourse flows north to south, just east of the Chester Millenium Greenway located to the west of the site.	Approximately 1490 metres to the west of the site.
River Dee/ Dee Estuary Special Scientific Site of Interest	River Dee/ Dee Estuary	NGR: SJ 32454 68601; approximately 1430 metres south of the site.
River Dee/ Dee Estuary Special Area of Conservation	River Dee/ Dee Estuary	NGR: SJ 32454 68601; approximately 1430 metres south of the site.
River Dee/ Dee Estuary Ramsar wetlands	River Dee/ Dee Estuary	NGR: SJ 32005 68766; approximately 1430 metres south of the site.
Tidal Flat Deposits Secondary (undifferentiated) aquifer	Underlying the site and surrounding study area	N/A

2.10.2 The bedrock Principal Aquifer is not considered to be a receptor as this is not likely to be intercepted by the 4-5m deep trench. Further to this, the presence of the low permeable clay within the lower TFD will act as a confining layer between the superficial aquifer and the bedrock.

2.10.3 Impact on potential receptors will be assessed and presented in Section 4, following the dewatering estimate calculations in Section 3.

2.11 Hydrogeological groundwater conceptual model

2.11.1 The hydrogeological conditions within the TFD, along the proposed raw water main route are conceptualised within three longitudinal east to west hydrogeological cross-sectional models and a further northwest southeast cross-section (presented in Appendix C). The conceptual models were produced using various available data sources including historical and recent GI information. Available ground conditions and groundwater strike and groundwater level information is presented within the borehole and trial pit logs in Appendix B, as well as groundwater strike, and monitoring levels in Section 2.8.

2.11.2 The site is underlain by shallow topsoil and made ground deposits, varying in depths from approximately 0.35mbgl to 2.5mbgl, respectively. Underlying the superficial topsoil and made ground, is loose to medium density, greyish brown, slightly silty fine sand of the TFD. The full extent of the TFD was not determined within the GI, however historic BGS borehole records indicate depths of 30 metres and suggest that the TFD becomes progressively clay rich as the depth increases. Historic BGS borehole log data indicated that the superficial TFD are underlain by the Kinnerton Sandstone Formation.

2.11.3 Groundwater strikes across the site, encountered during borehole installation during the GI, were between 1.1mbgl and 3mbgl. These groundwater strikes rose to between 0.90 mbgl and 2.60 mbgl, with the data capture occurring on 26 April (TP05) and 2 – 10 May 2023 (the two monitored boreholes), which is expected to increase during winter months.

2.11.4 The two monitoring boreholes (SWE-BH-01B and SWE-BH-02) monitored groundwater from different depths, with the resultant hydrograph displayed in Figure 2-1. Similarities in the groundwater level trend hydrograph, displayed in Figure 2-1 suggests superficial aquifer units at different depths are likely to be in hydraulic continuity and that groundwater is laterally connected beneath the site.

3 Preliminary dewatering estimates

3.1 Background

3.1.1 Excavation works for the installation of the new raw water main, will require temporary dewatering due to the shallow groundwater table present beneath the site and the permeable nature of the underlying TFD sands and gravels.

3.1.2 The proposed dewatering strategy involves the excavation of a series of trenches along the extent of the proposed water main route, to accommodate sections of 500mm external diameter HDPE/ductile iron pipe.

3.1.3 The trenches to be excavated are approximately 70 metres in length, by three metres wide, with a maximum depth of 5.0mbgl.

3.1.4 The dewatering methodology involves the dewatering of three sequential 70-metre-long trench sections at a time, with two of the trench excavations being exposed at a time. The first trench will be dewatered and exposed enabling installation of the water main, with the second section being dewatered and exposed to enable preparatory works to be conducted, whilst the third section will have the wellpoints installed. This is to enable the works to progress efficiently in a sequential fashion.

3.1.5 Wellpoint dewatering has been confirmed to comprise the installation of 6-metre-long, 38mm plastic riser pipes with a 60mm x 600mm cocoa wrapped filter at the base by the dewatering contractor. The wellpoints will be installed along a single side of the trench excavation, no further than 2.5 metres off the centre line of the trench.

3.1.6 It is envisaged that the entire dewatering works will last approximately 15 weeks, however this may vary depending on project progression once started.

3.1.7 To support the pumping equipment used within the dewatering, a foundation base pad is required to be temporarily constructed. The base pad will subsequently require further excavations and dewatering, following the same wellpoint methodology as the trench excavations, but on a separate system to the trench excavations.

3.1.8 Dimensions of the proposed dewatering excavations are presented in Table 3-1.

Table 3-1: Proposed dewatering excavation dimensions.

Excavation	Width (m)	Length (m)	Depth to base (mbgl)
Raw Main trench	3	140	5
Pump House Foundation Pad	6	10	4

3.1.9 It is understood that the abstracted groundwater will be discharged via a 6” discharge line and settlement tank, to the swales running north to south, as indicated from Appendix A. The swales will enable sufficient suspended solid settlement and subsequent water quality improvement, prior to discharge into the Garden City Drain and ultimately to the River Dee.

3.1.10 A discharge permit for this activity is also being sought from the NRW, as part of this application.

3.2 Dewatering estimates methodology

3.2.1 The temporary dewatering works is being designed by the appointed dewatering contractor, Dewatering Services Limited. The current understanding of arrangements is that dewatering will consist of a single row of well points, along one side of the open raw main trench excavation, no more than 2.5 metres from the trenches centre line to abstract groundwater and dewater the subsurface. Abstracted groundwater will then be discharged to the Garden City Drain, via a 6” discharge line and settlement tank and subsequent swales, following sufficient settling periods.

3.2.2 The inflow of groundwater to the excavations, was estimated using the empirical Sichardt equation and observational data from the GI. This method can underestimate the radius of influence due to overestimating the hydraulic gradient and consequently groundwater inflow.

3.2.3 Full dewatering calculation Excel spreadsheets, are presented in Appendix E.

3.3 Assumptions

3.3.1 The dewatering calculations have been carried out with the following assumptions:

- The radius of influence is centred within the effective radius and calculated using the Sichardt equation.
- An empirical calibration factor used in the Sichardt equation, C = 1500 is adopted for linear excavations, such as the implemented trench excavation to install the raw water main.
- Groundwater depths across the site range from 0.9mbgl to 2.6mbgl, within the TFD, and are therefore above the estimated excavation base depths of between 4mbgl and 5mbgl. These depths assume groundwater levels are required to be drawn down to 1m below the base of the excavation. This is to ensure that the excavation trench is fully dewatered.
- Estimates of likely excavation inflows are based on the excavation dimensions presented in Table 3-1 and are subject to potential change as detailed design progresses and becomes available.
- The excavations are assumed to be unlined and open.
- The shallowest groundwater level has been used in the calculations.
- Dewatering rates, calculated with regards to the trench excavations, assume a uniform maximum depth and width for the entire structure.
- The estimated dewatering calculations, within this assessment,
- Adopted hydraulic conductivity values are taken from in-situ testing and considering PSD analysis of TFD.
- To ensure an appropriate and conservative approach, the highest and lowest hydraulic conductivity values obtained from site-specific hydraulic falling head tests and PSD analysis have been applied to the calculations.
- Surface inflow, to the excavation trenches, from rainfall recharge is excluded as this component is also excluded from licenced quantities.

- Groundwater control measures, such as cofferdam or sheet piling, are understood to not be required as part of the dewatering strategy, and hence no allowance for them have been made.

3.4 Excavation inflow estimates

3.4.1 The calculated radii of influences determined using the Sichardt equation, and associated groundwater inflows using the Duipuit-Thiem equation, have been estimated for the excavation trench and working spreadsheets are provided in Appendix D and summarised below Table 3-2.

3.4.2 The calculated values displayed in Table 3-2, are based on a hydraulic conductivity range of a low hydraulic conductivity of 1.40 x 10^{-5} m/s to an upper hydraulic conductivity of to 7.20 x 10^{-5} m/s, with a mid-range hydraulic conductivity of 4.90 x 10^{-5} m/s. A summary of excavation inflow estimates is show in Table 3-2.

Table 3-2: Summary of estimated temporary construction dewatering requirements.

Excavation type	**Excavation base level (mbgl)**	**Maximum Groundwater level within superficial deposits (mbgl)**	**Inflow range (l/s)**	**Inflow range (m^3/day)**	**Calculated maximum radius of influence – Sichardt method (m)**	**Predominant geological units to be dewatered**
140m x 3m diameter trench excavation.	5.0	1.0	2 – 6	171 - 515	43 – 81	Tidal Flat Deposits
Pumping base pad – 10 x 6 excavation	5.0	1.0	1 – 3.2	83.2 - 318	43 – 81	Tidal Flat Deposits

3.4.3 These estimates are conservative and therefore considered to be a worst-case scenario. Additionally, groundwater inflows within the excavation, are likely to decrease as dewatering progresses and groundwater levels reduce due to abstraction driven draw down.

3.5 Abstraction licencing regulations for temporary dewatering

3.5.1 The national regulatory body of Wales with jurisdiction for groundwater, National Resources Wales (NRW), outlines that any abstraction of inland water and/or groundwater requires an abstraction licence, unless the following exemptions are applicable (NRW, 2023a):

- abstractions of 20 cubic metres a day or less
- abstraction by a vessel for use on that or another vessel
- abstraction for fire-fighting purposes, or for training/practice or testing of apparatus used in fire- fighting.
- some navigation, harbour, or conservancy authority abstractions
- abstractions within managed wetland systems
- draining water (dewatering) to prevent interference with building or engineering works, where the abstraction lasts for less than 6 consecutive months, subject to restrictions.

- third-party operated dry docks transferring water to and from a navigation authority's water system port, harbour, or conservancy authority emergency abstractions.

3.5.2 If none of the above listed conditions apply, then an abstraction licence is required.

3.5.3 When the specifications listed in the previous section are unsuitable or the dewatering requirements are non-compliant, then a groundwater abstraction licence will be required. The application for the appropriate abstraction licence must be supported by the submission of a hydrogeological impact appraisal (HIA).

3.5.4 The national regulatory authority of Wales, Natural Resources Wales (NRW), outlines three separate types of groundwater abstraction licence, listed below (NRW, 2023a):

- Full abstraction licence – to abstract water over a period of 28 days or more.
- Transfer licence – to take water from one source of supply to another source of supply without an intervening use, over a period of 28 days or more.
- Temporary abstraction licence – for a one-off abstraction of water over a period of less than 28 days.

3.5.5 As a result of the dewatering activities being expected to last greater than 28 days (approximately 15 weeks), with groundwater abstraction rates exceeding 20m^3/day and the subsequent intended discharge to a water course, with no intervening use, a Transfer Licence is being sought.

3.6 Discharge of abstracted groundwater

3.6.1 As outlined within the NRW online resources, the NRW applies the Environment Agencies (EA) guidance from England regarding the discharge of groundwater from excavations.

3.6.2 The implemented guidance from the Environment Agency Regulatory Position Statement (RPS) (Environment Agency, 2023a) indicates that an environmental discharge permit is not a standard required for short-term, temporary discharges of uncontaminated water to surface water bodies, so long as compliant to the following conditions.

Discharges must be no closer than 500 metres upstream of a conservation site such as:

- Site of Special Scientific Interest (SSSI),
- Special Area of Conservation (SAC),
- Special Protection Area (SPA),
- Ramsar Site,
- Site of community Importance,
- Sites in the process of becoming a SAC, SPA or Ramsar site,
- Marine conservation zones,
- Local wildlife and conservation sites.

3.6.3 Furthermore, discharges must not be for more than three consecutive months, whilst water discharges can stop during this time, but the clock continues and does not reset. Further discharge conditions include, that discharges must not:

- discharge silty water containing fine or coarse suspended solids into surface water.

- discharge site drainage from surface areas such as haul roads, storage or working areas.
- pollute surface water.
- discharge water containing any chemical dosing agents, flocculants, or coagulants.
- discharge from a site which is contaminated by oil, metals, hydrocarbons, solvents or pesticides or other polluting substances.
- discharge water that results in the spread of non-native invasive species, parasites or disease.
- cause flooding from surface water.
- cause erosion of the banks or bed of the receiving watercourse.
- discharge concrete wash water even if it has been treated.
- discharge from a site with naturally elevated concentrations of substances which exceed environmental quality standards.

3.6.4 Water discharge permits are required, under the RPS, if water discharges occur for a period greater than three months and where the following are applicable.

- water discharge is from ‘pump and treat’ (pumping out contaminated groundwater or water from contaminated land so it can be treated).
- Water discharge is from quarry activities.
- Activities which do not comply with the conditions within the RPS.

3.6.5 Since the estimated duration of the discharge activities are expected to be greater than three months, a discharge permit will be sought for these works.

3.7 Mitigation

3.7.1 Mitigation measures will be considered by the temporary works contractor, prior to works initiation.

3.7.2 Considerations such as reductions in dewatering rates by reductions in the size and number of open excavations at any one time, as well as consideration of temporary works solutions such as cofferdams to reduce groundwater inflow and subsequent required dewatering abstraction rates. However, its noted that reduction of the number and size of open excavations at a time, would likely negatively impact both the schedule and budget associated with the project.

3.8 Technical uncertainties

3.8.1 Several sources of technical uncertainties remain within the proposed works, which affect the accuracy of the inflow calculations.

3.8.2 Preliminary dewatering calculations will be reviewed and refined if further site-specific data and information is obtained, resulting in calculation accuracy improvement.

3.8.3 The supplied inflow calculations are suspected to reduce from initial peak, due to the underestimation of the radius of influence within the Sichardt method employed.

3.8.4 It should also be highlighted, that the contribution that rainfall has within groundwater inflows, is exempt from abstraction licensing, but would be required to be considered in any discharge permitting.

4 Preliminary impact assessment

4.1 Introduction

4.1.1 This section provides a preliminary impact assessment for the potential receptors identified in Section 2, in conjunction with the calculated dewatering rates and influence radii discussed in Section 3 of this report. It considers the likely hydraulic connection between the receptors and the dewatering activities, using a source-pathway-receptor approach.

4.1.2 Appendix D displays all the potential groundwater receptors notified to date, implemented within the initially applied 1.5km buffer zone, whilst Appendix F displays the potential groundwater receptors within the updates, calculated influence radius of 81 metres associated with the dewatering activities.

4.1.3 The current analytical solution used for the preliminary estimates assumed a constant head boundary outside of the excavation, i.e., no groundwater level impact to surrounding receptors, as well as the use of maximum recorded groundwater levels.

4.1.4 Wellpointing has been selected as the most suitable and effective method of dewatering, controlling inflows of groundwater into the base of the excavations required for the raw water main installation.

4.2 Potential risk to identified receptors

4.2.1 Groundwater drawdown, resulting from groundwater abstraction during dewatering activities such as wellpointing, presents a potential derogation risk to receptors which are reliant on groundwater.

4.2.2 Furthermore, the discharge of abstracted groundwater accumulated during dewatering activities, can also present a risk to any receiving water body, in terms of impacts on water quality and possible flood risk.

4.2.3 Table 4-1 displays the potential derogation risks facing the receptors identified.

Table 4-1: Receptor Impact Assessment

Receptor Name	Location	Comment	Potential Impact Risk
Greenfields Consented Discharge	“Greenfields” Residential property, Green Lane East, approximately 27 metres east of the proposed dewatering.	The consented discharge is located within the conservative radii of influence of the proposed dewatering wellpointing. Dewatering activities have potential to impact the groundwater flow paths and subsequent dilution effect of the discharged waste. Consequently, may result in reduction in the quality of groundwater abstracted through reduced groundwater residency time and reduced waste dilution. Since the proposed dewatering is temporary, and sufficient settlement will be provided via holding swales prior to discharge to the Garden City Drain. Garden City Drain WFD rating is poor thus discharge of abstracted groundwater from the consented discharge is likely to be greatly diluted by additional abstracted groundwater that any impact risk would be low.	Low
Bridge Farm Consented Discharge	Bridge Farm, Green Lane East, approximately 243 metres southeast of the proposed dewatering.	Dewatering activities are unlikely to impact the infiltration and dilution of the consented discharge, as the discharge outlet is out with the calculated radii of influence.	Low
Maesowyn Farm Consented Discharge	Maesowyn Farm, Green Lane East, approximately 691 metres north of the site		
Gateway to Wales Hotel site Consented Discharge	Former Gateway to Wales Hotel Site, Welsh Road (B5441) Deeside, approximately 608 metres south of the site.		
Pumping Station Consented Discharge	Between Dee Road and Leopard Moth Road, Deeside, approximately 627 metres southwest of the site.		
Industrial Unit Consented Discharge	Industrial Unit on the Northern Access Road, Garden City, Deeside, approximately 755 metres southwest of the site.		
Queensferry WWTW Consented Discharge – Storm Tank Overflow	Southern shoreline of the River Dee, north of industrial units on Riverside Way, Queensferry, approximately 1440 metres south of the site.		
Queensferry WWTW Consented Discharge – Treated Effluent Discharge	Southern shoreline of the River Dee, north of industrial units on Riverside Way, Queensferry, approximately 1470 metres south of the site.		
Pumping Station 1 – Consented Discharge	Tenth Avenue, Deeside Industrial Park, approximately 1485 metres northwest of the site.		
Ashgrove Pumping Station – Consented Discharge	Southern bankside of River Dee, South of Hawarden Bridge, Shotton, approximately 1500 metres southwest of the site		
TATA Steel UK – Licensed Groundwater Abstraction	Field abounded by Green Lane West, north of Welsh Road, approximately 1317 metres north of the site.	Dewatering activities are unlikely to impact licensed groundwater abstraction given that it is located out with the calculated radii of influence, of the associated dewatering works. Furthermore, the dewatering will be a temporary measure,	Low

		progressing sequentially from the east to west limiting the both the duration and spatial extent of effects.	
Historic Brook Farm Water Well	Brook Farm, north of Sealand Road, approximately 693 metres south of the site.	Dewatering activities are unlikely to impact this historic water well, given that it is located an significant distance out with the radii of influence, and suspected abstraction drawdown from the well are unlikely to extend sufficiently to be impacted by the temporary dewatering works. Borehole condition, status or use unknown.	Low
Historic Sealand Bank Farm Water Well	Former Sealand Bank Farm, west of the end of Farm Road, approximately 1370 metres south of the site.		
Historic Sealand Exploration Company No. 2 Borehole Water Well	Eastern side of the Shotwick Burn, west of the Garden City industrial Estate, approximately 1430 metres west of the site.		
Historic Ghorst's Cottage Water Well	North of Shotton Clocktower, approximately 1300 metres south of the site.		
Historic SJ36/5B Water Well	East of East Green, approximately 1440 metres south of the site.		
Historic Ferrybank Farm Water Well	Ferrybank Farm, approximately 1170 metres south of the site.		
Historic Williams & Robinson, Queens ferry Water Well	Ferrybank Farm, approximately 1390 metres south of the site.		
Historic SJ36/32 Water Well	West of Station Road, Queensferry, approximately 1450 metres south of the site.		
Historic SJ36/28A Water Well	North of Hawarden Bridge Railway Station, approximately 1310 metres west of the site.		
Historic SJ36/28B Water Well	North of Hawarden Bridge Railway Station, approximately 1310 metres west of the site.		
Historic SJ37/23 Water Well	Deeside Fishery, approximately 1130 metres northwest of the site.		
Historic SJ37/23 Water Well	Dee Marshes approximately 1100 meters north of the site.		
Historic SJ37/35 Water Well	BSC Shotton No. 1A – TATA Steelworks, approximately 1420 metres north of the site.		
Historic SJ37/5A Water Well	Shotton No. 1 – TATA Steelworks, approximately 1370 metres north of the site.		
Historic SJ37/4 Water Well	Shotwick Park House, approximately 1500 metres east of the site.		
Garden City Drain surface watercourse	Garden City Drain watercourse flows east to west parallel to the excavation between Green Lane East and A548, approximately 623 metres south of the site.	The Garden City Drain is considered to be disconnected from the underlying aquifer, therefore no risk of reduced flows. Dewatered water will be discharged via settlement tanks and swales to the Garden City Drain. Groundwater quality highlights minimal risk of elevated contaminants, whilst the WFD surface water body status is already poor and failing. Dewatering discharges are therefore highly unlikely to exacerbate the current conditions within the watercourse. The Garden City Drain already receives significant discharges from agricultural runoff and field drainage, as well as sewerage overflows and	Low

		discharges - additional dewatering discharges unlikely to affect flood risk.	
Manor Drain surface watercourse	Manor Drain surface watercourse flows southeast to northwest, just south of Sealand Road, just after Villa Road, approximately 623 metres south of the side	The Manor Drain is considered to be disconnected from the underlying aquifer, therefore no risk of reduced flows. Dewatered water will be discharged via settlement tanks and swales to the Garden City Drain, which the Manor Drain discharges into downstream, Furthermore, the Manor Drain is both uphill and significantly out with the dewatering calculated radii of influence.	Low
The Northern Drain	Northern Drain surface water course flowing east to west, approximately 15 metres to the north.	Dewatering activities have potential to impact the flow of water within the Northern Drain, given the close proximity to the trench excavation requiring dewatering. The impact will be minimal given the majority of the Northern Drain's extent which is close to the trench excavation is largely confined, preventing the abstraction of water from these sections of the watercourse. Furthermore, any negative impacts will be further minimised by the discharge of all abstracted groundwater to the Garden City drain, which the Northern Drain merges downstream of the site with, thus offsetting any water imbalance arising.	Low
River Dee/ Dee Estuary Special Scientific Site of Interest/ Special Area of Conservation/ Ramsar wetlands/ saltmarsh	River Dee/ Dee Estuary, approximately 1430 metres south of the site	The SSSI/SAC/ Ramsar designated area is located a greater distance than the calculated dewatering radii of influence. Furthermore, the abstracted groundwater will be discharged via settlement tanks and swales to the Garden City Drain, which ultimately flows into the River Dee/ Dee Estuary. Consequently, this discharge would offset any reduction in groundwater flow to the SSSI/ SAC/ Ramsar area.	Low
Tidal Flat Deposits Secondary (undifferentiated) aquifer	Underlying the site and surrounding region	The Tidal Flat Deposit Secondary (undifferentiated) aquifer, underlying the excavation trench will be partially dewatered to a depth of 5m bgl. The dewatering will be a temporary activity, progressing in a sequential manner to limit the area affected. The calculated radii of influence is 81 metres, however there is only a single identified groundwater receptor, a consented discharge identified within the calculated radii of influence.	Low

5 Conclusions

5.1.1 Preliminary groundwater estimated dewatering requirements for the proposed Deeside raw water main installation, have been calculated as follows:

- A dewatering rate range of 172.8 to 622.1 m^3/day (2.0 to 7.2 l/s), with a radius of influence between 43m and 81m has been calculated for dewatering of the 140m long trench sections.

- A dewatering rate range of 86.4 to 319.7 m^3/day (1.0 to 3.7 l/s) and radius of influence between 43m and 81m has been calculated for dewatering of excavations for the pumping base pad to facilitate the pump house.

5.1.2 The calculated groundwater inflows are considered a worst-case estimate.

5.1.3 There are no licenced or identified potentially unlicenced groundwater abstractions within the calculated influence radius of 81 metres.

5.1.4 There is a single consented discharge to groundwater (License reference CG0445601) within the radius of influence. It pertains to the residential dwelling “Greenfields”, on Green Lane East, located approximately 27 metres east of the site. Dewatering may impact the groundwater flow pathways associated with the consented discharge, resulting in reduced natural dilution available for the discharged sewerage, resulting in groundwater quality reduction within the vicinity. A minimal impact is envisaged due to the dewatering activities being temporary in nature, and implementation of settlement storage to facilitate water quality improvements, prior to discharge to the Garden City Drain.

5.1.5 The remaining identified potential receptor is the Northern Drain, located approximately 15 metres north of the excavation. The impact is also viewed to be minimal, on account that the dewatering works are temporary, the majority of the water course bordering the proposed excavation is culverted reducing any interaction with the surrounding groundwater, and that the abstracted groundwater is to be discharged into the Garden City Drain, which the Northern Drain discharges to, downstream of the excavation.

5.1.6 Based on the dewatering calculations listed above, dewatering abstractions are expected to exceed the 20m^3/day threshold necessitating the requirement of an abstraction licence.

5.1.7 Dewatering rates could likely be reduced, if the number and size of the open excavations, was reduced and/or through the implementation of temporary works solutions, such as cofferdams to reduce groundwater inflows.

5.1.8 Preliminary dewatering calculations are expected to be maximal values and reduce once greater understanding of the temporary works scheduling, and associated planned groundwater control measures are determined.

5.1.9 All preliminary dewatering calculations and radii of influences documented, will be continually reviewed, and updated as further detailed design and construction information becomes available.

6 References

British Geological Survey [BGS] (UKRI – BGS, 2023a). GeoIndex Onshore – Bedrock Geology 1:50,000 Scale. Available at: https://www.bgs.ac.uk/datasets/bgs-geology-50k-digmapgb/ . Accessed: 28 August 2023

British Geological Survey [BGS] (UKRI – BGS, 2023b). GeoIndex Onshore – Superficial Deposits 1:50,000 Scale. Available at: https://www.bgs.ac.uk/datasets/bgs-geology-50k-digmapgb/ . Accessed: 28 August 2023

British Geological Survey [BGS] (UKRI – BGS, 2023c). GeoIndex Onshore – Water wells dataset. Available at: https://mapapps2.bgs.ac.uk/geoindex/home.html Accessed: 28 August 2023

British Geological Survey [BGS] (UKRI – BGS, 2023d). Borehole Records. Available at: https://mapapps2.bgs.ac.uk/geoindex/home.html Accessed: 28 August 2023

DEFRA (2023) Aquifer Designation Dataset for England & Wales. Available at: https://magic.defra.gov.uk/magicmap.aspx. Accessed: 28 August 2023.

DEFRA (2023b) Catchment Data Explorer, Dee River Basin District, Management Catchments. Available at: https://environment.data.gov.uk/catchment-planning/RiverBasinDistrict/11 (Accessed: 21 September 2023)

DEFRA (2023c) Catchment Data Explorer, Dee Management Catchment Operational Catchments. Available at: https://environment.data.gov.uk/catchment-planning/ManagementCatchment/3024 (Accessed: 21 August 2023)

DEFRA (2023d) Catchment Data Explorer, Dee Estuary Operational Catchment Water Bodies. Available at: https://environment.data.gov.uk/catchment-planning/OperationalCatchment/3127 (Accessed: 21 September 2023)

DEFRA (2023e) Catchment Data Explorer, Garden City Drain Water Body. Available at: https://environment.data.gov.uk/catchment-planning/WaterBody/GB111067056960 (Accessed: 21 September 2023)

DEFRA (2023f) Hydrology Data Explorer. Available at: https://environment.data.gov.uk/hydrology/explore (Accessed: 25 September 2023)

Environment Agency (2023a) Temporary dewatering from excavations to surface water: RPS 261. Available at: https://www.gov.uk/government/publications/temporary-dewatering-from-excavations-to-surface-water/temporary-dewatering-from-excavations-to-surface-water (Accessed: 27 September 2023)

Geotechnics Ltd (2016) *Ground Investigation – Deeside Airfield Sewer Acquisition*. *Project No. PN163498*.

Natural England (2023a) Magic Maps. Available at: https://magic.defra.gov.uk/MagicMap.aspx (Accessed 28 September 2023)

Natural England (2023b) Sites of Special Scientific Interest (England). Available at: https://www.data.gov.uk/dataset/5b632bd7-9838-4ef2-9101-ea9384421b0d/sites-of-special-scientific-interest-england (Accessed: 12/09/2023)

Natural England (2023c) Special Areas of Conservation (England). Available at: https://www.data.gov.uk/dataset/a85e64d9-d0f1-4500-9080-b0e29b81fbc8/special-areas-of-conservation-england (Accessed: 12/09/2023).

Natural England (2023d) Local Nature Reserves (England). Available at: https://www.data.gov.uk/dataset/acdf4a9e-a115-41fb-bbe9-603c819aa7f7/local-nature-reserves-england (Accessed: 12/09/2023)

Natural England (2023e) National Nature Reserves (England). Available at: https://www.data.gov.uk/dataset/726484b0-d14e-44a3-9621-29e79fc47bfc/national-nature-reserves-england (Accessed: 12/09/2023).

Natural England (2023f) Ramsar Sites (England). Available at: https://www.data.gov.uk/dataset/67b4ef48-d0b2-4b6f-b659-4efa33469889/ramsar-england (Accessed: 12/09/2023)

Natural Resources Wales (2023a) 'Find out if you need a water abstraction or impoundment licence'. Available at: https://naturalresources.wales/permits-and-permissions/water-abstraction-and-impoundment/find-out-if-you-need-a-water-abstraction-or-impoundment-licence/?lang=en. Accessed: 14th August 2023.

Natural Resources Wales (2023b) Dee and Western Wales River basin management plans 2021-2027. Available at: https://naturalresources.wales/evidence-and-data/research-and-reports/water-reports/river-basin-management-plans/river-basin-management-plans-2021-2027?lang=en (Accessed: 21 September 2023)

Natural Resources Wales (2023c) Licensed Water Abstractions. Available at: https://datamap.gov.wales/layers/geonode:nrw_water_resource_permits (Accessed: 12/09/2023)

Natural Resources Wales (2023d) Permitted discharges to controlled waters with conditions. Available at: https://datamap.gov.wales/layers/geonode:nrw_water_quality_permits (Accessed: 12/09/2023)

Natural Resources Wales (2023e) Sites of Scientific Interest (SSSI). Available at: https://datamap.gov.wales/layers/inspire-nrw:NRW_SSSI (Accessed: 12/09/2023)

Natural Resources Wales (2023f) Special Areas of Conservation (SAC). Available at: https://datamap.gov.wales/layers/inspire-nrw:NRW_SAC (Accessed: 12/09/2023)

Natural Resources Wales (2023g) National Nature Reserves (NNR). Available at: https://datamap.gov.wales/layers/inspire-nrw:NRW_NNR (Accessed: 12/09/2023)

Natural Resources Wales (2023h) Local Nature Reserves (LNR). Available at: https://datamap.gov.wales/layers/inspire-nrw:NRW_LNR (Accessed: 12/09/2023).

Natural Resources Wales (2023i) Ramsar Wetlands of international importance. Available at: https://datamap.gov.wales/layers/inspire-nrw:NRW_RAMSAR (Accessed: 12/09/2023)

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

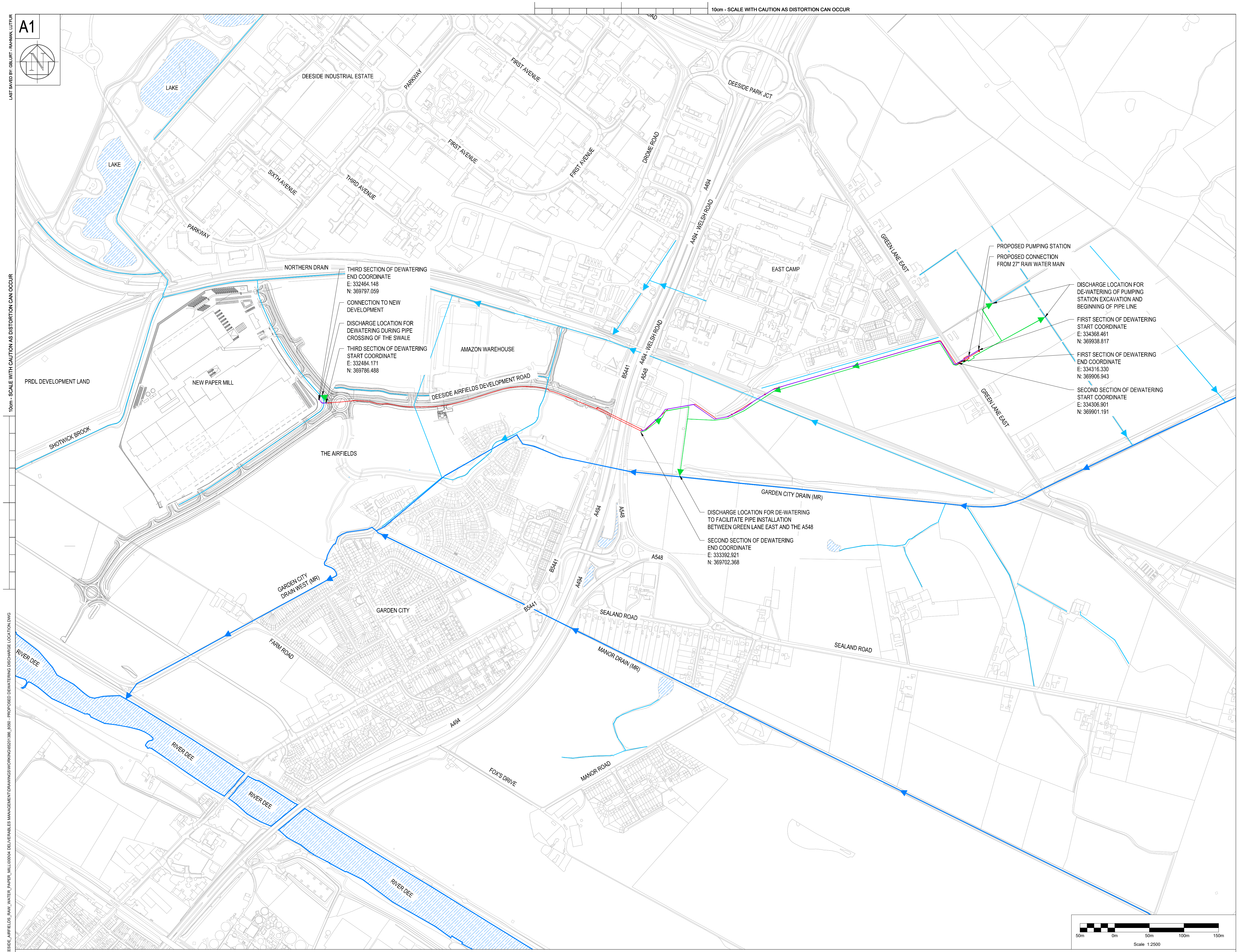
Sweco UK (2023). *Ground Investigation Report: Deeside Airfield Development – Raw Water Main*. Project Number: 65201386. Leeds, UK.

7 Appendices

LAST SAVED BY: GBLURT - RAHMAN, LUTFUR

10cm - SCALE WITH CAUTION AS DISTORTION CAN OCCUR

A1



THIRD SECTION OF DEWATERING END COORDINATE
E: 332464.148
N: 369797.059

CONNECTION TO NEW DEVELOPMENT

DISCHARGE LOCATION FOR DEWATERING DURING PIPE CROSSING OF THE SWALE

THIRD SECTION OF DEWATERING START COORDINATE
E: 332484.171
N: 369786.488

PROPOSED PUMPING STATION

PROPOSED CONNECTION FROM 27" RAW WATER MAIN

DISCHARGE LOCATION FOR DE-WATERING OF PUMPING STATION EXCAVATION AND BEGINNING OF PIPE LINE

FIRST SECTION OF DEWATERING START COORDINATE
E: 334368.461
N: 369938.817

FIRST SECTION OF DEWATERING END COORDINATE
E: 334316.330
N: 369906.943

SECOND SECTION OF DEWATERING START COORDINATE
E: 334306.901
N: 369901.191

DISCHARGE LOCATION FOR DE-WATERING TO FACILITATE PIPE INSTALLATION BETWEEN GREEN LANE EAST AND THE A548

SECOND SECTION OF DEWATERING END COORDINATE
E: 333392.921
N: 369702.368

Dwr Cymru Cyf gives this information as to the position of its underground apparatus by way of general guidance only on the strict understanding that it is based on the best information available and no warranty as to its correctness is relied upon in the event of excavations or other works made in the vicinity of the company's apparatus and any onus of locating the apparatus before carrying out any excavations rests entirely on you. It must be understood that the furnishing of the information is entirely without prejudice to the provision of the New Roads and Streetworks Act 1991 and of the Company's right to be compensated for any damage to its apparatus.

Dwr Cymru Cyf has no duty to identify private apparatus and the information as to the position of the private apparatus is given by way of general guidance only on the strict understanding that it is based on the best information available and no warranty as to its correctness is relied upon. Not all private apparatus is identified but their presence should be anticipated.

10cm - SCALE WITH CAUTION AS DISTORTION CAN OCCUR

P:\6542\65201386_DEESIDE_AIRFIELDS_RAW_WATER_PAPER_MILL\000\04 DELIVERABLES MANAGEMENT\DRAWINGS\WORKING\65201386_8050 - PROPOSED DEWATERING DISCHARGE LOCATION.DWG

NOTES

1. DO NOT SCALE THIS DRAWING
2. UNLESS NOTED OTHERWISE ALL DIMENSIONS ARE IN MILLIMETRES AND ALL LEVELS ARE INMETRES AOD.
3. O.S. REFERENCE 332289, 370251
   POSTCODE CH5 2NS
4. IT IS NOT GUARANTEED THAT THE INCLUDED INFRASTRUCTURE INFORMATION IS COMPLETE OR CORRECT AND THE CONTRACTOR SHOULD TAKE REASONABLE PRECAUTIONS TO CONFIRM THE PRESENCE OF BURIED SERVICES PRIOR TO EXCAVATION.
5. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE FOLLOWING SPECIFICATIONS :-
   a. THE CIVIL ENGINEERING FOR THE WATER INDUSTRY REVISION 7 (CESWI)
   b. THE DCWW CIVIL ENGINEERING SPECIFICATION ISSUE 3 (CS501)

KEY

🟥	NEW RAW WATER MAIN - NO DEWATERING REQUIRED
🟪	SECTION OF NEW RAW WATER MAIN REQUIRING DEWATERING
🟦	MAIN WATER COURSE
▨	RIVER/ POND
🟦	GENERAL WATER COURSE
🟩	PROPOSED DEWATERING DISCHARGE LOCATION

REV	DESCRIPTION	DRN	FORM CHK	CHK	APP	Date
I00	FOR INFORMATION	RGB	RM	RM	KF	12.10.23

Drawing Status
FOR INFORMATION

Dŵr Cymru
Welsh Water

Job Title
DEESIDE AIRFIELD
DEVELOPMENT
RAW WATER MAIN

Drawing Title
PROPOSED DEWATERING
DISCHARGE LOCATION

Grove House
Mansion Gate Drive
Leeds
LS7 4DN
Tel: +44 (0)113 262 0000
www.sweco.co.uk

SWECO

Consultants Job No. 117210
Scale 1:2500 Originator RGB
Checked RM Approved KF Date 12.10.23
SET Scheme No. TBC
Drawing No. 8050
Rev. I00

Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

Notes:

Scale:
1:6000

Surveyed By:
SOCOTEC UK Limited

Surveyed Date:
April to May 2023

Key:

● Cable Percussion
🟥 Trial Pit
◆ Dynamic (windowless) Sampling

SITE PLAN

SOCOTEC

Project ID:
F3023-23

Project Title:
DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE

Client:
Envolve Infrastructure Limited

Figure:
A2

Borehole Log

Checked	Depth	Dates	Method	Equipment	Rig Crew	Logger	Logged
R Fryer	0.00 - 1.20	02 May 23 - 02 May 23	Hand dug inspection pit to 1.20m.	Hand tools	J Gormer	S Omer	02 May 23
	1.20 - 4.00	02 May 23 - 02 May 23	Cable percussion boring to 4.00m.	Dando 2000	J Gormer	S Omer	02 May 23
Approved M Wareing							

Hole Depth	Hole Dia. (mm)	Casing Depth	Casing Dia. (mm)
3.00	200	3.00	200
4.00	150	4.00	150

Depth Related Remarks

Depth	Remarks

Ground Level	4.73 mOD
Coordinates	E 333269.72
National Grid	N 369743.26
System	OSGB

Date / Casing	Time / Water	Samples Depth	Samples Type & No.	Samples Records	Field Tests Depth	Field Tests Type	Field Tests Records	Samp / Test Casing	Samp / Test Water	Coring Depth (Diameter)	TCR % SCR % RQD %	Water added / Flush details	Depth (Thickness)	Level	Legend	Strata Description Main	Detail	Chisel.	Water Entry	Backfill
		0.20 0.20 0.50 0.50	D 1 ES 1 D 2 ES 2										(0.80)		▨	Dark brown gravelly fine to coarse SAND. Gravel is angular to subrounded fine to coarse of flint, quartzite and sandstone with occasional brick and limestone (40mm). (MADE GROUND)				
													0.80 (0.40)	+3.93		Orangish grey slightly gravelly slightly silty predominantly fine SAND. Gravel is angular to rounded fine and medium of flint, quartzite and sandstone. (TIDAL FLAT DEPOSITS)				
		1.00 1.00 - 1.20 1.00 1.20 - 1.65 1.20 - 1.65	D 3 B 4 ES 3 D 5 B 5		1.20 - 1.65	SPT S	N=8 (1,2/2,2,2,2) ID PB01 Er 65%		Damp				1.20	+3.53		Orangish grey fine to coarse SAND. (TIDAL FLAT DEPOSITS)			1	
		2.00 - 2.45 2.00 - 2.45	D 6 B 6		2.00 - 2.45	SPT S	N=8 (1,1/1,2,2,3) ID PB01 Er 65%	2.00	1.50			Water added: 1.20 - 3.00							2	
		2.50	W 1										(2.80)						2	
		3.00 - 3.46 3.00 - 3.45	D 7 B 7		3.00 - 3.45	SPT S	N=8 (1,1/1,2,2,3) ID PB01 Er 65%	3.00	2.00											
02 May 23 4.00	1230 2.50																			
					4.00 - 4.45	SPT S	N=17 (1,2/3,4,5,5) ID PB01 Er 65%	4.00	2.50				4.00	+0.73		END OF EXPLORATORY HOLE				4.00

General Remarks

Borehole was set up in the wrong location and subsequently terminated.

Hard Boring / Chiselling

Depths	Duration (mins)	Tool

Groundwater Entries

No.	Depth	Remarks	Sealed
1	1.20	Seepage.	
2	2.50	Rose to 1.84 m after 20 minutes.	

Notes

For explanation of symbols and abbreviations see Key to Exploratory Hole Records. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Project	DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE
Project No.	F3023-23
Carried out for	Envolve Infrastructure Limited

Status

FINAL

Scale 1:50

Printed 19 Jul 2023 10:19:35

AGS

Borehole

SWE-BH-01

Borehole Log

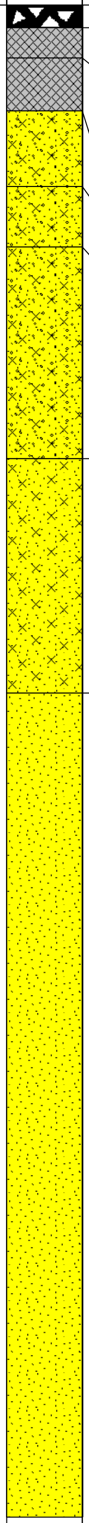
Checked	Depth	Dates	Method	Equipment	Rig Crew	Logger	Logged
R Fryer	0.00 - 3.00 3.00 - 15.00	03 May 23 - 03 May 23 03 May 23 - 03 May 23	Open holed through pre-excavated TP05. Cable percussion boring to 15.00m.	Dando 2000 Dando 2000	J Gormer J Gormer	A Adebayo	03 May 23
Approved M Wareing							

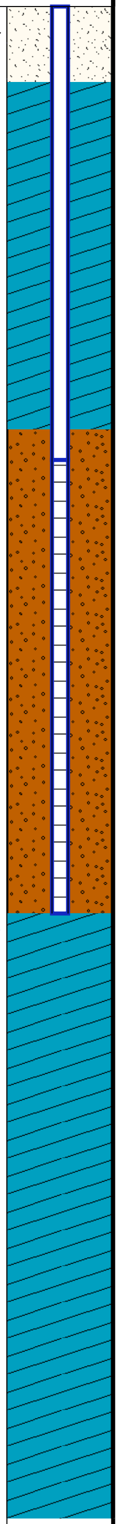
Hole Depth	Hole Dia. (mm)	Casing Depth	Casing Dia. (mm)
3.00 15.00	200 150	3.00 15.00	200 150

Depth Related Remarks: Depth	Remarks

Ground Level	5.72 mOD
Coordinates	E 333263.03
National Grid	N 369770.88
System	OSGB

	Date Casing	Time Water	Samples Depth	Samples Type & No.	Samples Records	Field Tests Depth	Field Tests Type	Field Tests Records	Samp / Test Casing	Samp / Test Water	Coring Depth (Diameter)	TCR % SCR % RQD %	Water added Flush details	Depth (Thickness)	Level	Legend	Strata Description Main	Strata Description Detail	Chisel.	Water Entry	Backfill
0	03 May 23 0.00	0700 Dry												(0.15) 0.15	+5.57		Black MACADAM.				Raised cover
														(0.20) 0.35	+5.37		Grey sandy angular to subangular medium and coarse GRAVEL of limestone. (FILL)				
														(0.35) 0.70	+5.02		Light brown gravelly slightly clayey fine to coarse SAND. Gravel is angular to subangular fine to coarse of flint with rare fragments of brick and concrete (<20x30mm). (MADE GROUND)				0.50
1														(0.50) 1.20	+4.52		Dark brown gravelly slightly silty fine to coarse SAND with rare rootlets (<3mm max. dia.). Gravel is angular to subangular fine to coarse of flint. (TIDAL FLAT DEPOSITS)				
														(0.40) 1.60	+4.12		Greyish brown gravelly slightly silty fine to coarse SAND. Gravel is angular to subangular fine to coarse of flint. (TIDAL FLAT DEPOSITS)				
2														(1.40) 3.00	+2.72		Light yellowish brown slightly silty fine to coarse SAND. Gravel is angular to subangular fine to coarse of flint. (TIDAL FLAT DEPOSITS)			1	2.80
3			3.00 - 3.45 3.00 - 3.45 3.00	D 1 B 1 W 1		3.00 - 3.45	SPT S	N=10 (1,1/2,2,3,3) ID PB01 Er 65%	3.00	2.60				(1.55) 4.55	+1.17		Medium dense brown silty predominantly fine SAND. (TIDAL FLAT DEPOSITS)			1	
4			4.00 - 4.45 4.00 - 4.45	D 2 B 2		4.00 - 4.45	SPT S	N=15 (1,2/3,3,4,5) ID PB01 Er 65%	4.00	3.00											
5			5.50 - 5.95 5.50 - 5.95	D 3 B 3		5.50 - 5.95	SPT S	N=12 (1,3/2,3,3,4) ID PB01 Er 65%	5.50	3.50							Medium dense brown, locally slightly silty, fine and medium SAND. (TIDAL FLAT DEPOSITS)				
6																					6.00 SP
7			7.00 - 7.45 7.00 - 7.45	D 4 B 4		7.00 - 7.45	SPT S	N=18 (1,2/3,4,5,6) ID PB01 Er 65%	7.00	4.00								7.00-7.45 Slightly silty.			
8			8.50 - 8.95 8.50 - 8.95	D 5 D 5		8.50 - 8.95	SPT S	N=21 (2,3/4,5,6,6) ID PB01 Er 65%	8.50	4.00											
9																					
10														(10.45)			Hole continues on next sheet				





General Remarks

Borehole located at centre of TP05. Strata descriptions between 0.00 and 3.00m taken from TP05 log.
50mm installation to 6.00m, Response zone 3.00 to 6.00m.

Hard Boring / Chiselling

Depths	Duration (mins)	Tool

Groundwater Entries

No.	Depth	Remarks	Sealed
1	3.00	Rose to 2.60 m after 20 minutes.	

Notes

For explanation of symbols and abbreviations see Key to Exploratory Hole Records. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Project	DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE
Project No.	F3023-23
Carried out for	Envolve Infrastructure Limited

Status

FINAL

Scale 1:50
Printed 19 Jul 2023 10:19:36

AGS

Borehole

SWE-BH-01B

Borehole Log

SOCOTEC

Checked	Depth	Dates	Method	Equipment	Rig Crew	Logger	Logged
R Fryer	0.00 - 3.00	03 May 23 - 03 May 23	Open holed through pre-excavated TP05.	Dando 2000	J Gormer	A Adebayo	03 May 23
	3.00 - 15.00	03 May 23 - 03 May 23	Cable percussion boring to 15.00m.	Dando 2000	J Gormer		
Approved							
M Wareing							

Hole Depth	Hole Dia. (mm)	Casing Depth	Casing Dia. (mm)
3.00	200	3.00	200
15.00	150	15.00	150

Depth Related Remarks

Depth	Remarks

Ground Level 5.72 mOD
Coordinates E 333263.03
National Grid N 369770.88
System OSGB

Date / Casing	Time / Water	Samples Depth	Type & No.	Records	Field Tests Depth	Type	Records	Samp / Test Casing	Water	Coring Depth (Diameter)	TCR % SCR % RQD %	Water added Flush details	Depth (Thickness)	Level	Legend	Strata Description Main	Detail	Chisel.	Water Entry	Backfill
		10.00 - 10.45 10.00 - 10.45	D 6 B 6		10.00 - 10.45	SPT S	N=19 (1,2/4,4,5,6) ID PB01 Er 65%	10.00	4.50							Medium dense brown, locally slightly silty, fine and medium SAND. (TIDAL FLAT DEPOSITS)				
		11.50 - 11.95 11.50 - 11.95	D 7 B 7		11.50 - 11.95	SPT S	N=20 (1,2/3,4,6,7) ID PB01 Er 65%	11.50	5.00											
		13.00 - 13.45 13.00 - 13.45	D 8 B 8		13.00 - 13.45	SPT S	N=18 (1,2/3,4,5,6) ID PB01 Er 65%	13.00	5.00											
		14.50 - 14.95 14.50 - 14.95	D 9 B 9		14.50 - 14.95	SPT S	N=21 (2,3/4,5,6,6) ID PB01 Er 65%	14.50	5.50											
03 May 23 15.00	1700 5.50																			
													15.00	-9.28		END OF EXPLORATORY HOLE				15.00

General Remarks

Borehole located at centre of TP05. Strata descriptions between 0.00 and 3.00m taken from TP05 log.
50mm installation to 6.00m, Response zone 3.00 to 6.00m.

Hard Boring / Chiselling

Depths	Duration (mins)	Tool

Groundwater Entries

No.	Depth	Remarks	Sealed

Notes

For explanation of symbols and abbreviations see Key to Exploratory Hole Records. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Project	DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE
Project No.	F3023-23
Carried out for	Envolve Infrastructure Limited

Status

FINAL

Scale 1:50
Printed 19 Jul 2023 10:19:36

AGS

Borehole

SWE-BH-01B

Borehole Log

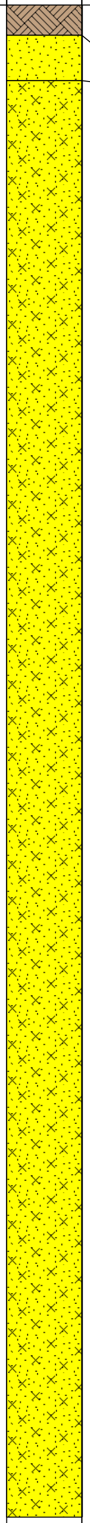
SOCOTEC

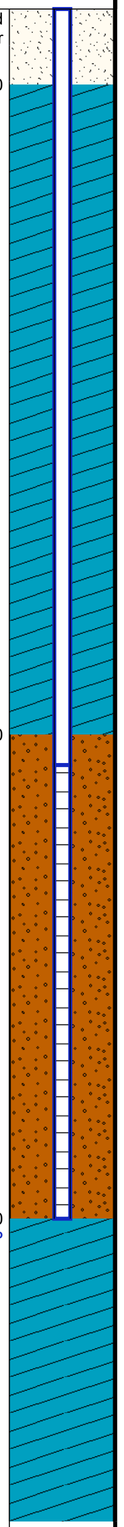
Checked	Depth	Dates	Method	Equipment	Rig Crew	Logger	Logged
R Fryer	0.00 - 1.20	04 May 23 - 04 May 23	Hand dug inspection pit to 1.20m	Hand tools	J Gormer	A Adebayo	04 May 23
Approved M Wareing	1.20 - 20.45	04 May 23 - 09 May 23	Cable percussion boring to 20.45m.	Dando 2000	J Gormer	A Adebayo	10 May 23

Hole		Casing		Depth Related Remarks	
Depth	Dia. (mm)	Depth	Dia. (mm)	Depth	Remarks
7.50	200	7.50	200		
20.00	150	20.00	150		

Ground Level	5.03 mOD
Coordinates	E 333377.50
National Grid	N 369717.52
System	OSGB

	Date Casing	Time Water	Samples Depth	Samples Type & No.	Samples Records	Field Tests Depth	Field Tests Type	Field Tests Records	Samp / Test Casing	Samp / Test Water	Coring Depth (Diameter)	TCR % SCR % RQD %	Water added Flush details	Depth (Thickness)	Level	Legend	Strata Description Main	Strata Description Detail	Chisel.	Water Entry	Backfill
0	04 May 23 0.00	0800 Dry	0.20 0.20	D 2 ES 1										(0.20) 0.20	+4.82		Brown slightly sandy SILT. (TOPSOIL)				Raised cover
			0.50 0.50	D 4 ES 3										(0.30) 0.50	+4.53		Brown fine to coarse SAND. (TIDAL FLAT DEPOSITS)				0.50
1			1.00 1.00 - 1.20 1.00 1.20 - 1.65 1.20 - 1.65	D 6 B 7 ES 5 D 8 B 9		1.20 - 1.65	SPT S	N=23 (2,4/5,5,6,7) ID PB01 Er 65%	0.00	Dry							Medium dense greyish brown slightly silty to silty fine and medium SAND. (TIDAL FLAT DEPOSITS)			1	
2			2.00 - 2.45 2.00 - 2.45 2.00	D 10 B 11 W 14		2.00 - 2.45	SPT S	N=16 (1,2/3,4,4,5) ID PB01 Er 65%	2.00	1.50										1	
3			3.00 - 3.45 3.00 - 3.45	D 12 B 13		3.00 - 3.45	SPT S	N=12 (1,1/1,2,2,7) ID PB01 Er 65%	3.00	2.00											
4			4.00 - 4.45 4.00 - 4.45	D 15 B 16		4.00 - 4.45	SPT S	N=13 (1,2/3,3,3,4) ID PB01 Er 65%	4.00	3.00											4.80
5			5.50 - 5.95 5.50 - 5.95	D 17 B 18		5.50 - 5.95	SPT S	N=17 (1,2/3,4,5,5) ID PB01 Er 65%	5.50	3.50											
	04 May 23 6.00	1700 3.50																			
6	05 May 23 6.00	0800 1.50																			
7			7.00 - 7.45	B 19		7.00 - 7.45	SPT S	N=18 (1,2/3,4,5,6) No recovery ID PB01 Er 65%	7.00	3.50											
8																					8.00 SP
			8.50 - 8.95 8.50 - 8.95	D 20 B 21		8.50 - 8.95	SPT S	N=14 (1,2/3,3,4,4) ID PB01 Er 65%	8.50	5.00											
9																					
10																					





Hole continues on next sheet

General Remarks

50mm installation to 8.00m, Response zone 4.80 to 8.00m.

Hard Boring / Chiselling

Depths	Duration (mins)	Tool

Groundwater Entries

No.	Depth	Remarks	Sealed
1	2.00	Rose to 1.50 m after 20 minutes.	

Notes

For explanation of symbols and abbreviations see Key to Exploratory Hole Records. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Project	DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE
Project No.	F3023-23
Carried out for	Envolve Infrastructure Limited

Status

FINAL

Scale 1:50

Printed 19 Jul 2023 10:19:37

AGS

Borehole

SWE-BH-02

Borehole Log

Checked	Depth	Dates	Method	Equipment	Rig Crew	Logger	Logged	Hole Depth	Hole Dia. (mm)	Casing Depth	Casing Dia. (mm)	Depth Related Remarks Depth	Remarks
R Fryer	0.00 - 1.20	04 May 23 - 04 May 23	Hand dug inspection pit to 1.20m	Hand tools	J Gormer	A Adebayo	04 May 23	7.50	200	7.50	200		
	1.20 - 20.45	04 May 23 - 09 May 23	Cable percussion boring to 20.45m.	Dando 2000	J Gormer	A Adebayo	10 May 23	20.00	150	20.00	150		
Approved													
M Wareing													

Ground Level	5.03 mOD
Coordinates	E 333377.50
National Grid	N 369717.52
System	OSGB

Date / Casing	Time / Water	Samples Depth	Type & No.	Records	Field Tests Depth	Type	Records	Samp / Test Casing	Water	Coring Depth (Diameter)	TCR % SCR % RQD %	Water added / Flush details	Depth (Thickness)	Level	Legend	Strata Description Main	Detail	Chisel.	Water Entry	Backfill
		10.00 - 10.45 10.00 - 10.45	D 22 B 23		10.00 - 10.45	SPT S	N=16 (1,2/3,3,5,5) ID PB01 Er 65%	10.00	5.00				(19.50)			Medium dense greyish brown slightly silty to silty fine and medium SAND. (TIDAL FLAT DEPOSITS)				
		11.50 - 11.95 11.50 - 11.95	D 24 B 25		11.50 - 11.95	SPT S	N=18 (1,2/3,4,5,6) ID PB01 Er 65%	11.50	5.00											
												Water added: 8.00 - 16.00								
		13.00 - 13.45 13.00 - 13.45	D 26 B 27		13.00 - 13.45	SPT S	N=18 (2,3/4,4,5,5) ID PB01 Er 65%	13.00	5.00											
		14.50 - 14.95 14.50 - 14.95	D 28 B 29		14.50 - 14.95	SPT S	N=15 (1,2/3,3,4,5) ID PB01 Er 65%	14.50	5.00											
		16.00 - 16.45 16.00 - 16.45	D 30 B 31		16.00 - 16.45	SPT S	N=16 (1,2/3,4,4,5) ID PB01 Er 65%	16.00	5.00											
05 May 23 16.50	1700 5.00																			
09 May 23 16.50	0800 1.50																			
		17.50 - 17.95 17.50 - 17.95	D 32 B 33		17.50 - 17.95	SPT S	N=17 (1,2/3,4,5,5) ID PB01 Er 65%	17.50	3.00											
		19.00 - 19.45 19.00 - 19.45	D 34 B 35		19.00 - 19.45	SPT S	N=18 (1,2/3,4,5,6) ID PB01 Er 65%	19.00	4.00											
													20.00	-14.98						

Hole continues on next sheet

General Remarks

50mm installation to 8.00m, Response zone 4.80 to 8.00m.

Hard Boring / Chiselling

Depths	Duration (mins)	Tool

Groundwater Entries

No.	Depth	Remarks	Sealed

Notes

For explanation of symbols and abbreviations see Key to Exploratory Hole Records. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Project	DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE
Project No.	F3023-23
Carried out for	Envolve Infrastructure Limited

Status

FINAL

Scale 1:50

Printed 19 Jul 2023 10:19:37

Borehole

SWE-BH-02

Borehole Log

Checked	Depth	Dates	Method	Equipment	Rig Crew	Logger	Logged
R Fryer	0.00 - 1.20	04 May 23 - 04 May 23	Hand dug inspection pit to 1.20m	Hand tools	J Gormer	A Adebayo	04 May 23
Approved	1.20 - 20.45	04 May 23 - 09 May 23	Cable percussion boring to 20.45m.	Dando 2000	J Gormer	A Adebayo	10 May 23
M Wareing							

Hole Depth	Hole Dia. (mm)	Casing Depth	Casing Dia. (mm)
7.50	200	7.50	200
20.00	150	20.00	150

Depth Related Remarks

Depth	Remarks

Ground Level	5.03 mOD
Coordinates	E 333377.50
National Grid	N 369717.52
System	OSGB

Date / Casing	Time / Water	Samples Depth	Samples Type & No.	Samples Records	Field Tests Depth	Field Tests Type	Field Tests Records	Samp / Test Casing	Samp / Test Water	Coring Depth (Diameter)	TCR % SCR % RQD %	Water added / Flush details	Depth (Thickness)	Level	Legend	Strata Description Main	Strata Description Detail	Chisel.	Water Entry	Backfill
09 May 23 20.00	1700 4.00	20.00 - 20.45	D 36		20.00 - 20.45	SPT S	N=17 (1,2/3,4,5,5) ID PB01 Er 65%	20.00	4.00				(0.45) 20.45	-15.42	▨	Firm to stiff greyish brown silty organic CLAY. Slight organic odour. (TIDAL FLAT DEPOSITS)				▨ 20.45
																END OF EXPLORATORY HOLE				

20
21
22
23
24
25
26
27
28
29
30

General Remarks

50mm installation to 8.00m, Response zone 4.80 to 8.00m.

Hard Boring / Chiselling

Depths	Duration (mins)	Tool

Groundwater Entries

No.	Depth	Remarks	Sealed

Notes

For explanation of symbols and abbreviations see Key to Exploratory Hole Records. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Project	DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE
Project No.	F3023-23
Carried out for	Envolve Infrastructure Limited

Status

FINAL

Scale 1:50
Printed 19 Jul 2023 10:19:37

AGS

Borehole

SWE-BH-02

Borehole Log

SOCOTEC

Checked	Depth	Dates	Method	Equipment	Rig Crew	Logger	Logged
R Fryer	0.00 - 1.20	09 May 23 - 09 May 23	Hand dug inspection pit to 1.20m.	Hand tools	J Round	A Adebayo	09 May 23
	1.20 - 5.45	09 May 23 - 09 May 23	Dynamic (windowless) sampling to 5.45m.	Dart 428	J Round	A Adebayo	09 May 23
Approved							
M Wareing							

Hole Depth	Hole Dia. (mm)	Casing Depth	Casing Dia. (mm)
3.00	102		
4.00	86		
5.00	76		

Depth Related Remarks

Depth	Remarks

Ground Level	4.60 mOD
Coordinates	E 333594.81
National Grid	N 369751.36
System	OSGB

Samples

Depth	Type & No.	Records
0.20	ES 1	
0.50	ES 2	
0.55	D 3	
1.00	ES 4	
1.20 - 1.65	D 5	
1.20 - 2.00	B 7	
1.20 - 2.00	DYS	100% rec, dia 87mm
1.50	D 6	
2.00 - 2.45	D 8	
2.00 - 3.00	B 10	
2.00 - 3.00	DYS	100% rec, dia 87mm
2.50	D 9	
3.00 - 3.45	D 11	
3.00 - 4.00	B 13	
3.00 - 4.00	DYS	100% rec, dia 77mm
3.50	D 12	
4.00 - 4.45	D 14	
4.00 - 5.00	B 16	
4.00 - 5.00	DYS	100% rec, dia 67mm
4.50	D 15	
5.00 - 5.45	D 17	

Field Tests

Depth	Type	Records
1.20 - 1.65	SPT S	N=15 (2,3/3,4,4,4) ID DART 428 Er 67%
2.00 - 2.45	SPT S	N=13 (2,2/3,3,3,4) ID DART 428 Er 67%
3.00 - 3.45	SPT S	N=21 (4,4/5,5,5,6) ID DART 428 Er 67%
4.00 - 4.45	SPT S	N=25 (4,5/6,6,6,7) ID DART 428 Er 67%
5.00 - 5.45	SPT S	N=23 (4,4/5,6,6,6) ID DART 428 Er 67%

Strata

Depth (Thickness)	Level	Legend	Strata Description Main	Detail	Water Entry	Backfill
0.35 (0.35)	+4.24	▨	Greyish brown slightly sandy slightly gravelly SILT with occasional rootlets. (MADE GROUND)			0.10
0.65 (0.30)	+3.94	▨	Dark greyish brown gravelly fine to coarse SAND. Gravel is angular to subangular fine to coarse of flint with occasional brick fragments (<20x20mm). (MADE GROUND)			
1.20 (0.55)	+3.40	⁙	Yellowish brown fine to coarse SAND. (TIDAL FLAT DEPOSITS)		1 ▽ 1 ▼	
5.45 (4.25)	-0.86	⁙	Medium dense greyish brown slightly silty fine SAND. (TIDAL FLAT DEPOSITS)			5.45

END OF EXPLORATORY HOLE

General Remarks

Hard Boring / Chiselling

Depths	Duration (mins)	Tool

Groundwater Entries

No.	Depth	Remarks	Sealed
1	1.20	Rose to 1.10 m after 20 minutes.	

Notes

For explanation of symbols and abbreviations see Key to Exploratory Hole Records. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Project	DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE
Project No.	F3023-23
Carried out for	Envolve Infrastructure Limited

Status

FINAL

Scale 1:50

Printed 19 Jul 2023 10:19:37

AGS

Borehole

SWE-WS-02

Borehole Log

SOCOTEC

Checked	Depth	Dates	Method	Equipment	Rig Crew	Logger	Logged
R Fryer	0.00 - 1.20	10 May 23 - 10 May 23	Hand dug inspection pit to 1.20m.	Hand tools	J Round	A Adebayo	10 May 23
Approved M Wareing	1.20 - 3.45	10 May 23 - 10 May 23	Dynamic (windowless) sampling to 3.45m.	Dart 428	J Round	A Adebayo	10 May 23

Hole Depth	Hole Dia. (mm)	Casing Depth	Casing Dia. (mm)
2.00	86		
3.00	76		

Depth Related Remarks

Depth	Remarks

Ground Level	4.60 mOD
Coordinates	E 333797.38
National Grid	N 369835.99
System	OSGB

Date / Casing	Time / Water	Samples Depth	Samples Type & No.	Samples Records	Field Tests Depth	Field Tests Type	Field Tests Records	Samp / Test Casing	Samp / Test Water	Coring Depth (Diameter)	TCR % SCR % RQD %	Water added / Flush details
		0.20	ES 1									
		0.50	ES 2									
		1.00	ES 3									
		1.20 - 2.00	B 5		1.20 - 1.65	SPT S	N=8 (1,2/2,2,2,2) No recovery ID DART 428 Er 67%					
		1.20 - 2.00	DYS	100% rec, dia 77mm								
		1.50	D 4									
		2.00 - 2.45	D 6		2.00 - 2.45	SPT S	N=12 (2,2/3,3,3,3) ID DART 428 Er 67%					
		2.00 - 3.00	B 8									
		2.00 - 3.00	DYS	100% rec, dia 67mm								
		2.50	D 7									
					3.00 - 3.45	SPT S	N=17 (2,3/3,4,4,6) ID DART 428 Er 67%					

Depth (Thickness)	Level	Legend	Strata Description Main	Detail	Chisel.	Water Entry
0.35 (0.35)	+4.25	▨	Greyish brown sandy SILT. (TOPSOIL)			
1.20 (0.85)	+3.40	▨	Yellowish brown fine to coarse SAND. (TIDAL FLAT DEPOSITS)			1 ▽ 1 ▼
3.45 (2.25)	+1.15	▨	Loose to medium dense greyish brown silty fine SAND. (TIDAL FLAT DEPOSITS)			
			END OF EXPLORATORY HOLE			

Backfill	
0.20	▨
3.45	▨

General Remarks

Hard Boring / Chiselling

Depths	Duration (mins)	Tool

Groundwater Entries

No.	Depth	Remarks	Sealed
1	1.20	Rose to 0.90 m after 20 minutes.	

Notes

For explanation of symbols and abbreviations see Key to Exploratory Hole Records. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Project	DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE
Project No.	F3023-23
Carried out for	Envolve Infrastructure Limited

Status

FINAL

Scale 1:50

Printed 19 Jul 2023 10:19:38

AGS

Borehole

SWE-WS-03

Borehole Log

Checked	Depth	Dates	Method	Equipment	Rig Crew	Logger	Logged
R Fryer	0.00 - 1.20	10 May 23 - 10 May 23	Hand dug inspection pit to 1.20m.	Hand tools	J Round	A Adebayo	10 May 23
Approved	1.20 - 3.45	10 May 23 - 10 May 23	Dynamic (windowless) sampling to 3.45m.	Dart 428	J Round	A Adebayo	10 May 23
M Wareing							

Hole Depth	Hole Dia. (mm)	Casing Depth	Casing Dia. (mm)
2.00	86		
3.00	76		

Depth Related Remarks

Depth	Remarks

Ground Level	4.73 mOD
Coordinates	E 334004.51
National Grid	N 369896.36
System	OSGB

Samples

Depth	Type & No.	Records
0.20	ES 1	
0.50	ES 2	
1.00	ES 3	
1.20 - 1.65	D 4	
1.20 - 2.00	B 6	
1.20 - 2.00	DYS	100% rec, dia 77mm
1.50	D 5	
2.00 - 2.45	D 7	
2.00 - 3.00	B 9	
2.00 - 3.00	DYS	100% rec, dia 67mm
2.50	D 8	

Field Tests

Depth	Type	Records
1.20 - 1.65	SPT S	N=10 (2,2/2,2,3,3) ID DART 428 Er 67%
2.00 - 2.45	SPT S	N=12 (2,2/2,3,3,4) ID DART 428 Er 67%
3.00 - 3.45	SPT S	N=21 (3,4/4,5,6,6) ID DART 428 Er 67%

Strata Description

Depth (Thickness)	Level	Legend	Main	Detail
0.35 (0.35)	+4.38	▨	Greyish brown sandy SILT. (TOPSOIL)	
1.20 (0.85)	+3.53	🟨	Yellowish brown fine to coarse SAND. (TIDAL FLAT DEPOSITS)	
3.45 (2.25)	+1.28	🟨	Medium dense greyish brown slightly silty fine SAND. (TIDAL FLAT DEPOSITS)	

END OF EXPLORATORY HOLE

Water Entry

Depth	Water Entry
1.00	1 ▽
1.20	1 ▼

Backfill

Depth	Backfill
0.20	🟫
3.45	▨

General Remarks

Hard Boring / Chiselling

Depths	Duration (mins)	Tool

Groundwater Entries

No.	Depth	Remarks	Sealed
1	1.20	Rose to 1.00 m after 20 minutes.	

Notes

For explanation of symbols and abbreviations see Key to Exploratory Hole Records. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Project	DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE
Project No.	F3023-23
Carried out for	Envolve Infrastructure Limited

Status

FINAL

Scale 1:50

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Borehole

SWE-WS-04

Borehole Log

Checked	Depth	Dates	Method	Equipment	Rig Crew	Logger	Logged
R Fryer	0.00 - 1.20	10 May 23 - 10 May 23	Hand dug inspection pit to 1.20m.	Hand tools	J Round	A Adebayo	10 May 23
	1.20 - 3.45	10 May 23 - 10 May 23	Dynamic (windowless) sampling to 3.45m.	Dart 428	J Round	A Adebayo	10 May 23
Approved							
M Wareing							

Hole		Casing		Depth Related Remarks	
Depth	Dia. (mm)	Depth	Dia. (mm)	Depth	Remarks
2.00	86				
3.00	76				

Ground Level	4.92 mOD
Coordinates	E 334303.98
National Grid	N 369899.58
System	OSGB

Date / Casing	Time / Water	Samples Depth	Samples Type & No.	Samples Records	Field Tests Depth	Field Tests Type	Field Tests Records	Samp / Test Casing	Samp / Test Water	Coring Depth (Diameter)	TCR % SCR % RQD %	Water added Flush details
		0.20	ES 1									
		0.50	ES 2									
		1.00	ES 3									
		1.20 - 1.65	D 4		1.20 - 1.65	SPT S	N=8 (1,2/2,2,2,2) ID DART 428 Er 67%					
		1.20 - 2.00	B 6									
		1.20 - 2.00	DYS	100% rec, dia 77mm								
		1.50	D 5									
		2.00 - 2.45	D 7		2.00 - 2.45	SPT S	N=12 (2,2/2,3,3,4) ID DART 428 Er 67%					
		2.00 - 3.00	B 9									
		2.00 - 3.00	DYS	100% rec, dia 67mm								
		2.50	D 8									
					3.00 - 3.45	SPT S	N=20 (3,4/4,5,5,6) ID DART 428 Er 67%					

Depth (Thickness)	Level	Legend	Strata Description Main	Detail	Chisel.	Water Entry	Backfill
(0.35) 0.35	+4.57	▨	Greyish brown sandy SILT. (TOPSOIL)				0.20 ■
(0.85) 1.20	+3.72	▨	Yellowish brown fine to coarse SAND. (TIDAL FLAT DEPOSITS)			1 ▽ 1 ▼	▨
(2.25) 3.45	+1.47	▨	Loose to medium dense greyish brown slightly silty fine SAND. (TIDAL FLAT DEPOSITS)				3.45 ▨
			END OF EXPLORATORY HOLE				

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

General Remarks

Hard Boring / Chiselling

Depths	Duration (mins)	Tool

Groundwater Entries

No.	Depth	Remarks	Sealed
1	1.10	Rose to 1.00 m after 20 minutes.	

Notes

For explanation of symbols and abbreviations see Key to Exploratory Hole Records. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Project	DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE
Project No.	F3023-23
Carried out for	Envolve Infrastructure Limited

Status

FINAL

Scale 1:50

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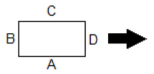
Borehole

SWE-WS-05

Trial Pit Log

Checked R Fryer	**Depth**	**Dates**	**Method**	**Equipment**	**Crew**	**Logger**	**Logged**	**Dimensions and Orientation**
Approved M Wareing	0.00 - 2.50	26 Apr 23 - 26 Apr 23	Machine excavated trial pit to 2.50m.	Excavator	A Williams	A Adebayo	26 Apr 23	Width 0.50 m Length 7.00 m 186 (Deg)



Depth Related Remarks

Depth	Remarks

Ground Level	5.56 mOD
Coordinates	E 333263.55
National Grid	N 369773.08
System	OSGB

Date	Time	Water
26 Apr 23	0900	
26 Apr 23	1200	

Samples Depth	Samples Type & No.	Samples Records	Field Tests Depth	Field Tests Type	Field Tests Records
0.10	ES 1		0.10	PID	2.8 ppmv (Test 1)
0.20 0.20	ES 2 ES 6	Face B	0.20	PID	1.2 ppmv (Test 2)
0.60	ES 3		0.60	PID	0.4 ppmv (Test 3)
1.00 1.00	ES 4 ES 5	Face B	1.00	PID	0.9 ppmv (Test 4)
1.50	ES 7		1.50	PID	0.9 ppmv (Test 5)
2.00	ES 8		2.00	PID	0.2 ppmv (Test 6)

Depth (Thickness)	Level	Legend	Strata Description Main	Strata Description Detail	Water Entry	Backfill
0.15 (0.15)	+5.42	■	Black MACADAM. (Pavement between 0 and 5m from Face D)	0.00-0.70 Greyish brown slightly sandy slightly gravelly SILT with occasional rootlets. (Grass verge between 5 and 7m from Face D)		🟫
0.35 (0.20)	+5.22	▨	Grey sandy angular to subangular medium and coarse GRAVEL of limestone. (FILL)			
0.70 (0.35)	+4.86	▨	Light brown gravelly slightly clayey fine to coarse SAND. Gravel is angular to subangular fine to coarse of flint with rare fragments of brick and concrete (<20x30mm). (MADE GROUND)			
1.20 (0.50)	+4.36	🟨	Dark brown gravelly slightly silty fine to coarse SAND with rare rootlets (<3mm max. dia.). Gravel is angular to subangular fine to coarse of flint. (TIDAL FLAT DEPOSITS)	0.70-1.20 Dark greyish brown gravelly slightly silty fine to coarse SAND. (Grass verge between 5 and 7m from Face D)		
1.60 (0.40)	+3.96	🟨	Greyish brown gravelly slightly silty fine to coarse SAND. Gravel is angular to subangular fine to coarse of flint. (TIDAL FLAT DEPOSITS)			
2.50 (0.90)	+3.06	🟨	Light yellowish brown gravelly slightly silty fine to coarse SAND. Gravel is angular to subangular fine to coarse of flint. (TIDAL FLAT DEPOSITS)		1 ▽	2.50
			END OF EXPLORATORY HOLE			

General Remarks

Trial pit extends across both hard standing and topsoil areas.

Stability	Unstable from 1.80m.
Shoring	None
Weather	Sunny

Groundwater Entries

No.	Depth	Remarks	Sealed
1	2.40		

Notes

For explanation of symbols and abbreviations see Key to Exploratory Hole Records. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Project	DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE
Project No.	F3023-23
Carried out for	Envolve Infrastructure Limited

Status

FINAL

Scale 1:25
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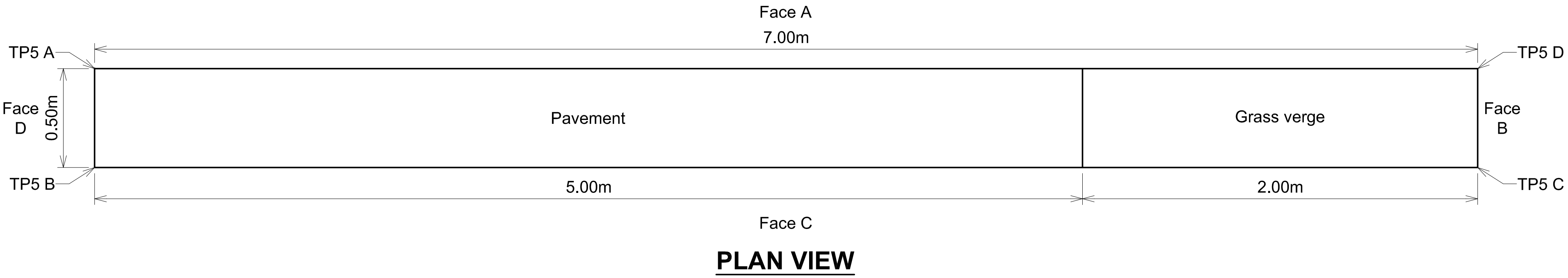
Trial Pit

TP05

Sheet 1 of 1

Trial Pit Drawing



PLAN VIEW

Point	Easting	Northing	Height
TP5 A	333261.993	369769.921	5.736
TP5 B	333263.071	369770.532	5.714
TP5 C	333264.097	369775.752	5.598
TP5 D	333264.748	369775.495	5.594

All dimensions in metres.

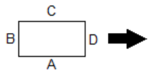
Scale: 1:30 A4

Project Deeside Airfields -Paper Mill Water Pipeline
Project no. F3023-23
Client Envolve Infrastructure

TP No.
TP05

Trial Pit Log

Checked R Fryer **Approved** M Wareing	**Depth** 0.00 - 2.50	**Dates** 25 Apr 23 - 25 Apr 23	**Method** Machine excavated trial pit to 2.50m.	**Equipment** Excavator	**Crew**	**Logger** A Adebayo	**Logged** 25 Apr 23	**Dimensions and Orientation** Width 0.50 m Length 4.00 m 84 (Deg)	**Depth Related Remarks**



Depth Related Remarks

Depth	Remarks
0.40 - 0.50	Face D - 2nr 100mm dia. PVC Electrical Service Ducts.

Ground Level	6.35 mOD
Coordinates	E 333108.97
National Grid	N 369828.26
System	OSGB

	Date	Time Water	Samples Depth	Samples Type & No.	Samples Records	Field Tests Depth	Field Tests Type	Field Tests Records	Depth (Thickness)	Level	Legend	Strata Description Main	Strata Description Detail	Water Entry	Backfill
0			0.20	ES 1					(0.30)		▨	Greyish brown slightly sandy slightly gravelly SILT with occasional rootlets (<8x10mm). Gravel is angular to subangular fine to coarse of flint. (MADE GROUND)			🟫
									0.30	+6.05	▨	Soft to firm orangish brown sandy silty CLAY with rare pockets (<10x15mm) of fine sand. (MADE GROUND)			🟫
			0.50	ES 2							▨		0.50-1.10 Face D - greyish brown.		🟫
1			1.00	ES 3					(1.20)		▨		1.10-1.50 Face D - Soft brownish sandy gravelly CLAY. (MADE GROUND)		🟫
			1.50	ES 4					1.50	+4.85	▨	Soft orangish brown sandy silty CLAY with rare pockets (<10x15mm) of fine sand. (MADE GROUND)	1.50-2.50 Face D - Soft orangish brown locally dark sandy gravelly CLAY. Gravel is angular to subangular fine to coarse of flint and brick with rare fragments of possible clinker (<5x5mm). (MADE GROUND)		🟫
2			2.00	ES 5					(1.00)		▨				🟫
									2.50	+3.85		END OF EXPLORATORY HOLE			2.50
3															
4															
5															

General Remarks

No groundwater encountered.

Stability	Stable
Shoring	None
Weather	Sunny

Groundwater Entries

No.	Depth	Remarks	Sealed

Notes

For explanation of symbols and abbreviations see Key to Exploratory Hole Records. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Project	DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE
Project No.	F3023-23
Carried out for	Envolve Infrastructure Limited

Status

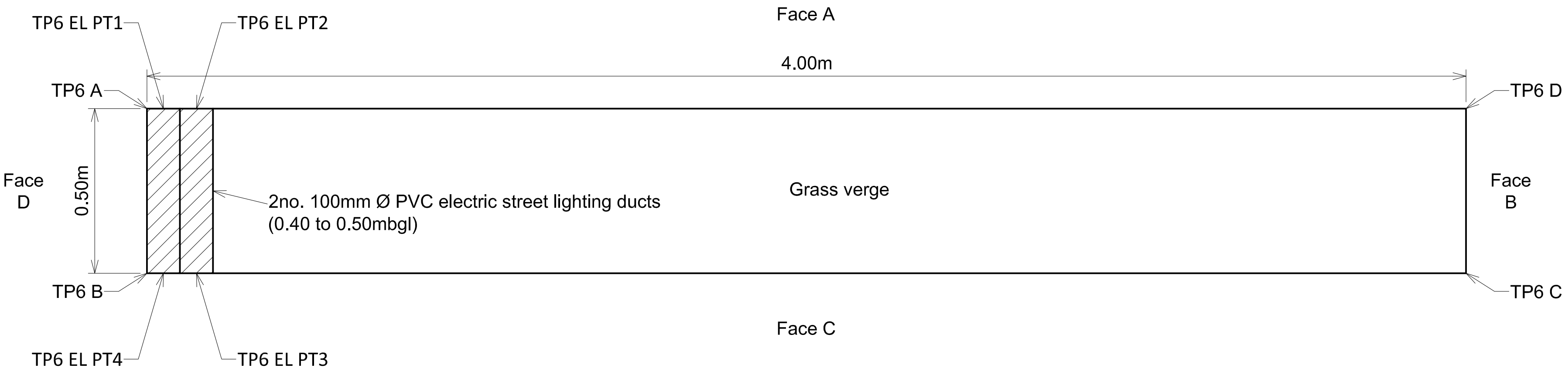
FINAL

Scale	1:25
Printed	19 Jul 2023 10:20:59

Trial Pit

TP06

Trial Pit Drawing



PLAN VIEW

Point	Easting	Northing	Height
TP6 A	333109.803	369830.759	6.281
TP6 B	333108.970	369830.926	6.262
TP6 C	333107.903	369826.589	6.259
TP6 D	333108.846	369826.346	6.291
TP6 EL PT1	333109.706	369830.209	5.978
TP6 EL PT2	333109.695	369830.202	5.982
TP6 EL PT3	333109.296	369830.292	5.933
TP6 EL PT4	333108.887	369830.394	5.974

All dimensions in metres.
Scale: 1:20 A4

Project Deeside Airfields -Paper Mill Water Pipeline
Project no. F3023-23
Client Envolve Infrastructure

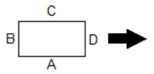
TP No.
TP06

Trial Pit Log

Checked	Depth	Dates	Method	Equipment	Crew	Logger	Logged
R Fryer	0.00 - 2.50	28 Apr 23 - 28 Apr 23	Machine excavated trial pit to 2.50m.	Excavator		A Adebayo	28 Apr 23
Approved							
M Wareing							

Dimensions and Orientation

Width 0.88 m
Length 4.00 m



88
(Deg)

Depth Related Remarks

Depth	Remarks

Ground Level	6.25 mOD
Coordinates	E 332800.18
National Grid	N 369775.03
System	OSGB

Date	Time / Water	Samples Depth	Samples Type & No.	Samples Records	Field Tests Depth	Field Tests Type	Field Tests Records	Depth (Thickness)	Level	Legend	Strata Description Main	Strata Description Detail	Water Entry	Backfill
		0.10	ES 1		0.10	PID	0.7 ppmv (Test 1)	(0.20)		▨	Greyish brown slightly sandy slightly gravelly SILT with occasional rootlets (<8x10mm). Gravel is angular to subangular fine to coarse of flint. (Probable MADE GROUND)			
								0.20	+6.05	▨	Yellowish brown gravelly slightly silty fine to coarse SAND. Gravel is angular to subangular fine to coarse of possibly flint. (TIDAL FLAT DEPOSITS)			
		0.70	ES 2		0.70	PID	0.7 ppmv (Test 2)							
								(2.30)						
								2.50	+3.75		END OF EXPLORATORY HOLE			2.50

General Remarks

No groundwater encountered.
Pit collapsed at 2.5m.

Stability	Unstable - pit collapsed at 2.50m.
Shoring	None
Weather	Cloudy

Groundwater Entries

No.	Depth	Remarks	Sealed

Notes

For explanation of symbols and abbreviations see Key to Exploratory Hole Records. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Project	DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE
Project No.	F3023-23
Carried out for	Envolve Infrastructure Limited

Status

FINAL

Scale 1:25
Printed 19 Jul 2023 10:21:00

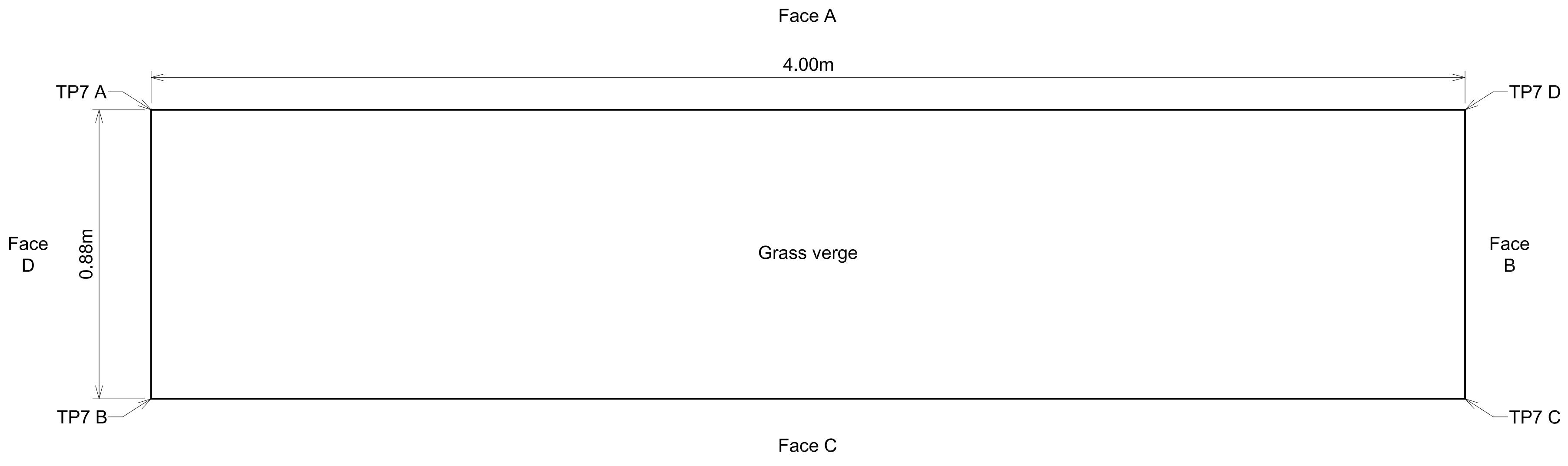
AGS

Trial Pit

TP07

Sheet 1 of 1

Trial Pit Drawing



PLAN VIEW

Point	Easting	Northing	Height
TP7 A	332800.464	369777.539	6.172
TP7 B	332799.626	369777.431	6.150
TP7 C	332799.810	369773.694	6.227
TP7 D	332800.885	369773.812	6.205

All dimensions in metres.

Scale: 1:20 A4

Project Deeside Airfields -Paper Mill Water Pipeline
Project no. F3023-23
Client Envolve Infrastructure

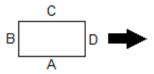
TP No.
TP07

Trial Pit Log

Checked	Depth	Dates	Method	Equipment	Crew	Logger	Logged
R Fryer	0.00 - 2.50	02 May 23 - 02 May 23	Machine excavated trial pit to 2.50m.	Excavator		A Adebayo	02 May 23
Approved							
M Wareing							

Dimensions and Orientation

Width 0.88 m
Length 4.00 m



88
(Deg)

Depth Related Remarks

Depth	Remarks
0.55 - 0.65	2nr electrical ducts street lighting.
2.20 - 2.43	Water main, possibly 225mm dia.

Ground Level	6.52 mOD
Coordinates	E 332653.46
National Grid	N 369783.37
System	OSGB

Date	Time Water	Samples Depth	Samples Type & No.	Samples Records	Field Tests Depth	Field Tests Type	Field Tests Records	Depth (Thickness)	Level	Legend	Strata Description Main	Strata Description Detail	Water Entry	Backfill
		0.10	ES 1		0.10	PID	0.1 ppmv (Test 1)	(0.20)		▨	Greyish brown slightly sandy slightly gravelly SILT with occasional rootlets (<8x10mm). Gravel is angular to subangular fine to coarse of flint. (MADE GROUND)			
								0.20	+6.32					
								(0.60)		▨	Light brown gravelly slightly clayey fine to coarse SAND. Gravel is angular to subangular fine to coarse of flint. (MADE GROUND)			
		0.70	ES 2		0.70	PID	0.1 ppmv (Test 2)							
								0.80	+5.72					
								(0.50)		▨	Light reddish brown gravelly clayey fine to coarse SAND. Gravel is angular to subangular fine to coarse of flint with rare fragments of brick (<20x30mm). (MADE GROUND)			
		1.20	ES 3		1.20	PID	0.1 ppmv (Test 3)							
								1.30	+5.22					
		1.60	ES 4		1.60	PID	0.1 ppmv (Test 4)	(0.60)		░	Light greyish brown slightly gravelly slightly clayey fine to coarse SAND. Gravel is angular to subangular fine to coarse of flint. (TIDAL FLAT DEPOSITS)			
								1.90	+4.62					
		2.10	ES 5		2.10	PID	0.3 ppmv (Test 5)	(0.60)		░	Yellowish brown slightly gravelly slightly clayey fine to coarse SAND. Gravel is angular to subangular fine to coarse of flint. (TIDAL FLAT DEPOSITS)			
								2.50	+4.02		END OF EXPLORATORY HOLE			2.50

General Remarks

No groundwater encountered.

Stability	Stable
Shoring	None
Weather	Sunny

Groundwater Entries

No.	Depth	Remarks	Sealed

Notes

For explanation of symbols and abbreviations see Key to Exploratory Hole Records. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Project	DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE
Project No.	F3023-23
Carried out for	Envolve Infrastructure Limited

Status

FINAL

Scale 1:25
Printed 19 Jul 2023 10:21:00

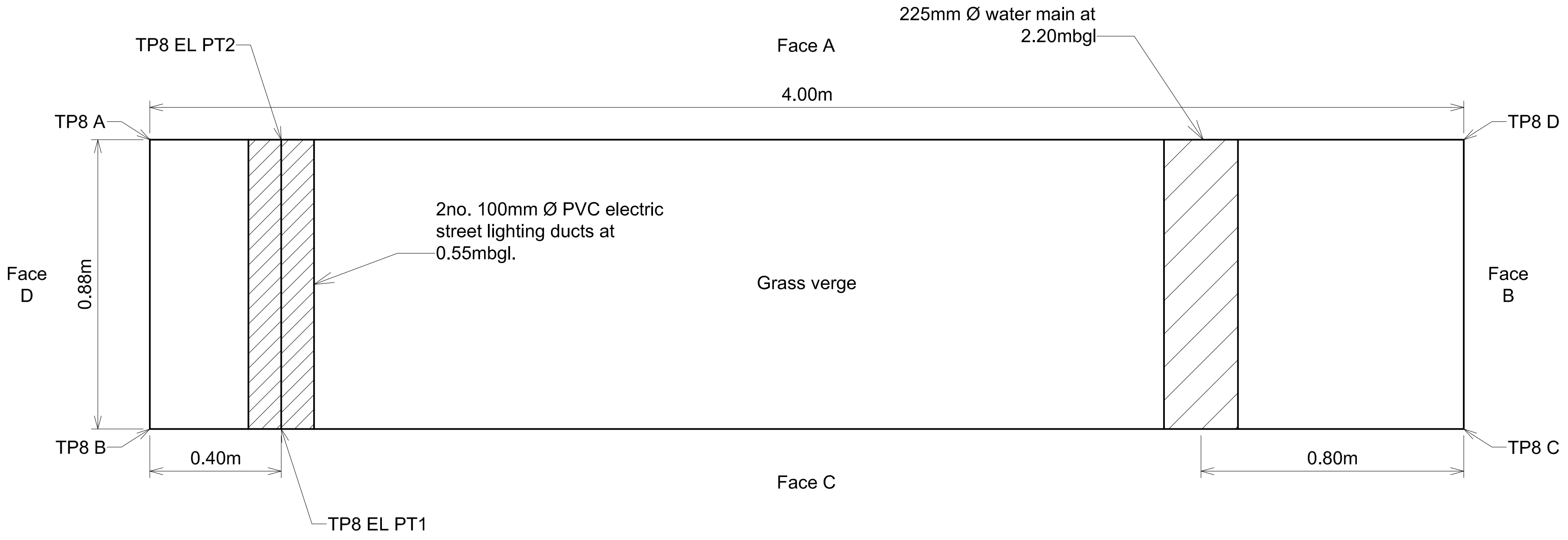
AGS

Trial Pit

TP08

Sheet 1 of 1

Trial Pit Drawing



PLAN VIEW

Point	Easting	Northing	Height
TP8 A	332653.999	369785.420	6.415
TP8 B	332653.040	369785.396	6.418
TP8 C	332653.093	369781.471	6.360
TP8 D	332654.141	369781.506	6.364
TP8 EL PT1	332653.143	369784.765	5.919
TP8 EL PT2	332653.699	369784.832	5.904

All dimensions in metres.

Scale: 1:20 A4

Project Deeside Airfields -Paper Mill Water Pipeline
Project no. F3023-23
Client Envolve Infrastructure

TP No.
TP08

Trial Pit Log

SOCOTEC

Checked	Depth	Dates	Method	Equipment	Crew	Logger	Logged
R Fryer	0.00 - 2.50	27 Apr 23 - 27 Apr 23	Machine excavated trial pit to 2.50m.	Excavator		A Adebayo	27 Apr 23
Approved M Wareing							

Dimensions and Orientation

Width 0.50 m
Length 6.00 m
C / B ☐ D / A ➡ 341 (Deg)

Depth Related Remarks

Depth	Remarks
0.45 - 0.45	1nr PVC 100mm cable.
0.70 - 0.70	2nr HVS, 2nr Pilots, 1nr LV (side by side).
0.90 - 0.90	1nr Gas, 2nr 90mm BT.
1.00 - 1.00	225mm Water Main.

Ground Level	6.09 mOD
Coordinates	E 332568.38
National Grid	N 369792.27
System	OSGB

Samples and Field Tests

Date	Time / Water	Sample Depth	Type & No.	Records	Field Test Depth	Type	Records
		0.05	ES 1		0.05	PID	0.3 ppmv (Test 1)
		0.20	ES 2	Fill	0.20	PID	0.6 ppmv (Test 2)
		0.20	ES 3	Topsoil			
		0.80	ES 4		0.80	PID	0.1 ppmv (Test 3)
		1.50	ES 5		1.50	PID	0.5 ppmv (Test 4)
		2.20	ES 6		2.20	PID	0.5 ppmv (Test 5)

Strata Description

Depth (Thickness)	Level	Legend	Main	Detail	Water Entry	Backfill
0.15 (0.15)	+5.94	▲	MACADAM. (Pavement between 0 and 3m from Face D)	0.00-0.30 Greyish brown slightly sandy slightly gravelly SILT with occasional rootlets. Gravel is angular to subangular fine to coarse of flint. (TOPSOIL) (Grass verge between 3 and 6m from Face D)		
0.35 (0.20)	+5.74	▨	Grey sandy angular to subangular fine to coarse GRAVEL of concrete. (FILL)			
1.20 (0.85)	+4.89	▨	Reddish brown gravelly slightly clayey fine to coarse SAND. Gravel is angular to subangular fine to coarse of mudstone. (Possible MADE GROUND)			
1.90 (0.70)	+4.19	⁘	Light grey to light greenish grey gravelly slightly clayey fine to coarse SAND. Gravel is angular to subangular fine to coarse of possibly flint. (TIDAL FLAT DEPOSITS)			
2.50 (0.60)	+3.59	⁘	Yellowish brown to light yellowish brown gravelly slightly clayey fine to coarse SAND. Gravel is angular to subangular fine to coarse of flint. (TIDAL FLAT DEPOSITS)			2.50
			END OF EXPLORATORY HOLE			

General Remarks

No groundwater encountered.

Stability	Stable
Shoring	None
Weather	Cloudy

Groundwater Entries

No.	Depth	Remarks	Sealed

Notes

For explanation of symbols and abbreviations see Key to Exploratory Hole Records. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Project	DEESIDE AIRFIELDS - PAPER MILL WATER PIPELINE
Project No.	F3023-23
Carried out for	Envolve Infrastructure Limited

Status

FINAL

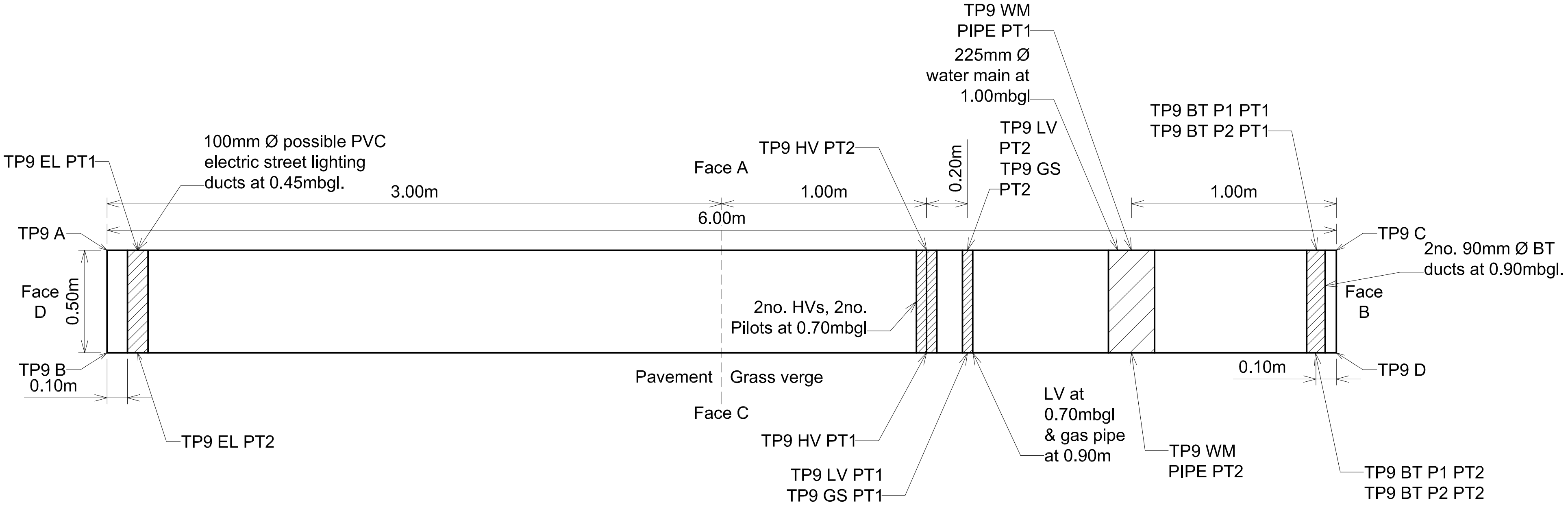
Scale 1:25
Printed 19 Jul 2023 10:21:00

AGS

Trial Pit

TP09

Trial Pit Drawing



PLAN VIEW

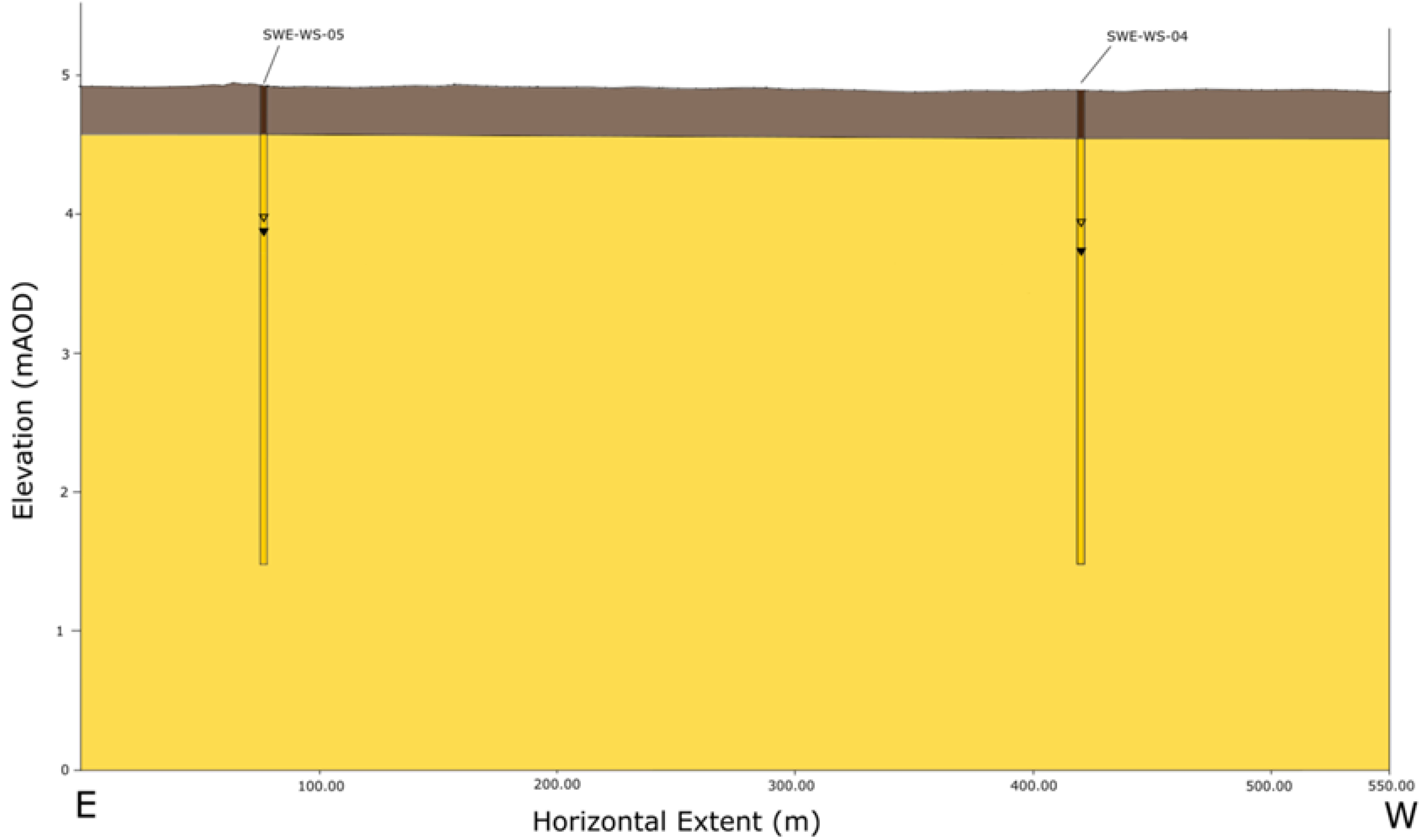
Point	Easting	Northing	Height
TP9 A	332568.709	369795.368	6.055
TP9 B	332568.153	369795.373	6.043
TP9 C	332568.641	369789.870	6.131
TP9 D	332567.893	369789.702	6.120
TP9 HV PT1	332568.013	369791.476	5.519
TP9 HV PT2	332568.433	369791.500	5.464
TP9 LV PT1	332568.018	369791.230	5.473
TP9 LV PT2	332568.390	369791.317	5.422
TP9 GS PT1	332567.999	369791.202	5.279
TP9 GS PT2	332568.400	369791.294	5.236
TP9 EL PT1	332568.194	369795.286	5.578
TP9 EL PT2	332568.582	369795.329	5.610
TP9 BT P1 PT1	332568.615	369789.461	5.293
TP9 BT P1 PT2	332568.104	369789.407	5.312
TP9 BT P2 PT1	332568.614	369789.598	5.278
TP9 BT P2 PT2	332568.071	369789.541	5.290
TP9 WM PIPE PT1	332568.469	369790.436	5.165
TP9 WM PIPE PT2	332568.210	369790.436	5.172

All dimensions in metres.

Scale: 1:30 A4

Project Deeside Airfields -Paper Mill Water Pipeline
Project no. F3023-23
Client Envolve Infrastructure

TP No.
TP09



Horizontal Scale:1mm = 1.43m
Vertical Scale: 40.63mm = 1m

🟨 Tidal Flat Deposit

🟫 Topsoil

▽ Groundwater Level

▼ Initial Groundwater Strike

Imagery (C)2023 Airbus, CNES/Airbus, Getmapping plc, Infoterra Ltd & Bluesky, Landsat/ Copernicus, Maxar Technologies, Map Data (C) 2023

Legend

▽ Groundwater Level

▼ Initial Groundwater Strike

🟫 Topsoil

🟨 Tidal Flat Deposits

⬛ Made Ground

Client
Dŵr Cymru
Welsh Water

Rev	Date	Amendment Details	Dr'n	Chk'	App'
Rev	09.11.2023	FIRST ISSUE	ABC	ABC	ABC

Sweco UK Limited,
Grove House, Mansion Gate Drive,
Leeds, LS7 4DN
Tel: +44 (0)113 262 0000
www.sweco.co.uk

SWECO

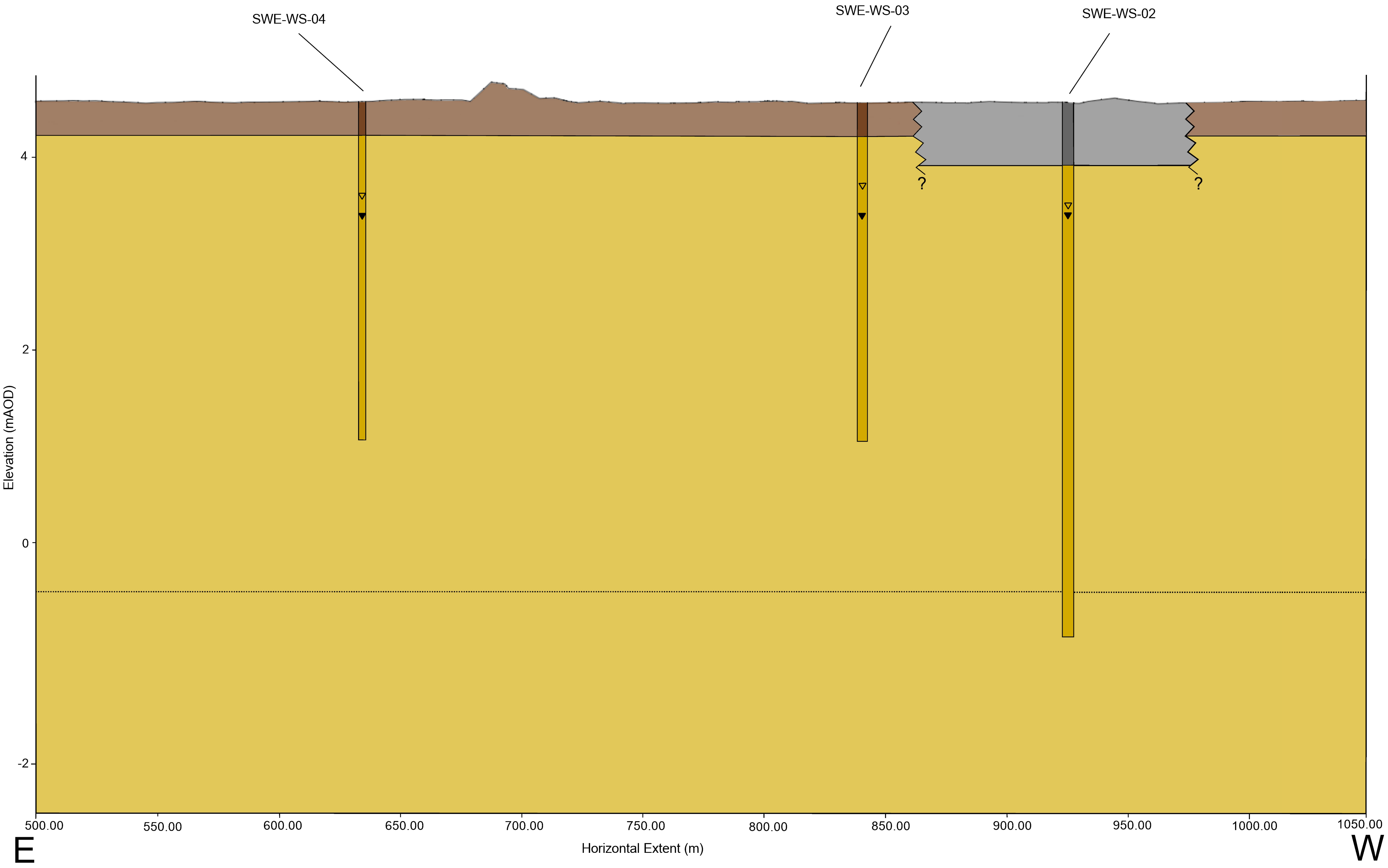
Project Title
Deeside Dewatering Airfield Raw Water Paper Mill

Drawing Title
Appendix C: E-W Parallel Hydrogeological Conceptual Model (0-550M Chainage)

Project Stage
STAGE 2

Status	Status Description		
WIP	Work in Progress		
Drawn	Designed	Checked	Approved
RMc	ABC	ABC	ABC
Sheet Size	Scale	Sweco Ref	Revision
A3	Horizontal: 1mm : 1.43M Vertical: 1mm : 0.025m	65201386	P01

Drawing Number
65201386-SWE-XX-00-DR-0-00002-P01-Appendix C1



Legend

▽ Groundwater Level

▼ Initial Groundwater Strike

┈┈ Proposed Excavation Base Depth

■ Topsoil

■ Tidal Flat Deposits

■ Made Ground

Client
Dŵr Cymru Welsh Water

Rev	09.11.2023	FIRST ISSUE	ABC	ABC	ABC
Rev	Date	Amendment Details	Dr'n	Chk'	App'

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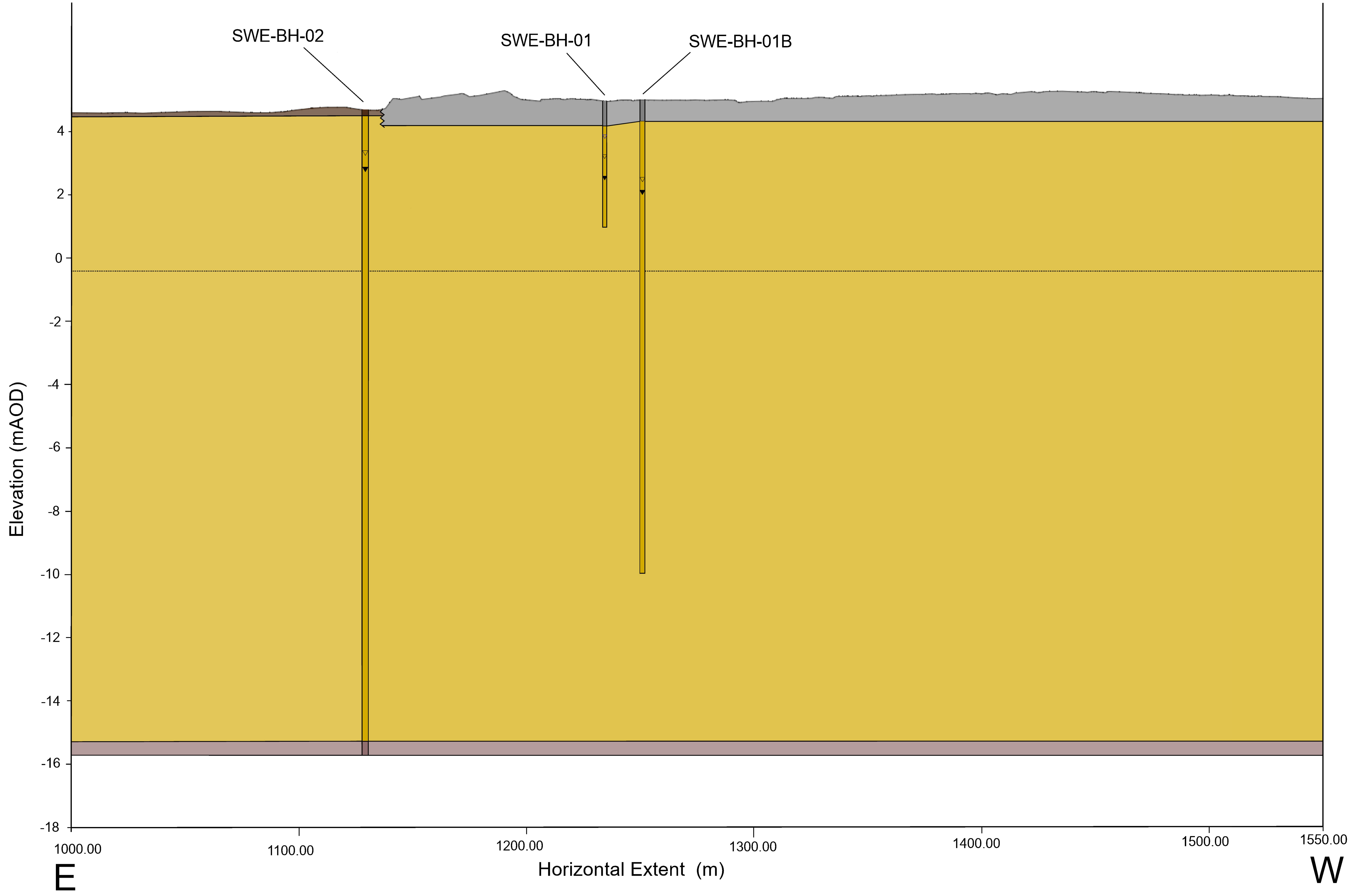
Project Title
Deeside Dewatering Airfield Raw Water Paper Mill

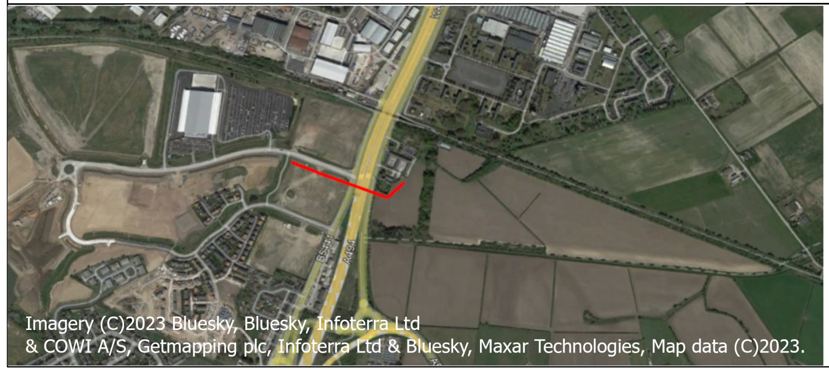
Drawing Title
Appendix C: E-W Parallel Hydrogeological Conceptual Model (500 -1050m Chainage)

Project Stage
STAGE 2

Status	Status Description		
WIP	Work in Progress		
Drawn	Designed	Checked	Approved
RMc	ABC	ABC	ABC
Sheet Size	Scale	Sweco Ref	Revision
A3	Horizontal: 1mm : 0.72m Vertical: 1mm : 0.034m	65201386	P01

Drawing Number
65201386-SWE-XX-00-DR-0-00003-P01-Appendix C2





Imagery (C)2023 Bluesky, Bluesky, Infoterra Ltd
& COWI A/S, Getmapping plc, Infoterra Ltd & Bluesky, Maxar Technologies, Map data (C)2023.

Legend

▽ Groundwater Level

▼ Initial Groundwater Strike

▽ Groundwater Seepage

.... Proposed Excavation Base

🟫 Topsoil

🟨 Tidal Flat Deposits - Sand/ Silt

■ Made Ground

■ Tidal Flat Deposits - Clay

Rev	09.11.2023	FIRST ISSUE	ABC	ABC	ABC
Rev	Date	Amendment Details	Dr'n	Chk'	App'

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www.sweco.co.uk

SWECO

Client
Dŵr Cymru
Welsh Water

Project Title
Deeside Dewatering Airfield Raw Water Paper Mill

Drawing Title
Appendix C: E-W Parallel Hydrogeological Conceptual Model (1000 - 1550m Chainage)

Project Stage
STAGE 2

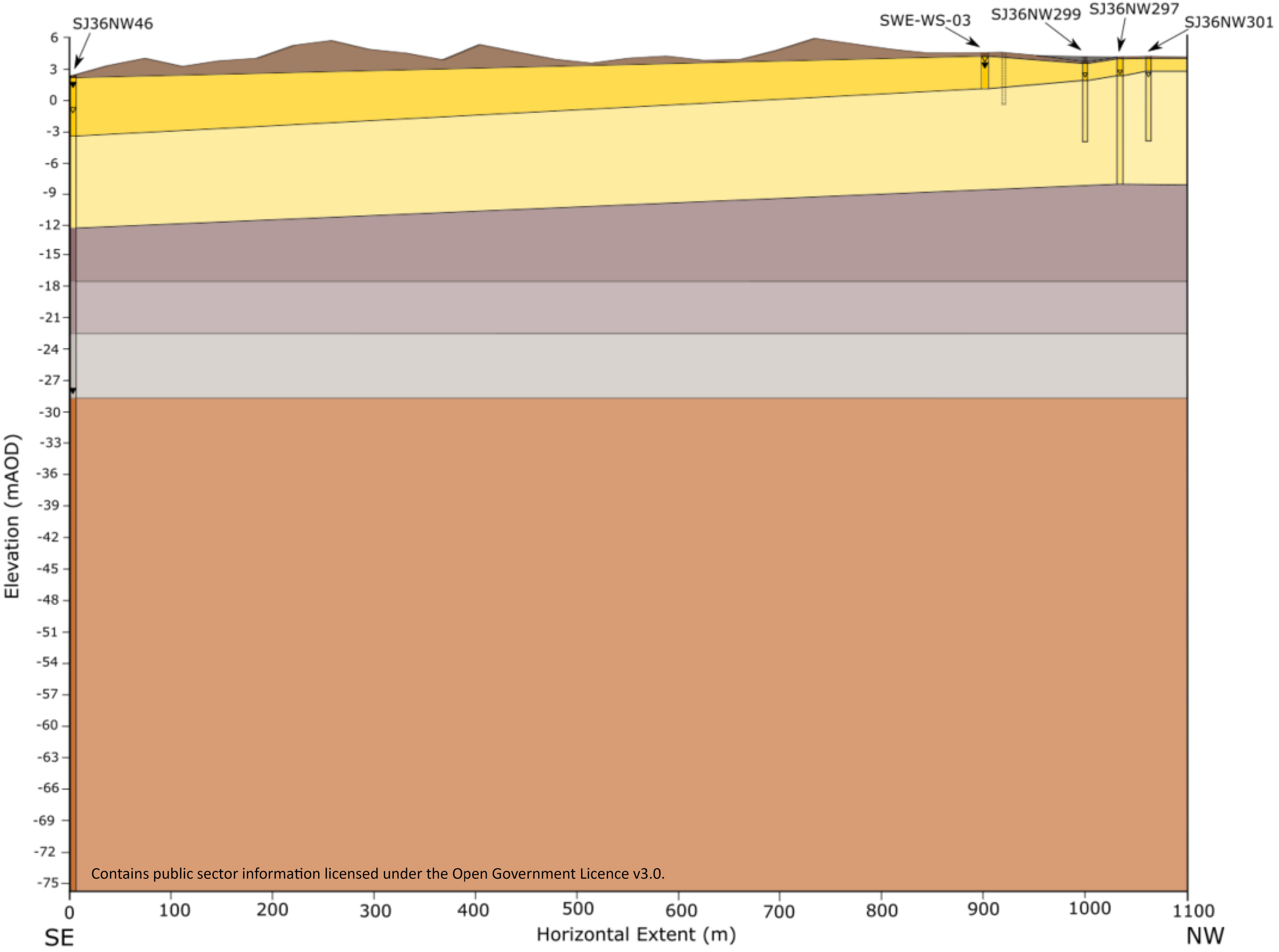
Status
WIP

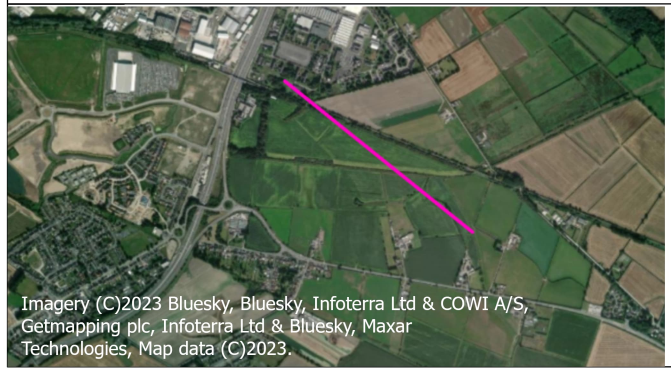
Status Description
Work In Progress

Drawn	Designed	Checked	Approved
RMc	ABC	ABC	ABC

Sheet Size	Scale	Sweco Ref	Revision
A3	Vertical: 9.23mm = 1m Horizontal: 0.6645mm = 1m	65201386	P01

Drawing Number
65201386-SWE-XX-00-DR-0-00004-P01-Appendix C3





Imagery (C)2023 Bluesky, Bluesky, Infoterra Ltd & COWI A/S, Getmapping plc, Infoterra Ltd & Bluesky, Maxar Technologies, Map data (C)2023.

Legend

▼ Initial Groundwater Strike
▽ Groundwater Level
┈ Trench Excavation

■ Made Ground
■ Topsoil
■ Tidal Flat Deposits - Sand
■ Tidal Flat Deposits - Sand & Gravel
■ Tidal Flat Deposit - Clay
■ Tidal Flat Deposit - Boulder Clay
■ Tidal Flat Deposits - Marly Rock
■ Red Sandstone

Rev	Date	Amendment Details	Dr'n	Chk'	App'
Rev	09.11.2023	FIRST ISSUE	ABC	ABC	ABC

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Grove House, Mansion Gate Drive,
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www.sweco.co.uk

Client
Dŵr Cymru
Welsh Water

Project Title
Deeside Dewatering Airfield Raw Water Paper Mill

Drawing Title
Appendix C: S-N Perpendicular Hydrogeological Conceptual Model (0 - 1100m extent)

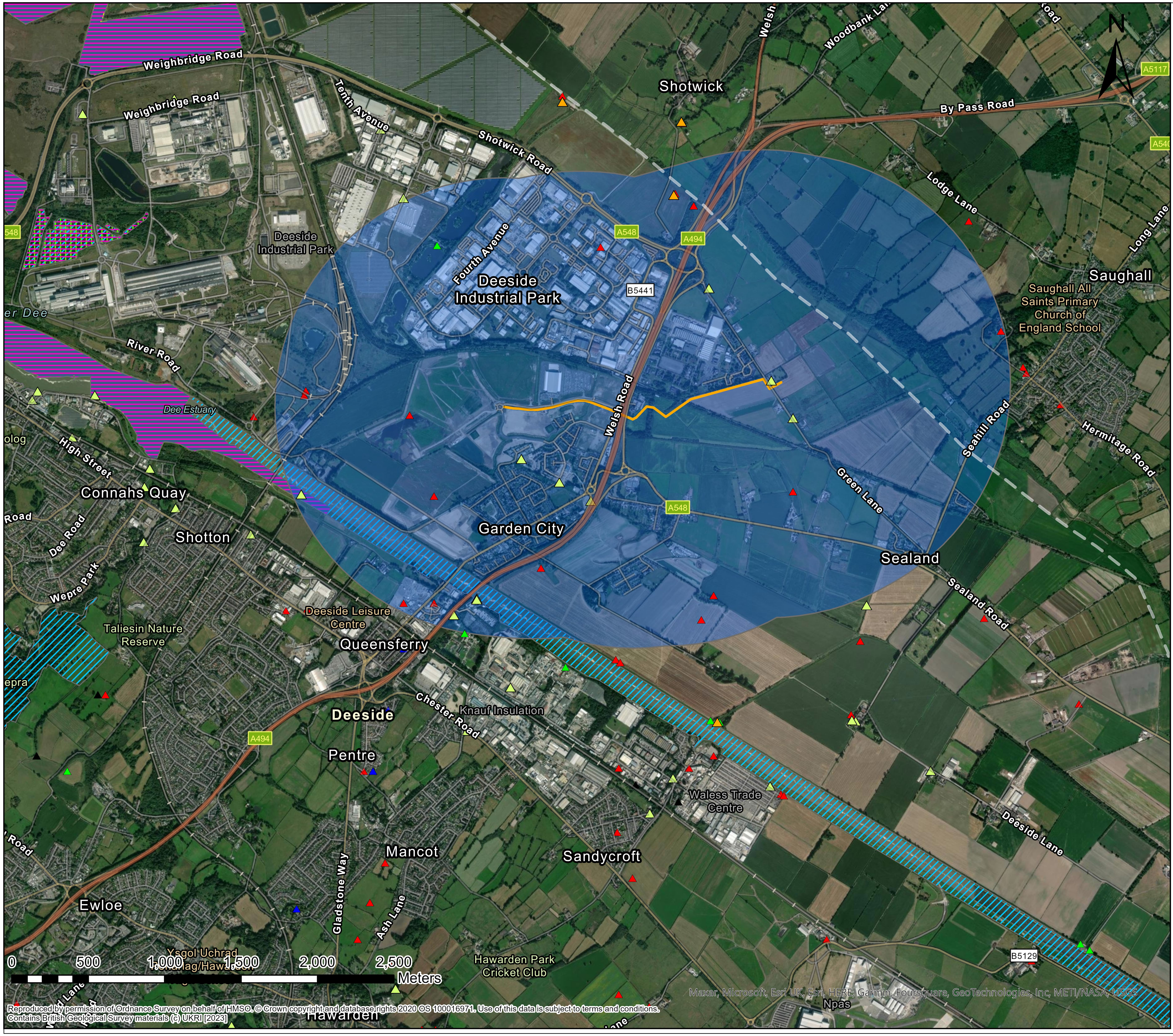
Project Stage
STAGE 2

Status	Status Description
WIP	Work In Progress

Drawn	Designed	Checked	Approved
RMc	ABC	ABC	ABC

Sheet Size	Scale	Sweco Ref	Revision
A3	Vertical: 3.21mm = 1m Horizontal: 0.3127mm = 1m	65201386	P01

Drawing Number
65201386-SWE-XX-00-DR-0-00005-P01-Appendix C4



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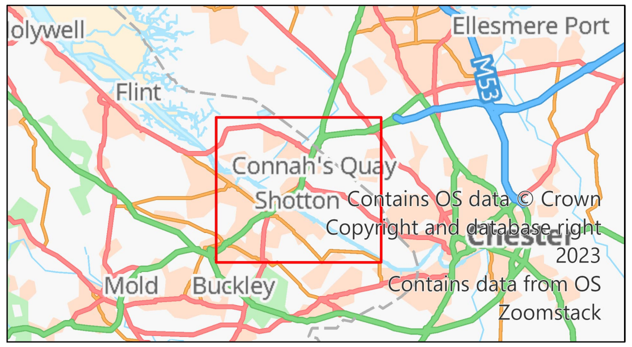
Legend

- ▲ Permitted Discharges to Controlled Waters
- ▲ Licensed Abstractions

Water Well

DEPTH

- ▲ Not Available
- ▲ 0 - 10m
- ▲ 10 - 30m
- ▲ 30m+
- — Dewatering Trench Outline (Parallel Sections)
- ▤ NRW - RAMSAAR Sites
- 🟧 NRW - Local Nature Reserves
- ▥ NRW - Special Protection Areas
- ▨ NRW - SSSI's
- 🟦 1.5km Buffer



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Rev	Date	Amendment Details	Dr'n	Chk'	App'
Rev	09.11.2023	FIRST ISSUE	ABC	ABC	ABC

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Grove House, Mansion Gate Drive,
Leeds, LS7 4DN
Tel: +44 (0)113 262 0000
www.sweco.co.uk

Client

Dŵr Cymru
Welsh Water

Project Title

Deeside Dewatering Airfields Raw Water Paper Mill

Drawing Title

Appendix D: Potential Groundwater Receptors within 1.5km Buffer

Project Stage
STAGE 2

Status	Status Description
WIP	INITIAL STATUS OR WIP

Drawn	Designed	Checked	Approved
RMc	ABC	ABC	ABC

Sheet Size	Scale	Sweco Ref	Revision
A3	1:24,000	65201386	P01

Drawing Number
65201386-SWE-XX-00-DR-0-00001-P01-Appendix D

Project Name and Structure ID:	**Deeside Dewatering - Dewatering Trench Excavation**		
Cutting chainage (From/Middle/To):	0	70	140
Strata to be dewatered:	Tidal Flat Deposits		
Depth/Elevation of Dewatering Zone (From to To):	1mbGL	to	5mbGL

<u>For A Linear Excavation in Unconfined Aquifers (Includes All Four Sides)</u>

DUPUIT-FORCHEIMER EQUATION (Steady State, Both Radial and Linear Flow, and Fully Penetrating Wells) - UNCONFINED AQUIFERS

Q=pi*K*(H^2-h_w^2)/ln(R_o/r_e) + (2*a*K*(H^2-h_w^2)/(2*L_o))   Where R_o>r_e;   With h_o@R_o and h_w@r_e

Q=pi*K*(H^2-h_w^2)/2.3*log(R_o/r_e) + (2*a*K*(H^2-hw^2)/(2*Lo))

Radius of Influence (R_o) By Empirical Formula of Sichardt (Unconfined Aquifer - Radial Flow)

R_o=C*(H-h_w)*(K^0.5)

Distance of Influence (L_o) based on Cashman and Preene (Unconfined Aquifer - Plane/Linear Flow)

L_o=1750*(H-h_w)*(K^0.5)

Total Radius/Distance of Influence, R_{oT} or L_{oT} (m)

R_{oT} or L_{oT} = r_e+(R_o or L_o)

Equivalent Well Radius ($r_{e(p)}$) based on Equivalent Perimeter (See below).

r_{e-p}=(a+b)/pi   **From CIRIA C750, 2016.**

Equivalent Well Radius ($r_{e(a)}$) based on Equivalent Area (See below).

r_{e-a}=(a*b/pi)^0.5   **(Use when R_o is much larger than r_e and a/b < 1.5).**

Equivalent Well Radius ($r_{e(MK)}$) based on Mansur and Kaufman (See below).

r_{e-mk}=2/pi*((a*b)^0.5)   **From S.S. Papadopulos April 28, 2017.**

Where,

Q = Flow rate	Calculated below	m^3/s				
K = Hydraulic conductivity range (Upper and Lower)	1.40E-05	(Low) to (High)	1.40E-05	m/s	Range of K Values	
K = Hydraulic conductivity	1.40E-05	m/s			Specific/Selected K Value	
R_o = Radius of influence	Calculated below	m				
r_e = Effective radius	Calculated below	m	Where length of excavation (a) =		140.0	m
			width of excavation (b) =		3.0	m
H = Static water level	5	m	Static head (h_o) above base of sump in excavation (refer to "004 Wansford Structures Dimensions April 19" spreadsheet).			
h_w = Dynamic/pumping water level	1	m	Dynamic/pumping head (h_w) above base of sump in excavation (refer to "004 Wansford Structures Dimensions April 19" spreadsheet).			
C = Radius/Distance of Influence Constant	2000	Unitless	Empirical calibration factor. For line flow to a line of wells use 1,500 to 2,000. Cashman and Preene use 1,750.			

<u>Calculation of required flow (Dupuit-Forcheimer), Calculation of radius of influence (Sichardt)</u>

Hydraulic Conductivity, K (m/d)	**Hydraulic Conductivity, K (m/s)**	**Drawdown, h_o - h_w (m)**	**Radius/Distance of Influence, R_o or L_o (m)**	**Equivalent Radius (r_e) Selected From Table 1 (m)**	**Total Radius/Distance of Influence, R_{oT} or L_{oT} (m)**	**Inflow to the excavation, Q (m^3/s)**	**Inflow to the excavation, Q (m^3/d)**	**Inflow to the excavation, Q (L/s)**	**Model run description**
1.21E+00	1.40E-05	4	29.9	13.0	42.9	0.00198	171	2.0	Dewatering strata is ????. Most likely K value for strata is ???? m/s.
1.21E-01	1.40E-06	4	9.5	13.0	22.5	0.00040	35	0.4	Sensitivity analysis (Lower K Value) - K / 10
1.21E+00	1.40E-05	4	29.9	13.0	42.9	0.00198	171	2.0	Lower K Value
1.21E+00	1.40E-05	4	29.9	13.0	42.9	0.00198	171	2.0	Upper K Value
1.21E+01	1.40E-04	4	94.7	13.0	107.7	0.00937	809	9.4	Sensitivity analysis (Upper K Value) - K * 10

Project Name and Structure ID:	**Deeside Dewatering - Dewatering Trench Excavation**		
Cutting chainage (From/Middle/To):	0	70	140
Strata to be dewatered:	Tidal Flat Deposits		
Depth/Elevation of Dewatering Zone (From to To):	1mbGL	to	5mbGL

For A Linear Excavation in Unconfined Aquifers (Includes All Four Sides)

DUPUIT-FORCHEIMER EQUATION (Steady State, Both Radial and Linear Flow, and Fully Penetrating Wells) - UNCONFINED AQUIFERS

Q=pi*K*(H^2-h_w^2)/ln(R_o/r_e) + (2*a*K*(H^2-h_w^2)/(2*L_o))   Where R_o>r_e;   With h_o@R_o and h_w@r_e

Q=pi*K*(H^2-h_w^2)/2.3*log(R_o/r_e) + (2*a*K*(H^2-hw^2)/(2*Lo))

Radius of Influence (R_o) By Empirical Formula of Sichardt (Unconfined Aquifer - Radial Flow)

R_o=C*(H-h_w)*(K^0.5)

Distance of Influence (L_o) based on Cashman and Preene (Unconfined Aquifer - Plane/Linear Flow)

L_o=1750*(H-h_w)*(K^0.5)

Total Radius/Distance of Influence, R_{oT} or L_{oT} (m)

R_{oT} or L_{oT} = r_e+(R_o or L_o)

Equivalent Well Radius ($r_{e(p)}$) based on Equivalent Perimeter (See below).

$r_{e\text{-}p}$=(a+b)/pi   **From CIRIA C750, 2016.**

Equivalent Well Radius ($r_{e(a)}$) based on Equivalent Area (See below).

$r_{e\text{-}a}$=(a*b/pi)^0.5   **(Use when R_o is much larger than r_e and a/b < 1.5).**

Equivalent Well Radius ($r_{e(MK)}$) based on Mansur and Kaufman (See below).

$r_{e\text{-}mk}$=2/pi*((a*b)^0.5)   **From S.S. Papadopulos April 28, 2017.**

Where,

Q = Flow rate	Calculated below	m^3/s				
K = Hydraulic conductivity range (Upper and Lower)	4.90E-05	(Low) to (High)	4.90E-05	m/s	Range of K Values	
K = Hydraulic conductivity	4.90E-05	m/s			Specific/Selected K Value	
R_o = Radius of influence	Calculated below	m				
r_e = Effective radius	Calculated below	m	Where length of excavation (a) =		140.0	m
			width of excavation (b) =		3.0	m
H = Static water level	5	m	Static head (h_o) above base of sump in excavation (refer to "004 Wansford Structures Dimensions April 19" spreadsheet).			
h_w = Dynamic/pumping water level	1	m	Dynamic/pumping head (h_w) above base of sump in excavation (refer to "004 Wansford Structures Dimensions April 19" spreadsheet).			
C = Radius/Distance of Influence Constant	2000	Unitless	Empirical calibration factor. For line flow to a line of wells use 1,500 to 2,000. Cashman and Preene use 1,750.			

Calculation of required flow (Dupuit-Forcheimer), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity, K (m/d)	**Hydraulic Conductivity, K (m/s)**	**Drawdown, h_o - h_w (m)**	**Radius/Distance of Influence, R_o or L_o (m)**	**Equivalent Radius (r_e) Selected From Table 1 (m)**	**Total Radius/Distance of Influence, R_{oT} or L_{oT} (m)**	**Inflow to the excavation, Q (m^3/s)**	**Inflow to the excavation, Q (m^3/d)**	**Inflow to the excavation, Q (L/s)**	**Model run description**
4.23E+00	4.90E-05	4	56.0	13.0	69.0	0.00460	398	4.6	Dewatering strata is ????. Most likely K value for strata is ???? m/s.
4.23E-01	4.90E-06	4	17.7	13.0	30.7	0.00097	83	1.0	Sensitivity analysis (Lower K Value) - K / 10
4.23E+00	4.90E-05	4	56.0	13.0	69.0	0.00460	398	4.6	Lower K Value
4.23E+00	4.90E-05	4	56.0	13.0	69.0	0.00460	398	4.6	Upper K Value
4.23E+01	4.90E-04	4	177.1	13.0	190.1	0.02245	1,940	22.4	Sensitivity analysis (Upper K Value) - K * 10

Project Name and Structure ID:	**Deeside Dewatering - Dewatering Trench Excavation**		
Cutting chainage (From/Middle/To):	0	70	140
Strata to be dewatered:	Tidal Flat Deposits		
Depth/Elevation of Dewatering Zone (From to To):	1mbGL	to	5mbGL

For A Linear Excavation in Unconfined Aquifers (Includes All Four Sides)

DUPUIT-FORCHEIMER EQUATION (Steady State, Both Radial and Linear Flow, and Fully Penetrating Wells) - UNCONFINED AQUIFERS

Q=pi*K*(H^2-h_w^2)/ln(R_o/r_e) + (2*a*K*(H^2-h_w^2)/(2*L_o))   Where R_o>r_e;   With h_o@R_o and h_w@r_e

Q=pi*K*(H^2-h_w^2)/2.3*log(R_o/r_e) + (2*a*K*(H^2-hw^2)/(2*Lo))

Radius of Influence (R_o) By Empirical Formula of Sichardt (Unconfined Aquifer - Radial Flow)

R_o=C*(H-h_w)*(K^0.5)

Distance of Influence (L_o) based on Cashman and Preene (Unconfined Aquifer - Plane/Linear Flow)

L_o=1750*(H-h_w)*(K^0.5)

Total Radius/Distance of Influence, R_{oT} or L_{oT} (m)

R_{oT} or L_{oT} = r_e+(R_o or L_o)

Equivalent Well Radius ($r_{e(p)}$) based on Equivalent Perimeter (See below).

$r_{e\text{-}p}$=(a+b)/pi   **From CIRIA C750, 2016.**

Equivalent Well Radius ($r_{e(a)}$) based on Equivalent Area (See below).

$r_{e\text{-}a}$=(a*b/pi)^0.5   **(Use when R_o is much larger than r_e and a/b < 1.5).**

Equivalent Well Radius ($r_{e(MK)}$) based on Mansur and Kaufman (See below).

$r_{e\text{-}mk}$=2/pi*((a*b)^0.5)   **From S.S. Papadopulos April 28, 2017.**

Where,

Q = Flow rate	Calculated below	m^3/s				
K = Hydraulic conductivity range (Upper and Lower)	7.20E-05	(Low) to (High)	7.20E-05	m/s	Range of K Values	
K = Hydraulic conductivity	7.20E-05	m/s			Specific/Selected K Value	
R_o = Radius of influence	Calculated below	m				
r_e = Effective radius	Calculated below	m	Where length of excavation (a) =		140.0	m
			width of excavation (b) =		3.0	m
H = Static water level	5	m	Static head (h_o) above base of sump in excavation (refer to "004 Wansford Structures Dimensions April 19" spreadsheet).			
h_w = Dynamic/pumping water level	1	m	Dynamic/pumping head (h_w) above base of sump in excavation (refer to "004 Wansford Structures Dimensions April 19" spreadsheet).			
C = Radius/Distance of Influence Constant	2000	Unitless	Empirical calibration factor. For line flow to a line of wells use 1,500 to 2,000. Cashman and Preene use 1,750.			

Calculation of required flow (Dupuit-Forcheimer), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity, K (m/d)	**Hydraulic Conductivity, K (m/s)**	**Drawdown, h_o - h_w (m)**	**Radius/Distance of Influence, R_o or L_o (m)**	**Equivalent Radius (r_e) Selected From Table 1 (m)**	**Total Radius/Distance of Influence, R_{oT} or L_{oT} (m)**	**Inflow to the excavation, Q (m^3/s)**	**Inflow to the excavation, Q (m^3/d)**	**Inflow to the excavation, Q (L/s)**	**Model run description**
6.22E+00	7.20E-05	4	67.9	13.0	80.9	0.00596	515	6.0	Dewatering strata is ????. Most likely K value for strata is ???? m/s.
6.22E-01	7.20E-06	4	21.5	13.0	34.5	0.00126	109	1.3	Sensitivity analysis (Lower K Value) - K / 10
6.22E+00	7.20E-05	4	67.9	13.0	80.9	0.00596	515	6.0	Lower K Value
6.22E+00	7.20E-05	4	67.9	13.0	80.9	0.00596	515	6.0	Upper K Value
6.22E+01	7.20E-04	4	214.7	13.0	227.7	0.02961	2,558	29.6	Sensitivity analysis (Upper K Value) - K * 10

Project Name and Structure ID: **Deeside Dewatering - Dewatering Trench Excavation**
Cutting chainage (From/Middle/To): 0 5 10
Strata to be dewatered: Tidal Flat Deposits
Depth/Elevation of Dewatering Zone (From to To): 1mbGL to 5mbGL

For A Linear Excavation in Unconfined Aquifers (Includes All Four Sides)

DUPUIT-FORCHEIMER EQUATION (Steady State, Both Radial and Linear Flow, and Fully Penetrating Wells) - UNCONFINED AQUIFERS

Q=pi*K*(H^2-h_w^2)/ln(R_o/r_e) + (2*a*K*(H^2-h_w^2)/(2*L_o)) Where R_o>r_e; With h_o@R_o and h_w@r_e
Q=pi*K*(H^2-h_w^2)/2.3*log(R_o/r_e) + (2*a*K*(H^2-hw^2)/(2*Lo))

Radius of Influence (R_o) By Empirical Formula of Sichardt (Unconfined Aquifer - Radial Flow)
R_o=C*(H-h_w)*(K^0.5)

Distance of Influence (L_o) based on Cashman and Preene (Unconfined Aquifer - Plane/Linear Flow)
L_o=1750*(H-h_w)*(K^0.5)

Total Radius/Distance of Influence, R_{oT} or L_{oT} (m)
R_{oT} or L_{oT} = r_e+(R_o or L_o)

Equivalent Well Radius ($r_{e(p)}$) based on Equivalent Perimeter (See below).
$r_{e\text{-}p}$=(a+b)/pi **From CIRIA C750, 2016.**

Equivalent Well Radius ($r_{e(a)}$) based on Equivalent Area (See below).
$r_{e\text{-}a}$=(a*b/pi)^0.5 **(Use when R_o is much larger than r_e and a/b < 1.5).**

Equivalent Well Radius ($r_{e(MK)}$) based on Mansur and Kaufman (See below).
$r_{e\text{-}mk}$=2/pi*((a*b)^0.5) **From S.S. Papadopulos April 28, 2017.**

Where,

Q = Flow rate	Calculated below	m^3/s		
K = Hydraulic conductivity range (Upper and Lower)	1.40E-05	(Low) to (High)	1.40E-05 m/s	Range of K Values
K = Hydraulic conductivity	1.40E-05	m/s		Specific/Selected K Value
R_o = Radius of influence	Calculated below	m		
r_e = Effective radius	Calculated below	m	Where length of excavation (a) =	10.0 m
			width of excavation (b) =	6.0 m
H = Static water level	5	m	Static head (h_o) above base of sump in excavation (refer to "004 Wansford Structures Dimensions April 19" spreadsheet).	
h_w = Dynamic/pumping water level	1	m	Dynamic/pumping head (h_w) above base of sump in excavation (refer to "004 Wansford Structures Dimensions April 19" spreadsheet).	
C = Radius/Distance of Influence Constant	2000	Unitless	Empirical calibration factor. For line flow to a line of wells use 1,500 to 2,000. Cashman and Preene use 1,750.	

Calculation of required flow (Dupuit-Forcheimer), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity, K (m/d)	**Hydraulic Conductivity, K (m/s)**	**Drawdown, h_o - h_w (m)**	**Radius/Distance of Influence, R_o or L_o (m)**	**Equivalent Radius (r_e) Selected From Table 1 (m)**	**Total Radius/Distance of Influence, R_{oT} or L_{oT} (m)**	**Inflow to the excavation, Q (m^3/s)**	**Inflow to the excavation, Q (m^3/d)**	**Inflow to the excavation, Q (L/s)**	**Model run description**
1.21E+00	1.40E-05	4	29.9	13.0	42.9	0.00096	83	1.0	Dewatering strata is ????. Most likely K value for strata is ???? m/s.
1.21E-01	1.40E-06	4	9.5	13.0	22.5	0.00021	18	0.2	Sensitivity analysis (Lower K Value) - K / 10
1.21E+00	1.40E-05	4	29.9	13.0	42.9	0.00096	83	1.0	Lower K Value
1.21E+00	1.40E-05	4	29.9	13.0	42.9	0.00096	83	1.0	Upper K Value
1.21E+01	1.40E-04	4	94.7	13.0	107.7	0.00531	459	5.3	Sensitivity analysis (Upper K Value) - K * 10

Project Name and Structure ID:	**Deeside Dewatering - Dewatering Trench Excavation**		
Cutting chainage (From/Middle/To):	0	5	10
Strata to be dewatered:	Tidal Flat Deposits		
Depth/Elevation of Dewatering Zone (From to To):	1mbGL	to	5mbGL

For A Linear Excavation in Unconfined Aquifers (Includes All Four Sides)

DUPUIT-FORCHEIMER EQUATION (Steady State, Both Radial and Linear Flow, and Fully Penetrating Wells) - UNCONFINED AQUIFERS

Q=pi*K*(H^2-h$_w$^2)/ln(R$_o$/r$_e$) + (2*a*K*(H^2-h$_w$^2)/(2*L$_o$))   Where R$_o$>r$_e$;   With h$_o$@R$_o$ and h$_w$@r$_e$

Q=pi*K*(H^2-h$_w$^2)/2.3*log(R$_o$/r$_e$) + (2*a*K*(H^2-hw^2)/(2*Lo))

Radius of Influence (R$_o$) By Empirical Formula of Sichardt (Unconfined Aquifer - Radial Flow)

R$_o$=C*(H-h$_w$)*(K^0.5)

Distance of Influence (L$_o$) based on Cashman and Preene (Unconfined Aquifer - Plane/Linear Flow)

L$_o$=1750*(H-h$_w$)*(K^0.5)

Total Radius/Distance of Influence, R$_{oT}$ or L$_{oT}$ (m)

R$_{oT}$ or L$_{oT}$ = r$_e$+(R$_o$ or L$_o$)

Equivalent Well Radius (r$_{e(p)}$) based on Equivalent Perimeter (See below).

r$_{e-p}$=(a+b)/pi   **From CIRIA C750, 2016.**

Equivalent Well Radius (r$_{e(a)}$) based on Equivalent Area (See below).

r$_{e-a}$=(a*b/pi)^0.5   **(Use when R$_o$ is much larger than r$_e$ and a/b < 1.5).**

Equivalent Well Radius (r$_{e(MK)}$) based on Mansur and Kaufman (See below).

r$_{e-mk}$=2/pi*((a*b)^0.5)   **From S.S. Papadopulos April 28, 2017.**

Where,

Q = Flow rate	Calculated below	m^3/s				
K = Hydraulic conductivity range (Upper and Lower)	4.90E-05	(Low) to (High)	4.90E-05	m/s	Range of K Values	
K = Hydraulic conductivity	4.90E-05	m/s			Specific/Selected K Value	
R$_o$ = Radius of influence	Calculated below	m				
r$_e$ = Effective radius	Calculated below	m	Where length of excavation (a) =		10.0	m
			width of excavation (b) =		6.0	m
H = Static water level	5	m	Static head (h$_o$) above base of sump in excavation (refer to "004 Wansford Structures Dimensions April 19" spreadsheet).			
h$_w$ = Dynamic/pumping water level	1	m	Dynamic/pumping head (h$_w$) above base of sump in excavation (refer to "004 Wansford Structures Dimensions April 19" spreadsheet).			
C = Radius/Distance of Influence Constant	2000	Unitless	Empirical calibration factor. For line flow to a line of wells use 1,500 to 2,000. Cashman and Preene use 1,750.			

Calculation of required flow (Dupuit-Forcheimer), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity, K (m/d)	**Hydraulic Conductivity, K (m/s)**	**Drawdown, h$_o$ - h$_w$ (m)**	**Radius/Distance of Influence, R$_o$ or L$_o$ (m)**	**Equivalent Radius (r$_e$) Selected From Table 1 (m)**	**Total Radius/Distance of Influence, R$_{oT}$ or L$_{oT}$ (m)**	**Inflow to the excavation, Q (m^3/s)**	**Inflow to the excavation, Q (m^3/d)**	**Inflow to the excavation, Q (L/s)**	**Model run description**
4.23E+00	4.90E-05	4	56.0	13.0	69.0	0.00239	206	2.4	Dewatering strata is ????. Most likely K value for strata is ???? m/s.
4.23E-01	4.90E-06	4	17.7	13.0	30.7	0.00047	40	0.5	Sensitivity analysis (Lower K Value) - K / 10
4.23E+00	4.90E-05	4	56.0	13.0	69.0	0.00239	206	2.4	Lower K Value
4.23E+00	4.90E-05	4	56.0	13.0	69.0	0.00239	206	2.4	Upper K Value
4.23E+01	4.90E-04	4	177.1	13.0	190.1	0.01441	1,245	14.4	Sensitivity analysis (Upper K Value) - K * 10

Project Name and Structure ID:	**Deeside Dewatering - Dewatering Trench Excavation**		
Cutting chainage (From/Middle/To):	0	5	10
Strata to be dewatered:	Tidal Flat Deposits		
Depth/Elevation of Dewatering Zone (From to To):	1mbGL	to	5mbGL

For A Linear Excavation in Unconfined Aquifers (Includes All Four Sides)

DUPUIT-FORCHEIMER EQUATION (Steady State, Both Radial and Linear Flow, and Fully Penetrating Wells) - UNCONFINED AQUIFERS

Q=pi*K*(H^2-h_w^2)/ln(R_o/r_e) + (2*a*K*(H^2-h_w^2)/(2*L_o))   Where R_o>r_e;   With h_o@R_o and h_w@r_e
Q=pi*K*(H^2-h_w^2)/2.3*log(R_o/r_e) + (2*a*K*(H^2-hw^2)/(2*Lo))

Radius of Influence (R_o) By Empirical Formula of Sichardt (Unconfined Aquifer - Radial Flow)

R_o=C*(H-h_w)*(K^0.5)

Distance of Influence (L_o) based on Cashman and Preene (Unconfined Aquifer - Plane/Linear Flow)

L_o=1750*(H-h_w)*(K^0.5)

Total Radius/Distance of Influence, R_{oT} or L_{oT} (m)

R_{oT} or L_{oT} = r_e+(R_o or L_o)

Equivalent Well Radius ($r_{e(p)}$) based on Equivalent Perimeter (See below).

r_{e-p}=(a+b)/pi   **From CIRIA C750, 2016.**

Equivalent Well Radius ($r_{e(a)}$) based on Equivalent Area (See below).

r_{e-a}=(a*b/pi)^0.5   **(Use when R_o is much larger than r_e and a/b < 1.5).**

Equivalent Well Radius ($r_{e(MK)}$) based on Mansur and Kaufman (See below).

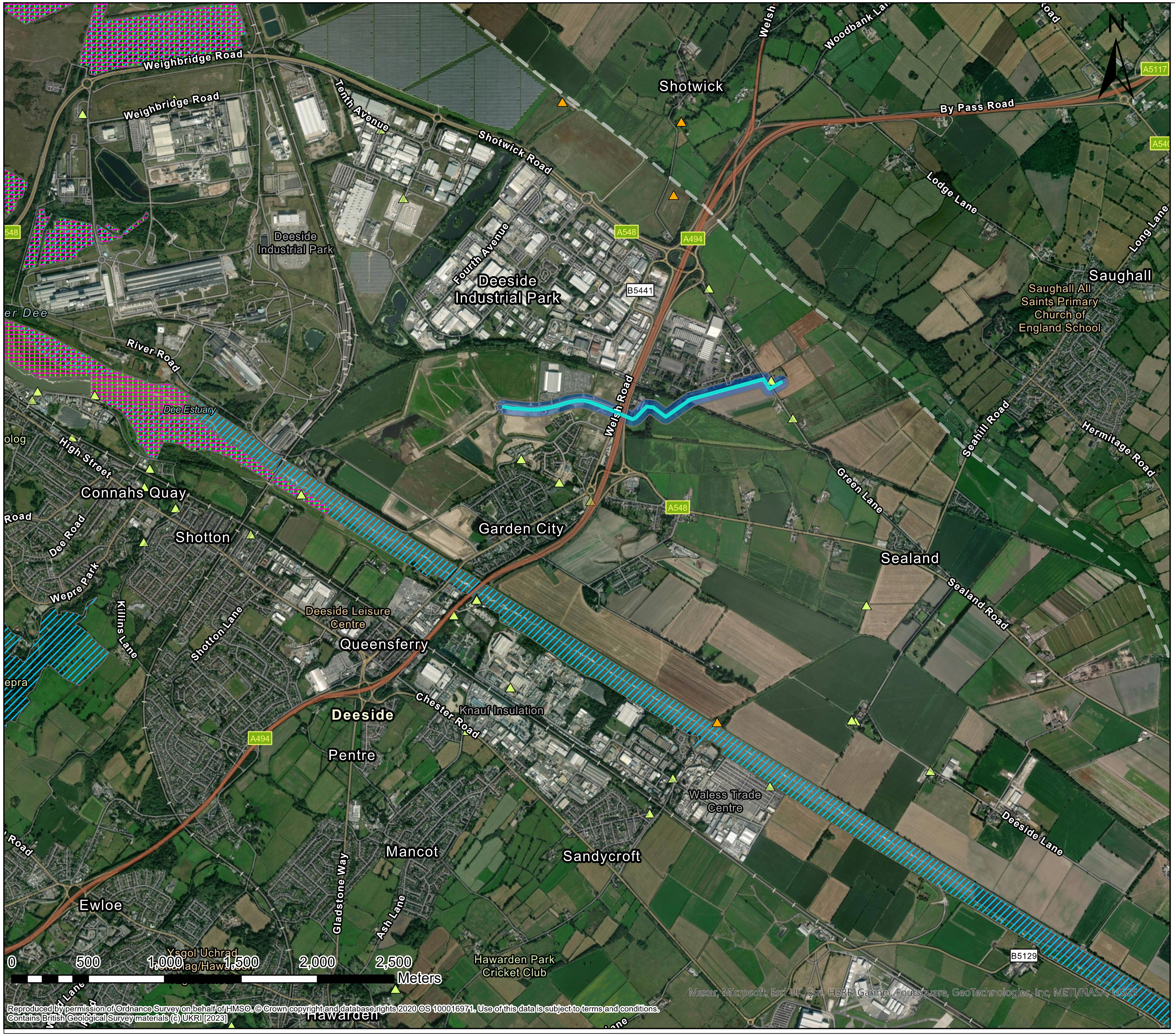
r_{e-mk}=2/pi*((a*b)^0.5)   **From S.S. Papadopulos April 28, 2017.**

Where,

Q = Flow rate	Calculated below	m^3/s			
K = Hydraulic conductivity range (Upper and Lower)	7.20E-05	(Low) to (High)	7.20E-05	m/s	Range of K Values
K = Hydraulic conductivity	7.20E-05	m/s			Specific/Selected K Value
R_o = Radius of influence	Calculated below	m			
r_e = Effective radius	Calculated below	m	Where length of excavation (a) =	10.0	m
			width of excavation (b) =	6.0	m
H = Static water level	5	m	Static head (h_o) above base of sump in excavation (refer to "004 Wansford Structures Dimensions April 19" spreadsheet).		
h_w = Dynamic/pumping water level	1	m	Dynamic/pumping head (h_w) above base of sump in excavation (refer to "004 Wansford Structures Dimensions April 19" spreadsheet).		
C = Radius/Distance of Influence Constant	2000	Unitless	Empirical calibration factor. For line flow to a line of wells use 1,500 to 2,000. Cashman and Preene use 1,750.		

Calculation of required flow (Dupuit-Forcheimer), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity, K (m/d)	Hydraulic Conductivity, K (m/s)	Drawdown, h_o - h_w (m)	Radius/Distance of Influence, R_o or L_o (m)	Equivalent Radius (r_e) Selected From Table 1 (m)	Total Radius/Distance of Influence, R_{oT} or L_{oT} (m)	Inflow to the excavation, Q (m^3/s)	Inflow to the excavation, Q (m^3/d)	Inflow to the excavation, Q (L/s)	Model run description
6.22E+00	7.20E-05	4	67.9	13.0	80.9	0.00319	275	3.2	Dewatering strata is ????. Most likely K value for strata is ???? m/s.
6.22E-01	7.20E-06	4	21.5	13.0	34.5	0.00061	52	0.6	Sensitivity analysis (Lower K Value) - K / 10
6.22E+00	7.20E-05	4	67.9	13.0	80.9	0.00319	275	3.2	Lower K Value
6.22E+00	7.20E-05	4	67.9	13.0	80.9	0.00319	275	3.2	Upper K Value
6.22E+01	7.20E-04	4	214.7	13.0	227.7	0.01974	1,706	19.7	Sensitivity analysis (Upper K Value) - K * 10



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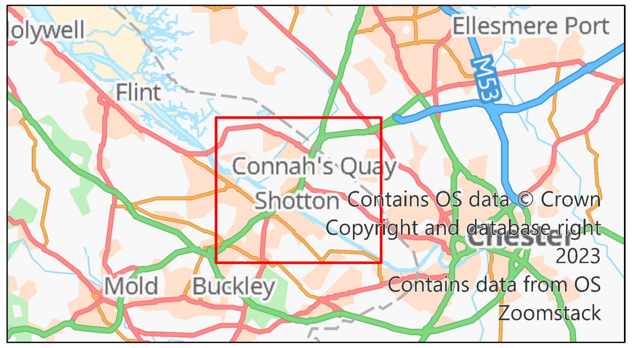
Legend

- △ Permitted Discharges to Controlled Waters with Conditions
- ▲ Licensed Abstractions
- — Dewatering Trench Outline (Parallel Sections)
- ▨ NRW - RAMSAAR Sites
- 🟧 NRW - Local Nature Reserves
- ▥ NRW - Special Protection Areas
- ▨ NRW - SSSI's
- ▭ Dewatering Buffer - 81m (Calculated Radius of Influence)



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Client

Dŵr Cymru
Welsh Water

Project Title

Deeside Dewatering Airfields Raw Water Paper Mill

Drawing Title

Project Stage
STAGE 2

Status	Status Description
WIP	INITIAL STATUS OR WIP

Drawn	Designed	Checked	Approved
RMc	ABC	ABC	ABC

Sheet Size	Scale	Sweco Ref	Revision
A3	1:50,000	65201386	P01

Drawing Number
65201386-SWE-XX-00-DR-0-00001-P01-Identified Receptors