Review of Environmental Factors

The Cooks to Cove GreenWay (In-Corridor Works)

Appendix B: Geotechnical Investigation (GHD, 2020)

June 2021

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Inner West Council

The GreenWay Geotechnical and Contamination Services
Geotechnical Report

March 2020

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Glossary

Term	Definition
IWC	Inner West Council
IWLR	Inner West Light Rail
ST	Sydney Trains
mm	Millimetres
m	Metres
km	Kilometres
A1	Area 1: The Bay Run and Richard Murden Reserve
A2	Area 2: Lewisham West IWLR corridor
A2D	Area 2 (Discretionary): Gadigal Reserve, Summer Hill and IWLR corridor, Summer Hill.
A3	Area 3: South of Davis Street to North Of Hercules Street, Dulwich Hill. Includes Johnson Park, IWC Bushcare sites, IWLR corridor, surrounding streets and private property.
A4	Area 4: South of Hercules Street, Dulwich Hill. Includes IWC Bushcare sites, IWLR and ST corridors and surrounding streets
BH	Borehole
LD	Large diameter
HA	Hand Auger
TP	Testpit
DCP	Dynamic Cone Penetrometer
SPT	Standard Penetration Test
mbgl	Metres below ground level
MGA56	Map Grid of Australia – Zone 56
AHD	Australian Height Datum
FMC	Field Moisture Content
LL	Liquid Limit
PL	Plastic Limit
PI	Plasticity Index
PSD	Particle Size Distribution
MDD	Maximum Dry Density
CBR	California Bearing Ratio
OMC	Optimum Moisture Content
CU	Consolidated Undrained
PLT	Point Load Testing
UCS	Unconfined Compressive Strength
pH	Potential Hydrogen
Cl^-	Chloride ions
$SO^{2-}{}_4$	Sulfate ions
EC	Electrical Conductivity
MPa	Megapascals
kPa	Kilopascals
mg/kg	Milligrams per kilogram
Is50	Point Load Strength Index at equivalent 50mm diameter of core.
AS	Australian Standard
NATA	National Accreditation and Testing Authority
DGB	Dense Graded Base

1. Introduction

1.1 The GreenWay – Project Description

The vision of the GreenWay is to create a near 6 km environmental and active travel corridor, providing a vital link for the residents to travel safely between the Cooks River and Iron Cove. After 10 years of campaigning by the community and the Council, this project has now secured state government funding for the southern section, and achieved recognition as Sydney's number one priority Green Grid project.

Figure 1-1 presents the entire alignment of this urban green corridor, traversing through Sydney's Inner West, through several different areas of land use. Some of these areas include:

- Established pedestrian and cycle ways like the heavily utilised and renowned Bay Run in Haberfield;
- IWC parks and reserves including Richard Murden Reserve in Haberfield, Gadigal Reserve in Summer Hill and Johnson Park in Dulwich Hill;
- Within transport infrastructure corridors such as the Inner West Light Rail extending from Summer Hill to Dulwich Hill and the Sydney Trains rail corridor in Dulwich Hill;
- Urbanised pedestrian areas including Weston Street, Hercules Street, Terrace Road, and Ness Avenue in Dulwich Hill.

The GreenWay aims to:

- Provide a shared, off-road cycling and pedestrian path linking the Bay Run at Iron Cove in Haberfield to the Cycleway at the Cooks River in Earlywood;
- Create an urban green corridor that provides safe passage through council Bushcare sites and nature reserves between the north and south of the Inner West Corridor;
- Promote a community partnership between IWC and the local community, encompassing the local arts, culture, Bushcare groups, sustainability education, festivals and events ensuring the continued relationship between local government and the community is not only maintained but also developed.
- Ensure environmental sustainability by providing a safe habitat for local flora and fauna, whilst creating quiet local streets where walking and cycling is encouraged, and linking council parks and reserves in the wider catchment area.

Figure 1-1 The GreenWay alignment (*source: The GreenWay website)*

1.2 Purpose of this report

This Geotechnical Report has been prepared by GHD to aid the detailed design and construction of the GreenWay project. The report has also been prepared to assist tender designs, detailed designs and constructability assessments.

The report has been produced following a targeted field and laboratory-testing program extending from October 2019 to January 2020. An assessment of the contamination field and laboratory-testing program is presented in a separate complimentary report titled "12515105-REP-0_The GreenWay Contamination Report_Final_GHD".

This report presents the geotechnical factual data collected for the project and data from nearby sources, released for use by Inner West Council (IWC). The report provides a review of the geotechnical results, preliminary design parameters and discussion on the likely construction of the infrastructure.

In summary, the geotechnical report includes:

- The results of the field investigations including borehole, hand auger and test pit engineering logs, laboratory test results, and other relevant data.
- A review of published information on Sydney geology relevant to the GreenWay area
- Geotechnical models in the form of interpretive sections (based on the design alignment supplied by IWC to GHD on 7 January 2020, file reference *'646ld_100% 3D path alignment only rev01 dwg'*).
- Discussion on the range of materials to be encountered along the GreenWay alignment.
- Recommended geotechnical design parameters.
- Discussion on the geotechnical design of specific GreenWay elements, including footpath pavement, retaining structures, and structure footings.

1.3 Limitations

This report: has been prepared by GHD for Inner West Council and may only be relied on by Inner West Council for the purpose as set out and in accordance with the agreement between GHD and the Inner West Council.

GHD otherwise disclaims responsibility to any person other than Inner West Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible. The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Inner West Council and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Available Information

2.1 Overview

The following information has been used to prepare this report for the GreenWay project:

- Existing published information including geological maps, technical papers and planning documents.
- Project site investigations which have included:
  - Boreholes, hand augers and test pits;
  - Insitu and laboratory testing.

2.2 Previous geotechnical studies & utilisation of existing geotechnical information

Relevant previous geotechnical and contamination investigations from the project area were sourced from IWC records and from GHD archives, released by IWC for use on this project. The reports or data for 36 previous geotechnical and contamination studies along the GreenWay alignment have been sourced for interpretation. The full list of referenced reports are contained in Table 2-1 below.

Some 44 previous engineering logs from these projects were incorporated into the overall geotechnical scope assessment. Historic investigation logs are contained in Appendix D for further reference.

Table 2-1 Previous reports

Ref No.	Authoring Company	Year	Title	Commissioned by
R01	Aurecon	2012	Aurecon 2012 Light Rail GI	John Holland Group
R02	Cardno	2018	Cardno 2018 Greenway Central Links DSI	Inner West Council
R03	Cardno	2018	Cardno 2018 Greenway Central Links PSI	Inner West Council
R04	Cardno	2018	Cardno 2018 Greenway Central Links RAP	Inner West Council
R05	Coffey	2011	Coffey 2011 Light Rail SI Phase 2	Transport for NSW
R06	Consara	2016	Consara 2016 Asbestos Reports	Transport for NSW
R07	EIS	2018	EIS 2018 Haberfield Richard SI	Inner West Council
R08	GHD	2011	GHD 2011 SLR IWE Geotech Desk Study	Pyrmont Light Rail Company
R09	GHD	2012	GHD 2012 SLR IWE and GW-Add GFR	Pyrmont Light Rail Company
R10	JK Geotechnics	2017	JK 2017 GW Central Links Geotech Leichhardt	Inner West Council
R11	JK Geotechnics	2018	JK 2018 Richard Murden Geotech Haberfield	Inner West Council
R12	Roads and Maritime Services	2010	RMS 2010 Richard Murden GFR	RMS (Internal)
R13	GHD	2011	SLR IWE and GW-App I-GFR	Pyrmont Light Rail Company
R14	AGJV (Aurecon GHD JV)	2019	SSC-Sydney Metro Southwest Corridor GI	John Holland Laing O'Rourke JV
R15	Pells Sullivan Meynink	2010	Rozelle Goods Line GI	Rail Corporation NSW
R16	Pells Sullivan Meynink	2010	Rozelle Goods Line Contam	Rail Corporation NSW
R17	Douglas Partners	2010	GDR Sydney Metro Stage 2	Sydney Metro
R18	Consulting Earth Scientists	2009	SW GIR 1-9 Weston St, Dulwich Hill	Sydney Water

Ref No.	Authoring Company	Year	Title	Commissioned by
R19	Coffey	2014	WestConnex Stage 1B M4 East SI	Roads and Maritime Services
R20	Golder Associates & Douglas Partner	2016	Sydney Metro City and Southwest GI	Transport for NSW
R21	GHD	2017	Sydney Metro Contam SP2	Transport for NSW
R22	Confidential	2011	186 Hawthorne Pde, Haberfield GI	Confidential
R23	Confidential	2012	UTS Rowing Shed, Haberfield GI	Confidential
R24	Confidential	2013	120c Old Canterbury Rd, Summer Hill GI	Confidential
R25	Confidential	2015	62 Constitution Rd, Dulwich Hill GI	Confidential
R26	JK Geotechnics	2010	Laxton Reserve, Dulwich Hill GI	Marrickville Council
R27	Confidential	2018	2 McGill St, Lewisham Contam SI	Confidential
R28	Confidential	2011	2-23 Smith St, Summer Hill SI	Confidential
R29	Confidential	2015	62 Constitution Rd, Dulwich Hill PGA	Confidential
R30	Confidential	2012	78-90 Old Canterbury Rd, Lewisham PGA	Confidential
R31	Confidential	2012	91-93 Hercules St, Dulwich Hill GI	Confidential
R32	Geotechnique	2012	Jack Shanahan Park, Dulwich Hill GI	Marrickville Council
R33	GeoEnviro Consultancy	2013	Arlington Reserve Synthetic Turf SI	Marrickville Council
R34	Coffey	2009	Arlington Reserve Dulwich Hill GI	Marrickville Council
R35	Confidential	2015	14 McGill St Lewisham, Prelim GI	Confidential
R36	Confidential	2016	4-12 McGill St Lewisham, Prelim GI	Confidential

2.3 Scope of current geotechnical and contamination investigation

The GreenWay geotechnical and contamination study commenced on 16 August 2019 with scope development, management plan development and approval, and landowner liaison.

Onsite geotechnical and contamination investigation activities were carried out over several weeks commencing 4 October 2019.

The geotechnical services for this project including:

- **Existing Information Review** – Previous geotechnical and contamination reports relating to earlier GreenWay investigation works together with previous rail infrastructure projects and isolated building and road upgrade projects have been reviewed as part of the present study.
- **Cored borehole drilling** – 19 vertical cored boreholes were completed along the alignment. The boreholes were drilled to depths of up to 14.65 m deep using NMLC drilling methods. Two of the cored boreholes were drilled using large diameter auger techniques for bulk sampling and extended into rock using NMLC coring techniques.
  - A summary list of the cored boreholes is provided in Section 4.3 of this report.
- **Augered borehole drilling** – 41 vertical augered boreholes were completed along the alignment. The boreholes were drilled to depths of up to 13.00 m deep using large 300 mm and 100 mm sized augers. Seventeen of the augered boreholes were drilled using large diameter auger techniques for bulk sampling purposes.
  - A summary list of all boreholes is provided in Section 4.3 of this report.
- **Test pits** – 5 test pits were excavated to depths of up to 3m in tight access or steeply sloping areas. The test pits provided bulk soil samples for material testing, using excavator and hand excavation to complete.
  - A summary list of all testpits is provided in Section 0 of this report.
- **Hand augers** – 18 hand augers were completed during the field investigations. These varied in purpose between geotechnical and contamination purposes and were used in council Bushcare areas and where access for mechanical plant was not possible.
  - A summary list of all testpits is provided in Section 4.5 of this report.
- **Soil Contamination Sampling** – Based on a review of historic and current land uses along the GreenWay alignment, soil samples were taken from investigation locations in areas of environmental concern. The soil samples were subjected to photoionisation detection (PID) screening in the field followed by a suite of chemical laboratory tests.
- **Geotechnical Laboratory Testing** – Geotechnical laboratory testing was performed on soil and rock samples. The testing included soil index testing, soil mechanics testing, rock mechanics testing and soil contamination testing.
  - Section 4.7 of this report provides a summary of the soil and rock geotechnical laboratory testing.

3. Site setting

3.1 General

The project alignment has been subdivided by IWC into the following four Areas:

- **Area 1**: The Bay Run and Richard Murden Reserve.
- **Area 2 (including Area 2D)**: Gadigal Reserve and Lewisham West.
- **Area 3**: South of Davis Street to North Of Hercules Street, Dulwich Hill. Includes Johnson Park, IWC Bushcare sites, IWLR corridor, surrounding streets and private property.
- **Area 4**: South of Hercules Street, Dulwich Hill. Includes IWC Bushcare sites, Inner West Light Rail (IWLR) and Sydney Trains (ST) corridors and surrounding streets

3.2 Site geology

Area 1

The Sydney 1:100,000-scale geological sheet indicates Area 1 is predominantly underlain by manmade fill, described as dredged estuarine sand and mud, demolition rubble, industrial and household waste. The fill is shown to overly Quaternary Alluvium, described as silty to peaty quartz sand, silt and clay with ferruginous & humic cementation in places and common shell layers.

These near surface conditions are considered to relate to the reclamation of the former Long Cove Creek and construction of the Hawthorne Canal.

The surrounding underlying bedrock is shown to consist of Hawkesbury Sandstone of Triassic age, described as medium to coarse-grained quartz sandstone, with minor shale and laminate lenses. Beyond this, to the east and west of the site, the younger Ashfield Shale, of the Wianamatta Group, is shown, described as black to dark grey shale and laminate.

Area 2

The geology sheet indicates the very northern half of Area 2 is underlain by the same sequence as Area 1, of fill and alluvial deposits.

South of Old Canterbury Road the sheet indicates the route is underlain by Ashfield Shale bedrock.

Seven igneous dykes are shown to the south and east of the alignment. The dykes on the geology sheet are describes as Basalt. It may be interpolated that one of the dykes may intersect the GreenWay alignment within Area 2.

Area 3

The geological sheet indicates the full alignment to be underlain by Triassic age Ashfield Shale bedrock.

Seven dykes are shown in the vicinity of Area, with four potentially intersecting the alignment.

The east-west trending Fairfield Basin syncline feature is shown passing below the site, in the vicinity of Constitution Road.

Area 4

The geological sheet indicates the alignment to be underlain by Triassic age Ashfield Shale bedrock, to the northernmost section of Jack Shanahan Reserve. The reserve, and the southernmost section of the Greenway Alignment, is shown to be underlain by Hawkesbury Sandstone.

3.3 Topography

The topography and drainage of the site is outlined in Table 3-1.

Table 3-1 Topography and drainage

Area	Description
1	The topography of Area 1 is generally flat, with an elevation of around 3.0 m Australian Height Datum (m AHD) across the site. To the east and west of the area, the surrounding areas slope moderately (10°) down towards the site and the Hawthorne Canal from an elevation of approximately 10 m AHD at 100 m distance. Surface runoff is expected to flow from east and west towards the canal, following topography and then northwards along the canal into Iron Cove.
2	The topography of Area 2 is varied, with elevations ranging from 22 m AHD at the southern end to 4 m AHD in the centre of the area near the railway line. To the east and west of Area 2, the surrounding areas slope moderately (10°) down towards the site from an elevation of approximately 20-30 m AHD at 300 m distance.
3	The topography of Area 3 is fairly level, with elevations ranging from 22 to 26 m AHD across the area. To the east and west of the area, the surrounding areas slope very gently down towards the area from an elevation of approximately 28 m AHD at 150 m distance.
4	The topography of the Area 4 dips gently to the south, with elevations ranging from 26 m AHD at the northern end of the area to 14 m AHD at the southern end. To the east and west of the area, the surrounding areas slope gently down towards the area and the Cooks River to the south of the area at a slope angle of approximately 5°.

3.4 Surface water

At the northern end of the alignment, the major surface water body is Iron Cove, which is part of the Parramatta River. Flowing northwards into Iron Cove is the Hawthorne Canal, which flows through Areas 1 and 2.

At the southern end of the project area (Area 4), the closest major surface water body is the Cooks River which is located approximately 250 metres south of Area 4, and which flows south-east into Botany Bay.

The ground surface in Area 1 is mainly comprised of a large unsealed, grassed parkland area (Richard Murden Reserve), with asphalted cycleway / walkway paths and hardstand surfaced playing courts. The ground surface is generally level through this area, with surface runoff expected to infiltrate the ground surface, or flow towards the Hawthorne Canal.

The ground surface at Area 2 (between Parramatta Road and Longport Street) is comprised of unsealed, steep embankments either side of the Hawthorne Canal, adjacent to the sealed GreenWay path. Surface runoff here is expected to infiltrate the ground surface, or be channelled into the Hawthorne Canal. South of Longport Street, Area 2 runs alongside the light rail line and associated infrastructure. Surface water runoff is expected to infiltrate the unsealed ground surface (ballast, grass), and discharges through track drainage.

In Area 3, excess surface water is expected to follow the topography and flow generally down the steep embankments, towards the light rail line, where it expected to infiltrate the unsealed surface (ballast, grass). The overall topography slopes very gently to the south towards Area 4, where surface water is expected to follow similar flow pathways as for Area 3.

Excess surface water from surrounding roads and adjacent properties at all areas is expected to enter the local stormwater drainage system.

4. Scope of geotechnical services and methodology

4.1 Planning & approval of works

Prior to the commencement of the GreenWay geotechnical and contamination investigations, GHD produced project specific management plans and reports for review and approval by IWC. These plans are listed below:

- Site Management Plan (12515105-PMD-0_Site Management Plan, dated 30 September 2019) which acted as a live document outlining the following items:
  - Scope and program of the geotechnical and contamination investigations, including potentially affected key stakeholders;
  - Aspects such as field investigation methodology, plant proposed onsite and proposed sampling and testing;
  - Traffic management plan;
  - Sediment control plan;
  - Waste management plan;
  - Contamination sampling brief.
- Work, Health and Safety Management Plan (12515105-PMD-0_HSE006 WHS Management Plan, dated 01 October 2019) which outlined how the various health, safety and welfare risks associated with the geotechnical and contamination investigation were to be managed.

Prior to field activities commencing, GHD obtained permission from affected public landowners (Transdev, Roads and Maritime Services NSW, IWC etc., where applicable) to access sites. Copies of specific management plans were made available to the relevant authorities, and landowners were updated on the programme of fieldwork.

Field crews were provided with copies of the plans and were instructed on the important aspects of the plans through a project specific induction presented by the GHD Project Manager.

Utility service providers were contacted through the Dial-Before-You-Dig service, or directly, to obtain plans of buried services for each of the investigation locations. GHD appointed a specialist services locator to scan each investigation location for underground services.

4.2 Scope of work summary

The GreenWay geotechnical and contamination study, commenced on 16 August 2019. The early study was focused on desktop review, scope development, management plan development and approval and landowner liaison.

Onsite geotechnical and contamination investigation activities were carried out over several weeks commencing 4 October 2019.

A programme of geotechnical and contamination laboratory testing ran concurrently with the site investigation, with all laboratory testing completed by early January 2020.

Site investigation encompassed the following activities:

- The drilling of 41 augered boreholes to depths between 0.8 m and 13.0 m;
- The drilling of 19 cored boreholes to depths between 6.0 m and 14.65 m;

- The excavation of 5 test pits to depths between 0.5 m and 3.0 m;
- Completion of 18 hand augers to depths between 0.15 m and 2.0 m
- Laboratory testing of soil and rock samples;
- Survey of test locations.

Field logging

The interpreted soil and rock strata has been recorded on field engineering logs using GHD's standard logging system, which uses a terminology based on AS1726-2017. Relevant field test results have been recorded on the engineering logs. The field logs were input into the GHD geotechnical database utilising gINT software.

On-site supervision

Engineering Geologists or Geotechnical Engineers from GHD were in full time attendance during site operations, serving as the principal contractor representative and implementing the requirements of the project management plans. A GHD Environmental Scientist was present onsite to perform field screening and sampling, where required. The GHD field staff were responsible for positioning investigations at the planned location, logging the stratum and recording the results of in situ testing. Water levels were measured during the investigation (where possible) and are presented on the engineering logs.

Environmental controls

Environmental controls during investigation were implemented jointly by GHD and the subcontracting teams. Cuttings and fluid created during drilling were recirculated and contained on site. Where necessary, geofabric absorbent booms and matting were placed around the working area to absorb any spills of drilling spoil or unforeseen oil leaks from equipment. At the completion of drilling, borehole cuttings and fluids were removed from site and disposed of at a licensed waste facility.

4.3 Boreholes

Sixty boreholes were drilled during the investigation, comprising 79.52 m of core drilling and 201.98 m of non-core drilling. Boreholes were drilled to depths of between 0.8 m and 14.65 m below ground level.

Drilling rigs from Stratacore Drilling Pty Ltd (Stratacore) and Terratest Pty Ltd (Terratest) were mobilised to the site to undertake the drilling programme. The boreholes were drilled using Stratacore's Comacchio Geo205, SD05 Ute mounted rig and hand carry rig with Terratest providing a XP60 Ute mounted rig and a X-country difficult access rig.

Soils were drilled using solid flight auger or washbore rotary drilling methods, as appropriate for the conditions above or below the groundwater table. Standard Penetration Tests (SPT) were undertaken at approximately 1.0-2.0 m intervals, and thin wall (U75) tube samples were taken where possible. Hand penetrometer strength tests were carried out on recovered clay samples from the SPT and tube samples, where appropriate.

In the cored boreholes, upon reaching the bedrock, steel casing was installed to advance the borehole using NMLC drilling techniques.

Rock core was placed in purpose built steel boxes with one metre of core per row. The GHD representative carried out logging and photographing of the core on site.

Point Load Index testing of rock core samples was undertaken at approximately 1 m spacing, with both diametral and axial tests conducted where possible. The results of the point load strength index tests are presented on the engineering logs.

Borehole engineering logs are presented in Appendix B

Table 4-1 provides a summary of the boreholes. The position of each borehole is presented in the enclosed figures in Section 11.

Table 4-1 Borehole details

Investigation ID	Easting (MGA56)	Northing (MGA56)	RL (m, AHD)	Location	Date completed	Type of investigation	Total depth (mbgl)
A1-BH01	328719.6	6250682.5	1.93	UTS Haberfield Club Carpark, Haberfield, NSW	10/10/2019	Augered Borehole	2.5
A1-BH02	328763.0	6250647.9	2.29		10/10/2019	Augered Borehole	3
A1-BH03	328835.4	6250540.9	1.38	The Bay Run, Haberfield, NSW	14/10/2019	Augered Borehole	0.25
A1-BH04	328840.7	6250534.2	1.40		11/10/2019	Augered Borehole	0.45
A1-BH05	328847.1	6250523.0	3.09		14/10/2019	Augered Borehole	5
A1-BH06	328855.3	6250530.3	1.57		16/10/2019	Cored Borehole	12
A1-BH07	328867.0	6250528.5	1.44		23/10/2019	Cored borehole	14.65
A1-LD01	328833.0	6250325.3	1.48	Richard Murden Reserve, Haberfield, NSW	8/10/2019	Large Diameter Augered Borehole	2
A1-LD02	328829.3	6250260.8	1.40		8/10/2019	Large Diameter Augered Borehole	2
A1-LD03	328757.8	6250090.0	1.30		8/10/2019	Large Diameter Augered Borehole	2
A1-LD04	328698.0	6249983.5	1.43		8/10/2019	Large Diameter Augered Borehole	2
A1-LD05	328632.5	6249919.4	1.55		8/10/2019	Large Diameter Augered Borehole	2
A1-LD06	328613.7	6249806.4	1.73		8/10/2019	Large Diameter Augered Borehole	2
A1-LD07	328582.2	6249715.1	1.75		9/10/2019	Large Diameter Augered Borehole	2
A1-LD08	328549.7	6249650.7	1.66		9/10/2019	Large Diameter Augered Borehole	2
A1-LD09	328498.3	6249539.3	1.83		9/10/2019	Large Diameter Augered Borehole	2

Investigation ID	Easting (MGA56)	Northing (MGA56)	RL (m, AHD)	Location	Date completed	Type of investigation	Total depth (mbgl)
A1-LD10	328404.6	6249367.8	1.82	Richard Murden Reserve, Haberfield, NSW	9/10/2019	Large Diameter Augered Borehole	2
A1-LD11	328400.1	6249225.9	2.20	Richard Murden Reserve, Haberfield, NSW	9/10/2019	Large Diameter Augered Borehole	2
A2-BH02	328380.2	6248168.6	9.24	IWLR Corridor, Lewisham, NSW	18/10/2019	Cored Borehole	8.6
A2-BH03	328173.7	6247796.9	17.28	Weston Street, Dulwich Hill, NSW	16/10/2019	Augered Borehole	1.5
A2-BH04	328174.7	6247742.2	15.82	Weston Street, Dulwich Hill, NSW	16/10/2019	Augered Borehole	1.05
A2D-BH04	328451.0	6248456.5	3.57	The GreenWay Footpath, Summer Hill, NSW	15/10/2019	Cored Borehole	7.09
A2D-BH05	328443.6	6248434.6	3.69	The GreenWay Footpath, Summer Hill, NSW	15/10/2019	Cored Borehole	6.97
A2D-BH06	328427.0	6248282.4	3.91	Gadigal Reserve, Summer Hill, NSW	14/10/2019	Cored Borehole	7.24
A2D-BH07	328415.1	6248285.3	4.57	The GreenWay Footpath, Summer Hill, NSW	14/10/2019	Cored Borehole	6
A2D-BH08	328425.9	6248261.6	4.78	Gadigal Reserve, Summer Hill, NSW	28/10/2019	Cored Borehole	7
A2D-BH09	328412.4	6248228.8	4.89	IWLR Corridor, Summer Hill, NSW	29/10/2019	Cored Borehole	6.88
A2D-LD01	328454.1	6248404.9	4.69	Gadigal Reserve, Summer Hill, NSW	25/10/2019	Large Diameter into Cored Borehole	7.46
A2D-LD02	328447.0	6248370.6	4.90	Gadigal Reserve, Summer Hill, NSW	25/10/2019	Large Diameter Augered Borehole	2
A2D-LD03	328433.1	6248307.7	5.08	Gadigal Reserve, Summer Hill, NSW	14/10/2019	Large Diameter Augered Borehole	2

Investigation ID	Easting (MGA56)	Northing (MGA56)	RL (m, AHD)	Location	Date completed	Type of investigation	Total depth (mbgl)
A2D-LD04	328389.1	6248199.2	14.81	Longport Street, Summer Hill, NSW	16/10/2019	Large Diameter Augered Borehole	13
A3-BH01	327838.3	6247276.8	22.67	Johnson Park, Dulwich Hill, NSW	10/10/2019	Augered Borehole	2
A3-BH02	327833.6	6247234.3	22.86	Johnson Park, Dulwich Hill, NSW	10/10/2019	Augered Borehole	2
A3-BH03	327830.2	6247201.7	23.12	Johnson Park, Dulwich Hill, NSW	10/10/2019	Augered Borehole	2
A3-BH04	327820.6	6247149.6	23.91	Johnson Park, Dulwich Hill, NSW	11/10/2019	Cored Borehole	10
A3-BH05	327831.7	6247124.1	23.87	Johnson Park, Dulwich Hill, NSW	11/10/2019	Cored Borehole	8.65
A3-BH06	327842.7	6247095.6	26.16	Constitution Road, Dulwich Hill, NSW	17/10/2019	Cored Borehole	11.79
A3-BH07	327848.9	6247080.0	23.63	IWLR Corridor, Dulwich Hill, NSW	30/10/2019	Cored Borehole	6.74
A3-BH08	327846.3	6247047.9	21.80	1-3 Williams Parade, Dulwich Hill, NSW	17/10/2019	Cored Borehole	10
A3-BH09	327867.7	6246929.2	28.86	IWLR Corridor, Dulwich Hill, NSW	23/10/2019	Cored Borehole	8.4
A3-BH10	327889.6	6246878.0	29.64	IWLR Corridor, Dulwich Hill, NSW	24/10/2019	Cored Borehole	13.32
A3-BH11	327927.2	6246811.0	28.30	Dulwich Grove Footpath, Dulwich Hill, NSW	24/10/2019	Cored Borehole	10.28
A3-LD/BH01	327981.4	6247478.6	23.91	Davis Street, Dulwich Hill, NSW	18/10/2019	Large Diameter into Cored Borehole	12.41
A3-LD01	327849.1	6247311.2	22.41	Johnson Park, Dulwich Hill, NSW	10/10/2019	Large Diameter Augered Borehole	2
A3-LD02	327838.4	6247108.9	24.05	Johnson Park, Dulwich Hill, NSW	21/10/2019	Large Diameter Augered Borehole	5.56

Investigation ID	Easting (MGA56)	Northing (MGA56)	RL (m, AHD)	Location	Date completed	Type of investigation	Total depth (mbgl)
A4-BH01	327961.9	6246716.6	25.00	Hercules Street, Dulwich Hill, NSW	21/10/2019	Augered Borehole	2.73
A4-BH02	328019.0	6246569.8	17.91	Bushcare Area, Dulwich Hill, NSW	22/10/2019	Augered Borehole	1.85
A4-BH03	328011.0	6246525.2	17.57	IWLR Corridor, Dulwich Hill, NSW	22/10/2019	Augered Borehole	4
A4-BH04	328020.3	6246484.6	19.88		22/10/2019	Augered Borehole	5.4
A4-BH05	328006.6	6246455.2	19.34		22/10/2019	Augered Borehole	3
A4-BH06	327984.3	6246424.2	18.63		23/10/2019	Augered Borehole	1
A4-BH07	327937.6	6246389.2	14.19		22/10/2019	Augered Borehole	5.3
A4-BH08	327806.1	6246218.9	12.14	Ness Avenue, Dulwich Hill, NSW	17/10/2019	Augered Borehole	0.8
A4-BH09	327984.4	6246710.3	23.05	Bushcare Area, Dulwich Hill, NSW	22/10/2019	Augered Borehole	2.6
A4-BH10	327995.1	6246698.4	22.86		22/10/2019	Augered Borehole	2.67
A4-BH11	328016.2	6246647.1	20.80		22/10/2019	Augered Borehole	1.22
A4-BH12	328025.7	6246608.0	18.98		22/10/2019	Augered Borehole	1.14
A4-HAC01	328005.3	6246672.7	21.68	Bushcare Area, Dulwich Hill, NSW	22/10/2019	Augered Borehole	3.1
A4-HAC02	328024.3	6246620.5	19.72		22/10/2019	Augered Borehole	1.6
A4-LD01	327864.1	6246315.6	13.75	Terrace Road, Dulwich Hill, NSW	21/10/2019	Large Diameter Augered Borehole	3.3

4.4 Test pits

Five test pits were excavated to depths ranging between 0.5 m and 3.0 m. Test pitting was performed in order to obtain bulk soil samples in proposed jacked-tunnel areas or as required.

Test pits were dug by either:

- 3 tonne excavator, supplied by Stratacore, equipped with a 300 mm, toothed bucked;
- Hand dug methods. Hand digging was used where access restrictions and shallow sampling was acceptable.

Dynamic Cone Penetration (DCP) testing was performed in relevant test pit locations to assess consistency/density of insitu material and bulk and disturbed samples collected for the purpose of geotechnical and contamination testing.

Upon completion of each test pit, the excavation and excavated spoil was photographed. The excavated spoil was replaced in the same sequence as it was exhumed, and compacted.

Table 4-2 provides a summary of Test Pits excavated. The position of each Test Pit is presented in the enclosed figures in Section 11

4.5 Hand augers

Eighteen hand augers were drilled to depths ranging between 0.15 m and 2.0 m. Hand augers were completed in areas such as Bushcare sites where low impact investigation activities were necessary, where tight access prevented the use of drilling rigs or for contamination purposes only.

DCP testing was completed in relevant hand auger locations to determine consistency/density of insitu material and disturbed samples collected for the purpose of geotechnical and contamination testing.

Upon completion of each hand auger, the excavation and excavated spoil was photographed. The excavated spoil was replaced and compacted.

Please note that all HAC series investigation were completed for the purpose of additional contamination sampling only and are not compliant with *AS1726 Geotechnical Site Investigations*.

Table 4-2 (below) provides a summary Hand Augers performed. The position of each Hand Auger and DCP test is presented in the enclosed figures in Section 11

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Table 4-2 Hand auger and Test pit details

Investigation ID	Easting (MGA56)	Northing (MGA56)	RL (m, AHD)	Location	Date completed	Type of investigation	Total depth (mbgl)
A1-HA01	328782.4	6250614.6	1.99	The Bay Run, Haberfield, NSW	11/10/2019	Hand Auger	0.9
A2-HA01	328401.0	6248153.5	9.18	IWLR Corridor, Lewisham, NSW	18/10/2019	Hand Auger	0.5
A2-HA02	328383.4	6248128.9	10.18		18/10/2019	Hand Auger	0.8
A2-HA03	328360.2	6248095.3	10.99		18/10/2019	Hand Auger	0.15
A2-HAC01	328358.1	6248141.7	9.25		18/10/2019	Hand Auger	0.6
A2-HAC02	328339.1	6248114.4	9.74		18/10/2019	Hand Auger	2
A2-HAC03	328317.8	6248033.3	10.21		22/10/2019	Hand Auger	1
A3-HA01	327963.9	6247462.1	18.65	Bushcare Area, Dulwich Hill, NSW	25/10/2019	Hand Auger	1.2
A3-HA02	327940.9	6247442.1	18.96		21/10/2019	Hand Auger	2
A3-HA03	327919.9	6247418.2	19.16		21/10/2019	Hand Auger	1
A3-HA04	327898.5	6247386.9	19.49		25/10/2019	Hand Auger	2
A3-HA05	327868.6	6247329.8	20.06		31/10/2019	Hand Auger	2
A3-HA06	327857.0	6247021.0	21.40	IWLR Corridor, Dulwich Hill, NSW	15/11/2019	Hand Auger	1.15
A3-HA07	327864.1	6246965.5	23.72		15/11/2019	Hand Auger	1.15
A4-HAC03	328048.8	6246572.5	21.54		22/10/2019	Hand Auger	1.5
A4-HAC04	328046.4	6246546.9	21.62		22/10/2019	Hand Auger	1.5
A4-HAC05	327911.8	6246375.4	14.69	Hercules Street, Dulwich Hill, NSW	22/10/2019	Hand Auger	1

Investigation ID	Easting (MGA56)	Northing (MGA56)	RL (m, AHD)	Location	Date completed	Type of investigation	Total depth (mbgl)
A4-HAC06	327878.6	6246363.1	14.93	Hercules Street, Dulwich Hill, NSW	22/10/2019	Hand Auger	1
A2-TP01	328385	6248182.9	12.25	IWLR Corridor, Lewisham, NSW	18/10/2019	Testpit	0.7
A3-TP01	328001.3	6247494.2	18.72		14/10/2019	Testpit	0.5
A3-TP02	327976.2	6247471.3	20.16		14/10/2019	Testpit	0.8
A4-TP01	327849.8	6246287.3	13.62	Sydney Trains Corridor, Dulwich Hill, NSW	29/11/2019	Testpit	3
A4-TP02	327850.5	6246290.0	13.99		29/11/2019	Testpit	1

4.6 Survey

Survey of test locations was carried out by registered surveyors from Utility Mapping Pty Ltd. All locations were levelled relative to the Australian Height Datum (AHD) and co-ordinate locations relative to MGA94 (Zone 56).

Test locations were surveyed using Real-Time Kinematic (RTK) GPS equipment operating within the NSW CORS-Net network, a state wide GPS reference station network allowing real-time centimetre-level positioning across the state.

The survey was connected to both the GreenWay Control Survey and additional State Survey Control marks to ensure positional accuracy. Where the use of GPS was not appropriate due to heavy vegetation or other obstructions, traditional survey methods were employed using total station and levelling equipment.

Both methods yield an expected maximum error of +/- 50mm in both horizontal and vertical position.

4.7 Laboratory testing

Soil and rock samples collected as part of the GreenWay site investigation were tested in the following laboratories:

- GHD's internal NATA accredited geotechnical laboratory, responsible for soil index testing, CBR and compaction testing, multi-stage consolidated undrained triaxial testing and point load index strength testing (where not completed in the field).
- Envriolab Services Pty Ltd, an external NATA accredited environmental laboratory, were engaged to undertake a full Aggressivity soils suite on select samples.

Table 4-3 summaries the geotechnical laboratory soil and rock testing carried out.

Table 4-3 Summary of geotechnical soil and rock testing

Test	Number of Tests	Test Method / Standard
Field Moisture Content	56	AS 1289.2.1.1
Atterberg Limits	43	AS1289.3.1.1, 3.2.1 & 3.3.3
Particle Size Distribution	22	AS 1289.3.6.1, AS1289.3.6.2
Standard Compaction	10	AS 1289.5.1.1
California Bearing Ratio	8	AS 1289.6.1.1
Consolidated Undrained Multistage Triaxial with pore water pressure	4	AS 1289.6.4.2
Point Load Testing	87	AS 4133.4.1
Aggressivity Suite (pH, Cl^-, SO^{2-}_4. EC)	58	APHA: 4110B, 4110B, 2510B and NEPM

Test results are discussed further in Section 5.4 and interpreted in Section 6.3, with the test certificates presented in Appendix D.

5. Geotechnical investigation results

5.1 General

Insitu testing was undertaken within all investigation locations during the geotechnical and contamination investigations. Laboratory testing has also been undertaken on selected samples of soil and rock, which were obtained during the investigation. Details of the findings from the insitu and laboratory testing are presented in the following report sections.

5.2 Investigation in-situ testing

In-situ testing during the geotechnical investigations generally comprised Standard Penetration Tests (SPTs) and Dynamic Cone Penetration Tests (DCPs).

SPT results

SPTs were undertaken in all BH series boreholes, selected LD series boreholes and select HAC series boreholes, typically undertaken at depth intervals of between 1.0 and 2 m, depending on the ground conditions encountered. A summary of the SPT results is provided in Appendix C.

DCP testing

DCPs were undertaken in selected BH series boreholes, selected LD series boreholes and selected HA/HAC series boreholes to the proposed depth of investigation or prior refusal. A summary of the DCP results is provided in Appendix C, with DCP test sheets presented in Appendix B.

5.3 Ground water

Previous and current investigations observed groundwater present in each Area of the alignment.

Within Area 1, groundwater was encountered at approximately RL 0 m AHD, likely dictated by the nearby Iron Cove and Hawthorne Canal water bodies. The level are likely to vary with tides, seasonal fluctuation and major rainfall events.

Groundwater was observed in borehole A2D-BH09, at the soil and rock interface, at approximately RL 2 m AHD. This level generally correlates with the base of the Hawthorne Canal.

Groundwater was observed in Area 3, in borehole A3-BH06, at the interface of the fill and residual soil, at approximately RL 22 m AHD.

Groundwater was observed in a number of boreholes in Area 4, likely due to the presence of the nearby drainage channel. Groundwater was recorded at approximately RL 20 m AHD at the northern section of Area 4 and trended down towards the southern low point of the area, approximately RL 15 m AHD. Groundwater levels are likely to vary due to seasonal fluctuations and following major rainfall events.

Note, no temporary or permanent groundwater monitoring instruments, such as ground water wells, were installed or reviewed during the desktop review or site investigation.

Whilst not recorded at all locations across the site, groundwater seepage is likely to be encountered typically at the soil and rock interface in the non-alluvial areas.

5.4 Sampling and laboratory test results

The results of the laboratory testing for both the geotechnical investigations are summarised in the subsequent sections. The relevant laboratory certificates are contained in Appendix D. These results should be read in conjunction with the Standard Sheets presented in Appendix A, which explain the limitations of the test procedures.

5.4.1 Soil test results

Geotechnical classification testing was undertaken on selected soil samples recovered from the investigation, at GHD's NATA-accredited laboratory.

Field Moisture Content and Atterberg Limits

66 soil samples from the current and previous investigations have been used in the review to assess Atterberg Limits (LL, PL and PI) to aid soil classification.

A full-list of test results is presented in Appendix C.

Table 5-1 Atterberg test results summary

Unit	No. of tests	Liquid Limit (%)			Plasticity Index		
		Min	Max	Mean	Min	Max	Mean
Fill - Pavement	1	23	23	23	10	10	10
Fill - Unit 2b	7	25	52	34	5	31	16
Fill - Unit 2c	17	22	46	33	9	29	18
Alluvium - Unit 3a	8	24	57	38	9	32	18
Alluvium - Unit 3b	3	31	45	39	12	25	19
Residual - Unit 4a	24	30	74	50	17	52	31
Residual - Unit 4b	5	28	46	36	13	28	19
Bedrock - Unit 6a	1	24	24	24	3	3	3

Particle Size Distribution

31 soil samples from both the current and previous investigations were reviewed to assess the range of particle size distribution of alignment materials. A full-list of test results is presented in Appendix C

Standard Compaction and California Bearing Ratio

Eight soil samples were tested for California Bearing Ratio (CBR) to assess likely pavement subgrade material. Standard compaction testing was completed on all CBR test samples prior to testing.

The results of the compaction and CBR testing are summarised in Table 5-2. A full-list of test results is presented in Appendix C.

Table 5-2 CBR test results summary

Unit		CBR @ 5 mm

	Number of tests	Min	Max	Mean
Fill - Unit 2a	4	2.3	6.8	4.8
Fill - Unit 2b	2	4.4	7.7	6.1
Alluvium - Unit 3a	1	3		
Residual - Unit 4a	1	3.6		

Consolidated Undrained Multistage Triaxial with pore water pressure

Consolidated undrained triaxial testing with pore pressure measurement (CU-PP) was carried out to assess the effective strength parameters of selected samples. The effective angle of shearing resistance of the material was calculated from these tests.

Triaxial testing was undertaken on remoulded fill material at locations specific to the proposed jacked tunnel structures for the project.

To carry out geotechnical design, typical cohesion and angle of shearing resistance is generally performed at a range of consistencies/densities by referring to the laboratory test results, together with past experience and published information. The testing results are summarised in Table 5-3 below.

Table 5-3 Summary of consolidated undrained triaxial test results

Investigation ID	Road	Depth (mbgl)	Material Description	Origin	FMC (%)	c' (kPa)	ϕ' (deg.)
A2D-LD04	Longport St, Summer Hill	4.1 - 4.4	Sandy CLAY	Fill	13.3	1	30
A3-BH06	Constitution Road, Dulwich Hill	1.5 - 1.95	Clayey SAND	Fill	12.5	0	35
A3-BH06	Constitution Road, Dulwich Hill	3.5 - 3.95	CLAY with gravel	Fill	24	10	32
A3-LD/BH01	Davis Street, Dulwich Hill	4.1 - 4.4	CLAY	Fill	16.7	5	27

5.4.2 Rock test results

Geotechnical rock strength testing was undertaken on selected rock core samples recovered from cored boreholes.

Point load index testing

Point load index tests were performed at approximately 1 m intervals on recovered rock core. A list of test results is presented in Appendix C

5.4.3 Chemical test results

Aggressivity test results

Selected soil samples were analysed for pH, sulphate, chloride and electrical conductivity for assessment of aggressivity to buried structures. Test results are presented in Appendix C.

5.5 Contamination testing

Contamination samples were collected and logged by a suitably trained geotechnical engineer or engineering geologist, with ongoing support from an experienced environmental scientist. The results of the contamination investigation and testing have been reported separately GHD (The GreenWay Contamination Report GHD).

6. Geotechnical model

6.1 General

The data presented during the geotechnical and contamination investigation and information historically sourced (as listed Section 2.2 of this report) has been used to characterise the soil and rock stratigraphy along the GreenWay alignment and group these materials into representative geotechnical units. These units are characterised and described throughout this section of the report.

Following the characterisation, a series of geotechnical long sections have been developed to assess the distribution of these units present along alignment.

The geotechnical longitudinal sections prepared for the GreenWay project along the current centreline of the GreenWay path are included in Section 12 of this report (Drawing set 21-12515105-Q001). The centreline of the GreenWay alignment was supplied by IWC on 7 January 2020, reference file *'646ld_100% 3D path alignment only rev01 dwg'*.

Sheets Q002 to Q007 of these drawings refers to the long section along Area 1 of the GreenWay alignment. These sheets were developed to plot the geological profile depicted by all "A1" series investigations.

Sheets Q008 to Q010 of these drawings refers to the long section along Area 2 and Area 2 (discretionary) of the GreenWay alignment. These sheets were developed to plot the geological profile depicted by all "A2" and "A2D" series investigations.

Sheets Q011 to Q013 of these drawings refers to the long section along Area 3 of the GreenWay alignment. These sheets were developed to plot the geological profile depicted by all "A3" series investigations.

Sheets Q014 to Q015 of these drawings refers to the long section along Area 4 of the GreenWay alignment. These sheets were developed to plot the geological profile depicted by all "A4" series investigations.

6.2 Ground conditions

6.2.1 Pavements

Footpath and road pavements were encountered in all areas across the GreenWay site. Pavements were observed specific to their purpose and location. Throughout the drilling investigation, both concrete and asphalt pavements, reinforced and unreinforced, were encountered of variable thickness.

At the junction of The Bay Run and the existing GreenWay path, a heavily reinforced concrete footpath pavement was encountered. Drilling through this pavement refused between 0.25 and 0.45 mbgl at A1-BH03 and A1-BH04 respectively.

The fill/sub-base underlying the investigated road pavements, was generally observed as a sandy gravel and gravelly sand material and appeared well compacted

For specific details of concrete and asphalt pavement, refer to individual engineering logs contained in Appendix B.

6.2.2 Unit 1 - Topsoil

Topsoil was encountered across in each of the GreenWay alignment Areas, found in council reserves, Bushcare sites, road verges and within the IWLR corridor. Topsoil mainly consisted of typical silty dark grey sand / sandy silt material containing rootlets and other organics. The average thickness of the topsoil material encountered during the investigation was 170 mm.

6.2.3 Unit 2 - Fill

Variable fill material was encountered across the GreenWay alignment during the geotechnical and contamination investigation. Three distinct units of fill material have been assessed based on the findings of the investigation. Variability of fill is to be expected and caution in developing designs of structures or slabs in fill units is advised.

Unit 2a: Reclamation fill

Predominantly Silty Gravelly Sand and Clayey Sand of grey and brown, fine to coarse sand and gravel and low to medium plasticity clay. Waste material such as brick, concrete, glass, tile and plastic commonly encountered during the investigation.

This fill unit is isolated to Area 1, located directly above the marine sediments of the Hawthorne Canal/Long Cove Creek.

Unit 2b: Corridor fill

Approximately 80% of the fill assigned as Corridor Fill was observed as granular, consisting of fine to coarse grained Silty Sand of brown and dark brown and fine to coarse Gravelly Sand of brown to dark brown. The remaining fill was typically observed as fine grained, low to medium plasticity sandy clay and clay of low to medium plasticity. Ballast was commonly encountered during the investigation, with traces of waste material (as per unit 2a) also encountered, of building and demolition rubble.

Unit 2c: Road and rail embankment fill

Embankment material encountered during the investigation was observed as an equal mix of fine grained and granular material. The fine-grained fill was generally described as a low to medium plasticity clay and sandy clay of grey and brown. The granular fill was typically described as gravelly, silty or clayey sand, fine to coarse grained of grey and brown. Material of this unit appeared to be locally sourced ripped sandstone and shale.

Area 1

The observed fill material in this Area is likely influenced by the presence of the Hawthorne Canal, running parallel to the proposed GreenWay alignment. The fill was observed mainly Unit 2a material granular, non-cohesive material of Silty Gravelly Sand / Clayey Sand mixtures with a dominant presence of waste such as brick, glass, plastic, tile and metal. It is anticipated that this was placed over soft alluvial soils and potential dredged sediments as a crust during land reclamation, particularly at Richard Murden Reserve.

Along the Bay Run, the fill is exposed to tidal groundwater and therefore compaction quality varies, with an average SPT N value of 9. In Richard Murden Reserve, the average depth of fill is 1.4 m from the base of the topsoil unit, with an average DCP value of 5 blows per 100 mm. This indicates moderate compaction of stiff / medium dense material.

Area 2 (and Area 2D)

The fill material encountered in Area 2 and Area 2D is likely influenced by the construction of the Hawthorne Canal, the IWLR and the Longport Street road overbridge.

The alignment, from Parramatta Road towards Gadigal reserve and the pedestrian bridge into Gadigal Reserve dog park, typically encounters fill of gravelly sand and silty gravelly sand of a high compaction. This material has been classed as Unit 2b.

Beneath Longport Street, fill material is predominantly low plasticity sandy Clay and medium plasticity clay of stiff to very stiff consistency. The consistency of the medium plasticity clay reduces with depth however. This material also contains traces of waste material. This material is classified as Unit 2c.

Within the IWLR corridor to the north and south of Longport Street, fill material is heavily influenced by the construction of the IWLR. To the north of Longport Street fill material is approximately 1.4 m deep and has an average DCP count of 4 blows per 100 mm, or poor to moderate compaction. Fill material is mainly granular with presence of ballast and waste. To the south of Longport Street, around Lewisham West Station, fill is highly variable due to old buried rail track material and blocks of concrete both at the surface and buried. The encountered fill material was observed as coarse grained with sand, gravel and ballast mixtures encountered. The average DCP in of the top 2 m was 5 blows per 100 mm.

Area 3

As observed in Area 2 and 2D, Fill in Area 3 was observed as predominantly Unit 2b.

The Council Bushcare Site to the north of Johnson Park and the area south of Davis Street has evidence of previous rail use. At depths of less than 1.0 m, Fill material is observed as clay, sand and gravel mixtures with a high percentage volume of ballast and cobble sized bricks and rubble waste. The compaction of this layer was found to be highly variable, reflecting loose to medium dense and dense material. Below 1.0 m, fill material grades to a fine grained material with a higher clay content at an approximately stiff consistency.

The Fill below Davis Street and Constitution Road, Dulwich Hill are similar in nature. Both types of Unit 2c fill appear to have been derived from ripped shale with Fill reflecting a clay of stiff consistency.

Constitution Road contains a thicker coarse grained, clayey sand unit of likely ripped sandstone and shale mixture, overlying a low plasticity clay fill. The embankment fill below Davis Street observed to be medium plasticity clay.

At the south end of Johnson Park, the thickness of fill material reduces and is of predominantly coarse grained. As the alignment moves toward Constitution Road, through Johnson Park, it increases in thickness and becomes cohesive in nature. Consistency of the fill material in this section of area suggests firm to stiff material.

Typically, fill material in the southern Area 3 zone is observed as coarse grained at shallow depths with ballast and cobble sized rubble encountered, grading to a fine grained fill at increased depth. The alignment runs along a high sandstone cutting of the IWLR route, with a thin Fill mantle.

Area 4

The alignment of Area 4 runs parallel to the IWLR where debris, likely generated during the construction of the Rozelle Goods Line / IWLR, has been placed. From Hercules Street at the northern extent of Area 4 to Ewart Street to the south of Area 4, Unit 2b material was encountered containing large cobbles of ballast, testing suggesting a loose to very dense material.

South from Hercules Street the Fill is typically thin before the alignment climbs a large fill embankment of generally very dense material. Drilling of A4-BH05 and A4-BH06 refused at 3.0 mbgl and 1.0 mbgl, respectively, due to the heavily compacted dry, gravel fill.

6.2.4 Unit 3 - Quaternary (alluvial) soils

Unit 3a Marine sediments

Sandy Clay and Clay, low to medium plasticity, dark grey, black and brown in colour, trace shells and gravel. Consistency of very soft to firm and wet of the plastic limit.

Unit 3a was only observed in Area 1, representative of soils associated with the tidal Iron Cove and the Hawthorne Canal. This material sits directly below the Unit 2a, Reclamation Fill, and therefore the upper boundary may be found to be reworked with the fill.

Unit 3b alluvium

Sandy Clay and Clayey Sand, of low to medium plasticity, fine to medium grained and brown, red-brown and pale brown in colour. Shells and organics such as rootlets and wood fibres were also encountered. Consistency is generally soft to firm (cohesive) and loose to medium dense (granular), remaining consistent with depth.

This material was encountered in localised areas along the Hawthorne Canal, in Area 2, and in close proximity to the creek/drainage line running parallel with the alignment in Area 4.

6.2.5 Unit 4 - Residual soil

Unit 4a: Residual Soil – shale derived

Clay, Sandy Clay and Gravelly Clay of medium to high plasticity, with fine to medium-grained sands, fine to medium, rounded ironstone gravel and pale grey, red-brown and brown in colour. Consistency is generally stiff to very stiff and firm in places where moisture increases. Material is likely to be the weathered product of the Ashfield Shale unit and Mittagong Formation.

Unit 4a was encountered across the central portion of the site, in Area 2 and Area 3, in areas of greater elevation.

Unit 4b: Residual Soil – sandstone derived

Unit 4b was typically encountered as a Clayey Sand or Sandy Clay, fine to coarse grained and low to medium plasticity, pale grey and pale brown. Consistency was typically medium dense or very stiff and generally increases with depth. The Material is assessed to be the weathered product of Hawksbury Sandstone bedrock.

Unit 4b is typically observed at the northern and southern sections of the site, in Area 1 and Area 4. At alluvium locations, Unit 4b is either thin or completely absent.

6.2.6 Unit 5 - Ashfield Shale

Ashfield Shale forms the lower part of the Wianamatta Group of rocks, a group of Triassic age fine-grained shales, sandstones and mudstones. The Ashfield Shale represents a regressive depositional episode grading from lacustrine at its base and up to a marine or brackish facies within the upper sequence. These were low energy depositional environments that allowed for the accumulation of typically fine-grained sediments such as clay, silt and fine sand particles.

The investigations did not encounter Ashfield Shale bedrock within the cored sections of boreholes; however, it is likely that thin horizons of weathered shale were drilled in the augered portions. Where encountered, the GreenWay will likely intersect the lowest subgroup of Ashfield Shale, the Rouse Hill Siltstone, with the shale completely absent in most parts of the site. Rouse Hill Siltstone, where fresh, is typically observed as a dark grey to black mudstone or shale, which is often observed to be faulted or sheared at the basal contact of formation with the underlying Mittagong Formation.

Based on the results of our investigation it is considered likely that, where found, Ashfield Shale is likely to be extremely to highly weathered.

Table 6-1 presents a summary of the geotechnical units of Ashfield Shale.

Table 6-1 Project units of Ashfield Shale

Unit No.	Geotechnical unit	Description
Unit 5a	Shale Class V	Extremely weathered to highly weathered Ashfield Shale, extremely low to very low strength, highly fractured or fragmented. Typically observed as a shaley clay or bands of weathered shale and very stiff and hard clay
Unit 5b	Shale Class IV	Highly weathered, very low strength Ashfield Shale, very closely spaced defects, with some hard clay seams.
Unit 5c	Shale Class III	Highly to moderately weathered, low strength Ashfield Shale, closely spaced fractures.

6.2.7 Unit 6 - Mittagong Formation

Mittagong Formation separates Ashfield Shale from the underlying Hawkesbury Sandstone. The formation represents the transition from the fluvial/terrestrial depositional environment of Hawkesbury Sandstone to the lacustrine depositional environment of upper Ashfield Shale. It was previously referred to as 'The Passage Beds', marking the passage from shale to sandstone, which reflects well the transitional nature of this material and the fact that the boundaries are often hard to clearly distinguish.

Mittagong Formation often comprises a, thin very fine-grained brownish sandstone unit (typically 0.5 m thick) below a unit of fine-grained sandstone and interlaminated or interbedded dark grey siltstone. The whole unit is typically 1 to 3 m thick but can be up to 10 m thick. In places the formation is completely absent, and where weathered, it is often indistinguishable from the younger Ashfield Shale.

Table 6-2 presents a summary of the project units of the Mittagong Formation.

Table 6-2 Project units of Mittagong Formation

Unit No.	Geotechnical unit	Description
Unit 6a	Mittagong HW	Highly weathered, interbedded fine-grained sandstone and shale. Very low strength, highly fractured, typically with clay seams and beds.
Unit 6b	Mittagong MW	Moderately weathered, interbedded fine-grained sandstone and shale. Low strength, closely fractured, with some clay seams and beds.

6.2.8 Unit 7 - Hawksbury Sandstone

Hawkesbury Sandstone is present below the whole site. The formation thickness has been proven elsewhere in Sydney by drilling to a maximum thickness of approximately 290 m. The Hawkesbury Sandstone is often described as a medium to coarse-grained quartzose sandstone deposited in 1-3 m thick beds. Shale breccia is common at the contacts between beds, with siltstone interbeds forming a minor part of the unit. Finer and coarser-grained bands represent changes in the depositional environment.

Hawkesbury Sandstone is inferred to represent deposition by fluvial processes in a large braided river system, with shale interbeds representing overbank and swamp type deposits.

The weathering of Hawkesbury Sandstone is characterised by iron staining with orange and red colouration partly or totally penetrating the rock mass. Typically, the iron staining extends into the rock mass some 5 to 10 m below ground surface.

Table 6-3 presents a summary of the project units of Hawksbury Sandstone.

Table 6-3 Project units of Hawksbury Sandstone

Unit No.	Geotechnical unit	Description
Unit 7a	Sandstone Class V	Extremely low to low strength, extremely to highly weathered sandstone with frequent zones of clay seams, highly fractured or fragmented.
Unit 7b	Sandstone Class IV	Low strength, highly weathered sandstone with significant clay seams, fractured.
Unit 7c	Sandstone Class III	Medium to very high strength, slightly to moderately weathered sandstone, fractured.

6.2.9 Unit 8 – Igneous Dyke

Igneous dykes of Jurassic age are sparsely distributed throughout the Sydney region; however, over 100 are shown on published mapping. The igneous intrusions, which also include rarer diatremes and sills, are understood to range in age from about 50–170 million years and are understood to pre-date many of the major faults within the Sydney Basin (Och et al. 2009). The dykes within the Sydney region generally consist of linear dolerite/basalt rock bodies intruded into the surrounding country rock and are typically orientated between 090° and 120°. The orientation of the intrusions is generally consistent with the direction of the dominant jointing in the region, suggesting that the dykes often follow these pre-existing lines of weakness.

Igneous dykes were not encountered during the current investigations; however, the published maps indicate that six such features may intersect the GreenWay alignment. Typically, dykes within the Sydney CBD area consist of a completely weathered plug at the surface, often indistinguishable with the surrounding residual soils. Weathering and faulting of the dyke can generally decrease with depth, often maintaining a less weathered, less fractured core where compared to the margins.

6.3 Material characterisation

A project specific soil and rock mass classification system has been developed to enable geotechnical interpretation and design. The classification system is a generalised system and variations within the adopted material units in both lateral extent and depth is expected.

6.3.1 Soil characterisation

The tables below summarise the main soil units and their thicknesses encountered during the site investigation along the project alignment, sorted by project area. The tables also specify the shallowest and deepest top and bottom of all encountered units and average thickness of unit.

Table 6-4 Summary of ground profile Area 1

Soil Unit	Depth (m)		Unit thickness (m)	Average unit thickness (m)
	From	To		
Pavement	0	0.05 to 0.45	0.05 to 0.45	0.15
Unit 1	0	0.1 to 0.3	0.1 to 0.3	0.20
Unit 2a	0.05 to 1.8	0.1 to 2.5	0.65 to 2.45	1.57
Unit 3a	1.1 to 4.5	2 to 16.5	0.5 to 14	10.5
Unit 4b	4 to 15	5 to 15.5	1 to 3.15	2.23

Table 6-5 Summary of ground profile Area 2 and Area 2D

Soil Unit	Depth (m)		Unit thickness (m)	Average unit thickness (m)
	From	To		
Pavement	0	0.07 to 0.8	0.07 to 0.8	0.36
Unit 1	0	0.05 to 0.25	0.05 to 0.25	0.14
Unit 2b	0 to 2	0.2 to 3.9	0.4 to 3.9	1.48
Unit 2c	0.1 to 7	0.15 to 9	8.6	8.60
Unit 3b	9	11	2	2.00
Unit 4a	0.05 to 11	0.9 to 12.9	0.13 to 3.4	1.25

Table 6-6 Summary of ground profile Area 3

Soil Unit	Depth (m)		Unit thickness (m)	Average unit thickness (m)
	From	To		
Pavement	0	0.08 to 0.3	0.08 to 0.12	0.10
Unit 1	0	0.1 to 0.5	0.1 to 0.5	0.24
Unit 2b	0 to 1.3	0.2 to 3.9	0.3 to 3.9	1.21
Unit 2c	0 to 3.65	0.3 to 7.3	0.6 to 7.3	3.37
Unit 4a	0.6 to 8	1 to 9	0.6 to 4.1	2.05
Unit 4b	0.6 to 9	1 to 10.4	0.15 to 1.4	0.65

Table 6-7 Summary of ground profile Area 4

Soil Unit	Depth (m)		Unit thickness (m)	Average unit thickness (m)
	From	To		
Pavement	0	0.01 to 0.45	0.05 to 0.45	0.25
Unit 1	0	0.1	0.1	0.10
Unit 2b	0 to 4	0.1 to 4.8	0.45 to 4.8	1.49
Unit 3b	0.9 to 3	1.55 to 3.8	0.65 to 0.8	0.73
Unit 4a	1.3	2.3	1	1.00
Unit 4b	0.45 to 4.8	0.6 to 5.3	0.15 to 4.3	1.07

In-situ and Laboratory Testing

The following sections present an assessment on the results from geotechnical laboratory testing for the following classification properties:

- Liquid Limit (LL), Plasticity Index (PI), Plastic Limit (PL) of fine-grained soils;
- Particle Size Distribution (PSD) of fine and coarse-grained soils;
- Consolidated Undrained Triaxial (CU);
- Standard Penetrometer Testing (SPT)
- Soil Aggressivity Tests.

All available laboratory test certificates for this project are presented in Appendix D.

Particle size distribution

The results from particle size distribution testing in Figure 6-1, Figure 6-2 and Figure 6-3 below indicate that:

- Unit 2b Fill material is more granular than Unit 2c Corridor Fill. Unit 2b is likely to be the result of the construction and maintenance of the IWLR. The results suggest that Unit 2c, Embankment Fill, is likely to be sourced from ripped Ashfield Shale, with a greater percentage of fine-grained material.

- The testing of the alluvial material indicates Units 3a and 3b are generally consistent. The results suggest material is a Clayey Sand and Sandy Clay.
- Unit 4, Residual Soil, test results indicate the granular nature of the sandstone bedrock derived soils, Unity 4b, and the generally fine grained Unit 4a, shale derived soil.

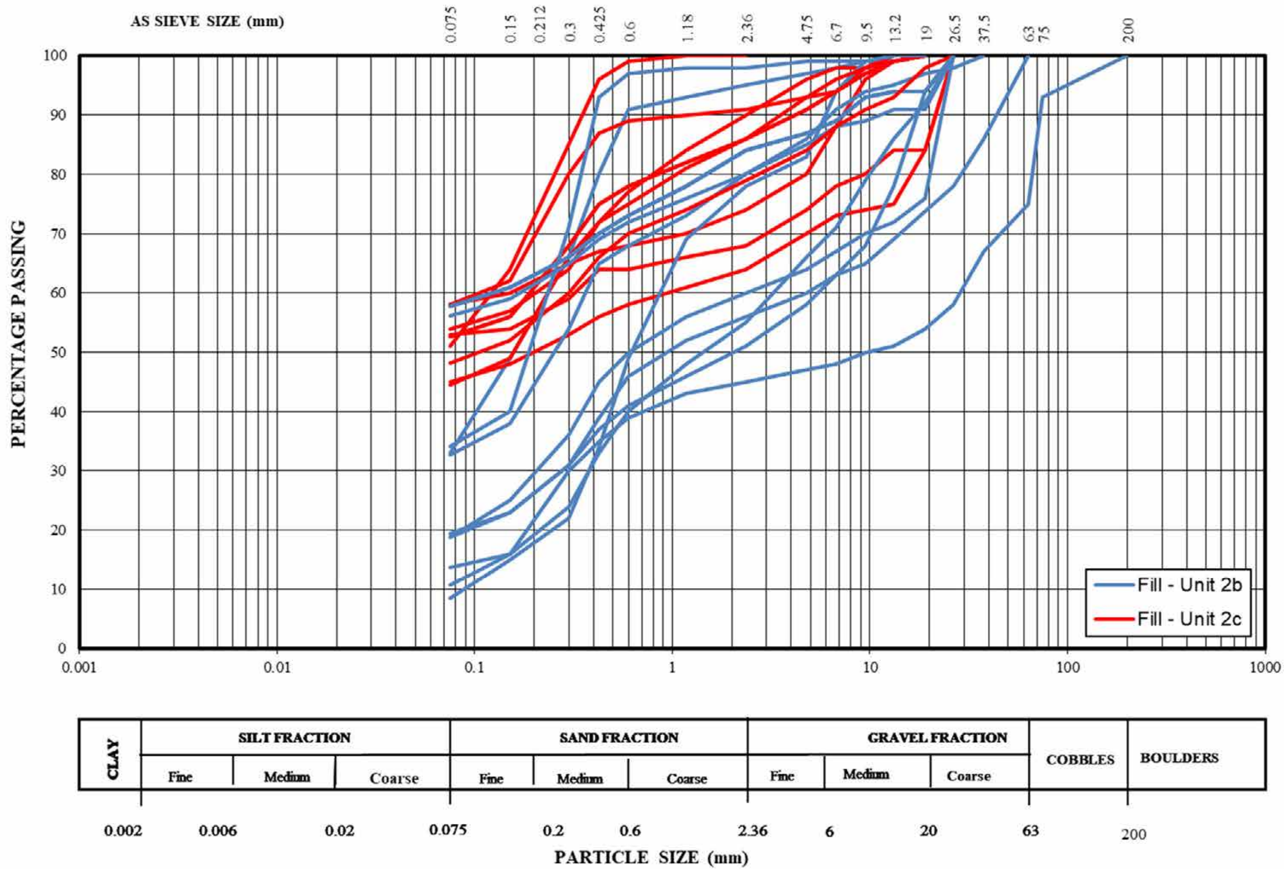

Figure 6-1 Particle size distribution chart – fill material

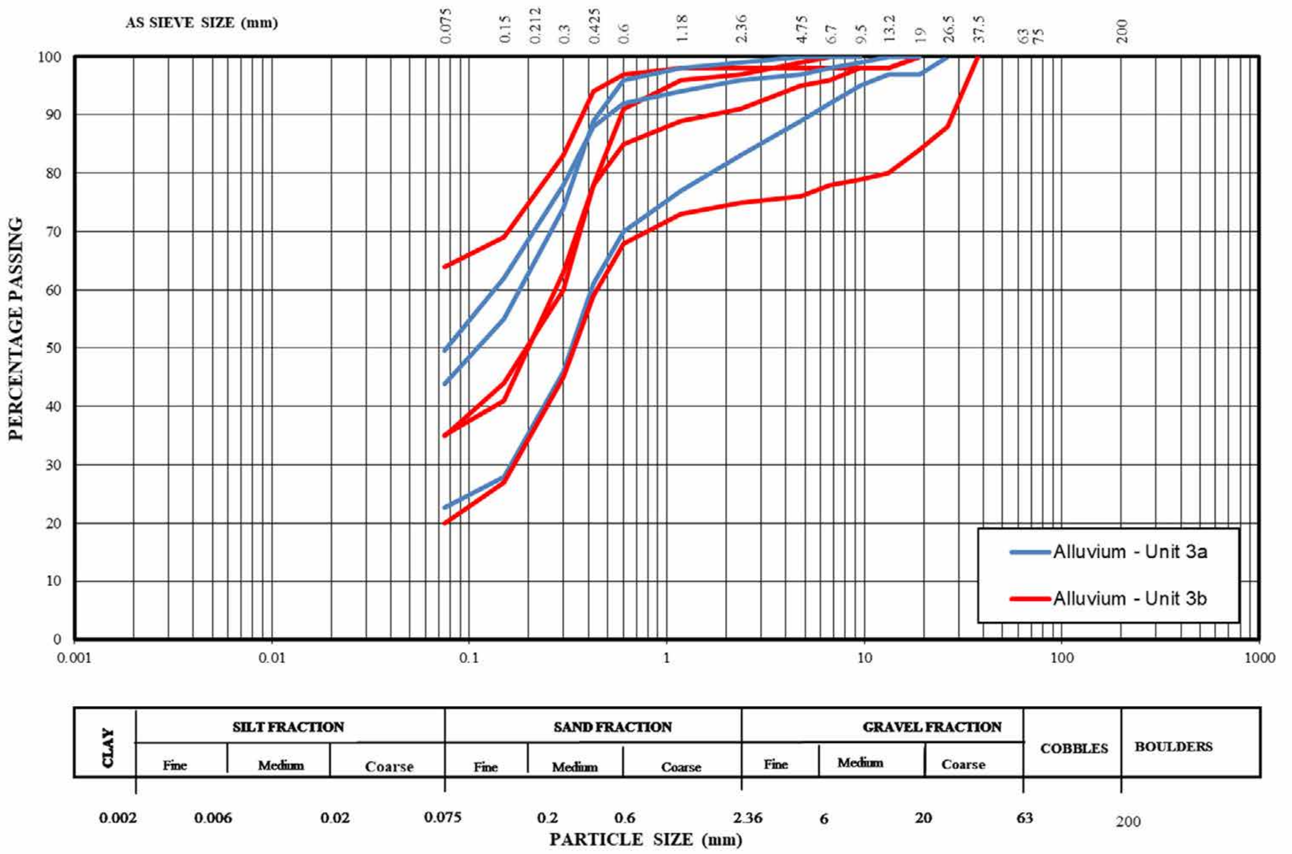

Figure 6-2 Particle size distribution – alluvial soils

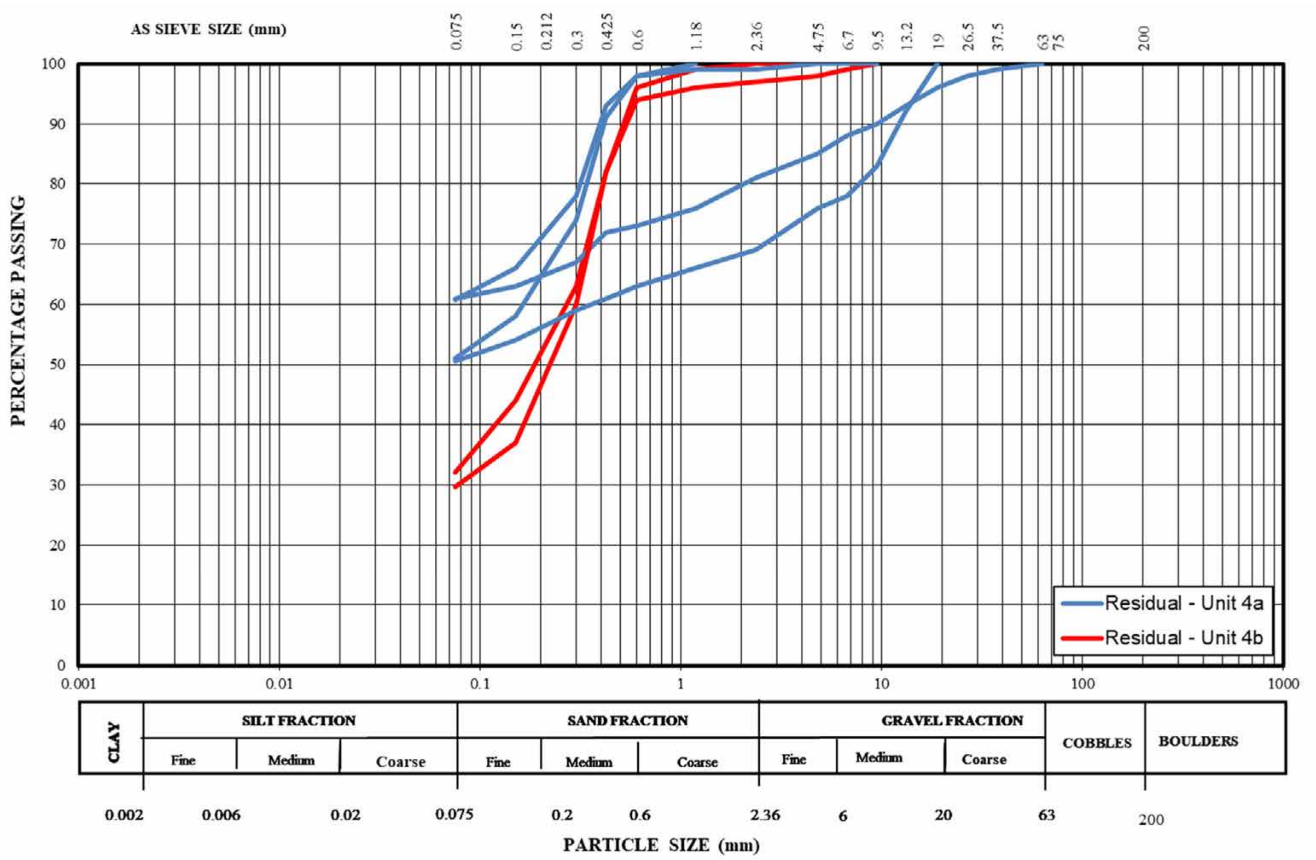

Figure 6-3 Particle size distribution – residual soils

Atterberg Limits

Atterberg limits tests were undertaken on the fine-grained fraction of fill, alluvium and residual soil samples.

AS1726 classifies plasticity by the liquid limit (LL) rather than the plasticity index (PI). The following limits apply:

- Low plasticity: LL≤35%
- Medium/Intermediate plasticity 35%<LL≤50%
- High plasticity LL>50%

The results from Atterberg limits testing have been plotted in the Casagrande's plasticity chart. Figure 6-4, Figure 6-5 and Figure 6-6 below tend to indicate that:

- Fill material tested ranged from low to medium plasticity.
- Alluvium typically is low to medium plasticity, with most values in the medium plasticity range. Testing of the marine sediments, Unit 3a, suggests plasticity ranges from low to high, with the Unit 3b falling within medium plasticity.
- The residual soils derived from the Ashfield Shale unit typically ranged from medium to high plasticity, as is expected in this geological setting. Residual soil found in areas where Hawksbury Sandstone bedrock is at shallow depths, is general coarse grained with a secondary clay component, tests indicate this is low to medium plasticity.

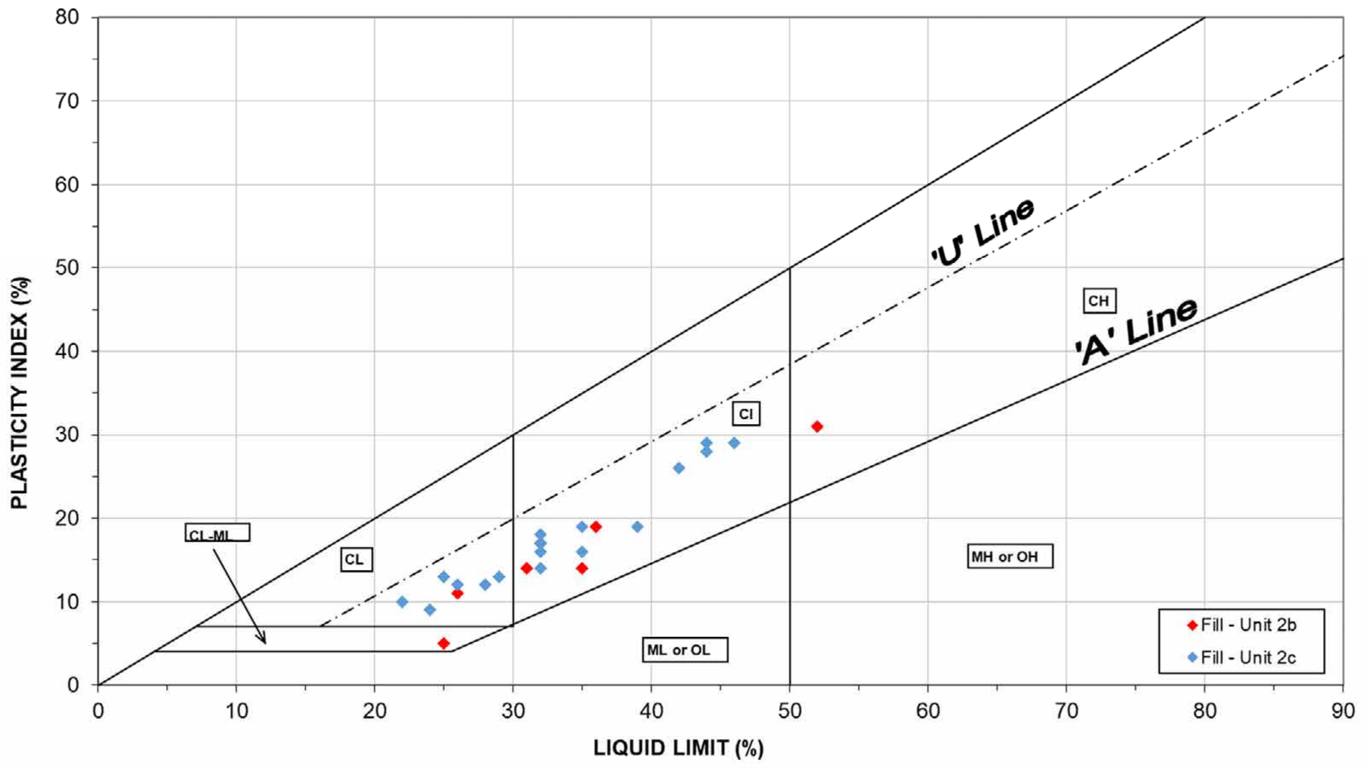

Figure 6-4 Atterberg limits plot – Fill

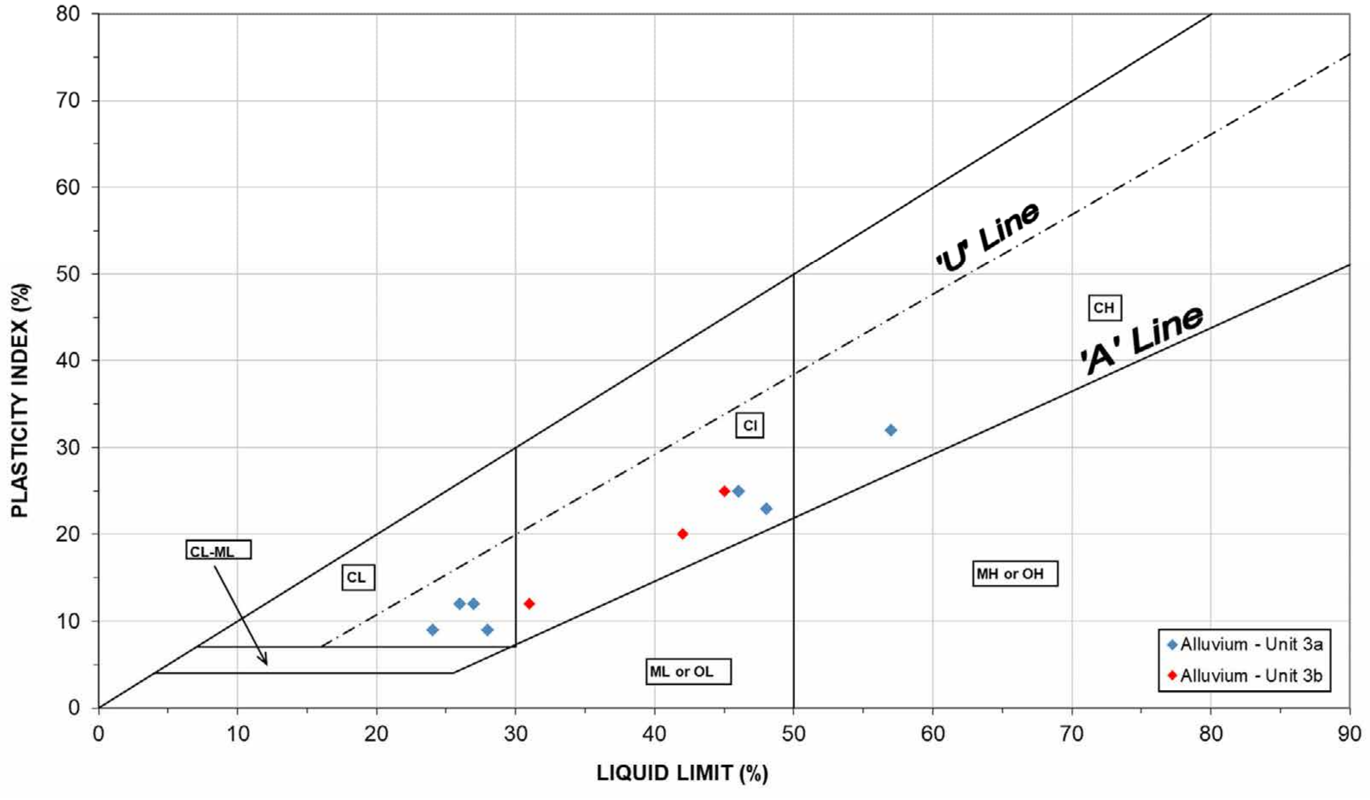

Figure 6-5 Atterberg limits plot – Alluvium

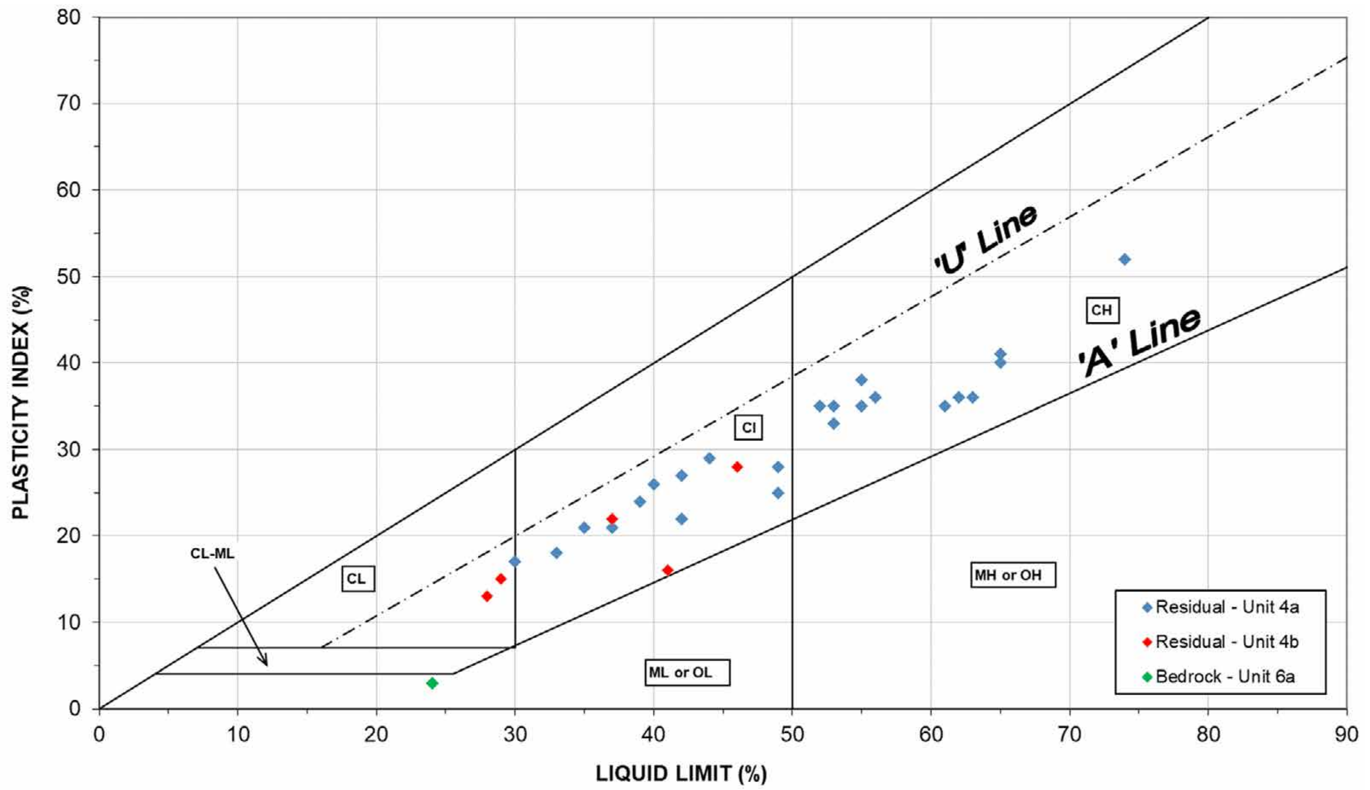

Figure 6-6 Atterberg limits plot – Residual Soil

Standard Penetration Tests

Standard Penetration Tests (SPT) blow counts (*N*) carried out during the project geotechnical investigation have been plotted in Figure 6-7, Figure 6-8 and Figure 6-9. Refusal is represented by a blow count of 50.

The SPT in Unit 2 can be influenced by gravels or larger particles, tests indicate *N*-vales typically range between 3 and >50, suggesting loose or soft to dense or very stiff, with a typical average *N*-value of 13. Very high SPT results in Fill may be a result of heavy compaction parallel to the IWLR line, particularly in Area 4.

SPT *N*-values in the Unit 3, Alluvium, typically range from 0 to 5, suggesting that this predominantly cohesive unit has a consistency of very soft to firm.

The *N*-values in tested Residual Soil ranged from 5 to refusal, with an average of 15. This wide variability of the *N*-value in the residual soils is expected due to the various degrees of weathering of the parent material, the highly variable depth to top of bedrock, and the potential presence of gravel (especially ironstones) as highlighted in some particle size distribution results. This unit is expected to range from a stiff to hard consistency.

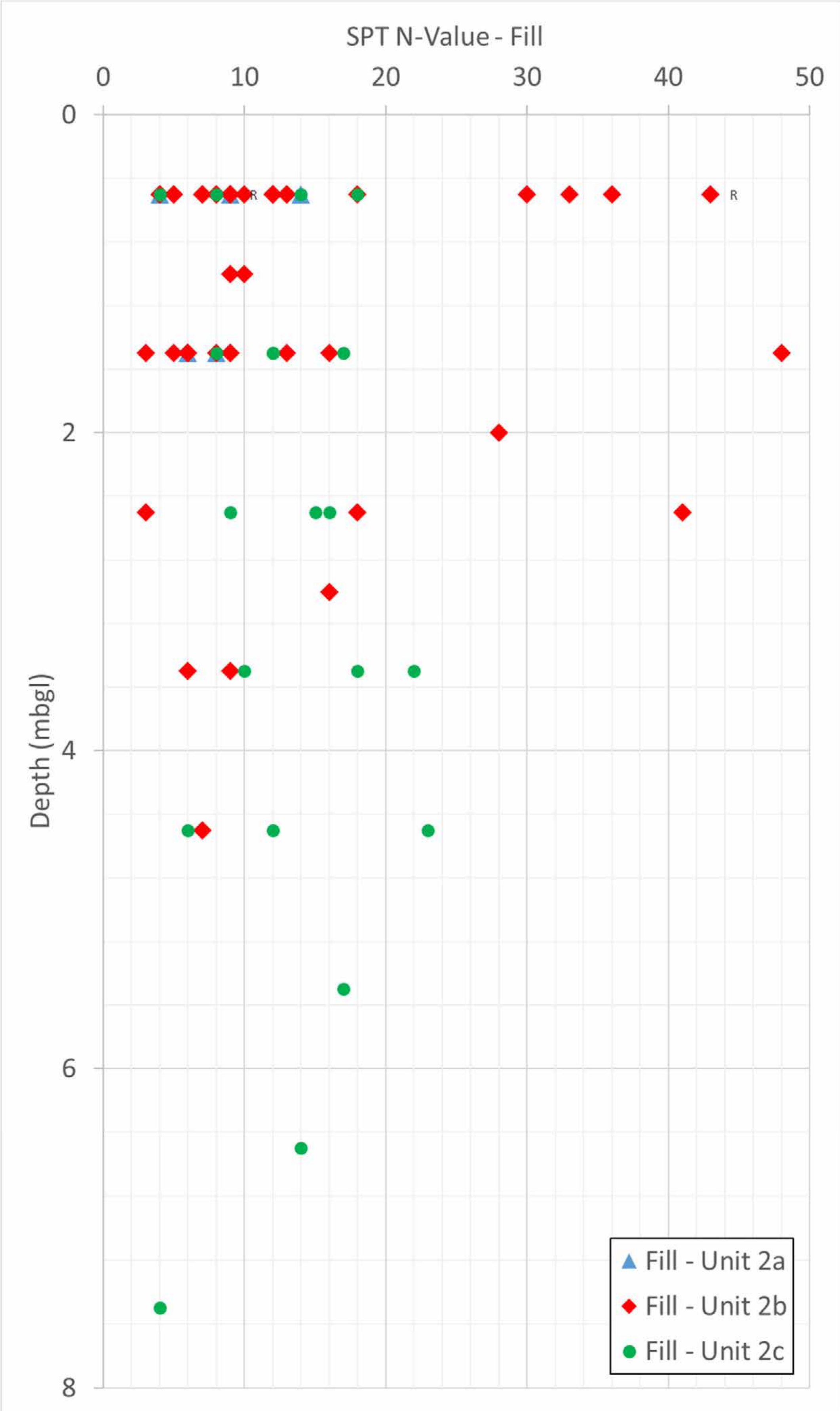

Figure 6-7 SPT N-value vs depth – Fill

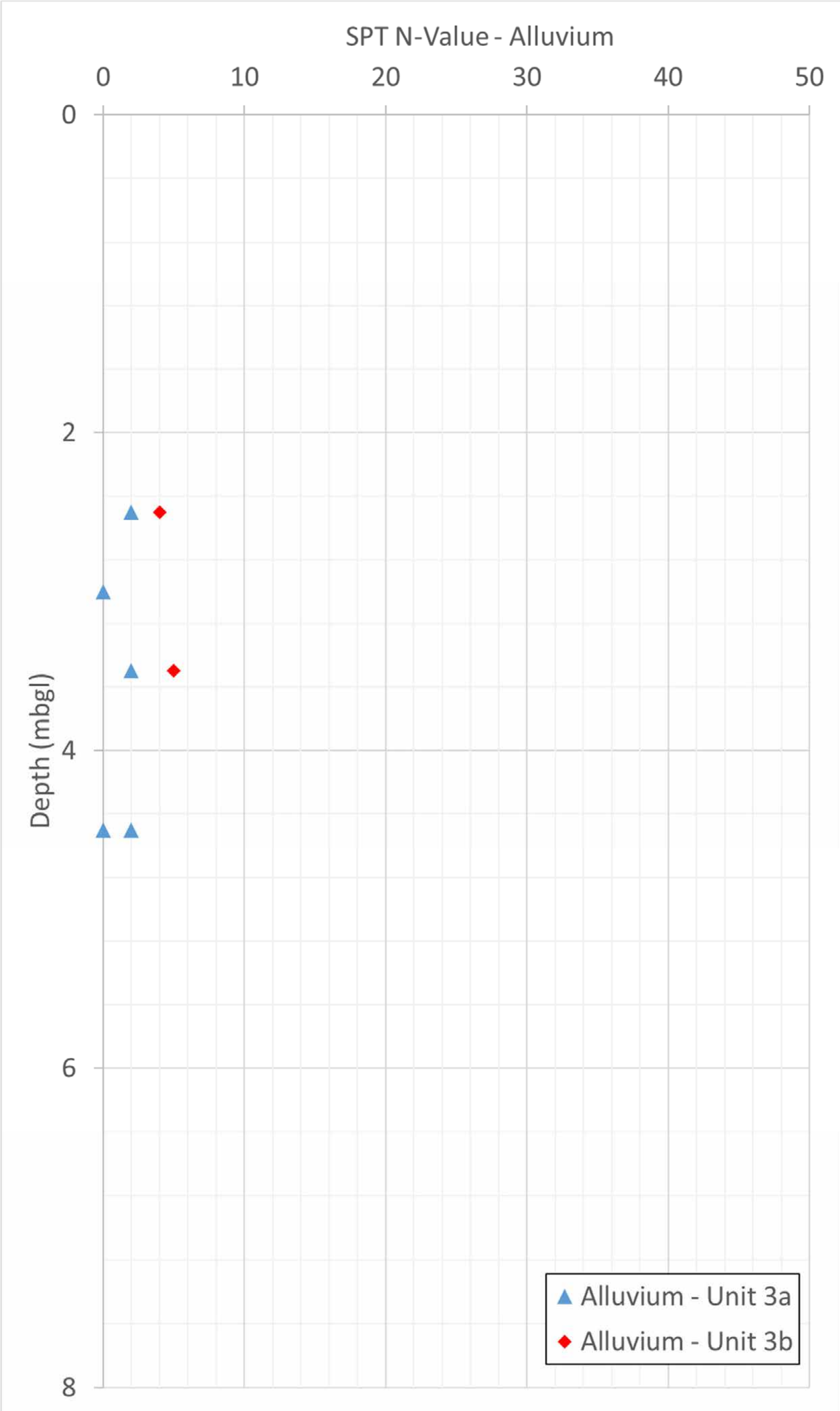

Figure 6-8 SPT N-value vs depth – Alluvium

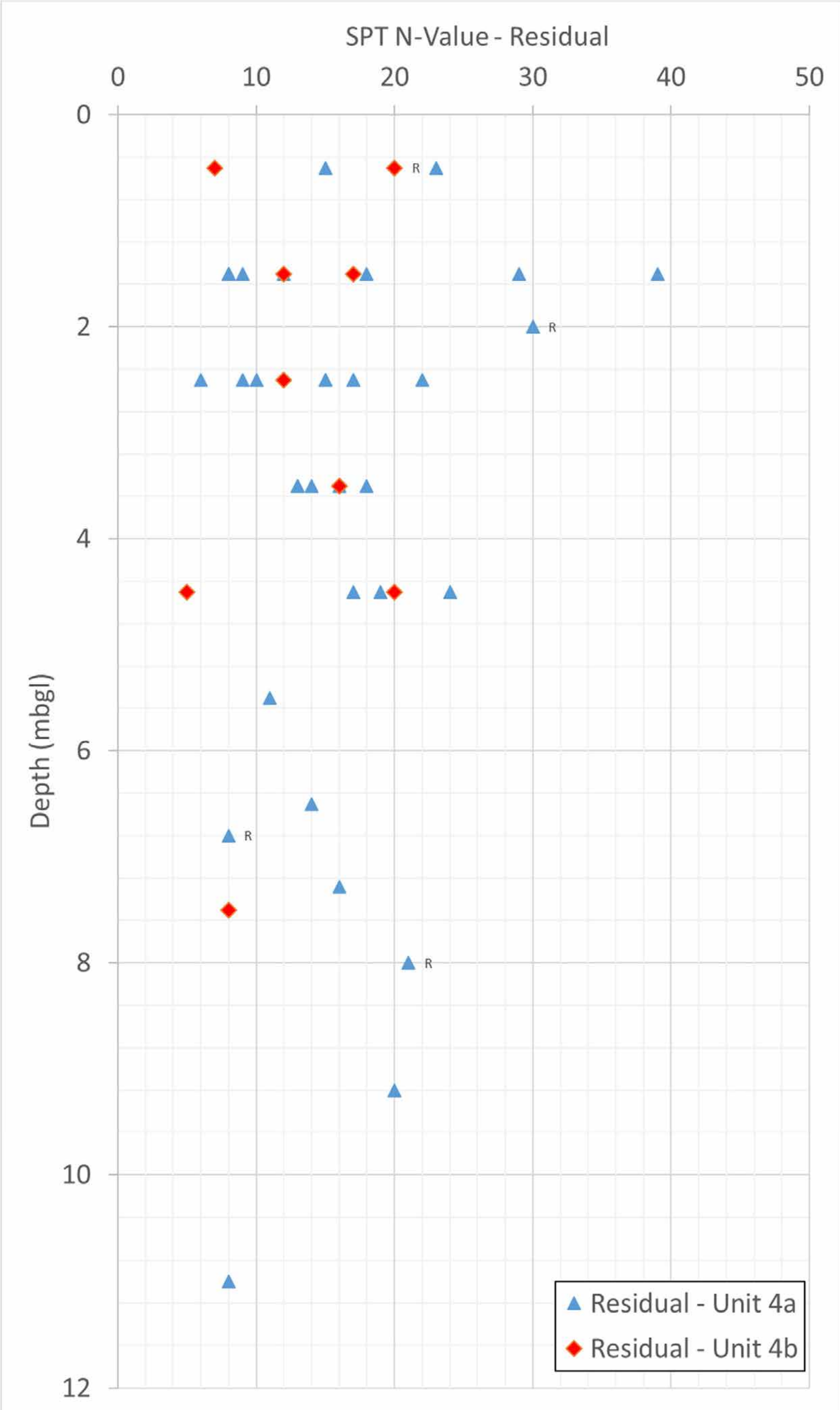

Figure 6-9 SPT N-value vs depth – Residual Soil

Soil Aggressivity

Exposure to soil or groundwater can result in damage to buried concrete structures. GreenWay buried structural elements are likely to comprise retaining wall footings, culverts and shallow/deep footings.

To address the durability for these structure elements, the soil aggressivity test results were assessed in terms of Tables 6.4.2(C) and 6.5.2(C) of AS2159-2009 'Piling – Design and Installation' and in accordance with Table 4.8.1 of AS3600-2009 'Concrete structures'.

A summary of the soil aggressivity test results are contained in Appendix C and assessed exposure classifications is provided below in Table 6-8.

Table 6-8 Summary of Assessed Exposure Classification

Investigation ID	Depth (m)	Material Description	Material Origin	Exposure classification to AS3600	Exposure classification to AS2159
A1-BH01	2.2 - 2.3	Clayey SAND with gravel	Alluvium	A1	Non-aggressive
A1-BH02	0.8 - 0.9	Sandy GRAVEL with silt	Fill	A1	Non-aggressive
A1-BH06	1.5 - 1.95	Sandy GRAVEL with silt	Fill	B1	Moderate
A1-BH06	3.5 - 3.95	CLAY with sand	Alluvium	B1	Moderate
A1-BH07	3 - 3.45	CLAY with gravel	Alluvium	B1	Moderate
A1-BH07	6.5 - 6.7	Sandy CLAY	Residual	A1	Non-aggressive
A1-LD01	1.1 - 1.5	Sandy CLAY	Fill	A1	Non-aggressive
A1-LD03	0.5 - 1	Silty SAND	Fill	A1	Non-aggressive
A1-LD04	1.8 - 1.9	CLAY	Alluvium	A1	Non-aggressive
A1-LD05	0.7 - 1	Silty CLAY with sand	Fill	A2	Mild
A1-LD06	1.1 - 1.5	CLAY	Alluvium	A1	Non-aggressive

Investigation ID	Depth (m)	Material Description	Material Origin	Exposure classification to AS3600	Exposure classification to AS2159
A1-LD07	0.5 - 1	Silty SAND with gravel	Fill	A1	Non-aggressive
A1-LD09	0.3 - 0.5	Sandy CLAY with gravel with rubble	Fill	A1	Non-aggressive
A1-LD10	1.2 - 1.5	Clayey SAND with gravel	Fill	A1	Non-aggressive
A2-BH02	2.5 - 2.95	Sandy CLAY	Residual	A1	Mild
A2-BH03	0.7 - 0.9	CLAY	Residual	A1	Mild
A2-BH04	0.3 - 0.5	Clayey SAND	Fill	A1	Non-aggressive
A2D-BH06	1.5 - 1.95	Sandy CLAY	Fill	A1	Non-aggressive
A2D-BH07	0.5 - 0.95	Sandy CLAY with gravel	Fill	A1	Non-aggressive
A2D-BH07	2.5 - 2.95	Sandy CLAY	Residual	A1	Non-aggressive
A2D-BH08	1 - 1.2	Sandy CLAY	Fill	A1	Non-aggressive
A2D-BH09	1.25 - 1.4	Clayey Sandy GRAVEL	Fill	A1	Non-aggressive
A2D-BH09	2.4 - 2.65	Sandy CLAY with gravel	Residual	A1	Mild
A2D-LD01	0.5 - 0.8	Gravelly Sandy SILT	Fill	A1	Non-aggressive
A2D-LD02	0.5 - 0.95	Gravelly Sandy SILT with ballast cobbles	Fill	A1	Non-aggressive
A2D-LD03	1 - 2	CLAY	Residual	A1	Mild
A2D-LD04	1.5 - 3.95 combined	Sandy CLAY	Fill	A1	Non-aggressive
A2D-LD04	4.5 - 6.95 combined	Sandy CLAY	Fill	A1	Non-aggressive

Investigation ID	Depth (m)	Material Description	Material Origin	Exposure classification to AS3600	Exposure classification to AS2159
A2-HA02	0.4 - 0.5	Sandy GRAVEL	Fill	A1	Non-aggressive
A2-TP01	0.3 - 0.6	Gravelly SAND	Fill	A1	Non-aggressive
A3-BH01	1.2 - 1.3	CLAY	Residual	A1	Mild
A3-BH03	1.7 - 1.8	CLAY	Residual	A1	Mild
A3-BH04	0.5 - 0.95	Sandy CLAY	Fill	A1	Non-aggressive
A3-BH04	2.5 - 2.95	Gravelly CLAY with sand	Residual	A1	Mild
A3-BH05	0.5 - 1.95	Silty Clayey SAND with gravel	Fill	A1	Non-aggressive
A3-BH06	1.5 - 2.95	Clayey SAND	Fill	A1	Non-aggressive
A3-BH06	3.5 - 4.95 combined	CLAY with gravel	Fill	A1	Mild
A3-BH07	1.5 - 1.7	CLAY	Fill	A1	Mild
A3-BH08	2.5 - 2.95	CLAY	Residual	A1	Mild
A3-BH10	4.1 - 4.2	CLAY	Residual	A1	Mild
A3-HA01	0.5 - 0.65	Clayey Sandy GRAVEL	Fill	A1	Non-aggressive
A3-HA02	0.3 - 0.5	Gravelly SAND with rubble	Fill	A1	Non-aggressive
A3-HA04	0.8 - 0.9	CLAY	Fill	A1	Mild
A3-HA05	0.3 - 0.4	Clayey Sandy GRAVEL	Fill	A1	Non-aggressive
A3-HA05	1.3 - 1.5	CLAY	Residual	A1	Non-aggressive
A3-HA06	0.3 - 0.4	Silty SAND with cobbles	Fill	A1	Non-aggressive

Investigation ID	Depth (m)	Material Description	Material Origin	Exposure classification to AS3600	Exposure classification to AS2159
A3-HA06	1 - 1.15	SHALE	Bedrock	A1	Non-aggressive
A3-HA07	0.6 - 0.7	Silty Sandy GRAVEL	Fill	A1	Non-aggressive
A3-LD/BH01	2.5 - 2.95	CLAY with gravel	Fill	A1	Non-aggressive
A3-LD02	0.5 - 1.95 combined	Sandy CLAY with gravel	Fill	A1	Non-aggressive
A4-BH02	0.7 - 0.9	Sandy CLAY	Fill	A1	Non-aggressive
A4-BH04	2.5 - 3.95	Clayey GRAVEL with sand	Fill	A1	Non-aggressive
A4-BH05	0.5 - 1.95	GRAVEL with ballast cobbles	Fill	A1	Non-aggressive
A4-BH08	0.3 - 0.4	Clayey SAND	Fill	A1	Non-aggressive
A4-BH09	0.5 - 0.95	Sandy CLAY	Residual	A1	Mild
A4-BH10	0.5 - 1.95	Clayey Gravelly SAND	Fill	A1	Non-aggressive
A4-BH12	0.5 - 0.95	Silty SAND	Fill	A1	Non-aggressive
A4-TP02	0.3 - 0.5	Silty SAND with cobbles and boulders	Fill	A1	Non-aggressive

6.3.2 Rock characterisation

For design purposes, the bedrock units are grouped by similar rock engineering behaviour and qualified by the Sydney Rock Mass Classification (SRMC). In summary, the units have been sub-divided into six classes, selected through a combination of rock strength, defect spacing and amount of weathered seams within nominated influence zones. SRMC criteria from Pells et al (1998) and Bertuzzi and Pells (2002) for the classification of shale and sandstone is presented below in Table 6-9.

Table 6-9 SRMC system criteria for shale and sandstone (from Pells et al, 1998)

Geotechnical Unit		UCS (MPa)	Defect spacing (mm)	Allowable seams
Unit 5 Shale	Class V	> 1	NA	NA
	Class IV	> 1	> 20	< 25%
	Class III or better	> 2	> 60	< 8%
Unit 7 Sandstone	Class V	> 1	NA	NA
	Class IV	> 2	> 60	< 10%
	Class III or better	> 7	> 200	< 5%

For the purposes of the geotechnical model development, the zone of rock being classified has been generally conducted “over a length of core of similar characteristics” (Pells et al, 1998). That is, the “classification system be applied to portions or units of rockmass having similar UCS, defect spacing and seam characteristics” (Bertuzzi and Pells, 2002).

Geotechnical design of individual elements will require revision of the rockmass classification based on the zone of influence of the structure. For instance, Pells et al (1978) states that the rockmass to be classified is for:

- Pad footings within a zone of influence of 1.5 times the least footing dimension, and,
- Socketed footings, within a zone equal to the length of the socket plus a further depth equal to the width of the footing.

There is very little published guidance as to the geotechnical parameters of the minor Mittagong Formation material. The unit is often encountered as a thin, variable material of interbedded fine-grained sandstone and shale. Where fresh, the fine-grained sandstone is typically observed as a high strength material and can be attributed similar parameters to Hawkesbury Sandstone. Where weathered, as is found within the GreenWay alignment, the shale beds may dictate the behaviour of footings, with parameters amended to suit.

Igneous dykes have been shown on the Geotechnical Long Sections interpolated from mapped intrusions. These dykes have not been encountered during the investigation but may be exposed during construction. Near surface, the features may be observed as extremely to highly weathered basalt/dolerite, of very low to soil strength. Where fresh this material may be encountered as medium to very high strength.

7. Geotechnical design parameters

Geotechnical design parameters are provided based on expected behaviour and the governing mechanisms of the different structures. Therefore, different parameters are provided for retaining walls and foundations.

The geotechnical design parameters have been selected based upon the laboratory and insitu test results discussed within this document, supplemented with published data and local experience, where appropriate.

Design parameters are provided as either a single value or a range, where appropriate. The adoption of specific design parameters within a given range should be based on the specific design element, the subsurface information available and the design approach. Specific design reports should provide guidance as the design parameters adopted in individual designs.

7.1 On-grade paths and pavements

On-grade paths are a prominent structure along the GreenWay alignment. The standard design for the on-grade paths are 3.5 m wide reinforced, 125 mm thick concrete over a Dense Graded Base.

On-grade paths will only be overlayed on Unit 2a and Unit 2b fill material across the project alignment. This must be taken into consideration when designing the path pavements and in the approach to construction as the variable nature of the fill material will require localised treatment eg. Excavation and replacement. A generic design suitable for economic construction over most the alignment may be developed, however it should be acknowledged localised amendments to the design are likely to be required during construction across the entire alignment. Therefore, some element of inspection and testing of the formation during construction is appropriate.

Table 7-1 presents the range of subgrade CBR likely to apply for the on-grade paths.

Table 7-1 Path subgrade CBR

Unit	Number of tests	CBR @ 5 mm			Design CBR (%)
		Min	Max	Mean	
Fill - Unit 2a	4	2.3	6.8	4.8	3.0
Fill - Unit 2b	2	4.4	7.7	6.1	3.0

In accordance with Table 7-1 above, design CBR adopted for the Unit 2a and Unit 2b is suggested as 3.0%. Whilst conservative, it reflects the variable nature of the fill material to be encountered along the alignment and likely to be appropriate for most ground conditions or otherwise require minimal treatment (eg. a small amount of excavation and replacement).

Prior to construction of the path pavement, the following is recommended as a minimum to achieve the required subgrade performance:

- Strip all topsoil;

- Excavate to formation level (as specified by the design) over excavate any obvious localised soft spots, deleterious material and large foreign objects and replace with compacted granular fill.
- Assessment of any removed fill should be made once stripped for potential re-use elsewhere.
- Placing of and suitably compacted non-cohesive, granular subbase / DGB to underside of the pavement.
- To avoid excessive excavation and replacement, any large areas of very soft / deep / otherwise unsuitable material should be referred to the superintendent for specific consideration or alternative solutions eg. A capping layer, separation and geogrid.

Ultimate thickness and type of base material to be placed is dependent on the subgrade strength and the design traffic loading. Further assessment of pavement structure, material and thickness should be made at detailed design stage using the information provided above as a guide.

7.2 Light pole footing

Light poles are proposed along the full length of the GreenWay alignment, typically 5 m high and 90 mm diameter, mounted in-ground for on-grade and low level elevated paths. At high-elevated paths, the lighting will be mounted on the structure.

As the near surface conditions along the alignment vary considerably, the design of light poles footings will require a number of potential standard types and sizes. In particularly the design of light pole footings within Area 1 will require careful consideration of the shallow uncontrolled fill, underlying compressible material and the potential for high groundwater table during flooding.

The following table presents preliminary design parameters to be adopted in the development of light pole footings.

Table 7-2 Preliminary bearing capacity parameters for light pole footings

Geotechnical unit	Ultimate end bearing (f_b) (kPa)	Ultimate shaft adhesion (f_s) (kPa)	Typical Young's Modulus (E') (MPa)	Serviceability bearing capacity (shallow or deep footings) (fa) (kPa)
Unit 2a – Reclamation Fill[1]	75	30	10	25
Unit 2b – Corridor Fill[2]	150	45	20	50
Unit 2c – Embankment Fill[3]	250	50	30	100
Unit 3a – Marine	90	8	4	30
Unit 3b - Alluvium	50	50	15	20
Unit 4 – Residual Soil	500	75	40	150

Notes to table

(1) Unit 2a is isolated to Area 1, with fill overlying the natural soft to firm marine soils. It is recommended that light pole footings designed in this area should be fully constructed within the reclaimed fill, to avoid exposure of the underlying marine soils and be subject to inspection during construction.
(2) Due to the highly variable nature of the Unit 2b 'corridor fill', where possible it is recommended that the design of footings in this material be avoided. Where required the above parameters should be used with caution and specific review of individual investigations nearby to the footings is recommended.
(3) Embankment fill is variable, representing the different timing and material sources during construction and therefore should be subject to inspection during construction to confirm expected bearing values.

The design of the light pole footings within Area 1 require careful consideration. It is recommended that detailed assessment of the light pole footings is performed to assess an economical and sustainable design that avoids the requirement of piling or excavation to depths greater than 2 m (above the typical groundwater level). We recommend that lightweight pad footings, constructed entirely within Unit 2a horizon may be possible.

Such footings may be constructed by over-excavating the Unit 2a material at the light pole site, and replacement with a lightweight fill. A lightweight concrete footing (e.g. a hollow precast unit), of sufficient size to avoid overturning, may then be constructed to support the light pole. This solution would result in a reduced or neutral net load to the underlying ground, potentially avoiding adverse settlement below the footing causing tilting of light poles over time. Settlement concerns may be reduced by avoiding excavation into the underlying marine sediments, together with reduced durability issues and disposal issues of potential Acid Sulfate Soils.

Non-displacement piles extending into the Unit 3a Marine soils may be considered, such as driven or screw piles, however, consideration of durability of piles will be required, dependant on the necessary design life. Such an option is likely a more expensive solution compared to the alternatives.

Whilst the pad footing should attempt to result in a reduced net loading on the ground below, the detailed design should take into consideration the buoyancy effect during potential flooding of the site and overturning due to lateral forces, such as wind loading.

Where not attached to structures, light pole footings in Areas 2 to 4 are anticipated to be constructed in either Unit 2b – Corridor Fill or Unit 4 – Residual Soil. Standard, shallow pad or piled footings are considered suitable for such areas using the preliminary design parameters presented above. It is recommended, however, that a suitably experienced geotechnical practitioner is involved to confirm the assessment of ground conditions during construction.

Where piled footings are chosen, the shaft adhesion values can only be adopted where piles have a minimum embedment of at least 2 pile diameters into the relevant stratum. A minimum 0.5 m embedment is required to adopt end-bearing values in relevant stratum.

7.3 Footing systems

Based on the site conditions suitable footing options for moderately to heavily loaded structures can include shallow pad/piled footings and deeper piles founded on the residual soil and bedrock. Bored piles will require casing through the fill and Unit 3 materials.

As a guide, strip, pad or bored piles founded on either the residual soil or shale/sandstone bedrock may be designed in accordance with the limit state design parameters in Table 7-3.

To support the analysis and limit state design of the foundations and structures, suggested geotechnical parameters are presented in Table 7-3 including values applicable to bored piles. The geotechnical parameters proposed in Table 7-3 have been derived from reference to published information, notably Pells et al (1998) and considering project-specific data. It is anticipated that the parameters will be optimised in conjunction with confirmation of local ground models during design, and to suit particular analytical approaches.

Ground conditions in the areas proposed for elevated structures are typically not suitable for driven piles.

Table 7-3 Preliminary design parameters for elevated structures

Geotechnical unit	Unit weight (kN/m^3)	Ultimate end bearing (f_b) (kPa)	Ultimate shaft adhesion (f_s) (kPa)	Typical Young's Modulus (E') (MPa)	Serviceability bearing (fa) (MPa)
4 – Residual Soil	20	500	75	40	150
5a – Shale Class V	21	3,000	80	150	700
5b – Shale Class IV	22	5,000	150	250	1,000
5c – Shale Class III or better	22	10,000	400	500	3,000
6 – Mittagong HW/MW	22	8,000	200	400	2,000
7a – Sandstone Class V	22	3,000	150	100	1,000
7b – Sandstone Class IV	23	10,000	500	500	2,500
7c – Sandstone Class III or better	23	30,000	1,200	1,000	5,000
Dyke – HW	21	250	50	50	75
Dyke – MW to Fr	24	20,000	250	1,000	4,000

Notes to table:

To adopt the parameters in the above table, piles should have a minimum embedment of 0.3 m into the relevant rock class and bases cleaned of debris and a clean socket of roughness R2 or better is required. Shaft adhesion values may have to be reduced if wall smear or polish is present.

For the design of piles, a geotechnical strength reduction factor Φ_g should be calculated based on the method presented in AS2159-2009. The value adopted for design will be dependent on factors such as the level of investigation available at a particular location and the nature and level of pile testing to be completed. Serviceability values provided are typical values only and have not been calculated using a Φ_g reduction factor.

It should be noted that ultimate resistance values occur at large settlements (>5% of the pile diameter). Pile settlements at serviceability loads should be assessed using the modulus values given in the table above. For serviceability, design both the settlement of individual piles and pile groups should be assessed.

Limit state design also requires assessment of the serviceability performance of the foundation system, including pile group interaction effects. This should be carried out by experienced geotechnical professional using well-established and soundly based methods. The modulus values given in the table can be used, though the accuracy of settlement prediction is dependent on construction methods as well as material stiffness, both of which can involve considerable uncertainty. Settlement predictions can have a large margin for error, and in some cases serviceability pile load testing should be completed when foundation settlement is critical to the structure's performance.

For laterally loaded piles, the lateral resistance of the bedrock units can be preliminarily taken to be 50% of the design values provided in the table.

Shaft adhesion values for the geotechnical units are based upon ranges provided in published data, with the adopted parameters based upon the subsurface properties observed along the GreenWay alignment. Guidance within Tomlinson (1994) suggests applying the following correlation to the average bedrock unconfined compressive strength (q_{uc}):

$$f_s = \alpha\beta.q_{uc}$$

Where β is a reduction factor related to fracture spacing, with α a reduction factor related directly to the unconfined compressive strength.

Applying such a correlation typically leads to higher capacities. The parameters have been applied by taking into account the calculated values, alternative published data (such as Pells, 1998) and previously applied values on similar Sydney projects.

Where there are localised excavations, such as adjacent to the light rail cutting, close to a major footings, bearing pressures may need to be downgraded by 50%. This may apply unless the entire base of the footing should lie outside a line projected upwards at 45° from the base of the excavation.

Where shallow footings are possible, the footings should be observed by a geotechnical practitioner to assess the exposed bedrock. Whilst the GreenWay is unlikely to require heavily loaded footings, where the required ultimate bearing pressure for shallow, pad or strip footings is greater than 3 MPa an assessment should also include spoon testing (or cored boreholes) to assess whether defects below the base of the footing are within tolerable limits for the respective rock class.

Where piles are adopted in design, a geotechnical practitioner should be engaged to observe piling and, depending on the adopted design parameters, proof coring may be required to confirm rock class at individual pile locations. Where an ultimate end bearing pressure of 3 MPa or greater is adopted initial allowance should be made for coring all pile or pile group locations. This requirement may be able to be reduced once pile layouts are known. In addition to verification of rock class by cored boreholes and observation of piling, pile load testing may also be required depending on the design loads and the settlement tolerances adopted. The need for pile testing should be assessed during detailed design, once footing layouts and loads are known, combined with an assessment of the confidence level required in the predicted settlements.

Whilst not encountered during the recent investigation, igneous dykes are known to intersect the GreenWay alignment. The parameters provided for weathered dyke material are included to allow for design of footings if encountered during construction. Where evident, it is recommended that footings are located away from dyke material or affected country rock, however, where this is not possible, the preliminary parameters may be used. It is recommended that dyke material be proof cored prior to construction to assess the rock strength, quality and depth.

Serviceability bearing capacity for footings within Fill and Alluvium can be estimated by adopting the parameters within Table 7-4. Due to the variability of the Fill, additional on-site confirmation of ground conditions and assessment of appropriate parameters should be performed at specific locations.

7.4 Retention structures

The following table provides soil and rock mass strength and stiffness parameters recommended for use in the design of retention structures.

The type of retention system will depend on a number of factors including the need to reduce induced ground movements due to structures near the excavation, and different ground conditions resulting in different failure mechanisms. Typical retention systems to be adopted along the GreenWay alignment include:

- soldier pile walls (with or without anchors)
- Contiguous piled walls
- soil nail walls
- low height blockwork or gravity walls

Retaining walls should be designed with due consideration of AS 4678 - Earth Retaining Structures and AS 5100 – Foundation and Soil Supporting Structures.

The design of flexible (embedded) retaining walls requires a good understanding of soil-structure interaction and the relative stiffness of the wall and support system to that of the soil/rock has a strong influence on the resulting earth pressure magnitude and distribution.

For the design of flexible retaining structures, where some wall movement is acceptable, it is recommended the design be based on active (K_a) lateral earth pressure. Where it is critical to limit the horizontal deformation of a retaining structure, use of an "at rest" (K_o) earth pressure coefficient is considered more appropriate.

The K_o values for rock materials having better quality (Class IV or better) are heavily reliant on the presence of discontinuities in the vicinity and its infill materials, in-situ stress regime, groundwater levels and excavation profile.

The wall friction angle on the active side of the wall should be taken as 2/3 of the effective friction angle. The wall friction angle on the passive side of the wall should be taken as half of the effective friction angle, but should be used with caution.

The design of block work retaining structures should consider checks for bearing capacity, overturning, sliding and overall stability of the slope.

For stability assessment considering earthquake loading, the earthquake hazard factor (Z) adopted for the project area is 0.08 as shown in Figure 3.2(A) of AS 1170.4-2007. The horizontal earthquake acceleration coefficient, a_h, given in Section I13 of AS 4678-2002 is:

$a_h = Z \approx 0.08$

The design earthquake coefficient (k_h) for the global stability analysis equals to one-half the acceleration coefficient (i.e. $k_h = 0.5a_h = 0.04$) in accordance with AS 5100.2 – 2017.

Table 7-4 Preliminary design parameters for retention structures

Unit	Description	Bulk unit weight (γ) (kN/m^3)	Effective cohesion (c') (kPa)	Effective friction angle (φ') (degrees)	Undrained shear strength (cu) (kPa)	UCS (MPa)	Elastic modulus (E') (MPa)	Elastic modulus range (E') (MPa)	Poissons ratio (v)	'At rest' Earth Pressure Coefficient (K_0)[1]	Active Earth Pressure Coefficient (Ka)	Passive Earth Pressure Coefficient (Kp)	Ultimate bond stress (kPa)
2a	Fill – Reclamation fill	18	0-3	25-30	0-40	N/a	10	5-20	0.3	0.5	0.35	2.8	N/a
2b	Fill – Corridor fill	19	0	33	N/a	N/a	10	10-40	0.3	0.5	0.3	3.3	10
2c	Fill – Embankment fill	19	0-5	30	N/a	N/a	10	5-20	0.3	0.5	0.4	2.5	10
3a	Marine deposits	17	0	24	15	N/a	10	5-15	0.35	0.5	0.4	2.5	N/a
3b	Alluvium	18	0	30	N/a	N/a	35	20-40	0.35	0.5	0.4	2.5	30
4	Residual soil	20	10	28	100-150	N/a	40	35-60	0.35	0.5	0.4	2.5	75
5a	Shale Class V	21	10	28	250	1	150	50-400	0.3	0.5[2]	0.4[2]	2.5[2]	150
5b	Shale Class IV	22	20	28	N/a	2	250	100-500	0.3	0.5[3]	0.33[3]	3.0[3]	300
5c	Shale Class III or better	22	100	30	N/a	5	500	300-1000	0.25	N/a	N/a	N/a	600
6	Mittagong Class	22	80	32	N/a	4	400	300-800	0.3	N/a	N/a	N/a	400

Unit	Description	Bulk unit weight (γ) (kN/m^3)	Effective cohesion (c') (kPa)	Effective friction angle (φ') (degrees)	Undrained shear strength (cu) (kPa)	UCS (MPa)	Elastic modulus (E') (MPa)	Elastic modulus range (E') (MPa)	Poissons ratio (v)	'At rest' Earth Pressure Coefficient (K_0)[1]	Active Earth Pressure Coefficient (Ka)	Passive Earth Pressure Coefficient (Kp)	Ultimate bond stress (kPa)
7a	Sandstone Class V	22	30	35	250	1	100	50-150	0.3	0.5[3]	0.27[3]	3.7[3]	200
7b	Sandstone Class IV	23	100	35	N/a	5	500	100-1000	0.25	N/a	N/a	N/a	400
7c	Sandstone Class III or better	23	200	36	N/a	12	1,000	350-1500	0.25	N/a	N/a	N/a	1000

Notes to table

(1) Initial ground movement assumed of about 0.1 % to 0.3 % of the wall height, causing reduction of the initial horizontal stress condition for rocks, but still higher than active earth pressure. For more sensitive structures, a soil-structure interaction analysis should be carried out considering the initial stress condition. Passive earth pressure require higher wall deflection to be mobilised.

(2) Earth pressures presented represent Unit 5a material where movement may occur along potential clay coated joint planes at 50-70 degree from horizontal

(3) Earth pressures presented represent rock mass failure mode

(4) Where specific in-situ Ko values are required for detailed soil-structure analysis, specific testing should be performed

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7.5 Excavatability

Due to the extensive nature of the site, passing through various areas of multiple ground conditions, excavation along the GreenWay is anticipated to be performed through the use of various size plant and machinery, ranging from small difficult access equipment to large-scale excavators. It is anticipated that excavation of the main, at-grade shared path sections will be performed using standard earthmoving equipment, with larger, specialist equipment employed at the jacked tunnel locations.

The assessment of the excavatability of rock for open earthworks can be very subjective and will depend on a number of factors including:

- the properties of the ground, in particular the strength of the intact rock and the spacing and nature of the defects in the rock mass
- the method of working and available working site size
- the type and size of excavating equipment used
- equipment condition/maintenance
- operator skill
- economics/productivity

For the excavation of the weathered and fresher rock materials, a number of excavatability assessment methods and charts are available to estimate machine types and production rates. Typically, these assessments utilise fracture spacing, rock strength and/or seismic velocity from geophysical investigations.

Pettifer and Fookes (1994) presents a chart of assessing excavatability based on Point Load Index (Is_{50}) and fracture spacing. Table 7-5 presents a review of the geotechnical units based on the average defect spacing and $Is_{(50)}$ strength.

Table 7-5 Assessed excavatability of material

Geotechnical unit	Approximate average $Is_{(50)}$ (MPa)	Typical fracture spacing index (I_f) (m)	Assessed excavatability[1]
2/3/4 - Fill/Alluvium/ Residual Soil	N/a	N/a	Easy to hard digging
5a – Shale Class V	0.1	0.04	Easy to hard digging
5b – Shale Class IV	0.2	0.15	Hard digging
5c – Shale Class III or better	>0.3	0.23	Easy ripping to very hard ripping
6a – Mittagong	0.2	0.2	Hard digging or hard ripping
7a – Sandstone Class V	0.1	0.2	Hard digging
7b – Sandstone Class IV	0.25	0.5	Easy ripping

Geotechnical unit	Approximate average $Is_{(50)}$ (MPa)	Typical fracture spacing index (I_f) (m)	Assessed excavatability[1]
7c – Sandstone Class III or better	>0.6	1.1	Hard ripping and very hard ripping to blasting and hydraulic breaking
Dyke	unknown	unknown	Easy digging to hard ripping

Notes to table

(1) Estimated from Pettifer and Fookes, 1994).

(2) The current concept design indicates that excavation of material with higher strength than that shown for Unit 7c. Where excavations are planned in Unit 7c, a detailed review of the Engineering Borehole Logs should be performed to assess areas of higher strength or less fracturing, where excavation may require specialist equipment
Excavation and piling contractors should be provided with the Engineering Borehole Logs and core photographs and be required to make their own assessment of the suitability and productivity of particular excavation or piling plant.
Excavation of Unit 8 Dyke materials may be required. Due to the lack of exposure of these materials, it is not possible to provide guidance on the plant suitable for excavation. Where observed in a completely weathered form the material is likely to be excavated by regular machine and bucket. In a fresh form, the dyke materials can be observed fractured but of high strength, requiring hydraulic breaking

7.6 Cut batters and batter support

It is anticipated that temporary and permanent cut batters will be required in the construction of the GreenWay. Table 7-6 presents advice for shallow cut slopes, less than 3m, not to be supported by engineer-designed retaining walls At any of these recommended batter angles, an assessment would also be required of the potential for global failure or a more extensive planar/wedge failure within bedrock units.

Table 7-6 Recommended excavated batter angles

Material	Permanent Batter Exposed	Permanent Batter Protected[4]	Temporary Batter Exposed	Temporary Batter Protected[1]
Unit 2 Fill	2.5H:1V	2.25H:1V	2H:1V	1.75H:1V
Unit 3 Alluvium	Not recommended			
Unit 4 Residual Soil	2H:1V	1.5H:1V	1.5H:1V	1.5H:1V
Unit 5a Shale Class V	2H:1V	1.5H:1V	1.5H:1V	1H:1V
Unit 5b Shale Class IV	1.5H:1V	1H:1V	1.5H:1V	1H:1V
Unit 5c Shale Class III or better[2]	Vertical	Vertical	Vertical	Vertical
Unit 6 Mittagong	1.5H:1V	1H:1V	1.5H:1V	1H:1V
Unit 7a Sandstone Class V	2H:1V	1.5H:1V	1.5H:1V	1H:1V
Unit 7b Sandstone Class IV	1H:1V	0.5H:1V	1H:1V	0.5H:1V
Unit 7c Sandstone Class I to III Sandstone[3]	Vertical	Vertical	Vertical	Vertical

Notes to table

(1) Temporary batter may be protected by short-term measures such as anchored or tied down plastic sheeting, or a thin layer of sprayed-on emulsions such as fibrecrete, gunite or bitumen, which promote runoff across the batter.

(2) Permanent vertical batters (<2 m high) in Class III to I Shale, which are protected long-term from the weather by structural elements, may need shotcrete with localised rock bolting to support unfavourably oriented defects and reduce fretting. Higher vertical shale batters will require either retaining wall support or systematic bolting/ anchoring/shotcreting to support larger wedges and some unfavourably oriented (lower angled) fault features.

(3) Localised rock bolting may be required to stabilise minor rock wedges or blocks formed by unfavourably oriented defects. Significant shale bands in the sandstone may require shotcrete protection against degradation.

(4) Permanent protection is assumed to involve shotcrete with adequate drainage. A building structure may provide satisfactory long-term protection from the weather and other destabilising influences (eg broken water services).

In areas where steep cuts are proposed for residual soil and weathered shale, soil nails may be a suitable alternative to retaining walls. Suggested geotechnical parameters applicable to soil nail design are presented in Section 7.4.

7.7 Jacked tunnel culvert and cut and cover tunnelling

Jacked tunnel culverts and/or cut and cover tunnels have been proposed at 3 locations along the project alignment. A borehole investigation and triaxial testing has been undertaken on the Unit 2c embankment road and rail fill material observed at each of these locations. Tunnelling is a highly specialised operation-requiring specialist and experienced contractors to design and construct these structures. The following is subject to review by a specialist contractor when undertaking detailed design and construction of thetunnels should review the following information:

- The results from the triaxial testing are summarised in Table 5-3. The triaxial testing was competed in the materials likely to be impacted by the jacked tunnelling;
- The borehole logs of the relevant and surrounding locations; and,
- The geotechnical long section prepared as part of this report.

It should be noted that a specialised tunnelling contractor may propose additional borehole drilling at critical locations in the detailed design stage of these structures.

7.8 Earthquake site sub-soil classification

The Earthquake Hazard Factor, Z, for the Sydney region is 0.08. Site subsoil classification along the GreenWay alignment varies. It is recommended that a specific site classification, in accordance with Section AS 1170.4-2007, is assessed at each major structure along the alignment during detailed design.

8. Geotechnical discussion and design considerations

The following section discusses the geotechnical considerations for the relevant GreenWay design elements. It is understood that the following structures have been proposed across the alignment.

- On-grade paths typically 3.5 m wide reinforced, 125 mm thick concrete over a Dense Graded Base, typically constructed 100 to 200 mm above the existing ground level to minimise excavation.
- High-level elevated paths typically 3.5 m wide steel superstructures, with FRP deck and steel balustrades, either supported on piles or directly bolted into rock. Typically 0.5 m to 4 m high.
- Retaining walls typically block work walls on strip footings or contiguous pile if required by site constrains. Typically 0.5 m to 2.5 m high.
- Tunnels typically jacked 3.5 x 2.4 m box culverts or cut and cover.
- Light poles are 5 m high and 90 mm diameter with a WE-EF VFL530 LED luminaire, mounted in-ground for on-grade and low level elevated paths, and off the structure for high-level elevated paths.

The concept design prepared by IWC has specified where each of the design elements are required across all 4 areas of the alignment. These elements are discussed per area in further detail below.

8.1 Area 1

Design element	Discussion	Potential Risks
On-grade shared path foundation generally in the area along the Bay Run and through Richard Murden Reserve; 1575 m long on-grade path through Richard Murden Reserve and 190 m on-grade shared path along Bay Run	• The on-grade path for area one is to be built entirely on reclamation fill material of varying compaction, quality and depth. • The typical methodology for laying the new path is to strip topsoil, over excavate and recompact fill material, remove deleterious material/soft spots or large foreign objects then placing of DGB. DGB would need to be compacted to a specified density before the path is constructed.	• CBR testing completed on unit 2a fill material ranged from 2.3 to 6.8 and therefore inconsistent. • Due to the uncontrolled nature of the Unit 2a fill material, deleterious material/soft spots or large foreign objects may be encountered resulting in over excavation. • Geogrid or geofabric should be considered to segregate the uncontrolled fill from the placed DGB material to minimise the risk of differential settlement below the pavement.

Design element	Discussion	Potential Risks
Light pole foundations at nominal 15 m spacings – 1575 m long on-grade path through Richard Murden Reserve and 190 m on-grade shared path along Bay Run	• It is recommended that high level, pad footings are used for the foundation of the light poles. • Excavation of the fill material and placement of geogrid and geo-fabric along an extended base of the proposed footing and designed to spread the footing load over a wider area is also suggested. This will help to segregate fill material from the light pole foundation and assist in spreading the load of footing evenly on the fill. • Footing design should minimise the risk of potential settlement of the footing by designing footings to minimise dead load increase on underlying soft clays to avoid reactivating consolidation and settlement. This would need careful consideration of the materials used (eg. lightweight / honey-combed / replace underlying fill with lighter materials) and the depth of the footing (as high as possible). • It is understood that monopoles have been proposed for the site. The success of a monopole approach will depend on the thickness of available fill and should be considered on a case-by-case basis.	• Settlement of fill material / marine sediments below the footing may cause leaning of the light poles, especially in flood events. • Low uplift capacity due to the lightweight nature of the footings during a flood event may lead to buoyancy issues and should be considered in the overall design.
Foundations and footings for 30 m long elevated ramp structure at junction of Bay Run and Greenway	• Soft to very soft marine sediments up to 4 m thick overlay residual soil profile. • Shallow foundations are not suitable for this area. The most appropriate solution is a piled foundation solution, extending into a suitable depth of rock.	• If bored piles are the selected type of pile, casing will be required to minimise the risk of cave-in. • Excessive vibration potential when using driven piles in an urban environment. • Bedrock level is undulating and will vary in strength due to Iron Cove and the Hawthorne Canal waterways.

Design element	Discussion	Potential Risks
		• Piles will need to be suitably designed for the purpose of durability in this costal, corrosive environment. • The location of proposed construction is in an extremely tight area for access and will require the use of specialised restricted access plant and methods of working.
Foundations and footings for 30 m long retaining wall(s) to support earthen ramp on Bay Run on approach to Lilyfield Road bridge	• Based on the investigation works and relevant as-built plans, the footpath pavement at the location of the proposed ramp widening is a heavily reinforced, post tensioned concrete plank. • Widening the currently utilised ramp for the purpose of this project is not anticipated to require any additional foundation construction, other than requirements to widen the ramp itself.	• The location of proposed construction is in an extremely tight access area and will require specialised limited access machinery and construction methods. • Depending on the final width of the ramp, additional work may be required to upgrade the sea wall of the Iron Cove bay.

8.2 Area 2 (Including Area 2 Discretionary)

Design element	Discussion	Potential Risks
Cantilevered structure from Parramatta Road underpass to the Gadigal Reserve Dog Park for approximately 60 m	• Piling / Piers to suspend the GreenWay off the embankment on the east side of the Hawthorne Canal wall is currently proposed. • Piles must extend into suitable bedrock for bearing and stability purposes. Shallow bedrock in the area will be beneficial to this process. • Cast-in-situ reinforced bored piles are likely to be appropriate for this work.	• Cave in of embankment fill during bored piling • Disturb the integrity of the Hawthorne Canal wall and compromise the integrity of the IWLR embankment due to the proposed close proximity of construction to the wall and embankment • Difficult access to the area will require specialised, limited access plant and working methods. • Driven piles are not recommended due to the potential vibration induced impact on the

Design element	Discussion	Potential Risks
	• Utilising sleeves / casing during the pile construction is recommended in the soil section behind the Hawthorne Canal wall to ensure minimal lateral load is placed on the existing wall during construction. • The sleeving is also anticipated to minimise the risk of de-stabilising the IWLR embankment during and post construction. • Water ingress is expected particularly below the toe of the embankment during piling	Hawthorne Canal wall and overall IWLR embankment stability
On-grade shared paths foundations and footings generally in the area on an eastern alignment through Gadigal Reserve for 160 m long path plus path lighting poles at nominal 15 m spacings	• The on-grade path for Area 1 is to be built entirely on Unit 2b corridor fill material of varying compaction, quality and depth. • The typical methodology for laying the new path is to strip topsoil, over excavate and recompact fill material, remove deleterious material/soft spots or large foreign objects then placing of DGB. DGB would need to be compacted to a specified density before the path is constructed.	• CBR of fill material 7.5% in Gadigal Reserve Dog Park. Based on that result less risk for footpath construction however, general corridor fill material is variable and contains waste material therefore cannot be relied upon.
Light pole foundations and footings generally in the area on an eastern alignment through Gadigal Reserve for 160 m at nominal 15 m spacings	• It is recommended that high level, pad footings are used for the foundation of the light poles. • Excavation of the fill material and placement of geogrid and geo-fabric along an extended base of the proposed footing and designed to spread the footing load over a wider area is also suggested. This will help to segregate fill material from the light pole foundation and assist in spreading the load of footing evenly on the fill. • Footing design should minimise the risk of potential settlement of the footing by designing footings to	• Settlement of fill material / marine sediments below the footing may cause leaning of the light poles, especially in flood events. • Low uplift capacity due to the lightweight nature of the footings during a flood event may lead to buoyancy issues and should be considered in the overall design.

Design element	Discussion	Potential Risks
	minimise dead load increase on underlying soft clays to avoid reactivating consolidation and settlement. This would need careful consideration of the materials used (eg. lightweight / honey-combed / replace underlying fill with lighter materials) and the depth of the footing (as high as possible). • It is understood that monopoles have been proposed for the site. The success of a monopole approach will depend on the thickness of available fill and should be considered on a case-by-case basis.	
Foundations and footings for a minor 4 m wide, 9 m long single span bridge over the Hawthorne Canal at the southern end of Gadigal Reserve	• Pile to extend into rock on both sides of the Hawthorne canal. Piles to extend into rock to a suitable depth. • Piles must extend into suitable bedrock for bearing and stability purposes. Shallow bedrock in the area will be beneficial to this process. • Cast-in-situ reinforced bored piles are likely to be appropriate for this work. • Utilising sleeves / casing during the pile construction is recommended in the soil section behind the Hawthorne Canal wall to ensure minimal lateral load is placed on the existing wall during construction. • The sleeving is also anticipated to minimise the risk of de-stabilising the IWLR embankment during and post construction. • Water ingress is expected particularly below the toe of the embankment during piling	• Disturb the integrity of the Hawthorne Canal wall due to the proposed close proximity of construction to the wall • Difficult access to the area will require specialised, limited access plant and working methods. • Driven piles are not recommended due to the potential vibration induced impact on the Hawthorne Canal wall and overall IWLR embankment stability.

Design element	Discussion	Potential Risks
Foundations and footings for a 75 m long elevated shared path structure on an eastern alignment at the southern end of Gadigal Reserve	• Piling / Piers to suspend the GreenWay off the ground on the east side of the Hawthorne Canal wall is currently proposed. • Piles must extend into suitable bedrock for bearing and stability purposes. Shallow bedrock in the area will be beneficial to this process. • Cast-in-situ reinforced bored piles are likely to be appropriate for this work. • Utilising sleeves / casing during the pile construction is recommended in the soil section behind the Hawthorne Canal wall to ensure minimal lateral load is placed on the existing wall during construction. • The sleeving is also anticipated to minimise the risk of de-stabilising the IWLR embankment during and post construction. • Water ingress is expected particularly below the toe of the embankment during piling	• Whilst IWLR embankment is minimal at this location, monitoring will be required during construction to minimise the risk to the integrity of the embankment. • The interaction between the piled foundations and the existing Main Southern Railway rail bridge needs to be considered in detailed design. • Cave in of embankment fill during bored piling • Disturb the integrity of the Hawthorne Canal wall and compromise the integrity of the IWLR embankment due to the proposed close proximity of construction to the wall and embankment • Difficult access to the area will require specialised, limited access plant and working methods. • Driven piles are not recommended due to the potential vibration induced impact on the Hawthorne Canal wall and overall IWLR embankment stability
30 m long jacked culvert below Longport Street on an eastern alignment	• Jacked culvert construction design requires input from specialist contractors. • 1 borehole, A2D-LD04, was completed as close as possible to the proposed location of the jack box tunnel below Longport Street. • Unit 2c fill material is encountered below Longport Street. During the investigation, fill material encountered was mostly uniform, however, the uncontrolled nature of the fill must be considered in	• Jacking can induce both “ground loss” (displacements into the tunnel) and heave as the box is jacked. Lateral heave adjacent to the existing brick abutment could induce distress in the brick abutment, and potential failure if sufficient control measures, are not implemented. • Due to the heavily trafficked nature of Longport Street and the uncontrolled fill material the proposed tunnel is to be jacked through, ground

Design element	Discussion	Potential Risks
	design. The encountered fill material extended to approximately 9 mbgl. • A triaxial test was completed on this material to further understand the shearing properties of this material, which will aid in the jack box tunnelling design process (see section 5.4.1 for results). • Consideration must be placed on the location of the thrust pit, the access constraints of the area and how to manage the construction risk due to the historic nature of the brick structure. • Jack box tunnelling in this location is anticipated to be a viable option but IWC must engage a specialist contractor to make further assessment.	loss due to over excavation is a risk that could directly affect the traffic above. • Controls can include additional excavation, increased offset from the abutment (though this affects the GreenWay alignment and embankment widening measures required north of the embankment) and/or buttressing or reinforcement of the abutment. • Ground support will be required in advance of the excavation through the fill. Support may be by forepoling/pipe arch and shotcrete, or soil nail stabilisation. This form of control must be discussed with a specialist contractor. • Due to the increased depth of fill in this structure, settlement considerations during construction below the jack box tunnel must be considered.
Wetland with 375 m^2 footprint just south of Longport Street on eastern side of light rail tracks	• DCP count in this area indicated that the density of the Unit 2b corridor fill is on average 5 blows per 100 mm or Medium Dense. • Based on the investigation in this area a minimum 20 tonne excavator is recommended to complete the earthworks component of the Wetlands.	• Uncontrolled corridor fill including buried rail track components and materials in this area may hinder excavation process. Recommend larger excavator to complete earthworks component to minimise this risk.
Stairs to Longport Street and tiered seating south of Longport Street on western side of light rail tracks	• Footings for the proposed staircase are likely to be shallow pad footings, founded within Unit 2c embankment fill or Unit 2b general corridor fill. • It is recommended that a specified amount of this fill is excavated, replaced, and suitably compacted prior to placing footings.	• Uncontrolled Unit 2b/c fill including waste material of variable density / consistency. Need to be mindful of unintentional over excavation and potential differential settlement below the footing. • Geogrid or geofabric should be considered to segregate the uncontrolled fill from the base of the

Design element	Discussion	Potential Risks
		footing to minimise the risk of differential settlement below.
Central median tree pits approximately 75 m long in Weston Street (to inform excavation only)	• Two boreholes were drilled on Weston Street to assess the anticipated ground conditions for the planted central medians. • Atterberg testing was conducted on pavement fill to assess the plasticity of the material. Fill material is shown to be granular with a minor component of low plasticity clay. • A small layer of residual, medium plasticity clay was observed in A2-BH03 of a very stiff to hard consistency. • Sandstone bedrock is shallow within A2-BH03 and A3-BH04, at 1.2 mbgl and 1.05 mbgl respectively.	• It is currently unclear on the depth of proposed excavation for the tree medians proposed by council. Based on the investigation in the road pavement of Weston Street, excavation may prove difficult due to the high consistency / density of the residual material and pavement fill material likely to be encountered during construction. If excavation is to extend below 1 m, sandstone bedrock may be encountered, causing hard excavation. • Vegetation / Trees with non-invasive root systems must be used for the median tree pits due to the risk of root jacking and increased shrink/swell risk of the pavement subgrade.

8.3 Area 3

Design element	Discussion	Potential Risks
30 m long jacked culvert below Davis Street	• Jacked culvert construction design requires input from specialist contractors. • 1 borehole, A3-LD/BH01, was completed as close as possible to the proposed location of the jack box tunnel below Davis Street. • Unit 2c fill material is encountered below Davis Street. During the investigation, fill material encountered was mostly uniform, however, due to the uncontrolled nature of the fill material this should not be relied upon. Unit 4a residual soil is anticipated	• Jacking can induce both “ground loss” (displacements into the tunnel) and heave as the box is jacked. Lateral heave adjacent to the existing brick abutment could induce distress in the brick abutment, and potential failure if sufficient control measures, are not implemented. • Due to the uncontrolled fill material the proposed tunnel is to be jacked through, ground loss due to over excavation is a risk that could directly affect the road traffic above.

Design element	Discussion	Potential Risks
	to be approximately 2 to 3 m below the base of the proposed jacked box tunnel. • A triaxial test was completed on the Unit 2c fill material to further understand the shearing properties of this material locally, which will aid in the jack box tunnelling design process (see section 5.4.1 for results). • Consideration must be placed on the location of the thrust pit, the tight access constraints of the area and how to manage the construction risk due to the historic nature of the brick abutment in the near vicinity • Jack box tunnelling in this location is anticipated to be a viable option but IWC must engage a specialist contractor to make further assessment.	• Controls can include additional excavation, increased offset from the abutment (changing the alignment to be as far as possible from the abutment), buttressing or reinforcement of the abutment, or soil nail stabilisation of the abutment. • Ground support will be required in advance of the excavation through the fill. Support may be by forepoling/pipe arch and shotcrete, or soil nail stabilisation. This form of control must be discussed with a specialist contractor.
Cut and Cover tunnel below Davis Street	• Cut and cover construction design requires careful considerations of constraints / constructability and the selection of temporary / permanent support methods accordingly. • 1 borehole, A3-LD/BH01, was completed as close as possible to the proposed location of the cut and cover tunnel below Davis Street. • Unit 2c fill material is encountered below Davis Street. During the investigation, fill material encountered was mostly uniform, however, due to the uncontrolled nature of the fill material this should not be relied upon.	• Removing higher volumes of unsuitable unit 2c fill than anticipated – may encounter voids in the fill, soft spots and generally poor foundation material. Over-excavation may lead to undermining of the existing roadway. • Disruption to traffic and pedestrian flow along Davis Street. • Increased lateral pressure on the existing brick abutment could induce distress in the brick abutment, and potential failure if sufficient control measures, are not implemented. • Ground support and temporary works will be required in advance of the excavation. Inadequate ground support may cause (but is not limited to)

Design element	Discussion	Potential Risks
	• Potential for re-use of the excavated material to cover the tunnel once constructed. Suitability of material will need to be assessed. • Design will need to consider constructability and geotechnical factors to assess if a temporary sheet pile wall, a temporary/permanent contiguous pile wall or a simple battered excavation is favourable. The data gathered from this study may be used to perform a preliminary assessment. • Underground services are running parallel with the road overbridge. Relocation or protection of these underground services will be necessary for construction purposes. • Cut and cover tunnelling in this location is anticipated to be a viable option. It is recommended that specialist contractors assess the design and construction risks associated with such an option.	over-excavation, under-mining of the existing pavement and construction delays.
Foundations and footings for 200 m long low level elevated paths (<0.5 m high) and light pole foundations at nominal 15 m spacings from Davis Street to Johnson Park	• Excavation of A3-HA01 to A3-HA05 has shown Unit 2b corridor fill material exists for this entire section of the alignment, of loose to medium dense and dense material. • This material is expected to be able support shallow pad footings within the soil profile provided low bearing capacities are adopted. Stripping of surface materials to a suitable depth, appropriate compaction (and removal of local unsuitable material) and replacement will be required as a minimum.	• Uncontrolled corridor fill including buried rail track components and materials in this area may hinder striping process • Uncontrolled fill may also cause differential settlement below the shallow pad footings if not appropriately designed and treated.

Design element	Discussion	Potential Risks
	• Use of geogrid and geofabric at the underside of the pad footings will help segregate the pad footings from the underlying fill material.	
On-grade shared paths foundations and footings generally in the area in Johnson Park for 175 m shared paths	• Excavation of A3-BH01 to A3-BH05 has shown Unit 2b corridor fill material exists for this entire section of the alignment, of loose to medium dense and dense material. • This material is expected to be able support the on-grade structure within the soil profile provided low bearing capacities are adopted. Stripping of surface materials to a suitable depth, appropriate compaction (and removal of local unsuitable material) and replacement will be required as a minimum. • Use of geogrid and geofabric at the underside of the footpath will help segregate the pad footings from the underlying fill material.	• Uncontrolled corridor fill including buried rail track components and materials in this area may hinder striping process • Uncontrolled fill may also cause differential settlement below the shallow pad footings if not appropriately designed and treated.
Light pole foundations and footings generally in the area in Johnson Park for 175 m at nominal 15 m spacings	• Excavation of A3-BH01 to A3-BH05 has shown Unit 2b corridor fill material exists for this entire section of the alignment, of loose to medium dense and dense material. Underlying this material is Unit 4a residual soil or stiff to very stiff consistency. • In localised areas, residual soil may be encountered during the excavation of light pole foundations. • Either high level, pad footings or augered piles are likely suitable foundations for the light poles in this location where Unit 4a material is encountered. • Where entirely in fill, excavation of the fill material before placement of geogrid and geo-fabric at the base of the proposed footing is also recommended.	• Settlement of fill material below the footing may cause leaning of the light pole due to the uncontrolled nature of the fill material. • Due to the variable nature, augering through uncontrolled fill material is a construction risk if a pile foundation solution is preferred. Obstructions, cave-in or over excavation may occur.

Design element	Discussion	Potential Risks
	This will help to segregate fil material from the light pole foundation and assist in spreading the load of footing evenly on the fill.	
Retaining wall foundations and footings north of Constitution Road on the approach to the proposed jacked culvert below Constitution Road – two 40 m long retaining walls to the north	• Based on the investigation completed either side of Constitution Road, Unit 2b / 2c fill material is the likely material required to be retained by these structures. • Based on the anticipated ground conditions, strip footing supporting a block wall or an L-shaped gravity wall may be suitable. • It is likely that retaining will be founded in either unit 2b / 2c fill material or residual unit 4a soil depending on detailed design. Due to the anticipated shallow depth of the fill (approximately 2.0 m), it is recommended that retaining wall strip footings are founded on Unit 4a residual soil.	• Deeper fill than anticipated may be encountered requiring larger footings or deeper excavation. • If founded on fill, differential settlement of the retaining wall footing may occur over time. To mitigate this risk we suggest placing and compacting DGB as a foundation material in combination with a geosynthetic material prior to constructing the footing. • Limited space for batter slopes, particularly in Unit 2b fill, required during construction.
Retaining wall foundations and footings south of Constitution Road on the approach to the proposed jacked culvert below Constitution Road – one 40 m contiguous pile retaining wall to the south	• Based on the investigation completed either side of Constitution Road, Unit 2b / 2c fill material is the likely material required to be retained by this structure. Unit 4a residual soils may also be encountered depending on the extent of proposed excavation. • A contiguous or solider pile wall with piles embedded into natural material may be suitable with consideration of the extremely difficult access for construction. Detailed design phase may consider alternate options such as post and panel walls or similar.	• The topography and terrain to the south of Constitution Road will require consideration in terms of design and construction. • Consideration of the slope stability on the eastern side of the path will need to be considered during detailed design. • Due to the extremely limited access and inconsistent ground condition, a number of design and construction hazards require addressing in this area. • Consideration of dyke-affected ground conditions may be encountered during construction.

Design element	Discussion	Potential Risks
30 m long jacked culvert below Constitution Road	• Jacked culvert construction design requires input from specialist contractors. • 1 borehole, A3-BH06, was completed as close as possible to the proposed location of the jack box tunnel below Constitution Road. Other boreholes were also completed to tie-in the retaining structures proposed either side of the jack box tunnel. These boreholes have been used to further confirm the ground lithology in this area. • Two types of Unit 2c fill material were encountered below Constitution Road. The top layer of fill was granular and extended to 3.65 mbgl. The next layer of fill was cohesive and extended to 5.0 mbgl. Unit 4a residual soil is anticipated to be within 1 m of the base of the proposed jack box tunnel. • 2 triaxial tests were completed on both the encountered types of Unit 2c fill material to further understand the shearing properties of the materials locally, which will aid in the jack box tunnelling design process (see section 5.4.1 for results). • Consideration must be placed on the location of the thrust pit, the tight access constraints of the area and how to manage the construction risk due to the historic nature of the brick abutment in the near vicinity • Jack box tunnelling in this location is anticipated to be a viable option but IWC must engage a specialist contractor to make further assessment.	• Based on the current design, two types of fill material will be encountered when pushing the culvert. This must be considered in the tunnel design. • Jacking can induce both “ground loss” (displacements into the tunnel) and heave as the box is jacked. Lateral heave adjacent to the existing brick abutment could induce distress in the brick abutment, and potential failure if sufficient control measures, are not implemented. • Due to the uncontrolled fill material the proposed tunnel is to be jacked through, ground loss due to over excavation is a risk that could directly affect the road traffic above. • Controls can include additional excavation, increased offset from the abutment (changing the alignment to be as far as possible from the abutment), buttressing or reinforcement of the abutment, or soil nail stabilisation of the abutment. • Ground support will be required in advance of the excavation through the fill. Support may be by forepoling/pipe arch and shotcrete, or soil nail stabilisation. This form of control must be discussed with a specialist contractor. • The presence of a historical drainage easement and groundwater recorded during drilling at this location implies that conditions may include high water ingress.

Design element	Discussion	Potential Risks
Cut and Cover tunnel below Constitution Road	• Cut and cover construction design requires careful considerations of constraints / constructability and the selection of temporary / permanent support methods accordingly. • 1 borehole, A3-BH06, was completed as close as possible to the proposed location of the cut and cover tunnel below Constitution Road. Other boreholes were also completed to tie-in the retaining structures proposed either side of the tunnel. These boreholes have been used to further confirm the ground lithology in this area. • Two types of Unit 2c fill material were encountered below Constitution Road. The top layer of fill was granular and extended to 3.65 mbgl. The next layer of fill was cohesive and extended to 5.0 mbgl. Unit 4a residual soil is anticipated to be within 1 m of the base of the proposed tunnel. • Potential for re-use of the excavated material to cover the tunnel once constructed. Suitability of material will need to be assessed. • Design will need to consider constructability and geotechnical factors to assess if a temporary sheet pile wall, a temporary/permanent contiguous pile wall or a simple battered excavation is favourable. The data gathered from this study may be used to perform a preliminary assessment. • Underground services are running parallel with the road overbridge. Relocation or protection of these	• Removing high volumes of unsuitable unit 2c fill than anticipated – may encounter voids, soft spots and generally poor foundation material. Over-excavation may lead to undermining of the existing roadway. • Disruption to traffic and pedestrian flow along Constitution Street. • Increased lateral pressure on the existing brick abutment could induce distress in the brick abutment, and potential failure if sufficient control measures, are not implemented. • Ground support and temporary works will be required in advance of the excavation. Inadequate ground support may cause (but is not limited to) over-excavation, under-mining of the existing pavement and construction delays.

Design element	Discussion	Potential Risks
	underground services will be necessary for construction purposes. • Cut and cover tunnelling in this location is anticipated to be a viable option. It is recommended that specialist contractors assess the design and construction risks associated with such an option.	
150 m long high level elevated shared path from Constitution Road to south of New Canterbury Road	• Piles constructed within the rock batters along this section will be required for suitable foundation in this area. • Piles must extend into suitable bedrock for bearing and stability purposes. Footings will require extending into stable strata isolated from surficial instability. • Cast-in-situ reinforced bored piles are likely to be appropriate for this work, however more suitable options may be considered. In detailed design. • The positioning of the GreenWay along these batters requires consideration of exposure to slip hazards (both in terms of risk levels for users and structural performance). • The stability of the cuts will require review, with detailed geological mapping of the surfaces. A risk assessment of this cutting is presented in the Aurecon 2012 "*Light Rail Geotechnical Investigations"* report (reference 2 as presented in Section 10) for further reference. • Construction using elevated structures will require either isolation of footings from batters (to avoid effects of surface instability), stabilisation of batters,	• Difficult access to the area will require lightweight, limited access plant. Rail possession will be required to access the area with the appropriate equipment. • Driven piles are not recommended due to the potential vibration induced impact on surrounding properties and the IWLR infrastructure. • Rock quality in this area varies, with weathered Mittagong Formation bedrock and igneous dykes. Variable ground conditions may be encountered during construction, requiring additional on-site assessment to be performed. • Stability of the rock batters will need to be stringently assessed during detailed design. Whilst a ground model can be generated in this area, local defects and rock quality must be observed in detail.

Design element	Discussion	Potential Risks
	or increased lateral capacity to withstand batter loading. Batter stabilisation may similarly include soil nailing or local retention works. Unless batter stabilisation works are undertaken, the deck of a suspended structure is to be isolated from steep batter sections to avoid slips and slumps affecting the structure.	

8.4 Area 4

Design element	Discussion	Potential Risks
Batter slopes or retaining wall foundations and footings for proposed 90 m long earthen ramps at northern end of the area to connect to Hercules Street	• Limited investigation has been completed for this structure due to the existing dwelling to be acquired and demolished for this section of the path. • It is however anticipated that Unit 2b fill material will be the founding material for the proposed structure in this area. • Battered non-cohesive granular engineered fill compacted in a controlled manner is recommended for this area due to the favourable site conditions. • Batter slopes of the foundations will depend on the proposed material used and the compaction effort applied during construction of the batter slopes. • Strip topsoil, over excavate and recompact fill material, remove deleterious material/soft spots or large foreign objects then placing of controlled fill is recommended.	• No investigation has been completed within the private property to be acquired for the project. • Due to the uncontrolled nature of the fill material to be founded on, encountering poorer than anticipated fill is a risk to be considered. • Removing high volumes of unsuitable unit 2b fill than anticipated – strip and replace to suitable depth to uncover voiding, soft spots and generally poor foundation material.

Design element	Discussion	Potential Risks
On-grade shared paths foundations and footings generally in the area for 225 m	• The on-grade path for area one is to be built entirely on Unit 2b corridor fill material of varying compaction, quality and depth. • The typical methodology for laying the new path is to strip topsoil, over excavate and recompact fill material, remove deleterious material/soft spots or large foreign objects then placing of DGB. DGB would need to be compacted to a specified density before the path is constructed.	• General corridor Unit 2b fill material is variable and contains waste material therefore cannot be relied upon. • Heavily compacted fill material encountered during the investigation may require additional effort in construction during excavation activities.
Light pole foundations and footings generally in the area for 225 m	• It is recommended that high level, pad footings are used for the foundation of the light poles. • Excavation of the fill material before placement of geogrid and geo-fabric at the base of the proposed footing is also recommended. This will help to segregate fil material from the light pole foundation and assist in spreading the load of footing evenly on the fill.	• Settlement of fill material below the footing may cause leaning of the light pole due to the uncontrolled nature of the fill material. • Heavily compacted fill material encountered during the investigation may require additional effort in construction during excavation activities.
Batter slopes or retaining wall foundations and footings for proposed 95 m long earthen ramps at southern end of the area to connect to Hercules Street	• It is anticipated that Unit 2b fill material will be the founding material for the proposed structure in this area. • Battered non-cohesive granular engineered fill compacted in a controlled manner is recommended for this area due to the favourable site conditions. • Batter slopes of the foundations will depend on the proposed material used and the compaction effort applied during construction of the batter slopes. • Strip topsoil, over excavate and recompact fill material, remove deleterious material/soft spots or	• Due to the uncontrolled nature of the fill material to be founded on, encountering poorer and deeper than anticipated fill is a risk to be considered. • Removing high volumes of unsuitable unit 2b fill than anticipated – strip and replace to suitable depth to uncover voiding, soft spots and generally poor foundation material. • Heavily compacted fill was encountered in A4-BH04, A4-BH05 and A4-BH06. This will require increased effort in construction if bulk earth works is required in this area.

Design element	Discussion	Potential Risks
	large foreign objects then placing of controlled fill is recommended.	
Retaining wall foundations and footings for 30 m long retaining wall on Terrace Road below Bankstown rail line.	• Unit 4b residual soil is expected to be the foundation material of the retaining structure. • A block-work wall with a shallow strip footing on residual soil is anticipated to be sufficient for this structure. • The existing rail over bridge abutment should be considered in the design of this structure. However, removing the fill material for the purpose of this structure is not anticipated to affect the bridge.	• Due to the uncontrolled nature of the fill material to be founded on, encountering poorer and deeper than anticipated fill is a risk to be considered. • Difficulty in block wall construction due to the instability of the fill material. High volume of cobbles and boulders are anticipated.
Central median tree pits approximately 25 m long in Ness Ave (to inform excavation only)	• 1 borehole was drilled to assess the anticipated ground conditions for the planted central medians. • PSD testing was conducted on pavement fill to assess classification. Fill material is shown to be granular with a minor component of low plasticity clay. • A small layer of residual, clayey sand was observed in A4-BH08 of medium dense. • Sandstone bedrock is shallow within the borehole encountered at 0.6 mbgl.	• It is currently unclear on the depth of proposed excavation for the tree medians proposed by council. Based on the investigation in the road pavement of Ness Avenue, excavation may prove difficult due to the high density of the residual material and pavement fill material likely to be encountered during construction. If excavation is to extend below 0.5 m, sandstone bedrock may be encountered, causing hard excavation. • Vegetation / Trees with non-invasive root systems must be used for the median tree pits due to the risk of root jacking and increased shrink/swell risk of the pavement subgrade.

9. Recommendations for further work

The investigation represents the design stage. Investigation used to aid the further development of the greenway design and guide construction methodology.

During the detailed design stage, additional confirmation investigations may be required based on contractor requirements.

Typically, the level of investigation can affect reduction factors. Better and more thorough investigation allows for a lower reduction factor in detailed design phase.

10. References

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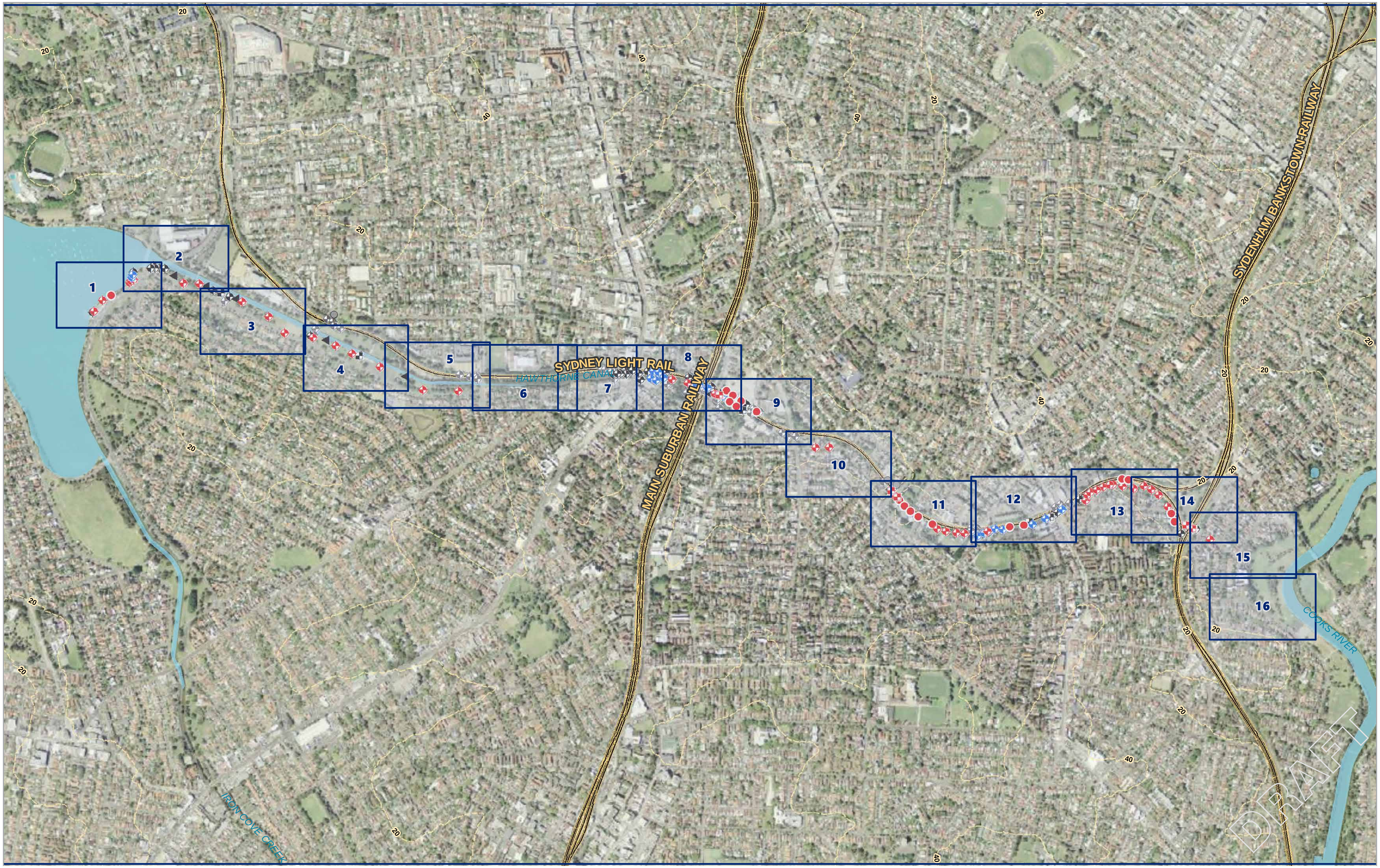
11. Geotechnical and contamination investigation figures



Legend

The GreenWay Investigation Locations
- Augered Borehole
- Cored Borehole
- Hand Auger
- Testpit

Historic Contamination Investigation Locations
- Borehole
- Hand Auger

Historic Geotechnical Investigation Locations
- Borehole
- CPT
- Testpit

- Contours
- Railways
- Watercourses
- Index

Paper Size ISO A3

0 100 200 300 400

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

The GreenWay Project

Geotechnical and Contamination Investigations - Overall Site View

Project No.	21-12515105
Revision No.	A
Date	28 Jan 2020

FIGURE 0

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Data source: General Topo - NSW LPI DTDB 2015. Aerial Imagery - Sixmaps 2018 . Created by: kqvelasco

Legend

The GreenWay Investigation Locations	Historic Contamination Investigation Locations	Historic Geotechnical Investigation Locations	
Augered Borehole	Borehole	Borehole	Contours
Cored Borehole	Hand Auger	CPT	Railways
Hand Auger		Testpit	Watercourses
Testpit			Index

Paper Size ISO A3

0 7.5 15 22.5 30

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

GHD

The GreenWay Project

Geotechnical and Contamination Investigations - LD_CD_101

Project No. 21-12515105
Revision No. A
Date 28 Jan 2020

FIGURE 1

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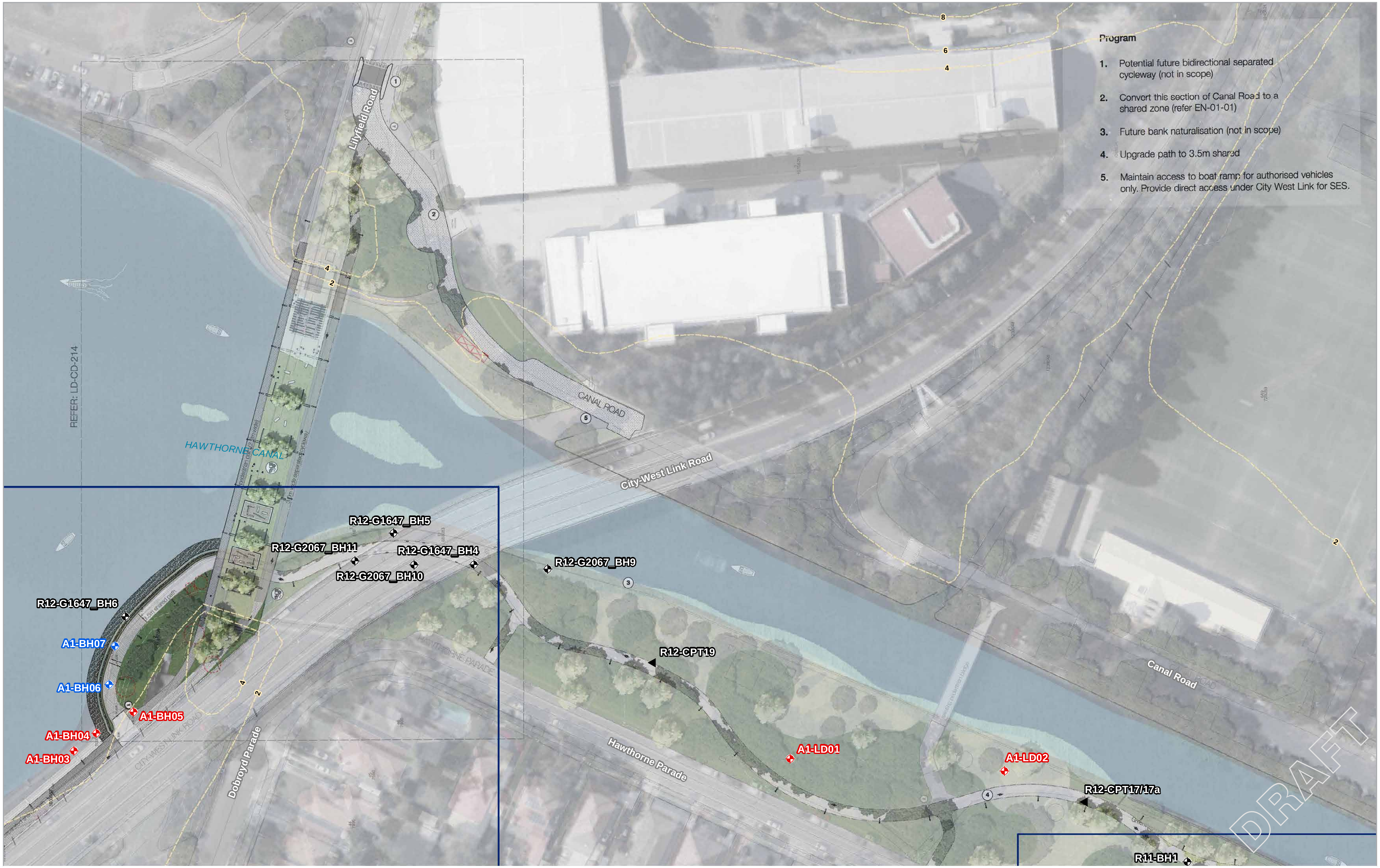

Legend

The GreenWay Investigation Locations
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- Borehole
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Paper Size ISO A3

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Meters

Map Projection: Transverse Mercator
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Grid: GDA 1994 MGA Zone 56

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GHD

The GreenWay Project

Geotechnical and Contamination Investigations - LD_CD_102

Project No. 21-12515105
Revision No. A
Date 28 Jan 2020

FIGURE 2

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Legend

The GreenWay Investigation Locations
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- Hand Auger
- Testpit

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Paper Size ISO A3

0 7.5 15 22.5 30

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

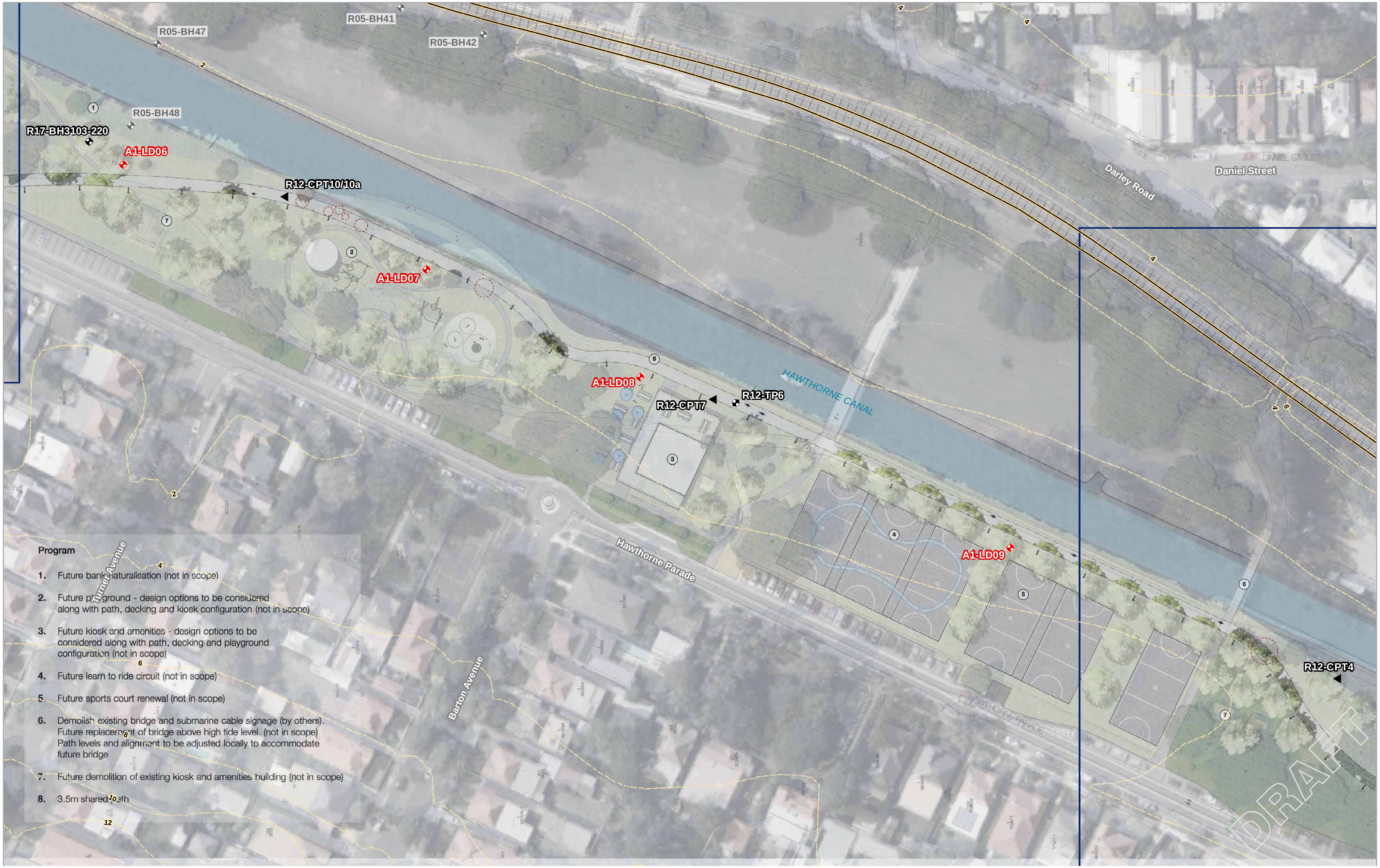
GHD

The GreenWay Project

Geotechnical and Contamination Investigations - LD_CD_103

Project No. 21-12515105
Revision No. A
Date 28 Jan 2020

FIGURE 3



Legend

The GreenWay Investigation Locations
- Augered Borehole
- Cored Borehole
- Hand Auger
- Testpit

Historic Contamination Investigation Locations
- Borehole
- Hand Auger

Historic Geotechnical Investigation Locations
- Borehole
- CPT
- Testpit

- Contours
- Railways
- Watercourses
- Index

Paper Size ISO A3
0 7.5 15 22.5 30
Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

The GreenWay Project

Geotechnical and Contamination Investigations - LD_CD_104

Project No. 21-12515105
Revision No. A
Date 28 Jan 2020

FIGURE 4

G:\21\12515105\GIS\Maps\Deliverables\21_12515105_Z003_GREENWAY_GCI_GeotechAndContaminationInvestigations.mxd
Print date: 28 Jan 2020 - 17:17

Data source: General Topo - NSW LPI DTDB 2015. Aerial Imagery - Sixmaps 2018 . Created by: kqvelasco

Legend

The GreenWay Investigation Locations
- Augered Borehole
- Cored Borehole
- Hand Auger
- Testpit

Historic Contamination Investigation Locations
- Borehole
- Hand Auger

Historic Geotechnical Investigation Locations
- Borehole
- CPT
- Testpit

- Contours
- Railways
- Watercourses
- Index

Paper Size ISO A3

0 7.5 15 22.5 30

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

GHD

The GreenWay Project

Geotechnical and Contamination Investigations - LD_CD_105

Project No. 21-12515105
Revision No. A
Date 28 Jan 2020

FIGURE 5

G:\21\12515105\GIS\Maps\Deliverables\21_12515105_Z003_GREENWAY_GCI_GeotechAndContaminationInvestigations.mxd
Print date: 28 Jan 2020 - 17:18

Data source: General Topo - NSW LPI DTDB 2015. Aerial Imagery - Sixmaps 2018 . Created by: kqvelasco

Legend

The GreenWay Investigation Locations
- Augered Borehole
- Cored Borehole
- Hand Auger
- Testpit

Historic Contamination Investigation Locations
- Borehole
- Hand Auger

Historic Geotechnical Investigation Locations
- Borehole
- CPT
- Testpit

- Contours
- Railways
- Watercourses
- Index

Paper Size ISO A3

0 7.5 15 22.5 30

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

The GreenWay Project

Geotechnical and Contamination Investigations - LD_CD_106

Project No. 21-12515105
Revision No. A
Date 28 Jan 2020

FIGURE 6

G:\21\12515105\GIS\Maps\Deliverables\21_12515105_Z003_GREENWAY_GCI_GeotechAndContaminationInvestigations.mxd
Print date: 28 Jan 2020 - 17:19

Data source: General Topo - NSW LPI DTDB 2015. Aerial Imagery - Sixmaps 2018 . Created by: kqvelasco

Legend

The GreenWay Investigation Locations
- Augered Borehole
- Cored Borehole
- Hand Auger
- Testpit

Historic Contamination Investigation Locations
- Borehole
- Hand Auger

Historic Geotechnical Investigation Locations
- Borehole
- CPT
- Testpit

- Contours
- Railways
- Watercourses
- Index

Paper Size ISO A3

0 7.5 15 22.5 30

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

GHD

The GreenWay Project

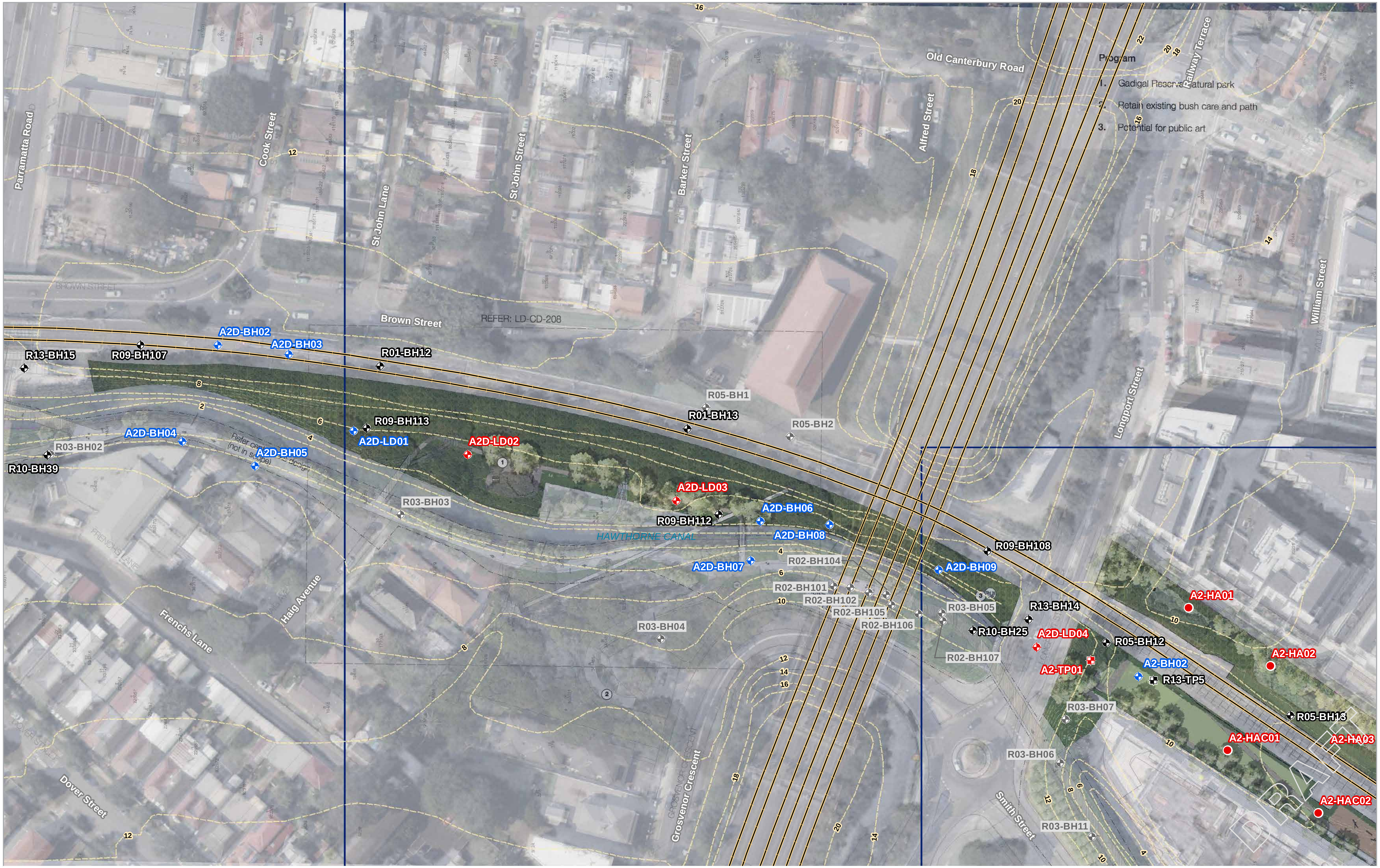
Geotechnical and Contamination Investigations - LD_CD_107

Project No. 21-12515105
Revision No. A
Date 28 Jan 2020

FIGURE 7

G:\21\12515105\GIS\Maps\Deliverables\21_12515105_Z003_GREENWAY_GCI_GeotechAndContaminationInvestigations.mxd
Print date: 28 Jan 2020 - 17:19

Data source: General Topo - NSW LPI DTDB 2015. Aerial Imagery - Sixmaps 2018 . Created by: kqvelasco



Legend

The GreenWay Investigation Locations
- Augered Borehole
- Cored Borehole
- Hand Auger
- Testpit

Historic Contamination Investigation Locations
- Borehole
- Hand Auger

Historic Geotechnical Investigation Locations
- Borehole
- CPT
- Testpit

- Contours
- Railways
- Watercourses
- Index

Paper Size ISO A3
0 7.5 15 22.5 30
Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

The GreenWay Project

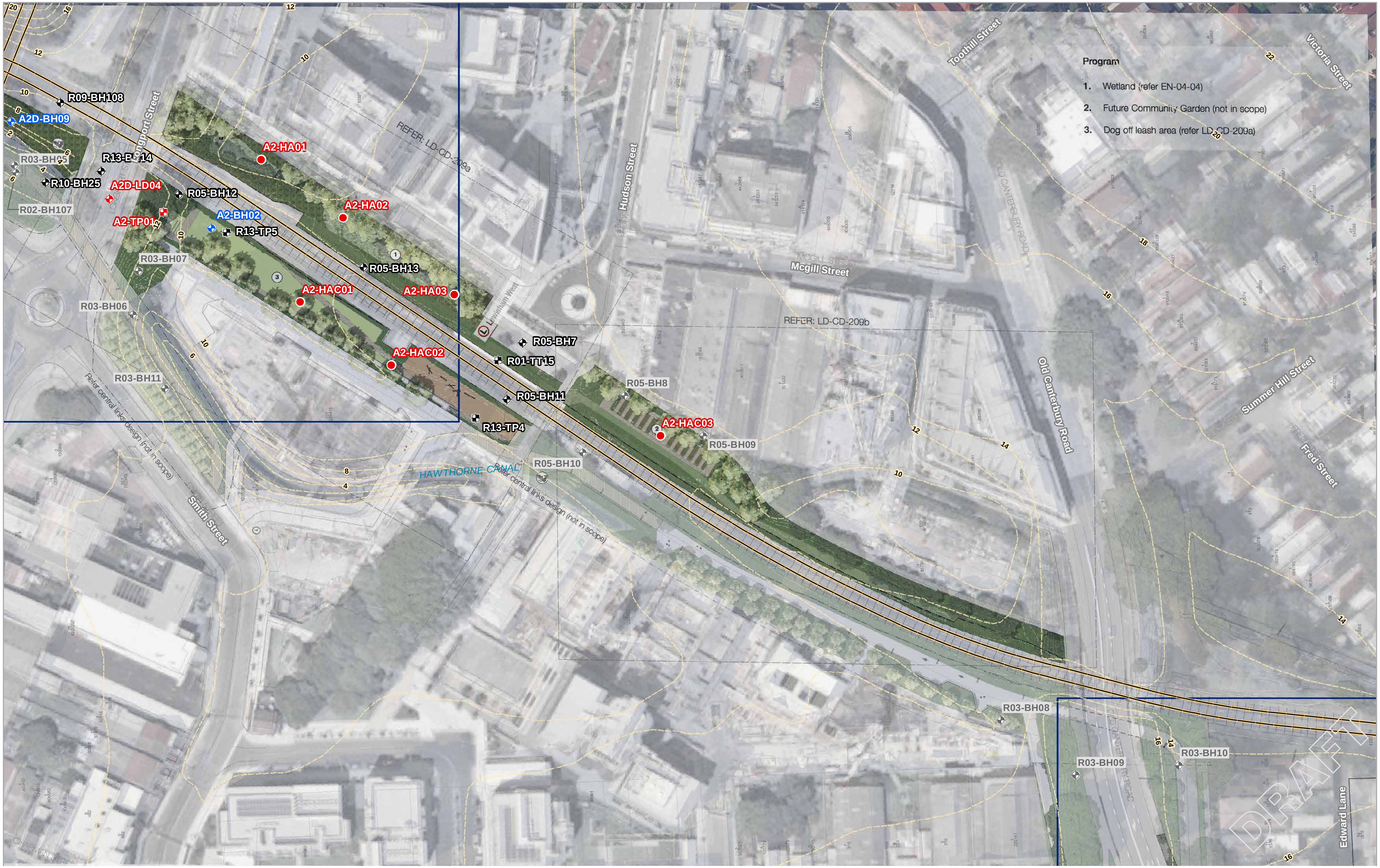
Geotechnical and Contamination Investigations - LD_CD_108

Project No. 21-12515105
Revision No. A
Date 28 Jan 2020

FIGURE 8

G:\21\12515105\GIS\Maps\Deliverables\21_12515105_Z003_GREENWAY_GCI_GeotechAndContaminationInvestigations.mxd
Print date: 28 Jan 2020 - 17:21

Data source: General Topo - NSW LPI DTDB 2015. Aerial Imagery - Sixmaps 2018 . Created by: kqvelasco



Legend

The GreenWay Investigation Locations	Historic Contamination Investigation Locations	Historic Geotechnical Investigation Locations	
Augered Borehole	Borehole	Borehole	Contours
Cored Borehole	Hand Auger	CPT	Railways
Hand Auger		Testpit	Watercourses
Testpit			Index

Paper Size ISO A3

0 7.5 15 22.5 30

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

The GreenWay Project

Geotechnical and Contamination Investigations - LD_CD_109

Project No. 21-12515105
Revision No. A
Date 28 Jan 2020

FIGURE 9

G:\21\12515105\GIS\Maps\Deliverables\21_12515105_Z003_GREENWAY_GCI_GeotechAndContaminationInvestigations.mxd
Print date: 28 Jan 2020 - 17:22

Data source: General Topo - NSW LPI DTDB 2015. Aerial Imagery - Sixmaps 2018 . Created by: kqvelasco

Legend

The GreenWay Investigation Locations
- Augered Borehole
- Cored Borehole
- Hand Auger
- Testpit

Historic Contamination Investigation Locations
- Borehole
- Hand Auger

Historic Geotechnical Investigation Locations
- Borehole
- CPT
- Testpit

- Contours
- Railways
- Watercourses
- Index

Paper Size ISO A3

0 7.5 15 22.5 30

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

GHD

The GreenWay Project

Geotechnical and Contamination Investigations - LD_CD_110

Project No. 21-12515105
Revision No. A
Date 28 Jan 2020

FIGURE 10

G:\21\12515105\GIS\Maps\Deliverables\21_12515105_Z003_GREENWAY_GCI_GeotechAndContaminationInvestigations.mxd
Print date: 28 Jan 2020 - 17:23

Data source: General Topo - NSW LPI DTDB 2015. Aerial Imagery - Sixmaps 2018 . Created by: kqvelasco

Legend

The GreenWay Investigation Locations
- Augered Borehole
- Cored Borehole
- Hand Auger
- Testpit

Historic Contamination Investigation Locations
- Borehole
- Hand Auger

Historic Geotechnical Investigation Locations
- Borehole
- CPT
- Testpit

- Contours
- Railways
- Watercourses
- Index

Paper Size ISO A3

0 7.5 15 22.5 30

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

GHD

The GreenWay Project

Geotechnical and Contamination Investigations - LD_CD_111

Project No. 21-12515105
Revision No. A
Date 28 Jan 2020

FIGURE 11

G:\21\12515105\GIS\Maps\Deliverables\21_12515105_Z003_GREENWAY_GCI_GeotechAndContaminationInvestigations.mxd
Print date: 28 Jan 2020 - 17:25

Data source: General Topo - NSW LPI DTDB 2015. Aerial Imagery - Sixmaps 2018 . Created by: kqvelasco

Legend

The GreenWay Investigation Locations
- Augered Borehole
- Cored Borehole
- Hand Auger
- Testpit

Historic Contamination Investigation Locations
- Borehole
- Hand Auger

Historic Geotechnical Investigation Locations
- Borehole
- CPT
- Testpit

- Contours
- Railways
- Watercourses
- Index

Paper Size ISO A3

0 7.5 15 22.5 30

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

GHD

The GreenWay Project

Geotechnical and Contamination Investigations - LD_CD_112

Project No.	21-12515105
Revision No.	A
Date	28 Jan 2020

FIGURE 12

G:\21\12515105\GIS\Maps\Deliverables\21_12515105_Z003_GREENWAY_GCI_GeotechAndContaminationInvestigations.mxd
Print date: 28 Jan 2020 - 17:26

Data source: General Topo - NSW LPI DTDB 2015. Aerial Imagery - Sixmaps 2018 . Created by: kqvelasco

Legend

The GreenWay Investigation Locations
- Augered Borehole
- Cored Borehole
- Hand Auger
- Testpit

Historic Contamination Investigation Locations
- Borehole
- Hand Auger

Historic Geotechnical Investigation Locations
- Borehole
- CPT
- Testpit

- Contours
- Railways
- Watercourses
- Index

Paper Size ISO A3

0 8 16 24 32

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

The GreenWay Project

Geotechnical and Contamination Investigations - LD_CD_113

Project No. 21-12515105
Revision No. A
Date 28 Jan 2020

FIGURE 13

G:\21\12515105\GIS\Maps\Deliverables\21_12515105_Z003_GREENWAY_GCI_GeotechAndContaminationInvestigations.mxd
Print date: 28 Jan 2020 - 17:26

Data source: General Topo - NSW LPI DTDB 2015. Aerial Imagery - Sixmaps 2018 . Created by: kqvelasco

Legend

The GreenWay Investigation Locations
- Augered Borehole
- Cored Borehole
- Hand Auger
- Testpit

Historic Contamination Investigation Locations
- Borehole
- Hand Auger

Historic Geotechnical Investigation Locations
- Borehole
- CPT
- Testpit

- Contours
- Railways
- Watercourses
- Index

Paper Size ISO A3

0 8 16 24 32

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

The GreenWay Project

Geotechnical and Contamination Investigations - LD_CD_114

Project No. 21-12515105
Revision No. A
Date 28 Jan 2020

FIGURE 14

G:\21\12515105\GIS\Maps\Deliverables\21_12515105_Z003_GREENWAY_GCI_GeotechAndContaminationInvestigations.mxd
Print date: 28 Jan 2020 - 17:27

Data source: General Topo - NSW LPI DTDB 2015. Aerial Imagery - Sixmaps 2018 . Created by: kqvelasco

Legend

The GreenWay Investigation Locations
- Augered Borehole
- Cored Borehole
- Hand Auger
- Testpit

Historic Contamination Investigation Locations
- Borehole
- Hand Auger

Historic Geotechnical Investigation Locations
- Borehole
- CPT
- Testpit

- Contours
- Railways
- Watercourses
- Index

Paper Size ISO A3

0 8 16 24 32

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

The GreenWay Project

Geotechnical and Contamination Investigations - LD_CD_115

Project No. 21-12515105
Revision No. A
Date 28 Jan 2020

FIGURE 15

G:\21\12515105\GIS\Maps\Deliverables\21_12515105_Z003_GREENWAY_GCI_GeotechAndContaminationInvestigations.mxd
Print date: 28 Jan 2020 - 17:28

Data source: General Topo - NSW LPI DTDB 2015. Aerial Imagery - Sixmaps 2018 . Created by: kqvelasco

Legend

The GreenWay Investigation Locations
- Augered Borehole
- Cored Borehole
- Hand Auger
- Testpit

Historic Contamination Investigation Locations
- Borehole
- Hand Auger

Historic Geotechnical Investigation Locations
- Borehole
- CPT
- Testpit

- Contours
- Railways
- Watercourses
- Index

Paper Size ISO A3
0 8 16 24 32
Meters
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

GHD

The GreenWay Project

Geotechnical and Contamination Investigations - LD_CD_116

Project No. 21-12515105
Revision No. A
Date 28 Jan 2020

FIGURE 16

G:\21\12515105\GIS\Maps\Deliverables\21_12515105_Z003_GREENWAY_GCI_GeotechAndContaminationInvestigations.mxd
Print date: 28 Jan 2020 - 17:29

Data source: General Topo - NSW LPI DTDB 2015. Aerial Imagery - Sixmaps 2018 . Created by: kqvelasco

12. Geotechnical long sections

INNER WEST COUNCIL
THE GREENWAY GEOTECHNICAL AND CONTAMINATION SERVICES
GEOTECHNICAL LONGITUDINAL SECTIONS

LINE LEGEND

- DESIGN SURFACE
- EXISTING SURFACE
- ? INFERRED GEOLOGICAL BOUNDARY

TABLE 1 - GEOTECHNICAL AND GEOLOGICAL UNITS

	UNIT	DESCRIPTION
1	UNIT 1	TOPSOIL
2A	UNIT 2A	RECLAMATION FILL
2B	UNIT 2B	GENERAL CORRIDOR FILL
2C	UNIT 2C	ROAD AND RAIL EMBANKMENT FILL
3A	UNIT 3A	MARINE SEDIMENTS
3B	UNIT 3B	ALLUVIUM
4A	UNIT 4A	RESIDUAL CLAYS - SHALE DERIVED
4B	UNIT 4B	RESIDUAL CLAYS - SANDSTONE DERIVED
5	UNIT 5	ASHFIELD SHALE
6A	UNIT 6A	HW MITTAGONG FORMATION
6B	UNIT 6B	MW MITTAGONG FORMATION
7	UNIT 7	HAWKSBURY SANDSTONE UNCLASSIFIED
7A	UNIT 7A	CLASS V HAWKSBURY SANDSTONE
7B	UNIT 7B	CLASS IV HAWKSBURY SANDSTONE
7C	UNIT 7C	CLASS III HAWKSBURY SANDSTONE
8	UNIT 8	IGNEOUS DYKE

LOGGING SYMBOLS

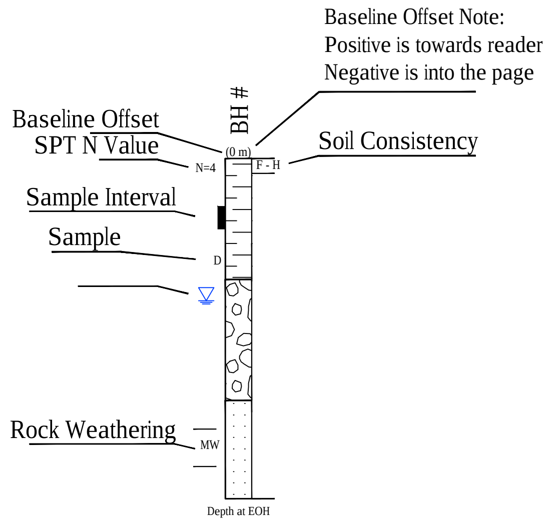
SOIL

ASPHALT, SAND, CLAY, FILL, SANDY CLAY, TOPSOIL, CLAYEY SAND

ROCK

CORE LOSS, CLAYSTONE, SANDSTONE, SILTSTONE

TEST HOLE STICK LEGEND



HYDROGEOLOGY

- WATER INFLOW (make)
- WATER OUTFLOW (complete loss)
- WATER OUTFLOW (partial loss)
- TEMPORARY WATER LEVEL (DURING DRILLING)
- FINAL WATER LEVEL

GENERAL NOTES

1. ALL DRAWINGS / SKETCHES TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.
2. THE DRAWINGS CONTAIN THE RESULTS OF EPISODIC GEOTECHNICAL INVESTIGATIONS CONDUCTED FOR SPECIFIC PURPOSES. THE RESULTS SHOULD NOT BE USED BY OTHER PARTIES OR FOR OTHER PURPOSES, AS THEY MAY CONTAIN NEITHER ADEQUATE NOR APPROPRIATE INFORMATION.
3. FOR DETAILS OF PARTICULAR BOREHOLES REFERENCE SHOULD BE MADE TO ORIGINAL LOGS FROM SOURCE DOCUMENTS. GRAPHIC SYMBOLS MAY VARY BETWEEN SOURCE DOCUMENTS AND THESE DRAWINGS IN THE INSTANCE OR DISCREPANCY BETWEEN ORIGINAL LOGS AND GRAPHICAL SUMMARY INFORMATION, REFERENCE IS TO BE MADE TO THE ORIGINAL LOGS.
4. REFER TO GHD GEOTECHNICS STANDARD SHEETS WITHIN THE ACCOMPANYING REPORT FOR SYMBOLS AND ABBREVIATION: GENERAL NOTES, SOIL DESCRIPTION, ROCK DESCRIPTION, CORE LOG SHEET NOTES, GLOSSARY OF SYMBOLS.
5. LOCAL VARIATIONS OR ANOMALIES IN GROUND CONDITIONS CAN OCCUR IN THE NATURAL ENVIRONMENT, PARTICULARLY BETWEEN DISCRETE TEST HOLE LOCATIONS. ANY CHANGES IN GROUND CONDITIONS OBSERVED DURING CONSTRUCTION, FROM THOSE ASSUMED OR DOCUMENTED, SHOULD BE REFERRED FOR APPROPRIATE ASSESSMENT AND COMMENT.
6. THE LOCATION OF SOME BOREHOLES, TEST SITES MAY HAVE BEEN MOVED SLIGHTLY TO FACILITATE GRAPHICAL PRESENTATION. PRECISE LOCATIONS SHOULD BE CONFIRMED FROM APPROPRIATE SURVEY DATA.
7. SOME RATIONALISATION OF BORELOG SYMBOLS AND GRAPHICAL DATA FROM DIFFERENT BORELOG SOURCES HAVE BEEN MADE FOR STANDARDISATION / PRESENTATION PURPOSES.
8. SELECTED HISTORICAL DATA HAS BEEN IMPORTED FROM DATABASE FORMATS THAT ARE NOT COMPATIBLE WITH CURRENT STANDARDS, AND MAY CONTAIN ERRORS OR DIFFERING NOMENCLATURE. DATA IS PROVIDED FOR ILLUSTRATIVE PURPOSES ONLY. REFERENCE MUST BE MADE TO ORIGINAL DATA SOURCES FOR DETAILED ASSESSMENT OR CRITICAL APPLICATION.
9. BASE PLAN AND ELEVATION DATA IS FOR ILLUSTRATIVE PRESENTATION ONLY AND IS NOT TO BE USED FOR DESIGN OR PLANNING PURPOSES.
10. PRESENTED GROUNDWATER LEVELS ARE BASED ON WATER LEVELS OBSERVED ON SITE DURING TESTING.
11. VERIFICATION OF THE GEOTECHNICAL ASSUMPTIONS AND/OR MODEL IS AN INTEGRAL PART OF THE DESIGN PROCESS - INVESTIGATION, CONSTRUCTION VERIFICATION, PERFORMANCE MONITORING. ALLOWANCE FOR VERIFICATION BY GEOTECHNICAL PERSONNEL SHOULD BE RECOGNISED AND PROGRAMMED DURING CONSTRUCTION.

LEGEND & NOTES

SCALE NTS

No	Revision	Drawn	Job Manager	Project Director	Date
A	FINAL ISSUE	HW	JS	MG	19.2.20

Note: * indicates signatures on original issue of drawing or last revision of drawing

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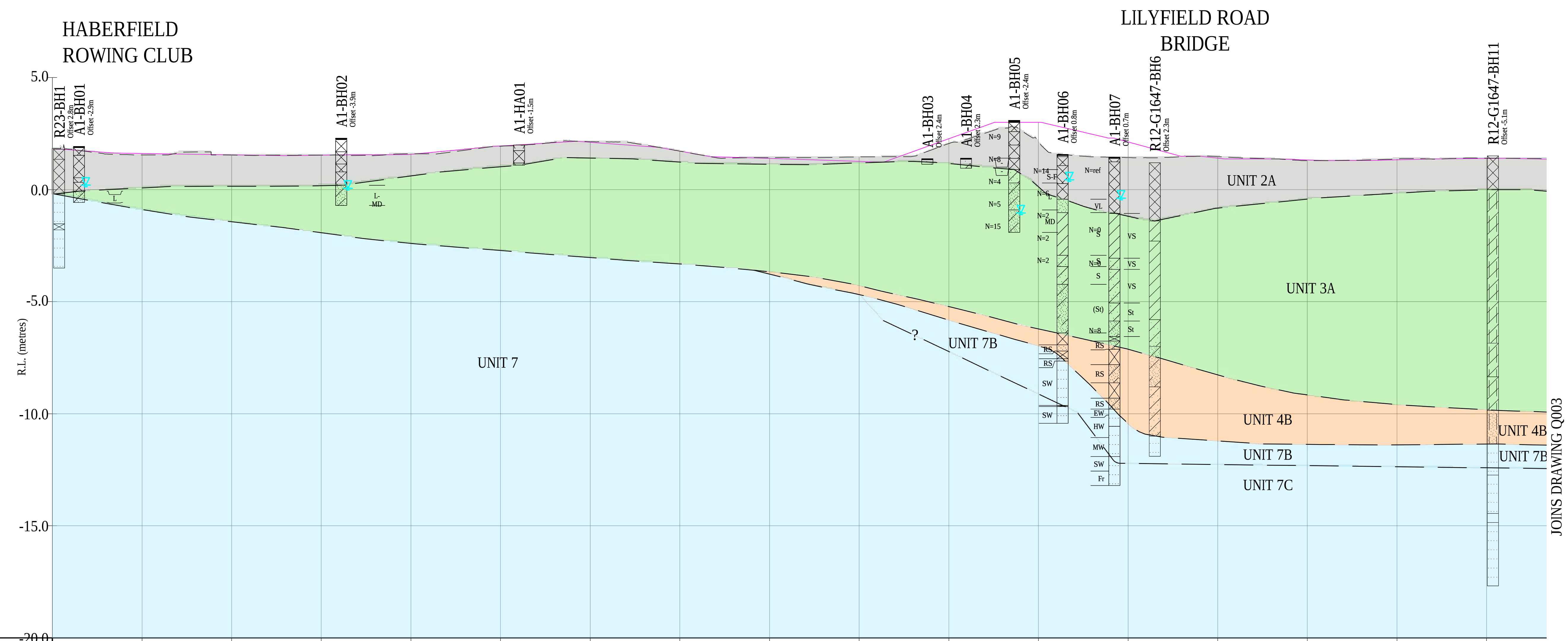
DO NOT SCALE

Drawn: R. C. J. ORTIZ
Designer: J. SCOGNAMIGLIO
Drafting Check: H. WARR
Design Check: M. GEORGE
Approved (Project Director): M. GEORGE
Date: 19.2.2020
Scale: AS SHOWN
This Drawing must not be used for Construction unless signed as Approved

Client: **INNER WEST COUNCIL**
Project: **THE GREENWAY GEOTECHNICAL/CONTAMINATION**
Title: **LEGEND AND NOTES**
Original Size: A3
Drawing No: **21-12515105-Q001**
Rev: A



DESIGN SURFACE LEVEL	1.831	1.609	1.546	1.533	1.575	1.940	2.113	1.716	1.390	1.261	2.268	3.000	2.127	1.401	1.321	1.327	1.389
EXISTING SURFACE LEVEL		1.542	1.539	1.537	1.597	1.931	2.141	1.715	1.428	1.457	2.054	2.139	1.429	1.473	1.290	1.372	1.403
CHAINAGE		20.000	40.000	60.000	80.000	100.000	120.000	140.000	160.000	180.000	200.000	220.000	240.000	260.000	280.000	300.000	320.000

LONGITUDINAL SECTION A-A

SCALE 1:V200 H1000

NOTE: REFER TO DRAWING Q001 FOR LEGEND AND NOTES.

No	Revision	Drawn	Job Manager	Project Director	Date
A	FINAL ISSUE	HW	JS	MG	19.2.20

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VERTICAL SCALE 1:200 AT ORIGINAL SIZE — 0 2 4 6m
HORIZONTAL SCALE 1:1000 AT ORIGINAL SIZE — 0 10 20 30m

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Drawn R. C. J. ORTIZ | Designer J. SCOGNAMIGLIO
Drafting Check H. WARR | Design Check M. GEORGE
Approved (Project Director) M. GEORGE
Date 19.2.2020
Scale AS SHOWN
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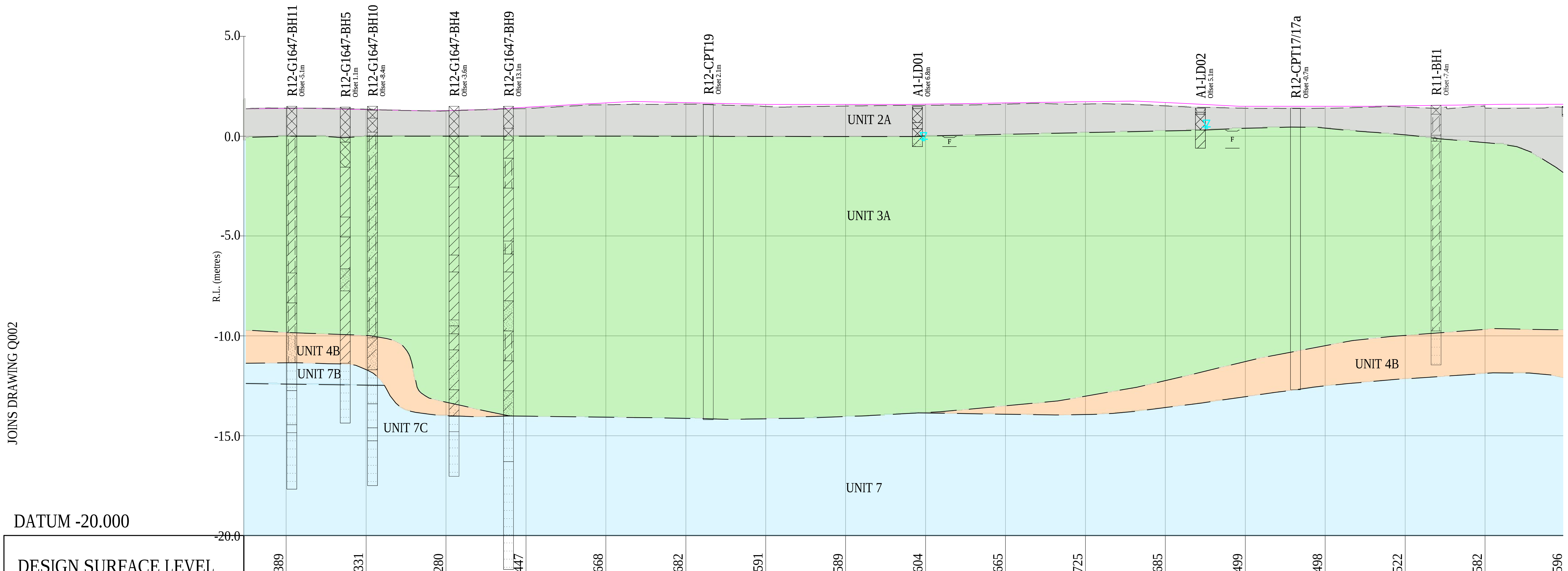
Client INNER WEST COUNCIL
Project THE GREENWAY GEOTECHNICAL/CONTAMINATION
Title SITE 1 ALIGNMENT
LONGITUDINAL SECTION A-A - SHEET 1 OF 6

Original Size A3 Drawing No: 21-12515105-Q002 Rev: A

Plot Date: 19 February 2020 - 10:25 AM Plotted By: Helen Warr Cad File No: \\ghdnet\ghd\AU\Sydney\Projects\21\12515105\CADD\Drawings\Geotech\21-12515105-Q002-Q015.dwg



DATUM -20.000

DESIGN SURFACE LEVEL	1.389	1.331	1.280	1.447	1.668	1.682	1.591	1.589	1.604	1.665	1.725	1.685	1.499	1.498	1.522	1.582	1.596
EXISTING SURFACE LEVEL	1.403	1.344	1.264	1.380	1.569	1.598	1.485	1.506	1.544	1.599	1.603	1.515	1.398	1.394	1.452	1.399	1.435
CHAINAGE	320.000	340.000	360.000	380.000	400.000	420.000	440.000	460.000	480.000	500.000	520.000	540.000	560.000	580.000	600.000	620.000	640.000

LONGITUDINAL SECTION A-A

SCALE 1:V200 H1000

NOTE: REFER TO DRAWING Q001 FOR LEGEND AND NOTES.

No	Revision	Drawn	Job Manager	Project Director	Date
A	FINAL ISSUE	HW	JS	MG	19.2.20

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VERTICAL SCALE 1:200 AT ORIGINAL SIZE — 0 2 4 6m

HORIZONTAL SCALE 1:1000 AT ORIGINAL SIZE — 0 10 20 30m

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Drafting Check	H. WARR	Design Check	M. GEORGE
Approved (Project Director)	M. GEORGE		
Date	19.2.2020		
Scale	AS SHOWN		This Drawing must not be used for Construction unless signed as Approved

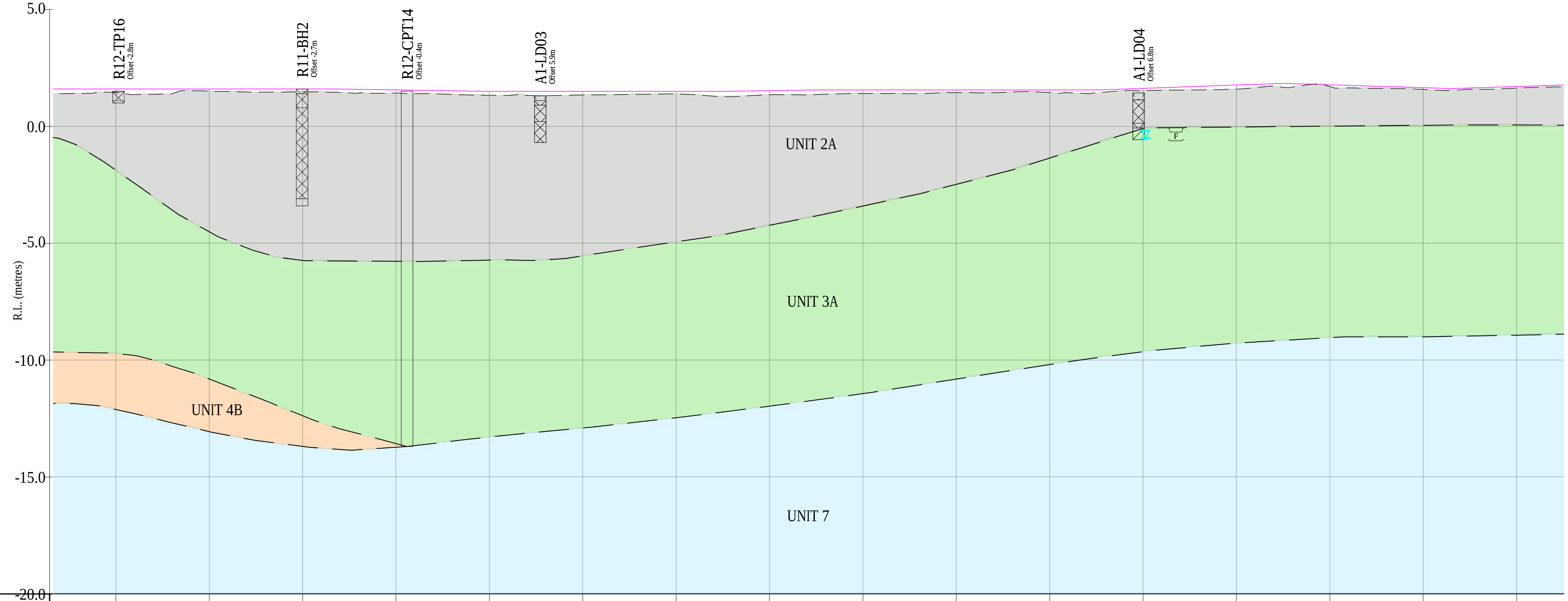
Client: INNER WEST COUNCIL
Project: THE GREENWAY GEOTECHNICAL/CONTAMINATION
Title: SITE 1 ALIGNMENT
LONGITUDINAL SECTION A-A - SHEET 2 OF 6

Original Size A3 Drawing No: 21-12515105-Q003 Rev: A

Plot Date: 19 February 2020 - 10:26 AM Plotted By: Helen Warr Cad File No: \\ghdnet\ghd\AU\Sydney\Projects\21\12515105\CADD\Drawings\Geotech\21-12515105-Q002-Q015.dwg

JOINS DRAWING Q003

JOINS DRAWING Q005



DATUM -20.000

DESIGN SURFACE LEVEL	1.596	1.596	1.596	1.557	1.497	1.496	1.496	1.524	1.554	1.554	1.554	1.625	1.766	1.774	1.654	1.702
EXISTING SURFACE LEVEL	1.435	1.505	1.468	1.418	1.324	1.337	1.386	1.348	1.403	1.439	1.437	1.522	1.586	1.694	1.572	1.633
CHAINAGE	640.000	660.000	680.000	700.000	720.000	740.000	760.000	780.000	800.000	820.000	840.000	860.000	880.000	900.000	920.000	940.000

LONGITUDINAL SECTION A-A

SCALE 1:V200 H1000

NOTE: REFER TO DRAWING Q001 FOR LEGEND AND NOTES.

No	Revision	Drawn	Job Manager	Project Director	Date
A	FINAL ISSUE	HW	JS	MG	19.2.20

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VERTICAL SCALE 1:200 AT ORIGINAL SIZE — 0 2 4 6m

HORIZONTAL SCALE 1:1000 AT ORIGINAL SIZE — 0 10 20 30m

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Drafting Check	H. WARR	Design Check	M. GEORGE
Approved (Project Director)	M. GEORGE		
Date	19.2.2020		
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Client: INNER WEST COUNCIL

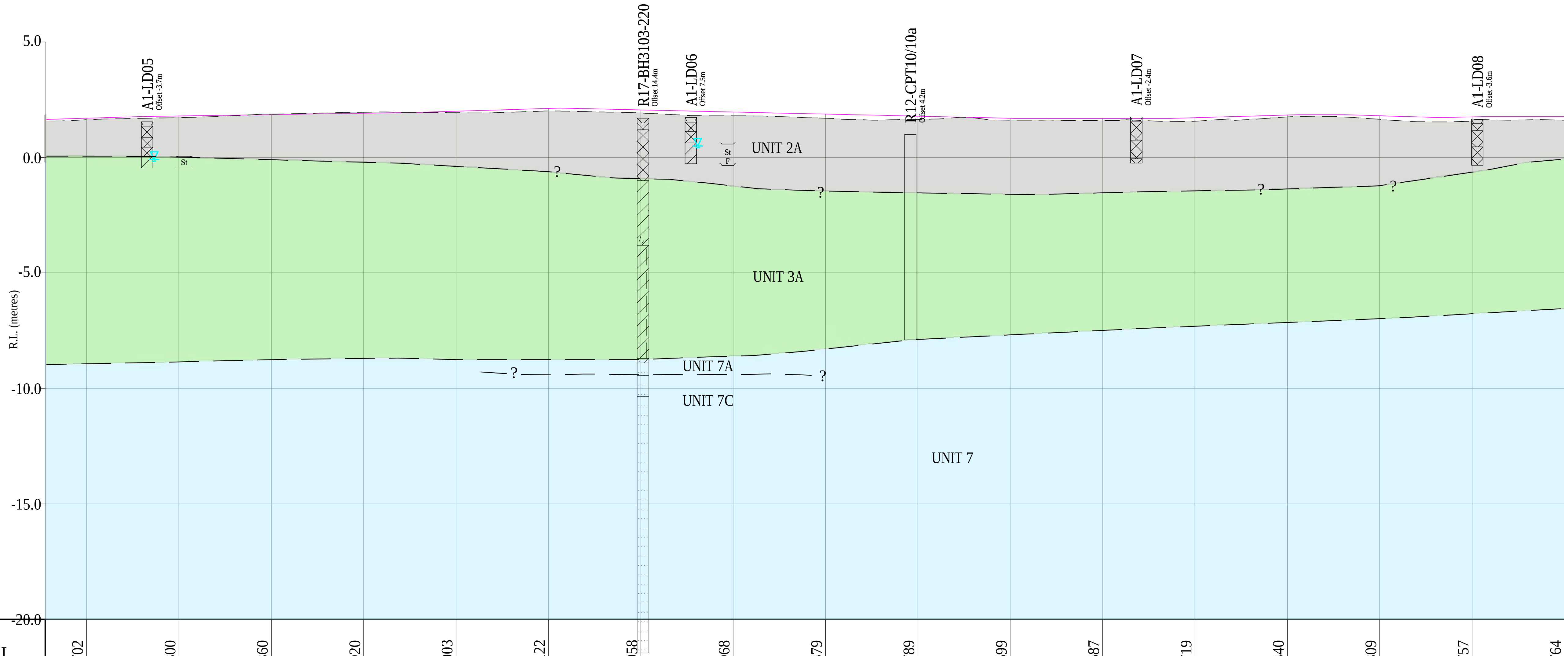
Project: THE GREENWAY GEOTECHNICAL/CONTAMINATION

Title: SITE 1 ALIGNMENT
LONGITUDINAL SECTION A-A - SHEET 3 OF 6

Original Size: A3 Drawing No: 21-12515105-Q004 Rev: A

Plot Date: 19 February 2020 - 10:26 AM Plotted By: Helen Warr Cad File No: \\ghdnet\ghd\AU\Sydney\Projects\21\12515105\CADD\Drawings\Geotech\21-12515105-Q002-Q015.dwg

JOINS DRAWING Q004



JOINS DRAWING Q006

DATUM -20.000

DESIGN SURFACE LEVEL	1.702	1.800	1.860	1.920	2.003	2.122	2.058	1.968	1.879	1.789	1.699	1.687	1.719	1.840	1.809	1.757	1.764
EXISTING SURFACE LEVEL	1.633	1.724	1.878	1.958	1.937	2.017	1.926	1.799	1.700	1.650	1.614	1.599	1.574	1.758	1.649	1.567	1.614
CHAINAGE	940.000	960.000	980.000	1000.000	1020.000	1040.000	1060.000	1080.000	1100.000	1120.000	1140.000	1160.000	1180.000	1200.000	1220.000	1240.000	1260.000

LONGITUDINAL SECTION A-A

SCALE 1:V200 H1000

NOTE: REFER TO DRAWING Q001 FOR LEGEND AND NOTES.

No	Revision	Drawn	Job Manager	Project Director	Date
A	FINAL ISSUE	HW	JS	MG	19.2.20

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HORIZONTAL SCALE 1:1000 AT ORIGINAL SIZE 0 10 20 30m

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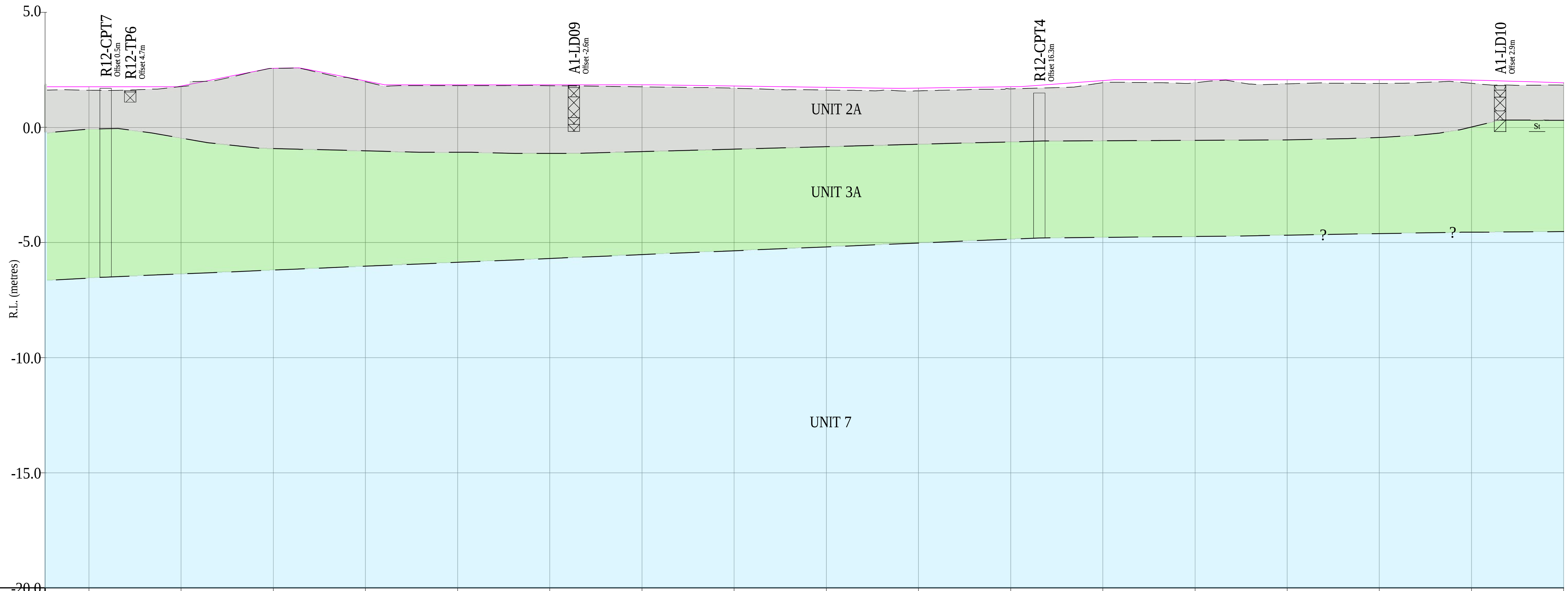
Client **INNER WEST COUNCIL**
Project **THE GREENWAY GEOTECHNICAL/CONTAMINATION**
Title **SITE 1 ALIGNMENT**
LONGITUDINAL SECTION A-A - SHEET 4 OF 6

Original Size **A3** Drawing No: **21-12515105-Q005** Rev: **A**

Plot Date: 19 February 2020 - 10:29 AM Plotted By: Helen Warr Cad File No: \\ghdnet\ghd\AU\Sydney\Projects\21\12515105\CADD\Drawings\Geotech\21-12515105-Q002-Q015.dwg



JOINS DRAWING Q005

JOINS DRAWING Q007

DATUM -20.000

DESIGN SURFACE LEVEL	1.764	1.799	2.565	2.018	1.856	1.856	1.856	1.803	1.743	1.709	1.768	2.039	2.075	2.075	2.075	2.053	1.941
EXISTING SURFACE LEVEL	1.614	1.775	2.567	1.985	1.815	1.815	1.765	1.703	1.625	1.589	1.677	1.945	1.944	1.894	1.912	1.916	1.837
CHAINAGE	1260.000	1280.000	1300.000	1320.000	1340.000	1360.000	1380.000	1400.000	1420.000	1440.000	1460.000	1480.000	1500.000	1520.000	1540.000	1560.000	1580.000

LONGITUDINAL SECTION A-A

SCALE 1:V200 H1000

NOTE: REFER TO DRAWING Q001 FOR LEGEND AND NOTES.

No	Revision	Drawn	Job Manager	Project Director	Date
A	FINAL ISSUE	HW	JS	MG	19.2.20

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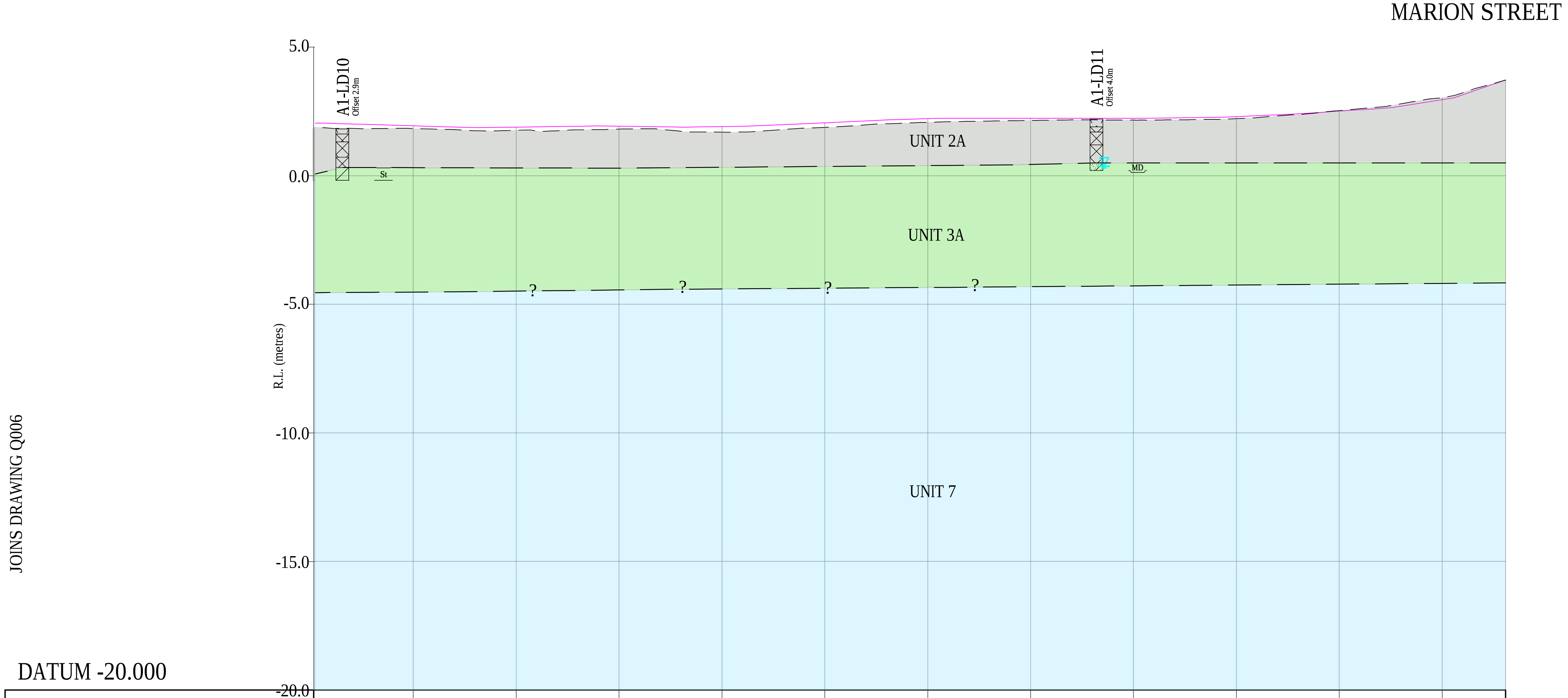
Project THE GREENWAY GEOTECHNICAL/CONTAMINATION
Title SITE 1 ALIGNMENT
LONGITUDINAL SECTION A-A - SHEET 5 OF 6

Original Size A3 | Drawing No: 21-12515105-Q006 | Rev: A

Plot Date: 19 February 2020 - 10:31 AM Plotted By: Helen Warr Cad File No: \\ghdnet\ghd\AU\Sydney\Projects\21\12515105\CADD\Drawings\Geotech\21-12515105-Q002-Q015.dwg



DESIGN SURFACE LEVEL	1.941	1.890	1.925	1.910	2.061	2.218	2.232	2.232	2.301	2.511	2.956	3.720
EXISTING SURFACE LEVEL	1.837	1.768	1.813	1.695	1.879	2.077	2.150	2.161	2.220	2.533	3.031	3.718
CHAINAGE	1580.000	1600.000	1620.000	1640.000	1660.000	1680.000	1700.000	1720.000	1740.000	1760.000	1780.000	1792.311

LONGITUDINAL SECTION A-A

SCALE 1:V200 H1000

NOTE: REFER TO DRAWING Q001 FOR LEGEND AND NOTES.

No	Revision	Drawn	Job Manager	Project Director	Date
A	FINAL ISSUE	HW	JS	MG	19.2.20

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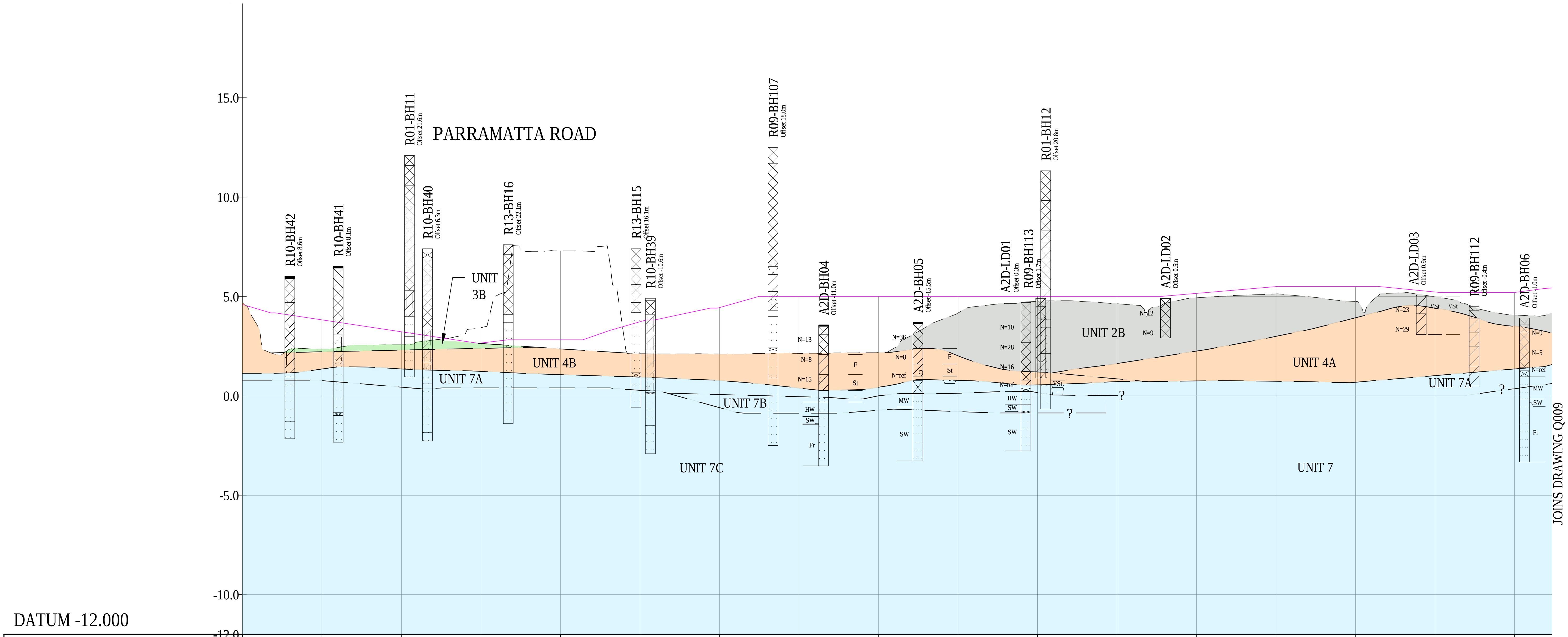
Client: **INNER WEST COUNCIL**
Project: **THE GREENWAY GEOTECHNICAL/CONTAMINATION**
Title: **SITE 1 ALIGNMENT LONGITUDINAL SECTION A-A - SHEET 6 OF 6**
Original Size: **A3**
Drawing No: **21-12515105-Q007**
Rev: **A**

Plot Date: 19 February 2020 - 10:35 AM Plotted By: Helen Warr Cad File No: \\ghdnet\ghd\AU\Sydney\Projects\21\12515105\CADD\Drawings\Geotech\21-12515105-Q002-Q015.dwg



DESIGN SURFACE LEVEL	4.600	3.820	3.220	2.654	2.820	3.727	4.437	5.000	5.000	5.000	5.000	5.000	5.152	5.492	5.500	5.225	5.201
EXISTING SURFACE LEVEL		2.353	2.566	3.426	7.288	2.116	2.104	2.130	2.173	4.166	4.753	4.632	4.931	5.130	4.746	4.979	4.065
CHAINAGE		20.000	40.000	60.000	80.000	100.000	120.000	140.000	160.000	180.000	200.000	220.000	240.000	260.000	280.000	300.000	320.000

LONGITUDINAL SECTION B-B

SCALE 1:V200 H1000

NOTE: REFER TO DRAWING Q001 FOR LEGEND AND NOTES.

No	Revision	Drawn	Job Manager	Project Director	Date
A	FINAL ISSUE	HW	JS	MG	19.2.20

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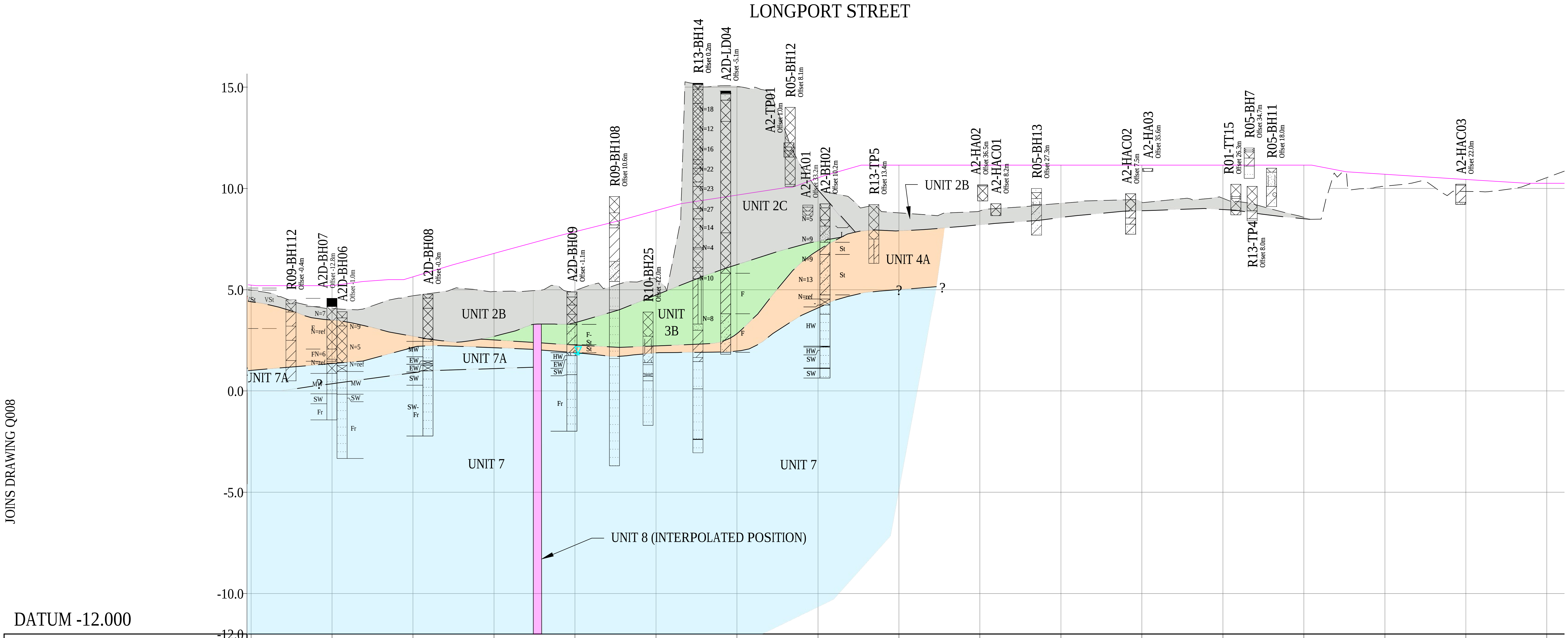
Project **THE GREENWAY GEOTECHNICAL/CONTAMINATION**
Title **SITE 2 ALIGNMENT**
LONGITUDINAL SECTION B-B - SHEET 1 OF 3

Original Size A3 | Drawing No: **21-12515105-Q008** | Rev: A



DESIGN SURFACE LEVEL	5.201	5.639	6.789	7.860	8.910	9.673	10.522	11.150	11.150	11.150	11.150	11.150	11.150	10.701	10.445	10.250
EXISTING SURFACE LEVEL	4.065	4.698	4.912	4.955	5.506	15.036	9.929	8.794	8.888	9.266	9.316	9.513	8.575	10.113	9.854	10.534
CHAINAGE	320.000	340.000	360.000	380.000	400.000	420.000	440.000	460.000	480.000	500.000	520.000	540.000	560.000	580.000	600.000	620.000

LONGITUDINAL SECTION B-B

SCALE 1:V200 H1000

NOTE: REFER TO DRAWING Q001 FOR LEGEND AND NOTES.

No	Revision	Drawn	Job Manager	Project Director	Date
A	FINAL ISSUE	HW	JS	MG	19.2.20

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HORIZONTAL SCALE 1:1000 AT ORIGINAL SIZE (0 10 20 30m)

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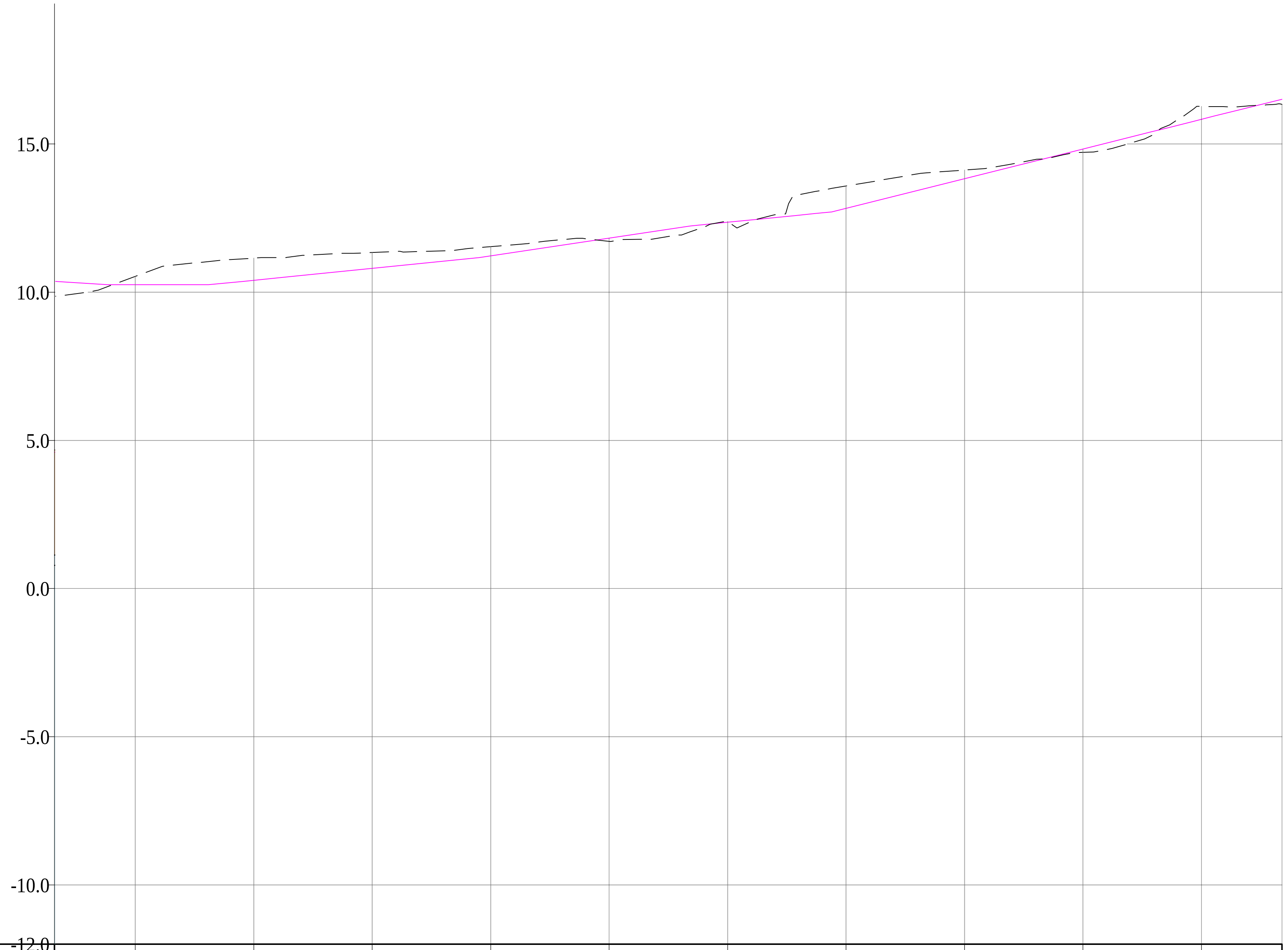
Project THE GREENWAY GEOTECHNICAL/CONTAMINATION
Title SITE 2 ALIGNMENT LONGITUDINAL SECTION B-B - SHEET 2 OF 3

Original Size A3 | Drawing No: 21-12515105-Q009 | Rev: A

Plot Date: 19 February 2020 - 6:16 PM Plotted By: Helen Warr Cad File No: \\ghdnet\ghd\AU\Sydney\Projects\21\12515105\CADD\Drawings\Geotech\21-12515105-Q002-Q015.dwg

JOINS DRAWING Q009



DATUM -12.000

DESIGN SURFACE LEVEL	10.250	10.403	10.803	11.222	11.822	12.360	12.833	13.833	14.832	15.833	16.512
EXISTING SURFACE LEVEL	10.534	11.150	11.338	11.538	11.719	12.386	13.582	14.123	14.719	16.272	16.342
CHAINAGE	620.000	640.000	660.000	680.000	700.000	720.000	740.000	760.000	780.000	800.000	813.592

LONGITUDINAL SECTION B-B

SCALE 1:V200 H1000

NOTE: REFER TO DRAWING Q001 FOR LEGEND AND NOTES.

No	Revision	Drawn	Job Manager	Project Director	Date
A	FINAL ISSUE	HW	JS	MG	19.2.20

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HORIZONTAL SCALE 1:1000 AT ORIGINAL SIZE — 0 10 20 30m

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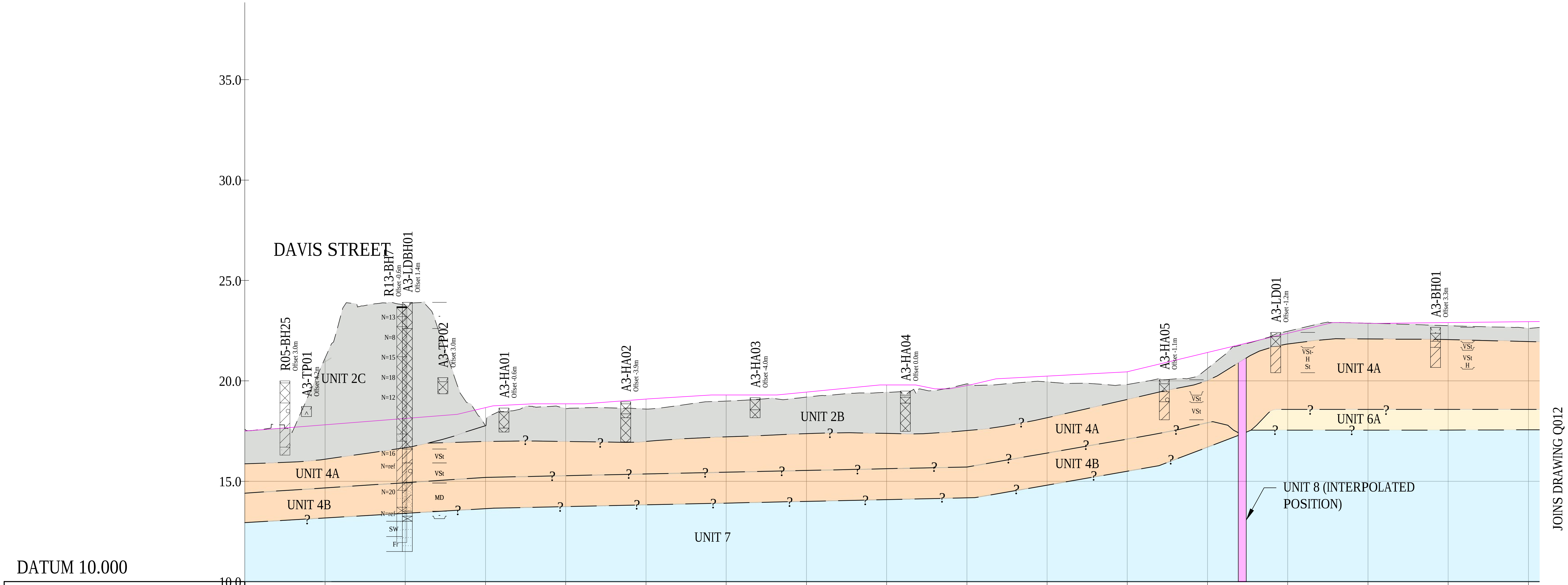
Client **INNER WEST COUNCIL**

Project **THE GREENWAY GEOTECHNICAL/CONTAMINATION**

Title **SITE 2 ALIGNMENT**
LONGITUDINAL SECTION B-B - SHEET 3 OF 3

Original Size A3 — Drawing No: **21-12515105-Q010** — Rev: A

Plot Date: 19 February 2020 - 11:43 AM Plotted By: Helen Warr Cad File No: \\ghdnet\ghd\AU\Sydney\Projects\21\12515105\CADD\Drawings\Geotech\21-12515105-Q002-Q015.dwg



DESIGN SURFACE LEVEL	17.500	17.814	18.129	18.670	18.855	19.093	19.300	19.444	19.800	19.770	20.236	20.453	21.413	22.373	22.873	22.905	22.948
EXISTING SURFACE LEVEL		21.130	23.794	17.770	18.616	18.592	18.994	19.191	19.429	19.851	19.945	19.818	20.615	22.471	22.872	22.748	22.614
CHAINAGE		20.000	40.000	60.000	80.000	100.000	120.000	140.000	160.000	180.000	200.000	220.000	240.000	260.000	280.000	300.000	320.000

LONGITUDINAL SECTION C-C

SCALE 1:V200 H1000

NOTE: REFER TO DRAWING Q001 FOR LEGEND AND NOTES.

No	Revision	Drawn	Job Manager	Project Director	Date
A	FINAL ISSUE	HW	JS	MG	19.2.20

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HORIZONTAL SCALE 1:1000 AT ORIGINAL SIZE (0 10 20 30m)

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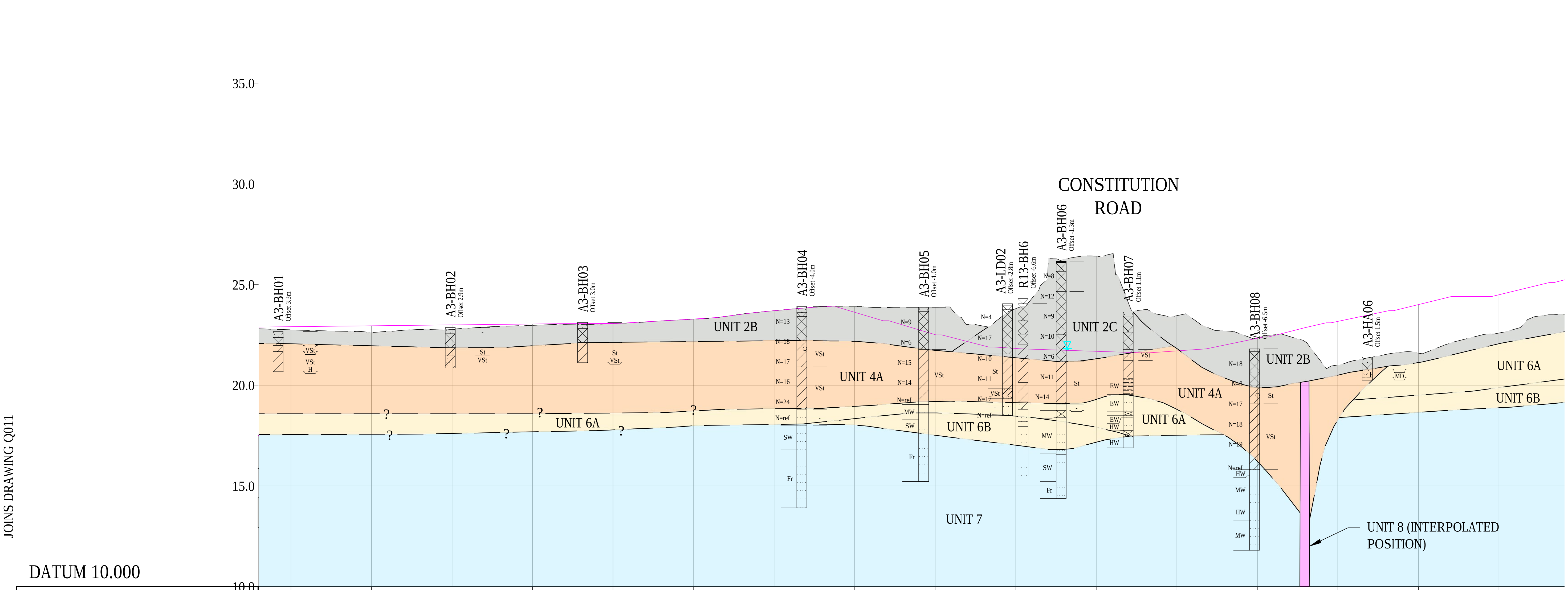
Project: THE GREENWAY GEOTECHNICAL/CONTAMINATION
Title: SITE 3 ALIGNMENT LONGITUDINAL SECTION C-C - SHEET 1 OF 3

Original Size: A3 — Drawing No: 21-12515105-Q011 — Rev: A

Plot Date: 19 February 2020 - 6:16 PM — Plotted By: Helen Warr — Cad File No: \\ghdnet\ghd\AU\Sydney\Projects\21\12515105\CADD\Drawings\Geotech\21-12515105-Q002-Q015.dwg



DESIGN SURFACE LEVEL	17.500 22.905	22.948	22.992	23.035	23.066	23.283	23.700	23.619	22.512	21.822	21.681	21.701	22.332	23.171	24.002	24.490
EXISTING SURFACE LEVEL	22.748	22.614	22.772	22.970	23.061	23.280	23.699	23.919	23.881	23.800	26.409	23.453	22.359	21.003	21.589	22.587
CHAINAGE	300.000	320.000	340.000	360.000	380.000	400.000	420.000	440.000	460.000	480.000	500.000	520.000	540.000	560.000	580.000	600.000

LONGITUDINAL SECTION C-C

SCALE 1:V200 H1000

NOTE: REFER TO DRAWING Q001 FOR LEGEND AND NOTES.

No	Revision	Drawn	Job Manager	Project Director	Date
A	FINAL ISSUE	HW	JS	MG	19.2.20

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HORIZONTAL SCALE 1:1000 AT ORIGINAL SIZE 0 10 20 30m

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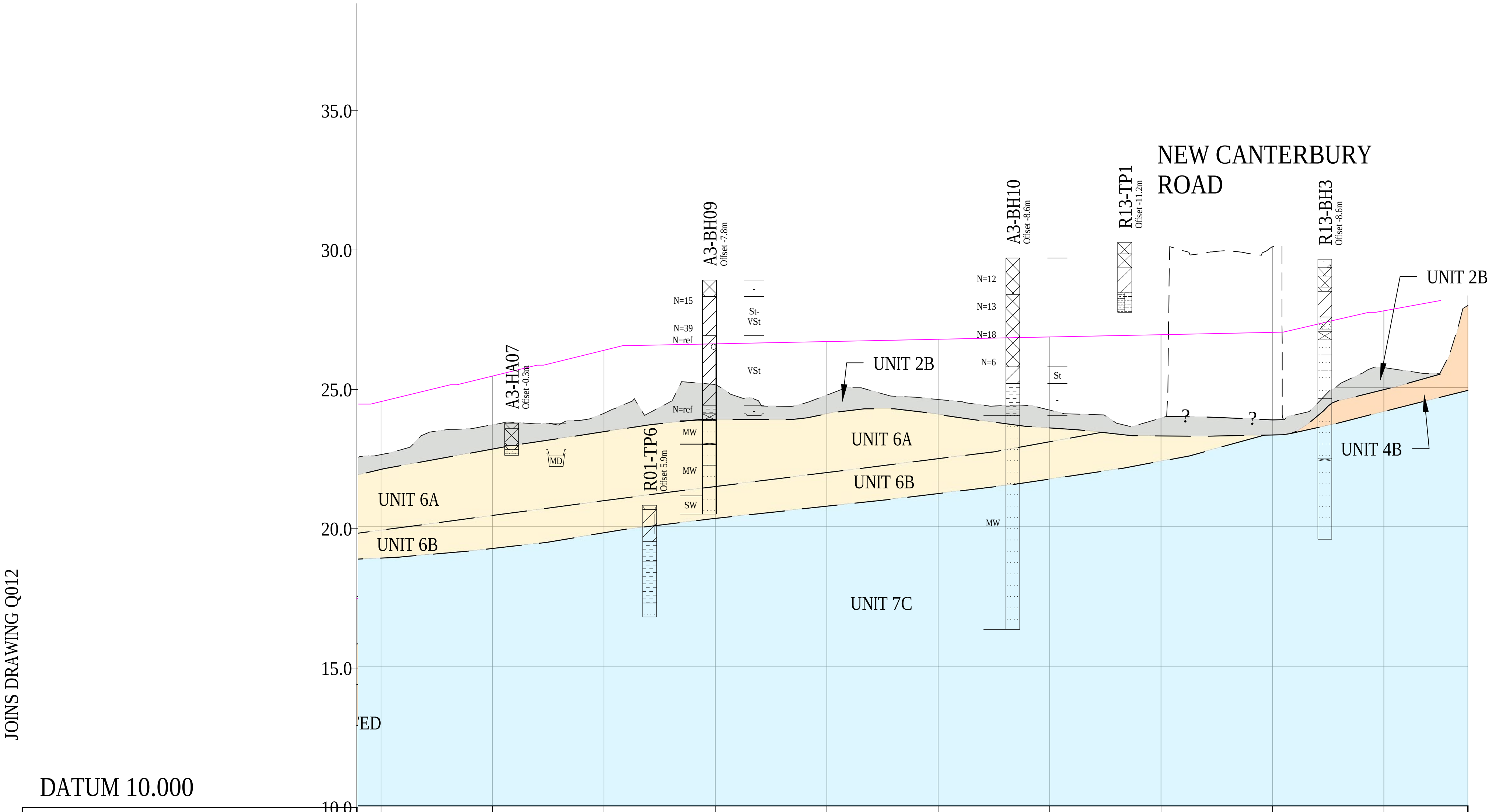
Project **THE GREENWAY GEOTECHNICAL/CONTAMINATION**
Title **SITE 3 ALIGNMENT**
LONGITUDINAL SECTION C-C - SHEET 2 OF 3

Original Size A3 Drawing No: **21-12515105-Q012** Rev: A

Plot Date: 19 February 2020 - 6:17 PM Plotted By: Helen Warr Cad File No: \\ghdnet\ghd\AU\Sydney\Projects\21\12515105\CADD\Drawings\Geotech\21-12515105-Q002-Q015.dwg



DESIGN SURFACE LEVEL	17.500 24.490	25.410	26.330	26.563	26.645	26.728	26.810	26.892	26.974	27.755	28.300
EXISTING SURFACE LEVEL	22.587	23.659	24.070	25.100	24.724	24.569	24.188	23.902	30.056	25.713	27.942
CHAINAGE	600.000	620.000	640.000	660.000	680.000	700.000	720.000	740.000	760.000	780.000	795.063

LONGITUDINAL SECTION C-C

SCALE 1:V200 H1000

NOTE: REFER TO DRAWING Q001 FOR LEGEND AND NOTES.

No	Revision	Drawn	Job Manager	Project Director	Date
A	FINAL ISSUE	HW	JS	MG	19.2.20

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HORIZONTAL SCALE 1:1000 AT ORIGINAL SIZE (0, 10, 20, 30m)

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Client INNER WEST COUNCIL
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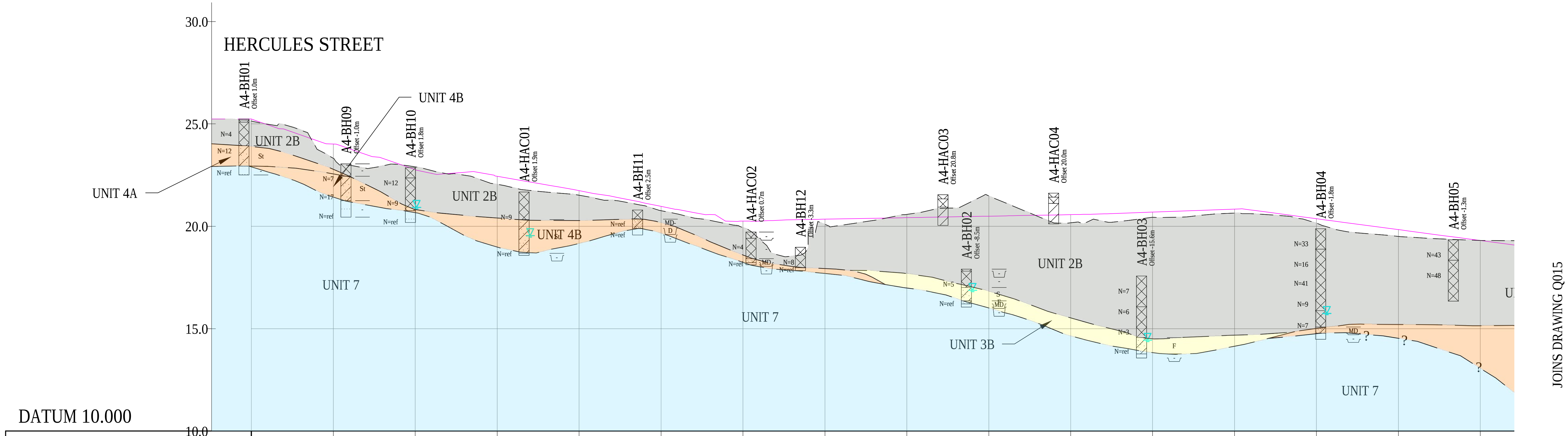
Title SITE 3 ALIGNMENT
LONGITUDINAL SECTION C-C - SHEET 3 OF 3

Original Size A3 | Drawing No: 21-12515105-Q013 | Rev: A



DESIGN SURFACE LEVEL	25.238	24.020	22.765	22.440	21.743	20.975	20.252	20.349	20.422	20.496	20.570	20.696	20.842	20.372	19.839	19.307
EXISTING SURFACE LEVEL		23.317	22.904	22.049	21.520	20.764	19.940	20.094	20.584	21.482	20.172	20.438	20.646	20.152	19.507	19.310
CHAINAGE		20.000	40.000	60.000	80.000	100.000	120.000	140.000	160.000	180.000	200.000	220.000	240.000	260.000	280.000	300.000

LONGITUDINAL SECTION D-D

SCALE 1:V200 H1000

NOTE: REFER TO DRAWING Q001 FOR LEGEND AND NOTES.

No	Revision	Drawn	Job Manager	Project Director	Date
A	FINAL ISSUE	HW	JS	MG	19.2.20

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HORIZONTAL SCALE 1:1000 AT ORIGINAL SIZE (0 10 20 30m)

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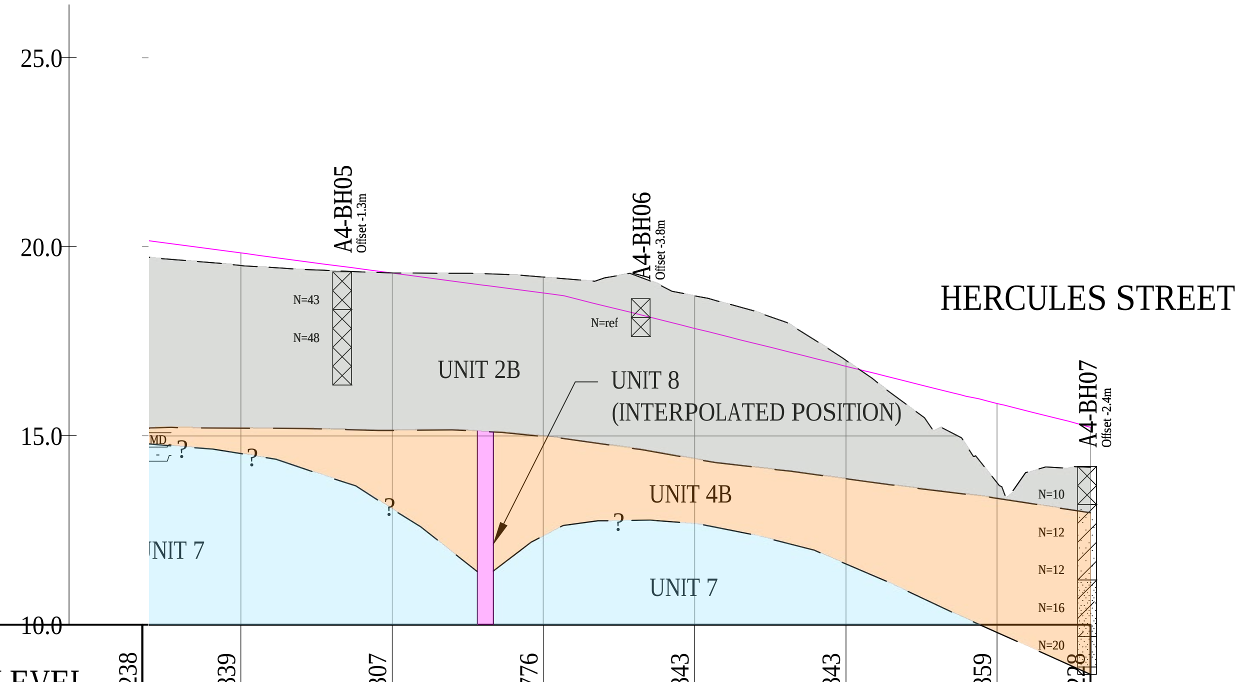
Client **INNER WEST COUNCIL**
Project **THE GREENWAY GEOTECHNICAL/CONTAMINATION**
Title **SITE 4 ALIGNMENT**
LONGITUDINAL SECTION D-D - SHEET 1 OF 2

Original Size A3 | Drawing No: **21-12515105-Q014** | Rev: A

Plot Date: 19 February 2020 - 12:06 PM Plotted By: Helen Warr Cad File No: \\ghdnet\ghd\AU\Sydney\Projects\21\12515105\CADD\Drawings\Geotech\21-12515105-Q002-Q015.dwg

JOINS DRAWING Q014



DATUM 10.000

DESIGN SURFACE LEVEL	25.238	19.839	19.307	18.776	17.843	16.843	15.859	15.228
EXISTING SURFACE LEVEL		19.507	19.310	19.199	18.705	16.999	13.760	14.172
CHAINAGE		280.000	300.000	320.000	340.000	360.000	380.000	392.372

LONGITUDINAL SECTION D-D

SCALE 1:V200 H1000

NOTE: REFER TO DRAWING Q001 FOR LEGEND AND NOTES.

No	Revision	Drawn	Job Manager	Project Director	Date
A	FINAL ISSUE	HW	JS	MG	19.2.20

Note: * indicates signatures on original issue of drawing or last revision of drawing

VERTICAL SCALE 1:200 AT ORIGINAL SIZE — 0 2 4 6m

HORIZONTAL SCALE 1:1000 AT ORIGINAL SIZE — 0 10 20 30m

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DO NOT SCALE

Drawn: R. C. J. ORTIZ — Designer: J. SCOGNAMIGLIO
Drafting Check: H. WARR — Design Check: M. GEORGE
Approved (Project Director): M. GEORGE
Date: 19.2.2020
Scale: AS SHOWN

This Drawing must not be used for Construction unless signed as Approved

Client: INNER WEST COUNCIL
Project: THE GREENWAY GEOTECHNICAL/CONTAMINATION
Title: SITE 4 ALIGNMENT
LONGITUDINAL SECTION D-D - SHEET 2 OF 2

Original Size: A3 — Drawing No: **21-12515105-Q015** — Rev: A

Plot Date: 19 February 2020 - 6:18 PM Plotted By: Helen Warr Cad File No: \\ghdnet\ghd\AU\Sydney\Projects\21\12515105\CADD\Drawings\Geotech\21-12515105-Q002-Q015.dwg