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CONSULTANTS IN ENGINEERING, ENVIRONMENTAL SCIENCE & PLANNING

DUBLIN AIRPORT NORTH RUNWAY DEVELOPMENT

MATERIAL MANAGEMENT DESIGN REPORT FOR THE MANAGEMENT FOR PFOS/PFOA IMPACTED SOILS

Prepared for: Roadbridge FCC Joint Venture

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Abstract: Fehily Timoney and Company (FT) was retained by RBFCC to undertake the design of the proposed material management plan at the Dublin Airport, North Runway Development. The design and management plan were required to outline the material management plan to reduce the potential residual risk to environmental receptors from the re-use of PFOS and PFOA impacted soils within the development site.

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1. INTRODUCTION

1.1 Project Overview

The Roadbridge FCC (RBFCC) Joint Venture was commissioned by Dublin Airport Authority to construct the North Runway Development.

Fehily Timoney and Company (FT) was retained by RBFCC to prepare a Material Management Plan (MMP) for Perfluorooctanoic acid (PFOA), Perfluorooctane sulfonate (PFOS) and Perfluorooctanesulfonamide (PFOSA) contaminated soils excavated from the former APEC 5 fire training ground located within the footprint of the proposed Dublin Airport, North Runway Development.

This report captures data from previous investigations, see Section 1.2 below, and makes reference to the earlier FT report *Material Management Options Assessment for the Management for PFOS and PFOA Impacted Soils (FT), March 2020* which carried out Detailed Quantitative Risk Assessments (DQRA) and made recommendations for the management of PFOS contaminated soils. The DQRAs made reference to:

- PFOS health-based criteria established by the Danish Environmental Protection Agency (DEPA) 2015.
- United States Environmental Protection Agency (USEPA) 2018. Regional Screening Levels (RSLs), RSL User's Guide, and RSL Calculator.

The FT report *Material Management Options Assessment for the Management for PFOS and PFOA Impacted Soils (FT), March 2020:*

- Presented:
  - The study objectives.
  - An overview of PFAS/PFOS materials, relevant legislation and technical guidance.
  - Previous site investigations, risk assessments and historic environmental monitoring (groundwater and gas).
  - Generic quantitative risk assessments with reference to potential environmental impacts on human health and groundwater contamination.
  - A soils options appraisal that examined alternate soil management and remediation options.
- Showed that that the maximum PFOS, PFOA and PFOSA concentrations reported:
  - Were below the DEPA human health-based soil quality criteria guideline values, and that
  - soils posed a potential risk to groundwater contamination with reference to USEPA Regional Screening Levels (RSLs).
- Clearly demonstrated the short- and long-term risks associated with managing PFAS/PFOS contaminated materials.
- Employed a risk-based environmental assessment of options for the management of soils excavated from the site and the management of the in-situ soil beneath the stockpile at APEC 5.
- With reference to the CL:AIRE Industry Code of Practice and principals defined in the Waste Framework Directive concluded the most sustainable solution, which best mitigated risks to human and groundwater receptors, was to excavate material for re-use on site with containment being provided by the naturally occurring and underlying Black and Brown Boulder Clay formations.

- Recommended that PFOS contaminated materials, hereinafter referred to as APEC 5 material be encapsulated by:
    - Re-using excavated APEC 5 material on site as backfill around tanks availing of the (sustainable) containment provided by insitu low permeability Dublin Boulder Clays to isolate APEC 5 material from the underlying groundwater.
    - Constructing a low permeability cap over the re-used APEC 5 material and naturally occurring underlying Dublin Boulder Clay containment to isolate the re-used APEC 5 material from rainfall inputs.

The proposed re-use encapsulation approach was considered to be the most viable way to prevent on-going risk to receptors at the site whilst also being cognisant of the waste hierarchy with respect to waste prevention and management.

Construction of the North Runway Development requires attenuation tanks to be installed below ground to provide attenuation to site drainage as part of the wider drainage and surface water management system. This report proposes the re-use of excavated APEC 5 material as backfill to the subsurface Polluted Water Holding Tank (PWHT) and Storm Water Attenuation Tank R2. These tanks will be constructed with reinforced concrete bases, walls and roof slabs.

The proposed re-use solution makes use of the insitu underlying Dublin Boulder Clays which are further described as being either a Brown or a Black boulder clay in the RBFCC reports titled *Ground Investigation Report for the West Area - Phase 2, August 2019* and *Geotechnical Investigation Report for the East Area – Phase 2, October 2019*. The insitu Brown and Black Boulder Clays both have very low permeabilities, see Table 2.5 and Table 2.6 below.

The insitu low permeability Brown and Black Boulder Clays and proposed low permeability cap using site won Brown Boulder Clay, will provide a naturally occurring long term sustainable containment solution which will:

- Isolate PFOS, PFOA and PFOSA contaminated materials from surface and underlying ground waters.
- Facilitate a construction methodology in accordance with best practice as defined by the CL:AIRE Code of Practice definition of waste.
- Be compliant with Article 4 of the Waste Framework Directive and Article 27 of the European Communities (Waste Directive) Regulations 2011.

The Material Management Plan (MMP) presented in this FT report titled *Material Management Design Report For The Management For PFOS/PFOA Impacted Soils* presents the recommended solutions for appropriate re-use of contaminated soils from APEC 5 excavations as backfill surrounding the proposed stormwater management tanks; PWHT and R2, as part of the proposed North Runway development.

1.2 Previous Investigations

This MMP makes reference to, see documents listed below, previous site investigations and environmental monitoring works reviewed by and or undertaken by FT when developing the *Material Management Options Assessment for the Management of PFOS/PFOA Impacted Soils dated 13 March 2020 (ref 16)*. The purpose of the Material Management Options Assessment report (ref 16) was to provide an assessment of material management options and the remedial strategy to manage concentrations of PFOS and PFOA compounds identified within soils at the North Runway Development site.

This MMP listed below makes reference to previous investigations and environmental monitoring works reviewed by and /or undertaken by FT relating to; APEC 5 materials at Dublin Airport, the potential for impacts to sensitive receptors from PFAS contaminants, and the geotechnical properties of underlying formations at the proposed re-use location.

1. *DAA North Runway Factual Ground Investigation Report, Ground Investigations Ireland, October 2016.*
2. *DAA North Runway (DANR) Sampling plan for further Environmental Site Assessment (Scope Only), (AECOM), October 2016.*
3. *APEC 5 Environmental Site Investigation & Risk Assessment Report, (FT) August 2017*.
4. *Preliminary Site Assessment Report, DAA North Runway, Co. Dublin, (FT) April 2017.*
5. *Quarterly Monitoring Report for Former Fire Training Ground (APEC5): Groundwater & Gas Monitoring, (FT), November 2017.*
6. *Quarterly Monitoring Report for Former Fire Training Ground (APEC5): Groundwater & Gas Monitoring, (FT) March 2018.*
7. *Quarterly Monitoring Report for Former Fire Training Ground (APEC5): Groundwater & Gas Monitoring, (FT) July 2018.*
8. *Quarterly Monitoring Report for Former Fire Training Ground (APEC5): Groundwater & Gas Monitoring, (FT) October 2018.*
9. *Environmental Monitoring Report for the Former Fire Training Ground (APEC5): Groundwater & Surface Waters. Report Period: August – September 2018, November 2018.*
10. *Dublin Airport North Runway: APEC 5 Detailed Quantitative Risk Assessment, (FT) November 2018.*
11. *Roadbridge FCC JV, North Runway Construction Package 2, Ground Investigation Report for West Area - Phase 2 (EDAD098015-CP2-RF-GGI-OTHW-RP-C-0601), Issue for Construction, August 2019.*
12. *Roadbridge FCC JV, North Runway Construction Package 2, Geotechnical Investigation Report for the East Area – Phase 2 (EDAD09805-CP2-RF-GGI-OTHE-CC-C-0602), Issue 3, September 2019.*
13. *Roadbridge FCC JV, North Runway Construction Package 2, Geotechnical Design Report - West Area, Phase 2 (EDAD098015-CP2-RF-GZZ-OTHW-RP-C-0603), Issue for Construction, October 2019.*
14. *Roadbridge FCC JV, North Runway Construction Package 2, Geotechnical Design Report - East Area, Phase 2 (EDAD098015-CP2-RF-GZZ-OTHW-RP-C-0604), Issue 4, October 2019.*
15. *Report - Groundwater and Surface Water Risk Assessment and Remediation Options Appraisal (FT), June 2020.*
16. *Material Management Options Assessment for the Management for PFOS and PFOA Impacted Soils (FT), March 2020.*
17. *Causeway Ground Investigation Additional Ground Investigation Work, Appendix 4 of the DQRA containing Borehole data for Boreholes BH01, BH04 and BH07 at the PWHR and R2 locations, 2018.*
18. *AECOM Site Investigation Report 2016.*

1.3 Material Management Plan Objectives and Report Structure

1.3.1 Objective

The primary objective of this MMP plan is to implement the recommendations from the FT report *"Material Management Options Assessment for the Management for PFOS and PFOA Impacted Soils (FT), March 2020* which recommended:

- Excavation of existing (uncontaminated) overburden deposits at the proposed R2 and PWHT surface water tank locations.
- Re-use of excavated on-site APEC 5 contaminated materials as backfill around concrete storm water management structures PWHT and R2.
- Re-use of excavated low permeability Brown Boulder Clay materials as a cap to isolate the re-used APEC 5 materials from rainfall inputs.
- Containment of APEC 5 materials within / above the sustainable and naturally occurring Brown / Black Boulder Clay deposits to isolate the APEC 5 material from the underlying groundwaters.

1.3.2 Report Structure

This MMP report structure is as follows:

- Section 1 – Introduction (this section).
    - Project overview.
    - Previous investigations.
    - Material management plan objectives and report structure.
- Section 2 – Material Management Plan.
    - Material management plan deliverables.
    - Site description.
    - Conceptual site model (revised to demonstrate management of environmental risk).
    - Materials management.
    - Construction quality assurance.
    - On-going environmental monitoring.
- Section 3 – Conclusions and recommendations.
- Section 4 – References.
- Appendix 1 Layout drawings and finished contours associated with the proposed works.
- Appendix 2 Drawings associated with:
    - Earth balance.
    - Borehole Locations at APEC 5 and PWHT and R2 Tank locations.
    - Backfill and excavation plans APEC 5 and PWHT and R2 Tank locations.
- Appendix 3 Typical section through attenuation tanks.
- Appendix 4 Environmental monitoring locations for surface water and groundwater quality monitoring before, during and following completion of the Works.

2. MATERIAL MANAGEMENT PLAN

2.1 Material Management Plan Deliverables

The objectives of the works presented in this MMP are to:

- Describe the site, source of and/proposed re-use destination of APEC 5 materials.
- Present the revised Conceptual Site Model (CSM), residual environmental risks and measures to protect the environment in accordance with the CL:AIRE Code of Practice.
- Outline the proposed Materials Management Plan to facilitate the re-use of the APEC 5 excavated contaminated materials. This will comprise:
    - The excavation of the existing overburden deposits at the proposed R2 and PWHT tank locations.
    - The excavation, temporary stockpiling and re-use of APEC 5 material as general fill for the backfill of the proposed R2 and PWHT tank excavations.
    - The encapsulation of the re-used APEC 5 material within the in-situ, low permeability Brown and Black Boulder Clays and proposed re-use of site won Brown Boulder Clay as a low permeability cap (see below).
- Provide a design for the capping of the re-use of Brown Boulder Clay material to form a low permeability clay cap with a final topsoil layer.
- Outline the Construction Quality Assurance (CQA) and validation reporting required to demonstrate an auditable system of works during the implementation of the MMP including a testing and inspection regime to validate that materials used in the implemented MMP are suitable for the proposed uses.

2.2 Site Description

The site locations of the: APEC 5 material, temporary APEC 5 material stockpiles, and the APEC 5 re-use destination at the R2 and PWHT tank locations are described below and presented in Appendix 2 Drawing P2214-0600-0001 Earth Balance for APEC 5 Source, Temporary Stockpiles and Final Re-Use Destinations (PWHT and R2 Tanks).

The proposed site layout, attenuation tank details and finished contours are shown on the following Appendix 1 drawings:

- P2214-0100-0001 1:5000 Site Layout.
- P2214-0100-0002 1:1000 Attenuation Tank Layout.
- P2214-0100-0003 1:500 Attenuation Tank Layout.
- P2214-0100-0004 1:1000 Final Contours.

2.2.1 Site Setting

The site comprises former agricultural land located between the realigned Naul Road and Forrest Little golf course to the north, and the existing Dublin Airport site immediately to the south. As shown in Drawing P2214-0100-0001 the site is within the boundary of the North Runway Development site.

The topography across the site is predominantly level, with a slight declining slope in the northern section of the site. The River Sluice is located at the base of this slope, flowing in a north-west direction.

2.2.2 Drift/Quaternary Geology

Teagasc mapping describes the soil and subsoil underlying the site as "*Limestone Glacial Till*".

The RBFCC North Runway Construction Package 2, Ground Investigation Report for the East Area – Phase 2 (EDAD09815-CP2-RF-GZZ-OTHE-RP-C-0604), Issue 4, October 2019 describes:

- The stratigraphic profile for the East Area as generally comprising *"…topsoil over brown sandy gravelly CLAY (BrBC) with occasional cobbles over black sandy gravelly CLAY with cobbles and boulders (BkBC)"*.

The RBFCC North Runway Construction Package 2, Ground Investigation Report for the East Area – Phase 2 (EDAD09815-CP2-RF-GGI-OTHW-RP-C-0602), Issue 4, October 2019 describes:

- The Topsoil as brown slightly sandy (slightly) gravelly CLAY.
- The Brown Boulder Clay is described as firm occasionally soft brown slightly sandy gravelly CLAY with frequent cobbles and occasional boulders. The gravel, cobble and boulders fractions were recorded to be of limestone origin. The report estimates the Brown Boulder Clay is between 0.1 m and 8.9 m thick, extending between 0.2 m to 12.5 m below ground level.
- The Black Boulder Clay is described as stiff to very stiff, grey/black to black, slightly sandy gravelly clay, with a medium to high cobble content and occasional boulders. It is estimated that the Black Boulder Clay extends between 0.6 to 10.0 m below ground level. The full depth to which the Black Boulder Clay extends is unknown as the deepest cable percussion borehole advanced in the area extended to 10.0 m below ground level.
- Gravel deposits were noted across several locations, typically between the Brown Boulder Clay and Black Boulder Clay.

A detailed description of the ground conditions at the proposed placement sites is given in Section 2.2.7.

2.2.3 Solid Geology

The GSI 1:100,000 scale bedrock geology map indicates the site is underlain by the Carboniferous Malahide Formation. The Malahide formation is described by the GSI as an *"argillaceous bioclastic limestone, shale"*. Bedrock faulting is noted in the general area on the GSI mapping, however faulting is not recorded in the locations of the PWHT and R2 tanks.

The *RBFCC Geotechnical Design Report – East Area, Phase 2, EDAD098015-CP2-RF-GZZ-OTHW-RP-C-0604), Issue for Construction, January 2020* stated that:

- "The depth to the bedrock was not determined." (Exploratory holes advanced in the area extended to depths between 10 m and 15 m).

2.2.4 Hydrogeology

There are no karst landforms within the site boundaries according to the GSI Groundwater Karst Data. The nearest karst landform is St. Doolaghs Well, approximately 7 km from the site. This is a spring and the lithology is limestone, clean (>=90% $CaCO_3$) and un-bedded.

There are no wells or springs within the boundary of site. The site location for the proposed attenuation tanks is within the Swords Groundwater Body with a poorly productive bedrock flow regime. The bedrock aquifer underlying the four sites is a '*Locally Important Aquifer (LI)*' which is *"moderately productive only in local zones"*. The River Basin District Code is 'Eastern'.

The River Sluice surface water body is located just north of the site, flowing in a north-west direction. The nearest protected area to the site is the Sluice River Marsh proposed Natural Heritage Area (pNHA) which is located approximately 10 km downstream of the site.

The GSI classifies the groundwater vulnerability as being '*Medium*'. Based on published information from the GSI this would indicate subsoil thicknesses of between 5 m to 10 m.

There are no groundwater wells or springs recorded by the GSI within the site or in the immediate vicinity. The GSI has mapped 3 No. warm springs approximately 3.7 km west of the site at St. Margaret's. At these localities typical water temperatures range from 12.5-25°C, which is significantly above temperatures normally expected for Irish groundwater. It is thought that the groundwater issuing from these springs comes from a much deeper source than most groundwaters in Ireland. The presence of warm springs has been associated with deep faults, which allows deeper, warmer waters to migrate to the surface.

There are no Groundwater Drinking Water Protection Areas within the site boundary, according to GSI. The closest groundwater protection areas to the site are the Dunboyne Water Supply to the west, and Bog of the Ring to the north. Dunboyne is situated approximately 14.7 km west of the site with the Bog of the Ring groundwater protection area situated approximately 15.8 km to the north. The outer protection area of Dunboyne Water Supply is 0.83 km^2 and the inner protection area is 1.18 km^2. The outer protection area of Bog of the Ring is 17.64 km^2. There are two inner protection areas, measuring 1.30 km^2 and 0.41 km^2.

2.2.5 Surface Water

Refer to Appendix 4 Drawing P2214-0700-0002 for surface water monitoring locations.

The western part of the North Runway Construction site including APEC 5 is within the Ward catchment. Surface water ditches (monitored as SWMP 1, 2 and 3) previously drained north from the site to a westerly flowing watercourse (Barberstown 08) but have now been cut off within the site by construction development and are no longer monitored. Surface water ditches from the west end of the north runway (monitored as SWMP7) drain to the north (Dunbro), merging with the Barberstown 08 watercourse. SWMP6 is located south of APEC 5. This is located within the Ward catchment, but the geometry of the drainage path is not shown on the EPA GIS mapping.

The eastern part of the North Runway Construction site, including the R2 and PWHT tanks, is in the Sluice catchment. The EPA mapping shows just one watercourse in this area (monitored as SWMP5a and SWMP5b). This flows north through Forest Little and then east through Forest Little Golf Club to Portmarnock. It is understood (anecdotal mention at meeting) that SWMP5a also receives run-off from part of the existing airport including hangars and north apron (the central and west apron are within the Mayne Catchment, which drains to the south-east). The SWMP shows an additional surface monitoring point for a tributary of the Sluice at SWMP4 immediately north of R2 and PWHT.

Baseline surface water monitoring data quality for Total PFOS and PFOA is presented in Table 2.1.

Table 2.1: Baseline Surface Monitoring Results

Location	Sampling Date	PFOS LIMIT[1] (ng)	TOTAL PFOS (ng)	PFOA (ng)
SWMP4	27/03/2020	0.65	<10	<10
SWMP5(A)	27/03/2020	0.65	<10	<10

[1] Environmental Quality Standard (EQS), as classified by S.I. No. 386 of 2015 European Union Environmental Objectives (Surface Water) (Amendment) Regulations

2.2.6 APEC 5 Material Description

During site investigations undertaken by AECOM between July and August 2016, Areas of Potential Environmental Concern (APECs) were identified on the site and reported in *the AECOM North Runway Sampling plan for further Environmental Site Assessment (Scope Only)*. The findings of the 2016 AECOM site investigations recommended that further site investigation be undertaken to delineate the full extent of contamination at the APECs and to investigate the presence of Polyfluoroalkyl Substances (PFASs) associated with the former use of the site.

In 2017 FT undertook an environmental assessment and intrusive site investigations at APEC 5 as reported in *APEC 5 Environmental Site Investigation & Risk Assessment Report dated August 2017*. In this study 7 No. trial pits were tested (TP425 through to TP431) and the concentrations were found to be below the Danish Environmental Protection Agency (DEPA) guideline limits for soils.

In 2018 FT in its report *Dublin Airport North Runway: APEC 5 Detailed Quantitative Risk Assessment, November 2018* undertook further site investigations at the APEC 5 location and:

- Drilled 3 No. additional boreholes (BH08 through BH10) from which a shallow water table was observed to vary between 0.26 m and 1.35 m below ground level
- Recovered 10 No. samples from trial pits (TP432 through TP441) for laboratory analysis.

Laboratory analysis for Perfluorooctanoic acid (PFOA) and Perfluorooctane sulfonate (PFOS) using samples from the 10 trial pits showed that residual concentrations of PFOS, PFOA and PFOSA contamination were identified in the soil, see a summary of the results in Table 2.2 below. The maximum concentrations reported were found to be below the guideline values when assessed against the health-based soil quality criteria for PFOS, PFOA and PFOSA published by the Danish Environmental Protection Agency (DEPA).

Refer to Appendix 2 for:

- Drawing P2214-0600-0005 showing APEC 5 footprint and trial pit and borehole locations.
- Drawing P2214-0600-0006 showing APEC 5 cross section details.

Table 2.2: Soil Sampling Results – PFOS/ PFOA Screening (DQRA, 2018)

Parameter	Units	Max	No of tests	SL1 Danish EPA Criteria	No > SL1
PFOA	ug/kg	7.98	18	1300	0
Total PFOS	ug/kg	128	18	390	0
PFOSA	ug/kg	<1	18	390	0

2.2.7 Existing Ground Conditions at PWHT and R2 Tank Locations

The existing ground conditions adjacent to and at PWHT and R2 tank locations are described in this section, with reference to:

- *Preliminary Site Assessment Report, DAA North Runway, Co. Dublin*, (FT) *April 2017.*
- *Roadbridge FCC JV, North Runway Construction Package 2, Geotechnical Investigation Report for the East Area – Phase 2 (EDAD09805-CP2-RF-GGI-OTHE-CC-C-0602), Issue 3, September 2019*.
- Appendix 2 Drawings
    - P2214-0600-0002 PWHT and R2 showing borehole locations and section details.
    - Drawing P2214-0600-0007 showing borehole, trial pit locations and section details along the Perimeter Road East adjacent to Tank Locations PWHT and R2.

The Preliminary Site Assessment Report, DAA North Runway, Co Dublin April 2017 reports on site investigation works supervised by FT as part of the Environmental Risk Assessment at the Forrest Little Site. This Forrest Little Site area is approximately 120 m north of the proposed tank locations. The works comprised the advancement of 10 No. trial pits/slit trenches (TP401 through TP411) along the centre line of new perimeter road at chainage 0700 (adjacent to BHE09). Whilst the Forest Hill trial pit locations are removed from tanks, a summary of natural ground conditions encountered during these works given in Table 2.3 shows that Brown and Black bolder clays are present in areas removed from and surrounding the tanks. Neither groundwater nor bedrock were encountered during the FT intrusive investigations. The trial pits advanced at the site reached a maximum depth of 3.5 m BGL and were terminated in the Black Boulder Clay.

Table 2.3: Existing Ground Conditions (Preliminary Site Assessment Report, FT, 2017)

Strata	Depth to Top Range (m BGL)	Thickness Range (m)
Soft to firm brown sandy slightly gravelly CLAY with occasional cobbles	0.0	0.6
Firm becoming stiff brown sandy gravelly CLAY with frequent cobbles and rare boulders (Brown Boulder Clay)	0.6	1.2
Stiff dark grey sandy gravelly CLAY with frequent cobbles and rare boulders (Black Boulder Clay)	1.8	NP (maximum depth of investigation was 3.5m BGL)

The Roadbridge FCC JV, North Runway Construction Package 2, Geotechnical Investigation Report for the East Area – Phase 2 (EDAD09805-CP2-RF-GGI-OTHE-CC-C-0602), Issue 3, September 2019 describes the advancement of trial pits and borehole investigations along the Perimeter Road East which is running east west parallel to and immediately off set to the north of the proposed tank locations, (see Drawing P2214-0600-0007).

A summary of the ground conditions from this given in Table 2.4:

Table 2.4: Existing Ground Conditions Adjacent to Proposed Tank Locations

Strata	Depth to Top Range (m BGL)	Thickness Range (m)
Topsoil - Brown slightly sandy CLAY with rootlets	0.0	0.20 to 0.50
Made ground - Brown sandy gravelly CLAY with occasional evidence of tarmac, brick, rubber, cable, concrete, fabric and plastic pipe		0.10 to 2.7
Brown Boulder Clay - Brown to dark brown, occasionally light brown with grey mottling, sandy gravelly CLAY with a low to medium cobble content.		0.1 to 5.3
Glacial Gravels - Grey Gravel with frequent cobbles and boulders.		0.2 to 3.9
Black Boulder Clay - Grey to black, slightly sandy gravelly CLAY, with a medium to high cobble content and occasional boulders.		0.2 to 8.9

See also Drawing P2214-0600-0002 Borehole logs BHE01, BHE04 and BHE07

Appendix 2 Drawing P2214-0600-0002:

- Shows Borehole logs BHE01, BHE04 and BHE07 sourced from the *Roadbridge FCC JV, North Runway Construction Package 2, Geotechnical Investigation Report for the East Area – Phase 2 (EDAD09805-CP2-RF-GGI-OTHE-CC-C-0602), Issue 3, September 2019*). The logs and east west section through the proposed PWHT and R2 tanks were copied from Drawing P2214-0600-0002 which developed sections along the adjacent Perimeter East road.
- Shows permeability observations from undisturbed samples taken from the floor of tank PWHT (2 No. 3.5 $*10^{-10}$ and $7.6*10^{-11}$ m/s) and from remoulded sampled taken from the batter side slopes (2 No. $1.5*10^{-10}$ and $2.7*10^{-10}$ m/s), see also Section 2.2.8 below for more detailed observations.
- Suggests the Brown Boulder Clay extends between 0.2 m and 12.5 m below ground level and the Black Boulder Clay extends between 0.6 m and 10 m below ground level.

Further excavations during construction immediately adjacent to the R2 and PWHT tank locations, re-confirmed the presence of Black and Brown Boulder Clay deposits. As demonstrated by photographic evidence of the excavation presented in Figures 2-1, 2-2 and 2-3, the tanks R2 and PWHT are founded within /on Brown /Black Boulder Clays. Figure 2-1 also clearly shows that there is at least 2.0 m of Black Boulder Clay below the structure.

Additional photographic records of the tanks and surrounding ground prior to backfilling, supplementing Figures 2-1, 2-2 and 2-3, will be provided in the final CQA report.

The *Roadbridge FCC JV, North Runway Construction Package 2, Geotechnical Investigation Report for the East Area – Phase 2 (EDAD09805-CP2-RF-GGI-OTHE-CC-C-0602), Issue 3, September 2019* states that bedrock was not encountered in the exploratory holes advanced in the area, which extended to depths between 10 m and 15 m. Based on the regional geological information it is assumed that the area is underlain by Lower Carboniferous Limestone and Malahide Limestone formation.

Figure 2-1: Dublin Boulder Clay Located below Tank PWHT

Figure 2-2: Dublin Boulder Clay Structure Below and to the North Side of Tank R2

Figure 2-3: Dublin Boulder Clay Structure Below and to the South Side of Tank PWHT

2.2.8 Permeability of Black and Brown Boulder Clays at PWHT and R2 Tank Locations

Table 2.4 and Drawing P2214-0600-0002 show the presence of Brown and underlying Black Boulder Clays to be present at the PWHT, R2 and surrounding locations.

Table 2.5 is a screen shot from Table 13 of the *Roadbridge FCC JV, North Runway Construction Package 2, Geotechnical Design Report - West Area, Phase 2 (EDAD098015-CP2-RF-GZZ-OTHW-RP-C-0603), Issue for Construction, October 2019.* It shows that both the published and site specific permeabilities (k) for the Brown and Black Boulder Clays are 1 x 10^{-9} m/s and 1 x 10^{-10} m/s respectively. Permeability values were not reported in the Geotechnical Investigation Report for the East Area – Phase 2. It was assumed when reviewing containment options that values reported for the west area are representative of the east area also. This approach was subsequently validated by site specific tests, see Table 2.6 below.

Table 2.5: Extract of Characteristic Soil Properties for the West Area (Table 13)

Table 13: Summary table for characteristic soil properties for the West Area

Characteristic properties	Brown Boulder Clay		Black Boulder Clay		Glacial Gravels
	Site specific	Published value*	Site specific	Published value*	Site specific
Liquid Limit (%)	25-68 (38)	29.3	26-39 (33)	25±4	30-35 (32)
Plastic Limit (%)	13-36 (20)	15.9	15-19(17)	15.1	14-16 (16)
Plasticity Index (%)	10-33 (18)	13.4	9-21 (15)	11±2	16-19 (17)
NMC (%)	10-59 (18)	13.1	8-19 (12)	11±3	8-15 (11)
γ (kN/m^3)	21.8	21.8	21.8	22.9	18
γ_{sat} (kN/m^3)	22	-	22	-	19
N_{60}	10-45	18-29	40-47	50-71	-
c_u (kN/m^2)	50-225	84	215-250	240-373	-

Characteristic properties	Brown Boulder Clay		Black Boulder Clay		Glacial Gravels
	Site specific	Published value*	Site specific	Published value*	Site specific
φ' (°)	30	36-44	32	36-44	35
c' (kN/m^2)	0	0	0	0	0
E_{uv} (MPa)	20-100	80-300	85-105	250-600	-
E'$_v$ (MPa)	10-55	-	48-57	80	-
m_v (m^2/MN)	0.2-0.05	0.0037 to 0.37	0.04-0.035	0.0037 to 0.37	-
k (m/s)	1x10^{-9}	1x10^{-9}	1x10^{-10}	1x10^{-10}	-
Insitu CBR (%)	3% - 6%	4%	6%	-	n/a
k_s (MPa/m)	27 - 40	-	40	-	n/a
Poisson's ratio (-) drained	0.2	-	0.2	0.2	0.25
% Cohesive material (<63µm)	10-90	27.8	22-64	39.5	4-30
% Granular material (>63µm)	10-90	72.2	36-78	60.5	70-96

* Published values as per Farrell et al. 1995, Farrell 2016, Hanrahan 1977, Long and Menkiti 2007a, Long and Menkiti 2007b, Long et al. 2012 and Aer Rianta 1989.

The presence of gravel lenses/horizons has been identified as follows:

- BH01 log presented in Appendix 2 on Drawing P2214-0600-0002 shows that a gravel horizon is present at the base of the Brown Boulder Clay.
- The *Roadbridge FCC JV, North Runway Construction Package 2, Geotechnical Investigation Report for the East Area – Phase 2 (EDAD09805-CP2-RF-GGI-OTHE-CC-C-0602), Issue 3, September 2019* identified that

`The brown boulder clay appears to comprise lenses of material with higher gravel content within its matrix are in places across the site which have been identified by particle size distribution analysis laboratory tests. Even though lenses/horizons may be present, the fines content in all of these samples are generally >20% which defines the engineering behaviour of the material as a clay.'

- Similar observations of gravel horizons were also found in the *Roadbridge FCC JV, North Runway Construction Package 2, Ground Investigation Report for West Area - Phase 2 (EDAD098015-CP2-RF-GGI-OTHW-RP-C-0601), Issue for Construction, August 2019* Phase 2 Chapter 5-1, which advised the *"…brown boulder clay appears to comprise lenses of gravel material within its matrix in places across the site..."* and this statement is also replicated in Table 12 of the Ground Investigation Report referenced above for the West Area.

Site inspections[1] carried out following the excavation works surrounding the PWHT and R2 tanks showed however no evidence of sand or gravel lenses being present in either the underlying Black or surrounding Brown Boulder Clays.

Table 2.6 and Appendix 1 Drawing P2214-0600-0002 shows results from laboratory permeability testing carried out on Black Boulder Clay in the base and batters of the excavations below and immediately adjacent to the PWHT tank location which returned permeability values of between 1.5 x 10^{-10} m/s to 7.6 x 10^{-11} m/s.

Table 2.6: Permeabilities Below and Immediately Adjacent to the PWHT Tank

Location	Sample	Permeability m/s	Equivalence of 2.0 m thick Black Boulder Clay barrier compared to 1.0 m barrier 1*10^{-9} m/s	Equivalence of 8.0 m thick Black Boulder Clay barrier compared to 1.0 m barrier 1*10^{-9} m/s
PHWT floor	Undisturbed	3.5 x 10^{-10}	5.71	22.86
PWHT floor	Undisturbed	7.6 x 10^{-11}	26.32	105.26
PWHT batter	Remoulded	1.5 x 10^{-10}	12.4	50.95
PWHT batter	Remoulded	2.7 x 10^{-10}	7.41	29.63

Table 2.6 equivalency calculations demonstrate the low permeability of the Black Boulder Clay with reference to a 1.0 m clay barrier, permeability 1 x 10^{-9} m/s which is a representative of a conservative permeability requirement for engineered clay containment barriers in Ireland and in Europe.

Table 2.6 Equivalency calculations were assessed for a:

- 2.0 m insitu (founding formation) Black Boulder Clay barrier as evidenced by Figure 2-2, and
- 8.0 m insitu (underlying) Black Boulder Clay barrier as evidenced by Design Joint Venture Ground Investigation (RBFCC) 2019 borehole observations.

[1] Email PMc to CJC dated 6 July 2020 re inspection of formation materials below and to side of tanks R2 and PWHT stated no gravel lenses present.

Results show that even for the lowest permeability and an observed 2.0 m thick Black Boulder Clay, the basal insitu barrier will be at least 5.71 times less permeable than a typical conservative requirement for an engineered clay barrier. Borehole logs indicate the Black Boulder Clay for a barrier of 8.0 m thick, will be at least 26.32 times less permeable than a typical conservative requirement for an engineered clay barrier.

The permeability results for the remoulded samples cannot be considered truly representative of the insitu conditions as they do not represent the permeability of insitu undisturbed surrounding soils.

Whilst the 4 No. permeability tests presented in Table 2.6 reflect site specific observations, Table 2.5 permeability results in the area generally ($1*10^{-9}$ m/s to $1*10^{-10}$ m/s) are low permeabilities and the value of $1*10^{-9}$ m/s is representative of design values used for containment barriers.

In summary, geotechnical investigations and supporting laboratory analyses suggest the insitu Brown and Black Boulder Clay barrier(s) will facilitate a naturally occurring, robust, long-term sustainable low permeability containment solution isolating the PFOS or PFOA materials from the underlying groundwater and adjacent surface waters.

2.3 Conceptual Site Model

2.3.1 Conceptual Model

The Conceptual Site Model (CSM) is presented graphically in Figure 2-4 below. The conceptual model illustrates the conceptual understanding of the geology at the destination sites of the re-used material in the post construction scenario. The CSM also takes the findings from the site investigation works carried out in 2017 into account.

The proposed attenuation tanks and re-used materials are indicated in the CSM as being confined by both the to the Brown and Black Boulder Clay horizons.

The CSM indicates the site is underlain by:

- A thick (typically 8-10 m thick) Black Boulder Clay horizon which in turn is underlain by Weathered Limestone bedrock of the Malahide Formation. (Based on borehole data from previous investigations, *Causeway Ground Investigation Additional Ground Investigation Work, 2018* – presented in *Appendix 4 of the Dublin Airport North Runway: APEC 5 Detailed Quantitative Risk Assessment, November 2018),* below which is
- The underlying Weathered Malahide Formation which comprises fractured Argillaceous Limestone and Mudstone.

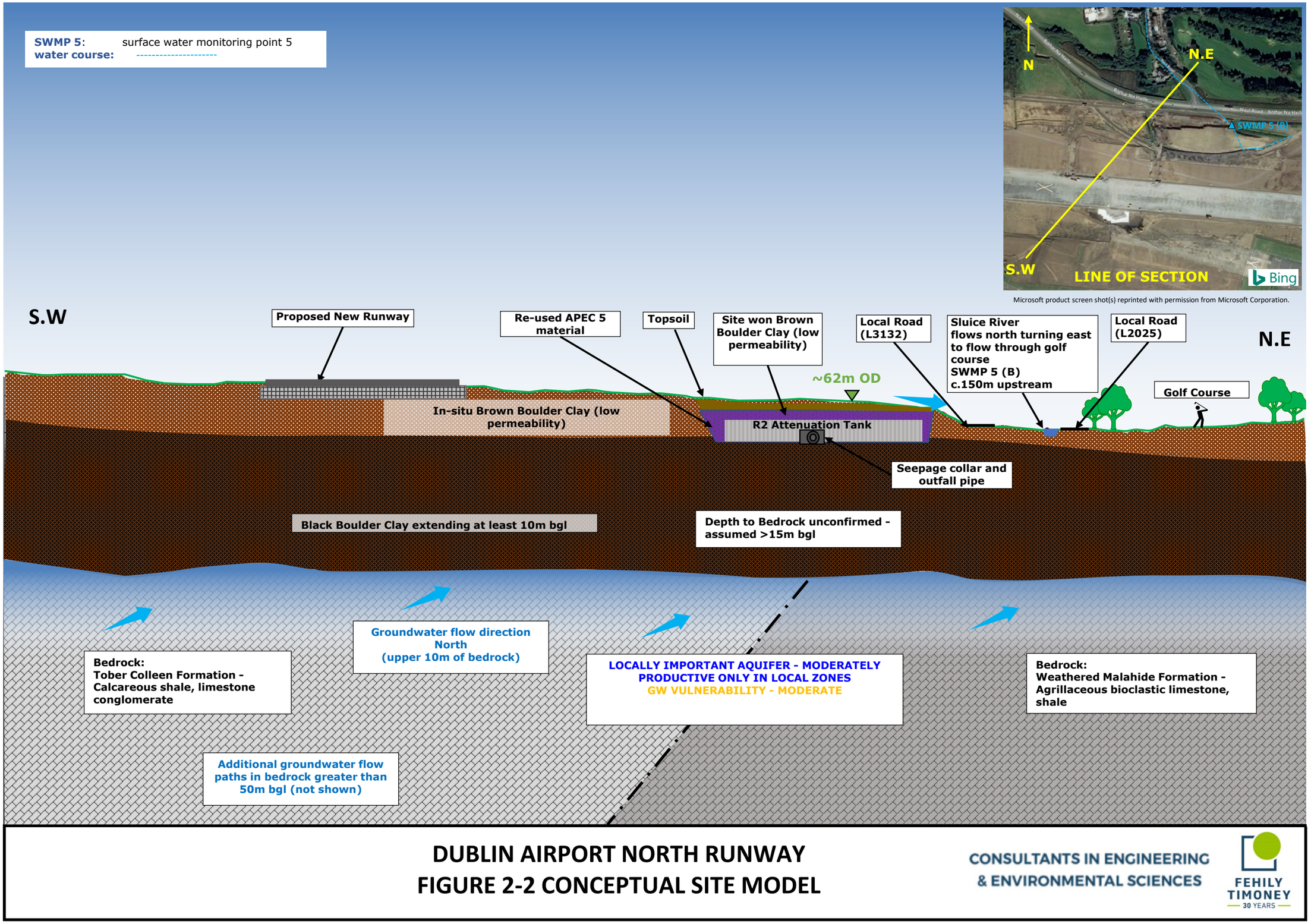
The site is located within an area having significant paved surfaces such that a large proportion of the effective rainfall becomes surface runoff, which falls towards the Sluice River to the north east of proposed locations of the R2 and PWHT tanks.

The installation of a low permeability Brown Boulder Clay cap over the reinstated R2 and PWHT attenuation tanks further reduces the recharge potential at the site and thus reduces the potential for the leaching of any residual contaminants from the re-used material to either the underlying aquifer or the downstream surface waters.

Based on the revised CSM for the site it is considered that the depth to bedrock and low permeabilities of both the Brown and Black Boulder Clay deposits at this location mitigate the potential for significant groundwater recharge from the surrounding lands.

It is considered that groundwater flow will be within the upper 10 metres of fractured bedrock. There may be some additional isolated flow paths along fractures and fissures located at depths up to 50 m BGL (these deeper flow paths were not presented on the CSM owing to scale constraints).

Figure 2-4: Conceptual Site Model



2.3.2 Residual Environmental Risks

Following a comprehensive risk assessment on the residual PFAS contaminants within soils, FT identified the primary source-pathway-receptor (S-P-R) linkages for the site as leaching of PFAS contaminants and subsequent migration through combined surface water and groundwater pathways.

To assess the residual risk associated with PFAS contaminants at the site, reported laboratory concentrations for PFOS and PFOA were compared with the USEPA Regional Screening Levels (RSLs) above which soils pose a potential risk to groundwater for leaching of contaminants. As presented in the Soil Table of the ITRC PFAS Fact Sheets PFAS-1, the published USEPA RSLs are as follows:

- PFOS 0.000172 mg/kg
- PFOA 0.000378 mg/kg

Laboratory analyses undertaken on the APEC 5 soils reported maximum PFOS and PFOA concentrations of 0.151 mg/kg and 0.015 mg/kg respectively. These concentrations of PFOS and PFOA exceed the published USEPA RSLs for the potential impact of soil contaminants to groundwater. As such, the residual contaminant concentrations within soils pose a potential risk to groundwater quality beneath the site. The overall significance of the potential risk from the soils, which are currently stockpiled, will be determined by the final use and on-site destination of the material.

To implement the materials management plan, a suitable site for the placement and re-use of the material was required. The surrounding geological and hydrogeological conditions at the receiving location will contain materials and mitigate the residual risks posed to groundwater beneath the site.

A review of past geotechnical investigations and evidence gained during construction in the vicinity of the proposed R2 and PWHT attenuation tanks, clearly identified deposits of Brown and Black Boulder Clays.

The geotechnical characteristics of the Brown and Black Boulder Clays are well documented and are based on detailed site investigations and site experience from large infrastructure projects in Dublin. Brown and Black Boulder Clays typically demonstrate permeability values ranging from 1×10^{-9} m/s to 1×10^{-10} m/s, as shown in Table 2.5, making it suitable as a landfill barrier liner and a favourable material for basement construction and other deep foundations within the Dublin area. Permeability testing completed by RBFCC on Black Boulder Clay deposits encountered in excavations for the PWHT measured permeability values between 1.5×10^{-10} m/s to 7.6×10^{-11} m/s, as shown in Table 2.6.

As shown in the Section 2.3 Figure 2-4, the CSM for the proposed works, it is considered that existing in-situ Brown and Black Boulder Clay deposits will provide low permeability barriers to the potential migration of contaminants to both surface and ground water receptors. FT considers that the in-situ Brown and Black Boulder Clay materials will provide an appropriate geological setting to accommodate the re-use of the excavated materials. Testing requirements for the re-use of the excavated materials are outlined in Section 2.5 below.

To further reduce the leachability of PFOS and PFOA from the re-used general fill, a suitable low permeability Brown Boulder Clay will be used as a cap during backfilling works. This material is readily available on site and will be won from excavations from the R2, PWHT and adjacent tanks.

Whilst residual contaminant concentrations within soils exceed the published USEPA RSLs, the environmental risk of APEC 5 contaminants impacting receiving ground (and surface) waters is considered to be insignificant because:

- Use of a low permeability Brown Boulder Clay material for the cap and cap contours will encourage surface runoff and will isolate the APEC 5 material from deep percolation of rainfall inputs.
- The insitu Brown and Black Boulder Clays will provide a natural, sustainable insitu low permeability containment barrier isolating the APEC 5 material from the underlying groundwater.

2.3.3 Mitigation of Leaks via Pipe Bed and Surround Materials

To prevent creation of preferential pathways through the bed and surround, to groundwater, a "vertical" cut-off shall be installed at all inlet and outlet pipes and shall comprise:

- A cut-off using HDPE, concrete or a similar approved barrier surrounding respective pipe extending at least 1 pipe diameter beyond the pipe circumference, and /or
- A sand bentonite mix bed and surround for a distance not less than 1 m either side of the cut-off.

Individual site-specific details for all pipe outfalls will be prepared for construction issue drawings and shall also be reflected in as built and photographic records.

2.3.4 CL:AIRE Code of Practice for Re-use of APEC 5 Material

The FT report *Material Management Options Assessment for the Management for PFOS and PFOA Impacted Soils (FT), March 2020* recommended that re-use of the material within the site boundary be compliant with CL:AIRE Code of Practice criteria, namely:

1. Protection of Human Health and the Environment.
2. Suitability for Use, Without Further Treatment.
3. Certainty of Use.
4. Quantity of Material.

The CL:AIRE Definition of Waste: Development (United Kingdom) Industry Code of Practice (CL:AIRE, 2011) was first published in 2008 and updated in 2011. The Code of Practice (CoP) sets out good practice for the development industry to use when assessing whether excavated materials are classified as waste or not. It also allows the determination, on a site-specific basis, as to when treated excavated waste can cease to be waste for a particular use. The CL:AIRE CoP was used as a guide when determining the re-use of APEC 5 materials.

Section 2.4 describes the materials management proposed containment solution and the quantities of materials associated with the works.

2.3.5 Proposed Containment Solution

The rational for the site selection was summarised in Section 2.2 of this report - The Conceptual Site Model (CSM) which describes how the underlying Brown and Black Boulder Clays and proposed re-use of Brown Boulder Clay for the low permeability cap solution will provide a sustainable and natural solution that will protect human health and the environment whilst allowing re-use of APEC 5 materials without further treatment.

The proposed engineering containment solution to mitigate environmental risks associated with the onsite re-use of *PFOS/PFOA Impacted Soils* in accordance with the CL:AIRE Code of Practice requires:

- Re-use of excavated on-site APEC 5 contaminated materials as backfill round concrete storm water management structures PWHT and R2.
- Re-use of excavated non contaminated (Brown Boulder Clay) low permeability material as a cap to isolate the re-used APEC 5 materials from rainfall inputs.
- Sustainable containment of APEC 5 materials within the naturally occurring low permeability Brown and Black Boulder Clay deposits to isolate the APEC 5 material from the underlying groundwaters and adjacent surface waters.

2.4 Materials Management

2.4.1 Proposed Works

The proposed works will require:

- Excavation and temporary stockpiling of APEC 5 contaminated material.
- Excavation of overburden at PWHT and R2 tank locations.
- Construction of PWHT and R2 stormwater tanks.
- Installation of associated infrastructure.
- Re-use of APEC 5 materials as backfill to PWHT and R2 tanks.
- Backfill between Tank R2 and P5 using site won Brown Boulder Clay.
- Isolation of preferential pathways via pipe surrounds existing tank excavations.
- Installation of a Brown Boulder Clay low permeability sub soil cap.
- Top soiling of the low permeability cap.

Drawing P2214-0400-0003 in Appendix 3 shows a Schematic Cross-Section (through the PWHT tank) of the Proposed Works.

2.4.2 Re-Use of APEC 5 Materials

The proposed placement of materials and typical sections are shown on the following Appendix 2 drawings.

- P2214-0600-0001 Earth Balance for APEC 5 Source, temporary Stockpiles and Final Re-Use Destinations (PWHT and R2 Tanks).
- P2214-0600-0002 PWHT and R2 Borehole Locations and Section.
- P2214-0600-0003 PHWT and R2 Backfill and Excavation Plans.
- P2214-0600-0004 PWHT and R2 Typical Sections.
- P2214-0600-0005 APEC 5 Excavation Area Borehole and Trial Pits.
- P2214-0600-0006 APEC 5 Cross Sections.

The proposed re-use of the materials will be as general fill for backfilling excavations during the construction of the R2 and PWHT attenuation tanks. The total volume of APEC 5 material to be re-used under this MMP is approximately 26,244 m^3. This APEC 5 volume comprises three main material types:

- 20,669 m^3 boulder clay with residual PFAS concentrations. This material type will contain:
  - 17,538 m^3 of existing boulder clay excavations
  - 3,131 m^3 of future boulder clay excavation post June 2020
- 3,711 m^3 of topsoil with residual PFAS concentrations.
- 1,864 m^3 of rock.

As of September, 2020[2] 2020 APEC 5 material has been stored at the following locations:

- 3,711 m^3 of topsoil stored in Bund 3, West of Sub-station 10L (Material A).
- 17,538 m^3 of boulder clay stored on the Southern runway grades strip at chainage 600 (Material B).
- 3,131 m^3 of boulder clay excavation, insitu as of June 2020, which following excavation will be re-used as fill around Tanks PWHC and R2 (Material C).
- 1,864 m^3 of rock which was initially moved In July 2019 to the East Compound and as of June 2020 is stored at the recently demolished Gate 1A (Material D).

The estimated backfill requirement over tanks R2 and PWHT is 44,555 m^3 and it will comprise

- 26,244 m^3 (see above) APEC 5 material.
- 18,311 m^3 using previously excavated boulder clay currently stockpiled in “Bund 5”.

[2] Email PMc to CJC dated 28/9/2020

2.4.3 APEC 5 Material Description

TII Specification for Highway Work: Series 600 Earthworks material classification as defined by Table 6/1 Acceptable Earthwork Materials Volume 1 advises APEC 5 excavated materials comply with:

- Class 2C for the contaminated boulder clay; and
- Class 1A for the granular materials. Both materials are deemed to be suitable for general fill and backfill around structures.

Class 2C materials may contain rock up to 500 mm diameter.

1,864 m^3 of Class 1 A rock shall be mixed and backfilled with Class 2C materials. No boulders greater than 500 mm diameter will be used as backfill. In the event that boulders are in excess of 500 mm diameter they shall be crushed prior to placement.

APEC 5 soils shall be compacted in accordance TII Specification for Highway Work: Series 600 Earthworks, Table 6/4: Method Compaction for Earthworks Materials Plant and Methods.

The schedule for testing of re-used material is outlined in Section 2.5 of this MMP.

Where topsoil with residual PFAS concentrations is to be re-used as backfill to excavations, it shall be placed within areas where no above or below ground infrastructure is proposed above the tanks.

To mitigate the risk of differential settlement arising from future oxidation of organic matter in APEC 5 topsoil material, it shall be placed in thin (< 150 mm thick) uniform layers over extended plan areas.

2.4.4 Low Permeability Cap

Upon the placement of the re-used APEC 5 material as General Fill during the backfill of the R2 and PWHT attenuation tanks, a permanent capping layer shall be placed over the footprint of the reinstated excavations. The cap will comprise:

- 200 mm uncontaminated Topsoil; on
- 800 mm of re-used site won Brown Boulder Clay Sub-soil.

Topsoil

Topsoil 200 mm thick will be compliant to BS3882:2015 or equal approved and graded to ensure no localised surface depressions are present.

Topsoil will be seeded in accordance with the specifications for grass areas within the North Runway Development.

Topsoil shall be graded such that no localised depressions are present that might cause ponded water to be present post rainfall events.

Final profile of topsoil shall be surveyed as outlined in Section 2.5 of this MMP.

Subsoil

Brown Boulder Clay Subsoil 800 mm thick will be provided using a uniformly graded material with stone sizes not greater that 50 mm or equal as approved.

Materials selected for use in the capping works will be un-contaminated and will:

- Meet the requirements for use on the North Runway Development, and
- Comply the general classification criteria as outlined in the TII Specification for Highway Work: Series 600 Earthworks.

Materials proposed for the capping outlined above will be won from on-site sources.

Subsoil material shall be compacted in accordance TII Specification for Highway Work: Series 600 Earthworks, Table 6/4: Method Compaction for Earthworks Materials Plant and Methods.

The schedule for testing this material is outlined in Section 2.5 of this MMP.

2.5 Construction Quality Assurance (CQA)

Following the completion of all works associated with this MMP, the Contractor will complete a Construction Quality Assurance Validation Report. The report will include the following information:

- A description of the works.
- As-built drawings of the works.
- Records and results of all tests carried out (including failures).
- Drawings showing the location of all samples and tests carried out.
- Daily record sheets/diary.
- Name(s) of contractor(s)/individual(s) responsible for undertaking the MMP works.
- Name(s) of individual(s) responsible for the supervision of works and for quality assurance validation works.
- Records of any problems and remedial works carried out to resolve those problems.

The Construction Quality Assurance (CQA) report structure and test frequencies are described in the following sections.

2.5.1 Description of the Works

The Contractor will describe those elements of the works on which contract quality assurance has been completed. The principal CQA elements will be:

- Low permeability cap constructed using site won Brown Boulder Clay.
- In-situ Brown and Black Boulder Clay Deposits.

- Re-used APEC 5 Material (General Fill).
- A survey of the void to be filled (existing surface, base and walls) prior to placing the APEC 5 material to confirm that ground conditions are representative of conditions presented in the drawings immediately prior to filling.
- Survey ground levels after placement of APEC 5 material and prior to capping.
- Detailed photographic record of conditions prior to and during placement.
- Detailed photographic record of pipe surround mitigation works.

2.5.2 As-Built Civil Drawings of the Works

The Contractor will be responsible for recording as-built information and the production of as-built drawings. The Contractor will produce the as-built drawings necessary for the production of the CQA report within 4 weeks prior to handover and/or substantial completion of the contract.

2.5.3 Drawings Showing the Location of all Samples and Tests Carried Out

The Contractor shall provide drawings (and section as may be required) showing the XYZ location of all samples.

2.5.4 Records and Results of all Tests Carried Out (including failures)

The Contractor will be responsible for compilation of all records, results and interpretive findings in respect of the requirements as set out in this document and will present findings in a Construction Quality Assurance (CQA) Validation Report to the Employers Representative. Particular attention will be given to the contract quality assurance in respect of all infrastructure designed specifically to protect the environment, e.g. capping material and in-situ clay deposits. The Contractor will include cross-references within the as-built drawings for all locations and results. All failures will be carefully tracked through the CQA documents. A photographic record of the works undertaken will also be included.

2.5.5 Daily Record Sheets/Diary

The Contractor will ensure that all parties maintain and complete their daily record sheets and diaries insofar as it supports the CQA report. The Contractor will obtain daily record sheets and compile them into the CQA report.

Where issues relevant to the contract quality assurance are identified in the daily record sheets, the Contractor will also record how the issues were successfully resolved and also record the final outcome.

2.5.6 Names of Contractors Responsible for Undertaking the MMP

The Contractor will include, as a matter of course, a list of names of those parties that have undertaken all works associated with this MMP.

2.5.7 Names of Individuals Responsible for Supervision of Works

The Contractor will ensure that a full list of all companies (and their site supervisors), which may also be the Contractor, responsible for the supervision of the works and for quality assurance validation of the works are included in the report.

2.5.8 Records of Problems and Remedial Works Carried Out to Resolve the Problems

The Contractor will include an interpretation of failures (if any) in his report and measures put in place to either remedy failures or mitigate the impacts of failures and non-compliances. Where remedial works are carried out, re-testing will be required.

2.5.9 Schedule of Testing for Materials

The Contractor will be responsible for the classification and testing of proposed earthworks materials. Classification of the material designated for re-use and material proposed for capping will be undertaken in accordance with the TII document: Specification for Highway Work: Series 600 Earthworks. The frequency of testing to determine materials acceptability is provided in Series 600: Appendix 1/5. Asterix values in Table 6/1 (Series 600) denote typical values which are to be verified by calibration testing. Once verified, the values will be amended via the site design change process, and the method of determining acceptability confirmed (e.g. MCV, cu, OMC).

The tests and minimum quantity of tests required of materials at the base, sides of top excavations will be executed and completed by the Contractor in accordance with Table 2.7 below.

The Contractor will ensure that the specified testing is being completed and will confirm that the following required permeability values are met prior to proceeding with filling using the APEC 5 material:

- Insitu Brown and Black Boulder Clay side slopes and formation permeabilities are less than 1×10^{-9} m/s.
- The re-used Brown Boulder Clay low permeability cap is less than 1×10^{-7} m/s.

The Contractor or appointed CQA entity will collate the clay CQA documentation regularly to enable any documentation errors to be detected during the clay placement process (see also Section 2.9 above re Interim Reports).

If, during the installation of the clay cap, the Contractor forms the opinion that either through a deterioration in the quality of the raw material (clay) or due to poor workmanship or testing undertaken by the Contractor, there is a risk that the specified permeability of the clay will not be achieved, then the Contractor will advise the Employer with respect to appropriate actions.

Table 2.7: Testing Frequencies for the Mineral Component (Clay)

Tests	Re-used APEC 5	Insitu Black Boulder Clay	Insitu Brown Boulder Clay	Low permeability Cap (15,000 m^2 Totals)
In-situ Tests				
M.C. (Direct Oven Drying)	5	5	5	5
Density (Nuclear Method)	1	1	1	1
Hydraulic Conductivity (Cores to be taken)			5	5
Laboratory tests				
Grading to BS:1377 Part 2	5		5	5
Plastic Limit to BS 1377 Part 2	5		5	5
Moisture content to BS:1377 Part 2	5		5	5
MCV to BS:1377 Part 2 Clause 632	5		5	5
Undrained shear strength Clause 632	5		5	5

Loose layer thickness of fill layers shall not exceed:

- 500 mm at tank sides and 1.0 m above tanks.
- 1000 mm immediately above the tanks.

As-built records detailing where the topsoil was placed will be maintained by the Contractor.

Topographic surveys of the final cap surface shall be carried out:

- Upon completion of capping.
- 12 months after completion of capping.

In the event that local surface depressions are present following differential settlement and are shown to cause localised ponding following rainfall, re-profiling shall be carried out to reduce percolation of rainfall inputs.

2.6 On-going Environmental Monitoring

Environmental monitoring is currently on-going as part of the environmental management plan for the on-going construction works associated with the North Runway Development.

2.6.1 Surface Water Monitoring

Appendix 4 shows surface water monitoring related drawings as follows:

- P2214-0700-0002 Surface Water and Groundwater Monitoring Locations.

Drawing P2214-0700-0002 references to SWMP 1, 2, 3, 4, 5, 6 and 7 were used as monitoring locations in the original surface water monitoring programme.

SWMP 1, 2 and 3 no longer have storm flows owing to construction of the development and there will be no future monitoring from these locations.

SWML 5 will, going forward, be split to form two subsamples:

- SWML 5 (a) will allow representative samples from the Forest Road catchment
- SWML 5 (b) will allow representative samples to be collected from the site/airport catchment (5b)

2.6.2 Groundwater Monitoring

It is proposed to install 5 no. groundwater monitoring borehole locations to facilitate groundwater monitoring after placement of the APEC 5 material. The proposed groundwater monitoring borehole locations are as follows:

- GWML 4 - east and outside of the works boundary, beside existing Stilling Pond 3 (SP3).
- GWML 5 - east and outside of the works Boundary.
- GWML 6 - south of and removed from the runway at the entrance to the West Construction Compound (within DAA lands).
- GWML 7 - west of and removed from localised antenna 28R adjacent to an access track (within DAA lands).
- GWML 8 - north of and removed from the runway west of Attenuation Tank P8 accessible using access track leading into anemometer station (within DAA lands).
- GWML 9 north west of the works boundary adjacent to Attenuation Tank P7 and upgradient of Keelings Farm.

Due to construction programme constraints it may not be possible to install the groundwater monitoring boreholes prior to placing the APEC 5 material. If this is the case baseline data will not be collected.

2.6.3 Monitoring Program During Construction

Surface Water Monitoring

The environmental monitoring undertaken by RBFCC for the duration of the construction period includes monthly sampling and analysis of surface waters at designated monitoring locations at the site.

To provide on-going validation to the remedial option outlined in this MMP, analysis for PFAS contaminants (PFOA, PFOS and PFOSA) will be included in the on-going surface water monitoring program. Baseline surface water monitoring was completed in March 2020 and is presented in Table 2.1. COVID-19 impacted sampling and analysis from mid-March until May 2020 resulting in a gap in data collection.

Sampling and analyses recommenced in May and post June 2020 was undertaken on a weekly basis for the duration of the works at designated surface water monitoring locations down-gradient of the final location of the R2 and PWHT attenuation tanks.

Surface water monitoring locations are presented in Appendix 4 Drawing P2214-0700-0002. Previous surface water monitoring samples were collected from a drainage channel north of APEC 5 which could be used for monthly surface water sampling. Samples were taken from a down-gradient location, the potential discharge zone for groundwater and downgradient locations. These locations provide an assessment of the potential impact from the migration of PFOS/ PFOA contaminants along the site drainage.

It is proposed that the samples will be analysed by ALS Hawarden for every round of monitoring to ensure consistency of the data collected. This laboratory was previously used for surface water monitoring analysis. The surface water samples will be assessed against the Maximum Allowable Concentration (MAC) for Inland Surface Waters for Total PFOS, set by S.I. No. 386 of 2015. The detection limit employed by ALS Hawarden for PFOS/PFOA will be set at detection 0.65 ng/l.

Sampling precautions specific to PFAS will refer to "ITRC Fact Sheet https://pfas-1.itrcweb.org/wp-content/uploads/2020/04/PFAS_Fact_Sheet_Site_Characterization_April2020.pdf)".

Groundwater Monitoring

Groundwater shall also be sampled and tested for PFAS contaminants on a weekly basis for the duration of the construction period at designated monitoring locations within the site.

2.6.4 Monitoring Program Post Construction

Post completion of the works it is proposed to continue sampling during the defects period as follows:

- Surface water sampling and analysis for PFAS contaminants on a quarterly basis.
- Groundwater sampling and analysis for PFAS contaminants on a quarterly basis.

At the end of 12 months it is proposed to review results and to determine thereafter a long-term monitoring frequency. Subject to there being no evidence of contamination in downstream surface and ground waters the proposed monitoring frequency post defects period, will be 12 months for both surface and ground waters.

3. CONCLUSIONS AND RECOMMENDATIONS

FT was retained by RBFCC to submit a MMP for soils excavated from the former fire training ground (APEC 5) at the Dublin Airport North Runway Development. Residual concentrations of PFOS and PFOA contaminants were identified within soils in 'Cut' areas of the runway development in the location of APEC 5. This material, which will comprise approximately 26,244 m^3, was/will be excavated from within the runway footprint of APEC 5 area and stockpiled within the APEC 5 boundary outside of the North Runway footprint.

An appropriate solution was required to reduce the risk posed by PFOS and PFOA contaminations to sensitive environmental receptors and to facilitate the construction program. The recommended solution is to re-use the material as general fill during the backfill works associated with the proposed concrete attenuation tanks R2 and PWHT.

R2 and PWHT comprise pre-cast concrete tanks with a reinforced concrete floor slab, pre-cast internal walls and reinforced concrete slab roof construction. The tanks are to be backfilled with the general fill before covering the topsoil and grass to achieve final finished levels.

The on-going risk posed from residual PFOS and PFOA concentrations in the post construction scenario has been examined in the CSM for the developed site. As shown in the CSM, Black and Brown Boulder Clay deposits underlie the proposed destination site for the material.

Permeability testing:

- Shown in Table 2.5 Extracted from the *Roadbridge FCC JV, North Runway Construction Package 2, Geotechnical Design Report - West Area, Phase 2 (EDAD098015-CP2-RF-GZZ-OTHW-RP-C-0603), Issue for Construction, October 2019* shows that both the published and site specific permeabilities (k) for the Brown and Black Boulder Clays in adjacent locality to be between 1 x 10^{-9} m/s and 1 x 10^{-10} m/s. Whilst permeability values were not reported in the Geotechnical Investigation Report for the East Area it was assumed that values reported for the west area are representative of the east area also.
- Shown in Table 2.6 on Black Boulder Clay deposits encountered during excavations for the PWHT returned permeability values of between 1.5 x 10^{-10} m/s to 7.6 x 10^{-11} m/s.

As such it is considered the existing Brown and Black Boulder Clay overburden deposits in the base and sides of the excavations for the R2 and PWHT tanks will provide a low permeability barrier for the encapsulation of the re-used APEC 5 material and a barrier preventing the vertical and lateral migration of residual PFAS contaminants.

From the development of the CSM for the destination site for the re-used APEC 5 material and following the implementation of measures outlined in this MMP, it is considered that there will be no outstanding residual risks posed to environmental receptors at or adjacent to the site from the re-use of this material.

Prior to the commencement of the works, classification of the material designated for re-use and material proposed for capping should be undertaken in accordance with the TII document: Specification for Highway Work: Series 600 Earthworks. Prior to the placement of the re-used material within excavations, sampling and testing should be undertaken to ensure that the permeability achieved by the:

- Insitu Brown and Black Boulder Clay formations are less than 1 x 10^{-9} m/s
- Brown Boulder low permeability cap is less than 1 x 10^{-7} m/s

Following the completion of all works associated with this MMP, the Contractor will complete a construction Quality Assurance Validation Report. The report will be required to include the information outlined in Section 2.5 of this document.

During the construction period monitoring for and analysis of PFAS contaminants will be conducted monthly for surface waters and weekly for groundwaters.

During the defects period monitoring for and analysis of PFAS contaminants will be conducted weekly for groundwaters.

At the end of the Defects period a review of monitoring results will be conducted and subject to here being no evidence of PFAS contaminants, it is proposed that monitoring for and analysis of PFAS contaminants will be carried out annually.

4. REFERENCES

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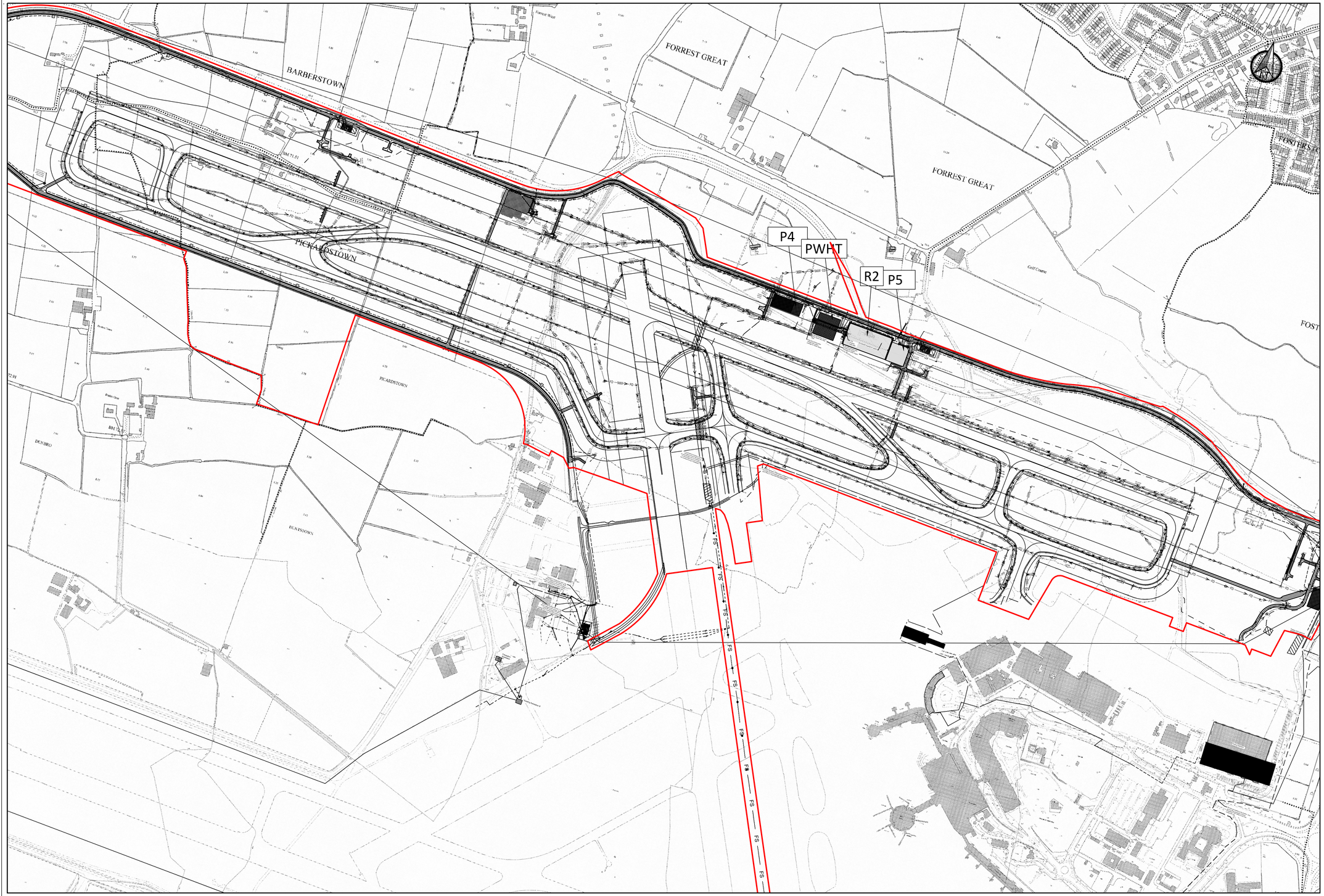
APPENDIX 1

Layout Drawings



Legend

Site Boundary

0m 50m 100m 150m 200m 250m 300m 350m 400m 450m 500m

Scale 1:5000

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Rev.	Description	App By	Date
A	ISSUE FOR COMMENT	BDH	18.02.20
B	ISSUE FOR INFORMATION	BG	24.06.20

PROJECT

DUBLIN AIRPORT NORTH RUNWAY REMEDIATION

CLIENT

ROADBRIDGE

SHEET

1:5000 SITE LAYOUT

Date: 18.02.20

Project number: P2214

Scale (@ A1-): 1:5000

Drawn by: SOC

Checked by: JD

Drawing Number: **P2214-0100-0001**

Rev: **B**

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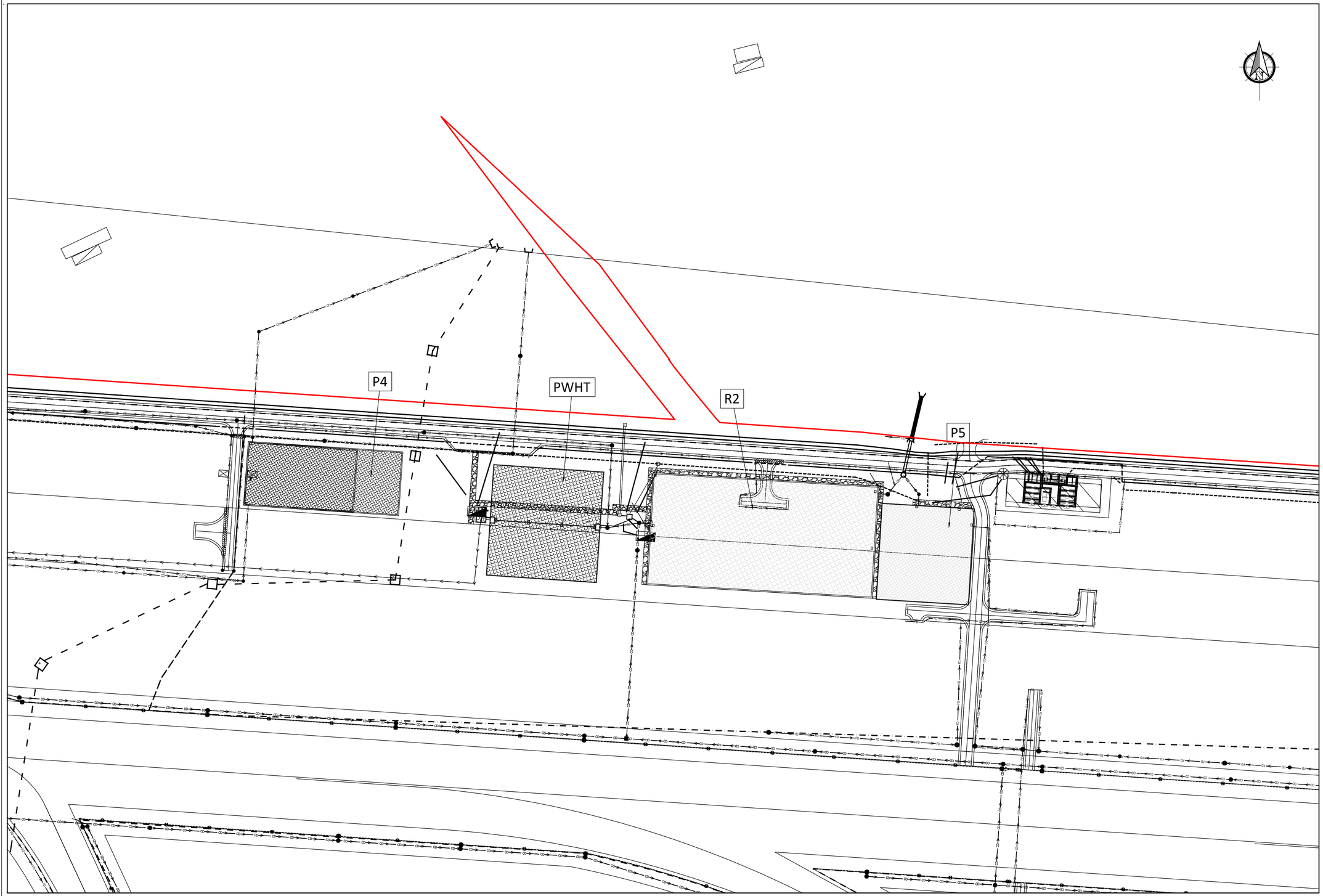
24 June 2020



Legend

Site Boundary

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Scale 1:1000

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Rev.	Description	App By	Date
A	ISSUE FOR COMMENT	BDH	18.02.20
B	ISSUE FOR INFORMATION	BG	24.06.20

PROJECT
DUBLIN AIRPORT NORTH RUNWAY REMEDIATION

CLIENT
ROADBRIDGE

SHEET
1:1000 ATTENUATION TANK LAYOUT

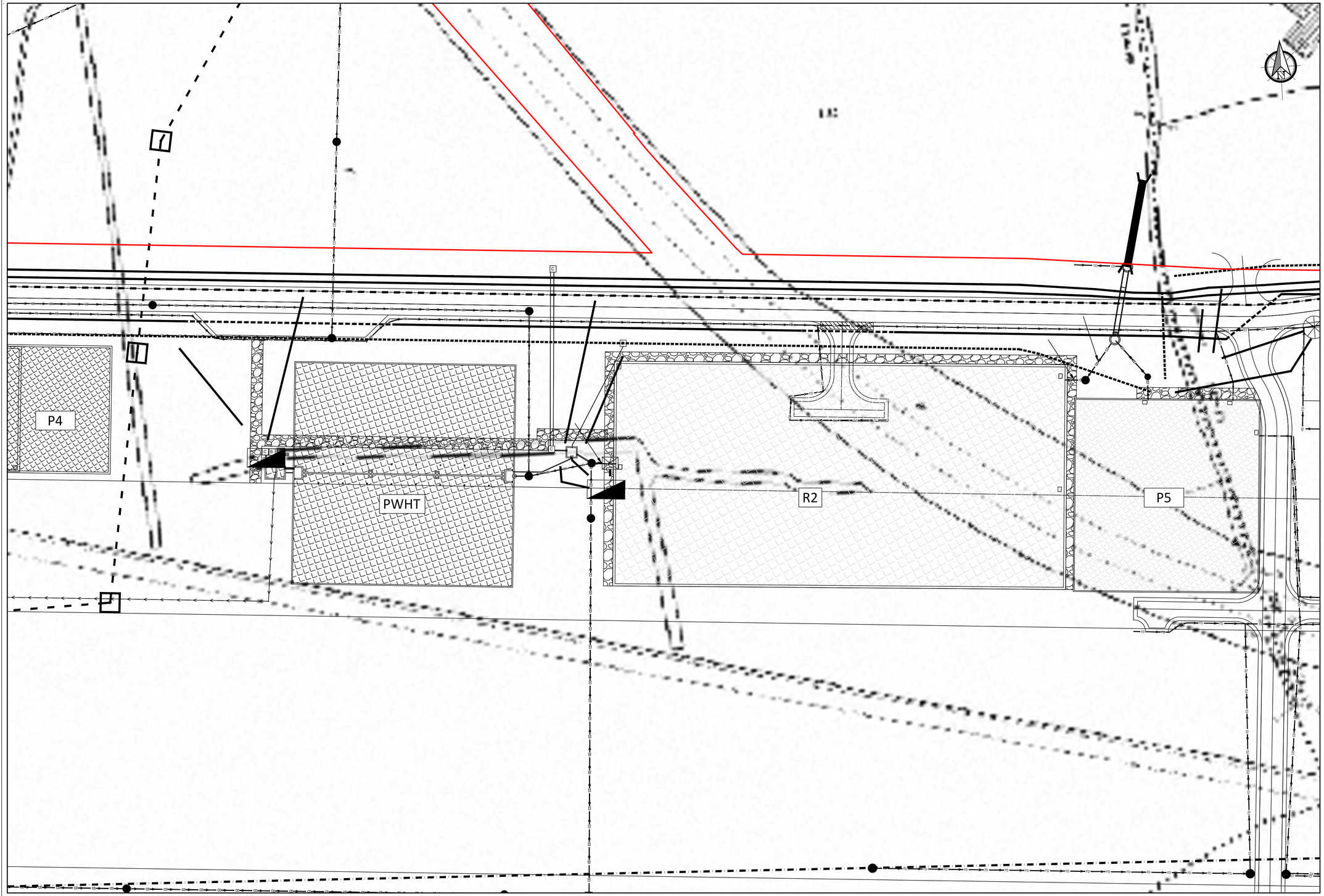
Date: 18.02.20
Drawn by: SOC
Checked by: JD

Project number: P2214
Scale (@ A1-): 1:1000

Drawing Number: **P2214-0100-0002**
Rev: **B**

O:\ACAD\2020\P2214\P2214-0100-0002

24 June 2020



Legend

Site Boundary

0m 5m 10m 15m 20m 25m 30m 35m 40m 45m 50m

Scale 1:500

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Rev.	Description	App By	Date
A	ISSUE FOR COMMENT	BDH	19.02.20
B	ISSUE FOR INFORMATION	BG	24.06.20
C	ISSUE FOR INFORMATION	BG	06.07.20

PROJECT
DUBLIN AIRPORT NORTH RUNWAY REMEDIATION

CLIENT
ROADBRIDGE

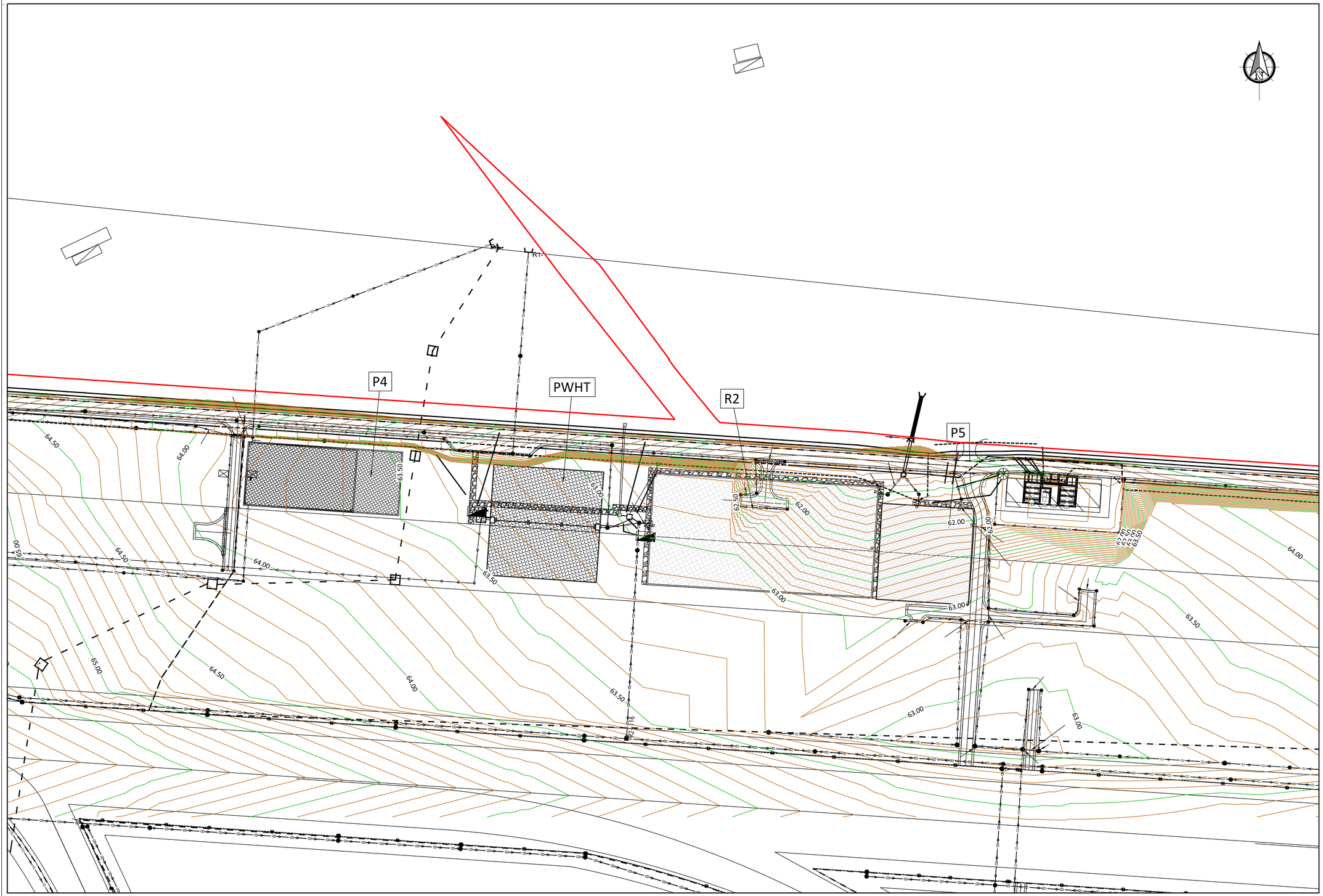
SHEET
1:500 ATTENUATION TANK LAYOUT

Date 19.02.20
Drawn by SOC
Checked by JD

Project number P2214
Scale (@ A1-) 1:500
Drawing Number **P2214-0100-0003**
Rev **C**

O:\ACAD\2020\P2214\P2214-0100-0003

06 July 2020



Refer to Appendix 2 Drawings P2214-0600-0003 and 0004 for Excavation and Backfill Plan and Typical Sections

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A	ISSUE FOR INFORMATION	BG	23.06.20

PROJECT
DUBLIN AIRPORT NORTH RUNWAY REMEDIATION

CLIENT
ROADBRIDGE

SHEET
FINAL CONTOURS

Date: 23.06.20
Project number: P2214
Scale (@ A1-): 1:1000
Drawn by: SOC
Checked by: CJC
Drawing Number: **P2214-0100-0004**
Rev: **A**

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24 June 2020

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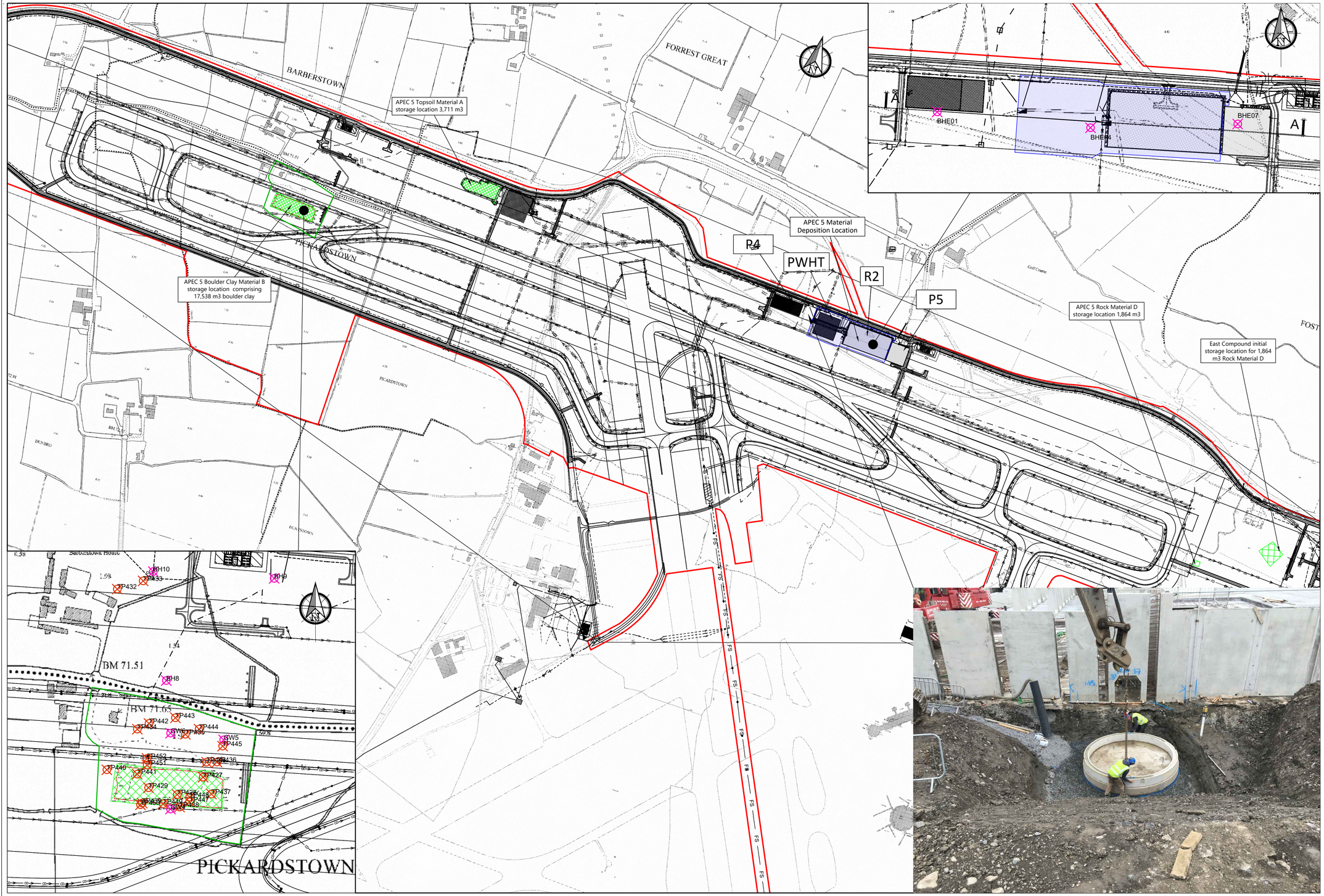
APPENDIX 2

Earth Balance Drawings



Legend

- Site Boundary
- APEC 5 Excavation Footprint
- Bore Hole
- Trial Pit
- APEC 5 Temporary Storage Locations
- Proposed APEC 5 Contaminated Backfill Footprint

Notes

For Borehole Locations and geotechnical Section see drawing P2214-0600-0002
For Backfill around R2 and PWHT tanks see drawings P2214-0600-0003 & P2214-0600-0004
For APEC 5 Excavation Plan and Sections see drawings P2214-0600-0005 & P2214-0600-0006

0m 50m 100m 150m 200m 250m 300m 350m 400m 450m 500m

Scale 1:5000

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A	ISSUE FOR INFORMATION	BG	19.06.20
B	ISSUE FOR INFORMATION	BG	06.07.20

PROJECT
DUBLIN AIRPORT NORTH RUNWAY REMEDIATION

CLIENT
ROADBRIDGE

SHEET
EARTH BALANCE FOR APEC 5 SOURCE, TEMPORARY STOCKPILES & FINAL RE-USE DESTINATIONS (PWHT & R2 TANKS)

Date 19.06.20	Project number P2214	Scale (@ A1-) 1:5000	
Drawn by SOC	Drawing Number P2214-0600-0001		Rev B
Checked by CJC			

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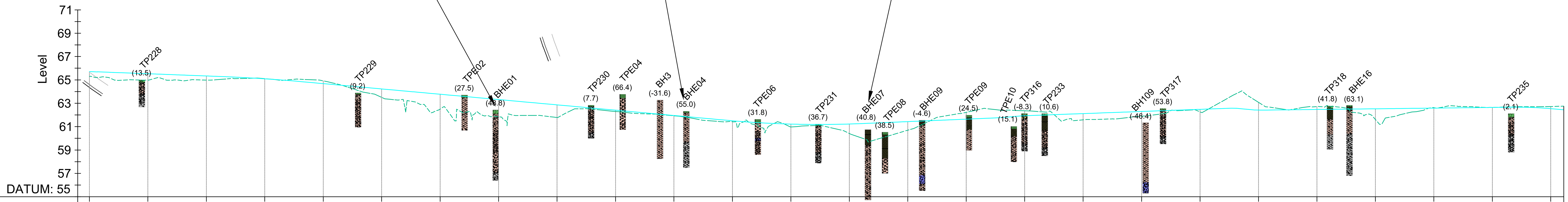
06 July 2020

PLAN

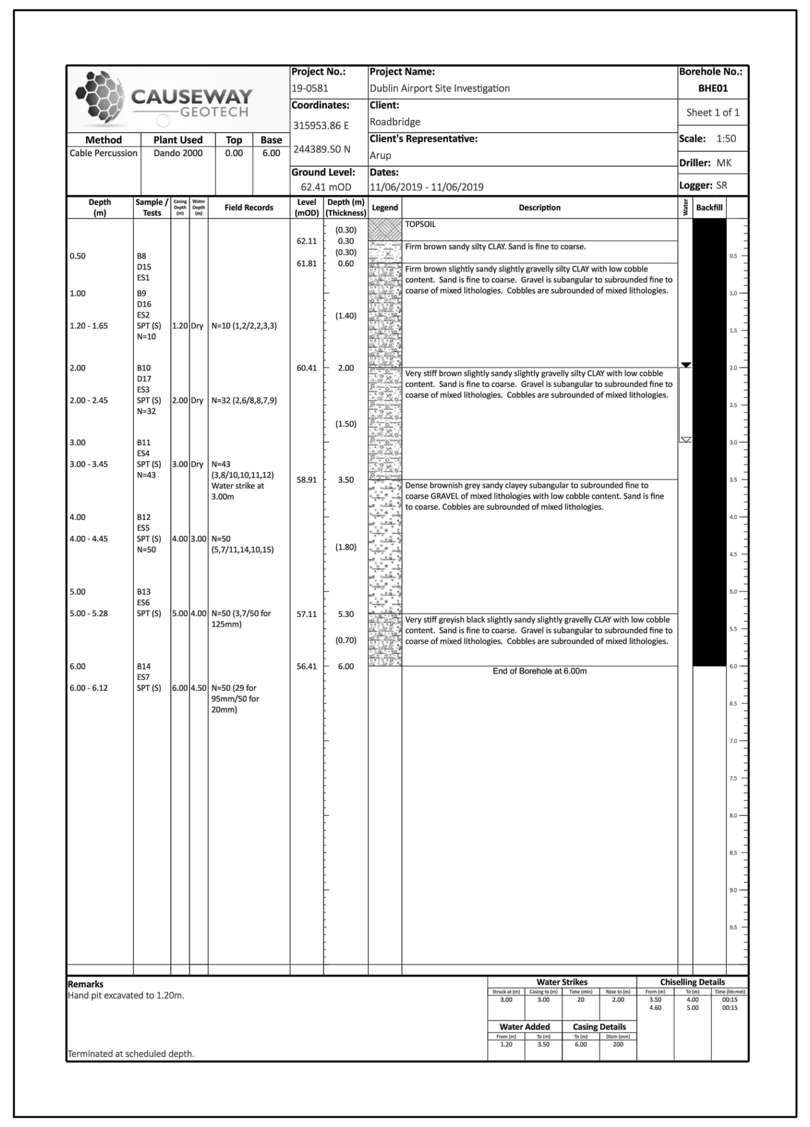
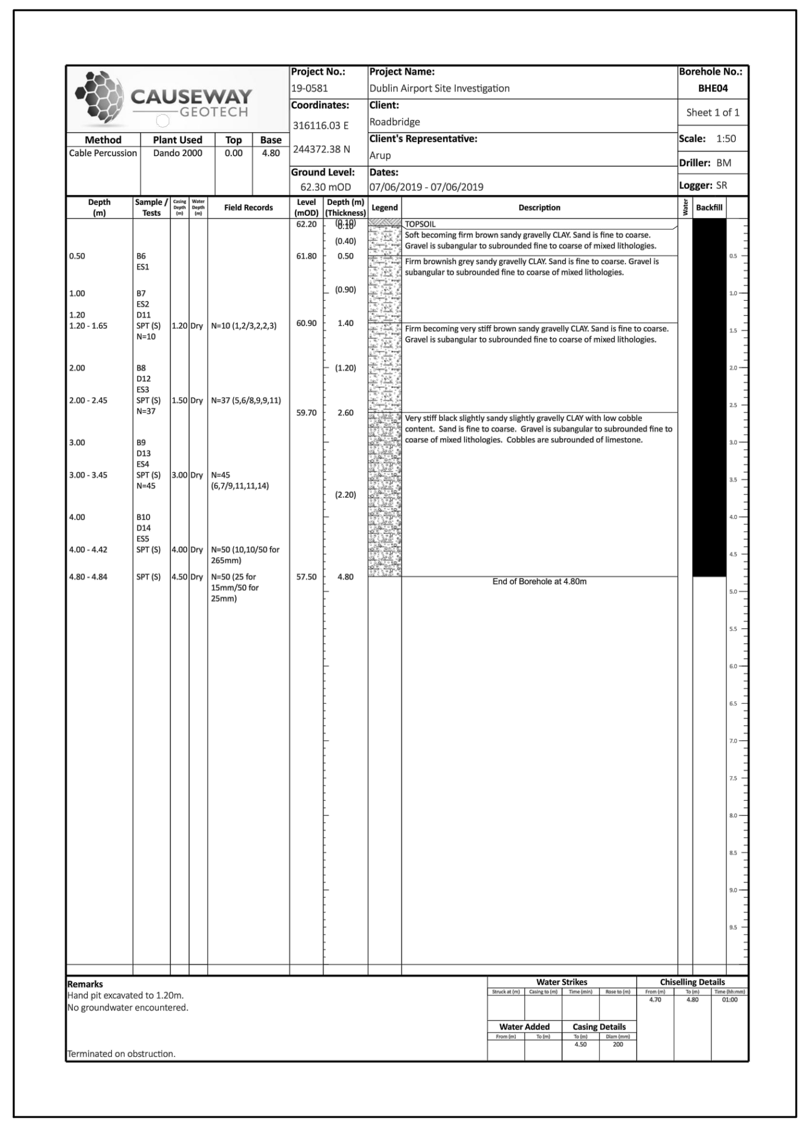
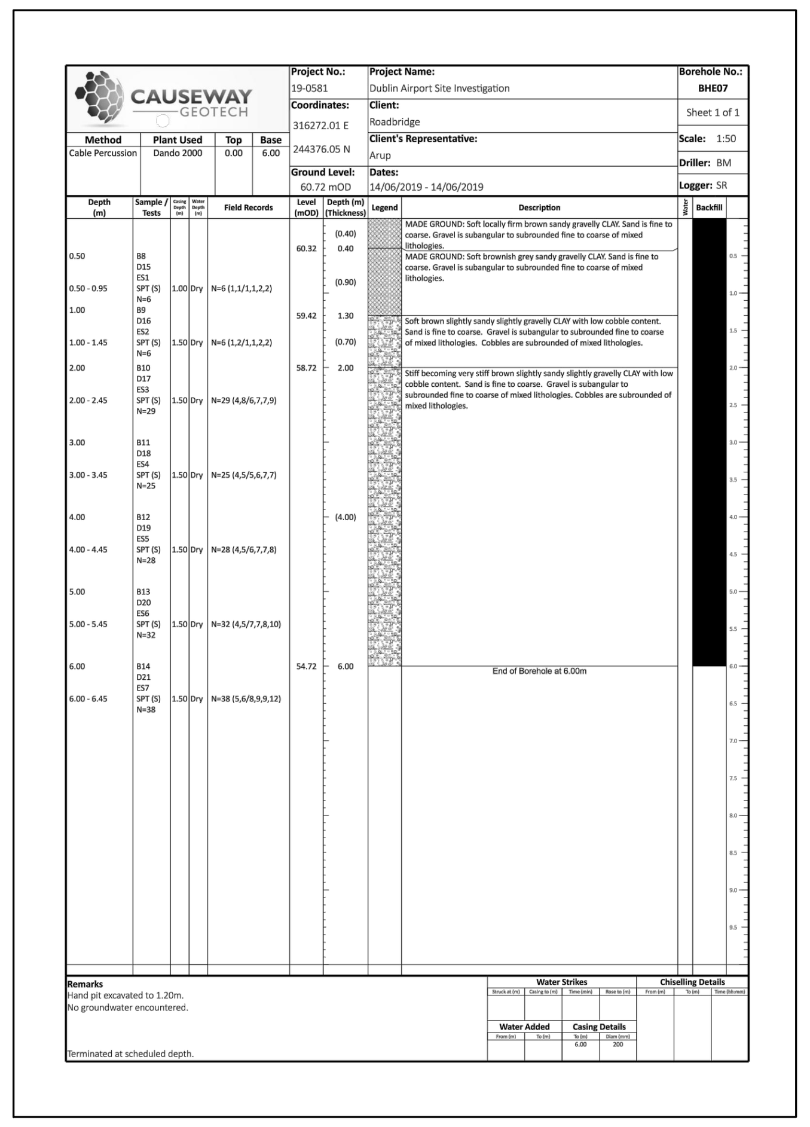
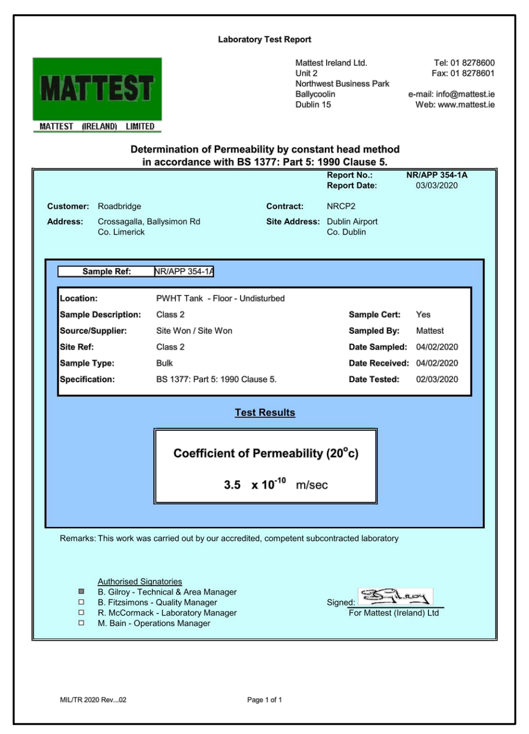
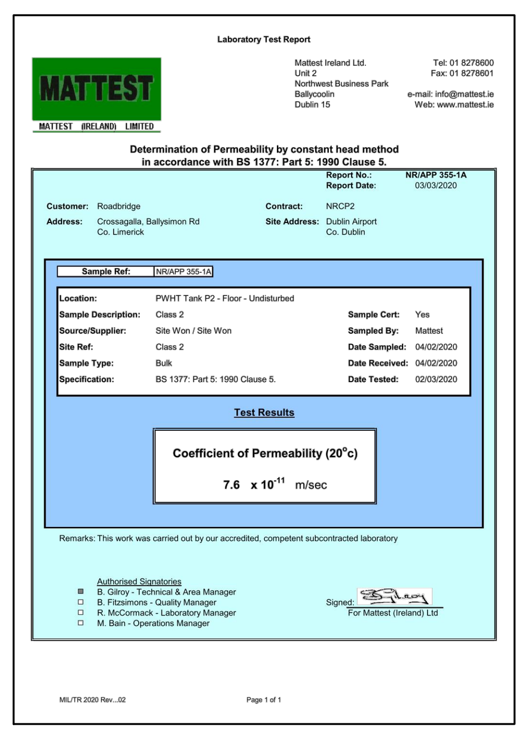
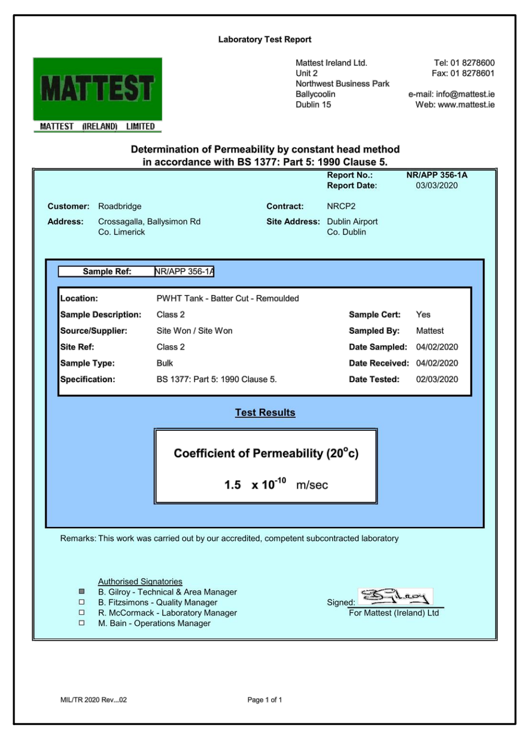
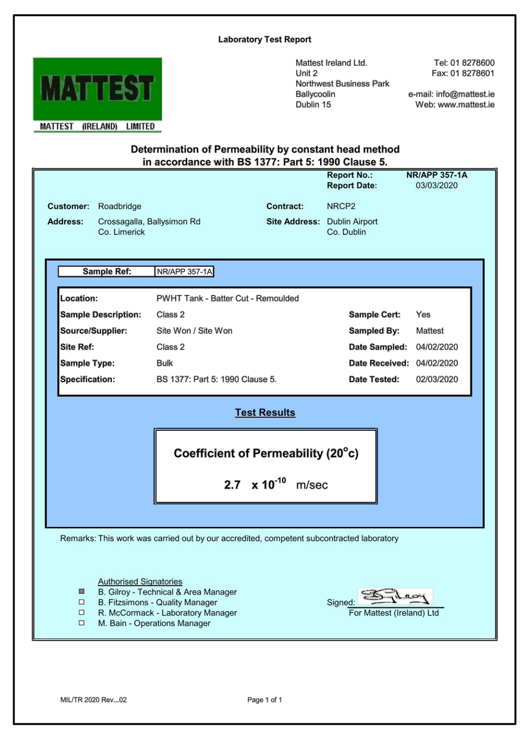
Scale 1:1250



Section Chainage	Proposed Ground Levels	Existing Ground Levels
00	65.709	65.303
50	65.527	64.981
100	65.337	64.981
150	65.092	65.107
200	64.681	64.917
250	64.226	63.505
300	63.772	62.499
350	63.317	61.842
400	62.863	61.779
450	62.409	62.297
500	61.954	61.923
550	61.501	61.418
600	61.217	60.966
650	61.225	60.413
700	61.430	60.696
750	61.641	62.224
800	61.931	62.357
850	62.115	61.583
900	62.298	61.893
950	62.480	62.266
1000	62.416	63.076
1050	62.469	62.717
1100	62.527	61.605
1150	62.585	62.620
1200	62.643	62.647
1250	62.540	62.722

SECTION A-A

Scale 1:2000

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A	ISSUE FOR INFORMATION	BG	19.06.20
B	ISSUE FOR INFORMATION	BG	06.07.20

PROJECT: DUBLIN AIRPORT NORTH RUNWAY REMEDIATION

CLIENT: ROADBRIDGE

SHEET: PWHT AND R2 BOREHOLE LOCATIONS AND SECTION

Date: 19.06.20	Project number: P2214	Scale (@ A1-): As Shown	
Drawn by: SOC	Drawing Number: P2214-0600-0002		Rev: B
Checked by: CJC			

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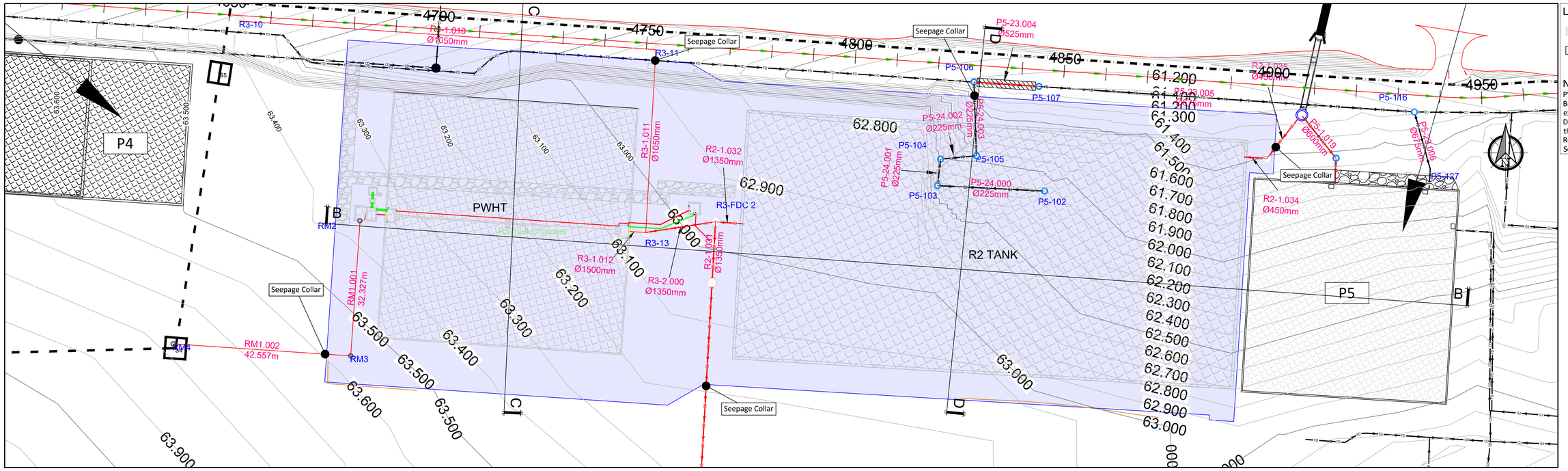
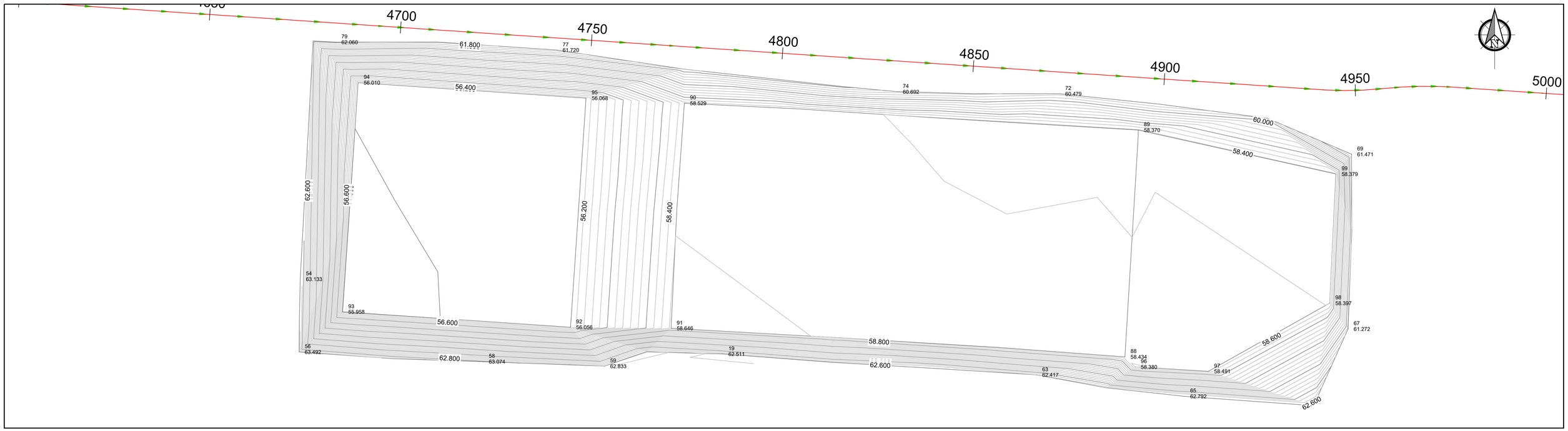
06 July 2020



BACKFILL PLAN

Scale 1:500



EXCAVATION PLAN

Scale 1:500

0m 5m 10m 15m 20m 25m 30m 35m 40m 45m 50m

Scale 1:500

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A	ISSUE FOR INFORMATION	BG	19.06.20
B	ISSUE FOR INFORMATION	BG	06.07.20

PROJECT
DUBLIN AIRPORT NORTH RUNWAY REMEDIATION

CLIENT
ROADBRIDGE

SHEET
PWHT AND R2 BACKFILL AND EXCAVATION PLANS

Date: 19.06.20
Drawn by: SOC
Checked by: CJC
Project number: P2214
Scale (@ A1-): 1:500
Drawing Number: P2214-0600-0003
Rev: B

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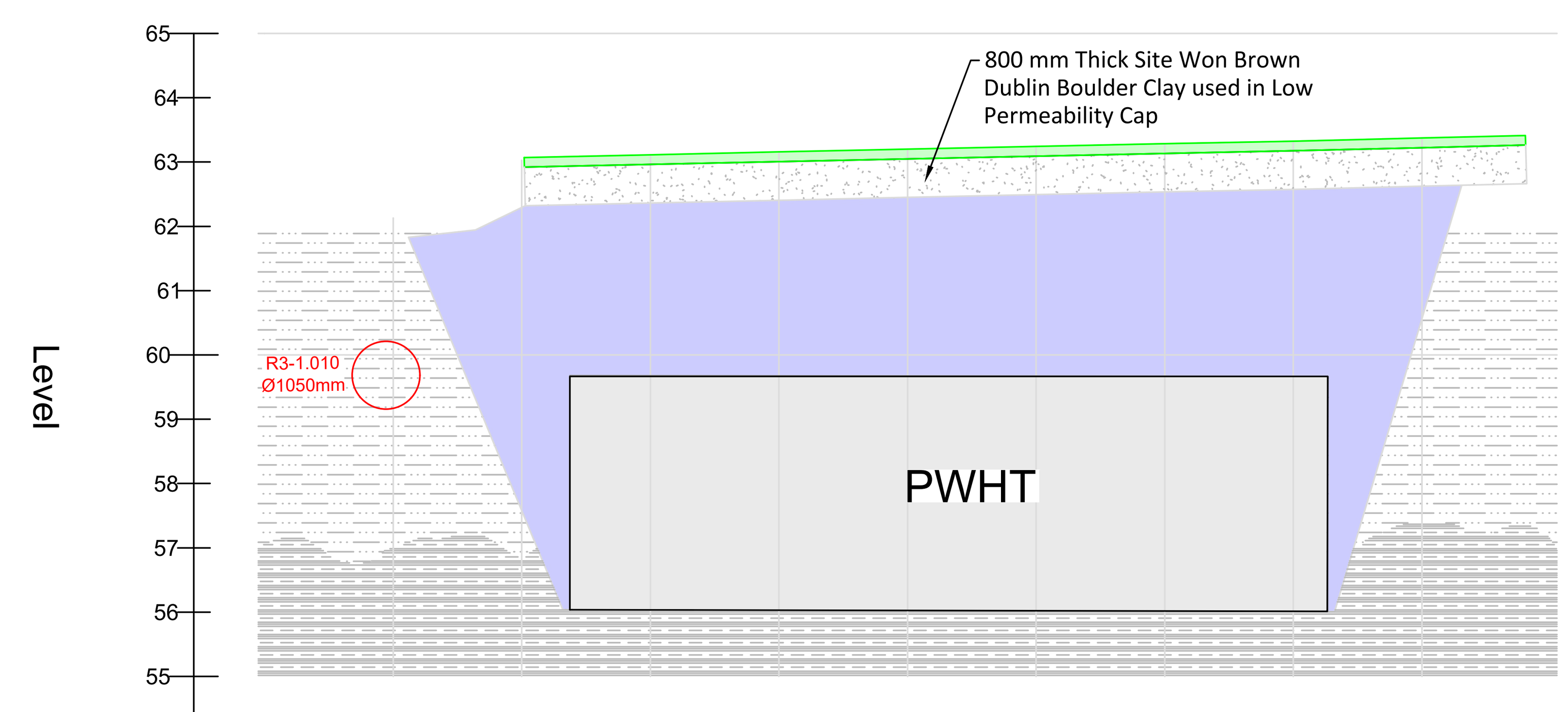
06 July 2020

CROSS SECTION CC' PWHT - LONGSECTION
SCALE: H 1:500,V 1:100. DATUM: 55.000

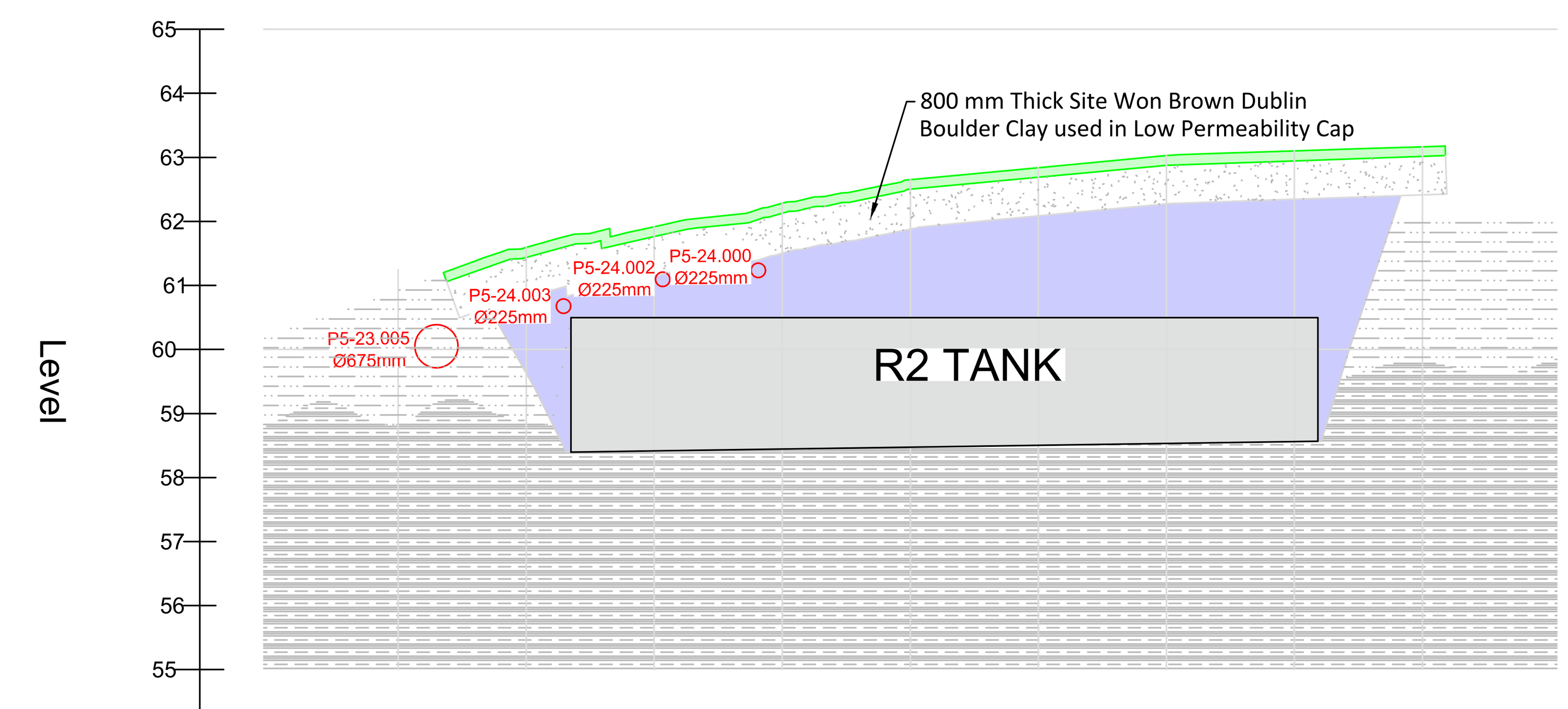


Chainage	Proposed Ground Levels	Existing Ground Levels
-00.500		
00.000		
10.000		
20.000	63.033	57.597
30.000	63.113	56.038
40.000	63.156	56.036
50.000	63.199	56.028
60.000	63.242	56.019
70.000	63.285	56.012
80.000	63.325	56.011
90.000	63.373	60.567
100.000		
100.500		

SECTION C-C

Scale 1:500

CROSS SECTION DD' TANK R2 - LONGSECTION
SCALE: H 1:500,V 1:100. DATUM: 55.000



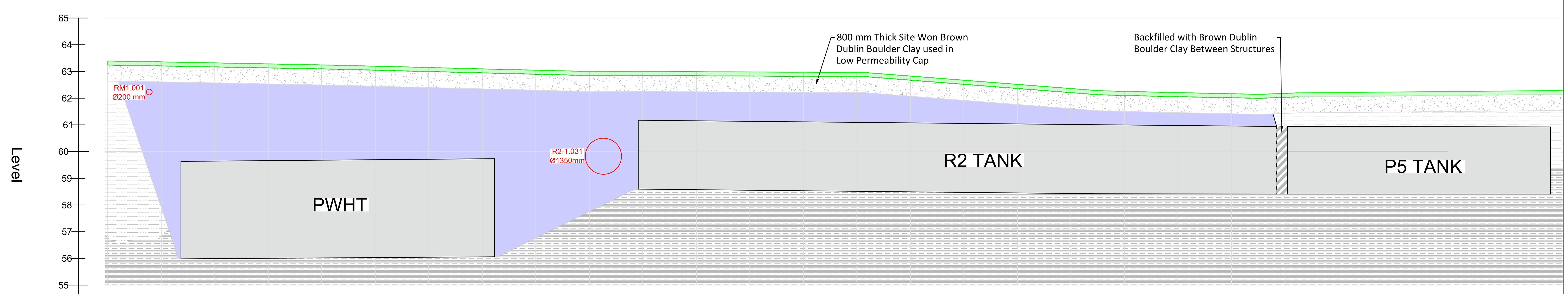
Chainage	Proposed Ground Levels	Existing Ground Levels
-00.500		
00.000		
10.000		
20.000	61.593	59.626
30.000	61.917	58.414
40.000	62.284	58.444
50.000	62.652	58.473
60.000	62.839	58.502
70.000	63.026	58.530
80.000	63.101	58.559
90.000		
100.000		
100.500		

SECTION D-D

Scale 1:500

Legend
- Topsoil
- Backfill from APEC 5
- Tank
- Insitu Low Permeability Brown Dublin Boulder Clay
- Insitu Low Permeability Black Dublin Boulder Clay
- Re-used Brown Dublin Boulder Clay in Low Permeability Clay Cap

LONG SECTION PWHT- TANK R2 - LONGSECTION
SCALE: H 1:500,V 1:100. DATUM: 55.000



Chainage	Proposed Ground Levels	Existing Ground Levels
-00.500		
00.000		
10.000	63.358	57.924
20.000	63.320	55.991
30.000	63.283	56.004
40.000	63.246	56.017
50.000	63.198	56.030
60.000	63.148	56.043
70.000	63.098	56.057
80.000	63.048	56.768
90.000	63.005	57.753
100.000	62.996	58.597
110.000	62.988	58.583
120.000	62.980	58.565
130.000	62.972	58.547
140.000	62.964	58.526
150.000	62.826	58.500
160.000	62.671	58.472
170.000	62.515	58.444
180.000	62.359	58.426
190.000	62.254	58.425
200.000	62.207	58.427
210.000	62.166	58.416
220.000	62.181	58.414
230.000		
240.000		
250.000		
260.000		
262.000		

SECTION B-B

Scale 1:500

0m 5m 10m 15m 20m 25m 30m 35m 40m 45m 50m

Scale 1:500

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PROJECT: DUBLIN AIRPORT NORTH RUNWAY REMEDIATION

CLIENT: ROADBRIDGE

SHEET: PWHT AND R2 TYPICAL SECTIONS

Date	Project number	Scale (@ A1-)
19.06.20	P2214	1:500

Drawn by: SOC

Checked by: CJC

Drawing Number: P2214-0600-0004

Rev: B

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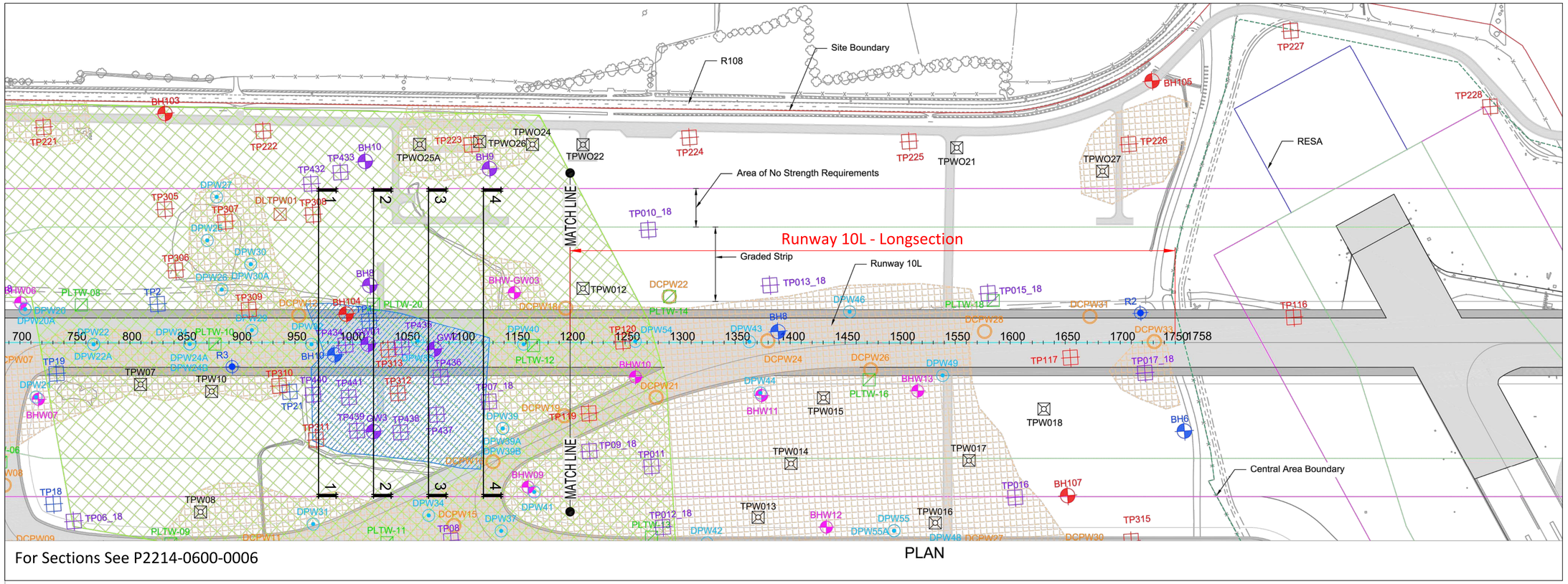
06 July 2020



For Sections See P2214-0600-0006

PLAN

Legend: Plan

1999 GI
- BH* Bore Hole (BH)
- TP* Trial Pit (TP)
- R* Rotary Core (RC)

2019 GI
- BH** Bore Hole (BH)

2016 GI
- BH* Bore Hole (BH)
- TP* Trial Pit (TP)
- R* Rotary Core (RC)
- DCP** Dynamic Cone Penetration (DCP)
- DP** Dynamic Probe (DPSH)
- PLT** Plate Load Test (PLT)

2018 GI
- BH* Bore Hole (BH)
- TP* Trial Pit (TP)
- R* Rotary Core (RC)
- TP** Trial Pit (TP)
- DLTP** Double Lift Trial Pit (DLTP)

Surface Geophysics survey

Potential Soft Spots

APEC 5

Section

Proposed Ground

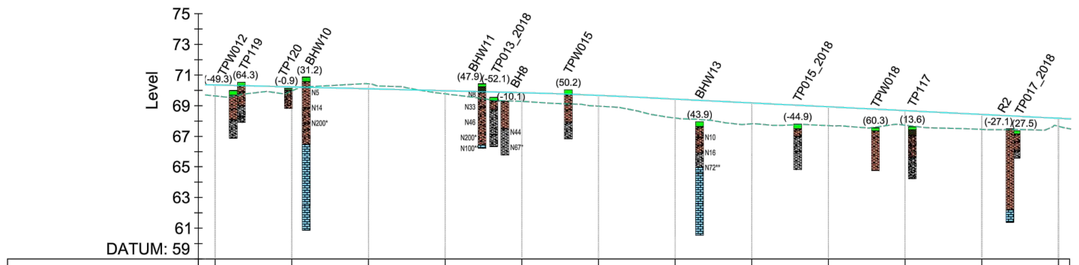
Existing Ground

- Made Ground
- Topsoil
- Peat
- Glacial Gravel
- Brown Boulder Clay
- Black Boulder Clay
- Weathered Rock
- Carboniferous Limestone and Shale

(-xx.x) Left Offset from Center

(xx.x) Right Offset from Center

Note:
1. This drawing made reference to source drawing EDAD098015-CP2-RF-GGI-OTHW-DR-C-0609, Rev C01 dated 10/01/19 prepared by Sener Arup presented in North Runway Construction Package 2 Ground Investigation Report for the West Area Phase 2



Proposed Ground Levels	70.353	70.228	70.103	69.978	69.852	69.676	69.432	69.182	68.932	68.682	68.432	68.182
Existing Ground Levels	69.638	69.966	70.429	69.777	69.282	68.972	68.197	67.824	67.703	67.729	67.459	67.660
Section Chainage	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750

RUNWAY-10L - LONGSECTION

0m 20m 40m 60m 80m 100m 120m 140m 160m 180m 200m

Scale 1:2000

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Rev.	Description	App By	Date
A	ISSUE FOR INFORMATION	BG	22.06.20

PROJECT: **DUBLIN AIRPORT NORTH RUNWAY REMEDIATION**

CLIENT: **ROADBRIDGE**

SHEET: **APEC 5 EXCAVATION AREA BOREHOLE & TRIAL PITS**

Date: 22.06.20

Drawn by: SOC

Checked by: CJC

Project number: P2214

Scale (@ A1-): 1:2000

Drawing Number: **P2214-0600-0005**

Rev: **A**

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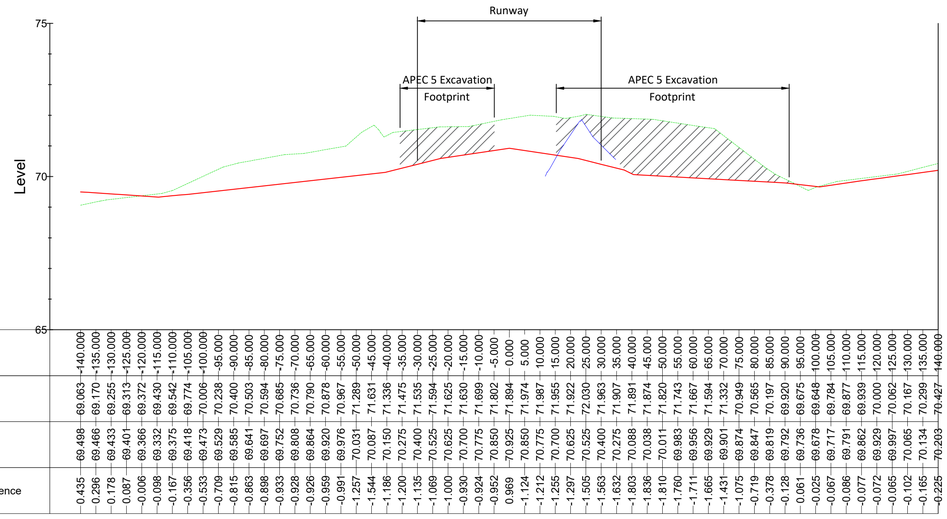
11 November 2020



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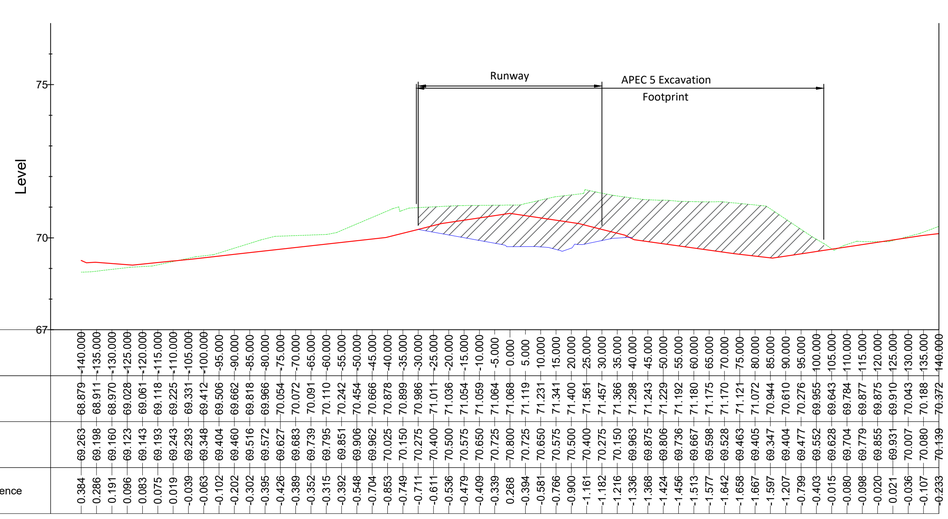
Existing Levels	69.063	69.170	69.255	69.313	69.372	69.430	69.542	69.774	70.006	70.238	70.400	70.503	70.594	70.685	70.736	70.790	70.878	70.967	71.031	71.289	71.631	71.336	71.475	71.535	71.594	71.625	71.630	71.699	71.802	71.894	71.974	71.987	71.955	71.922	72.030	71.963	71.907	71.891	71.874	71.820	71.743	71.667	71.594	71.332	70.949	70.565	70.197	69.920	69.675	69.648	69.784	69.877	69.939	70.062	70.167	70.299	70.427
Proposed Levels	69.498	69.466	69.433	69.401	69.366	69.332	69.375	69.418	69.473	69.529	69.585	69.641	69.697	69.752	69.808	69.864	69.920	69.976	70.031	70.087	70.150	70.275	70.400	70.525	70.700	70.775	70.850	70.925	70.969	71.124	71.212	71.255	71.297	71.505	71.563	71.632	71.803	71.836	71.810	71.760	71.711	71.665	71.563	71.431	71.075	70.719	70.378	70.128	70.061	70.025	70.067	70.086	70.077	70.072	70.065	70.102	70.165	70.225
Level Difference	0.435	0.296	0.178	0.087	-0.006	-0.098	-0.167	-0.356	-0.533	-0.709	-0.815	-0.863	-0.898	-0.933	-0.928	-0.926	-0.959	-0.991	-1.257	-1.544	-1.186	-1.200	-1.135	-1.069	-1.000	-0.930	-0.924	-0.952	-0.969	-1.212	-1.255	-1.297	-1.505	-1.563	-1.632	-1.803	-1.836	-1.810	-1.760	-1.711	-1.665	-1.563	-1.431	-1.075	-0.719	-0.378	-0.128	-0.061	-0.025	-0.067	-0.086	-0.077	-0.072	-0.065	-0.102	-0.165	-0.225

Section 1-1



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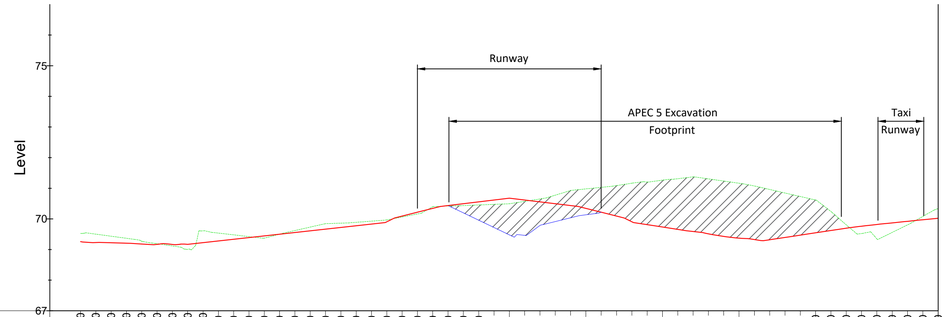
Existing Levels	68.879	68.911	68.970	69.028	69.061	69.118	69.225	69.331	69.412	69.506	69.662	69.818	69.966	70.072	70.091	70.110	70.242	70.454	70.666	70.878	70.899	70.986	71.011	71.036	71.054	71.059	71.064	71.068	71.119	71.231	71.341	71.400	71.561	71.457	71.366	71.298	71.243	71.229	71.192	71.180	71.175	71.170	71.121	71.072	70.944	70.610	70.276	69.955	69.643	69.784	69.877	70.044	70.188	70.372	70.372
Proposed Levels	69.263	69.198	69.160	69.123	69.143	69.193	69.243	69.293	69.348	69.404	69.460	69.516	69.572	69.627	69.683	69.739	69.795	69.851	69.906	70.025	70.150	70.275	70.400	70.500	70.575	70.650	70.725	70.800	70.725	70.650	70.575	70.500	70.400	70.275	70.150	69.963	69.875	69.736	69.598	69.528	69.463	69.405	69.347	69.404	69.477	69.552	69.628	69.704	69.779	69.855	69.931	70.007	70.080	70.139	70.139
Level Difference	0.384	0.286	0.191	0.096	0.083	0.075	0.019	-0.039	-0.063	-0.102	-0.202	-0.302	-0.395	-0.426	-0.389	-0.352	-0.315	-0.392	-0.548	-0.853	-0.749	-0.711	-0.611	-0.536	-0.479	-0.409	-0.339	-0.268	-0.394	-0.581	-0.766	-0.900	-1.161	-1.182	-1.216	-1.336	-1.368	-1.424	-1.456	-1.513	-1.577	-1.642	-1.658	-1.667	-1.597	-1.207	-0.799	-0.403	-0.015	-0.080	-0.098	-0.020	-0.059	-0.021	-0.036	-0.107	-0.233

Section 2-2



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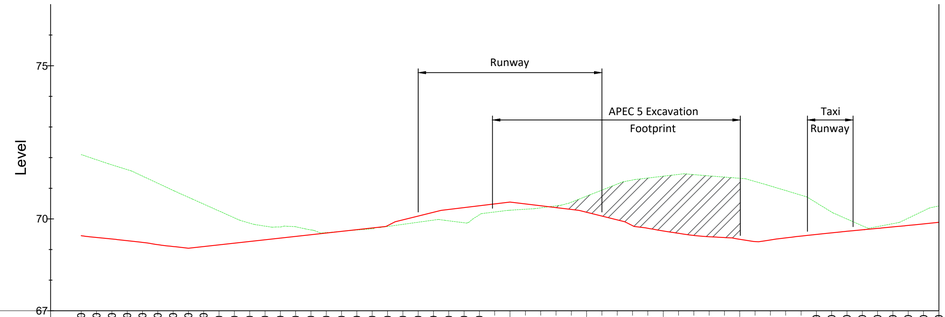
Existing Levels	69.526	69.502	69.435	69.367	69.267	69.191	69.117	69.006	69.610	69.537	69.480	69.422	69.371	69.503	69.620	69.733	69.844	69.861	69.888	69.927	69.965	70.064	70.162	70.399	70.420	70.434	70.454	70.474	70.494	70.573	70.651	70.774	70.927	70.979	71.029	71.088	71.165	71.201	71.264	71.311	71.372	71.306	71.235	71.074	70.960	70.845	70.731	70.616	70.241	69.806	69.345	69.804	69.080	69.972	70.338	70.338
Proposed Levels	69.256	69.229	69.222	69.206	69.180	69.168	69.166	69.168	69.223	69.278	69.333	69.388	69.444	69.499	69.554	69.609	69.665	69.720	69.775	69.830	69.905	70.093	70.218	70.343	70.435	70.495	70.555	70.615	70.675	70.615	70.555	70.495	70.435	70.342	70.217	70.092	69.905	69.811	69.734	69.657	69.588	69.512	69.429	69.371	69.324	69.318	69.394	69.470	69.546	69.622	69.698	69.760	69.819	69.870	69.921	69.972	70.022	70.022
Level Difference	-0.270	-0.273	-0.213	-0.161	-0.087	-0.023	0.049	0.161	-0.387	-0.259	-0.146	-0.034	0.073	0.004	-0.066	-0.124	-0.180	-0.141	-0.113	-0.096	-0.060	0.029	0.056	-0.056	0.015	0.061	0.101	0.141	-0.181	0.042	-0.096	-0.279	-0.492	-0.637	-0.812	-0.995	-1.260	-1.390	-1.530	-1.655	-1.783	-1.794	-1.806	-1.793	-1.750	-1.642	-1.451	-1.260	-1.070	-0.620	-0.108	0.238	0.474	0.311	0.117	-0.108	-0.316	-0.316

Section 3-3



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Existing Levels	72.100	71.930	71.764	71.609	71.396	71.163	70.929	70.705	70.482	70.258	70.035	69.862	69.764	69.735	69.743	69.641	69.553	69.595	69.636	69.678	69.753	69.822	69.891	69.960	69.936	69.874	70.133	70.226	70.284	70.315	70.425	70.545	70.742	70.940	71.137	71.269	71.334	71.393	71.453	71.445	71.404	71.364	71.325	71.221	71.076	70.925	70.775	70.527	70.221	69.996	69.776	69.749	69.844	70.023	70.263	70.420	70.420
Proposed Levels	69.452	69.394	69.343	69.289	69.232	69.157	69.099	69.043	69.098	69.153	69.208	69.263	69.319	69.374	69.429	69.484	69.540	69.595	69.650	69.705	69.780	69.968	70.093	70.218	70.310	70.370	70.430	70.490	70.550	70.490	70.430	70.370	70.310	70.092	69.967	69.780	69.693	69.607	69.529	69.460	69.419	69.391	69.333	69.260	69.312	69.380	69.494	69.595	69.690	69.738	69.788	69.837	69.888	69.888	69.888
Level Difference	-2.648	-2.536	-2.421	-2.320	-2.164	-2.005	-1.830	-1.663	-1.384	-1.105	-0.826	-0.598	-0.445	-0.361	-0.314	-0.156	-0.014	0.000	0.014	0.028	0.028	-0.146	0.201	0.257	0.374	0.496	0.297	0.264	-0.266	0.175	0.070	-0.055	-0.235	-0.525	-0.847	-1.170	-1.489	-1.786	-1.924	-1.986	-1.985	-1.973	-1.992	-1.961	-1.763	-1.545	-1.335	-1.034	-0.676	-0.400	-0.133	-0.059	-0.107	-0.236	-0.426	-0.532	-0.532

Section 4-4

Legend
- EGL
- Proposed Level
- Rock Level
- Excavated Area

0m 10m 20m 30m 40m 50m 60m 70m 80m 90m 100m

Scale 1:1000

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Rev.	Description	App By	Date
A	ISSUE FOR INFORMATION	BG	22.06.20

PROJECT
DUBLIN AIRPORT NORTH RUNWAY REMEDIATION

CLIENT
ROADBRIDGE

SHEET
APEC 5 CROSS SECTIONS

Date 22.06.20
Project number P2214
Scale (@ A1-) 1:1000
Drawn by SOC
Checked by CJC
Drawing Number **P2214-0600-0006**
Rev **A**

O:\ACAD\2020\P2214\P2214-0600-0006

24 June 2020

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30 YEARS

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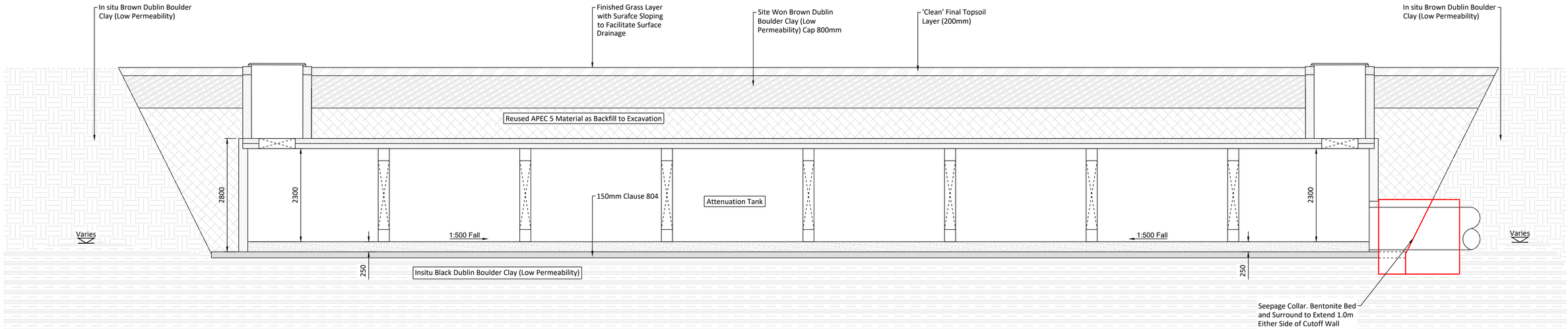
ENVIRONMENTAL SCIENCE & PLANNING

APPENDIX 3

Typical Section Through Attenuation Tank Details



Refer to Appendix 2 Drawings P2214-0600-0003 and 0004 for Excavation and Backfill Plan and Typical Sections

0m 0.5m 1.0m 1.5m 2.0m 2.5m 3.0m 3.5m 4.0m 4.5m 5.0m

Scale 1:50

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Rev.	Description	App By	Date
A	ISSUE FOR APPROVAL	BDH	04.03.20
B	ISSUE FOR CLIENT	CJC	30.03.20
C	ISSUE FOR INFORMATION	BG	24.06.20
D	ISSUE FOR INFORMATION	BG	06.07.20

PROJECT: DUBLIN AIRPORT NORTH RUNWAY REMEDIATION

CLIENT: ROADBRIDGE

SHEET: TYPICAL SECTION THROUGH ATTENUATION TANK DETAILS

Date: 04.03.20

Project number: P2214

Scale (@ A1-): 1:50

Drawn by: SOC

Checked by: JD

Drawing Number: P2214-0400-0003

Rev: D

O:\ACAD\2020\P2214\P2214-0400-0003

06 July 2020

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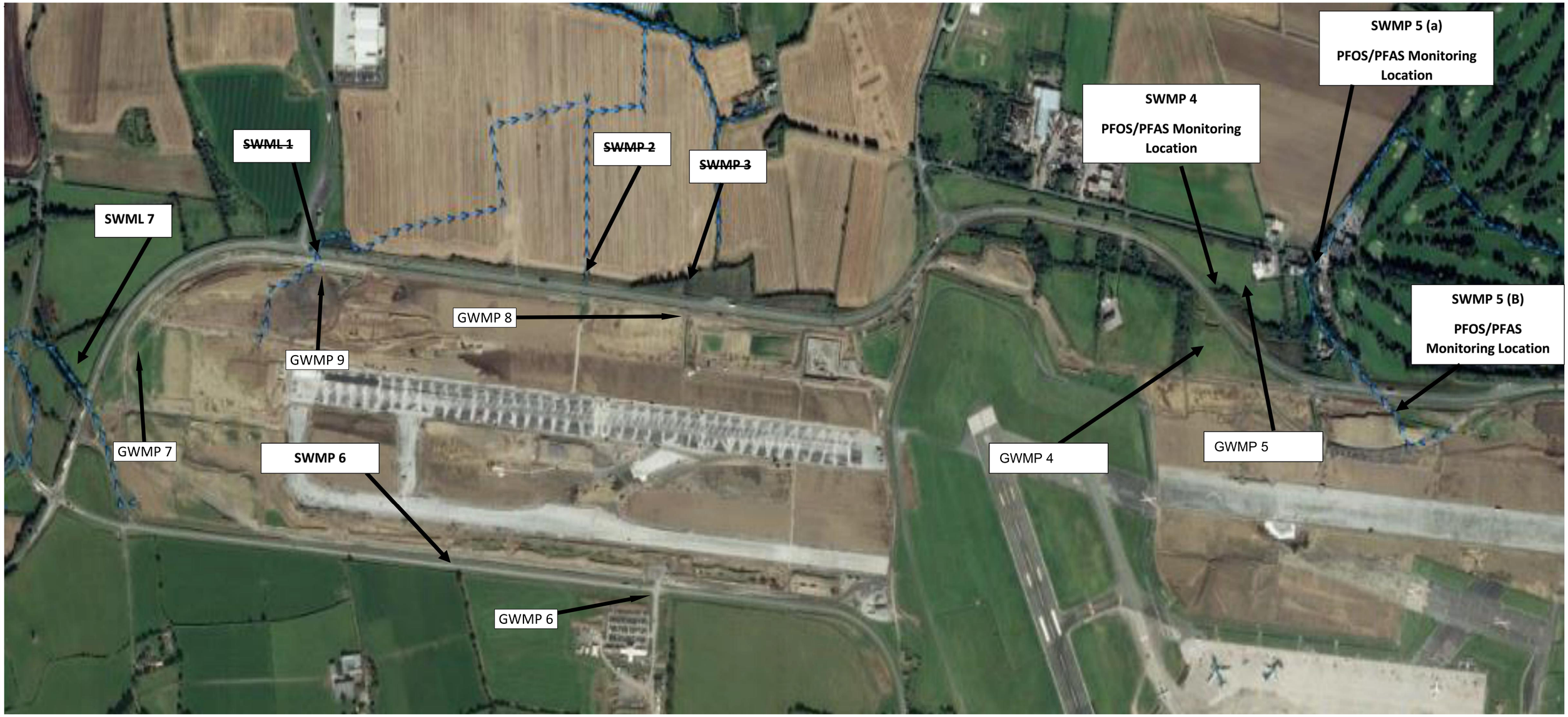
APPENDIX 4

Surface Water and Groundwater Monitoring Locations Drawing



Notes:

1. Drawing P2214-0700-0002 references to SWMP 1, 2, 3, 4, 5, 6 and 7 were used as monitoring locations in the original surface water monitoring programme.

2. SWMP 1, 2 and 3 no longer have storm flows owing to construction of the proposed development and there will be no future monitoring from these locations.

3. SWML 5 will, going forward, be split to form two subsamples:
   - SWML 5 (a) will allow representative samples from the Forest Road catchment
   - SWML 5 (b) will allow representative samples to be collected from the site/airport catchment (5b)

4. Groundwater monitoring borehole locations will be:
   - GWMP 4 - outside of the works boundary, beside existing Stilling Pond 3 (SP3).

5. GWMP 6 - south of and removed from the runway at the entrance to the West Construction Compound (within DAA lands).
   - GWMP 7 - west of and removed from localised Antenna 28R adjacent to an access track (within DAA lands).
   - GWMP 8 - north of and removed from the runway west of Attenuation Tank P8 accessible via access track leading into anemometer station (within DAA lands).
   - GWMP 9 north west of the works boundary adjacent to Attenuation Tank P7 and upgradient of Keelings Farm.

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Rev.	Description	App By	Date
A	ISSUE FOR INFORMATION	BG	23.06.20
B	ISSUE FOR INFORMATION	CJC	30.11.20

PROJECT
DUBLIN AIRPORT NORTH RUNWAY REMEDIATION

CLIENT
ROADBRIDGE

SHEET
SURFACE WATER & GROUNDWATER MONITORING LOCATIONS

Date 23.06.20	Project number P2214	Scale (@ A1-) NTS	
Drawn by SOC	Drawing Number P2214-0700-0002		Rev B
Checked by CJC			

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02 December 2020

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