highways england

Volume 6

A303 Amesbury to Berwick Down

TR010025

6.3 Environmental Statement Appendices

Appendix 10.1 Preliminary Ground Investigation Report

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

October 2018

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Foreword

The A303 Amesbury to Berwick Down scheme ("the Scheme") forms part of a programme of improvements for upgrading the A303/A358 corridor, improving this vital connection between the South West and London and the South East and including the upgrade of remaining single carriageway sections on the route to dual carriageway. This investment is stated as a priority project in the National Infrastructure Plan and Government's commitment is confirmed in the Road Investment Strategy (2015-2020). Subject to achieving an approved Development Consent Order ("DCO"), preliminary works are planned to start in 2020 with the main construction works following in 2021, and the Scheme is due to open to traffic in 2026.

Objectives for the Scheme have been formulated both to address identified problems and to take advantage of the opportunities that new infrastructure would provide. The objectives are defined by the Department for Transport ("DfT"):

- **Transport** - To create a high quality reliable route between the South East and the South West that meets the future needs of traffic;
- **Economic Growth** - to enable growth in jobs and housing by providing a free flowing and reliable connection between the South East and the South West.
- **Cultural Heritage** - To help conserve and enhance the World Heritage Site and to make it easier to reach and explore; and
- **Environment and Community** - To improve biodiversity and provide a positive legacy for nearby communities.

The objectives would be achieved by providing a high quality, two-lane dual carriageway on the A303 trunk road between Amesbury and Berwick Down in Wiltshire. The Scheme would resolve traffic problems and, at the same time, protect and enhance the Stonehenge component of the Stonehenge, Avebury and Associated Sites World Heritage Site, hereafter referred to as the "WHS". The Scheme would be approximately 8 miles (13km) long and comprise the following key components:

a) A northern bypass of Winterbourne Stoke with a viaduct over the River Till valley;
b) A new junction between the A303 and A360 to the west of and outside the WHS, replacing the existing Longbarrow roundabout;
c) A twin-bore tunnel approximately 2 miles (3.3km) long, past Stonehenge; and
d) A new junction between the A303 and A345 at the existing Countess roundabout.

Executive Summary

Highways England proposes to improve the A303 past Stonehenge by providing a dual two-lane carriageway between Amesbury and Berwick Down in Wiltshire (the Scheme). The Scheme would help unlock economic growth in the South West by improving journey reliability, increasing safety and improving connectivity with neighbouring regions, while protecting and enhancing the environment. The existing A303 passes through the Stonehenge section of the Stonehenge, Avebury and Associated Sites World Heritage Site (the WHS), passing approximately 165 metres from the Stonehenge monument itself.

The Scheme comprises provision of a high quality, two-lane dual carriageway on the A303 trunk road between Amesbury and Berwick Down in Wiltshire. The Scheme would resolve traffic problems and, at the same time, protect and enhance the WHS.

This Preliminary Ground Investigation Report (pGIR) is based on information from available historical ground investigations and ground investigations carried out in 2017.

The dominant land use along the Scheme has historically comprised, and currently comprises, agricultural use and some open space. The proposed alignment intersects the former RAF Oatlands Hill (operational between 1941 and1945) and the former RAF Stonehenge (operational between 1917 and 1921) to the west and east of Longbarrow roundabout, respectively. Information in the Preliminary Sources Study Report (PSSR) [1] indicates RAF Oatlands Hill was only very lightly used and the section of RAF Stonehenge intersected by the alignment was occupied by the residential part of the main camp. Both military sites were restored to agricultural land use in the periods post wars.

The Scheme is directly underlain by the White Chalk Subgroup. Superficial deposits have been encountered but are absent across parts of the whole Scheme. Made Ground has been primarily encountered in the areas of the Countess and Longbarrow junctions in association with historical earthworks. Head Deposits are present where the scheme crosses the fluvial, tributary and ephemeral valleys, with the most significant presence in the valley of River Till. Clayey and silty Alluvium was encountered in the River Avon valley. Peat was identified in the ground investigation from 1965 [2] but it is anticipated subsequently to have been partly removed as part of the historical earthworks in the area of the Countess Roundabout. River Terrace Deposits that are predominantly sand and gravel are found as the lowest superficial deposits in the River Avon valley.

Newhaven Chalk Formation is the youngest formation of the White Chalk Subgroup identified within the site, and was encountered over higher elevations in the interfluve regions either side of the Stonehenge Bottom. The Seaford Chalk Formation has been encountered either at outcrop or underlying the Newhaven Chalk Formation. The Lewes Nodular Chalk Formation is the oldest chalk formation and has been encountered only in the deepest exploratory hole locations. Definition of particular formations is limited to parts of the historical investigations and retrospective has been undertaken as part of this pGIR.

Structureless chalk has been mainly encountered as clast dominant grade Dc chalk to the classification of CIRIA C574. Structureless chalk is typically present at the upper horizon. The structureless chalk is typically 1m in thickness on the higher elevations in the interfluve zones but deeper and thicker occurrences have been observed in the areas of River Till valley, the Stonehenge Bottom dry valley and the Countess Roundabout/River Avon valley.

Phosphate-containing chalk has been identified in the area to the west of Stonehenge Bottom based on the description of the recovered cores, samples and results from the down-hole natural gamma logging carried out in the historical and recent ground investigations. P-S wave logging carried out in the phosphatic Chalk section in a single exploratory hole 29779-P505 shows that the phosphatic Chalk stiffness tends to lie towards the lower bound of the overall stiffness data population of the normal Chalk. Other index, strength and stiffness type testing carried out so far reveals that there is little significant variation between phosphatic Chalk and non-phosphorus containing chalk. This may be partly a result of sampling bias, and particularly for the strength type testing. For example, the unconfined compressive strength (UCS) testing requires the samples to remain intact prior to testing. This would have prevented some of the friable and pelletal nature phosphatic Chalk to be selected for UCS tests.

The Scheme traverses the Chalk Group bedrock outcrop which is classified by the Environment Agency (EA) as a Principal Aquifer and in the study area supports private and public water supply and base flow within rivers.

Groundwater levels in the Chalk are controlled by recharge from rainfall infiltration and by natural discharge to the rivers Avon and Till resulting in natural seasonal variations of between 8m and 10m beneath the dry valleys and about 15m below the topographic divide.

Groundwater in the Chalk aquifer generally flows in a north to south direction (with groundwater flow divides in the eastern and western margins of the study area) and discharges naturally as base flow to the rivers Avon and Till. Localised flow occurs within the dry valleys in the Chalk landscape, where preferential pathways are formed as more permeable zones exist. The dry valleys, such as Stonehenge Bottom, are corridors where the majority of the flow occurs beneath the surface and occasionally partially above surface when groundwater levels are particularly high.

The results of the leachate analysis undertaken on phosphatic Chalk reported concentrations of reactive phosphorus below the adopted laboratory level of detection (<0.05mg/l) in all 16 samples. The detected concentrations of reactive phosphorus were better than the ‘good’ water quality standard recommended in the UK Water Framework Directive guidance (0.052-0.091mg/l) for a lowland high alkalinity river (i.e. higher quality). Based on the findings, the re-use of phosphatic Chalk tunnel arisings at ground surface is not considered to pose an unacceptable risk to the phosphate element of water quality of the River Till or River Avon through groundwater migration and/or direct surface water runoff. Screening of the phosphatic Chalk cores for naturally occurring radiation of materials (NORM) showed that each of the readings taken were below the threshold for determining the presence of measurable radioactivity.

Based on the results of human health risk assessments undertaken on limited soil samples obtained from the 2017 investigation and available historic investigations, it is concluded that there is unlikely to be an appreciable significant risk to human health based on the areas investigated. The controlled waters risk assessment identified generally minor levels of metals and nitrogen compounds within the tested groundwater and soil leachate samples and isolated detections of fluoranthene in soil leachate and cyanide in groundwater. Where exceedances against adopted screening values have been noted, this is generally considered to be attributable to background soil and groundwater conditions and the measured concentrations are not considered to represent an unacceptable risk to water quality. Whilst the chemical results are considered to be broadly representative of general ground conditions, it should be acknowledged that no site specific sampling was completed to target all of the potential sources identified, particularly the former military sites.

This report presents the information forming the basis of the environmental impact assessment (EIA) with regard to the potential for likely significant effects associated with geotechnical issues for the Scheme. Further ground investigation will be undertaken to provide information to inform the detailed design of the Scheme, and provide further monitoring facilities for the same purpose.

1 Introduction

1.1 Scope and Objective of the Report

1.1.1 This preliminary Ground Investigation Report (pGIR) has been prepared to support the preparation of the Development Consent Order (DCO) Application for the Scheme. It has been prepared in accordance with the requirements set out in BS EN 1997-1 [3], BS EN 1997-2 [4] and the Design Manual for Roads and Bridges (DMRB) document, Volume 4, Section 1, Part 2 “Managing Geotechnical Risk”, document ref. HD 22/08 [5].

1.1.2 This pGIR is based on information from available historical ground investigations and ground investigations carried out in 2017. Where possible figures within this report have been embedded within the text. Where this is not possible they are included at the rear of the report.

1.2 Description of Project (including Site Description)

1.2.1 The Scheme covers an approximately 13km long section of the existing A303 carriageway between Amesbury and Berwick Down in Wiltshire.

1.2.2 The Scheme proposes an upgrade of the current single carriageway to a dual carriageway as part of a wider priority project (National Infrastructure Plan 2014) proposing improvements to the A303/A30/A358 corridor.

1.2.3 The current carriageway passes through the Stonehenge and Avebury World Heritage Site (WHS) including the Stonehenge monument which is situated within 165m from the carriageway.

1.2.4 The Preferred Route for the Scheme was announced by the Secretary of State for Transport on 12 September 2017. Key features are summarised below:

a) A new grade separated junction between the A303 and A345 in the area of the existing Countess roundabout; accommodating free-flowing traffic movements between the two roads;
b) A twin-bore tunnel, at least 2.9km long passing Stonehenge;
c) A new grade separated junction to the west and outside the WHS in the area close to the existing Longbarrow roundabout accommodating free-flowing A303 and A360 traffic movements, as well as a link to Winterbourne Stoke;
d) A bypass to the north of Winterbourne Stoke, with a viaduct crossing the River Till.

1.2.5 Specific references are made to the route detailed in the following two models. These represent a refinement of the Preferred Route and have been adopted in this pGIR for the purpose of analysis of geotechnical information.

a) Scheme Wide Mainline Road Profiles, HE551506-AMW-HML-SW_ML_M00_Z-M2-CH-0401 (version P09)
b) Scheme Wide Mainline Horizontal Alignment, HE551506-AMW-HML-SW_ML_M00_Z-M2-CH-0001 (version P03)

1.2.6 The proposal to upgrade the existing A303 carriageway can be dated back to late 1980’s and it has since undergone various public consultations and route proposals. The Preferred Route announced in September 2017 is a further development of previous route options which were taken to non-statutory consultation in early 2017.

1.2.7 Two proposed routes were considered in the early 2017 consultation and were officially named as Options 1N and 1S for the northern and southern bypasses at Winterbourne Stoke respectively. Route Options 1N and 1S have been referenced as Options D061 and D062 respectively in the PSSR. Revision of the PSSR to reflect development of the route has not been proposed.

1.2.8 The Preferred Route and the previous Route Options are shown in Figure 2-1 [8]. The Preferred Route closely resembles Route Option 1N, and is mostly unchanged in alignment for the road sections that are situated to the west of the Winterbourne Stoke northern bypass, and to the east of the proposed eastern tunnel portal. For the intermediate road section, including the proposed tunnel, the Preferred Route has adopted a route that aligns closer to the existing A303.

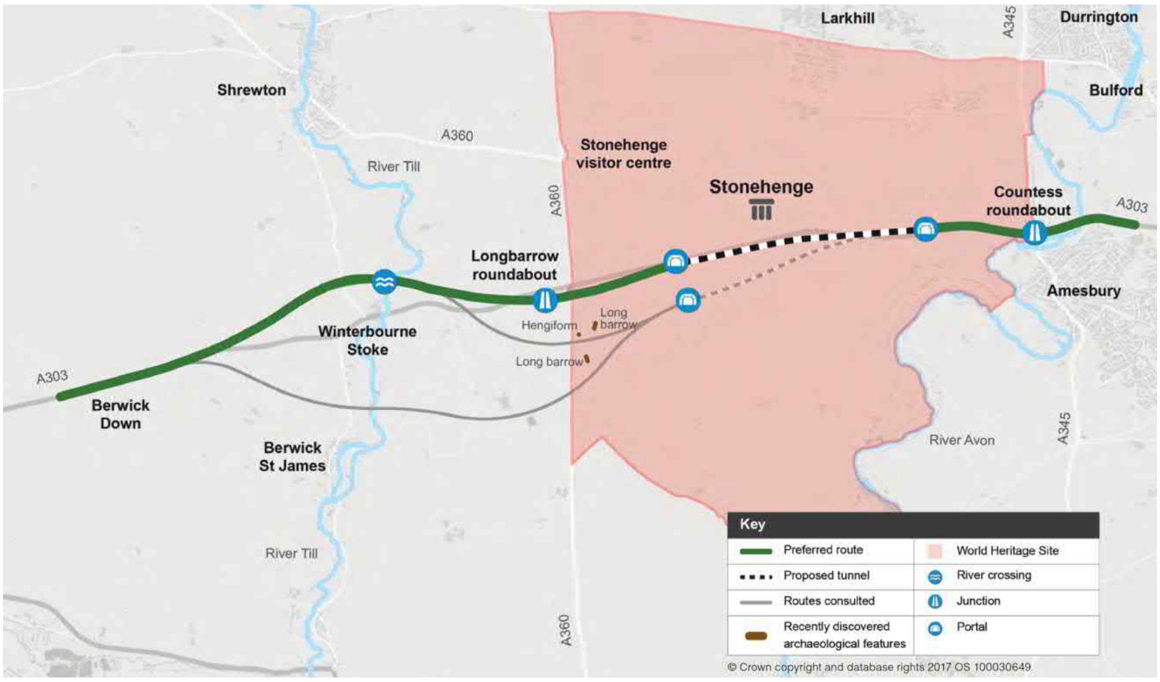

Figure 2-1 Preferred Route and Non-statutory Consultation Route Options

1.3 Geotechnical Category of Project

1.3.1 The Scheme is considered to fall under two Geotechnical Categories in accordance with BS EN 1997-1 [3]:

a) The tunnel is classified as Geotechnical Category 3;

b) The remaining structures and earthworks are classified as Geotechnical Category 2.

1.3.2 The current assessed Geotechnical Category should be reviewed throughout the development of preliminary and detailed design.

1.4 Scheme Programme

1.4.1 The Scheme programme is set to achieve a DCO application submission in late 2018 and the following key milestone:

Milestone	Target Date
SoS DCO Decision	February 2020
DCO Judicial Review period ends	March 2020
Land entry effected	July 2020, dependent on powers in DCO
Start of DCO preliminary works	July 2020
Start of main works	July 2021
Full Scheme open to traffic	2026

1.5 Other Relevant Information

1.5.1 Not used.

2 Existing Information

2.1 Introduction

2.1.1 This section summarises and reviews the relevant geotechnical and geo-environmental information available for the Scheme at the time of drafting this report. The review will primarily focus on the information in association with the PSSR [1]. The relevance of the information to the Preferred Route has been appraised.

2.2 Topographical Maps

2.2.1 No additional topographical information has been made available. Please refer to the PSSR [1].

2.3 Geological Maps and Memoirs

2.3.1 No additional maps or memoirs have been consulted. Please refer to the PSSR [1].

2.4 Aerial Photographs

2.4.1 No additional aerial photographs have been consulted. Please refer to the PSSR [1].

2.5 Records of Mines and Mineral Deposits

2.5.1 No additional evidence of mining activity has become apparent. Please refer to the PSSR [1].

2.6 Land Use and Soil Survey Information

Historical land use

2.6.1 Historical Ordnance Survey (OS) map extracts were obtained from the Landmark Information Group [9] as part of the Preliminary Sources Study Report (PSSR) [1] which generally cover the Preferred Route and some of the surrounding area. This mapping along with further documentary information within the PSSR (including aerial photographs) has been reviewed to evaluate the potential for past activities, both on and adjacent to the Preferred Route (up to 250m distance), to have impacted upon the land quality. A plan illustrating the key historical commercial/industrial activities is provided as Figure 3-1.

Berwick Down to East of Longbarrow Roundabout

2.6.2 This historical review section relates to the start of the Preferred Route at Berwick Down moving east to the Longbarrow roundabout at approximate chainage 6400. A summary of the historical mapping review is presented in Table 3-1.

Table 3-1 Northern Bypass of Winterbourne Stoke historical land use

Map Year	Description On Site[1]	Description Off Site
1877 1887 1889	A track/road is shown along the alignment of the current A303 and at the location of the current Longbarrow roundabout a Longbarrow crossroads is shown labelled Longbarrow Cross Roads. Land use along the Preferred Route comprises open agricultural land. The River Till runs generally in a north-south direction and is shown intersecting the Preferred Routeto the east of Winterbourne Stoke.	The surrounding area is mostly open land with occasional woodland areas and ancient burial mounds (barrows). Parsonage Down is labelled adjacent to the north of the track/road. A barn (Grant's Barn) is located adjacent north of the track/road, approximately 50m north of the Preferred Route (chainage 5000). Yarnbury Castle is located approximately 100m north-west of the western extent of the Preferred Route. Two old chalk pits are labelled approximately 140m south of the Preferred Route, south of Longbarrow Cross Roads. An old chalk pit is labelled to the east of Winterbourne Stoke, approximately 230m south of the Preferred Route. Manor Farm is present approximately 240m south of the proposed bypass.
1901	No significant changes since the 1887 map.	No significant changes since the1887 map.
1924 1926	No significant changes since the 1887 map.	A small wind pump and reservoir are labelled approximately 220m north of the proposed Longbarrow roundabout.
1939	The road is now labelled as the A303. No other significant changes occurred since the 1887 map.	A tank is labelled near Grant's Barn. At the Longbarrow Cross Roads, the northbound road (now labelled A360) has been re-aligned. The first 100m of the road has been moved approximately 50m to the west of the crossroad centre point. The reservoir 220m north is shown to be approximately 200m^2 in area.
1961 1962	No significant changes since the 1887 map.	The pump house 220m north is labelled a wind pump and the reservoir is no longer labelled.
1972	No significant changes since 1887 map.	The Longbarrow Crossroads are shown as a roundabout. The northern branch of the A360 has been re-aligned to its original alignment (pre-1939 mapping).
1977	A small pump house is present at approximate chainage 3400, west of the B3083 and north of Scotland Farm.	The old chalk pit to the east of Winterbourne Stoke appears to have been infilled.

[1] Within the footprint of the Preferred Route

Map Year	Description On Site[1]	Description Off Site
1980-1984 1984 1980-1985	The western part of the A303 between chainage 0000 and chainage 1500 has been widened.	Grant's Barn is no longer shown A drain is present adjacent north-west of Longbarrow Crossroads, approximately 50m north of the Preferred Route. The old chalk pits approximately 140m to the south of Longbarrow Cross Roads appear to have been infilled. The wind pump 220m north is now labelled a pump house and the reservoir is labelled as being covered.
1994	No significant changes since the 1980-1985 mapping.	No significant changes since the 1985 map.
2000	No significant changes since the 1980-1985 mapping.	No significant changes since the 1985 map.
2016	No significant change since the 1980-1985 mapping other than Longbarrow Cross Roads is labelled Longbarrow Roundabout.	The covered reservoir 220m north is no longer labelled, the pump house remains.

2.6.3 Information in the PSSR [1] indicates that a former military airfield named RAF Oatlands Hill was located to the south of the A303 and west of the A360. The proposed Longbarrow roundabout and associated link roads to the existing A303 and A360 southbound, intersect the former airfield between chainages 4800 and 6200.

2.6.4 The site is understood to have been a World War II satellite site for RAF Sarum and comprised a grass airfield, three small blister hangers with underground fuel storage facilities. The airfield was operational between 1941 and 1946 and appears to have been only very lightly used. A review of the aerial photographs from 1945 undertaken for the PSSR shows no visible evidence of aircraft use on the open grass field or in the vicinity of the hangars at the time of photographing.

East of Longbarrow Roundabout to East of Countess Roundabout

2.6.5 The historical review section below covers the preferred alignment between Longbarrow Roundabout and the eastern end of the scheme (approximate chainage 12570). A summary of the historical mapping review is presented in Table 3-2.

Table 3-2 East of A360 historical land use

Map Year	Description On Site[2]	Description Off Site
1877–1878;1879; 1883-1887; 1887	The Preferred Route is shown to pass through open agricultural land. A road is shown to be present along the	The surrounding area is mostly open land with occasional woodland areas and ancient burial mounds (barrows). Ratfyn Farm is located approximately 155m

[2] Within the footprint of the Preferred Route

Map Year	Description On Site[2]	Description Off Site
	alignment of the current A303 as far east as chainage 10000 where it continues south-east into Amesbury village along the currently named Stonehenge Road.	north-east of chainage 12500 and a small gravel pit is labelled to the south (approximately 60m north-east of the Preferred Route). A gas works comprising a small building and gasometer is labelled approximately 190m south of chainage 11800, south of the River Avon. Stonehenge monument is located approximately 230m north of chainage 8700. Little Amesbury (later called West Amesbury) is located approximately 500m to the south of the eastern area of the Preferred Route.
1901	A small 'old quarry' is labelled at chainage 11100 to the north-west of Amesbury.	The aforementioned gravel pit located near Ratfyn Farm is now labelled as a chalk pit.
1924-1926	Stonehenge Pedigree Stock Farm is labelled to the west of Stonehenge monument intersecting the Preferred Route between chainages 7700 and 8300. An associated above ground storage tank is also labelled. A dismantled railway (Larkhill Military Light Railway) is shown approximately 40m east of the labelled Longbarrow Cross Roads (south to north orientation) and intersects the alignment at approximately chainage 6450.	Amesbury & Military Camp Light Railway (Bulford Extension) is located approximately 80m east of the Preferred Route. A small disused sewage works is labelled approximately 175m south of chainage 8700, south of Stonehenge monument. The gas works located approximately 190m south is no longer labelled and the gasometer has been removed.
1929	No significant changes since the 1926 map.	No significant changes since the1926 map.
1961	No significant changes since the 1926 map.	No significant changes since the1926 map.
1971-1976; 1974 1972-1976	The dismantled Larkhill Military Light Railway, east of the Longbarrow Cross Roads is no longer labelled. The A303 Amesbury bypass and Countess Roundabout have been constructed. The PSSR (REF) indicates that this was constructed in the late 1960s. The duelled section of the A303 has been constructed directly through the aforementioned old quarry at chainage 11100. A pumping station is labelled in the north-west corner of the roundabout.	The aforementioned chalk pit located approximately 60m north-east of the eastern extent of the Preferred Route is no longer labelled and appears to have been infilled. Countess Farm is located approximately 65m north of chainage 11700, to the north-west of Countess Roundabout. The railway line approximately 80m east of the Preferred Route has been dismantled. The disused sewage works approximately 175m south is no longer present. Garages are present approximately 190m south-east of the eastern extent of the Preferred Route (south of River Avon). A small disused tip is labelled approximately 250m south of chainage 8700 near the former sewage works.
1990	No significant changes since the 1976 map.	The garages approximately 190m south-east are no longer present.
1994	No significant changes since the 1976 map.	A filling station (Countess Services) is located approximately 70m north of chainage 11800, north-east of Countess Roundabout. The aforementioned small disused tip is labelled approximately 250m to the south is no longer present.

Map Year	Description On Site[2]	Description Off Site
2000	No significant changes since the 1976 map.	No significant changes since the 1994 map.
2016	No significant changes since the 1976 map.	No significant changes since the 1994 map.

2.6.6 The PSSR [1] identified a former World War I military airfield and airbase named RAF Stonehenge located approximately 330m east of the current Longbarrow roundabout. The site was in operation between 1917 and 1921 and covered an area of approximately 360 acres, mainly in the fields north of the A303. The airbase's main camp was split into a technical area and a domestic area located north and south of the A303, respectively. The Preferred Route intersects the former main camp south of the A303 between chainages 7500 and 8500.

2.6.7 The technical area of RAF Stonehenge is understood to have contained aeroplane hangars, general repair hangars, numerous buildings for workshops, Bessonneau hangars as well as fuel storage tanks. The domestic area housed off duty aircraft crews and comprised various messes and a large barracks comprising an area of tents and buildings. The information reviewed [1] refers to a potential disposal area and tanks in the technical area of RAF Stonehenge on the north side of the A303. In addition, a military risk assessment [10] carried out for the PSSR [1] states that the aerodrome site would have had small arms ammunition stores, a semi-underground bomb store and an underground petrol tank. However the locations of these are unknown and do not appear on the only known site plan. A spur of the Larkhill Military Light Railway served RAF Stonehenge during its operation and a railway terminal and goods yard were historically present within the technical area of the airbase, to the north of the A303.

2.6.8 It is understood that buildings in the main camp were auctioned off between 1921 and 1922 and some of the buildings were subsequently used as a pig farm [11]. Some buildings remained in 1930s when most of the site was in the ownership of the National Trust. The information reviewed makes reference to the buildings being auctioned off, on condition of them being removed, it also states that prospective purchasers would have been interested in the value of the raw materials, including asbestos, indicating it may have been present.

2.6.9 The PSSR [1] indicates that the disused sewage works identified on the 1924 historical map (approximately 175m south of chainage 8700) was associated with the airbase. Aerial photographs indicate that this was dismantled at sometime between 1943 and 1970 and was no longer present on the 1972 OS map. Information in the PSSR [1] suggests that the nearby 'disused tip' (approximately 175m south of chainage 8700) was associated with soakaway beds relating to the former sewage works [1].

2.7 Archaeological and Historical Investigations

2.7.1 No additional archaeological or historical investigations have been carried out. Please refer to the PSSR [1].

2.8 Existing Ground Investigations

2.8.1 This section provides a review of the ground investigations carried out before the GI which was carried out in early 2017. Separate discussions regarding the 2017 GI are provided in Section 4.3.

2.8.2 A summary of the available existing ground investigation reports is provided in Table 3-3. The unique Highways Agency (former Highways England) Geotechnical Data Management System (HAGDMS) reference numbers for each report are given when available in Table 3-3.

2.8.3 The earliest ground investigation information reviewed is dated to 1965. The ground investigation was carried out for a proposed bypass in the area of the existing Countess roundabout.

2.8.4 A series of ground investigations were carried out between 2000 and 2004 to support the design development of the published scheme at that time. The ground investigations were carried out in three major phases:

a) A preliminary ground investigation took place in 2000 and comprised three boreholes. The boreholes are located within 70m from the centreline of the tunnel section of the Preferred Route.

b) A main ground investigation was carried out in two phases. The locations of the majority of exploratory holes in general follow the alignment of the current Preferred Route. The combined two phases are considered to contribute the majority of geotechnical information in terms of exploratory hole numbers and area coverage.

- Phase 1 started in February 2001 and investigated the area between Countess roundabout and Longbarrow roundabout.

- Phase 2 was carried out from August to September 2001. It investigated the area to the west of Longbarrow roundabout as well as the location of two alternative routes both for a northern bypass of Winterbourne Stoke.

c) A supplementary ground investigation was carried out between 2002 and 2004 with early contractor involvement in three phases:

- Phase 1A took place from 2002 to 2003. The exploratory hole locations in general are distributed along the Preferred Route. Higher densities of exploratory holes are noted in the areas of the Countess Roundabout, proposed tunnel and the Winterbourne Stoke northern bypass.

- Phase 1B comprised two pumping tests. The first test was first carried out in winter 2002 and the same was repeated in summer 2004. The pumping tests took place in the areas of Stonehenge Down and Stonehenge Bottom. Both test locations are close to the proposed tunnel alignment on the Preferred Route. The pumped water was discharged into a recharge area located approximately 700m to the south of the proposed tunnel and the water level in that area was monitored by a series of standpipe piezometers.

- Phase 2 comprised site trial of four numbers of cone penetration test (CPT) gamma cone in the area of the Preferred Route tunnel in 2004.

2.8.5 A ground investigation was carried out in 2002 for a proposed Stonehenge Visitors Centre located to the north of existing Countess roundabout.

2.8.6 A ground investigation was carried out for improvement works at the Countess roundabout in 2009. It comprised two boreholes and sixteen trial pits.

2.8.7 A separate ground investigation in 2009-2010, comprising five trial pits, was carried out for the improvement works at the Longbarrow roundabout.

Table 3-3 Existing Ground Investigation Factual Reports

HAGDMS Reference (1)	Report Title	Time of Fieldwork	Contractor	Consultant	Summary of Scope
17031	A303 Stonehenge-Countess Roundabout, Geotechnical Review Technical Note [2]	1965	Foundation Engineering	N/A	The technical note was prepared by Halcrow Group Ltd and refers to a ground investigation carried out by Foundation Engineering in 1965 in the area around the Countess Roundabout for a London-Penzance Trunk Road A303 Amesbury by-pass. The ground investigation factual report has not been appended but a summary of ground and groundwater encountered in the exploratory holes is provided.
N/A	A303 Stonehenge Countess Roundabout Assessment of Improvement Options June 2000 [12]	May 2000	Halcrow Transportation Infrastructure	Halcrow Transportation Infrastructure	Eight trial pits in the areas along the existing route of A303 carriageway around Countess roundabout.
17439	A303 Preliminary Ground Investigation [13]	Oct – Nov 2000	Soil Mechanics	Mott MacDonald	Three boreholes
16175	A303 Stonehenge Ground Investigation Factual Report on Phase I Main Ground Investigation Volume 1 to 5. [14]	Feb – May 2001	Soil Mechanics	Mott MacDonald	Factual report presenting the results of a ground investigation carried out along and to the south of the A303 between the ‘Avenue’ and Normanton Gorse.
16174	A303 Stonehenge Ground Investigation Factual Report on Phase II Main Ground Investigation, Volume 1 and 2. [15]	Aug – Sept 2001	Soil Mechanics	Mott MacDonald	Factual report presenting the results of a ground investigation carried out along and to the south of the A303 between the Avenue and Normanton Gorse and around Winterbourne Stoke.
16996	Stonehenge Visitors Centre, Amesbury, Wiltshire - Ground Investigation Factual Report [16]	April – May 2002	John Grimes Partnership	Anthony Hunt Associates	Factual report presenting the results of a ground investigation carried out to the north of Countess Roundabout.

HAGDMS Reference (1)	Report Title	Time of Fieldwork	Contractor	Consultant	Summary of Scope
21762	Factual Report Phase 1A Supplementary Ground Investigation for A303 Stonehenge Improvement Volume 1 to 5 [17]	Nov 2002 – Jan 2003	Soil Mechanics	Halcrow-Gifford	Factual report presenting the results of a ground investigation carried out along and to the south of the A303.
N/A	A303 Stonehenge Improvements: Pumping Test Factual Report Ref 312/1098 [18]	Oct – Dec 2002	WJ Groundwater	Balfour Beatty Major Projects	Factual report presenting the results of two pumping tests on Stonehenge Down and Stonehenge Bottom and a recharge trial for the A303 Stonehenge Improvements.
N/A	A303 Stonehenge Improvements; Summer Pumping Tests Factual Report [19]	Sept 2004	WJ Groundwater	Balfour Beatty Major Projects	Factual report presenting the results of the 2002 tests repeated in September 2004 when groundwater levels were at a seasonal high.
21758	A303 Stonehenge Improvement, Phase 2 Supplementary Investigation, Static Cone Penetration Tests Factual Report [20]	Aug 2004	Soil Mechanics / Lankelma	Halcrow-Gifford	Trials of CPT and surface geophysics including gamma cone.
24822	A303 Countess Roundabout - Safety Scheme [21]	June 2009	Soil Mechanics	Mott MacDonald	Factual report presenting the results of a ground investigation carried out around Countess Roundabout (Junction between the A303 and A345).
24930	A303 Longbarrow Roundabout Improvement Scheme [22]	Dec 2009 to Jan 2010	Soil Mechanics	Mott MacDonald	Factual report presenting the results of a ground investigation at Longbarrow roundabout (Junction between the A303 and A360).

2.8.8 Table 3-4 summarises the exploratory holes carried out in each of the existing ground investigations. The locations of existing ground investigation exploratory holes have been combined onto drawings provided in Appendix A.

Table 3-4 Summary of Existing Ground Investigation Holes

Ground Investigation HAGDMS Ref.	Hole Type [1]	Number	Hole Depth (m bgl)	Ground Level (m AOD)	Chainage [2] (m)	Offset [2] (m)
17031	CP	27	0.0 - 13.3	68.8 - 87.8	11099 - 12423	1.8 - 182.9
N/A (Halcrow 2000)	TP	8	3.0 – 5.2	66.15 – 68.89	11372 - 12186	0.5 - 16.0
17439	CP+RC	3	31.3 - 35.8	80.9 - 109.5	8526 - 9806	20.4 - 66.0
16175	RC	24	15.6 - 51.0	79.5 - 109.9	7543 - 10438	3.9 - 103.5
	RO	4	45.0 - 50.5	90.8 - 93.1	8700 - 8985	63.1 - 73.5
	TP	22	3.5 - 5.0	79.7 - 110.3	7625 - 10508	8.9 - 113.1
16174	CP	6	15.4 - 20.0	71.4 - 75.3	4031 - 4498	0.5 - 264.9
	RC	3	15.2 - 20.0	97.6 - 119.9	2790 - 5047	9.5 - 73.1
	TP	69	3.5 - 6.0	74.2 - 140.0	1193 - 10764	0.8 - 268.1
16996	CP	5	13.0 - 15.0	76.9 - 84.5	11613 - 12039	414.2 - 644.2
	CP+RC	6	13.2 - 15.1	69.9 - 84.2	11887 - 12053	50.6 - 630.4
	DP	16	1.6 - 11.0	70.2 - 70.2	11663 - 12048	48.0 - 648.3
	TP	18	2.4 - 6.7	72.1 - 83.4	11604 - 12151	45.3 - 616.4
	WS	1	5.1 - 5.1	81.4 - 81.4	11669 - 11669	447.0 - 447.0
21762	CP	14	12.4 - 40.0	69.9 - 95.0	8432 - 12055	15.2 - 797.5
	CP+RC	3	15.0 - 20.1	71.1 - 71.5	11441 - 11835	1.0 - 19.5
	RC	22	0.0 - 50.4	71.7 - 122.3	2632 - 10096	0.5 - 851.5
	RO	5	14.0 - 42.0	79.7 - 94.2	8638 - 9202	15.5 - 73.0
	TP	26	1.1 - 5.4	70.0 - 127.6	1950 - 11849	6.7 - 136.7
	WS	4	3.0 - 3.0	68.9 - 69.2	11608 - 11889	39.5 - 50.9
24822	BH	2	5.5 - 12.5	71.0 - 71.1	11826 - 11833	13.4 - 20.9
	TP	11	1.1 - 3.5	70.2 - 71.5	11703 - 11811	5.2 - 79.1
24930	TP	5	1.2 - 3.0	110.1 - 111.3	6195 - 6303	65.1 - 126.0

Notes: [1] TP = trial pitting; CP = cable percussion; RC = rotary coring; RO = rotary open hole; DP = dynamic probing; WS = window sampling; CP+RC = cable percussion with rotary coring follow-on; BH = borehole with unspecified technique.

[2] Offset is the perpendicular distance between the mainline Preferred Route alignment and the exploratory hole location. Chainage is the distance from the start of the Scheme at Berwick Down to the position where the perpendicular line drawn from the exploratory hole intercepts the mainline Preferred Route alignment.

Table 3-5 Summary of Scope of the Existing Ground Investigations

Testing	Test Type	Ground Investigations in HAGDMS Reference Number								
		17031	17439	16175	16174	16996	21762	WJG 2002 & 2004	24822	24930
In-situ	Standard Penetration Test (SPT)			✓	✓	✓	✓		✓	
	Dynamic Probe					✓				
	In-situ CBR				✓		✓			
	Plate Load				✓		✓			
	Wireline Logging / Geophysics									
	- Optical Televiewer		✓	✓			✓			
	- Acoustic Televiewer			✓						
	- Caliper		✓	✓			✓			
	- Natural Gamma		✓	✓			✓	✓		
	- Flowmeter		✓	✓				✓		
	- Fluid Temp		✓	✓				✓		
	- Fluid Conductivity		✓	✓						
	- P & S Wave									
	High Pressure Dilatometer (HPD) Pressuremeter			✓						
	Soakaway					✓	✓			✓
	Packer			✓			✓			
	Pumping							✓		
Instrumentation and Monitoring	Installation		✓	✓	✓	✓	✓			
	Post-fieldworks Groundwater Monitoring		✓	✓	✓	✓	✓			
	Remote Telemetry Piezometer Installation and Monitoring						✓ (1)			
Laboratory - Soils	Moisture Content (Saturated or Natural)		✓	✓	✓	✓	✓		✓	✓
	Dry Density				✓					
	Bulk Density				✓					
	Saturated Density				✓					
	Atterberg Limits			✓	✓	✓	✓		✓	✓
	Particle Size Distribution			✓	✓	✓	✓		✓	✓
	Compaction Tests			✓	✓		✓			
	Laboratory CBR					✓	✓			
	Laboratory Vane								✓	
	Consolidation				✓		✓			
Laboratory - Rock	Point Load		✓	✓	✓		✓			
	Uniaxial Compressive Strength (UCS)		✓	✓			✓			
	- with Deformability Measurement			✓			✓			
	Shear Box			✓						

Testing	Test Type	Ground Investigations in HAGDMS Reference Number								
		17031	17439	16175	16174	16996	21762	WJG 2002 & 2004	24822	24930
	Chalk Crushing Value			✓	✓	✓	✓			
	Natural Moisture Content		✓	✓	✓		✓		✓	✓
	Saturated Moisture Content		✓	✓	✓	✓	✓		✓	✓
	Dry Density		✓	✓	✓	✓	✓		✓	✓
	Bulk Density		✓	✓	✓		✓		✓	✓
	Saturated Density		✓	✓	✓		✓		✓	✓
Laboratory-Chemical	Geotechnical-Chemical			✓	✓		✓		✓	

Notes: (1) Borehole R158 was reinstated and a diver data-logger was installed by Structural Soils Ltd. in September 2016.

2.9 Consultation with Statutory Bodies and Agencies

2.9.1 Table 3-6 presents a summary of the statutory bodies consulted for this report.

Table 3-6 Summary of Consulted Statutory Bodies

Statutory Body	Details
Wiltshire Council	• Enquiries made via Groundsure regarding records of land impacted by contamination, mining and ground instability hazards. • Historic Environment Records (HER) consulted to inform the heritage assessment. • Enquiries made to obtain information on groundwater abstraction in the study area, extending beyond the immediate vicinity of the Scheme to include water bodies from the River Till and River Avon and source protection zones of groundwater abstractions within those catchments.
Environmental Agency (EA) and other environmental bodies	• Publicly available records accessed through EA website. Data enquiry made in February 2016. • EA records consulted through Groundsure search regarding hydrogeology, landfill sites and pollution incidents and Integrated Pollution Prevention and Control (IPPC) permits. • Industry Profiles produced by former Department of Environment reviewed to identify likely contaminants associated with former or current industrial land uses. • Groundwater abstraction information obtained from the EA and Wessex Water. • Groundwater level monitoring data requested from the EA to complete the ground investigation data set. • Groundwater quality data was supplied by the Environment Agency and Wessex Water.

2.10 Flood Records

2.10.1 No additional flood records have been consulted. Please refer to the PSSR [1].

2.11 Contaminated Land

Environmental Sensitivity

2.11.1 This section presents a summary of the environmental conditions at, and within a 250m radius of, the Preferred Route (1km radius for groundwater abstractions) and is based on information presented in the PSSR (including the Groundsure Report, [1] and the Environment Agency's (EA) 'What's in Your Backyard' website[3] (accessed 22 September 2017) [23].

Ecologically Sensitive Sites

2.11.2 The Preferred Route lies within a groundwater Nitrate Vulnerable Zone (NVZ) area. These are designated areas of land draining into waters polluted by nitrates from agriculture. The European Nitrates Directive requires NVZs to be designated and for farmers with land in NVZs to follow mandatory rules to tackle nitrate loss from agriculture.

2.11.3 The River Till and the River Avon are designated as Site of Special Scientific Interest (SSSI) and are located within a Special Area of Conservation. The rivers cross the west and east parts of the Preferred Route, respectively. Parsonage Down, an extensive area of Chalk downland to the north-west of Winterbourne Stoke (50m north of the preferred alignment at its closest point) is designated a SSSI and National Nature Reserve.

Groundwater Sensitivity

2.11.4 Groundwater within the Chalk bedrock, which underlies the Preferred Route, is classified by the EA as a Principal Aquifer of high and intermediate vulnerability.

2.11.5 Source protection zones (SPZ) are areas designated by the EA in order to protect significant potable water groundwater abstractions. The zones identify areas which may be at risk of pollution resulting in contamination of the groundwater source. They are classified into three zones depending on travel time of pollutants and therefore potential risk to the source: the inner zone (or zone 1), the outer zone (or zone 2) and the total catchment (or zone 3). The zones have been determined to represent a 50 day travel time, a 400 day travel time, and the whole groundwater catchment for public water supply groundwater sources.

2.11.6 There is no designated groundwater SPZ within 1km of the Preferred Route. Between 1km and 2km the following SPZs are present:

a) SPZ1 (Inner Protection Zone) and SPZ2 (Outer Protection Zone) located east of Larkhill (approximately 1.2km north of the Preferred Route);

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[3] This open source data is due to be transferred to the magic.defra.gov.uk and data.gov.uk websites in April 2018

b) SPZ1 and SPZ2 located north-east of Bulford Camp (approximately 1.8km north-east of the Preferred Route);
c) SPZ1, SPZ2 and SPZ3 (Total Catchment) located at Shrewton (approximately 1.9km north of the Preferred Route); and
d) SPZ3 located south of Amesbury (approximately 2km south of Preferred Route).

2.11.7 Groundwater within the locally present Head Deposits is classified as a Secondary (undifferentiated) Aquifer. The EA classifies groundwater within Alluvium, River Terrace Deposits and rare Peat that is associated with the channels of the River Avon and River Till, as Secondary-A Aquifers. These are permeable layers with a moderate to high primary permeability and which are capable of supporting water supplies at a local rather than strategic scale, and in some cases form an important source of baseflow to rivers. The deposits provide groundwater that flows to the River Avon and River Till. Secondary (undifferentiated) aquifers are defined where it has not been possible to provide an A or B category.

Surface Water Features

2.11.8 Two rivers intersect the Preferred Route; the River Till flowing southwards through Winterbourne Stoke at the western extent (chainage 4100), and the River Avon at the eastern extent (chainage 12300).

2.11.9 Two springs are located approximately 70m and 650m south of the eastern area of the Preferred Route within Amesbury Abbey Amesbury springs) and West Amesbury.

Regulatory records

Landfills and Waste Management Facilities

2.11.10 There are no registered historic or current landfills or waste management facilities within 250m of the Preferred Route.

Fuel Station Entries

2.11.11 The Groundsure Report indicates one fuel station to be present within 250m of the Preferred Route – Shell Amesbury located at the A303 Countess Services, Countess Road, Amesbury, Salisbury, SP4 7AS (70m north of the proposed Countess Junction Flyover). The status is identified as Open.

Current Industrial Activities

2.11.12 The Groundsure Report indicates that there are three current industrial activities within 250m of the Preferred Route, all of which are located in Amesbury, south of the River Avon. These activities are summarised in Table 3-7 below.

Table 3-7 Summary of Current Industrial Activities

Name	Classification	Location
Action Rubbish Clearance Ltd	Waste Storage, Processing and Disposal	Approximately 150m south of chainage 12200

Name	Classification	Location
B & C Reconditioning Gears Ltd	Repairs and Servicing	Approximately 140m south-east of the eastern extent of the Preferred Route
Marie Sparshatt	Precision engineers	Approximately 205m south-east of the eastern extent of the Preferred Route

2.11.13 Information in the PSSR [1] notes that the address provided in the Groundsure Report [24] for Action Rubbish Clearance Limited relates to a residential property rather than a waste facility and it is likely that the company is registered to this address but does not operate from this location.

Pollution Controls

2.11.14 According to the Groundsure Report, there are no Integrated Pollution Prevention and Control (IPPC) processes located within 250m of the Preferred Route.

Pollution Incidents to Controlled Waters

2.11.15 The Groundsure Report shows there is one recorded pollution incident to controlled waters within 250m of the Preferred Route. The incident was reported on 29 October 2002 and relates to a release of oils and fuel to ground, approximately 190m south of the Preferred Route (south-west of Countess Roundabout). This was reported as Category 3 – Minor Incident.

Licensed Discharge Consents and Water Abstraction Licences

2.11.16 According to the Groundsure Report there are two licensed discharge consents within 250m of the Preferred Route, both of which have been revoked:

a) Countess Service Station (approximately 30m north of the proposed Countess Flyover): discharge of surface water to an unnamed tributary of the River Avon, licence revoked 23rd October 2010; and
b) Mr WR Sebborn (domestic property approximately 70m south of the proposed Countess Flyover): discharge of surface water to the River Avon, licence revoked 23rd November 1998.

2.11.17 EA information contained in the Groundsure Report indicates that there are no licenced surface water abstractions located within 1km of the Preferred Route.

2.11.18 There are four groundwater abstraction licences located within 1km of the Preferred Route. Three of these abstractions are for general farming or commercial use and one relates to a private potable water supply abstraction. A summary of the groundwater abstraction licence details is provided in Table 3-8 below.

Table 3-8 Groundwater Abstraction License Summary

Abstraction Borehole Name	Type of Use	Licence Number	Location
Oatlands Hill, Winterbourne Stoke Well Point B	General farming and domestic	13/43/023/G/065	560m south-west of the proposed A303 link road to Long Barrow Junction

Abstraction Borehole Name	Type of Use	Licence Number	Location
Borehole ‘A’ at Airman’s Corner	Energy – heating pump	SW/043/0021/003	620m north of proposed A360 northbound link road (adjacent Stonehenge Visitor Centre)
Borehole ‘B’ at Airman’s Corner	Private Water Supply: Drinking, Cooking, Sanitary, Washing, (Small Garden) - Commercial/Industrial/Public Services	SW/043/0021/003	690m north of proposed A360 northbound link road (adjacent Stonehenge Visitor Centre)
WISMA Farm Borehole Point A	General agriculture	13/43/023/G/246	960m south, off Berwick Road south of Winterbourne Stoke

Previous Geo-environmental Assessments

2.11.19 This section provides a review of the key available geo-environmental assessments undertaken associated with proposed historical route alignments. A limited amount of chemical testing was completed during the two phases of the Main Ground Investigation in 2001 carried out along, and to the south of, the A303 between the Avenue and Normanton Gorse and around Winterbourne Stoke. In addition, chemical testing was also completed during investigations to inform improvements at the Countess and Longbarrow roundabouts in 2009 and 2010. Drawings showing the locations of the previous exploratory holes undertaken are presented in Appendix A.

2.11.20 Chemical testing was also undertaken in 2002 as part of a ground investigation (GI) for a proposed Stonehenge visitors’ centre which was not subsequently developed, approximately 350m north of Countess Roundabout. This information has not been reviewed in view of the distance of the investigation from the Preferred Route. The closest chemical sampling point is approximately 390m north of the Preferred Route.

2.11.21 Note that the risk assessment criteria used in the below assessments were those that were applicable at the time of the assessment completed. A review of the available chemical data against current assessment criteria is undertaken in Section 6, along with the data collected during the 2017 EP GI [25].

Phase I of Main Ground Investigation, Mott MacDonald (2001)

2.11.22 The objective of the Main Ground Investigation was to obtain ground conditions data to inform the construction of a 2km long tunnel in the vicinity of Stonehenge monument and, a bypass north of Winterbourne Stoke (the 1999 published scheme). The GI was undertaken in two phases due to a nationwide outbreak of Foot and Mouth Disease. Phase I covered the area between Longbarrow and Countess roundabouts.

2.11.23 The Phase I GI was undertaken between February and May 2001 and comprised a total of 40 exploratory holes (20 trial pits to between 3.5m to 5.0 metres below ground level (m bgl) and 20 boreholes to between 20m to 51m bgl) located in arable fields to the south of the existing A303. Groundwater monitoring installations were installed in twelve of the boreholes. The GI findings were assessed in Mott Macdonald’s Site Investigation Interpretative Report dated October 2001, HAGDMS reference 17317 [26]. Chalk was encountered in all exploratory holes and was generally present within 0.5m of the ground surface (with overlying topsoil and locally very thin Head Deposits. No visual or olfactory evidence of chemical contamination was observed during the field work.

2.11.24 A total of four topsoil samples and four groundwater samples (collected from well screens positioned within the Chalk aquifer) were submitted for chemical analysis. The locations of the soil samples taken are not clear from the information provided in the interpretative or factual report. However, it is stated that the samples were collected from shallow hand excavations across the site. The testing suite adopted comprised:

a) inorganics: metals, metalloids, pH, anions; and
b) organics: gasoline range organics (GRO), diesel range organics, (DRO), speciated polycyclic aromatic hydrocarbons (PAH), phenols, organochlorine pesticides, organophosphorus pesticides, triazine herbicides, polychlorinated biphenyls (PCB) and volatile organic compounds (VOC).

2.11.25 Groundwater samples were collected from four well installations; designated R13 and R16 and P1 and P2. Exploratory holes P1 and P2 had been drilled during an earlier Preliminary Ground Investigation undertaken in 2000. Groundwater samples were analysed for the following geo-chemical parameters:

a) inorganics: metals, metalloids, pH, anions, total dissolved solids, chemical oxygen demand (COD) and biological oxygen demand (BOD); and
b) organics: faecal coliforms, total coliforms, PCB, DRO, GRO, PAH, phenols, organochlorine pesticides, organophosphorus pesticides, triazines and VOC.

2.11.26 The report compared the four soil results with Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL) [27] levels which were applicable at the time as a means for assessing the risk to human health. The concentrations of tested analytes in all samples were found to be below the most conservative thresholds published for domestic gardens. Concentrations of pesticides, herbicides, VOCs and PCBs were all recorded below the laboratory limit of detection.

2.11.27 The groundwater results were screened against UK Water Supply Regulations (UKWSR) which was applicable at the time. Exceedances were recorded for iron (two samples), faecal coliforms (one sample) and total coliform (two samples). It was suggested that it was common for silt-sized particles to have high iron content and so these results could have been expected. The presence of coliforms was considered likely to be associated with bacteria in the soil and faecal coliforms due to the recent animal activity. The report noted that whilst concentrations of cyanide, thiocyanate, GRO, DRO, PAH, PCB and phenol were below the laboratory method detection limit, the limit was in fact higher than the corresponding UKWSR values.

2.11.28 The report concluded that ‘no contamination was revealed by chemical testing of the soil’ and ‘no contamination of the groundwater was encountered’.

Phase II of Main Ground Investigation, Mott MacDonald (2002)

2.11.29 Phase II of the GI was undertaken between August and September 2001 and mainly covered the section west of the Long Barrow Roundabout and included for the investigation of the proposed A303 northern bypass of Winterbourne

Stoke. The GI comprised nine boreholes (drilled to 15m to 20m bgl except borehole W1 which was drilled to 50m bgl to intercept deep groundwater adjacent to the LongbarrowRoundabout) and sixty-nine trial pits (to depths of between 3.5m – 5.0m bgl). Groundwater monitoring standpipes were installed in five of the boreholes.

2.11.30 Made Ground was encountered in a single shallow trial pit (STP12) located towards the western extent of the scheme comprising sandy gravel with tarmac and glass to 0.6m bgl. In addition, an area of disturbed ground adjacent to borehole CP3 was noted to have been used for tipping in the past. It was reported that discussions with the landowner indicated that the area contained demolition debris from a local hotel, potentially including asbestos. It was noted that the disturbed ground was on farmland and the presence of animal carcasses and fertilisers could not be discounted. This area is located approximately 170m north of the current preferred alignment.

2.11.31 A total of five soil samples were analysed including a sample collected from the disturbed ground identified adjacent to borehole CP3 (0.2m bgl). The report does not specify any further details as to what this disturbed ground relates to. The soil test suite included the following chemical analytes:

a) inorganics: metals, metalloids, anions, COD, BOD; and
b) organics: PCB, DRO, GRO, PAH, phenols, organochlorine pesticides, organophosphorus pesticides, triazines, VOC.

2.11.32 The chemical laboratory certificates were not included in the Soil Mechanics Factual Report, HAGDMS reference 16174 [15]. However, a summary was provided in the interpretative report, HAGDMS reference 16182 [28]. One soil sample from borehole CP2 (0.2m bgl) recorded elevated concentrations of total PAH (188mg/kg) compared to the ICRCL Trigger Threshold for Gardens of 50mg/kg. No Made Ground was identified in the sample and the report stated that the concentrations were likely to be associated with small fragments of timber coated in wood preservatives/creosote originating from wooden boards used to contain soil arisings (cross-contamination). No other tested analytes were recorded above adopted screening values in the four remaining samples.

2.11.33 Groundwater samples were collected from the five cable percussive boreholes (CP1-CP5) drilled in the flood plain of the River Till. The installation response zones were screened through superficial deposits (CP1 and CP2) and the Chalk (CP3 to CP5). The groundwater testing suite comprised:

a) inorganics: metals, metalloids, anions, total dissolved solids; and
b) organics: faecal coliforms, total coliforms, GRO, DRO, PAH, speciated phenols, PCB, organochlorine pesticides organophosphorus pesticides, triazines and VOC.

2.11.34 The groundwater results were compared with UKWSR and Water Quality Objectives Regulations (WQOR), which were considered to be protective of groundwater and surface water receptors respectively. A limited number of exceedances were recorded. A single exceedance of the WQOR for ammoniacal nitrogen was recorded in the groundwater sample taken from borehole CP2. Exceedances of the UKWSR were recorded in at least one sample for fluoride, chloride, iron, ferrous iron, total iron, selenium, calcium and sodium.

2.11.35 Microbiological analytical results were compared with the standards contained in the EC Directive on Drinking Water (75/440/EEC). The groundwater quality was considered representative of the baseline conditions in the area and typical of unfiltered samples. Mott MacDonald noted that groundwater abstracted during construction may require treatment by settlement, oxidation and mixing with clean water prior to discharge to the River Till.

Longbarrow Roundabout Improvement Scheme, Mott MacDonald 2010

2.11.36 The reported objective of the investigation at Longbarrow roundabout was to provide geotechnical data to assist with a proposed scheme to realign the roundabout to the south-west. The GI was undertaken on17th December 2009 and 12th January 2010 and comprised five trial pits excavated to depths of between 1.2m and 3.0m bgl within and around the existing roundabout. The investigation findings were presented in a Ground Investigation Report prepared by Mott MacDonald in March 2010, HAGDMS reference 24930 [21] .

2.11.37 The ground conditions encountered comprised Made Ground overlying Chalk. The Made Ground extended to depths of between 0.4m and 1.25m bgl and generally comprised brown sandy gravelly silt with occasional fragments of Chalk, flint, clinker, bitumen, tarmacadam, concrete and rootlets. Groundwater was not encountered in any of the exploratory hole locations. No visual or olfactory evidence of contamination was recorded.

2.11.38 Chemical testing was undertaken on three samples of Made Ground ranging between 0.2m to 0.3m depth for a suite of metals, speciated PAHs and speciated Total Petroleum Hydrocarbons (TPH) to assess the risks to construction workers and to identify the correct waste streams. The report screened the analytical data against human health generic assessment criteria (GAC) derived for a residential with gardens land use. The waste classification assessment was carried out using the McArdle-Atkins CAT-WASTESOIL model (a Hazardous Waste classification tool).

2.11.39 The recorded concentrations of inorganic and organic analytes were below the corresponding GAC except for marginally elevated concentrations of the PAHs benzo(a)pyrene (max 8.35mg/kg vs GAC of 1.74mg/kg) and chrysene (11.13mg/kg vs GAC of 10.9mg/kg) which were identified in three samples and one of the samples, respectively. The report concluded that the concentrations were not considered to pose significant risks to construction workers as long as appropriate personal protective equipment (PPE) was provided and safety procedures followed. The results of the waste classification assessment indicated that Made Ground would be classified as Non-Hazardous Waste.

Countess Roundabout - Safety Scheme, Mott MacDonald 2010

2.11.40 The aim of this investigation at Countess Roundabout was to obtain geotechnical data to assist with the re-design of the roundabout. The GI was undertaken in June 2009 and comprised two boreholes (5.45m to 12.45m bgl) and eleven trial pits (1.1m to 3.5m bgl). The investigation findings were presented in a ground investigation report prepared in April 2010, HAGDMS reference 24822 [29] .

2.11.41 The ground conditions encountered comprised Made Ground, superficial deposits (River Terrace Deposits - clays, silts and gravels) and Chalk. Made

Ground was found in all exploratory holes to depths of between 1.8m and 3.2m bgl. It comprised a variety of materials, but typically, silt, clayey sand, gravel, clay and highly weathered Chalk; although silt and sand were dominant. Gravel of ash and clinker with a strong hydrocarbon odour was noted in trial pit TP4 between 0.60m and 0.80m bgl which extended horizontally for approximately 1.20m.

2.11.42 The River Terrace Deposits were proven in BH1 and BH2 at thicknesses of between 4.0m and 2.2m, respectively. The Chalk was encountered in the boreholes at depths of 5m (BH1) and 6m bgl (BH2). During drilling, groundwater strikes were recorded in both boreholes within the gravel (4m bgl) and Chalk (5m and 9m bgl). A groundwater monitoring standpipe was installed in borehole BH1 (screened through the Made Ground, River Terrace Deposits and Chalk) and levels were subsequently recorded between 2.7m and 2.91m bgl corresponding with the sandy, gravelly clay.

2.11.43 Chemical testing was undertaken on eleven samples of Made Ground (0.2m to 0.6m depth) for a suite of metals, speciated PAHs and TPH to assess the risks to construction workers and to undertake a preliminary waste classification. The analytical data was screened against conservative human health GAC for a residential with plant uptake land use scenario. Exceedances were reported for TPH (TP4 only) and PAHs (TP4, BH1, TP2 and TP8) with particularly high concentrations corresponding with TP4 where a hydrocarbon odour was observed (TPH = 13,900mg/kg, benzo(a)pyrene = 43.6mg/kg). With the exception of TP4, exceedances for PAH were limited to benzo(a)pyrene and were relatively minor (ranging between 2.73 and 7.64mg/kg). The report suggested that the elevated concentrations were likely to be associated with a recent fuel spillage. No significant risk was identified to construction workers as long as appropriate PPE is provided and safety procedures followed.

2.11.44 The results of the waste assessment using the McArdle-Atkins CAT-WASTESOIL model indicated that one Made Ground sample from trial pit TP4 would be classified as Hazardous Waste due to the elevated TPH and PAH concentrations. The remaining ten samples were classified as Non Hazardous.

Summary of Previous Ground Investigation

2.11.45 As part of the Main Ground Investigation undertaken in 2001, a total of 118 exploratory holes were advanced in agricultural fields along and to the south of the existing A303 and to the north of Winterbourne Stoke. Made Ground was recorded in one of the trial pits only (STP12, approximately 100m south of the Preferred Route) and an area of disturbed ground was also observed adjacent to borehole CP3 (approximately 200m north of the Preferred Route). No visual or olfactory evidence of chemical contamination was observed.

2.11.46 The results of the soil chemical testing (nine samples) completed were consistent with the field observations with only one topsoil sample from borehole CP2 reporting elevated concentrations of PAH. Mott MacDonald concluded that this was most likely a result of cross-contamination during sampling. The results of the nine groundwater samples collected during the Main Ground Investigation at Stonehenge Bottom and the River Till valley revealed occasional exceedances for anions, metals (namely iron), ammoniacal nitrogen and microbial contaminants above the adopted screening criteria. However, Mott MacDonald concluded that the groundwater quality was considered representative of the baseline conditions in the area and typical of unfiltered samples.

2.11.47 The 2009 and 2010 ground investigations at Countess and Longbarrow roundabouts encountered Made Ground up to 3.2m thick. A strong hydrocarbon odour was recorded in Made Ground at one of the thirteen exploratory holes at Countess roundabout (TP4) which was considered likely to be associated with a localised fuel spillage. The soil testing completed on Made Ground samples (three from Longbarrow roundabout and eleven from Countess roundabout) recorded occasional minor exceedances for PAH above the adopted conservative residential with plant uptake GAC adopted. Higher concentrations of PAH and elevated TPH were recorded in TP4 where olfactory evidence of hydrocarbon contamination was observed. Mott MacDonald concluded that the concentrations were not considered to pose an unacceptable risk to construction workers involved in proposed amendments to the roundabouts.

Preliminary Conceptual Site Model

2.11.48 The preliminary conceptual site model (CSM) has been developed based on the Preferred Route's environmental setting and a review of current and historical development onsite and in the immediate surroundings, and the potential for these uses to impact land quality. The CSM is presented below in terms of potential contaminant sources, potential sensitive receptors and associated exposure and migration pathways.

Sources of Potential Contamination

2.11.49 A summary of the key sources of potential contamination identified onsite and offsite (within a 250m buffer) are summarised in Table 3-9 and Table 3-10 respectively. The potential contaminative land uses are also illustrated in Figure 3-1, Appendix A.

Table 3-9 Summary of Potential Sources on Site

Feature	Location
Current water pumping house	Intersected by the Preferred Route at chainage 3400, west of the B3083 and north of Scotland Farm
Former RAF Oatlands Hill (1941 – 1946)	Intersected by the proposed Longbarrow Junction, chainage 4800 - 6200
Former Larkhill Military Light Railway (present up to 1924)	Intersected at chainage 6300, east of Longbarrow roundabout
Current pig farm (identified during site walkover visit in August 2017)	Intersected by the Preferred Route between chainages 6500 and 6800, to the south-east of Longbarrow roundabout
Former RAF Stonehenge (1917 – 1921)	Intersects the Preferred Route between chainages 7450 and 8500
Former quarry (1901 – 1961)	Intersects the Preferred Route at chainage 11100

2.11.50 *Current Water Pumping House*

2.11.51 The current water pumping house is situated within a section of the Preferred Route where an earthworks embankment is proposed (chainage 3,400m). This feature is not visible on current aerial imagery and is therefore likely to be of relatively small scale. OS contour mapping [30] shows that the pumping station is located within a relatively low-lying area of arable farmland which suggests that the pump is possibly used for drainage purposes. It is currently unknown whether the pump is electric or powered by a diesel generator.

2.11.52 Whilst some potential exists for fuel leaks and/or spills to have occurred these are expected to be minor given the size of the pump and the likelihood that any generator is present above ground, therefore defects would be noticed by farm workers and rectified. In view of the proposed earthworks in this area the potential for hydrocarbon impacted soils being encountered and disturbed is considered to be low.

Former RAF Oatlands Hill

2.11.53 Cut earthworks are proposed in the footprint of the former RAF Oatlands Hill associated with the proposed new Longbarrow Junction construction. Whilst no chemical testing was completed during the previous GI in this area, the ground conditions along the Preferred Route of the A303 mainline is known.

2.11.54 During the 2001 Main Ground Investigation six trial pits (STP40-STP44 and DTP11) were excavated to depths of between 3.5m and 5m bgl. In addition, as part of the Phase 1A Supplementary GI undertaken in 2003, two rotary boreholes (R129 and R130) were drilled to depths of 18m bgl and one trial pit excavated to 5m bgl. A thin layer of topsoil was encountered overlying Chalk in all locations. No groundwater strikes were reported in the boreholes or trial pits and no visual or olfactory evidence of chemical impacts were recorded.

2.11.55 Given the length of time since the main operation of the site (approximately 70 years) and the use of the land for agricultural purposes, degradation and attenuation of contamination (particularly volatile contaminants) is expected to have occurred, although this does not mean there will have been total removal of the source.

Former Military Light Railway

2.11.56 2.10.39 To the east of the existing Long Barrow Roundabout excavations are proposed through a small section of the former Larkhill Military Light Railway. As part of the 2001 Main GI, trial pit DTP12 was excavated within the former railway line footprint (adjacent north of the preferred alignment) to 5m bgl. Topsoil was encountered overlying Chalk and no groundwater strikes were noted. No chemical testing was undertaken at this location however the exploratory log indicates that no visual or olfactory evidence of chemical impacts were recorded.

Current Pig Farm

2.11.57 The preferred alignment crosses the northern extent of a current pig farm that was identified during the site walkover in August 2017. Recent aerial photography indicates that this area is occupied by relatively sparsely spread radial pig pens (more intensive hog rearing rectangular pens are located further to the south). Cut excavations are proposed in this area.

2.11.58 Aerial photography obtained as part of the PSSR [1] show the farm was present in 2009 when it also occupied the adjacent fields to the east. The PSSR did not identify the farm as a potential source of contamination although the spreading of manure and potential use of insecticides and pesticides has the potential to impact soil and groundwater quality.

Former RAF Stonehenge

2.11.59 The current Preferred Route cross-section drawing indicates that deep excavations are proposed at the Western Tunnel Portal. This section corresponds with the western extent of the former domestic parts of the main airbase camp. From chainage 7500 to chainage 8500 the alignment will be tunnelled to depths of around 25m bgl.

2.11.60 During the Main GI in 2001, five rotary boreholes (R4 to R8, 20m to 35m bgl) and five trial pits (DTP17 to DTP21, up to 5m bgl) were positioned along the section of the Preferred Route which intersects the former RAF Stonehenge site. The ground conditions encountered comprised topsoil over Chalk. Evidence of previous human activity was recorded in the west end of trial pit DTP17 between ground level and 2m comprising buried pottery, wire and bones. No groundwater strikes were recorded in the trial pits and in the rotary boreholes strikes were reported to have been masked by the drilling flush medium and the levels were not recorded on the geological logs.

2.11.61 In addition, as part of the Phase 1A Supplementary GI undertaken in 2003 one rotary borehole (R135, 20.2m bgl) and one trial pit (DTP136, 5.3m bgl) were positioned on this section of the alignment. The ground conditions comprised topsoil overlying Chalk and no groundwater strikes were recorded. In the area of Stonehenge groundwater levels are expected to be between 67.5m AOD and 85m AOD based on the groundwater model developed using Environment Agency groundwater level monitoring data. Therefore, the water table might not have been intercepted if the investigation was undertaken at a time when the water table was low.

2.11.62 No visual or olfactory evidence of chemical impact was observed in any of the twelve exploratory holes and with the exception of trial pit DTP17, no evidence of Made Ground was recorded. Given the length of time since the main operation of the site (approximately 95 years) and the use of the land for agricultural purposes, degradation and attenuation of contamination (particularly volatile contaminants) is expected to have occurred.

Former Quarry

2.11.63 A small former quarry (approximately 1,000m^2 in area) intersects the Preferred Route approximately 500m west of Countess Roundabout. The feature is labelled as an ‘old quarry’ on the 1901 OS map and remains until at least 1961. The next available map dated 1971-1972 shows the existing A303 to have been constructed directly through the location of the quarry and therefore it is considered most likely that the quarry was infilled with engineered aggregate rather than waste.

2.11.64 No previous GI information is available in the vicinity of the former quarry. However, the current engineering cross sections indicate that below ground excavation is not proposed for this section of the Preferred Route and ground levels will be raised by approximately 0.5m. Therefore there is considered to be limited potential to encounter or disturb infilled material during future construction works.

Table 3-10 Summary of Potential Sources of Contamination off Site Within 250m

Feature	Location / Approximate Chainage
Current pig farm (identified from aerial imagery)	Adjacent south of the western extent of the Preferred Route
Current water pump house	Adjacent north of chainage 11750 within Countess Roundabout
Historic barn and above ground tank (1877 – 1961)	Approximately 50m south of the Preferred Route, adjacent north of Oatlands Hill and the existing A303
Old chalk pit (1878 - 1961)	Approximately 60m north-east of the Preferred Route near Ratfyn Farm
Countess Farm	Located approximately 65m north of chainage 11700, to the north-west of Countess Roundabout
Countess Filling Station	Approximately 70m north of chainage 11800, north-east of Countess Roundabout
Former SR Bulford Extension Railway (1924 – 1937)	Approximately 80m east of the Preferred Route at its closest point
Area of Fill (Demolition Rubble)	North-east of Winterbourne Stoke, approximately 95m north of chainage 4500
Gear reconditioning facility	Approximately 140m south-east of the eastern extent of the Preferred Route
Old chalk pits (1877 -1939)	Approximately 140m south of Longbarrow roundabout
Ratfyn Farm	Approximately 155m north-east of chainage 12500 (eastern extent of the Preferred Route)
Former RAF Stonehenge Sewage Works (disused 1924, removed 1970)	Approximately 175m south of chainage 8700
Historical Gas Works (1879 – 1901)	Approximately 190m south of chainage 11800 (south of the River Avon)
Engineering Services	Approximately 205m south-east of the eastern extent of the Preferred Route
Current pumping house and former covered reservoir	Approximately 220m north of chainage 5500 (north of proposed Longbarrow Junction)
Former Winterbourne Stoke chalk pit	Approximately 230m south of chainage 4300 (east of Winterbourne Stoke)
Manor Farm	In Winterbourne Stoke, approximately 240 south of chainage 3900

2.11.65 In view of the distances of the majority of the potential off-site contamination sources from the Preferred Route, they are unlikely to have significantly impacted on the soils onsite. Consequently, migration onsite would be restricted to, and dependent on, the presence, extent and flow direction of shallow groundwater beneath the study area. Regionally, groundwater flow is generally southward into the study area, with flow converging towards the River Till in the west of the study area and south-east towards the River Avon in the east. The centre of the study area is characterised by the Stonehenge Bottom dry valley forming a groundwater sub-catchment separated from the main Till and Avon catchments by inter-fluvial areas. In the southern part of the study area groundwater flow in the Stonehenge Bottom valley flows in a south-easterly direction to discharge into the River Avon. Inferred groundwater level contour plots produced using the groundwater model are presented in Figure 3-2.

2.11.66 The current pig farm, former Winterbourne Stoke chalk pit, old chalk pits south of Longbarrow roundabout, Manor Farm, the historic barn and the former sewage works are positioned hydraulically down-gradient of the Preferred Route and therefore the potential for cross-boundary migration of contamination to the construction area is low.

2.11.67 The area of demolition rubble is positioned hydraulically up-gradient of the Preferred Route and some potential exists for cross-boundary migration of contamination in groundwater. During the 2001 Main GI, two trial pits were excavated along the section of preferred alignment positioned down hydraulic gradient of the area of fill (STP29 and STP30, 4.1m and 3.5m bgl respectively). The ground conditions comprised topsoil overlying Chalk and no groundwater strikes were recorded. No field evidence of chemical impacts were recorded in either trial pit. The engineering cross-sections indicate that only minor ground re-profiling is proposed in this area. Based on the geological logs, the significance of this potential contamination source is considered to be relatively low.

2.11.68 There is some potential for off-site contamination associated with the current engineering services, gear reconditioning facility, current Ratfyn Farm, the old chalk pit south of Ratfyn Farm and the former Bulford Extension railway to have migrated in groundwater towards the eastern extent of the Preferred Route. However, the current engineering cross-sections indicate that only minor regrading of the existing road levels is proposed to the east of the River Avon Bridge. Therefore it is considered unlikely that impacted soil or groundwater will be encountered during future construction.

2.11.69 A small water pumping house is located within the north-west corner of Countess Roundabout. The historical OS map from 1972 [9] shows the pumping house was constructed at the same time as the roundabout and it is likely to be used to prevent surface water flooding. A review of current aerial imagery [31] indicates that the pumping house is electrical and the significance of this potential contamination source is therefore considered to be negligible.

2.11.70 A further water pumping house and associated former covered reservoir are also present approximately 220m north of the Preferred Route. Historical mapping [9] indicates that the covered reservoir was relatively small in size (approximately 200m^2) and was potentially infilled with material of an unknown chemical quality post-2000 mapping. Given the size and distance of the feature from the Preferred

Route, the potential for cross-boundary migration associated with potential infilled material is considered to be low.

2.11.71 The River Avon is positioned between the eastern end of the Preferred Route and the former gas works. This surface water feature is expected to act as a barrier to migration of chemicals in shallow groundwater associated with this potential off-site source. In addition the former gas works is positioned down hydraulic gradient of the Preferred Route.

2.11.72 The key potential off-site sources of contamination are considered to be the current Countess Filling Station, and to a lesser extent Countess Farm. The petrol filling station (present since at least 1994) and farm are positioned hydraulically up-gradient of the proposed Countess Junction flyover. Groundwater within the River Terrace Deposits and Chalk is likely to flow in a southerly direction towards the River Avon and some potential exists for cross-boundary migration of contamination to the construction area.

2.11.73 During the 2009 Countess Roundabout GI, no visual or olfactory evidence of chemical impact was observed in the saturated zone (indicative of off-site contamination). However, there is potential for leaks and/or spills to have occurred at the petrol filling and the farm station since 2009. Groundwater depths were measured in a standpipe piezometer (BH1) between 2.7 and 2.91m bgl, therefore the potential exists to encounter shallow groundwater during construction. Earthworks associated with the Countess Junction flyover construction will predominantly comprise embankments associated with the approach roads and below ground excavation is expected to be localised to the proposed bridge footings and foundations.

Potential contaminants of concern

2.11.74 In view of the former and current activities identified onsite and in the surrounding area, it is considered that the following may be present in parts of the Preferred Route:

a) hydrocarbons associated with former storage and use at the former military airbases, the former military light railway onsite and the current petrol filling station and Countess Farm off site;
b) metals, PAHs and TPH: associated with Made Ground/engineered fill present along the existing A303;
c) asbestos associated with Made Ground present along the existing A303 and demolition rubble from former buildings at the RAF Stonehenge main camp;
d) pesticides, insecticides and herbicides associated with agricultural land use and farming activities onsite including the former Pedigree Stock Farm, the current pig farm and Countess Farm offsite; and
e) microbial contaminants associated with the current pig farm onsite.

Potential Pathways

2.11.75 The human health exposure pathways that are considered viable based on the proposed residual end use but also accounting for neighbouring properties and people during the construction are listed below:

a) dermal contact with soil, dust and groundwater;
b) ingestion of soil, dust and groundwater;
c) inhalation of dust;

d) inhalation of vapours (from soils and groundwater); and
e) inhalation of ground-gas in confined spaces.

2.11.76 The controlled waters pathways considered viable are as follows:

a) vertical and lateral migration of leachate through the unsaturated soils to groundwater;
b) vertical and lateral groundwater migration; and
c) surface water run-off.

Potential Receptors

2.11.77 The following potential receptors have been identified:

a) human health - current site users including land/farm owners and agricultural workers;
b) human health - future site users including construction workers and maintenance workers;
c) human health - current and future off site receptors including residents, land/farm owners, agricultural workers and members of the public;
d) groundwater - Secondary (undifferentiated) aquifer associated with the Head deposits; Secondary-A aquifer associated with the Alluvium, River Terrace Deposits and rare peat associated with the channels of the River Avon and River Till; and Principal aquifer associated with the Chalk stratum.
e) surface water features - River Till and River Avon at the western and eastern extents of the Preferred Route respectively and the Blick Mead spring located 70m south of the western extent; and
f) development infrastructure - Concrete structures placed below ground may be degraded if elevated concentrations of sulphate are present. Concrete cast in-situ may also be adversely affected by the presence of hydrocarbons. Plastic piped services can be adversely affected by the presence of hydrocarbons, where the integrity of the pipes can be compromised.

2.12 Other Relevant Information

2.12.1 Other documentations that have been prepared historically in association with former published schemes are summarised in Table 3-11 to Table 3-13.

Table 3-11 Existing Desk Study Reports

HAGDMS Reference	Document Title	Time of Issue	Consultant
2351	A303 Amesbury - Berwick Down, Geotechnical Desk Study Report	Feb-92	Sir William Halcrow and Partners
16850	A303 Amesbury - Berwick Down, Geotechnical Desk Study Report (2)	Jan-96	Sir William Halcrow and Partners

Table 3-12 Existing Site Investigation Interpretative Reports

HAGDMS Reference	Document Title	Time of Issue	Contractor	Consultant
17317	A303 Stonehenge, Site Investigation Interpretative Report, Preliminary Investigation and Phase I of Main	Oct-01	n/a	Mott MacDonald

HAGDMS Reference	Document Title	Time of Issue	Contractor	Consultant
	Ground Investigation			
16182	A303 Stonehenge, Site Investigation Interpretative Report, Phase II Main Ground Investigation	Apr-02	n/a	Mott MacDonald
n/a	A303 Stonehenge Improvement, Pumping Test Interpretation	Feb-03	n/a	WJ Groundwater
n/a	A303 Stonehenge Improvement, Summer Pumping Test September 2004 Interpretation	Dec-04		WJ Groundwater

Table 3-13 Existing Other Documents

HAGDMS Reference	Document Title [Document Type]	Time of Issue	Contractor	Consultant
17031	A303 Stonehenge - Countess Roundabout, Geotechnical Review [Technical Note]	Mar-00	n/a	Halcrow
n/a	A303 Stonehenge Improvement, Geotechnical Baseline for Tunnel Design [Report]	Jun-04	n/a	Balfour Beatty-Costain
20543	A303 Stonehenge Improvement, Preliminary Geotechnical Report [Report]	Mar-06	n/a	Balfour Beatty-Costain
n/a	A303 Stonehenge Improvement, Relationships between Aquifer Recharge, Groundwater Levels and Springflow [Report]	Nov-06	n/a	Balfour Beatty-Costain
24956	A303 Longbarrow Roundabout Improvement Scheme [Geotechnical Memorandum]	Jun-10	n/a	Balfour Beatty-Mott MacDonald

2.12.2 Table 3-14 summarises the key ground investigation relating documentation that have been prepared during the development of the current scheme.

Table 3-14 Documentation Prepared During the Development of the Current Scheme

Reference No.	Document Title	Year of Issue
HE551506-AA-HGT-SWI-RP-CX-000004	A303 Amesbury to Berwick Down, Preliminary Sources Study Report. P05 S3. HAGDMS no. 29300.	Dec-16
HE551506-AA-HGT-SWI-RP-CX-000005	A303 Amesbury to Berwick Down, Annex A to Preliminary Sources Study: Early phase ground investigation requirements. P03 S2. HAGDMS no. 29170.	Jul-16

Reference No.	Document Title	Year of Issue
HE551506-AA-HGT-D_SWI-CT-CX-000002	A303 Amesbury to Berwick Down, Geotechnical Certificate (for PSSR)	Dec-16
HE551506-AA-HGT-D_SWI-CT-CX-000001	A303 Amesbury to Berwick Down, Geotechnical Certificate. (for Annex A to PSSR)	Jul-16
HE551506-AA-HGT-SWI-SP-CX-000007	A303 Amesbury to Berwick Down. Base Scope: Ground Investigation Specification. P01.1 S0	Sep-16
HE551506-AA-HGT-D_SWI-FN-CX-000001	A303 Amesbury to Berwick Down. Technical Note. Chalk Cut Slopes	May-16
HE551506-AA-HGT-SWI-RP-CX-000009	A303 Amesbury to Berwick Down. Technical Note. A303 Amesbury to Berwick Down – S32 Application for Pumping Tests	Nov-16
HE551506-AA-HGT-D_SWI-FN-CX-000002	A303 Amesbury to Berwick Down. Technical Note. A303 Amesbury to Berwick Down – Reuse of tunnel arisings	Dec-16
HE551506-AA-HGT-D_SWI-FN-CX-000004	A303 Stonehenge. Technical Note. Revised Ground Investigation within Land Parcel 78/16	Jun-17
HE551506-AA-EHR-SWI-RP-YE-000003	A303 Amesbury to Berwick Down. Geophysical Survey Report Stage 1 Final. P06 S3	May-17
HE551506-AA-HGT-X_SWI-RP-CX-000001	A303 Stonehenge, Amesbury to Berwick Down. 2016/17 Ground Investigation Close Out Report. P01.1	Aug-17

2.12.3 Chalk specialist Professor Rory Mortimore has been consulted at various stages of the development of this scheme. This involves a combination of core logging and published reports and papers. The following reports and papers have been reviewed:

a) R. Mortimore, "A303 Stonehenge Improvement: Preliminary Geotechnical Report – Appendix C: Geological Report," 2003 [32];
b) R. Mortimore, "Making Sense of Chalk: A Total Rock Approach to its Engineering Geology" 2012, [33];
c) R. Mortimore et al., "Stonehenge—a unique Late Cretaceous phosphatic chalk geology: implications for sea-level, climate and tectonics and impact on engineering and archaeology", [34].

2.12.4 In addition to published reports and papers, Professor Mortimore has carried out chalk logging at various stages of the scheme development in order to confirm the identification of chalk formations, flint bands, marl beds, sponges and potential phosphatic chalk.

2.12.5 Graphic logs for the following exploratory holes have been prepared by Professor Mortimore:

a) HAGDMS 16175-DTP21, R8, R9, R11, R12, R13, R16, R18 and R20;
b) HAGDMS 21762-DTP155C, R111, R121, R123, R124, R129, R138, R142, R146, R157 and R158;
c) HAGDMS 29779-R501, P502B and P505.

Table 3-15 Summary of Documentation that Contains Professor Mortimore Graphic Logs

Document Title	Time of Issue	Summary
A303 Amesbury-Berwick Down, Stonehenge (Incorporating the Winterbourne Stoke Bypass), Geological Report [32]	Mar-06	Document contains graphic logs for existing ground investigation exploratory holes.
Memo: A303 Site Investigation: Site Visit 03 March 2017 [35]	Mar-17	Document contains graphic log for 2017 GI borehole 29779-R501.
Memo: A303 Site Investigation: P502B and P505 core logs 2017 [36]	May-17	Document contains graphic logs for 2017 GI borehole 29779-P502B and P505.

3 Field and Laboratory Studies

3.1 Walkover Survey

3.1.1 A number of recent site walkovers have been carried out and these are noted below:

a) 14 March 2016. This site walkover was carried out by AAJV with access made via public rights of way, including footpaths and byways. Coneybury Hill and Stonehenge Bottom were also visited as part of the site walkover. The locations of groundwater standpipes at 17439-P1 and P2, 16175-R22, 21762-R158, W137 and W148 were visited with a view to implement further groundwater monitoring. These features are summarised in Appendix D of the PSSR;

b) 20 July 2017. Site walkover carried out by AmW geotechnical engineers in order to acquire a visual survey of the Site relative to the two route options discussed in the PSSR, with access limited to public rights of way, footpaths and byways. West Amesbury Spring was also visited as a key feature. Access to Blick Mead was not possible as it is located on private property. West Amesbury Spring was visited, close to the River Avon, where at the time of visiting a v-notch weir was in place and water levels were relatively low.

3.1.2 Photographs from the March 2016 site walkover are provided in the PSSR [1]. Photographs from the July 2017 site walkover are presented in Appendix B.

3.2 Geomorphological / Geological Mapping

3.2.1 No geomorphological / geological mapping has been undertaken during the scheme development to date

3.2.2 As identified in the Balfour Beatty-Costain's 'A303 Stonehenge Improvement: Preliminary Geotechnical Report' [37], the lack of natural exposures in the area severely limits the scope for detailed geological mapping. Thus intrusive investigations are the main source of lithostratigraphical information.

3.2.3 It has been noted that there are very few geomorphological features, if any, which provide evidence for localised features. This is mainly a result of the subdued topography as well as the agricultural impacts on topography which have removed much of these subtle geomorphological features.

3.3 Recent Ground Investigations

Description of Fieldworks

3.3.1 AAJV was appointed by Highways England to progress the Scheme through options development. As part of the commission AAJV designed, planned and procured a ground investigation with the intention to provide information for the preliminary design and DCO planning requirements in the follow-on preliminary design.

3.3.2 The fieldwork was carried out between 9 January and 16 April 2017 by ground investigation contractor Structural Soils Ltd (SSL).

3.3.3 The completed early phase ground investigation is summarised in Table 4-1. The completed fieldworks comprised:

a) Five rotary cored boreholes;
b) Twenty-two rotary open holed boreholes;
c) Fifteen hand dug inspection pits – all of these pits were planned for follow-on drilling but were cancelled due to issue with access to land parcel 78/16;
d) Eleven machine excavated trial pits;
e) In-situ geotechnical testing
   - In-situ hand vane
   - Downhole wireline optical televiewer in three boreholes
   - Downhole wireline geophysical logging (a full suite comprised caliper, natural gamma and P & S wave velocity) in seven boreholes
f) In-situ hydrogeological testing
   - Nine soakaway infiltration tests in trial pits
   - Five single packer tests in one borehole
   - Two constant head borehole permeability testing in two boreholes
g) Geotechnical and geo-environmental sampling
h) Constructions of groundwater monitoring wells, including the supply, installation, maintenance and handover of automated remote logging systems.
i) Reinstatement of the groundwater monitoring standpipe in the existing borehole 21762-R158 and installation of a diver data logger and set up of remote telemetry system.
j) Post-fieldworks manual groundwater monitoring

3.3.4 The completed exploratory hole locations are shown in drawings HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE- 0012 to 0021 in Appendix A. The location of the in-situ testing that has been carried out are shown in drawings HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0022 to 0036 and 0045 to 0058.

3.3.5 In addition to the Early Phase GI, one cable percussion borehole was carried out inside the Countess roundabout on12 March 2018 by ground investigation contractor Geotechnics Ltd. The HAGDMS reference of this GI is 30295. The ground investigation was commissioned by HE with Kier Highways Ltd as the project engineer. The borehole was drilled to 8.45m below ground and comprised in-situ standard penetration testing. Soil samples were taken for chemical laboratory testing to BRE Digest 365. The factual report is titled “A303 Countess RAB CCTV, Factual Report on Ground Investigation” [39]. The factual report was not available at the time of writing of this pGIR. Information is based on the digital data in the ags file.

Table 4-1 Summary of Early Phase Completed Ground Investigation and HAGDMS 30295 Ground Investigation

Exploratory Hole ID	Type (1)	Hole Depth (m bgl)	Chainage (m) (2)	Offset (m) (2)	Groundwater Monitoring Installations		Remote Telemetry		In-situ testing (3)	Primary Purpose of the Exploratory Hole to Annex A [6][4]
					Depth (m bgl)	R.Z. (1) (m bgl)	Piezometer Depth (m bgl)	Rain Gauge		
29779-P502B	RO+RC	42.2	7900	373.6	-	-	-	-	DWGL	Not specified.
29779-P505	RC	42.4	8160	342.8	-	-	-	-	DWGL	Not specified.
29779-R501 (4)	RC	36.5	8640	46.6	-	-	-	-	-	Phosphatic chalk investigation around hole R142.
29779-R503B	RC	48.4	7680	410.4	47.0	47.0 - 9.0	43.0	-	CHP, DWGL and DWOPTV	Previous western portal location - borehole soil infiltration and geology investigation.
29779-R507A	RC	36.5	10500	21.7	35.0	35.0 - 8.0	31.0	-	CHP, DWGL and DWOPTV	Phosphatic chalk investigation relation to hydrogeology and spatial extent.
29779-PX504	RO	42.5	7840	384.7	-	-	-	-	DWGL	Not specified.
29779-PX505A	RO	45.0	8030	344.0	43.0	43.0 - 7.0	39.0	-	DWGL and DWOPTV	Not specified.
29779-PX506	RO	44.0	8280	321.0	43.0	43.0 - 6.0	38.0	-	DWGL	Not specified.
29779-R502 (5)	RO	3.1	8640	58.0	-	-	-	-	-	Phosphatic chalk investigation around hole R142.
29779-RX501 (4)	RO	67.0	9610	701.5	-	-	-	-	-	Coneybury Hill: Hydrogeological investigation of the chalk ridge.
29779-RX502A (4)	RO	59.5	9680	766.3	-	-	-	-	Packer	Coneybury Hill: Hydrogeological investigation of the chalk ridge.
29779-RX503 (4)	RO	72.0	9700	786.4	70.0	70.0 - 26.0 (decommissioned)	-	-	-	Coneybury Hill: Hydrogeological investigation of the chalk ridge.
29779-RX504 (4)	RO	71.5	9700	759.5	-	-	-	-	-	Coneybury Hill: Hydrogeological

Exploratory Hole ID	Type (1)	Hole Depth (m bgl)	Chainage (m) (2)	Offset (m) (2)	Groundwater Monitoring Installations		Remote Telemetry		In-situ testing (3)	Primary Purpose of the Exploratory Hole to Annex A [6][4]
					Depth (m bgl)	R.Z. (1) (m bgl)	Piezometer Depth (m bgl)	Rain Gauge		
										investigation of the chalk ridge.
29779-RX505 (4)	RO	71.3	9720	740.3	70.0	70.0 - 26.0 (decommissioned)	-	-	-	Coneybury Hill: Hydrogeological investigation of the chalk ridge.
29779-RX506	RO	56.0	8730	3001.1	55.0	55.0 - 21.0	51.0	Installed	-	Hydrogeological investigation of catchment.
29779-RX507	RO	49.0	9940	2110.4	48.0	48.0 - 18.0	44.0	-	-	Hydrogeological investigation of catchment.
29779-RX508A	RO	32.0	8920	1218.6	31.0	31.0 - 4.0	28.0	-	-	Hydrogeological investigation of catchment.
29779-RX509	RO	47.5	7880	873.9	46.0	46.0 - 7.0	42.0	-	-	Hydrogeological investigation of catchment.
29779-RX510A	RO	51.0	9950	732.2	50.0	50.0 - 22.0	46.0	-	-	Hydrogeological investigation of catchment.
29779-RX511B	RO	8.6	4100	496.0	8.0	8.0 - 4.0	6.5	-	-	Not specified.
29779-RX512A	RO	23.0	5120	767.9	22.0	22.0 - 4.0	18.0	-	-	Not specified.
29779-RX513A	RO	23.0	8310	1861.5	20.0	20.0 - 4.0	16.0	Installed	-	Not specified.
29779-RX514A	RO	64.0	6310	3369.2	62.0	62.0 - 33.0	58.0	-	-	Not specified.
29779-RX515A	RO	78.8	5180	2431.6	77.0	77.0 - 52.0	73.0	-	-	Not specified.
29779-RX516A (4)	RO	29.3	9100	327.4	-	-	-	-	-	Not specified.
29779-RX517A (4)	RO	51.3	9110	279.1	50.0	50.0 - 6.0 (decommissioned)	-	-	-	Not specified.
29779-W503 (5)	RO	3.5	9680	774.0	-	-	-	-	-	Coneybury Hill: Hydrogeological investigation of the chalk ridge.
29779-GC501 (6)	HP	1.2	8640	52.7	-	-	-	-	-	Phosphatic chalk investigation around hole R142.
29779-P507A (6)	HP	1.2	8380	308.8	-	-	-	-	-	Not specified.

Exploratory Hole ID	Type (1)	Hole Depth (m bgl)	Chainage (m) (2)	Offset (m) (2)	Groundwater Monitoring Installations		Remote Telemetry		In-situ testing (3)	Primary Purpose of the Exploratory Hole to Annex A [6]4
					Depth (m bgl)	R.Z. (1) (m bgl)	Piezometer Depth (m bgl)	Rain Gauge		
29779-P509 (6)	HP	1.2	8580	262.3	-	-	-	-	-	Not specified.
29779-P510 (6)	HP	1.2	8780	215.6	-	-	-	-	-	Not specified.
29779-PX507 (6)	HP	1.2	8470	287.2	-	-	-	-	-	Not specified.
29779-PX508 (6)	HP	1.2	8670	241.7	-	-	-	-	-	Not specified.
29779-PX509 (6)	HP	1.2	8890	190.0	-	-	-	-	-	Not specified.
29779-R504A (6)	HP	1.2	9110	239.7	-	-	-	-	-	Phosphatic chalk investigation relation to hydrogeology and spatial extent.
29779-R505B (6)	HP	1.2	9140	233.5	-	-	-	-	-	Phosphatic chalk investigation relation to hydrogeology and spatial extent.
29779-R506 (6)	HP	0.6	9080	338.9	-	-	-	-	-	Phosphatic chalk investigation relation to hydrogeology and spatial extent; Hydrogeological investigation of catchment.
29779-R506A (6)	HP	1.0	9150	232.1	-	-	-	-	-	Phosphatic chalk investigation relation to hydrogeology and spatial extent.
29779-RX509A (6)	HP	1.2	7880	921.2	-	-	-	-	-	Hydrogeological investigation of catchment.
29779-RZ501 (6)	HP	1.2	8630	56.6	-	-	-	-	-	Phosphatic chalk investigation around hole R142.
29779-SBP501 (6)	HP	1.2	8630	50.2	-	-	-	-	-	Phosphatic chalk investigation around hole R142.
29779-W502 (6)	HP	1.2	9110	229.5	-	-	-	-	-	Stonehenge Bottom "dry" valley geological and hydrogeological investigation.
29779-SA501	TP	2.0	4570	129.3	-	-	-	-	Soakaway	West of previous tunnel alignment: Soakaway for road drainage design and waste/contamination assessment.
29779-SA502	TP	2.0	5280	112.7	-	-	-	-	Soakaway	Soakaway for road drainage design and waste/contamination assessment.
29779-SA503A	TP	2.5	6080	943.8	-	-	-	-	Soakaway	Soakaway for road drainage design and waste/contamination assessment.
29779-SA504	TP	2.1	7270	451.1	-	-	-	-	Soakaway	Soakaway for road drainage design and waste/contamination assessment.
29779-SA505	TP	1.4	11440	43.0	-	-	-	-	Soakaway	Soakaway for road drainage design and

Exploratory Hole ID	Type [1]	Hole Depth (m bgl)	Chainage (m) [2]	Offset (m) [2]	Groundwater Monitoring Installations		Remote Telemetry		In-situ testing [3]	Primary Purpose of the Exploratory Hole to Annex A [6][4]
					Depth (m bgl)	R.Z. [1] (m bgl)	Piezometer Depth (m bgl)	Rain Gauge		
										waste/contamination assessment.
29779-SA506	TP	2.4	11970	53.4	-	-	-	-	-	Soakaway for road drainage design and waste/contamination assessment.
29779-SA506A	TP	1.9	11980	54.1	-	-	-	-	Soakaway	Soakaway for road drainage design and waste/contamination assessment.
29779-SA507	TP	2.2	8200	1272.8	-	-	-	-	Soakaway	Spring Bottom Farm: soil infiltration for temporary dewatering recharge scheme.
29779-SA508	TP	2.5	8400	1601.7	-	-	-	-	Soakaway	Spring Bottom Farm: soil infiltration for temporary dewatering recharge scheme.
29779-SA509A	TP	2.2	9100	1920.5	-	-	-	-	Soakaway	Spring Bottom Farm: soil infiltration for temporary dewatering recharge scheme.
29779-STP501	TP	3.0	2750	309.4	-	-	-	-	-	West of previous tunnel alignment: waste/contamination assessment.
30295-BH01	CP	8.45	11753	28.2	-	-	-	-	SPT	-

Notes: (1) CP = cable percussion borehole; RC = rotary cored borehole; RO = rotary open borehole; RO+RC = rotary cored and open borehole; HP = hand dug inspection pit; TP = machine dug trial pit; R.Z. = response zone

(2) Chainage and offsets are determined in relationship with the Preferred Route mainline horizontal alignment.

(3) SPT = Standard penetration testing; DWGL = Downhole wireline geophysical logging; CHP = Constant head permeability; DWOPTV = Downhole wireline optical televiewer

(4) Boreholes were drilled to scheduled depths. Groundwater monitoring instrumentation and downhole wireline geophysical logging have been planned for these boreholes but could not be completed due to access issue to land parcel 78/16.

(5) Boreholes were terminated before reaching the scheduled depth due to access issue to land parcel 78/16.

(6) Planned boreholes as part of the early phase ground investigation scope. Only hand dug inspection pits were dug for these boreholes. Drilling did not commence due to access issue to land parcel 78/16.

Ground Investigation Reports

3.3.6 The factual information gathered from the completed parts of the early phase ground investigation can be found in the SSL's ground investigation report [25].

Results of In-situ Tests

In-situ Hand Vane Tests

3.3.7 Hand vane tests were carried out within the cohesive strata within machine excavated trial pits where it was considered safe to do so, or were carried out on the excavated materials.

Downhole Wireline Optical Televiewer and Geophysical Logging

3.3.8 Optical televiewer logging was undertaken in boreholes R503B, R507A and PX505A from the base of the temporary casing at approximately 1.55m bgl to the base of the boreholes. The boreholes were flushed with clean water and left to settle before the optical televiewer logging was carried out.

3.3.9 Downhole geophysical logging comprised a suite of caliper, natural gamma and P & S wave velocity. It was carried out in seven boreholes.

3.3.10 The results are included in Appendix C of SSL's factual report [25].

3.3.11 See drawings HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0054 to 0057 in Appendix A for test locations.

Soakaway Testing in Trial Pits

3.3.12 Soakaway tests were carried out in nine trial pits in accordance with the recommended procedure in BRE Digest 365. Each soakaway test comprised a set of three tests, with exception in borehole SA506A where only two tests were undertaken.

3.3.13 The infiltration rates have been calculated by SSL with the results present in the factual report.

3.3.14 See drawings HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0045 to 0053 in Appendix A for test locations.

Packer Tests

3.3.15 Five single packer tests were carried out in borehole RX502A in general accordance with BS EN ISO 22282-3: 2012 [40]. The lengths of the response zone varied from 3 to 4m. The tests were carried out at regular 3m intervals with the top of the test range between 44.5m and 56.5m bgl.

3.3.16 Both recent and historical packer tests are discussed in further detail in Section 4.7.

3.3.17 See drawings HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0045 to 0053 in Appendix A for test locations.

Borehole Permeability Tests

3.3.18 The borehole permeability tests were undertaken in R503B and R507A in general accordance with BS EN ISO 22282-2: 2012 [41].

3.3.19 Four constant head tests were carried out in borehole R503B with the response zone depth ranges from 24.4m to 25.9m bgl.

3.3.20 The first permeability test in borehole R507A was unable to achieve a constant head of water and a falling head test was carried out instead. Three further constant head tests were attempted in the same borehole and one test was unsuccessful due to the presence of chalk granules in the flow meter catcher. All tests were carried out with the response zone depth ranges from 18.8 to 20m bgl.

3.3.21 Both recent and historical permeability tests are discussed in further detail in Section 4.7.

3.3.22 See drawings HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0045 to 0053 in Appendix A for test locations.

Geo-environmental testing and sampling

3.3.23 As part of the 2017 EP GI [25] environmental soil samples were collected from topsoil (eleven samples), Head Deposits (three samples), Alluvium (two samples) and Chalk (twelve samples) from thirteen exploratory locations for subsequent laboratory testing. Soil leachability analysis was scheduled on eleven samples collected from topsoil (four samples), Head Deposits (one sample), Alluvium (one sample) and Chalk (five samples). Groundwater samples were obtained from three wells screened in the Chalk between 27 March and 26 April 2017 for chemical analysis.

3.3.24 The environmental sample locations and chemical parameters analysed are summarised in Table 4-2 and Table 4-3 respectively. The chemical test certificates and exploratory hole location plans are presented in SSL's factual report [25].

Table 4-2 Geo-environmental Sample Location Summary

Sample Point	Depth (mbgl)	Stratum	Test Type	Location
STP501	0.5	Head Deposits	Soil and Soil Leachate	Chainage 2900 (west of Winterbourne Stoke), approximately 300m south of the Preferred Route.
	1.0	Chalk	Soil	
SA501	0.1-0.3	Topsoil	Soil	Chainage 4600 (east of Winterbourne Stoke), approximately 40m north of the Preferred Route, adjacent to area of fill (demolition rubble)
	1.0	Chalk	Soil and Soil Leachate	
SA502	0.0 - 0.2	Topsoil	Soil	Chainage 5300 (Oatlands Hill, adjacent north-west of former RAF Oatlands Hill), approximately100m south of the Preferred Route.
	0.5	Head Deposits	Soil	
SA503A	0.0 – 0.2	Topsoil	Soil	Chainage 6200 (south of Longbarrow roundabout), approximately 960m south of the Preferred Route, south-east corner of former
	0.5	Chalk	Soil and Soil	

Sample Point	Depth (mbgl)	Stratum	Test Type	Location
			Leachate	RAF Oatlands Hill.
SA504	0.1 – 0.25	Topsoil	Soil	Chainage 7300, approximately 340m south of the Preferred Route.
	0.5	Chalk	Soil and Soil Leachate	
R503B	0.0 – 0.1	Topsoil	Soil	Chainage 7700, approximately 320m south of the Preferred Route
	6.2	Chalk	Soil and Soil Leachate	
	36.54	Chalk	Groundwater	
P502B	0.0 – 0.1	Topsoil	Soil and Soil Leachate	Chainage 7800, approximately 270m south of the Preferred Route.
	0.7 – 0.9	Chalk	Soil	
	3.2	Chalk	Soil	
PX505A	31.8	Chalk	Groundwater	Chainage 8000, approximately 240m south of the Preferred Route.
P505	0.15	Topsoil	Soil and Soil Leachate	Chainage 8200, approximately 250m south of the Preferred Route.
	0.5	Head Deposits	Soil	
P510	0.5	Chalk	Soil	Chainage 8800, approximately190m south of the Preferred Route
R506A	0.2 – 0.5	Topsoil	Soil and Soil Leachate	Chainage 9100, approximately 200m south the Preferred Route.
	0.5 – 1.0	Chalk	Soil	
R507A	0.0 – 0.05	Topsoil	Soil	Chainage 10100, adjacent south of the Preferred Route (proposed eastern tunnel portal)
	0.5 – 1.0	Chalk	Soil and Soil Leachate	
	3.9	Chalk	Soil	
	23.2	Chalk	Groundwater	
SA505	0.0 – 0.15	Topsoil	Soil	Chainage 11500, adjacent north of the Preferred Route.
	0.8	Alluvium	Soil and Soil Leachate	
	1.0	Chalk	Soil	
SA506	0.0 – 0.25	Topsoil	Soil and Soil Leachate	Chainage 11900, approximately40m north of the Preferred Route.
	0.6	Alluvium	Soil	

Table Notes:

mbgl = meters below ground level

Table 4-3 Chemical Analysis Testing Summary

Test	Soil	Leachate	Groundwater
Suite E: metals, TPH CWG, BTEX, PAHs, VOC/SVOCs, TOC/OM, phenol, free/total cyanide, sulphate, pH, available phosphorous and asbestos screen	28	-	-
Microbial suite: E-coli (faecal coliforms), coliforms (total), intestinal enterococci (faecal streptococci /	3	11	3

faecal enterococci), TVC 22°C, TVC 37°C			
Pesticides and insecticides: organochlorine, organophosphate and organonitrogen pesticides and synthetic pyrethroids	27	-	-
Suite F: metals, nickel, nitrate, nitrite, chloride, phosphorus, selenium, zinc, free cyanide, total cyanide, hardness, alkalinity, nitrate, nitrite, ammoniacal nitrogen, sulphate, magnesium, calcium, potassium, sodium, PAH, TPH CWG, BTEX, dissolved gases, dissolved organic carbon, soluble sulphate, phenol, pH, VOC and SVOC	-	11	3
AAJV Full Waste Acceptance Criteria (WAC) Suite	28	-	-

Table Notes:

- Metals: antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total, hexavalent and trivalent), copper, lead, manganese, mercury, molybdenum, nickel and selenium
- TPH CWG = Total Petroleum Hydrocarbon Criteria Working Group
- BTEX = Benzene, Toluene, Ethylbenzene and Xylene
- PAH = Polycyclic Aromatic Hydrocarbons
- SVOC = Semi Volatile Organic Compounds
- VOC = Volatile Organic Compounds
- TOC = Total Organic Carbon
- OM = Organic Matter
- TVC = Total Viable Count

3.3.25 In addition to the chemical analysis for geo-environmental parameters, a total of twenty-three Chalk samples collected from three boreholes (P502B – 1 sample, P505 – 2 samples and R501 – 20 samples) were analysed for total phosphorus content. The sample locations correlate with horizons of phosphatic Chalk. Analysis for water soluble phosphorus and extractable phosphorus was also undertaken on five of the Chalk samples from borehole R501 (collected between 11.6 and 35.4m bgl).

3.4 Drainage Studies

3.4.1 AAJV has scheduled trial pit soakaway testing at the likely positions of road discharge points and borehole permeability tests for the temporary dewatering discharge during the 2017 ground investigation according to the non-statutory consultation route options in order to supplement those been carried out in previous investigations.

3.5 Geophysical Surveys

3.5.1 Downhole geophysical surveys that were completed as part of the 2017 ground investigation are discussed in Section 4.3.

3.6 Pile Tests

3.6.1 Not used.

3.7 In-Situ Hydrogeological Testing – Recent and Historical

Falling, Rising and Constant Head Tests

3.7.1 Falling and rising head tests were conducted (to BS5930:1999) [42] in seventeen boreholes in January 2003. The data showed very high permeability in Stonehenge Bottom (17439-P2 and 16175-R16), low values at W1 close to the topographic divide, low values east of Stonehenge Bottom (16175-R18, 16175-R19A, 16175-R20 beneath a topographic high), rising to moderate permeability at 21762-R158. Permeability to the West of Stonehenge Bottom was variable but notably high at 17439-P1. Data is summarised in Table 4-4 below.

Table 4-4 Falling Head Test Results

Borehole	Permeability (m/d)	Interval Tested (m bgl)	Test Type	Investigation Date
W1	0.035	4.5-50.6	Falling Head Test	January 2003
16175-R7	50.8	25-29.6		
16175-R9	6.6	30-35		
17439-P1	128	30-35		
16175-R10	2.2	20-25		
16175-R11	0.035	16-45.7		
16175-R13	33.8	16.77-50		
16175-R15A	40.9	17.77-50		
17439-P2	286	30-35		
16175-R16	180	33-36		
16175-R18	6.3	20-51		
16175-R19A	0.1	42-45		
16175-R20	3.6	33-35		
21762-R158	31.7	? - 50		
29779-R503B	0.66 – 36.8	-	Constant Head Test	February- March 2017
29779-R507A	15.81– 71.8	-	Constant Head Test	
29779-R507A	0.31	-	Falling Head Test	
16175-R13T	0.03	35 - 38	Rising Head Test	April 2001

3.7.2 A series of falling head tests were also requested in 21762-R121, R126, CP163, CP168, R146, R157 and R167. Tests could not be carried out in 21762-R126, CP123 or CP168 as the water level was too close to ground level. No details on permeability results were reported except for R167 (Balfour Beatty-Costain JV, May 2003, volume 2, for which the test was carried in the alluvium) [17]. However, the permeability was considered to be unrepresentative most likely due to the presence of fines at the bottom of the borehole and the gravel permeability of $1.0x10^{-4}$ to $5.0x10^{-3}$m/s was therefore assumed (Balfour Beatty Costain & Halcrow-Gifford, March 2006) [37].

Packer Tests

3.7.3 During Phase 1 of the investigation, packer tests were conducted (to BS5930: 1999) [42] in five boreholes in 2001 (16175-R11T, R13T, R15, R16T and R18T) and indicated that the permeability of the chalk varies from 2.3×10^{-7} to 3.4×10^{-4} m/s.

3.7.4 During Phase 1A Supplementary Investigation (November 2002 to January 2003), additional packer tests were conducted in four additional boreholes (R142A, R152A, R152AA, R154A, R157A). Packer tests were carried out in open-holed boreholes. A graphic summary of the permeability determined from the packer tests is shown in Figure 5-8.

3.7.5 In the 2017 Structural Soils ground investigation [25] a packer test was also conducted in RX502A showing permeability values ranging from 1.1×10^{-7} to 2.1×10^{-4} m/s.

Table 4-5 Packer Test Investigations

Hole ID	Test Zone (mbgl)	Type of test	Investigation Date
16175-R11T	24 – 27; 30 – 33; 36 – 39; 42 - 45	Pump in, single packer with guard cell	2001
16175-R11T	27 – 30; 33 – 36; 39 - 42	Pump out, single packer with guard cell	2001
16175-R13T	23 – 26; 31 – 34; 39 – 42; 47 – 50	Pump in, single packer with guard cell	2001
16175-R13T	27 – 30; 35 – 38; 43 - 46	Pump out, single packer with guard cell	2001
16175-R15T	24 – 27; 30 – 33; 36 – 39; 42 – 45	Pump in, single packer with guard cell	2001
16175-R15T	27 – 30; 33 – 36; 39 - 42	Pump out, single packer with guard cell	2001
16175-R16T	12 – 15; 20 – 23; 28.2 – 31	Pump in, single packer with guard cell	2001
16175-R16T	16 – 19; 24 – 27; 32 - 35	Pump out, single packer with guard cell	2001
16175-R18T	25 – 28; 32 – 35; 41 – 44; 48 - 51	Pump in, single packer with guard cell	2001
16175-R18T	28 – 31; 35 – 38; 44 - 47	Pump out, single packer with guard cell	2001
21762-R142A	16.60-20; 18.1-20; 21-23; 23-26; 24-26; 26-29; 26.50-29; 29.50-32; 32-35; 35-38; 38-41	Pump in, single packer with guard cell	2002 - 2003
21762-R152A	9.2-11.5; 11.4-14;	Pump in, single packer with guard cell	2002 - 2003

Hole ID	Test Zone (mbgl)	Type of test	Investigation Date
21762-R152A	14.5-17; 17-20; 20-23	Pump in, single packer with guard cell	2002 - 2003
21762-R154A	10.0-13; 13-16; 14-16; 16.5-19; 17-19; 19-22; 20-22; 22-25; 25-28; 28-31	Pump in, single packer with guard cell	2002 - 2003
21762-R157A	4.0-7; 16-19; 16.5-19; 17-19; 19-22; 19.5-22; 22-25; 25-28	Pump in, single packer with guard cell	2002 - 2003
29779-RX502A	44.5-47.5; 47.5-50.5; 50.5-53.5; 53.5-57.5; 56.5-59.5	Pump in, single packer with guard cell	2017

Pumping Tests

3.7.6 Two sets of pumping tests were conducted in 21762-W148 and W137 in November-December 2002 and September 2004. 21762-W148 is located in a dry valley whereas 21762-W137 is located in an interfluve. The 2002 pumping test were carried out when water levels were relatively high (approximately 76m AOD in both boreholes), whereas the 2004 pumping test was undertaken when groundwater levels were at a seasonal low (approximately 66.5m AOD in both boreholes). A full description of the tests is described in WJ Groundwater reports [18], [19], [43] and [44]. The values determined from the pumping test are presented in Table 4-6 below:

Table 4-6 Aquifer Transmissivity Determined from Pumping Tests

Pumping Test	W137	W148	Approximate Rest Water Level
December 2002	850 m^2/d	2,650 m^2/d	76 m AOD
September 2004	400 m^2/d	1,430 m^2/d	66.5 m AOD

3.7.7 The reduction in the thickness of the aquifer between the low and high groundwater level explains the reduction in the calculated transmissivity values between December 2002 and September 2004. The difference between 21762-W137 and 21762-W148 would also be expected as transmissivity are usually greater beneath dry valleys where preferential groundwater flow resulted in the increased development of fissures within the Chalk. This difference has also been used to calculate the Chalk permeability for the zone between the high and low groundwater level. It has been estimated at 122m/d in 21762-W148 and 32m/d in 21762-W137 for the chalk above 66m AOD. The chalk permeability below 66m AOD is estimated at 106m/d (1.2x10-3m/s) in 21762-W148 and 67m/d (7.8x10-4 m/s) at 21762-W137. The increase of permeability at depth in 21762-W137 is probably due to the presence of phosphatic Chalk which is interpreted as having a relatively high proportion of sand-size particles (Balfour Beatty-Costain, 2006) [37].

3.7.8 The permeability values obtained from the pumping tests are noticeably higher than those obtained from the packer test, this could be explained by the fact that the packer test zones are localised and not representative of the extended fractured system within the Chalk.

3.8 Other Fieldwork

3.8.1 Not used.

3.9 Laboratory Investigation

Description of Tests

3.9.1 The laboratory testing was scheduled by AAJV. The geotechnical testing was carried out in SSL's in-house laboratory. The chemical testing was carried out by Envirolab. Full details of test methods and standards are provided in the SSL's factual report [25]. The following tests were undertaken:

3.9.2 Classification (chalk) testing comprised one hundred and seventy-seven natural moisture content tests, sixty-six saturation moisture content tests, sixty-six intact dry density tests, sixty-six bulk density tests and sixty-six saturated density tests.

3.9.3 Thirty-six uniaxial compressive strength (UCS) tests were carried out on chalk, of which nine tests were measured for deformation.

3.9.4 Twelve direct shear strength tests were carried out on rock (chalk) under constant normal stress on natural discontinuities or saw cut surfaces. Each test in general comprised three specimen tested at three different constant normal stresses.

3.9.5 Seven slake durability tests were carried out on rock (chalk).

3.9.6 Geotechnical-chemical testing on chalk samples comprised two pH tests, two water soluble sulphate tests, twenty-two total phosphorus content tests and five extractable phosphorus content testing.

Test Results

3.9.7 Full details of the tests carried out and the results are presented in the factual report prepared by SSL [25].

4 Ground Summary

4.1 Topography

4.1.1 The topography of the area is dissected by the two north to south flowing rivers (the River Till towards the west of the scheme and the River Avon to the eastern extent of the proposed Scheme) with interfluves and the dry valley at Stonehenge Bottom between the two.

4.1.2 Following the route through increasing chainage eastbound from the western extent, the ground level typically starts at approximately 160m AOD, steadily sloping downwards, becoming steeper until reaching the River Till at approximately 71m AOD. The ground level then increases to approximately 112m AOD at the highest point of the interfluve and drops down to approximately 80m AOD in the dry valley at Stonehenge Bottom. A rise then occurs up to approximately 110m AOD at the interfluve before dropping to approximately 73m AOD around the River Avon.

4.2 Geology

General

4.2.1 The geological succession, as confirmed by the previous and recent ground investigations along the Preferred Route, is summarised as follows:

a) Superficial Deposits
   - Topsoil
   - Made Ground
   - Head Deposits
   - Alluvium
   - River Terrace Deposits

b) Solid Geology
   - White Chalk Subgroup including the Newhaven, Seaford and Lewes Nodular Chalk Formations, with localised phosphatic Chalk encountered in regional boreholes.

4.2.2 Topsoil is present in majority of the exploratory holes as the uppermost layer. The superficial deposits are locally absent across the site. Phosphatic Chalk was primarily encountered in the area of the interfluve located to the west of Stonehenge Bottom.

4.2.3 A summary of the encountered strata based on the exploratory holes located within a buffer of 250m either side of the horizontal alignment of the Preferred Route is provided in Table 5-1.

Table 5-1 Summary of Encountered Strata within 250m Offset from Mainline Horizontal Alignment of the Preferred Route Option

Stratum	Approximate Chainage (m)	Exploratory Hole Locations Encountered	Depth to Top (m bgl)	Level to Top (m OD)	Proven Thickness (m)	Location
Topsoil	1,190- 12,410	194	0.0 - 0.0	69.0 - 140.0	0.09 - 1.50	Scheme-wide
Made Ground	2,260	1	0.0	125.6	0.60	Borehole 16174-STP12.
	6,200 - 6,300	4	0.0 - 0.0	110.1 - 111.3	0.40 - 1.25	Trial pits 24930-TP1, TP3, TP4 and TP5. In the area in vicinity of the existing Longbarrow roundabout.
	10,760 - 10,760	1	0.0 - 0.0	80.6 - 80.6	0.35 - 0.35	Borehole 16174-STP57.
	11,690 - 11,960	29	0.0 - 0.5	68.5 - 72.49	0.10 - 4.95	In the area in vicinity of the existing Countess Roundabout.
Head Deposits	3,490 - 3,700	8	0.0 - 0.3	75.4 - 91.6	0.20 - 4.15	High ground to the west of River Till valley.
	3,960 - 4,500	12	0.2 - 1.9	71.1 - 87.5	0.15 - 4.00	River Till valley.
	5,130 - 5,280	3	0.2 - 0.3	94.8 - 101.7	0.45 - 1.10	High ground to the east of River Till valley.
	9,080 - 9,110	4	0.2 - 0.8	80.1 - 81.5	0.17 - 2.00	Stonehenge Bottom,
	9,630 - 9,810	2	0.2 - 0.4	103.5 - 109.3	0.34 - 0.42	Interfluve between Stonehenge Bottom and River Avon valley.
	10,675 - 10,675	1	0.3 - 0.3	82.2 - 82.2	1.25 - 1.25	Interfluve between Stonehenge Bottom and River Avon valley.
	11,740 - 11,750	2	0.3 - 0.5	68.7 - 69.4	1.06 - 1.22	River Avon.
Alluvium	4,500	3	0.1 - 0.3	73.1 - 74.1	1.60 - 3.40 (1)	River Till valley.
	11,380 - 12,360	50	0.0 - 5.1	67.5 - 72.7	0.10 (1) - 3.90	River Avon valley.
River Terrace Deposits	11,380 - 12,290	43	0.3 - 4.2	66.0 - 72.2	0.20 (1) - 4.42	River Avon valley.
White Chalk Subgroup	1,190 - 12,410	212	0.0 - 6.7	62.4 - 139.7	0.40 (1) - 50.65 (1)	Scheme-wide.
Phosphatic Chalk	8,260 - 9,030	13	1.8 - 43.6	47.2 - 99.1	2.15 (2) - 34.60 (1)	West of Stonehenge Bottom.

Notes: (1) Full thickness was not proven due to termination of exploratory hole.
(2) The thickness range does not include the possible phosphatic nodules (<10mm) noted in boreholes 16175-R15A and 21762-R149.

4.2.4 The encountered strata are also presented in geological sections that have been prepared along the mainline alignment of the Preferred Route and are included in Appendix A.

4.2.5 Detailed discussions of materials encountered are provided in general chronological order in the following sections.

Topsoil

4.2.6 One hundred and ninety-four out of the total two hundred and fifty-nine exploratory holes carried out within the 250m offset searched zone have encountered Topsoil as the uppermost stratum.

4.2.7 High thicknesses of Topsoil, up to 1.5m in thickness, are recorded with reference to Table 5-1. The high thicknesses are associated with the groundwater investigation carried out by WJ Groundwater Ltd (WJGL) during 2002 as part of the previous scheme Phase 1B pumping test holes. Only basic logging has been carried out and the Topsoil thicknesses associated with these boreholes are recorded to range from 1.1m to 1.5m. It is speculated that the structureless Chalk underlying Topsoil may not have been differentiated during the logging. The Topsoil thickness is averaged as 0.3m scheme-wide if the WJGL boreholes are not considered.

Made Ground

4.2.8 Made Ground was primarily encountered in the areas of the existing Longbarrow and Countess roundabouts although it was also recorded locally in trial pits in 16174-STP12 and STP57.

4.2.9 Made Ground can be highly variable in composition with the presence of variable sizes of man-made objects such as pipes, metal bars and broken tarmac etc.

4.2.10 In the area of the Longbarrow Roundabout, four trial pits (24930-TP1, TP3, TP4 and TP5) have encountered Made Ground. It is typically described as brown sandy gravelly silt up to 1.25m in thickness, noted to be loose in trial pit 24930-TP1.

4.2.11 To the west of Winterbourne Stoke, Made Ground has been encountered from ground level to 0.6m bgl in trial pit 16174-STP12 and is described as brown sandy sub-angular to rounded fine to coarse gravel of flint with occasional chalk and tarmac and rare brick. The density of material is not stated.

4.2.12 To the west of Countess Roundabout, Made Ground encountered in trial pit 16174-STP57, 0.35m in thickness, is described as brown sandy angular to sub-rounded fine to coarse gravel of limestone (road base), some tarmac, flint and chalk.

4.2.13 There are relatively extensive numbers of ground investigation carried out in the areas between chainage 11,100 to 12,500 along the existing A303 carriageway which passes through the Countess roundabout. The earliest ground investigation was carried out in 1965 (HAGDMS 17031) in association with the proposed London to Penzance trunk road at the time. The 1965 ground investigation comprised twenty-seven boreholes that were drilled from 3.05m to

13.26m deep. It revealed a natural geological sequence of thin topsoil, peat layers, alluvial silt, and river terrace deposits overlying chalk. The peat layers are typically 1-2m in thickness along the main route alignment, with the exception in borehole 17032-BH12 where the peat was found to be 2.5m thick. Peat is typically underlain by alluvium that is described as soft grey and yellow organic silt ranging 0.45 to 1.8m in thickness.

4.2.14 Made/Fill Ground, typically 2.5m to 3.5m in thickness, was encountered in the same areas in the ground investigations carried out after 1965 (HAGDMS 16996, 21762, 29779, 30295 and Halcrow’s investigation in 2000). The elevated ground levels in these ground investigations (typical range 71.5m to 72.8m OD) in comparison to the year 1965 ground investigation (typical range 68.9m to 69.8m OD) suggested that earthworks has taken place and an embankment was constructed post-1965. The ground investigation information suggests that excavation and replacement was undertaken, evidenced by the absence of the peat layers and alluvial silt and their replacement with Made/Fill Ground.

4.2.15 The Made/Fill Ground encountered post-1965 is typically described as medium dense, clayey silty sandy chalk gravel with occasional flints, with occasional findings of fragments of tarmac and rubbles.

4.2.16 The base of the Made/Fill ground was encountered at 67.1m to 68.9m OD along the mainline route alignment, and is lowest below the Countess roundabout where the lowest point of the River Avon once crossed.

4.2.17 Layers that are typically described as very soft to firm greenish to brownish grey slightly sandy slightly gravelly clay has been found in the post-1965 ground investigations to lie between the Made/Fill Ground and the river terrace sand and gravel. These layers are likely to be the remnants of the bases of the alluvial deposits that had not been fully removed as part of the embankment construction works. The proven thickness of these remnant layers ranges from 0.1m to 2.3m (average 1m). The higher thicknesses are found in the exploratory holes located within and in close proximity to the Countess roundabout, with revised thickness range from 0.7m to 2.3m (average 1.6m).

4.2.18 A strong organic odour has been recorded in trial pits 24822-TP6 and TP9 at 2.6-3.0m and 2.4-3.1m bgl respectively. Both trial pits are located within the Countess roundabout. To the immediate north-west of the Countess Roundabout, a slight hydrocarbon odour was recorded in trial pit 24822-TP4 between 0.3m and 2.8m bgl.

Head Deposits

4.2.19 Head Deposits are not present across the entire scheme but have been encountered at several locations where the scheme crosses fluvial, tributary and ephemeral valleys.

4.2.20 The most significant presence of Head Deposits is found in the River Till valley (in boreholes between Chainage 3,963 and Chainage 4,498). According to the BGS geological map (sheet 298, title “Salisbury”, bedrock and superficial deposits, England and Wales, scale 1:50,000, 2005 [45]) the outcrop deposits are indicated as “Gravelly Head” comprising “variable deposits of gravelly, silty clay”. Head Deposits encountered in the exploratory holes have been typically described as brown silty sandy sub-angular to sub-rounded fine to coarse gravel of flint and occasional chalk, with rare cobbles of flints. The local thickness of Head Deposits ranges from 0.15m to 4.0m but the typical thickness ranges from 1.7 to 3m.

4.2.21 Head Deposits have also been encountered along a tributary valley which lies to the west of River Till (in boreholes between Chainage 3,489 and Chainage 3,700). They have been described as loose pale to dark brown silty gravelly fine to medium sand or silty sandy gravel with occasion flint cobbles. Gravel is angular to sub-rounded fine to coarse broken rinded flint. High thickness is found in trial pit 21762-DTP118 (4m) otherwise typical thickness ranges from 0.2m to 1.75m.

4.2.22 Head Deposits have also been encountered as soft to firm light to dark brown slightly sandy gravelly clay or silt towards the lower part of the slope locates to the west of Stonehenge Bottom (in boreholes between chainage 9,076 and 9,112). Thickness encountered ranges from 0.2m to 0.4m, with the exception of trial pit 21762-DTP155C where a 2m thickness of Head Deposits was encountered.

4.2.23 There are other dispersed locations along the scheme where Head Deposits have been recorded and they are summarised in Table 5-1.

Alluvium

4.2.24 Alluvium has been identified in the River Avon valley, and is generally overlain by Made/Fill Ground around the area of the Countess Roundabout. Alluvium has also been encountered in the River Till valley in boreholes 16174-CP3, CP3A and STP31 which are located beyond 200m from the mainline alignment to the north of the scheme.

4.2.25 Alluvium around the River Till valley is observed to be predominantly granular, thickness ranging from 0.9 to 2.1m. Granular Alluvium is described as light brown to brown, occasionally orange brown, slightly to very clayey occasionally gravelly fine to medium sand. In exploratory holes 16174-STP26 and STP31 this is underlain by cohesive Alluvium, 1.8m and 1.7m thick respectively, and is typically described as orange brown, brown or light brown, occasionally mottled white silty, slightly sandy slightly gravelly clay.

4.2.26 Alluvium in the areas of the Countess Roundabout and the River Avon has generally been observed to be more cohesive. Cohesive Alluvium has been identified as approximately 0.1 to 2.3m thick, and is found beneath the Made/Fill Ground and typically described as very soft to firm greenish to brownish grey slightly sandy slightly gravelly clay, with occasional finding of rootlets and pockets of peat and organic matter.

4.2.27 Granular Alluvium has been identified around Countess Roundabout and the River Avon, and is typically described as medium dense, pale greenish brown, clayey, gravelly sand. Granular Alluvium has been observed in the following exploratory holes:

a) Overlying the cohesive Alluvium in 21762-R165 and R167 (2.4m and 1.05m thick respectively). Granular Alluvium is described as firm, “off white”, mottled brown, gravelly, silty sand in borehole 21762-R165;

b) Underlying the cohesive Alluvium in 21762-CP168 and WS181B (0.35m and 0.7m thick respectively);
c) With no cohesive Alluvium in STP181A and WS181 (0.7m and 1.2m thick respectively). Granular Alluvium is described as medium dense, brown, slightly silty, slightly gravelly sand in borehole 21762-CP168.

4.2.28 Soft, silty, occasionally sandy peat has been identified in Alluvium in the year 1965 boreholes referenced in the ground investigation report HAGDMS reference 17031. This report was prepared in 2000 to inform the proposed improvement works at Countess Roundabout at the time. The PSSR suggests that the peat would have been removed at the time of construction of the Amesbury bypass and is supported by the absence of peat layers in the ground investigations carried out after year 1965. A summary of remnant alluvial layers encountered below the Made/Fill Ground in the post-1965 ground investigations is provided in Table 5-2.

Table 5-2 Summary of Encountered Alluvial Layers in the Post-1965 Ground Investigation

Chainage (m)	Hole ID	Depth to Top (m bgl)	Depth to Base (m bgl)	Thickness (m)
11,583	Halcrow 2000-TP6	2.8	3.4	0.6
11,692	21762-R166	2.6	3.4	0.9
11,734	24822-TP6	2.6	3.0	0.4 (1)
11,754	24822-TP9	2.0	3.4	1.4
11,811	24822-TP11	2.4	3.1	0.7
11,826	24822-BH1	2.0	4.0	2.0
11,835	21762-R167	1.9	4.2	2.3
11,849	21762-STP181A	2.4	3.1	0.7 (1)
12,109	Halcrow 2000-TP2	5.0	5.2	0.2
12,186	Halcrow 2000-TP1	5.1	5.2	0.1

Notes: (1) The full thickness was not proven due to termination of the exploratory hole.

4.2.29 A strong organic odour was recorded in exploratory holes 24822-BH2, BH11, TP9, and TP6. Slight hydrogen sulphide odour was also noted in borehole 21762-R167.

River Terrace Deposits

4.2.30 River Terrace Deposits are predominantly granular in nature and have been found in the River Avon valley. This stratum is found underlying Alluvium, and has been described as loose to medium dense, brown to brownish grey, silty sand and/or gravel with occasional flint cobbles. Sand is fine to coarse and gravel is angular to sub-rounded fine to coarse flint and occasional chalk.

White Chalk Subgroup – Introduction

4.2.31 The entire Preferred Route is underlain by the White Chalk Subgroup. The Newhaven Formation is the youngest outcrop, generally encountered over higher elevations in the interfluve regions, notably either side of Stonehenge Bottom. The Seaford Chalk Formation underlies the Newhaven Chalk Formation and is the major chalk outcrops in the area of the scheme in the lower terrain where Newhaven Formation is absent. The Lewes Nodular Chalk Formation underlies the Seaford Chalk Formation at great depth, and is only observed in borehole 29779-P505 at a depth of 39.4m bgl (56.88m AOD) amongst the borehole dataset.

4.2.32 Chalk has been identified as phosphatic in exploratory holes to the west of Stonehenge Bottom at depths within both the Newhaven Chalk Formation and Seaford Chalk Formation. Exploratory hole descriptions identify phosphatic Chalk as appearing to be interbedded within each formation. However, it can also be defined by absolute thickness, as Professor Mortimore [34] states that it is believed that the phosphatic Chalk has been deposited in scoured marine channels (known as cuvettes) in an organic rich environment.

4.2.33 The classification of chalk can be subjective in nature. As such, the CIRIA C574 Grading Scheme (Lord *et al.*, 2002) [46] provides a framework against which to classify chalk with respect to discontinuity aperture, subdivision by discontinuity spacing and engineering behaviour.

4.2.34 Professor Rory Mortimore has been consulted and reviewed for the recovered cores for boreholes 29779-P502B, P505 and R501.

Structureless Chalk – General

4.2.35 For the purpose of this report, structureless Chalk refers to chalk logged as either CIRIA C574 grade Dm or grade Dc.

4.2.36 Structureless Chalk overlies structured Chalk with varying thicknesses throughout the Preferred Route. The thickness of structureless Chalk is described in the PSSR as being less than 1m throughout higher elevations, particularly in interfluve zones. The thickness increases to up to 3m in the River Till Valley north of Winterbourne Stoke, up to 7m in the dry valleys (Stonehenge Bottom, north-east and north-west of Winterbourne Stoke) and up to a maximum thickness of 10m in the Avon Valley at Countess Roundabout and around the River Till valley.

4.2.37 Between chainage 0 and 7,000 (to the east of Longbarrow roundabout), structureless Chalk has been largely classified as grade Dc, with the exception of the following exploratory holes:

a) 21762-DTP116, R111, R135 and STP134;
b) 29779-P502B, PX504, R503B, RX509, RX509A, RX512A and RX515A.

4.2.38 Between chainage 0 and 7,000, structureless Chalk is generally described as comprising white or very light brown slightly silty to silty, silty, sandy, fine to coarse gravel and cobbles of chalk. Clasts are very weak to moderately strong (occasionally strong) with occasional orange and light brown staining. Occasional flints have been logged between chainage 3,196 and 6,543.

4.2.39 Between chainage 7,000 and 12,569, structureless Chalk typically comprises interbedded layers of grade Dm and Dc.

4.2.40 Between chainage 7,000 and 12,569, grade Dm structureless Chalk is typically described as white, cream or light brown slightly gravelly to gravelly, sandy silt. Grade Dc structureless Chalk is typically described as silty, slightly sandy to sandy, angular to subangular fine to coarse gravel with occasional cobbles and boulders and occasional orange staining and black speckling throughout. Clasts are generally weak to moderately weak, low to medium density white chalk, with the exception of observations in boreholes 21762-R152, R152A and R152AA (chainage 9,070 to 9,080), where clasts are described as weak to moderately strong, medium to high density white chalk. Occasional gravel of flint has been observed between chainage 7,000 and 12,569.

4.2.41 Marl has been identified within undifferentiated structureless Chalk in four boreholes at different areas of the proposed scheme. Within borehole 21762-R121 at a depth of 4.4m bgl, Professor Mortimore logged 40 to 80mm of green grey marl (Shoreham Marl).

4.2.42 Sponge beds have been identified within undifferentiated structureless Chalk by Professor Mortimore in trial pit 21762-DTP155C at depths of 3m, 3.9m and 4.1m bgl. These are described as red, iron-stained sponge beds.

Structureless Newhaven Chalk Formation

4.2.43 Structureless Chalk is identified as being part of the Newhaven Chalk Formation between chainage 7,837 and 9,719. Grade Dm structureless Chalk typically overlies grade Dc.

4.2.44 Grade Dm structureless Chalk of the Newhaven Chalk Formation is generally described as being composed of uncompact to compact cream, slightly gravelly to gravelly, slightly sandy to sandy silt. Gravel is described as very weak to weak low density white chalk, and occasional flint cobbles are noted. An orange brown appearance has been observed in borehole 29779-P510 (chainage 8,780).

4.2.45 Grade Dc structureless Chalk of the Newhaven Chalk Formation is typically described as being composed of slightly sandy silty subangular to rounded medium to coarse gravel with occasional observations of cobbles. Gravel is observed as very weak to weak low to high density white chalk. Flints have been logged occasionally, typically presenting a medium gravel to cobble size nodules.

Structureless Seaford Chalk Formation

4.2.46 Structureless Chalk of the Seaford Chalk Formation has been identified between chainage 4,568 and 10,497. The grade varies between grade Dm and grade Dc. Grade Dm typically overlies grade Dc between chainage 4,568 and 9,000, with structureless Chalk being logged as interbedded grade Dm and grade Dc at further chainages.

4.2.47 Grade Dm structureless Chalk of the Seaford Chalk Formation is typically described as uncompact (occasionally compact) cream, slightly gravelly, sandy silt. Gravel is typically very weak, low density and the matrix typically uncompact locally brown chalk. Black rinded gravel and cobble size flints are occasionally present throughout.

4.2.48 Grade Dc structureless Chalk of the Seaford Chalk Formation is typically described as being composed of silty, occasionally sandy subangular fine to coarse gravel. Gravel is in general logged as very weak to medium density white. Black rinded gravel and cobble size flints are occasionally present throughout.

Structured Chalk – General

4.2.49 For the purpose of this report, structured Chalk refers to chalk logged as either CIRIA C574 grade A, grade B or grade C.

4.2.50 Throughout the site, structured Chalk typically underlies structureless Chalk, with the exception of holes where structureless Chalk is not logged and the following holes where structureless Chalk has been logged as interbedded within structured Chalk:

a) Chainage 8,639 in borehole 29779-R501. At 5.8m bgl, a 0.15m thick layer of grade Dc structureless Chalk has been logged within structured Chalk of the Newhaven Chalk Formation;
b) Chainage 9,075 in trial pit 16175-DTP26. A 1.6m thick layer of weak medium density white chalk with slight black speckling has been logged between two layers of grade Dc structureless Chalk at 0.62m bgl (with corresponding layers of structureless Chalk at 0.39m and 2.2m bgl);
c) Chainage 9,080 in borehole 21762-R152. Grade Dm/Dc structureless Chalk logged as underlying structured Chalk at 21.7m bgl. Structureless Chalk is described as “cream, slightly sandy, silty Chalk, with gravel sized clasts”. The full thickness of the structureless chalk was undetermined due to the termination of the exploratory hole;
d) Chainage 10,497 in borehole 29779-R507A. A 0.3m thick layer of grade Dc Seaford Chalk Formation logged within structured Seaford Chalk Formation.

4.2.51 Structured Chalk generally comprises CIRIA discontinuity aperture grades A, B and C. Each grade has been observed throughout the length of the route. However, grade B is the most represented:

a) CIRIA grade A is logged in 17% of exploratory holes;
b) CIRIA grade B is logged in 43% of exploratory holes;
c) CIRIA grade C is logged in 26% of exploratory holes.

4.2.52 CIRIA discontinuity spacing suffices range between 1 and 5, each observed throughout the length of the Preferred Route. Suffices 3 and 4 are the most frequently represented. The percentage distribution of CIRIA grade distribution over the total number of boreholes is represented by the following:

a) Suffix 1 is logged in 2% of exploratory holes;
b) Suffix 2 is logged in 18% of exploratory holes;
c) Suffix 3 is logged in 43% of exploratory holes;
d) Suffix 4 is logged in 41% of exploratory holes;
e) Suffix 5 is logged in 10% of exploratory holes.

4.2.53 With respect to the CIRIA chalk grades, there does not appear to be a distinct succession of grades over depth or distance observed for the scheme. Discontinuity aperture and spacing are variable, with individual logs frequently stating changes from grade C to B and returning to C against depth.

4.2.54 Throughout chainage 0 to 6,500, structured Chalk is typically described as being weak to moderately weak, medium density, white to cream chalk with occasional orange and brown staining and rare to occasional black speckling. Apertures are typically open or infilled with silty, occasionally sandy, pale brown chalk. Occasional flint has been observed throughout, with description detail limited due to variable recovery. Within this chainage range there is an exception between chainage 3,900 and 4,100, where weak to moderately strong, medium to high density white and cream chalk is observed with some yellow staining and rare black speckling. Rare flint bands have been observed in this region, and descriptions correspond to grade A Chalk.

4.2.55 From approximately chainage 6,500 onwards, typical descriptions for structured Chalk are very weak to moderately weak, low to medium density cream and white chalk. Rare to occasional brown and orange staining and rare slight yellow staining is logged throughout. Rare to occasional flints are noted in the logs throughout the section. Exceptions to the typical description occur occasionally within thin strata of CIRIA grade A structured Chalk throughout the section, and are typically described as moderately strong to strong, medium to high density, white chalk with slight brown and orange staining and occasional black speckling. Descriptions also differ in phosphatic Chalk encountered, which is discussed in Section 5.2.88.

4.2.56 Marl seams have been identified within structured Chalk at varying depths throughout the entire Preferred Route. Marl seams are thin layers of marl that are rich in clay minerals and occurred episodically and have a grey to green colour in contrast to the otherwise normally white colour of the White Chalk Subgroups. Well studied marl seams provide key marker beds for chalk stratification. Marl seam layer thicknesses typically vary between 1mm and 4mm, and the observed vertical spacing ranges from 10mm to greater than 1m.

4.2.57 Sponge beds have been identified at varying depths over the entire scheme, and are more commonly noted in the independent logs prepared by Professor Mortimore than they are in contractor logs. Their appearance ranges from red, typically iron stained, sponge beds, brown sponge beds and yellow sponge beds.

4.2.58 Chalk hardground was formed during a pause in sedimentation or erosion in which time cementation took place in the seabed. Hardgrounds have been observed at varying depths within undifferentiated structured Chalk, the Seaford Chalk Formation and in phosphatic Chalk. They have been described in the following exploratory holes:

a) 16175-DTP31, DTP32, DTP33, R9, R10 and R18;
b) 21762-R123 and 124, and 29779-P502B and P505.

4.2.59 Hardgrounds are typically described in logs as either red, iron stained nodular hardgrounds or as glauconitic hardgrounds.

Structured Newhaven Chalk Formation

4.2.60 The Newhaven Chalk Formation has been identified in exploratory holes between chainage 7,800 and 9,800, and encountered at depths ranging from 0.2m to 23m bgl to the lowest level of 72.64m AOD. In addition to the historic borehole descriptions discussed in the PSSR, the 2017 EP GI boreholes typically describe the Newhaven Chalk Formation as weak, low to high density white brown stained chalk, with corresponding CIRIA grading ranging from structureless to B3, with grade A4 logged in borehole 29779-P505 at 3.5m bgl (92.78m AOD).

4.2.61 Structured Chalk of the Newhaven Chalk Formation is typically described as weak, low to medium density white chalk with occasional rinded flint cobbles.

Occasional orange staining is noted, in addition to brown stained sponges. The formation has also been identified in check logs by Professor Mortimore through the occasional identification of zoophycos flints.

4.2.62 Occasional marl, less than 2mm thick, has been noted throughout the depth of boreholes logged within the structured Newhaven Chalk Formation. Vertical spacing between marl layers ranges from100mm to more than 4m.

4.2.63 Sponge beds are commonly identified within the structured Newhaven Chalk Formation. Vertical spacing typically varies from 200mm to greater than 2m. Descriptions of sponge beds vary from brown stained sponges to orange or red, iron stained sponges and yellow, orange stained sponges.

Structured Seaford Chalk Formation

4.2.64 The Seaford Chalk Formation has been encountered between chainage 7,800 to 10,500 over the Preferred Route. Structured Chalk of the Seaford Chalk Formation is typically described as extremely weak to weak medium to high density white, slightly brown stained chalk with occasional black speckling and with fractures infilled by white or brown silt. Occasional orange staining is also noted throughout, as well as brown stained sponges and nodular flint and hardgrounds.

4.2.65 Typically thin wispy marl has been identified within the Seaford Chalk Formation with a vertical spacing ranges from 5mm to 3m. Vertical thicknesses range between 1mm and 5mm.

4.2.66 Professor Mortimore’s logs [32] note that the Belle Tout Marls have been observed with frequent vertical spacing within the following boreholes:

a) Borehole 16175-R13 (chainag 8,844) at a vertical spacing of between 100mm and 900mm, identified between 43.7m and 49.4m bgl (49.4m and 43.7m AOD respectively);
b) Borehole 16175-R16 (chainage 9,143) at a vertical spacing of between 250mm and 1.3m, identified between 32m and 36m bgl (47.5m and 43.5m AOD respectively).

4.2.67 Sponge beds have been noted in the structured Seaford Chalk Formation. Vertical spacing typically varies between 100mm and 9m. The sponge beds are described as yellow to brown to orange to red iron stained.

4.2.68 A glauconitic hardground has been observed within grade A2 chalk of the Seaford Chalk Formation in borehole 16175-R18 at 4.3m bgl (92.2m AOD).

Structured Lewes Nodular Chalk Formation

4.2.69 Observations of the Lewes Nodular Chalk Formation have been made in borehole 29779-P505 in the 2017 EP GI at chainage 8,157 from 38m bgl (58.28m AOD) with an unproven thickness due to hole termination. It is described as very weak low to medium density white chalk with brown staining and black speckling, with corresponding CIRIA grades of B1 to B3.

4.2.70 Brown stained sponges have been observed within the Lewes Nodular Chalk Formation in borehole 29779-P505 at frequent vertical spacing between 38.1m bgl (58.18m AOD) and 41.9m bgl (42.05m AOD). These are typically described either as brown stained sponges, or orange iron stained sponges.

Deeper Formations of the White Chalk Subgroup

4.2.71 Lower strata within the White Chalk Subgroup have been identified regionally through geological memoirs, including the New Pit Chalk Formation and the Holywell Nodular Chalk Formation. However, these have not been identified or encountered in the ground investigations carried out as part of the Scheme.

Phosphatic Chalk

4.2.72 The phosphatic Chalk is summarised and discussed in previous ground investigation reports and the PSSR [1], and has been identified within an approximate chainage range of Ch 7,600m to Ch 9,040m. Encountered depth ranges for the phosphatic Chalk vary throughout this chainage range, having been typically logged as interbedded within both Newhaven Chalk Formation and Seaford Chalk Formation. The top of phosphatic Chalk has been logged at depths ranging from 1.8m to a top depth of 42.2m bgl and between minimum and maximum levels of 47.1m and 99.98m AOD respectively.

4.2.73 Due to the apparent interbedded nature of the phosphatic Chalk, its thickness could be considered in terms of both interbedded and absolute thicknesses. Typical interbedded thicknesses logged for phosphatic Chalk range from 0.1m to beyond 23.5m, with logged absolute thicknesses ranging between 0.1m and 34.6m.The full thickness of phosphatic Chalk has not been proven in exploratory holes 16715-DTP21 and 29779-R501 due to the bases of the hole having been reached.

4.2.74 Observation and interpretation of properties of the phosphatic Chalk is often subjective. Comparisons have been made between the ground investigation contractor's logs and graphic logs carried out by Professor Rory Mortimore. The graphic logs produced by Professor Mortimore as part of the 2017 EP GI focus primarily on the identification of phosphatic Chalk and other features in chalk such as marker beds for the purpose of chalk stratification. Professor Mortimore's logs regarding the 2017 EP GI are discussed in Paragraph 5.2.97.

4.2.75 Phosphatic Chalk has been logged in the 2017EP GI in boreholes 29779-P502B, P505, R503B and R501. Throughout these boreholes the phosphatic Chalk is logged by the contractor with varying thicknesses starting from approximately 8m bgl (with the exception of 29779-P503B starting at 4.3m bgl), and is generally described as variable, often weakly cemented, low to high density brown "sandy" chalk with pelletal phosphatic grains. The concentration of phosphates varies with depth, as weakly phosphatic layers can be interbedded with relatively thin burrows infilled with phosphatic pebbles or with pockets of phosphatic nodules. Occasional glauconitic streaks are noted as well as brown stained sponges.

4.2.76 Layers of streaky and wispy marl have been identified within phosphatic Chalk at frequent vertical spacing throughout the depth of boreholes and at thicknesses ranging between less then 1mm and approximately 2mm.

4.2.77 Sponge beds have been identified within phosphatic Chalk. Vertical spacing typically varies between 100mm and greater than 9m. Descriptions of sponge beds vary from brown stained sponges to orange or red iron stained sponges and yellow, orange stained sponges.

4.2.78 Hardgrounds have been identified within phosphatic Chalk at depths ranging from 6.6m bgl to 15.1m bgl (reduced level range of 84m AOD to 92.8m AOD) in the following boreholes:
a) 16175-R9 and R10;
b) 29779-P502B and P505.

4.2.79 Hardgrounds are typically described as red, iron stained mineralised hardgrounds.

4.2.80 Down-hole natural gamma survey is a geophysical technique that is typically employed during ground investigation to measure gamma radiation emits by clay-rich lithology and it has been used to identify marl seams in chalk. The previous ground investigations had carried out natural gamma surveyed in selected exploratory holes and has demonstrated a strong correlation between natural gamma radiation and phosphatic Chalk. This technique has also been scheduled in the 2017 EP GI.

4.2.81 The natural gamma readings have been categorised into three levels of response in an attempt to study the likelihood of presence of the phosphatic Chalk and its spatial distribution:
a) **Response R0:** Background level response (typically less than 5 or 7.5 API) – presence of phosphate-rich chalk is considered to be unlikely.
b) **Response R1:** Moderate gamma response (typically 7.5-12.5 API) – indication of presence of phosphate-rich chalk.
c) **Response R2:** High gamma response (greater than 12.5 API) – strong indication of presence of phosphate-rich chalk.

4.2.82 The natural gamma survey has been carried out in the previous and 2017 EP GI boreholes covering project chainage chainage 6,030-10,500. Longitudinal sections showing the profiles of the natural gamma response in individual boreholes is presented in drawings HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0068 to 0076.

4.2.83 Elevated natural gamma readings (i.e. with response R1 or higher) are mainly observed in boreholes that are located west of Stonehenge Bottom. The western-most borehole with elevated natural gamma readings may be considered to be borehole 16175-R6 (chainage 7,840). The elevated natural gamma response horizons both thickened and intensified from the western end in borehole 16175-R6, and from the eastern end at the Stonehenge Bottom, in opposite directions centrally towards boreholes 21762-R142 (chainage 8,640) and 16175-R11 (chainage 8,700). An exception to this observation is made in borehole 17439-P2 located at the Stonehenge Bottom which has encountered significant thickness of elevated gamma response. As noted in the PSSR [1], the presence of phosphatic Chalk has not been positively identified during core logging. The elevated gamma response in borehole 17439-P2 may be related to the presence of marl.

4.2.84 Moderate to high gamma responses are detected in borehole 16175-R20 (chainage 9,630) from ground level to approximately 29m bgl. This borehole is located to the east of the Stonehenge Bottom. Although the chalk has been described to include brown to orange staining with the findings of slight to occasional black speckling, there is no substantial descriptive evidence to suggest that phosphatic Chalk is present in this borehole. Boreholes 16175-R19A (chainage 9,480) and 16175-R21 (chainage 9,947) are located nearest to borehole 16175-R20, with the former comprising a down-hole natural gamma survey. Both of these nearby boreholes did not indicate elevated natural gamma readings nor provide descriptive evidence to suggest the presence of phosphatic Chalk.

4.2.85 Occasional peaks of moderate gamma response are detected in borehole 29779-R507A (chainage 10,500) from approximately 4m to 24m bgl. This borehole is located close to the proposed eastern tunnel portal east of Stonehenge Bottom. Borehole 29779-R507A is significant in terms of the presence of core loss zone and fractures that have been logged as possibly faulting induced from 10.6m bgl to the base of hole at 36.5m bgl. Aside from the presence of possible faults and the descriptions of the chalk being brown stained with black specks, there is no substantial descriptive evidence to suggest that phosphatic Chalk is present in this borehole. The nearest borehole 16175-R24 (chainage10,440) also does not provide descriptive evidence to suggest the presence of phosphatic Chalk.

4.2.86 Boreholes 29779-PX504, P502B, PX505A, P505 and PX506 together form a linear series of south-west to north-east oriented boreholes. These boreholes were drilled as part of the 2017 EP GI and their locations were chosen in association with the previously proposed route during the non-statutory consultation in the early 2017. These boreholes are located between chainage 7,840 and Ch 8,280, and are 321to385m offset to the south from the Preferred Route mainline alignment. Moderate to high gamma responses have been detected in these boreholes as shown on drawing HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0077. The presence of phosphatic Chalk has also been confirmed via core logging by the ground investigation contractor and Professor Mortimore in boreholes 29779-P505 and P502B. However, boreholes 29779-PX504, PX505A and PX506 were formed by open holed drilling techniques therefore cores were not available for detail logging. The natural gamma survey has indicated the presence of a main phosphatic Chalk horizon under boreholes 29779-PX504, P502B, PX505A, P505 and PX506, with high gamma responses in general 10m below ground level. This main horizon is in general 5-10m in thickness and tends to follow the existing topography and falls in levels towards the Stonehenge Bottom. Occasional moderate gamma responses have been detected at discrete depths below this main horizon. A moderate to high gamma response zone was detected in borehole 29779-PX506 from 34.6m to 38.2m bgl (54.7-58.3m AOD). Similarly moderate to high gamma responses have been detected below the main horizon in the nearest borehole 29779-P505.

4.2.87 The identification of the presence of phosphatic Chalk has been based on three sources: the ground investigation contractors' borehole logs, Professor Mortimore's graphic logs and the results from the downhole natural gamma survey. A summary comparing the findings of phosphatic Chalk from the three sources are provided in Table 5-3. Drawings HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0078 to 0082 show the locations of the encountered phosphatic Chalk and should be read in conjunction with Table 5-3.

Table 5-3 Summary of Potential Phosphatic Chalk Identified

Hole Chainage (m)	Exploratory Hole ID	Factual Report Exploratory Hole Logs	Professor Mortimore's Log	Natural Gamma Survey
2,632	21762-R111	Slight brown staining observed., However, no phosphatic materials inferred.	No phosphatic materials encountered.	Not surveyed.-
3,691	21762-R121	Occasional brown staining and black speckling observed, however no phosphatic materials inferred.	No phosphatic materials encountered.	Not surveyed.
4,009	21762-R123	No phosphatic materials encountered.	No phosphatic materials encountered.	Not surveyed.
4,092	21762-R124	No phosphatic materials encountered.	No phosphatic materials encountered.	Not surveyed.
6,026	21762-R129	Slight brown staining and black speckling observed, however no phosphate inferred.	No phosphatic materials encountered.	Surveyed depth: 1.6-17m bgl (15.3m). Response in percentage surveyed depth, R0 / R1 / R2 (%): 100 / 0 / 0 Discussion: Background level response.
6,187	21762-R130	Occasional slight brown staining observed in chalk throughout depth of borehole.,However, no phosphate inferred.	Not logged.	Surveyed depth: 1.7-17.5m bgl (15.8m). Response in percentage surveyed depth, R0 / R1 / R2 (%): 100 / 0 / 0 Discussion: Background level response.
6,543	21762-R132	No evidence of phosphate observed.	Not logged.	Surveyed depth: 1.6-15.8m bgl (14.2m). Response in percentage surveyed depth, R0 / R1 / R2 (%): 100 / 0 / 0 Discussion: Background level response.
7,679	29779-R503B	Light brown staining often observed in chalk from 0.3m bgl onwards (chalk is structureless between 0.3m and 1.2m bgl). **Closely spaced layers of phosphatic nodules encountered from 4.3m bgl to 6.96m bgl, then becoming occasional up**	Not logged.	Surveyed depth: 2.5-47.7m bgl (45.1m). Response in percentage surveyed depth, R0 / R1 / R2 (%): 100 / 0 / 0 Discussion: Background level response.

Hole Chainage (m)	Exploratory Hole ID	Factual Report Exploratory Hole Logs	Professor Mortimore's Log	Natural Gamma Survey
		to 8.45m bgl. Occasional brown stained sponges observed from 9.55m bgl onwards.		
7,788	21762-R135	No evidence of phosphatic condition observed.	Not logged.	Surveyed depth: 0.6-20.1m bgl (19.5m). Response in percentage surveyed depth, R0 / R1 / R2 (%): 100 / 0 / 0 Discussion: Background level response.
7,837	16175-R6	Occasional brown, orange and yellow staining, in addition to black speckling, observed throughout depth of borehole. Phosphate not explicitly noted.	Not logged.	Surveyed depth: 1.1-25.7m bgl (24.5m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 88.1 / 11.8 / 0** Discussion: Moderate gamma response recorded.
7,837	29779-PX504	Borehole not logged, as cored using open-hole drilling techniques.	Not logged.	Surveyed depth: 2.3-42.9m bgl (40.6m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 82.9 / 8.4 / 8.6** Discussion: Moderate to high response recorded.
7,897	29779-P502B	**Structured chalk becoming "weak light brown and white lightly brown stained slightly phosphatic chalk" from 12.2m bgl. Occasional sand sized phosphates and light brown pockets of phosphates and phosphatic nodules to 13.7m bgl. Chalk described as phosphatic from 13.7m to 19.85m bgl.** Occasional light brown staining and brown sponges at greater depths.	**<u>From12.0m bgl</u>:** **becoming coarse, weakly phosphatic, gritty chalk, phosphatic thin gey marl burrowed down.** **<u>Below 13.4m bgl</u>: become coarser more strongly. phosphatic.** **<u>14.05-14.4m bgl</u>: richly phosphatic burrow-fills.**	Surveyed depth: 2.3-42.4m bgl (40.1m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 84.4 / 10.5 / 4.9** **Discussion: Moderate to high gamma response recorded. Fluctuations at approximately 14m bgl and slight fluctuations at approximately 19.4m bgl, coinciding with observations of phosphates.**
7,998	16175-R7	Occasional orange staining and black speckling noted throughout, however no mention of brown appearance and	Not logged.	Surveyed depth: 1.1-29.3m bgl (28.1m). **Response in percentage surveyed depth, R0 /**

Hole Chainage (m)	Exploratory Hole ID	Factual Report Exploratory Hole Logs	Professor Mortimore's Log	Natural Gamma Survey
		phosphate not explicitly noted.		**R1 / R2 (%): 61.8 / 38.1 / 0** Discussion: moderate gamma response recorded.
8,031	29779-PX505A	Borehole not logged, as cored using open-hole drilling techniques.	Not logged.	Surveyed depth: 2.6-43.9m bgl (41.2m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 69.9 / 20.3 / 9.7** Discussion: Moderate to high gamma response recorded.
8,148	16175-R8	Occasional orange staining and black speckling noted throughout, however no mention of brown appearance and phosphate not explicitly noted.	No phosphatic materials encountered.	Surveyed depth: 2.4-35.7m bgl (33.2m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 82.5 / 17.4 / 0** Discussion: Moderate gamma response recorded.
8,157	29779-P505	**"Very weak medium density brown highly phosphatic chalk" from 9m to 10.8m bgl, with slightly phosphatic chalk to 12.4m bgl** and occasional brown stained sponges at greater depths.	**9.0-9.4m bgl: richly phosphatic, burrow-mottled chalk observed.** **10.3-10.6m bgl: phosphatic chalk burrowed below hardground, slightly firmer, low to medium density white chalk.** **19.8m bgl: thin phosphatic grey marl.** **19.85-20.2m bgl: weakly phosphatic chalk with very hard partly green, glauconised lumps and brown phosphatic pebbles, high to very high density density chalkstone fragmented hardground.** **26.95m bgl: phosphatic nodule**	Surveyed depth: 2.5-42.1m bgl (39.6m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 68.5 / 23.8 / 7.6** **Discussion: Moderate to high gamma response recorded. Highest readings recorded coincide with observations of phosphates between 9m and 10m bgl.**

Hole Chainage (m)	Exploratory Hole ID	Factual Report Exploratory Hole Logs	Professor Mortimore's Log	Natural Gamma Survey
			bed. **32.4m bgl and 33.8m bgl: phosphatic chalk pebbles.**	
8,265	16175-DTP21	0.7m of structured chalk logged as "**very weak medium bedded very light brown grey yellow medium grained sandstone** with frequent clasts of weak medium density white with slight black speckling sand and gravel of chalk".	**"Sandy", brown, pelletal phosphatic chalks encountered.**	Not surveyed.
8,277	29779-PX506	Borehole not logged, as cored using open-hole drilling techniques.	Not logged.	Surveyed Depth: 2.3-43.6m bgl (41.2m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 65.2 / 22.9 / 11.7** **Discussion: Moderate to high response recorded.**
8,332	16175-R9	**Phosphatic nodules observed at 7.73m and 8.45m bgl, with possible phosphatic replaced shell fragments at 8.5m bgl.**	**1.8m bgl: phosphatic chalk burrow-fills.** **6.4m, 6.9m, 7.6m, 7.9m and 9.6m bgl: phosphatic pebble beds.**	Surveyed depth: 2.4-35.6m bgl (33.1m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 88.2 / 4.2 / 7.5** **Discussion: Moderate to high gamma response recorded. Concentrated fluctuations coincide with observations of phosphatic regions in logs.**
8,432	21762-R143	Only minimal descriptions are provided since the hole was formed by open-hole drilling.	Not logged.	**The results are not available but Halcrow-Gifford's Preliminary Geotechnical Report has discussed that phosphatic material has been inferred in this hole based on the natural gamma survey's API profile.**
8,496	21762-R138	Observations of very weak, low density, light brown, grey to white mottled Chalk. Phosphate not explicitly noted.	**10.4-14.3m bgl: coarse gritty, weakly phosphatic chalks.** **11.3-15.2m blg: phosphatised**	Surveyed depth: 0-34m bgl (34m). **Response in percentage surveyed depth, R0 /**

Hole Chainage (m)	Exploratory Hole ID	Factual Report Exploratory Hole Logs	Professor Mortimore's Log	Natural Gamma Survey
			inoceramid shell-fragments, pebble beds and very hard minerlaised ((calcite, calcium phosphate and iron) hardground. **16.8-17.2m bgl: strongly developed phosphate pebble bed.** **21.9m and 23.5m bgl: phosphate pebble beds.**	**R1 / R2 (%): 67.9 / 19.4 / 12.6** **Discussion: Moderate to high gamma response recorded.**
8,507	21762-R140	Only minimal descriptions are provided as the hole was formed by open-hole drilling.	Not logged.	Surveyed depth: 0-34m bgl (34m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 61.7 / 12 / 26.1** **Discussion: Moderate to high gamma response recorded.**
8,512	21762-R139	Only minimal descriptions are provided since the hole was formed by open-hole drilling.	Not logged.	Surveyed depth: 0-34m bgl (34m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 71.4 / 10.5 / 17.9** **Discussion: Moderate to high response recorded.**
8,518	21762-W137	Only minimal descriptions are provided since the hole was formed by open-hole drilling.	Not logged.	Surveyed depth: 0-40m bgl (40m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 75 / 8.7 / 16.2** **Discussion: Moderate to high gamma response recorded.**
8,526	17439-P1	**Log speculates the presence of potentially phosphatic chalk with occasional observation of brown sandy chalk with locally heavy orange staining.**	Not logged.	Surveyed depth: 2.5-36.7m bgl (34.2m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 44.7 / 41.8 / 13.4** **Discussion: Moderate to high gamma**

Hole Chainage (m)	Exploratory Hole ID	Factual Report Exploratory Hole Logs	Professor Mortimore's Log	Natural Gamma Survey
				response recorded.
8,566	21762-R141	Only minimal descriptions are provided since the hole was formed by open-hole drilling.	Not logged.	**The results are not available but Halcrow-Gifford's Preliminary Geotechnical Report has discussed that phosphatic material has been inferred in this hole based on the natural gamma survey's API profile.**
8,638	21762-R142	Observations of very weak to moderately strong low to medium density white, occasionally brown to light yellow stained chalk, with slight orange and yellow staining and black speckling.	**7.15-7.4m bgl: phosphatic chalk bed.** **11.3m bgl: scattered phosphatic grains and phosphatic burrow-fills.** **12.0-13.8m bgl: coarse gritty, weakly phosphatic chalks.** **13.8-26.5m bgl: coarse gritty, strongly developed dark brown phosphatic chalk.** **26.7-30.8m bgl: zone of conjugate jointing, paler stronger (medium density) chalk, coarse, sandy chalks, less concentrated phosphatic grains.** **36.0-36.5m bgl: phosphatised pebble of sponge fossils and inoceramid fragments.**	Surveyed depth: 1.6-44.7m bgl (43.1m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 66.3 / 7.8 / 25.7** **Discussion: Moderate to high gamma response recorded over depth.**
8,639	29779-R501	Occasional brown staining noted on structured chalk from 6.1m to 10.4m bgl. White (slightly) brown stained chalk observed between 10.4m and 13.7m bgl. **Phosphatic chalk identified from 13.7m onwards, with varying concentrations of phosphate present in pebble beds.**	**10.0-22.3m bgl: frequent findings of normal to richly phosphatic chalk and pebble beds.** **24.6m, 25.5m, 30.4m, 31.4m bgl: phosphatic chalk burrow-fills, fine to medium sand grade calcarenites (phosphatic chalk)**	Not surveyed.

Hole Chainage (m)	Exploratory Hole ID	Factual Report Exploratory Hole Logs	Professor Mortimore's Log	Natural Gamma Survey
			and pale to richly phosphatic chalk beds. **33.8-36.05m bgl: frequent findings of phosphatic and glauconitic pebble beds and phosphatic chalk filled burrows.**	
8,696	16175-R11	Chalk logged as "**weak medium bedded light brown silty fine to medium grained sandstone" between approximately 30m and 32m bgl,** with occasional orange brown staining noted on chalk at subsequent depths.	**11.1-11.4m bgl: coarse phosphatic chalk in burrow-fills, topmost phosphate bed.** **13.2-16.6m bgl: phopsphatic bed with glauconitic hardground and phosphatic pebble bed with pyrite at top.** **26.8-32.6m bgl: second main phosphatic bed.** **35.0-39.0m bgl: frequent findings of phosphate pebble beds.**	Surveyed depth: 1.1-45.6m bgl (44.4m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 25.9 / 40.7 / 33.3** **Discussion: Moderate to high gamma response recorded, with intermittent fluctuations.**
8,723	16175-R10	Areas of slight to heavy brown staining noted throughout depth of borehole, with occasional orange-brown and yellow brown staining and black speckling.	Not logged.	Not surveyed.
8,785	21762-R146	Observations of weak to moderately strong, low to high density white and cream chalk with brown and yellow staining and occasional black speckling.	**8.0-16.7m bgl: dark, crumbly, coarse, gritty phosphatic chalk 200mm thick interbedded with paler phosphates and abudant re-worked, phosphatised inoceramid shell debris.**	Surveyed depth: 1.8-43.2m bgl (41.4m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 88.1 / 7.7 / 4.1** **Discussion: Moderate to high gamma response, with slightly higher responses recorded at shallower depths.**
8,844	16175-R13	**Frequent brown staining and brown "phosphatic" nodules, along with occasional green glauconitic nodules, observed from ground level to**	**9.0-9.3m bgl: glauconitic and phosphatic hardground.** **12.3m, 15.7m, 17.7m and 18.6m**	Surveyed depth: 2.4-50.4m bgl (47.9m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 87.6 / 10.2 / 2**

Hole Chainage (m)	Exploratory Hole ID	Factual Report Exploratory Hole Logs	Professor Mortimore's Log	Natural Gamma Survey
		approximately 20.4m bgl.	**bgl: phosphatic pebbles.**	**Discussion: Moderate to high gamma response recorded over relatively shallow depths.**
8,867	16175-R12	**Chalk logged as "weak to very weak thinly bedded light brown (to brown) silty fine to medium grained sandstone" at points between 9.69m and 17.3m bgl. Pelletal phosphate chalk observed, as well as brown silty sand-filled discontinuities.**	**9.4-23.4m bgl: alternating pale to dark rich phosphatic beds and white chalk with phosphate-filled burrows.**	Not surveyed.
8,985	16175-R15A	**Occasional observations of brown silty chalk within structured strata, as well as a band of phosphatic hardground and phosphatic nodules to a depth of approximately 20m bgl.** Observations of brown and glauconitic staining are rare beyond this depth.	Not logged.	Surveyed depth: 2.4-46m bgl (43.5m). **Response in percentage surveyed depth, R0 / R1 / R2 (%): 69.2 / 25.9 / 4.8** **Discussion: Moderate to high gamma response recorded.**
9,030	21762-R149	Observations of weak to moderately weak, low to medium density white chalk with occasional yellow staining and black speckling.	Not logged.	Not surveyed.
9,080	21762-R152	Observations of structureless chalk composed of brown, mottled white, gravelly, slightly sandy silt or gravel sized clasts in a brown matrix.	Not logged.	Surveyed depth: 0.4-22.4m bgl (22m). Response in percentage surveyed depth, R0 / R1 / R2 (%): 100 / 0 / 0 Discussion: Background level response.
9,092	21762-DTP155C	Observed structureless chalk, composed of cream and pale brown, locally slightly silty, sandy, gravel and cobble size chalk clasts in a pale brown matrix.	No phosphatic materials encountered.	Not surveyed.
9,108	17439-P2	Cream to light brown matrix noted within structureless chalk between 2.7m and 5.96m bgl with rare patches of orange	Not logged.	Surveyed depth: 2.5-35.5m bgl (33m). Response in percentage surveyed depth, R0 /

Hole Chainage (m)	Exploratory Hole ID	Factual Report Exploratory Hole Logs	Professor Mortimore's Log	Natural Gamma Survey
		brown staining. Rare patches of light to heavy orange brown staining throughout greater depths.		R1 / R2 (%): 35.7 / 57.5 / 6.6 Discussion: Moderate to high gamma response recorded.
9,145	21762-R157A	A few observations of moderately weak, medium density white chalk with occasional brown and yellow staining with black speckling.	No phosphatic materials encountered.	Not surveyed.
9,149	16175-R16	Cream to light brown matrix noted within structureless chalk between 2.7m and 5.96m bgl with occasional yellow brown staining.	No phosphatic materials encountered.	Not surveyed.
9,173	21762-W148	Only minimal descriptions are provided since the hole was formed by open-hole drilling.	Not logged.	Surveyed depth: 0-25m bgl (25m). Response in percentage surveyed depth, R0 / R1 / R2 (%): 100 / 0 / 0 Discussion: Background level response.
9,173	21762-R153	Only minimal descriptions are provided since the hole was formed by open-hole drilling.	Not logged.	Surveyed Depth: 0-20m bgl (20m). Response in percentage surveyed depth, R0 / R1 / R2 (%): 84 / 16 / 0 Discussion: General background level response with elevated gamma responses within 3m from ground surface.
9,173	21762-R157	Occasional observations of slight brown staining on both structures and structureless chalk.	No phosphatic materials encountered.	Surveyed depth: 1.8-27.7m bgl (25.9m). Response in percentage surveyed depth, R0 / R1 / R2 (%): 100 / 0 / 0 Discussion: Background level response.
9,176	21762-R150	Only minimal descriptions are provided since the hole was formed by open-hole drilling.	Not logged.	Surveyed depth: 0-25m bgl (25m). Response in percentage surveyed depth, R0 / R1 / R2 (%): 83.6 / 16.4 / 0

Hole Chainage (m)	Exploratory Hole ID	Factual Report Exploratory Hole Logs	Professor Mortimore's Log	Natural Gamma Survey
				Discussion: General background level response with elevated gamma responses within 1m from ground surface.
9,178	21762-R151	Only minimal descriptions are provided since the hole was formed by open-hole drilling.	Not logged.	Surveyed depth: 0-20m bgl (20m). Response in percentage surveyed depth, R0 / R1 / R2 (%): 88 / 12 / 0 Discussion: General background level response with elevated gamma responses within 1m from ground.
9,209	21762-R154	Occasional observations of very weak to weak, low to medium density white chalk with moderate black speckling and slight grey and brown staining, however no phosphate inferred.	Not logged.	Surveyed depth: 1.5-32.1m bgl (30.6m). Response in percentage surveyed depth, R0 / R1 / R2 (%): 100 / 0 / 0 Discussion: Background level response.
9,282	16175-R18	Occasional brown staining observed in both structureless and structured chalk throughout borehole, however no phosphate inferred.	Not logged.	Surveyed depth: 2.4-50.5m bgl (48m). Response in percentage surveyed depth, R0 / R1 / R2 (%): 100 / 0 / 0 Discussion: Background level response.
9,478	16175-R19A	Rare brown staining observed, however no phosphate inferred.	Not logged.	Surveyed depth: 2.4-44.6m bgl (42.1m). Response in percentage surveyed septh, R0 / R1 / R2 (%): 100 / 0 / 0 Discussion: Background level response.
9,631	16175-R20	Very rare brown and orange-brown staining at shallow depths.	Not logged.	Surveyed depth: 2.4-34.5m bgl (32m). Response in percentage surveyed depth, R0 / R1 / R2 (%): 41.5 / 52.4 / 5.9 Discussion: Moderate to high gamma response recorded.

Hole Chainage (m)	Exploratory Hole ID	Factual Report Exploratory Hole Logs	Professor Mortimore's Log	Natural Gamma Survey
10,096	21762-R158	Occasional and slight black speckling and brown staining observed throughout borehole log.	No phosphatic materials encountered.	Surveyed depth: 0.6-49.4m bgl (48.8m). Response in Percentage Surveyed Depth, R0 / R1 / R2 (%): 100 / 0 / 0 Discussion: Background level response.
10,497	29779-R507A	Occasional brown staining observed in chalk throughout borehole.	Not logged.	Surveyed depth: 2.4-36.5m bgl (34.1m). Response in percentage surveyed depth, R0 / R1 / R2 (%): 94.6 / 5.3 / 0 Discussion: Moderate gamma response recorded.

4.2.88 Typical depths, reduced levels and thicknesses of interpreted formations within the White Chalk subgroup are summarised in Table 5-4.

Table 5-4 Ranges of Chalk Formation Depths, Levels and Thicknesses (Within 250m Chainage Offset Limit)

Route Segment	Route Segment Chainage (m)	Number of Exploratory Holes	Encountered Hole Chainage (m)	Chalk Formation	Chalk Grades (CIRIA)	Depth to Top (m bgl)	Level to Top (m AOD)	Thickness (m) (1)	Remarks
Berwick Down to River Till	0 - 3,950	44	1,193 – 3,877	Structureless (undifferentiated formation)	Grade Dm	0.0 - 2.0	74.9 - 127.4	0.50 - 2.20	/
					Grade Dc	0.0 – 4.4	75.1 – 139.7	0.20 – 8.90	
			1,193 – 3,877	Structured Chalk (undifferentiated formation)	Grade C (3 – 5) Grade B (3 – 5) Grade A (1 – 5)	0.2 - 9.6	66.4 - 139.2	0.40 – (19.15)	/
River Till	3,950 - 4,200	7	3,963 – 4,159	Structureless Chalk (undifferentiated formation)	Grade Dm	4.7	68.3	4.20	/
					Grade Dc	2.9 – 4.7	68.3 – 70.0	3.00 –	

Route Segment	Route Segment Chainage (m)	Number of Exploratory Holes	Encountered Hole Chainage (m)	Chalk Formation	Chalk Grades (CIRIA)	Depth to Top (m bgl)	Level to Top (m AOD)	Thickness (m) (1)	Remarks
								4.20	
			3,963 – 4,171	Structured Chalk (undifferentiated formation)	Grade C (3 and 4) Grade B (3 and 4) Grade A (1 – 3)	0.0 - 6.0	65.7 - 71.7	13.00 – (20.00)	Chalk grade A2 logged as overlying grade A3 in borehole 21762-R122.
River Till to Proposed Tunnel	4,200 - 7,400	51	4,264 – 7,349	Structureless Chalk (undifferentiated formation)	Grade Dm	0.0 and 2.4	94.2 and 109.8	0.45 and 1.10	/
					Grade Dc	0.0 – 3.9	69.5 – 110.9	0.10 – 3.05	
			4,264 – 7,349	Structured Chalk (undifferentiated formation)	Grade C (3 – 5) Grade B (3 – 5) Grade A (2 – 4)	0.0 - 6.1	67.3 - 110.9	0.20 – (15.70)	/
Proposed Tunnel	7,400 - 10,400	94	7,449 – 10,391	Structureless Chalk (undifferentiated formation)	Grade Dm	0.0 – 21.7	61.8 – 106.7	0.50 – 2.6	/
					Grade Dc	0.0 – 21.7	61.8 – 110.1	0.30 – 5.80	
			7,449 – 10,391	Structured Chalk (undifferentiated formation)	Grade C (2 – 5) Grade B (1 – 5) Grade A (1 – 5)	0.0 - 8.5	71.2 - 109.8	0.25 – (50.37)	
			8,332 – 9,631	Newhaven Chalk Formation – Structureless	Grade Dm	0.2 – 0.6	90.8 – 93.6	(0.05) – (0.50)	/
					Grade Dc	0.2 – 5.2	78.4 – 103.2	(0.15) – (1.09)	
			8,332 – 9,631	Newhaven Chalk Formation – Structured	Grade C (2 – 5) Grade B (2 – 5)	0.5 – 3.2	77.9 – 102.1	(0.25) – (23.00)	Phosphatic Chalk interbedded within Newhaven Chalk Formation

Route Segment	Route Segment Chainage (m)	Number of Exploratory Holes	Encountered Hole Chainage (m)	Chalk Formation	Chalk Grades (CIRIA)	Depth to Top (m bgl)	Level to Top (m AOD)	Thickness (m) (1)	Remarks
					Grade A2				
			8,332 – 9,030	Seaford Chalk Formation – Structureless	Grade Dm	0.3 and 0.5	78.3 and 82.5	(0.25) and (0.50)	/
					Grade Dc	0.1 – 0.8	79.4 – 80.5	(0.45) – (0.95)	
			8,332 – 9,030	Seaford Chalk Formation – Structured	Grade C3 Grade B (2 – 4) Grade A (2 and 3)	4.0 – 23.0	62.1 – 98.9	(0.6) – (47.0)	Thin strata due to interbedded nature of phosphatic Chalk
			8,332 – 9,030	Potential phosphatic Chalk	Grade C (2 – 4) Grade B (2 – 4) Grade A (3 and 5)	1.8 - 43.6	47.2 - 97.6	2.37 - 34.6	Phosphatic Chalk interbedded within both Newhaven Chalk Formation and Seaford Chalk Formation
Section to the East of Proposed Tunnel	10,400 - 12,569	63	10,497 – 12,055	Structureless Chalk (undifferentiated formation)	Grade Dm	1.7 – 6.1	59.5– 69.9	0.60 – 9.70	/
					Grade Dc	0.3 – 6.0	59.1 – 94.6	0.25 – 7.95	/
			10,438 – 12,407	Structured Chalk (undifferentiated formation)	Grade C3 Grade B (2 – 4) Grade A (2 – 4)	0.0 - 15.2	56.1 - 97.1	0.45 – (35.20)	/
			10,497 – 10,497	Seaford Chalk Formation – Structureless	Grade Dm	0.2	92.1	0.3	/
					Grade Dc	0.5	91.8	(0.5)	Grade Dc logged between grade Dm strata and grade C4 strata.
			10,497 – 10,497	Seaford Chalk Formation – Structured	Grade C (2 – 4) Grade B4	1.3	91.0	(35.2)	Seaford Chalk Formation logged in borehole 29779-R507A.

Route Segment	Route Segment Chainage (m)	Number of Exploratory Holes	Encountered Hole Chainage (m)	Chalk Formation	Chalk Grades (CIRIA)	Depth to Top (m bgl)	Level to Top (m AOD)	Thickness (m) [1]	Remarks
									Grade B4 logged between grade C3 strata.
			/	Potential phosphatic Chalk	/	/	/	/	Not encountered.

Notes: [1] Values in brackets '( )' denotes the full stratum thickness was not proven.

Flint

4.2.89 Occurrences and bands of flint have been observed in exploratory holes throughout the entirety of the Preferred Route and in all Chalk formations. However, constrictions associated with boreholes due to their limited diameter can prohibit the detailed interpretation of larger flints and their lateral spatial distribution, and the interpretation of size and type should be conducted with caution. The following types of flint have been identified:
a) Cobbles and boulders of flint;
b) Nodular flint;
c) Tabular flint;
d) Tubular flint;
e) Sheet flint.

4.2.90 Vertical spacing between encountered flints is typically variable, ranging between 0.1m and 4.0m. The PSSR [1] suggests that vertical spacing is typically 1m, associated with bedding partings.

4.2.91 Zones of core loss have occasionally been attributed to the possible presence of flint. However, the presence and possible size and type of flints cannot be determined with confidence on this evidence alone.

4.2.92 Boulders of flint have been identified and interpreted as being up to and, in some cases, greater than 600mm in diameter. An example is borehole 16175-R7 (chainage 8000) at 6.1m bgl (100.3m AOD) where a sub-rounded boulder of flint (600mm) was logged.

4.2.93 The PSSR [1] states that the flint nodules are typically between 100mm and 200mm diameter. Nodular flints have been identified in the 2017 EP GI in boreholes 29779-P502B, P505 and R507A, with diameters of up to 80mm within both the Seaford Chalk Formation and the phosphatic Chalk.

4.2.94 Tabular flints have been encountered, as stated in the PSSR. The PSSR states that encountered tabular flints are between 20mm to 40mm thick. However, it has been noted in exploratory holes that thicknesses could be up to and greater than 600mm where tabular flints have been observed together with cobbles and boulders of flint (within grade B3 undifferentiated Structured Chalk in trial pit 16175-DTP28).

4.2.95 Tubular flint has been identified in the 2017 EP GI at depths up to 40.5m bgl (in borehole 29779-P502B). The maximum logged length of tubular flint is 140mm (2.14m bgl in borehole 29779-R503B). In some cases these are recovered as fractured, and it is unclear from logs whether or not tubular flints are infilled.

4.2.96 Sheet flint has been observed throughout the length of the Preferred Route and at varying depths within undifferentiated structureless and structured Chalk, Newhaven Chalk Formation, Seaford Chalk Formation and phosphatic Chalk. Thicknesses range between 10mm and 120mm.

4.2.97 The PSSR suggests that flints are largely absent from the phosphatic Chalk. However, flint nodules have been logged in boreholes 29779-P502B, P505 and R501 in the 2017 EP investigation, and flint bands and nodules have been logged at approximately 1m to 2m vertical spacing by both the GI contractor and Professor Rory Mortimore in borehole 16175-R11.

Dissolution Features

4.2.98 Potential dissolution features are discussed in the PSSR and in previous reports by Halcrow-Gifford and Balfour Beatty-Costain [37] [47]. Existing ground investigations and reports show little evidence for dissolution features in the vicinity of the Preferred Route. In trial pit 21762-STP120, between 0.8m and 3.4m bgl, the exploratory hole description adds that the granular Head Deposits include a “solution pipe feature infilled with dark brown sandy silt”.

4.2.99 Halcrow-Gifford [37] reported apparent occurrences of both open and collapsed voids within the interpreted structured phosphatic Chalk. However, evidence of such was inconclusive.

4.2.100 Minor, small scale dissolution features have been reported in the PSSR [1] and the Halcrow-Gifford [37] report, however observations are based on trial pit observations and geophysical survey responses.

4.2.101 Despite there currently being little evidence for the presence of dissolution features, the possible influence of dissolution features cannot be discounted.

4.3 Hydrology

4.3.1 Regional hydrological features are discussed in the PSSR [1]. Nearly all flow in the River Avon at Amersbury is derived from ground water discharging from the chalk aquifer. The fluvial sub-catchment of the River Till is a groundwater catchment containing no surface water flows at all. The Stonehenge catchment drains to the Avon through the dry valley of Stonehenge Bottom.

4.3.2 The most notable springs are identified at the following locations:

a) West Amesbury on the west bank of the Avon (relatively low flow during AmW site walkover on 20th July 2017 (Appendix B);
b) Springbottom Farm (at times of peak seasonal groundwater levels only);
c) The pond at Lake with outflow to the Avon (seasonal);
d) Springs feeding the River Till upstream of Berwick St James.

4.3.3 Flood zone maps for the Avon and Till valleys are presented in the PSSR.

4.4 Hydrogeology

Background

4.4.1 Groundwater conditions at Stonehenge Bottom and in the vicinity have been interpreted from the findings of groundwater monitoring carried out in the study area between 2001 and 2006 and more recently starting in April 2017.

4.4.2 The Preferred Route traverses the Chalk Group bedrock outcrop which is classified by the Environment Agency (EA) as a Principal Aquifer and in the study area supports private and public water supply and base flow within rivers. The alluvium and head deposits presents in the river valleys crossing the scheme are classified as Secondary A aquifers. These are capable of supporting water supplies at local scale and can form an important source of base flow to rivers.

4.4.3 Although the Chalk matrix is a highly porous medium, its intrinsic permeability is very low. The main aquifer groundwater flow characteristics are derived as a consequence of the fracture distribution, which provide secondary permeability for groundwater flow. The majority of the groundwater flows in the Chalk occurs in the upper layers of the Chalk where the natural seasonal water fluctuation has enhanced the fracture distribution. The most important flow zone is found within the top 50m of the aquifer (Allen and al., 1997) [48]. Topography also controls transmissivity in the area with high transmissivity occurring within valleys and decreasing towards the interfluves.

4.4.4 Alluvium and River Terrace Deposits are likely to have high intergranular permeability facilitating groundwater flow.

Groundwater Abstractions and Source Protection Zones

4.4.5 Thirty one licensed abstractions are located in the study area and twenty private water supplies (PWS) are registered with Wiltshire Council of which three are licensed with the EA. It is not compulsory to register abstractions of less than $20m^3/d$, and therefore the local authority register might be incomplete and other abstractions targeting the Chalk aquifer might be present within the study area.

4.4.6 Enquiries have been made to the Ministry of Defence (MOD) as their abstractions are exempt of licence. Although the location of their supplies could not be shared it is believed that there are several water supply sources in the study area near Larkhill and Bulford Camp to the north of the scheme.

4.4.7 The proposed scheme does not cross any Source Protection Zone (SPZ). However several SPZs are located within the Salisbury Plain; six are within 5km of the Preferred Route and are associated with public water supply abstracting groundwater from sources near Shrewton, Durrington, Bulford (2), Wylie and Little Dunford.

4.4.8 Groundwater abstractions and SPZ are presented in Figure 5-10.

Groundwater Level and Flow

4.4.9 Groundwater monitoring data from ground investigation boreholes installed in 2001 near the tunnel section of the proposed mainline alignment covers the 2001-2006 period. Additional groundwater level monitoring boreholes were installed in 2017. Telemetry monitoring started in the additional groundwater level monitoring boreholes from April 2017 and is currently ongoing. Additional long term groundwater level data is available from EA monitoring boreholes. The location of groundwater monitoring boreholes is presented in Figure 5-11.

4.4.10 Table 5-5 below summarises the groundwater level data available from the ground investigation piezometers.

Table 5-5 Piezometer Summary Table

Borehole ID	Easting	Northing	Ground Level (m AOD)	Borehole Depth (m bgl)	Screened Section / response Zone (m bgl)	Data record	Type of Data
Historic							
16174-CP1	407995	141727	75.30	20.00	1-4	21/09/2001 – 01/05/2003	Manual dips
16174-CP2	408152	141665	73.30	20.00	1-4	21/09/2001 – 01/05/2003	Manual dips
16174-CP3A	408273	141623	73.38	20.00	5-20	21/09/2001 – 01/05/2003	Manual dips
16174-CP4	407773	141490	71.40	20.00	3-20	21/09/2001 – 01/05/2003	Manual dips
16174-CP5	407914	141485	73.38	20.00	1-20	21/09/2001 – 01/05/2003	Manual dips
W1	N/A	N/A	N/A	50.6	5-50.6	21/09/2001 – 06/06/2006	Manual dips + Logger
17439-P1	412166	141910	96.12	35.0	30-35	09/03/2001 – 06/06/2006	Manual dips + Logger
17439-P2	412739	142040	80.88	35.0	30-35	09/03/2001 – 20/12/2004	Manual dips + Logger
17439-P3	413445	141975	109.48	31.3	26-30	03/12/2000 – 01/05/2003	Manual dips
16174-R1	406655	141067	119.90	20.0	2-19.5	21/09/2001 – 01/05/2003	Manual dips
16174-R2	406791	141230	107.00	20.0	2-20	21/09/2001 – 01/05/2003	Manual dips
16174-R3	408774	141319	97.60	15.2	2-15	21/09/2001 – 01/05/2003	Manual dips
16175-R7	411653	141782	106.40	29.6	25-29.6	20/03/2001 – 01/05/2003	Manual dips
16175-R9	411978	141861	99.40	35.4	30-35	20/03/2001 – 01/05/2003	Manual dips
16175-R10	412356	141968	94.40	25.4	20-25	07/03/2001 – 01/05/2003	Manual dips
16175-R11	412349	141863	92.90	45.7	16-45.7	09/03/2001 – 01/05/2003	Manual dips
16175-R13	412493	141887	93.10	50.0	16.8-50	26/04/2001 – 01/05/2003	Manual dips
16175-R15A	412631	141899	90.80	46.0	17.8-44.2	26/04/2001 – 01/05/2003	Manual dips
16175-R16	412792	141906	79.50	36.0	33-36	15/03/2001 – 01/05/2003	Manual dips
16175-R18	412924	141917	96.50	51.0	20-51	14/03/2001 – 01/05/2003	Manual dips
16175-R19A	413115	141992	106.33	45.0	42-45	13/03/2001 – 01/05/2003	Manual dips
16175-R20	413272	141943	103.90	35.0	33-35	15/03/2001 – 01/05/2003	Manual dips
16175-R21	413588	141959	109.90	26.2	22-25	26/03/2001 – 01/05/2003	Manual dips
16175-R22	413770	141964	106.10	20.9	17.9-20.9	07/03/2001 – 01/05/2003	Manual dips
21762-R121	407444	141408	76.01	15.10	5-9	21/01/2003 – 01/05/2003	Manual dips

Borehole ID	Easting	Northing	Ground Level (m AOD)	Borehole Depth (m bgl)	Screened Section / response Zone (m bgl)	Data record	Type of Data
21762-R122	4077045	141490	72.93	20.50	2-20.2	19/12/2002 – 01/05/2003	Manual dips
21762-R123	407752	141501	71.71	20.00	2-20	21/01/2003 – 01/05/2003	Manual dips
21762-R124	407834	141484	71.72	20.10	2-20	21/01/2003 – 01/05/2003	Manual dips
21762-R126	407883	141362	72.93	15.00	5-9	19/12/2002 – 01/05/2003	Manual dips
21762-R138B	412171	141872	94.91	38.00	2-34	19/12/2002 – 01/05/2003	Manual dips
21762-R142	412291	141863	92.94	45.00	2-42	19/12/2002 – 01/05/2003	Manual dips
21762-R146	412431	141905	93.50	45.00	2-45	19/12/2002 – 01/05/2003	Manual dips
21762-R149	412674	141915	88.48	28.45	10-28	19/12/2002 – 01/05/2003	Manual dips
21762-R151	412823	141877	79.39	20.00	2-20	19/12/2002 – 01/05/2003	Manual dips
21762-R152	412723	141922	83.48	23.00	2-23	21/01/2003 – 01/05/2003	Manual dips
21762-R153	412829	141738	79.09	20.00	2-20	19/12/2002 – 01/05/2003	Manual dips
21762-R154	412850	141926	88.21	32.41	2-32	19/12/2002 – 01/05/2003	Manual dips
21762-R157	412813	141941	79.67	28.00	10-28	19/12/2002 – 01/05/2003	Manual dips
21762-R158	413736	141972	107.3	50.0	2-50	25/11/2002– 06/06/2006 and 26/09/2016 - now	Manual dips + Logger
21762-CP163	415043	142087	70.17	12.38	2-12.38	19/12/2002 – 01/05/2003	Manual dips
21762-R165	415065	142045	71.48	15.00	7-11	19/12/2002 – 01/05/2003	Manual dips
21762-R167	415461	142028	71.07	20.05	7-11	19/12/2002 – 01/05/2003	Manual dips
21762-CP168	415652	142158	69.91	12.85	2-12.4	19/12/2002 – 01/05/2003	Manual dips
21762-R172	412763	141131	76.48	30.10	2-30.1	19/12/2002 – 01/05/2003	Manual dips
2017 EP Ground Investigation							
29779-PX505A	411760	141449	99.54	43.0	7-43	26/04/2017 - now	Logger + manual dips
29779-PX506	411996	141524	92.86	43.0	6-43	26/04/2017 - now	Logger + manual dips
29779-R503B	411430	141309	104.28	47.0	9-47	27/04/2017 - 13/07/2017	Logger + manual dips
29779-R507A	414131	142074	92.33	35.0	8-35	26/04/2017 - 22/06/2017	Logger + manual dips
29779-RX506	411801	144879	115.23	55.0	21-55	26/04/2017 - 02/08/2017	Logger + manual dips

Borehole ID	Easting	Northing	Ground Level (m AOD)	Borehole Depth (m bgl)	Screened Section / response Zone (m bgl)	Data record	Type of Data
29779-RX507A	413406	144155	108.37	48.0	18-48	26/04/2017 - 21/06/2017	Logger + manual dips
29779-RX508A	412382	143169	90.31	31.0	4-31	26/04/2017 - 27/06/2017	Logger + manual dips
29779-RX509	411350	142606	104.87	46.0	7-46	26/04/2017 - 23/07/2017	Logger + manual dips
29779-RX510A	413521	142782	109.22	50.0	22-50	26/04/2017 - 18/09/2017	Logger + manual dips
29779-RX511B	407785	140990	70.71	8.0	4-8	26/04/2017 - 09/07/217	Logger + manual dips
29779-RX512A	408957	142058	82.34	22.0	4-22	26/04/2017 – 23/09/2017	Logger + manual dips
29779-RX513A	412355	140025	70.57	20.0	4-20	None	Logger + manual dips
29779-RX514A	410690	138027	115.71	62.0	33-62	26/04/2017 - 08/06/2017	Logger + manual dips
29779-RX515A	408603	138877	131.94	77.0	52-77	14/06/2017 - 15/06/2017	Logger + manual dips

4.4.11 Data collected between 2001 and 2006 is presented in Figure 5-1. Data collected in 2017 is presented in Figure 5-2 below. Data from the 2017 telemetry is presented in Appendix C. Some gaps are presents due recording failures from the telemetry system.

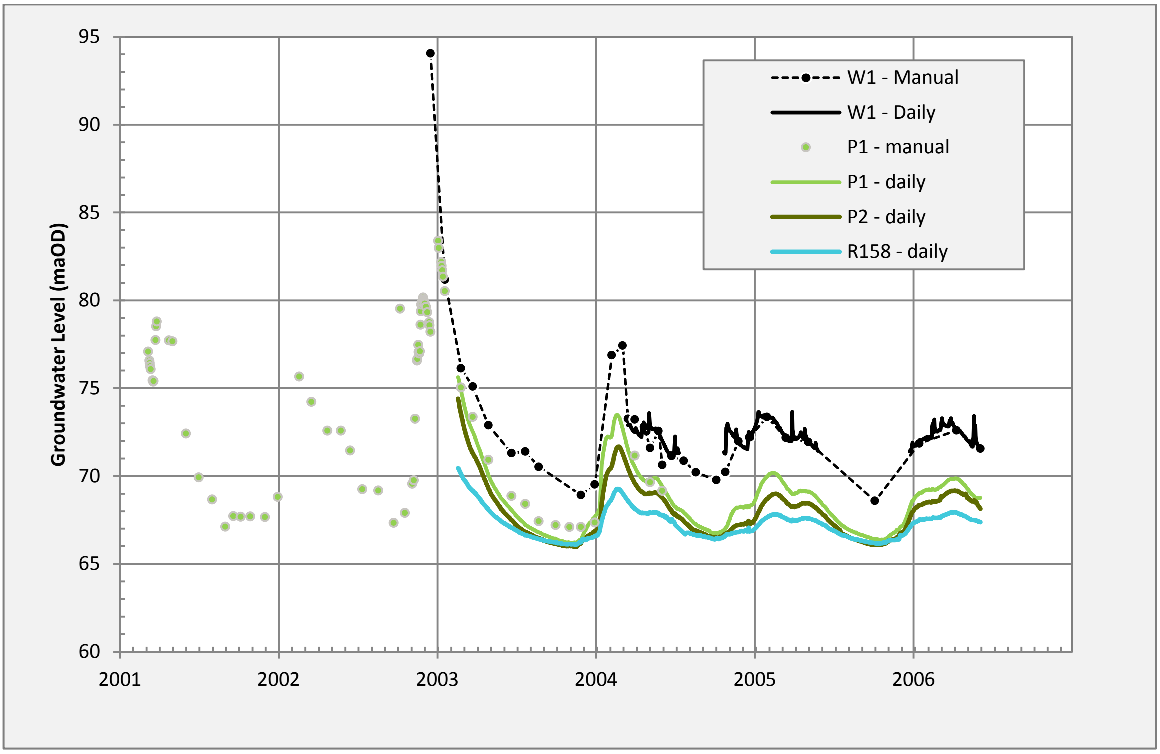

Figure 5-1 Hydrograph – Historic Boreholes

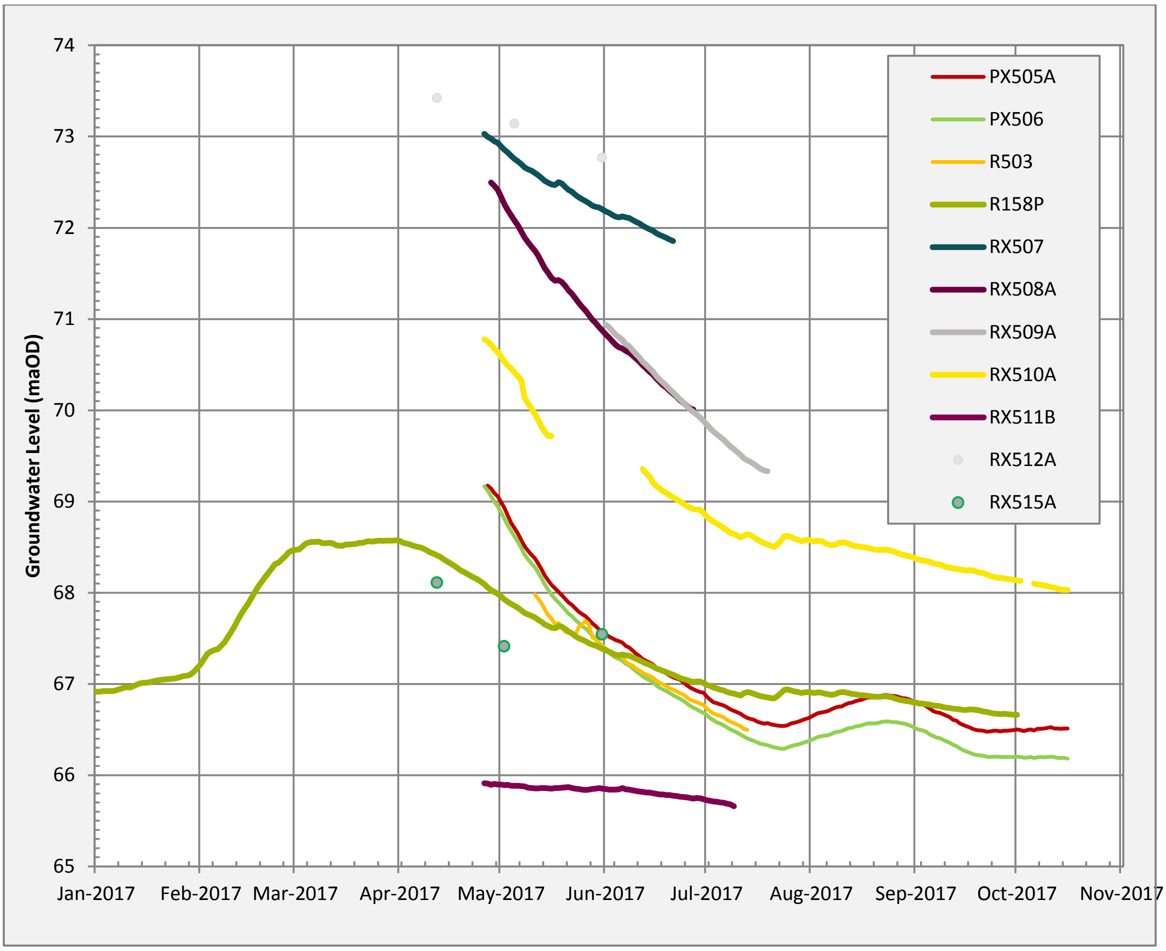

Figure 5-2 Hydrograph – 2017 Boreholes

4.4.12 Note that level data from the loggers from 29779-RX506, RX507A, RX514A are considered to be incorrect (unexplained high levels or noisy data) and are not illustrated on the combined hydrograph, but may be found in Appendix C.

4.4.13 Data from the Environment Agency was also consulted and water level from the closest boreholes to the scheme and the corresponding hydrographs are presented in Figure 5-4 and Figure 5-5. Figure 5-3 illustrates the high fluctuation in the interfluve areas.

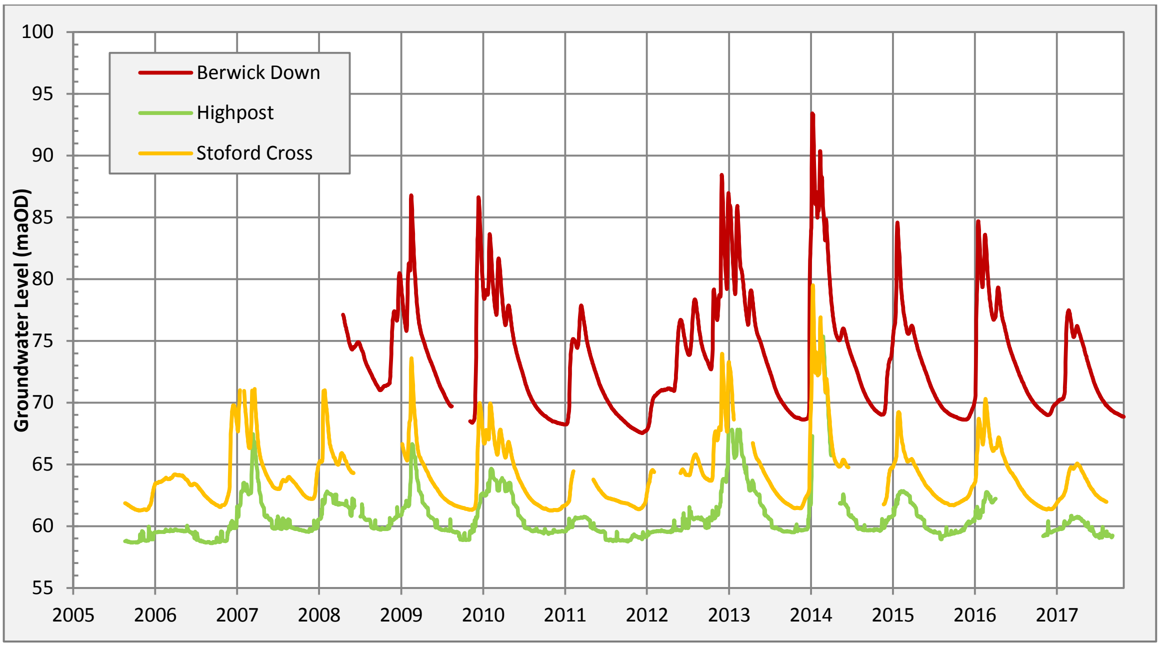

Figure 5-3 Environment Agency Groundwater Level Monitoring – Interfluve locations

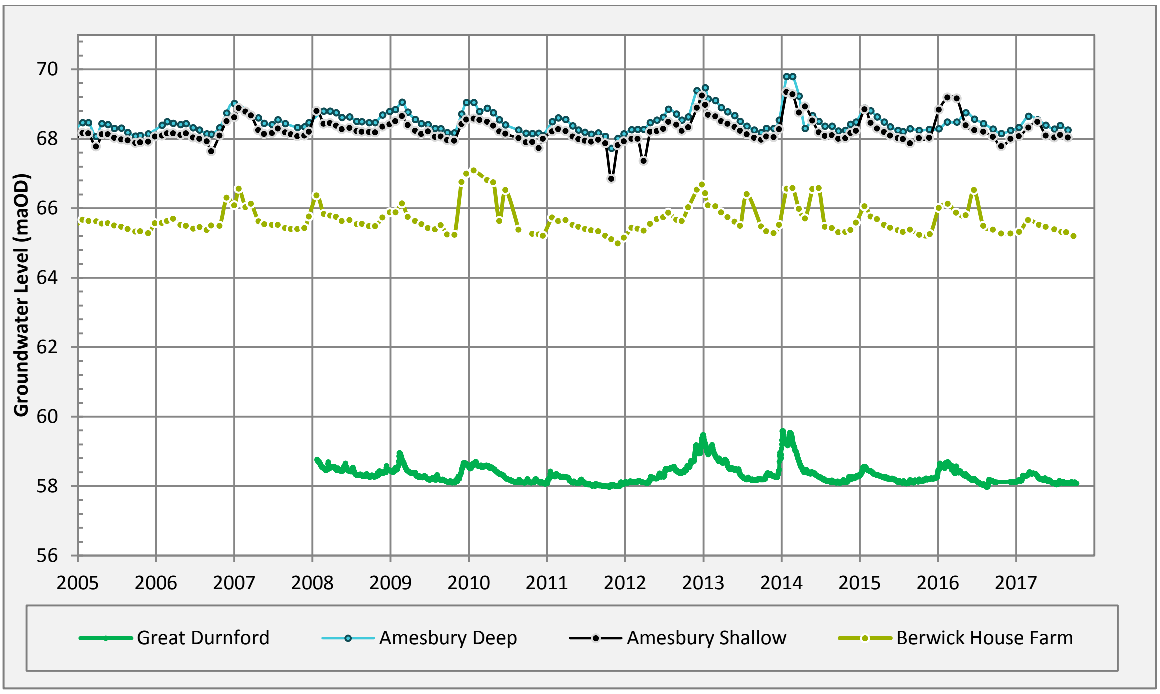

Figure 5-4 Environment Agency Groundwater Level Monitoring – Valley locations

4.4.14 Groundwater levels in the Chalk are controlled by recharge from rainfall infiltration and by natural discharge to the rivers Avon and Till resulting in natural seasonal variations of between 8m and 10m beneath the dry valleys and about 15m below the topographic divide.

4.4.15 The long term monitoring data shows that groundwater levels in the Chalk aquifer respond rapidly to recharge events at the surface due to a low storage capacity, and significant changes in groundwater level can occur over short periods of time. Annual fluctuations shown in the Environment Agency borehole at Berwick Down are between approximately 6m and 25m, with rapid rises in excess of 10m occurring over approximately one month as shown in Figure 5-3.

4.4.16 The seasonal fluctuations tend to be smaller in the dry valleys than below topographic divides as the specific yield is usually greater beneath dry valley systems than in the interfluve areas.

4.4.17 Groundwater is known to rise to the surface in otherwise dry valleys during periods of high rainfall, including in Stonehenge Bottom (80m AOD near 17439-P2) and the River Till north of Berwick St James.

4.4.18 Groundwater in the Chalk aquifer generally flows in a north to south direction (with groundwater flow divides in the eastern and western margins of the study area) and discharges naturally as baseflow to the rivers Avon and Till. Localised flow occurs within the dry valleys in the Chalk landscape, where preferential pathways are formed as more permeable zones exist. The dry valleys, such as Stonehenge Bottom, are corridors where the majority of the flow occurs beneath the surface and occasionally partially above surface when groundwater levels are particularly high.

4.4.19 A sub-catchment groundwater divide exists between the Stonehenge Bottom dry valley, which joins the Avon at Lake, and a second dry valley to the east marked by Coneybury Hill which joins the Avon at West Amesbury. There are also north-south trending dry valleys to the east of Coneybury Hill, and above the existing A303 to the north of the Blick Mead area.

4.4.20 The maximum groundwater flows will occur after periods of rainfall recharge when groundwater levels are at their highest in late winter to early spring. Low flows generally occur in autumn.

4.4.21 Throughput in Stonehenge Bottom has been estimated between 1Ml/d and 19Ml/d and could reach 30Ml/d during an extreme recharge event (Halcrow, 2006).

4.4.22 **Berwick Down to River Till Viaduct (Chainage 0 to 3950)**

4.4.23 There is a reference monitoring borehole (EA Berwick Down A303 Borehole - SU 053 404) between Berwick Down and the proposed River Till viaduct. Groundwater level data is available from November 2002 until present and shows that fluctuations up to around 25m can be seen within three weeks (winter 2013-14) as illustrated in Figure 5-5.

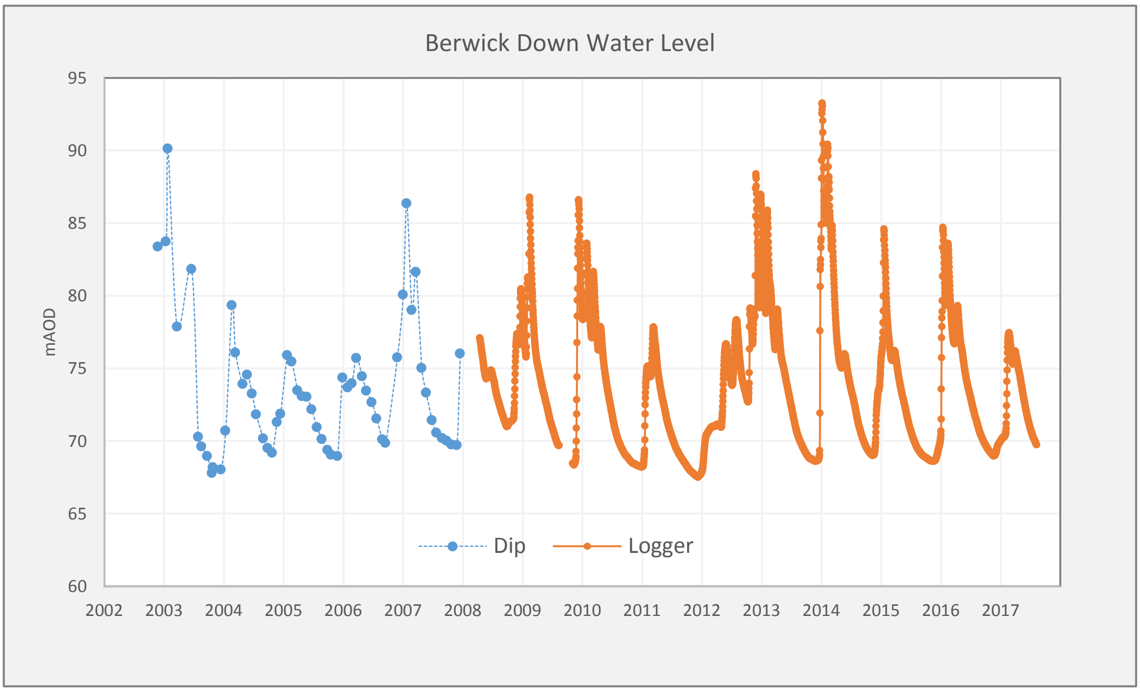

Figure 5-5 Berwick Down Water Levels

River Till Viaduct (Chainage 3950 to 4200)

4.4.24 The River Till is known to be a winterbourne and groundwater levels will be close to ground level in the wetter months. Groundwater levels at Manor Farm Winterbourne Stoke EA borehole, which is about 350m downstream of the proposed route, fluctuated between 68.4m AOD and 72.2m AOD between March 1991 and July 2004 with a median value of 70.3m AOD. The corresponding hydrograph is presented in Figure 5-6 below.

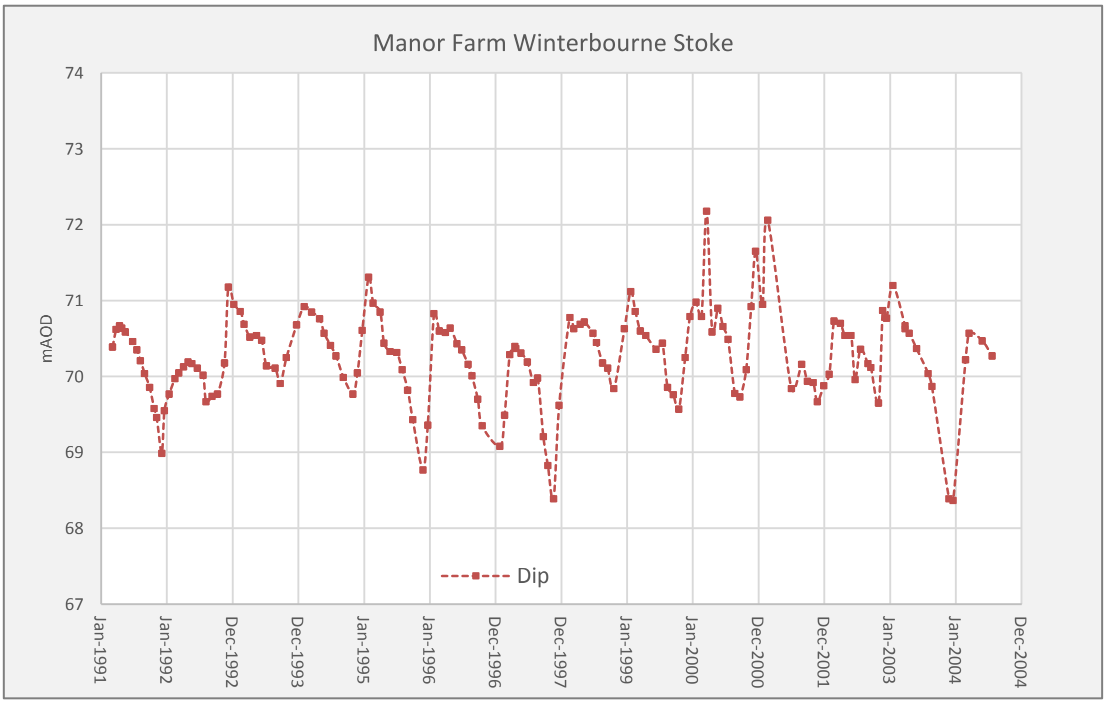

Figure 5-6 Manor Farm Winterbourne Stoke Water Levels

River Till Viaduct to A360 junction to Longbarrow (Chainage 4200 to 5200)

4.4.25 There are no monitoring boreholes along this section between the River Till and Long Barrow junction. The closest historical investigation borehole is 16174-R3 and was dry when water levels measurements were taken during September 2001 to May 2003.

A360 Junction to Longbarrow to Western Tunnel Entrance (Chainage 5200 to 7200)

4.4.26 The Longbarrow roundabout is located on the topographic divide between the valleys of the Till and the Avon. The western tunnel entrance is located approximately half way between boreholes W1 and 17439-P1.

4.4.27 Borehole W1, located on the southeast side of the existing roundabout, was drilled in July 2001 and was used to collect groundwater levels from September 2001 to June 2006. 17439-P1 was drilled in winter 2000 and groundwater levels were collected between March 2001 and June 2006. Data shows rapid high fluctuations (Figure 5-1). The maximum groundwater level recorded during that period at W1 was a dipped level of 94m AOD in December 2002. This value is unique and isolated from other measurement so its validity could be questioned. The maximum groundwater level recorded during that period at P1 was a dipped level of 83.4m AOD in January 2003.

4.4.28 It should be noted that the existing monitoring data does not cover years where extreme rainfall occurred (in the area 2001, 2013 and 2014 were extremely wet years).

Western Tunnel Portal (Chainage 7200 to 7500)

4.4.29 There are no monitoring boreholes near the proposed Western Tunnel Portal. The nearest historical investigation borehole is 16175-R7. Water level measurements were taken at regular intervals during the field investigation between March 2001 and May 2003.

Proposed Tunnel Section (Chainage 7500 to 10400)

4.4.30 Standpipe piezometers were installed in boreholes 16175-R7, R9, R10, R11, R13, R15A, R16, R18, R19A, R20, R21 and R22 and water level monitored frequently during the 2001 site work (manual dip). The data has been used to show the profile of the water table along the proposed tunnel alignment and is shown on Figure 5-7 below. Although water levels will fluctuate seasonally the graph gives an idea of the relative gradient along the section.

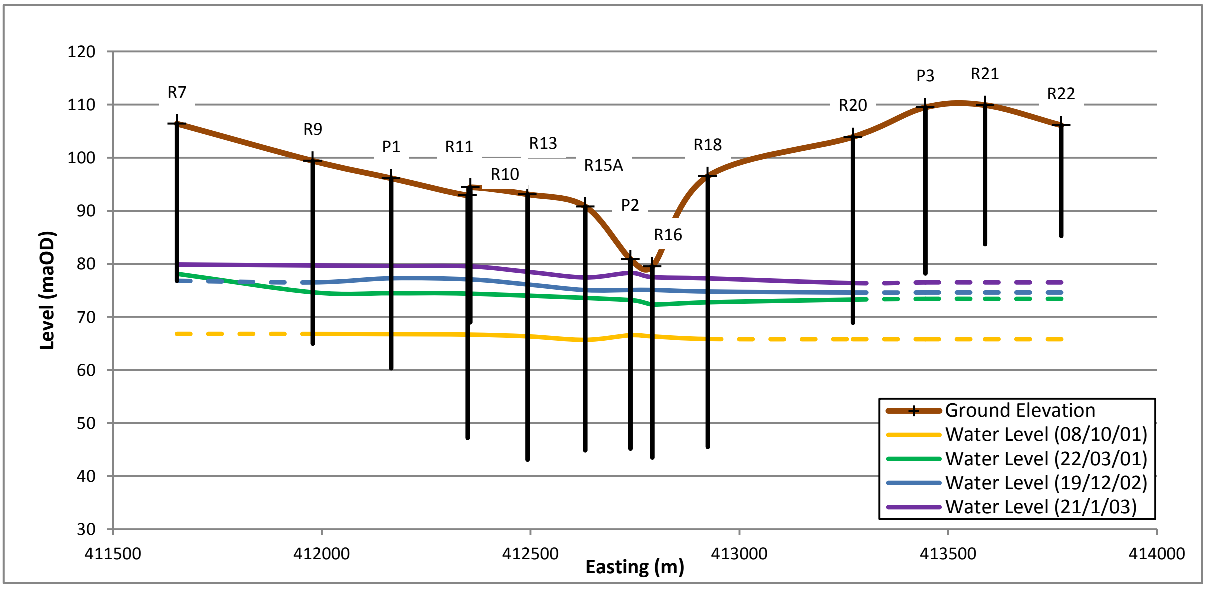

Figure 5-7 Groundwater Along Proposed Tunnel Alignment (2001)

Note that the dashed line represents extrapolated levels. These are historic levels and do not represent extreme events.

4.4.31 The results of the packer tests suggested that there are three vertical zones of permeability in the vicinity of the proposed tunnel [37] as shown in Figure 5-8:

a) Low: <1m/d (<1 x 10^{-5} m/s)
b) Moderate: 1 to 30 m/d (1 x 10^{-5} to 3 x10^{-4} m/s)
c) High: >100 m/d (>1 x 10^{-3} m/s)

4.4.32 The three zones are present beneath Stonehenge Bottom with the junction between the High to Moderate and Moderate to Low profiles at approximately 70m AOD and 52.5m AOD respectively. The effective base of the aquifer is delimited by the base of the Moderate permeability zone at 52.5m AOD [36].

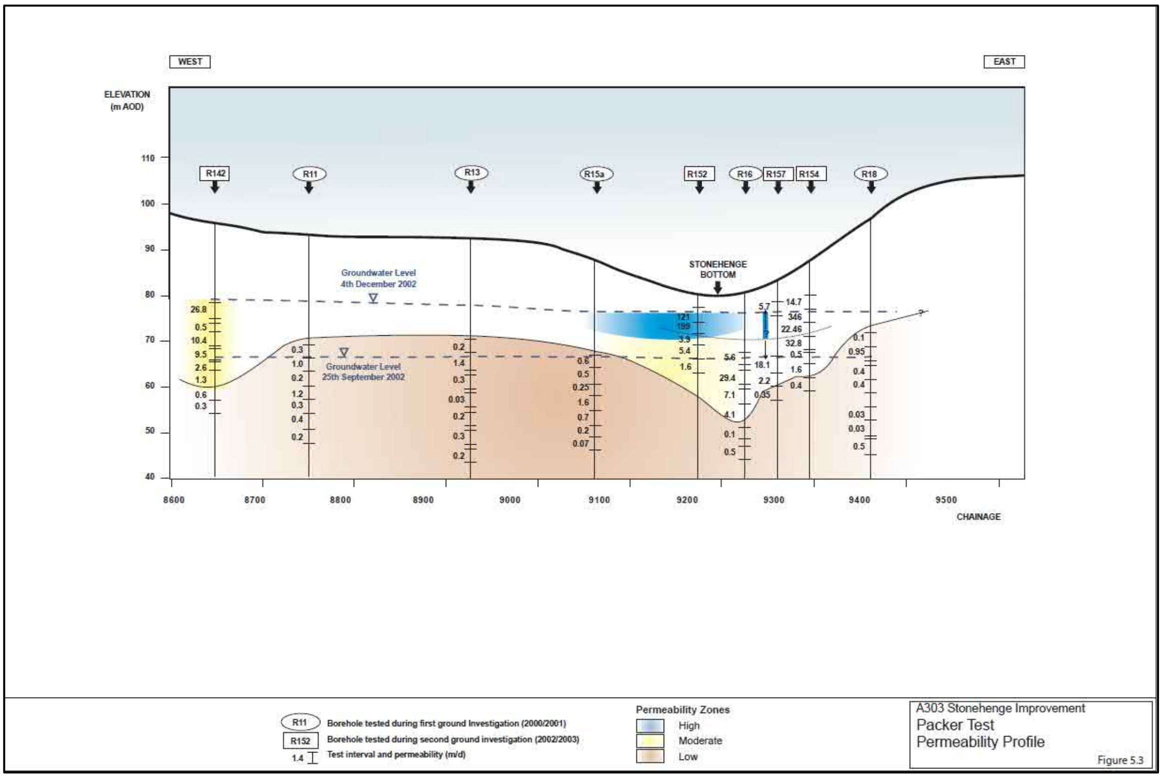

Figure 5-8 2001 Packer Test results (Balfour Beatty-Costain-Halcrow-Gifford, 2006)

Eastern Tunnel Portal Onwards

4.4.33 Boreholes 21762-R158 and 29779-R507A are located close to the eastern portal and fitted with a telemetry system recording groundwater levels at least hourly. These systems will allow a better understanding of seasonal groundwater level fluctuations and improved correlation with longer term records. Water levels are presented in Figure 5-2.

4.4.34 Groundwater levels at 21762-R158 were collected between November 2002 and June 2006. Data is shown on Figure 5-2. The maximum groundwater level recorded during that period at R158 was a dipped level of 73.5m AOD in January 2003. The recent telemetry system in 21762-R158 has only recorded groundwater levels since September 2016. Data is not available for the extreme wet years of 2001, 2013 and 2014.

4.4.35 The EA is currently monitoring two boreholes near the Countess Roundabout (Amesbury Deep and Amesbury Shallow). Between February 2002 and September 2017, the groundwater level was on average 68.5m AOD with maximum fluctuations in the order of +/- 1.5m AOD. A maximum of 69.8m AOD (artesian condition) was reached in Amesbury Deep in February 2014 as shown on Figure 5-9.

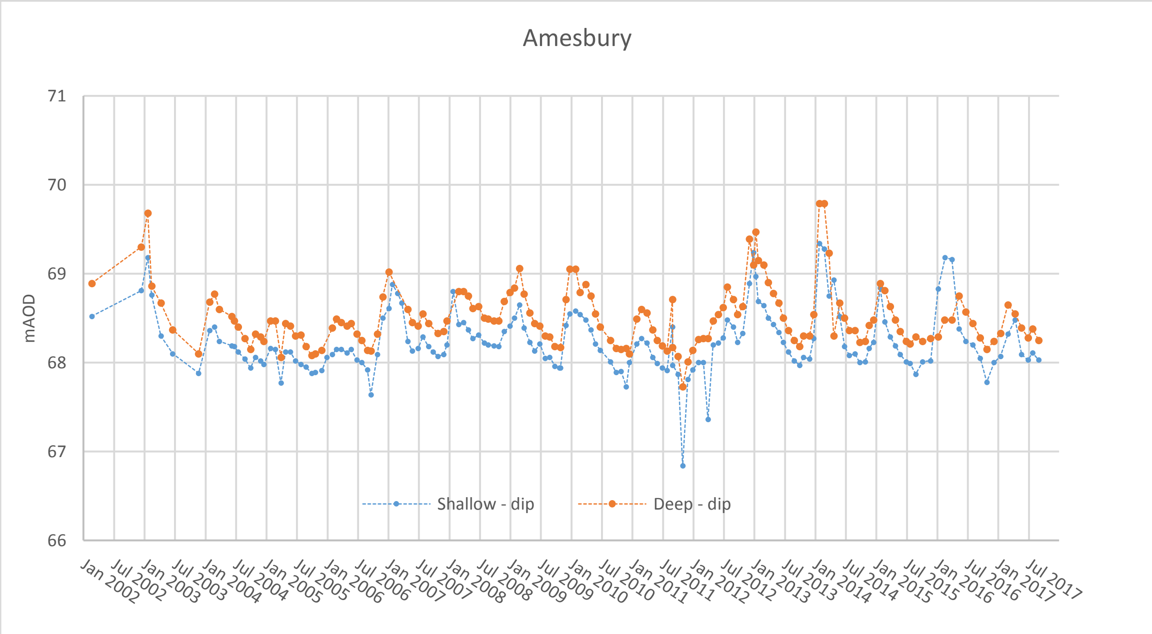

Figure 5-9 Amesbury Monitoring Boreholes

4.5 Geomorphology

4.5.1 The geomorphology is discussed in the PSSR [1]. The features summarised include the following:

a) The region can be divided into two distinct zones, with higher elevation and deeply incised dry valleys to the west and lower undulating chalk with a denser network of more symmetrical dry valleys and dry tributary swales to the east;
b) Key geomorphological features involve interfluves, dry valleys and active fluvial valleys. The River Till and River Avon can be classed as active fluvial valleys, with Stonehenge Bottom forming the most prominent dry valley. Interfluves make up the areas of higher elevation between these features.

4.5.2 When the 2017 EP GI was carried out, its primary purpose was not to provide geomorphological mapping data, and as such the investigation carried out involved intrusive boreholes and trial pits. Exposures have therefore not been observed.

4.6 Structural Geology

4.6.1 Faulting and folding is discussed in the PSSR, based on the following published sources:

a) BGS memoir on the Geology of the Salisbury District;
b) Professor Mortimore's interpretation of local structural geology (2003) [32].

4.6.2 In addition to the inferred faulted zones presented in the PSSR, Table 5-6 shows the locations in which the ground investigation contractor or Professor Mortimore has recorded striations or slickensides in the discontinuities or potential faulting.

4.6.3 It should be noted that the following comments only suggest potential evidence for faulting, and may not confirm it as such. The distance from boreholes should be considered as well as the quality of rotary borehole core recovery.

Table 5-6 Summary of Locations of Striations and Faulting in the Structured Chalk

Hole Chainage (m)	Exploratory Hole ID	Depth (m bgl)	Reduced Level (m AOD)	Chalk Formation	Contractor Description
3,963 (3.3m from Preferred Route alignment)	21762-R122	18.3 – 18.4	54.6 – 54.7	Undifferentiated Chalk	Extensive yellow staining and marl. Some surface areas are polished and striated.
		19.5 – 19.6	53.4 – 53.45	Undifferentiated Chalk	Slickensided shear zone, with polished, striated surface. Moderate orange and grey staining, slight black speckling.
		20.0	52.9	Undifferentiated Chalk	Slickensided shear zone, with crystals of calcite. (10/10mm).
4,009 (9.7m from Preferred Route alignment)	21762-R123	13.5 – 13.6	58.1 – 58.3	Undifferentiated Chalk	Fractured chalk, with extensive yellow to orange staining. Polished, striated surfaces.
		17.6 – 17.8	53.9 – 54.1	Undifferentiated Chalk	Polished, striated, marl joint.
		17.9 – 18.0	53.7 – 53.8	Undifferentiated Chalk	Polished, striated marl joint.
		18.7 – 18.75	53.0 – 53.1	Undifferentiated Chalk	Light brown to grey marly joint, polished and striated.
		19.2 – 19.3	52.4 – 52.5	Undifferentiated Chalk	Chalk non-intact. Shattered, strong, crystalline, striated joint surface material present. High marl content.
7,679 (410m from Preferred Route alignment)	29779-R503B	36.2 – 37.5	66.8 – 68.1	*Not available*	Zone of core loss (possible faulting).
7,897 (374m from Preferred Route alignment)	29779-P502B	23.3 – 23.6	79.7 – 80.0	Seaford Chalk Formation	*Professor Mortimore*: Sample gone, three steeply inclined, slickensided shears (samples gone).
		23.9 – 24.0	79.3 – 79.4	Seaford Chalk Formation	Dipping at 60°, slickensided, brown staining.
		29.4 – 31.0	72.3 – 73.8	*Not available*	Zone of core loss (possible faulting).
8,157 (343m from Preferred Route alignment)	29779-P505	13.1 – 13.2	83.1 – 83.2	Phosphatic Chalk	*Professor Mortimore*: Slickensided inclined shear.
		13.2	83.1	Phosphatic Chalk	*Professor Mortimore*: Thin grey, interwoven marl (sample gone?), slickensided inclined shear.
		13.2 – 13.4	82.9 – 83.1	Phosphatic Chalk	*Professor Mortimore*: Slickensided inclined shear.
		21.2 – 21.4	74.9 – 75.1	Phosphatic Chalk	Black specks with polished striated surface (possible movement).
		26.2	70.1	Seaford Chalk Formation	Black specks and brown stained with polished and striated surface (possible movement).
		30.0 – 30.2	66.1 – 66.3	Seaford Chalk Formation	*Professor Mortimore*: Inclined 700 slickensided shear fracture, Fragmented, solid flint.
		30.2	66.0	Seaford Chalk Formation	Possible minor fault with slickensides.
		35.9	60.4	Seaford Chalk Formation	*Professor Mortimore*: Downwards inclined slickensided shear.
		36.0	60.2	Seaford Chalk Formation	Evidence of possible slickensided fracture in non-intact chalk.

Hole Chainage (m)	Exploratory Hole ID	Depth (m bgl)	Reduced Level (m AOD)	Chalk Formation	Contractor Description
		39.4 – 39.7	56.6 – 56.9	Lewes Nodular Chalk Formation	*Professor Mortimore*: Box 27 solid core, no flint and two 70° slickensided fractures.
		39.7 – 39.8	56.5 – 56.6	Lewes Nodular Chalk Formation	*Professor Mortimore*: Box 27 solid core, no flint and two 70° slickensided fractures.
		39.7 – 39.9	56.2 – 56.4	Lewes Nodular Chalk Formation	Black specks and brown staining with slickensides.
		40.0 – 40.1	56.1 – 56.2	Lewes Nodular Chalk Formation	Brown stains with slickensides.
		40.1 – 40.2	56.1 – 56.2	Lewes Nodular Chalk Formation	*Professor Mortimore*: Orange, iron-stained sponge bed, box 27 solid core, no flint and two 70° slickensided fractures.
		40.2 – 40.3	56.0 – 56.1	Lewes Nodular Chalk Formation	*Professor Mortimore*: Box 27 solid core, no flint and two 70° slickensided fractures.
		40.3 – 40.4	55.9 – 56.0	Lewes Nodular Chalk Formation	*Professor Mortimore*: Inclined fracture (no slickensides), box 27 solid core, no flint and two 70° slickensided fractures.
		40.4 – 40.5	55.8 – 55.9	Lewes Nodular Chalk Formation	*Professor Mortimore*: Box 27 solid core, no flint and two 70° slickensided fractures.
		40.5 – 40.9	55.4 – 55.8	Lewes Nodular Chalk Formation	*Professor Mortimore*: Closed to tight vertical joint, box 27 solid core, no flint and two 70° slickensided fractures.
8,785 (38.6m from Preferred Route alignment)	21762-R146	30.4 – 30.5	63.0 – 63.1	Undifferentiated Chalk	Flint, rounded, rinded and broken, 50 x 40 x 30mm - striated, polished shear zone.
9,080 (60.9m from Preferred Route alignment)	21762-R152	20.89 – 20.9	62.6 – 62.7	Undifferentiated Chalk	Slickensided shear fracture. Highly polished, with slight orange staining and black speckling.
9,145 (73m from Preferred Route alignment)	21762-R157A	22.0 – 23.0	56.7 – 57.7	Undifferentiated Chalk	*Professor Mortimore*: Polished, clay-smeared, slickensided conjugate joints.
		22.2 – 22.35	57.4 – 57.5	Undifferentiated Chalk	Slickenside side shear zones, with brown and grey striations. Slight yellow staining.
9,947 (93.1m from Preferred Route alignment)	16175-R21	20.4	89.5	Undifferentiated Chalk	Polished andpatchy striated fracture surface.
		21.0	88.9	Undifferentiated Chalk	Patchy polished -and striated surface on beddingfracture surface.
10,095 (91.6m	21762-R158	15.6 – 16.3	91.0 – 91.7	Undifferentiated Chalk	*Professor Mortimore*: Sheet flints on a steeply inclined shear planes (possible

Hole Chainage (m)	Exploratory Hole ID	Depth (m bgl)	Reduced Level (m AOD)	Chalk Formation	Contractor Description
from Preferred Route alignment)					faults). Clay-fill and slickensides.
		16.9	90.4	Undifferentiate d Chalk	*Professor Mortimore*: Slickensided shears.
		21.8	85.6	Undifferentiate d Chalk	*Professor Mortimore*: Slickensided shears, regular flint bands.
10,311 (91.7m from Preferred Route alignment)	16175-DTP33	3.0 – 3.5	97.1 – 97.6	Undifferentiate d Chalk	Moderately strong very high -density white CHALK, hardground in places fractures are stained orange brown withmoderate black specklng, polished andstriated in places.
10,497 (22m from Preferred Route alignment)	29779-R507A	15.5 – 15.8	76.6 – 76.8	Seaford Chalk Formation	Fracture is sub vertical undulating striated… containing black specks and brown staining with slickensides (possible movement along the fracture/possible minor fault).
		17.5 – 18.2	74.1 – 74.8	*Not available*	Assumed zone of core loss (possible faulting)
		34.5 – 34.5	57.8 – 57.8	Seaford Chalk Formation	Slickensides with shiny surfaces.

4.7 Man-made Features

4.7.1 A summary of the significant existing man-made features encountered along the Preferred Route is presented in Table 5-7.

Table 5-7 Existing Man-made Features Encountered on Preferred Route

Approximate Chainage (m)	Feature
3,250	Esso high pressure oil pipeline
3,540	Alignment crosses B3083
5,470 to 5,780	Alignment crosses existing A303
6,240	Alignment crosses existing A360
9,800 to 10,000	Tunnel passes under Stonehenge Cottages
10,600	High voltage overhead power lines
10,770	Vespasian’s underpass
11,700 to 11,900	Countess Roundabout, including a pedestrian subway and pumping station
12,330	Bridge across River Avon

5 Ground Conditions and Material Properties

5.1 General

5.1.1 The results of the in-situ and laboratory testing carried out for the individual materials encountered across the scheme are summarised in this report section to the requirements set out in BS EN 1997-1 [3], BS EN 1997-2 [4] and HD 22/08 [5]. Where appropriate, the data is presented and interpreted using published correlations to produce derived values. Global geotechnical parameters are analysed and summarised in terms of ranges with any irregularities highlighted.

5.1.2 The geotechnical parameters given in this pGIR shall not be viewed as equivalent to the characteristic values for the purpose of design to the definition of the Eurocodes. The selection of appropriate design parameters should be based on review of the geotechnical information that is specific to structures and their locations and to be documented in a Geotechnical Design Report (GDR).

5.1.3 Due to the relatively large coverage area of the project, it is anticipated that variations in terms of ground and groundwater conditions are likely to exist along the proposed scheme. To assist in the evaluation of the geotechnical information in this context, the proposed Preferred Route has been divided into different segments as presented in Table 6-1. Geotechnical parameters are summarised as global ranges and additionally to the proposed segments where appropriate.

Table 6-1 Division of the Proposed Route for Material Property Evaluation

Proposed Route Segment Reference	Descriptions	Approximate Chainage (m)	
		From	To
S-1	From Berwick Down to River Till	0	3950
S-2	River Till	3950	4200
S-3	From River Till to the proposed A360 junction near Longbarrow	4200	5200
S-4	From Longbarrow to the proposed western tunnel entrance	5200	7200
S-5	Proposed western tunnel portal including canopy extension	7200	7400
S-6	Proposed tunnel	7400	10400
S-7	Proposed eastern tunnel portal	10400	-
S-8	Proposed eastern tunnel portal to the western end of the proposed route at Countess	10400	12569

5.1.4 Unless stated otherwise, the material property evaluation is based on ground investigation data available from the exploratory holes that are located within 500m offset and parallel to the mainline horizontal alignment of the Preferred Route. The chainage ranges defined in Table 6-1 are extended along the mainline horizontal alignment by 200m at both ends of the route segment extents in the search of ground investigation data in order to provide wider coverage of data in the evaluation.

5.2 Made Ground (MG)

General

5.2.1 Made Ground was encountered in two main areas near the existing Longbarrow and Countess roundabouts. Its presence is likely to be in association with the historical earthworks in these areas.

5.2.2 Made Ground was encountered in four trial pits in the area of the Longbarrow Roundabout and has been described as silty gravelly silt.

5.2.3 Made Ground present in the area of Countess Roundabout is likely to be reworked chalk fill. An examination of the existing topography and geology suggests that the pre-existing top layer of the Alluvium has potentially been partially removed, replaced and/or subsequently built up with chalk fill.

5.2.4 Granular Made Ground comprises brown clayey sandy flint, and chalk gravel is found around and within the Countess Roundabout Cohesive Made Ground has been encountered in the area to the south of the Countess Roundabout, and has been typically described as brown sandy gravelly silt with low cobble and boulder content. Gravel cobble and boulder are of chalk.

Classification Testing

Bulk Density

5.2.5 There is no bulk density test carried out in the Made Ground.

5.2.6 *Natural Moisture Content (NMC)*

5.2.7 NMC tests have been carried out on Made Ground samples recovered from the exploratory holes near Countess Roundabout. There are three NMC tests on granular Made Ground and the results have a range of 7-24% (average 13%). Thirteen tests on cohesive Made Ground samples were carried out with results within the range of 11 to 33% (average 21%).

Atterberg Limits

5.2.8 The liquid limit, plastic limit and plasticity index based on the results from eleven Made Ground samples recovered from the exploratory holes near Countess Roundabout are 27 to 43% (average 32.3%), 15 to 32% (average 20.5%) and 8 to 18% (average 11.7%) respectively.

Particle Size Distribution (PSD)

5.2.9 The PSD test results have been grouped according to cohesive and granular Made Group by descriptions and plotted in Figure 6-25 and Figure 6-26 respectively.

5.2.10 Seven PSD tests have been carried out on the granular Made Ground samples. The highest PSD curve (i.e. with 48% passing at particle size 0.063mm) is the result from the test carried out on the sample recovered from trial pit 16174-STP12 at 0.5m bgl. This particular sample has been described as fine to coarse very gravelly clay, in contrast to the corresponding stratum description of sandy fine to coarse gravel of flint. The test on this sample therefore has recorded higher fine content compared with the general stratum description. The remaining six PSD samples were taken from the exploratory holes around the Countess Roundabout. Discounting the PSD test from 16174-STP12, the percentage passing particle size 0.063mm (i.e. particle size limit between silt and sand) ranged from 9 to 32%.

5.2.11 Twelve PSD tests have been carried out on the cohesive Made Ground. The samples were recovered from exploratory holes around the Countess Roundabout. The percentage passing particle size 0.063mm ranged from 22 to 52%.

Strength

Standard Penetration Testing (SPT)

5.2.12 There are a total of eight SPT carried out in made ground in the area of the Countess Roundabout in five boreholes. Seven tests were in granular Made Ground with a SPT N range of 8 to 71. If the lowest N value of 8 is discounted, the range is 19 to 71 (average 35). One SPT was carried out in the cohesive Made Ground with an SPT N value of 8.

Undrained Shear Strength Correlated from SPT

5.2.13 The undrained shear strength (C_u) of the cohesive Made Ground has been derived from the single SPT N value after the empirical correlation proposed by Stroud (1989) using a conservative f_1 factor of 4.5. C_u is estimated as 36kN/m².

5.2.14 *Effective Strength Derived from BS8002:2015 for Cohesive Made Ground*

5.2.15 The constant volume effective friction angle (φ'_{cv}) (also known as critical state), of the cohesive Made Ground is estimated based on plasticity index (I_p) by the equation (BS8002:2015) [49] below.

$$\phi'_{cv} = (42\quad° - 12.5\, Log_{10} I_p)$$

5.2.16 The φ'_{cv} has been estimated as 24.5°-30.5° (average 28.0°)

5.2.17 *Effective Strength Derived from SPT for Granular Made Ground*

5.2.18 The effective strength of the granular Made Ground is correlated with the SPT N values (after Stroud, 1989) [50] and is calculated to have a range of 34.0° -37.5° (average 35.5°).

Stiffness

5.2.19 *Stiffness Correlated from SPT for Cohesive Made Ground*

5.2.20 The undrained Young's modulus (E_u) of the cohesive Made Ground can be estimated from the SPT N value by the relationship below (CIRIA R143) [51].

$$E_u = N\, 1.0\ (MN/m^2)$$

5.2.21 The drained Young's modulus (E') for the cohesive Made Ground can be estimated assuming the material is isotropic and is related to E_u by the relationship $E'/E_u = (1+\nu')/(1+\nu_u)$ where ν' and ν_u are the undrained and drained Poisson's ratio. $E' = 0.8\ E_u$ for an assumed ν' of 0.2.

5.2.22 The E_u and E' moduli are calculated as 8 MN/m² and 6.4 MN/m² respectively using the single SPT N value within the cohesive Made Ground.

Stiffness correlated from SPT for Granular Made Ground

5.2.23 The drained stiffness (E') of the granular Made Ground is estimated from SPT N based on a correlation factor of 1 (MN/m²) and the material is normally-consolidated with reference to CIRIA R143. E' is estimated as 19-71 MN/m² (average 35 MN/m²).

Table 6-2 Summary of Geotechnical Parameters for Made Ground

Parameter	Cohesive	Granular
Classification		
Bulk Density (Mg/m³)	-	-
NMC (%)	11-33 (21), 13	7-24 (13), 3
LL (%)	27-43 (32), 11	n/a
PL (%)	15-32 (20.5), 11	n/a
PI (%)	8-18 (11.7), 11	n/a
PSD (no. of tests)	12	7
In-situ Testing		
SPT N (no. of blows per 300mm)	8 (8), 1	8-71, 7 *19-71 (35), 6*
Strength		
C_u correlated from SPT N (kN/m²)	36 (36), 1	n/a
ϕ'_{cv} derived from BS8002:2015 (degrees)	24.5-30.5 (28.0), 12.0	n/a
ϕ' after Stroud (1989) (degrees)	n/a	*34.0-40.0 (35.5),3*
Stiffness		
E_u correlated from SPT N (MN/ m²)	8 (8), 1	n/a
E' correlated from SPT N (MN/ m²)	6.4 (6.4), 1	*19-71 (35), 6*

Notes: '-' denotes no testing is available. 'n/a' denotes the test is not applicable for the material.
Values in bracket '( )' are the average values and are provided where appropriate.
Values after the comma ',' are the numbers of test or results.
Values in grey and italic are revised results after discount of anomalous values – refer to the text for details.

5.3 Head Deposits (HD)

General

5.3.1 Head Deposits have not been encountered across the entire scheme but have been encountered at several locations where the scheme crosses fluvial, tributary and ephemeral valleys. The locations where Head Deposits were encountered are summarised in Table 5-1.

5.3.2 When identified, Head Deposits are most frequently encountered as silty gravelly sand or silty sandy gravel. This is the case in the area of the River Till valley where the most significant occurrence of granular Head Deposits was found. Head Deposits have also been identified as silt and clay layers in disperse locations along the route alignment, with the most notable presence in the area towards the lower part of the western slope at Stonehenge Bottom.

Classification Testing

Bulk density

5.3.3 A single bulk density test has been carried out in the Head Deposits in the route-wide dataset. The test was undertaken on a granular Head Deposit sample recovered from trial pit 21762-DTP118 (chainage 3,621) and bulk density is reported as 2.05 Mg/m³.

Nature Moisture Content (NMC)

5.3.4 There have been four NMC tests on the granular Head Deposits. Samples were recovered from exploratory holes 16174-CP5 (chainage 4,171), SSTP23 (chainage 3,661) and 21762-DTP118 (chainage 3,621). NMC is reported to have a range of 10-21% (average 17.3%).

5.3.5 There have been two NMC tests on the cohesive Head Deposits. Samples were both recovered from trial pit 16174-SPT56 (chainage 10,675) and NMC are 12% and 18%.

Atterberg Limits

5.3.6 Two Atterberg Limit tests have been carried out on the cohesive Head Deposits. Samples were both recovered from trial pit 16174-SPT56 (chainage 10,675). The results are 42% and 44% for liquid limit, 26% and 28% for plastic limit, and the plasticity index was 16% for both tests.

Particle Size Distribution (PSD)

5.3.7 There are twenty-seven PSD tests on the granular Head Deposits. The samples were recovered from twelve exploratory holes located between chainage 3,489 and 5,216. The results are presented in Figure 6-28.

5.3.8 Two PSD tests were carried out on the cohesive Head Deposits with the sample recovered from trial pit 16174-STP56 (chainage 10,675). The results are presented in Figure 6-27.

Strength

Standard Penetration Testing (SPT)

5.3.9 SPT were only carried out in the granular Head Deposits. A total of fifteen SPT were carried out in boreholes 16174-CP1 to CP5 (chainage 4,030 to 4497). SPT N is found as 10 t0 59 (average 22) with not notably trend with depth. The SPT N values are plotted against depth and reduced level in Figure 6-43 and Figure 6-44 respectively.

5.3.10 *Effective Strength derived from SPT for Granular Head Deposits*

5.3.11 The effective strength of the granular Head Deposits is correlated with the SPT N values (after Stroud, 1989) and is calculated to have a range of 30.4° to43° (average 34°).

Stiffness

Stiffness Correlated from SPT for Granular Head Deposits

5.3.12 With reference to Stroud (1989) and CIRIA R143, a reasonable approximation of the drained stiffness may be achieved by:

$$E' = N\ 1.0\ (MN/m^2)$$

5.3.13 The E' moduli based on SPT in the granular Head Deposits has a range of 10 to 59 MN/m² (average 22 MN/m²).

5.3.14 The correlation factor of 1.0 assumed a factor of safety of 3 on bearing capacity for normally-consolidated soils (as assumed for all superficial deposits encountered in the scheme).

Stiffness by Plate Load Test (PLT)

5.3.15 One field PLT was carried out on granular Head Deposits in the trial pit16174-SSTP23 at 0.6m bgl. Structureless grade Dc chalk is only located 0.1m below the test depth. This test has been grouped under Head Deposits for reporting but it may be more appropriate to be considered the PLT as have been done on structureless grade Dc chalk due to the stressed zone being predominantly within the Chalk.

5.3.16 The modulus of subgrade reaction (k) and strain modulus (E_v) were derived from the PLT results and reported by the ground investigation contractor. The secant modulus (E_{sec}) is calculated based on an applied stress at 200kN/m² after the recommendation within CIRIA C574. Further discussions on the PLT results are provided in section 6.7 of this pGIR. The E_v, E_{sec} and k values are summarised in in Table 6-17. The E_v and E_{sec} based on the PLT are found to be 9.3 MN/m² and 13.8 MN/m² respectively.

Table 6-3 Summary of Geotechnical Parameters for Head Deposits

Parameter	Cohesive	Granular
Classification		
Bulk Density (Mg/m^3)	-	2.05 (2.05), 1
NMC (%)	12 & 18 (15), 2	10-21 (17.3), 4
LL (%)	42 & 44 (43), 2	n/a
PL (%)	26 & 28 (27), 2	n/a
PI (%)	16 (16), 2	n/a
PSD (no. of tests)	2	27
In-situ Testing		
SPT N (no. of blows per 300mm)	-	10-59 (22), 15
Strength		
ϕ' after Stroud (1989) (degree)	-	30.4-43.0 (33.5), 15
Stiffness		
E' correlated from SPT N (MN/ m²)	-	10-59 (22), 15
Plate Load Test		
E_v (MN/ m²)	-	9.3, 1
E_{sec} at 200kN/m^2 Applied Stress (MN/ m²)	-	13.8, 1

Notes: '-' denotes no testing is available. 'n/a' denotes the test is not applicable for the material. Values in bracket '( )' are the average values and are provided where appropriate. Values after the comma ',' are the numbers of test or results. Values in grey and italic are revised results after discount of abnormal values – refer to the report for details.

5.4 Alluvium (ALV)

General

5.4.1 Alluvium has been encountered in two local areas of the scheme in the low-lying flood plains of River Till and River Avon valleys. With reference to the BGS geological map, the superficial deposits crossed by the mainline alignment in the area River Till valley are gravelly Head Deposits, whereas Alluvium comprising layers of clay and sand, has been encountered at locations beyond 200m to the north of the alignment in boreholes 16174-CP1, STP26, STP31, CP3 and CP3A.

5.4.2 Alluvium in the River Avon has, is in general, been found to comprise soft peat overlying silty and clayey deposits. The peaty clay or peat layers were only encountered in the 1965 historical ground investigation [52], with one exception in borehole 21762-WS181. With reference to the Preliminary Design Report [37], the larger part of the peaty deposits is likely to have been removed during the construction of the A303 works at and around the Countess Roundabout in the late 1960's. This suggestion appears to be supported by the lack of findings of peaty deposits in the post-1960's ground investigations carried out around the same area.

Classification Testing

Bulk Density

5.4.2.1 There are a very limited number of bulk density tests carried out in the Alluvium across the scheme. Three bulk density tests were carried on samples recovered from the area of the River Till valley, with results varies from 1.7 to 2.1 Mg/m³ (average 1.9 Mg/m³).

Nature Moisture Content

5.4.3 The nature moisture content of the granular Alluvium in the area of the River Till valley has been found to have a range of 13 to23% (average 16.9% on eight tests). Two tests were carried out on cohesive Alluvium and the results were reported as 14% and 20% (average 17%).

5.4.4 There have been sixteen nature moisture content tests carried out on the cohesive Alluvium in the area of the River Avon, with the results ranging from 10 to61%. There are two notably high results of 56% and 61%. The former result is associated with tested sample recovered immediately fibrous peat layer (24822-TP11). The latter result is associated with tested sample recovered from “slightly organic” clay. If these two results are discounted, the result range may be revised to 10 to 27% (average 20%).

Atterberg Limits

5.4.5 There have been seven Atterberg Limit tests carried out on the cohesive Alluvium in the area of the River Till valley. The ranges of liquid limit, plastic limit and plasticity index are found to be 26 to 42% (average 33%), 17 to 24% (average 20%) and 9 to 18% (average 13%) respectively.

5.4.6 There have been fifteen Atterberg Limit tests carried out on the cohesive Alluvium in the area of the River Avon valley. The ranges of liquid limit, plastic limit and plasticity index are found to be 28 to 51% (average 36%), 14 to 26% (average 20%) and 11 to 25% (average 17%) respectively.

Particle Size Distribution (PSD)

5.4.7 A total of twenty-four PSD tests were carried out on Alluvium and the PSD curves are presented in Figure 6-29 to Figure 6-31. The PSD results have been presented according the overall classifications of the strata where the tested samples were taken. In contrary, the PSD curves as presented in the Preliminary Geotechnical Report [37] have been arranged according to the descriptions of the individual tested samples as well as taken considerations of the proportions of fine and coarse sized particles of the sample. One example is the PSD test carried out on the sample taken at 0.5m bgl from borehole 16174-STP31. This particular PSD test has resulted in the highest percentage passing (94%) particle size of 0.063mm among all tested Alluvium samples. The particular sample has been described as “light brown slightly sandy slightly fine gravelly clay” in the laboratory record, and the PSD curve was grouped in the “cohesive alluvial deposits” PSD plot in Figure 6.2 in the Preliminary Geotechnical Report [37]. As comparison, the corresponding stratum (0.1-1.8m bgl) where the sample was taken has been described as “light brown slightly gravelly fine to coarse sand”.

Strength

Standard Penetration Testing (SPT)

5.4.8 Three SPTs were carried in the sandy Alluvium in the area of the River Till and the N values recorded were 18, 20 and 24.

5.4.9 Six SPT were carried out in the cohesive Alluvium in the area of River Avon with N values ranging from 4 to 33 (average 14). One SPT was carried out in sandy Alluvium with an N value reported as 33.

Undrained Shear Strength correlated from SPT

5.4.10 The undrained shear strength (C_u) of the cohesive Alluvium has been derived from the SPT N values after the empirical correlation proposed by Stroud (1989) using a conservative f_1 factor of 4.5. The results range from 18 to 148.5 kN/m² (average? 61 kN/m²) for the area of River Avon.

5.4.11 There have been very limited numbers of SPT carried out overall and therefore the C_u derived from SPT may not be representative for the entire stratum.

Effective Strength derived from BS8002:2015 for Cohesive Alluvium

5.4.12 The constant volume effective friction angle (φ'_{cv}) (also known as critical state) , of the cohesive Alluvium is estimated based on plasticity index (I_p) by the equation (BS8002:2015) below.

$$\phi'_{cv} = (42^o - 12.5\ Log_{10} I_p)$$

5.4.13 The φ'_{cv} has been calculated as ranging from 26° to 30° (average 28°) for the cohesive Alluvium of the River Till valley and from 25° to29° (27°) for the River Avon valley.

Effective Strength derived from SPT for Granular Alluvium

5.4.14 The effective strength of the granular Alluvium is correlated with the SPT N values (after Stroud, 1989) and is calculated to have a range of 32.5°–to 34.0° (average 33°) and 36° for the areas in the River Till and River Avon valleys respectively.

Effective Strength derived from Drained Shear Box Test

5.4.15 There have been three drained shear box tests carried out on Alluvium samples in the scheme. Samples were recovered from exploratory holes 16174-CP1 and STP26 (both located at distance greater than 200m to the north of the mainline alignment) in the area of River Till valley. The shear box test results are summarised in Table 6-4 and presented in Figure 6-59 and Figure 6-60.

5.4.16 The three samples have been typically described as “slightly sandy slightly gravelly clay” which would suggest the cohesive nature of the tested samples. It should be noted that the same three shear box tests have been grouped and discussed as Alluvium silt in the Preliminary Design Report [37].

5.4.17 Examination of the effective shear strength values show that the results from the test on the sample at 1.5m bgl from trial pit 16174-STP26 is distinctively lower than the others. The lower values of the said sample is likely to be due to the higher fine content as recorded in the description of the corresponding stratum and PSD test (48% passing at sieve size 0.063mm). The relatively high test values of ϕ' = 39.5° and 45.5° are more indicative for granular materials which is reflected in the stratum descriptions.

Table 6-4 Summary of Drained Shear Box Test Results on Alluvium

Hole ID	Sample Depth (m bgl)	ϕ' (°)	c' (kN/m²)	Stratum Description
16174-STP26	1.5	25.0	9.5	Gravelly sandy clay.
16174-CP1	1.5-1.95	45.5	19.0	Medium dense clayey to very clayey fine to medium sand with occasional gravel of flint.
16174-STP26	0.5	39.5	14.0	Slightly clayey gravelly fine to medium sand.

Stiffness

Stiffness Correlated from SPT for Cohesive Alluvium

5.4.18 The undrained Young's modulus (E_u) of the cohesive Alluvium can be estimated from the SPT N value by the relationship below (CIRIA R143).

$$E_u = N\ 1.0\ (MN/m^2)$$

5.4.19 The drained Young's modulus (E') for the cohesive Alluvium can be estimated assuming the material is isotropic and is related to E_u by the relationship $E'/E_u = (1+\nu')/(1+\nu_u)$ where ν' and ν_u are the undrained and drained Poisson's Ratio. E' = 0.8 E_u for an assumed ν' of 0.2.

5.4.20 The E_u and E' moduli based on six SPT in the Alluvium clay of River Avon valley are 4 to 33 MN/m² (average 14 MN/m²) and 3.2 to 26.4 MN/m² (average 11 MN/m²) respectively.

Stiffness Correlated from SPT for Granular Alluvium

5.4.21 The drained stiffness (E') of the granular Alluvium can be estimated from the SPT N value based on a correlation factor of 1 (MN/m²) and the material is normally-consolidated with reference to CIRIA R143. The E' moduli based on the three SPT in the Alluvium sand of the River Till valley has a range of 18 to 24 MN/m² (average 21 MN/m²).

5.4.22 A single SPT has been carried out in the sandy Alluvium in the area of the River Avon and E' is correlated as 33 MN/m².

Stiffness by Plate Load Test (PLT)

5.4.23 Two field PLT were carried out on granular Alluvium in the area of the River Till valley during previous ground investigation in trial pits16174-STP26 and STP31 at 0.6m and 0.2mbgl respectively.

5.4.24 The modulus of subgrade reaction (k) and strain modulus (E_v) were derived from the PLT results and reported by the ground investigation contractor. The secant modulus (E_{sec}) is calculated based on an applied stress at 200kN/m² after recommendation by CIRIA C574. The E_v and E_{sec} based on the PLT are found to be 5.5 and 10.6 MN/m², and 7.2 and 14.7 MN/m² respectively. The E_v, E_{sec} and k values are summarised in in Table 6-17. Further discussions on the PLT results are provided in Section 6.7 of this pGIR.

Coefficients of Volume Compressibility and Consolidation

5.4.25 The coefficient of volume compressibility (m_v) and coefficient of consolidation (c_v) have been determined by laboratory one-dimensional consolidation testing in two cohesive Alluvium samples recovered from boreholes 21762-R165 and 21762-R167. Both boreholes are located in the area of the River Avon valley.

5.4.26 The m_v and c_v have also been calculated based on the results from the consolidation stage prior to the shearing stage in the shear box testing and reported by the ground investigation contractor in the factual report.

5.4.27 The m_v and c_v values from all testing are summarised in Table 6-5. It is noted that the m_v and c_v values for design should be dependent on the stress level to be applied by the future structure. In the case of the m_v and c_v values determined from the consolidation stage of shear box testing, the corresponding applied test stresses are low when compared with the one-dimensional consolidation testing.

Table 6-5 Coefficients of Volume Compressibility and Consolidation for Alluvium

Hole ID	Material Type by Stratum Description	Sample Depth (m bgl)	Applied Stress Range (kN/m^2)	m_v (m^2/MN)	c_v by Square root of time ($m^2/year$)	c_v by Logarithm of time ($m^2/year$)	Test Method
River Till Valley							
16174-CP1	Granular	1.5-1.95	11-41	0.23-0.64	7.4-43.6	-	Consolidation stage prior to shearing in shear box test.
16174-STP26	Granular	0.5	11-41	0.04-0.21	84.7-113.5	-	Consolidation stage prior to shearing in shear box test.
16174-STP26	Cohesive	1.5	11-40	0.45-0.80	4.4-25.0	-	Consolidation stage prior to shearing in shear box test.
River Avon Valley							
21762-R165	Cohesive	2.7-3.15	50-800	0.02-0.31	18.0-40.0	5.2-11.0	Consolidation test.
21762-R167	Cohesive	4.0-4.45	50-800	0.03-0.47	6.8-28.0	3.8-11.0	Consolidation test.

5.4.28 **Peat**

5.4.29 A single PSD test has been found to associate with the alluvial peat. The sample was taken at 0.8 to 1.2m bgl from the window sampler borehole 21762-WS181. The sample was described as “dark grey organic peaty clay”.

5.4.30 No other scheme specific in-situ and laboratory testing on the alluvial peat at River Avon valley has been found amongst the dataset.

Table 6-6 Summary of Geotechnical Parameters for Alluvium

Parameter	River Till Valley Area		River Avon Valley Area		
	Cohesive	Granular	Cohesive	Granular	Peat
Classification					
Bulk Density (Mg/m^3)	1.9 (1.9), 1	1.7-2.1 (1.9), 2	-	-	-
NMC (%)	14 & 20 (17), 2	13-23 (16.9), 8	10-61, 16 *10-27* *(20), 14*	-	-
LL (%)	26-42 (33.4), 7	n/a	28-51 (36.4), 15	n/a	-
PL (%)	17-24 (20.4), 7	n/a	14-26 (19.9), 15	n/a	-
PI (%)	9-18 (13.0), 7	n/a	11-25 (17.1), 15	n/a	-
PSD (no. of tests)	3	6	9	5	1
In-situ Testing					
SPT N (no. of blows per 300mm)	-	18-24 (21), 3	4-33 (14), 6	33 (33), 1	-
Strength					
C_u correlated from SPT N (kN/m^2)	-	n/a	18-148.5 (60.8), 6	n/a	-
ϕ'_{cv} derived from BS8002:2015 (degree)	26.3-30.1 (28.1), 7	n/a	24.5-29.0 (26.6), 15	n/a	-
ϕ' after Stroud (1989) (degree)	n/a	32.5-34.0 (33.2), 3	n/a	36.3 (36.3), 1	
ϕ'_p from Shear Box Test (degree)	25 (25), 1	39.5 & 45.5 (42.5), 2	-	-	-
c'_p from Shear Box Test (kN/m^2)	9.5 (9.5), 1	14.0 & 19.5 (16.5), 2	-	-	-
Stiffness					
E_u correlated from SPT N (MN/m^2)	-	n/a	4-33 (13.5), 6	n/a	-
E' correlated from SPT N (MN/m^2)	-	18-24 (21), 3	3.2-26.4 (10.8), 6	33 (33), 1	-
<u>Consolidation</u>					
m_v from Consolidation Test (m^2/MN)	0.04-0.80, 3 [(1)]	n/a	0.02-0.47, 2 [(2)]	n/a	-
c_v from Consolidation Test (m^2/year)	<u>Square-root Time</u>: 4.4-113.5, 3	n/a	<u>Square-root Time</u>: 6.8-40.0, 2 <u>Log Time</u>: 3.8-11.0, 2	n/a	-
<u>Plate Load Test</u>					
E_v (MN/m^2)	-	5.5 &10.6, 2	-	-	-
E_{sec} at 200kN/m^2 Applied Stress (MN/m^2)	-	7.2 & 14.7, 2	-	-	-
k (MN/m^3)	-	32 & 56, 2	-	-	-

Notes: '-' denotes no testing is available. 'n/a' denotes the test is not applicable for the material.
Values in bracket '( )' are the average values and are provided where appropriate.
Values after the comma ',' are the numbers of test or results.
Values in grey and italic are revised results after discount of abnormal values – refer to the report for details.

(1) From consolidation stage prior to shear box. Applied stress: 11 to 41 kN/m².
(2) From one dimension consolidation test. Applied stress: 50 to 800 kN/m².

5.5 River Terrace Deposits (RTD)

General

5.5.1 River Terrace Deposits have only been encountered in the area of the River Avon valley. Granular RTD that is primarily described as sand and gravel, is found in general beneath the Alluvium and above structureless Chalk, in the exploratory holes that are located within an approximate 250m corridor either side of the main route alignment. This is in agreement with the published geological map. Cohesive River Terrace Deposits have been identified in the cluster of exploratory holes associated with ground investigation 16996 located at distance greater than 400m north of the Countess Roundabout.

5.5.2 The discussions below focus on the corridor of granular RTD found along the mainline alignment when it crosses the River Avon valley.

Classification Testing

Bulk Density

5.5.3 There has been no bulk density testing carried out on the granular RTD.

Nature Moisture Content

5.5.4 There have been three natural moisture content tests carried out in the granular RTD. Results are 12%, 13% and 23%.

Particle Size Distribution (PSD)

5.5.5 There have been sixteen PSD tests on the granular RTD. With the exception of two tests, the results in general agree with the descriptions of the principal soils being sand and/or gravel.

Strength

Standard Penetration Testing (SPT)

5.5.6 Fifteen SPT have been carried out in the granular RTD with N values ranging from 5 to 34 (average 16).

5.5.7 *Effective Strength Derived from SPT for Granular RTD*

5.5.8 The effective strength of the granular RTD is correlated with the SPT N values (after Stroud, 1989) and is calculated to range from 29°to 37° (average 32°).

Stiffness

Stiffness Correlated from SPT for Granular RTD

5.5.9 The drained stiffness (E’) of the granular RTD has been estimated from the SPT N based on a correlation factor of 1 (MN/m²) and the material is normally-consolidated. E' has been calculated as ranging from 5 to 34MN/m² (average 16.5 MN/m^2).

Table 6-7 Summary of Geotechnical Parameters for River Terrace Deposits

Parameter	Granular
Classification	
NMC (%)	12-23 (16), 3
PSD (no. of tests)	16
In-situ Testing	
SPT N (no. of blows per 300mm)	5-34 (16), 15
Strength	
ϕ' after Stroud (1989) (degree)	29-37 (32), 15
Stiffness	
E' correlated from SPT N (MN/m²)	5-34 (16), 15

Notes: '-' denotes no testing is available. 'n/a' denotes the test is not applicable for the material. Values in bracket '( )' are the average values and are provided where appropriate. Values after the comma ',' are the numbers of test or results. Values in grey and italic are revised results after discount of abnormal values – refer to the report for details.

5.6 Structureless Chalk

General

5.6.1 Structureless Chalk has been encountered generally above the structured Chalk across the scheme. Structureless Chalk has been encountered predominantly as grade Dc chalk to the classification system proposed in CIRIA C574 [46]. Grade Dc chalk was encountered in one hundred and fifty-two exploratory holes located within 500mm from the mainline alignment. In contrast, twenty occurrence of grade Dm chalk was found in the same extent.

5.6.2 The average depth to the base of the structureless Chalk is approximately 1m bgl along the route. Structureless Chalk to greater depths are observed in three main areas: River Till valley, Stonehenge Bottom and Countess Roundabout/River Avon valley. The locations where structureless Chalk have been encountered at depth greater than 2m are summarised in Table 6-8.

5.6.3 Structureless Chalk was found at greater depths in the areas of River Till valley and Countess Roundabout / River Avon valley primarily due to the presence of the overlying superficial deposits.

5.6.4 In the River Till valley, the base of structureless Chalk was encountered at its greatest depth in borehole 21762-R121 at 9.6m bgl. Boreholes 16174-CP3 and CP3A were formed by cable percussion technique and the recovered chalk is likely to have been disturbed and recovered as structureless Chalk due to the technique's destructive nature. Discounting 21762-R121, 16174-CP3 and CP3A, the base of the structured Chalk is revised to 3.5-6.0m bgl.

5.6.5 Structureless Chalk was found in the area of the Countess Roundabout / River Avon Valley, down to a maximum depth to the base at 15.15m bgl. However, the cable percussive drilling technique may have resulted in disturbance of the samples and may not reflect the in-situ state of the material.

a) Boreholes 21762-CP163, CP168 and 24822-BH1 were formed solely by cable percussion technique.
b) 16996-TP15 is a trial pit terminated at 3.4m bgl.
c) The base of structureless Chalk in the remaining three boreholes (21762-R165, R166 and R167) ranged from 14.25m to 15.15m bgl. These boreholes were initially drilled by cable percussion technique (down to 9.1-12.0m bgl) and followed by rotary coring. It is not uncommon for the first few core runs in a rotary coring follow-on borehole to return very low RQD or poor recovery (as observed in 21762-R165 and R167) as a direct result of drilling technique transition and may not be a reflection of the actual condition of the chalk.

Table 6-8 Summary of Exploratory Holes that Encountered Structureless Chalk at a Depth Greater than 2m

General Location	Hole Chainage (m)	Max Base Depth (m bgl)	Hole ID
River Till Valley	3353-4498	3.5-9.6	16174: ***DTP6***, ***CP3***, ***CP3A***, ***SSTP23***, STP28 and STP29 21762: ***DTP116***, ***DTP117***, ***DTP118***, ***DTP119***, ***R121***, ***R122***, ***R124*** and STP114
Stonehenge Bottom	9030-9209	2.4-8.5	16175: DTP26, ***DTP27*** 17439: ***P2*** 21762: ***DTP155C***, DTP155D, DTP155E, R149, R149B, R152, R152A, R152AA, ***R154***, ***R154A***, ***R157*** and ***R157A***
Countess Roundabout / River Avon Valley	11,411-12,055	3.4-15.15	16996: TP15 21762: ***CP163***, ***CP168***, ***R165***, ***R166*** and ***R167*** 24822: ***BH1***

Note: Exploratory holes that encountered structurelss Chalk at depth >4m are in **bold** and *italic*.

Classification

Particle Size Distribution (PSD)

5.6.6 The results of PSD tests for grades Dm and Dc Chalk are plotted in Figure 6-35 and Figure 6-36 respectively. Majority of the tests were performed on grade Dc samples and is a reflection of the predominant presence of grade Dc chalk in the scheme.

5.6.7 CIRIA C574 provides guidelines for the sub-division of the grade D chalk by particle size proportion. It suggests that for structureless Chalk that has greater than 35% of its particles in the “fine” soil fraction, the material is likely to be matrix dominated ‘comminuted chalk’ and can be classed as grade Dm. If the “fine” soil fraction is less than 35%, then the chalk clasts dominate and can be classed as grade Dc.

5.6.8 The grade Dc PSD chart (Figure 6-36) illustrates that some of the PSD curves lie above 35% at particle size of 0.063mm. Similarly the grade Dm PSD chart

(Figure 6-35) shows that all of the PSD curves but one lie below 35% at particle size of 0.063mm. This observation would indicate misclassification of grade Dm chalk from grade Dc chalk (and vice versa). The same observation has been made in the Preliminary Geotechnical Report [37]. With reference to the Preliminary Geotechnical Report [37] , the misclassification could be due to the presence of sub-horizontal bands of grade Dm chalk that were not obvious when the classification was carried out in-situ. However, it is recognised that the observed in-situ collective character of the materials is also important and may become the over-riding factor in the classification.

Atterberg Limits

5.6.9 A single Atterberg Limit test has been carried out on grade Dm chalk sample recovered from trial pit 16174-STP56 at 1.5m bgl. The sample is described as brown chalky gravel with much sandy clay. Liquid and plastic limits were found to be 42% and 28% respectively with a plasticity index of 14%.

Bulk Density

5.6.10 The results from the route-wide thirty nine bulk density tests on grade Dc chalk range from 1.9 to 2.1 Mg/m³ (average 2.0 Mg/m³) and for five tests on grade Dm chalk range from 1.9 to 2.0 Mg/m³ (average 2.0 Mg/m³).

Dry Density

5.6.11 The results from the route-wide eighty nine dry density tests on grade Dc chalk range from 1.5 to 1.9 Mg/m³ (average 1.7 Mg/m³) and for five tests on grade Dm chalk range from 1.5 to 1.6 Mgm³ (average 1.6 Mg/m³).

Specific Gravity/ Particle Density

5.6.12 Five particle density tests have been carried out on grade Dc chalk and the range of results is 2.70 to 2.73 Mg/m³ (average 2.7 Mg/m³). No particle density testing was carried out on grade Dm chalk.

Natural Moisture Content (NMC)

5.6.13 One hundred and fifty eight NMC tests of grade Dc chalk resulted in a range of 8.4 to 34%. If the abnormally high value of 34% is discounted, the route-wide range is revised to 8.4-29% (average 20.4%). The NMC is observed to increase with chainage. The average NMC is found to be 18.3% in route segment S-1, gradually increasing to an average of 24.9% in route segment S-8.

5.6.14 There is a single NMC test on grade Dm chalk (in route segment S-8) with a result of 26%.

Strength

Standard Penetration Test (SPT)

5.6.15 Fifteen SPT tests have been carried out on grade Dc chalk. Tests were carried out within route segments S-1 and S-8. The SPT N values range from 3 to 27 (average 13, discounting one value of 50 which did not reach full test drive penetration).

5.6.16 Twelve SPT tests have been carried out on grade Dm chalk. All tests were carried out in route segment S-8. SPT N values range from is 3 to 17 (average 7).

5.6.17 The SPT N values are plotted against depth and reduced levels in Figure 6-49 and Figure 6-50.

Effective Strength

5.6.18 Clayton (1978) [53] has performed a series of laboratory effective stress tests on remould chalks. The results show the effective friction angle (ϕ') to vary between 29° and 34°, with most results falling within the range from 31° to 33°°. With reference to CIRIA C574, the effective strength parameters for grade Dm chalk are not likely to be less than the range determined by Clayton (1978). For grade Dc chalk,ϕ' may be expected to be greater due to effect of particle interlocking.

Stiffness

5.6.19 *Stiffness by Plate Load Test (PLT)*

5.6.20 A total of twenty field PLT were carried out on the structureless Chalk during previous ground investigations 16174 and 21762. All tests were carried out using 300mm diameter plate within trial pits on grade Dc chalk at depth ranges from 0.45m to 1.2m bgl. Tests were located within route segments S-1, S-3 to S-5.

5.6.21 The modulus of subgrade reaction (k) and strain modulus (E_v) were derived from the PLT results and reported by the ground investigation contractors. The secant modulus (E_{sec}) is calculated based on an applied stress at 200kN/m² after recommendation by CIRIA C574. Further discussions on the PLT results are provided in section 6.7 of this pGIR. The E_v, E_{sec} and k values are summarised in in Table 6-17.

5.6.22 The E_v and E_{sec} for the grade Dc chalk based on the PLT were found to range from 11 to 185 MN/m² (average 77 MN/m²) and from 16 to 438 MN/m^2 (average 129 MN/m^2) respectively.

5.6.23 The E_{sec} moduli derived from field PLT are considered to be short-term due to the relatively quick application of the test loads. The long-term E_{sec} suggested by CIRIA C574 has taken into account the influence of creep, and is based on field settlement measurement for five storey buildings on soft chalk at Reading. In this particular study, the long-term E_{sec} is found to be half of the short-term E_{sec} as derived from the field PLT.

Stiffness by Correlation with SPT N Values

5.6.24 Stroud (1989) and CIRIA R143 has suggested that a conservative estimate of immediate settlement of spread foundation in chalk can be made by using the relationship below with the SPT N values to estimate chalk stiffness:

$$E_m = N_{60}\,5\;(MN/m^2)$$

5.6.25 The SPT N has been recorded to range from 3 to 27 (average 13) for grade Dc chalk. If the correlation above is adopted for estimation of E_m the range is calculated as 5 to 135 MN/m² (average 65 MN/m²) assuming N = N_{60}. The average E_m of 65 MN/m² is lower (approximately half) than the average short-term E_{sec} of 129 MN/m² as derived from the PLT. It should be noted that SPT were only carried out within route segments S-1 and S-8 and there are limited to fifteen tests. Therefore, the E_m correlated from SPT N may not be comparable to the E_{sec} derived from PLT.

5.6.26 The Young's modulus of the grade Dm chalk may be estimated from the SPT N value assuming it behaves as cohesive soils by the relation for undrained stiffness E_u / N = 1.0 (MN/m²) (CIRIA R143), and drained stiffness E' = 0.8 E_u. E_u and E' are calculated as 3 to 17 MN/m^2 (average 7.0 MN/m^2) and 2.4 to 13.6 MN/m^2 (average 5.6 MN/m^2) respectively.

Table 6-9 Summary of Geotechnical Parameters for Structureless Chalk

Parameter	Grade Dc	Grade Dm
Classification		
Bulk Density (Mg/m^3)	1.9-2.1 (2.0), 39	1.9-2.0 (2.0), 5
Dry Density (Mg/m^3)	1.5-1.9 (1.7), 89	1.5-1.6 (1.6), 5
Particle Density (Mg/m^3)	2.70-2.73 (2.70), 5	-
NMC (%)	8.4-34.0, 158 *8.4-29.0 (20.4), 157*	26 (26), 1
LL (%)	-	42 (42), 1
PL (%)	-	28 (28), 1
PI (%)	-	14 (14), 1
PSD (no. of tests)	49	7
In-situ Testing		
SPT N (no. of blows per 300mm)	3-50, 15 *3-27 (13), 14*	3-17 (7), 12
Strength		
C_u correlated from SPT N (kN/m^2)	n/a	13.5-76.5 (31.5), 12
ϕ'_{cv} derived from BS8002:2015 (degree)	n/a	27.7 (27.7), 1
ϕ' after Stroud (1989) (degree)	*28.6-34.8 (31.2), 14*	n/a
Stiffness		
E_u correlated from SPT N (MN/m^2)	n/a	3-17 (7), 12
E' correlated from SPT N (MN/m^2)	*3-27 (13), 14*	2.4-13.6 (5.6), 12
E_m correlated from SPT N (MN/m^2)	*5-135 (65), 14* (1)	-
Plate Load Test		
E_v (MN/m^2)	11-462, 19 *11-185 (77), 18*	-
E_{sec} at 200kN/m^2 Applied Stress (MN/m^2)	16-544, 19 *16-438 (129), 18*	-
k (MN/m^3)	40-1088, 19 *40-744 (315), 18*	-

Notes: '-' denotes no testing is available. 'n/a' denotes the test is not applicable for the material.

Values in bracket '( )' are the average values and are provided where appropriate.
Values after the comma ',' are the numbers of test or results.
Values in grey and italic are revised results after discount of abnormal values – refer to the report for details.
(1) Correlation factor E_m/N = 5 (to CIRIA R143).

5.7 Structured Chalk

General

CIRIA Chalk Grade

5.7.1 Structured Chalk is considered in the context of this pGIR to be chalk that has been classified to the CIRIA C574 grades other than Dm or Dc. An attempt is made to statistically analyse the distribution and thickness of structured Chalk along the route and the results are summarised in Table 6-10 and Table 6-11.

5.7.2 The analysis considers structured Chalk encountered within an offset of 500m from the mainline horizontal route alignment. The results are presented in terms of percentages to the overall drilled meterage in the structured Chalk. Only structured Chalk that has been positively logged as single CIRIA grades are included in the analysis. For the structured Chalk that has been logged with multiple grades, for examples for grades B3-4 or C3/B3, they have not been included in the analyses. Table 6-10 is a summary of the identified structured Chalk. Table 6-11 is an expansion of Table 6-10 with sub-divisions in terms of depth ranges and the route segments as defined in Table 6-1.

5.7.3 The following observations are made on Table 6-10 and Table 6-11:

a) The majority of structured Chalk encountered is grade B which contributes to a total of approximately 63% of the route-wide structured Chalk.
b) Chalk grade suffix 3 has the most occurrences. Chalk grades A3, B3 and C3 combines to a total of approximately 56% of the route-wide structured chalk.
c) Chalk grade suffices 2 and 4 contribute to a total of approximately 41% of the route-wide structured chalk.
d) Chalk grade suffix 5 contributes to a total of 2.6% of the route-wide structured chalk.
e) Chalk grade suffix 1 has the least occurrences with a total of 0.5% route-wide.
f) Chalk grade C1 has not been identified route-wide.
g) Chalk grade prefixes A, B and C were identified across the entire investigated depth (up to 50m), with the exception of Chalk grade prefix A which was not identified below 40m bgl.
h) The investigated depths of the exploratory holes within route segments S-1 to S-5, S-7 and S-8 are less than 20m. Deeper exploratory holes are located within route segment S-6 (i.e. proposed tunnel).

Table 6-10 Summary of CIRIA Chalk Grades for the Structured Chalk

CIRIA Grade	A1	A2	A3	A4	A5	Grade A Overall	B1	B2	B3	B4	B5	Grade B Overall	C1	C2	C3	C4	C5	Grade C Overall
Route-wide Total (%)	0.1	4.4	13.5	2.7	0.2	20.8	0.4	14.9	32.6	13.3	1.5	62.8	-	1.4	10.2	3.9	0.9	16.4

Note: Percentage to the total drilled and identified structured Chalk meterage of 839m.

Table 6-11 Expanded Version of the Summary in Table 6-10

Depth Range	Route Segment	CIRIA Grade A						CIRIA Grade B						CIRIA Grade C					
		A1	A2	A3	A4	A5	Grade A Overall	B1	B2	B3	B4	B5	Grade B Overall	C1	C2	C3	C4	C5	Grade C Overall
0-10m	S-1	0.1	0.2	2.1	0.1	0.1	2.6	-	-	3.4	2.5	0.2	6.2	-	-	-	0.2	0.2	0.4
	S-2	-	0.2	0.1	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-
	S-3	-	-	-	-	-	-	-	-	0.0	0.1	0.1	0.1	-	-	-	-	-	-
	S-4	-	0.3	1.8	0.4	-	2.6	-	-	3.1	0.8	0.4	4.3	-	-	-	0.2	-	0.2
	S-5	-	-	-	-	-	-	-	-	2.3	0.5	0.1	2.9	-	-	-	0.2	-	0.2
	S-6	-	2.2	3.7	0.7	-	6.6	-	3.1	12.5	9.3	0.9	25.8	-	0.7	1.0	2.8	0.7	5.3
	S-7	-	0.6	0.6	0.1	-	1.3	-	-	0.9	0.5	-	1.4	-	-	-	1.1	-	1.1
	S-8	-	0.6	0.6	0.1	-	1.3	-	-	1.1	0.8	-	2.0	-	-	-	1.1	-	1.1
	Route-wide Total	0.1	2.8	7.6	1.3	0.1	11.7	-	3.1	19.3	12.9	1.5	36.8	-	0.7	1.0	3.2	0.9	5.8
10-20m	S-1	-	0.3	1.3	-	-	1.6	-	-	-	-	-	-	-	-	0.5	-	-	0.5
	S-2	-	-	0.8	-	-	0.8	-	-	0.2	-	-	0.2	-	-	0.5	-	-	0.5
	S-3	-	-	-	-	-	-	-	-	0.8	-	-	0.8	-	-	-	-	-	-
	S-4	-	0.2	0.5	-	-	0.8	-	-	0.6	-	-	0.6	-	-	-	-	-	-
	S-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-6	-	0.6	1.7	1.2	-	3.5	0.2	4.3	9.4	0.2	-	14.1	-	0.1	2.0	0.3	-	2.5

Depth Range	Route Segment	CIRIA Grade A						CIRIA Grade B						CIRIA Grade C					
		A1	A2	A3	A4	A5	Grade A Overall	B1	B2	B3	B4	B5	Grade B Overall	C1	C2	C3	C4	C5	Grade C Overall
	S-7	-	-	-	-	-	-	-	0.4	-	-	-	0.4	-	-	0.8	0.1	-	0.9
	S-8	-	-	0.5	-	-	0.5	-	0.4	-	-	-	0.4	-	-	0.4	-	-	0.4
	Route - wide Total	-	1.1	4.1	1.2	-	6.4	0.2	4.3	10.1	0.2	-	14.8	-	0.1	3.0	0.3	-	3.4
20-30m	S-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-6	-	-	1.8	0.2	0.1	2.0	-	5.1	2.4	0.2	-	7.7	-	-	3.4	-	-	3.4
	S-7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9	-	-	0.9
	S-8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9	-	-	0.9
	Route - wide Total	-	-	1.8	0.2	0.1	2.0	-	5.1	2.4	0.2	-	7.7	-	-	3.4	0.1	-	3.5
30-40m	S-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-6	-	0.6	-	-	-	0.6	0.3	1.7	0.7	-	-	2.7	-	0.6	-	-	-	0.6
	S-7	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-	-	0.2
	S-8	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-	-	0.2
	Route - wide Total	-	0.6	-	-	-	0.6	0.3	1.7	0.7	-	-	2.7	-	0.6	2.3	0.2	-	3.1

Depth Range	Route Segment	CIRIA Grade A						CIRIA Grade B						CIRIA Grade C					
		A1	A2	A3	A4	A5	Grade A Overall	B1	B2	B3	B4	B5	Grade B Overall	C1	C2	C3	C4	C5	Grade C Overall
40-50m	S-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-6	-	-	-	-	-	-	-	0.7	-	-	-	0.7	-	-	0.5	-	-	0.5
	S-7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	S-8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Route - wide Total	-	-	-	-	-	-	-	0.7	-	-	-	0.7	-	-	0.5	-	-	0.5

Note: Percentage to the total drilled and identified structured Chalk meterage of 839m.

Discontinuity Properties

Joint Roughness Coefficient (JRC)

5.7.4 The Joint Roughness Coefficient (JRC) is a number relating to the roughness of a discontinuity in a scale of 0 to 20. Increasing JRC values represent an increase in undulation and aperture of the discontinuity and hence the roughness.

5.7.5 The as-logged JRC values have been recorded in the previous ground investigations 16174, 16175, 17439 and 21762.

5.7.6 The JRC values have been analysed according to the locations (in terms of route segments), the CIRIA chalk grades and chalk formations. The results are summarised in Table 6-12.

5.7.7 The overall route-wide JRC values range from 1 to 20 with an average of 7.6.

5.7.8 The average JRC values for the route segments range from 7.3 to 9.9. This range excludes the average JRC value of 12.1 for route segment S-2 which is considered abnormally high in comparison with the other average route segment JRC values. It is noted that the JRC values in route segment S-2 has a narrow range from 8 to 16 and based on 115 number of JRC values against a total route wide number of 8018 (i.e. approximate to 1.4% of the total).

5.7.9 JRC values are available generally to depths less than 20m bgl. An exception is route segment S-6 where it contains JRC values down to just below 50m bgl and it also has the most JRC records (7043 out of total number of JRC values of 8018). For this segment, average JRC values range from 7.0 to 7.6 from ground level to 50m bgl. The average JCR value is 9.0 below 50m bgl. However, the dataset contains only three JRC records and it may not be appropriate to suggest a trend of higher JRC values below 50m bgl based on such a small number of records.

5.7.10 The JRC values have been matched against corresponding CIRIA Chalk grade prefixes. The average JRC values are 7.7 for both CIRIA Chalk grade prefixes A and B, and are close to the overall route-wide average of 7.6. The average JRC value for CIRIA Chalk grade prefix C is higher at 10.3.

5.7.11 The JRC values have also been assessed for their corresponding Chalk formations. The average JRC values for Newhaven Chalk and Seaford Chalk Formations are 6.5 and 6.8 respectively which are less than the overall route-wide average value.

5.7.12 Potential phosphatic Chalk has been identified as standalone group in the dataset and their average JRC value is calculated to be 7.6 (i.e. same value as the overall route-wide average JRC).

Table 6-12 Summary of Joint Roughness Coefficient

Count

Depth Range	Route-wide	Route Segment								CIRIA Grade Prefix			Formation			
		S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	A	B	C	NCK	SCK	LNCK	PC
0-10m	3102	247	11	60	167	112	2688	206	206	364	1185	173	459	193	-	40
10-20m	3166	401	104	38	123	85	2605	113	150	457	379	178	160	454	-	288
20-30m	1156	-	-	-	-	-	1156	-	-	186	365	56	-	387	-	113
30-40m	462	-	-	-	-	-	462	-	-	99	89	21	-	200	-	40
40-50m	129	-	-	-	-	-	129	-	-	11	12	12	-	64	-	4
>50m	3	-	-	-	-	-	3	-	-	1	2	-	-	2	-	-
All depths	*8018*	*648*	*115*	*98*	*290*	*197*	*7043*	*319*	*356*	*1118*	*2032*	*440*	*619*	*1300*	*-*	*485*

Minimum

Depth Range	Route-wide	Route Segment								CIRIA Grade Prefix			Formation			
		S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	A	B	C	NCK	SCK	LNCK	PC
0-10m	1.0	2.0	8.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0	2.0	1.0	1.0	2.0	-	3.0
10-20m	1.0	2.0	8.0	4.0	2.0	3.0	1.0	4.0	4.0	1.0	2.0	2.0	2.0	1.0	-	2.0
20-30m	1.0	-	-	-	-	-	1.0	-	-	1.0	2.0	2.0	-	2.0	-	3.0
30-40m	2.0	-	-	-	-	-	2.0	-	-	3.0	2.0	8.0	-	2.0	-	2.0
40-50m	3.0	-	-	-	-	-	3.0	-	-	4.0	4.0	4.0	-	3.0	-	4.0
>50m	5.0	-	-	-	-	-	5.0	-	-	6.0	5.0	-	-	5.0	-	-
All depths	*1.0*	*2.0*	*8.0*	*2.0*	*1.0*	*2.0*	*1.0*	*1.0*	*1.0*	*1.0*	*2.0*	*1.0*	*1.0*	*1.0*	*-*	*2.0*

Maximum

Depth Range	Route-wide	Route Segment								CIRIA Grade Prefix			Formation			
		S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	A	B	C	NCK	SCK	LNCK	PC
0-10m	20.0	20.0	14.0	17.0	17.0	18.0	19.0	18.0	18.0	18.0	20.0	18.0	17.0	17.0	-	16.0
10-20m	19.0	19.0	16.0	17.0	17.0	17.0	19.0	19.0	19.0	18.0	19.0	19.0	17.0	17.0	-	19.0
20-30m	20.0	-	-	-	-	-	20.0	-	-	18.0	17.0	18.0	-	18.0	-	18.0
30-40m	20.0	-	-	-	-	-	20.0	-	-	16.0	20.0	18.0	-	20.0	-	17.0
40-50m	17.0	-	-	-	-	-	17.0	-	-	10.0	14.0	14.0	-	17.0	-	7.0
>50m	16.0	-	-	-	-	-	16.0	-	-	6.0	16.0	-	-	16.0	-	-

All depths	*20.0*	*20.0*	*16.0*	*17.0*	*17.0*	*18.0*	*20.0*	*19.0*	*19.0*	*18.0*	*20.0*	*19.0*	*17.0*	*20.0*	*-*	*19.0*

Average

Depth Range	Route-wide	Route Segment								CIRIA Grade Prefix			Formation			
		S-1	**S-2**	**S-3**	**S-4**	**S-5**	**S-6**	**S-7**	**S-8**	**A**	**B**	**C**	**NCK**	**SCK**	**LNCK**	**PC**
0-10m	7.2	8.9	10.5	7.7	7.8	7.9	7.0	8.8	8.8	7.1	7.3	9.5	6.2	6.0	-	7.1
10-20m	8.0	10.5	12.2	9.9	8.3	6.5	7.5	10.4	10.2	7.8	9.5	11.2	7.3	6.8	-	7.6
20-30m	7.5	-	-	-	-	-	7.5	-	-	8.3	7.2	9.9	-	6.9	-	7.5
30-40m	7.6	-	-	-	-	-	7.6	-	-	8.2	8.1	11.3	-	7.1	-	8.7
40-50m	7.5	-	-	-	-	-	7.5	-	-	7.8	8.3	8.3	-	8.1	-	5.0
>50m	9.0	-	-	-	-	-	9.0	-	-	6.0	10.5	-	-	10.5	-	-
All depth	*7.6*	*9.9*	*12.1*	*8.6*	*8.1*	*7.3*	*7.3*	*9.3*	*9.4*	*7.7*	*7.7*	*10.3*	*6.5*	*6.8*	*-*	*7.6*

Notes: NCK = Newhaven Chalk Formation; SCK = Seaford Chalk Formation; LNCK = Lewes Noduluar Chalk Formation; PC = Phosphatic Chalk.

n; SCK = Seaford Chalk Formation; LNCK = Lewes Noduluar Chalk Formation; PC = Phosphatic Chalk.

Discontinuity Direction and Dip Angle

5.7.13 OPTV surveys were carried out as part of the geophysical surveys during the previous ground investigations (16175, 17439 and 21762) and the 2017 ground investigation (29779).

5.7.14 Optical televiewer (OPTV) surveys were carried out by wireline techniques inside formed boreholes. OPTV uses a camera for taking continuous 360° imagery of the borehole perimeter. Discontinuities as shown on the images can be picked up with the aid of computer software and the associated dip directions (to the true north) and dip angles are computed.

5.7.15 The processed discontinuity data is provided in the information package. OPTV derived dip direction and angle data is available between chainage 6026 and 10497.

5.7.16 The dip directions and angles are plotted against depth and reduced level for the individual boreholes and the plots can be found in Appendix D of this pGIR. Additionally, the dip direction and angle of a discontinuity has been combined and plotted as a single point in the circular chart in Appendix D. In the circular charts, the distance between a point and the chart's origin represents the dip angle. The dip direction is represented by the angle measured between the true north line and the line joining the point to the chart's origin.

5.7.17 An attempt has been made to analyse the data per borehole against chainage. A summary of the dip directions and angles by boreholes and arranged in ascending chainage order is provided in Table 6-13. The dip directions, dip angles and their average are plotted against chainage and they are presented at the end of Appendix D. It is observed that the averaged directions in general lie between 135°[2] and 225° and therefore it may be suggested that the dips are in general southerly direction. The averaged dip angles are observed to generally range between 15° and 45° before chainage 9500, with a wider range of 6° to 57° between chainage 9947 and 10497.

Table 6-13 Summary of Discontinuity Directions and Dip Angles from the OPTV Surveys

Hole ID	Chainage (m)	Offset (m)	Surveyed Depth (m bgl)		Surveyed Level (m OD)		Dip Direction (degree)			Dip Angle (degree)		
			From	To	From	To	min	max	avg	min	max	avg
21762-R129	6026	35	3.3	12.5	107.8	98.6	43	242	117	0	37	14
21762-R130	6187	47	2.7	15.7	107.2	94.2	38	354	159	9	22	16
21762-R132	6543	88	5.1	13.1	100.6	92.6	48	332	174	5	57	27
16175-R4	7543	28	1.5	19.3	101.4	83.6	20	310	189	3	64	24
29779-R503B	7679	410	4.2	46.3	100.1	58.0	4	357	181	2	86	20
16175-R5	7697	16	3.0	19.4	101.9	85.5	1	354	206	3	66	24
21762-R135	7788	21	4.4	18.2	102.7	89.0	76	307	185	9	58	37
16175-R6	7837	12	2.0	20.0	105.9	87.9	46	302	168	2	75	22
16175-R7	7998	4	2.9	27.5	103.5	78.9	120	246	200	4	51	15
29779-PX505A	8031	344	5.8	40.7	93.7	58.8	7	353	161	2	77	25
16175-R8	8148	5	8.9	33.6	94.7	70.0	36	342	171	2	72	26
16175-R9	8332	12	3.8	31.2	95.6	68.2	15	354	211	3	70	37
17439-P1	8526	20	1.9	35.3	94.2	60.9	1	358	200	2	85	34
21762-R142	8638	52	3.7	42.8	89.3	50.2	2	355	188	4	65	26
16175-R11	8696	64	29.8	43.9	63.1	49.0	0	353	173	1	78	21
16175-R10	8723	37	6.2	24.1	88.2	70.3	30	354	213	1	37	16
21762-R146	8785	39	3.7	17.7	89.8	75.9	38	358	223	9	33	20
16175-R13	8844	66	1.6	47.4	91.5	45.7	4	353	159	5	71	32
16175-R12	8867	37	1.8	23.6	90.6	68.8	21	354	158	4	65	23
16175-R14	9021	36	4.3	19.4	81.7	66.6	31	353	208	5	63	30
17439-P2	9108	55	14.9	34.2	65.9	46.6	15	356	217	1	75	40
21762-R152	9080	61	Not available due to poor quality OPTV image.									
21762-R157	9173	50	9.6	22.0	70.0	57.7	15	351	232	2	49	26
21762-R154	9209	68	9.0	28.8	79.2	59.4	18	337	156	11	76	37
16175-R18	9282	83	7.5	48.3	89.0	48.2	8	354	206	7	79	43

Hole ID	Chainage (m)	Offset (m)	Surveyed Depth (m bgl)		Surveyed Level (m OD)		Dip Direction (degree)			Dip Angle (degree)		
			From	To	From	To	min	max	avg	min	max	avg
16175-R17	9285	22	2.1	15.2	95.0	81.9	80	310	193	4	30	16
16175-R19	9478	23	8.6	38.7	97.7	67.6	31	326	212	3	73	19
16175-R21	9947	93	12.3	19.2	97.6	90.7	42	319	181	6	6	6
21762-R158	10096	92	9.3	31.4	98.0	75.9	30	271	146	22	81	57
16175-R22	10129	103	2.4	19.5	103.7	86.6	2	357	124	12	77	47
16175-R23	10281	104	12.3	18.2	89.1	83.2	162	307	224	2	84	42
16175-R24	10438	83	2.7	13.4	94.4	83.7	27	355	222	27	74	52
29779-R507A	10497	22	7.3	35.8	85.0	56.6	12	359	138	1	70	21

Rock Quality Designation (RQD)

5.7.18 The Rock Quality Designation (RQD) values are reported in the factual reports in the previous ground investigations 16174, 16175, 17439 and 21762, and the 2017 ground investigation 29779.

5.7.19 RQD values have been analysed according to the locations (in terms of route segments), the CIRIA chalk grades and Chalk formations. The results are summarised in Table 6-14.

5.7.20 The route wide RQD values are sorted and averaged in 10m depth intervals. The averaged route wide RQD values are found to increase with depth. The average route wide RQD is 39% between 0-10m bgl and increases to 78% between 40-50m bgl.

5.7.21 The RQD values are further sorted and averaged according to the route segments. RQD values are only available for depths less than 20m within route segments S-1 to S-5.

5.7.22 Route segment S-6 contains a total of 588 RQD records, which equates to 87% of the route-wide RQD records. The difference in average RQD values between route wide and route segment S-6 are small (differences up to 3%) above 20m bgl and the values are identical below 20m bgl.

5.7.23 In route segments S-7 and S-8, the averaged RQD is noted to initially increase from 27% for depth range 0-10m, to 43-44% for depth range 10-20m. However, the averaged RQD values subsequently drop to 33% and 35% at depth ranges 20-30m and 30-40m respectively, which are approximately half of the averaged route wide values for these depth ranges. Borehole 29779-R507A in has been included in both S-7 and S-8 route segments in the RQD analysis. The relatively low averaged RQD values below 20m bgl in route segments S-7 and S-8 are influenced by the presence of possible faulting logged in borehole 29779-R507A.

5.7.24 The RQD values have been matched for their corresponding CIRIA chalk grade suffices. The CIRIA grade suffix is based on typical discontinuity spacing therefore it may be considered indirectly linked to the RQD. The averaged RQD values are noted to decrease as the numbers of the CIRIA grade suffix increase. The averaged RQD for CIRIA grade suffix 1 (for typical discontinuity spacing greater than 600mm) is 86%; decreasing to an averaged RQD of 29% for CIRIA grade suffix 5 (for typical discontinuity spacing less than 20mm).

5.7.25 The RQD values have also been matched against corresponding Chalk formations. The averaged RQD in Newhaven, Seaford and Lewes Nodular Chalk Formations are 30%, 61% and 68% respectively.

5.7.26 Potential phosphatic Chalk has been identified as standalone group within the dataset. There is a trend of increasing averaged RQD with depth and the values are not substantially different to those of the Seaford and Lewes Nodular Chalk Formations.

Table 6-14 Summary of Rock Quality Designation Values

Count

Depth Range	Route-wide	Route Segment								CIRIA Grade Suffix					Formation			
		S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	1	2	3	4	5	NCK	SCK	LNCK	PC
0-10m	191	16	3	5	15	5	160	16	16	-	28	73	53	7	41	16	-	2
10-20m	245	34	17	4	16	5	188	17	23	1	78	130	18	1	10	34	-	28
20-30m	128	-	-	-	-	-	128	7	7	1	54	48	6	1	1	45	-	11
30-40m	80	-	-	-	-	-	80	4	4	5	38	27	5	-	-	38	1	11
40-50m	32	-	-	-	-	-	32	-	-	-	25	4	-	-	-	12	1	4
>50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
All depth	*676*	*50*	*20*	*9*	*31*	*10*	*588*	*44*	*50*	*7*	*223*	*282*	*82*	*9*	*52*	*145*	*3*	*56*

Minimum

Depth Range	Route-wide	Route Segment								CIRIA Grade Suffix					Formation			
		S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	1	2	3	4	5	NCK	SCK	LNCK	PC
0-10m	0	0	0	36	36	0	0	0	0	-	33	0	0	0	0	0	-	23
10-20m	0	0	0	0	0	56	0	0	0	80	0	0	0	77	0	0	-	9
20-30m	0	-	-	-	-	-	0	18	18	100	35	0	18	36	83	18	-	27
30-40m	0	-	-	-	-	-	0	17	17	73	23	0	36	-	-	0	93	60
40-50m	0	-	-	-	-	-	0	-	-	-	0	7	-	-	-	7	70	44
>50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
All depth	0	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*73*	*0*	*0*	*0*	*0*	*0*	*0*	*40*	*9*

Maximum

Depth Range	Route-wide	Route Segment								CIRIA Grade Suffix					Formation			
		S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	1	2	3	4	5	NCK	SCK	LNCK	PC
0-10m	100	93	79	85	96	50	100	65	65	-	99	100	82	98	83	86	-	27
10-20m	100	100	92	97	100	84	100	95	95	80	100	100	94	77	90	91	-	100
20-30m	100	-	-	-	-	-	100	56	56	100	100	100	87	36	83	100	-	97
30-40m	100	-	-	-	-	-	100	50	50	100	100	100	80	-	-	100	93	100
40-50m	100	-	-	-	-	-	100	-	-	-	100	77	-	-	-	100	70	100
>50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

All depth	*100*	*100*	*92*	*97*	*100*	*84*	*100*	*95*	*95*	*100*	*100*	*100*	*94*	*98*	*90*	*100*	*93*	*100*

Average

Depth Range	Route-wide	Route Segment								CIRIA Grade Suffix					Formation			
		S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	1	2	3	4	5	NCK	SCK	LNCK	PC
0-10m	39	39	44	67	72	30	36	27	27	-	67	44	23	22	28	19	-	25
10-20m	55	53	46	61	76	64	54	43	44	80	69	49	44	77	37	49	-	52
20-30m	65	-	-	-	-	-	65	33	33	100	76	57	56	36	83	68	-	61
30-40m	71	-	-	-	-	-	71	35	35	85	79	58	59	-	-	73	93	81
40-50m	78	-	-	-	-	-	78	-	-	-	82	46	-	-	-	86	70	84
>50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
All depth	*55*	*49*	*45*	*64*	*74*	*47*	*55*	*35*	*36*	*86*	*73*	*50*	*32*	*29*	*30*	*61*	*68*	*61*

Notes: NCK = Newhaven Chalk Formation; SCK = Seaford Chalk Formation; LNCK = Lewes Noduluar Chalk Formation; PC = Phosphatic Chalk.

Classification

Bulk Density

5.7.27 Results from the absolute route wide bulk density testing range from 1.6 to 2.3 Mg/m³ (average 2.0 Mg/m³) but a narrower range can be seen to vary from 1.9 to and 2.1 Mg/m^3 with reference to bulk density against depth and reduced level plots in Figure 6-3 and Figure 6-4. Significant variation in bulk density relative to chalk formation and location is not apparent.

Intact Dry Density (IDD)

5.7.28 The intact dry density (IDD) of the structured Chalk tested route wide was found to range from 1.24 to 2.03 Mg/m³ (average 1.60 Mg/m³) and in general fall within the range for typical English Chalk from 1.29 to 2.46 Mg/m³ (Clayton, 1983).

5.7.29 The route wide IDD results are plotted against depth and reduced levels in Figure 6-9 and Figure 6-10. The IDD data is observed to be relatively wider spread above 20m bgl than below and is associated with the results from structured Chalk that has not been differentiated for formation. Otherwise, a narrower range of 1.5 to 1.7 Mg/m³ can be identified and the range corresponds to the tested chalk with medium density in accordance with Table 3.2 of CIRIA C574 (Lord *et al.*, 2002) [46] .

5.7.30 Observed variations between the different chalk formations are minor. The averaged IDD for the Newhaven, Seaford and Lewes Nodular formations are 1.56, 1.58 and 1.53 Mg/m^3 respectively.

5.7.31 The averaged IDD for the tested chalk in the western route segments S-1 to S-3 (range 1.69 to 1.79 Mg/m³) are noted to be slightly higher than those in the central to eastern route segments S-4 to S-8 (1.53 to 1.61 Mg/m³).

Specific Gravity/ Particle Density

5.7.32 A total of thirty three particle density tests were carried out on the Chalk samples as part of the historical ground investigation HAGDMS reference 16174. The particle density test results range from 2.67 to 2.73 Mg/m³ with an average of 2.71 Mg/m³. The averaged particle density is within the typical range of 2.69-2.71 Mg/m³ as reported by Clayton (1983) for normal chalk.

Natural Moisture Content (NMC)

5.7.33 Route wide NMC results are plotted against depth and reduced level in Figure 6-11 and Figure 6-12. NMC results range from 9.8 to 83% (average 25.1%). The dataset contains two abnormally high NMC of 83% and 77% from the tested samples taken from 16175-R8 at 24.56m bgl and 16175-R15A at 29.56m bgl respectively. The range may be revised to 9.8 to 37% (average 24.9%) if the two abnormal results are removed.

5.7.34 The ranges of NMC for Newhaven Chalk Formation is 19 to 32% (average 26.6%); Seaford Chalk Formation is 18 to 37% (average 26.0%), and Lewes Nodular Chalk Formation is 25 to26% (average 25.7%, based on three tests only). There are limited variations in the averaged NMC between the different chalk formations. However, the individual Chalk formation averages are all slightly higher than the route wide average of 24.9% which includes test results from Chalk that has not been differentiated for formations.

5.7.35 It is observed there is a trend of increase in average NMC from west to east. The average NMC is 22.2% in route segment S-1 and although it initially falls to 18.9% in route-segment S-2, it gradually rises to 27.0 and 27.4% in route segments S-7 and S-8. This trend may be related to the investigated depths by the exploratory holes. Investigation depths in the western route segments extend to maximum depths of approximately 20m bgl. In comparison, the investigated depths in the eastern route segments are in general deeper (up to 51.3m bgl) than the west, in particular in the areas of the proposed tunnel and Countess Roundabout.

5.7.36 With reference to the route wide NMC against depth plot (Figure 6-11), the dataset is most widely distributed at upper levels and is confined to the approximated lower limit of 10% and upper limit of 30% at ground level. The lower and upper limits may be considered to be 20% and 28% respectively below 40m bgl. The spread of data therefore reduces with depth, in a fashion that the rate of increase of the lower limit is greater than the rate of deduction of the upper limit.

Saturated Moisture Content (SMC)

5.7.37 Route wide SMC values are plotted against depth and reduced level in Figure 6-13 and Figure 6-14. The SMC ranges from 2 to 37%. The route wide SMC value range may be revised to between13 and 37% (average 25.4%, corresponding to medium density chalk to CIRIA C574) when two abnormal values of 2 and 11% are dismissed and is within the typical SMC value of 4 to 40% for normal chalk (Clayton, 1983).

5.7.38 The average NMC for the Newhaven, Seaford and Lewes Nodular Chalk Formations are 27.1%, 26.1% and 28% (one test only) respectively. The individual chalk formation average SMC values are all higher than the route wide averaged SMC of 25.4% which includes test results from chalk that has not been differentiated for formations. The dataset of SMC for the undifferentiated chalk tends to be wider in distribution but collectively slightly lower in value than those with identified formations.

5.7.39 It is observed that there is a trend of increasing average SMC values from west to east. The average SMC value is 22.8% in route segment S-1 and although it initially falls to 19.2% in route-segment S-2, it gradually rises to become 27.9 and 28.4% in route segments S-7 and S-8.

Saturation

5.7.40 The NMC results are matched with the corresponding SMC results to determine the degree of saturation (in percentage) of the tested structured chalk. The route-wide saturation is found to range from 42 to 100%, with an averaged value of 98% indicating high degree of saturation.

Strength

Point Load Index ($I_{s(50)}$)

5.7.41 Point load tests have been carried out on specimens that were sub-sampled from Chalk cores. The specimens were tested in both the axial and diametrical directions. Additional point load tests were carried out on irregular lumps. The results have been corrected to the equivalent size of 50mm diameter and reported as Point Load Index $I_{s(50)}$.

5.7.42 The route wide $I_{s(50)}$ values are found to range from 0.02 to 0.9 MN/m² (average 0.19 MN/m²) for the axial tests and from 0.01 to 0.93 MN/m² (average 0.15 MN/m²) for the diametrical tests. The results range from 0.01 to 1.1 MN/m² (average 0.19 MN/m²) for the tests carried out on irregular lumps. The average route wide $I_{s(50)}$ value considering all tests is 0.175 MN/m². The $I_{s(50)}$ values fall within the range of 0.01 to 1.15 MN/m² for typical chalk in England (Clayton, 1983).

5.7.43 In most cases, multiple specimens were taken from the same chalk sample and tested axially and diametrically. This enables an opportunity to investigate the anisotropy in terms of chalk strength. The route-wide diametrical $I_{s(50)}$ is plotted against the axial $I_{s(50)}$ and presented in Figure 6-66. The plot shows that the data is generally scattered. A line representing diametrical $I_{s(50)}$ to axial $I_{s(50)}$ ratio of unity is plotted in Figure 6-66. It shows that majority of the data points lie below this line which indicates that the horizontal (diametrical) strength is in general lower than the vertical (axial) strength.

5.7.44 The diametrical $I_{s(50)}$ to axial $I_{s(50)}$ ratio is calculated and plotted against axial $I_{s(50)}$ in Figure 6-67. Whilst the distribution of the data points remain scattered, the plot shows that there is a tendency of the diametrical $I_{s(50)}$ to axial $I_{s(50)}$ ratio to decrease non-linearly with increasing axial $I_{s(50)}$.

Unconfined Uniaxial Compressive Strength (UCS)

5.7.45 The absolute route-wide UCS range varies from 0.5 to 5.2 MN/m² (average 2.2 MN/m²). With reference to Figure 6-68 and Figure 6-69 it can be seen that majority of the results range between 1.0 to 3.5 MN/m².

5.7.46 UCS tests carried out on the Seaford Chalk Formation range from 0.5 to 4.2 MN/m². UCS tests carried on the Newhaven and Lewes Nodular Chalk Formations are 0.6 MN/m² and 1.5 MN/m² respectively but only one test was carried out in each of these formations. It shall be noted that UCS tests were only carried out on chalk cores from boreholes located between chainage 7,400 to 10,400.

5.7.47 The results from the UCS testing classify the structured Chalk to be of low to medium density Chalk. The structured Chalk is classified to be extremely weak to very weak according to BS EN ISO 14689-1:2003.

5.7.48 A correlation factor, K, exists between the Point Load Index and the unconfined uniaxial compressive strength. The K factor (UCS over $I_{s(50)}$) is typically assumed as 24 for general use. With reference to Bowden et al (1998), however, for weak rock (i.e. less than 25 MN/m²) the K factor is less than 24 and is usually in the range between 10 and 20.

5.7.49 Route wide axial $I_{s(50)}$ values have been correlated with UCS test results that were carried out within 0.5m from each other. The axial $I_{s(50)}$ values are plotted against UCS and presented in Figure 6-70. Three lines representing K factors of 5, 10 and 20 are drawn in Figure 6-70. The plot shows that the majority of the scheme's results are distributed in the space between the K=5 and K=20 lines. This observation is in agreement with the findings in the Bowden et al (1998) study in which the authors had utilised results from tests carried out on Newhaven Chalk Formation from the Southwick Hill Tunnel project and other areas in the north Kent. The Bowden et al (1998) study, however, contains UCS results ranging from approximately 1 to 8 MN/m² whereas the A303 scheme has a narrower range of approximately 0.5 to 5.2 MN/m² (or 0.5 to 3.2 MN/m² if the data point associated with a UCS of 5.2 MN/m^2 is discounted).

5.7.50 The same data that was selected in the preparation of Figure 6-70 has been calculated in terms of K factors, and are plotted against UCS and presented in Figure 6-70. The plot demonstrates that there is a tendency for the K factors to increase with increasing UCS, albeit one extreme value for a UCS at 5.2 MN/m² and returns a high K factor of 40. The K factor therefore is strength dependent and the same conclusion is made as by Bowden et at (1998 [54], CIRIA 574).

5.7.51 The UCS is plotted against IDD in Figure 6-72. Whilst the results are slightly scattered, a general trend of increasing UCS with increasing IDD can still be observed. The results are also comparable to the UCS (saturated chalk) to IDD relationship proposed by Matthews and Clayton (1993 [55], CIRIA 574).

Undrained Shear Strength (C_u)

5.7.52 The undrained shear strength of the structured Chalk has been estimated based on the results of the down hole High Pressure Dilatometer (HPD) tests carried out in 4.3-6.9m depth intervals in three boreholes that were formed during the previous ground investigation 16175.

5.7.53 Borehole 16175-R13 (chainage 8,844) is located at the western interfluve of the Stonehenge Bottom. The HPD tests carried out in this borehole cover the depth between 7.45m and 49.5m bgl. The top two HPD tests were carried out in the Newhaven Chalk Formation. The remainders were in the Seaford Chalk Formation.

5.7.54 Borehole 16175-R16 (chainage 9,149) is located at the Stonehenge Bottom. The HPD tests were carried out between 9.2m and 33.6m bgl. All HPD tests were in the Seaford Chalk Formation.

5.7.55 Borehole 16175-R18 (chainage 9,282) is located at the eastern interfluve of the Stonehenge Bottom. The HPD tests were carried out between 8.2m and 42.4m bgl. All HPD tests were in the Seaford Chalk Formation.

5.7.56 The HPD test derived undrained shear strengths are plotted against depth and reduced level in Figure 6-53 and Figure 6-54. Undrained shear strength varies from 1.2 to 5.7 MN/m². The undrained shear strength is shown to increase with depth and reduced level.

5.7.57 The undrained shear strength of rock may be estimated as half of the UCS value. The UCS against depth and reduced levels are given in Figure 6-68 and Figure

6-69. The UCS plots show that majority of the UCS data falls within 1 to 3.5 MN/m^2 and indicate little evidence in variation with depth. The UCS range is halved to give an undrained shear strength range of 0.5 to 1.75 MN/m^2, which is lower than the range of 1.2 to 5.7 MN/m^2 derived from the HPD tests.

5.7.58 With reference to the Preliminary Geotechnical Report [36], the higher estimated undrained shear strength from the HPD tests may be due to the chalk mass not acting in an undrained manner and volume changes occurring which in turn invalidate the analytical method. The undrained shear strength derived from the HPD tests therefore should be treated with caution.

Effective Strength

5.7.59 The shear strength of the discontinuities and intact chalk has been investigated by carrying out laboratory direct shear box testing. Nine shear box tests were carried out on samples recovered from the structured Chalk in boreholes 29779-P502B, P505 and R503B, R507A during the 2017 EP GI. All boreholes are considered to locate within the proposed tunnel section. Borehole 29779-R507A is located approximately 22m from the Preferred Route mainline alignment whilst the others are located at a distance of greater than 340m.

5.7.60 Shear box tests were either undertaken on natural joints or newly prepared saw-cut discontinuities. Each saw-cut shear box test comprised testing at three different constant normal pressures ranging from $100kN/m^2$ up to $1000kN/m^2$. Only one normal pressure was applied on each natural joint test with overall testing pressures vary from $320kN/m^2$ to $700kN/m^2$.

5.7.61 The shear stresses from the shear box tests are plotted against the applied normal stresses in Figure 6-61 to Figure 6-63.

5.7.62 A summary of the shear box results is presented in Table 6-15.

5.7.63 The shear stresses against shear displacement plots are available in the 2017 EP GI factual report. For all shear box tests on saw-cut samples, it is observed that the shear stresses remain relatively constant after shear failure occurs (i.e. appear as relatively horizontal line on the plot) suggesting that the prepared cuts are planar and smooth. The reported Joint Roughness Coefficient (JRC) ranges from 0 to 2 which confirm this observation. The contribution from the discontinuity surface roughness in the estimated friction angle in these tests would be minimal. The reported saw-cut peak friction angles (ϕ_p) in Table 6-15 therefore can be considered to be representative of the intact rock friction angles (ϕ_r).

5.7.64 Amongst the natural joint shear box tests, only the test carried out in borehole 29779-P505 on the sample taken between 26.8-27.4m bgl has demonstrated notably a reduction in shear stress after the peak shear strength has been reached. Only for this test can a residual friction angle be estimated. The intact rock friction angle (ϕ_r) for this test only is presented by the residual friction angle (ϕ_{res}). For other natural joint shear box tests, ϕ_r may be taken as ϕ_p.

5.7.65 With reference to Table 6-15, the intact rock friction angle of the Seaford Chalk Formation has been tested to range from 38.7° to 42.8°. The results compare well with the published friction angle of 40° by Burland et al (1983 [56], CIRIA C574) based on axial test results on intact former Upper Chalk samples in the area of Salisbury. The results compare well with the “moderately conservative” strength parameters of ϕ’ = 39° and c’ = 20 kN/m² suggested by CIRIA C574 for former Upper Chalk (for information, the suggested “worst credible” parameters are ϕ’ = 34° and c’ = 0 kN/m²).

5.7.66 The estimated intact rock friction angles based on four shear box tests on undifferentiated structured Chalk and Lewes Nodular Chalk Formation samples overall range from 9.1° to 13.1°. This range is considerably lower than those estimated for the Seaford Chalk Formation or published Upper Chalk. Examination of the exploratory hole records and discontinuity logs reveal that the test samples contain either sponges (for tests in 29779-R503B 32.4-33.3m bgl sample and 29779-P505 38.1-38.8m bgl sample) or possible micro fault fractures (29779-P505 39.5-39.8m bgl sample) which may influence the strength of the intact chalk. However, this evidence alone does not fully explain the low values. The range is relatively narrow (4° difference). The presence of sponge in the samples is expected to influence the result differently in magnitude to the sample with presence of micro fault factures and the difference is expected to be reflected with a wider friction angle range. Moreover, no unusual characteristics have been noted for the test carried out at 27.8-28.1m bgl in 29779-R503B and the shear box test still return a low intact rock friction angle of 12.5°. The friction angles predicted for the undifferentiated chalk and Lewes Nodular Chalk Formation should be treated with caution until further shear box testing is carried out.

Table 6-15 Summary of Direct Shear Box Test Results on Structured Chalk

Hole ID	Chainage, Offset (m), (m)	Test Depth (m bgl)	Applied Normal Stress (kN/m²)	Type of Discon-tinuity	Shear Strength based on Individual Test		Friction Angle Range	
					$\square_p$ / c_p (deg. / kN/ m²)	$\square_{res}$ / c_{res} (deg. / kN/ m²)	$\square$ + i (deg.)	$\square$ (deg.)
Undifferentiated Chalk								
29779-R503B	7679, 410	27.8 - 28.1	500	natural	12.5 [1] / -	- / -	-	12.5 – 12.7 [2]
29779-R503B	7679, 410	32.4 - 33.3	250, 500, 750	saw-cut	12.7 / 0	- / -		
Seaford Chalk Formation								
29779-P502B	7897, 374	22.9 - 23.9	400, 600, 800	saw-cut	41.4 / 0	- / -	44.5	38.7 – 42.8
29779-P505	8157, 343	26.8 - 27.4	500	natural	44.5 [1] / -	40 [1] / -		
29779-R507A	10497, 22	16.8 - 17.1	320	natural	38.7 [1] / -	- / -		
29779-R507A	10497, 22	20.7 - 20.9	100, 200, 400	saw-cut	42.8 / 0	- / -		
29779-R507A	10497, 22	30.1 - 30.3	200, 400, 800	saw-cut	42.2 / 48	- / -		
Lewes Nodular Chalk Formation								
29779-P505	8157, 343	38.1 - 38.8	600, 800, 1000	saw-cut	9.1 / 38	- / -	-	9.1 – 13.1 [2]
29779-P505	8157, 343	39.5 - 39.8	700	natural	13.1 [1] / -	- / -		

Notes: [1] Estimated based on the result from a single applied normal stress.

(2) Friction angles are very low for Chalk and are considered anomalous. Refer to text for discussions.

5.7.67 It should be recognised that whilst the shear box test provides a means of estimating the rock mass shear strength of the structured Chalk, the size of the tested sample is small in relation to scale of chalk mass

5.7.68 The rock mass shear strength of the structured Chalk may be alternatively determined by empirical method such as the generalised Hoek-Brown criterion (1994). The Hoek-Brown method first considers the basic properties of the intact rock (e.g. rock type and uniaxial compressive strength) and subsequently reduces them to reflect those of the rock mass by taking into account of the state of the fracture and condition of the discontinuity surface. It further considers the reduction of the rock mass strength due to the type of construction (e.g. tunnelling, excavation) and the associated degree of disturbance. The derivation of the rock mass strength to the generalised Hoek-Brown criterion is considered to be outside the scope of this pGIR.

Stiffness

Poisson's Ratio

5.7.69 Poisson's ratio can be determined from the UCS tests that are coupled with deformation measurement. There have been nineteen of these tests carried out in the ground investigation 16175 but the Poisson's ratio values have not been provided.

5.7.70 Poisson's ratio of the structured Chalk was determined in five UCS tests on samples recovered from boreholes 21762-R142, 29779-P505 and R503B. The depth of the tested samples ranges from 10.8m to 26.1m bgl. Four of the five tests were from the ground investigation 29779, and reported Poisson's ratio of 0.06-0.19. The test carried out in on the 21762-R142 sample (test depth 10.8m bgl) reported Poisson's ratio of 0.19. There are few published values of Poisson's ratio for chalk as noted in CIRIA C574 [46].

5.7.71 The dynamic Poisson's ratio in chalk has been derived from the results of the P-S logging and is shown in Figure 6-87 and Figure 6-88. Further discussions on the P-S logging are provided in the later section of this report. The absolute range of the dynamic Poisson's ratio is found to be 0.24-0.39. The range may be revised to 0.28-0.39, if the abnormal smallest two values are discounted.

Stiffness by High Pressure Dilatometer (HPD) Testing

5.7.72 The stress-strain curves from the HPD test results have been interpreted by the ground investigation contractor to derive the shear moduli (G). G has been derived for both the initial loading phase (G_i, the gradient of the tangent line of the initial linear part of the loading curve) and the unload-reload loops (G_{UR}, the gradient of a line through each loop). The Young's moduli (E) is estimated by the following equation:

$$E = 2\,G\,(1 + \nu)$$

where ν is the Poisson's ratio and has been assumed as 0.24.

5.7.73 The initial Young's Modulus (E_i) and unload-reload loop Young's Modulus (E_{UR}) are plotted against depth and reduced level in Figure 6-78 and Figure 6-79. The absolute range of E_{UR} is found to vary from 0.1 to 15.0 GN/m² .However, the E_{UR} values of 9.4 GN/ m², 14.9 GN/ m² and 15.0 GN/ m² may be considered as extreme values and if discounted the E_{UR} range may be revised to 0.1 to 6.2 GN/ m². E_{UR} can be seen to increase with increasing depth or reducing reduced level.

5.7.74 The E_i range is found to range from 69 to 868 MN/ m². The values of E_i are small in comparison with those of E_{UR} but it is not unexpected. The HDP test pockets were formed by pre-boring and the walls of the hole are likely to have been disturbed by stress relief as soon as the coring bits were retracted. The tested materials during the initial loading phase therefore have been disturbed and the E values derived may not be representative to those of undisturbed rock mass.

5.7.75 The HPD tests were carried out in a strain range of 0.37-3.8% which is considered to be large strain and the stiffness derived from the HDP testing could be considered to be the rock mass stiffness.

Stiffness by UCS Test with Deformality Measurement

5.7.76 Laboratory UCS testing with deformality measurement has been carried out as part of the ground investigations 16175 (twenty-one tests), 21762 (three tests) and 29779 (nine tests). Test depth ranges from 9.6m to 34.5m bgl. Testing was on undifferentiated Chalk, Seaford Chalk Formation and phosphatic Chalk samples. The boreholes where the tested samples were recovered are as follows:

a) 16175-R10, R11, R12, R13, R17, R18, R19A, R20, R24, R6, R8 and R9.
b) 21762-R142
c) 29779-P502B, P505 and R503B

5.7.77 The axial intact rock modulus (E_{int}) has been derived from the axial stress-strain curves by the ground investigation contractors. E is typically determined following three methods as follows:

a) Tangent Modulus (E_{tan}): the gradient of the tangent line measured at a fixed percentage of the ultimate strength.
b) Average Modulus (E_{av}): the gradient of a straight line through the linear portion of the curve.
c) Secant Modulus (E_{sec}): the gradient of a straight line joining the point in the stress-strain curve at a fixed percentage of the ultimate strength to the origin.

5.7.78 The Young's Moduli derived by the different methods and the axial strain at failure are summarised in Table 6-16. The Young's Moduli are plotted against depth and reduced level in Figure 6-80 and Figure 6-81.

5.7.79 The overall E_{int} range is 0.47-7.93 GN/m^2 with no notable variation with depth or reduced level.

5.7.80 E_{av} are in general lower than and approximately half of the E values measured by other methods. E_{av} are only measured in the ground investigation 16175. With reference to Table 6-16, the lower E may correspond to the general larger strain required to test the 16175 samples to failure (approximately two times larger than 21762 and three times larger than 29779).

5.7.81 The overall strain range is 0.03-0.4%. The stiffness derived from the UCS testing is considered to be towards the upper limit of small strain to large strain.

Table 6-16 Summary of Structured Chalk Intact Young's Modulus and Failure Test Strain from the UCS Tests with Deformality Measurement

Ground Investigation		16175	21762	29779
Young's Modulus (GN/m²)	E_{tan} [1]	-	-	3.61 to 7.93
	E_{av}	0.47 to 2.84	-	-
	E_{sec} [1]	-	4.78	4.02 to 7.40
Strain at Failure (% strain)	Minimum	0.080	0.095	0.028
	maximum	0.400	0.120	0.120
	average	0.210	0.103	0.061

Notes: [1] E was measured at 50% of the ultimate strength.

5.7.82 The E_{int} derived from the UCS testing are matched for the corresponding IDD and plotted in Figure 6-82. It can be seen there is a trend of increasing E_{int} with increasing IDD. E_{int} would have fallen towards the lower bound or below to the published E_{int} to IDD relationship plot in CIRIA C574 [46]. However, E_{int} derived so far for the scheme and those presented in CIRIA C574 [46] are not directly comparable. The E_{int} from CIRIA C574 [46] are either "initial" moduli or tangent moduli measured at 50kN/m², meaning they were derived from a strain range that is considered much smaller than those measured for the scheme. In other words, the CIRIA C574 E_{int} are determined from the initial loading phase of the tests and they should be higher that the scheme E_{int} as expected.

Stiffness by Plate Load Test (PLT)

5.7.83 The mass modulus (E_m) of the chalk has been investigated by in-situ PLT. A total of twenty nine PLT have been carried as part of the previous ground investigations 16174 (24 tests) and 21762 (5 tests). The tests were carried out in trial pits at relatively shallow depth between 0.45m and 1.5m bgl. The trial pits are located between chainage 1,294 to 7,210 (i.e. within route segments S-1 to S-5), with offset from the main route alignment ranging from 3m to 165m.

5.7.84 Due to the relatively shallow depth of testing, the majority of the PLT (20 tests) were carried out on the weathered structureless Chalk (CIRIA grade Dc) found in the upper-most part of the underlying chalk. Six PLT were carried out on undifferentiated structured Chalk.

5.7.85 The modulus of subgrade reaction (k) and strain modulus (E_v) were derived from the PLT results and reported by the ground investigation contractors. The results are summarised in Table 6-17.

5.7.86 The applied stresses are plotted against normalised settlements (settlement over the plate diameter of 300mm, ρ/D, expressed in percentage) in Figure 6-86 after the recommendation to CIRIA C574. The plots indicate that the applied stresses respond in general linearly with ρ/D. Only nine tests were carried out beyond ρ/D=0.4%, a threshold value that CIRA C574 considers should be exceeded for the estimation of the yield modulus (E_y) and yield stress (q_y). The E_y and q_y have not been estimated from the test results for these reasons.

5.7.87 CIRIA C574 [46] recommends that the mass chalk modulus may be estimated from the stress against ρ/D plot by calculating the secant modulus (E_{sec}) based on an applied stress of 200kN/m², a stress level that is considered representative of the likely applied stress in practice. The calculated E_{sec} are summarised in Table 6-17. The maximum applied stress in 21762-DTP113 (0.5m bgl) and DTP133 (1.5m bgl) were less than 200kN/m² therefore E_{sec} cannot be determined. The strain at the applied stress of 200kN/m² is calculated to range from 0.04-1.29% (average 0.36%), and corresponds to small to large strain level.

Table 6-17 Summary of Plate Load Test Result

Stratum	E_v (MN/m^2)	E_{sec} at 200 kN/m^2 (MN/m^2)	k (MN/m^3)
Head Deposits [(1)]	9.3 [(2)]	13.8	3472 – as reported 34.7 - corrected [(2)]
Alluvium	5.5 & 10.6	7.2 & 14.7	32 & 56
Grade Dc Chalk[(3)]	11 – 185 (77)	16 - 438 (129)	40 - 744 (315)
Undifferentiated Structured Chalk [(4)]	6 - 92 (41)	16 - 60 (44)	64 - 384 (205)

Notes: [(1)] The test was carried out at in trial pit 16174-SSTP23. Grade Dc chalk is found only 0.1m below the test depth. Therefore the result may be more appropriate to be considered as part of the grade Dc chalk PLT tests.
[(2)] The k value reported by the GI contractor is based on the load against settlement curve prepared by the GI contractor. The loads on the plot are 100 times greater than the actual applied loads. The reported k should be corrected by division of 100 to determine the corrected k value (i.e. 34.7MN/m^2). Ev is not affected.
[(3)] Excluded abnormal results from 16174-STP9 at 0.5m bgl. E_v, E_{sec} and k are 462 MN/m^2, 544 MN/m^2 and 1088 MN/m^3 respectively. Horizontal bands of medium to widely spaced gravel to cobble sized flints were reported in the borehole record at 0.5m bgl.
[(4)] Excluded abnormal results from 16174-STP30 at 1.2m bgl. E_v, E_{sec} and k are 212 MN/m^2, 382 MN/m^2 and 856 MN/m^3 respectively. Horizontal bands of medium to widely spaced gravel to cobble sized flints were reported in the borehole record at 1.5m bgl (i.e. 300mm below test surface).
[(5)] Average values in brackets ().

Stiffness by Downhole P-S Logging

5.7.88 The compression and shear wave velocities (V_p and V_s respectively) of the chalk were measured by downhole P-S logging (also known as P-S suspension logging) during the ground investigation 29779. The tests were carried out in exploratory holes 29779-P502B, P503B, P505, P507A, PX504, PX505A and PX506 at depths range from 23m to 44m bgl.

5.7.89 P-S logging is a dynamic non-intrusive test and the shear and Young's moduli derived from such method are associated with small to very small strain level. The derived values are the maximum (or upper bound) shear and Young's moduli, and are referred as G_{max} and E_{max} respectively.

5.7.90 The stiffness analysis is based on the following equations using elastic wave propagation theory:

$$G_{max} = \rho {V_s}^2$$

$$\nu = \frac{{V_p}^2 - 2{V_s}^2}{2\,({V_p}^2 - {V_s}^2)}$$

$$E_{max} = 2G\,(1 + \nu)$$

where ρ is the bulk density and ν the dynamic Poisson's ratio.

5.7.91 There is a trend of increasing E_{max} with depth with reference to Figure 6-89 and Figure 6-90. E_{max} can be observed as 5.8-7.6 GN/m² amongst the shallowest tests between 23m and 25m bgl, and gradually increase with depth to between 8 and 12.3 GN/m² for deepest tests carried out between 40m and 45m bgl.

Stiffness by Correlation with SPT N Values

5.7.92 Burland and Lord (1970 [57] , CIRIA R143) has suggested that the intact modulus of chalk (E_{int}) may be estimated from the results of SPT carried out in relatively unweathered chalk by:

$$E_{int} = N_{60}\,50\;(MN/m^2)$$

5.7.93 The E_{int} derived from the scheme's SPT results using this relationship would compare well with the E_{max} derived from the P-S logging.

5.7.94 For chalk large strain level mass modulus (E_m) , Stroud (1989 [50], CIRIA R143) has suggested the following:

$$E_m = N_{60}\,5\;(MN/m^2)$$

Table 6-18 Summary of Geotechnical Parameters for Structured Chalk

Parameter	Overall	UND	NNC	SFC	LNC
Classification					
Bulk Density (Mg/m³)	1.6-2.3 (2.0), 1011	1.6-2.3 (2.0), 738	1.6-2.1 (2.0), 55	1.7-2.2 (2.0), 217	1.9 (1.9), 1
Intact Dry Density (Mg/m³)	1.24 - 2.03 (1.60), 1196	1.38-2.03 (1.61), 923	1.24-1.73 (1.57), 55	1.32-1.86 (1.58), 217	1.53 (1.53), 1
Particle Density (Mg/m³)	2.67-2.73 (2.71) , 32	2.67-2.73 (2.71) , 32	-	-	-
NMC (%)	9.8-83.0 (25.1), 1519 *9.8-37 (24.9), 1517*	9.8-83.0 (24.6), 1174	19-32 (26.6), 67	18-37 (25.9), 275	25-26 (25.7), 3
SMC (%)	2-37, 1176 *13-37 (25.4), 1174*	11-35 (25.1), 899	21-32 (27.1), 57	2-37 (26.0) 219	28 (28), 1
Saturation (%)	42-100 (98)	-	-	-	-
Strength					
Point Load Index, $I_{s(50)}$					
Axial (MN/m²)	0.02-0.9 (0.19), 339	0.02-0.83 (0.20), 313	0.02-0.39 (0.13), 20	0.02-0.41 (0.18), 106	-
Diametrical (MN/m²)	0.01-0.93 (0.15), 528	0.01-0.93 (0.15), 390	0.01-0.39 (0.11), 19	0.01-0.56 (0.13), 119	-
Irregular Lump (MN/m²)	0.01-1.1 (0.19), 491	0.01-1.10 (0.24), 334	0.02-0.19 (0.08), 37	0.01-0.31 (0.11), 120	-

Parameter	Overall	UND	NNC	SFC	LNC
Unconfined Compressive Strength, UCS (MN/m²)	0.5-5.2 (2.2), 79	1.0-5.2 (2.2), 44	0.6 (0.6), 1	0.5-4.2 (2.3), 33	1.5 (1.5), 1
C_u from HPD (MN/m²)	1.2-5.7 (2.9), 21	-	1.4 & 2.2 (1.8), 2	1.2 - 5.7 (3.1), 19	-
Direct Shear Box					
Friction Angle of Rock, ϕ'_r (degree)	n/a	12.5 & 12.7 (12.6), 2 (1)	-	38.7-42.8 (41.0), 5	9.1 & 13.1 (11.1), 2 (1)
Friction Angle of Rock plus Discontinuity Surface Roughness, ϕ'_{r+i} (degree)	n/a	-	-	44.5 (44.5), 1	-
Stiffness					
High Pressure Dilatometer					
Initial Young's Modulus, E_i (GN/m²)	0.07-0.87, 21	-	0.11 & 0.32, 2	0.07-0.87, 19	-
Unload-Reload Young's Modulus, E_{UR} (GN/m²)	0.1-15.0, 40 *0.1-6.2, 38*	-	0.5-1.4, 4	0.1-15.0, 36	-
UCS					
Poisson's Ratio, ν (unit-less)	0.06-0.19, 5	0.06-0.08, 3	-	0.08 & 0.19, 2	-
Axial Intact Rock Modulus E_{int} by tangent method, E_{tan} (GN/m²)	3.61-7.93, 4	1.0-5.2 (2.2), 44	0.6 (0.6), 1	0.5-4.2 (2.3), 33	1.5 (1.5), 1
Axial Intact Rock Modulus E_{int} by average method, E_{av} (GN/m²)	0.47-2.84, 19	0.47-2.84, 13	-	0.80-2.82, 6	-
Axial Intact Rock Modulus E_{int} by secant method, E_{sec} (GN/m²)	4.02-7.40, 5	4.02-7.40, 3	-	4.78 & 6.62, 2	-
Plate Load Test					
E_v (MN/m²)	6-212, 6 *6-92 (41), 5*	6-212, 6 *6-92 (41), 5*	-	-	-
E_{sec} at 200kN/m^2 Applied Stress (MN/m²)	16-382, 6 *16-60 (44), 5*	16-382, 6 *16-60 (44), 5*	-	-	-
k (MN/m³)	40-856, 6 *64-384 (205), 5*	40-856, 6 *64-384 (205), 5*	-	-	-
Downhole P-S Logging					
Dynamic Poisson's Ratio, ν (unit-less)	0.24-0.39, 6 holes *0.28-0.39, 4 holes*	0.24-0.39, 4 holes	0.32 & 0.39, 2 holes	-	-
E_{max} (GN/m²)	5.8-12.3, 6 holes	6.1-12.3, 4 holes	5.8 & 9.4, 2 holes	-	-

Notes: (1) Friction angles are very low for Chalk and are considered anomalous. Refer to text for discussions.
'-' denotes no testing is available. 'n/a' denotes the test is not applicable for the material.
Values in bracket '( )' are the average values and are provided where appropriate.
Values after the comma ',' are the numbers of test or results.
Values in grey and italic are revised results after discount of abnormal values – refer to the report for details.
'UND' = undifferentiated formation chalk; 'NHC' = Newhaven Chalk Formation; 'SFC' = Seaford Chalk Formation; 'LNC' = Lewes Nodular Chalk Formation.

5.8 Phosphatic Chalk

General

5.8.1 Phosphatic Chalk is considered in the context of this pGIR to be the potential phosphate containing chalk that has been identified via field logging or downhole geophysical natural gamma logging. Phosphatic Chalk has been differentiated from the “normal” chalk and reported and analysed accordingly in the following sections.

Classification

Bulk Density

5.8.2 A total of eighty eight bulk density tests were carried out on phosphatic Chalk samples and the results range is 1.9 to 2.1Mg/m³ (average 2.0 Mg/m³). The results are within the range of 1.6 to 2.3Mg/m³ for normal chalk. The results are presented in Figure 6-3 and Figure 6-4. It can be seen that there is no significant difference in bulk density between phosphatic Chalk and the “normal” chalk.

Intact Dry Density (IDD)

5.8.3 A total of eighty eight IDD tests were carried out on phosphatic Chalk samples and the results range from 1.48 to 1.78 Mg/m³ (average 1.61 Mg/m³). The results fall within the route-wide range of 1.24 to 2.03 Mg/m³ for normal chalk. The results are presented in Figure 6-9 and Figure 6-10. There is no significant difference in IDD between the phosphatic Chalk and the normal chalk.

Natural Moisture Content (NMC)

5.8.4 A total of one hundred and twenty four NMC tests were carried out on phosphatic Chalk samples. The results form a relatively narrow range of 19 to 31% (average 25.2%) in comparison with the route-wide range of 9.8-37%. The NMC results are presented in Figure 6-11 and Figure 6-12.

Saturated Moisture Content (SMC)

5.8.5 A total of eighty eight SMC tests were carried out on phosphatic Chalk samples. The results range from 19 to 31% (average 25.3%) and fall within the route-wide normal chalk range of 13-37% (average 25.4%). The results are presented in Figure 6-13 and Figure 6-14.

Saturation

5.8.6 The NMC results are matched with the corresponding SMC results to determine the degree of saturation (in percentage) of the tested phosphatic Chalk samples. Saturation was found to range from 87 to100%, with an averaged value of 99% which is close to the averaged value of 98% for normal chalk.

Slake Durability Index (I_{d2})

5.8.7 A total of thirteen slake durability tests were carried out on phosphatic Chalk samples recovered from four exploratory holes. The slake durability index (I_{d2}) results are summarised in Table 6-19 below. The second cycle I_{d2} values from the 29779 investigation testing have a range of 70.9 to 84.5% (average 80.9%), which is notably higher than the range of 8.0 to 70.7% (average 38.5%) from the previous ground investigations.

5.8.8 The two boreholes from 29779 investigation are located at some distance from the previous ground investigation boreholes. The differences in I_{d2} may be partly related to the variation in both the composition and locality of the phosphatic Chalk.

Table 6-19 Summary of Slake Durability Test Results

Hole ID	Offset (m)	Chainage (m)	Test Depth (m bgl)	1st Cycle I_{d2} (%)	2nd Cycle I_{d2} (%)
16175-R12	37	8867	19.5	-	61.8
21762-R142	52	8638	13.8	40.1	27.9
			14.0	28.8	17.8
			20.8	11.4	8.0
			26.0	66.0	44.5
			30.0	75.0	70.7
29779-P502B	374	7897	10.8	88.9	80.4
			17.5	90.3	82.6
29779-P505	343	8157	9.1	84.3	70.9
			10.6	91.9	84.5
			12.5	90.9	84.0
			15.9	90.5	83.0
			20.5	91.8	80.6

Strength

Point Load Index ($I_{s(50)}$)

5.8.9 The $I_{s(50)}$ determined from the point load tests carried out on axial, diametrical and irregular phosphatic Chalk samples are found to be 0.03 to 0.48 MN/m² (average 0.16 MN/m²), 0.01 to 0.30 MN/m² (average 0.13 MN/ m²) and 0.02 to 1.08 MN/ m² (average 0.20 MN/ m²) respectively.

5.8.10 The axial and diametrical $I_{s(50)}$values for normal chalk are 0.02 to 0.90 MN/m^2 (average 0.19 MN/ m²) and 0.01 to 0.93 MN/ m² (average 0.15 MN/m^2) respectively therefore are more widely distributed. The irregular $I_{s(50)}$ for normal chalk is 0.02 to 1.08 MN/ m² (average 0.20 MN/ m²) which is similar to those of the phosphatic Chalk.

5.8.11 The phosphatic Chalk diametrical $I_{s(50)}$ values are plotted against axial $I_{s(50)}$ values in Figure 6-66. Similar to the normal chalk, majority of the phosphatic Chalk data points are located below the 1:1 ratio line indicating that the horizontal (diametrical) strength is in general lower than the vertical (axial) strength.

Unconfined Uniaxial Compressive Strength (UCS)

5.8.12 There are a total of eighteen UCS tests carried out on phosphatic Chalk samples. The overall UCS is found to have a range of 1.2 to 3.6 MN/m² (average 2.6 MN/m²). The results are summarised in Table 6-20 and plotted in Figure 6-68 and

Figure 6-69. The plots show that there is little differentiation in the UCS results between phosphatic Chalk and normal chalk.

5.8.13 Six UCS tests have been carried out in the previous ground investigations (16175 and 21762) and the UCS is found to have a range of 1.2 to 3.1 MN/m². The UCS from the previous ground investigations are in general lower than those determined in the 29779 investigation (2.0 to 3.6 MN/m²).

5.8.14 Variations in UCS between those measured in the previous ground investigations and the 29779 investigation have been reviewed by examination of the strength descriptions provided in the borehole records (see Table 6-20). The strata where the phosphatic Chalk samples were taken in the previous ground investigation have in general been described as being “weak” in strength. In contrast, the 29779 investigation chalk samples have in general been descried as “very weak”.

5.8.15 The strength descriptors in the previous ground investigations were prepared to BS5930:1999. The terminology “weak” is associated with UCS of 1.25 to 5 MN/m² to BS5930:1999. The strength terminologies in BS5930:1999 have since been revised in line with Eurocodes. The 29779 investigation in 2017 was prepared to its later version, BS5930:2015, and the term “very weak” is associated with UCS of 1 to 5 MN/m². Therefore, the UCS ranges cover by the terms “weak” to BS5930:1999 and “very weak” to BS5930:2015 are very similar, and the phosphatic Chalk samples could not be distinguished in strength between the different the ground investigations based on the strength descriptors.

5.8.16 The height (H) to diameter ratios of the phosphatic Chalk test samples are calculated and given in Table 6-20. The H:D ratios are also plotted against laboratory UCS in Figure 6-91.

5.8.17 BS EN 1997-2:2007 recommends that the sample subject to UCS testing to have a H:D ratio between 2 and 3. Four samples are found to have H:D ratio below 2. It can be seen that there is a trend of increasing UCS with reducing H:D ratio in Figure 6-91. Figure 6-91 also illustrates that the previous ground investigations samples have H:D ratios above 2.5 (with one exception of H:D= 2 for the sample taken from borehole 21762-R142 at 30.6m bgl). In comparison, the H:D ratios for the 29779 investigation samples are all below 2.5. The higher UCS associated with the 29779 investigation may be partly contributed by the tested samples having smaller H:D ratios.

5.8.18 Boreholes 16175-R11 and R12, 21762-R142 and 29779-R501 are located in relatively close proximity to each other. They are located between chainage 8,638m to 8,867m, and within 65m from the mainline alignment.

5.8.19 As highlighted in the Preliminary Geotechnical Report [37], the UCS test would require the sample to be relatively “well-cemented” in nature so that it remains intact (or would not disintegrate by minimal handling) prior to testing. This would have prevented phosphatic Chalk of a friable and pelletal nature being selected as suitable samples for the UCS test. The results from the UCS test carried out to date correspond to a material that is “very weak” in strength (1 to 5 MN/m² to BS5930:2015). Potentially “extremely weak” (0.6 to 1 MN/m²) but weaker phosphatic Chalk may exist which could not be tested by the laboratory UCS test method.

Table 6-20 Summary of UCS of the Phosphatic Chalk

Hole ID	Offset	Chainage	Depth (m blg)	Reduced Level (m AOD)	H:D Ratio	UCS by Testing (MN/m²)	Stratum Strength Class [(1)]	UCS by Descriptions
16175-R11	64	8696	31.52	61.38	2.7	1.2	Weak	1.25 - 5.0
			33.18	59.72	2.7	2.6	Weak	1.25 - 5.0
			34.67	58.23	3.0	1.8	Weak	1.25 - 5.0
16175-R12	37	8867	16.72	75.68	3.0	1.8	Weak to very weak	<1.25 to 5.0
21762-R142	52	8638	26.15	66.79	2.6	1.5	Moderately strong	12.5 - 50.0
			30.62	62.32	2.0	3.1	Weak	1.25 - 5.0
29779-P502B	374	7897	11.75	91.48	2.2	2.6	Very weak	1.0 - 5.0
			14.61	88.62	1.5	2.8	Very weak	1.0 - 5.0
			16.27	86.96	1.8	3.2	Very weak	1.0 - 5.0
			19.33	83.9	2.2	3.0	Very weak	1.0 - 5.0
29779-P505	343	8157	12.83	83.45	2.2	3.6	Very weak	1.0 - 5.0
			32.85	63.43	2.2	2.1	Very weak locally weak	1.0 - 5.0 (locally 5 - 25)
			34.45	61.83	2.1	2.7	Very weak locally weak	1.0 - 5.0 (locally 5 - 25)
29779-R501	47	8639	15.23	77.93	1.7	2.7	Very weak to weak locally extremely weak	1 - 25 (locally 0.6-1.0)
			17	76.16	2.0	2.6	Very weak to weak locally extremely weak	1 - 25 (locally 0.6-1.0)
			21	72.16	2.3	3.3	Very weak	1.0 - 5.0
			25.12	68.04	1.8	2.0	Very weak	1.0 - 5.0
			26.13	67.03	2.4	3.4	Weak and very weak	1 - 25

Note: [(1)] the strength class in the previous ground investigations 16175 and 21762 were prepared to BS5930:1999; the 29779 investigation to BS5930:2015.

Undrained Shear Strength (C_u)

5.8.20 An estimate of undrained shear strength from HPD test results cannot be provided for phosphatic Chalk since the material was not tested. The undrained shear strength of the phosphatic Chalk may be estimated as half of its UCS value.

Effective Strength

5.8.21 A total of four direct shear box tests were carried out on samples recovered from phosphatic Chalk. A summary of the shear box results is presented in Table

6-21. The tests were carried out on a mixture of samples with discontinuities that are either prepared by saw-cut or natural.

5.8.22 The results on the samples recovered from boreholes 29779-R501 (26.5-26.7m bgl) and 16175-R12 (19.5-20.1m bgl) have demonstrated a reduction in shear stress after the peak shear strength has been reached and therefore the intact rock friction angle (ϕ_r) for these two tests are presented by the residual friction angle (ϕ_{res}). For the other tests, ϕ_r could be taken as the reported peak friction angle (ϕ_p).

5.8.23 The results may be divided into two groups. The first group comprises the results from boreholes 16175-R12 and 29779-R501 (29.0-29.5m bgl) with ϕ_r measured at 32° and 33.2° respectively. The material from 16175-R12 has been described as dense to very dense silty fine to medium grained sandstone with the sand being sub-rounded pelletal phosphatic chalk. The material from 29779-R501 has been described as weak to very weak medium to high density phosphatic chalk, with the specific sample depth highlighted being "very weak" as measured by field technique. The ϕ_r of the first group is slightly below the suggested "worst credible" ϕ' of 34° for former Upper Chalk by CIRIA C574.

5.8.24 The second group comprises the results from the remaining shear box tests. The ϕ_r were measured at 42.6° and 45.0°. These values are towards the upper range and above the measured values for the structured Seaford Chalk Formation. They are above the published friction angle of 40° by Burland et al (1983) for former Upper Chalk in the area of Salisbury. They are above the suggested "moderately conservative" ϕ' of 39° for former Upper Chalk by CIRIA C574.

5.8.25 The difference in intact rock friction angles between the two groups potentially is a reflection on the variation in strength of the phosphatic Chalk. More direct shear box tests will be required to confirm the validity of strength grouping and strength range.

Table 6-21 Summary of Direct Shear Box Test Results on Phosphatic Chalk

Hole ID	Chainage, Offset (m), (m)	Test Depth (m bgl)	Applied Normal Stress (kN/m²)	Type of Discon-tinuity	Shear Strength based on Individual Test		Friction Angle Range	
					□p / c_p (deg. / kN/m²)	□res / c_{res} (deg. / kN/m²)	□ + i (deg.)	□ (deg.)
16175-R12[1]	8867, 37	19.5 - 20.1	200, 400, 800	Unspecified	28.0 / 170	32.0 / 45	28.0 & 48.1	32.0 – 45.0
29779-P502B	7897, 374	15.4 – 16.0	200, 400, 800	saw-cut	42.6 / 15	- / -		
29779-R501	8639, 47	26.5 - 26.7	450	natural	48.1 [2] / -	45.0 [2] / -		
29779-R501	8639, 47	29.0 - 29.5	150, 300, 600	saw-cut	33.2 / 91	- / -		

Notes: [1] Tested in submerged condition.
[2] Estimated based on the result from a single applied normal stress.

Stiffness

Poisson's Ratio

5.8.26 A total of seven Poisson's ratio values were determined from the UCS tests coupled with deformation measurements. Phosphatic Chalk samples were recovered from three boreholes. The Poisson's ratio values determined from the 29779 investigation have a range of 0.01-0.19 (average 0.07) which is markedly lower than the values of 0.29 and 0.30 determined from the previous ground investigation.

Table 6-22 Summary of Poisson's Ratio Determined from UCS Test

Hole ID	Test Depth (m bgl)	Poisson's Ratio
21762-R142	26.15	0.30
	30.62	0.29
29779-P502B	14.61	0.01
	19.33	0.04
29779-P505	12.83	0.04
	16.9	0.19
	34.45	0.06

5.8.27 The dynamic Poisson's ratio in chalk has been derived from the results of the P-S logging and is shown in Figure 6-87 and Figure 6-88. Only the tested section carried out in borehole 29779-P505 is within phosphatic Chalk. The dynamic Poisson's ratio is found to have a range of 0.31-0.37, if one anomalous result of 0.25 is discounted.

Stiffness by High Pressure Dilatometer (HPD) Testing

5.8.28 The HDP testing was carried out in three previous ground investigation boreholes which have not been identified with the presence of phosphatic Chalk.

Stiffness by UCS Test with Deformality Measurement

5.8.29 The intact rock moduli have been derived from nine UCS tests that were coupled with deformation measurement. These boreholes and tested depths are:

a) 16175-R11 31.5m bgl
b) 16175-R12 16.7m bgl
c) 21762-R142 26.2m and 30.6m bgl
d) 29779-P502B 14.6m and 16.3m bgl
e) 29779-P505 12.83m, 16.9m, 34.5m bgl

5.8.30 The Young's Moduli are summarised in Table 6-23. The Young's Moduli are plotted against depth and reduced level in Figure 6-80 and Figure 6-81.

5.8.31 The overall E_{int} range for phosphatic Chalk is 0.95 to 7.38 GN/m², which is relatively consistent in magnitude with values derived for normal structured Chalk, except that the E_{int} range for phosphatic Chalk is slightly narrower.

Table 6-23 Summary of Phosphatic Chalk Intact Chalk Young's Modulus from the UCS Tests with Deformality Measurement

Ground Investigation	16175	21762	29779

Ground Investigation		16175	21762	29779
Young's Modulus (GN/m^2)	E_{tan} (1)	-	-	0.95 to 7.38
	E_{av}	1.93 & 3.61	-	-
	E_{sec} (1)	-	4.77 & 4.92	2.07 to 6.87

Notes: (1) E was measured at 50% of the ultimate strength.

Stiffness by Plate Load Test (PLT)

5.8.32 PLT has been carried out in trial pits therefore the tested depths are relatively shallow (deepest depth at 1.5m bgl) and did not test any phosphatic Chalk stratum.

Stiffness by Downhole P-S Logging

5.8.33 Only the tested section carried out in borehole 29779-P505 is within the phosphatic Chalk horizon and the results are shown on Figure 6-89 and Figure 6-90. E_{max} ranged from 6.7 to 8.5 GN/m². The results are observed to sit closely towards the lower bound of the overall data population of the normal Chalk.

Table 6-24 Summary of Geotechnical Parameters for Phosphatic Chalk

Parameter	Values
Classification	
Bulk Density (Mg/m^3)	1.9-2.1 (2.0), 88
Intact Dry Density (Mg/m^3)	1.48-1.78 (1.61), 88
Particle Density (Mg/m^3)	-
NMC (%)	19-31 (25.2), 124
SMC (%)	19-31 (25.3), 88
Saturation (%)	87-100 (99)
Slake Durability	
First Cycle I_{d2} (%)	11.4-91.9 (70.8), 12
Second Cycle I_{d2} (%)	8.0-84.5 (61.3), 13
Strength	
Point Load Index, $I_{s(50)}$	
Axial (MN/m^2)	0.03-0.48 (0.16), 45
Diametrical (MN/m^2)	0.01-0.30 (0.13), 52
Irregular Lump (MN/m^2)	0.01-1.10 (0.19), 33
Unconfined Compressive Strength, UCS (MN/m^2)	1.2-3.6 (2.6), 18
Direct Shear Box	
Friction Angle of Rock, □'$_r$ (degree)	32.0-45.0 (38.2), 4
Friction Angle of Rock plus Discontinuity Surface Roughness, □'$_{r+i}$ (degree)	28.0 & 48.1 (38.1), 2
Stiffness	
UCS	
Poisson's Ratio, □ (unitless)	0.01-0.30, 7
Axial Intact Rock Modulus E_{int} by tangent method, E_{tan} (GN/m^2)	0.95-7.38, 5

Parameter	Values
Axial Intact Rock Modulus E_{int} by average method, E_{av} (GN/m^2)	1.93 & 3.61, 2
Axial Intact Rock Modulus E_{int} by secant method, E_{sec} (GN/m^2)	2.07-6.87, 7
Downhole P-S Logging	
Dynamic Poisson's Ratio, □□ (unit less)	0.25-0.37, 1 hole *0.31-0.37, 1 hole*
E_{max} (GN/m^2)	6.7-8.5, 1 hole

Notes: '-' denotes no testing is available. 'n/a' denotes the test is not applicable for the material. Values in bracket '( )' are the average values and are provided where appropriate. Values after the comma ',' are the numbers of test or results. Values in grey and italic are revised results after discount of abnormal values – refer to the report for details.

5.9 Aquifer Permeability

5.9.1 Permeability values for the chalk aquifer have been estimated from falling and rising head tests, packer tests and pumping test as described in Section 4.7. The aquifer has divided into three zones in previous reports as shown in Figure 5-8:

a) Low: <1m/d (<1.0 x 10^{-5} m/s)
b) Moderate: 1 to 30 m/d (1.0 x 10^{-5} to 3.0 x10^{-4} m/s)
c) High: >100 m/d (>1.0 x 10^{-3} m/s)

5.9.2 Fracturing and fissuring is more developed in the upper part of the aquifer due to the water table fluctuations resulting in higher permeability. Permeability then decreases with depth. The base of the aquifer has been delimited by the base of the moderate permeability zone.

5.10 Soil and Groundwater Chemistry

Sulphates

5.10.1 A range of soil and groundwater sulphate and pH testing has been undertaken to determine the aggressive chemical environment for concrete (ACEC). The assessment has been undertaken separately for each stratum (when possible) in accordance with BRE Special Digest 1 [58].

Table 6-25 Sulphate Aggressivity Analysis Results

Stratum	Property	No. of Tests	Results Range	Characteristic Value	DS Class without TPS	ACEC Class without TPS	DS Class with TPS	ACEC Class with TPS
Topsoil	2:1 water soluble sulphates (mg/l)	*	*	*	-	-	-	-
	Groundwater sulphates (mg/l)	*	*	*				

Stratum	Property	No. of Tests	Results Range	Characteristic Value	DS Class without TPS	ACEC Class without TPS	DS Class with TPS	ACEC Class with TPS
	Total Potential Sulphates (%)	-	-	-				
	pH soil	10	7.8 – 8.6	7.9				
	pH groundwater	-	-	-				
Made Ground	2:1 water soluble sulphates (mg/l)	20**	15 – 450 ** (20 – 2700)	200** (900)	DS-1 (DS-2)	AC-1s (AC-2)	DS-1 (DS-2)	AC-1s (AC-2)
Made Ground	Groundwater sulphates (mg/l)	-	-	-	DS-1 (DS-2)	AC-1s (AC-2)	DS-1 (DS-2)	AC-1s (AC-2)
Made Ground	Total Potential Sulphates (%)	2	0.2	0.2	DS-1 (DS-2)	AC-1s (AC-2)	DS-1 (DS-2)	AC-1s (AC-2)
Made Ground	pH soil	24	7.8 – 10.7	8.0	DS-1 (DS-2)	AC-1s (AC-2)	DS-1 (DS-2)	AC-1s (AC-2)
Made Ground	pH groundwater	-	-	-	DS-1 (DS-2)	AC-1s (AC-2)	DS-1 (DS-2)	AC-1s (AC-2)
Head Deposits	2:1 water soluble sulphates (mg/l)	-	-	-	DS-1	AC-1	-	-
Head Deposits	Groundwater sulphates (mg/l)	1	30	30	DS-1	AC-1	-	-
Head Deposits	Total Potential Sulphates (%)	-	-	-	DS-1	AC-1	-	-
Head Deposits	pH soil	14	7.5 – 8.7	7.7	DS-1	AC-1	-	-
Head Deposits	pH groundwater	1	9	9	DS-1	AC-1	-	-
Alluvium	2:1 water soluble sulphates (mg/l)	3	20 – 30	30	DS-1	AC-1	DS-1	AC-1
Alluvium	Groundwater sulphates (mg/l)	1	30	30	DS-1	AC-1	DS-1	AC-1
Alluvium	Total Potential Sulphates (%)	1	0.1	0.1	DS-1	AC-1	DS-1	AC-1
Alluvium	pH soil	10	7.7 – 8.4	7.8	DS-1	AC-1	DS-1	AC-1
Alluvium	pH groundwater	-	-	-	DS-1	AC-1	DS-1	AC-1

Stratum	Property	No. of Tests	Results Range	Characteristic Value	DS Class without TPS	ACEC Class without TPS	DS Class with TPS	ACEC Class with TPS
River Terrace Deposits	2:1 water soluble sulphates (mg/l)	1	40	40	DS-1	AC-1	-	-
	Groundwater sulphates (mg/l)	2	20 and 30	30				
	Total Potential Sulphates (%)	-	-	-				
	pH soil	6	7.4 – 8.7	7.4				
	pH groundwater	-	-	-				
Undifferentiated Chalk	2:1 water soluble sulphates (mg/l)	4	10 – 80	80	DS-1	AC-1	-	-
	Groundwater sulphates (mg/l)	1	30	30				
	Total Potential Sulphates (%)	-	-	-				
	pH soil	18	8.3 – 9.4	8.3				
	pH groundwater	2	7.6 and 8.5	7.6				
Chalk – Newhaven Formation	2:1 water soluble sulphates (mg/l)	1	30	30	DS-1	AC-1	-	-
	Groundwater sulphates (mg/l)	-	-	-				
	Total Potential Sulphates (%)	-	-	-				
	pH soil	5	7.9 – 8.4	7.9				
	pH groundwater	-	-	-				
Chalk – Seaford Formation	2:1 water soluble sulphates (mg/l)	1	30	30	DS-1	AC-1	-	-
	Groundwater sulphates (mg/l)	-	-	-				
	Total Potential Sulphates (%)	-	-	-				

Stratum	Property	No. of Tests	Results Range	Characteristic Value	DS Class without TPS	ACEC Class without TPS	DS Class with TPS	ACEC Class with TPS
	pH soil	13	8.3 – 9.0	8.3				
	pH groundwater	1	7.7	7.7				
Phosphatic Chalk	2:1 water soluble sulphates (mg/l)	2	11 and 13	13	DS-1	AC-1	-	-
	Groundwater sulphates (mg/l)	-	-	-				
	Total Potential Sulphates (%)	-	-	-				
	pH soil	5	7.5 – 9.2	7.5				
	pH groundwater	-	-	-				

Notes

1) * Four hand dug trial pits carried out as part of the ground investigation for HAGDMS ref 16175 with corresponding chemical testing samples. Neither coordinates nor relevant strata were provided in the factual report, and as such values have not been provided in Table 6-25. However, results from these tests suggest water soluble sulphates ranging between 50 – 320 mg/l and total potential sulphates between 0.0018 – 0.0024%, and therefore resulting in classifications to greater than DS-1 and AC-1.

2) ** One test for water soluble sulphate in the ground investigation for HAGDMS ref 24930 produced a value of 2700 mg/l. The corresponding factual report discarded this value as an anomaly. However, for the purpose of this report the corresponding characteristic value and classification has been included in brackets. The values not in brackets provided do not account for this test result.

3) Four tests were carried out on groundwater samples as part of the ground investigation for HAGDMS ref 16175 in boreholes P1, P2, R13 and R16. Values have not been included in Table 6-25, as corresponding depths and strata were not provided in the factual report. However, in each case the reading for water soluble sulphate is 12 mg/l, and therefore resulting in classifications no greater than DS-1 and AC-1.

Chlorides

5.10.2 A total of three water soluble chloride samples have been taken and observed in historic boreholes. One sample lies within cohesive Alluvium (21762-R165) and two in granular River Terrace Deposits (21762-R166 and R167), with results in all three samples less than 0.01%.

Organic Matter Content

5.10.3 Organic matter content test results have been observed within historic exploratory holes. The results are presented in Table 6-26.

Table 6-26 Summary of Organic Matter Content Tests Carried out in Historic Exploratory Holes

Approximate Chainage (m)	Exploratory Hole Ref.	Depth (m bgl)	Reduced Level (m AOD)	Stratum	Organic Matter Content (%)
4,031	16174-CP4	1.3	70.1	Granular Head Deposits	7.99
		2.8	68.6	Granular Head Deposits	0.64
4,207	16174-CP1	1	74.3	Granular Alluvium	0.32
4,226	16174-STP26	0.5	74.6	Granular Alluvium	0.48
4,370	16174-CP2	2.1	71.2	Granular Head Deposits	0.48
4,494	16174-STP31	0.5	73.7	Granular Alluvium	2.56
4,498	16174-CP3	1	73.2	Granular Alluvium	0.8
		3.9	70.3	Granular Head Deposits	0.16
11,703	24822-TP4	2.9	67.84	Cohesive Alluvium	0.1
11,707	24822-TP5	3	68.1	Cohesive Alluvium	1.1
11,734	24822-TP6	1.6	69.45	Cohesive Made Ground	8.9
		2	69.05	Cohesive Made Ground	1.9
		2.7	68.35	Cohesive Alluvium	1.5
11,737	24822-TP7	2.4	67.98	Cohesive Alluvium	4.8
11,754	24822-TP9	2.1	68.67	Cohesive Alluvium	1.5
		2.4	68.37	Cohesive Alluvium	2.1
		3.2	67.57	Cohesive Alluvium	0.3
11,811	24822-TP11	2.5	67.7	Cohesive Alluvium	2.6
		3	67.2	Cohesive Alluvium	0.5
11,835	21762-R167	4	67.07	Cohesive Alluvium	0.79

Notes: Tests were carried out to BS1377 part 3 by mass loss on ignition method in the 16174 investigation. Tests carried out in other ground investigations were to BS1377 part 3 but unspecified method.

5.10.4 Organic matter content tests have generally returned results of less than 3%, with the exception of three tests:

a) 7.99% in 16174-CP4 at 1.3m bgl. Described as “medium dense brown slightly sandy angular to subrounded fine to coarse gravel of rindless, occasionally rinded flint”;
b) 8.9% in 24822-TP6 at 1.6m bgl. Described as “soft to firm dark brown organic slightly gravelly sandy clay with occasional rootlets. Gravel is subangular to subrounded fine to coarse of flint. Rare fragments of barbed wire. Strong organic odour”;
c) 4.8% in 24822-TP7 at 2.4m bgl. Described as “very soft to soft dark and light brown slightly organic slightly sandy slightly gravelly clay. Gravel is subangular to subrounded fine to medium of flint”.

5.10.5 No testing was carried out in solely peat samples. Tested sample from 24822-TP9 at 2.4m bgl has been described to contain pockets of peat. Test samples from 16174-STP26 and 16174-STP31 at 0.5m bgl have been described to contain traces of root.

5.11 Re-use of Site Won Material

Geotechnical Properties

5.11.1 The majority of the site-won material is anticipated to originate from the chalk underlying the scheme. The 29779 investigation has carried out additional intact dry density and slakes durability testing on chalk samples. Otherwise, other potential material re-use or earthwork type laboratory tests were undertaken in the previous ground investigations 16174, 16175, 16996 and 21762. These include testing for chalk crushing value (CCV), 10% fines value , Compaction for dry density-moisture content relationship (by 2.5kg rammer), California Bearing Ratio (CBR)-moisture content relationship and Moisture Condition Value.

5.11.2 The locations of the tested samples reasonably cover the anticipated areas of potential future cutting or excavation. The 10% fines value, CBR and compaction tests were carried out on samples recovered from relatively shallow depths (averaged depths 4.5m, 4.1m and 2.8m bgl respectively). The CCV tests have been carried out on deeper samples, down to approximately 50m bgl in the area of the proposed tunnel section. The results have been summarised in the Preliminary Geotechnical Report [37].

Phosphatic Chalk Leachate Potential

Initial Phosphorus Testing

5.11.3 As part of the 29779 investigation site works undertaken between January and April 2017, one sample collected from the Chalk with occasional pockets of phosphatic Chalk nodules (borehole 29779-R503B, 6.2m bgl) was analysed for leachable total phosphorus. The concentration was recorded below the laboratory level of detection (<20µg/l). Testing for water soluble phosphorus was also undertaken on five samples of phosphatic Chalk in borehole 29779-R501 (one of the completed 'control' cluster boreholes) and all samples reported concentrations below the adopted laboratory level of detection (<2.5mg/l).

5.11.4 The analysis of groundwater recovered from an area of the phosphatic Chalk was limited to one sample collected from borehole 29779-R503B. In this borehole groundwater was not in direct contact with the phosphatic Chalk nodules (the water level at the time of recovery being located over 15 m lower). The reported concentration was below the laboratory level of detection (<0.02µg/l).

5.11.5 The UK Water Framework Directive (2013) indicates that for a lowland high alkalinity river (such as the River Till or River Avon) the 'good' standard for 'reactive phosphorus' (also called orthophosphate) is between 52 and 91µg/l. The phosphorus testing to date has measured total phosphorus present in all forms (including reactive phosphorus) and therefore provides a conservative measure relative to the surface water standard. It is noted that the guidance document specifies that reactive phosphorus is measured using the phosphomolybdenum blue colorimetric method, rather than the acid extractable method used for the 29779 investigation analysis.

5.11.6 The soil leachate and groundwater results from borehole 29779-R501 suggested that concentrations of phosphorus at that location do not pose an unacceptable risk to surface water quality. Whilst the water soluble concentrations from phosphatic Chalk in borehole 29779-R501 were below the laboratory level of detection, it is noted that the detection limit used is two orders of magnitude above the relevant surface water risk assessment criteria.

5.11.7 Phosphorus leachate testing was undertaken in February 2018 on the phosphatic Chalk cores obtained during the 29779 investigation.

Additional Phosphatic Chalk Testing

Sampling Rationale

5.11.8 In order to provide more quantitative evidence to assess the potential risk to surface water quality and help to support the identification of potential re-use scenarios for any phosphatic Chalk arisings, additional sampling from the existing rock cores (held in SSL's sample stores in Bristol) from boreholes 29779-R501, R503B and P505 was undertaken on 12 February 2018. These boreholes were located to the west of Stonehenge Bottom and correspond with the western tunnel portal (29779-R503B – 400m south / western half of the proposed tunnel alignment, 29779-R501 – adjacent south and 29779-P505 – 360m south).

5.11.9 Borehole 29779-R501 was drilled in an area of known phosphatic Chalk deposits identified in historical borehole 21762-R142 (2001 Main GI). In 29779-R501, phosphatic Chalk was logged by the drilling contractor from 13.7m to 36.5m bgl. In boreholes 29779-R503B and P505 occasional phosphatic Chalk nodules/pockets of phosphate were logged between 4.7m and 9.4m bgl and 9.0m to 37.4m bgl, respectively.

5.11.10 A total of sixteen phosphatic Chalk samples were collected at depths ranging between 8.45m and 32.6m bgl. The majority of these samples (14) were collected from 29779-R501 based on its proximity to the Preferred Route and the relative prevalence of logged phosphatic Chalk. Samples were collected from 29779-R503B and P505 to provide some spatial variance. In addition, borehole 29779-R503B was installed with a groundwater monitoring standpipe and it is proposed to collect groundwater quality samples from this in the future for comparison.

5.11.11 Representative phosphatic Chalk samples were selected for chemical analysis based on a review of the borehole logs and are summarised in Table 6-27.

Table 6-27 Phosphatic Chalk sample location summary

Borehole ID	Sample depth (m)	Sample ID	Material Description
29779-R501	14.4	S1	Very weak to weak medium density brown phosphatic Chalk
	15.2	S2	Very weak to weak medium density brown phosphatic Chalk
	16.6	S3	Very weak to weak medium density brown phosphatic Chalk
	17.4	S4	Very weak to weak medium density brown phosphatic Chalk
	18.9	S5	Extremely weak and very weak brown phosphatic Chalk
	20.1	S6	Very weak and weak brown phosphatic Chalk
	21.8	S7	Very weak high density brown phosphatic Chalk
	23.6	S8	Very weak medium density brown phosphatic Chalk
	24.8	S9	Extremely weak low density brown phosphatic Chalk
	26.1	S10	Weak and very weak medium density brown phosphatic Chalk

Borehole ID	Sample depth (m)	Sample ID	Material Description
	27.8	S11	Weak and very weak medium density brown phosphatic Chalk
	29.8	S12	Weak and very weak medium density brown phosphatic Chalk
	31.3	S13	Weak and very weak medium density brown phosphatic Chalk
	32.6	S14	Very weak to weak medium to high density white brown stained phosphatic Chalk
29779-R503B	8.45	S15	Very weak medium density white light brown black specks Chalk with light pockets of brown phosphate with rare nodules
29779-P505	9.15	S16	Very weak medium density brown highly phosphatic Chalk

Chemical Analysis

5.11.12 The 16 phosphatic Chalk samples were submitted for leachate analysis[4] for a suite comprising reactive phosphorus (also known as orthophosphate) and selected major ions. The reactive phosphorus leachate analysis was undertaken using an automated colorimetric method (discrete analyser) in accordance with the recommendations in the UK Water Framework Directive (2013) guidance. The purpose of the leachate analysis was to determine the concentrations of phosphorus that may come out in solution from phosphatic Chalk arisings should they be placed at ground level and where infiltration is likely with a view to assessing potential risks to surface water through groundwater migration and direct surface water runoff.

5.11.13 In addition to the testing undertaken for geo-environmental purposes, the 16 phosphatic Chalk samples were submitted for specialist fertiliser analysis to understand the materials value to land spreading on agricultural land. The geo-environmental and fertiliser chemical parameters analysed are summarised in Table 6-28 and the chemical test certificates are presented in Appendix E of SSL's factual report.

[4] Leachate preparation on samples undertaken to BS EN 12457-2 with a 10:1 ratio

Table 6-28 Phosphatic Chalk chemical analysis summary

Test	Soil	Leachate
Geo-environmental leachate suite: Reactive phosphorus (orthophosphate), phosphorus (total), chloride, sulphate, calcium, magnesium, potassium, sodium, alkalinity expressed as bicarbonate and alkalinity expressed as calcium carbonate	-	16
Fertiliser value suite: Moisture content, total phosphorus, neutral ammonium citrate soluble phosphorus, dry matter content and total neutralising value ($CaCO_3$ equivalent).	16	-

Leachate Analysis Results

5.11.14 The results of the additional leachate analysis reported concentrations of reactive phosphorus below the adopted laboratory level of detection (<0.05mg/l) in allsamples. Concentrations of leachable total phosphorus were not recorded above the laboratory level of detection (<1mg/l). The detected concentrations of reactive phosphorus exceed the ‘good’ water quality standard recommended in the UK Water Framework Directive guidance (0.052 to 0.091mg/l) for a lowland high alkalinity river (i.e. higher quality).

5.11.15 The leachate test results suggest that the dominant calcium carbonate chemistry of the Chalk is likely to generate a precipitation (mineral formation) rather than a dissolution environment, such that the rock is unlikely to yield large concentrations of dissolved phosphorus. Based on the findings of the additional leachate testing, the re-use of phosphatic Chalk tunnel arisings at ground surface is not considered to pose an unacceptable risk to the phosphate element of water quality of the River Till or River Avon through groundwater migration and/or direct surface water runoff.

Fertiliser Value Results

5.11.16 The results of the specialist fertiliser value analysis indicate the following:

a) The phosphatic Chalk samples are exceptionally pure calcium carbonate and are unusually dry. The low moisture content of the samples is likely to be partly attributable to the age of the samples (*c*. 12 months old) and also the characteristics of the phosphatic Chalk which has been observed to be relatively friable;
b) The phosphatic Chalk samples comprises one third non-carbonate material, of which a significant proportion is phosphorus (14%); and
c) The Neutral Ammonium Citrate (NAC) test extracts slightly soluble phosphates such as di-calcium phosphate. The analysis indicates that no phosphorus in the chalk is in such forms, and therefore it is not likely to be available to plants. Geological papers[5] suggest the phosphorus is present as calcium fluoro-apatite which is extremely insoluble.

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[5] Jarvis, Ian: The Santonian – Campanian phosphatic chalks of England and France, 2006

5.11.17 The testing conducted on the 16 phosphatic Chalk samples suggests that the material is unlikely to be of potential value as fertiliser/soil additive given the lack of plant- tilisable phosphorus. However, the results suggest that the material may be suitable for re-use onsite as a substrate for habitat creation (e.g. if placed at/near surface east of Parsonage Down) since the phosphorus content is unlikely to lead to higher soil fertility which could affect the establishment of species-rich calcareous grassland.

Naturally Occurring Radiation of Materials

5.11.18 The cores from boreholes 29779-R501, P503B and R505 recovered from the 29779 investigation through the phosphatic Chalk were screened using a Tracerco NORM Monitor on 12th February 2018; approximately 12 months after the cores were recovered. The monitor (serial no 134256) was hired from Tracerco between 12th and 14th February 2018. Calibration certificates are attached to this report in Appendix F.

5.11.19 Background was established by the collection of five integrated 100 second counts in both Highways England's Bristol office and the SSL core store providing a Threshold for statistically identifiable radioactivity (three times background) of 2.07 counts per second. Levels above three times background are considered to be statistically indicative of radioactive contamination. The results of the background assessment are presented in Table 6-29.

Table 6-29 Background Assessment

Background check – Highways England office, Bristol	Value CPS (counts per second)	Background check -SSL warehouse, Unit 1A, Princess Street, Bristol, BS3 4AG	Value CPS (counts per second)
1	0.38	1	0.76
2	0.46	2	0.78
3	0.48	3	0.58
4	0.44	4	0.49
5	0.43	5	0.85
average:	0.44	average:	0.69
Threshold for statistically identifiable radioactivity.	1.32	Threshold for statistically identifiable radioactivity.	2.07

5.11.20 Each core box was screened for its entire length using the contamination monitoring function to identify the point of Maximum Measured Value in counts per second. At each point of Maximum Measured Value, measurement of 100 second count time was taken and is reported in Table 6-30.

5.11.21 Some fluctuation in the readings is considered likely due to a combination of the local environment, cosmic radiation and mineral content (e.g. clays) within the cores and surrounding materials. Each of the readings are below the threshold for determining the presence of measurable radioactivity. Based on these measurements it is therefore considered that radioactivity need not be a factor in determining the fate of Chalk removed as part of the excavation.

Table 6-30 Results from Scanned Cores

No	BH No.	Depth (m) (on Box)	Approximate Depth of Maximum Measured Value (m)	Integrated 100 second count at identified Maximum Measured Value (cps)
1	R503B	3.8 - 4.9	4.0	0.54
2	R503B	7.9 - 9.4	8.9	0.41
3	P505	7.9 - 9.4	8.1	0.58
4	P505	9.4 - 10.9	9.8	0.56
5	R501	13.7 - 14.75	14.2	1.26
6	R501	14.75 - 16.0	16.5	0.81
7	R501	16.0 - 17.0	16.3	0.68
8	R501	17.0 - 18.7	18.0	0.64
9	R501	18.75 - 20.25	19.3	0.69
10	R501	20.25 - 21.0	20.4	0.53
11	R501	21.0 - 23.2	21.1	0.56
12	R501	23.2 - 24.0	23.35	0.82
13	R501	24.0 - 26.0	24.15	0.87
14	R501	26.0 - 27.5	26.05	0.87
15	R501	27.5 - 29.0	28.3	0.56
16	R501	29.0 - 30.5	30.0	0.44
17	R501	30.5 - 32.0	31.5	0.76
18	R501	32.0 - 33.5	33.3	0.53
19	R501	33.5- 35.0	34.4	0.58

5.12 Soil Infiltration Rate

5.12.1 The results of the soil infiltration tests carried out historical and in the recent 29779 investigation trial pits in 2017 are summarised in Table 6-31.

Table 6-31 Summary of Soil Infiltration Test Results

Soakaway Pit ID	Test Stratum	Test Depth (m bgl)	Test No.	Soil Infiltration Rate (m/s x 10^{-4})
16996-TP12	River Terrace Deposits / Structureless Chalk	1.20	1	1.09
16996-TP13	River Terrace Deposits / Structureless Chalk	1.20	1	0.77
16996-TP15	River Terrace Deposits / Structureless Chalk	1.15	1	0.32
16996-TP18	Structureless Chalk	2.45	1	0.07
16996-TP19	Structureless Chalk	1.40	1	0.07
21762-STP101	Structureless Chalk	2.00	1	1.30
		2.00	2	1.10
		2.00	3	1.00
21762-STP120	Structureless Chalk	1.80	1	0.43
		1.80	2	0.37
21762-STP125	Structureless Chalk	1.60	1	2.80
		1.60	2	2.50

Soakaway Pit ID	Test Stratum	Test Depth (m bgl)	Test No.	Soil Infiltration Rate (m/s x 10^{-4})
		1.60	3	3.10
21762-STP134	Structureless Chalk	2.00	1	4.30
		2.00	2	2.80
		2.00	3	4.20
21762-STP162	Structureless Chalk	2.00	1	1.30
		2.00	2	1.20
		2.00	3	0.86
24930-TP2	Structureless Chalk	3.00	1	0.04
24930-TP3	Structureless Chalk	2.50	1	0.10
29779-SA501	Structured Chalk Grade B5	1.83	1	16.30
		1.83	2	16.00
		1.83	3	15.00
29779-SA502	Structureless Chalk	1.98	1	6.16
		1.98	2	4.87
		1.98	3	5.02
29779-SA503A	Structured Chalk Grade B5	2.31	1	4.78
		2.31	2	4.33
		2.31	3	4.35
29779-SA504	Structured Chalk Grade B5	1.80	1	7.46
		1.80	2	6.93
		1.80	3	6.57
29779-SA505	Structureless Chalk	1.25	1	Unable to calculate infiltration rate due to insufficient drop in water level during test.
		1.25	2	
		1.25	3	
29779-SA506A	Alluvium	1.94	1	Unable to calculate infiltration rate due to insufficient drop in water level during test.
		1.94	2	
29779-SA507	Structured Chalk Grade B5	2.20	1	1.17
		2.20	2	1.15
		2.20	3	1.53
29779-SA508	Structureless Chalk	2.47	1	17.70
		2.47	2	20.90
		2.47	3	11.90
29779-SA509A	Structured Chalk Grade B4	2.09	1	0.29
		2.09	2	0.24
		2.09	3	0.21

6 Contamination Assessment

6.1 General

6.1.1 Preliminary desk study research suggested a generally low potential for ground contamination to exist. The dominant land use along the Preferred Route has historically comprised, and currently comprises, agricultural use. The alignment intersects the former RAF Oatlands Hill (operational between 1941 to 1945) and the former RAF Stonehenge (operational between 1917 to 1921) to the west and east of the existing Longbarrow roundabout, respectively. Information in the PSSR [1]indicates RAF Oatlands Hill was only very lightly used and the section of RAF Stonehenge intersected by the alignment was occupied by the domestic part of the main camp (relatively lower contamination potential compared with the technical area and airfield). Both military sites were restored to agricultural land use in the post war period and historical GI in these areas has recorded no visual or olfactory indicators of contamination, therefore the potential for residual contamination is considered to be relatively low.

6.1.2 As part of the EP GI a total of twenty-eight soil samples, eleven soil leachate samples and three groundwater samples were recovered and submitted for laboratory analysis for the suite of determinands presented in Table 4-3. The geo-environmental sampling points relate to exploratory positions along the previously assumed alignment and also include targeted locations around Stonehenge Bottom and the River Till and River Avon catchments. All of the exploratory positions sampled were located in agricultural fields.

6.1.3 A review of the EP GI [25] sampling points in relation to the current preferred alignment is provided in Table 4-2. Of the fourteen exploratory holes where soil and groundwater testing was undertaken, four of the soil sampling points and one of the groundwater points were within 50m of the current Preferred Route. In addition, no specific sampling was undertaken to evaluate the potential sources of contamination identified in Section 3. However, the geo-environmental samples taken do provide a quantified measure of baseline soil and groundwater quality in the general area of the Preferred Route.

6.1.4 In addition to samples collected during the EP GI [25], some limited geo-environmental soil and groundwater testing was undertaken during the investigation carried out between 2001 and 2010 (see Section 3 for further details). The laboratory results from the 2001 Phase II Main Investigation [28] have not been sourced to review. Also, the locations of the four topsoil samples collected during 2001 Phase II of the Main Investigation are unknown and therefore cannot be put into context with the current Preferred Route. The relevant available historic geo-environmental data comprises fourteen soil samples collected from investigations at the Longbarrow and Countess roundabouts (Mott MacDonald, 2009-2010 [22] [29]) and four groundwater samples collected in the Stonehenge Bottom area (in the vicinity of the proposed tunnel) during the 2001 Phase I Main Investigation [14].

6.1.5 To provide some context to the measured concentrations within the soils and groundwater sampled during the EP GI and historic investigations, a generic quantitative risk assessment (GQRA) has been undertaken as an initial conservative screen based on a set of default assumptions about land use, soils, controlled water sensitivity and receptor exposure. A plan showing the geo-environmental sample locations is presented in Figure 7-1.

6.1.6 Two screening assessments have been undertaken. The first has looked to screen the soil results against GAC that are considered to be protective of human health. The second has screened soil leachate and groundwater concentrations against GAC that are considered to be protective of controlled waters. These screening assessments are presented in the following sections 7.2 and 7.4.

6.1.7 Risk to construction/maintenance workers involved in any construction works are discussed in Section 7.3 as the methodology and assumptions presented for human health described in Section 7.2 do not consider the short-term, and typically high frequency of exposure for this receptor group.

6.2 Human Health Generic Assessment

Methodology

6.2.1 Soil GAC have been published for numerous contaminants by both regulatory and industry recognised bodies. Where GAC have not been published, Highways England has derived its own GAC values using industry recommended and accepted methods.

6.2.2 GAC have been derived for several land use scenarios including residential with plant uptake (with private gardens), residential without plant uptake (no private gardens), commercial/industrial, allotments, public open space (parks) and public open space (residential). GAC have been selected for the Preferred Route based on the proposed development as a highway and the soil concentration data have been screened against GAC for an open space (parks) land use which is consistent with criteria used in the GQRA section of the PSSR [1].

6.2.3 The public open space (parks) end-use scenario assumes the critical receptor to be a female child aged 0 to 6 years. The exposure routes considered are:

a) direct ingestion of soil (outdoors) and dust derived from soil (indoors)
b) ingestion of soil (outdoors);
c) dermal contact with soil (outdoors);
d) inhalation of dust derived from soil (outdoors); and
e) inhalation of vapours (outdoors).

6.2.4 The full tabulated chemical data screened against the human health GAC is presented in Table G1, Appendix G. The assessment is based on a direct comparison of the maximum value against the relevant GAC. Where a contaminant has exceeded a GAC this is deemed as potentially significant and therefore requires further consideration. Where recorded less than the GAC they have not been regarded as significant. The assessment at this stage makes no distinction between different material types. Further consideration of material type and depth is made following the initial screening exercise, if required.

6.2.5 The following hierarchy has been adopted in selecting the appropriate GAC to use for the determinands to screen as part of this assessment:

a) Land Quality Management (LQM) / Chartered Institute of Environmental Health (CIEH) Suitable for Use Levels (2014). Public Open Space (park) (Inorganic) [59];

b) LQM/CIEH Suitable for Use Levels (2014). Public Open Space (park) (1% Soil Organic Matter, Sandy Loam) [59];
c) AECOM GAC, modified LQM/CIEH Suitable 4 Use Levels (2014) (Public Open Space (park), 1% SOM, Sand) [59];
d) Department of Food and Rural Affairs (Defra) SP1010: Development of Category 4 Screening Levels for Assessment of Land Contamination - Policy Companion Document (December 2014) (1% Soil Organic Matter, Public Open Space 2) [60]; and
e) Department of Food and Rural Affairs (Defra) SP1010: Development of Category 4 Screening Levels for Assessment of Land Contamination - Policy Companion Document (December 2014) (6% Soil Organic Matter, Public Open Space 2) [60].

Human Health Screening Assessment Results

6.2.6 All of the twenty eight soil samples collected during the EP GI recorded concentrations of tested determinands below the adopted screening criteria designed to be protective of human health within a public open space setting. It is noted that pesticides and herbicides were not recorded above the laboratory method detection limit, and therefore below the available GAC, in the soil samples analysed. Concentrations of organic analytes (PAHs, TPH, phenols, VOCs and SVOCs) were measured below the corresponding GAC and also generally recorded below the laboratory method detection limit.

6.2.7 As part of the EP GI [25] a total of three soil samples collected from two exploratory locations to the south of Stonehenge monument (R506A – two samples from topsoil and Chalk and P510 – one Chalk sample) were analysed for microbial contaminants. Measurable concentrations of total coliforms were detected in all three samples ranging from 240 colony forming unit (cfu)/g to 1,900cfu/g. Concentrations of Intestinal Enterococci were detected in the topsoil sample from 29779-R506A only (1,700cfu/g) and Escherichia coli (E. coli) was recorded in 29779-P510 only (420cfu/g). It is noted that the highest concentrations of tested microbial contaminants were detected in the topsoil sample from 29779-R506A. There is no corresponding human health GAC for microbial contaminants in soil. However, the presence of pathogens is not unexpected and most likely the result of the use of manure or sewage sludge as a fertiliser. A discussion of associated risks to controlled waters is presented in Section 6.4.

6.2.8 The fourteen soil samples collected during the Longbarrow (three samples) and Countess Roundabout (eleven samples) historic ground investigations (references [22] and [29]respectively) all relate to shallow Made Ground. The results show that concentrations of PAHs in two samples taken from trial pits located on the north-western side of Countess Roundabout (TP2 and TP4) during the Countess Roundabout investigation [29] exceeded their adopted screening criteria. In trial pit 24822-TP2 a marginal exceedance for PAH dibenz(a,h)anthracene was also recorded (1.38mg/kg vs GAC of 1.1mg/kg).

6.2.9 The sample from trial pit 24822-TP4 relates to Made Ground where a strong hydrocarbon odour was noted. Concentrations of the PAHs, benzo(a) pyrene, dibenz(a,h)anthracene and benzo(b)fluoranthene, were recorded above the corresponding GAC by factors of 4, 5 and 4, respectively. Elevated concentrations of TPH were also recorded in 24822-TP4 (TPH = 13,900mg/kg). TPH analysis was undertaken for combined aliphatic and aromatic bands and therefore no direct comparison to a GAC is possible. However, a comparison of the combined concentrations against the aromatic TPH GAC (the lower of the two criteria) indicates that there are no exceedances. No free product was recorded by Mott MacDonald [29].

6.2.10 Six of the Made Ground samples collected during the historic Countess Roundabout investigation [29] were screened under a microscope for asbestos containing materials (ACM) by the analytical laboratory. In addition all twenty-eight samples of topsoil and natural deposits were screened as part of the EP GI [25]. No ACM was detected in any of the samples analysed.

Human health risk assessment conclusions

6.2.11 Based on the results of the human health risk assessments undertaken on soil samples obtained from the EP GI and available historic investigations, it is concluded that there is unlikely to be an appreciable significant risk to human health based on the areas investigated. Whilst the chemical results are considered to be broadly representative of general ground conditions across Preferred Route given the land use history, no site specific sampling was completed to target all of the potential sources identified in Section 2, particularly the former military sites.

6.2.12 This was identified in the Ground Investigation Gap Analysis Report [61] and recommendations for undertaking further targeted soil and groundwater sampling in these areas were included..

6.3 Construction and Maintenance Workers

6.3.1 The main pollutant linkages applicable to construction/maintenance workers are:

a) direct contact / ingestion of contaminants within soils, groundwater and soil derived dust;
b) inhalation of organic vapours from soils, groundwater and soil derived dust; and
c) ground gas inhalation / explosion risk.

6.3.2 Prior to construction works, a construction phase site health and safety plan should be prepared incorporating any Personal Protective Equipment (PPE) requirements in accordance with statutory health and safety requirements.

6.4 Controlled Waters Generic Quantitative Risk Assessment

Methodology

6.4.1 In order to assess the baseline groundwater quality and any potential risks to controlled waters, a comparison of maximum concentrations recorded in groundwater and soil leachate against published limits (GAC), has been undertaken. The controlled waters receptors identified in Section 2 are:

a) groundwater: Principal Chalk Aquifer and groundwater within the localised superficial deposits associated with dry valleys and river channels classified as Secondary-A Aquifers (Alluvium and River Terrace Deposits) and Secondary (Undifferentiated) Aquifer (Head Deposits). Four groundwater abstraction boreholes are located within a range of 560m and 960m of the

Preferred Route (three general farming/commercial abstractions and one private potable water supply abstraction). These abstractions are not associated with the SPZs within 2km of the alignment which relate to public water supply groundwater abstractions; and

b) surface waters: the nearest surface water features are the River Till and the River Avon which are intersected by the Preferred Route and the Amesbury Abbey springs located approximately 70m south of the eastern extent of the alignment.

6.4.2 For the assessment of linkages associated with potential adverse effects to controlled waters and taking into account the information presented in Section 2, GAC have been selected to be protective of groundwater as a drinking water resource and to be protective of surface water bodies that might be affected by lateral migration from affected groundwater. The water GAC have been derived based on UK Drinking Water Standards (DWS) and Environmental Quality Standards (EQS) and taken from the following sources:

a) UK Drinking Water Standards (DWS) – The Water Supply (Water Quality) Regulations 2016 [62];
b) Environmental Quality Standards (EQS) – Water Framework Directive (England & Wales) 2015 [63], Water Environment Regulations (Scotland) 2015 [64]and Scottish Environmental Protection Agency (SEPA) Freshwater EQS, 2018 [65];
c) World Health Organisation (WHO) Guidelines for Drinking Water Quality (4th edition), 2017 [66];
d) World Health Organisation (WHO), 2008. Petroleum Products in Drinking-water. Background document for development of WHO Guidelines for Drinking-water Quality [67];
e) United States Environment Protection Agency (USEPA) Regional Screening Levels (RSLs) (tap water) [68];
f) AECOM Drinking Water Guidelines (adopting World Health Organisation methodology) ; and
g) European Union (EU) Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) – Freshwater Predicted No Effect Concentration (PNEC) [69].

6.4.3 The full tabulated chemical data screened against the controlled waters GAC is presented in Table G2 (soil leachate) and Table G3 (groundwater), Appendix G. The assessment is based on a direct comparison of the maximum value against the relevant GAC. Where a contaminant was found to have exceeded a GAC, this was considered further. Where a concentration was recorded to be less than the GAC, this has not been regarded as significant and hence no further assessment has been considered warranted.

6.4.4 Available soil leachate samples were also compared against the GAC to assess risks to controlled waters from the contaminants which may be present within the soil. Leachate analysis provides an assessment of the potential leachability and mobility of metals and less volatile organic compounds within soils. Assessment of the leachate results is also useful within the context of understanding any groundwater concentrations present above their respective published limits.

Controlled Waters Screening Assessment Results

6.4.5 As part of the EP GI [25], groundwater samples were taken from three boreholes; 29779-R503B and 29779-PX505A located in Stonehenge Bottom, approximately 240m south of the proposed tunnel/western portal and 29779-R507A located north-west of Amesbury adjacent north of the current A303/proposed eastern tunnel portal. The response zones in these boreholes were installed within the Chalk.

6.4.6 During the 2001 Phase I Main Investigation [14], groundwater samples were collected from four boreholes (16175-R13, 16175-R16, 17439-P1 and 17439-P2) located at Stonehenge Bottom, adjacent to/within 45m of the proposed tunnel. The response zones in these four boreholes were also installed within the Chalk.

6.4.7 Soil samples for leachate analysis were collected from a total of eleven exploratory holes positioned across the agricultural land surrounding the Preferred Route during the EP GI [25].

6.4.8 A plan showing the groundwater and soil leachability sample locations is presented in Figure 7-1 and the tabulated screening assessment results are presented in Appendix F. Table 7-1 and Table 7-2 below present a summary of the key findings of the controlled waters screening assessment.

Table 7-1 Summary of Controlled Waters Groundwater GAC Exceedances

Contaminant of Concern	No. of Samples	Concentration (µg/l)		GAC (µg/l)		No. of Exceedances	
		Minimum	Maximum	EQS	DWS	EQS	DWS
Copper	7	2	20	1	2,000	7	0
Lead	7	<1	13	1.2	10	1	1
Zinc	7	1	35	10.9	6,000	2	0
Cyanide (total)	7	<0.005	0.6	0.001	0.05	1	1
Nitrate as NO_3	7	4.9 mg/l	85.13 mg/l	-	50 mg/l	-	1
Ammoniacal Nitrogen	7	<0.02 mg/l	0.76 mg/l	0.3 mg/l	-	1	-

Table 7-2 Summary of Controlled Waters Leachate GAC exceedances

Contaminant of Concern	No. of Samples	Concentration (µg/l)		GAC (µg/l)		No. of Exceedances	
		Minimum	Maximum	EQS	DWS	EQS	DWS
Copper	11	<1	3	1	2,000	2	0
Mercury	11	<0.1	2	0.07	1	2	0
Zinc	11	<1	13	10.9	6,000	1	0
Nitrite as NO_2	11	<0.1 mg/l	0.92 mg/l	-	0.5 mg/l	-	3
Fluoranthene	11	<0.02	0.08	0.0063	4	3	0

Organic Parameters

6.4.9 The screening assessment has identified that no phenols, TPH, VOCs or SVOCs were detected greater than their respective test method limit of detection within groundwater and/or the soil leachate samples analysed. In addition, all PAHs were also detected less than the limit of detection of the test method within the groundwater samples taken.

6.4.10 The soil leachate test results show that the PAH fluoranthene was detected in excess of the EQS screening value in samples taken from trial pits 29779-SA504 (0.5m bgl, Chalk), 29779-SA505 (0.8m bgl, Alluvium) and 29779-STP501 (0.5m bgl, Head Deposits). PAHs were not detected above the limit of detection within the soils solid state analysis undertaken on these samples and no obvious source is evident. Given the relatively isolated nature of the fluoranthene exceedances, the measured concentrations in soil leachate are not considered to represent an unacceptable risk to controlled waters. For comparison, the maximum concentration is 50 times below the corresponding drinking water criteria.

Metals and Inorganic Parameters

6.4.11 The metals; copper, lead and zinc were detected in the groundwater samples at concentrations greater than the screening value adopted to be protective of freshwater surface water features. Copper was recorded above the EQS value in all seven groundwater samples by factors of between 2 and 20. The detected exceedances for lead and zinc were limited to boreholes 17439-P1 and 17439-P2 sampled in 2001. Lead exceeded the EQS value (by a factor of 10.8) and to a lesser extent the DWS value (by a factor of 1.2) in one sample from borehole 17439-P1 and zinc marginally exceeded the EQS value only in boreholes P1 (factor of 3.2) and 17439-P2 (factor of 2.4). Concentrations of lead in the other six groundwater samples were detected below/at the laboratory detection limit (<1µg/l).

6.4.12 The British Geological Survey (BGS) has published groundwater quality baseline reports to establish the chemistry of water from aquifers in the UK under natural conditions. The reports provide a summary of the inorganic chemical status of groundwater in a given area or aquifer. There is no specific BGS baseline report covering the study area however the published report on the Chalk aquifer of Hampshire [70] is considered relevant given its regional proximity. The BGS baseline concentrations for copper (which exceeded the GAC most frequently) ranged between 10µg/l and 31.8µg/l; therefore the copper concentrations recorded in groundwater during the ground investigations are considered to be within the natural baseline chemistry range. Similarly, the concentrations of zinc recorded in groundwater during the ground investigations fall within the BGS baseline range of 3.07µg/l to 253µg/l. The isolated lead exceendance reported historically in borehole 17439-P1 is approximately ten times higher than the maximum BGS baseline concentration of 1.35µg/l.

6.4.13 Corresponding soil analysis results are only available for sampling points 29779-R503B and 29779-R507A drilled as part of the EP GI. Elevated copper was detected in groundwater at both locations compared to the EQS value of 1µg/l (29779-R503B =2µg/l and 29779-R507A =10µg/l). The solid state analysis completed on the topsoil and Chalk samples recorded low concentrations of copper (8mg/kg in topsoil and 1mg/kg in Chalk in both boreholes) consistent with the average concentrations measured along the Preferred Route (average copper concentrations in topsoil and Chalk were 2mg/kg and 7mg/kg respectively). Based on the available soil data, there does not appear to be a discernible link between concentrations of metals in shallow soils and the groundwater exceedances recorded.

6.4.14 All seven groundwater samples were collected from exploratory holes drilled in agricultural fields where topsoil overlying Chalk was encountered (no Made Ground encountered). Whilst the highest concentrations of copper, lead and zinc were recorded in boreholes 17439-P1 and 17439-P2 located adjacent south of the A303 road, with the exception lead, concentrations were similar in groundwater sampling points located over 100m south of the A303 (same order of magnitude). The significance of the road as a potential source of elevated metals in groundwater is therefore considered to be low.

6.4.15 Soil analysis was completed at two of the seven groundwater sampling points (29779-R503B and 29779-R507A drilled as part of the EP GI). Concentrations of copper in groundwater were recorded above the EQS value in both 29779-R503B (2µg/l) and 29779-R507A (10µg/l) however the soil analysis undertaken on topsoil and Chalk samples reported low concentrations of copper (8mg/kg in topsoil and 1mg/kg in Chalk) consistent with the results from the other eleven exploratory holes where natural soils were sampled (average copper concentrations in topsoil and Chalk were 2mg/kg and 7mg/kg respectively).

6.4.16 Concentrations of metals detected in the eleven soil leachate samples were generally reported below the corresponding screening criteria. Relatively minor exceedances of the EQS values were recorded for copper (two samples, up to a factor of 3), mercury (two samples, up to a factor of 1.4) and zinc (one sample, up to a factor of 1.2). The solid state soil analysis results show metal concentrations that were notably higher in topsoil compared with samples collected from the underlying superficial deposit/Chalk in the same sampling locations. This suggests that the topsoil within the area of the Preferred Route has a low potential for leaching of metals which supports the soil leachate results.

6.4.17 The concentrations of metals recorded in the soils are similar to those recorded in the area by the UK Soil Observatory (UKSO) [71] based on information held on their website. A comparison to the published background concentrations for the area has been made and is presented in Table 7-3. The results showed that the soil sample levels are generally similar to those recorded in the area by the UKSO. Whilst the highest recorded soil result for lead is approximately twice the background range (maximum result = 85mg/kg), the average concentration of the 40 shallow samples (top 1m) tested is 15mg/kg which is lower than the background range. Therefore, it is concluded that the concentrations obtained from the soils sampled at the exploratory hole locations (and their leachate concentrations), are likely to be reflective of natural background concentrations.

Table 7-3 Observed Metal / Metalloid Soil Concentrations versus Background Soil Concentrations

Metal	Ground investigation range (mg/kg)	Published background concentration range for the area (mg/kg)
Copper	1 - 14	8.92 - 15.04
Lead	1 – 85	33.91 - 42.95
Nickel	2 – 4	15.98 – 20.0
Zinc	9 – 87	66.19 - 87.98

6.4.18 Elevated total cyanide concentrations were detected in one groundwater sample collected from borehole 16175-R13 (located approximately 45m south of the proposed tunnel) when compared to the EQS (exceeds by two orders of magnitude) and DWS (one order of magnitude) values. However, cyanide was not detected at concentrations greater than the laboratory limit of detection within any of the other six groundwater samples, five of which were also located in the Stonehenge Bottom area. In addition, cyanide was not detected within any of the soil samples tested or any of the other soil leachability tests undertaken. There is no obvious source present within the soils in the vicinity of 16175-R13 which may explain the isolated value recorded. Based on the isolated nature of the exceedance, no unacceptable risk to controlled water is considered to exist from the soils or groundwater sampled. It should also be noted that the EQS value is based on the concentration of free, rather than total cyanide and therefore is considered to be conservative for the assessment of risk to surface waters.

6.4.19 One minor exceedance of the DWS value for nitrate was detected in the groundwater sample taken from borehole PX505A (factor of 1.7) located in the Stonehenge Bottom area. Marginally elevated concentrations of nitrite were detected in three soil leachate samples collected from topsoil in the same area (29779-P502B, 29779-P505 and 29779-R506A) compared to the DWS value (factors of between 1.3 and 1.8). In addition, concentrations of ammoniacal nitrogen were detected above the EQS value in one soil leachate sample collected from topsoil (29779-SA506A). Given the agricultural use of the area, the presence of nitrogen compounds within groundwater and soil leachate would not be an uncommon finding. The area is located within a groundwater nitrate vulnerable zone and thus farmers are required to adhere to regulations with regards to managing the nitrate impact upon groundwater.

Microbial Parameters

6.4.20 All three groundwater samples were analysed for microbial contaminants (faecal coliforms, total coliforms and enterococci). Concentrations of faecal coliforms were recorded below the laboratory detection limit in all three samples. A maximum concentration of 1cfu/100ml was recorded for enterococci (one sample) and total coliforms (two samples) which marginally exceeds the corresponding DWS criteria values of 0cfu/100ml (applies to all three microbial contaminants).

6.4.21 All eleven soil leachate samples were also analysed for the same determinands. Concentrations of faecal coliforms and enterococci were recorded below the laboratory detection limit in all eleven soil leachate samples. Total coliforms were detected in three samples with concentrations ranging between 4cfu/100ml and 300cfu/100ml. The maximum concentration was detected in a topsoil sample collected from borehole R506A where the highest solid state soil concentrations were also reported. For comparison the UK Bathing Water Directive [72] guideline for enterococci is 200cfu/100ml in inland waters with an “excellent” classification is 200cfu/100ml. This indicates that the bacterial contaminants detected in groundwater are not particularly elevated.

Controlled Waters Risk Assessment Conclusions

6.4.22 The use of EQS and DWS values are considered conservative given that the guidance concentrations are applicable to the concentration at the receiving water/consumer tap. Soil leachate concentrations would also undergo additional dilution upon infiltration into groundwater during migration to the surface water body. Additionally, the Part 2A statutory guidance (Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance April, 2012) [73] notes that normal levels of contaminants in soil should not be considered to cause land to qualify as contaminated land, unless there is a particular reason to consider otherwise.

6.4.23 Given the generally minor level of metals and nitrogen compounds identified within the groundwater and the soil leachability concentrations, the isolated detections of fluoranthene in soil leachate and cyanide in groundwater and the field observations (natural soils and no olfactory evidence of chemical impact) the measured concentrations are not considered to represent an unacceptable risk to water quality. Where exceedances against adopted screening values have been noted, this is generally considered to be attributable to background soil and groundwater conditions.

6.4.24 The Ground Investigation Gap Analysis Report [61] included recommendations for undertaking further targeted groundwater monitoring and testing in these areas to inform the detailed design.

7 Geotechnical Risk Register

7.1.1 This Geotechnical Risk Register is based on the current proposals for design, incorporating the risks as presented in the PSSR and including additional risks made apparent in the 2017 EP GI. The scales against which the likelihood and consequence are measured and the resulting degree of risk determined are shown below in Table 8-1 to Table 8-3.

Table 8-1 Risk Rating Matrix

		Risk Rating (R) = Likelihood (P) x Consequence (C)				
Likelihood	5 Very Likely	5	10	15	20	25
	4 Likely	4	8	12	16	20
	3 Possible	3	6	9	12	15
	2 Unlikely	2	4	6	8	10
	1 Negligible	1	2	3	4	5
		1 Very Low	2 Low	3 Medium	4 High	5 Very High
		Consequence				

	Definitions
Likelihood	The probability of a risk occurring.
Consequence	The impact caused by the occurrence of a risk, with respect to health, safety, environment, quality, cost, programme and reputation.

Critical Risk

High Risk

Medium Risk

Low Risk

Risk	Guidance
Critical	Unacceptable level of risk
High	Should be regarded as safety critical
Medium	Considerable thought must be given to the measures required to reduce the risk
Low	Manageable risk that is controlled by existing procedures

Table 8-2 Indicative Likelihood Scores for Geotechnical Risk Register

Category	1 Very Low	2 Low	3 Medium	4 High	5 Very High
Likelihood	<5%	5% - 20%	21% - 50%	51% - 75%	>75%

Table 8-3 Indicative Consequence Scores for Geotechnical Risk Register

Category	1 Very Low	2 Low	3 Medium	4 High	5 Very High
Cost (£), ***C***	<5m	5m-10m	10m-30m	30m-50m	>50m
Programme (time), ***P***	<1 month	1-2 months	2-4 months	4-8 months	>8 months
Quality, ***Q***	Meets or exceeds mandatory requirements	A few minor shortfalls, some small changes required to rectify.	Some shortfalls requiring moderate changes to rectify but not impacting on delivery of an objective.	A large shortfall with an objective not being met, significant change required to rectify.	A major shortfall with more than one objective not being met and requiring significant changes to rectify.
Reputation, ***R***	Public criticism of less than one day requiring minimal additional press office involvement.	Public criticism of over one day to one week and/or requiring a project team response.	Public criticism of over one to two weeks and/or requiring a significant project team response.	Public criticism of over one to two weeks and/or requiring a Chief Executive response.	Public criticism over three to four weeks and/or requiring a Secretary of State response.
Health & Safety (Effect on project employees or any other parties), ***H&S***	Minor injuries (non-reportable); minor health or welfare issue (non-reportable)	Reportable < 3 day incident; health or welfare issue affecting < 100 people for < 3 days; significant near miss	Reportable: major injury or dangerous occurrence; health or welfare issue affecting >100 people < 3 days or <100 people > 3 days.	Single fatality; health or welfare issue affecting >100 people > 3 days.	Multiple fatalities or single fatality and multiple injuries. Health or welfare issue affecting > 1000 people > 3 days.
Environmental, ***E***	Minor pollution event contained within site. Failure to achieve local sustainability measures.	Contamination or similar impact off site - no lasting damage; failure to achieve Highways England sustainability targets < 1 week.	Contamination or similar impact off site - damage < 1 month); failure to achieve Highways England sustainability targets < 1 month.	Contamination or similar impact off site - damage < 1 year; failure to achieve Highways England sustainability targets < 1 year.	Contamination or similar impact off site - damage > 1 year; failure to achieve Highways England sustainability targets > 1 year.

Table 8-4 Geotechnical Risk Register

Ref	Description of risk	Potential impact (DCO Submission)	Potential impact (Detailed Design)	Critical Consequence Categories	Risk Rating			Mitigation	Post Mitigation Risk Rating			Mitigation of Residual Risk to be Identified prior to Detailed Design
					Likelihood	Consequence	Risk Score		Likelihood	Consequence	Risk Score	
Geo1	Extent and characteristics of the phosphatic chalk along proposed tunnel alignment are not understood sufficiently	May influence selection of tunnel construction method, waste management planning, potential re-use options, vertical alignment and consequent effects to adjoining cutting design and Red Line Boundary.	Over-design of tunnel, additional land take, programme impact and construction cost.	C P E	5	5	25	Complete 2017 EP GI. Additional leachate and groundwater analysis of the phosphatic Chalk to allow an accurate assessment of potential risk to surface water and inform re-use options.	2	4	8	Design and construction planning to take account of range of anticipated conditions. Trial Shaft for detailed design.
Geo2	Suitability of tunnel arisings for intended use.	Will impact on cut/fill balance and quantity of material assumed for disposal, and therefore disposal strategy. May influence selection of tunnel construction method.	Will impact on design of treatment works, land required for stockpiling and drying.	C P E	4	5	20	Studies suggest Tunnel Boring Machine (TBM) arisings not suitable for re-use as Earthworks fill, however potentially they could be suitable for landscaping purposes. Carry out additional earthworks testing as part of 2017 EP GI	2	4	8	Trials could be undertaken on potential re-use as landscape/other fill. Depends on TBM type (Slurry/Earth Pressure Balanced) as to whether this is worthwhile. Stockpiling and processing should be considered within construction planning. Research of case studies and previous major schemes and the adopted earthworks strategy
Geo3	Depth and characteristics of structureless Chalk, particularly at tunnel portals and in Stonehenge Bottom is uncertain.	May influence temporary support requirements for tunnel. May influence cut slope design which in turn impacts on Red Line Boundary.	Over-design of temporary support requirements for tunnel and cut-slope design, leading to inefficiencies and increased construction costs potentially impacting beyond Red Line Boundary.	C P H&S	4	5	20	Complete 2017 EP GI at Stonehenge Bottom and East Portal, and further boreholes at the Western Portal and along the tunnel alignment. Geophysics input to determine stratigraphy to the east of Stonehenge Bottom.	2	5	10	Design and construction planning to take into account the depth and properties of structureless Chalk.
Geo4 and Geo9	Uncertainty in the volume of groundwater flow through Stonehenge Bottom.	May impact on assessment of temporary and permanent impacts on groundwater levels and strategies for groundwater management which need to be defined for DCO submission.	May impact on design of dewatering system and assessment of temporary and permanent impacts on groundwater levels within and outside of the Scheme.	C P H&S E	4	5	20	Installation of monitoring wells with data loggers in catchment to complete 2017 EP GI.	2	5	10	Results from 2017 EP GI monitoring wells to be incorporated in hydrogeology design and assessment of permanent impacts of tunnel on groundwater levels.
Geo5	Uncertainty and variability in the transmissivity of the ground including the Coneybury Hill interfluve between the Avon and Stonehenge Bottom.	May impact on design of any dewatering system and assessment of flow volumes towards the tunnel site from the River Avon.	Over-design of any dewatering system with cost and programme implications.	C P	4	4	16	Testing specified as part of 2017 EP GI to be completed. Hydrogeology team to incorporate results from monitoring in design and assessment of dewatering and assessment of permanent impacts of tunnel on groundwater levels.	2	4	8	
Geo6	Recharge capability around Spring Bottom.	Uncertainty regarding feasibility of use of soakaway during temporary dewatering.	More expensive solution required. Additional project cost and programme implications.	C P	4	4	16	2017 EP GI complete at Spring Bottom Farm. Hydrogeology team to use results to determine if there is an alternative to direct discharge into River Avon.	2	4	8	Fast recharge following pumping tests indicate potential faulting and water movements which should be mapped with Geophysics.

Ref	Description of risk	Potential impact (DCO Submission)	Potential impact (Detailed Design)	Critical Consequence Categories	Risk Rating			Mitigation	Post Mitigation Risk Rating			Mitigation of Residual Risk to be Identified prior to Detailed Design
					Likelihood	Consequence	Risk Score		Likelihood	Consequence	Risk Score	
Geo7	Groundwater modelling and response to rainfall events.	May cause over or under-estimation of the groundwater flows into Stonehenge Bottom which will impact on design of any dewatering system and assessment of impact on River Till. May cause over or under-estimation of groundwater levels during wet periods, which will impact on the design of drainage and tunnel/road design.	May impact on design of any dewatering system, drainage system and road levels.	C P Q H&S E	4	4	16	Catchment boreholes were installed during 2017 EP GI. Additional boreholes recommended to de-lineate between the Avon and Till valleys. Incorporate results from monitoring in design and assessment of dewatering and assessment of permanent impacts of tunnel on groundwater levels.	2	4	8	
Geo8	Joint characteristics and/or orientations within chalk vary from existing data set.	May influence temporary support requirements for tunnel and over-estimation of ground movements. May influence cut slope design and derivation of Red Line Boundary.	Could lead to over-design of slopes and tunnel, leading to increased land take requirements, costs and programmed implications.	C P	4	5	20	Additional ground investigation for preliminary design including televiewer in selected boreholes.	2	5	10	Further focussed investigations at detailed design stage to further optimise designs.
Geo10	Localised areas of potentially contaminated land (i.e. former RAF Stonehenge and RAF Oatlands Hill on Site and Countess Filling off-Site). Uncertainty regarding the chemical status of soils and groundwater in these areas.	May lead to conservatism regarding the assessment of potential risks to human health and controlled waters and how soil arisings and groundwater is re-used and managed on or off-Site.	If the same uncertainties are present during detailed design stage, this may present issues with the regulatory authorities in the context of discharging planning conditions if it is considered that the risks have not been fully assessed.	C P Q H&S E	3	3	9	Further targeted ground investigation and testing to better assess and delineate any potential areas of significant contamination. Stage 2 and Stage 3 risk assessments to be carried out depending on findings from the EP GI.	1	3	3	Include contingencies for mitigation in GI and construction planning if required.
Geo11	Uncertainty and variability in infiltration characteristics.	Impact on preliminary sizing of Drainage Treatment Areas and land take required.	Impact on sizing of Drainage Treatment Areas and land take required.	C P Q H&S E	4	4	16	Soakaway tests undertaken during EP GI. Incorporate appropriate contingencies in preliminary design.	2	4	8	Further infiltration tests at detailed design stage.
Geo12	Uncertainty regarding presence of dissolution features	May influence temporary support requirements for the tunnel, foundation design, potential collapse settlement and cutting excavation.	May influence temporary support requirements for tunnel, foundation design, potential collapse settlement and cutting excavation.	C P Q H&S	4	5	20	Geophysical surveys to provide more confidence regarding potential presence of large karst features.	1	5	5	Design and construction planning to take account of range of anticipated conditions.
Geo13	Radon potential of the phosphatic Chalk.	The risk is considered to be minimal and limited to the construction phase of the tunnel. Risks to construction workers can be mitigated through ventilation and air monitoring. The radon potential has been raised as a concern by the	Without data to re-assure on the material's properties, it may be difficult to allay any public concerns during future construction activities.	R H&S E	3	2	6	Radon screening of phosphatic Chalk cores recovered to date, in addition to those from the EP GI and additional GI in the phosphatic Chalk zone in order to demonstrate that no significant risk is present.	1	2	2	

Ref	Description of risk	Potential impact (DCO Submission)	Potential impact (Detailed Design)	Critical Consequence Categories	Risk Rating			Mitigation	Post Mitigation Risk Rating			Mitigation of Residual Risk to be Identified prior to Detailed Design
					Likelihood	Consequence	Risk Score		Likelihood	Consequence	Risk Score	
		community groups. Without data to re-assure on the material's properties, it may be difficult to allay any public concerns during future construction activities.										
Geo15	Soft or compressible alluvial deposits including peat layers in Till or Avon valleys.	Conservative values may impact on design and space requirements for the approach embankments at Countess Roundabout junction and River Till crossing.	May impact on design and construction of the approach embankments at Countess Roundabout junction and River Till crossing.	C P	4	3	12	Additional GI in Till valley (compression tests).	2	3	6	Additional GI advised at Countess roundabout.
Geo16	Extent and nature of flint bands.	May impact on preliminary assessment of requirements for TBM and chalk excavation/processing equipment.	May impact on preliminary assessment of requirements for TBM and chalk excavation/ processing equipment.	C P	4	4	16	Additional investigation points will add to information regarding the location of flint bands.	2	4	8	Carry out statistical assessment in relation to location and nature of the flint bands. Allow for uncertainty regarding locations and detailed logging of flint types and bands in selection of tunnel construction method. Include appropriate contingencies.
Geo17	Presence of UXOs. Explosive Ordnance Desktop Threat Assessment carried out by Dynasafe BACTEC Ltd (report date 31st August 2016), following which the site is classed as low risk.	Possible requirement for risk mitigation during further ground investigations.	Possible requirement for risk mitigation during construction.	C P H&S E	1	5	5	Advance in accordance with advice from the Explosive Ordnance Desktop Threat Assessment, Site Specific Explosive Ordnance Safety and Awareness.	1	5	5	Briefings still required for workforce undertaking intrusive work. Appropriate measures as identified by UXO specialist to be adopted
Geo18	Uncertain ground conditions in close proximity to existing structures that are sensitive to ground movements.	Conservative preliminary assessment of ground movement, indicating potential unacceptable levels of damage to fragile structures.	Unacceptable levels of damage to fragile/sensitive structures.	C P R H&S, E	4	5	20	Additional GI for DCO assessment to add confidence and certainty to assumed ground conditions.	2	5	10	Further focused GI for detailed design.
Geo19	Unknown ground conditions in vicinity of Esso Pipeline at current alignment and through Parsonage Down.	Conservative preliminary assessment of ground movement, indicating potential unacceptable levels of damage to pipeline.	Unacceptable levels of damage to pipeline.	C P R H&S, E	5	5	25	Additional GI for DCO assessment to add confidence and certainty to assumed ground movement assessments.	1	5	5	Further focused GI for detailed design.
Geo20	Uncertainties on groundwater level fluctuations at Parsonage Down.	May impact on preliminary risk assessment of tunnel waste material disposal. May have an impact on drainage and potential for groundwater flooding.	May impact on preliminary risk assessment of tunnel waste material disposal. May have an impact on drainage and potential for groundwater flooding.	C P H&S E	4	4	16	Additional GI and groundwater monitoring boreholes to be completed.	2	4	8	Further GI to be done ahead of detailed design should this location be selected for disposal of tunnel waste material.
Geo21	Uncertainties regarding faulting and folding within structured Chalk. Common evidence of presence	May impact on design options for tunnel and associated temporary support, as well as deep	May impact on design options for tunnel and associated temporary support, as well as deep foundation design within	C P Q	4	4	16	Additional investigation points will add to information regarding faulting characteristics and location.	2	4	8	Allow for uncertainty in selection of tunnel construction method. Include appropriate contingencies.

Ref	Description of risk	Potential impact (DCO Submission)	Potential impact (Detailed Design)	Critical Consequence Categories	Risk Rating			Mitigation	Post Mitigation Risk Rating			Mitigation of Residual Risk to be Identified prior to Detailed Design
					Likelihood	Consequence	Risk Score		Likelihood	Consequence	Risk Score	
	exists, however extents have not been confirmed on a local scale.	foundation design within structured Chalk.	structured Chalk.									

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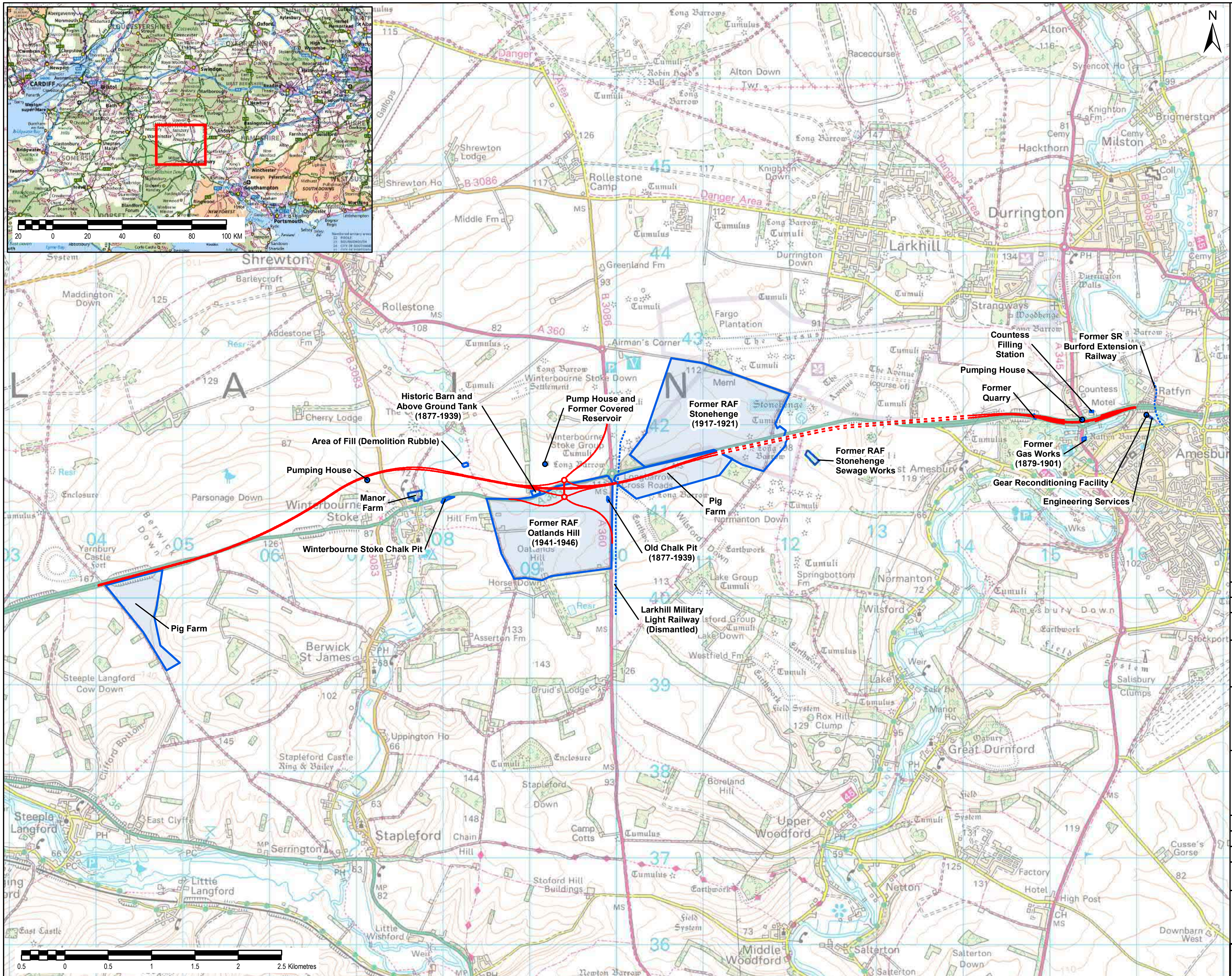
Figures



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NOTES / LEGEND

- Preferred Alignment (as at 15/09/2017)
- Potential Area of Contamination
- Potential Area of Contamination (Linear)
- Potential Area of Contamination (Point)

Revision Details	By Check	Date	Suffix

Purpose of issue: DRAFT

Client: Highways England

Working on behalf of highways england

Project Title: A303 STONEHENGE AMESBURY TO BERWICK DOWN

Drawing Title: FIGURE 3-1 POTENTIAL SOURCES OF CONTAMINATION

Designed	Drawn	Checked	Approved	Date
CM	KD	CC	CM	31/10/17

Internal Project No.	Suitability
60541439	xx

Scale @ A3	Zone
1:40,000	SW

Highways England
Temple Quay House
2 Temple Quay
Bristol
BS1 6PN

AmW
AECOM + mace + WSP

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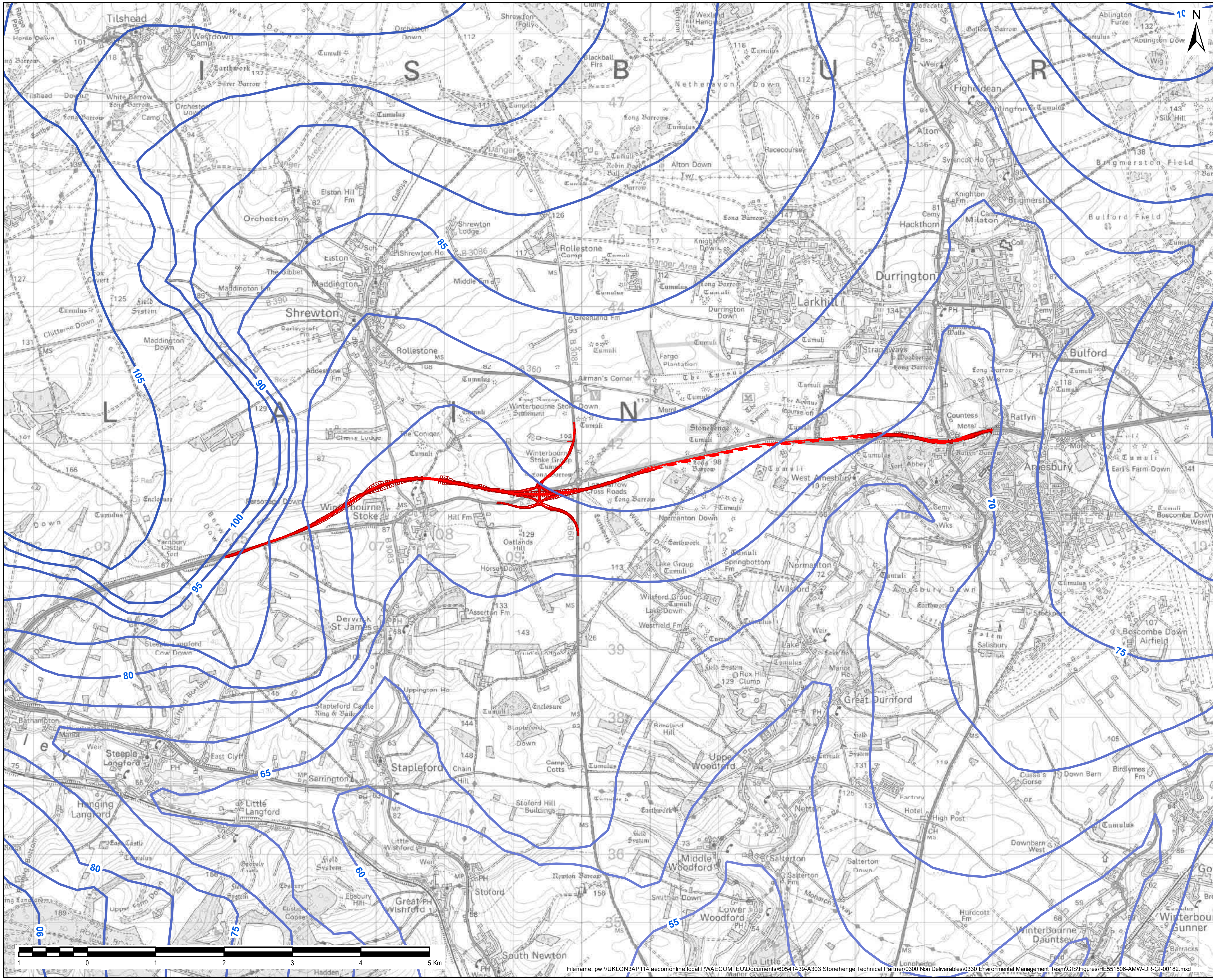

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NOTES / LEGEND

A303 Preferred Route Alignment - 17/01/2018

- Route Alignment
- Tunnel
- Earthworks

Groundwater Contour (mAOD)

- 55
- 60
- 65
- 70
- 75
- 80
- 85
- 90
- 95
- 100
- 105

Revision Details	By / Check	Date	Suffix

Purpose of issue: DRAFT

Client: Highways England — Working on behalf of highways england

Project Title: A303 STONEHENGE AMESBURY TO BERWICK DOWN

Drawing Title: FIGURE 3-2 GROUNDWATER CONTOURS SIMULATED AVERAGE HIGH JANUARY 1996

Designed	Drawn	Checked	Approved	Date
HS	KD	CC	AE	29/03/18

Internal Project No. 60541200

Scale @ A3: 1:50,000 | Zone: SW

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2 The Square, Temple Quay
Bristol
BS1 6HA

AmW — AECOM + mace + WSP

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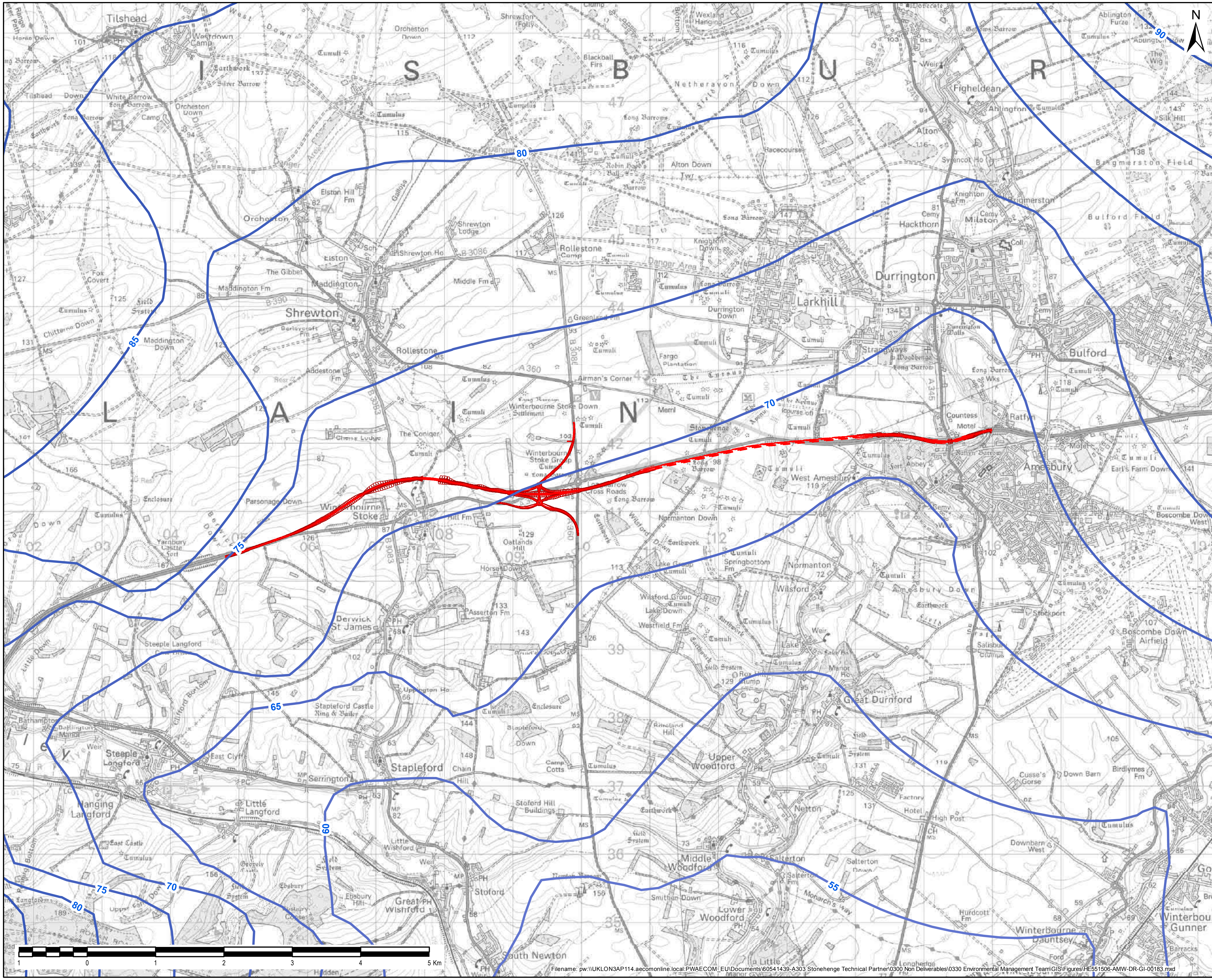

NOTES / LEGEND

A303 Preferred Route Alignment - 17/01/2018

- Route Alignment
- Tunnel
- Earthworks

Groundwater Contour (mAOD)

- 55
- 60
- 65
- 70
- 75
- 80
- 85
- 90

Revision Details	By / Check	Date	Suffix

Purpose of issue: FINAL

Client: Highways England — Working on behalf of highways england

Project Title: A303 STONEHENGE AMESBURY TO BERWICK DOWN

Drawing Title: FIGURE 3-2 GROUNDWATER CONTOURS SIMULATED AVERAGE LOW NOVEMBER 1995

Designed	Drawn	Checked	Approved	Date
HS	KD	CC	AE	29/03/18

Internal Project No. 60541200

Scale @ A3: 1:50,000 | Zone: SW

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BS1 6HA

AmW — AECOM + mace + WSP

Drawing Number Highways England PIN	Originator	Volume	Rev
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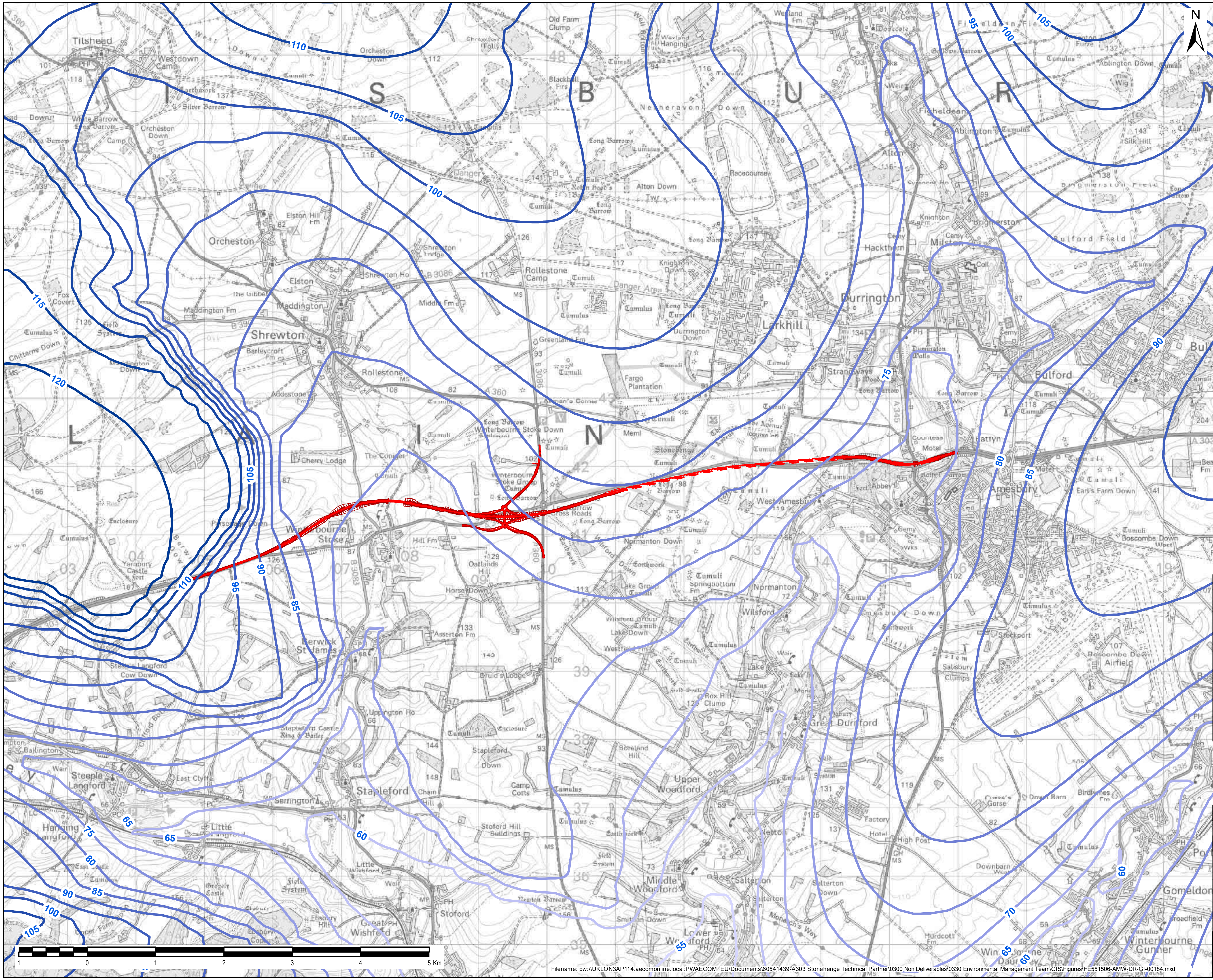

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NOTES / LEGEND

A303 Preferred Route Alignment - 17/01/2018

- Route Alignment
- Tunnel
- Earthworks

Groundwater Contour (mAOD)

- 55
- 60
- 65
- 70
- 75
- 80
- 85
- 90
- 95
- 100
- 105
- 110
- 115
- 120

Revision Details	By / Check	Date	Suffix

Purpose of issue: FINAL

Client: Highways England — Working on behalf of highways england

Project Title: A303 STONEHENGE AMESBURY TO BERWICK DOWN

Drawing Title: FIGURE 3-2 GROUNDWATER CONTOURS SIMULATED EXTREME HIGH FEBRUARY 2014

Designed	Drawn	Checked	Approved	Date
HS	KD	CC	AE	29/03/18

Internal Project No. 60541200

Scale @ A3: 1:50,000 — Zone: SW

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Bristol
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Drawing Number				Rev
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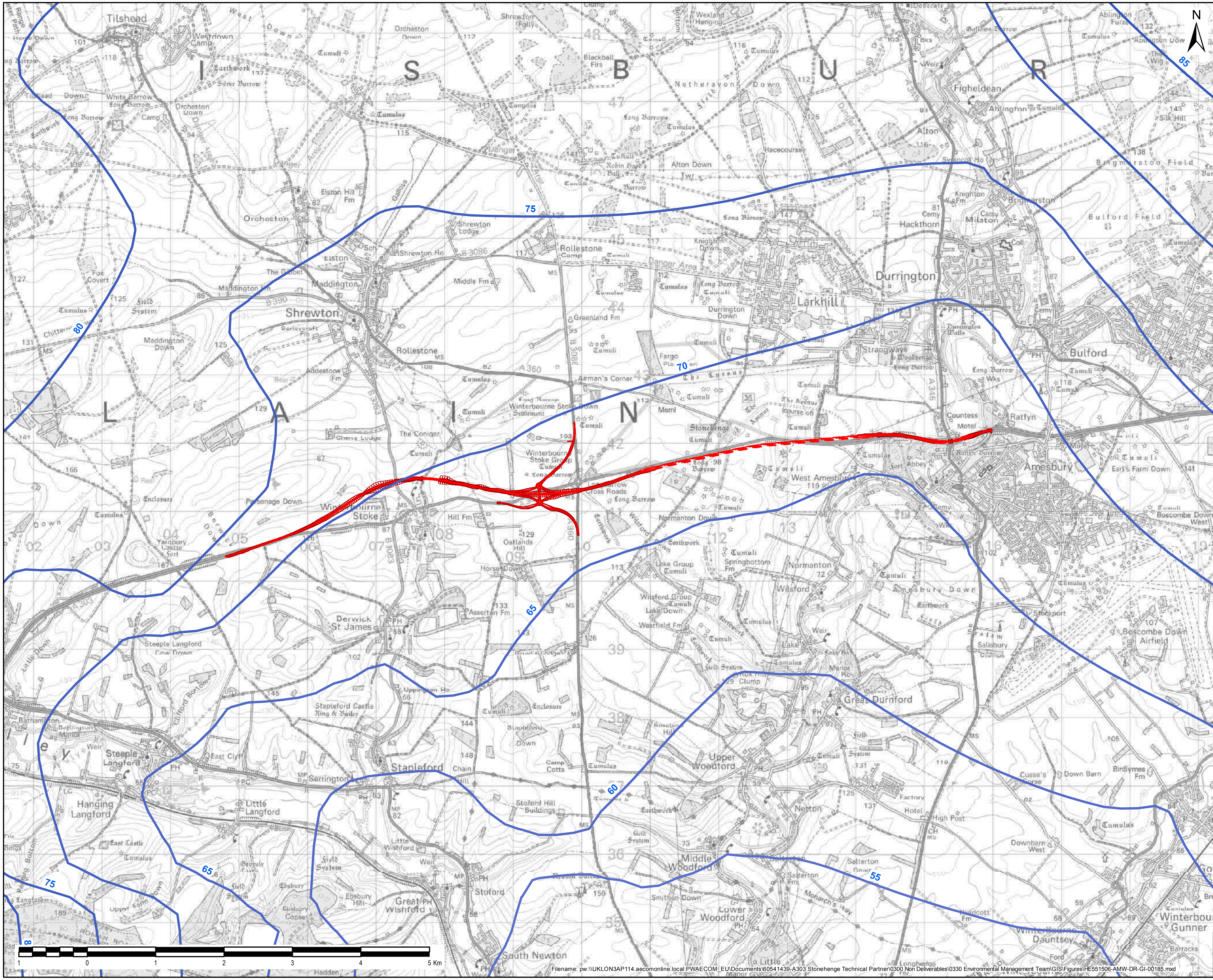

NOTES / LEGEND

A303 Preferred Route Alignment - 17/01/2018

- Route Alignment
- Tunnel
- Earthworks

Groundwater Contour (mAOD)

- 55
- 60
- 65
- 70
- 75
- 80
- 85

Revision Details	By / Check	Date	Suffix

Purpose of issue: FINAL

Client: Highways England — Working on behalf of highways england

Project Title: A303 STONEHENGE AMESBURY TO BERWICK DOWN

Drawing Title: FIGURE 3-2 GROUNDWATER CONTOURS SIMULATED EXETREME LOW SEPTEMBER 1976

Designed	Drawn	Checked	Approved	Date
HS	KD	CC	AE	29/03/18

Internal Project No. 60541200

Scale @ A3: 1:50,000 | Zone: SW

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2 The Square, Temple Quay
Bristol
BS1 6HA

AmW — AECOM + mace + WSP

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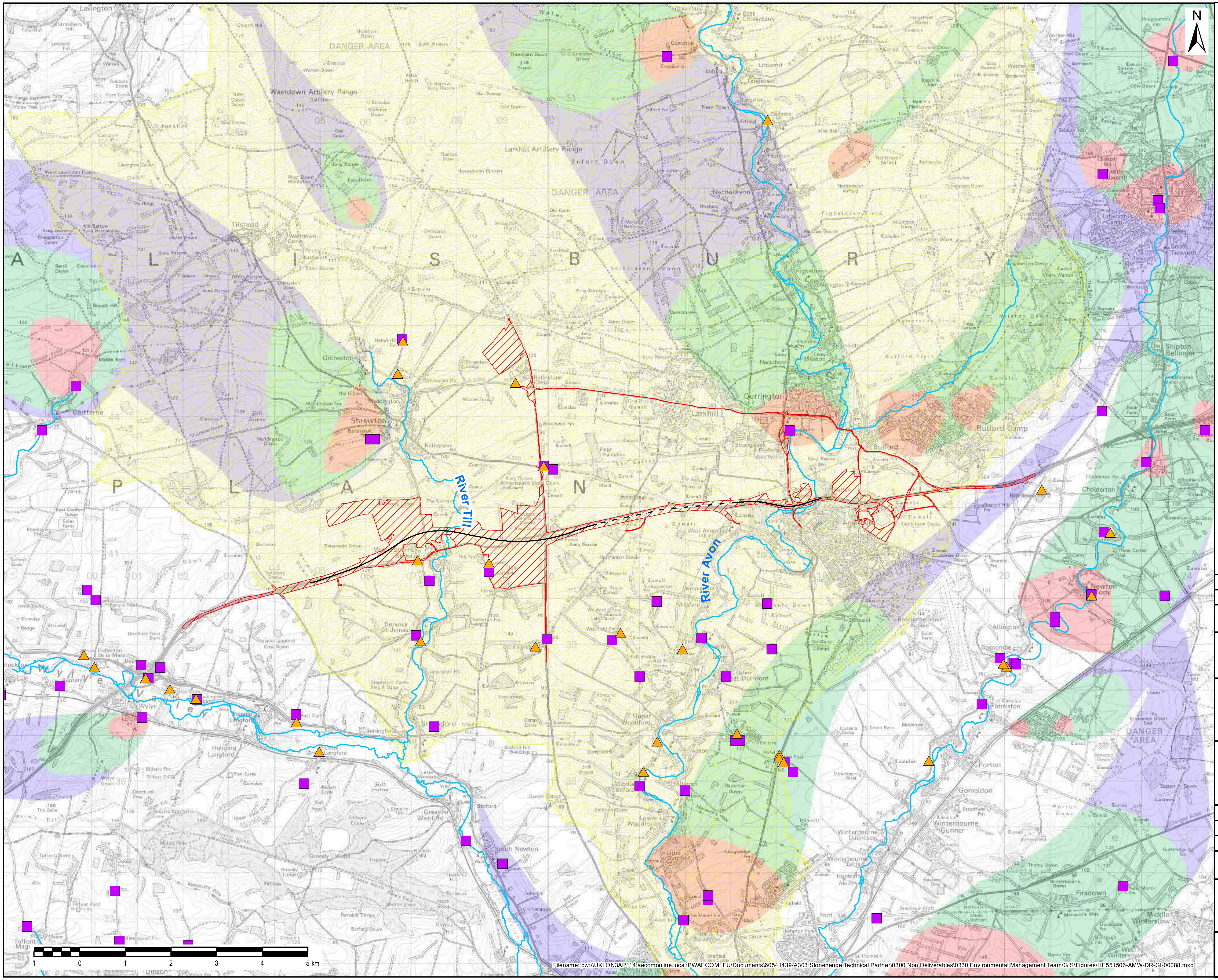

NOTES / LEGEND

- Indicative centreline for the purposes of GI Report
- Proposed Tunnel
- Proposed draft DCO site boundary for the purposes of GI Report (Feb 2018)
- WFD River Waterbody
- Private Water Supplies provided by Wiltshire Council
- Licenced Groundwater Abstraction provided by Environment Agency
- Cumulative Effects Assessment Area

EA Source Protection Zones

- Zone I - Inner Protection Zone
- Zone II - Outer Protection Zone
- Zone III - Total Catchment

Revision Details	By / Check	Date	Suffix

Purpose of issue: FINAL

Client: Highways England

Working on behalf of highways england

Project Title: A303 STONEHENGE AMESBURY TO BERWICK DOWN

Drawing Title: FIGURE 5-10 GROUNDWATER ABSTRACTION AND SOURCE PROTECTION ZONES

Designed	Drawn	Checked	Approved	Date
AB	KD	HC	CC	11/04/18

Internal Project No. 60541200

Scale @ A3: 1:75,000 | Zone: SW

Highways England
Temple Quay House
2 The Square, Temple Quay
Bristol
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Drawing Number

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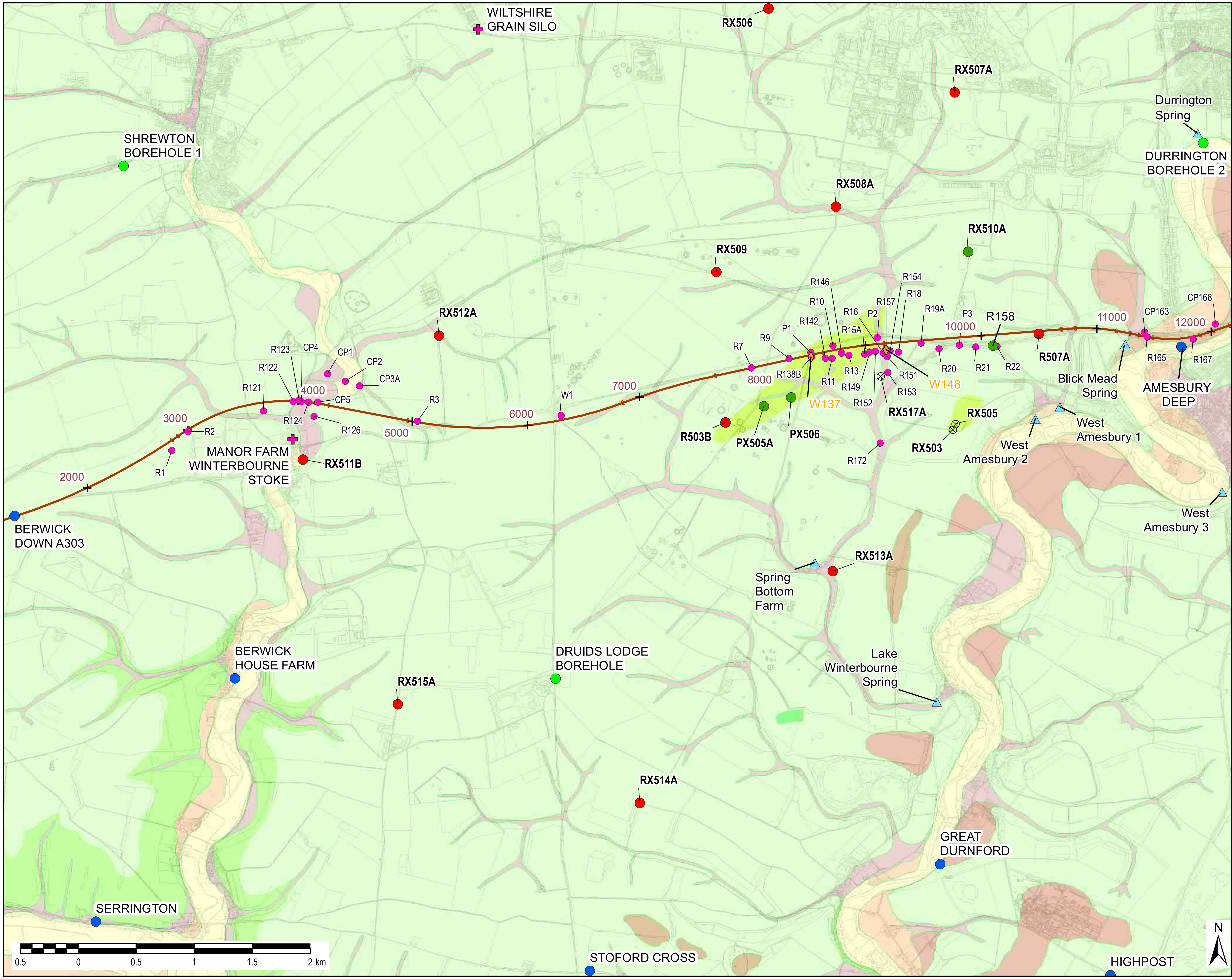
Location	Type / Role	Number	



NOTES / LEGEND

- Indicative Centreline for the Purposes of GI Report
- Chainage
- EA Water Level Borehole 2017
- EA Disused Water Level Borehole 2017
- Historic Piezometer
- Historic PumpTest Borehole
- Spring

2017 Monitoring Network

- Installed
- Transmitting
- Backfilled

Geology

- Lewes Nodular Chalk Fn
- Newhaven Chalk Fn
- Seaford Chalk Fn
- Stockbridge Rock Mb - Limestone
- Head - Gravel
- Head - Clay, Silt Sand & Gravel
- River Terrace Deposits
- Alluviums
- Clay with Flints Fn

Revision Details	By / Check	Date	Suffix

Purpose of issue: FINAL

Client: Highways England

Working on behalf of highways england

Project Title: A303 STONEHENGE AMESBURY TO BERWICK DOWN

Drawing Title: FIGURE 5-11 GROUNDWATER MONITORING LOCATIONS

Designed	Drawn	Checked	Approved	Date
AB	TD	DH	AB	11/04/18

Internal Project No. 60547200

Scale @ A3: 1:30,000 | Zone: SW

Highways England
Temple Quay House
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Bristol
BS1 6HA

AmW AECOM + mace + WSP

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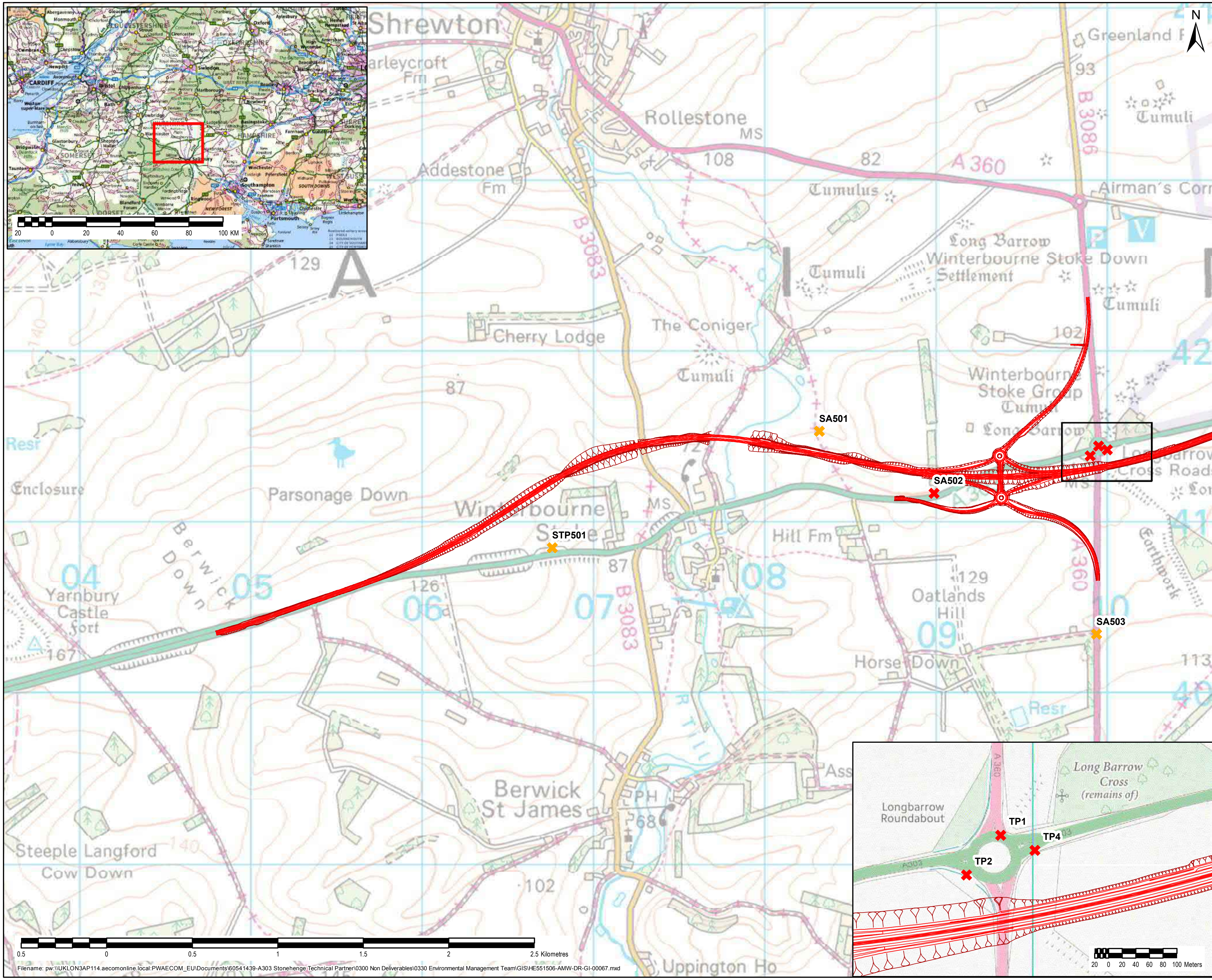

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NOTES / LEGEND

A303 Preferred Route Alignment - 17/01/2018

- Route Alignment
- Tunnel
- Earthworks

Geo-environmental Testing Points

- Groundwater Testing
- Soil Testing
- Soil and Leachate Testing
- Soil, Leachate and Groundwater Testing

Revision Details	By / Check	Date	Suffix

Purpose of issue: DRAFT

Client: Highways England — Working on behalf of highways england

Project Title: FIGURE 7-1 A303 STONEHENGE AMESBURY TO BERWICK DOWN

Drawing Title: GEO-ENVIRONMENTAL TESTING LOCATIONS SHEET 1

Designed	Drawn	Checked	Approved	Date
CM	KD	CC	CM	29/03/18

Internal Project No.: 60541439 — Suitability: xx

Scale @ A3: 1:20,000 — Zone: SW

Highways England
Temple Quay House
2 Temple Quay
Bristol
BS1 6PN

AmW — AECOM + mace + WSP

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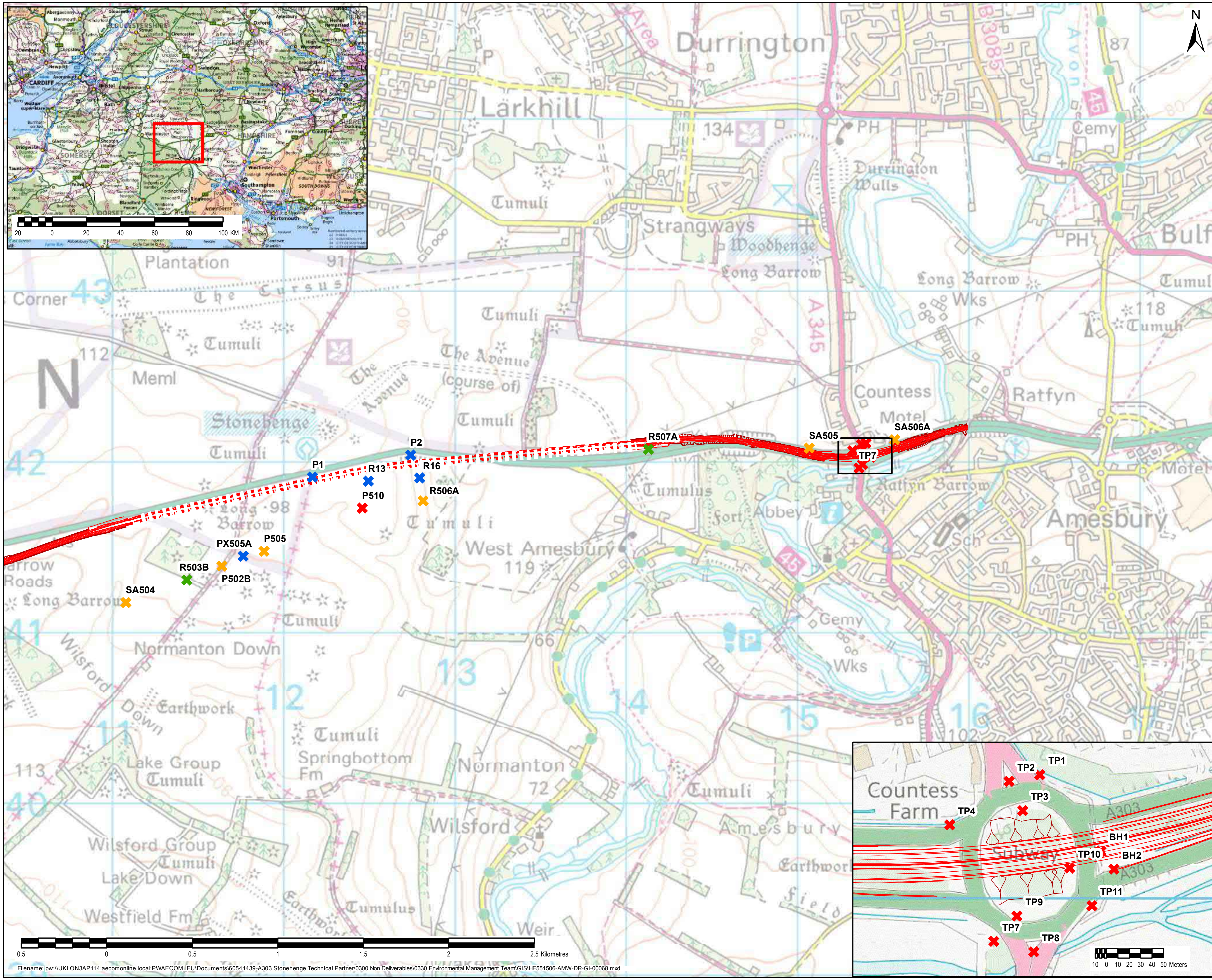

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NOTES / LEGEND

A303 Preferred Route Alignment - 17/01/2018

- Route Alignment
- Tunnel
- Earthworks

Geo-environmental Testing Points

- Groundwater Testing
- Soil Testing
- Soil and Leachate Testing
- Soil, Leachate and Groundwater Testing

Revision Details	By / Check	Date	Suffix

Purpose of issue: DRAFT

Client: Highways England

Working on behalf of highways england

Project Title

FIGURE 7-1:
A303 STONEHENGE
AMESBURY TO BERWICK DOWN

Drawing Title

GEO-ENVIRONMENTAL
TESTING LOCATIONS
SHEET 2

Designed	Drawn	Checked	Approved	Date
CM	KD	CC	CM	29/03/18

Internal Project No.	Suitability
60541439	xx
Scale @ A3	**Zone**
1:20,000	SW

Highways England
Temple Quay House
2 Temple Quay
Bristol
BS1 6PN

AmW
AECOM + mace + WSP

Drawing Number: Highways England PIN	Originator	Volume		Rev
HE551506	AMW	GEN		01
SCHEME WIDE	GN	GI	0068	
Location	Type	Role	Number	

Geotechnical Parameter Figures – Key and Legend

Marker	Series Code	Stratum
●	TS	Topsoil
▲	TS-C	Topsoil - Cohesive
■	TS-G	Topsoil - Granular
●	MG	Made Ground
▲	MG-C	Made Ground - Cohesive
■	MG-G	Made Ground - Granular
■	C-FLINT	Flint Layer within Structured Chalk
●	HD	Head Deposits
■	HD-C	Head Deposits - Cohesive
▲	HD-G	Head Deposits - Granular
▲	HD-Dc	Head Deposits with structureless weathered Chalk - grade Dc
■	C-GR	Chalk Gravel
■	ALV-C	Alluvium - Cohesive
▲	ALV-G	Alluvium - Granular
●	ALV-PT	Alluvium - Peat
●	RTD	River Terrace Deposits
▲	RTD-C	River Terrace Deposits - Cohesive
■	RTD-G	River Terrace Deposits - Granular
■	C-SL	Chalk with Silt
■	C-Dc/m	Chalk - Structureless weathered grade Dc or Dm
■	C-Dm	Chalk - Structureless weathered grade Dm
▲	C-Dc	Chalk - Structureless weathered grade Dc
■	C-SFC-Dm	Chalk - Structureless weathered Seaford grade Dm
▲	C-SFC-Dc	Chalk - Structureless weathered Seaford grade Dc
■	C-NHC-Dm/Dc	Chalk - Structureless weathered Newhaven grade Dc or Dm
■	C-NHC-Dm	Chalk - Structureless weathered Newhaven grade Dm
▲	C-NHC-Dc	Chalk - Structureless weathered Newhaven grade Dc
●	C	Chalk - Structured
●	C-PC	Chalk - Phosphatic
●	C-SFC	Chalk - Seaford
■	C-SFC-FLINT	Flint Layer within Seaford Chalk
●	C-NHC	Chalk - Newhaven
●	C-LNC	Chalk - Lewes Nodular Formation

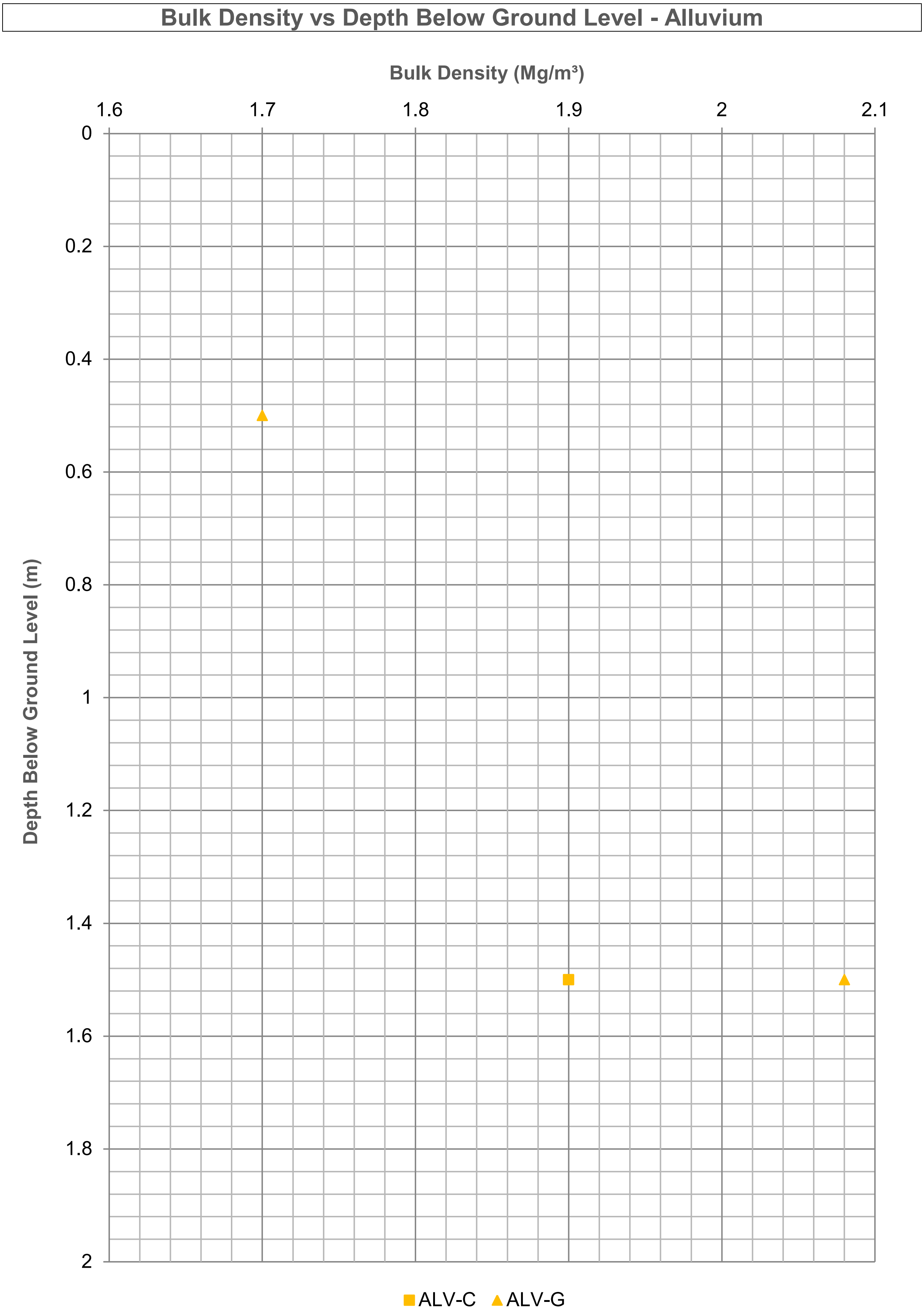

Bulk Density vs Depth Below Ground Level - Alluvium
Bulk Density (Mg/m³)
1.6
1.7
1.8
1.9
2
2.1
Depth Below Ground Level (m)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
ALV-C
ALV-G

Figure 6-1

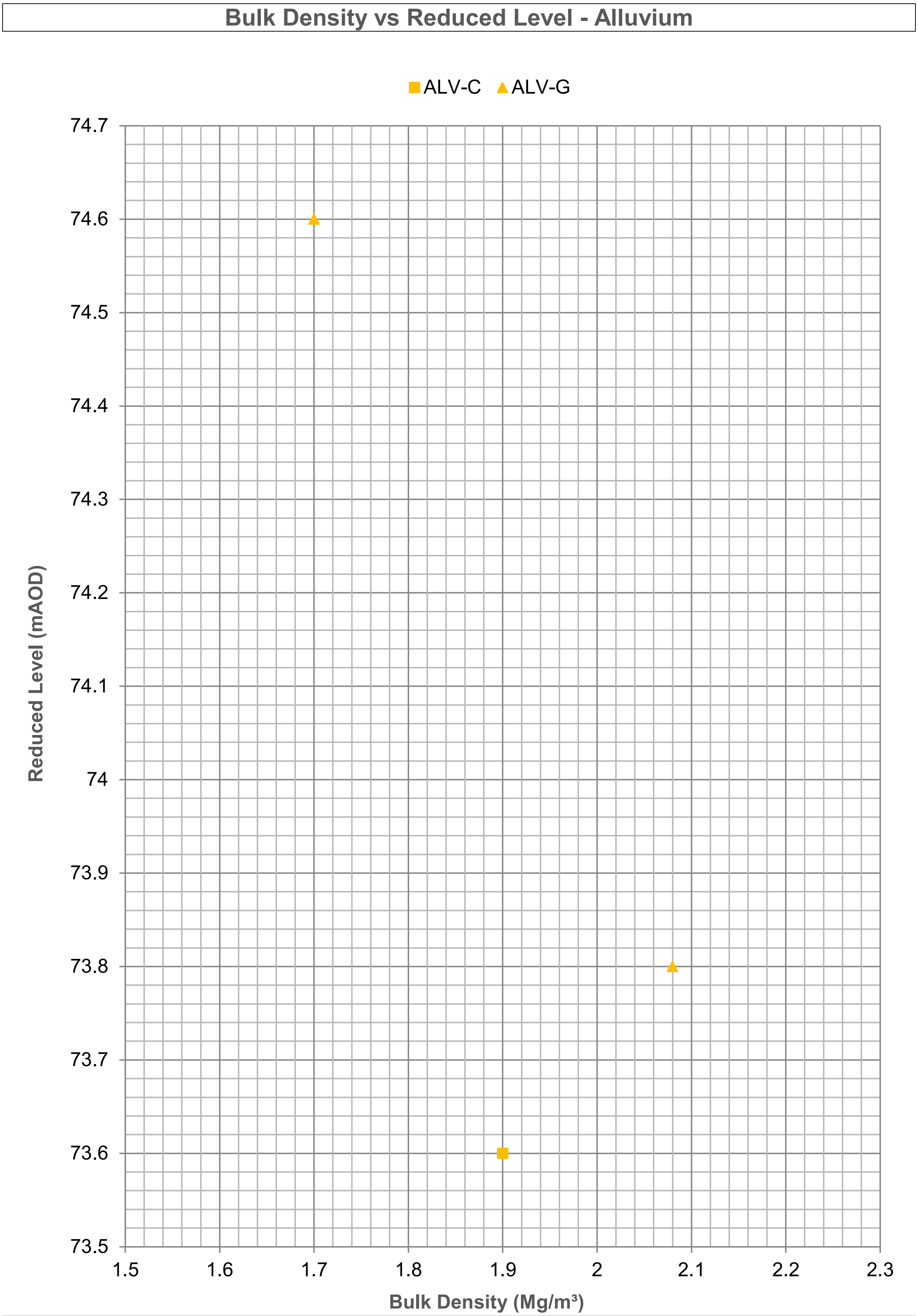

Bulk Density vs Reduced Level - Alluvium
ALV-C
ALV-G
Reduced Level (mAOD)
74.7
74.6
74.5
74.4
74.3
74.2
74.1
74
73.9
73.8
73.7
73.6
73.5
1.5
1.6
1.7
1.8
1.9
2
2.1
2.2
2.3
Bulk Density (Mg/m³)

Figure 6-2

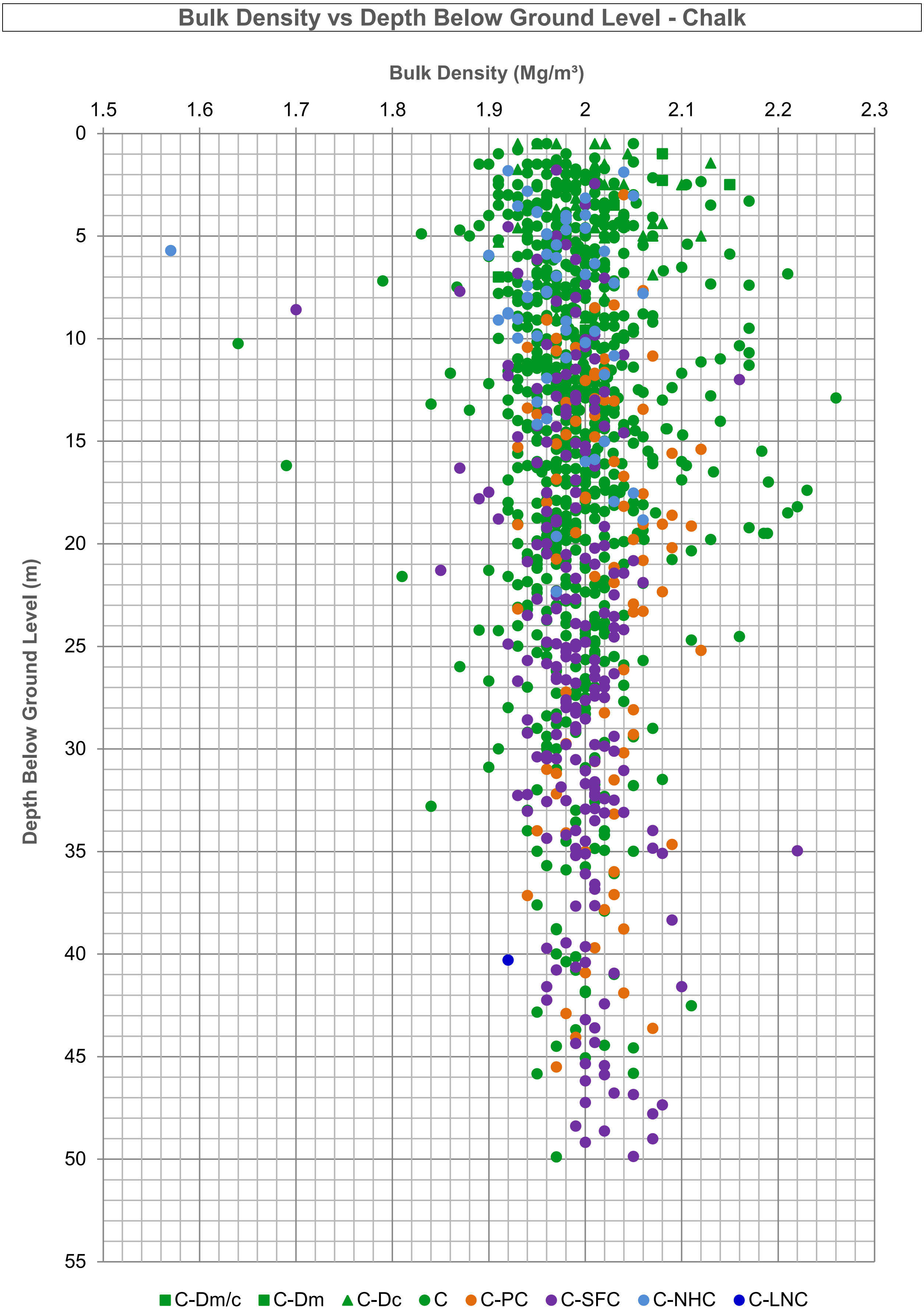

Bulk Density vs Depth Below Ground Level - Chalk
Bulk Density (Mg/m³)
1.5
1.6
1.7
1.8
1.9
2
2.1
2.2
2.3
Depth Below Ground Level (m)
0
5
10
15
20
25
30
35
40
45
50
55
C-Dm/c
C-Dm
C-Dc
C
C-PC
C-SFC
C-NHC
C-LNC

Figure 6-3

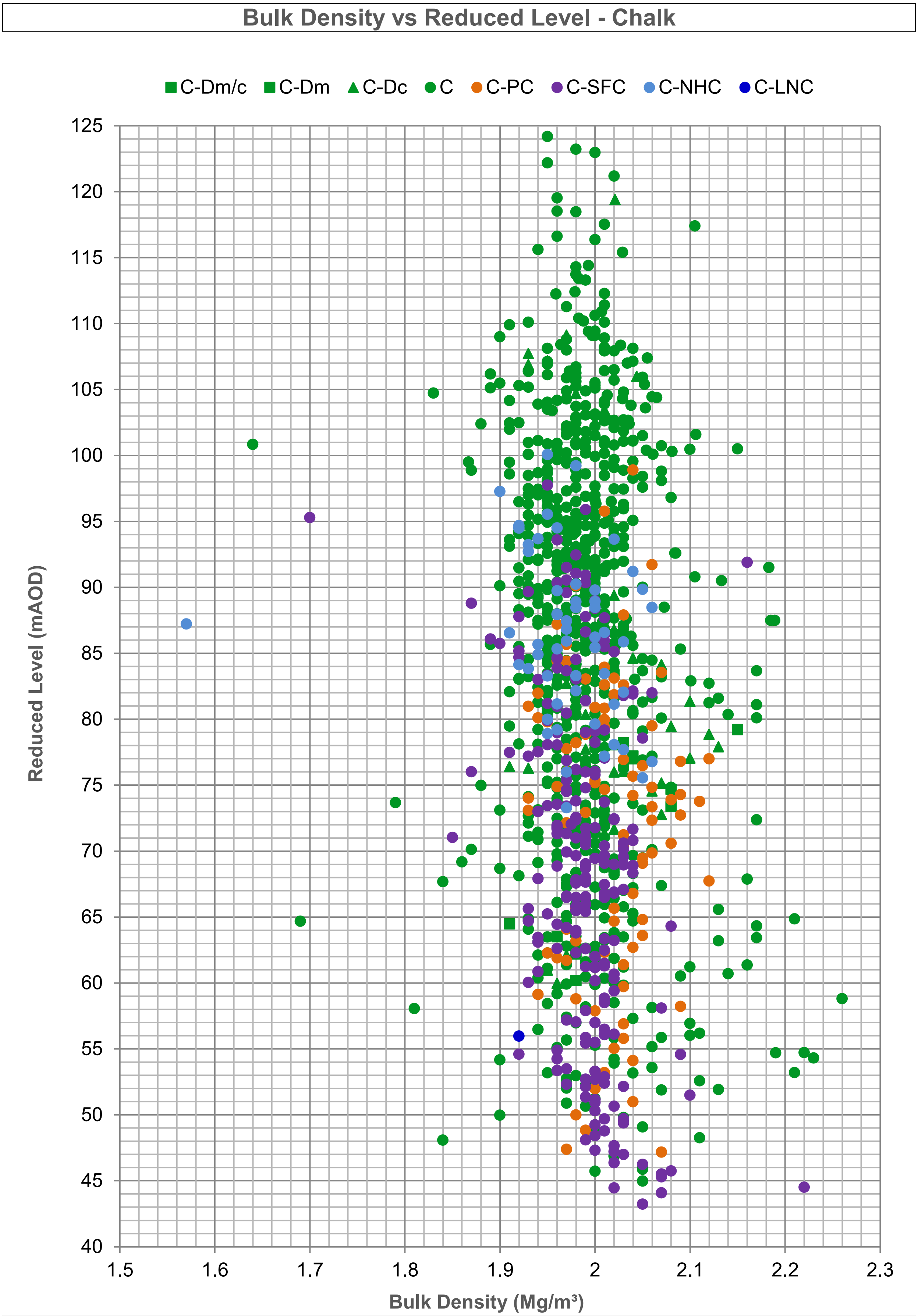

Bulk Density vs Reduced Level - Chalk
C-Dm/c
C-Dm
C-Dc
C
C-PC
C-SFC
C-NHC
C-LNC
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
Reduced Level (mAOD)
1.5
1.6
1.7
1.8
1.9
2
2.1
2.2
2.3
Bulk Density (Mg/m³)

Figure 6-4

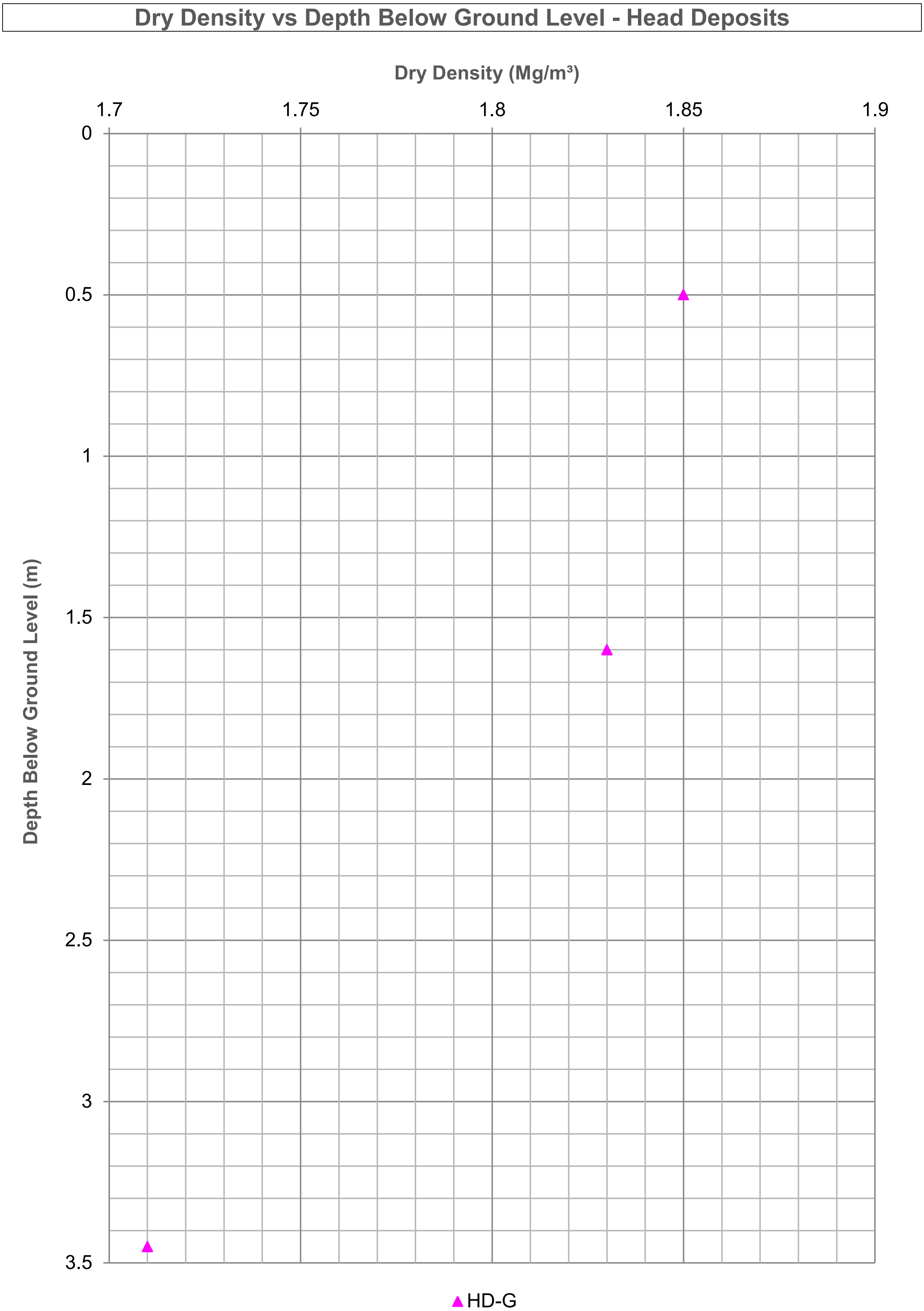

Dry Density vs Depth Below Ground Level - Head Deposits
Dry Density (Mg/m³)
1.7
1.75
1.8
1.85
1.9
Depth Below Ground Level (m)
0
0.5
1
1.5
2
2.5
3
3.5
HD-G

Figure 6-5

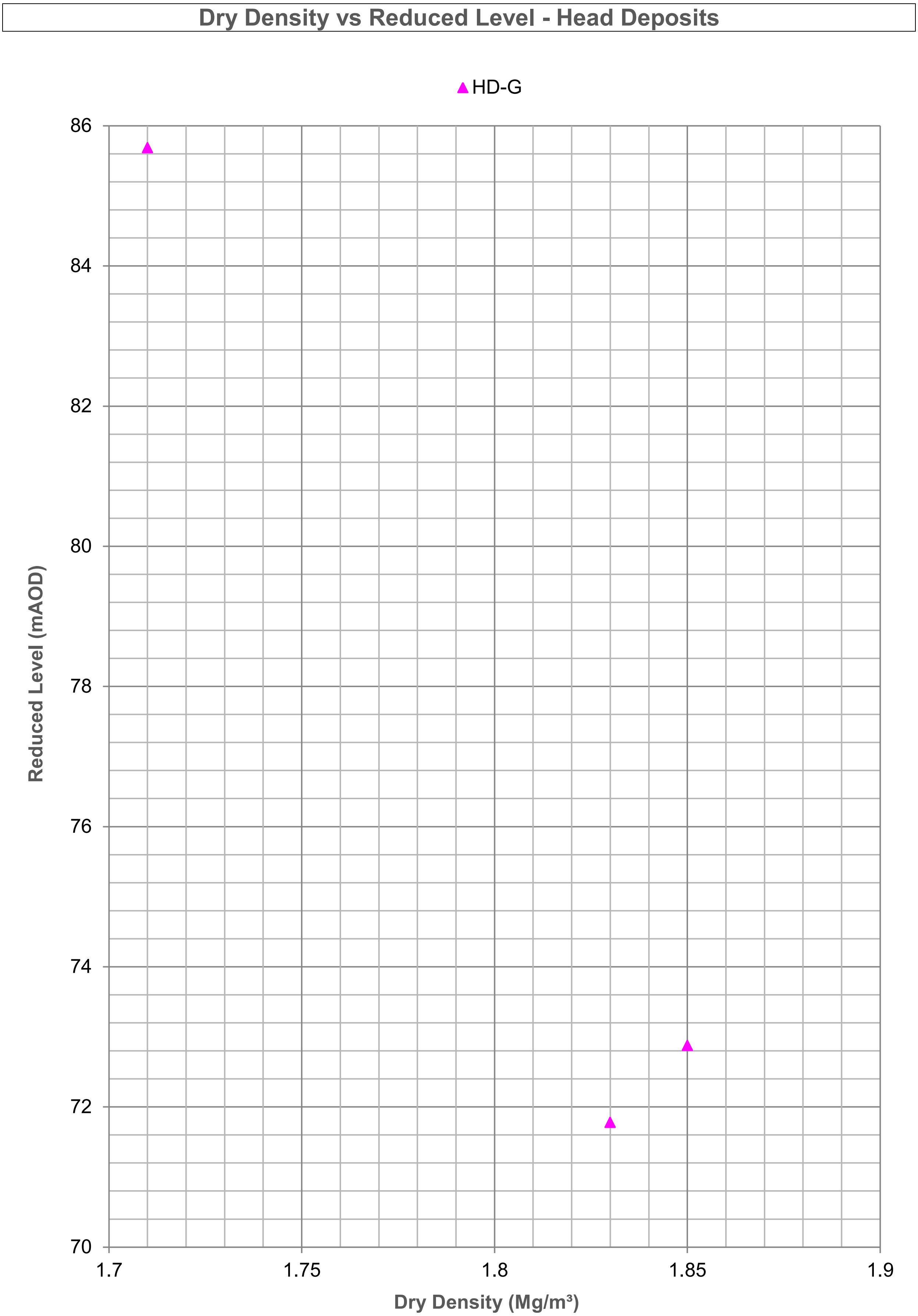
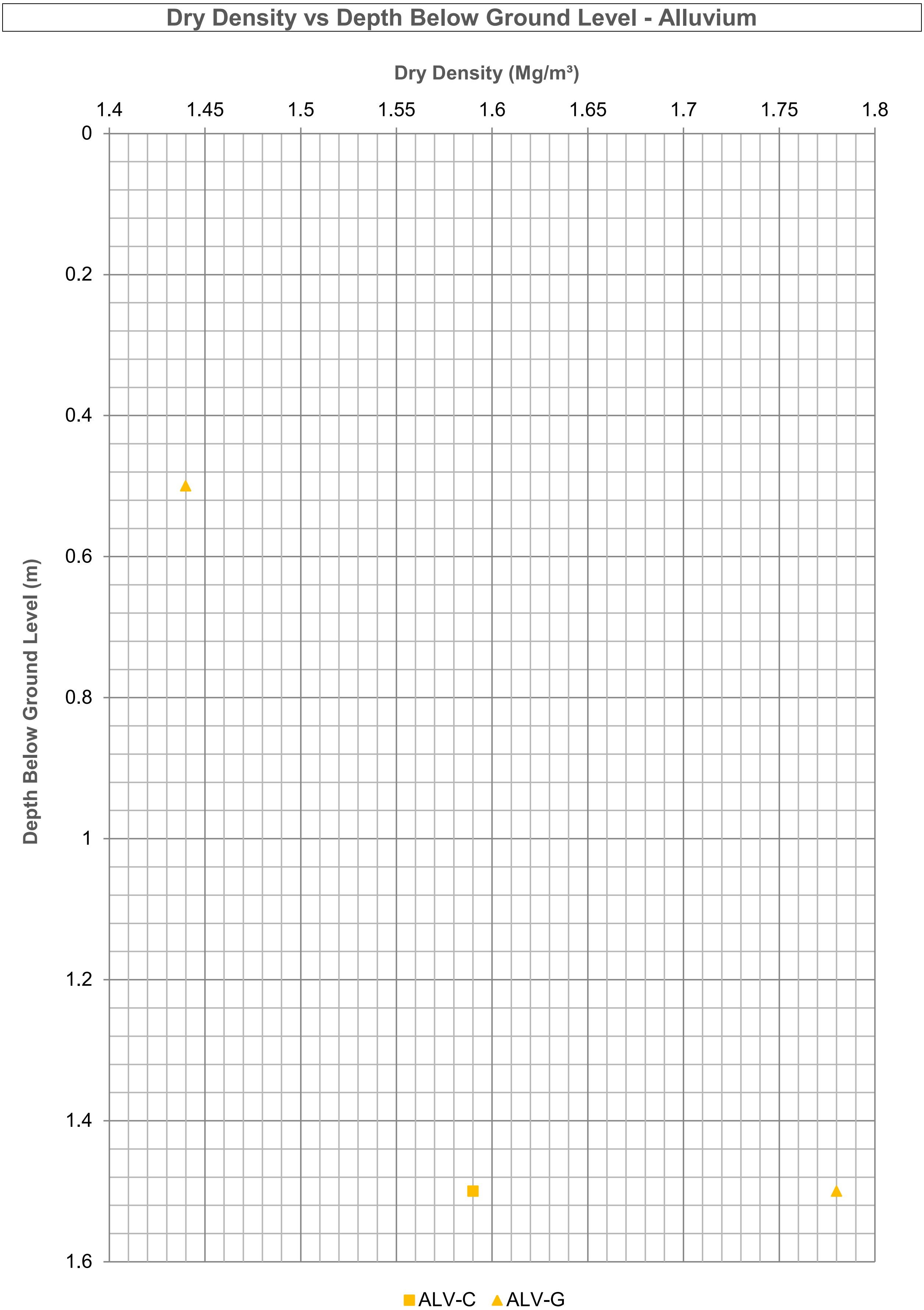

Dry Density vs Reduced Level - Head Deposits
HD-G
86
84
82
80
78
76
74
72
70
Reduced Level (mAOD)
1.7
1.75
1.8
1.85
1.9
Dry Density (Mg/m³)

Figure 6-6



Dry Density vs Depth Below Ground Level - Alluvium
Dry Density (Mg/m³)
1.4
1.45
1.5
1.55
1.6
1.65
1.7
1.75
1.8
Depth Below Ground Level (m)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
ALV-C
ALV-G

Figure 6-7

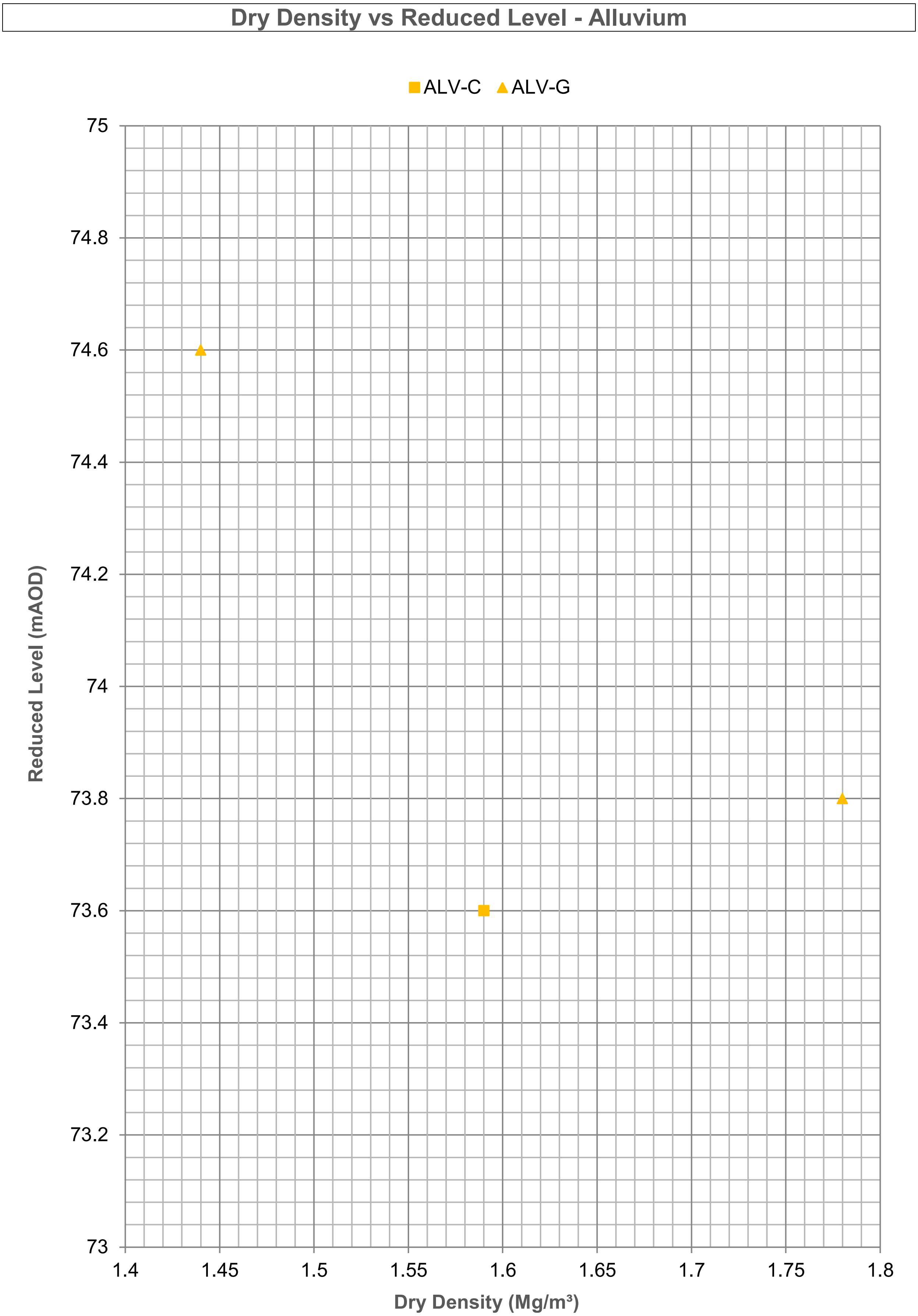

Dry Density vs Reduced Level - Alluvium
ALV-C
ALV-G
75
74.8
74.6
74.4
74.2
74
73.8
73.6
73.4
73.2
73
1.4
1.45
1.5
1.55
1.6
1.65
1.7
1.75
1.8
Reduced Level (mAOD)
Dry Density (Mg/m³)

Figure 6-8

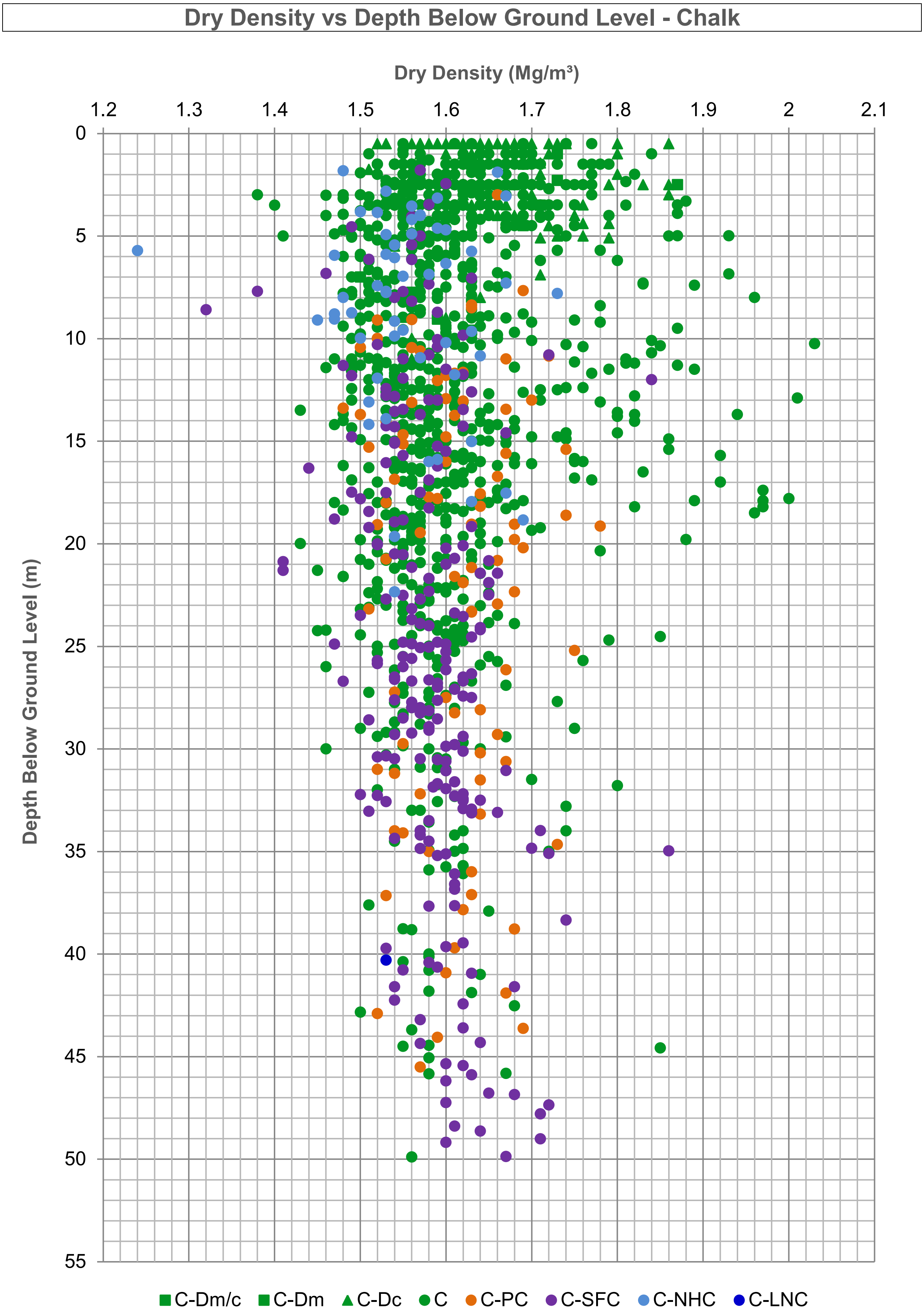

Dry Density vs Depth Below Ground Level - Chalk
Dry Density (Mg/m³)
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
2.1
0
5
10
15
20
25
30
35
40
45
50
55
Depth Below Ground Level (m)
C-Dm/c
C-Dm
C-Dc
C
C-PC
C-SFC
C-NHC
C-LNC

Figure 6-9

Dry Density vs Reduced Level - Chalk

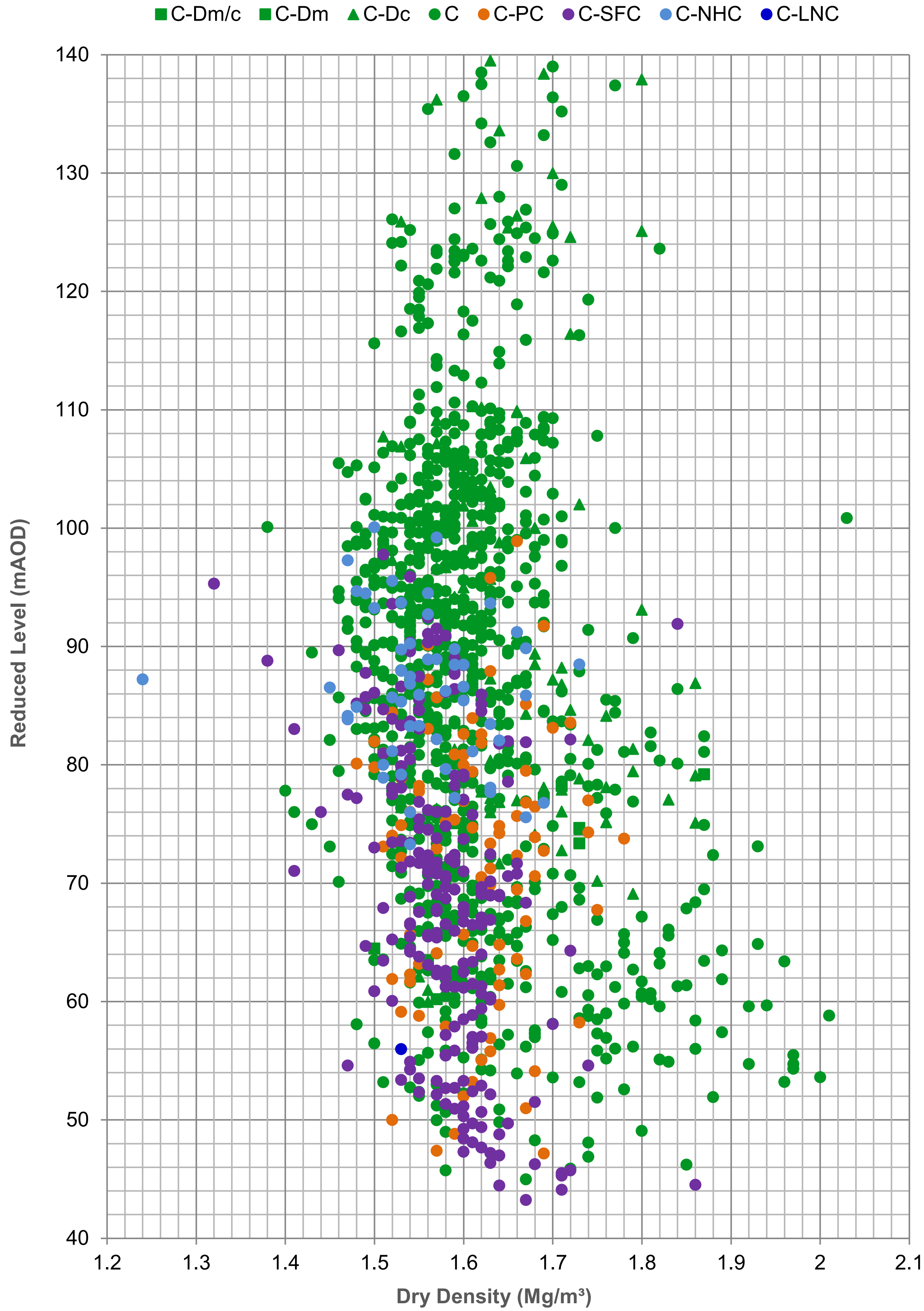


Figure 6-10

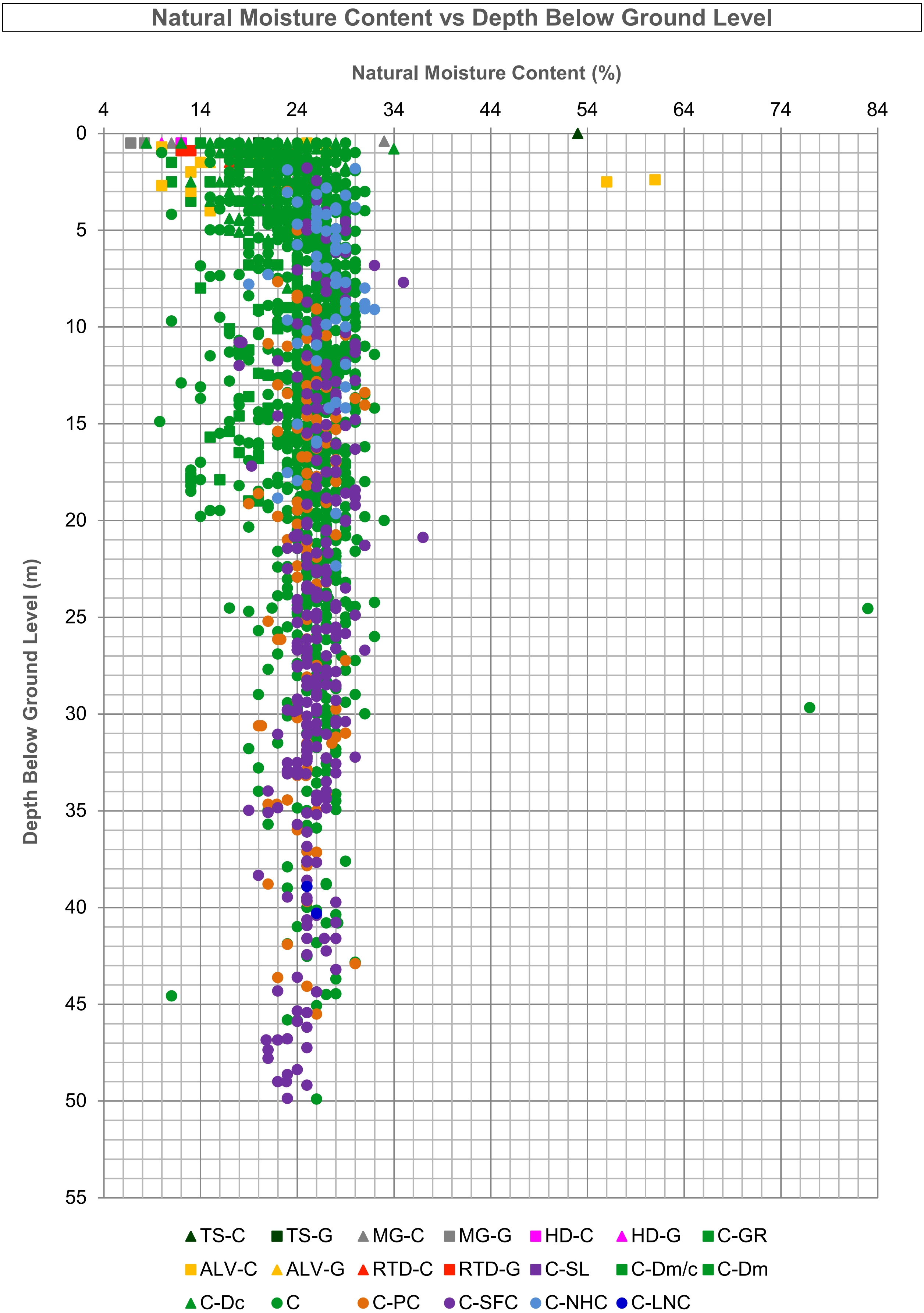

Natural Moisture Content vs Depth Below Ground Level
Natural Moisture Content (%)
4
14
24
34
44
54
64
74
84
0
5
10
15
20
25
30
35
40
45
50
55
Depth Below Ground Level (m)
TS-C
TS-G
MG-C
MG-G
HD-C
HD-G
C-GR
ALV-C
ALV-G
RTD-C
RTD-G
C-SL
C-Dm/c
C-Dm
C-Dc
C
C-PC
C-SFC
C-NHC
C-LNC

Figure 6-11

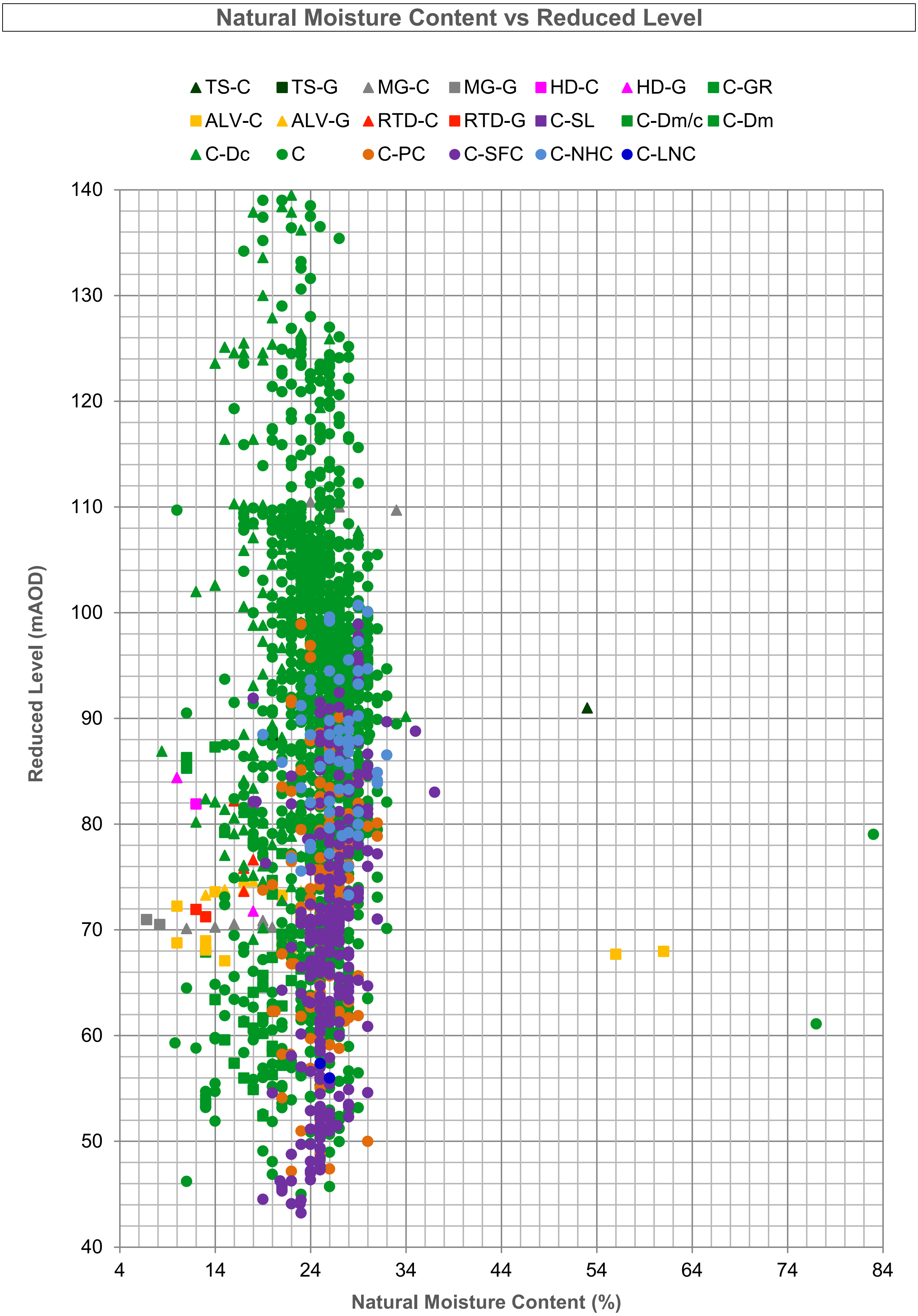

Natural Moisture Content vs Reduced Level
TS-C
TS-G
MG-C
MG-G
HD-C
HD-G
C-GR
ALV-C
ALV-G
RTD-C
RTD-G
C-SL
C-Dm/c
C-Dm
C-Dc
C
C-PC
C-SFC
C-NHC
C-LNC
Reduced Level (mAOD)
140
130
120
110
100
90
80
70
60
50
40
4
14
24
34
44
54
64
74
84
Natural Moisture Content (%)

Figure 6-12

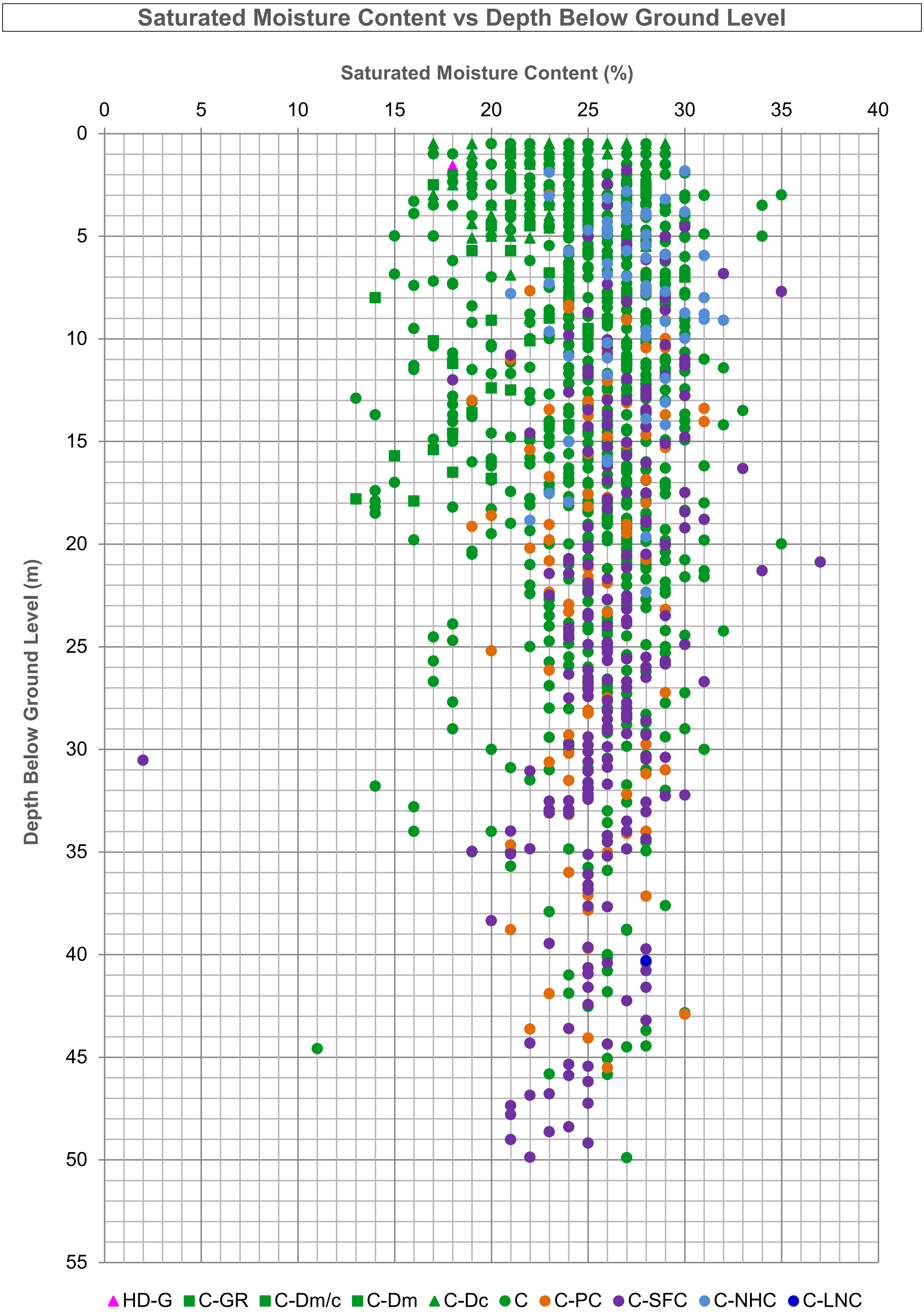

Saturated Moisture Content vs Depth Below Ground Level
Saturated Moisture Content (%)
0
5
10
15
20
25
30
35
40
Depth Below Ground Level (m)
0
5
10
15
20
25
30
35
40
45
50
55
HD-G
C-GR
C-Dm/c
C-Dm
C-Dc
C
C-PC
C-SFC
C-NHC
C-LNC

Figure 6-13

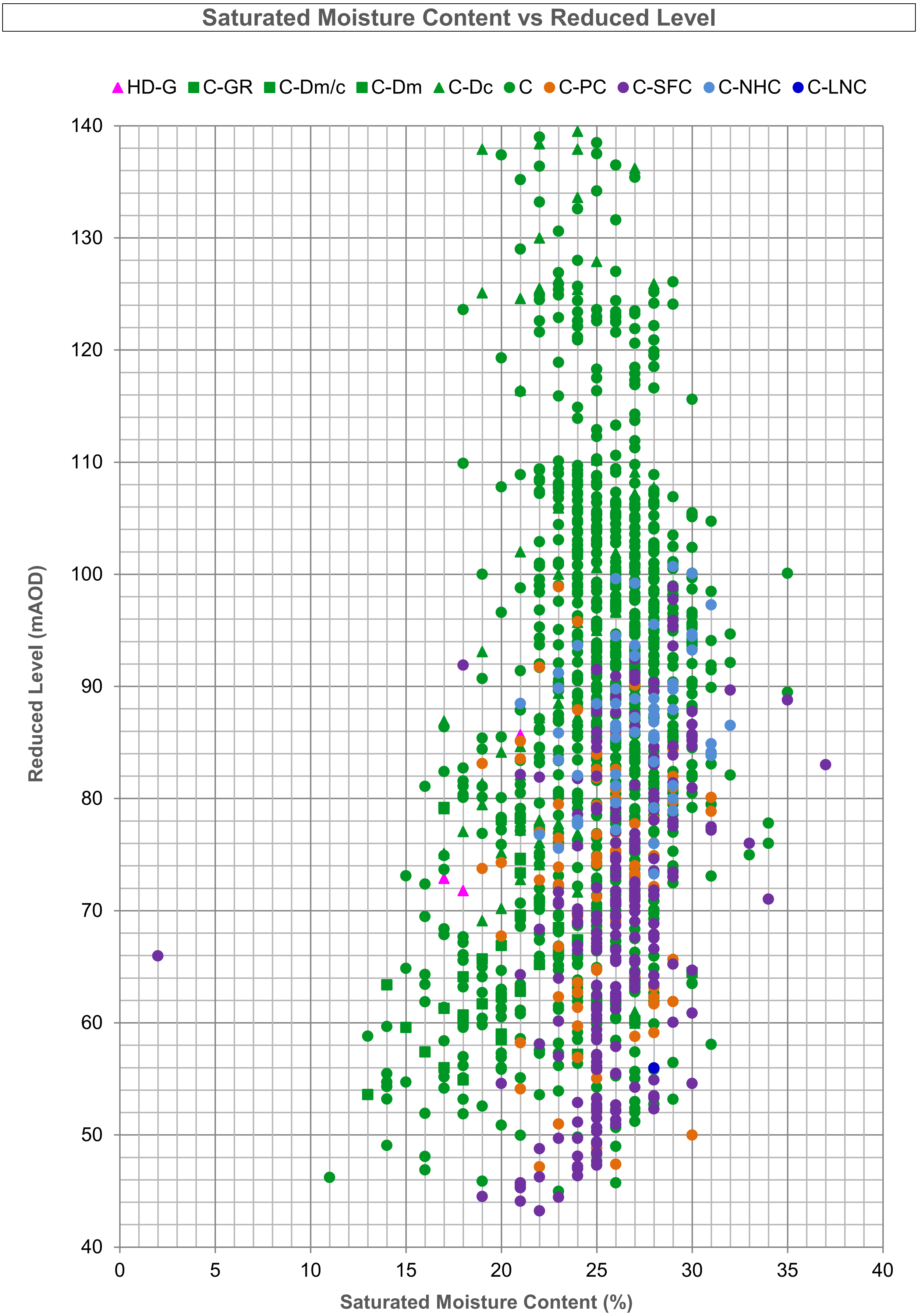

Saturated Moisture Content vs Reduced Level
HD-G
C-GR
C-Dm/c
C-Dm
C-Dc
C
C-PC
C-SFC
C-NHC
C-LNC
Reduced Level (mAOD)
140
130
120
110
100
90
80
70
60
50
40
0
5
10
15
20
25
30
35
40
Saturated Moisture Content (%)

Figure 6-14

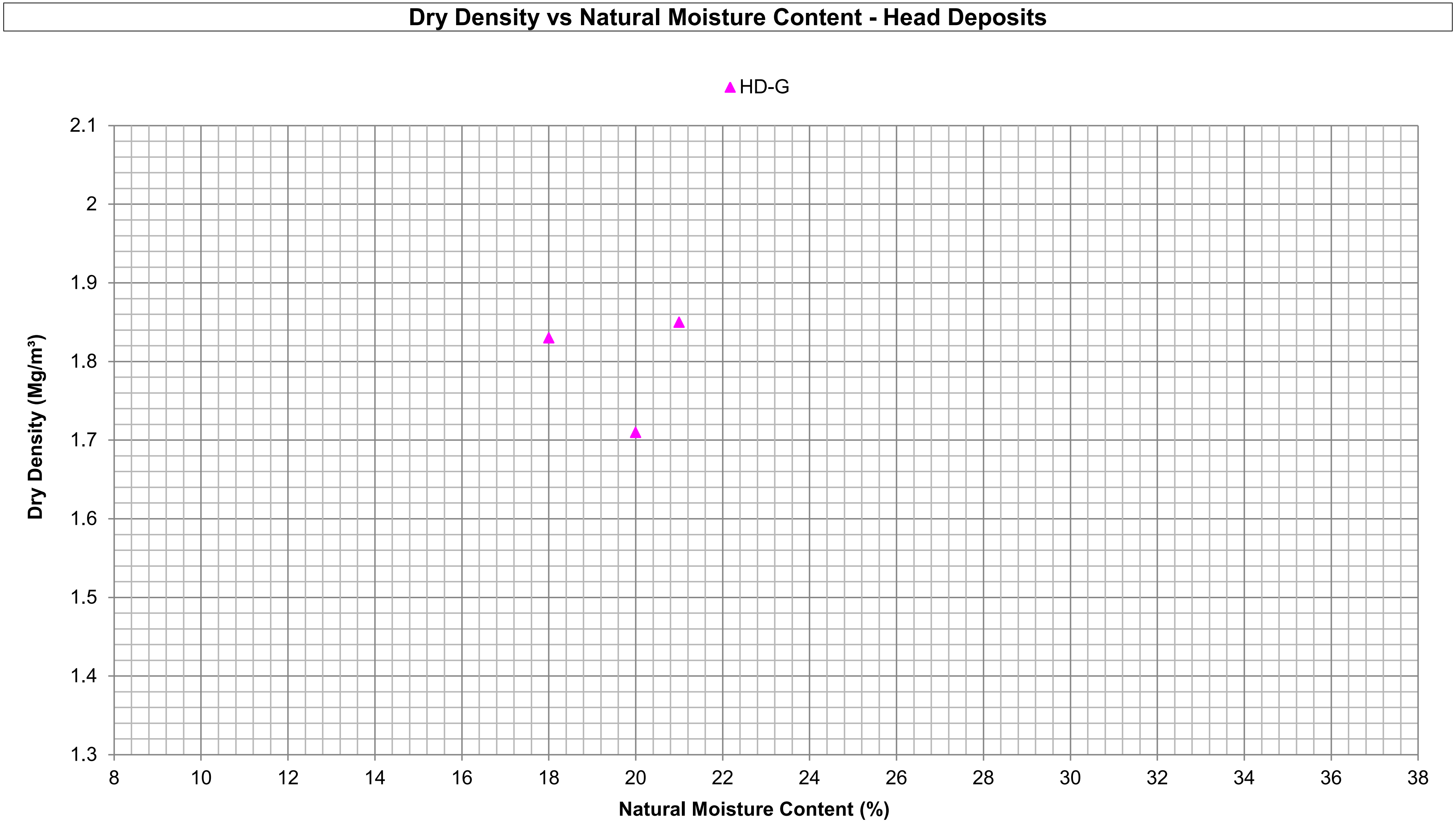

Dry Density vs Natural Moisture Content - Head Deposits
HD-G
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
Dry Density (Mg/m³)
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
Natural Moisture Content (%)

Figure 6-15

Dry Density vs Natural Moisture Content - Alluvium

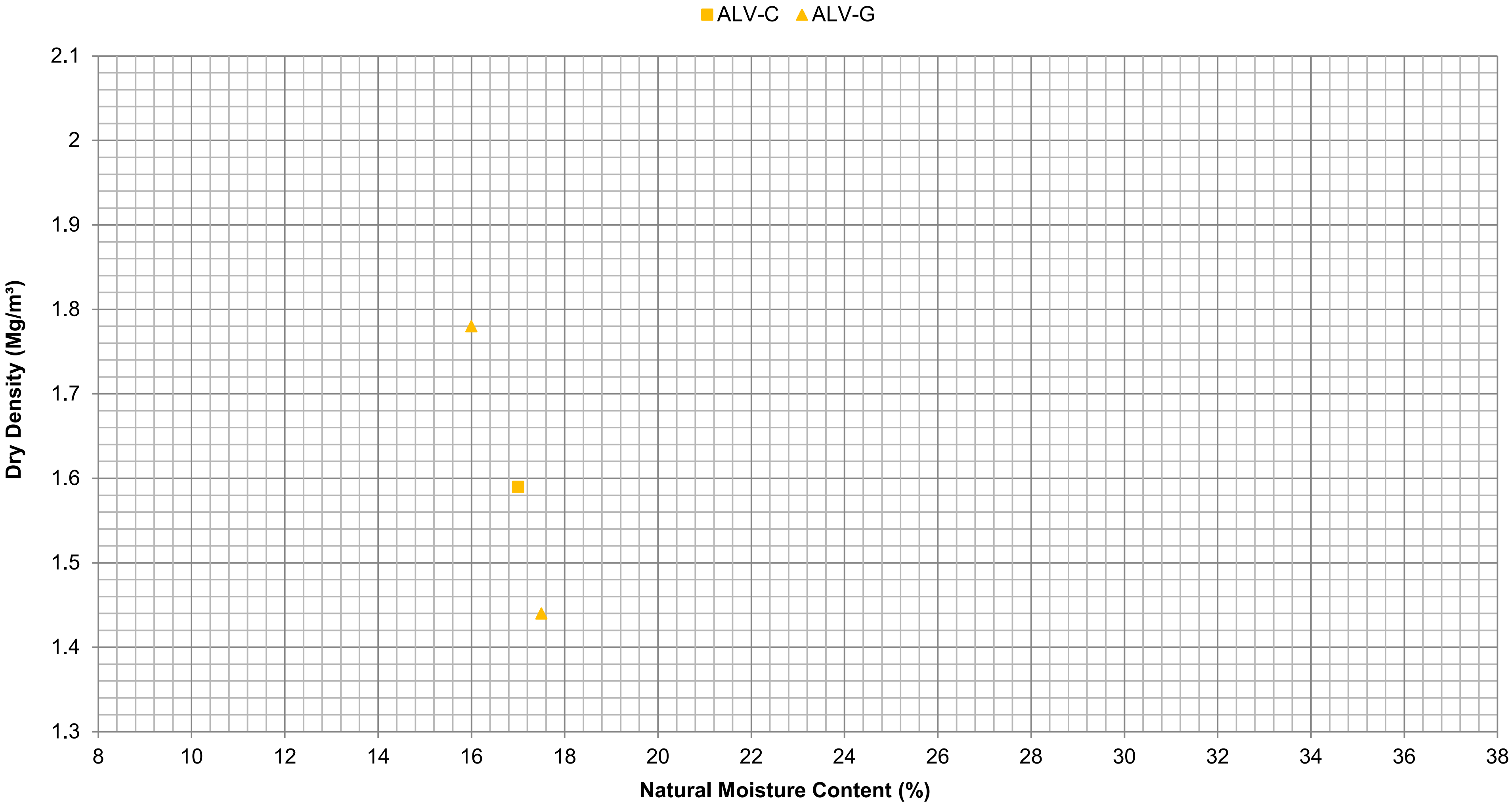


Figure 6-16

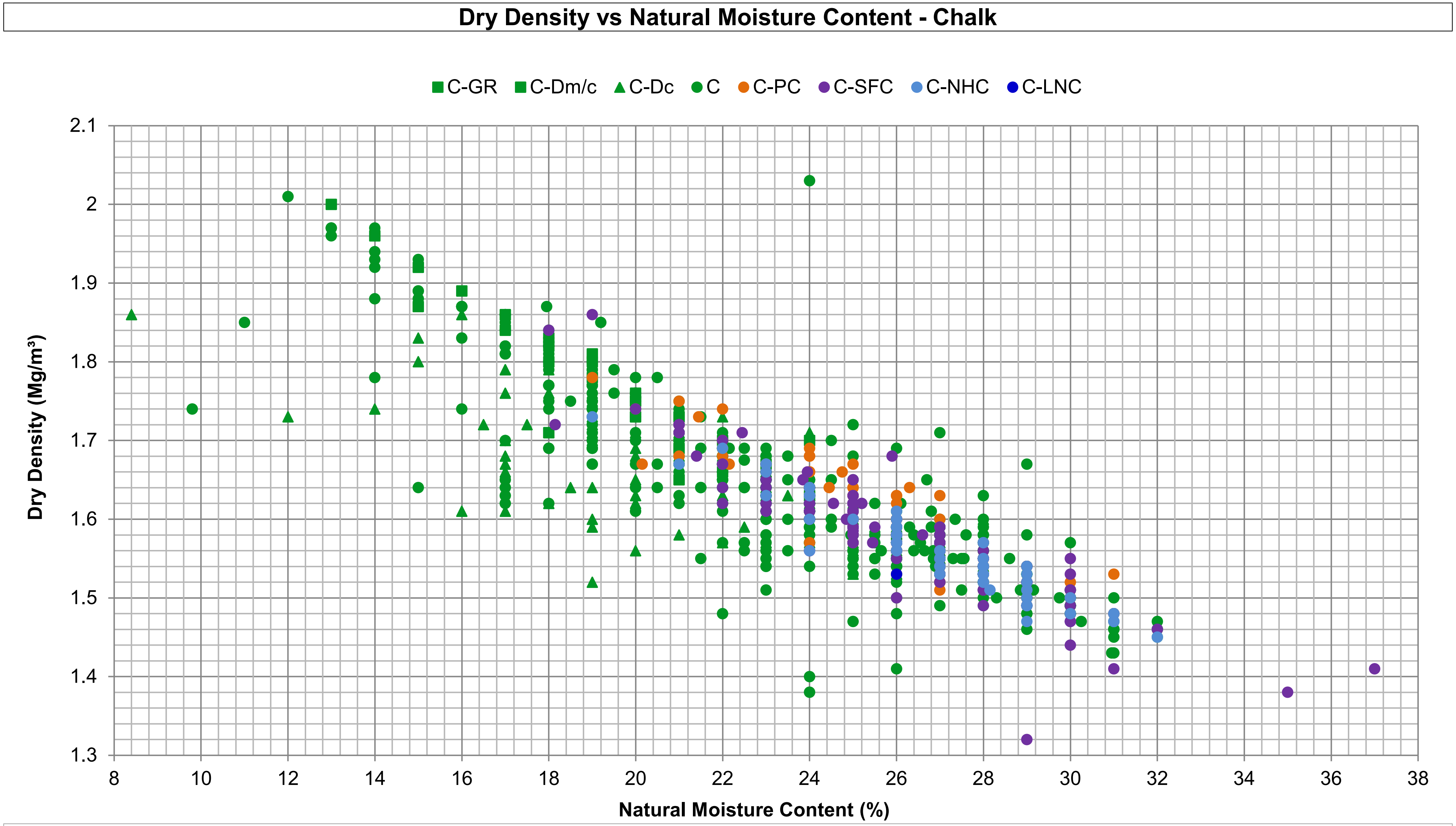

Dry Density vs Natural Moisture Content - Chalk
C-GR
C-Dm/c
C-Dc
C
C-PC
C-SFC
C-NHC
C-LNC
Dry Density (Mg/m³)
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
Natural Moisture Content (%)

Figure 6-17

Plasticity Chart - Topsoil

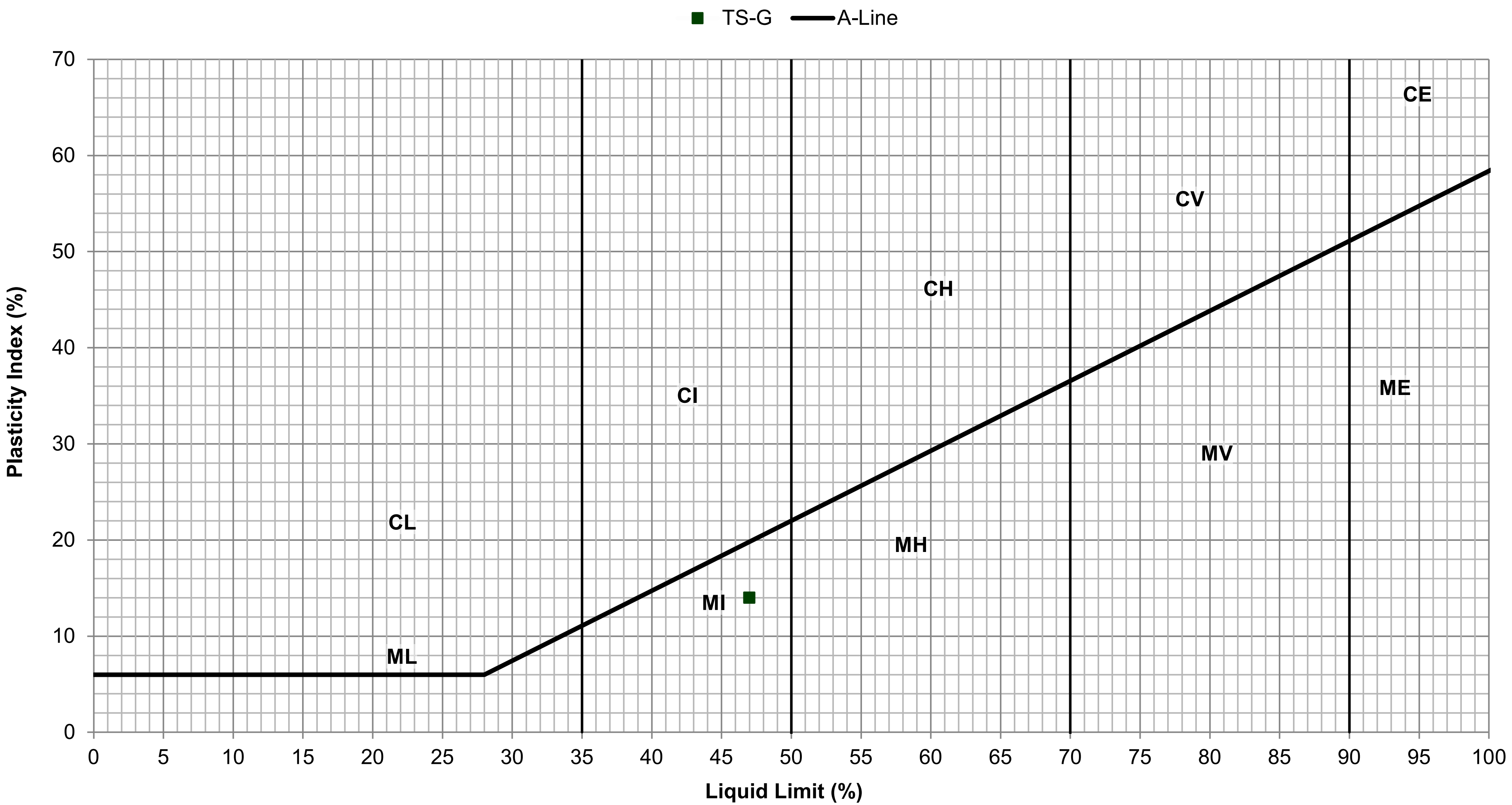


Figure 6-18

Plasticity Chart - Made Ground

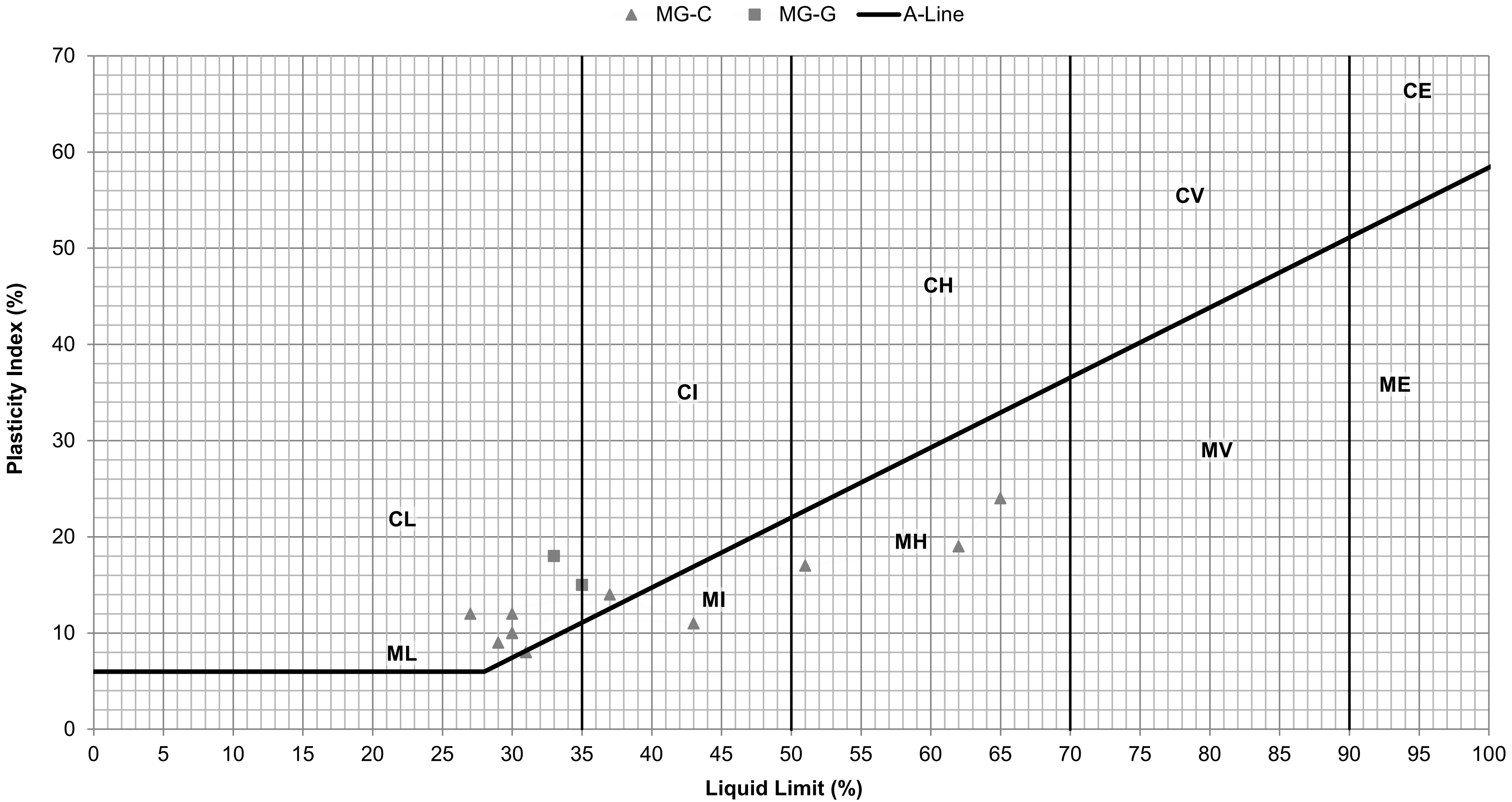


Figure 6-19

Plasticity Chart - Head Deposits

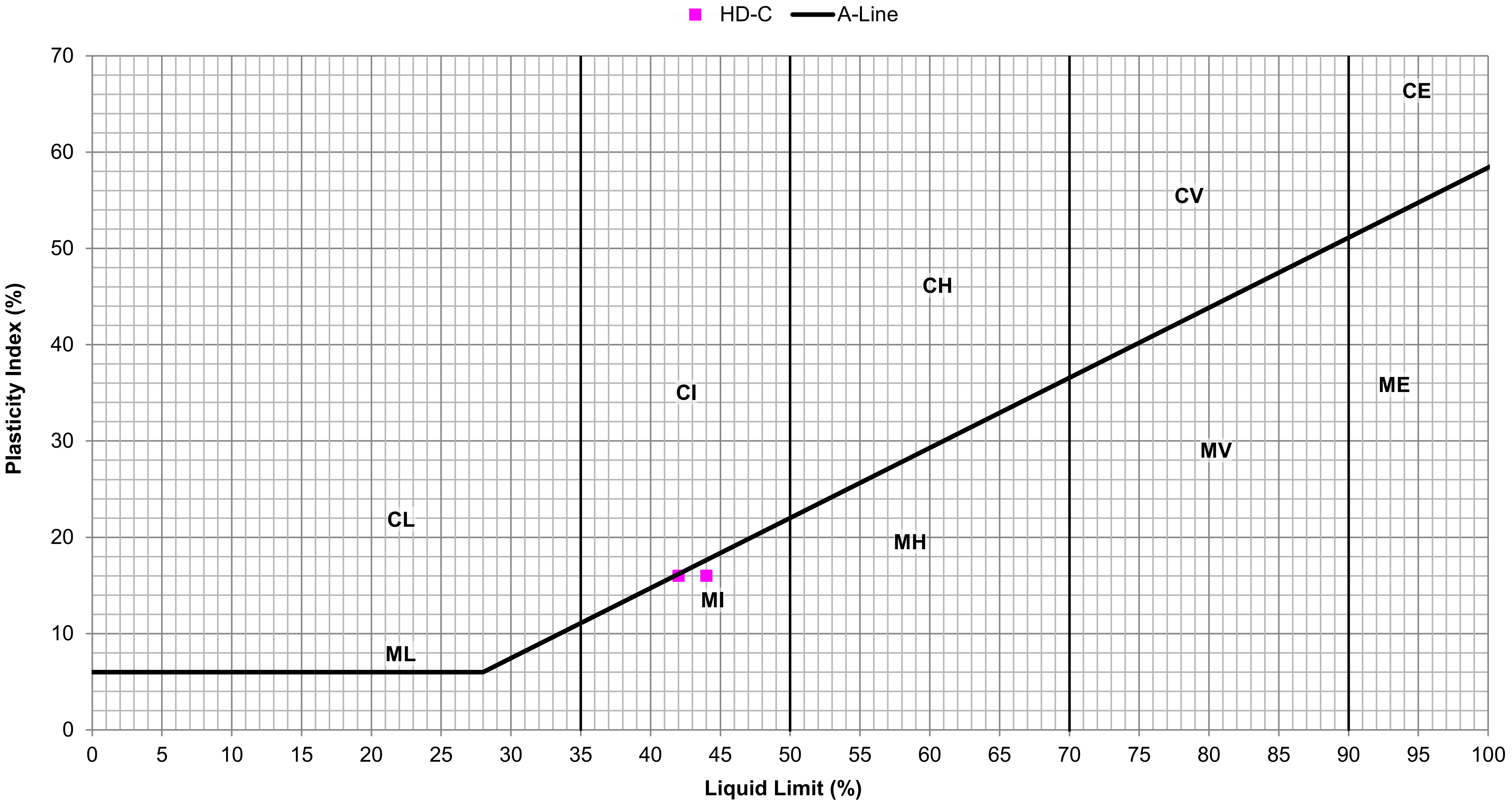


Figure 6-20

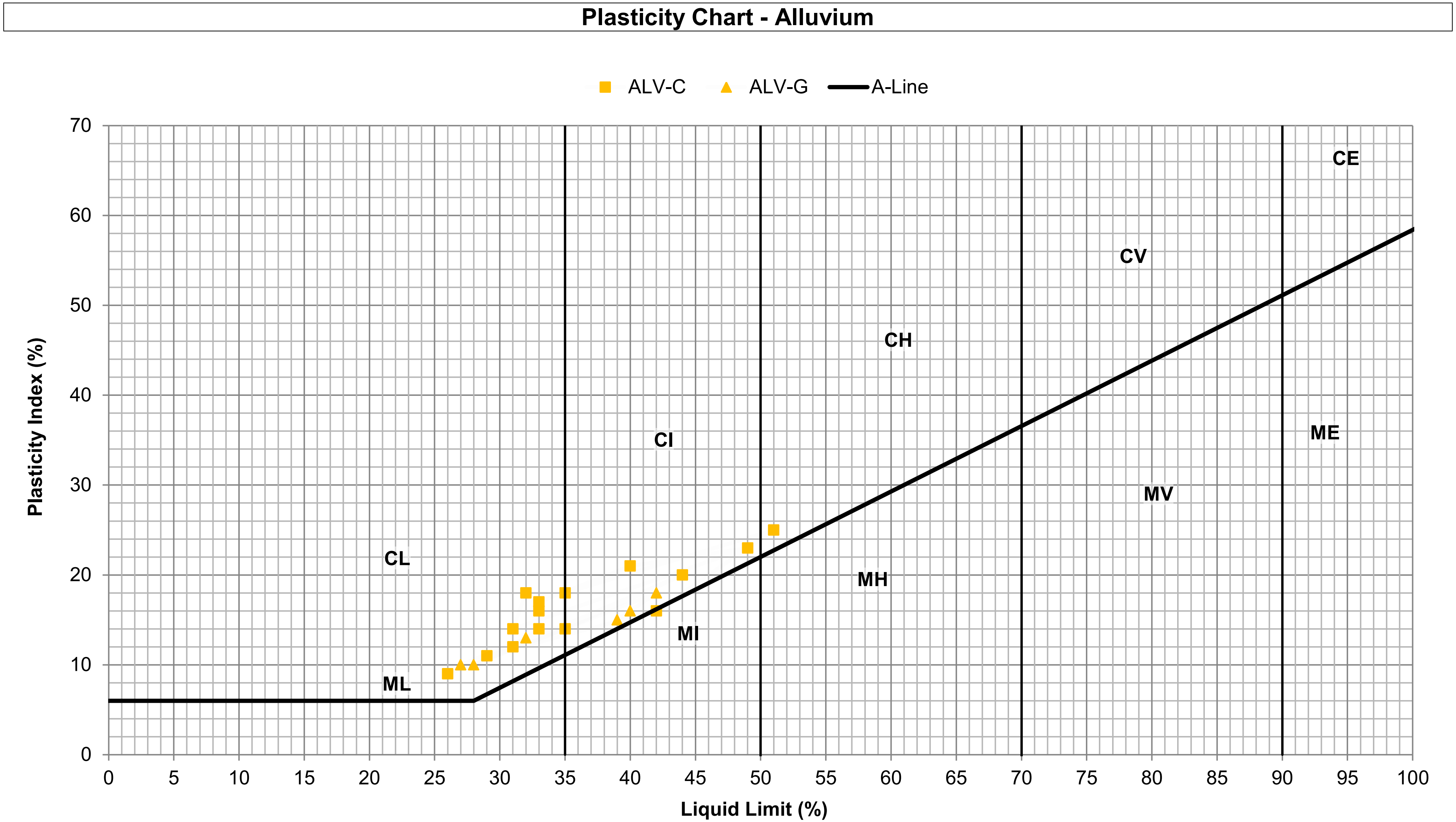

Plasticity Chart - Alluvium
ALV-C
ALV-G
A-Line
Plasticity Index (%)
Liquid Limit (%)
0
10
20
30
40
50
60
70
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
CL
ML
CI
MI
CH
MH
CV
MV
CE
ME

Figure 6-21

Plasticity Chart - Chalk - River Terrace Deposits

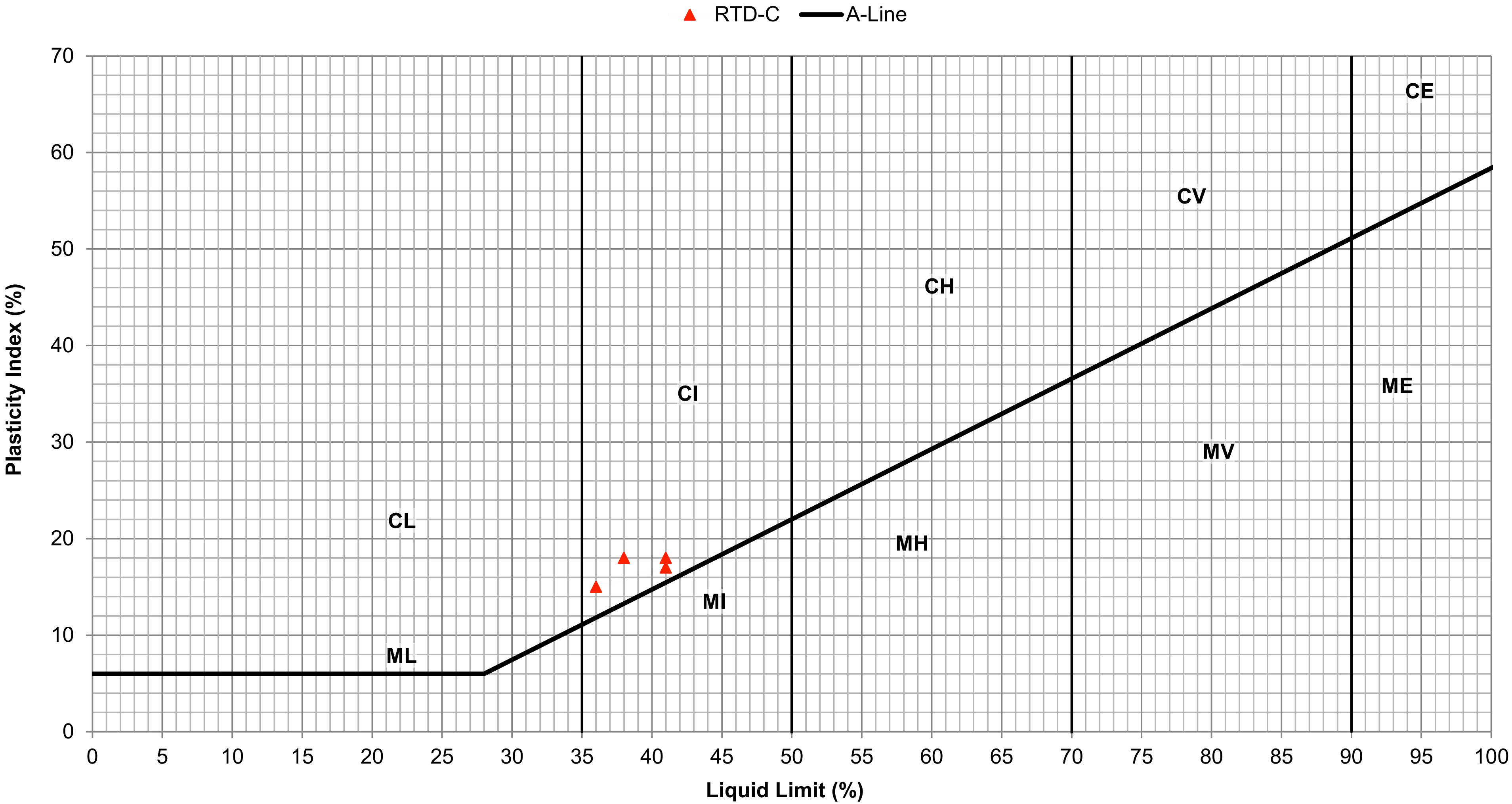


Figure 6-22

Plasticity Chart - Chalk

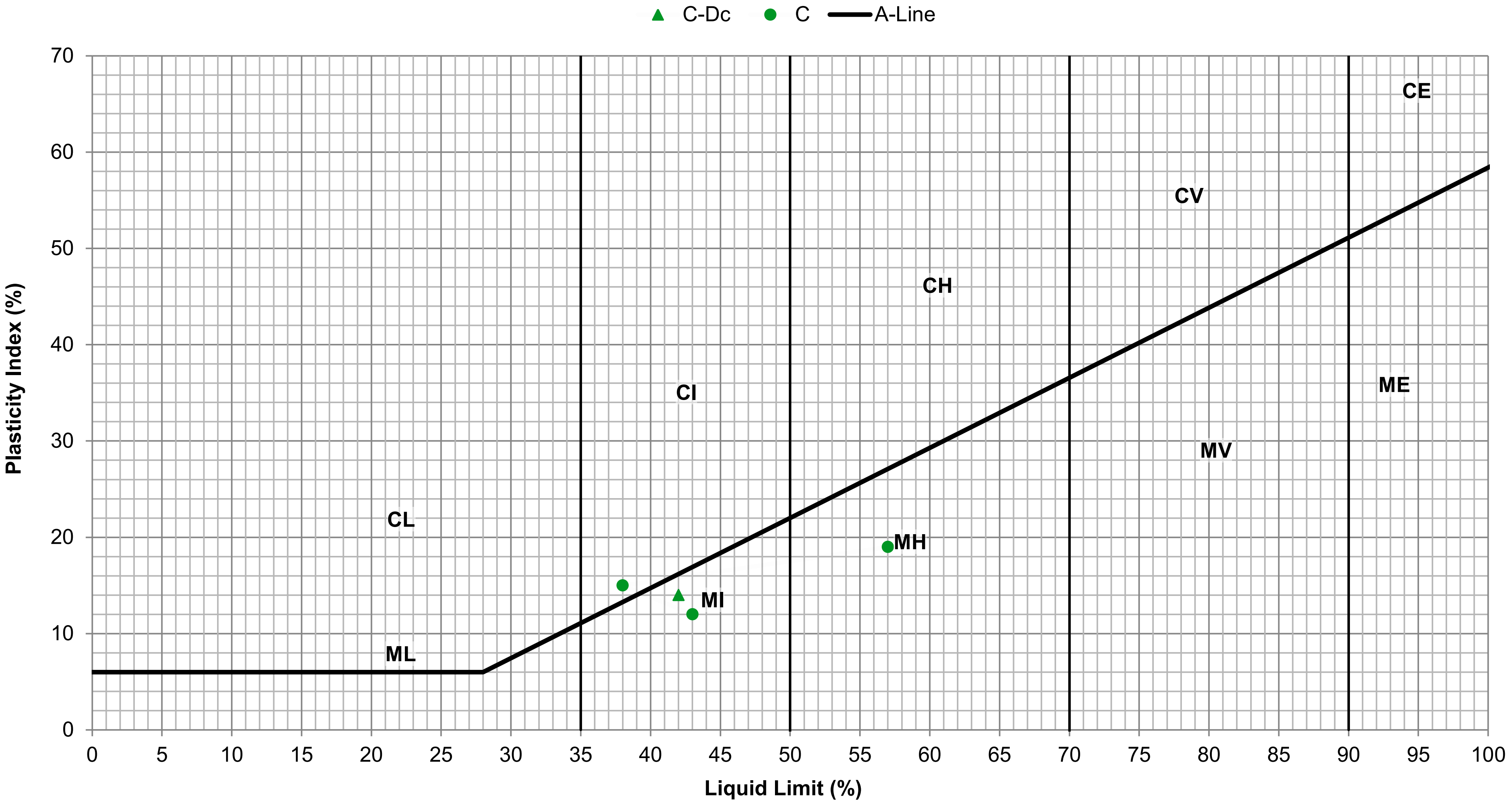


Figure 6-23

Particle Size Distribution - Topsoil (Granular)

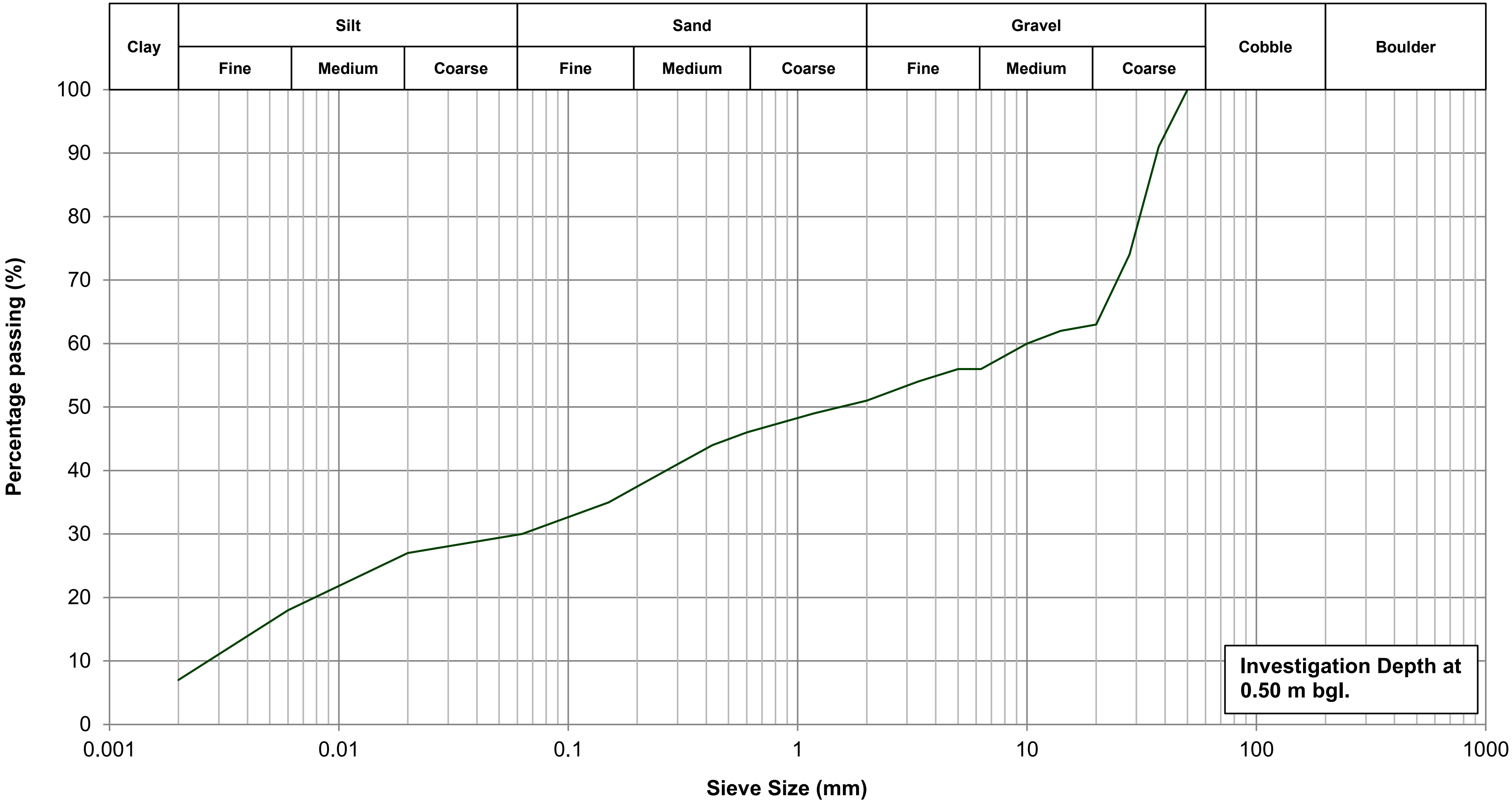


Figure 6-24

Particle Size Distribution - Made Ground (Cohesive)

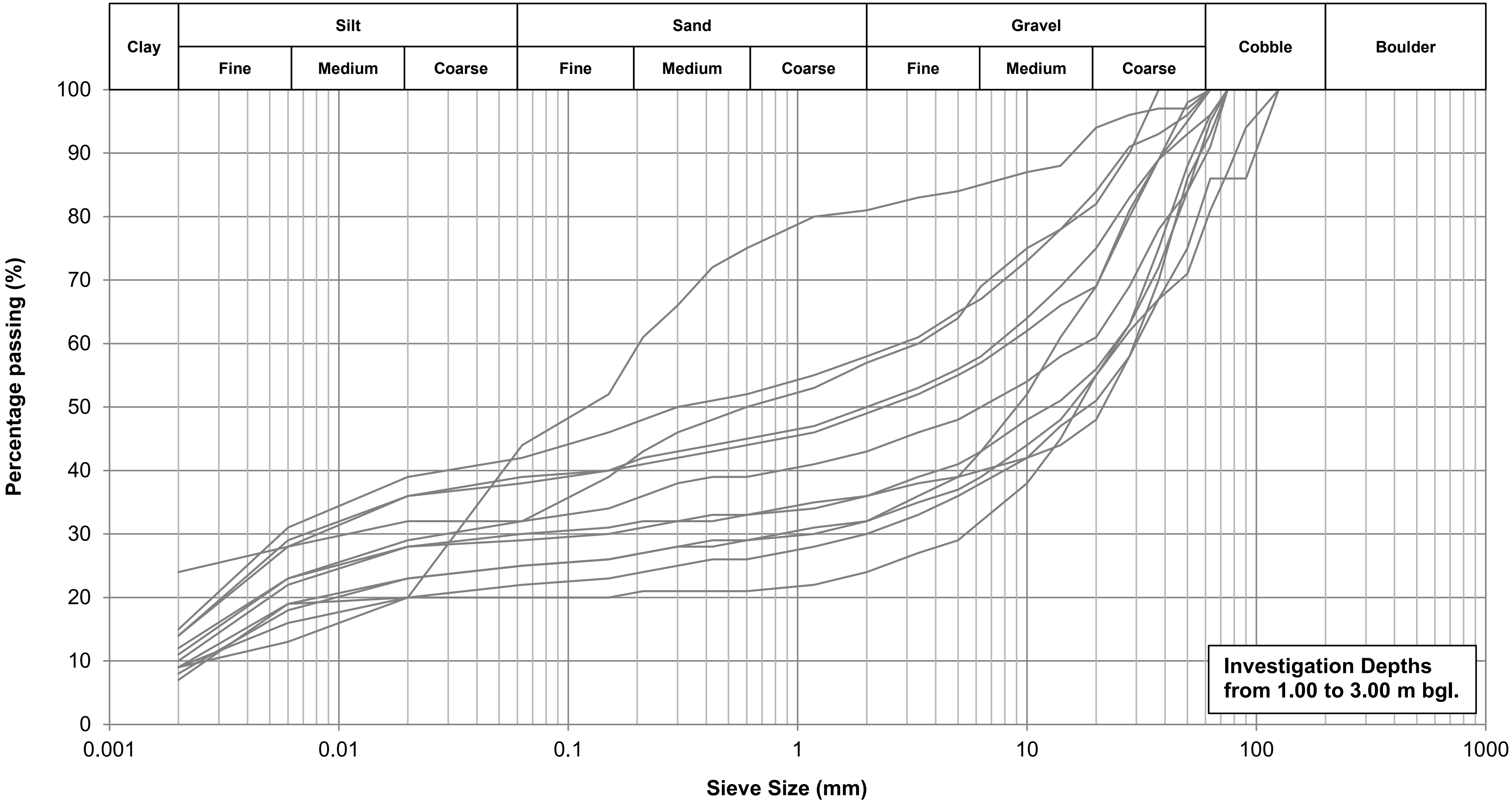


Figure 6-25

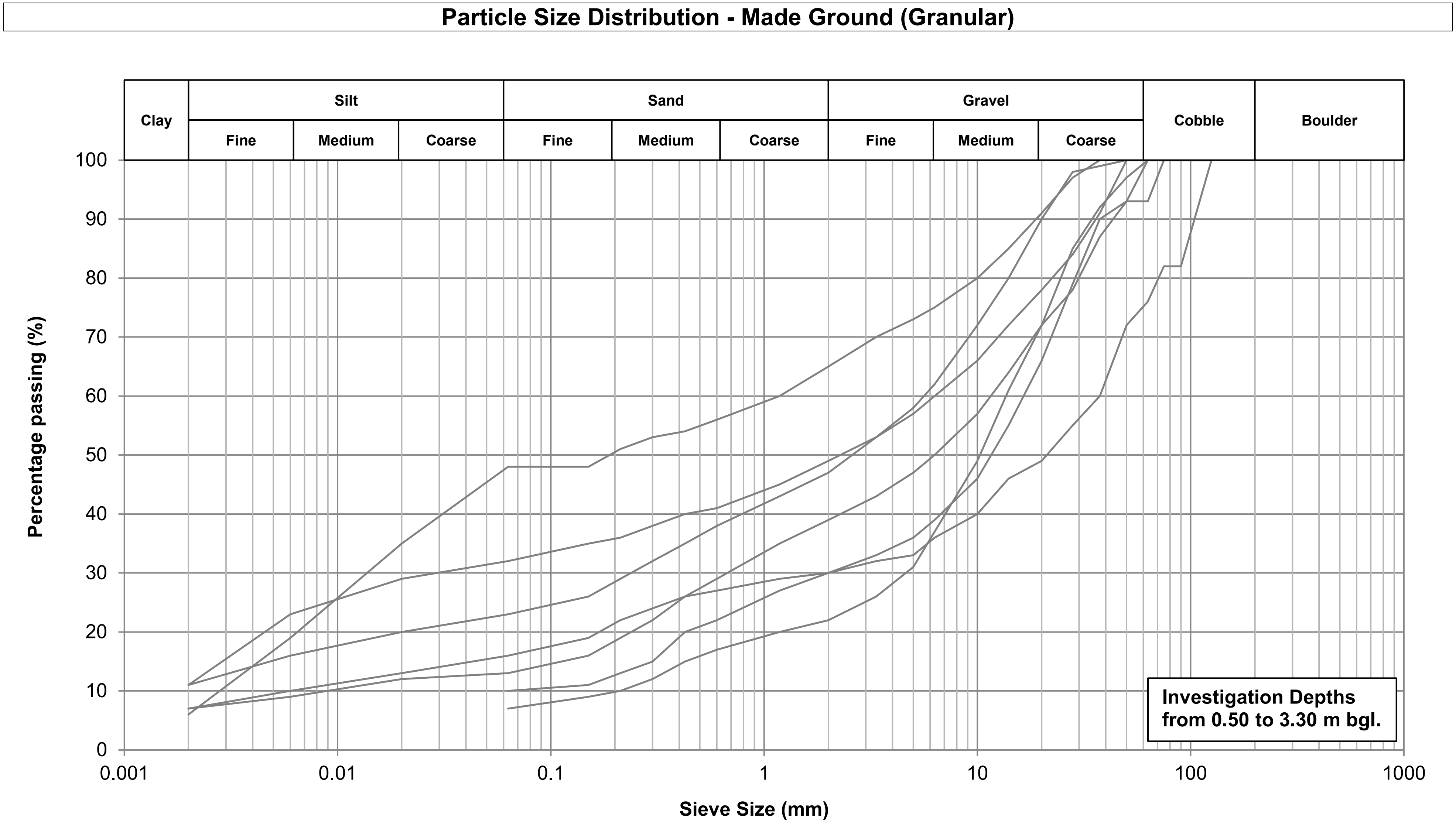

Particle Size Distribution - Made Ground (Granular)
Clay
Silt
Sand
Gravel
Fine
Medium
Coarse
Fine
Medium
Coarse
Fine
Medium
Coarse
Cobble
Boulder
Percentage passing (%)
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
1000
Sieve Size (mm)
Investigation Depths
from 0.50 to 3.30 m bgl.

Figure 6-26

Particle Size Distribution - Head Deposits (Cohesive)

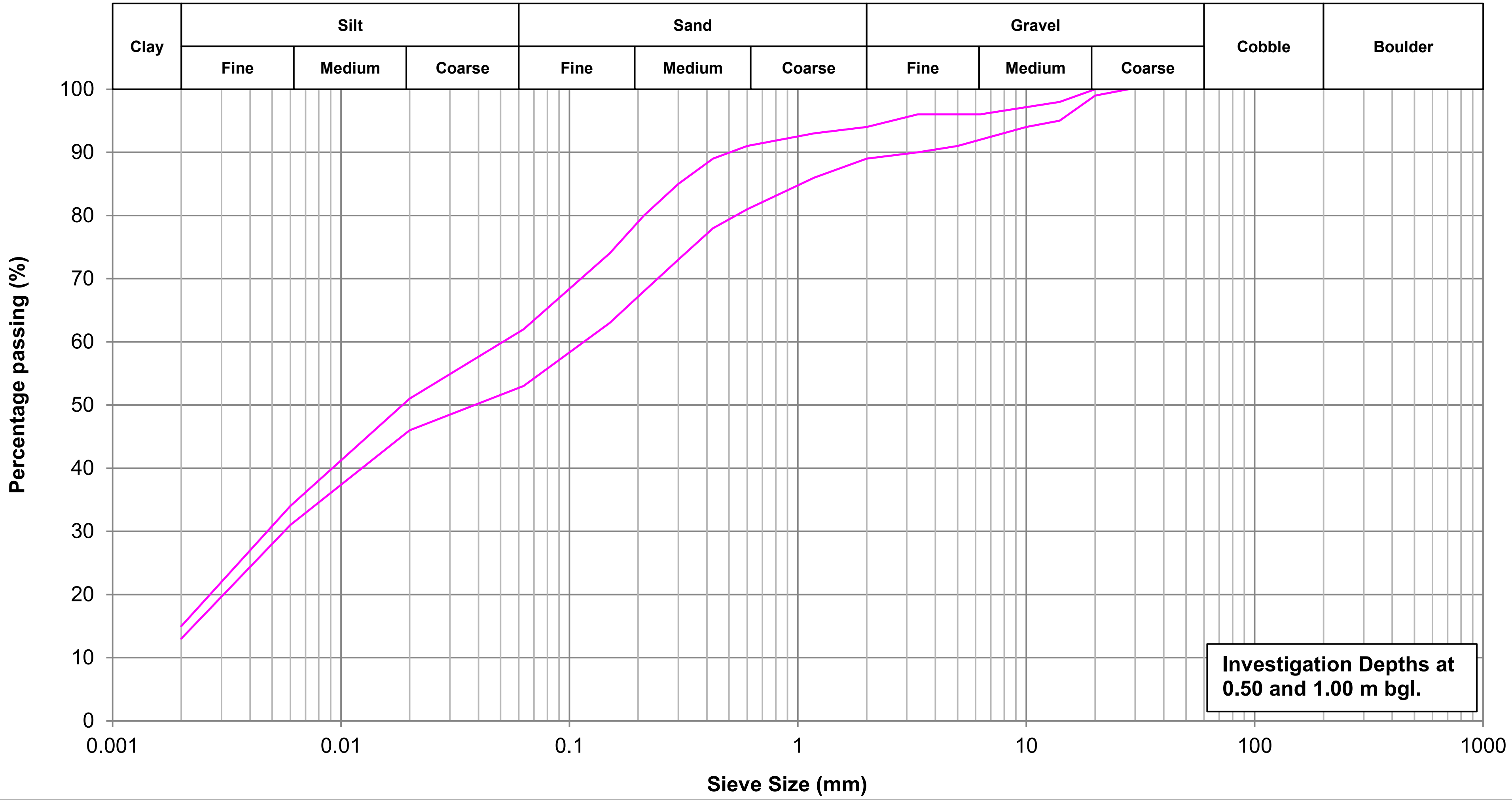


Figure 6-27

Particle Size Distribution - Head Deposits (Granular)

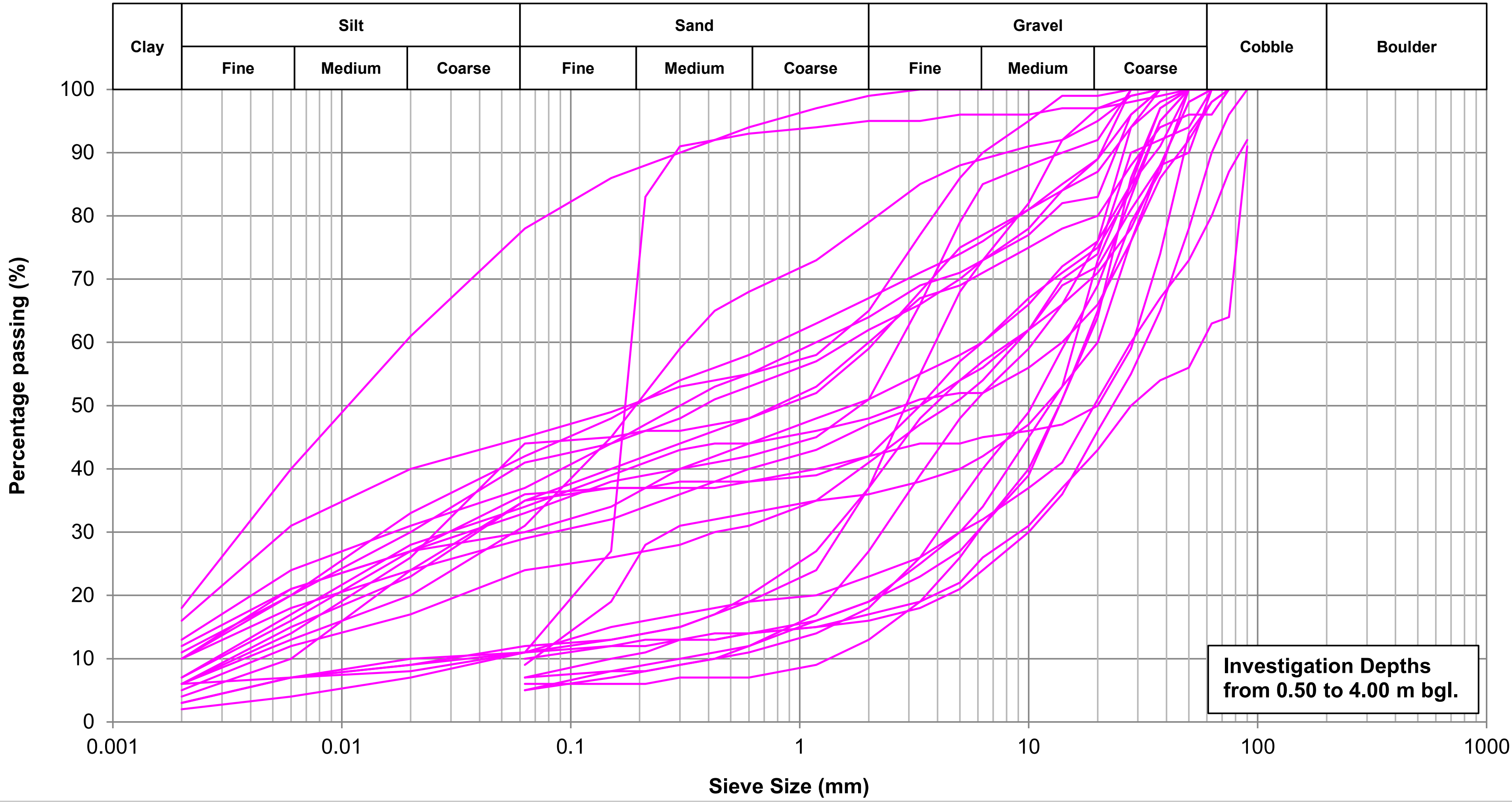


Figure 6-28

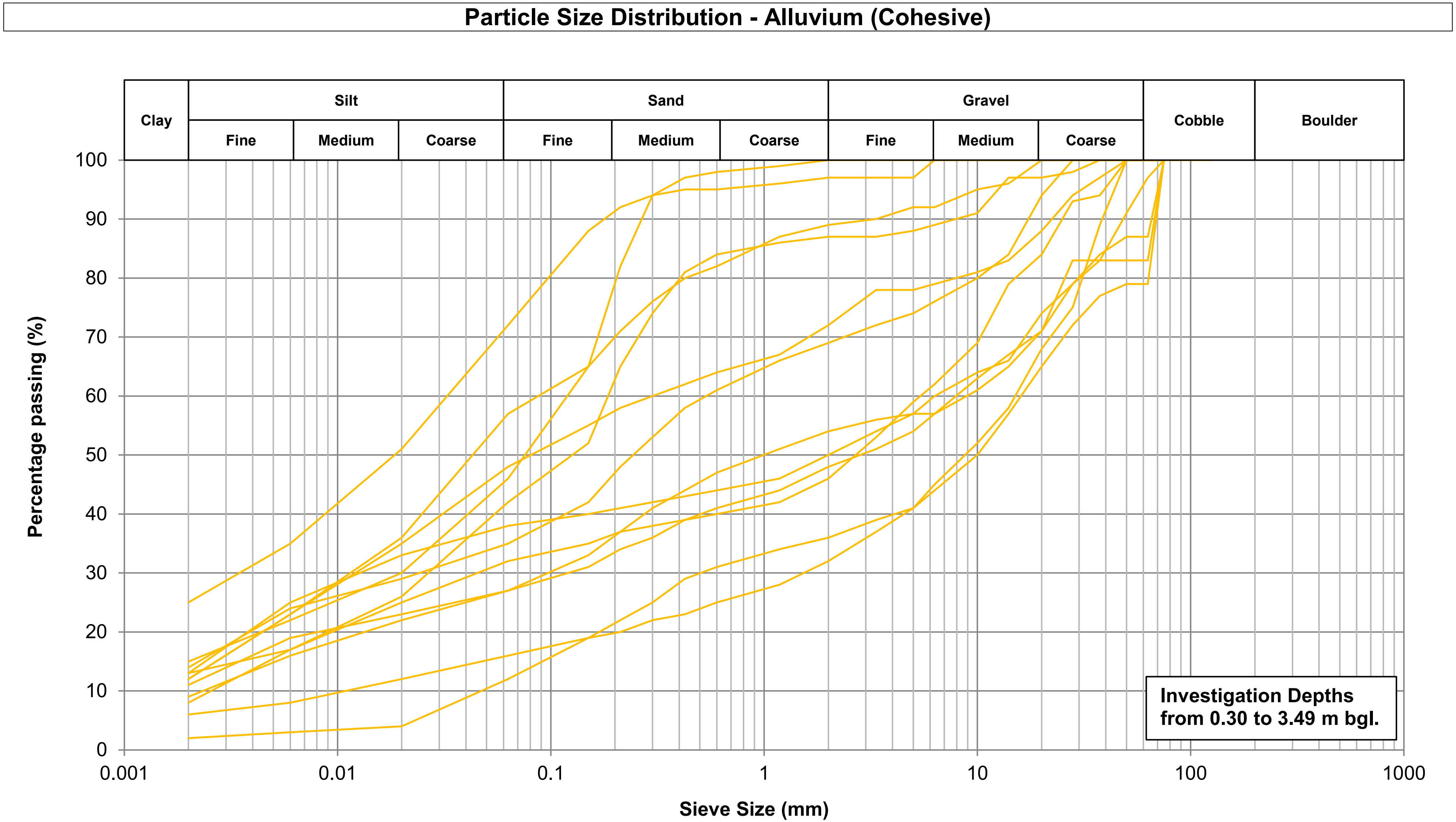

Particle Size Distribution - Alluvium (Cohesive)
Clay
Silt
Sand
Gravel
Cobble
Boulder
Fine
Medium
Coarse
Fine
Medium
Coarse
Fine
Medium
Coarse
Percentage passing (%)
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
1000
Sieve Size (mm)
Investigation Depths from 0.30 to 3.49 m bgl.

Figure 6-29

Particle Size Distribution - Alluvium (Granular)

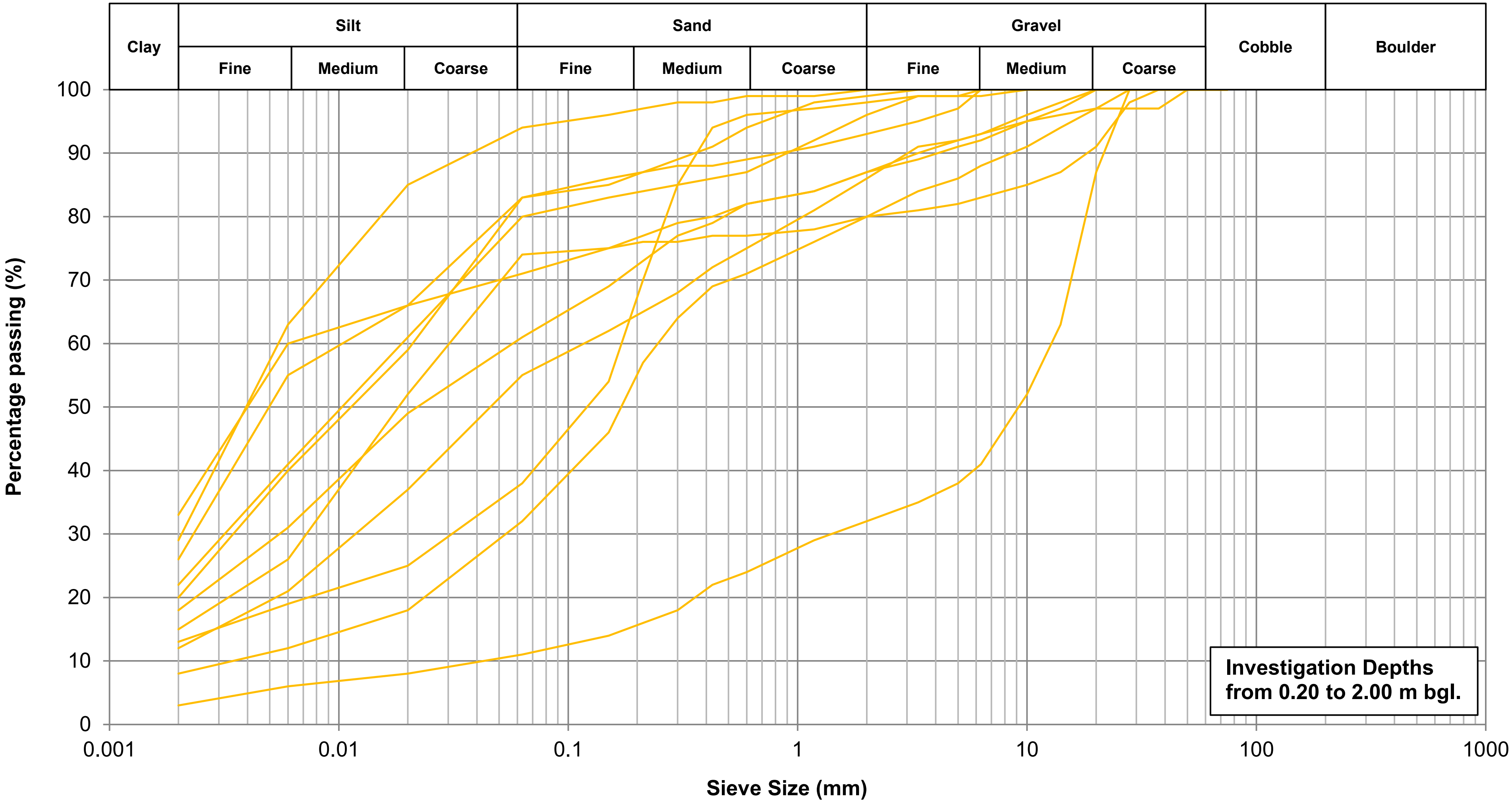


Figure 6-30

Particle Size Distribution - Alluvium (Peat)

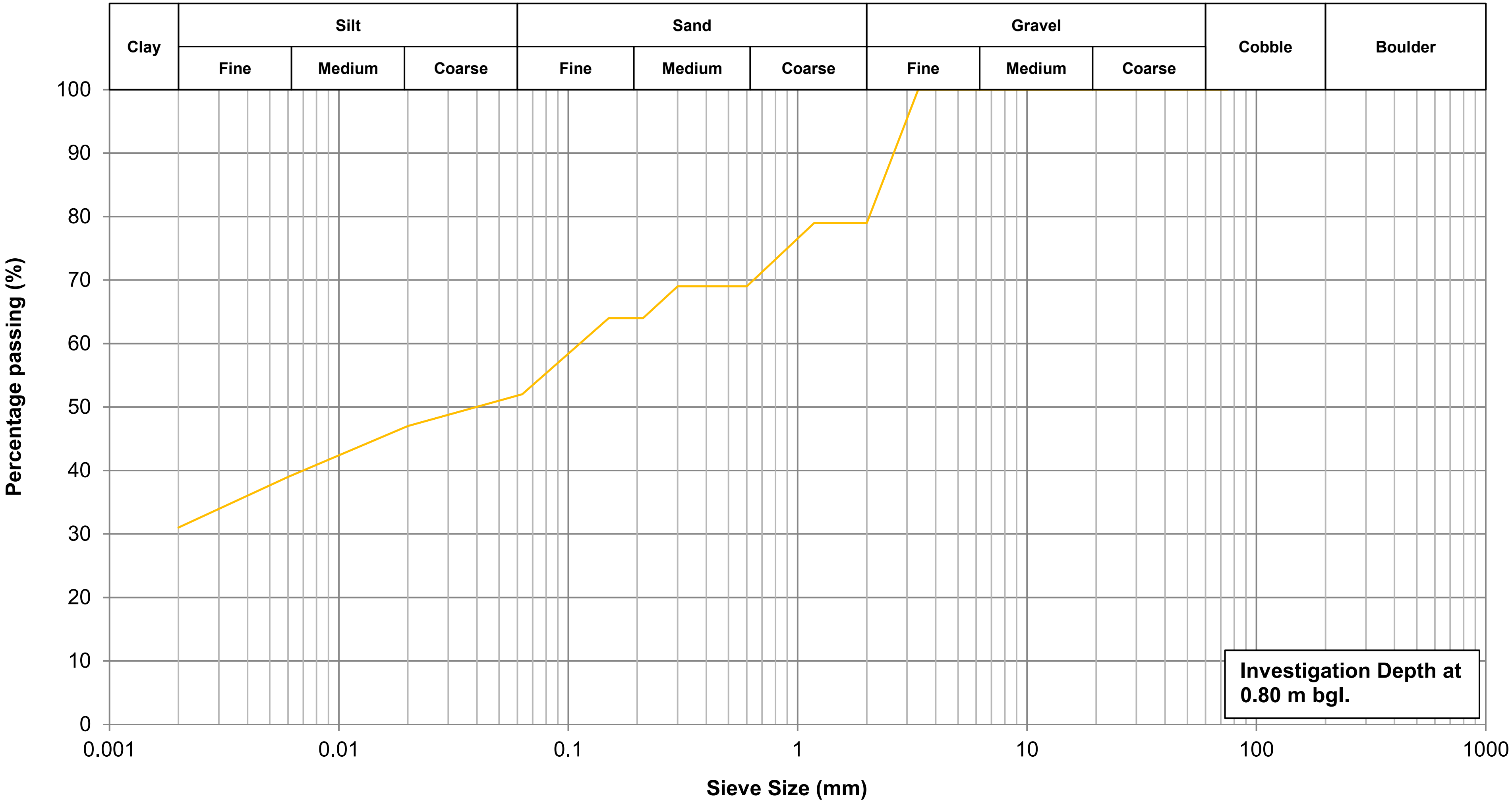


Figure 6-31

Particle Size Distribution - River Terrace Deposits (Cohesive)

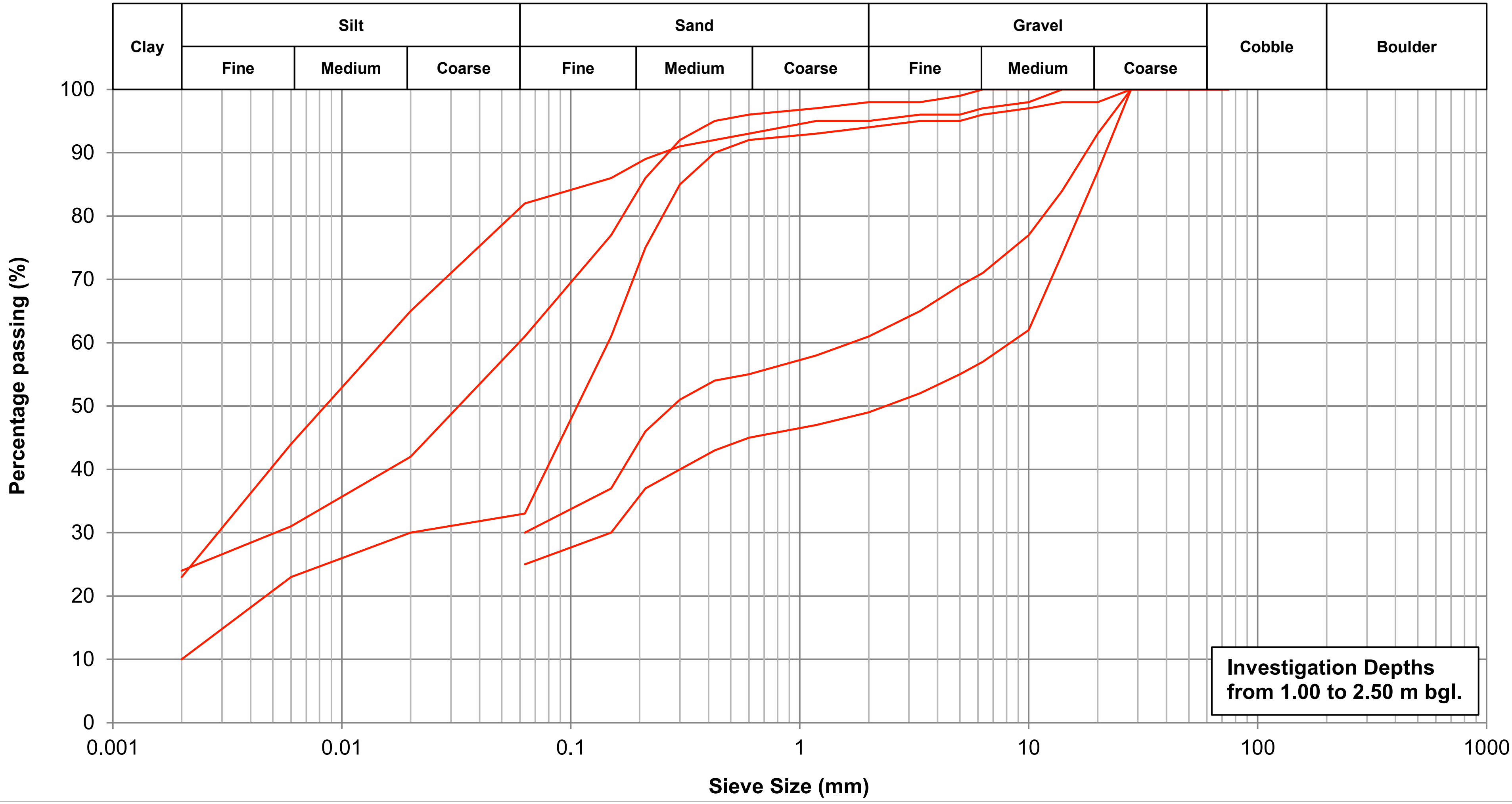


Figure 6-32

Particle Size Distribution - River Terrace Deposits (Granular)

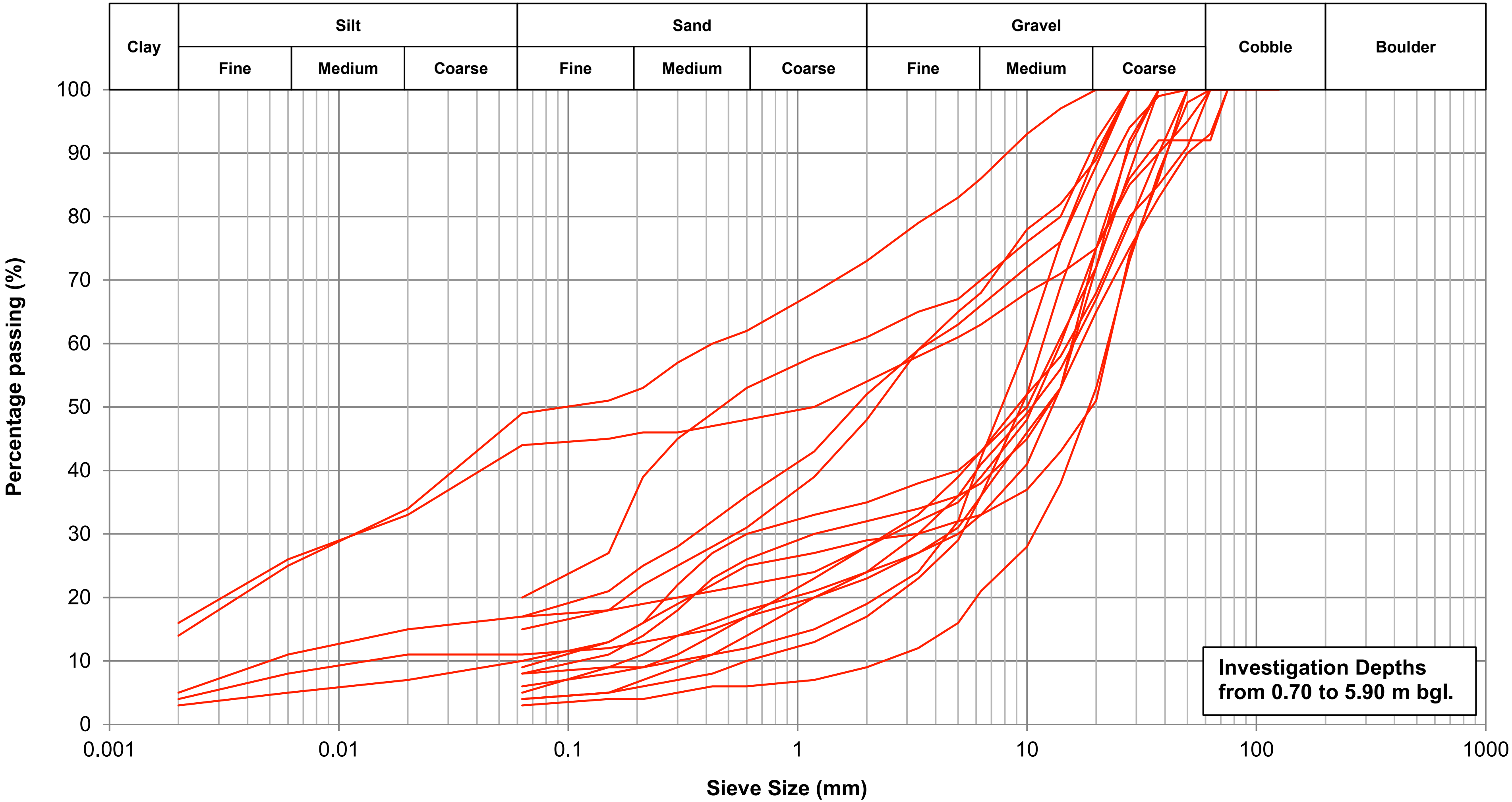


Figure 6-33

Particle Size Distribution - Chalk (Structureless weathered Grade Dc or Dm)

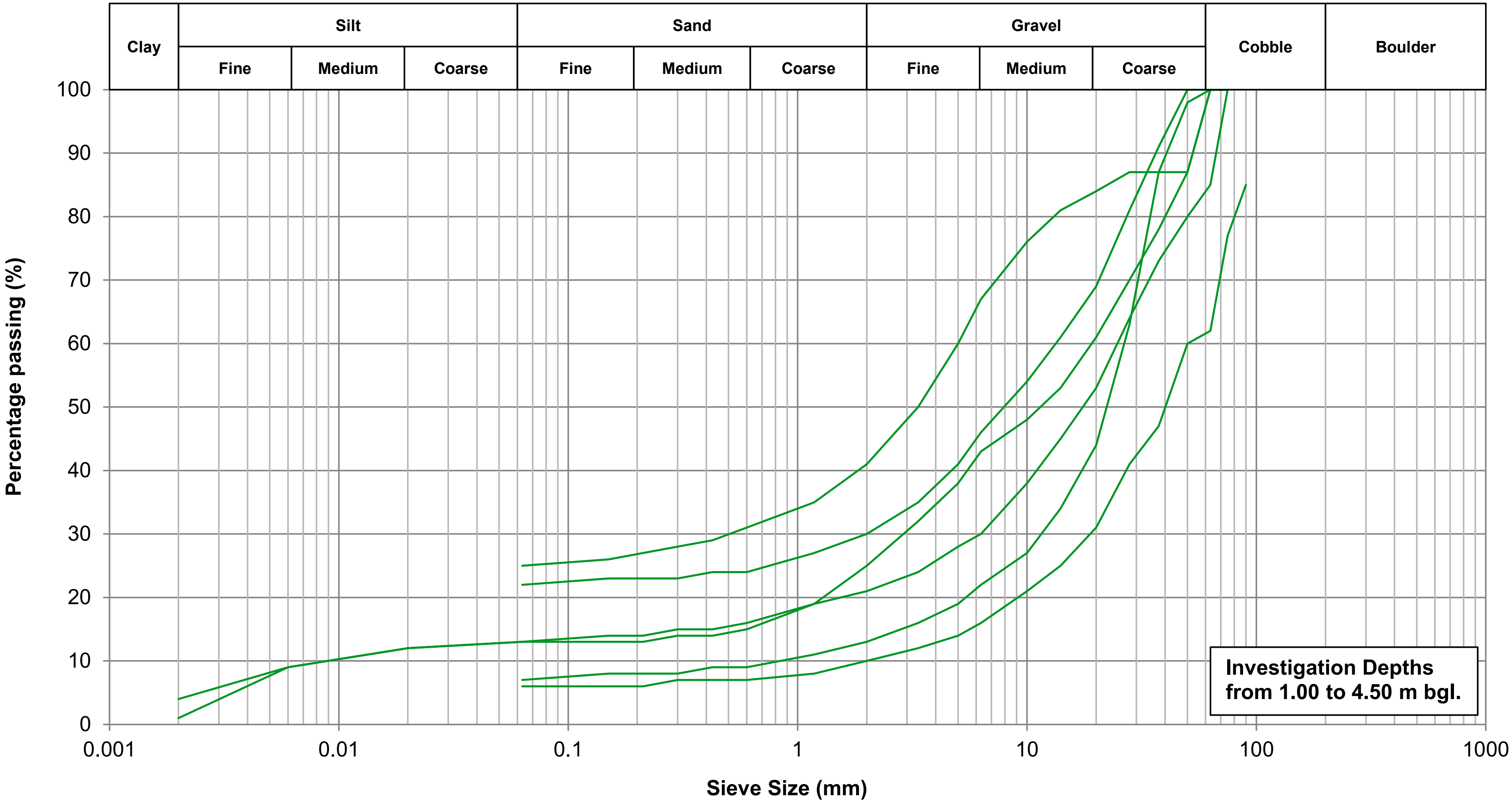
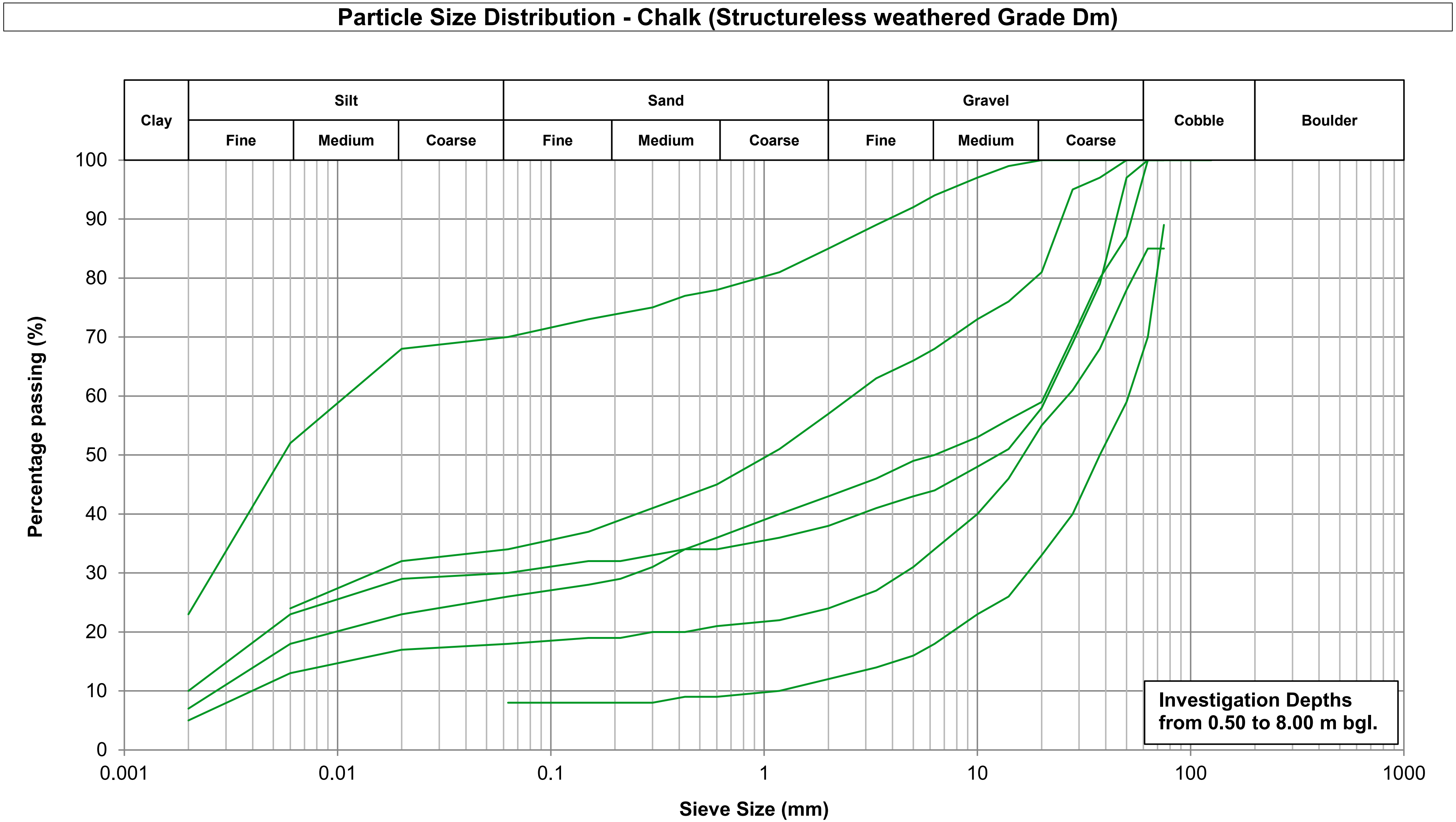


Figure 6-34



Particle Size Distribution - Chalk (Structureless weathered Grade Dm)
Clay
Silt
Fine
Medium
Coarse
Sand
Fine
Medium
Coarse
Gravel
Fine
Medium
Coarse
Cobble
Boulder
Percentage passing (%)
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
1000
Sieve Size (mm)
Investigation Depths from 0.50 to 8.00 m bgl.

Figure 6-35

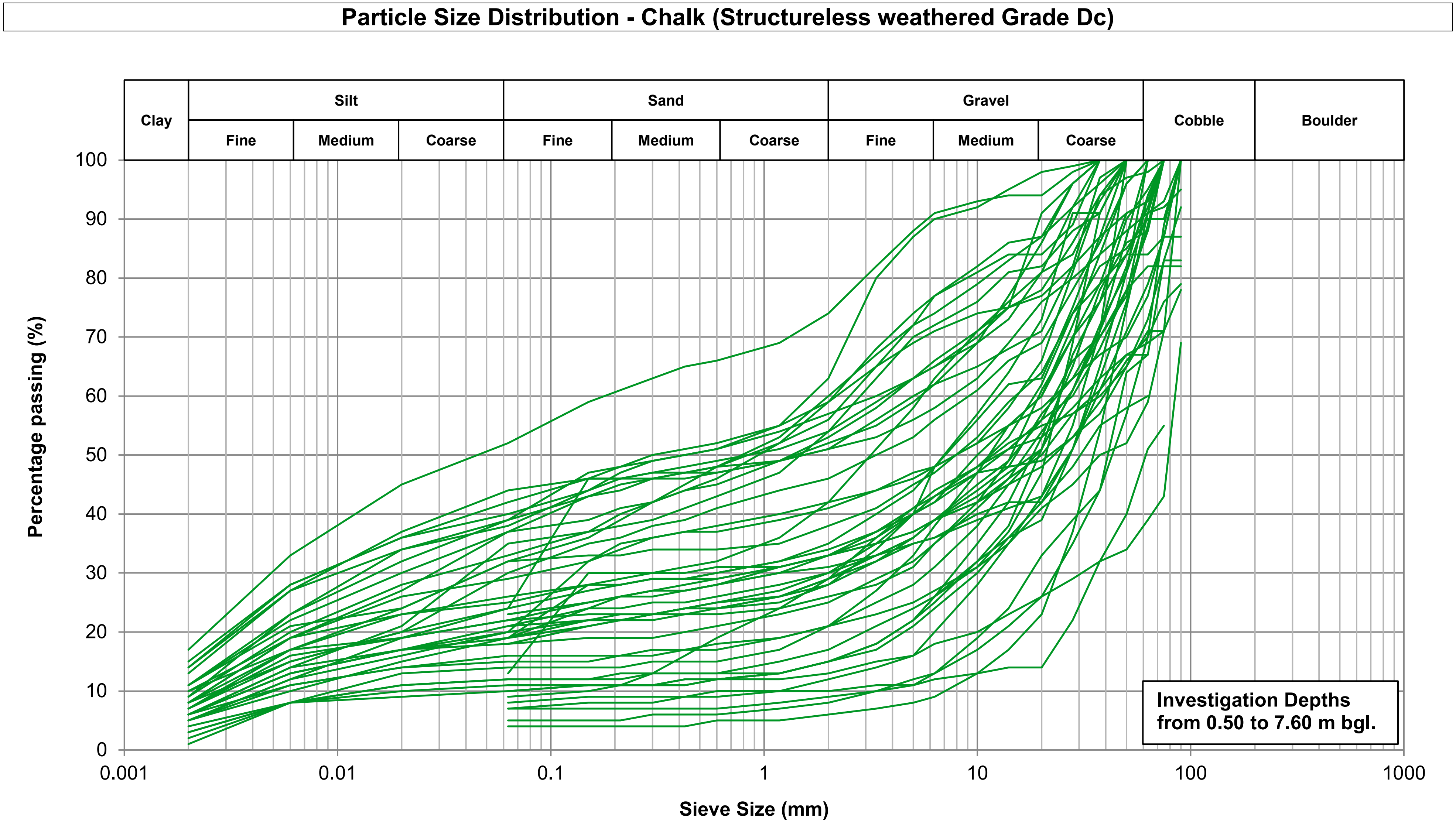

Particle Size Distribution - Chalk (Structureless weathered Grade Dc)
Clay
Silt
Fine
Medium
Coarse
Sand
Fine
Medium
Coarse
Gravel
Fine
Medium
Coarse
Cobble
Boulder
Percentage passing (%)
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
1000
Sieve Size (mm)
Investigation Depths from 0.50 to 7.60 m bgl.

Figure 6-36

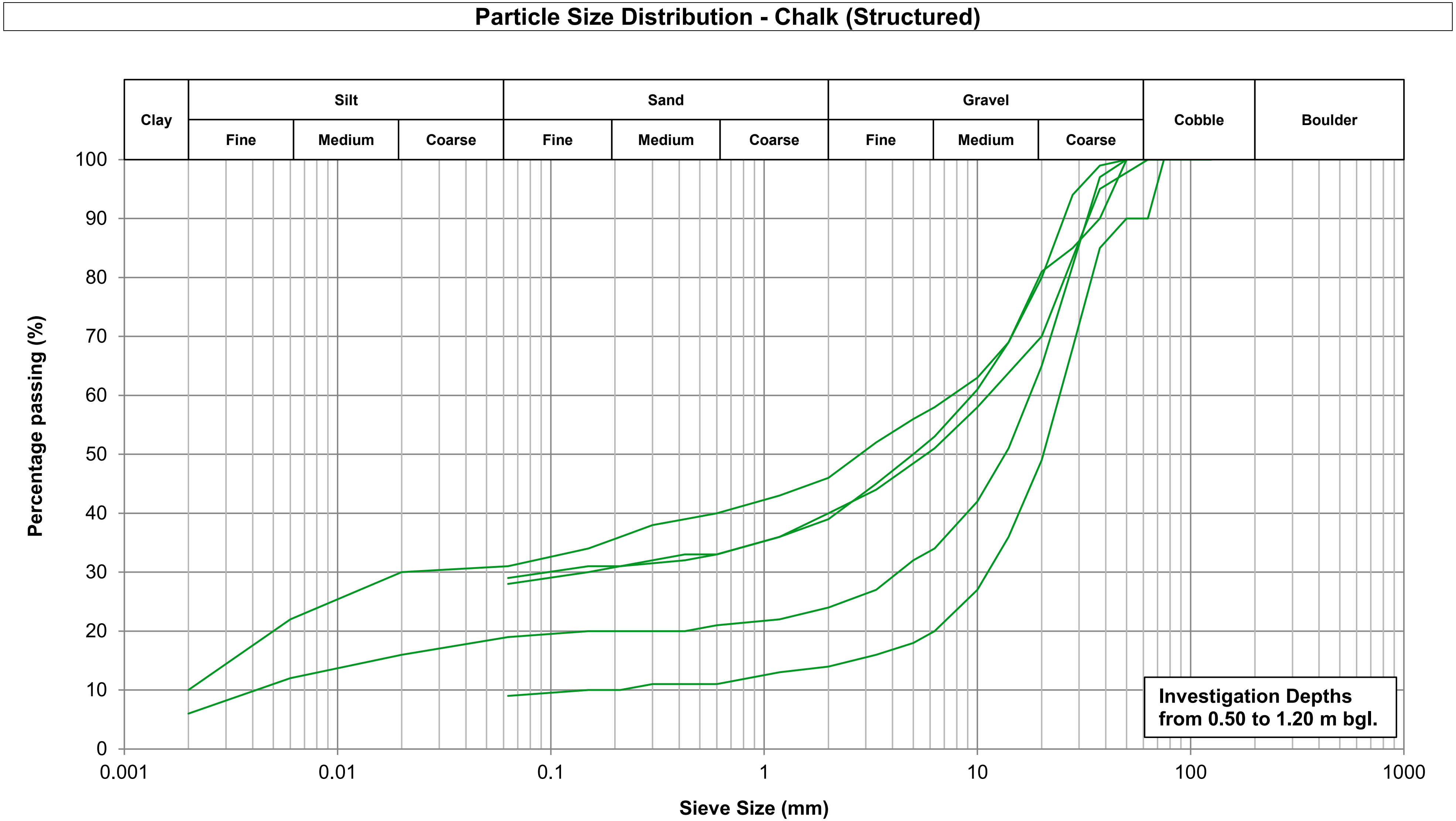

Particle Size Distribution - Chalk (Structured)
Clay
Silt
Fine
Medium
Coarse
Sand
Fine
Medium
Coarse
Gravel
Fine
Medium
Coarse
Cobble
Boulder
Percentage passing (%)
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
1000
Sieve Size (mm)
Investigation Depths from 0.50 to 1.20 m bgl.

Figure 6-37

Particle Size Distribution - Chalk (Phosphatic)

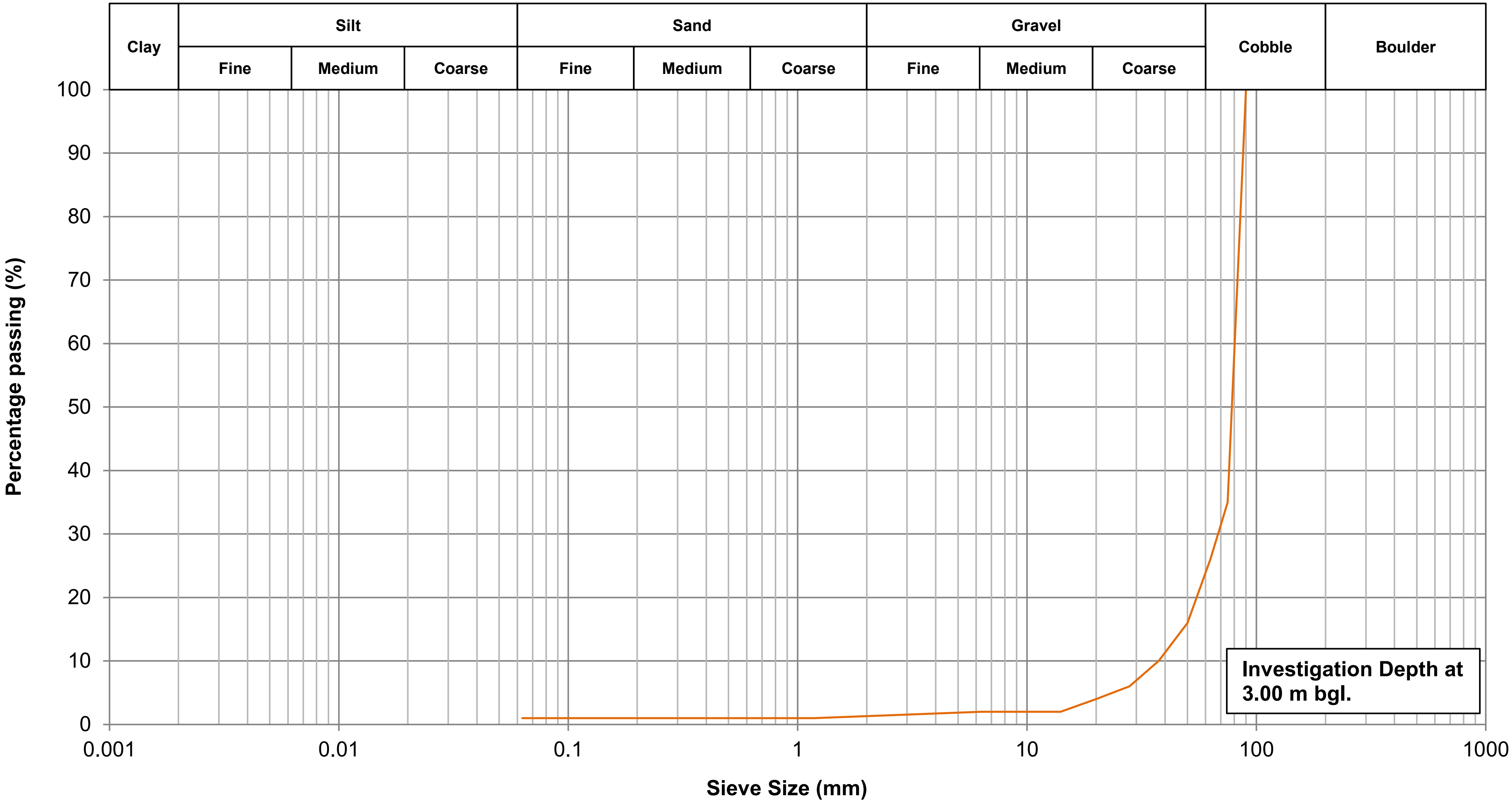


Figure 6-38

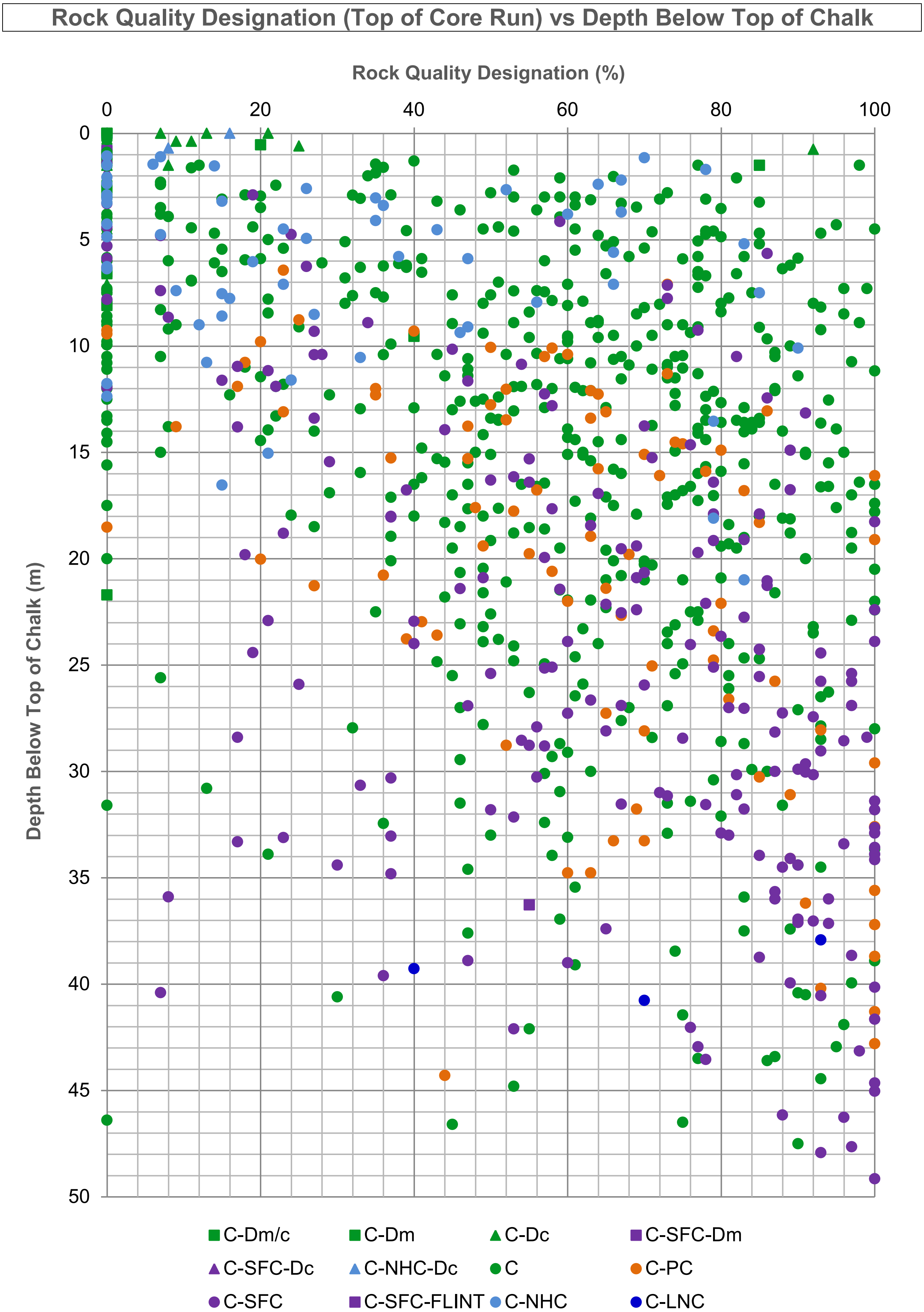

Rock Quality Designation (Top of Core Run) vs Depth Below Top of Chalk
Rock Quality Designation (%)
0
20
40
60
80
100
0
5
10
15
20
25
30
35
40
45
50
Depth Below Top of Chalk (m)
C-Dm/c
C-Dm
C-Dc
C-SFC-Dm
C-SFC-Dc
C-NHC-Dc
C
C-PC
C-SFC
C-SFC-FLINT
C-NHC
C-LNC

Figure 6-39

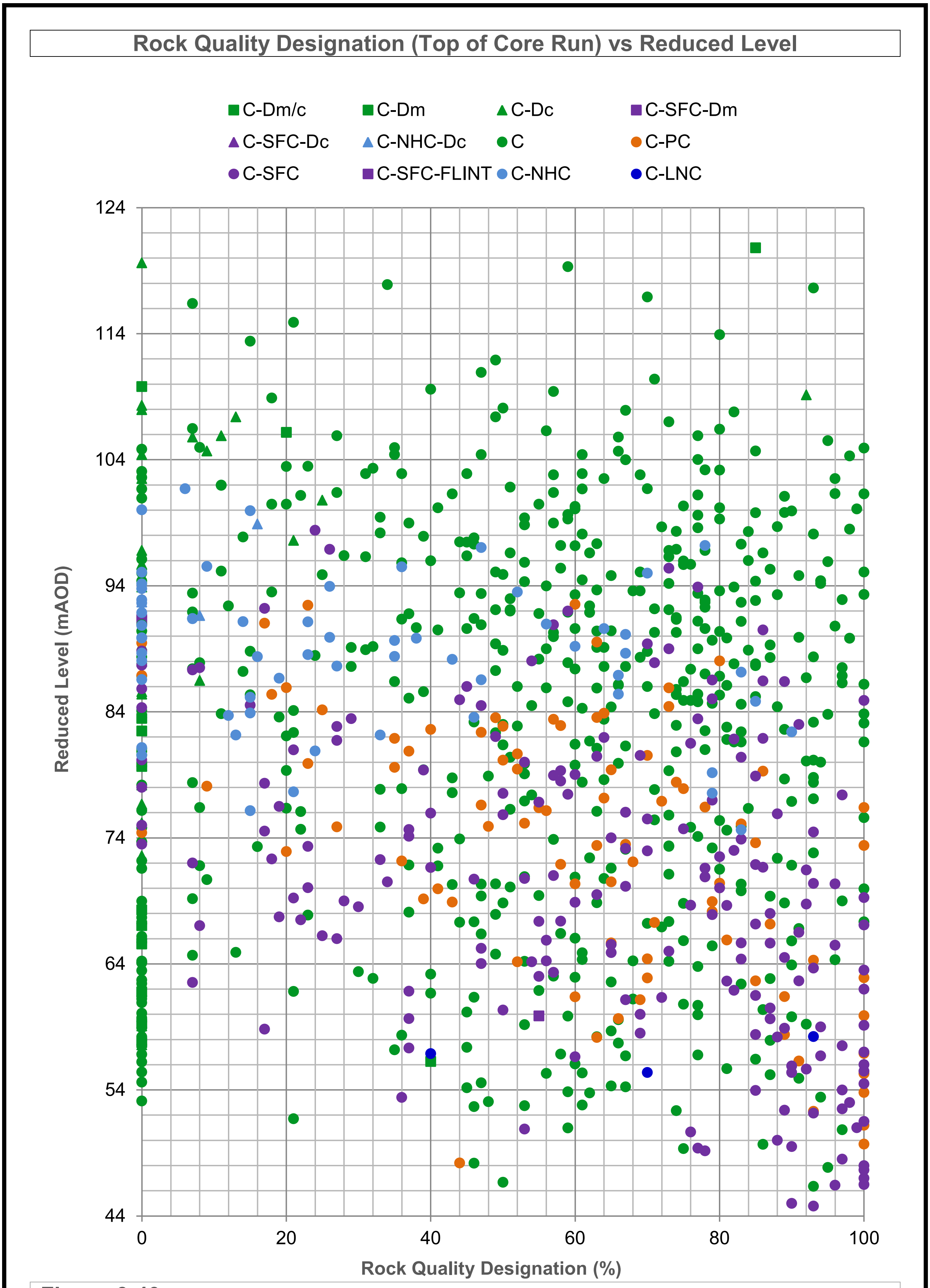

Rock Quality Designation (Top of Core Run) vs Reduced Level
C-Dm/c
C-Dm
C-Dc
C-SFC-Dm
C-SFC-Dc
C-NHC-Dc
C
C-PC
C-SFC
C-SFC-FLINT
C-NHC
C-LNC
124
114
104
94
84
74
64
54
44
Reduced Level (mAOD)
0
20
40
60
80
100
Rock Quality Designation (%)

Figure 6-40

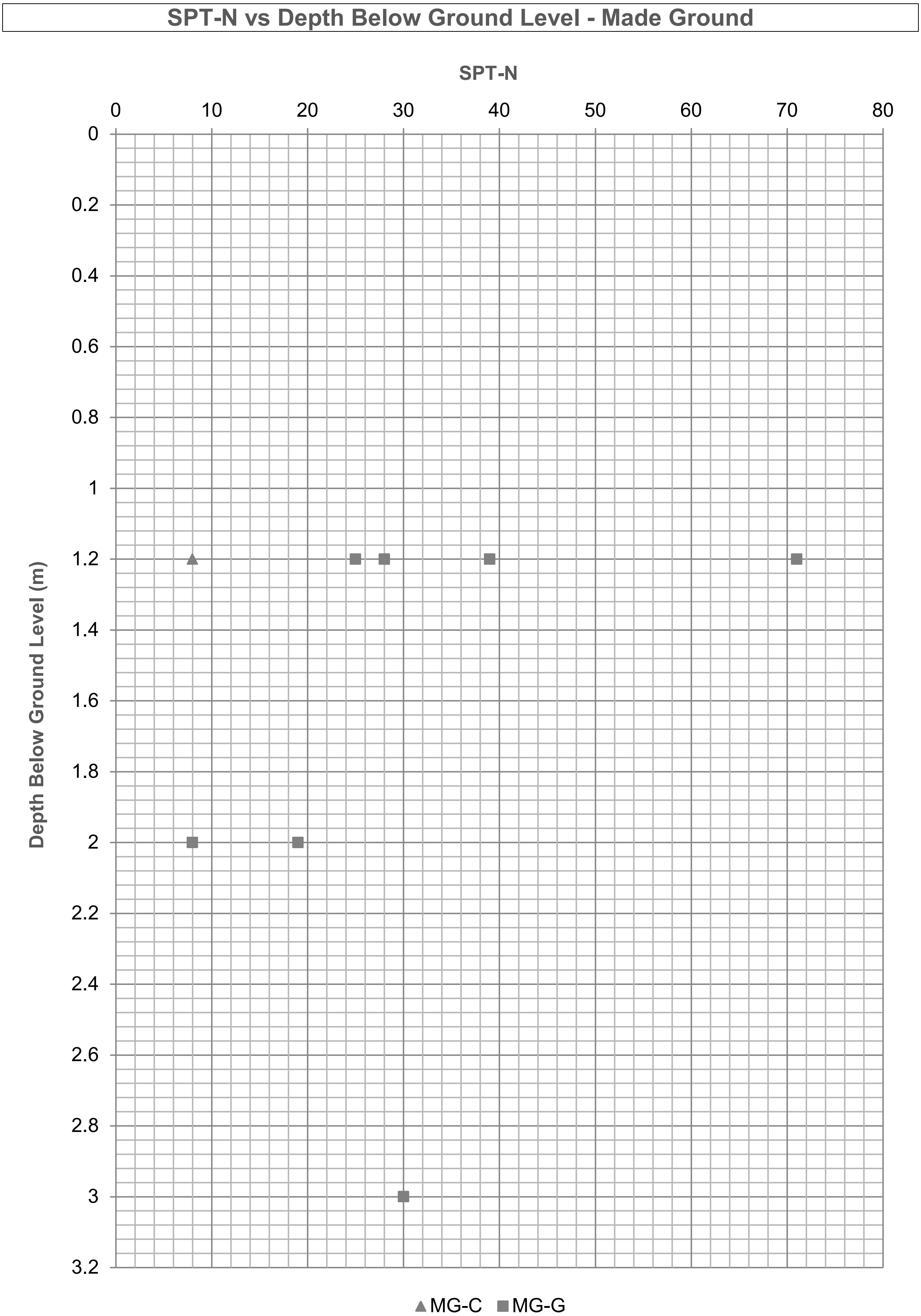

SPT-N vs Depth Below Ground Level - Made Ground
SPT-N
0
10
20
30
40
50
60
70
80
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
Depth Below Ground Level (m)
MG-C
MG-G

Figure 6-41

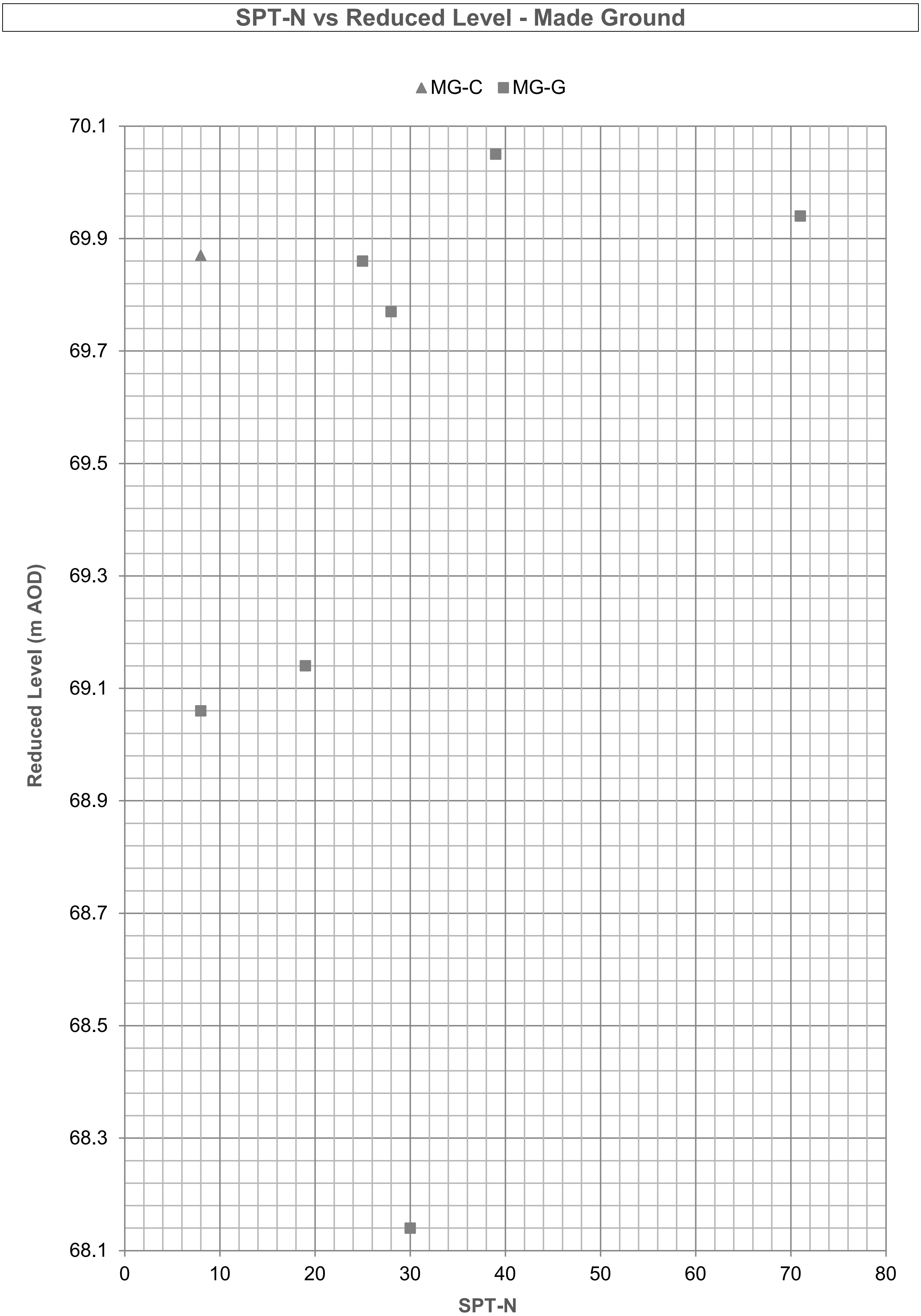

SPT-N vs Reduced Level - Made Ground
MG-C
MG-G
70.1
69.9
69.7
69.5
69.3
69.1
68.9
68.7
68.5
68.3
68.1
Reduced Level (m AOD)
0
10
20
30
40
50
60
70
80
SPT-N

Figure 6-42

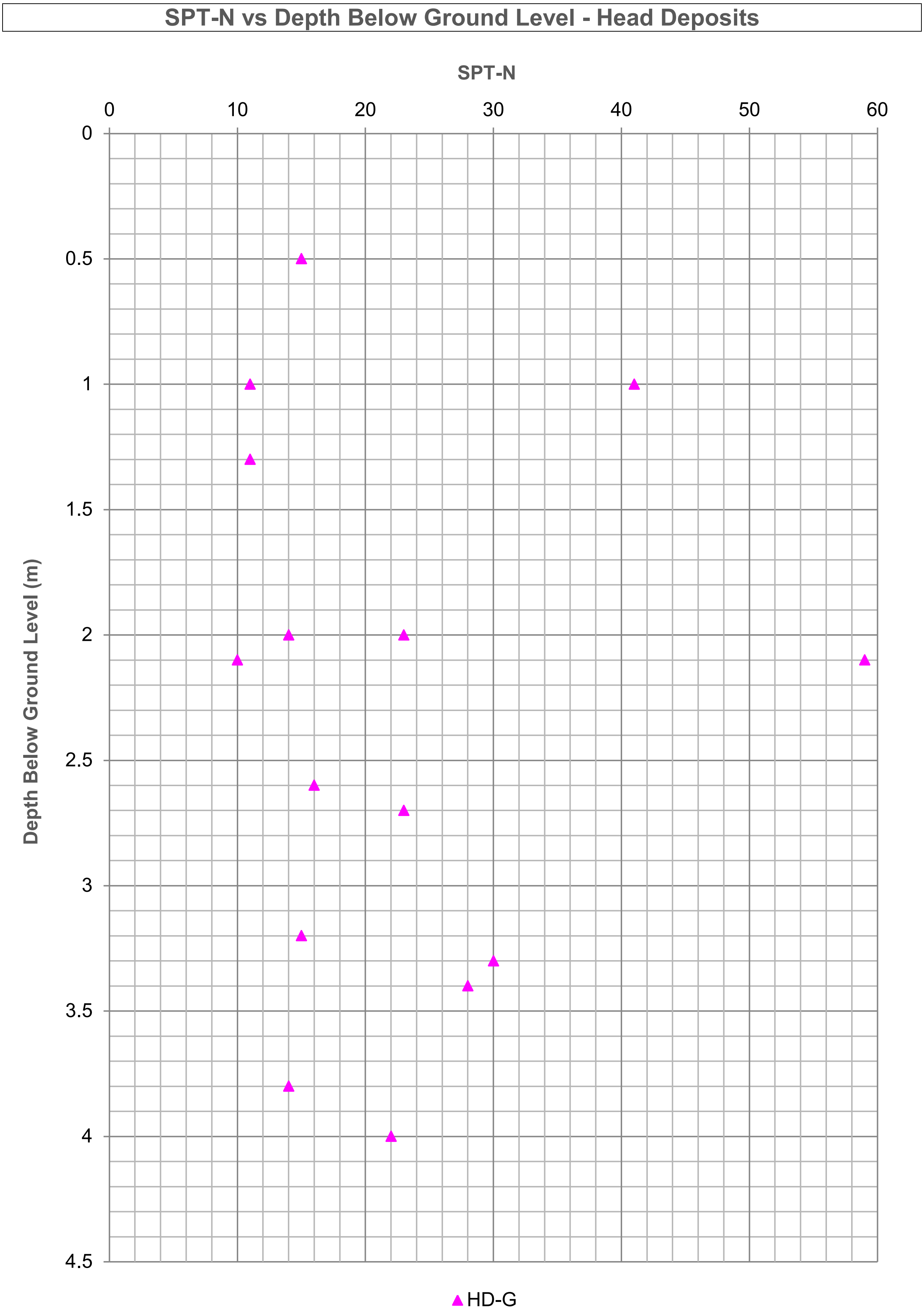

SPT-N vs Depth Below Ground Level - Head Deposits
SPT-N
0
10
20
30
40
50
60
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Depth Below Ground Level (m)
HD-G

Figure 6-43

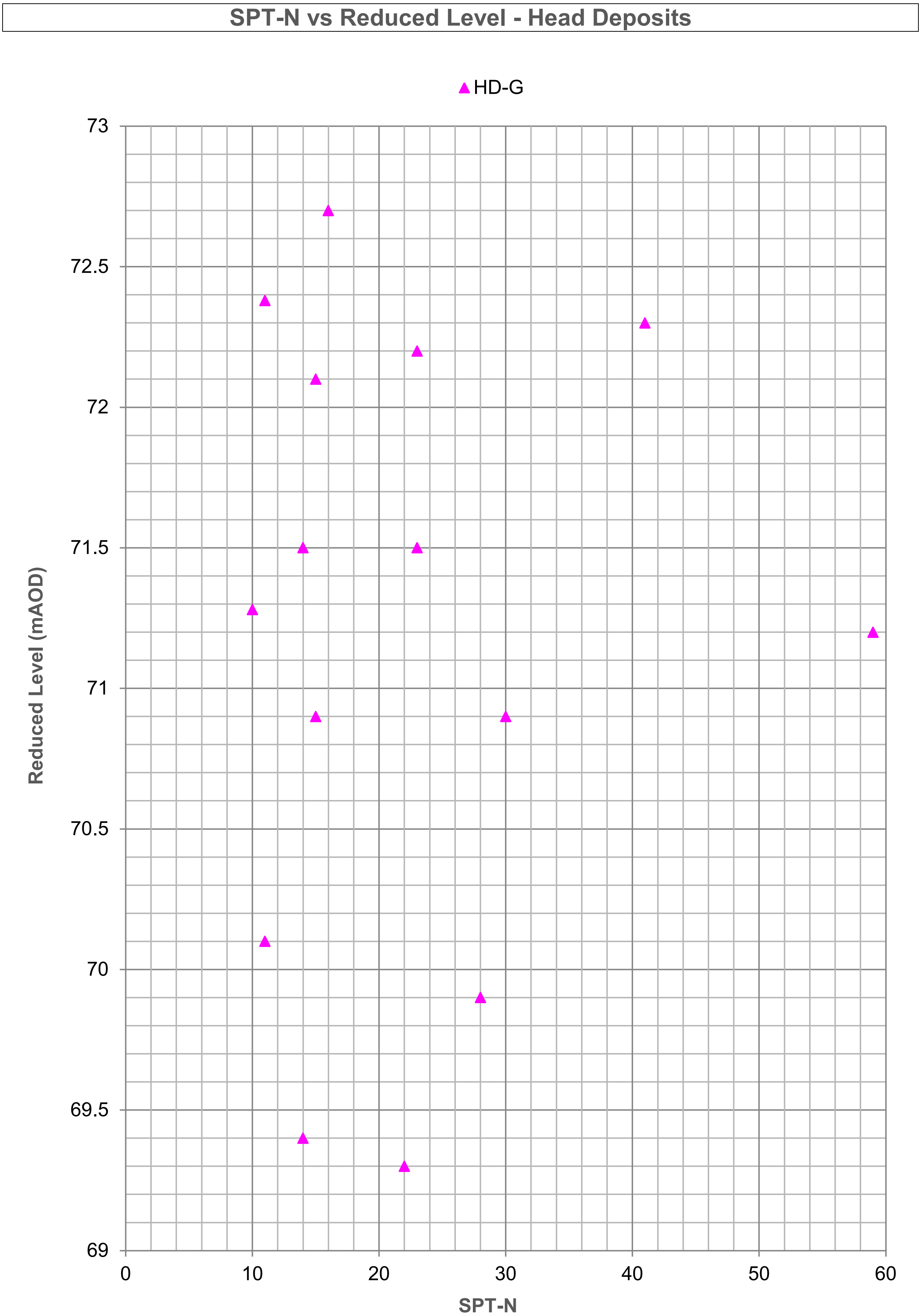

SPT-N vs Reduced Level - Head Deposits
HD-G
73
72.5
72
71.5
71
70.5
70
69.5
69
0
10
20
30
40
50
60
SPT-N
Reduced Level (mAOD)

Figure 6-44

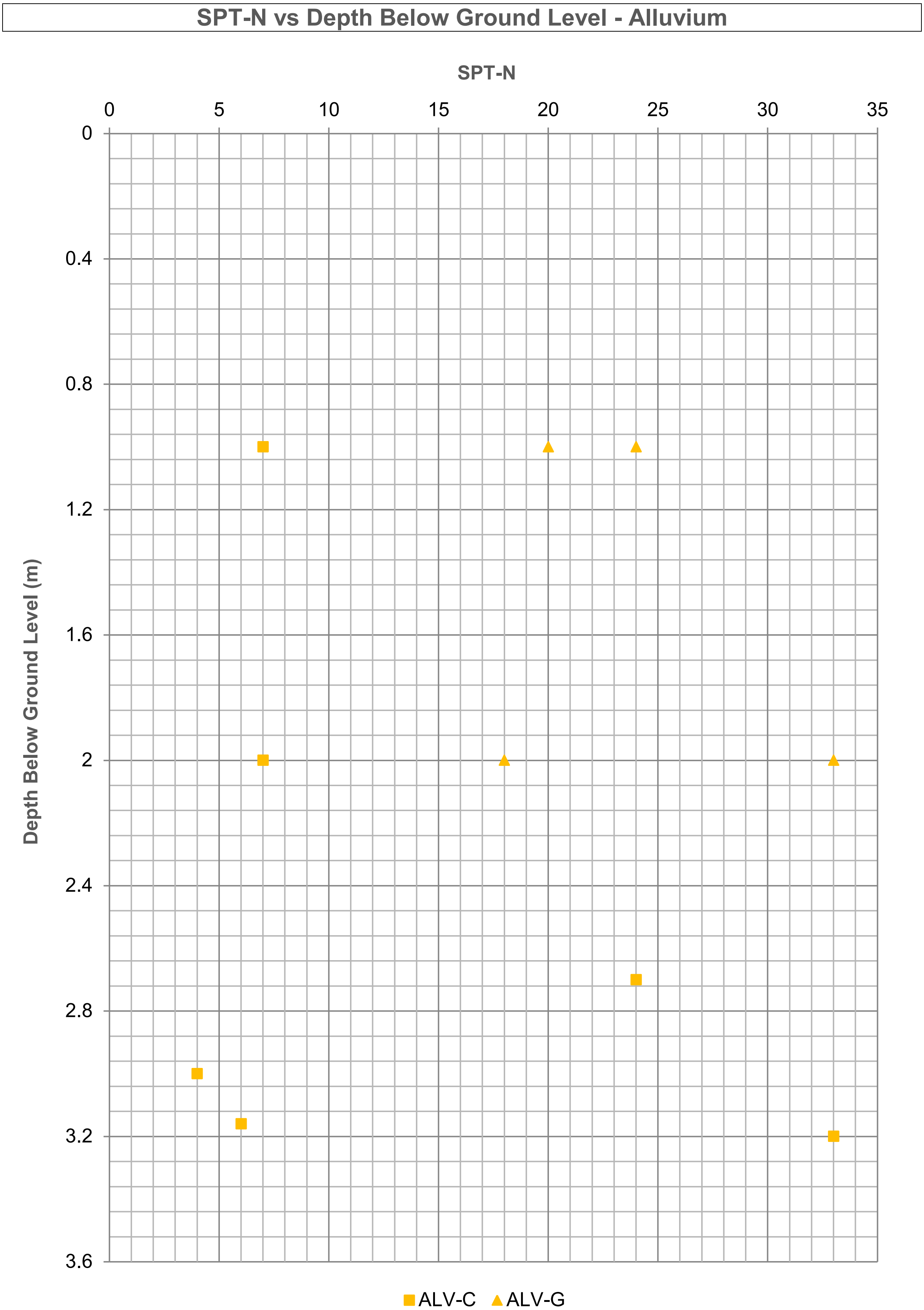

SPT-N vs Depth Below Ground Level - Alluvium
SPT-N
0
5
10
15
20
25
30
35
Depth Below Ground Level (m)
0
0.4
0.8
1.2
1.6
2
2.4
2.8
3.2
3.6
ALV-C
ALV-G

Figure 6-45

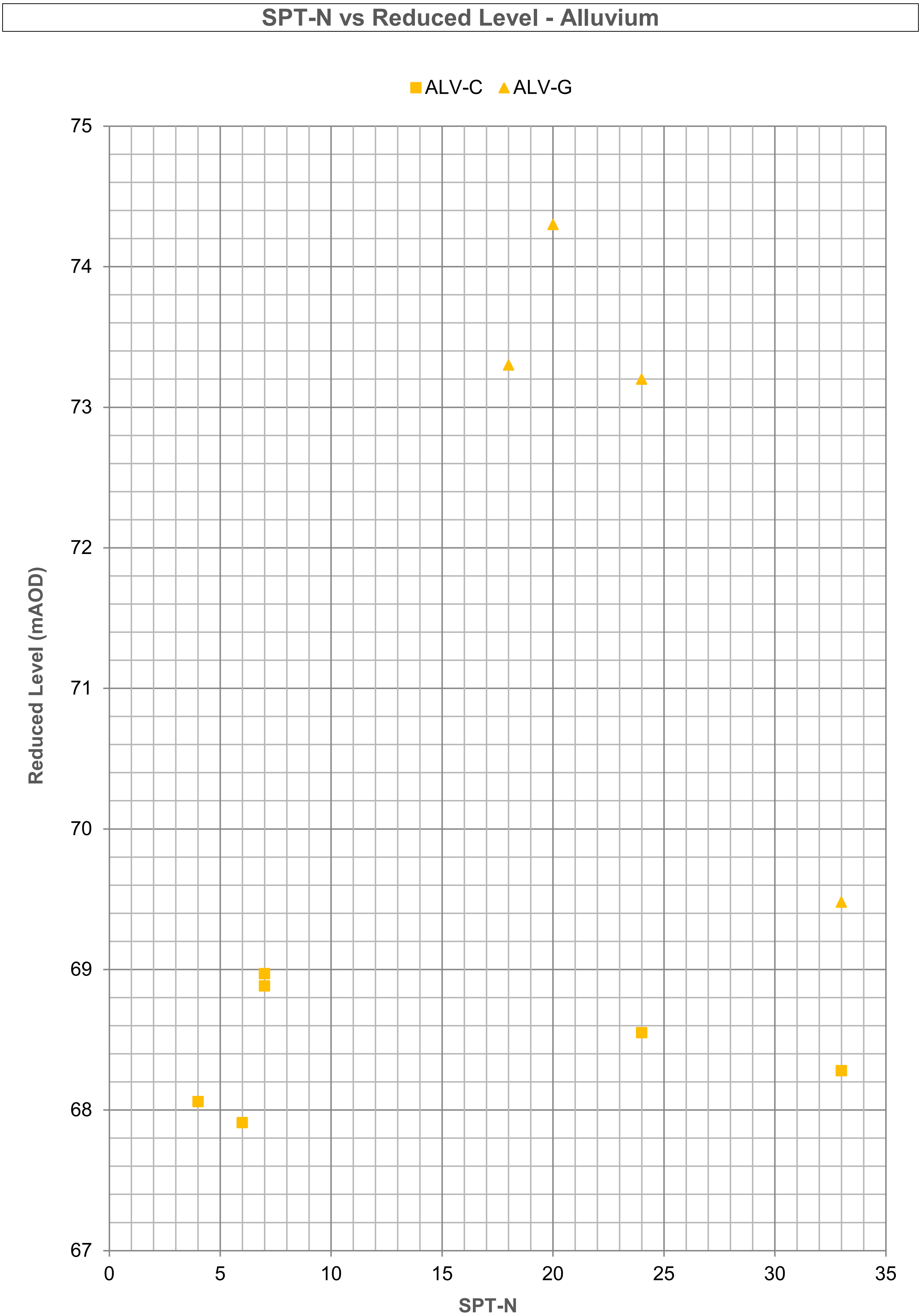

SPT-N vs Reduced Level - Alluvium
ALV-C
ALV-G
75
74
73
72
71
70
69
68
67
Reduced Level (mAOD)
0
5
10
15
20
25
30
35
SPT-N

Figure 6-46

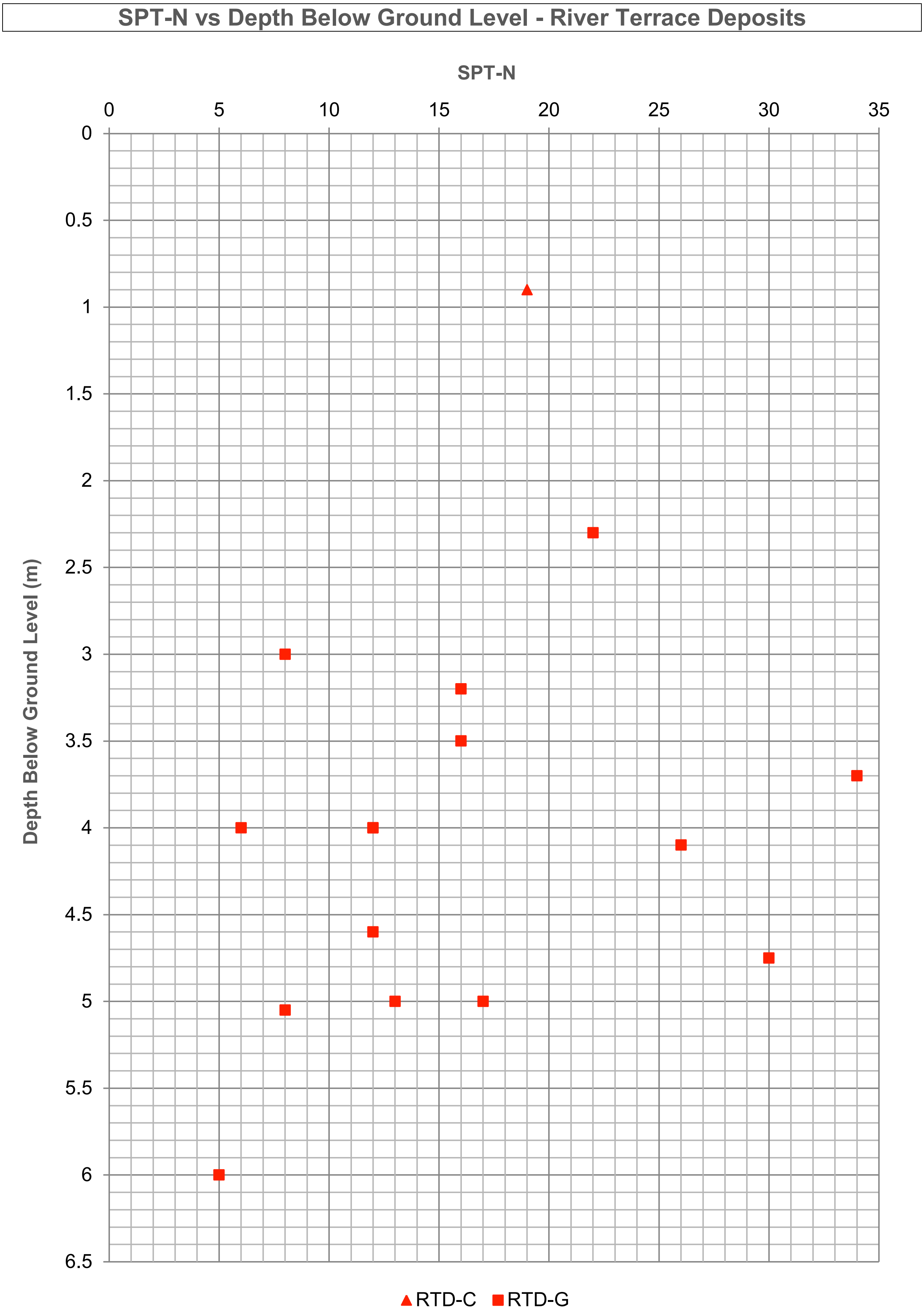

SPT-N vs Depth Below Ground Level - River Terrace Deposits
SPT-N
0
5
10
15
20
25
30
35
Depth Below Ground Level (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
RTD-C
RTD-G

Figure 6-47

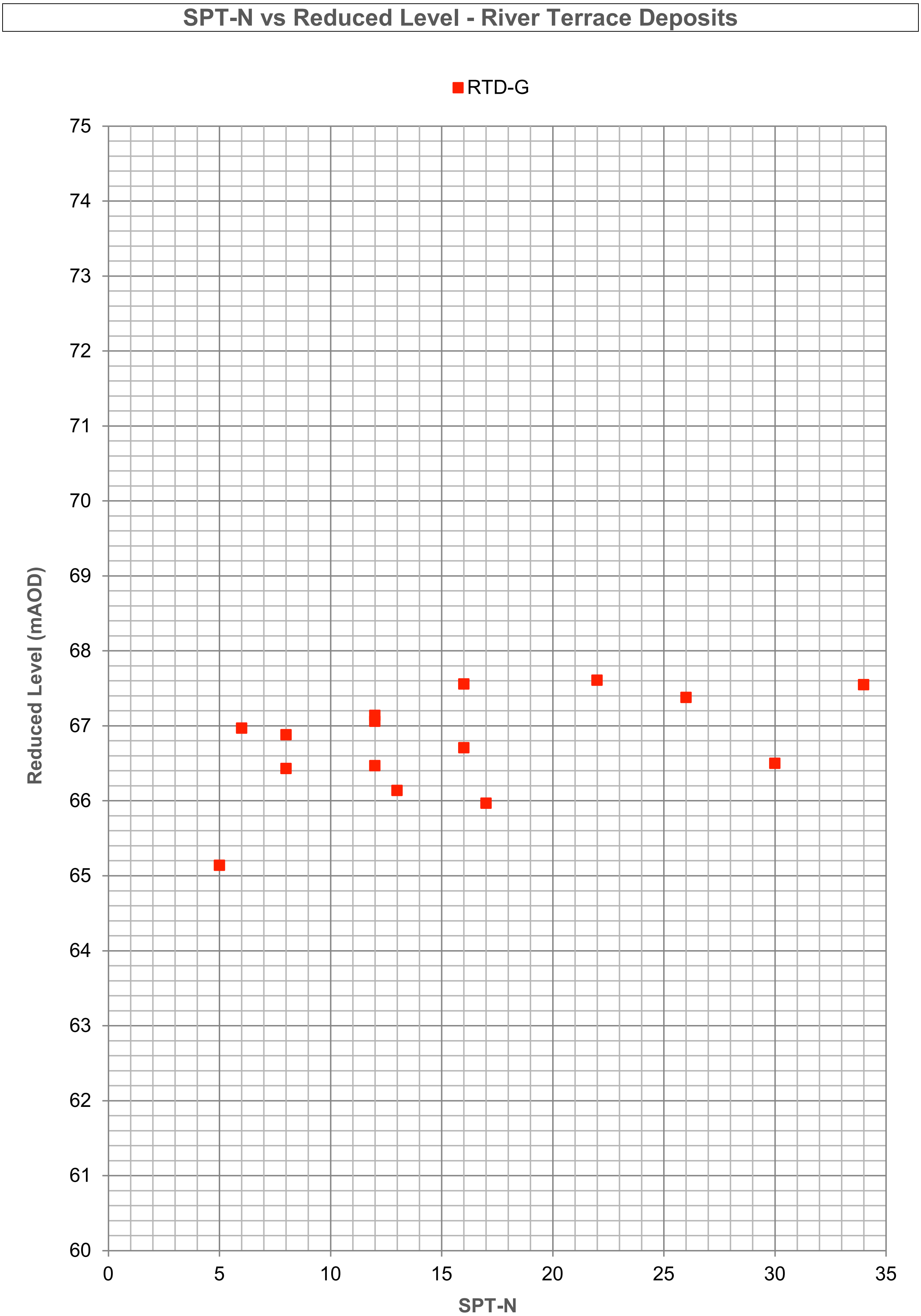

SPT-N vs Reduced Level - River Terrace Deposits
RTD-G
Reduced Level (mAOD)
75
74
73
72
71
70
69
68
67
66
65
64
63
62
61
60
0
5
10
15
20
25
30
35
SPT-N

Figure 6-48

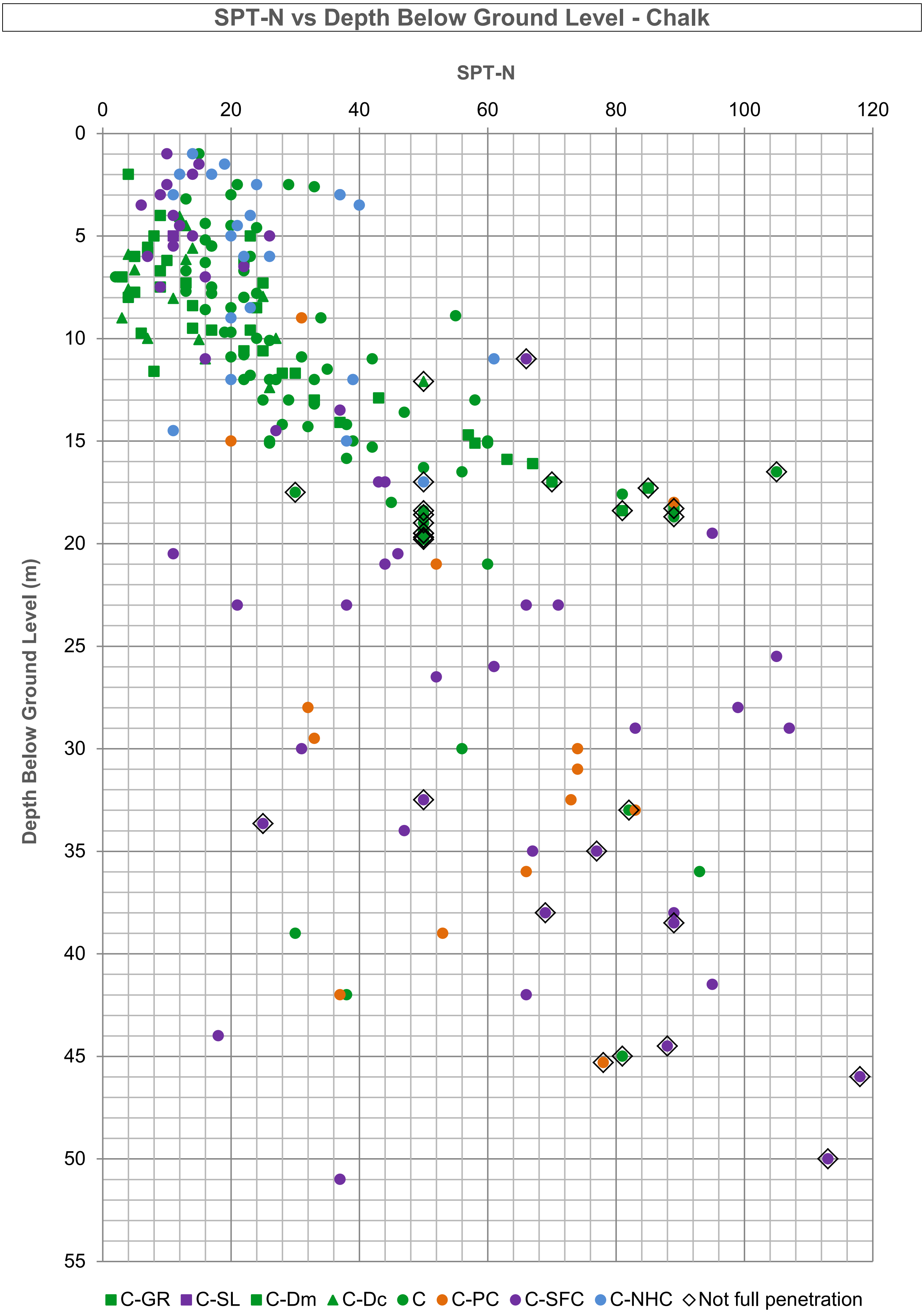
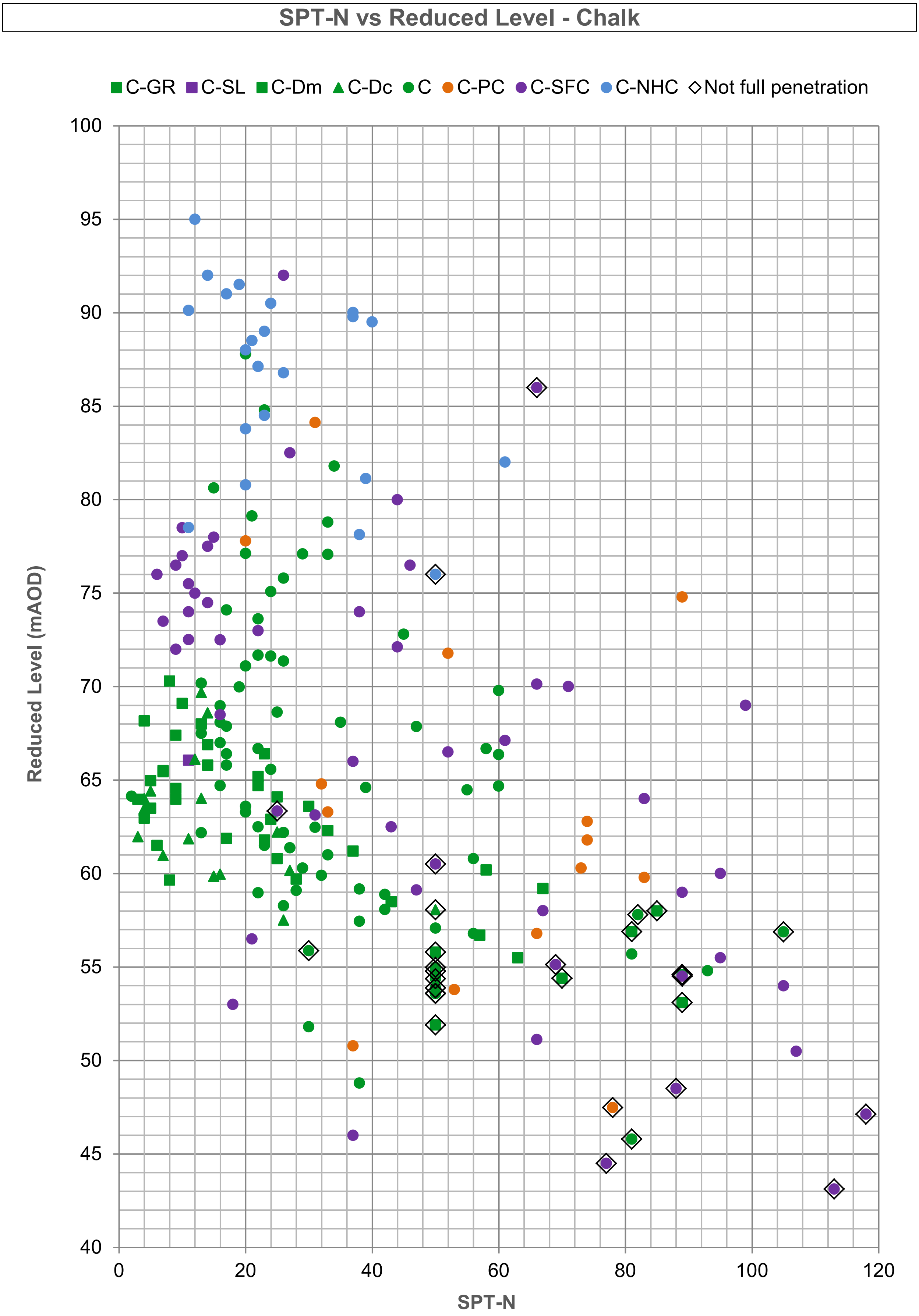

SPT-N vs Depth Below Ground Level - Chalk
SPT-N
0
20
40
60
80
100
120
0
5
10
15
20
25
30
35
40
45
50
55
Depth Below Ground Level (m)
C-GR
C-SL
C-Dm
C-Dc
C
C-PC
C-SFC
C-NHC
Not full penetration

Figure 6-49



SPT-N vs Reduced Level - Chalk
C-GR
C-SL
C-Dm
C-Dc
C
C-PC
C-SFC
C-NHC
Not full penetration
Reduced Level (mAOD)
100
95
90
85
80
75
70
65
60
55
50
45
40
0
20
40
60
80
100
120
SPT-N

Figure 6-50

Undrained Shear Strength vs Depth Below Ground Level

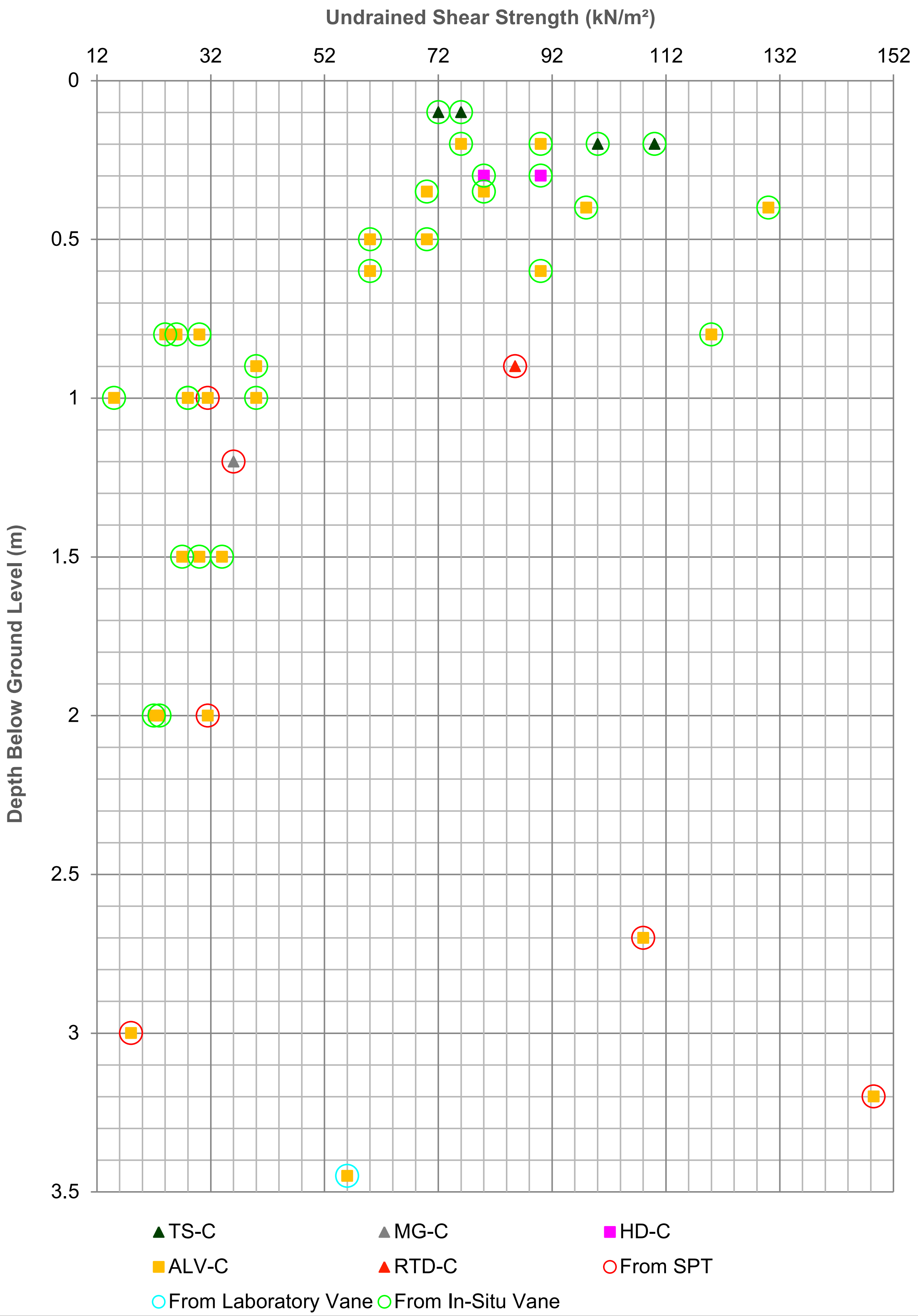


Figure 6-51

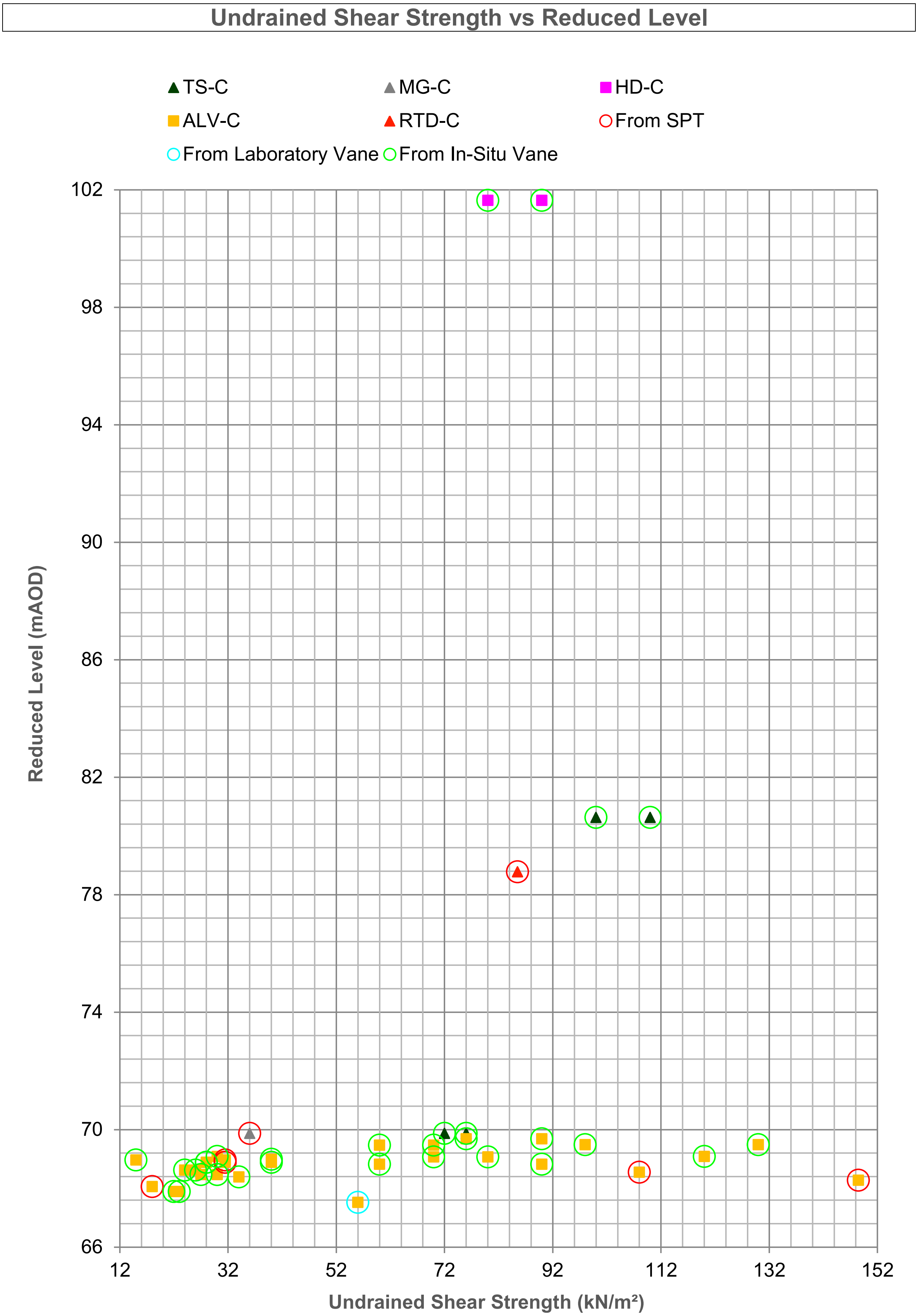
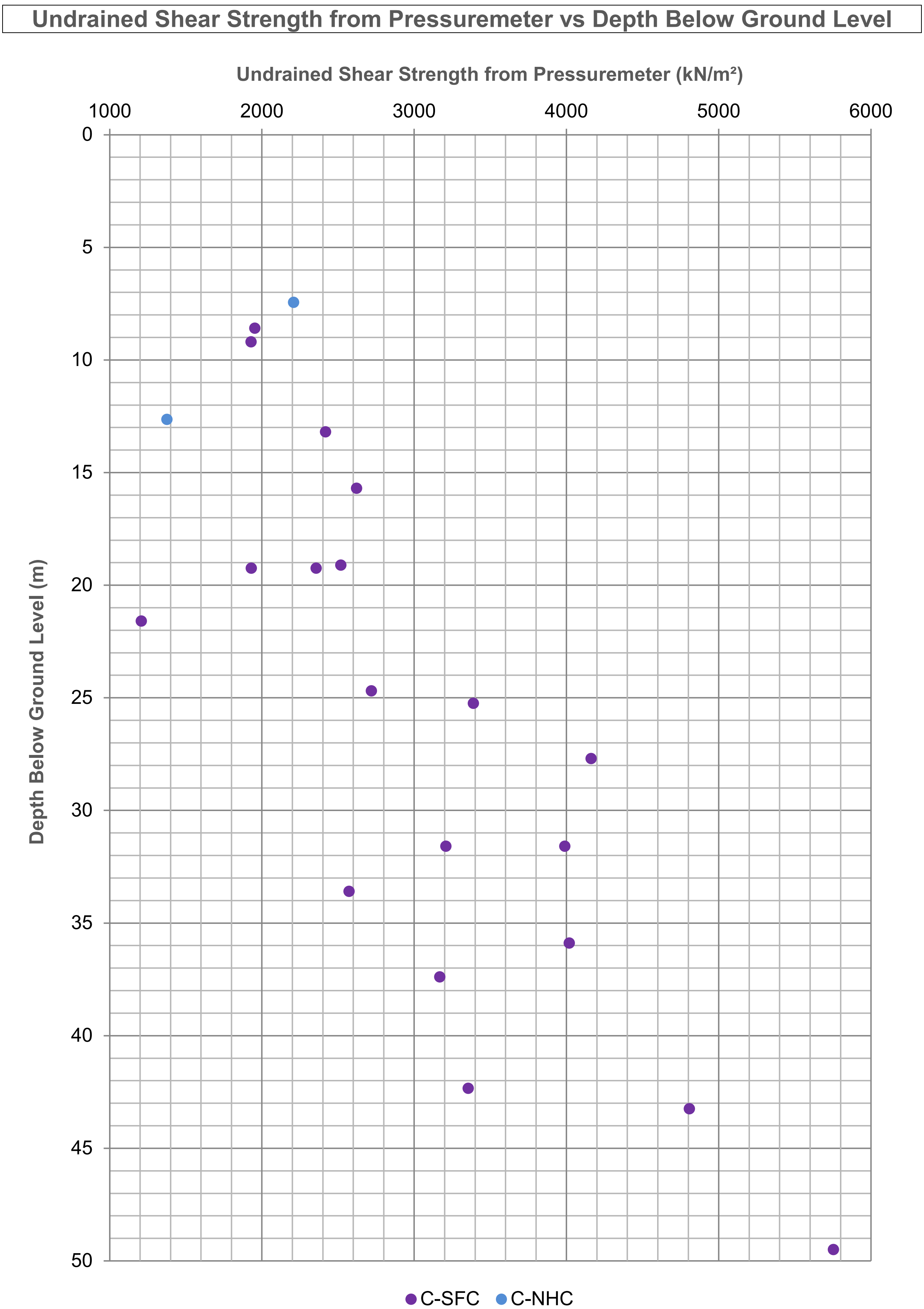
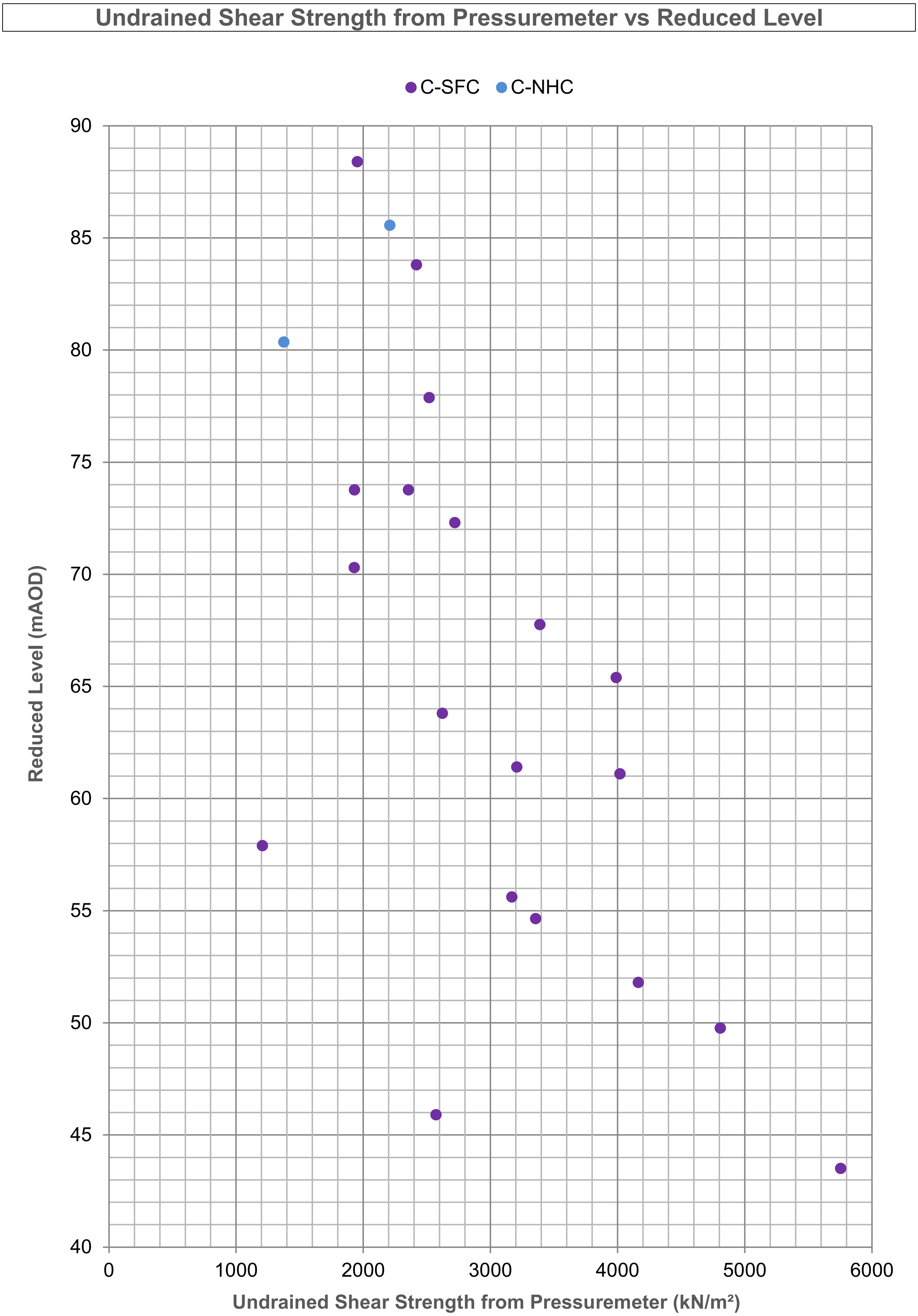

Undrained Shear Strength vs Reduced Level
TS-C
MG-C
HD-C
ALV-C
RTD-C
From SPT
From Laboratory Vane
From In-Situ Vane
102
98
94
90
86
82
78
74
70
66
Reduced Level (mAOD)
12
32
52
72
92
112
132
152
Undrained Shear Strength (kN/m²)

Figure 6-52



Undrained Shear Strength from Pressuremeter vs Depth Below Ground Level
Undrained Shear Strength from Pressuremeter (kN/m²)
1000
2000
3000
4000
5000
6000
0
5
10
15
20
25
30
35
40
45
50
Depth Below Ground Level (m)
C-SFC
C-NHC

Figure 6-53



Undrained Shear Strength from Pressuremeter vs Reduced Level
C-SFC
C-NHC
90
85
80
75
70
65
60
55
50
45
40
Reduced Level (mAOD)
0
1000
2000
3000
4000
5000
6000
Undrained Shear Strength from Pressuremeter (kN/m²)

Figure 6-54

Effective Friction Angle from SPT (Stroud, 1989) vs Depth Below Ground Level

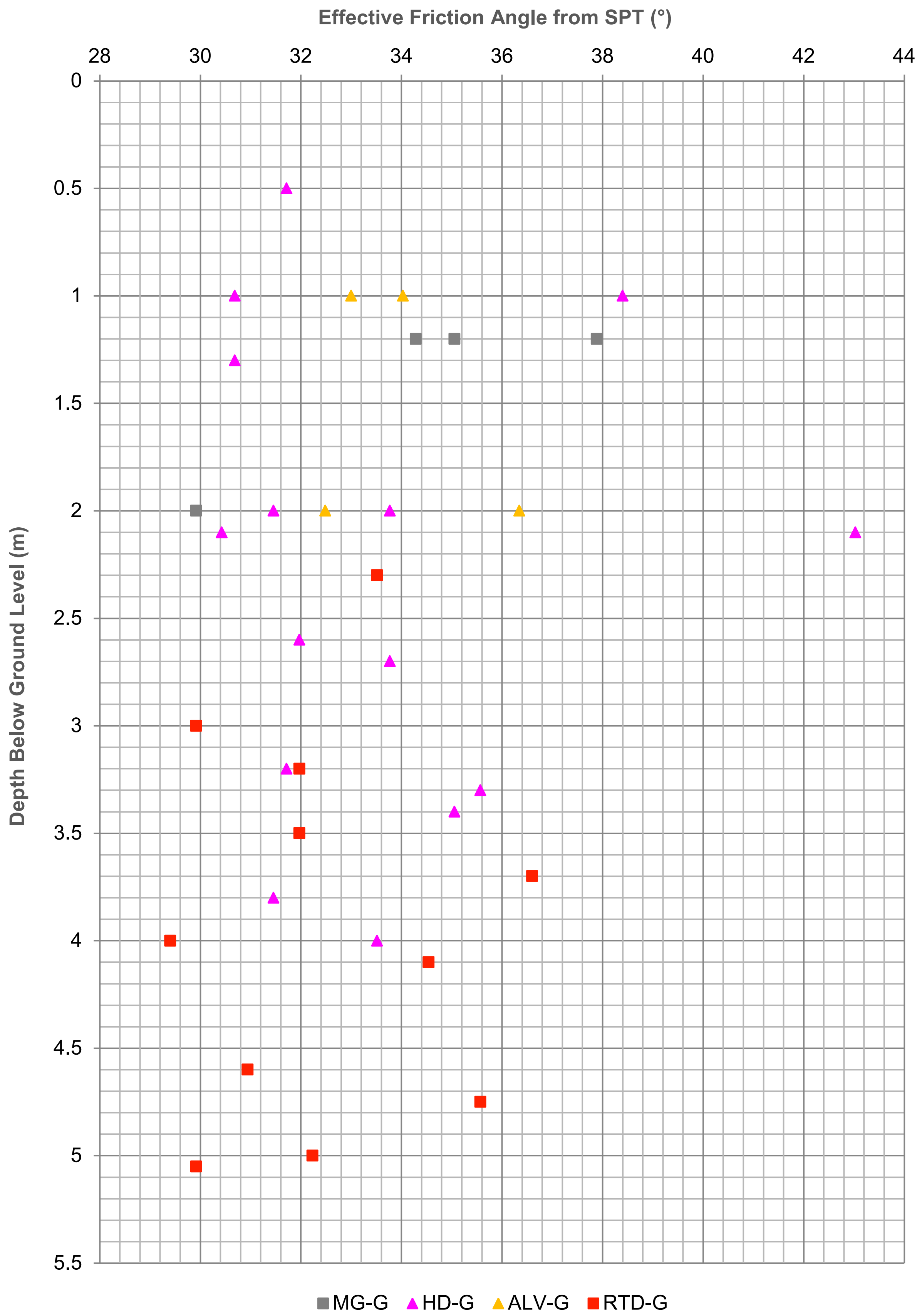
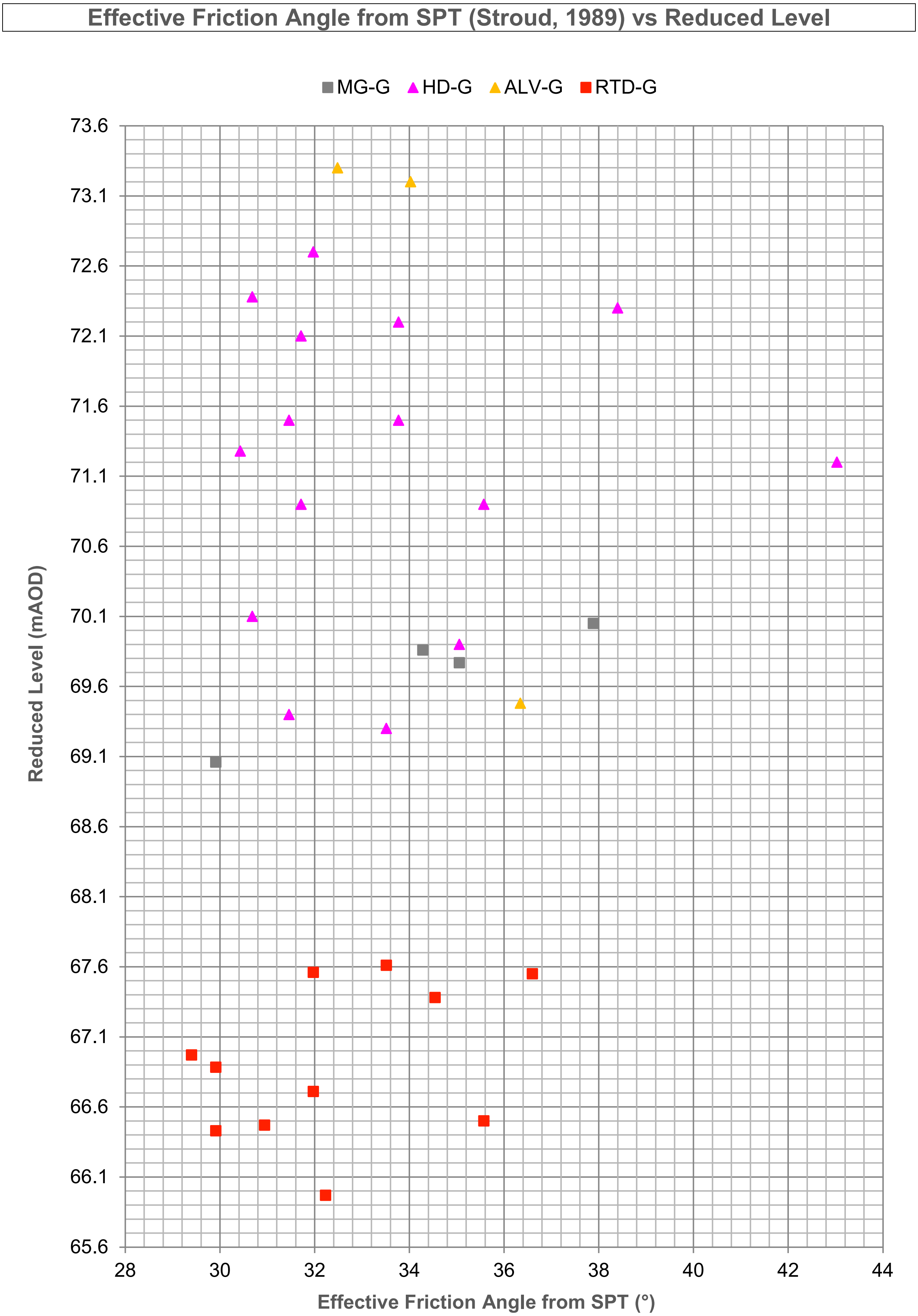


Figure 6-55



Effective Friction Angle from SPT (Stroud, 1989) vs Reduced Level
MG-G
HD-G
ALV-G
RTD-G
73.6
73.1
72.6
72.1
71.6
71.1
70.6
70.1
69.6
69.1
68.6
68.1
67.6
67.1
66.6
66.1
65.6
Reduced Level (mAOD)
28
30
32
34
36
38
40
42
44
Effective Friction Angle from SPT (°)

Figure 6-56

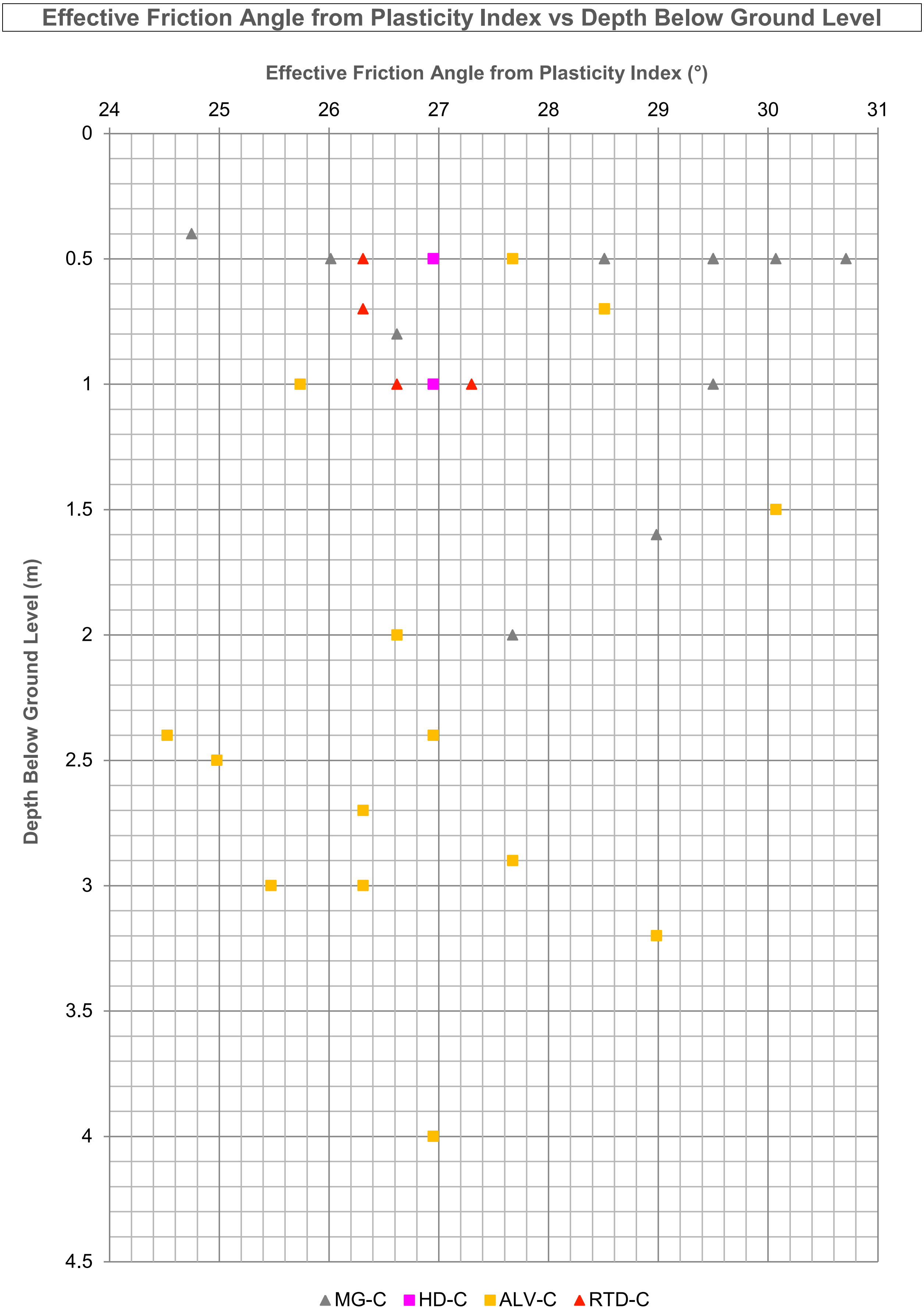
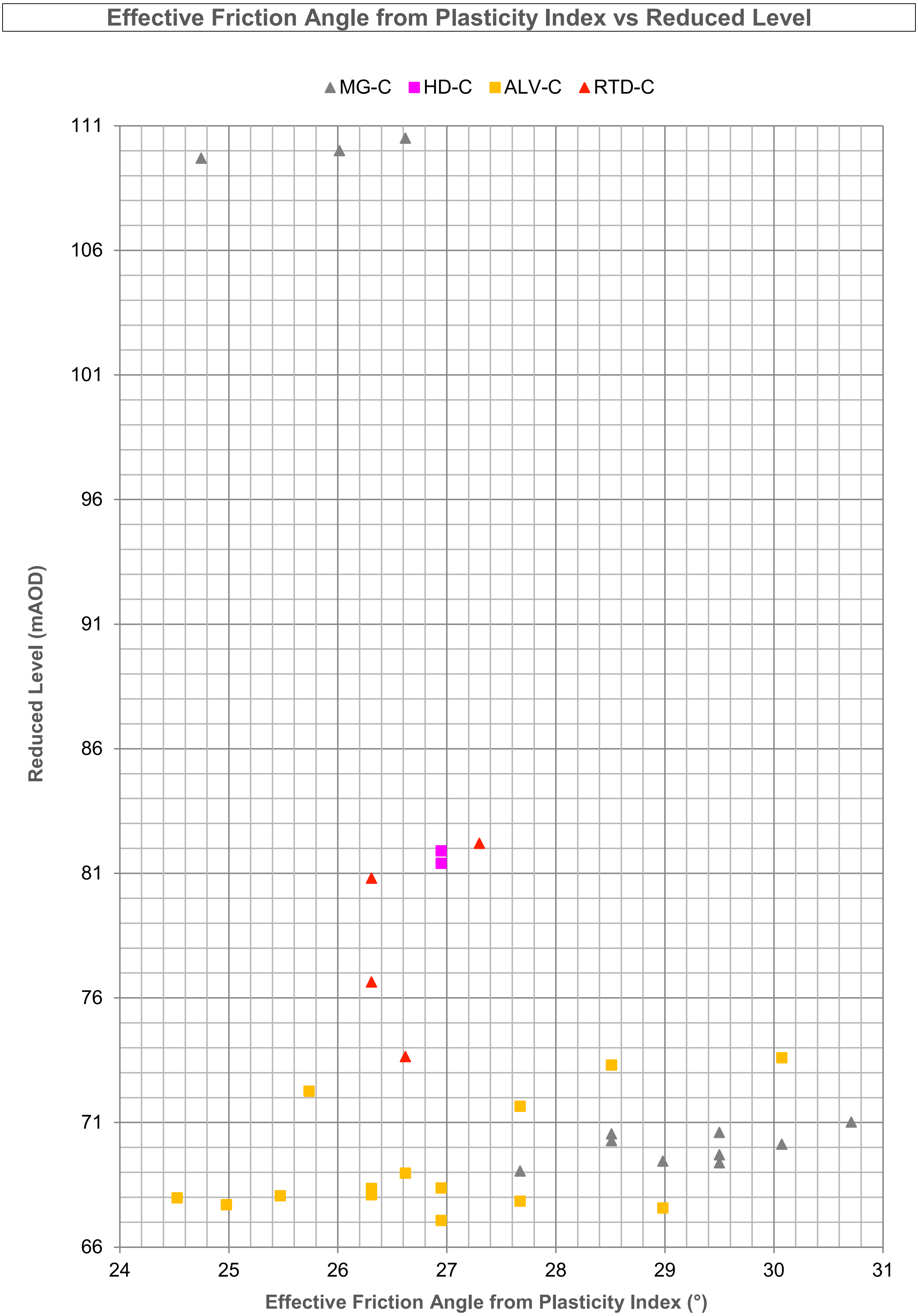
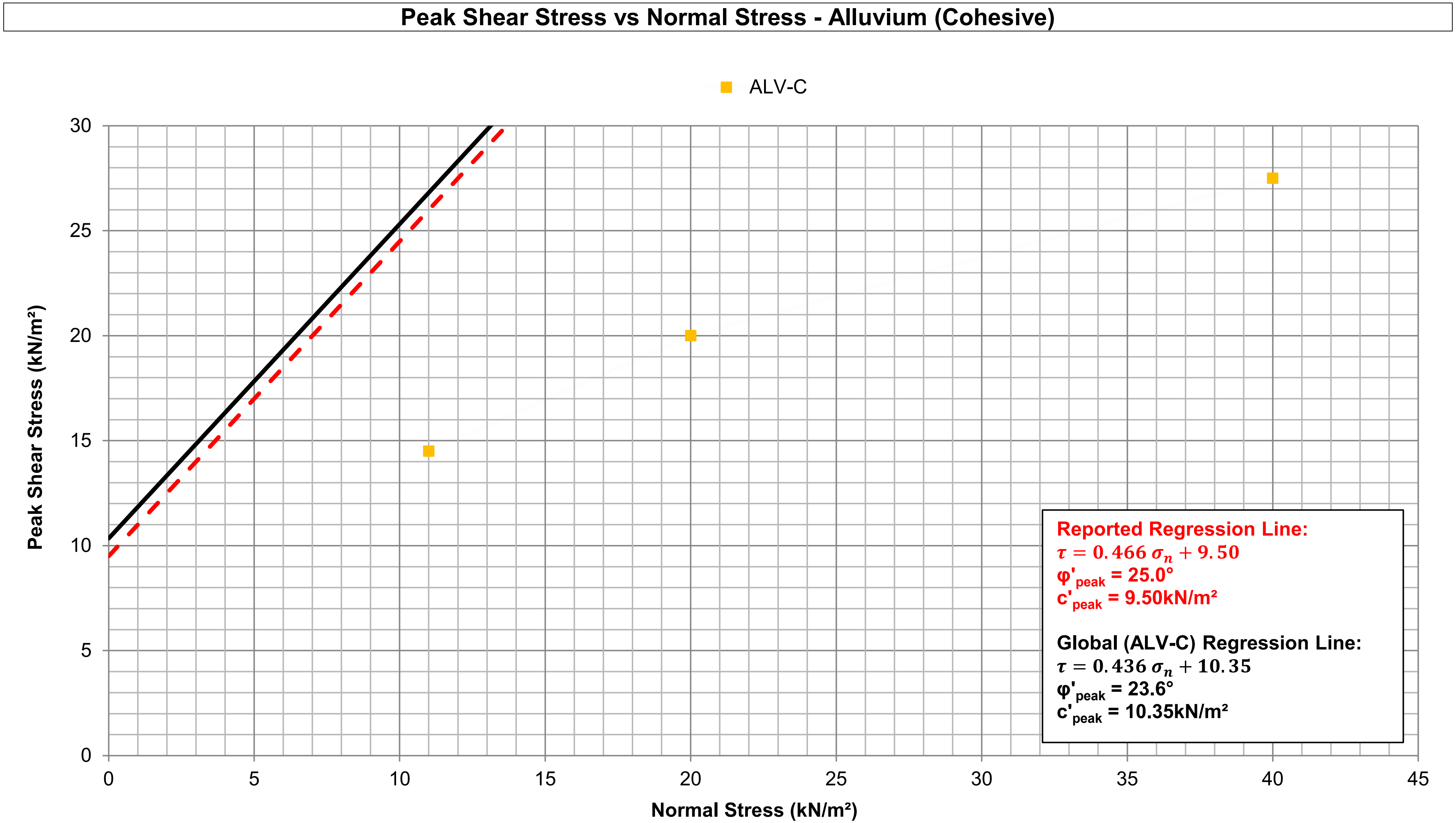

Effective Friction Angle from Plasticity Index vs Depth Below Ground Level
Effective Friction Angle from Plasticity Index (°)
24
25
26
27
28
29
30
31
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Depth Below Ground Level (m)
MG-C
HD-C
ALV-C
RTD-C

Figure 6-57



Effective Friction Angle from Plasticity Index vs Reduced Level
MG-C
HD-C
ALV-C
RTD-C
111
106
101
96
91
86
81
76
71
66
Reduced Level (mAOD)
24
25
26
27
28
29
30
31
Effective Friction Angle from Plasticity Index (°)

Figure 6-58



Peak Shear Stress vs Normal Stress - Alluvium (Cohesive)
ALV-C
Peak Shear Stress (kN/m²)
Normal Stress (kN/m²)
0
5
10
15
20
25
30
35
40
45
Reported Regression Line:
$\tau = 0.466\ \sigma_n + 9.50$
φ'peak = 25.0°
c'peak = 9.50kN/m²
Global (ALV-C) Regression Line:
$\tau = 0.436\ \sigma_n + 10.35$
φ'peak = 23.6°
c'peak = 10.35kN/m²

Figure 6-59

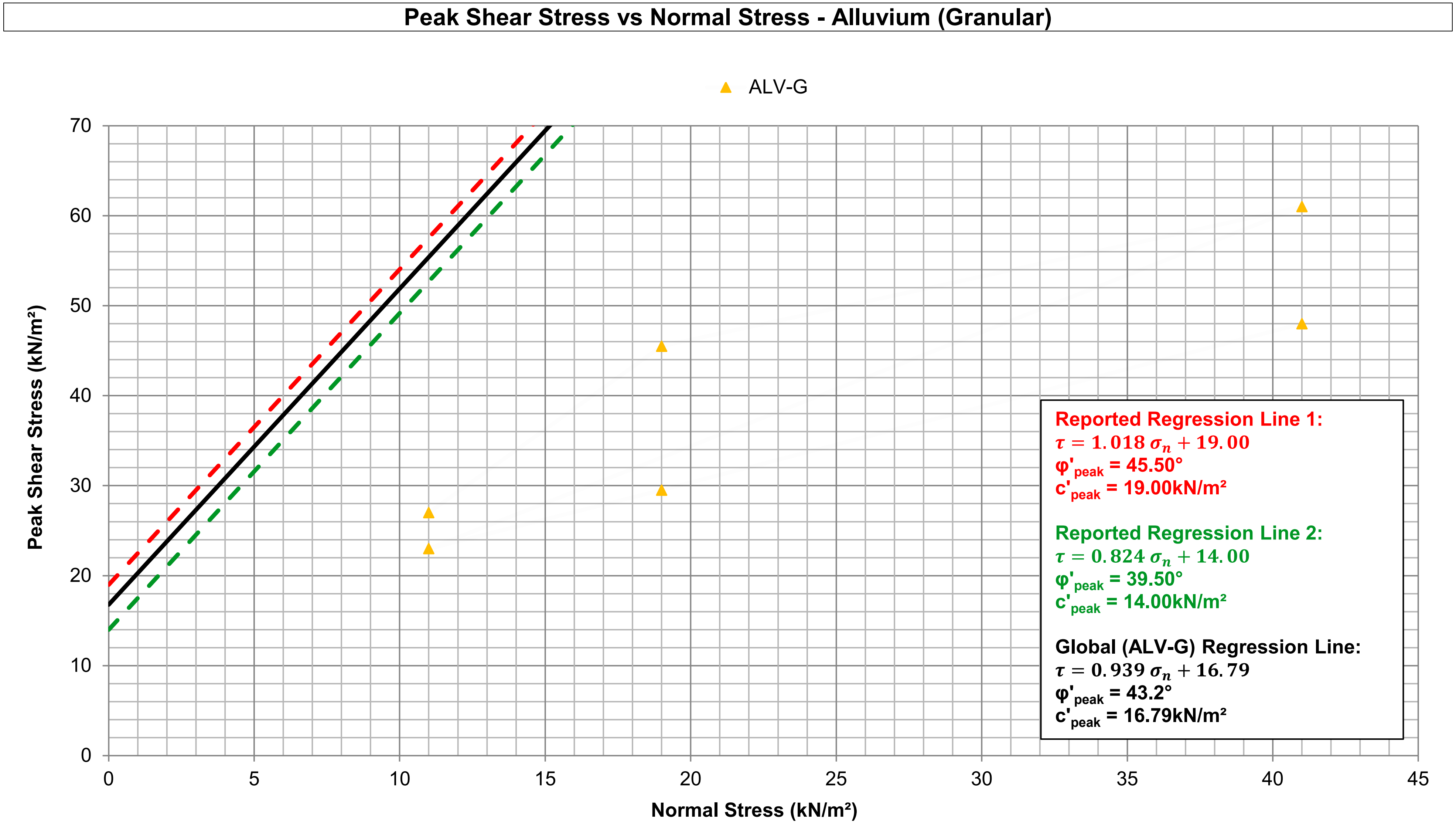

Peak Shear Stress vs Normal Stress - Alluvium (Granular)
ALV-G
Peak Shear Stress (kN/m²)
Normal Stress (kN/m²)
0
10
20
30
40
50
60
70
0
5
10
15
20
25
30
35
40
45
Reported Regression Line 1:
τ = 1.018 σn + 19.00
φ'peak = 45.50°
c'peak = 19.00kN/m²
Reported Regression Line 2:
τ = 0.824 σn + 14.00
φ'peak = 39.50°
c'peak = 14.00kN/m²
Global (ALV-G) Regression Line:
τ = 0.939 σn + 16.79
φ'peak = 43.2°
c'peak = 16.79kN/m²

Figure 6-60

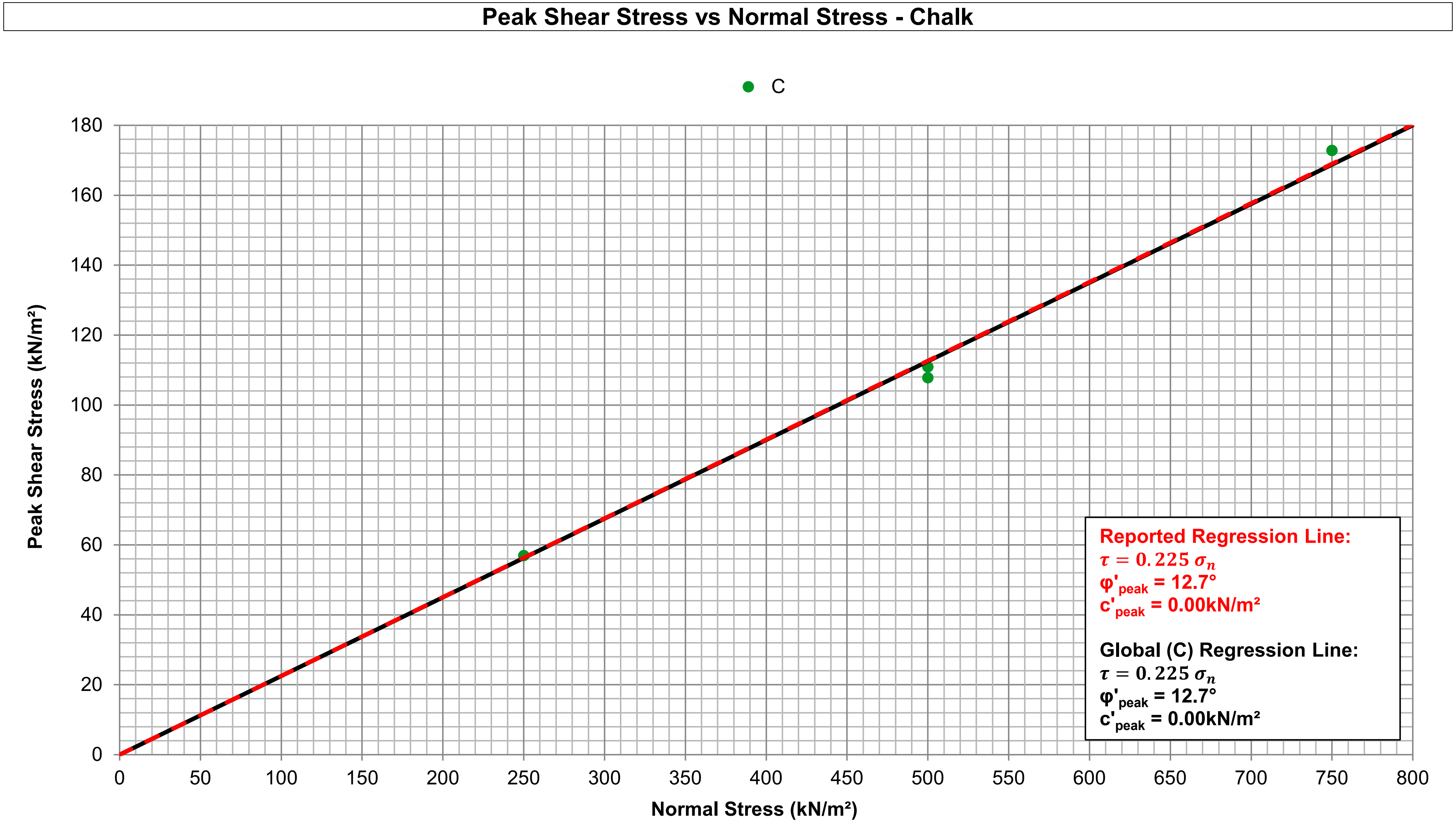
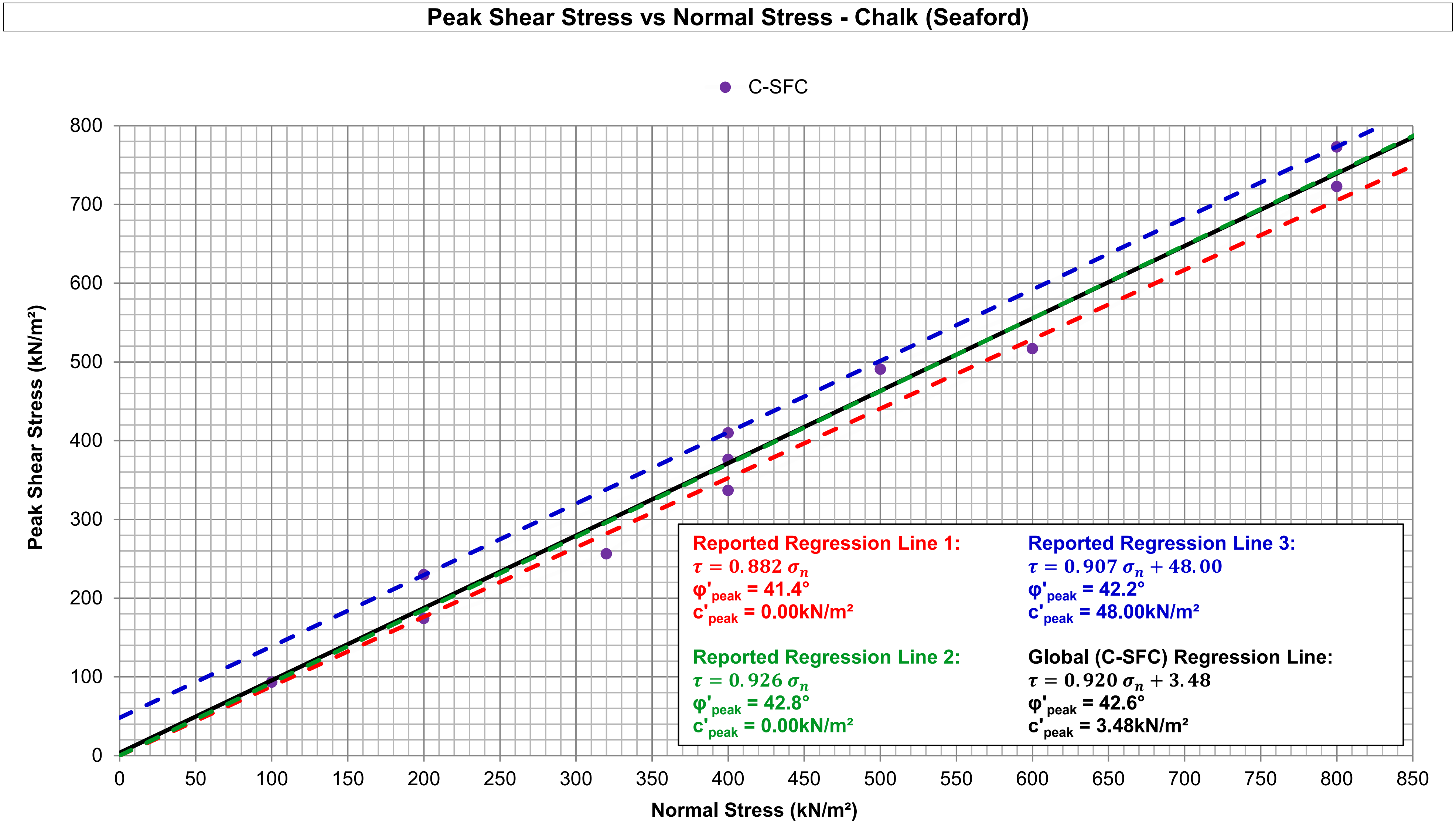
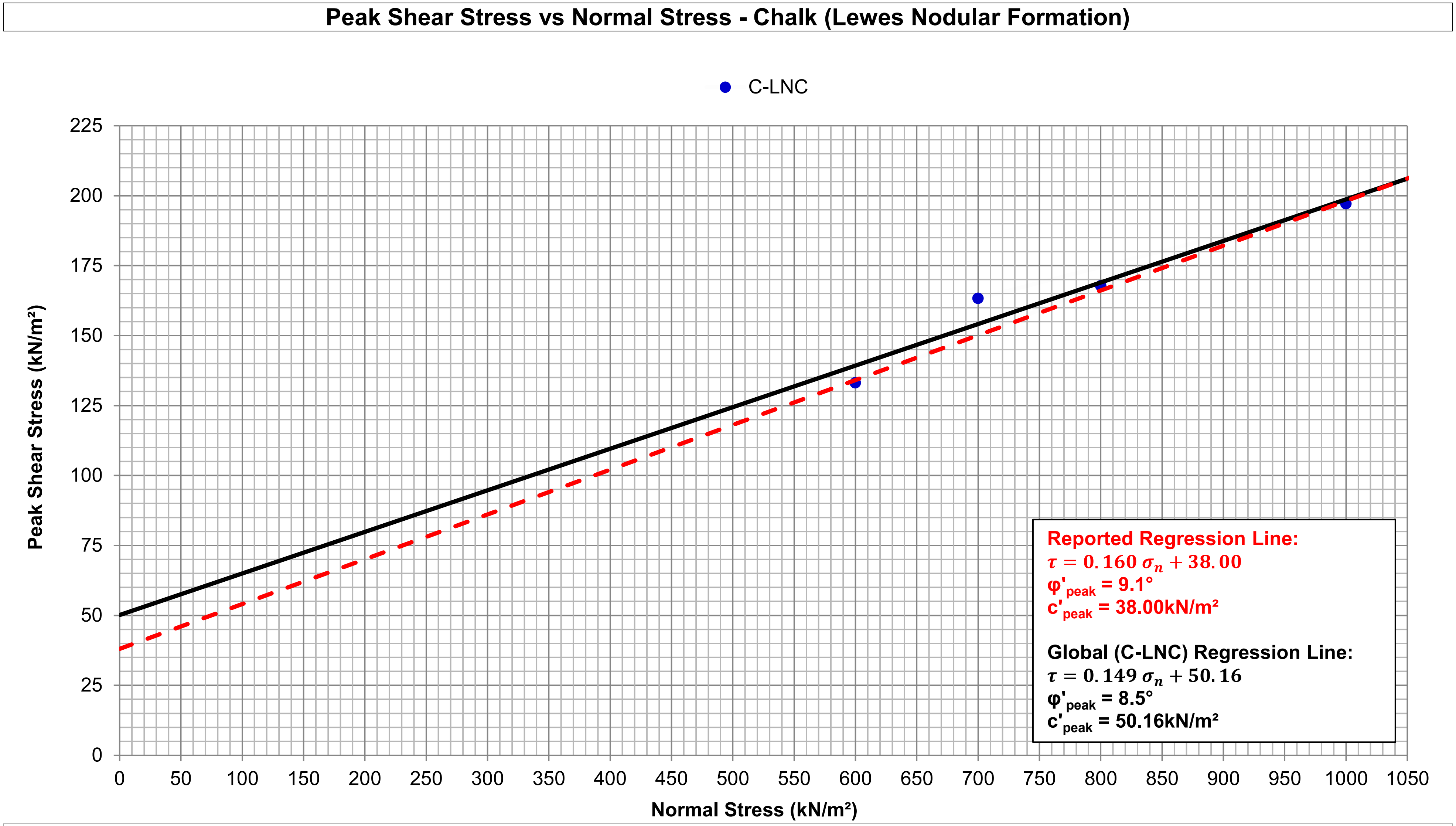

Peak Shear Stress vs Normal Stress - Chalk
C
Peak Shear Stress (kN/m²)
Normal Stress (kN/m²)
0
20
40
60
80
100
120
140
160
180
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Reported Regression Line:
τ = 0.225 σn
φ'peak = 12.7°
c'peak = 0.00kN/m²
Global (C) Regression Line:
τ = 0.225 σn
φ'peak = 12.7°
c'peak = 0.00kN/m²

Figure 6-61



Peak Shear Stress vs Normal Stress - Chalk (Seaford)
C-SFC
Peak Shear Stress (kN/m²)
Normal Stress (kN/m²)
0
100
200
300
400
500
600
700
800
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
Reported Regression Line 1:
$\tau = 0.882\ \sigma_n$
φ'_{peak} = 41.4°
c'_{peak} = 0.00kN/m²
Reported Regression Line 2:
$\tau = 0.926\ \sigma_n$
φ'_{peak} = 42.8°
c'_{peak} = 0.00kN/m²
Reported Regression Line 3:
$\tau = 0.907\ \sigma_n + 48.00$
φ'_{peak} = 42.2°
c'_{peak} = 48.00kN/m²
Global (C-SFC) Regression Line:
$\tau = 0.920\ \sigma_n + 3.48$
φ'_{peak} = 42.6°
c'_{peak} = 3.48kN/m²

Figure 6-62



Peak Shear Stress vs Normal Stress - Chalk (Lewes Nodular Formation)
C-LNC
225
200
175
150
125
100
75
50
25
0
Peak Shear Stress (kN/m²)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
Normal Stress (kN/m²)
Reported Regression Line:
τ = 0.160 σn + 38.00
φ'peak = 9.1°
c'peak = 38.00kN/m²
Global (C-LNC) Regression Line:
τ = 0.149 σn + 50.16
φ'peak = 8.5°
c'peak = 50.16kN/m²

Figure 6-63

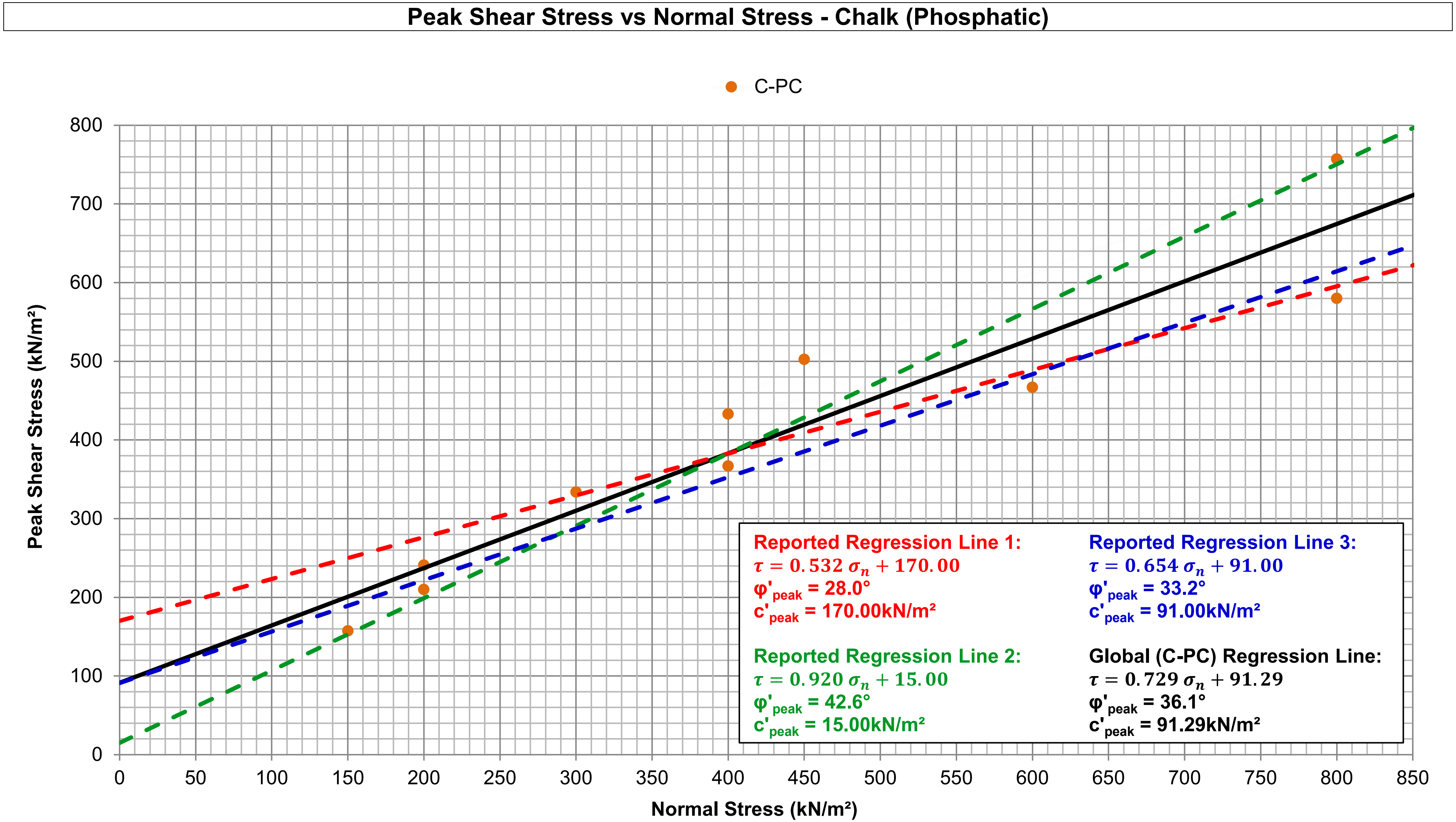
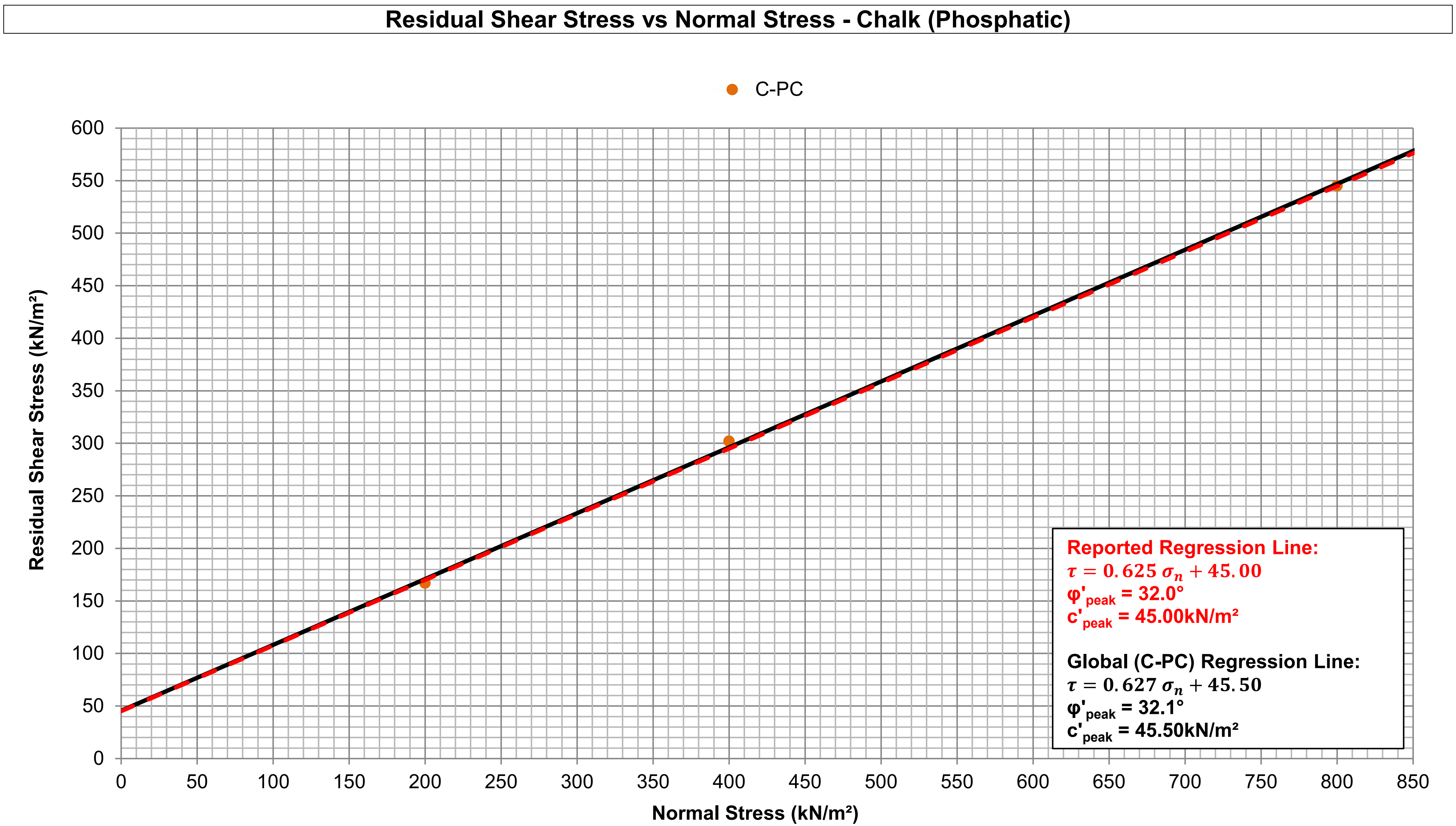

Peak Shear Stress vs Normal Stress - Chalk (Phosphatic)
C-PC
Peak Shear Stress (kN/m²)
Normal Stress (kN/m²)
0
100
200
300
400
500
600
700
800
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
Reported Regression Line 1:
$\tau = 0.532\ \sigma_n + 170.00$
φ'peak = 28.0°
c'peak = 170.00kN/m²
Reported Regression Line 2:
$\tau = 0.920\ \sigma_n + 15.00$
φ'peak = 42.6°
c'peak = 15.00kN/m²
Reported Regression Line 3:
$\tau = 0.654\ \sigma_n + 91.00$
φ'peak = 33.2°
c'peak = 91.00kN/m²
Global (C-PC) Regression Line:
$\tau = 0.729\ \sigma_n + 91.29$
φ'peak = 36.1°
c'peak = 91.29kN/m²

Figure 6-64



Residual Shear Stress vs Normal Stress - Chalk (Phosphatic)
C-PC
Residual Shear Stress (kN/m²)
Normal Stress (kN/m²)
0
50
100
150
200
250
300
350
400
450
500
550
600
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
Reported Regression Line:
$\tau = 0.625\ \sigma_n + 45.00$
φ'_{peak} = 32.0°
c'_{peak} = 45.00kN/m²
Global (C-PC) Regression Line:
$\tau = 0.627\ \sigma_n + 45.50$
φ'_{peak} = 32.1°
c'_{peak} = 45.50kN/m²

Figure 6-65

Diametrical vs Axial Point Load Index $I_{s(50)}$

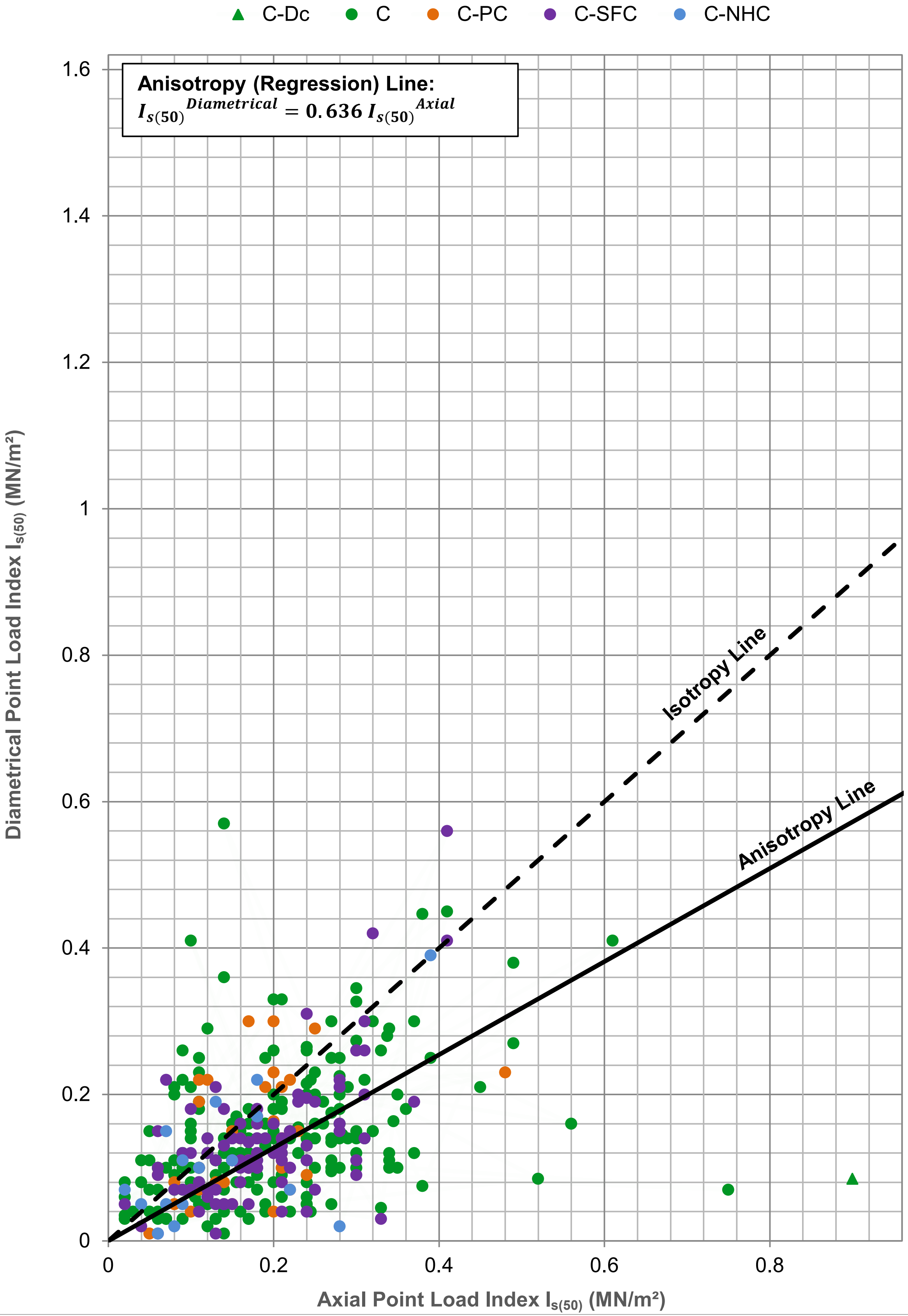


Figure 6-66

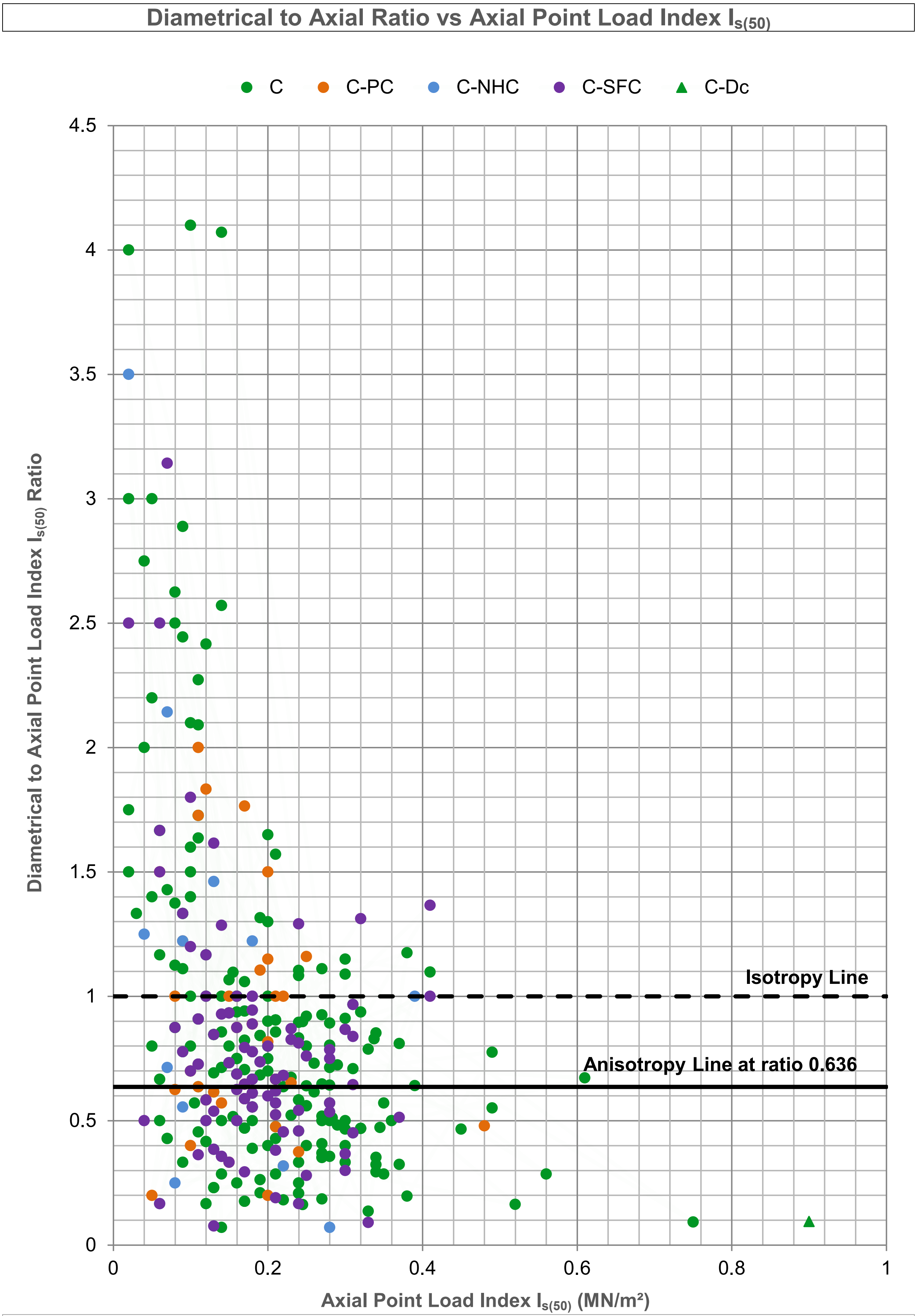

Diametrical to Axial Ratio vs Axial Point Load Index Is(50)
C
C-PC
C-NHC
C-SFC
C-Dc
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.2
0.4
0.6
0.8
1
Diametrical to Axial Point Load Index Is(50) Ratio
Axial Point Load Index Is(50) (MN/m²)
Isotropy Line
Anisotropy Line at ratio 0.636

Figure 6-67

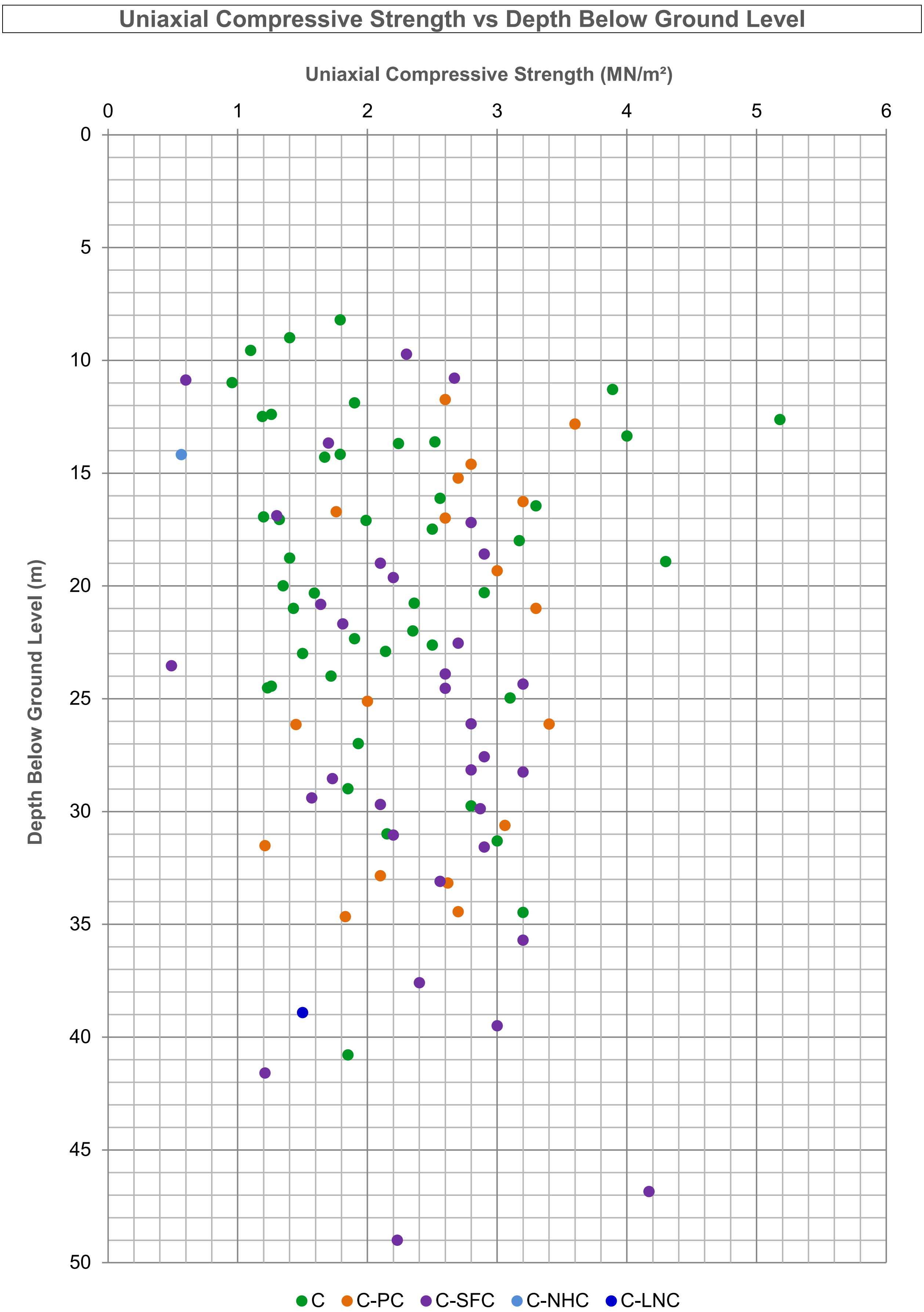

Uniaxial Compressive Strength vs Depth Below Ground Level
Uniaxial Compressive Strength (MN/m²)
0
1
2
3
4
5
6
Depth Below Ground Level (m)
0
5
10
15
20
25
30
35
40
45
50
C
C-PC
C-SFC
C-NHC
C-LNC

Figure 6-68

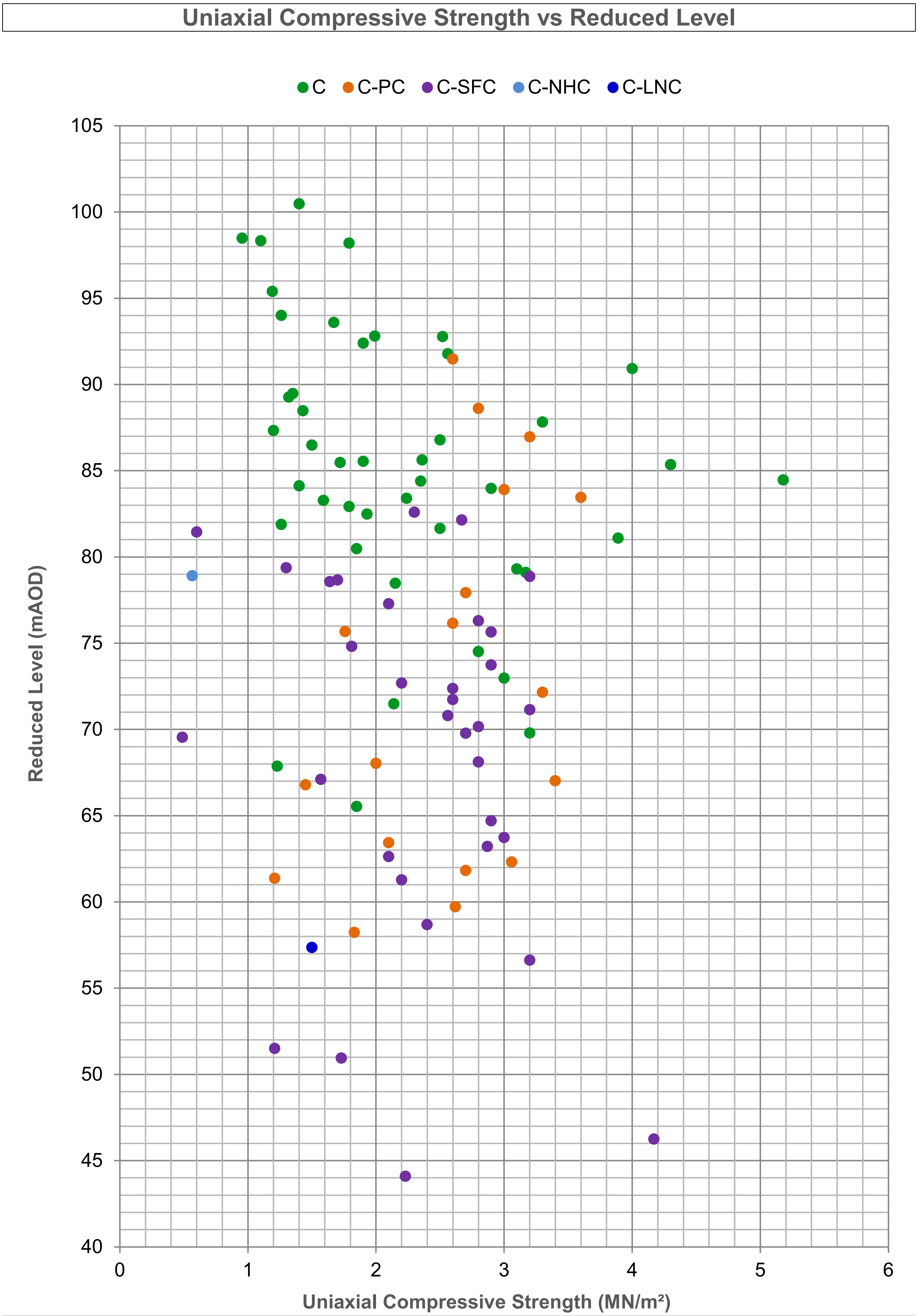

Uniaxial Compressive Strength vs Reduced Level
C
C-PC
C-SFC
C-NHC
C-LNC
105
100
95
90
85
80
75
70
65
60
55
50
45
40
Reduced Level (mAOD)
0
1
2
3
4
5
6
Uniaxial Compressive Strength (MN/m²)

Figure 6-69

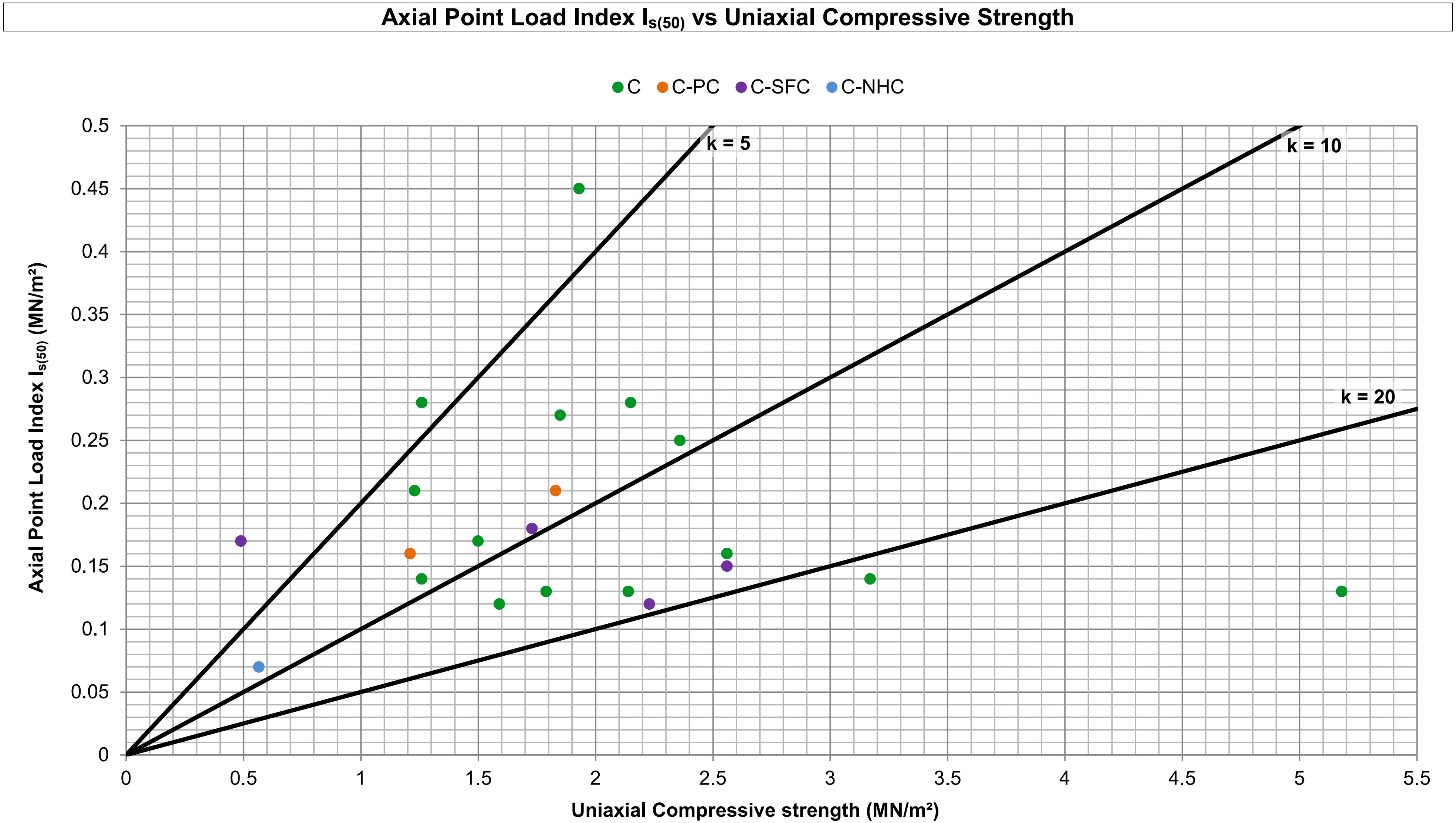
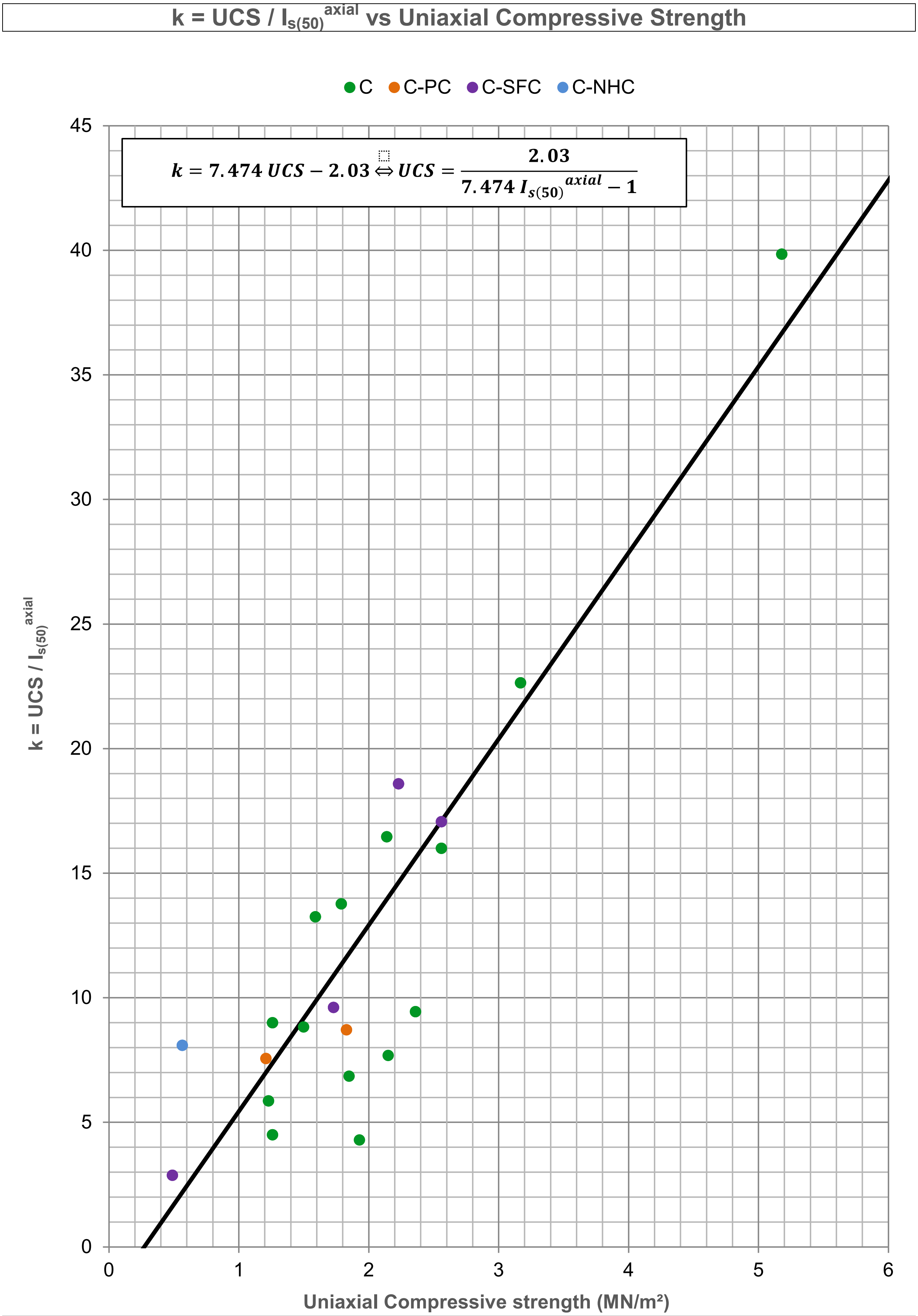

Axial Point Load Index $I_{s(50)}$ vs Uniaxial Compressive Strength
C
C-PC
C-SFC
C-NHC
k = 5
k = 10
k = 20
Axial Point Load Index $I_{s(50)}$ (MN/m²)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
Uniaxial Compressive strength (MN/m²)

Figure 6-70



k = UCS / $I_{s(50)}^{axial}$ vs Uniaxial Compressive Strength
C
C-PC
C-SFC
C-NHC
$k = 7.474\,UCS - 2.03 \Leftrightarrow UCS = \frac{2.03}{7.474\,I_{s(50)}^{axial} - 1}$
45
40
35
30
25
20
15
10
5
0
0
1
2
3
4
5
6
k = UCS / $I_{s(50)}^{axial}$
Uniaxial Compressive strength (MN/m²)

Figure 6-71

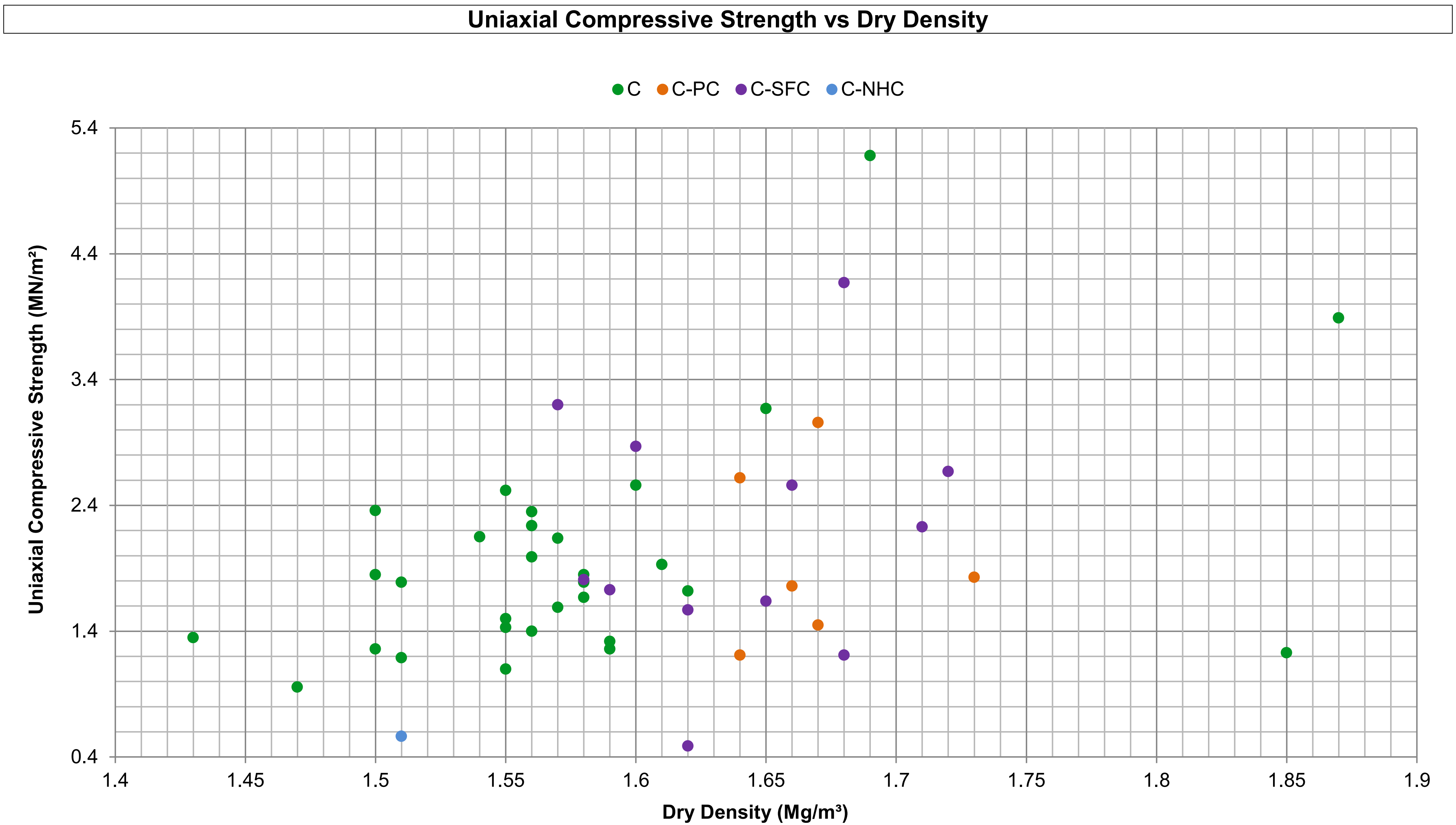

Uniaxial Compressive Strength vs Dry Density
C
C-PC
C-SFC
C-NHC
Uniaxial Compressive Strength (MN/m²)
5.4
4.4
3.4
2.4
1.4
0.4
1.4
1.45
1.5
1.55
1.6
1.65
1.7
1.75
1.8
1.85
1.9
Dry Density (Mg/m³)

Figure 6-72

Chalk Crushing Value vs Saturated Moisture Content

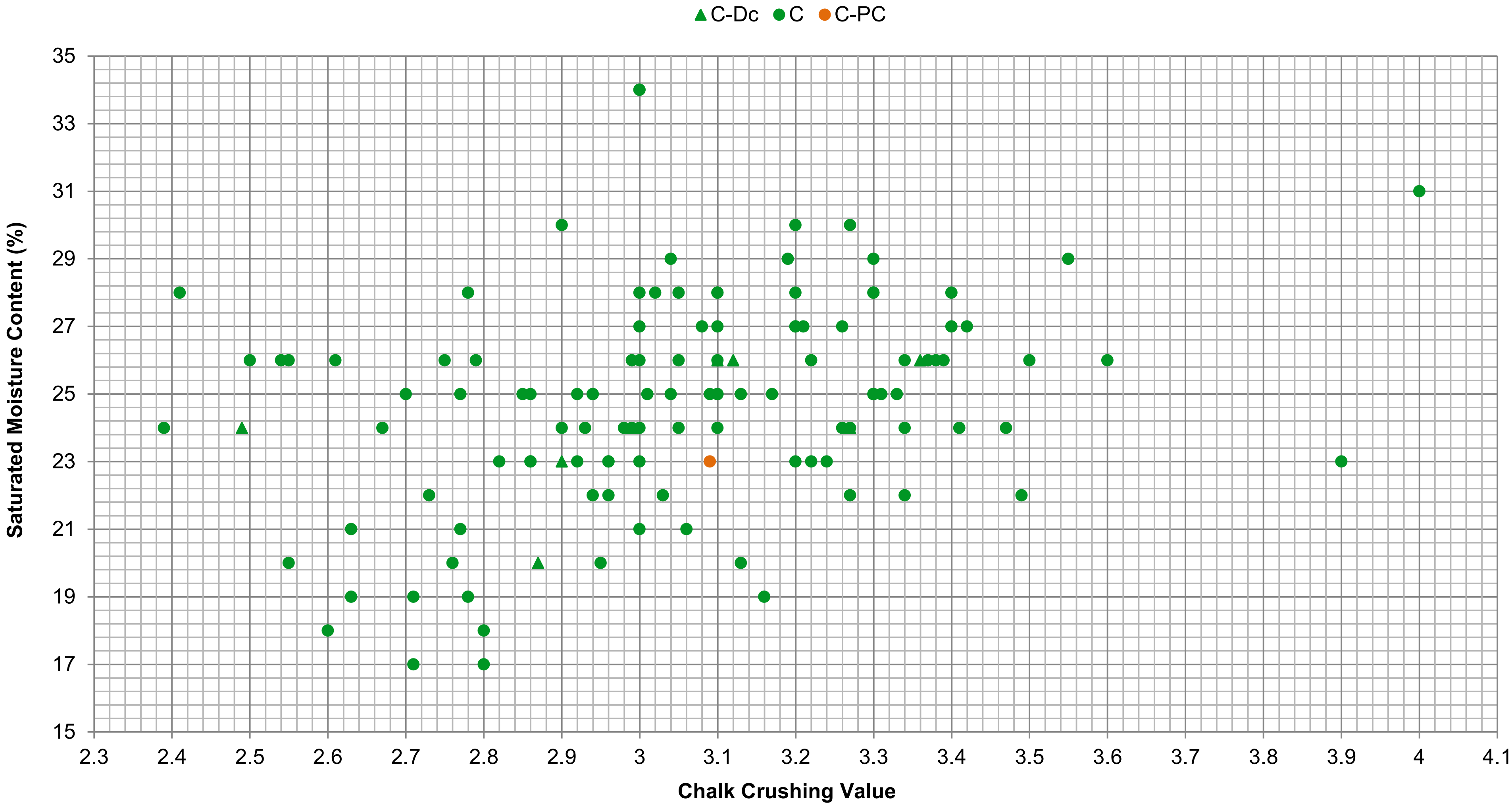


Figure 6-73

Volume Compressibility Coefficient vs Stress Increment - Alluvium (Cohesive)

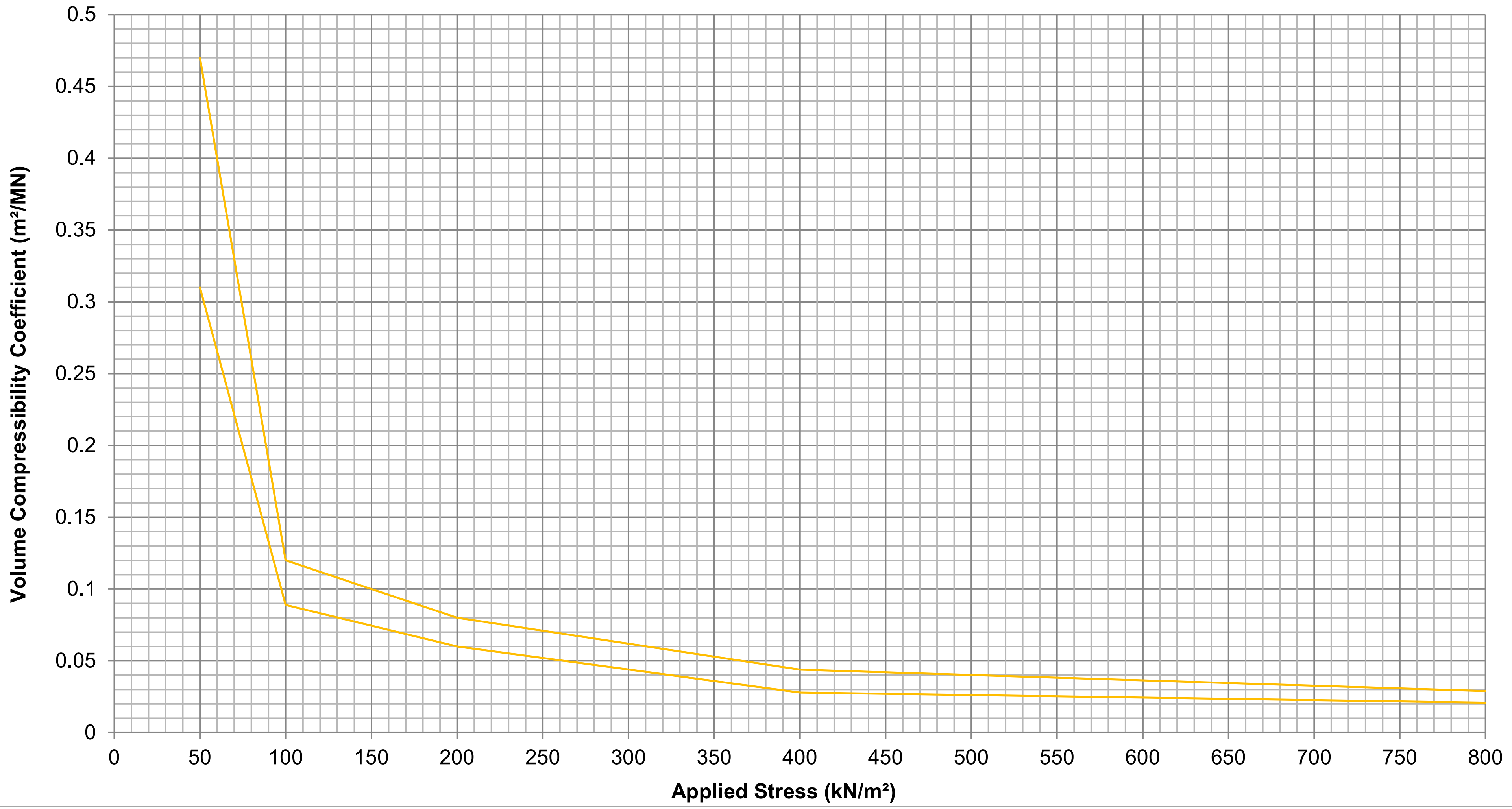


Figure 6-74

Coefficient of Consolidation vs Stress Increment - Alluvium (Cohesive)

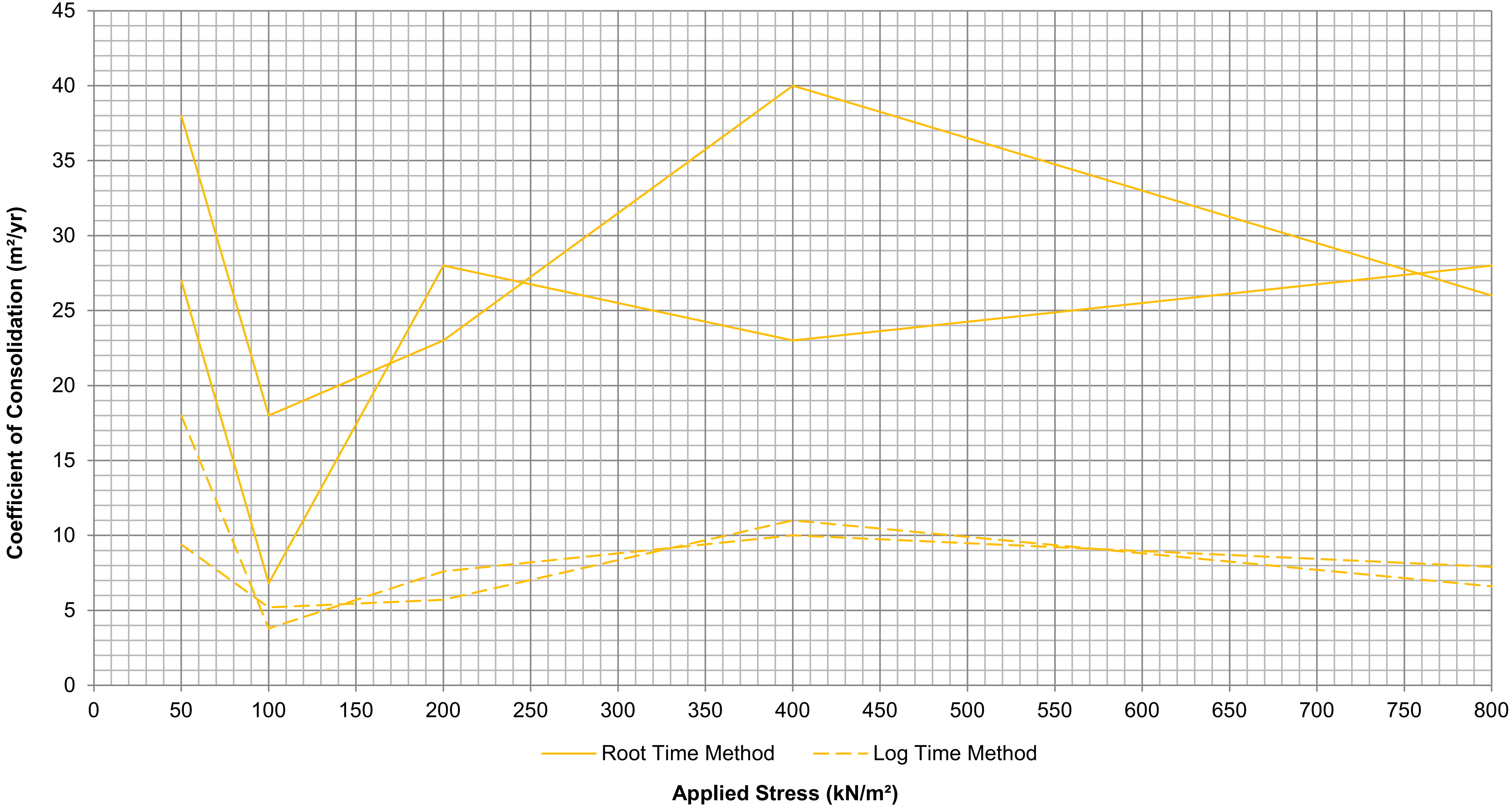


Figure 6-75

Poisson's Ratio from Uniaxial Compression vs Depth Below Ground Level

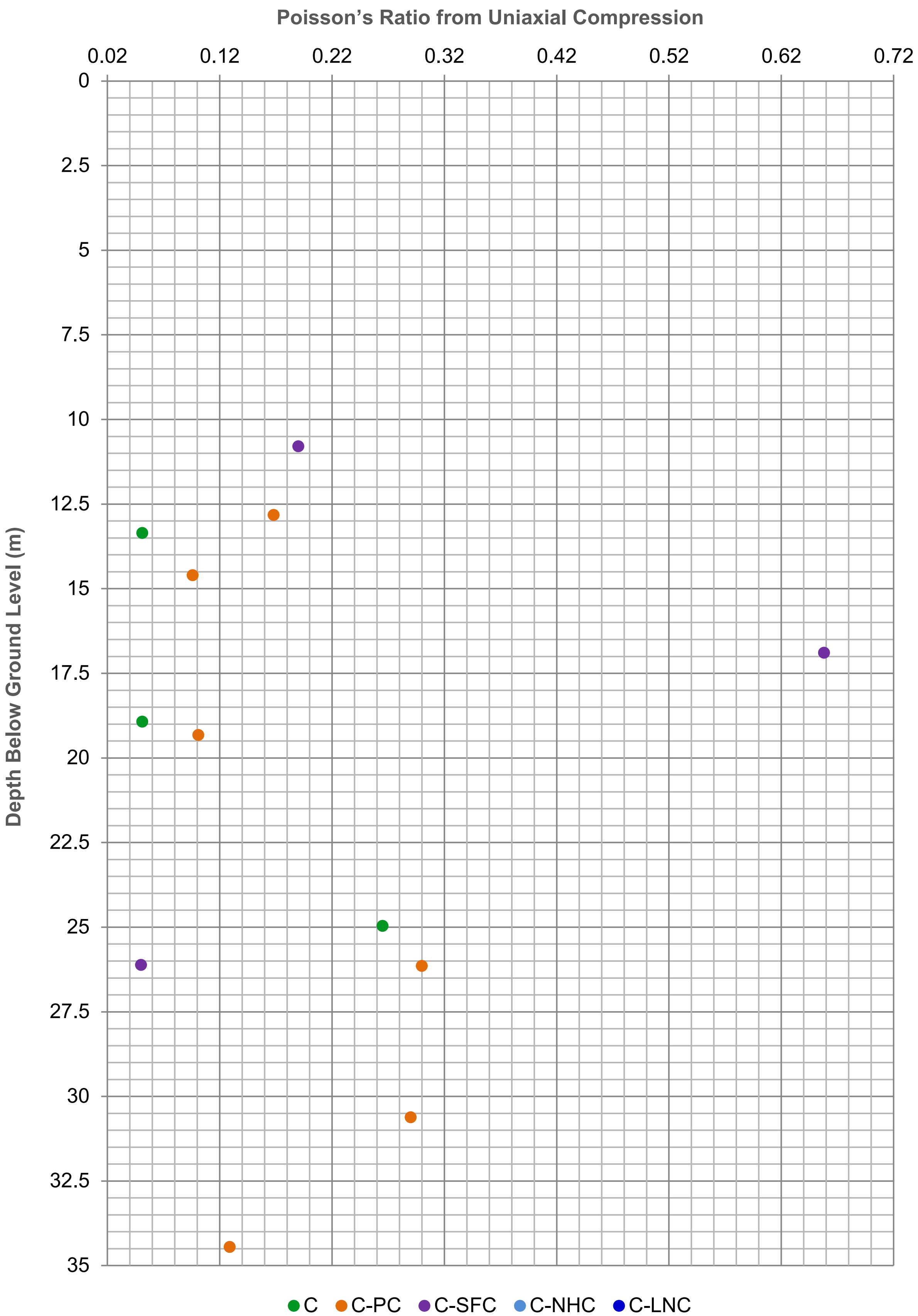


Figure 6-76

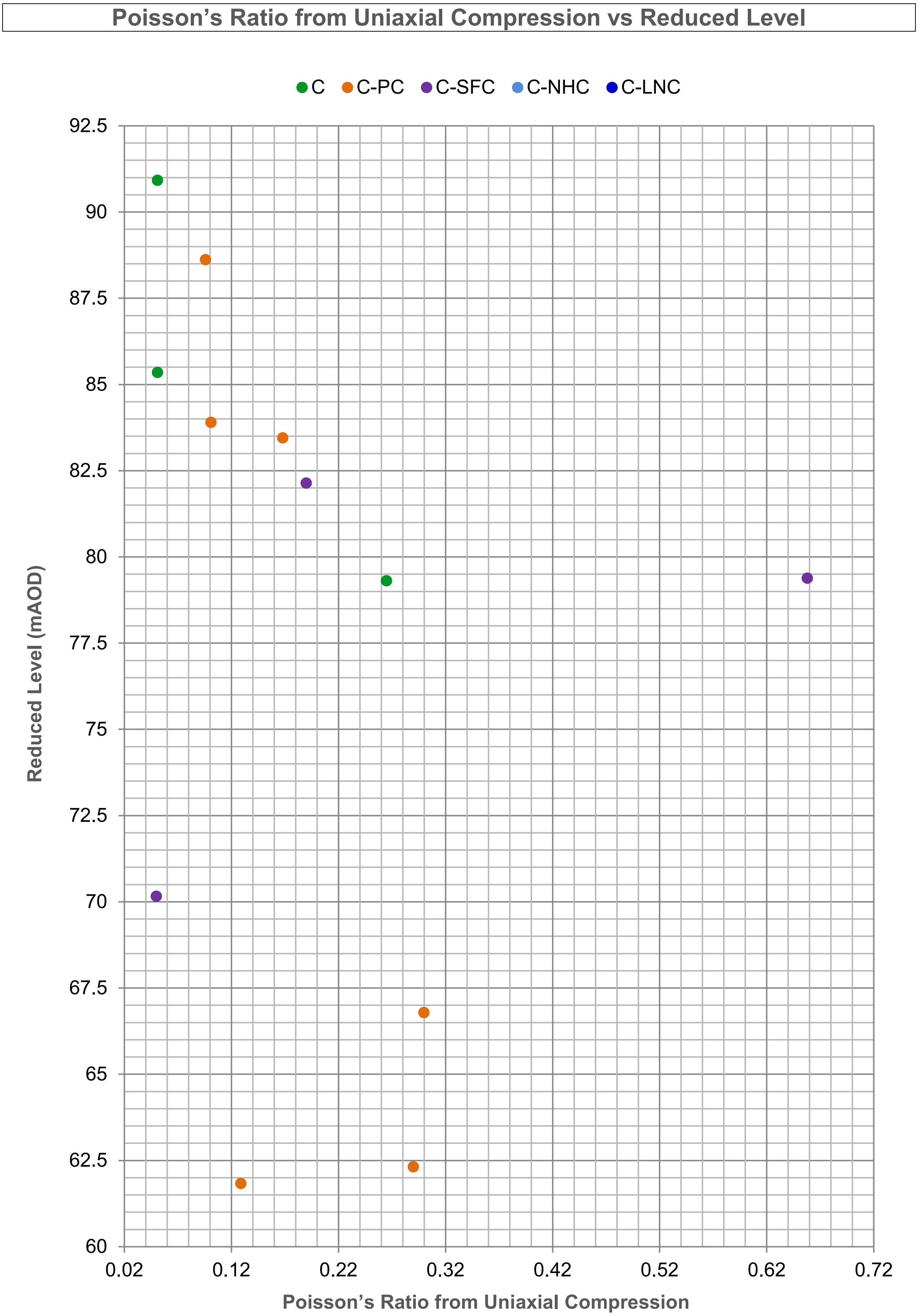

Poisson's Ratio from Uniaxial Compression vs Reduced Level
C
C-PC
C-SFC
C-NHC
C-LNC
Reduced Level (mAOD)
92.5
90
87.5
85
82.5
80
77.5
75
72.5
70
67.5
65
62.5
60
0.02
0.12
0.22
0.32
0.42
0.52
0.62
0.72
Poisson's Ratio from Uniaxial Compression

Figure 6-77

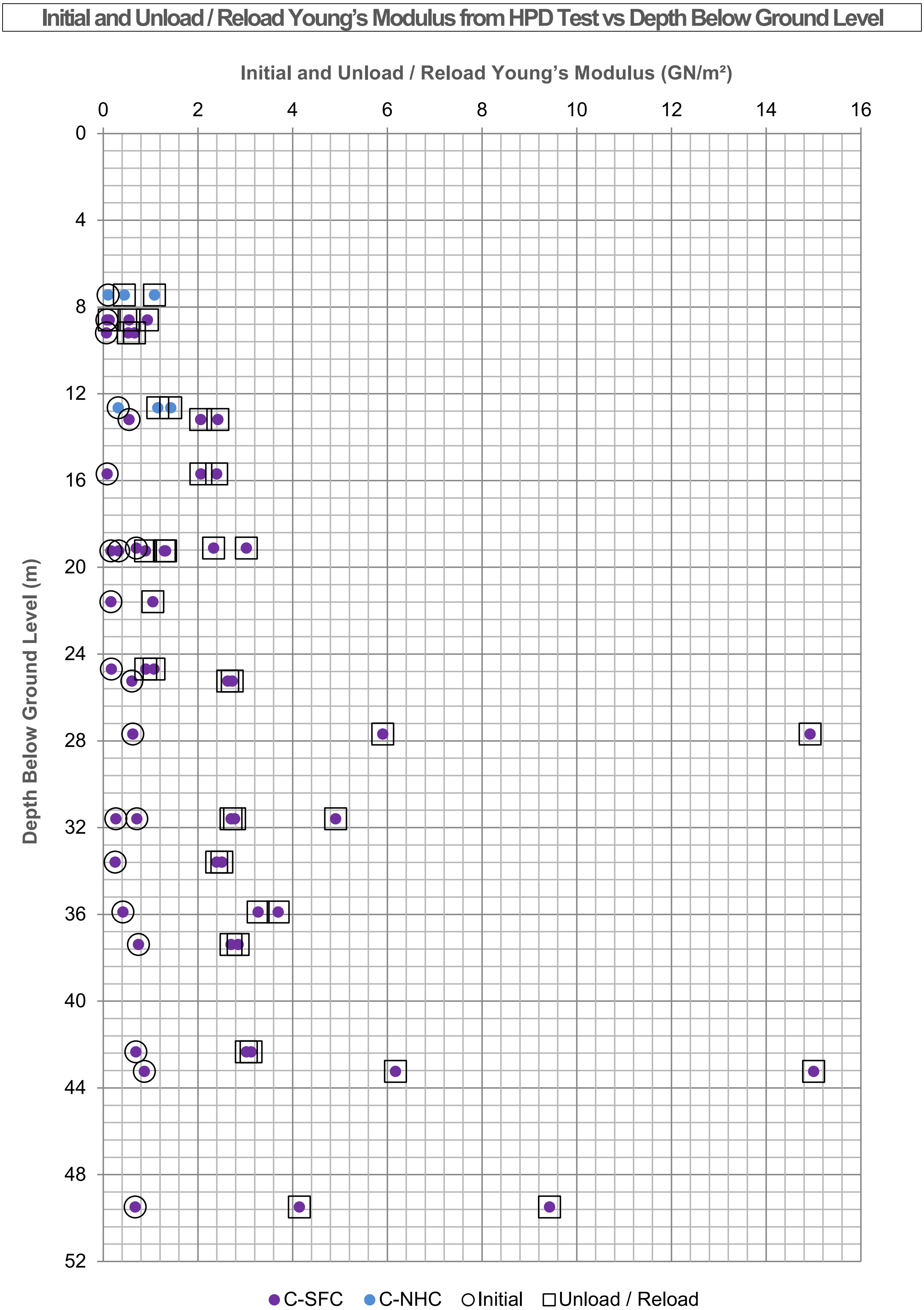

Initial and Unload / Reload Young's Modulus from HPD Test vs Depth Below Ground Level
Initial and Unload / Reload Young's Modulus (GN/m²)
0
2
4
6
8
10
12
14
16
Depth Below Ground Level (m)
0
4
8
12
16
20
24
28
32
36
40
44
48
52
C-SFC
C-NHC
Initial
Unload / Reload

Figure 6-78

Initial and Unload / Reload Young's Modulus from HPD Test vs Reduced Level

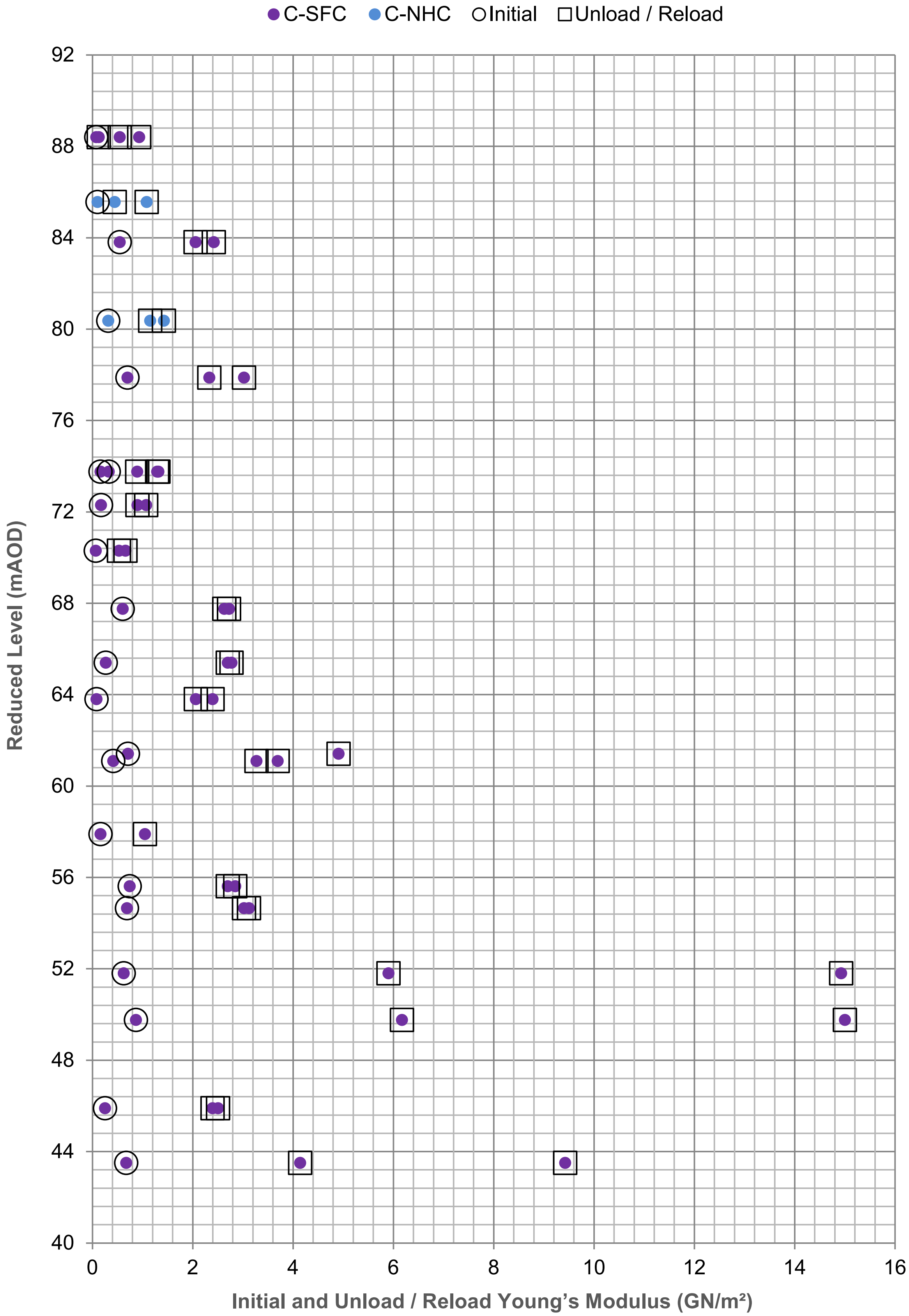


Figure 6-79

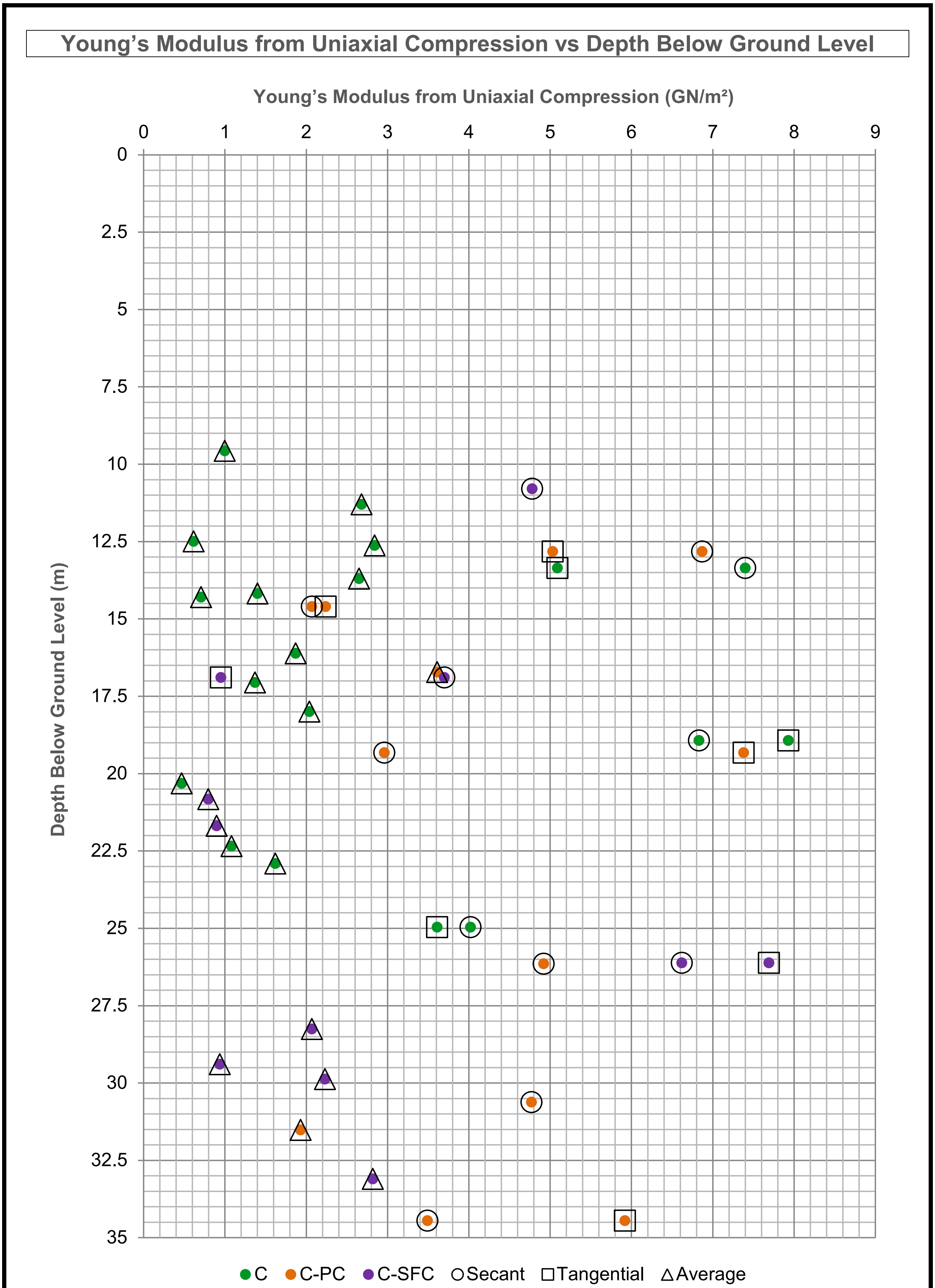

Young's Modulus from Uniaxial Compression vs Depth Below Ground Level
Young's Modulus from Uniaxial Compression (GN/m²)
0
1
2
3
4
5
6
7
8
9
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
27.5
30
32.5
35
Depth Below Ground Level (m)
C
C-PC
C-SFC
Secant
Tangential
Average

Figure 6-80

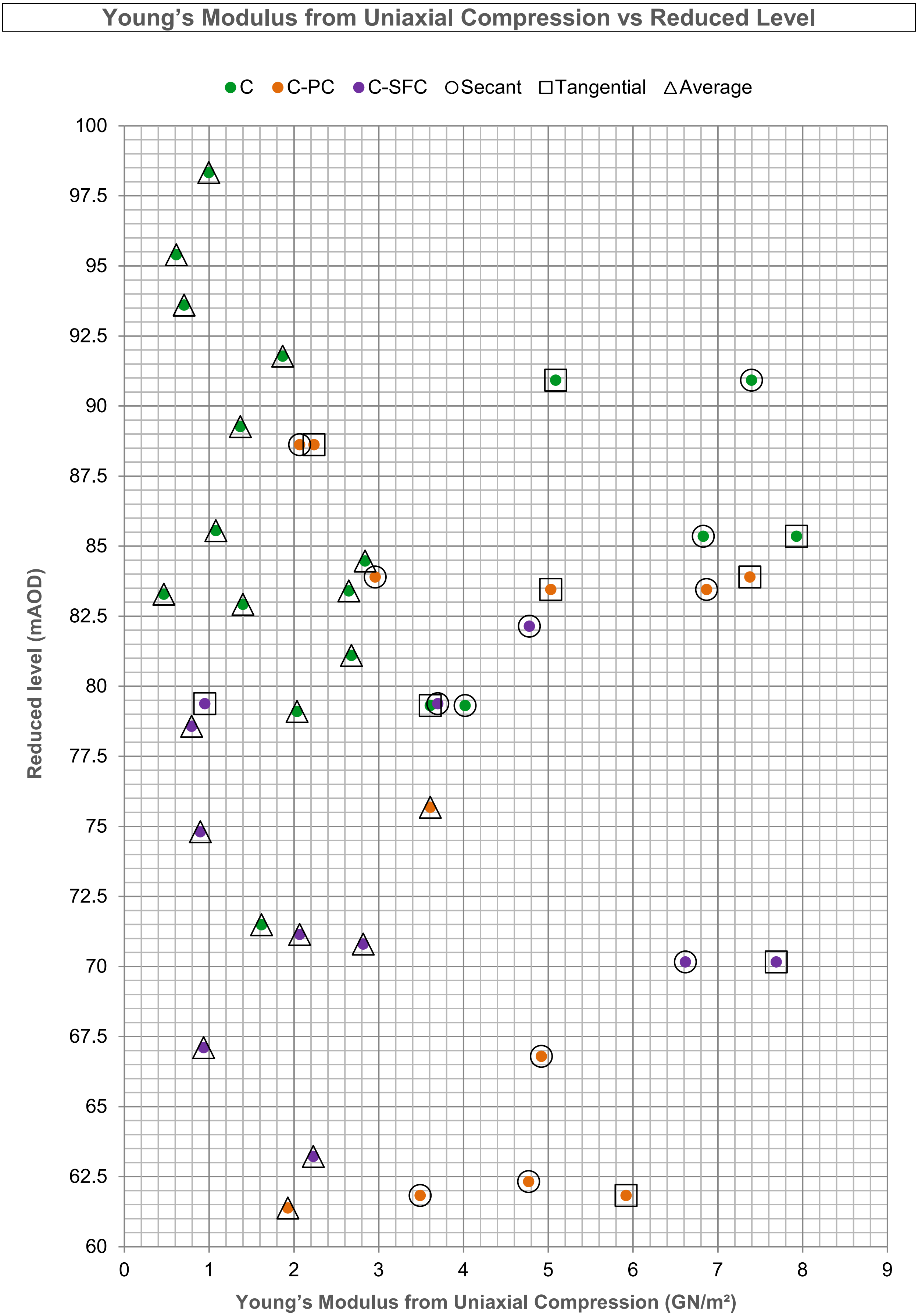

Young's Modulus from Uniaxial Compression vs Reduced Level
C
C-PC
C-SFC
Secant
Tangential
Average
Reduced level (mAOD)
100
97.5
95
92.5
90
87.5
85
82.5
80
77.5
75
72.5
70
67.5
65
62.5
60
0
1
2
3
4
5
6
7
8
9
Young's Modulus from Uniaxial Compression (GN/m²)

Figure 6-81

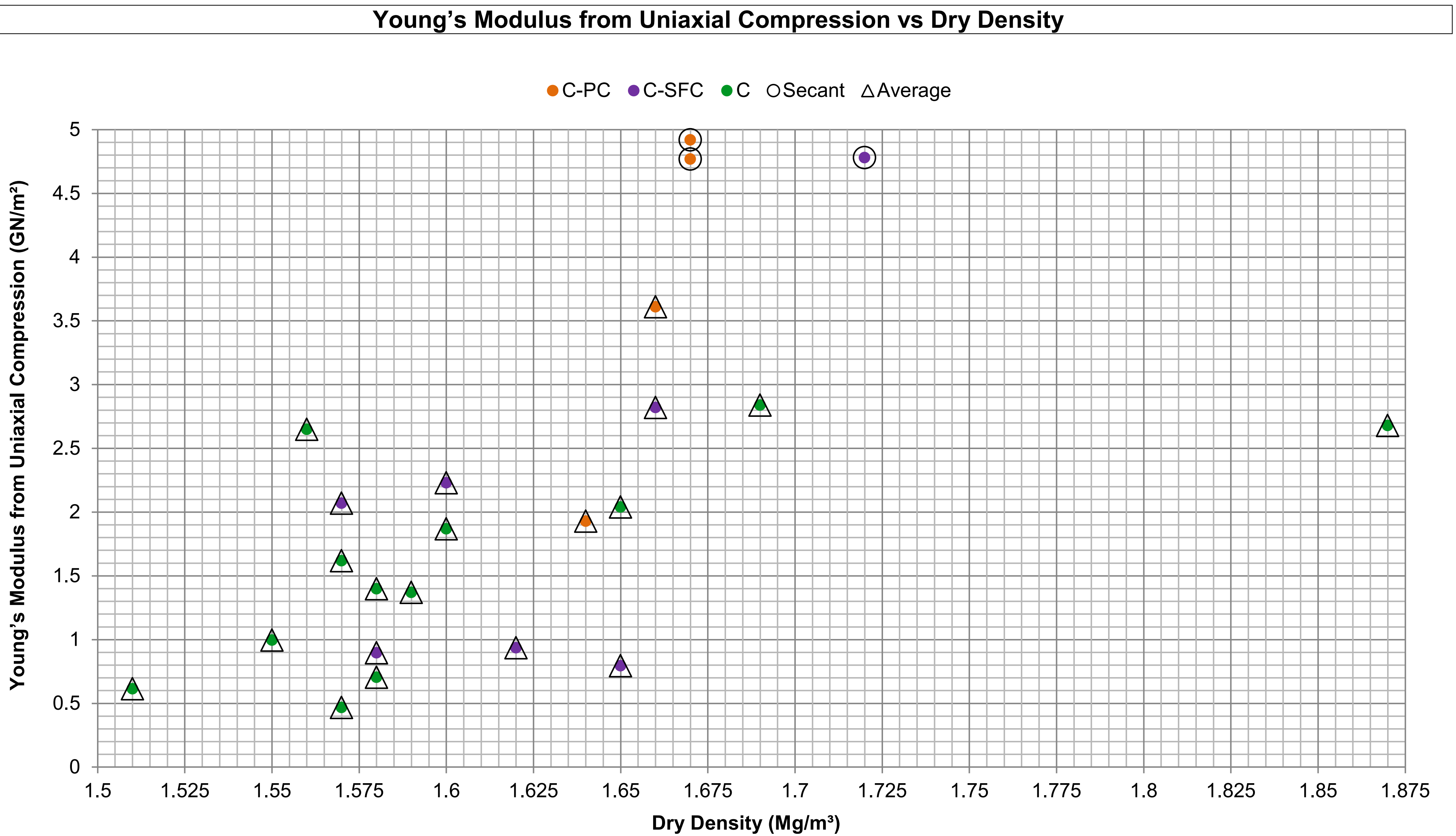

Young's Modulus from Uniaxial Compression vs Dry Density
C-PC
C-SFC
C
Secant
Average
Young's Modulus from Uniaxial Compression (GN/m²)
Dry Density (Mg/m³)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1.5
1.525
1.55
1.575
1.6
1.625
1.65
1.675
1.7
1.725
1.75
1.775
1.8
1.825
1.85
1.875

Figure 6-82


Settlement from Plate Load Test over Plate Diameter vs Applied Stress - Head Deposits (Granular)
HD-G
225
200
175
150
125
100
75
50
25
0
Applied Stress (kN/m²)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
Settlement over Plate Diameter (%)

Figure 6-83

Settlement from Plate Load Test over Plate Diameter vs Applied Stress - Alluvium (Granular)

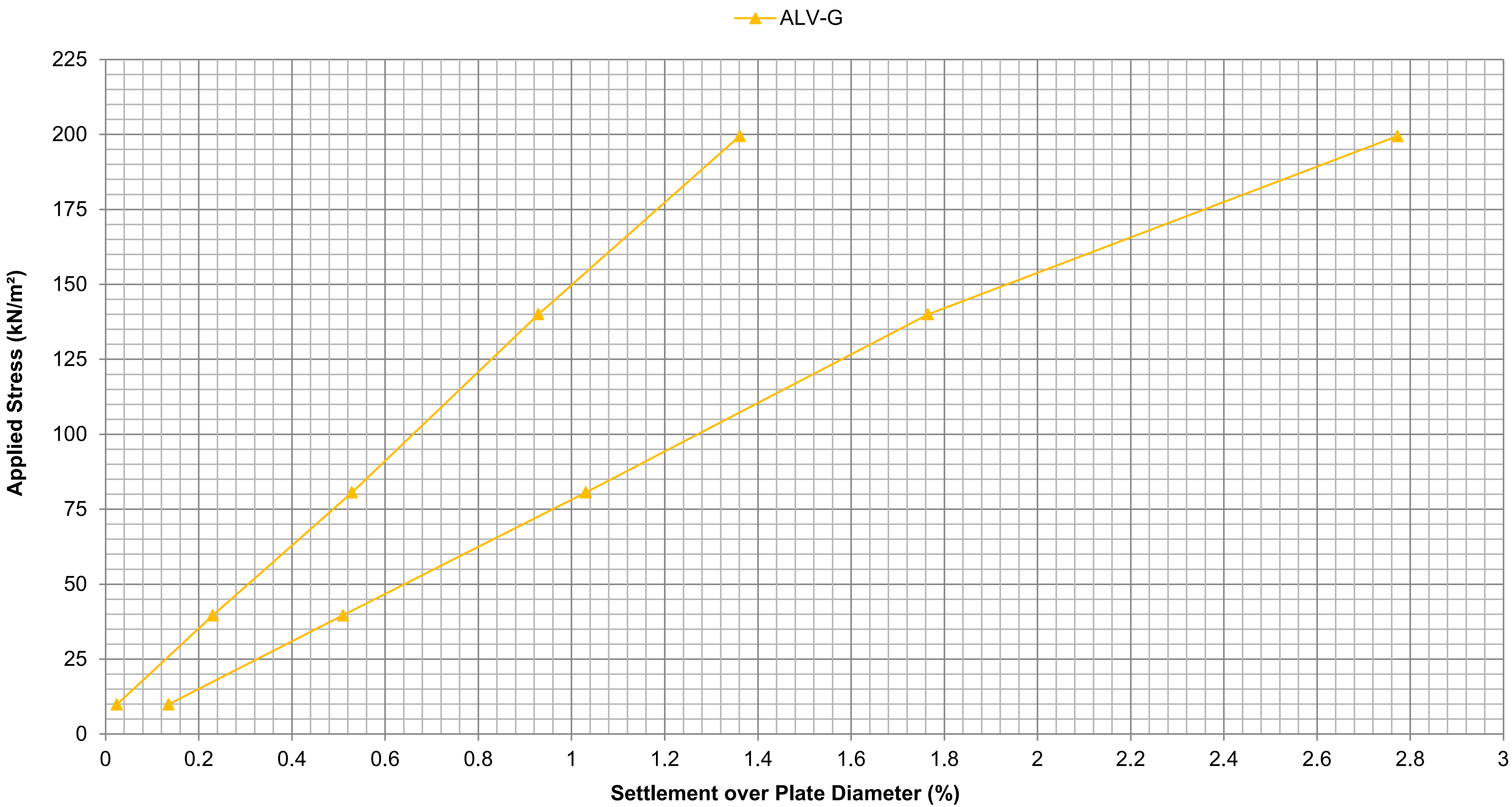


Figure 6-84

Settlement from Plate Load Test over Plate Diameter vs Applied Stress - Chalk (Structureless weathered Grade Dc or Dm)

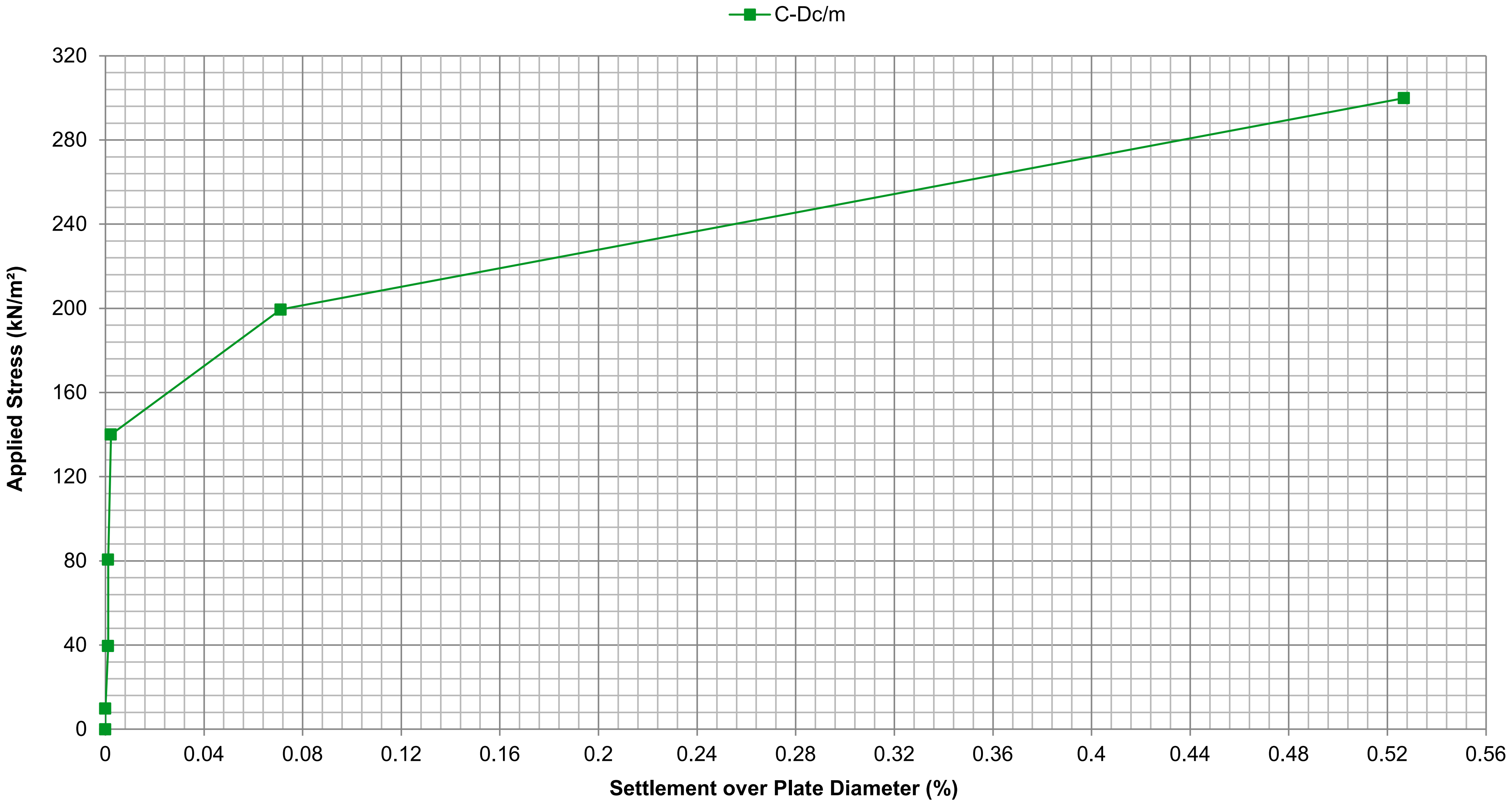


Figure 6-85

Settlement from Plate Load Test over Plate Diameter vs Applied Stress - Chalk and Chalk (Structureless weathered Grade Dc)

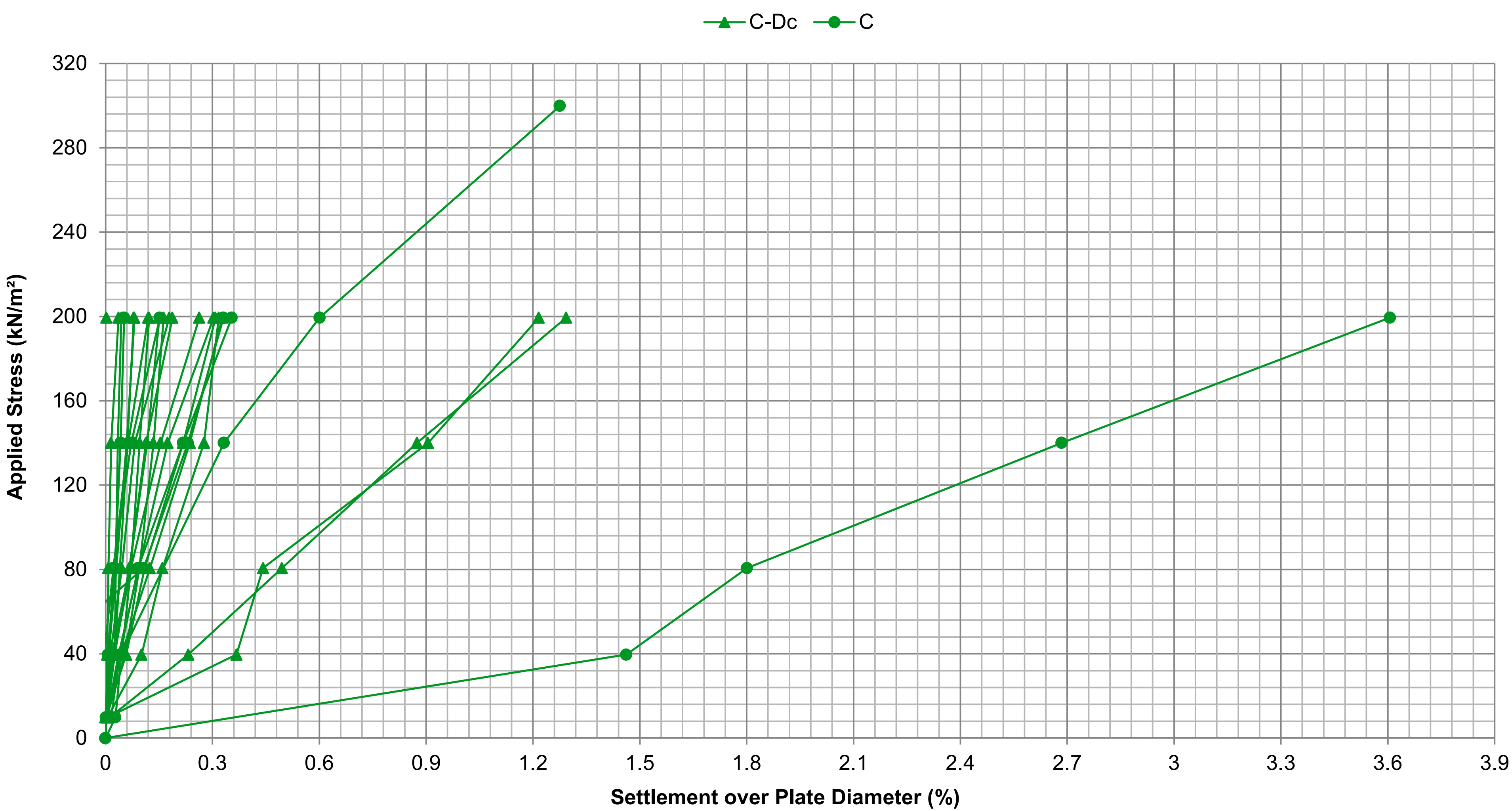
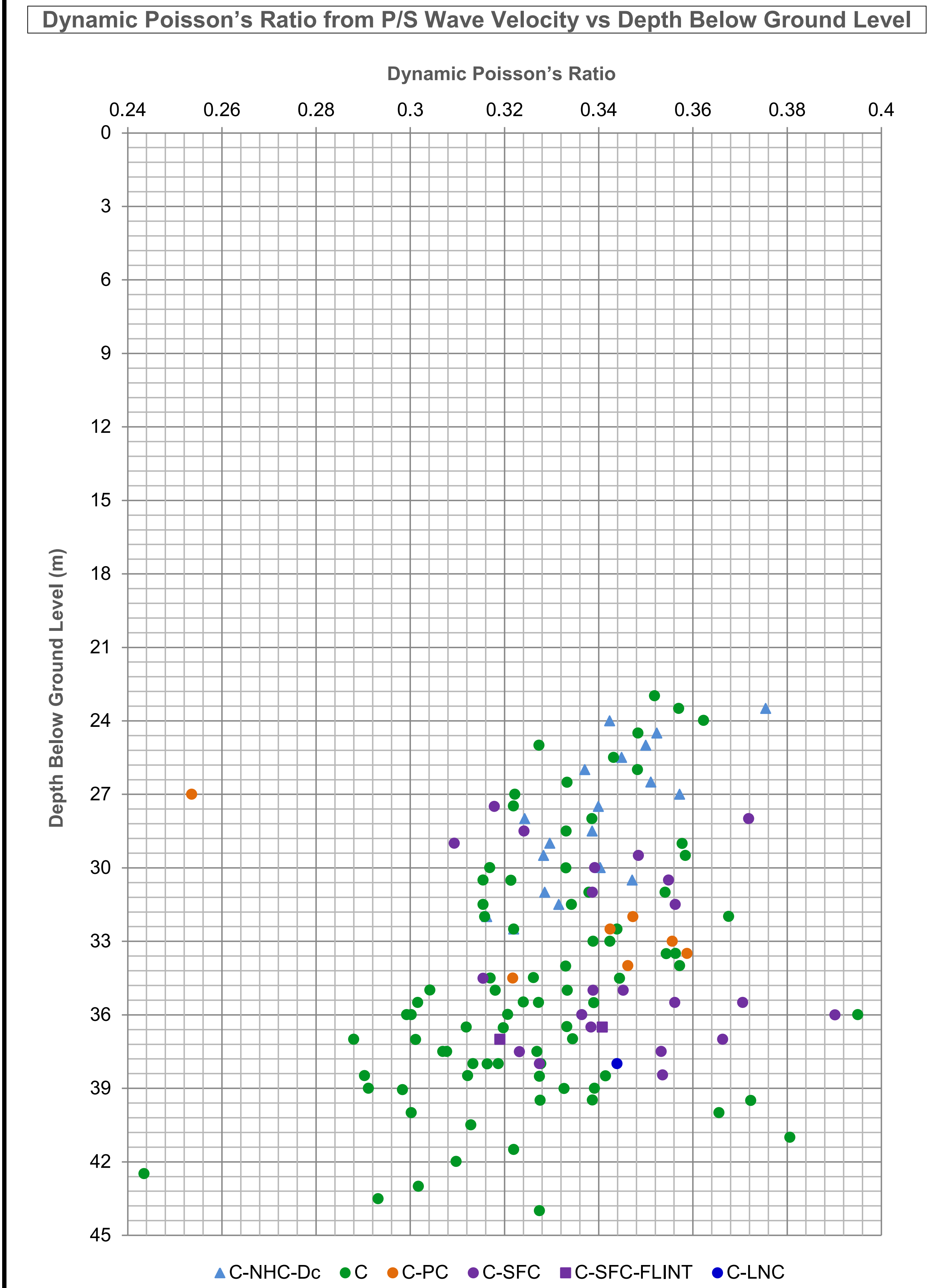


Figure 6-86



Dynamic Poisson's Ratio from P/S Wave Velocity vs Depth Below Ground Level
Dynamic Poisson's Ratio
0.24
0.26
0.28
0.3
0.32
0.34
0.36
0.38
0.4
Depth Below Ground Level (m)
0
3
6
9
12
15
18
21
24
27
30
33
36
39
42
45
C-NHC-Dc
C
C-PC
C-SFC
C-SFC-FLINT
C-LNC

Figure 6-87

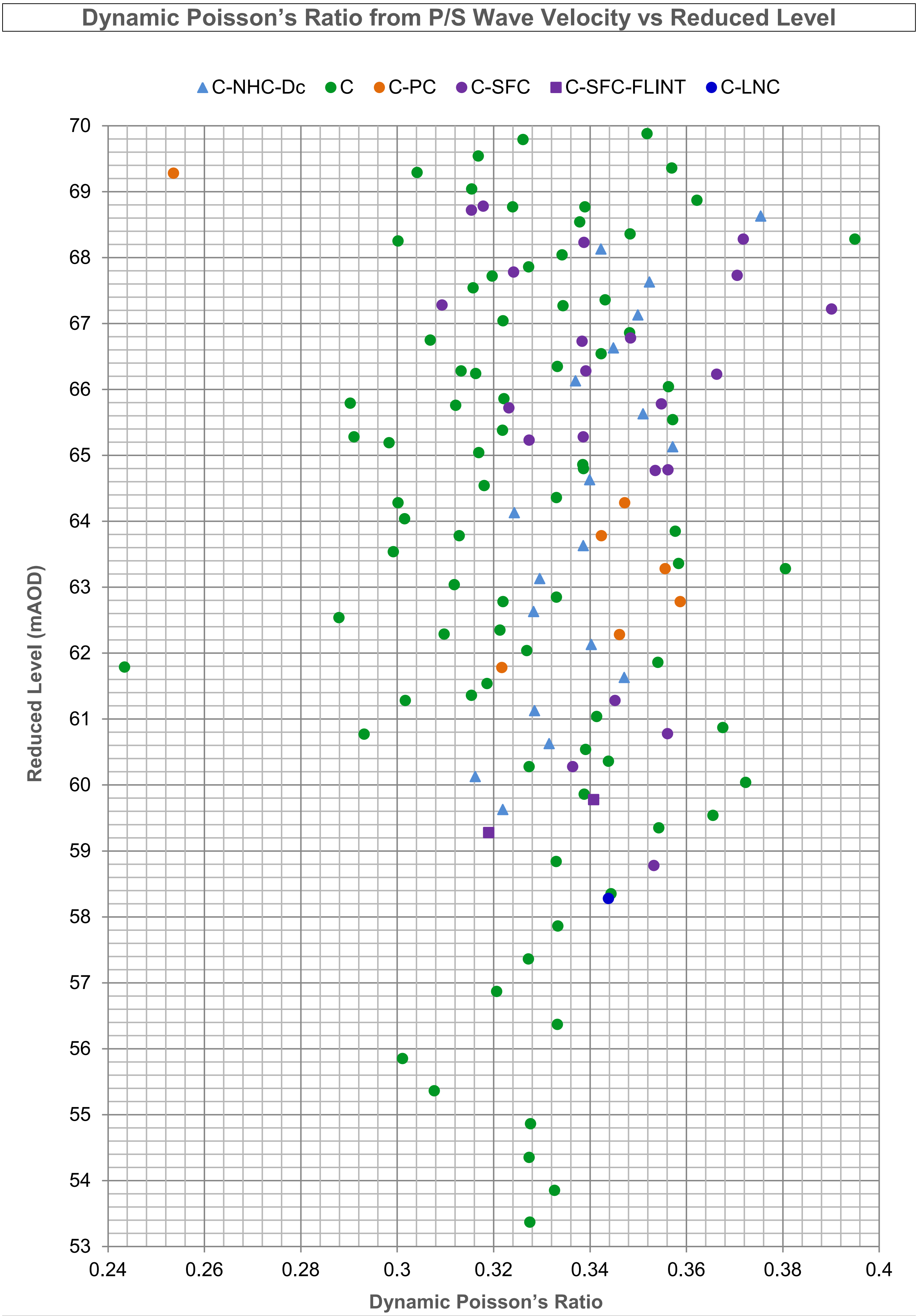
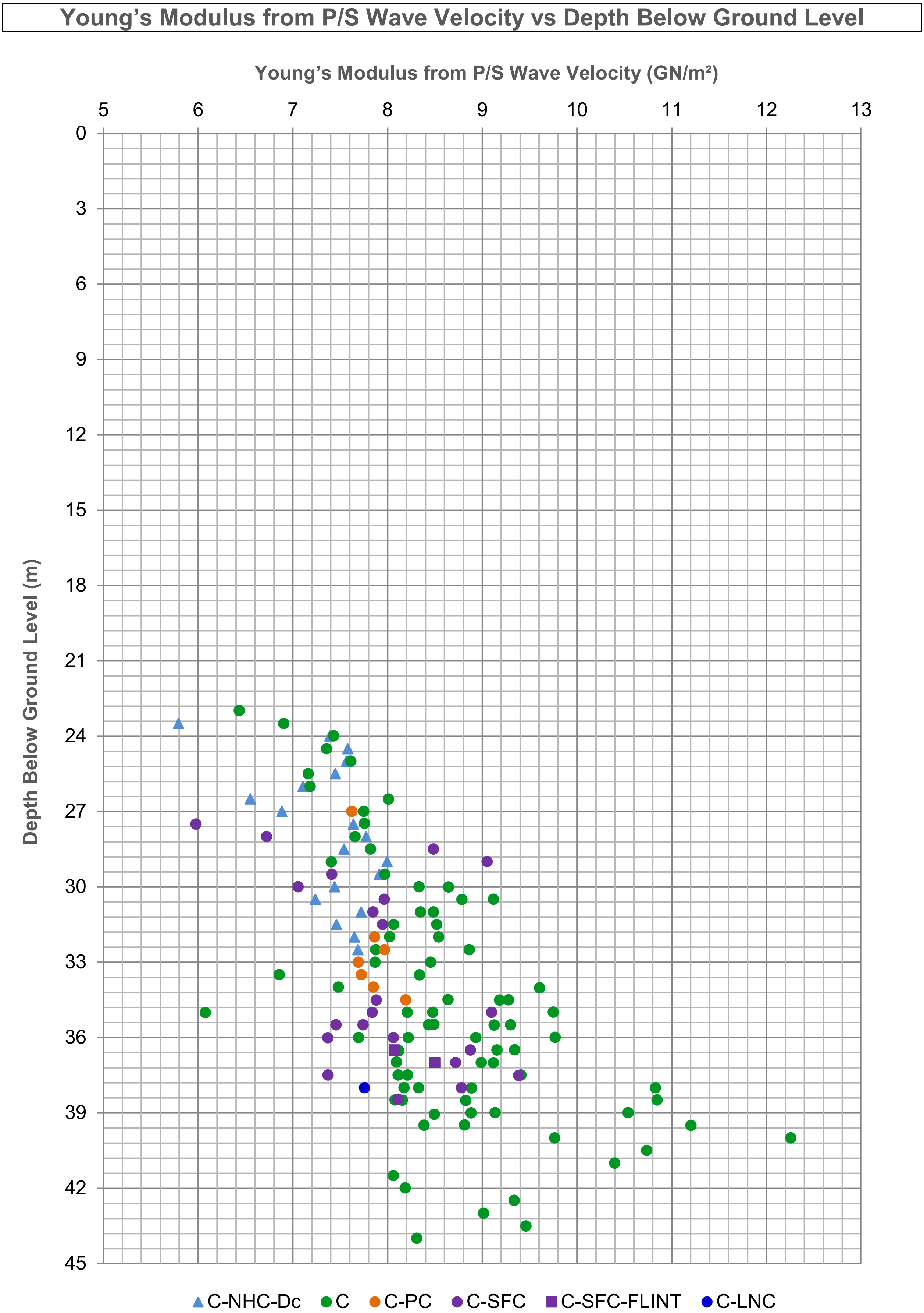
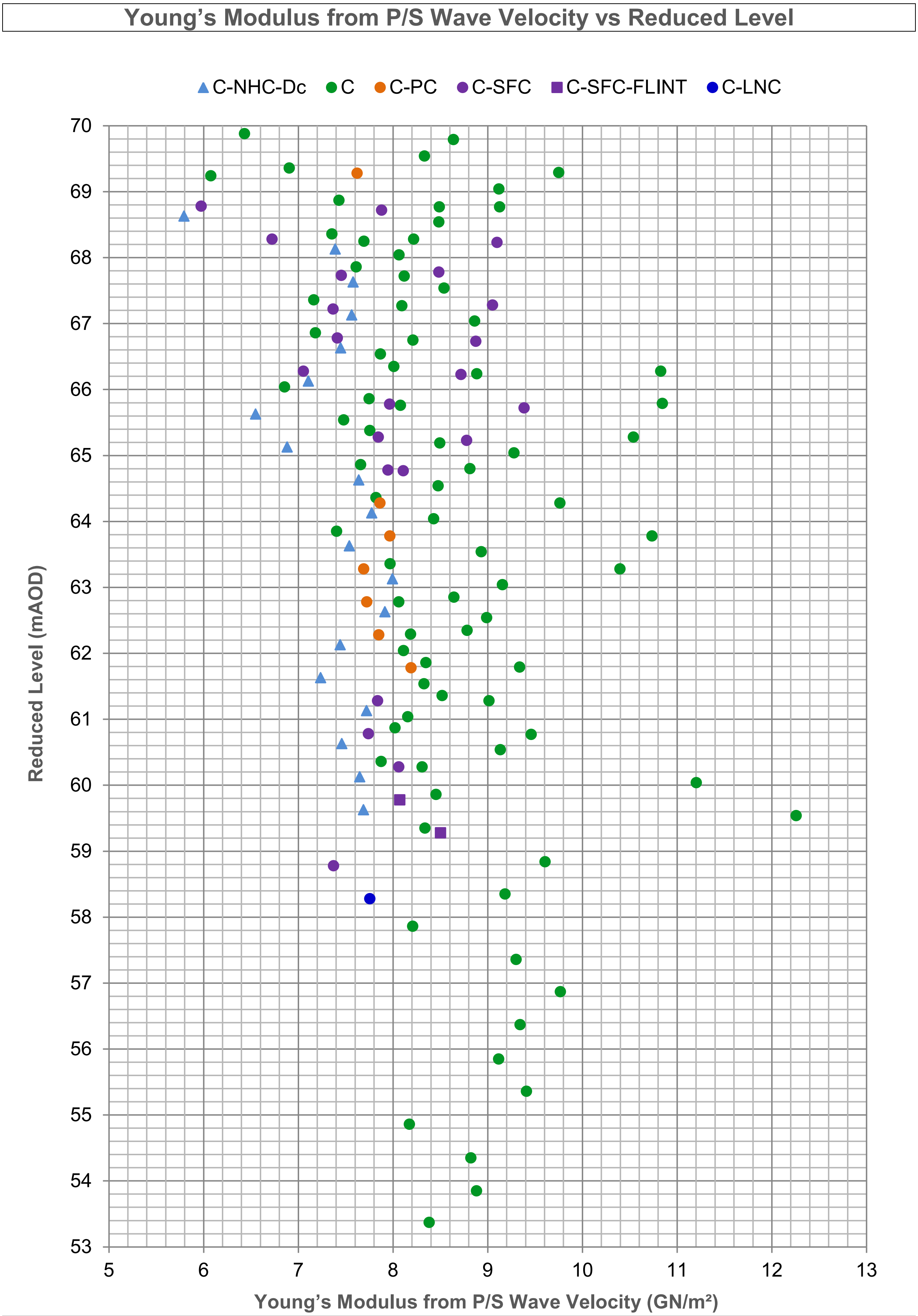

Dynamic Poisson's Ratio from P/S Wave Velocity vs Reduced Level
C-NHC-Dc
C
C-PC
C-SFC
C-SFC-FLINT
C-LNC
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
Reduced Level (mAOD)
0.24
0.26
0.28
0.3
0.32
0.34
0.36
0.38
0.4
Dynamic Poisson's Ratio

Figure 6-88



Young's Modulus from P/S Wave Velocity vs Depth Below Ground Level
Young's Modulus from P/S Wave Velocity (GN/m²)
5
6
7
8
9
10
11
12
13
0
3
6
9
12
15
18
21
24
27
30
33
36
39
42
45
Depth Below Ground Level (m)
C-NHC-Dc
C
C-PC
C-SFC
C-SFC-FLINT
C-LNC

Figure 6-89



Young's Modulus from P/S Wave Velocity vs Reduced Level
C-NHC-Dc
C
C-PC
C-SFC
C-SFC-FLINT
C-LNC
Reduced Level (mAOD)
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
5
6
7
8
9
10
11
12
13
Young's Modulus from P/S Wave Velocity (GN/m²)

Figure 6-90

Sample Height (H) to Diameter (D) Ration vs Uniaxial Compressive Strength

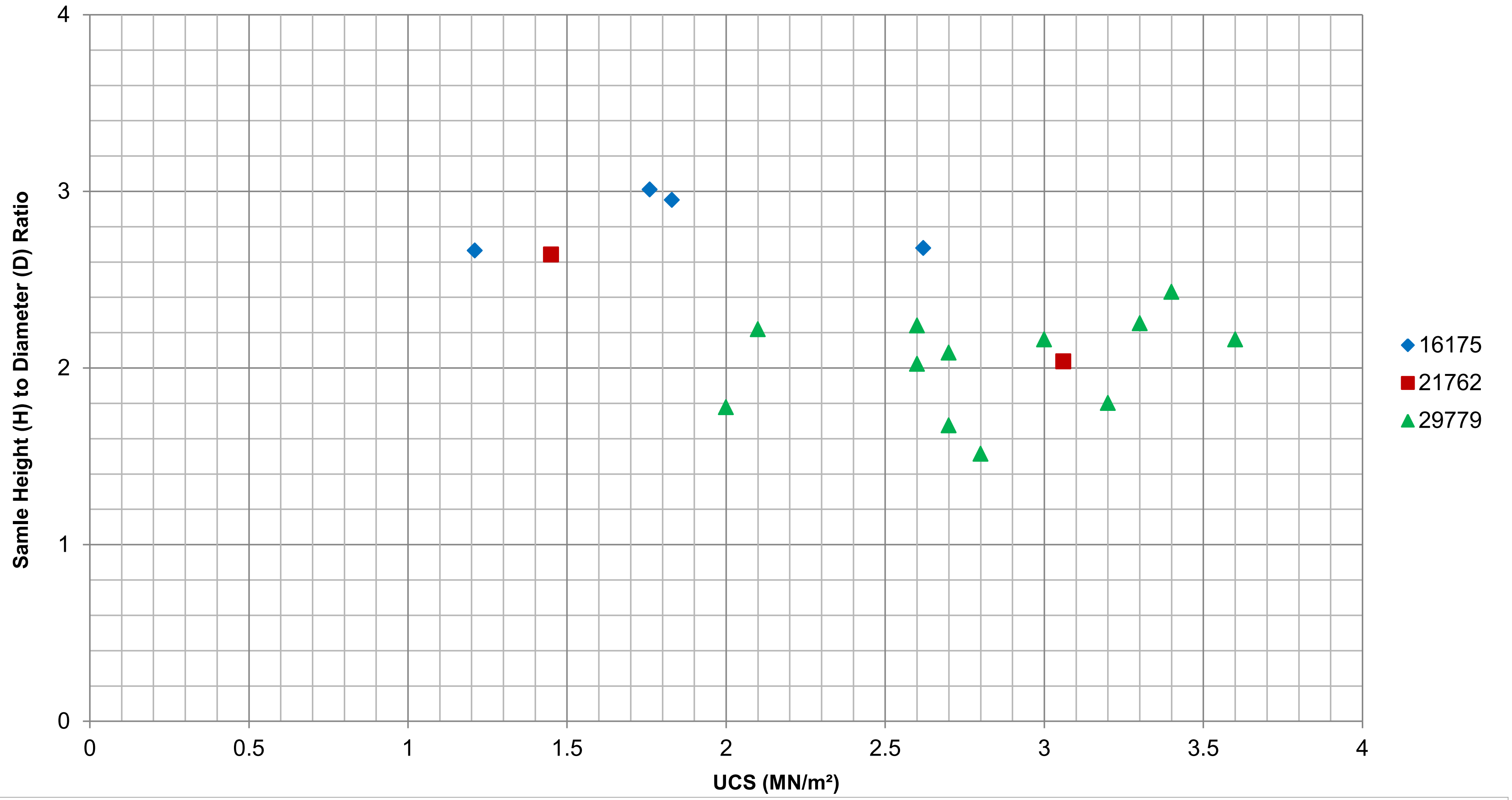


Figure 6-91

Appendices

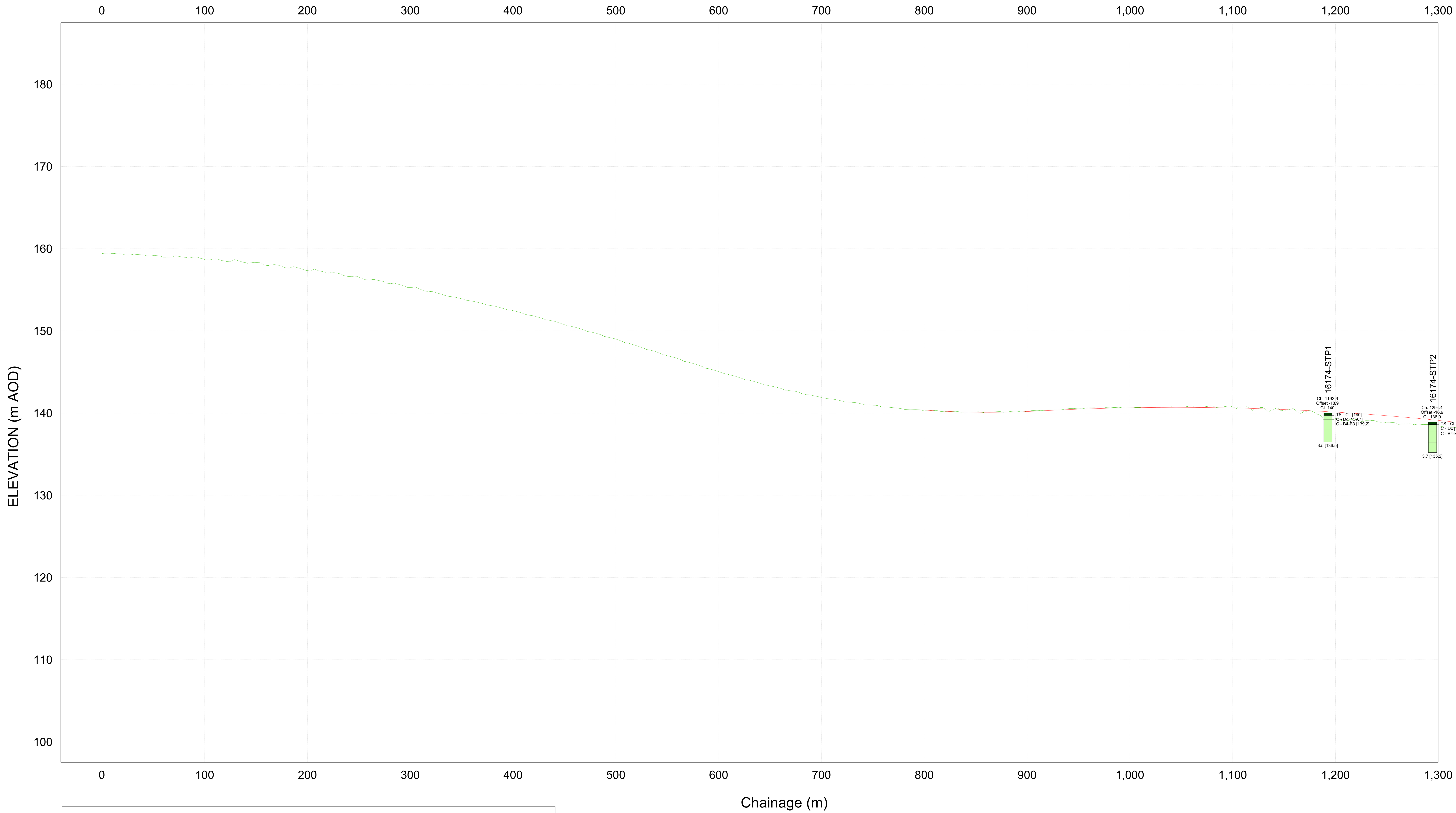
Appendix A Drawings

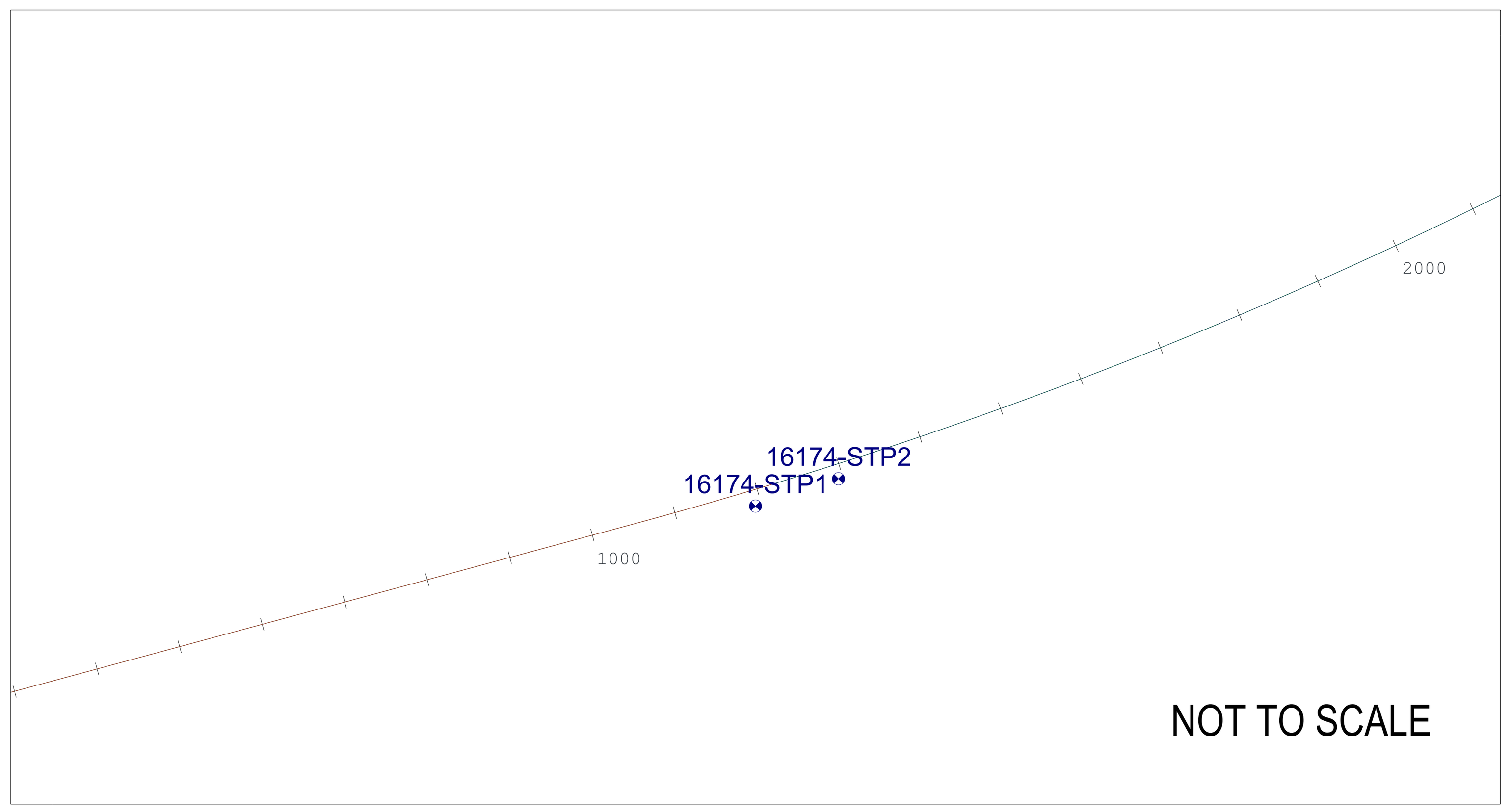
A.1 Drawing List

Drawing No.	Description
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0001	Geological Section 01_CH 0 to 1300
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0002	Geological Section 02_CH 1300 to 2400
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0003	Geological Section 03_CH 2400 to 3600
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0004	Geological Section 04_CH 3600 to 4800
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0005	Geological Section 05_CH 4800m to 6000m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0006	Geological Section 06_CH 6000m to 7200m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0007	Geological Section 07_CH 7200m to 8400m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0008	Geological Section 08_CH 8400m to 9700m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0009	Geological Section 09_CH 9700m to 10800m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0010	Geological Section 10_CH 10800m to 12000m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0011	Geological Section 11_CH 12000m to 12572m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0012	Exploratory Holes Location Plan - Sheet 1
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0013	Exploratory Holes Location Plan - Sheet 2
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0014	Exploratory Holes Location Plan - Sheet 3
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0015	Exploratory Holes Location Plan - Sheet 4
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0016	Exploratory Holes Location Plan - Sheet 5
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0017	Exploratory Holes Location Plan - Sheet 6
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0018	Exploratory Holes Location Plan - Sheet 7
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0019	Exploratory Holes Location Plan - Sheet 8
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0020	Exploratory Holes Location Plan - Sheet 9
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0021	Exploratory Holes Location Plan - Sheet 10
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0022	Ground Investigations - SPT Locations - Sheet 1
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0023	Ground Investigations - SPT Locations - Sheet 2
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0024	Ground Investigations - SPT Locations - Sheet 3
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0025	Ground Investigations - In-situ CBR Locations - Sheet 1
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0026	Ground Investigations - In-situ CBR Locations - Sheet 2

Drawing No.	Description
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0027	Ground Investigations - In-situ CBR Locations - Sheet 3
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0028	Ground Investigations - In-situ CBR Locations - Sheet 4
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0029	Ground Investigations - In-situ CBR Locations - Sheet 5
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0030	Ground Investigations - In-situ CBR Locations - Sheet 6
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0031	Ground Investigations - Plate Load Test Locations - Sheet 1
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0032	Ground Investigations - Plate Load Test Locations - Sheet 2
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0033	Ground Investigations - Plate Load Test Locations - Sheet 3
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0034	Ground Investigations - Plate Load Test Locations - Sheet 4
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0035	Ground Investigations - Plate Load Test Locations - Sheet 5
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0036	Ground Investigations - HPD Pressuremeter Test Locations
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0037	Ground Investigations - Standpipe Piezometers Locations - Sheet 1
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0038	Ground Investigations - Standpipe Piezometers Locations - Sheet 2
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0085	Ground Investigations - Standpipe Piezometers Locations - Sheet 3
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0039	Ground Investigations - Standpipe Piezometers Locations - Sheet 4
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0040	Ground Investigations - Standpipe Piezometers Locations - Sheet 5
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0041	Ground Investigations - Standpipe Piezometers Locations - Sheet 6
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0042	Ground Investigations - Standpipe Piezometers Locations - Sheet 7
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0043	Ground Investigations - Standpipe Piezometers Locations - Sheet 8
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0044	Ground Investigations - Standpipe Piezometers Locations - Sheet 9
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0045	Ground Investigations - In-situ Groundwater Test Locations - Sheet 1
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0046	Ground Investigations - In-situ Groundwater Test Locations - Sheet 2
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0047	Ground Investigations - In-situ Groundwater Test Locations - Sheet 3
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0048	Ground Investigations - In-situ Groundwater Test Locations - Sheet 4
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0049	Ground Investigations - In-situ Groundwater Test Locations - Sheet 5
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0050	Ground Investigations - In-situ Groundwater Test Locations - Sheet 6
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0051	Ground Investigations - In-situ Groundwater Test Locations - Sheet 7
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0052	Ground Investigations - In-situ Groundwater Test Locations - Sheet 8
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0053	Ground Investigations - In-situ Groundwater Test Locations - Sheet 9
HE551506-AMW-HGT-	Ground Investigations - Down-hole Wireline Geophysical

Drawing No.	Description
SW_ML_M00_Z-DR-CE-0054	Locations - Sheet 1
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0055	Ground Investigations - Down-hole Wireline Geophysical Locations - Sheet 2
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0056	Ground Investigations - Down-hole Wireline Geophysical Locations - Sheet 3
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0057	Ground Investigations - Down-hole Wireline Geophysical Locations - Sheet 4
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0058	Ground Investigations - Pumping Locations
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063	Ground Investigations - Legend and Abbreviations
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0068	Phosphatic Chalk Section 01. CH 7700m to 8000m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0069	Phosphatic Chalk Section 02. CH 8000m to 8300m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0070	Phosphatic Chalk Section 03. CH 8300m to 8600m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0071	Phosphatic Chalk Section 04. CH 8600m to 8900m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0072	Phosphatic Chalk Section 05. CH 8900m to 9200m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0073	Phosphatic Chalk Section 06. CH 9200m to 9500m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0074	Phosphatic Chalk Section 07. CH 9500m to 9800m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0075	Phosphatic Chalk Section 08. CH 9800m to 10100m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0076	Phosphatic Chalk Section 09. CH 10400m to 10700m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0077	Phosphatic Chalk Section 10. CH 7400m to 7700m
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0078	Phosphatic chalk Locations - Sheet 1
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0079	Phosphatic chalk Locations - Sheet 2
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0080	Phosphatic chalk Locations - Sheet 3
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0081	Phosphatic chalk Locations - Sheet 4
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0082	Phosphatic chalk Locations - Sheet 5





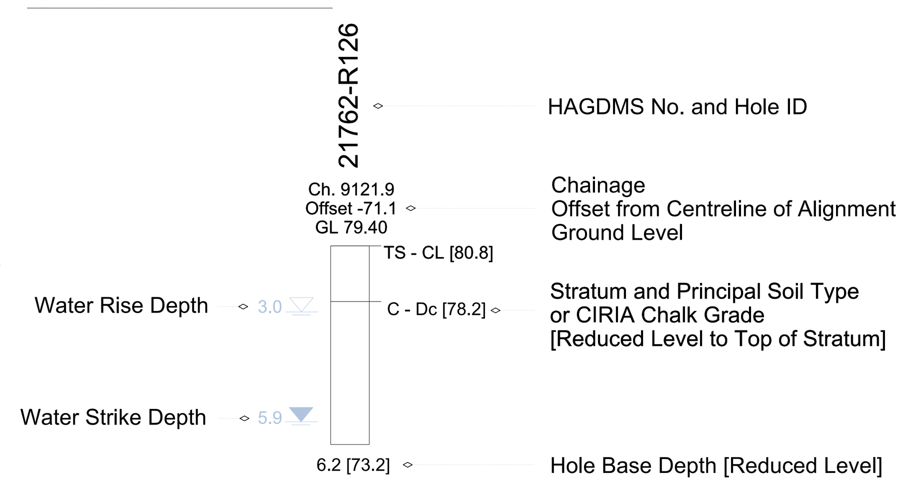
GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferetiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

SECTION KEY:



- Existing Ground Level
- Proposed Level
- Moved Hole

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

IT IS ASSUMED THAT ALL WORKS ON THIS DRAWING WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROPRIATE METHOD STATEMENT.

THIS DRAWING IS TO BE USED ONLY FOR THE PURPOSE OF ISSUE THAT IT WAS ISSUED FOR AND IS SUBJECT TO AMENDMENT.

EXCEPTIONAL RISKS RELATING TO THE WORKS ASSOCIATED WITH THIS DRAWING ARE IDENTIFIED BELOW.

CONSTRUCTION

MAINTENANCE / OPERATION / DECOMMISSIONING / DEMOLITION

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DOCUMENTATION.
2. DO NOT SCALE FROM THIS DRAWING, USE ONLY PRINTED DIMENSIONS.
3. ALL DIMENSIONS IN MILLIMETRES, ALL CHAINAGES, LEVELS AND COORDINATES ARE IN METRES UNLESS DEFINED OTHERWISE.
4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
5. MAINLINE VERTICAL PROFILE AND HORIZONTAL ALIGNMENT BASED ON P09 AND P03 RESPECTIVELY.
6. SOME EXPLORATORY HOLES MAY HAVE BEEN MOVED FOR PURPOSES OF CLARITY WHERE DEFINED ON THE DRAWING.
7. ONLY EXPLORATORY HOLES LOCATED WITHIN 250m SEARCH BUFFER EITHER SIDE OF THE CENTRELINE OF THE ALIGNMENT ARE SHOWN ON THE GEOLOGICAL SECTION.

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	18/09/17	P01
Second Issue	EZ / GK	26/04/18	P02

Purpose of issue

FOR REVIEW & COMMENT

Client
Highways England
The Cube
199 Wharfside Street
Birmingham
B1 1RN

Working on behalf of highways england

Project Title

A303 Stonehenge Amesbury to Berwick Down

Drawing Title

GEOLOGICAL SECTION 01 CH 0M TO 1300M

Designed	Drawn	Checked	Approved	Date
OL	EZ	OL	GK	26/04/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
Tel:
Fax:

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume | Location | Type | Role | Number

HE551506 -AMW -HGT - SW_ML_M00_Z -DR-CE-0001

Rev P02

Plot Time :10:00
Plot Date :---
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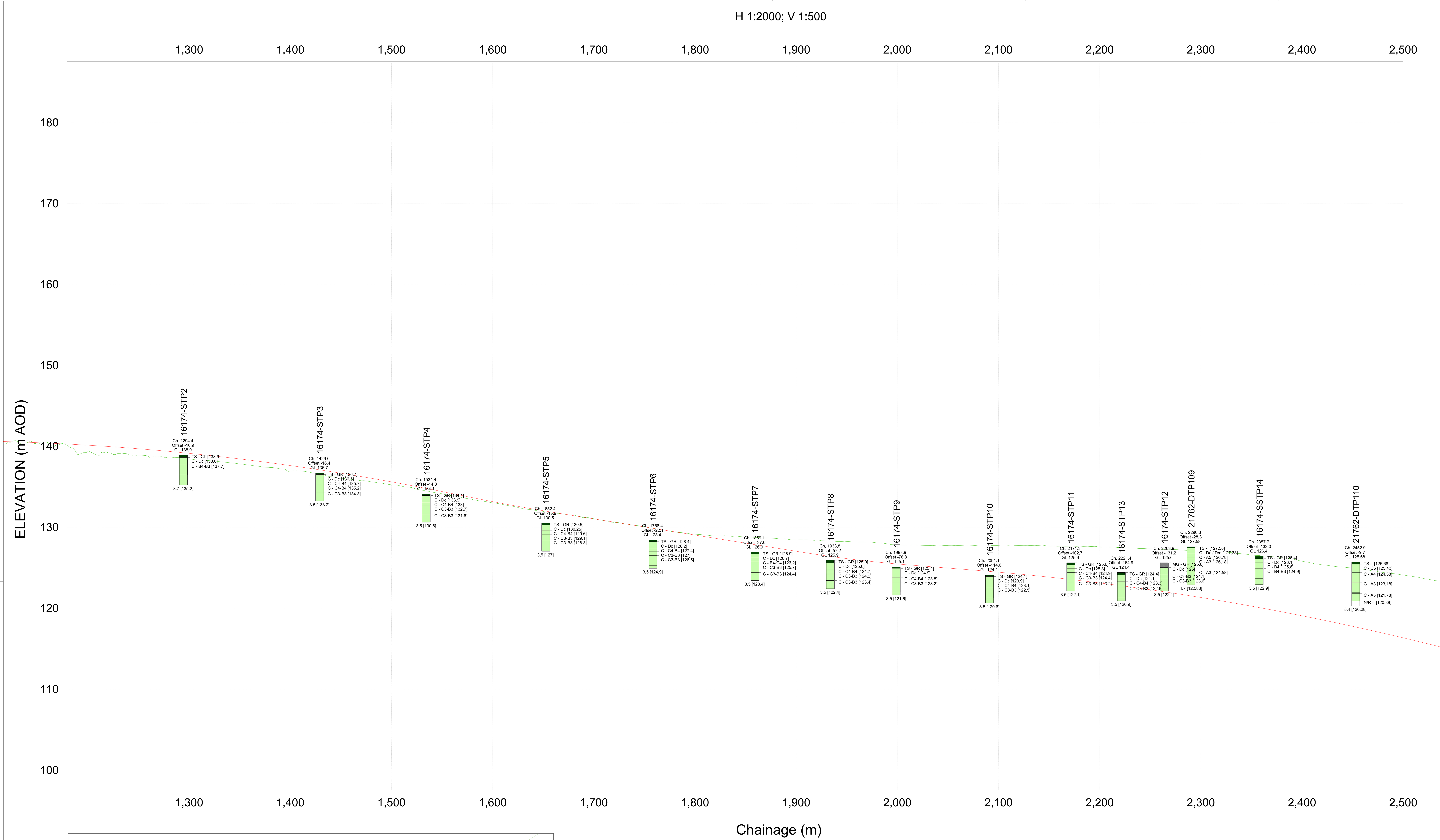
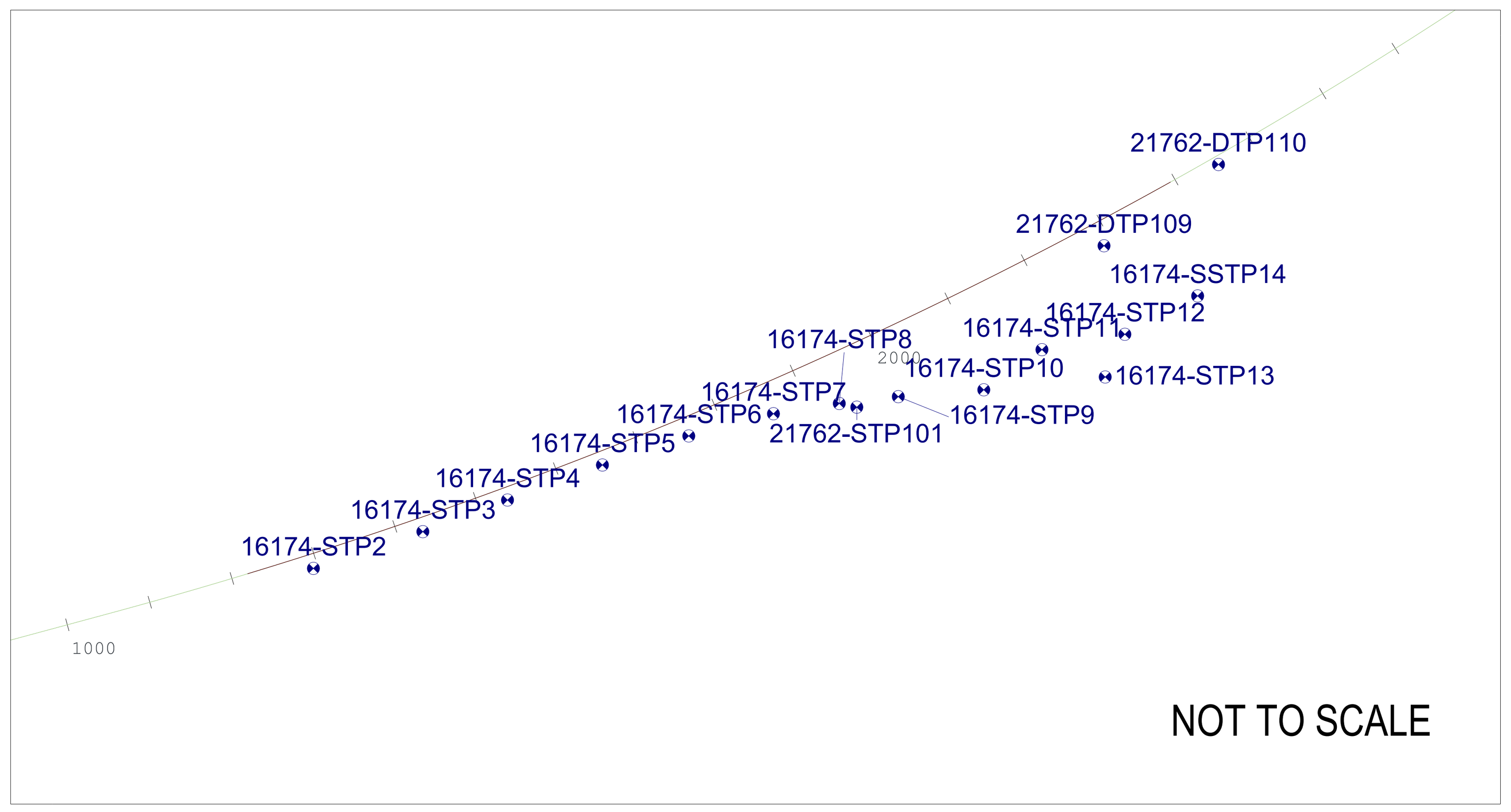




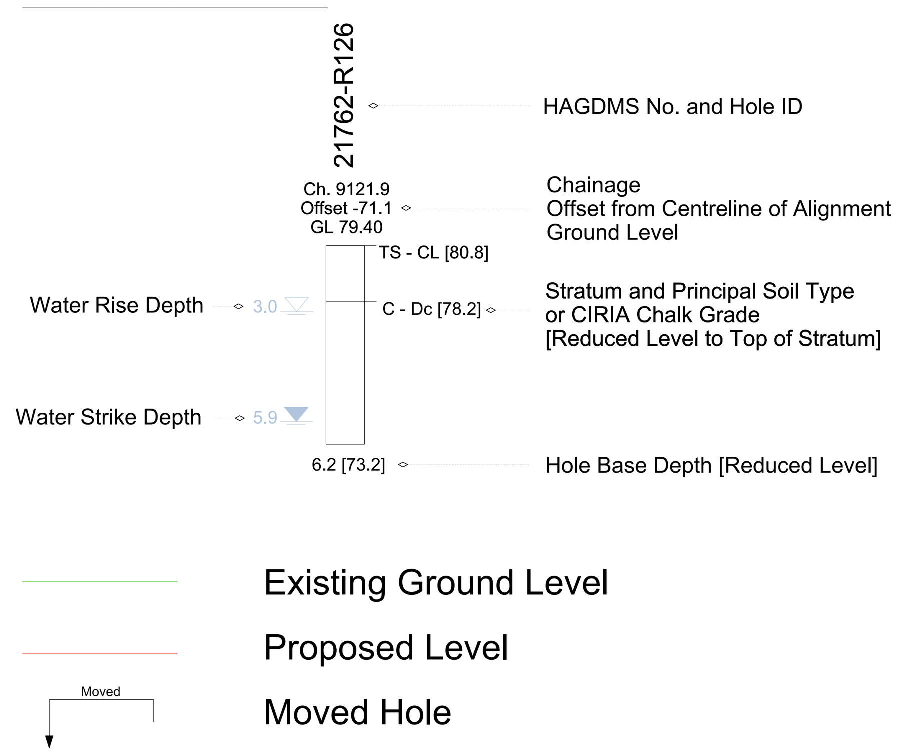
GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undiffetiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

SECTION KEY:



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

IT IS ASSUMED THAT ALL WORKS ON THIS DRAWING WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROPRIATE METHOD STATEMENT.

THIS DRAWING IS TO BE USED ONLY FOR THE PURPOSE OF ISSUE THAT IT WAS ISSUED FOR AND IS SUBJECT TO AMENDMENT.

EXCEPTIONAL RISKS RELATING TO THE WORKS ASSOCIATED WITH THIS DRAWING ARE IDENTIFIED BELOW.

CONSTRUCTION

MAINTENANCE / OPERATION / DECOMMISSIONING / DEMOLITION

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3. ALL DIMENSIONS IN MILLIMETRES, ALL CHAINAGES, LEVELS AND COORDINATES ARE IN METRES UNLESS DEFINED OTHERWISE.
4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
5. MAINLINE VERTICAL PROFILE AND HORIZONTAL ALIGNMENT BASED ON P09 AND P03 RESPECTIVELY.
6. SOME EXPLORATORY HOLES MAY HAVE BEEN MOVED FOR PURPOSES OF CLARITY WHERE DEFINED ON THE DRAWING.
7. FOR CLARITY PURPOSE ONLY SELECTED EXPLORATORY HOLES LOCATED WITHIN 250m SEARCH BUFFER EITHER SIDE OF THE CENTRELINE OF THE ALIGNMENT ARE SHOWN ON THE GEOLOGICAL SECTION. EXPLORATORY HOLE THAT HAS NOT BEEN SELECTED WITHIN THE BUFFER IS 21762-STP101.

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	18/09/17	P01
Second Issue	EZ / GK	26/04/18	P02

Purpose of issue

FOR REVIEW & COMMENT

Client
Highways England
The Cube
199 Wharfside Street
Birmingham
B1 1RN

Working on behalf of highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GEOLOGICAL SECTION 02
CH 1300M TO 2400M

Designed	Drawn	Checked	Approved	Date
OL	EZ	OL	GK	26/04/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
Tel:
Fax:

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR-CE-0002
Location | Type | Role | Number

Rev P02

Plot Time : 10:00
Plot Date : ---
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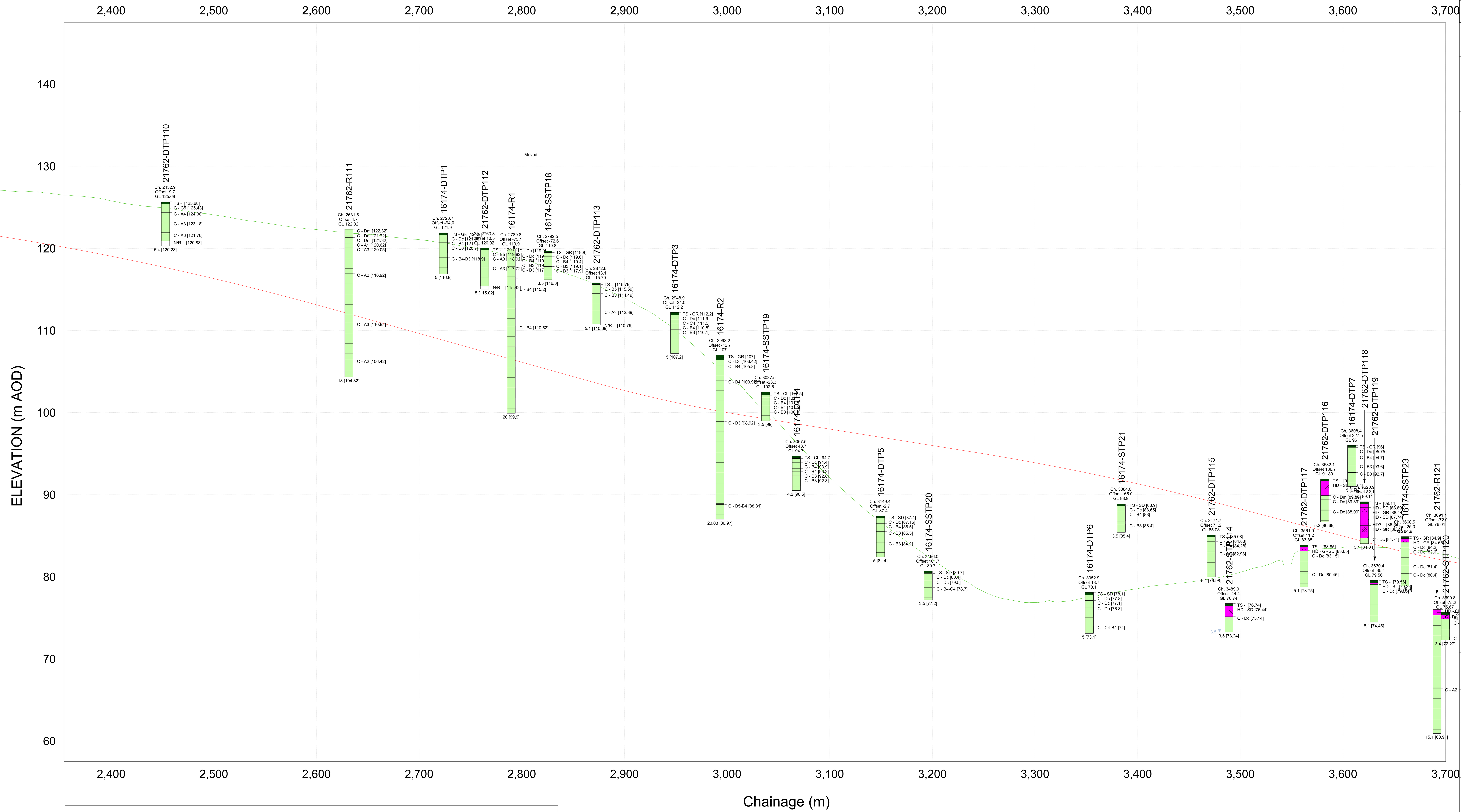
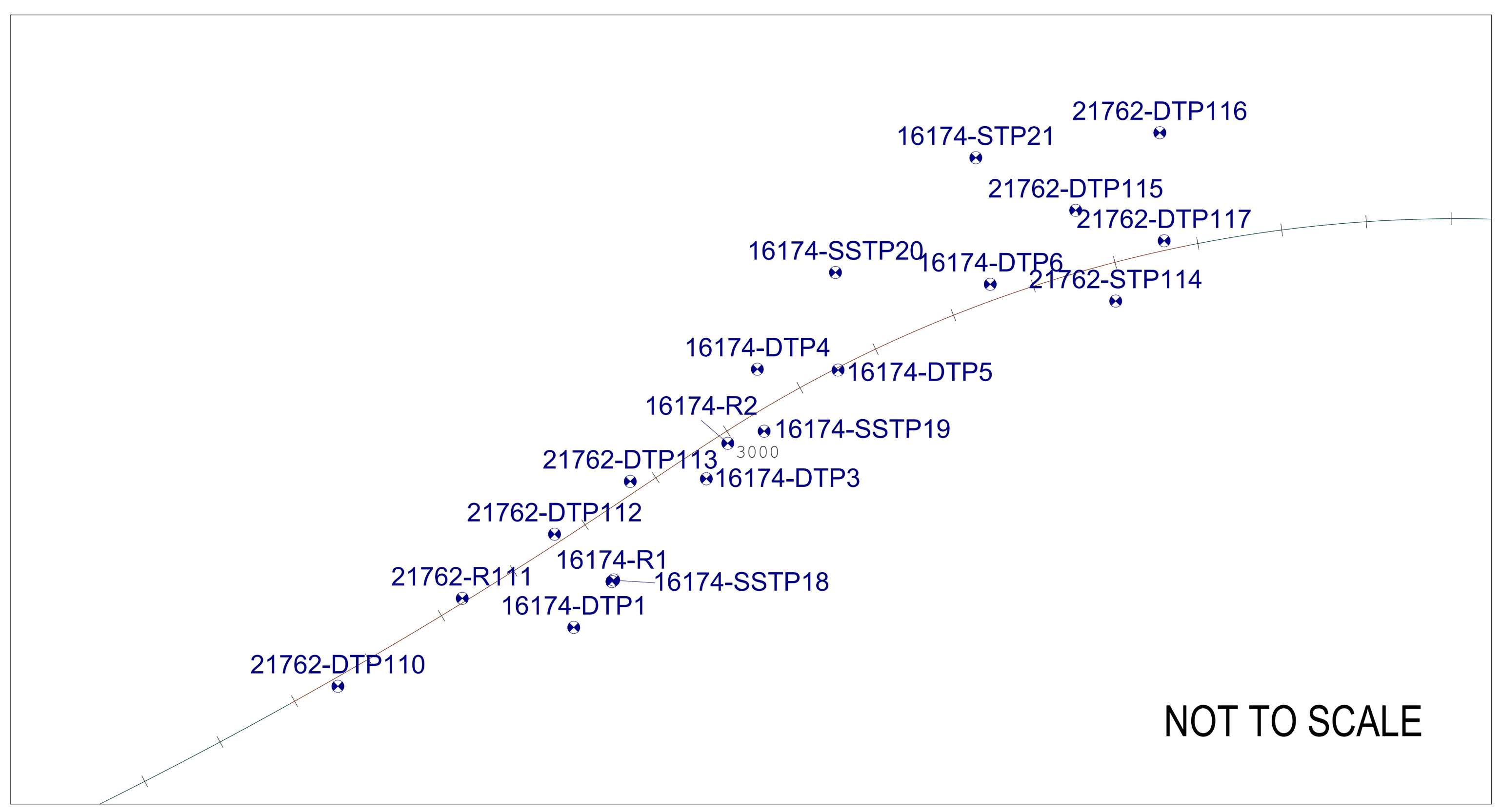




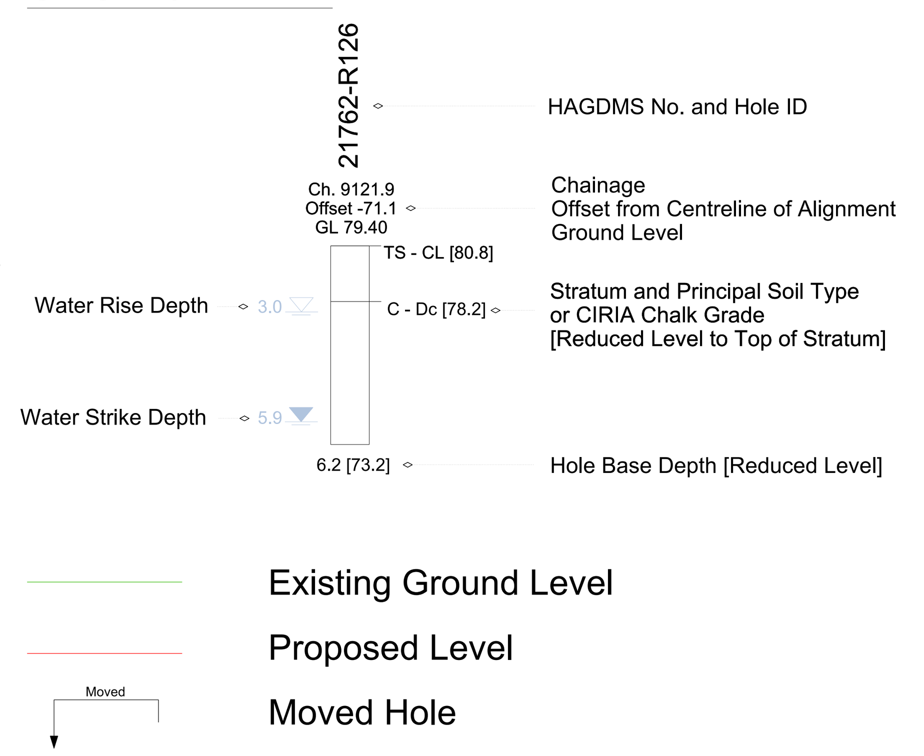
GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferetiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

SECTION KEY:



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

IT IS ASSUMED THAT ALL WORKS ON THIS DRAWING WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROPRIATE METHOD STATEMENT.

THIS DRAWING IS TO BE USED ONLY FOR THE PURPOSE OF ISSUE THAT IT WAS ISSUED FOR AND IS SUBJECT TO AMENDMENT.

EXCEPTIONAL RISKS RELATING TO THE WORKS ASSOCIATED WITH THIS DRAWING ARE IDENTIFIED BELOW.

CONSTRUCTION

MAINTENANCE / OPERATION / DECOMMISSIONING / DEMOLITION

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DOCUMENTATION.
2. DO NOT SCALE FROM THIS DRAWING, USE ONLY PRINTED DIMENSIONS.
3. ALL DIMENSIONS IN MILLIMETRES, ALL CHAINAGES, LEVELS AND COORDINATES ARE IN METRES UNLESS DEFINED OTHERWISE.
4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
5. MAINLINE VERTICAL PROFILE AND HORIZONTAL ALIGNMENT BASED ON P09 AND P03 RESPECTIVELY.
6. SOME EXPLORATORY HOLES MAY HAVE BEEN MOVED FOR PURPOSES OF CLARITY WHERE DEFINED ON THE DRAWING.
7. FOR CLARITY PURPOSE ONLY SELECTED EXPLORATORY HOLES LOCATED WITHIN 250m SEARCH BUFFER EITHER SIDE OF THE CENTRELINE OF THE ALIGNMENT ARE SHOWN ON THE GEOLOGICAL SECTION. EXPLORATORY HOLES THAT HAVE NOT BEEN SELECTED WITHIN THE BUFFER ARE 16174-SSTP15 AND 16174-DTP2.

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	18/09/17	P01
Second Issue	EZ / GK	26/04/18	P02

Purpose of issue

FOR REVIEW & COMMENT

Client
Highways England
The Cube
199 Wharfside Street
Birmingham
B1 1RN

Working on behalf of highways england

Project Title

A303 Stonehenge Amesbury to Berwick Down

Drawing Title

GEOLOGICAL SECTION 03 CH 2400M TO 3600M

Designed	Drawn	Checked	Approved	Date
OL	EZ	OL	GK	26/04/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
Tel:
Fax:

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR -CE -0003
Location | Type | Role | Number
Rev P02

Plot Time: 10:00
Plot Date: ---
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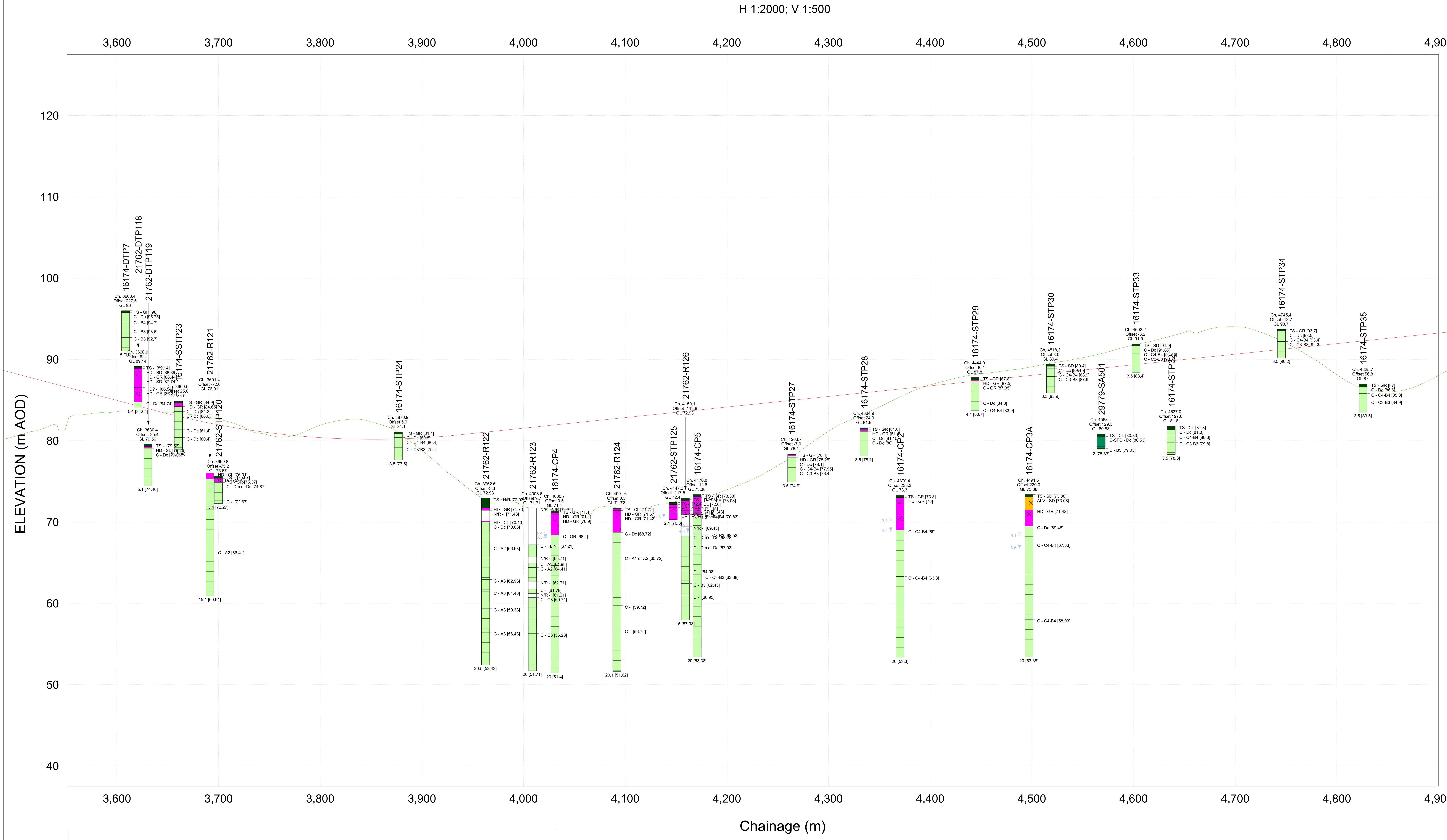
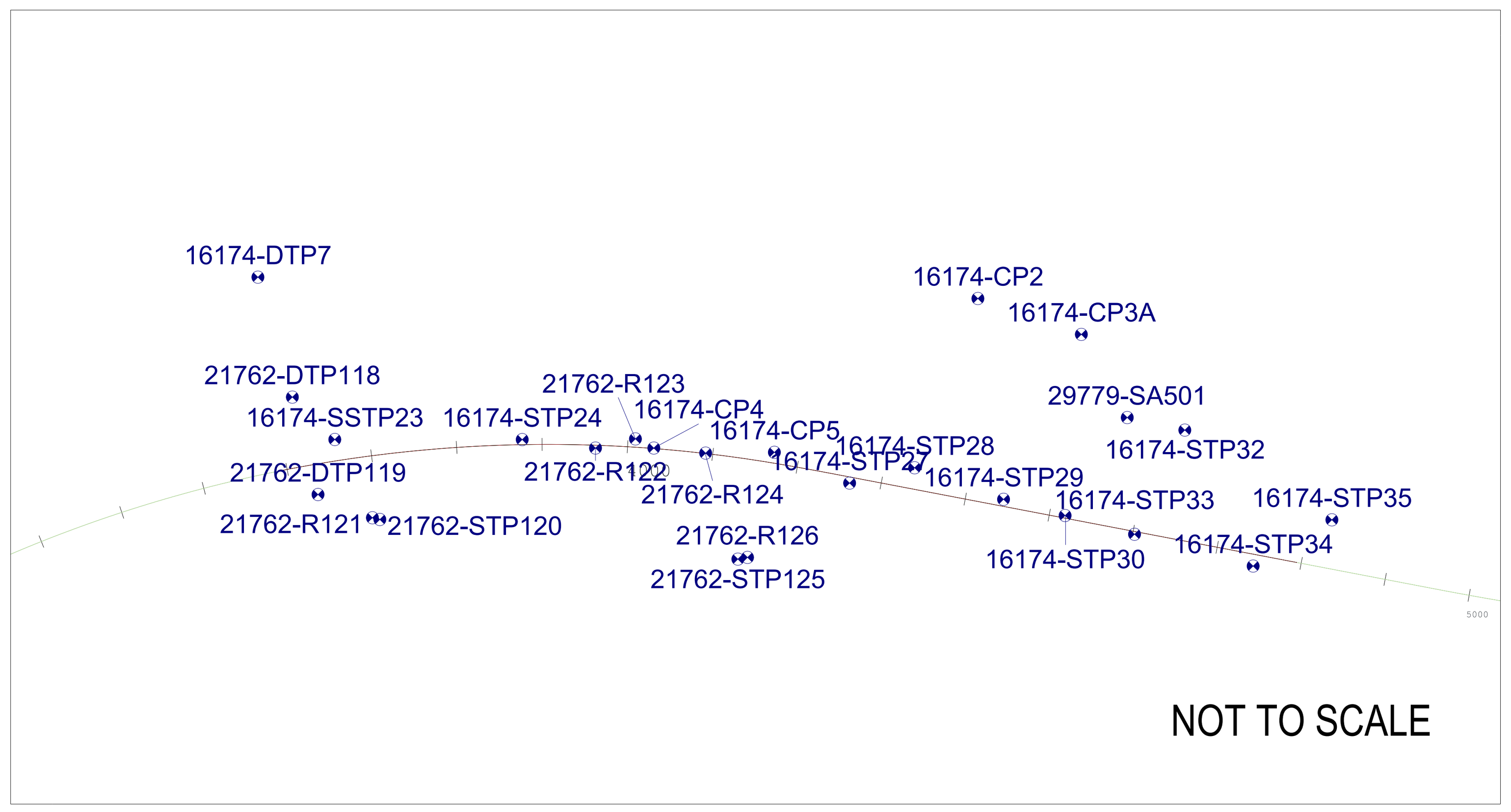
H 1:2000; V 1:500





GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferetiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

SECTION KEY:

- HAGDMS No. and Hole ID
- Chainage / Offset from Centreline of Alignment / Ground Level
- Stratum and Principal Soil Type or CIRIA Chalk Grade [Reduced Level to Top of Stratum]
- Water Rise Depth
- Water Strike Depth
- Hole Base Depth [Reduced Level]
- Existing Ground Level
- Proposed Level
- Moved Hole

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

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5. MAINLINE VERTICAL PROFILE AND HORIZONTAL ALIGNMENT BASED ON P09 AND P03 RESPECTIVELY.
6. SOME EXPLORATORY HOLES MAY HAVE BEEN MOVED FOR PURPOSES OF CLARITY WHERE DEFINED ON THE DRAWING.
7. FOR CLARITY PURPOSE ONLY SELECTED EXPLORATORY HOLES LOCATED WITHIN 250m SEARCH BUFFER EITHER SIDE OF THE CENTRELINE OF THE ALIGNMENT ARE SHOWN ON THE GEOLOGICAL SECTION. EXPLORATORY HOLE THAT HAVE NOT BEEN SELECTED WITHIN THE BUFFER ARE 16174-DTP8,16174-STP31 AND16174-CP3.

Revision Details	By	Check	Date	Suffix
First Issue	EZ	GK	18/09/17	P01
SecondIssue	EZ	GK	26/04/18	P02

Purpose of issue

FOR REVIEW & COMMENT

Client
Highways England
The Cube
199 Wharfside Street
Birmingham
B1 1RN

Working on behalf of highways england

Project Title

A303 Stonehenge Amesbury to Berwick Down

Drawing Title

GEOLOGICAL SECTION 04 CH 3600M TO 4800M

Designed	Drawn	Checked	Approved	Date
OL	EZ	OL	GK	26/04/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

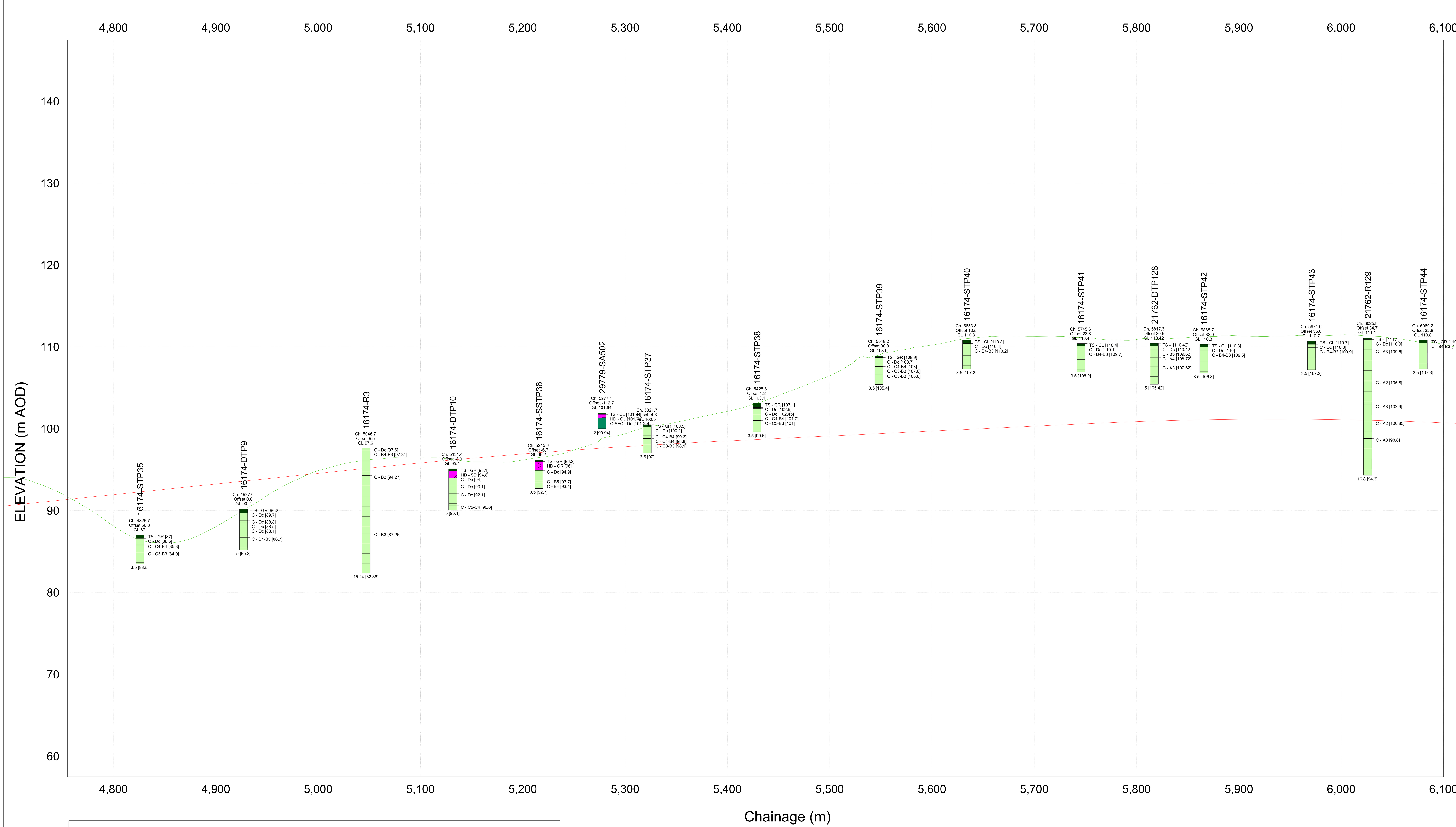
Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
Tel:
Fax:

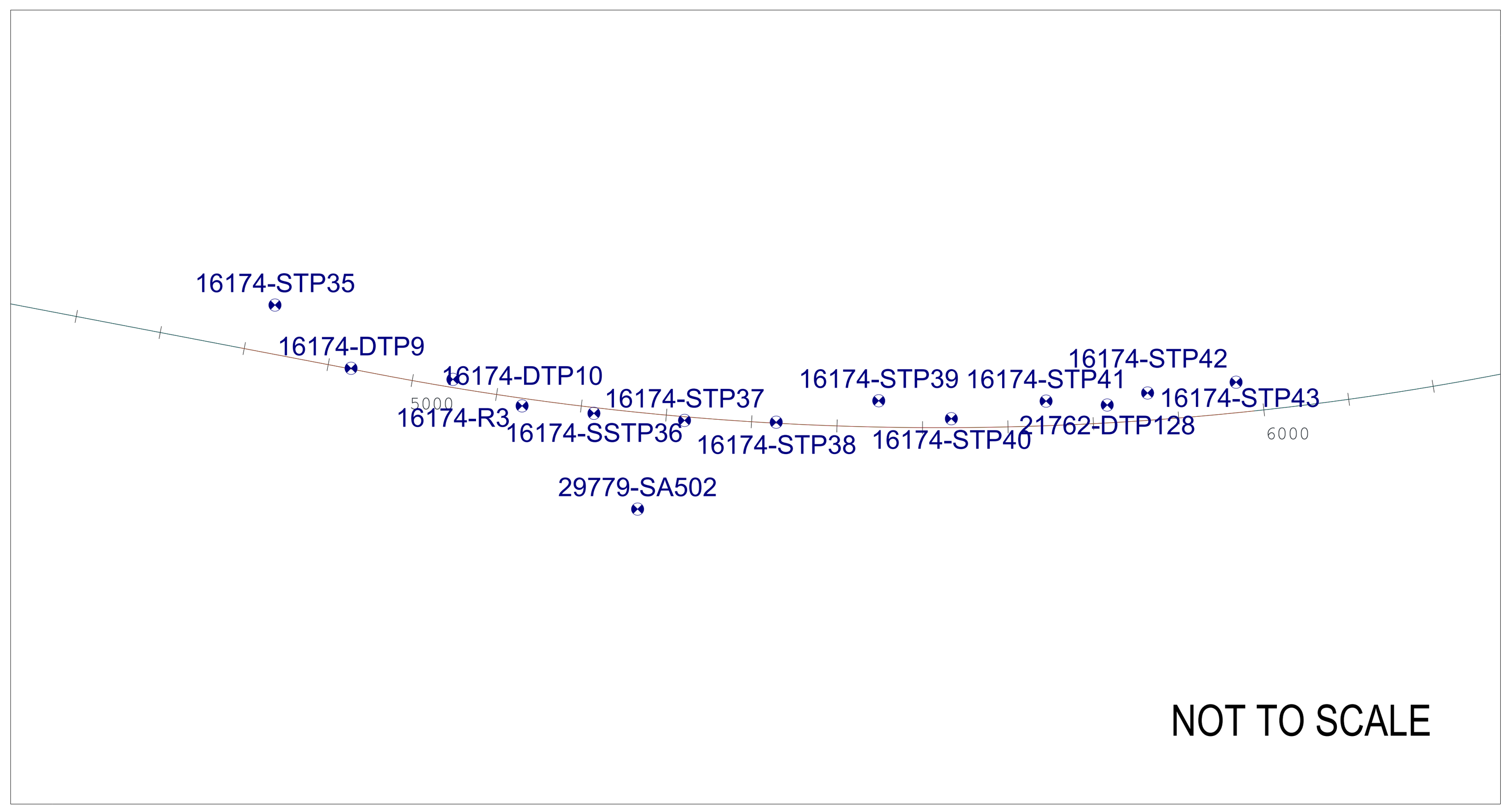
AmW
AECOM + mace + WSP

Drawing Number
HE551506 -AMW -HGT -SW_ML_M00_Z -DR -CE -0004

Rev P02

H 1:2000; V 1:500





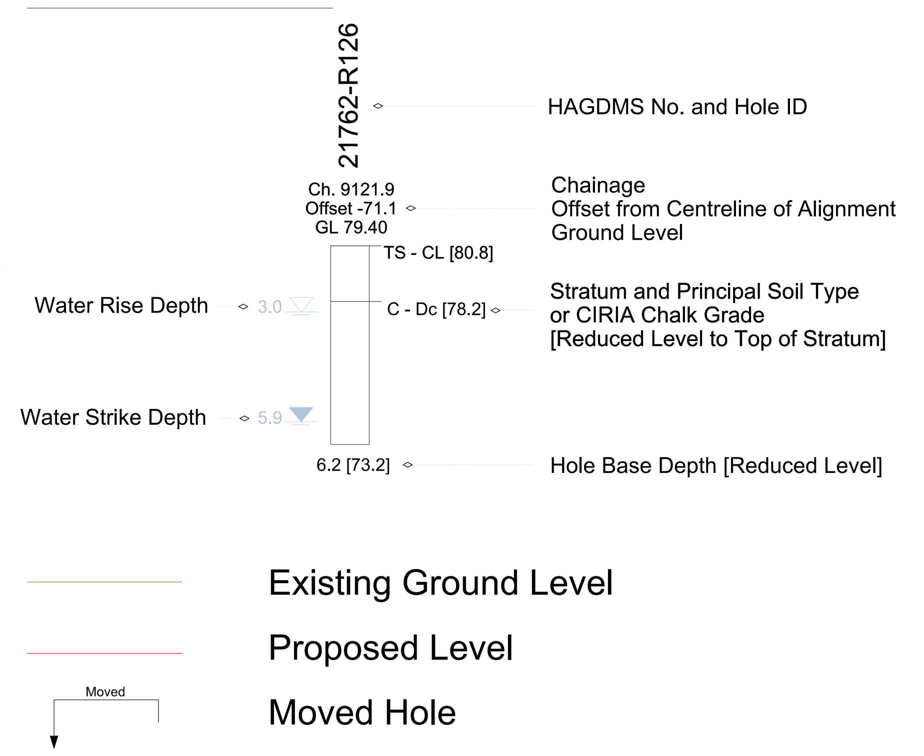
GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferetiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

SECTION KEY:



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

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CONSTRUCTION

MAINTENANCE / OPERATION / DECOMMISSIONING / DEMOLITION

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5. MAINLINE VERTICAL PROFILE AND HORIZONTAL ALIGNMENT BASED ON P09 AND P03 RESPECTIVELY.
6. SOME EXPLORATORY HOLES MAY HAVE BEEN MOVED FOR PURPOSES OF CLARITY WHERE DEFINED ON THE DRAWING.
7. ONLY EXPLORATORY HOLES LOCATED WITHIN 250m SEARCH BUFFER EITHER SIDE OF THE CENTRELINE OF THE ALIGNMENT ARE SHOWN ON THE GEOLOGICAL SECTION.

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	18/09/17	P01
Second Issue	EZ / GK	26/04/18	P02

Purpose of issue

FOR REVIEW & COMMENT

Client
Highways England
The Cube
199 Wharfside Street
Birmingham
B1 1RN

Working on behalf of

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GEOLOGICAL SECTION 05
CH 4800M TO 6000M

Designed	Drawn	Checked	Approved	Date
OL	EZ	OL	GK	26/04/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
Tel:
Fax:

AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 - AMW - HGT - SW_ML_M00_Z - DR - CE - 0005
Location | Type | Role | Number

Rev P02

Plot Time : 10:00
Plot Date : ---
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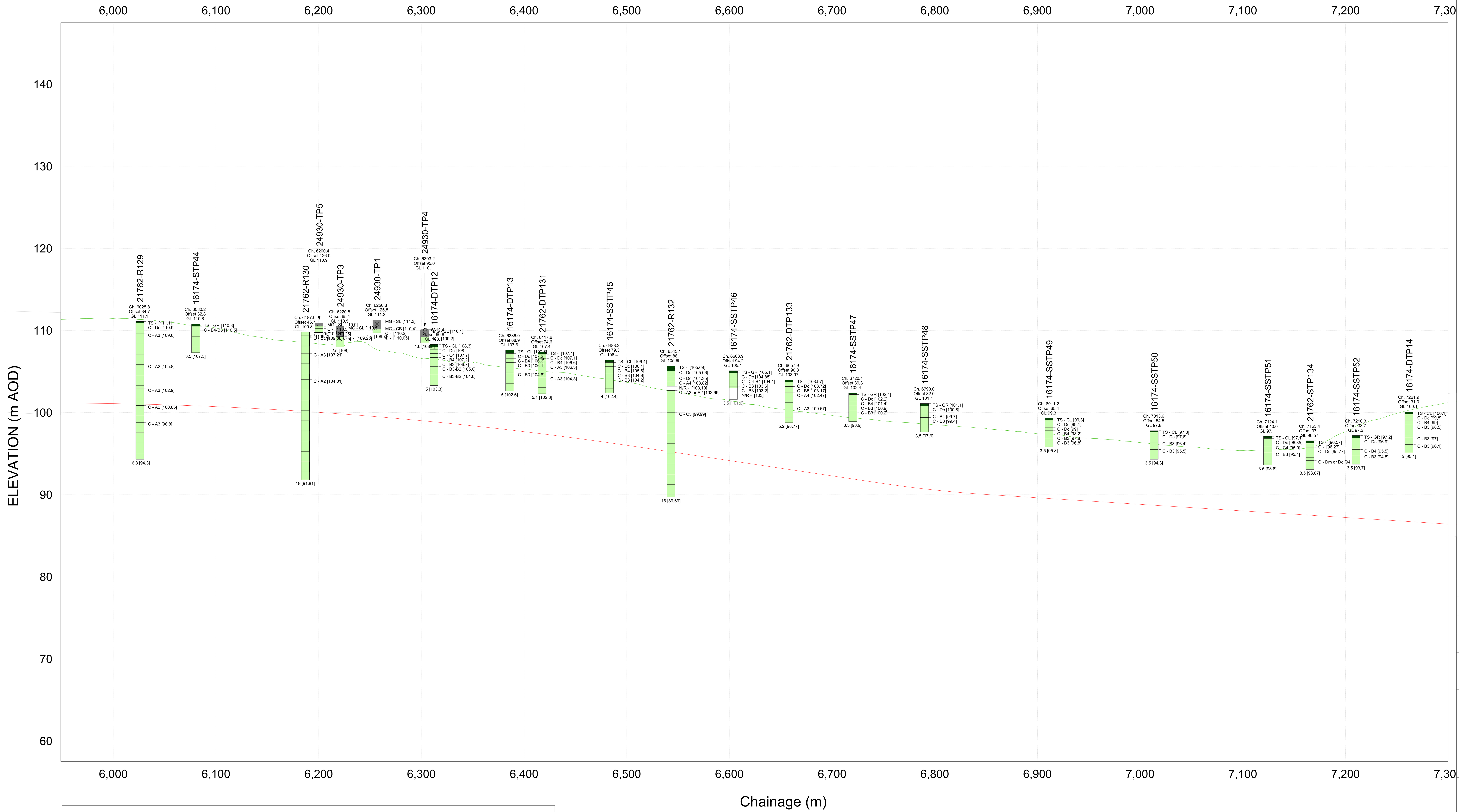
H 1:2000; V 1:500



1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DOCUMENTATION.
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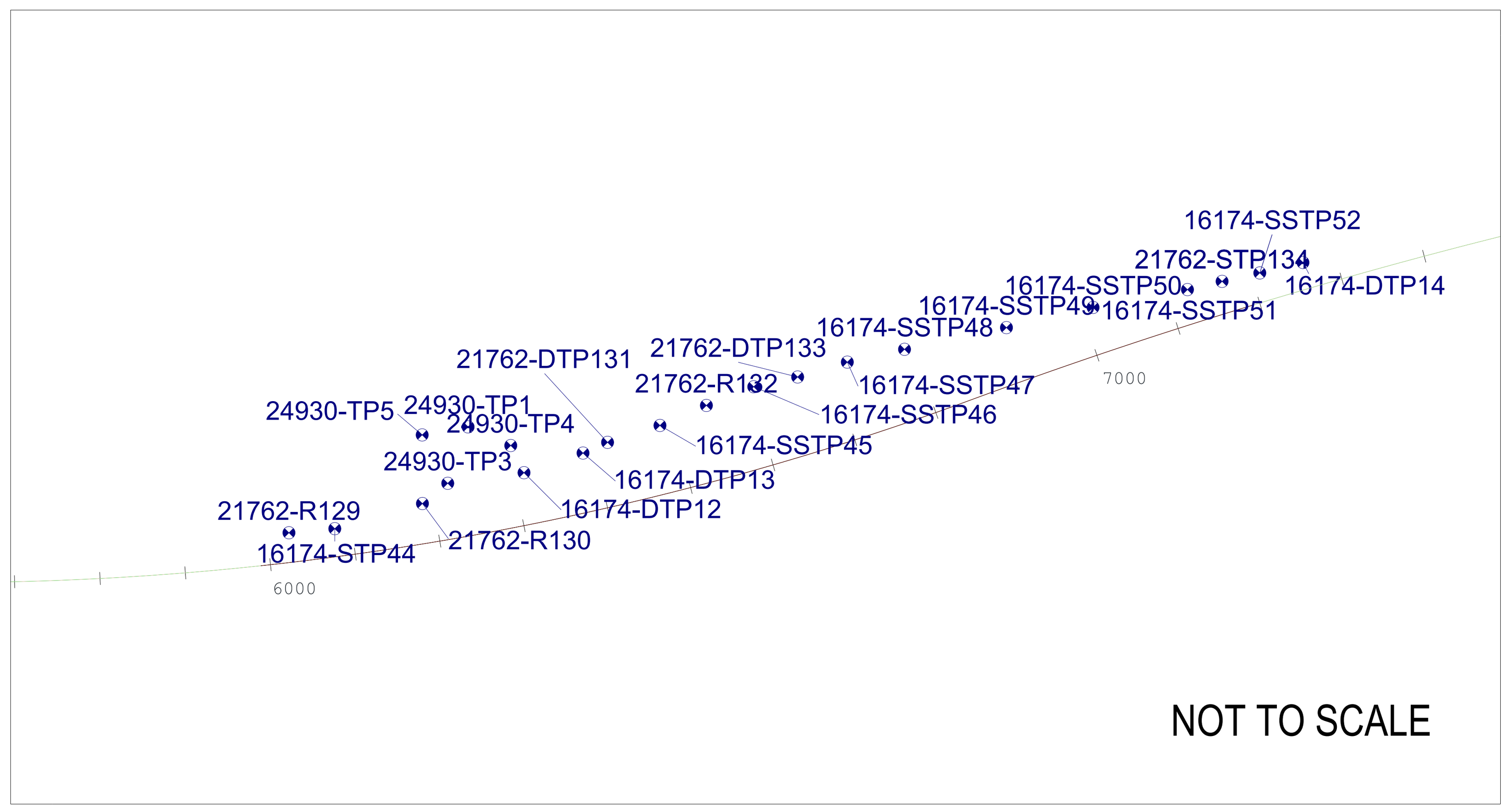
5. MAINLINE VERTICAL PROFILE AND HORIZONTAL ALIGNMENT BASED ON P09 AND P03 RESPECTIVELY.
6. SOME EXPLORATORY HOLES MAY HAVE BEEN MOVED FOR PURPOSES OF CLARITY WHERE DEFINED ON THE DRAWING.
7. FOR CLARITY PURPOSE ONLY SELECTED EXPLORATORY HOLES LOCATED WITHIN 250m SEARCH BUFFER EITHER SIDE OF THE CENTRELINE OF THE ALIGNMENT ARE SHOWN ON THE GEOLOGICAL SECTION. EXPLORATORY HOLES THAT HAVE NOT BEEN SELECTED WITHIN THE BUFFER ARE 16174-DTP11, 24930-TP2 AND 16174-W1.



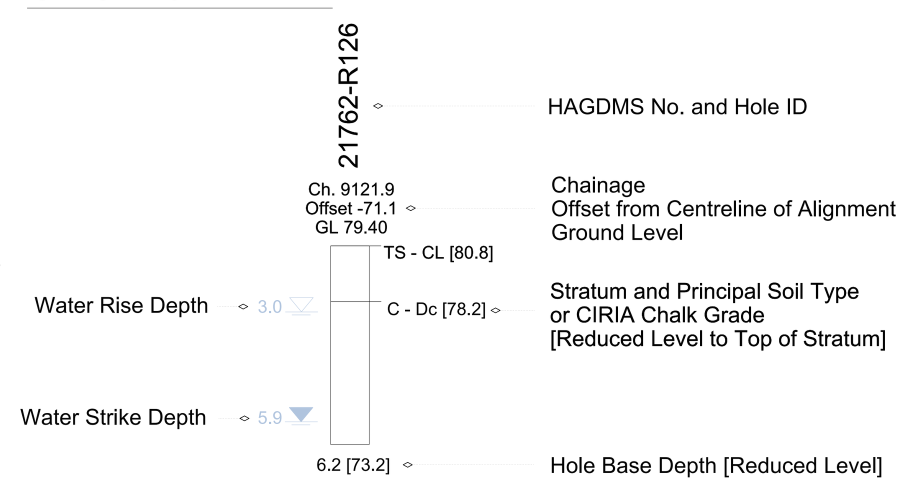
GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferetiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

SECTION KEY:



- Existing Ground Level
- Proposed Level
- Moved Hole

Revision Details	By	Check	Date	Suffix
First Issue	EZ	GK	18/09/17	P01
Second Issue	EZ	GK	26/04/18	P02
Third Issue – updated notes	EZ	GK	17/08/18	P03

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge Amesbury to Berwick Down

Drawing Title

GEOLOGICAL SECTION 06 CH 6000M TO 7200M

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number: HE551506 -AMW -HGT -SW_ML_M00_Z -DR -CE -0006
Rev: P03

Plot Time : 10:00
Plot Date : 13 February 2018 12:16:20
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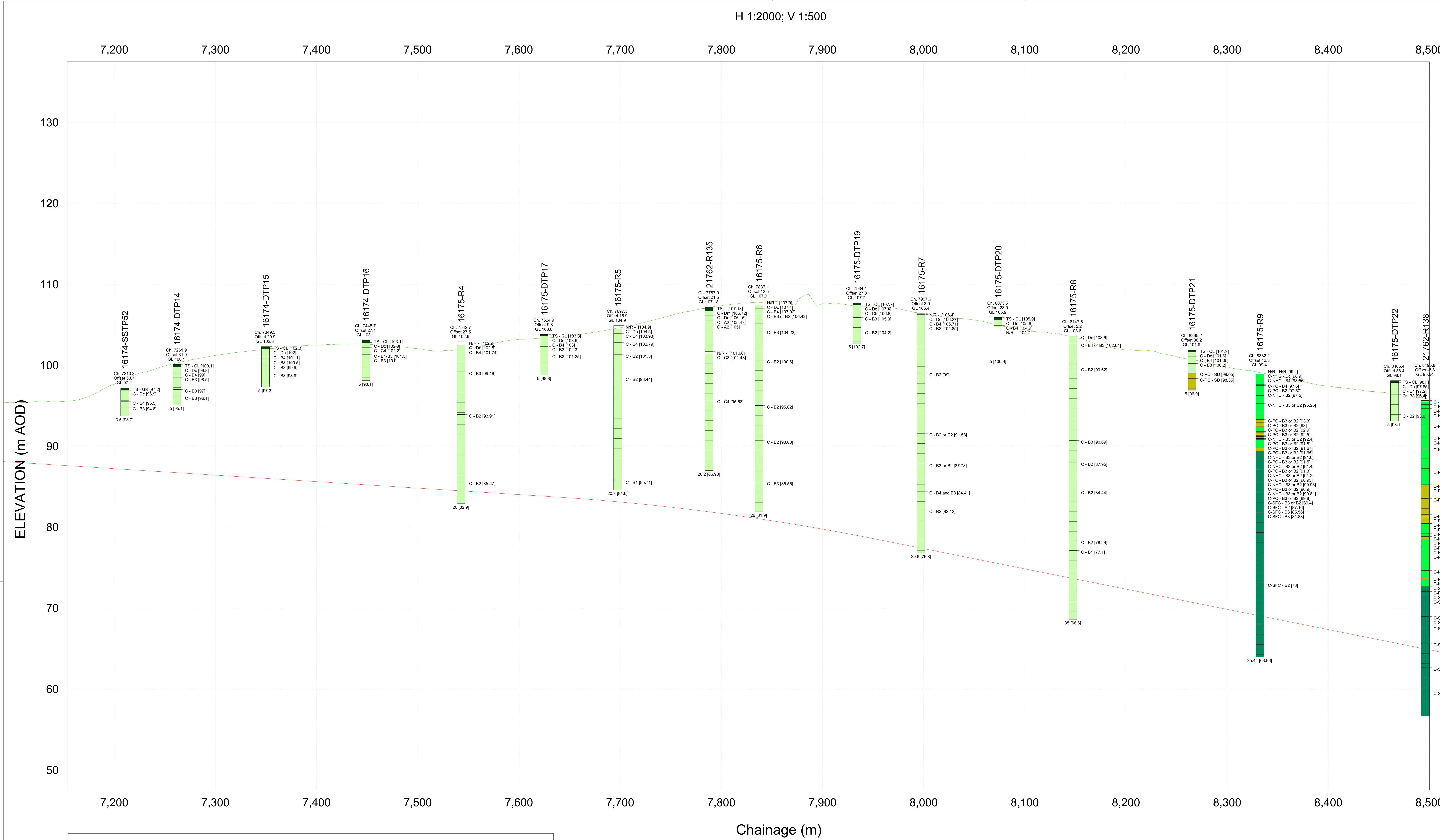
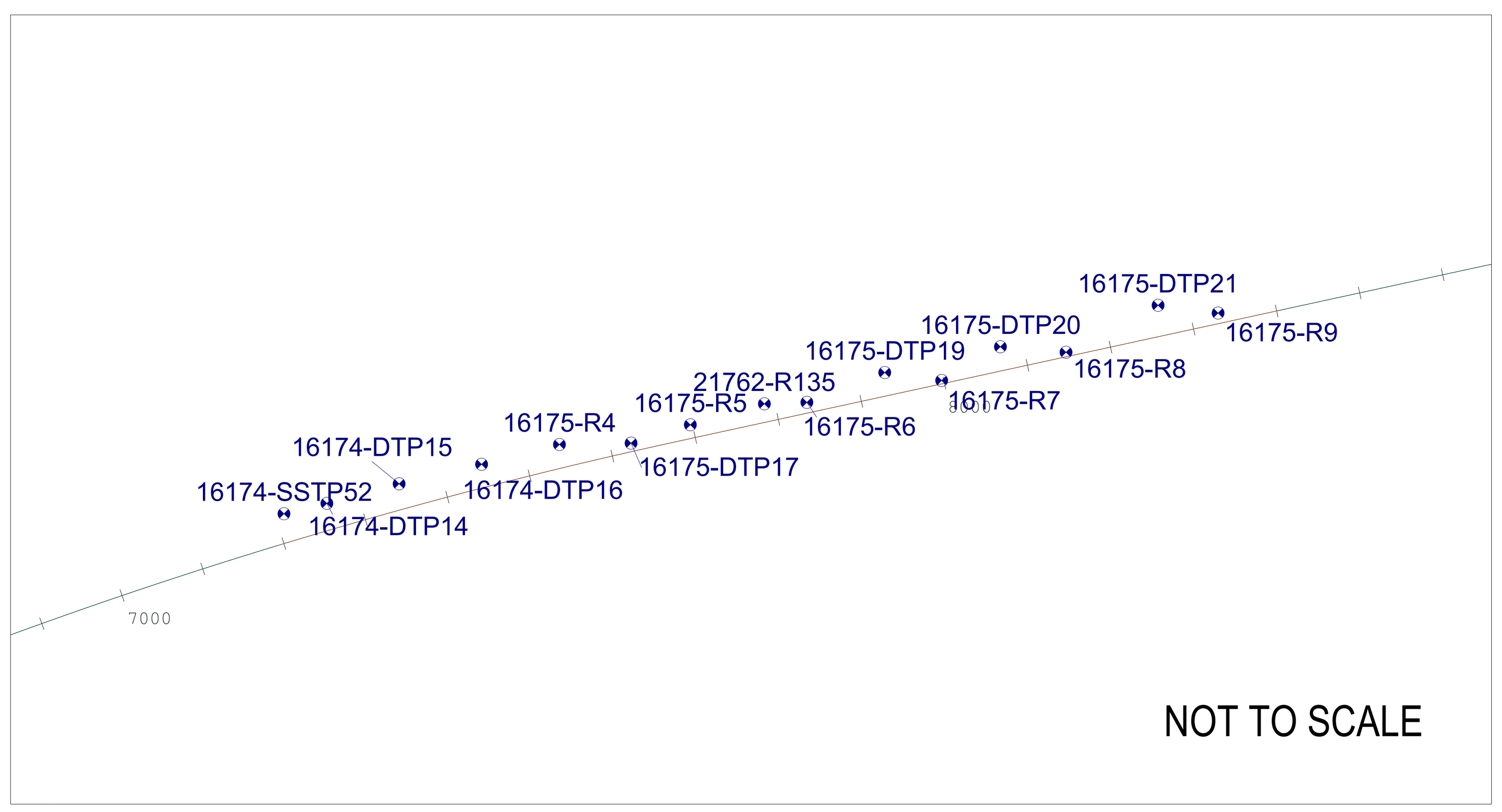




GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferetiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

SECTION KEY:

- 21762-R126 — HAGDMS No. and Hole ID
- Ch. 9121.9 / Offset -71.1 / GL 79.40 — Chainage / Offset from Centreline of Alignment / Ground Level
- TS - CL [80.8] / C - Dc [78.2] — Stratum and Principal Soil Type or CIRIA Chalk Grade [Reduced Level to Top of Stratum]
- Water Rise Depth 3.0
- Water Strike Depth 5.9
- 6.2 [73.2] — Hole Base Depth [Reduced Level]
- Existing Ground Level
- Proposed Level
- Moved — Moved Hole

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

IT IS ASSUMED THAT ALL WORKS ON THIS DRAWING WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROPRIATE METHOD STATEMENT.

THIS DRAWING IS TO BE USED ONLY FOR THE PURPOSE OF ISSUE THAT IT WAS ISSUED FOR AND IS SUBJECT TO AMENDMENT.

EXCEPTIONAL RISKS RELATING TO THE WORKS ASSOCIATED WITH THIS DRAWING ARE IDENTIFIED BELOW.

CONSTRUCTION

MAINTENANCE / OPERATION / DECOMMISSIONING / DEMOLITION

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DOCUMENTATION.
2. DO NOT SCALE FROM THIS DRAWING, USE ONLY PRINTED DIMENSIONS.
3. ALL DIMENSIONS IN MILLIMETRES, ALL CHAINAGES, LEVELS AND COORDINATES ARE IN METRES UNLESS DEFINED OTHERWISE.
4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
5. MAINLINE VERTICAL PROFILE AND HORIZONTAL ALIGNMENT BASED ON P09 AND P03 RESPECTIVELY.
6. SOME EXPLORATORY HOLES MAY HAVE BEEN MOVED FOR PURPOSES OF CLARITY WHERE DEFINED ON THE DRAWING.
7. FOR CLARITY PURPOSE ONLY SELECTED EXPLORATORY HOLES LOCATED WITHIN 250m SEARCH BUFFER EITHER SIDE OF THE CENTRELINE OF THE ALIGNMENT ARE SHOWN ON THE GEOLOGICAL SECTION. EXPLORATORY HOLE THAT HAVE NOT BEEN SELECTED WITHIN THE BUFFER ARE 16175-DTP18,21762-DTP136 AND 16175-DTP20A.

Revision Details	By	Check	Date	Suffix
First Issue	EZ	GK	18/09/17	P01
Second Issue	EZ	GK	26/04/18	P02

Purpose of issue

FOR REVIEW & COMMENT

Client
Highways England
The Cube
199 Wharfside Street
Birmingham
B1 1RN

Working on behalf of highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GEOLOGICAL SECTION 07 CH 7200M TO 8400M

Designed	Drawn	Checked	Approved	Date
OL	EZ	OL	GK	26/04/18

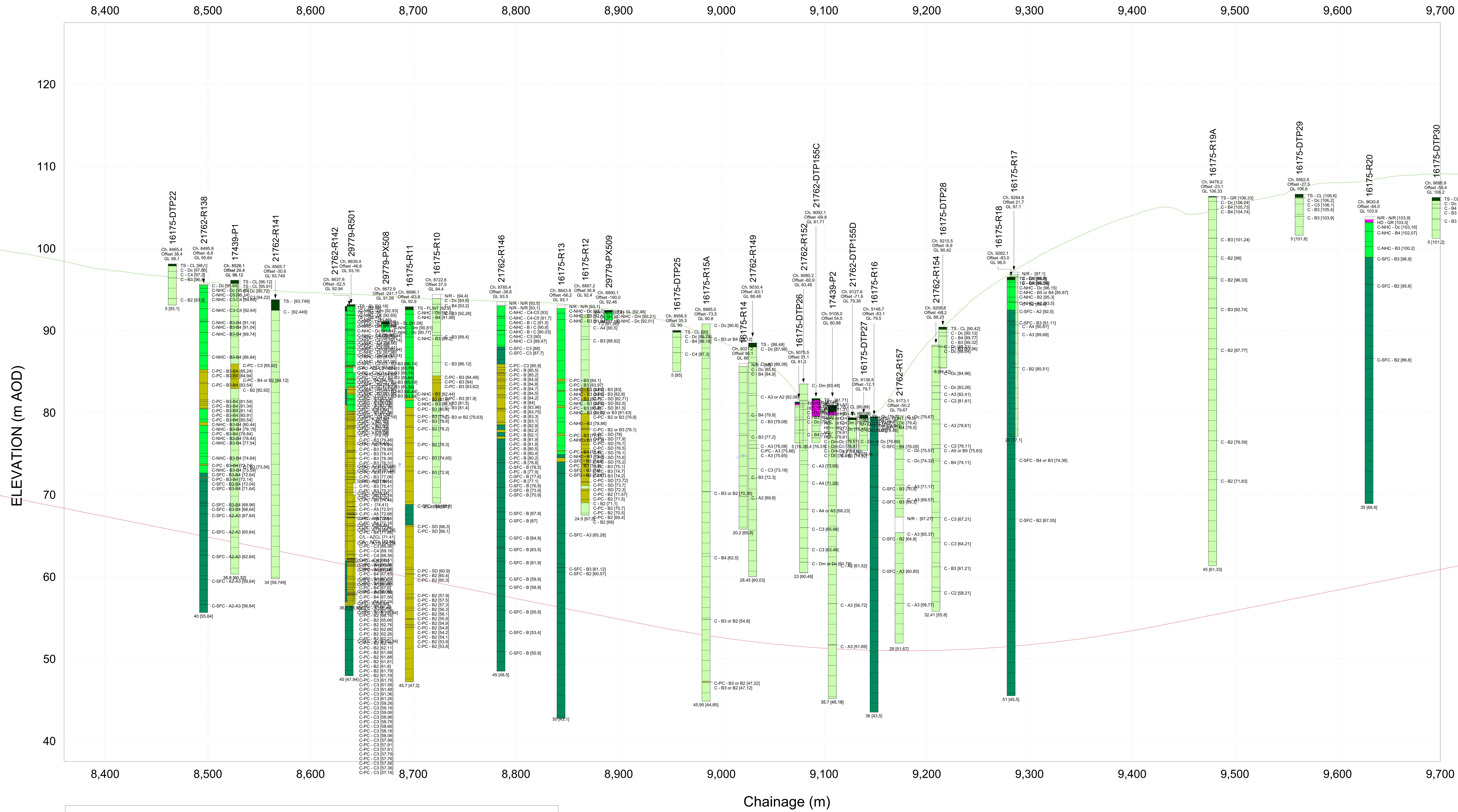
Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

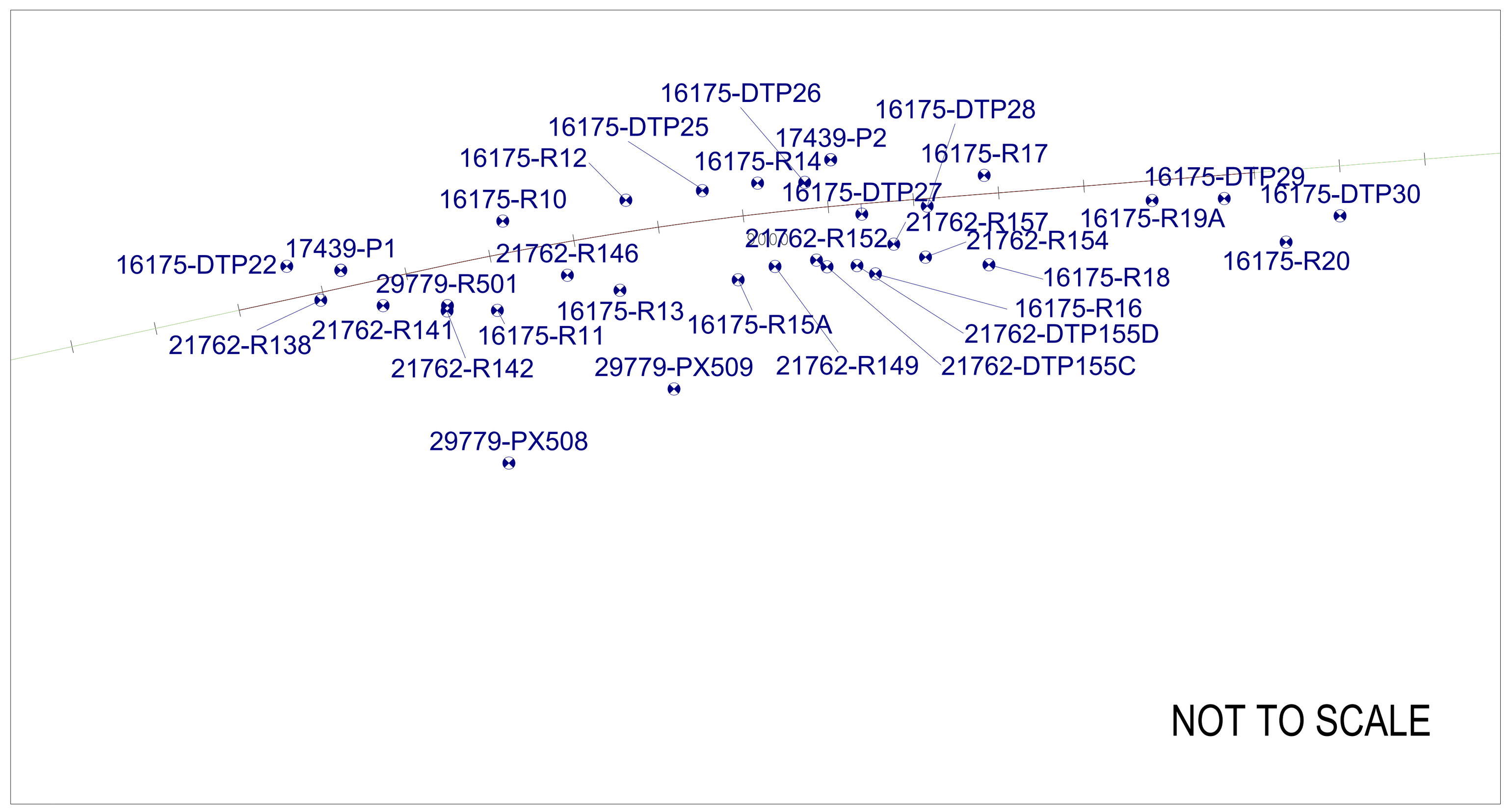
Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
Tel:
Fax:

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 - AMW - HGT - SW_ML_M00_Z - DR - CE - 0007
Location | Type | Role | Number

Rev P02





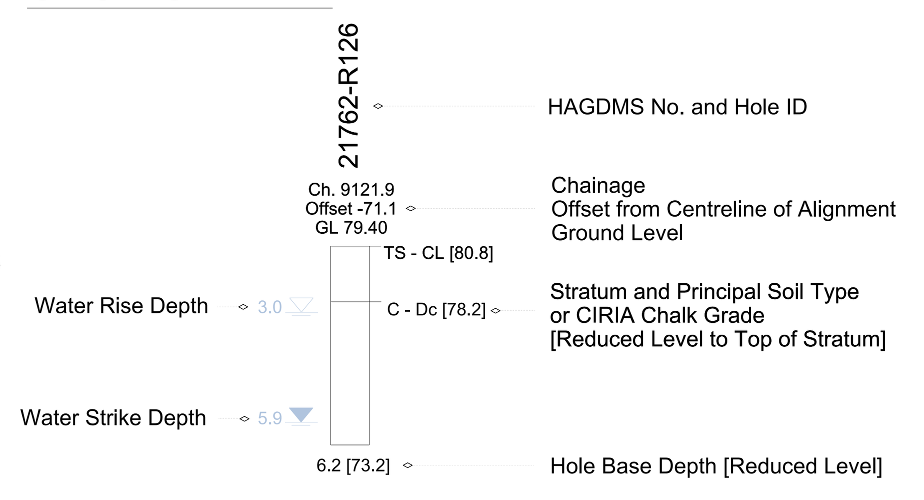
GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferetiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

SECTION KEY:



- Existing Ground Level
- Proposed Level
- Moved Hole

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

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CONSTRUCTION

MAINTENANCE / OPERATION / DECOMMISSIONING / DEMOLITION

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4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
5. MAINLINE VERTICAL PROFILE AND HORIZONTAL ALIGNMENT BASED ON P09 AND P03 RESPECTIVELY.
6. SOME EXPLORATORY HOLES MAY HAVE BEEN MOVED FOR PURPOSES OF CLARITY WHERE DEFINED ON THE DRAWING.
7. FOR CLARITY PURPOSE ONLY SELECTED EXPLORATORY HOLES LOCATED WITHIN 250m SEARCH BUFFER EITHER SIDE OF THE CENTRELINE OF THE ALIGNMENT ARE SHOWN ON THE GEOLOGICAL SECTION. EXPLORATORY HOLE THAT HAVE NOT BEEN SELECTED WITHIN THE BUFFER ARE 21762-R138B,16175-STP53,16175-DTP23,29779-SBP501, 29779-RZ501,1762-R142A,29779-R502,29779-GC501,29779-P510, 16175-DTP24,16175-R13T,16175-R13T1,16175-STP54, 16175-R15T,21762-R152A,21762-R152AA,29779-R504A, 29779-W502,29779-R505B,21762-R157A,16175-R16T, 16175-R16T1,29779-R506A,21762-DTP155E,21762-R151, 21762-R154A,21762-R139,21762-R140,21762-R143,21762-R150, 21762-W137 AND 21762-W148.

Revision Details	By	Check	Date	Suffix
First Issue	EZ	GK	18/09/17	P01
Second Issue	EZ	GK	26/04/18	P02

Purpose of issue

FOR REVIEW & COMMENT

Client
Highways England
The Cube
199 Wharfside Street
Birmingham
B1 1RN

Working on behalf of highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GEOLOGICAL SECTION 08
CH 8400M TO 9700M

Designed	Drawn	Checked	Approved	Date
OL	EZ	OL	GK	26/04/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone / Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
Tel:
Fax:

AmW
AECOM + mace + WSP

Drawing Number
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0008
Rev P02

Plot Time - 10:00
Plot Date - ---
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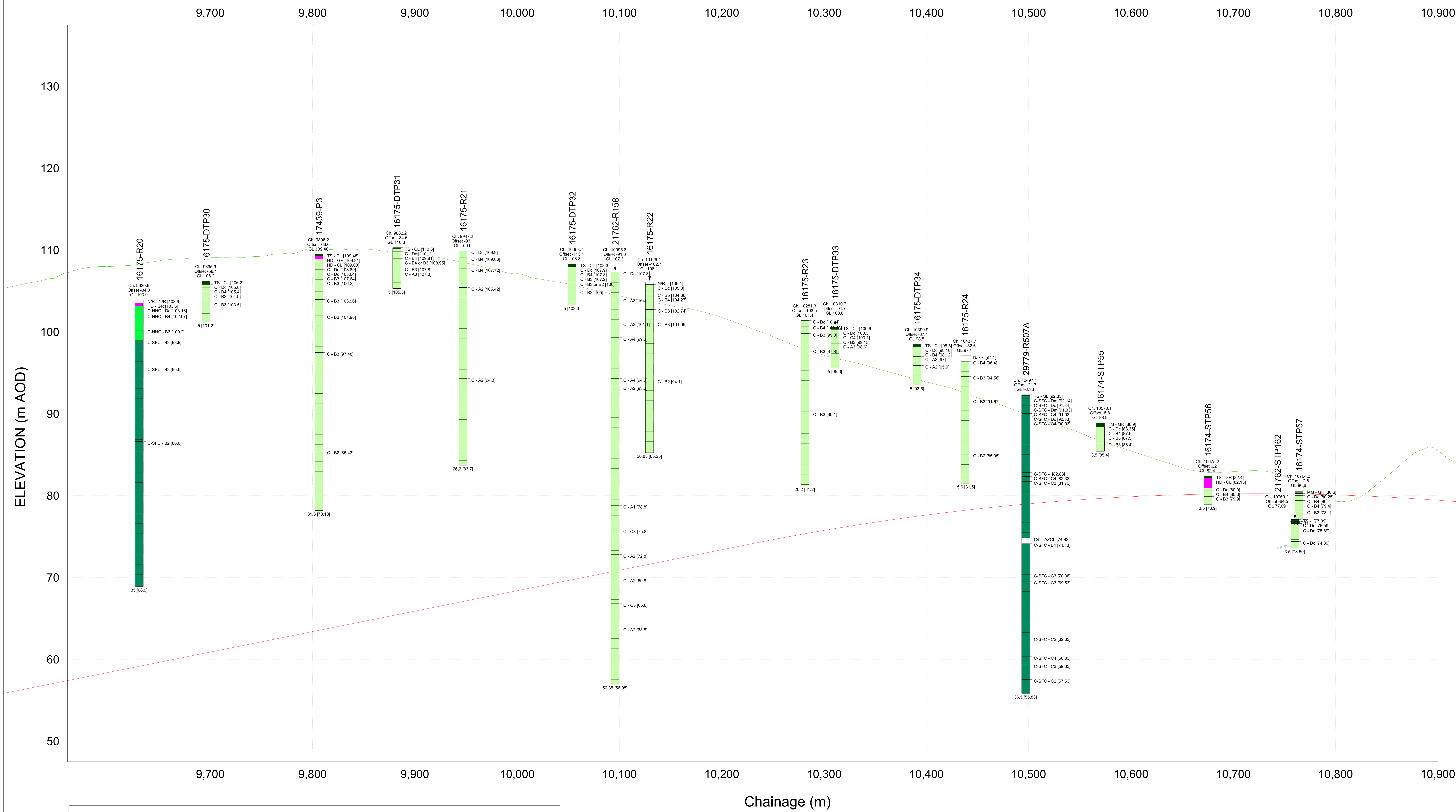

GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferetiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

SECTION KEY:

- 21762-R126 — HAGDMS No. and Hole ID
- Ch. 9121.9 / Offset -71.1 / GL 79.40 — Chainage / Offset from Centreline of Alignment / Ground Level
- TS - CL [80.8], C - Dc [78.2] — Stratum and Principal Soil Type or CIRIA Chalk Grade [Reduced Level to Top of Stratum]
- Water Rise Depth — 3.0
- Water Strike Depth — 5.9
- 6.2 [73.2] — Hole Base Depth [Reduced Level]
- Existing Ground Level
- Proposed Level
- Moved Hole

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

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CONSTRUCTION

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7. FOR CLARITY PURPOSE ONLY SELECTED EXPLORATORY HOLES LOCATED WITHIN 250m SEARCH BUFFER EITHER SIDE OF THE CENTRELINE OF THE ALIGNMENT ARE SHOWN ON THE GEOLOGICAL SECTION. EXPLORATORY HOLE THAT HAVE NOT BEEN SELECTED WITHIN THE BUFFER ARE 21762-DTP159,21762-DTP160 AND 16175-DTP35.

Revision Details	By	Check	Date	Suffix
First Issue	EZ	GK	18/09/17	P01
Second Issue	OL	GK	20/09/17	P02
Second Issue	EZ	GK	26/04/18	P03

Purpose of issue

FOR REVIEW & COMMENT

Client
Highways England
The Cube
199 Wharfside Street
Birmingham
B1 1RN

Working on behalf of highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GEOLOGICAL SECTION 09 CH 9700M TO 10800M

Designed	Drawn	Checked	Approved	Date
OL	EZ	OL	GK	26/04/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
Tel:
Fax:

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR -CE -0009
Location | Type | Role | Number
Rev P03

Plot Time : 10:00
Plot Date : ---
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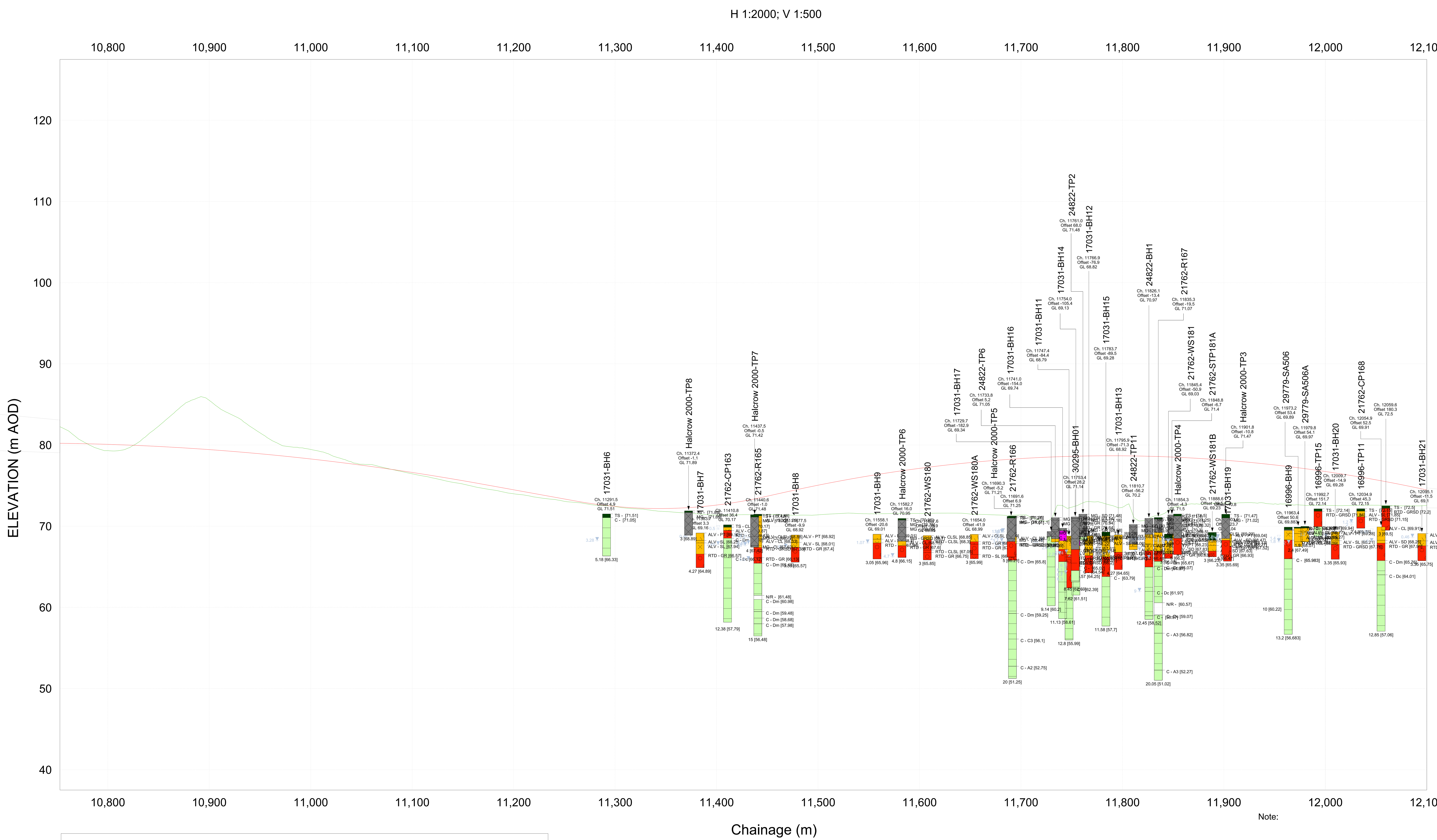
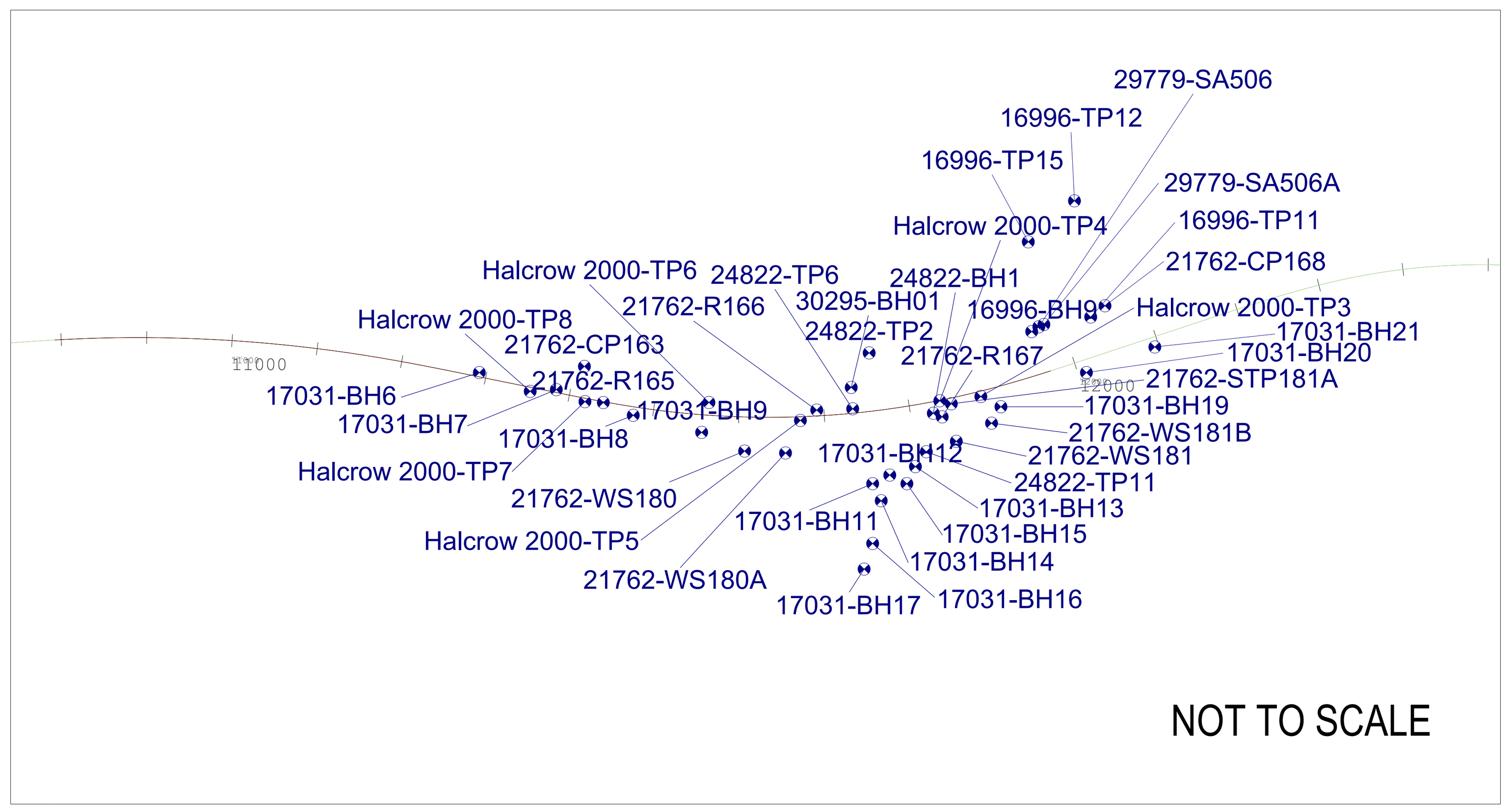
H 1:2000; V 1:500





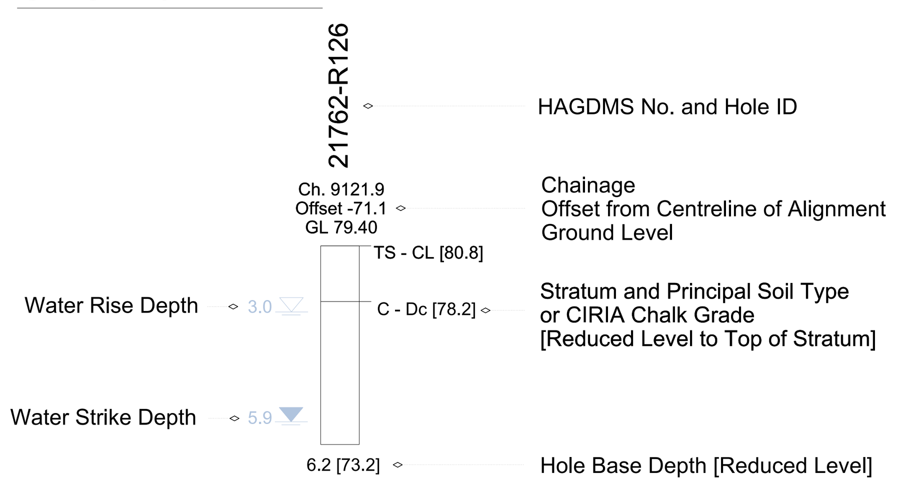
GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferetiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

SECTION KEY:



- Existing Ground Level
- Proposed Level
- Moved Hole

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4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
5. MAINLINE ROAD PROFILE AND HORIZONTAL ALIGNMENT BASED ON VERSIONS P03.
6. SOME EXPLORATORY HOLES MAY HAVE BEEN MOVED FOR PURPOSES OF CLARITY WHERE DEFINED ON THE DRAWING.
7. FOR CLARITY PURPOSE ONLY SELECTED EXPLORATORY HOLES LOCATED WITHIN 250m SEARCH BUFFER EITHER SIDE OF THE CENTRELINE OF THE ALIGNMENT ARE SHOWN ON THE GEOLOGICAL SECTION. EXPLORATORY HOLE THAT HAVE NOT BEEN SELECTED WITHIN THE BUFFER ARE 21762-STP164,29779-SA505,17031-BH10,24822-TP4,24822-TP5, 24822-TP7,24822-TP9,24822-TP8,24822-TP3,24822-TP1, 24822-TP10,17031-BH18,24822-BH2,16996-PH14 AND 6996-TP17.

Revision Details	By	Check	Date	Suffix
First Issue	EZ	GK	18/09/17	P01
Second Issue	EZ	GK	26/04/18	P02
Third Issue – added holes	EZ	GK	17/08/18	P03

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge Amesbury to Berwick Down

Drawing Title

GEOLOGICAL SECTION 10 CH 10800M TO 12000M

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR-CE-0010
Location | Type | Role | Number

Rev P03

Plot Time : 10:00
Plot Date : 13 February 2018 12:16:20
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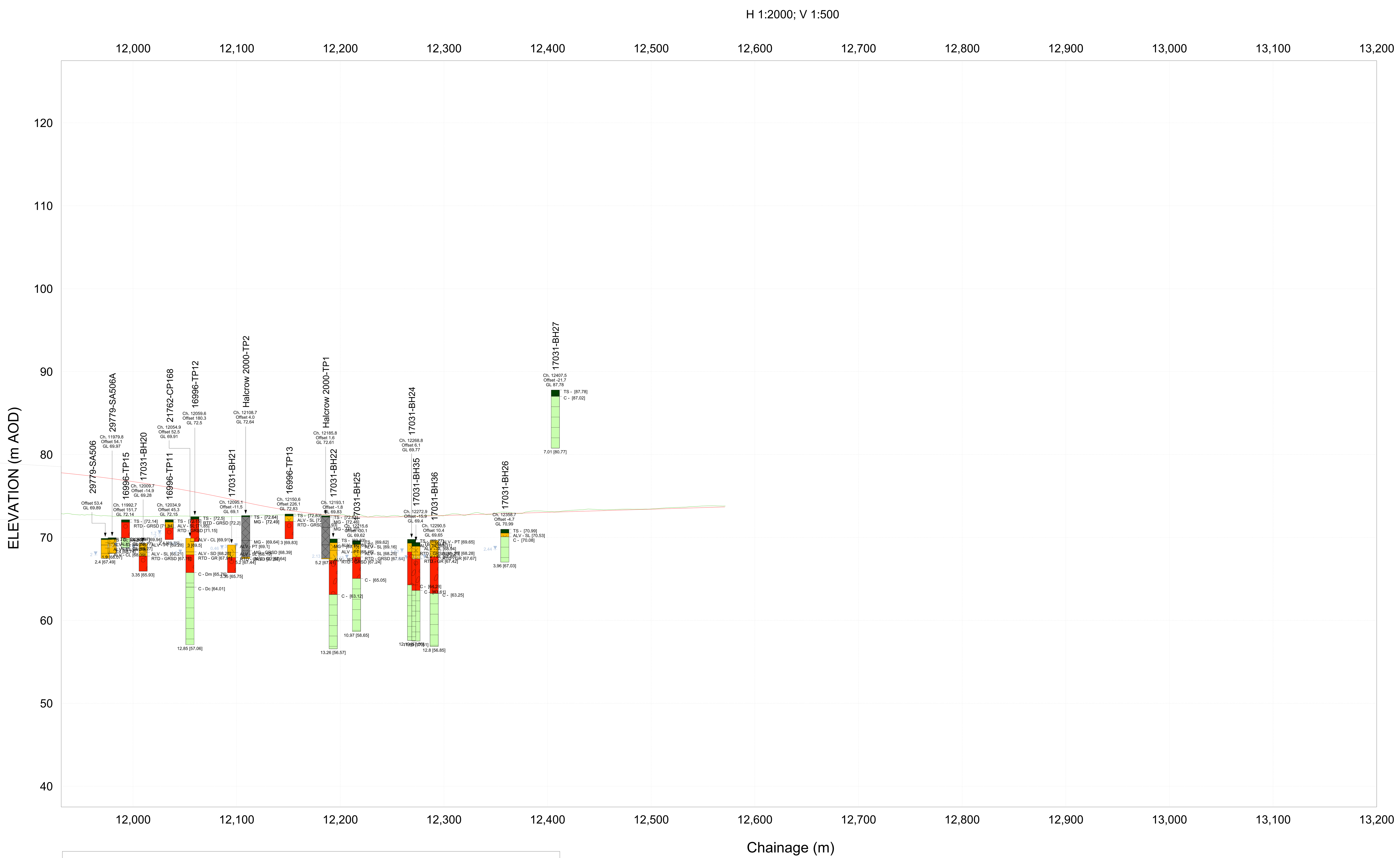
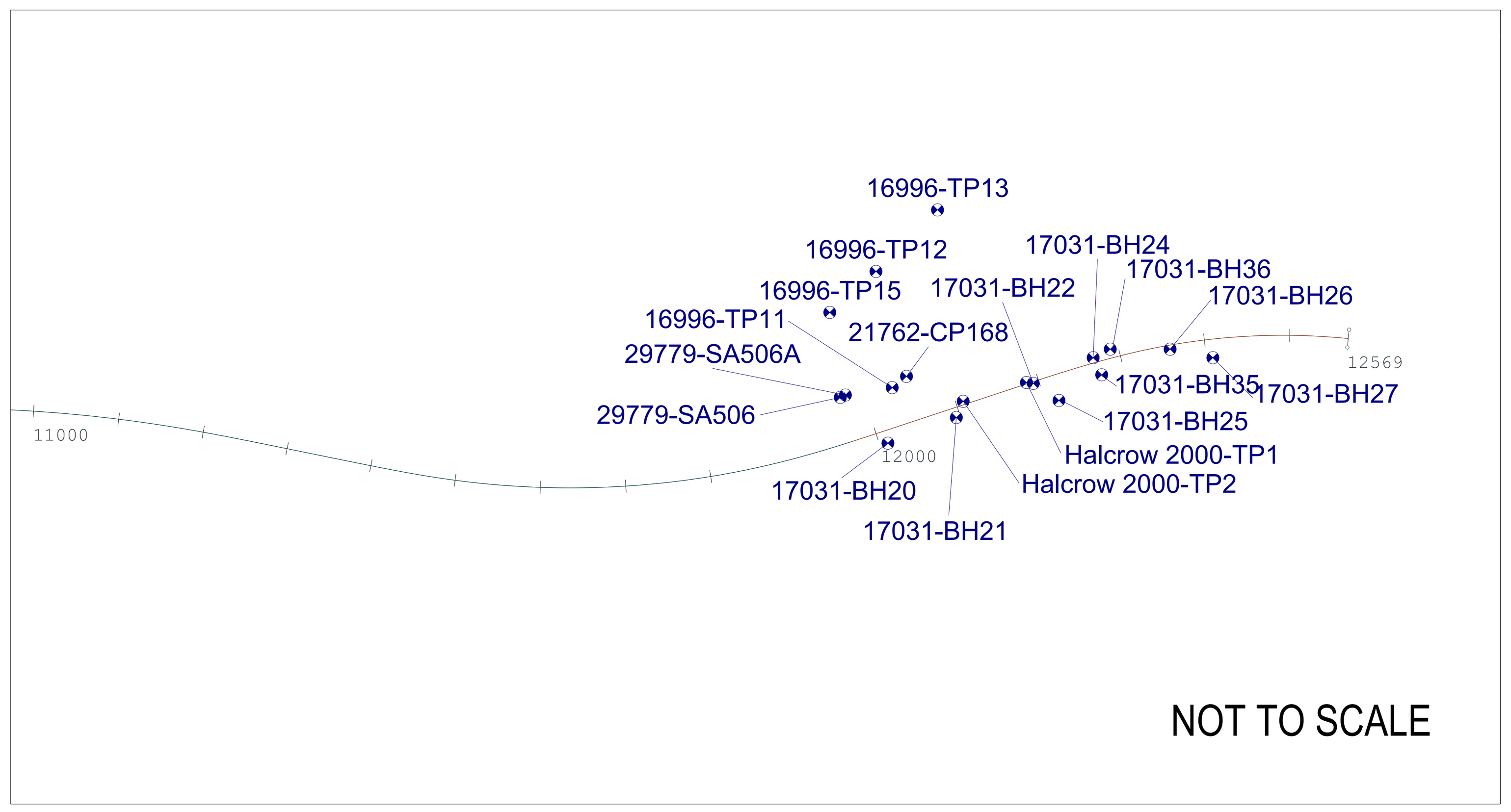




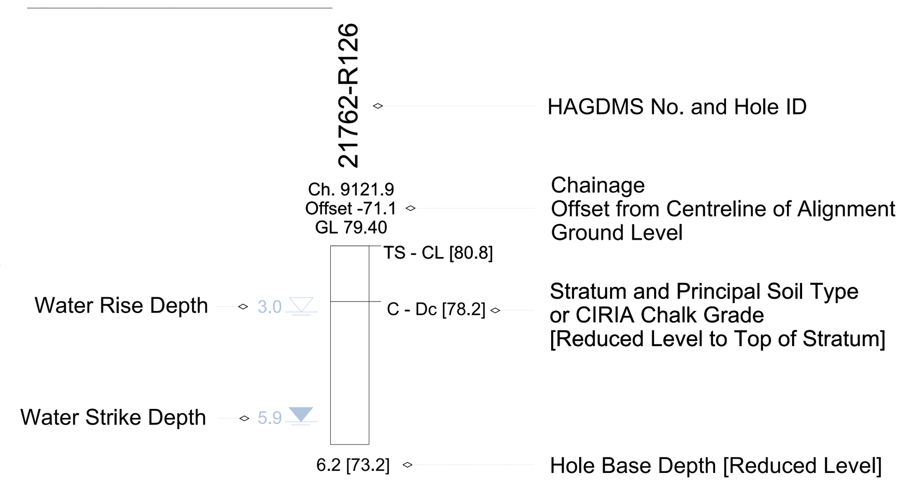
GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferetiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

SECTION KEY:



- Existing Ground Level
- Proposed Level
- Moved Hole

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5. MAINLINE VERTICAL PROFILE AND HORIZONTAL ALIGNMENT BASED ON P09 AND P03 RESPECTIVELY.
6. SOME EXPLORATORY HOLES MAY HAVE BEEN MOVED FOR PURPOSES OF CLARITY WHERE DEFINED ON THE DRAWING.
7. ONLY EXPLORATORY HOLES LOCATED WITHIN 250m SEARCH BUFFER EITHER SIDE OF THE CENTRELINE OF THE ALIGNMENT ARE SHOWN ON THE GEOLOGICAL SECTION.

Revision Details	By	Check	Date	Suffix
First Issue	EZ	GK	18/09/17	P01
Second Issue	EZ	GK	26/04/18	P02
Third Issue – added holes	EZ	GK	17/08/18	P03

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

**GEOLOGICAL SECTION 11
CH 12000M TO 12572M**

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number

Highways England PIN | Originator | Volume | Location | Type | Role | Number

HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0011

Rev P03

Plot Time : 10:00
Plot Date : 13 February 2018 12:16:20
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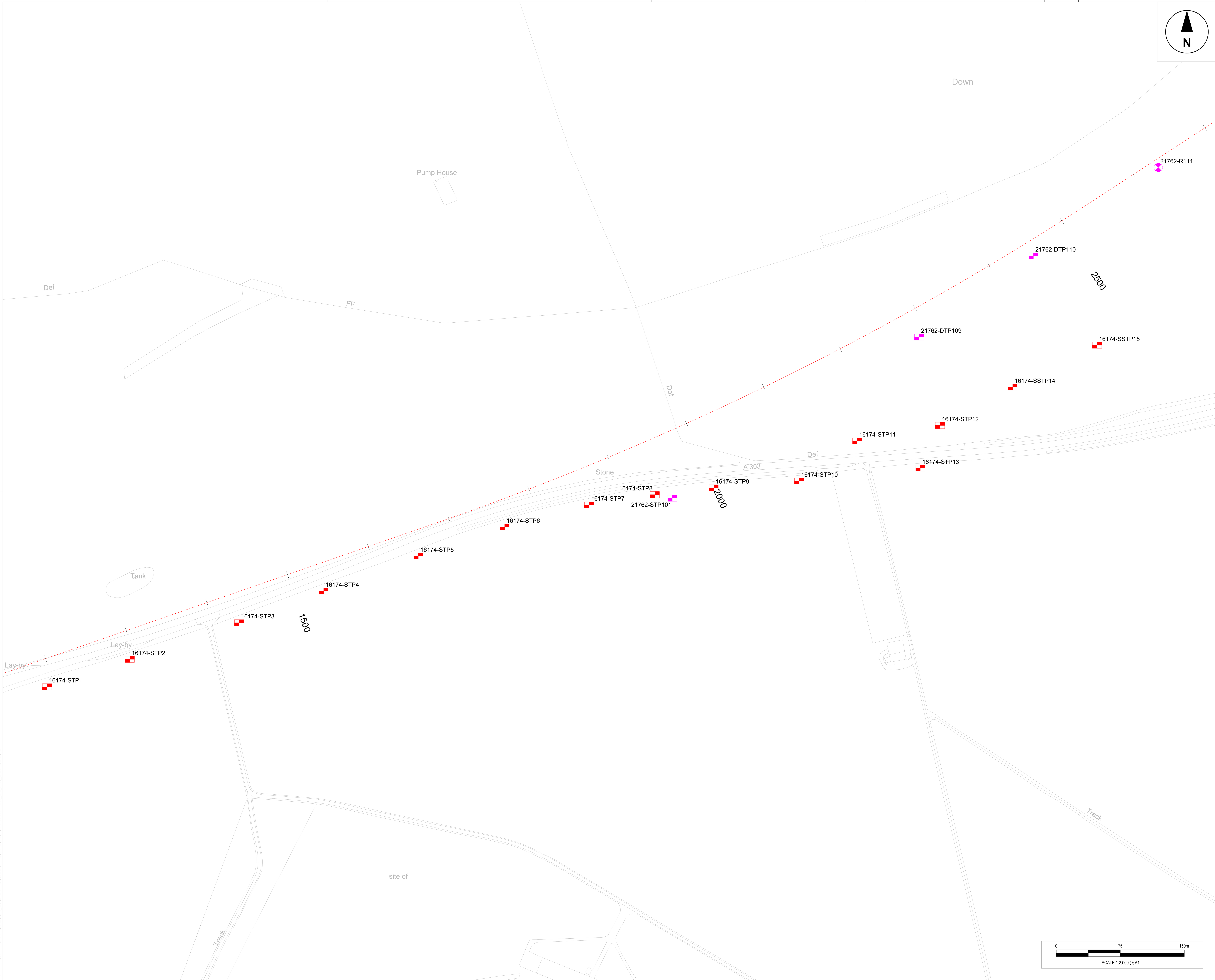

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	26/04/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
EXPLORATORY HOLES LOCATION PLAN - SHEET 1

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR-CE-0012
Location | Type | Role | Number
Rev
P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
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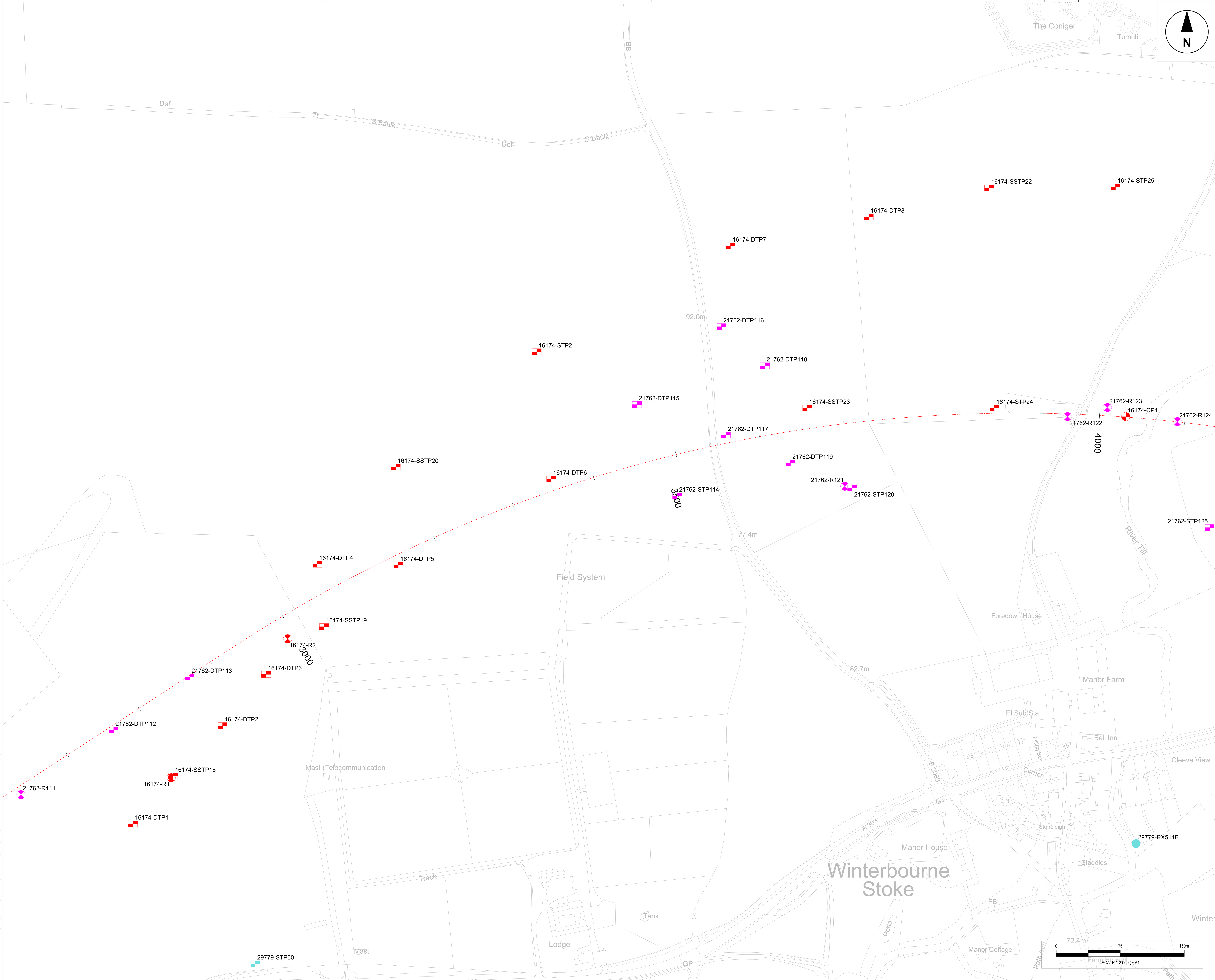

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	26/04/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge Amesbury to Berwick Down

Drawing Title

EXPLORATORY HOLES LOCATION PLAN - SHEET 2

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

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Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR -CE -0013
Location | Type | Role | Number

Rev
P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
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N

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DOCUMENTATION.
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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	26/04/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

EXPLORATORY HOLES LOCATION PLAN - SHEET 3

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0014
Location | Type | Role | Number

Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name: C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0014

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label	
Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Revision Details	By	Check	Date	Suffix
First Issue	EZ	GK	26/04/18	P01
Second Issue – added holes & updated legend	EZ	GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

EXPLORATORY HOLES LOCATION PLAN - SHEET 4

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

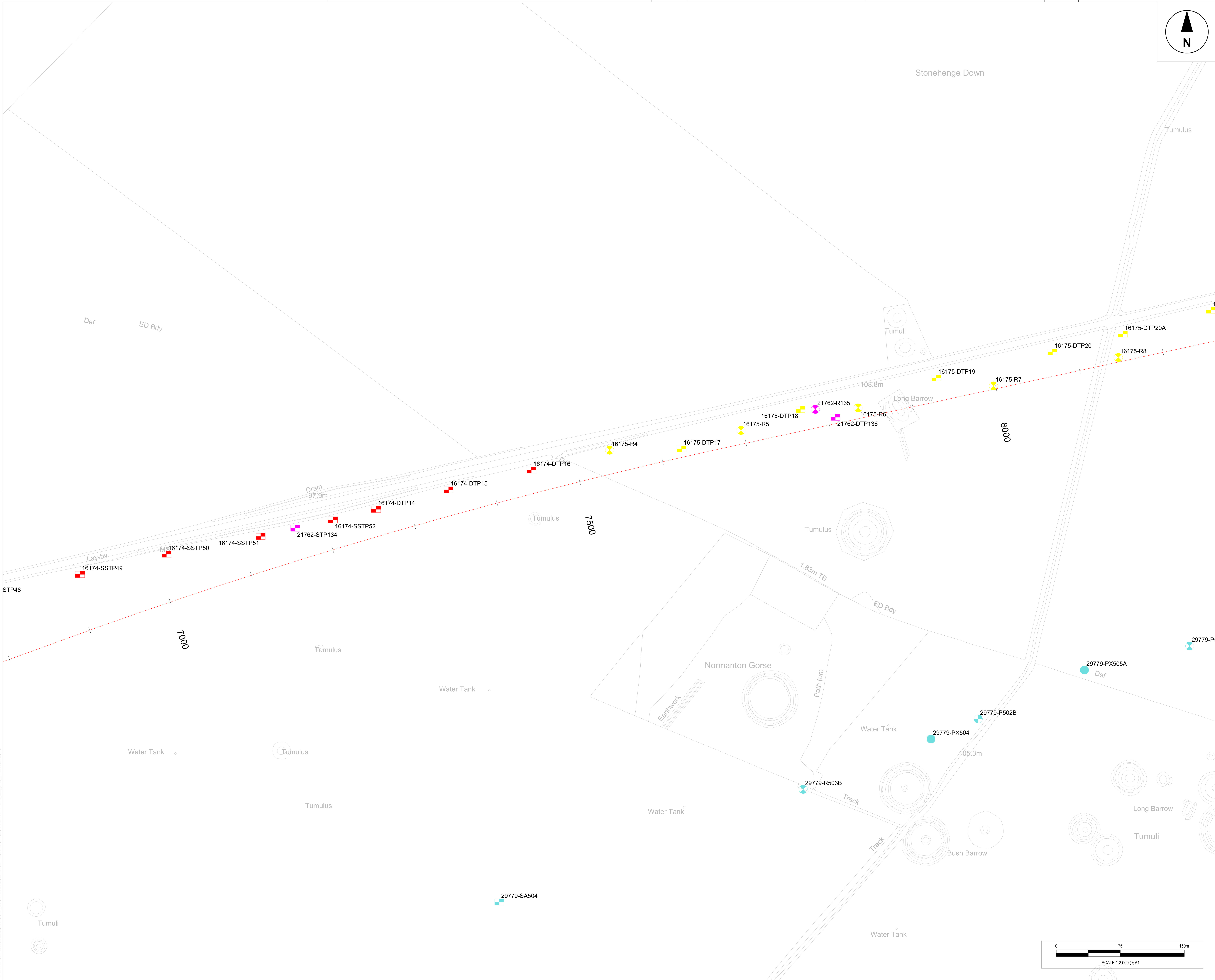
Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0015
Location | Type | Role | Number

Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0015



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4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Revision Details	By	Check	Date	Suffix
First Issue	EZ	GK	26/04/18	P01
Second Issue – updated legend	EZ	GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title
A303 Stonehenge Amesbury to Berwick Down

Drawing Title
EXPLORATORY HOLES LOCATION PLAN - SHEET 5

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR -CE -0016
Location | Type | Role | Number

Rev
P02

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	26/04/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge Amesbury to Berwick Down

Drawing Title

EXPLORATORY HOLES LOCATION PLAN - SHEET 6

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT - SW_ML_M00_Z -DR-CE-0017
Location | Type | Role | Number

Rev
P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
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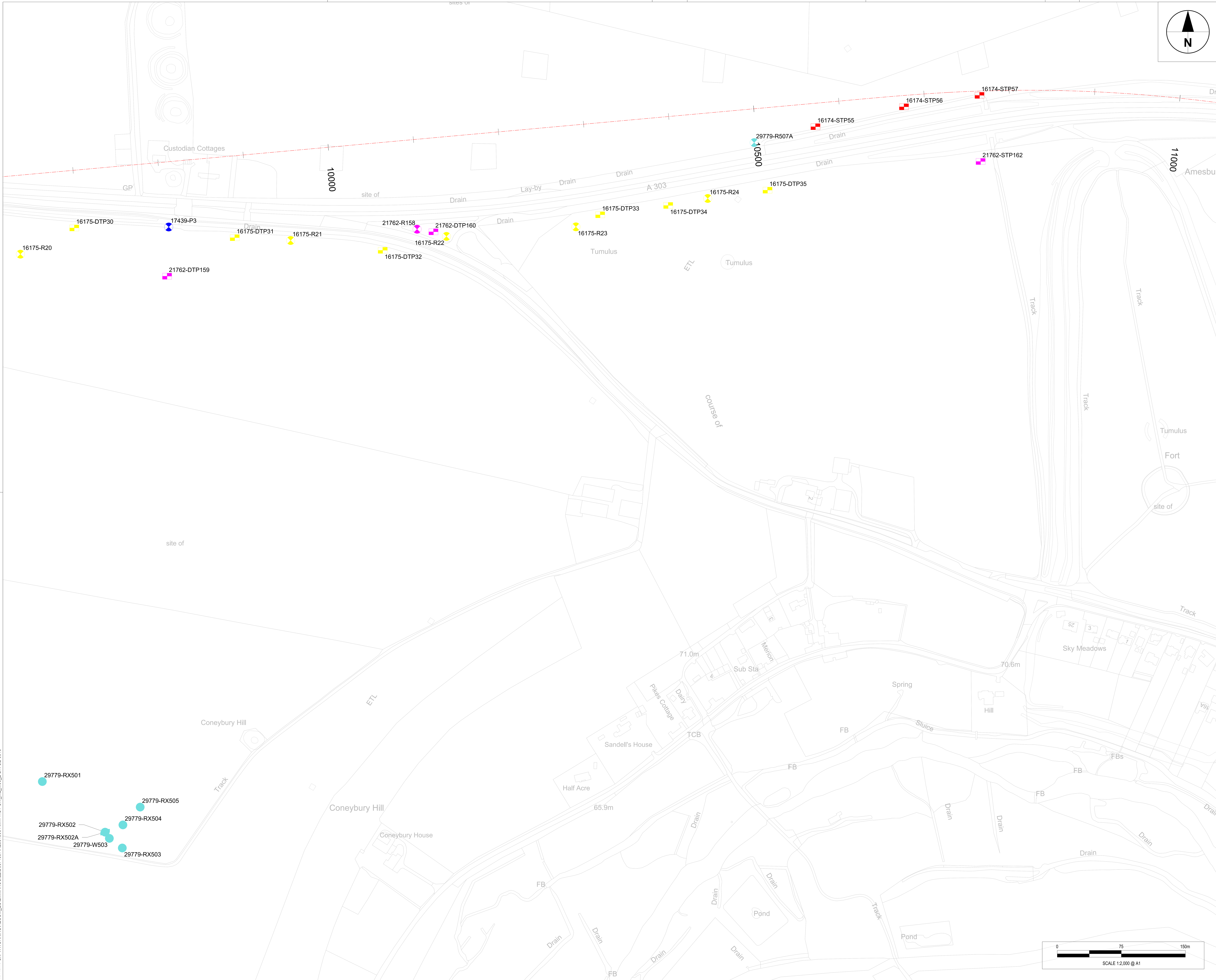

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	26/04/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
EXPLORATORY HOLES LOCATION PLAN - SHEET 7

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439 | Suitability S3
Scale @ A1 1:2000 | Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0018
Location | Type | Role | Number
Rev P02

Plot Time : 15:00
Plot Date : 13 June 2018 14:54:45
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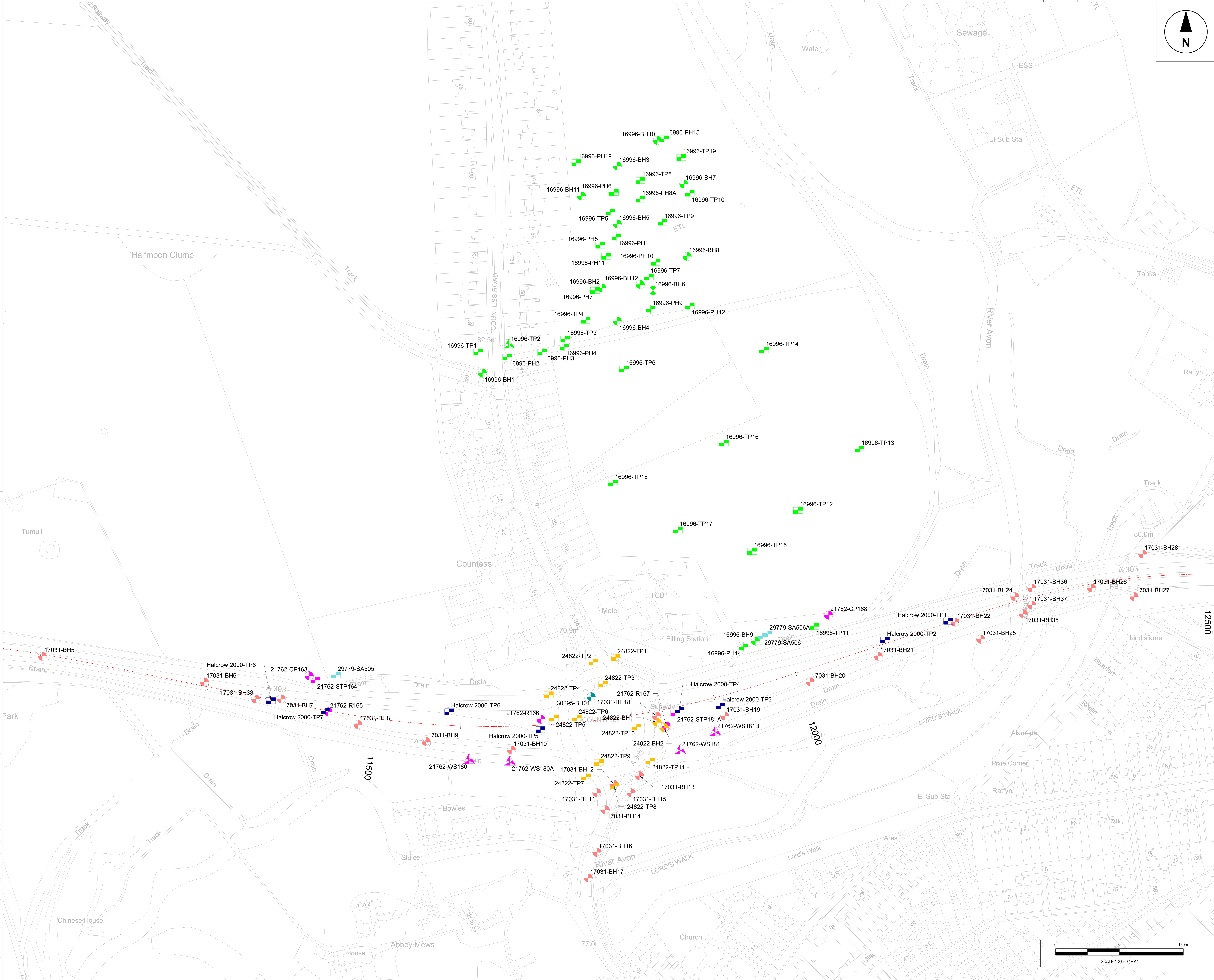

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Symbol	Type
Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	26/04/18	P01
Second Issue – added holes & updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

EXPLORATORY HOLES LOCATION PLAN - SHEET 8

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0019
Location | Type | Role | Number

Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0019

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4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 16175, 16996, 17031, 17439, 21762, 24822, 24930, 29779, 30295, Halcrow 2000

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	26/04/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
EXPLORATORY HOLES LOCATION PLAN - SHEET 9

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:5000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT - SW_ML_M00_Z -DR-CE-0020
Location | Type | Role | Number
Rev P02

Plot Time :10:00
Plot Date :17 August 2018 17:06:52
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0020

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 16175, 16996, 17031, 17439, 21762, 24822, 24930, 29779, 30295, Halcrow 2000

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	26/04/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

EXPLORATORY HOLES LOCATION PLAN - SHEET 10

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No.	Suitability
60541439	S3
Scale @ A1	Zone
1:10000	Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR -CE -0021
Location | Type | Role | Number

Rev
P02

Plot Time : 10:00
Plot Date : 17 August 2018 17:08:55
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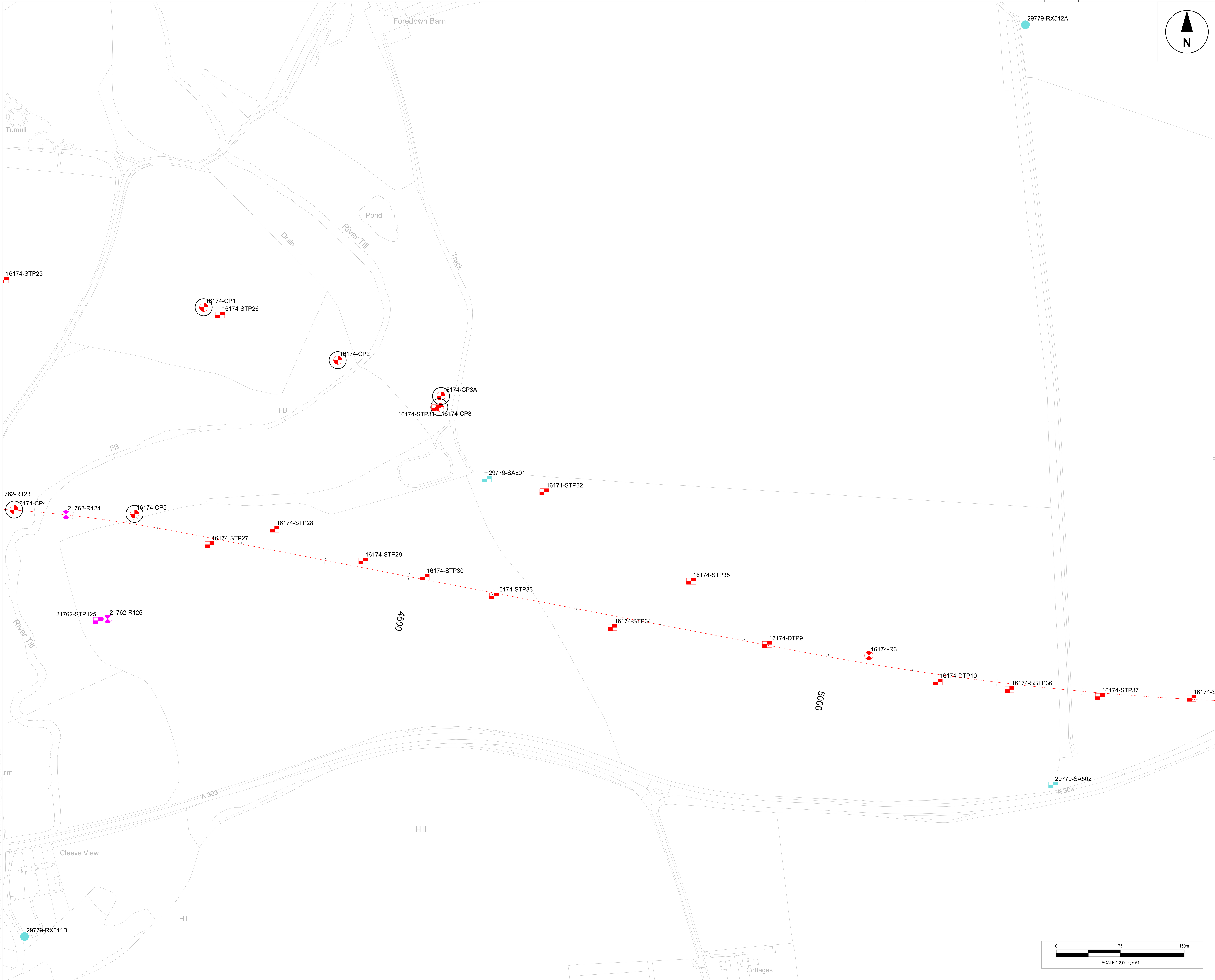

Plot Time : 10:00
Plot Date : 13 February 2018 12:16:20
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0022

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Symbol	Type
Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

SPT Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - SPT LOCATIONS - SHEET 1

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

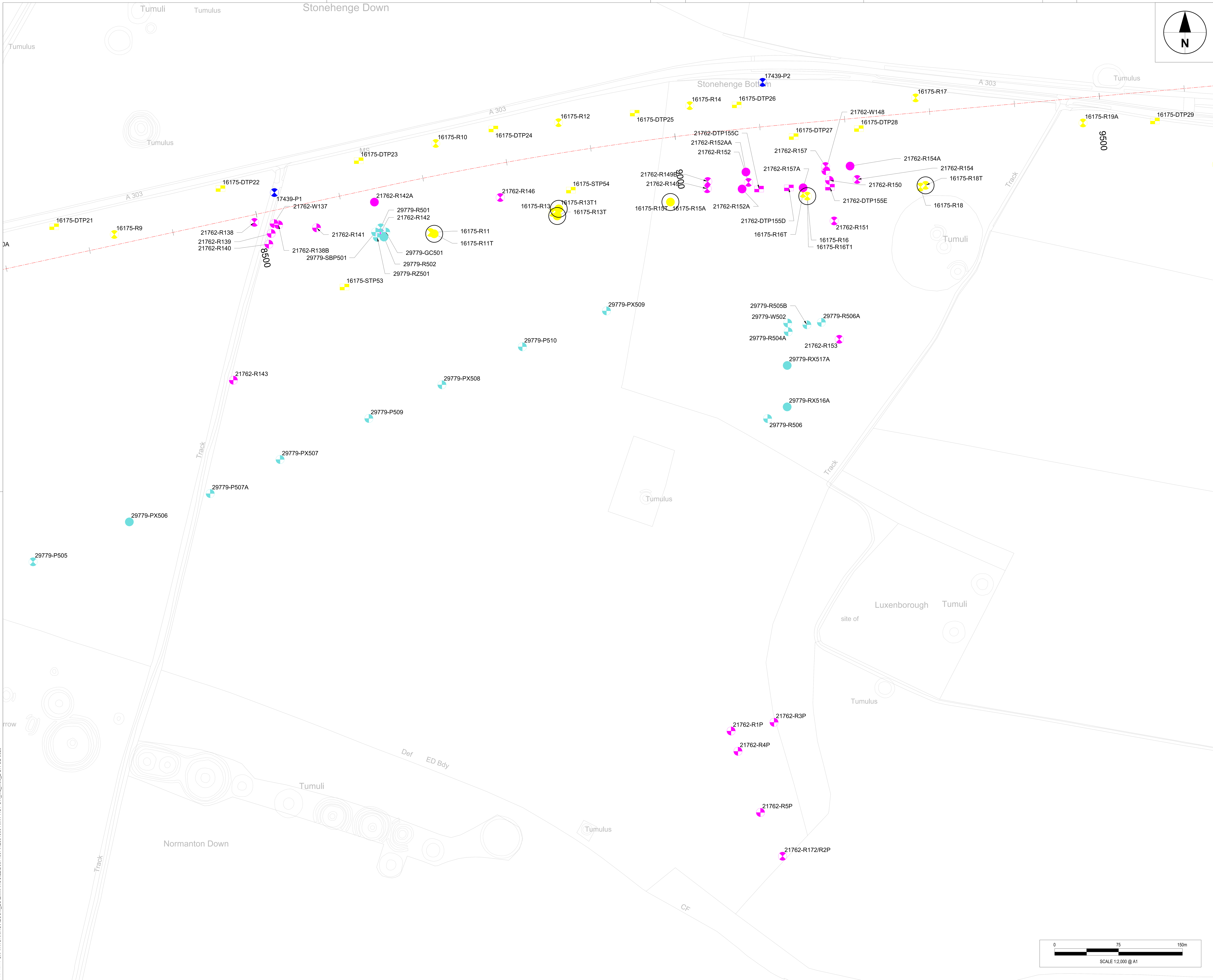
Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0022
Location | Type | Role | Number

Rev P02



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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC
SPT Location

Revision Details	By	Check	Date	Suffix
First Issue	EZ	GK	15/06/18	P01
Second Issue – updated legend	EZ	GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - SPT LOCATIONS - SHEET 2

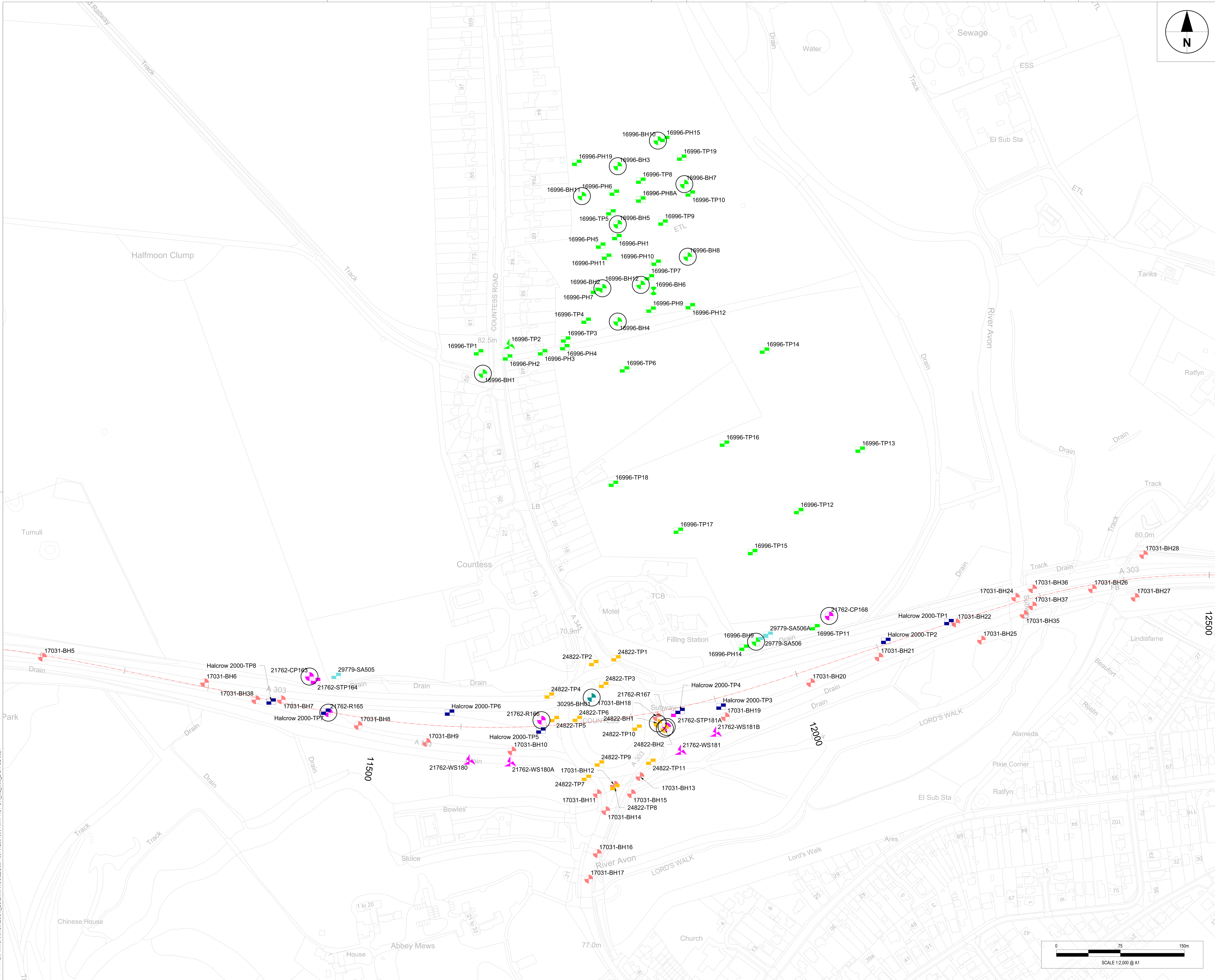
Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0023
Location | Type | Role | Number
Rev P02

Plot Time : 10:00
Plot Date : 13 February 2018 12:16:20
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0023



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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 16175, 16996, 17031, 17439, 21762, 24822, 24930, 29779, 30295, Halcrow 2000

Label CP | Label TP | Label RC | Label RO | Label BH | Label WS | Label CP+RC | Label RO+RC | SPT Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – added holes & updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

highways england

The Cube
199 Wharfside Street
Birmingham
B1 1RN

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - SPT LOCATIONS - SHEET 3

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR -CE -0024
Location | Type | Role | Number

Rev P02

Plot Time : 13:00
Plot Date : 13 February 2018 12:16:20
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0024

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC
In-situ CBR Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - IN-SITU CBR LOCATIONS - SHEET 1

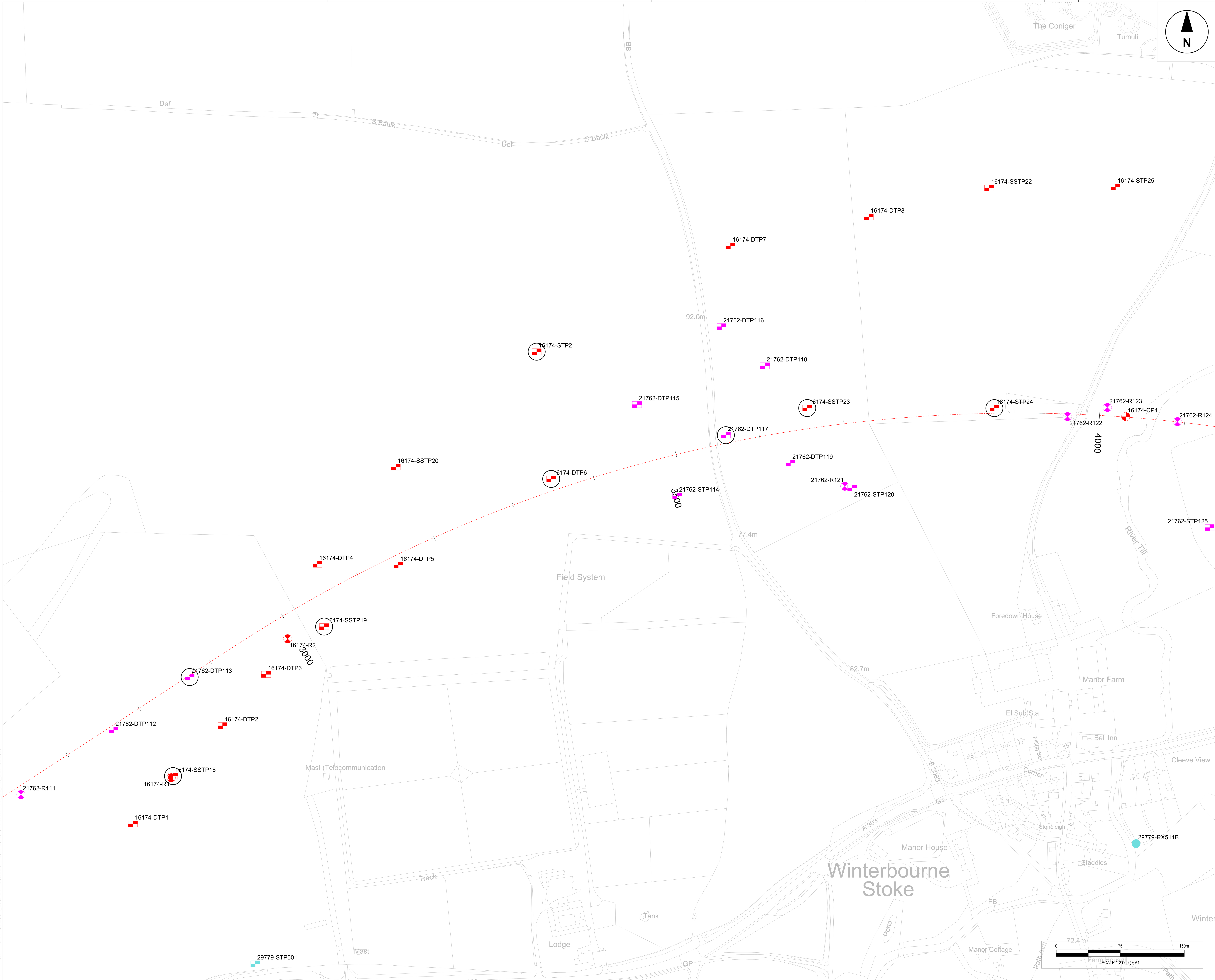
Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR-CE-0025
Location | Type | Role | Number
Rev
P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0025



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4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

In-situ CBR Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - IN-SITU CBR LOCATIONS - SHEET 2

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT - SW_ML_M00_Z -DR-CE-0026
Location | Type | Role | Number

Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0026

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

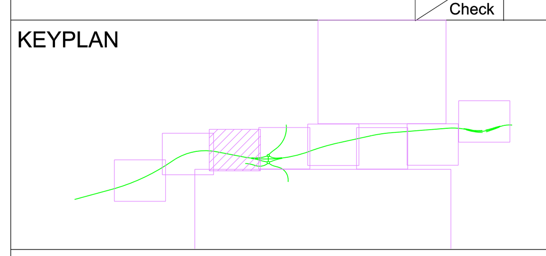
16174, 16175, 16996, 17031, 17439, 21762, 24822, 24930, 29779, 30295, Halcrow 2000

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

In-situ CBR Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN



Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - IN-SITU CBR LOCATIONS - SHEET 3

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No.	Suitability
60541439	S3
Scale @ A1	Zone
1:2000	Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR-CE-0027
Location | Type | Role | Number

Rev
P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0027

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Symbol	Type
Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

In-situ CBR Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – added holes & updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - IN-SITU CBR LOCATIONS SHEET 4

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR-CE-0028
Location | Type | Role | Number

Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
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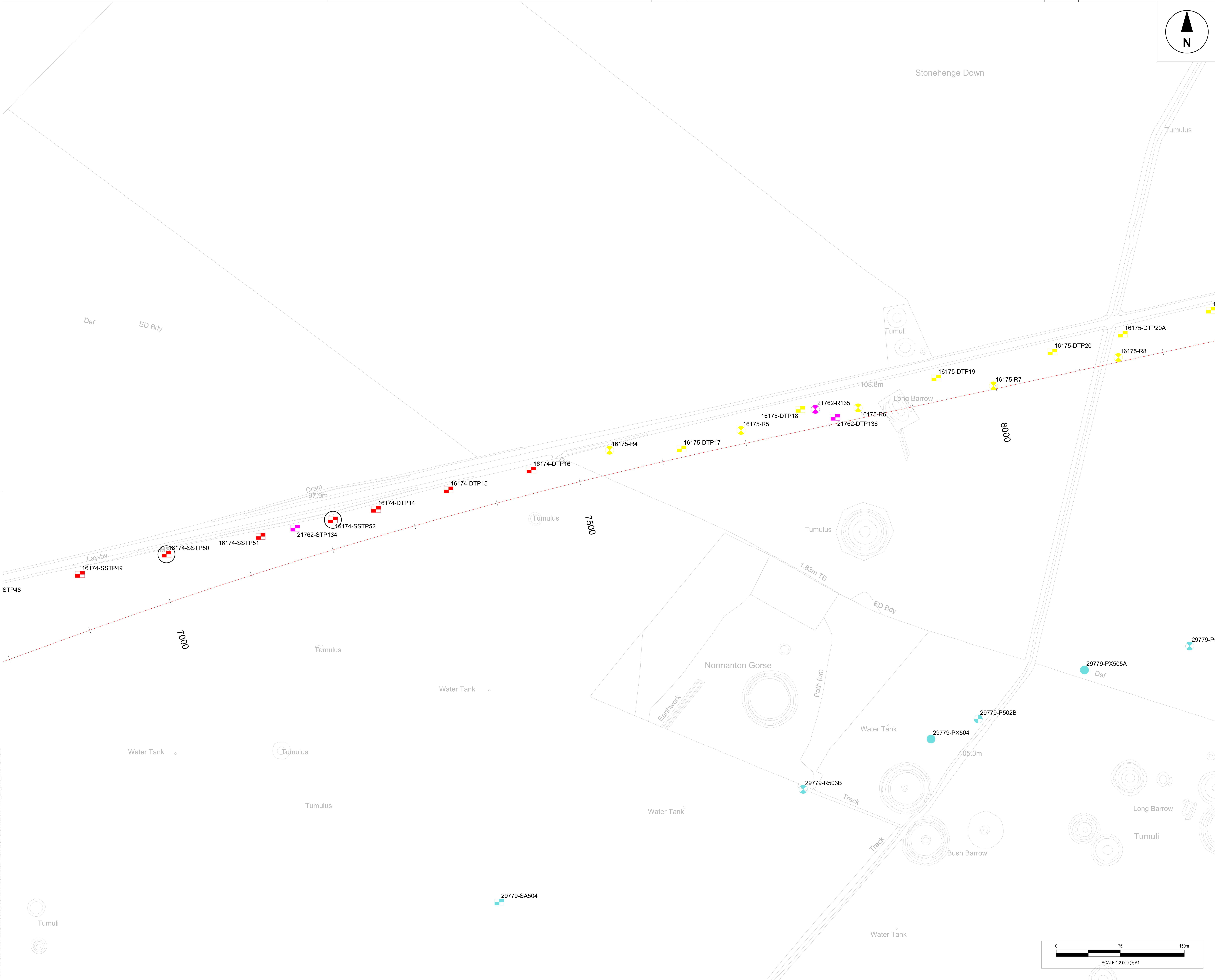

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 16175, 16996, 17031, 17439, 21762, 24822, 24930, 29779, 30295, Halcrow 2000

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC
In-situ CBR Location

Revision Details	By	Check	Date	Suffix
First Issue	EZ	GK	15/06/18	P01
Second Issue – updated legend	EZ	GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - IN-SITU CBR LOCATIONS SHEET 5

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No.	Suitability
60541439	S3
Scale @ A1	Zone
1:2000	Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT-SW_ML_M00_Z -DR-CE-0029
Location | Type | Role | Number
Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
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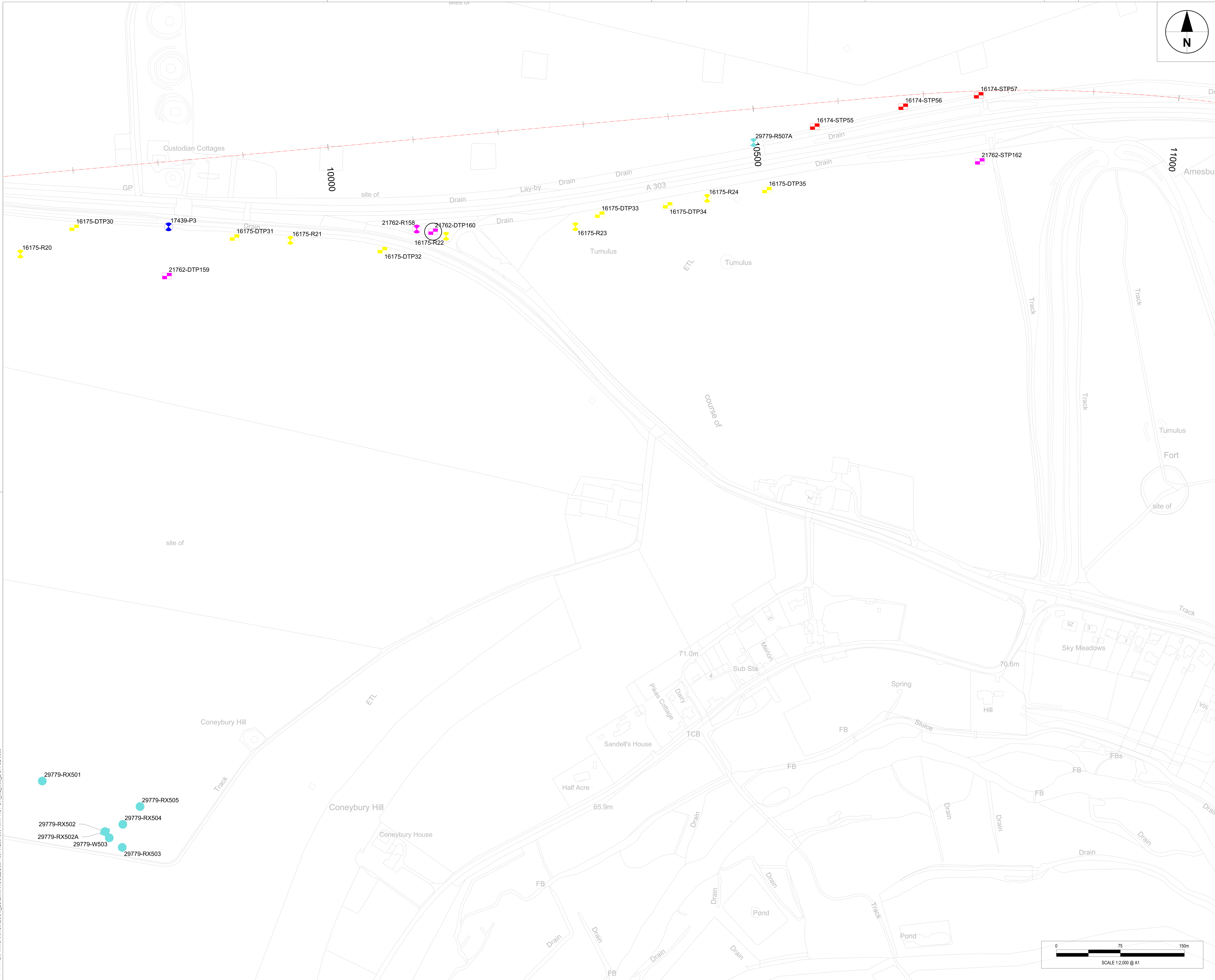

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC
In-situ CBR Location

Revision Details	By	Check	Date	Suffix
First Issue	EZ	GK	15/06/18	P01
Second Issue – updated legend	EZ	GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - IN-SITU CBR LOCATIONS SHEET 6

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0030
Location | Type | Role | Number
Rev P02

Plot Time : 15:00
Plot Date : 13 June 2018 14:54:45
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0030

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Plate Load Test Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - PLATE LOAD TEST LOCATIONS - SHEET 1

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

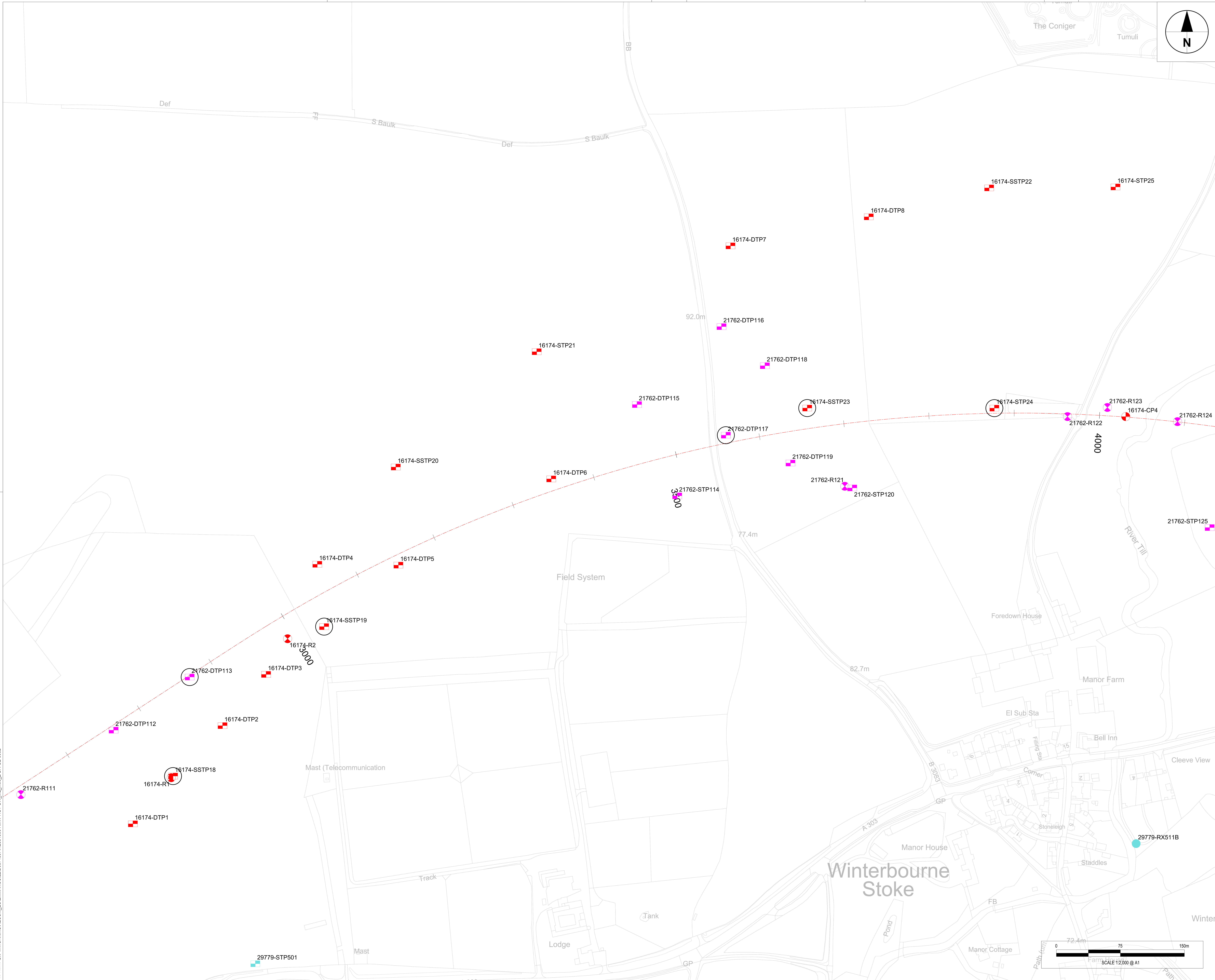
Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR -CE -0031
Location | Type | Role | Number

Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0031



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LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Symbol	
Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Plate Load Test Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - PLATE LOAD TEST LOCATIONS - SHEET 2

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

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Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0032
Location | Type | Role | Number
Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name: C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0032

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

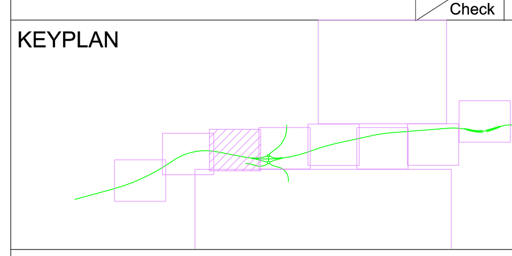
16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Symbol	Type
Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Plate Load Test Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN



Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - PLATE LOAD TEST LOCATIONS - SHEET 3

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume | Location | Type | Role | Number
HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0033

Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name: C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0033

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 16175, 16996, 17031, 17439, 21762, 24822, 24930, 29779, 30295, Halcrow 2000

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

Plate Load Test Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – added holes & updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - PLATE LOAD TEST LOCATIONS - SHEET 4

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

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Bristol, BS1 6HA

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AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR-CE-0034
Location | Type | Role | Number

Rev
P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
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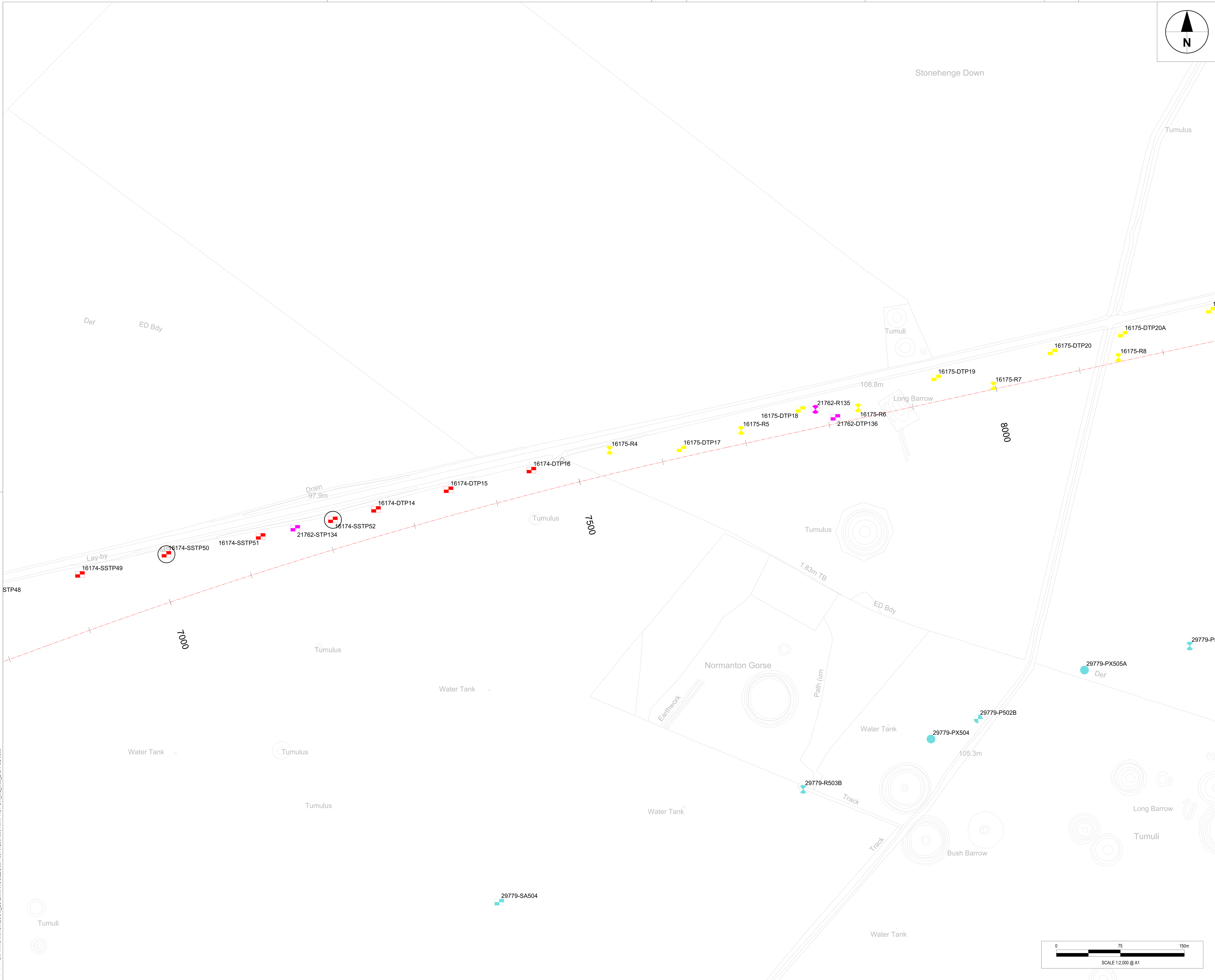

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 16175, 16996, 17031, 17439, 21762, 24822, 24930, 29779, 30295, Halcrow 2000

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

Plate Load Test Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - PLATE LOAD TEST LOCATIONS - SHEET 5

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR -CE -0035
Location | Type | Role | Number

Rev
P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
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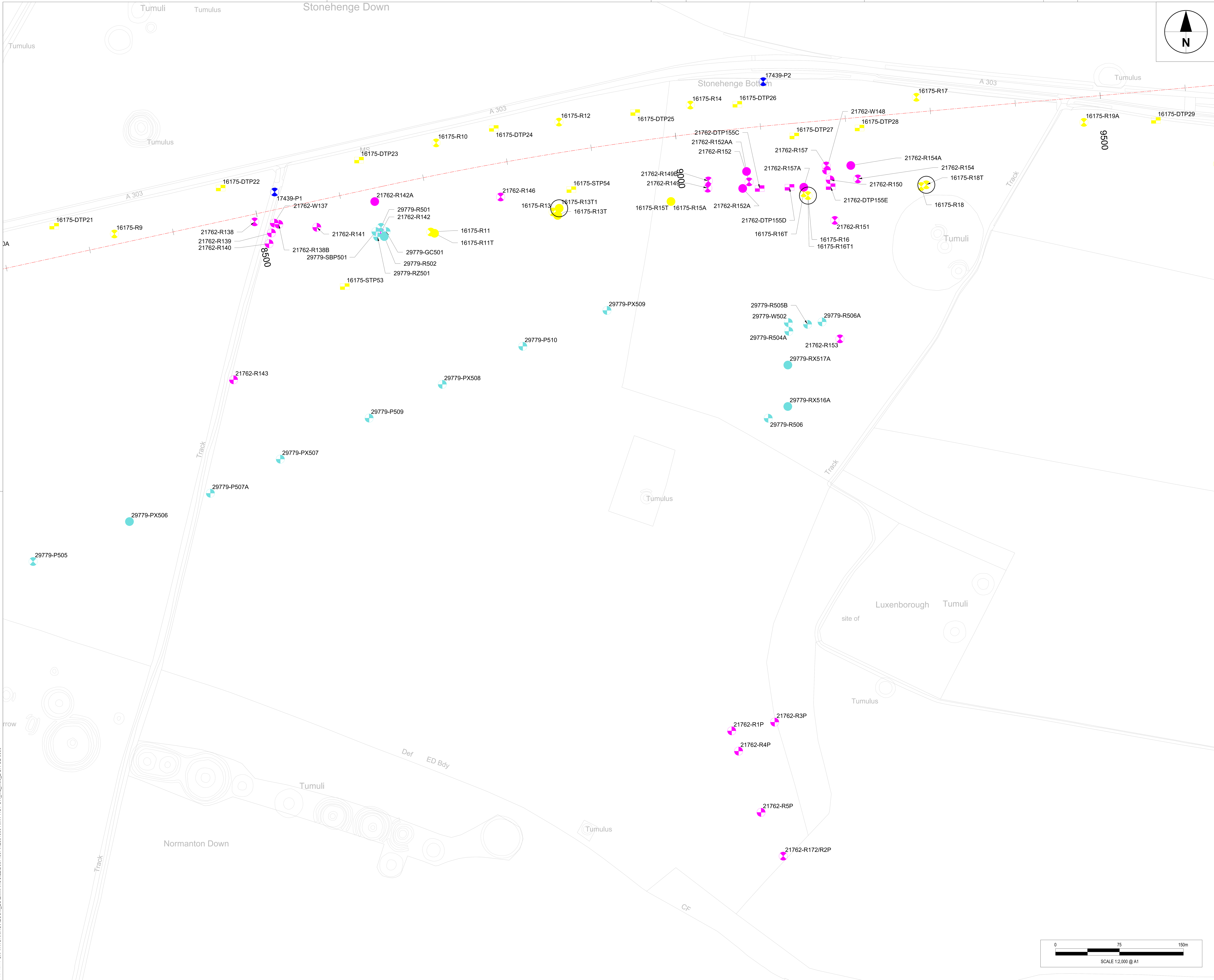

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

High Pressure Dilatometer Test Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - HPD PRESSUREMETER TEST LOCATIONS - SHEET 1

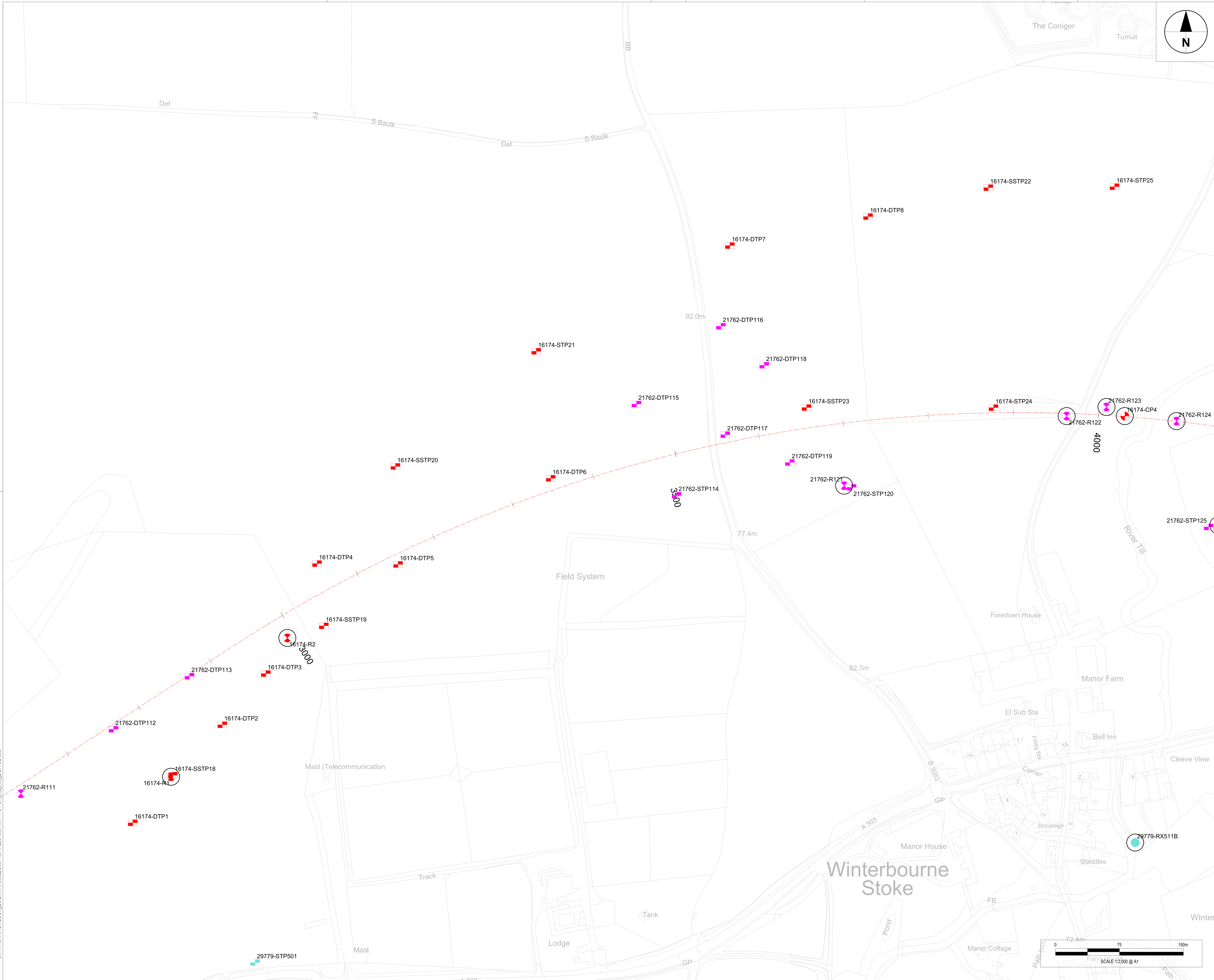
Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR -CE -0036
Location | Type | Role | Number
Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name: C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0036



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4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

Standpipe Piezometer Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - STANDPIPE PIEZOMETERS LOCATIONS - SHEET 1

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume | Location | Type | Role | Number
HE551506 -AMW -HGT - SW_ML_M00_Z -DR-CE-0037

Rev P02

Plot Time : 15:00
Plot Date : 13 June 2018 14:54:45
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0037

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Symbol	Type
Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Standpipe Piezometer Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - STANDPIPE PIEZOMETERS LOCATIONS - SHEET 2

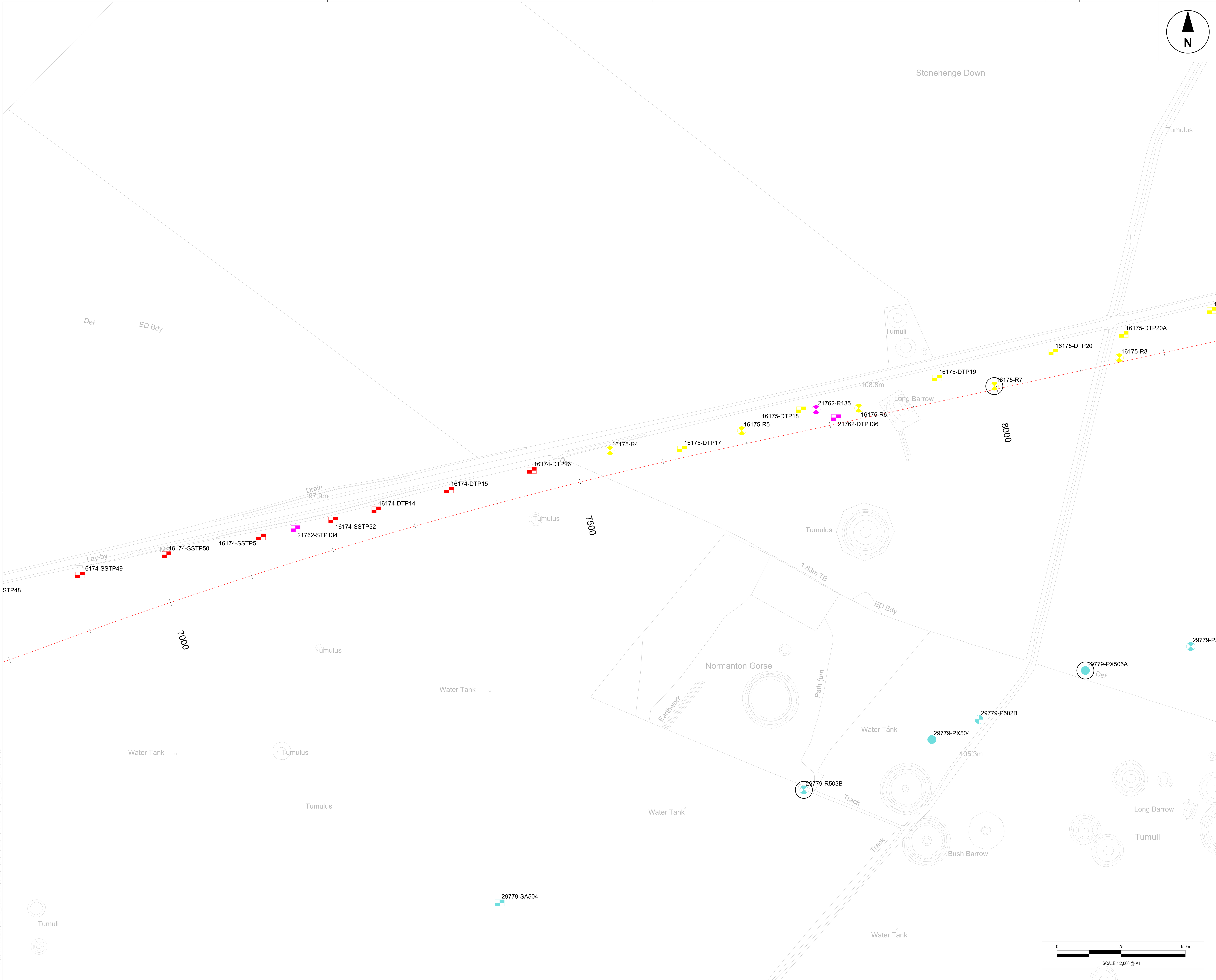
Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0038
Location | Type | Role | Number
Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name: C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0038



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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

Standpipe Piezometer Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – changed drawing sheet number & updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - STANDPIPE PIEZOMETERS LOCATIONS - SHEET 4

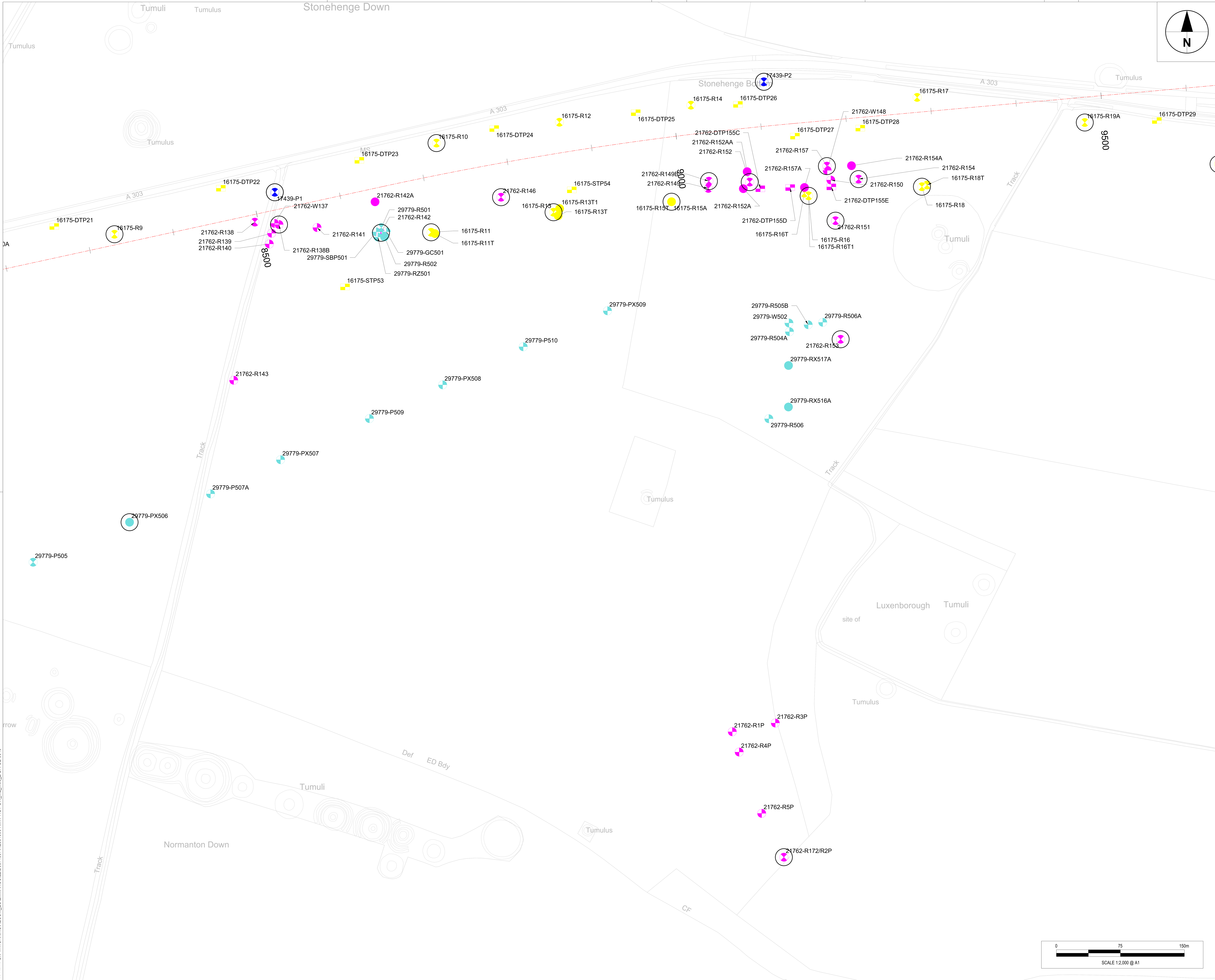
Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR-CE-0039
Location | Type | Role | Number
Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name: C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0039



Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0040

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP	Standpipe Piezometer Location
Label TP	
Label RC	
Label RO	
Label BH	
Label WS	
Label CP+RC	
Label RO+RC	

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – changed drawing sheet number & updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

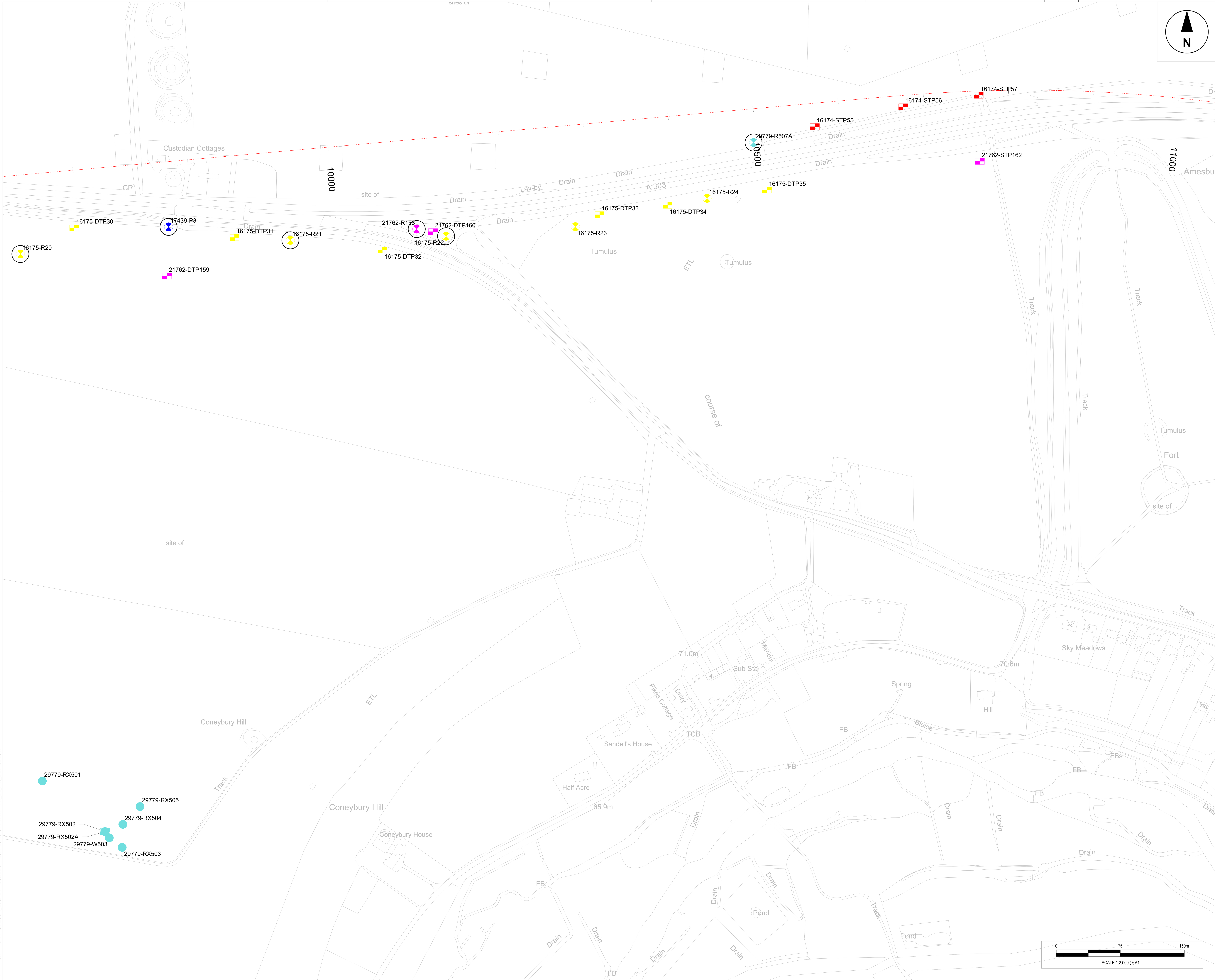
Drawing Title
GROUND INVESTIGATIONS - STANDPIPE PIEZOMETERS LOCATIONS - SHEET 5

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 - AMW - HGT - SW_ML_M00_Z - DR - CE - 0040
Location | Type | Role | Number
Rev P02



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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

Standpipe Piezometer Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – changed drawing sheet number & updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - STANDPIPE PIEZOMETERS LOCATIONS - SHEET 6

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR -CE -0041
Location | Type | Role | Number

Rev P02

Plot Time : 15:00
Plot Date : 13 June 2018 14:54:45
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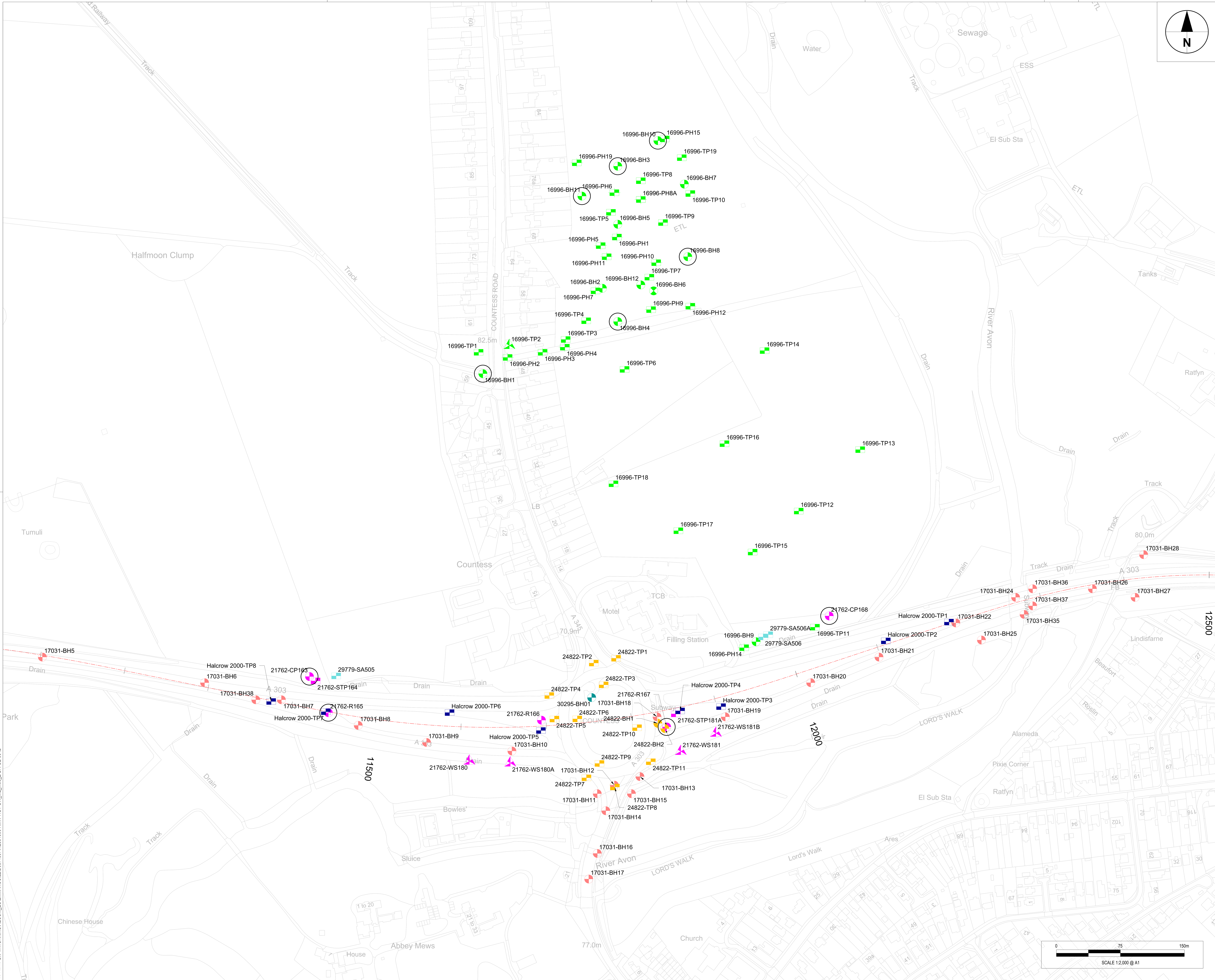

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

Standpipe Piezometer Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – added hole, changed drawing sheet number & updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - STANDPIPE PIEZOMETERS LOCATIONS - SHEET 7

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR-CE-0042
Location | Type | Role | Number

Rev P02

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

Standpipe Piezometer Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – changed drawing sheet number & updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - STANDPIPE PIEZOMETERS LOCATIONS - SHEET 8

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:5000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR -CE -0043
Location | Type | Role | Number
Rev P02

Plot Time :10:00
Plot Date : 17 August 2018 17:10:13
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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Standpipe Piezometer Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – changed drawing sheet number & updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - STANDPIPE PIEZOMETERS LOCATIONS - SHEET 9

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No.	Suitability
60541439	S3
Scale @ A1	**Zone**
1:10000	Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0044
Location | Type | Role | Number

Rev
P02

Plot Time :10:00
Plot Date :17 August 2018 17:11:44
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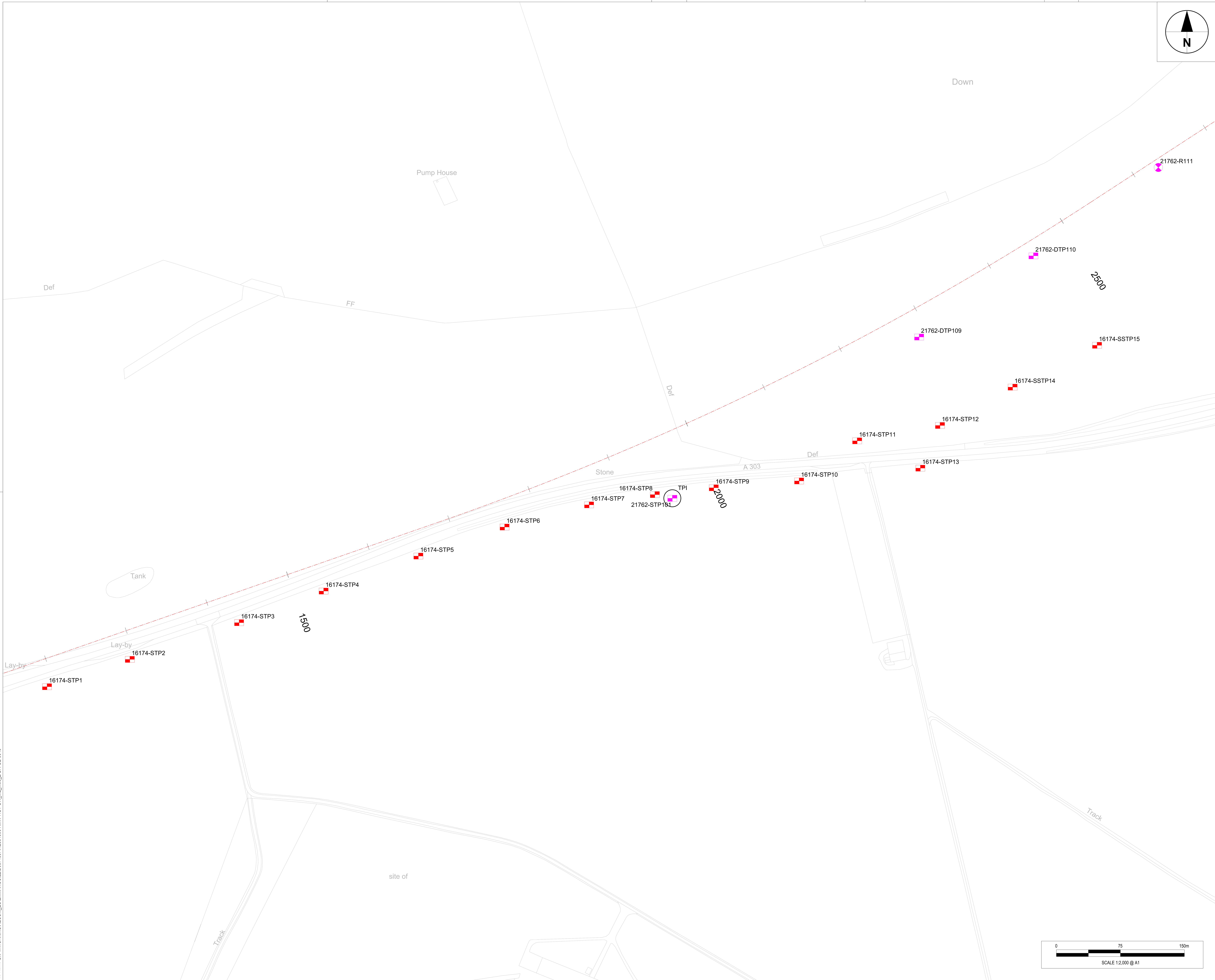

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

Type — In-situ Groundwater Test Location

Type:
1. PK: Packer Test
2. VH: Variable Head Test
3. CH: Constant Head Test
4. SP: Single Packer Test
5. TPI: Trial Pit Infiltration (Soakaway) Test

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - IN-SITU GROUNDWATER TEST LOCATIONS - SHEET 1

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR -CE -0045
Location | Type | Role | Number
Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
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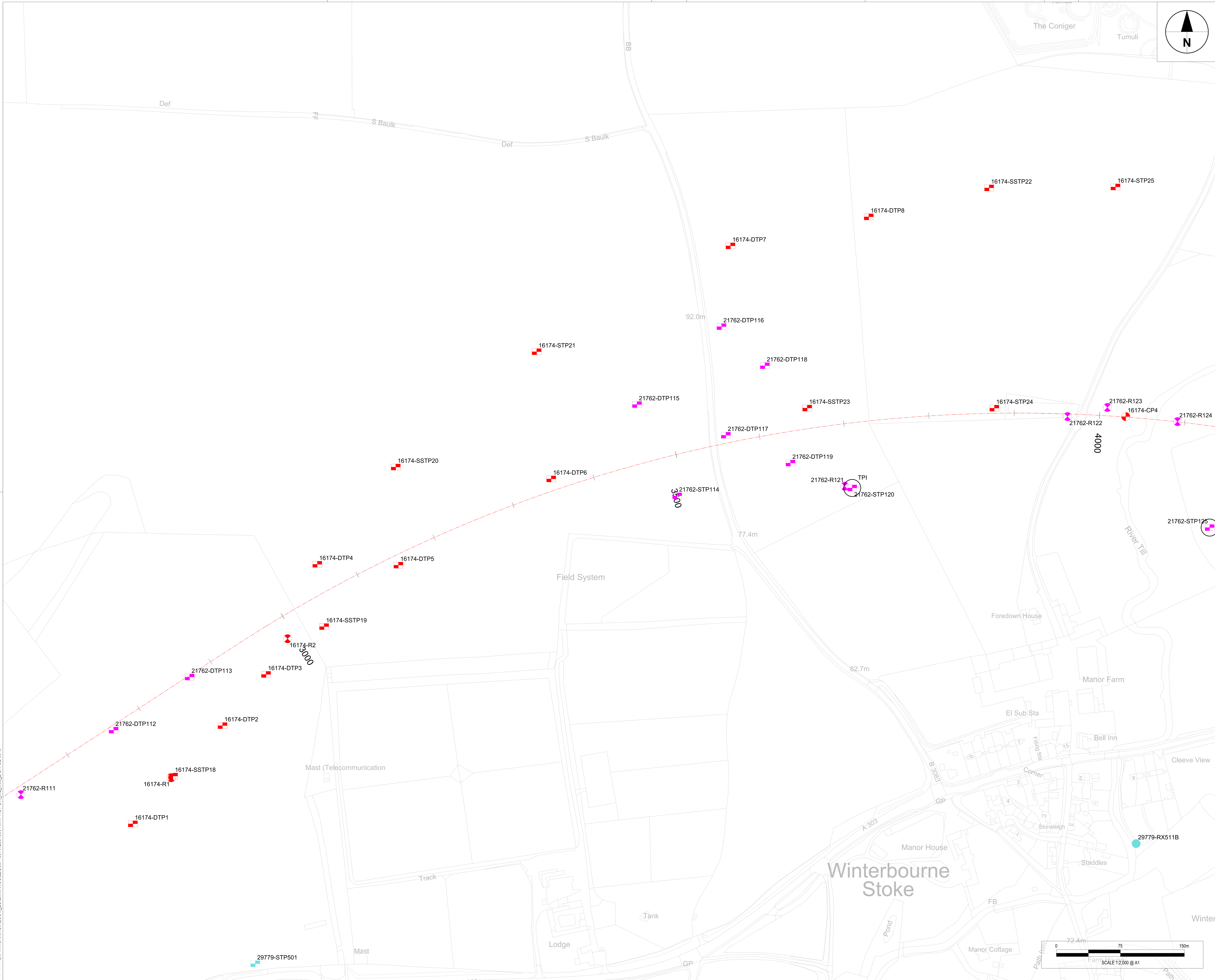

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 17031, 24822, 30295, 16175, 17439, 24930, Halcrow 2000, 16996, 21762, 29779

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

Type — In-situ Groundwater Test Location

Type:
1. PK: Packer Test
2. VH: Variable Head Test
3. CH: Constant Head Test
4. SP: Single Packer Test
5. TPI: Trial Pit Infiltration (Soakaway) Test

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - IN-SITU GROUNDWATER TEST LOCATIONS - SHEET 2

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No.	Suitability
60541439	S3
Scale @ A1	Zone
1:2000	Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR -CE -0046
Location | Type | Role | Number

Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
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4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 16175, 16996, 17031, 17439, 21762, 24822, 24930, 29779, 30295, Halcrow 2000

Label CP; Label TP; Label RC; Label RO; Label BH; Label WS; Label CP+RC; Label RO+RC

Type — In-situ Groundwater Test Location

Type:
1. PK: Packer Test
2. VH: Variable Head Test
3. CH: Constant Head Test
4. SP: Single Packer Test
5. TPI: Trial Pit Infiltration (Soakaway) Test

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - IN-SITU GROUNDWATER TEST LOCATIONS - SHEET 3

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439
Suitability S3
Scale @ A1 1:2000
Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR -CE -0047
Location | Type | Role | Number
Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name: C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0047

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Symbol	Type
Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

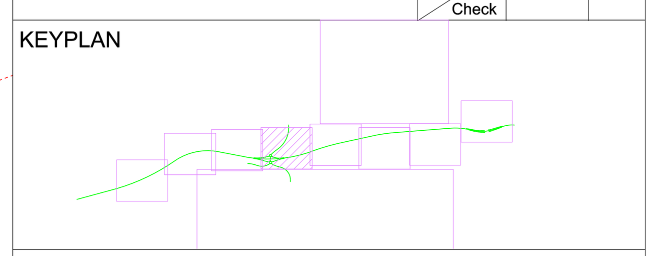
Type — In-situ Groundwater Test Location

Type:

1. PK: Packer Test
2. VH: Variable Head Test
3. CH: Constant Head Test
4. SP: Single Packer Test
5. TPI: Trial Pit Infiltration (Soakaway) Test

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – added holes & updated legend	EZ / GK	17/08/18	P02

KEYPLAN



Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - IN-SITU GROUNDWATER TEST LOCATIONS - SHEET 4

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No.	Suitability
60541439	S3
Scale @ A1	**Zone**
1:2000	Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number

Highways England PIN	Originator	Volume	Location	Type	Role	Number	Rev
HE551506	AMW	HGT	SW_ML_M00_Z	DR	CE	0048	P02

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label	
Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Type: In-situ Groundwater Test Location

Type:
1. PK: Packer Test
2. VH: Variable Head Test
3. CH: Constant Head Test
4. SP: Single Packer Test
5. TPI: Trial Pit Infiltration (Soakaway) Test

Revision Details	By	Check	Date	Suffix
First Issue	EZ	GK	15/06/18	P01
Second Issue – updated legend	EZ	GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - IN-SITU GROUNDWATER TEST LOCATIONS - SHEET 5

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0049
Location | Type | Role | Number
Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name: C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0049

N

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4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 16175, 16996, 17031, 17439, 21762, 24822, 24930, 29779, 30295, Halcrow 2000

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

Type: In-situ Groundwater Test Location

Type:
1. PK: Packer Test
2. VH: Variable Head Test
3. CH: Constant Head Test
4. SP: Single Packer Test
5. TPI: Trial Pit Infiltration (Soakaway) Test

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - IN-SITU GROUNDWATER TEST LOCATIONS - SHEET 6

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No.	Suitability
60541439	S3
Scale @ A1	**Zone**
1:2000	Scheme Wide

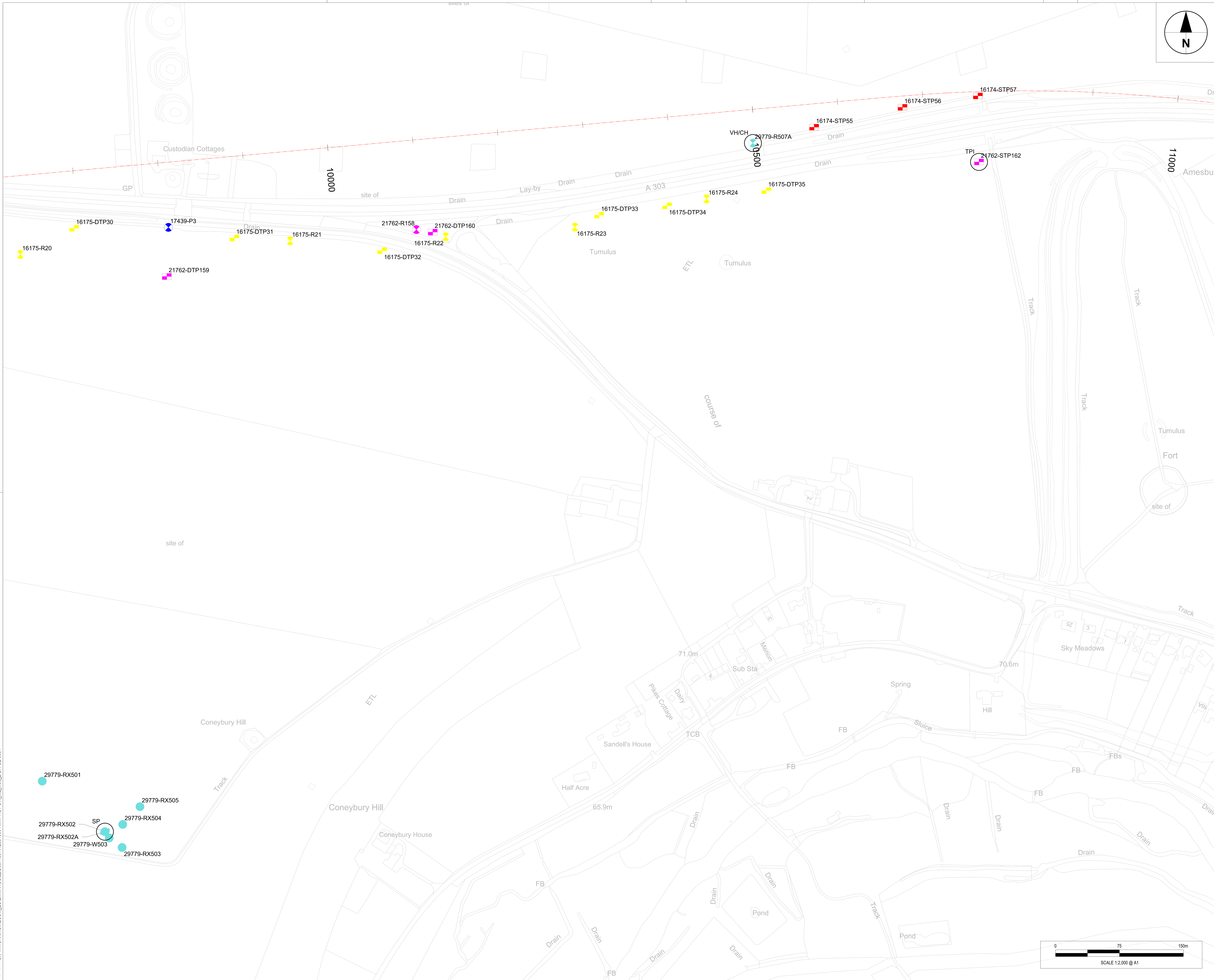
Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR -CE -0050
Location | Type | Role | Number

Rev
P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0050



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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

Type — In-situ Groundwater Test Location

Type:
1. PK: Packer Test
2. VH: Variable Head Test
3. CH: Constant Head Test
4. SP: Single Packer Test
5. TPI: Trial Pit Infiltration (Soakaway) Test

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - IN-SITU GROUNDWATER TEST LOCATIONS - SHEET 7

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

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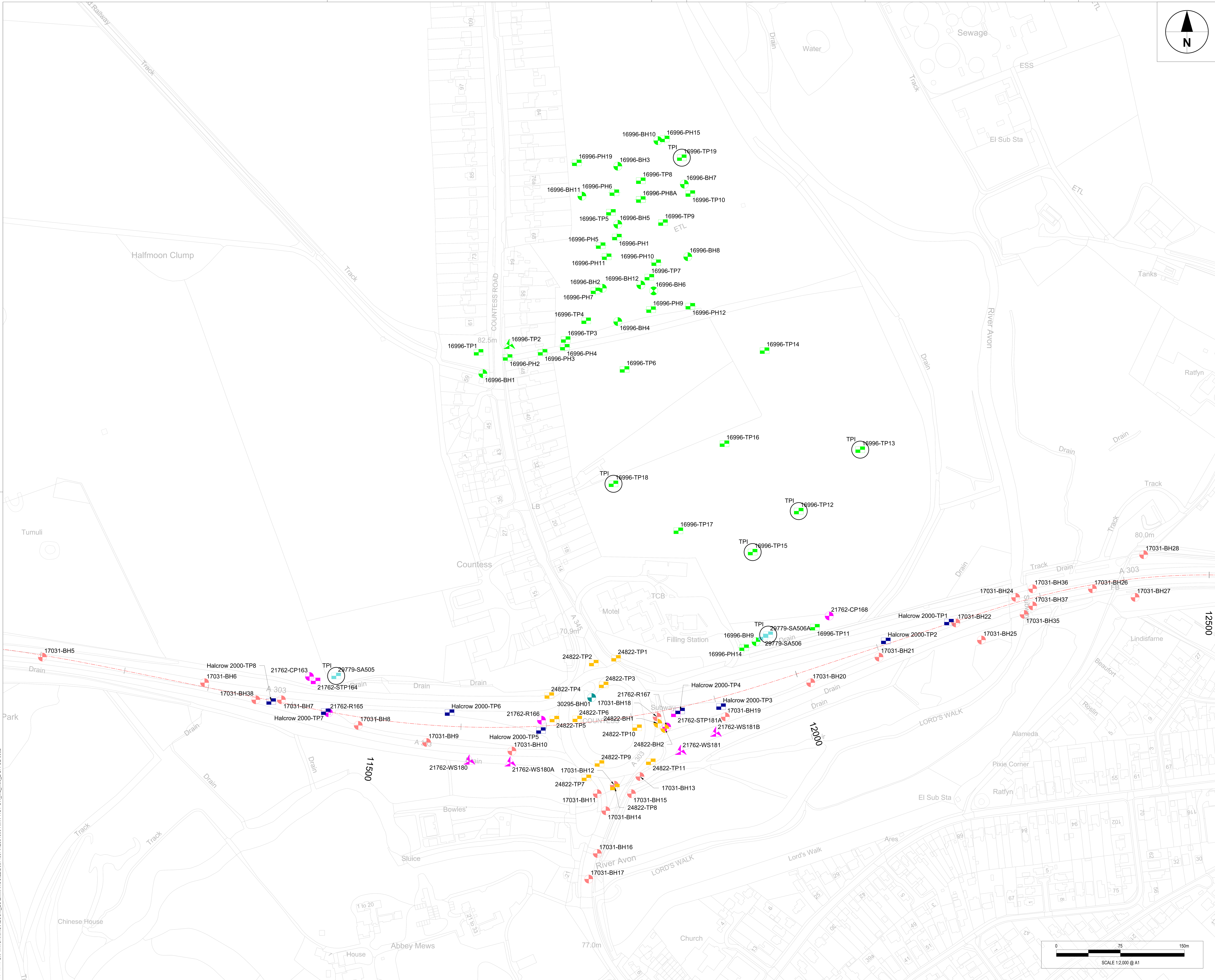
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR-CE-0051
Location | Type | Role | Number
Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0051



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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 16175, 16996, 17031, 17439, 21762, 24822, 24930, 29779, 30295, Halcrow 2000

Label	
Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Type — In-situ Groundwater Test Location

Type:
1. PK: Packer Test
2. VH: Variable Head Test
3. CH: Constant Head Test
4. SP: Single Packer Test
5. TPI: Trial Pit Infiltration (Soakaway) Test

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – added holes & updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - IN-SITU GROUNDWATER TEST LOCATIONS - SHEET 8

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439
Suitability S3
Scale @ A1 1:2000
Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0052
Location | Type | Role | Number
Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name: C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0052

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

Type — In-situ Groundwater Test Location

Type:

1. PK: Packer Test
2. VH: Variable Head Test
3. CH: Constant Head Test
4. SP: Single Packer Test
5. TPI: Trial Pit Infiltration (Soakaway) Test

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - IN-SITU GROUNDWATER TEST LOCATIONS - SHEET 9

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:10000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0053
Location | Type | Role | Number

Rev P02

Plot Time :10:00
Plot Date :17 August 2018 17:13:22
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0053

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Symbol	Type
Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Type — Down-hole Wireline Geophysical Test Location

Type:

1. OT: Optical Televiewer Test
2. AC: Acoustic Televiewer Test
3. CA: Caliper Test
4. NG: Natural Gamma Test
5. FM: Flowmeter Test
6. FT: Fluid Temperature Test
7. FC: Fluid Conductivity Test
8. PS: P & S Wave logging Test

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – added holes & updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - DOWN-HOLE WIRELINE GEOPHYSICAL LOCATIONS - SHEET 1

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number

Highways England PIN	Originator	Volume	Location	Type	Role	Number	Rev
HE551506	AMW	HGT	SW_ML_M00_Z	DR	CE	0054	P02

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 16175, 16996, 17031, 17439, 21762, 24822, 24930, 29779, 30295, Halcrow 2000

Label CP · Label TP · Label RC · Label RO · Label BH · Label WS · Label CP+RC · Label RO+RC

Type: Down-hole Wireline Geophysical Test Location

Type:
1. OT: Optical Televiewer Test
2. AC: Acoustic Televiewer Test
3. CA: Caliper Test
4. NG: Natural Gamma Test
5. FM: Flowmeter Test
6. FT: Fluid Temperature Test
7. FC: Fluid Conductivity Test
8. PS: P & S Wave logging Test

Revision Details	By	Check	Date	Suffix
First Issue	EZ	GK	15/06/18	P01
Second Issue – updated legend	EZ	GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - DOWN-HOLE WIRELINE GEOPHYSICAL LOCATIONS - SHEET 2

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT-SW_ML_M00_Z -DR-CE-0055
Location | Type | Role | Number
Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0055

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label	Type
Label	CP
Label	TP
Label	RC
Label	RO
Label	BH
Label	WS
Label	CP+RC
Label	RO+RC

Type: Down-hole Wireline Geophysical Test Location

Type:
1. OT: Optical Televiewer Test
2. AC: Acoustic Televiewer Test
3. CA: Caliper Test
4. NG: Natural Gamma Test
5. FM: Flowmeter Test
6. FT: Fluid Temperature Test
7. FC: Fluid Conductivity Test
8. PS: P & S Wave logging Test

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS - DOWN-HOLE WIRELINE GEOPHYSICAL LOCATIONS - SHEET 3

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

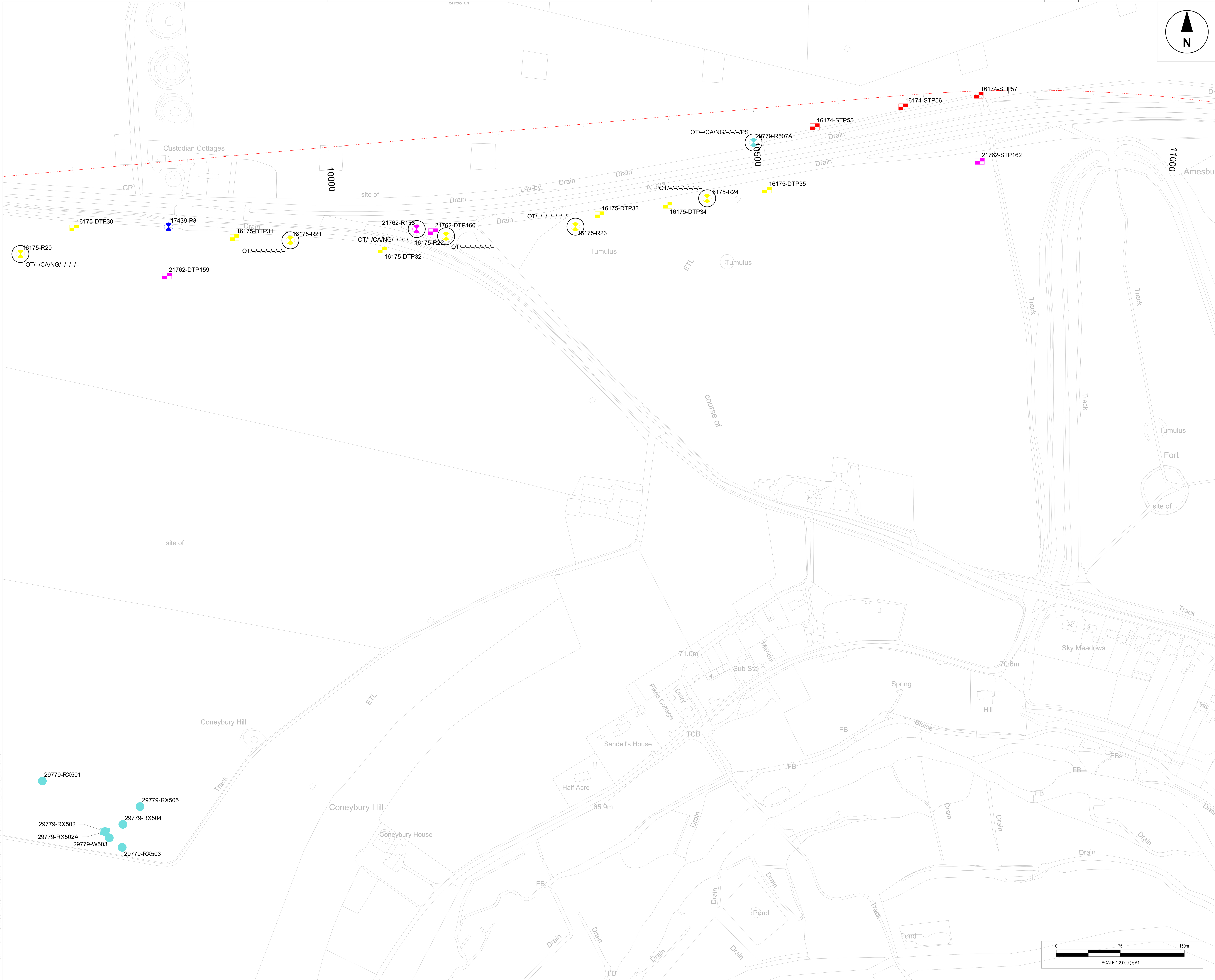
Internal Project No.	Suitability
60541439	S3
Scale @ A1	**Zone**
1:2000	Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0056
Location | Type | Role | Number

Rev
P02



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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label	Type
CP	
TP	
RC	
RO	
BH	
WS	
CP+RC	
RO+RC	

Type: Down-hole Wireline Geophysical Test Location

Type:
1. OT: Optical Televiewer Test
2. AC: Acoustic Televiewer Test
3. CA: Caliper Test
4. NG: Natural Gamma Test
5. FM: Flowmeter Test
6. FT: Fluid Temperature Test
7. FC: Fluid Conductivity Test
8. PS: P & S Wave logging Test

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - DOWN-HOLE WIRELINE GEOPHYSICAL LOCATIONS - SHEET 4

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0057
Location | Type | Role | Number

Rev P02

Plot Time: 15:00
Plot Date: 13 June 2018 14:54:45
File Name: C:\PWWORKING\AECOM_EU\EMMANOUILZ\d0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0057

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5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 16175, 16996, 17031, 17439, 21762, 24822, 24930, 29779, 30295, Halcrow 2000

Label CP; Label TP; Label RC; Label RO; Label BH; Label WS; Label CP+RC; Label RO+RC

Pumping Well Location; Monitoring Well Location; Recharging Well Location

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
The Cube
199 Wharfside Street
Birmingham
B1 1RN
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
GROUND INVESTIGATIONS - PUMPING LOCATIONS

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439 — Suitability S3
Scale @ A1 1:2000 — Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0058
Location | Type | Role | Number
Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:54:45
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0058

Marker	Acronyms	Acronym Explanation
Label	CP	Cable Percussive
Label	TP	Trial Pit
Label	RC	Rotary Cored
Label	RO	Rotary Open
Label	BH	Borehole (technique non-specified)
Label	WS	Window Sampling
Label	CP+RC	Cable Percussive and Rotary Cored
Label	RO+RC	Rotary Open and Rotary Corehole

Note: Exploratory hole label is a combination of the ground investigation's HAGDMS number and the specific hole reference number. For example 16175-R23.

Location Marker, used to denote locations of SPT, In-situ CBR tests, Plate Load tests, High Pressure Dilatometer tests, Stanspipe Piezometers and Monitoring Wells.

Pumping Well Location

Recharging Well Location

Type

In-situ Groundwater Test Location

Type:

1. PK: Packer Test
2. VH: Variable Head Test
3. CH: Constant Head Test
4. SP: Single Packer Test
5. TPI: Trial Pit Infiltration (Soakaway) Test

Type

Down-hole Wireline Geophysical Test Location

Type:

1. OT: Optical Televiewer Test
2. AC: Acoustic Televiewer Test
3. CA: Caliper Test
4. NG: Natural Gamma Test
5. FM: Flowmeter Test
6. FT: Fluid Temperature Test
7. FC: Fluid Conductivity Test
8. PS: P & S Wave logging Test

Note: If a down-hole wireline geophysical survey type is carried out in an exploratory hole, its corresponding acronym is shown next to the marker. For example, OT/-/-/NG-/-/-/- represents that optical televiewer and natural gamma surveys were carried out in the exploratory hole.

Legend	HAGDMS No.	Ground Investigation	Time of Fieldwork	Contractor	Consultant
	17031	A303 Stonehenge - Countess Roundabout	1965	Foundation Engineering	N/A
	17439	A303 Preliminary Ground Investigation	Oct - Nov 2000	Soil Mechanics	Mott MacDonald
	16175	A303 Stonehenge Phase I Main Ground Investigation	Feb - May 2001	Soil Mechanics	Mott MacDonald
	16174	A303 Stonehenge Phase II Main Ground Investigation	Aug - Sep 2001	Soil Mechanics	Mott MacDonald
	16996	Stonehenge Visitors Centre, Amesbury, Wiltshire - Ground Investigation	Apr - May 2002	John Grimes Partnership	Anthony Hunt Associates
	21762	Phase 1A Supplementary Ground Investigation for A303 Stonehenge Improvement	Nov 2002 - Jan 2003	Soil Mechanics	Halcrow - Gifford
	24822	A303 Countess Roundabout - Safety Scheme	Jan 2009	Soil Mechanics	Mott MacDonald
	24930	A303 Longbarrow Roundabout Improvement Scheme	Dec 2009 - Jan 2010	Soil Mechanics	Mott MacDonald
	29779	A303 Amesbury to Berwick Down – Ground Investigation	2017	Structural Soils	Arup - Atkins Joint Venture (AAJV)
	30925	A303 Countess RAB CCTV	Mar 2018	Geotechnics	Kier Highway
	Halcrow 2000	A303 Countess Roundabout	2000	Halcrow Transportation Infrastructure	N/A

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Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – added GI	EZ / GK	17/08/18	P02

Purpose of issue

FOR REVIEW & COMMENT

Client

The Cube
199 Wharfside Street
Birmingham
B1 1RN

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

GROUND INVESTIGATIONS – LEGENDS AND ABBREVIATIONS

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439 | Suitability S3
Scale @ A1 N/A | Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

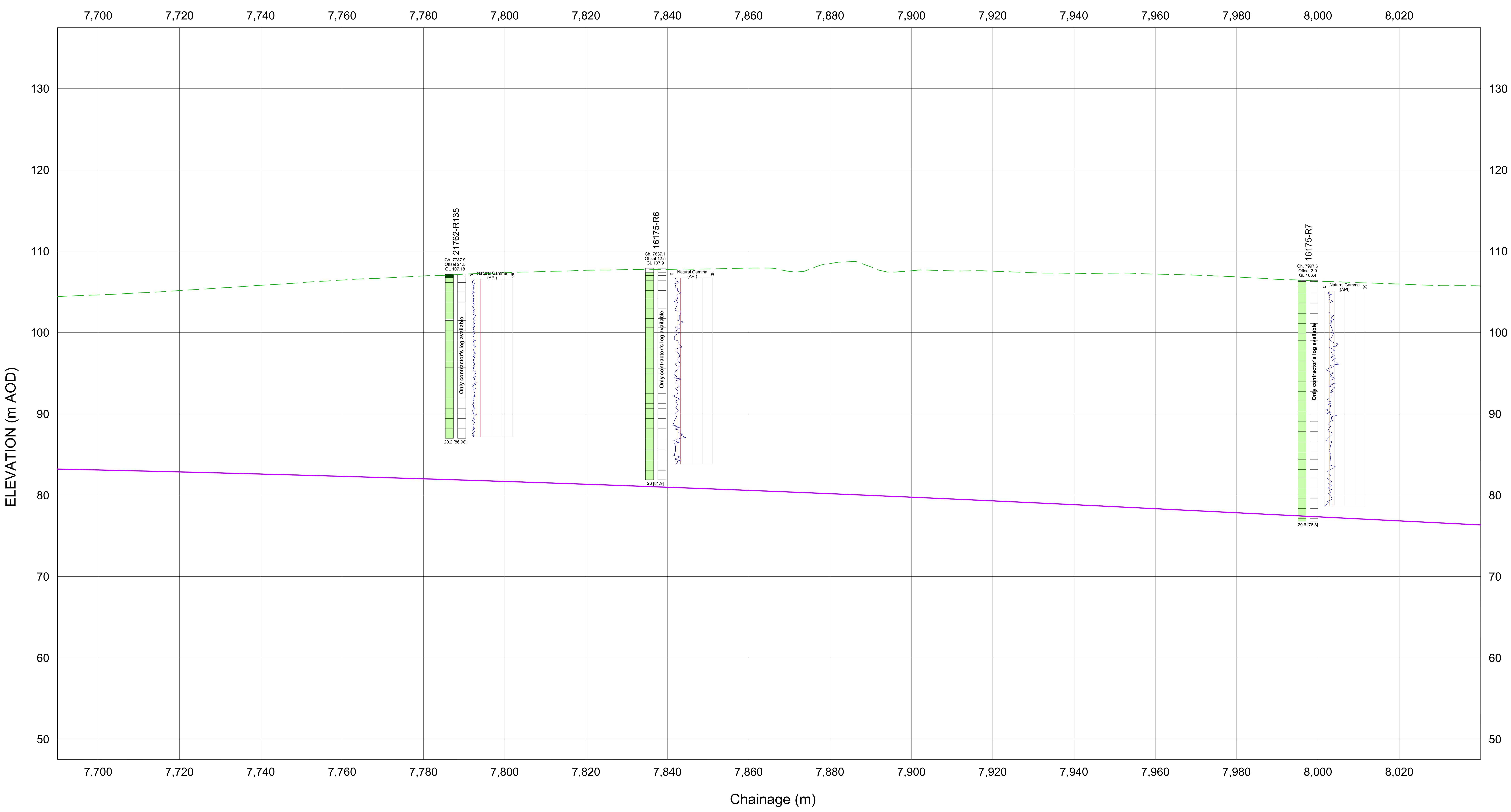
AmW
AECOM + mace + WSP

Drawing Number (Highways England PIN | Originator | Volume | Location | Type | Role | Number): HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063

Rev: P02

Plot Time : 10:00
Plot Date : 13 February 2018 12:16:20
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063

H 1:500; V 1:250



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7. ONLY EXPLORATORY HOLES THAT HAVE BEEN IDENTIFIED WITH THE PRESENCE OF PHOSPHATIC CHALK BY THE GROUND INVESTIGATION CONTRACTORS AND/OR PROFESSOR RORY MORTIMORE, OR HAVE BEEN CARRIED OUT FOR DOWNHOLE NATURAL GAMMA LOGGING, ARE INCLUDED IN THE SECTION.

GEOLOGICAL UNITS LEGEND:

Topsoil (TS)
Made Ground (MG)
Alluvium (ALV)
Head Deposits (HD)
River Terrace Deposits (RTD)
Superficial Deposits (SD)
Chalk - Undifferentiated (C)
Newhaven Chalk Formation (C-NHC)
Seaford Chalk Formation (C-SFC)
Phosphatic Chalk (C-PC)
Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

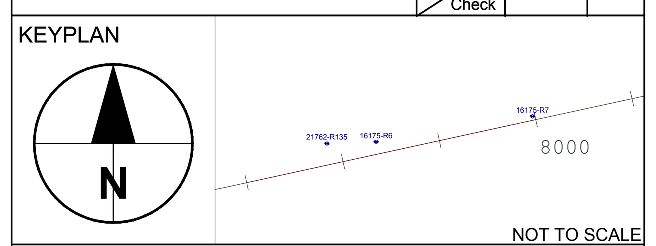
Topsoil, Silt, Gravel, Peat, Made Ground, Sand, Cobbles, Chalk, Clay, Boulders

SECTION KEY:

HAGDMS No. and Hole ID
Chainage
Offset from Centreline of Alignment
Ground Level
Ground Investigation Contractor's Classification
Professor Rory Mortimore's Classification
Moderate Response Lower Limit (7.5 API)
High Response Lower Limit (12.5 API)
Natural Gamma Reading
Hole Base Depth (Reduced Level)
Existing Ground Level
Proposed Level
Moved Hole

First Issue	EZ / GK	15/06/18	P01
Revision Details	By / Check	Date	Suffix

KEYPLAN



NOT TO SCALE

Purpose of issue

FOR REVIEW & COMMENT

Client

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

PHOSPHATIC CHALK
SECTION 01.
CH 7700M TO 8000M

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	15/06/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number: HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0068 (Highways England PIN / Originator / Volume / Location / Type / Role / Number)

Rev: P01

Plot Time : 10:00
Plot Date : 15 June 2018 16:59:32
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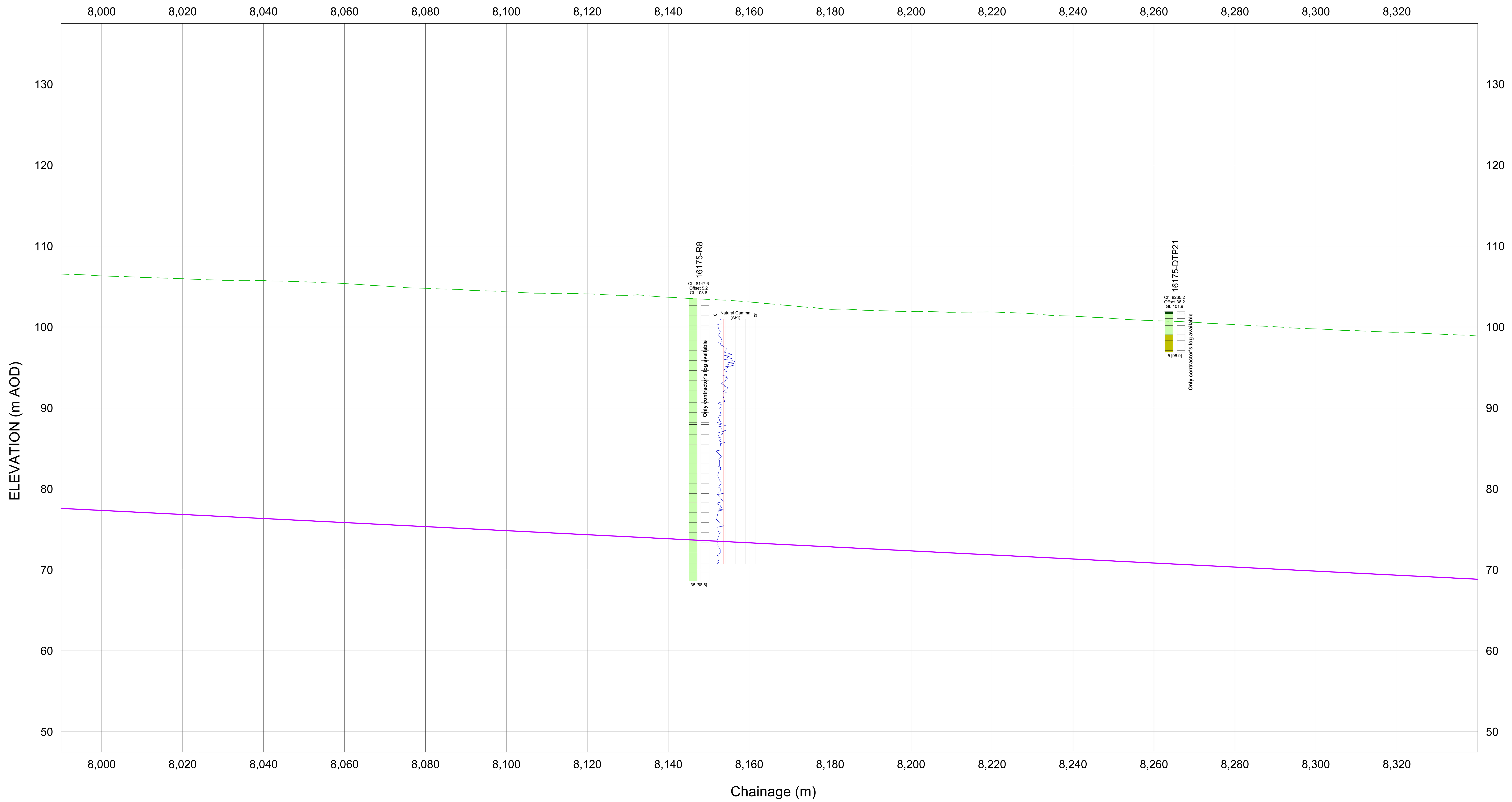
H 1:500; V 1:250



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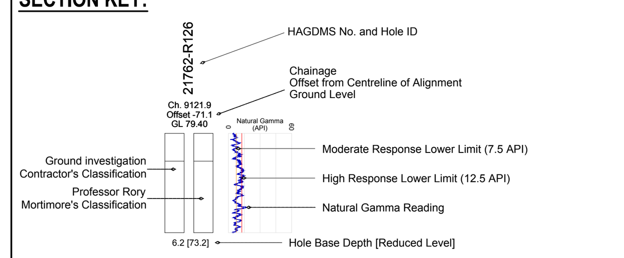
GEOLOGICAL UNITS LEGEND:

Topsoil (TS)
Made Ground (MG)
Alluvium (ALV)
Head Deposits (HD)
River Terrace Deposits (RTD)
Superficial Deposits (SD)
Chalk - Undifferentiated (C)
Newhaven Chalk Formation (C-NHC)
Seaford Chalk Formation (C-SFC)
Phosphatic Chalk (C-PC)
Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

Topsoil, Silt, Gravel, Peat, Made Ground, Sand, Cobbles, Chalk, Clay, Boulders

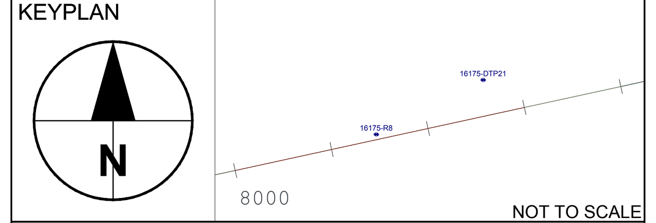
SECTION KEY:



Existing Ground Level
Proposed Level
Moved Hole

First Issue	EZ / GK	15/06/18	P01
Revision Details	By / Check	Date	Suffix

KEYPLAN



Purpose of issue
FOR REVIEW & COMMENT

Client
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
PHOSPHATIC CHALK
SECTION 02.
CH 8000M TO 8300M

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	15/06/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0069
Location | Type | Role | Number
Rev P01

Plot Time : 10:00
Plot Date : 15 June 2018 16:59:56
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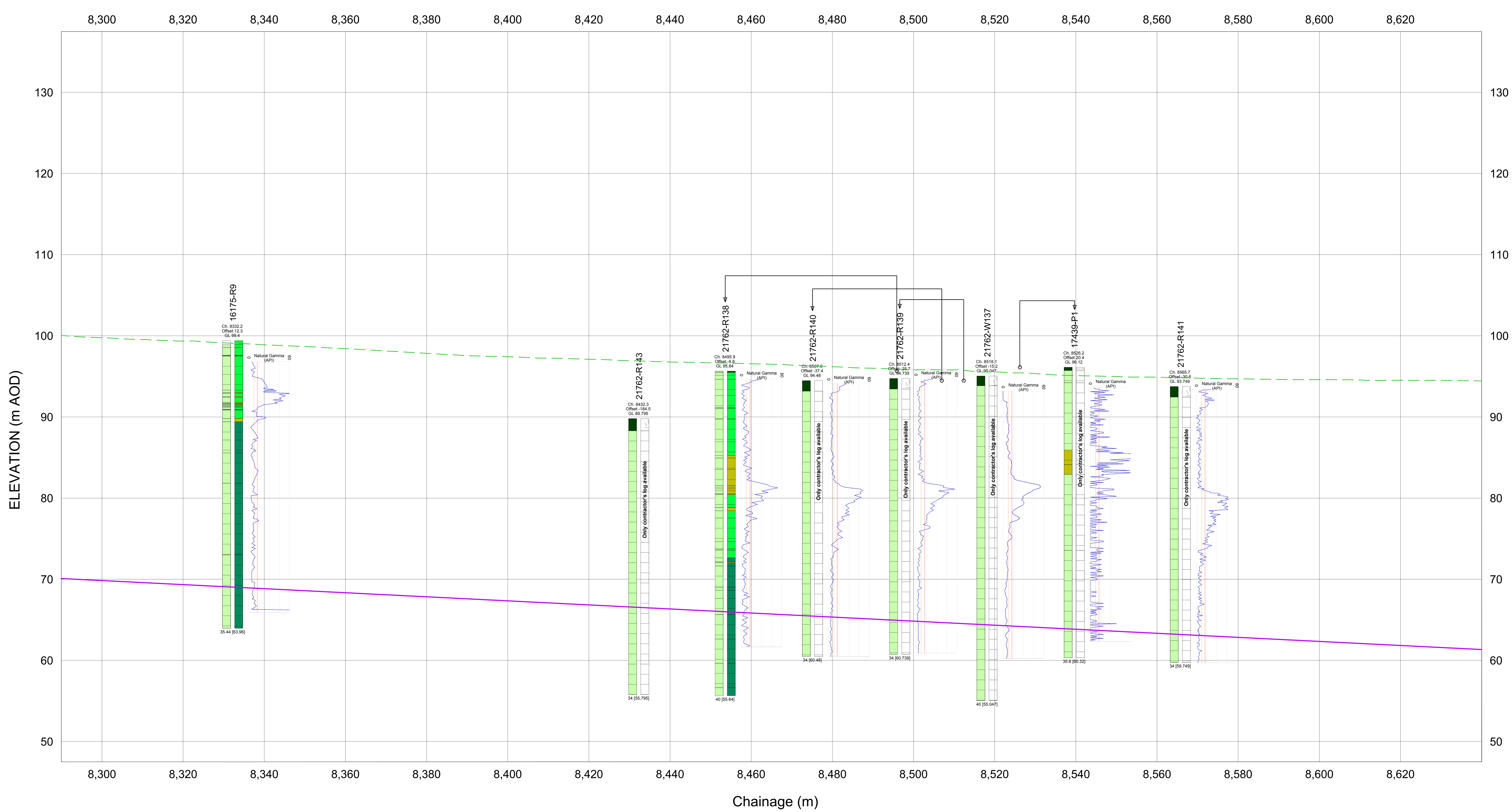

NOTES:

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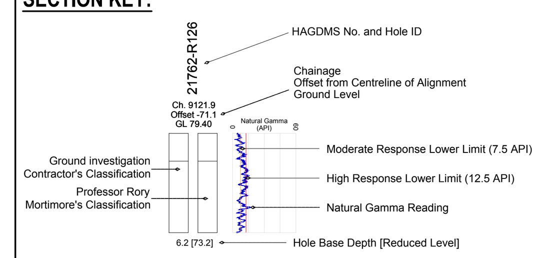
GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferentiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

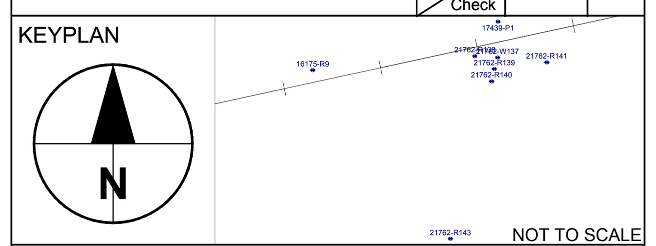
SECTION KEY:



- Existing Ground Level
- Proposed Level
- Moved Hole

First Issue	EZ / GK	15/06/18	P01
Revision Details	By / Check	Date	Suffix

KEYPLAN



Purpose of issue

FOR REVIEW & COMMENT

Client

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

PHOSPHATIC CHALK
SECTION 03.
CH 8300M TO 8600M

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	15/06/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume | Location | Type | Role | Number
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0070

Rev P01

Plot Time : 10:00
Plot Date : 15 June 2018 17:00:21
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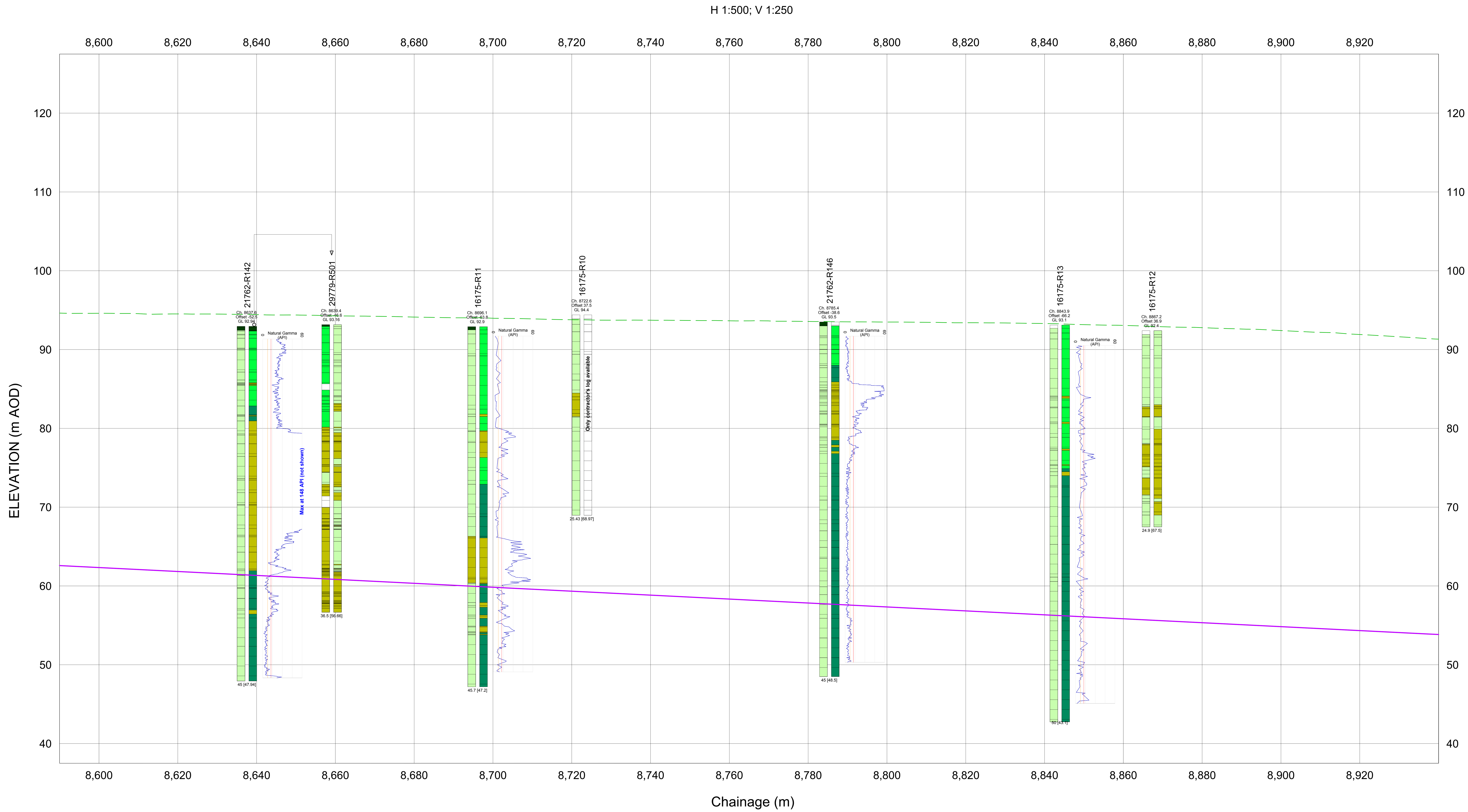

Chainage (m)

NOTES:

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GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferentiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

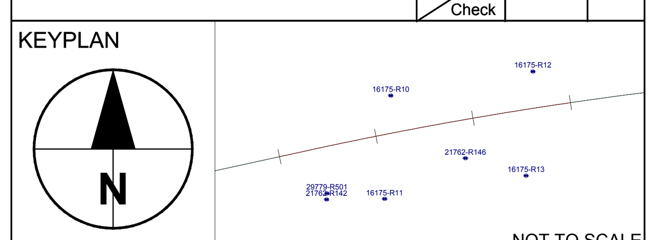
- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

SECTION KEY:

- HAGDMS No. and Hole ID
- Chainage / Offset from Centreline of Alignment / Ground Level
- Ground investigation Contractor's Classification
- Professor Rory Mortimore's Classification
- Moderate Response Lower Limit (7.5 API)
- High Response Lower Limit (12.5 API)
- Natural Gamma Reading
- Hole Base Depth [Reduced Level]
- Existing Ground Level
- Proposed Level
- Moved Hole

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01

KEYPLAN



NOT TO SCALE

Purpose of issue

FOR REVIEW & COMMENT

Client

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

PHOSPHATIC CHALK
SECTION 04.
CH 8600M TO 8900M

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	15/06/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR-CE-0071
Location | Type | Role | Number

Rev P01

Plot Time : 10:00
Plot Date : 15 June 2018 17:00:44
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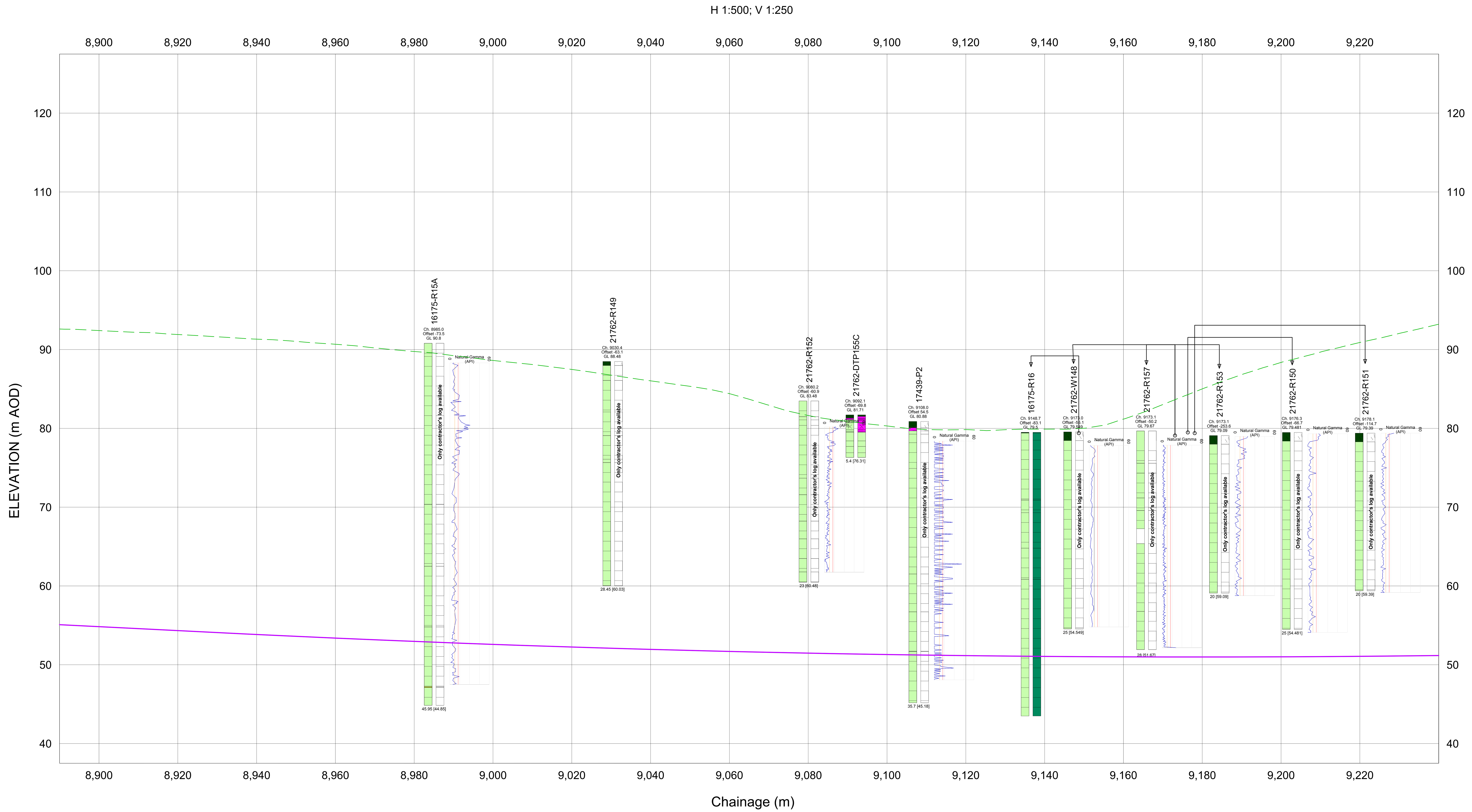

NOTES:

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GEOLOGICAL UNITS LEGEND:

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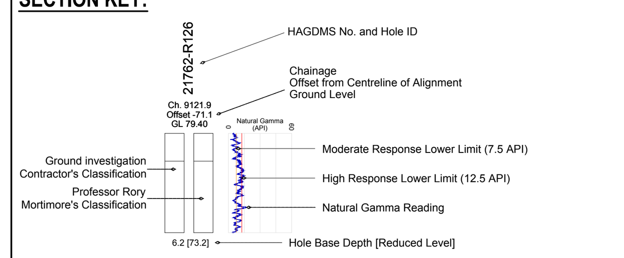
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferentiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

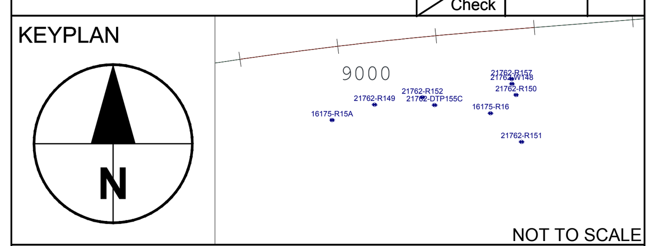
SECTION KEY:



- Existing Ground Level
- Proposed Level
- Moved Hole

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01

KEYPLAN



Purpose of issue

FOR REVIEW & COMMENT

Client

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

PHOSPHATIC CHALK
SECTION 05.
CH 8900M TO 9200M

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	15/06/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN / Originator / Volume / Location / Type / Role / Number

HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0072

Rev P01

Plot Time : 10:00
Plot Date : 15 June 2018 17:01:09
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0072

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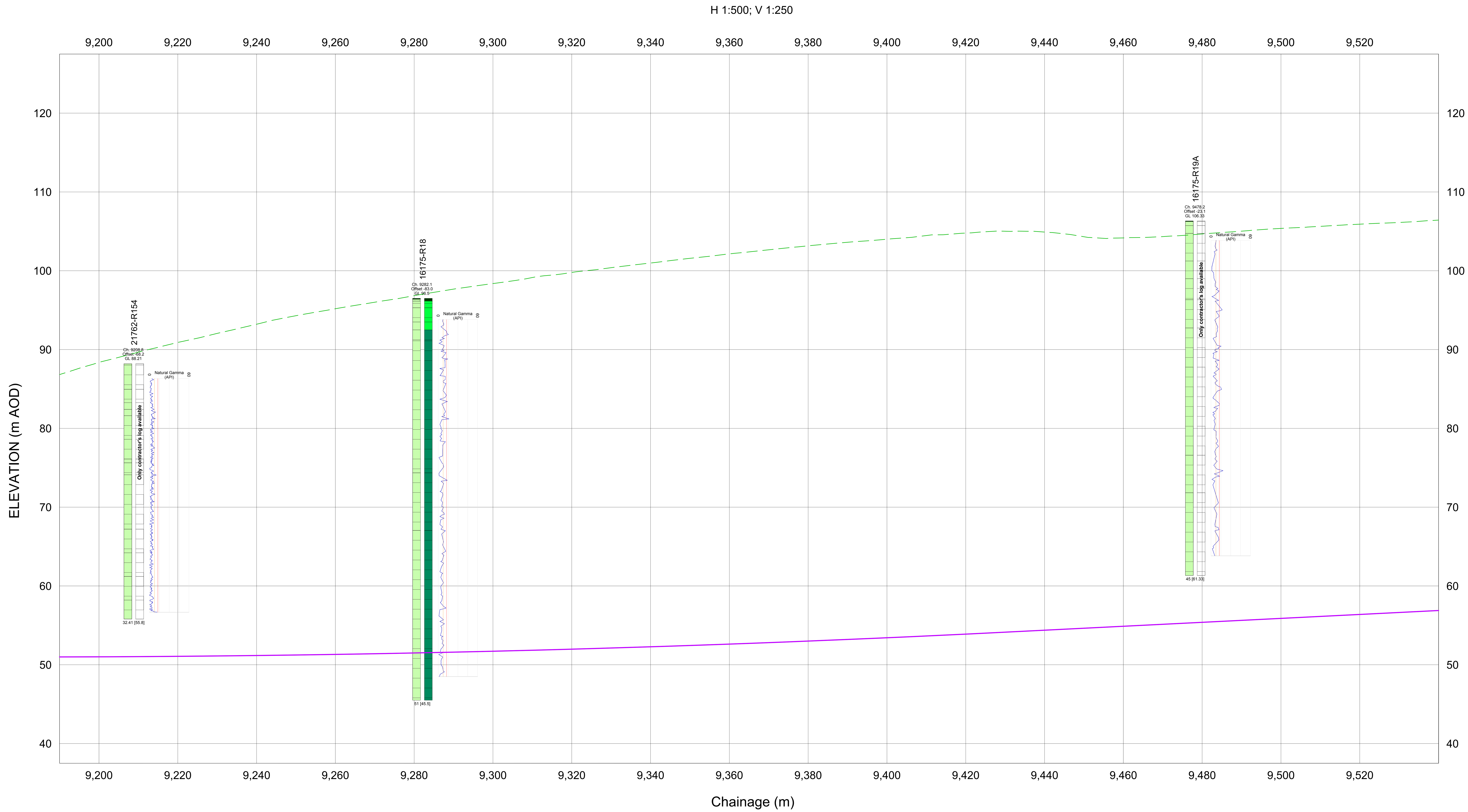

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6. SOME EXPLORATORY HOLES MAY HAVE BEEN MOVED FOR PURPOSES OF CLARITY WHERE DEFINED ON THE DRAWING.
7. ONLY EXPLORATORY HOLES THAT HAVE BEEN IDENTIFIED WITH THE PRESENCE OF PHOSPHATIC CHALK BY THE GROUND INVESTIGATION CONTRACTORS AND/OR PROFESSOR RORY MORTIMORE, OR HAVE BEEN CARRIED OUT FOR DOWNHOLE NATURAL GAMMA LOGGING, ARE INCLUDED IN THE SECTION.

GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferentiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

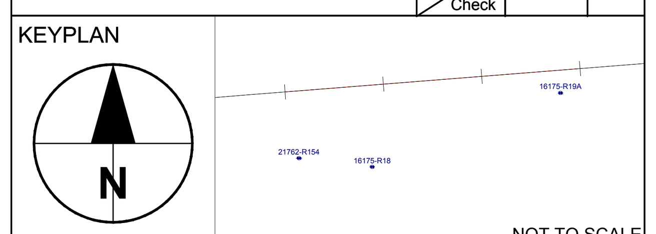
- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

SECTION KEY:

- HAGDMS No. and Hole ID
- Chainage, Offset from Centreline of Alignment, Ground Level
- Moderate Response Lower Limit (7.5 API)
- High Response Lower Limit (12.5 API)
- Natural Gamma Reading
- Hole Base Depth [Reduced Level]
- Ground Investigation Contractor's Classification
- Professor Rory Mortimore's Classification
- Existing Ground Level
- Proposed Level
- Moved Hole

Revision Details	By	Check	Date	Suffix
First Issue	EZ	GK	15/06/18	P01

KEYPLAN



NOT TO SCALE

Purpose of issue

FOR REVIEW & COMMENT

Client

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

PHOSPHATIC CHALK
SECTION 06.
CH 9200M TO 9500M

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	15/06/18

Internal Project No.	Suitability
60541439	S3
Scale @ A1	Zone
AS SHOWN	Scheme Wide

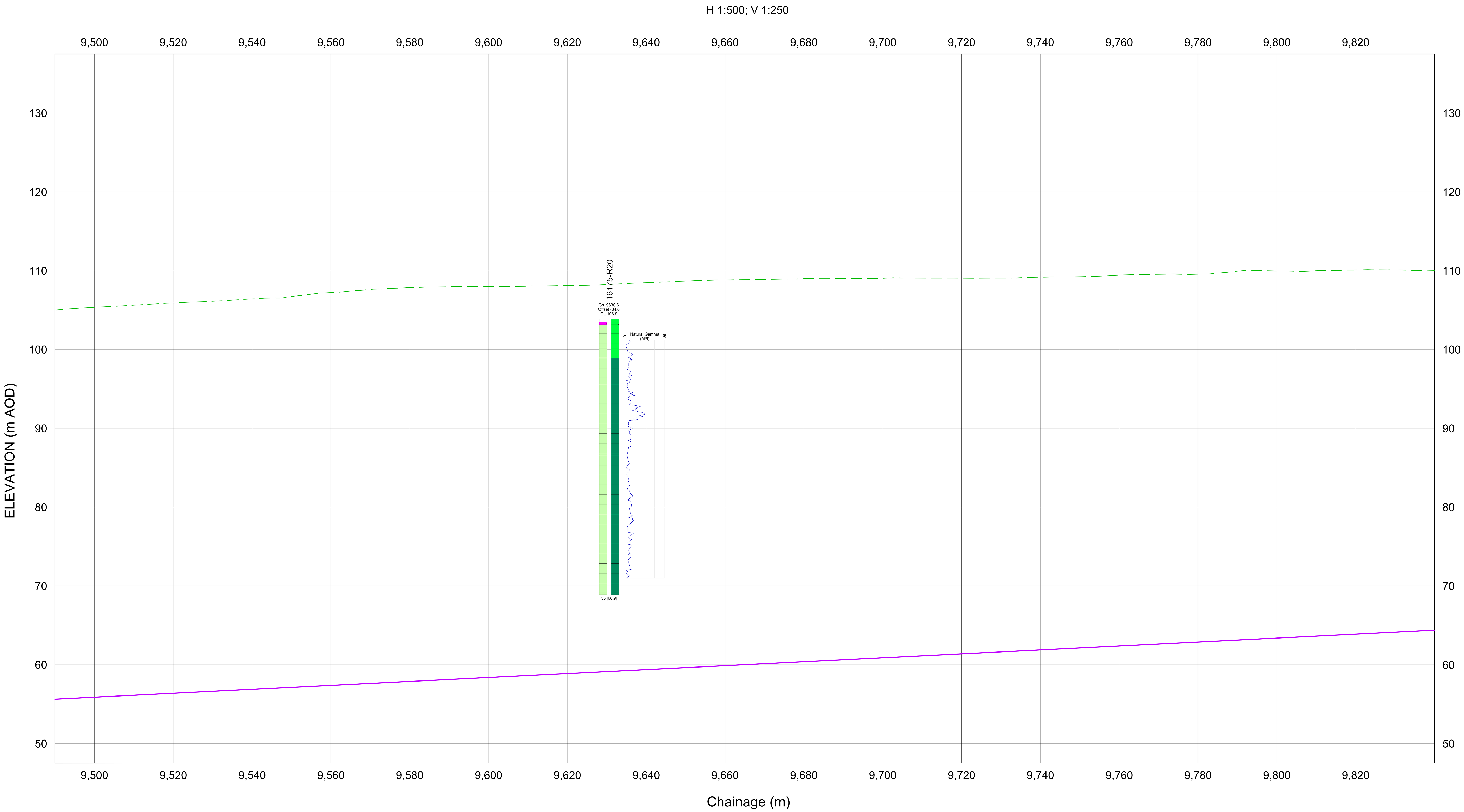
Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR-CE-0073
Location | Type | Role | Number

Rev
P01

Plot Time : 10:00
Plot Date : 15 June 2018 17:01:32
File Name C:\PW\WORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0073



NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DOCUMENTATION.
2. DO NOT SCALE FROM THIS DRAWING, USE ONLY PRINTED DIMENSIONS.
3. ALL DIMENSIONS IN MILLIMETRES, ALL CHAINAGES, LEVELS AND COORDINATES ARE IN METRES UNLESS DEFINED OTHERWISE.
4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
5. MAINLINE VERTICAL PROFILE AND HORIZONTAL ALIGNMENT BASED ON P09 AND P03 RESPECTIVELY.
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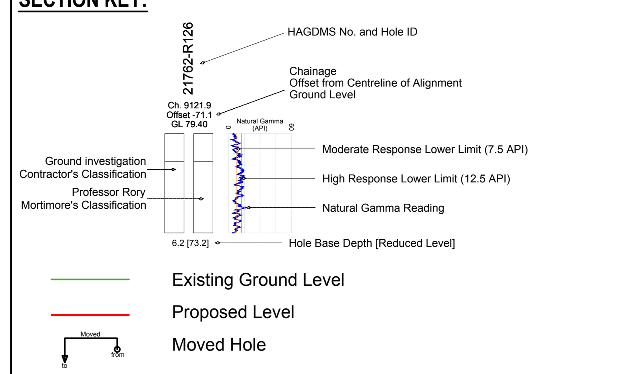
GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferentiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

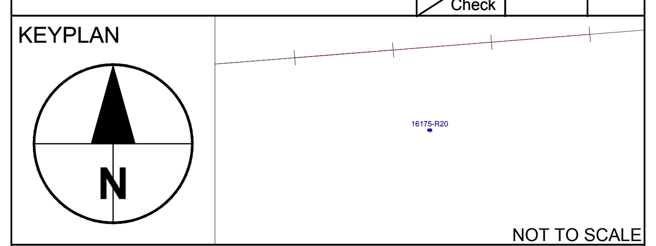
SECTION KEY:



- Existing Ground Level
- Proposed Level
- Moved Hole

First Issue	EZ / GK	15/06/18	P01
Revision Details	By / Check	Date	Suffix

KEYPLAN



Purpose of issue

FOR REVIEW & COMMENT

Client

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

PHOSPHATIC CHALK SECTION 07. CH 9500M TO 9800M

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	15/06/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume | Location | Type | Role | Number

HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0074

Rev P01

Plot Time : 10:00
Plot Date : 15 June 2018 17:01:56
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0074

NOTES:

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5. MAINLINE VERTICAL PROFILE AND HORIZONTAL ALIGNMENT BASED ON P09 AND P03 RESPECTIVELY.
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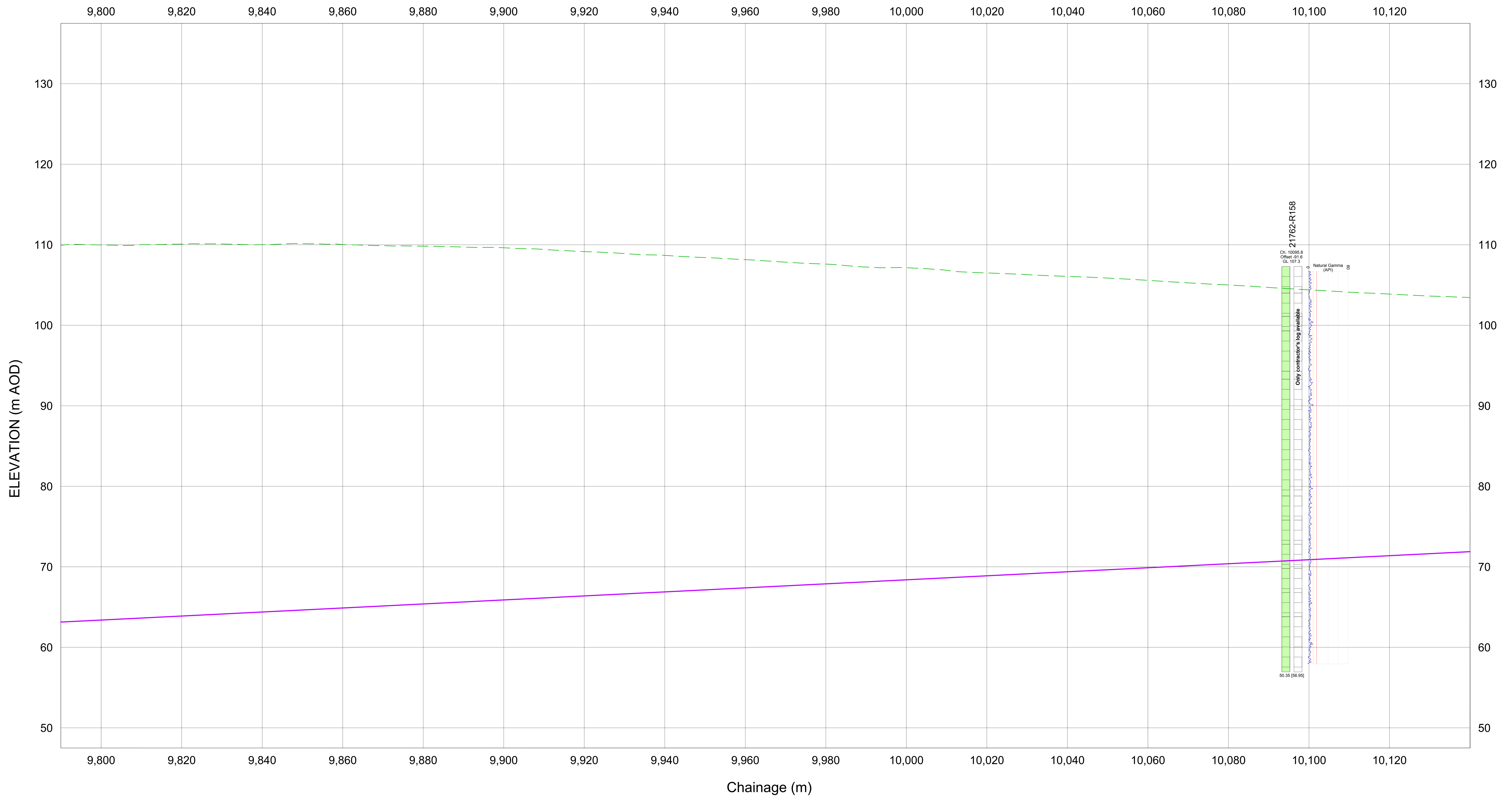
H 1:500; V 1:250



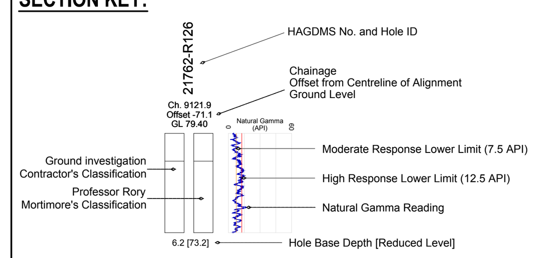
GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferetiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

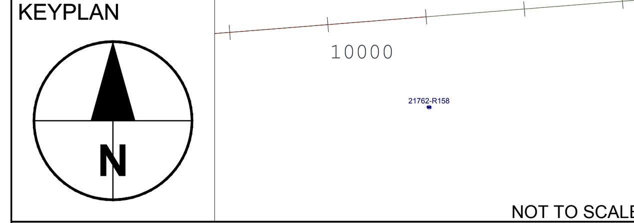
SECTION KEY:



- Existing Ground Level
- Proposed Level
- Moved Hole

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01

KEYPLAN



Purpose of issue

FOR REVIEW & COMMENT

Client

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

PHOSPHATIC CHALK
SECTION 08.
CH 9800M TO 10100M

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	15/06/18

Internal Project No.	Suitability
60541439	S3
Scale @ A1	Zone
AS SHOWN	Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

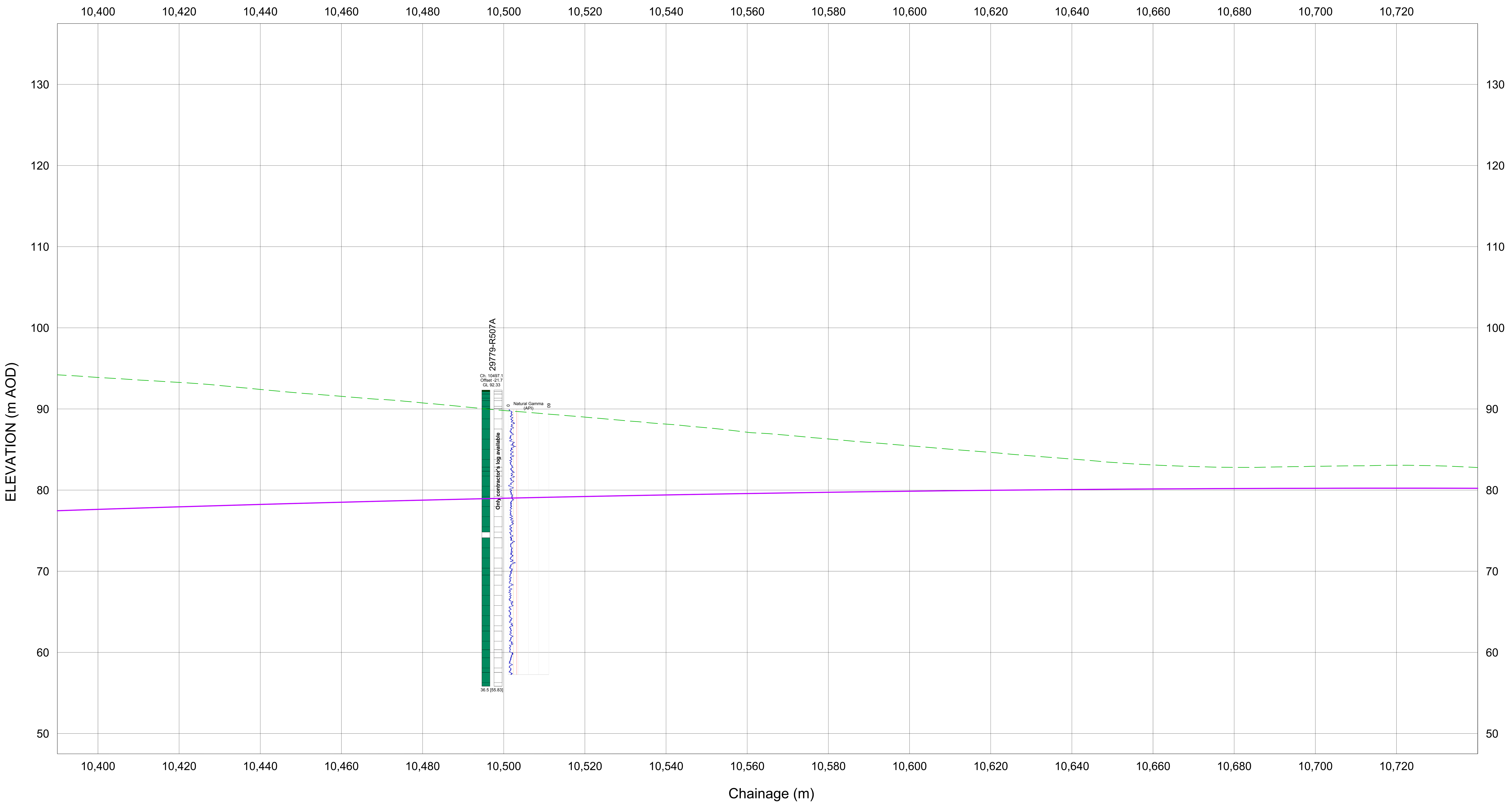
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR-CE-0075
Location | Type | Role | Number

Rev
P01

Plot Time : 10:00
Plot Date : 15 June 2018 17:02:20
File Name C:\PWWORKING\AECOM_EU\EMMANOUILZ\D0371397\HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0075

H 1:500; V 1:250



NOTES:

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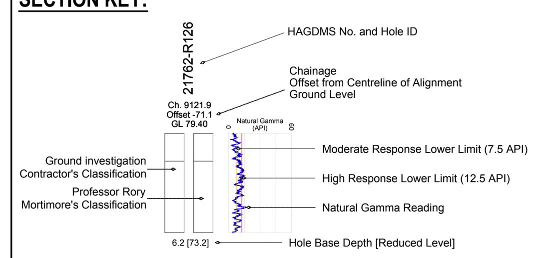
GEOLOGICAL UNITS LEGEND:

- Topsoil (TS)
- Made Ground (MG)
- Alluvium (ALV)
- Head Deposits (HD)
- River Terrace Deposits (RTD)
- Superficial Deposits (SD)
- Chalk - Undifferentiated (C)
- Newhaven Chalk Formation (C-NHC)
- Seaford Chalk Formation (C-SFC)
- Phosphatic Chalk (C-PC)
- Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

- Topsoil
- Made Ground
- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders
- Peat
- Chalk

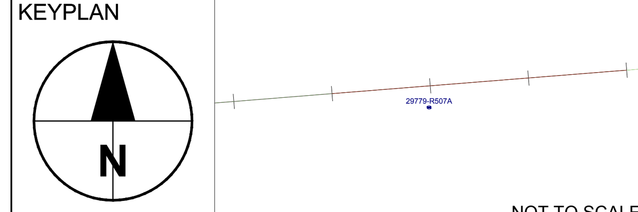
SECTION KEY:



- Existing Ground Level
- Proposed Level
- Moved Hole

First Issue	EZ / GK	15/06/18	P01
Revision Details	By / Check	Date	Suffix

KEYPLAN



NOT TO SCALE

Purpose of issue

FOR REVIEW & COMMENT

Client

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

PHOSPHATIC CHALK
SECTION 09.
CH 10400M TO 10700M

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	15/06/18

Internal Project No.	Suitability
60541439	S3
Scale @ A1	Zone
AS SHOWN	Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR-CE-0076
Location | Type | Role | Number

Rev
P01

Plot Time : 10:00
Plot Date : 15 June 2018 17:02:44
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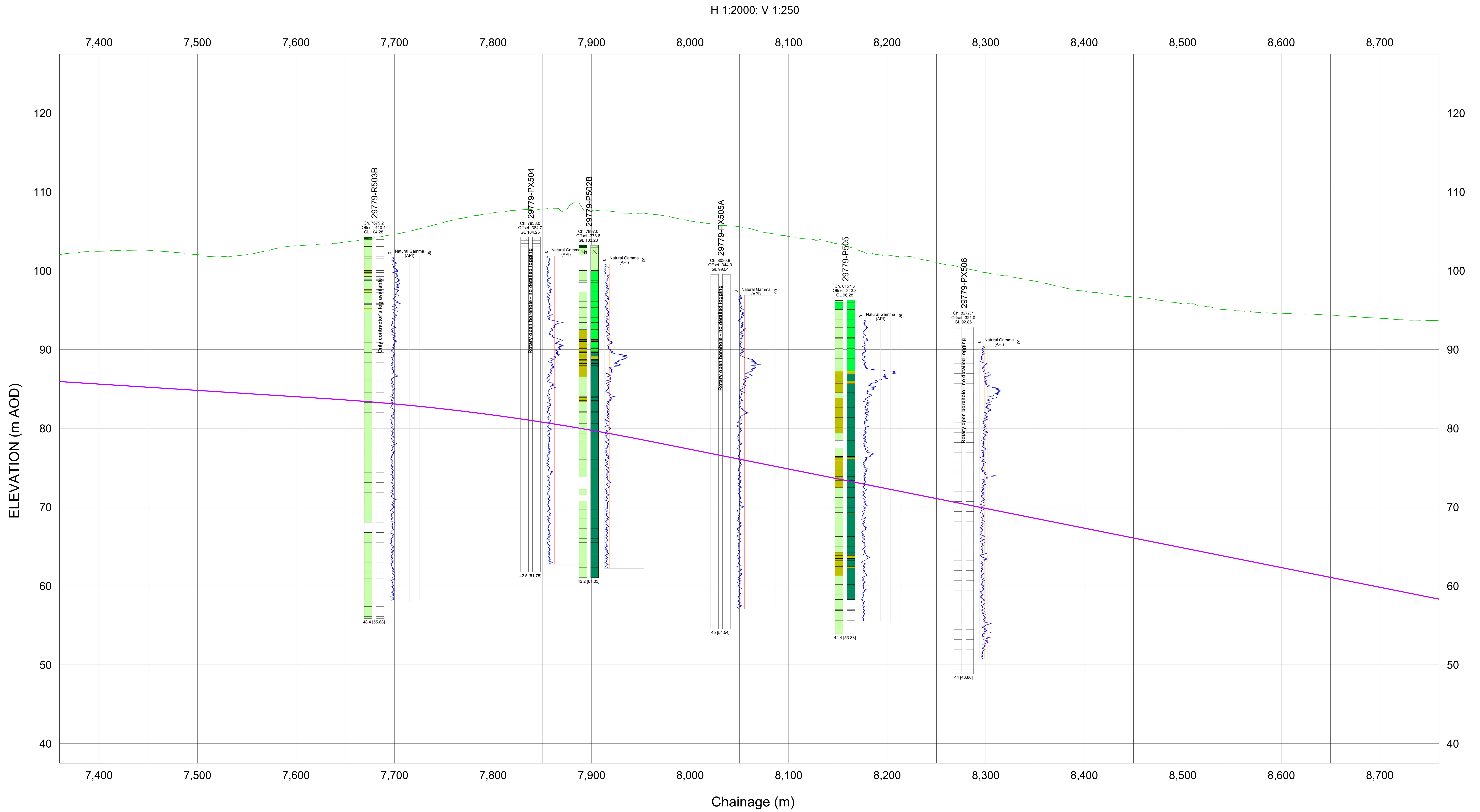
H 1:2000; V 1:250



NOTES:

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5. MAINLINE VERTICAL PROFILE AND HORIZONTAL ALIGNMENT BASED ON P09 AND P03 RESPECTIVELY.
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GEOLOGICAL UNITS LEGEND:

Topsoil (TS)
Made Ground (MG)
Alluvium (ALV)
Head Deposits (HD)
River Terrace Deposits (RTD)
Superficial Deposits (SD)
Chalk - Undifferetiated (C)
Newhaven Chalk Formation (C-NHC)
Seaford Chalk Formation (C-SFC)
Phosphatic Chalk (C-PC)
Core Loss (C/L) or No Recovery (N/R)

STRATA KEY:

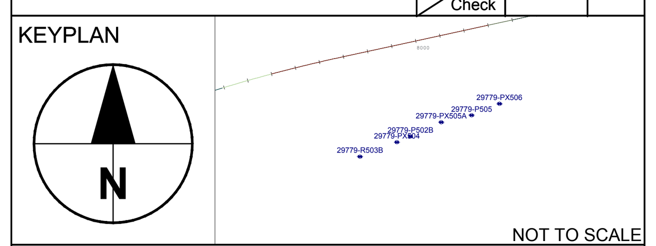
Topsoil, Silt, Gravel, Peat, Made Ground, Sand, Cobbles, Chalk, Clay, Boulders

SECTION KEY:

HAGDMS No. and Hole ID
Chainage, Offset from Centreline of Alignment, Ground Level
Ground investigation Contractor's Classification
Professor Rory Mortimore's Classification
Moderate Response Lower Limit (7.5 API)
High Response Lower Limit (12.5 API)
Natural Gamma Reading
Hole Base Depth [Reduced Level]
Existing Ground Level
Proposed Level
Moved Hole

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01

KEYPLAN



Purpose of issue
FOR REVIEW & COMMENT

Client
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
PHOSPHATIC CHALK
SECTION 10.
CH 7400M TO 7700M

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	15/06/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 AS SHOWN	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0077
Location | Type | Role | Number
Rev P01

Plot Time : 10:00
Plot Date : 15 June 2018 17:03:10
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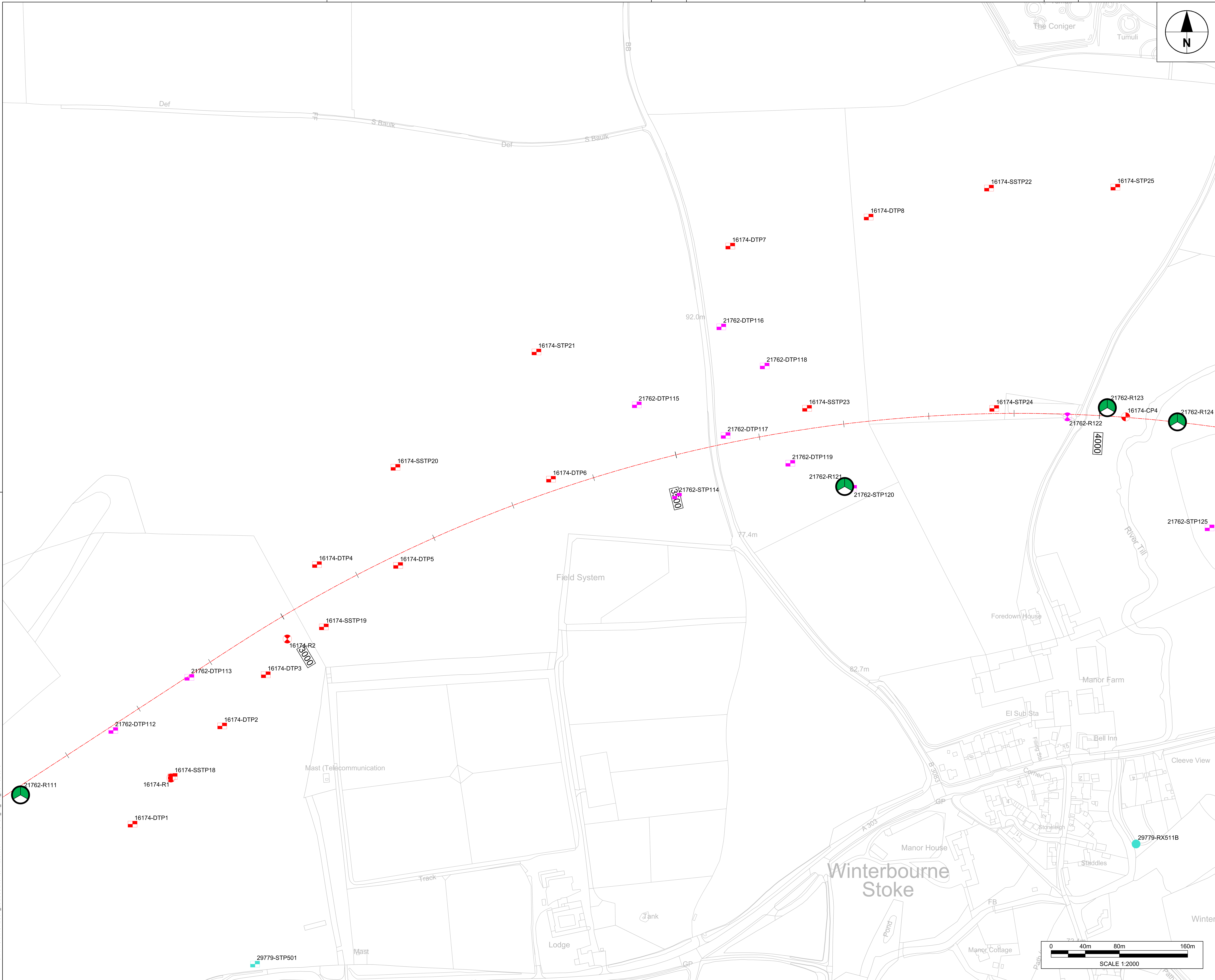

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3. ALL DIMENSIONS IN MILLIMETRES, ALL CHAINAGES, LEVELS AND COORDINATES ARE IN METRES UNLESS DEFINED OTHERWISE.
4. MAINLINE HORIZONTAL ALIGNMENT IS BASED ON VERSION P03.
5. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
6. ONLY EXPLORATORY HOLES THAT HAVE BEEN IDENTIFIED WITH THE PRESENCE OF PHOSPHATIC CHALK BY THE GROUND INVESTIGATION CONTRACTORS, OR HAVE BEEN LOGGED BY PROFESSOR RORY MORTIMORE, OR HAVE BEEN CARRIED OUT FOR DOWNHOLE NATURAL GAMMA LOGGING ARE INCLUDED AND INDICATED WITH THE ENLARGED SYMBOLS.
7. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z- DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

See Note 6.
1. Factual Report Exploratory Hole Logs
2. Prof. Mortimore's Logs
3. Natural Gamma Survey

1 & 2:
No cores for logging or not logged by Prof. Mortimore
Phosphatic chalk not recorded
Phosphatic chalk recorded

3:
Not surveyed
Background response
Moderate response
Moderate to high response

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
PHOSPHATIC CHALK LOCATIONS - SHEET 1

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439
Suitability S3
Scale @ A1 1:2000
Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN / Originator / Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0078
Location / Type / Role / Number
Rev P02

Plot Time : 15:00
Plot Date : 17 August 2018 15:59:32
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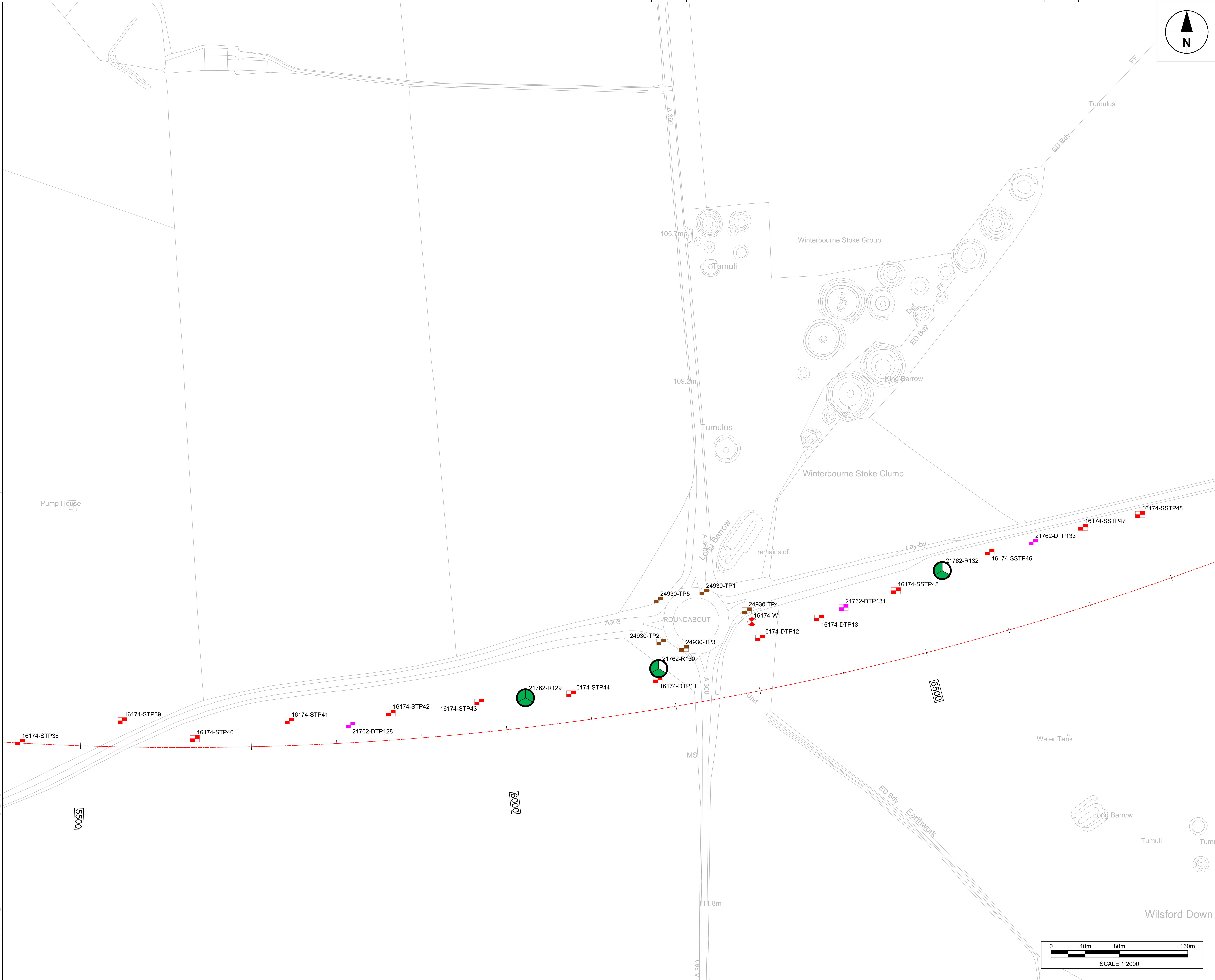

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7. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z- DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 16175, 16996, 17031, 17439, 21762, 24822, 24930, 29779, 30295, Halcrow 2000

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

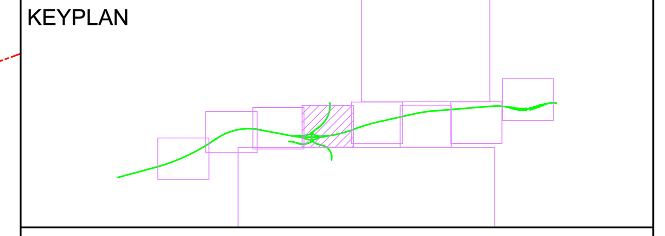
See Note 6.
1. Factual Report Exploratory Hole Logs
2. Prof. Mortimore's Logs
3. Natural Gamma Survey

1 & 2:
No cores for logging or not logged by Prof. Mortimore
Phosphatic chalk not recorded
Phosphatic chalk recorded

3:
Not surveyed
Background response
Moderate response
Moderate to high response

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – added holes & updated legend	EZ / GK	17/08/18	P02

KEYPLAN



Purpose of issue

FOR REVIEW & COMMENT

Client

highways england

Project Title

A303 Stonehenge Amesbury to Berwick Down

Drawing Title

PHOSPHATIC CHALK LOCATIONS - SHEET 2

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No.	Suitability
60541439	S3
Scale @ A1: 1:2000	Zone: Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT - SW_ML_M00_Z -DR-CE-0079
Location | Type | Role | Number

Rev P02

Plot Time: 15:00
Plot Date: 17 August 2018 15:52:26
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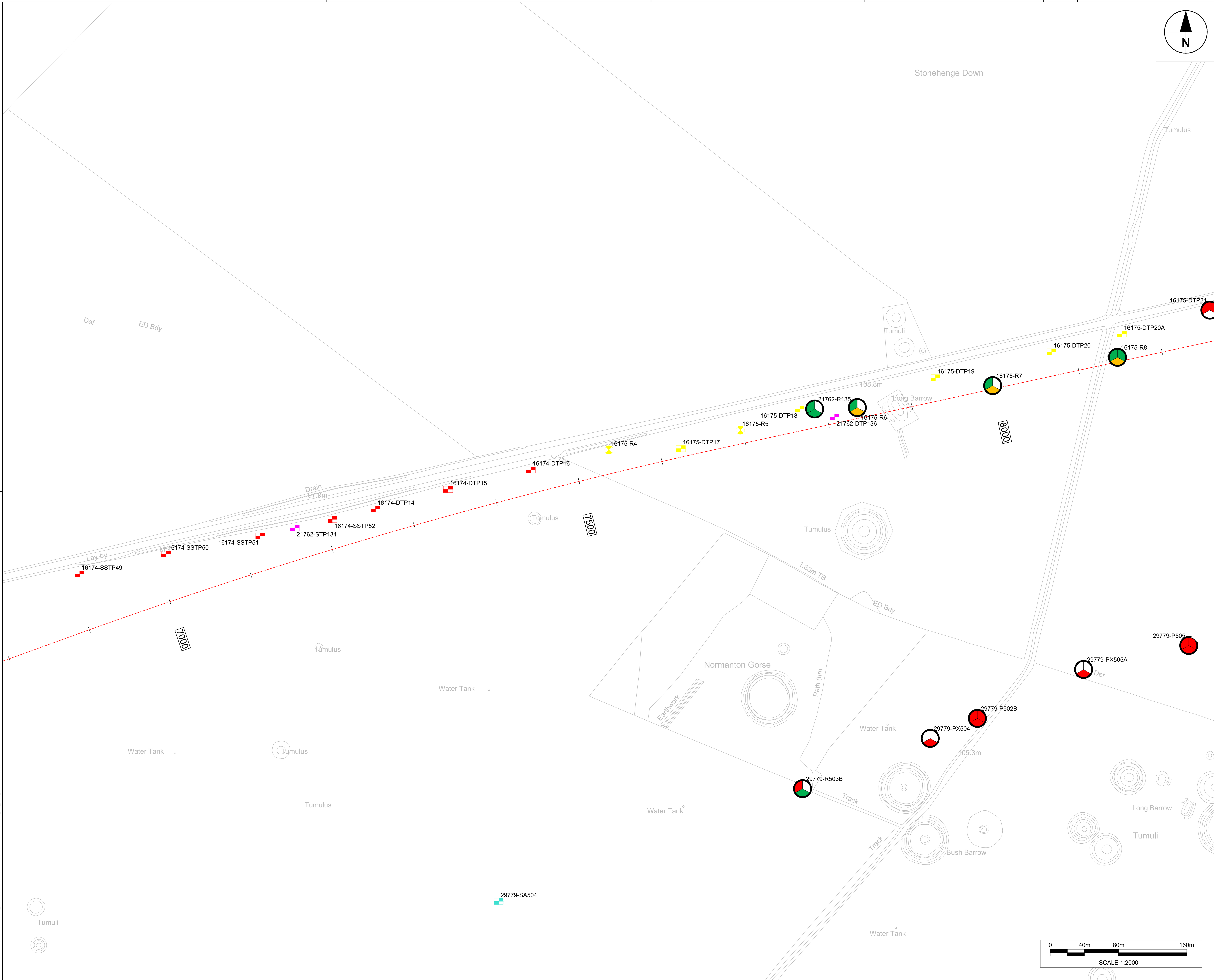

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7. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z- DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 16175, 16996, 17031, 17439, 21762, 24822, 24930, 29779, 30295, Halcrow 2000

Label CP
Label TP
Label RC
Label RO
Label BH
Label WS
Label CP+RC
Label RO+RC

See Note 6.

1. Factual Report Exploratory Hole Logs
2. Prof. Mortimore's Logs
3. Natural Gamma Survey

1 & 2:
- No cores for logging or not logged by Prof. Mortimore
- Phosphatic chalk not recorded
- Phosphatic chalk recorded

3:
- Not surveyed
- Background response
- Moderate response
- Moderate to high response

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

highways england

Project Title

A303 Stonehenge
Amesbury to Berwick Down

Drawing Title

PHOSPHATIC CHALK LOCATIONS - SHEET 3

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -
SW_ML_M00_Z -DR-CE-0080
Location | Type | Role | Number

Rev P02

Plot Time : 15:00
Plot Date : 17 August 2018 15:49:43
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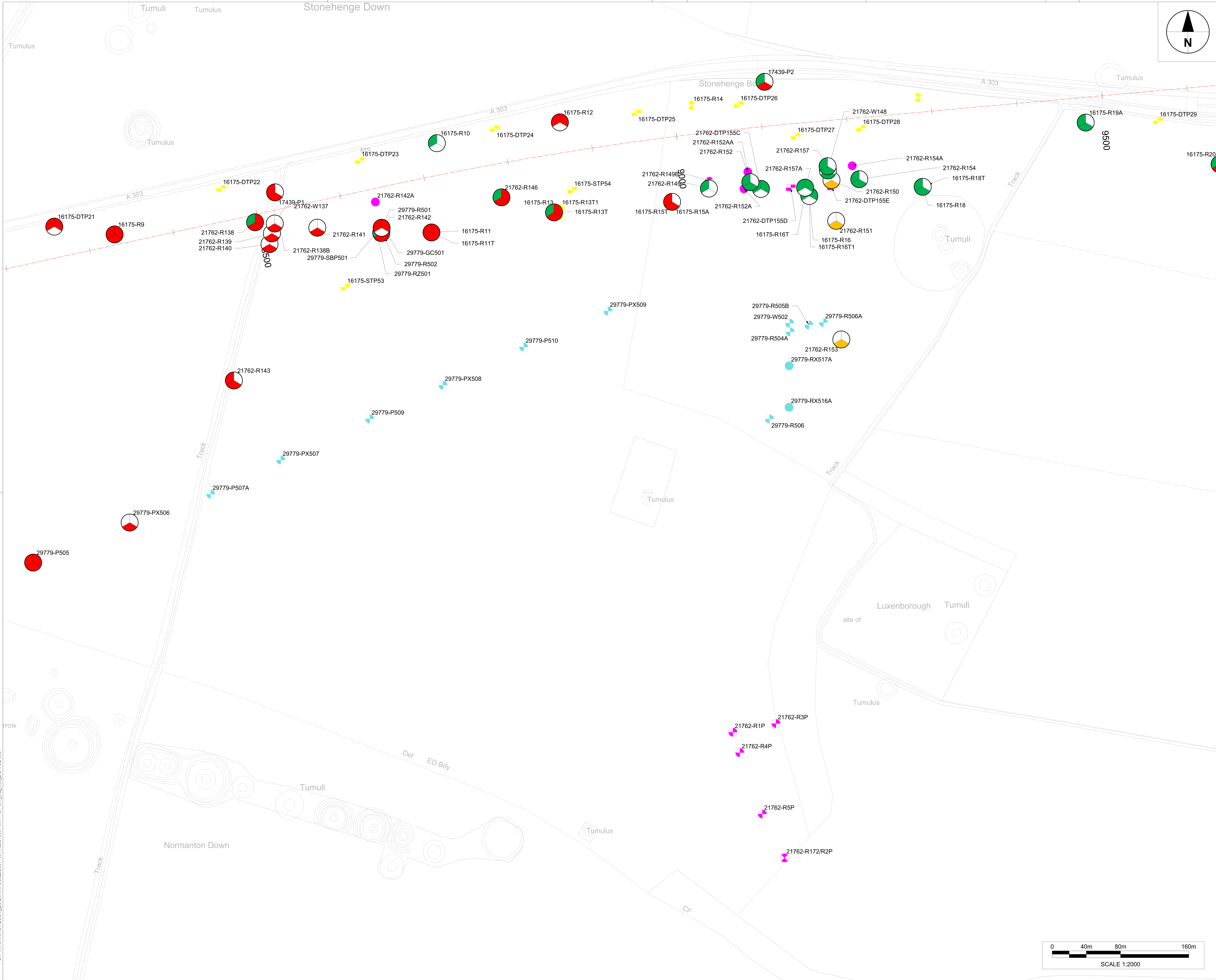

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3. ALL DIMENSIONS IN MILLIMETRES, ALL CHAINAGES, LEVELS AND COORDINATES ARE IN METRES UNLESS DEFINED OTHERWISE.
4. MAINLINE HORIZONTAL ALIGNMENT IS BASED ON VERSION P03.
5. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
6. ONLY EXPLORATORY HOLES THAT HAVE BEEN IDENTIFIED WITH THE PRESENCE OF PHOSPHATIC CHALK BY THE GROUND INVESTIGATION CONTRACTORS, OR HAVE BEEN LOGGED BY PROFESSOR RORY MORTIMORE, OR HAVE BEEN CARRIED OUT FOR DOWNHOLE NATURAL GAMMA LOGGING ARE INCLUDED AND INDICATED WITH THE ENLARGED SYMBOLS.
7. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z- DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 16175, 16996, 17031, 17439, 21762, 24822, 24930, 29779, 30295, Halcrow 2000

Label CP; Label TP; Label RC; Label RO; Label BH; Label WS; Label CP+RC; Label RO+RC

See Note 6.
1. Factual Report Exploratory Hole Logs
2. Prof. Mortimore's Logs
3. Natural Gamma Survey

1 & 2:
- No cores for logging or not logged by Prof. Mortimore
- Phosphatic chalk not recorded
- Phosphatic chalk recorded

3:
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- Background response
- Moderate response
- Moderate to high response

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
PHOSPHATIC CHALK LOCATIONS - SHEET 4

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439
Suitability S3
Scale @ A1 1:2000
Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0081
Location | Type | Role | Number

Rev P02

Plot Time : 10:00
Plot Date : 13 June 2018 14:49:27
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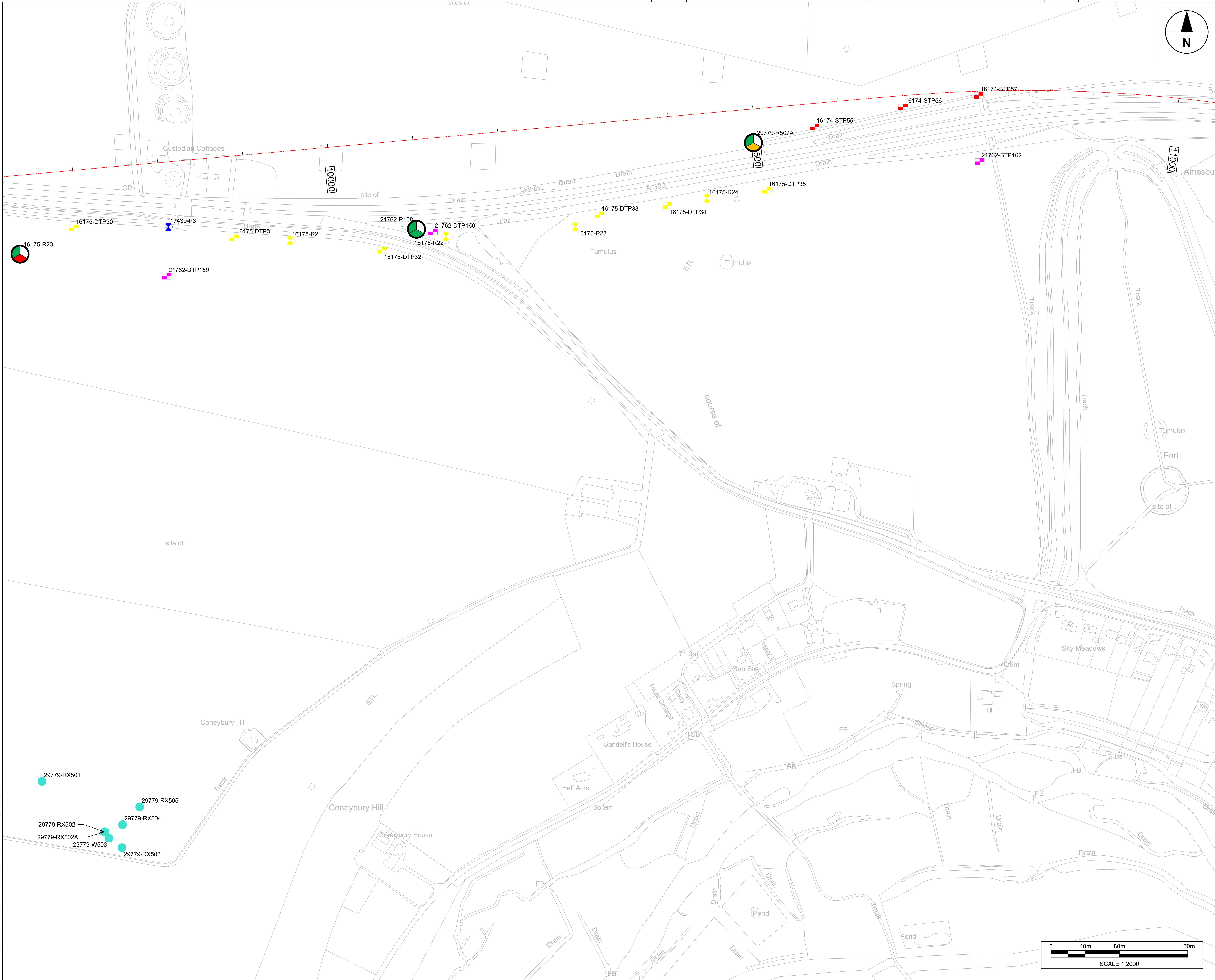

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DOCUMENTATION.
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3. ALL DIMENSIONS IN MILLIMETRES, ALL CHAINAGES, LEVELS AND COORDINATES ARE IN METRES UNLESS DEFINED OTHERWISE.
4. MAINLINE HORIZONTAL ALIGNMENT IS BASED ON VERSION P03.
5. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
6. ONLY EXPLORATORY HOLES THAT HAVE BEEN IDENTIFIED WITH THE PRESENCE OF PHOSPHATIC CHALK BY THE GROUND INVESTIGATION CONTRACTORS, OR HAVE BEEN LOGGED BY PROFESSOR RORY MORTIMORE, OR HAVE BEEN CARRIED OUT FOR DOWNHOLE NATURAL GAMMA LOGGING ARE INCLUDED AND INDICATED WITH THE ENLARGED SYMBOLS.
7. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z- DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174, 17031, 24822, 30295, 16175, 17439, 24930, Halcrow 2000, 16996, 21762, 29779

Label CP; Label TP; Label RC; Label RO; Label BH; Label WS; Label CP+RC; Label RO+RC

See Note 6.
1. Factual Report Exploratory Hole Logs
2. Prof. Mortimore's Logs
3. Natural Gamma Survey

1 & 2:
No cores for logging or not logged by Prof. Mortimore
Phosphatic chalk not recorded
Phosphatic chalk recorded

3:
Not surveyed
Background response
Moderate response
Moderate to high response

Revision Details	By / Check	Date	Suffix
First Issue	EZ / GK	15/06/18	P01
Second Issue – updated legend	EZ / GK	17/08/18	P02

KEYPLAN

Purpose of issue
FOR REVIEW & COMMENT

Client
highways england

Project Title
A303 Stonehenge
Amesbury to Berwick Down

Drawing Title
PHOSPHATIC CHALK LOCATIONS - SHEET 5

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439
Suitability S3
Scale @ A1 1:2000
Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA
AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0082
Location | Type | Role | Number
Rev P02

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4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
5. REFER TO DRAWING "HE551506-AMW-HGT-SW_ML_M00_Z-DR-CE-0063" FOR LEGEND AND ABBREVIATIONS.

LEGEND

16174	17031	24822	30295
16175	17439	24930	Halcrow 2000
16996	21762	29779	

Label CP	Standpipe Piezometer Location
Label TP	
Label RC	
Label RO	
Label BH	
Label WS	
Label CP+RC	
Label RO+RC	

Revision Details	By / Check	Date	Suffix
First Issue – new drawing	EZ / GK	17/08/18	P01

KEYPLAN

Purpose of issue

FOR REVIEW & COMMENT

Client

highways england

Project Title

A303 Stonehenge

Drawing Title

GROUND INVESTIGATIONS - STANDPIPE PIEZOMETERS LOCATIONS - SHEET 3

Designed	Drawn	Checked	Approved	Date
EZ	EZ	OL	GK	17/08/18

Internal Project No. 60541439	Suitability S3
Scale @ A1 1:2000	Zone Scheme Wide

Highways England Project Office
Temple Quay House
2 The Square, Temple Quay
Bristol, BS1 6HA

AmW
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume
HE551506 -AMW -HGT -SW_ML_M00_Z -DR-CE-0085
Location | Type | Role | Number

Rev P01

Plot Time : 10:00
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Appendix B Site Walkover Photographs

B.1 Site visit date 20 July 2017

Photo	Location	Orientation	Comment
	B3083, layby north of Winterbourne Stoke. Point at which proposed route intersects B3083.	West	View to the westernmost section of the Preferred Route, with embankment proposed.
	B3083, layby north of Winterbourne Stoke. Point at which proposed route intersects B3083.	North	View uphill, B3083.
	Public bridleway, leaving the A303 to the north, west of the Bell Inn pub. At the point crossing the proposed viaduct.	West	Embankment proposed away from viaduct abutment in this direction.

Photo	Location	Orientation	Comment
	Public bridleway, leaving the A303 to the north, west of the Bell Inn pub. At the point crossing the proposed viaduct.	East	River Till runs along the line of trees. Viaduct proposed for this section.
	Public bridleway, leaving the A303 to the north, west of the Bell Inn pub. At the point crossing the proposed viaduct.	North-East	River Till runs along the line of trees. Viaduct proposed for this section.
	Public bridleway, leaving the A303 to the north, west of the Bell Inn pub. At the point crossing the proposed viaduct.	East	River Till. Proposed viaduct to pass over river.

Photo	Location	Orientation	Comment
	Public footpath between fields, approaching the A303 to the east of Winterbourne Stoke.	North-West	Underpass constructed for the River Till.
	Public footpath between fields, approaching the A303 to the east of Winterbourne Stoke. Just north of the point where the proposed route crosses the footpath.	(N/A)	“Dumping” pit observed, with chalk present (minimal to no Flint in excavated material).
	Public footpath between fields, approaching the A303 to the east of Winterbourne Stoke. At the point where the proposed route crosses the footpath.	East	Proposed cutting looking ahead to the east.

Photo	Location	Orientation	Comment
	Public footpath between fields, approaching the A303 to the east of Winterbourne Stoke. At the point where the proposed route crosses the footpath.	West	Looking towards where the proposed viaduct is envisaged.
	A360, south of the roundabout junction with the A303. Where the new junction is proposed.	West	Not possible to safely exit the vehicle in this area. Photo taken by passenger.
	A303, approaching Stonehenge Eastbound.	North	Photo taken by passenger.

Photo	Location	Orientation	Comment
	West Amesbury Spring, south of Stonehenge Road and north of the River Avon.	North	Water level appears to be relatively low. V-notch weir is present, yet ineffective.
	West of Amesbury, on the public footpath in Land Parcel 78/16 (ref HE551506-AA-HGT -D_SWI-FN-CX-000004), around the proposed cluster of boreholes near borehole R142.	North-West	View of Stonehenge.
	West of Amesbury, on the public footpath in Land Parcel 78/16 (ref HE551506-AA-HGT -D_SWI-FN-CX-000004), around the proposed cluster of boreholes near borehole R142.	North-West	View of Stonehenge.

Photo	Location	Orientation	Comment
	West of Amesbury, on the public footpath in Land Parcel 78/16 (ref HE551506-AA-HGT -D_SWI-FN-CX-000004), around the proposed cluster of boreholes near borehole R142.	North-West	View of area of proposed GI investigation into phosphatic Chalk. Stonehenge visible in the distance.
	West of Amesbury, on the public footpath in Land Parcel 78/16 (ref HE551506-AA-HGT -D_SWI-FN-CX-000004), around the proposed cluster of boreholes near borehole R142.	North-East	Sloping downward gradient towards Amesbury.
	West of Amesbury, on the public footpath in Land Parcel 78/16 (ref HE551506-AA-HGT -D_SWI-FN-CX-000004), around the proposed cluster of boreholes near borehole R142.	South-West	View towards proposed GI soakaway testing area.

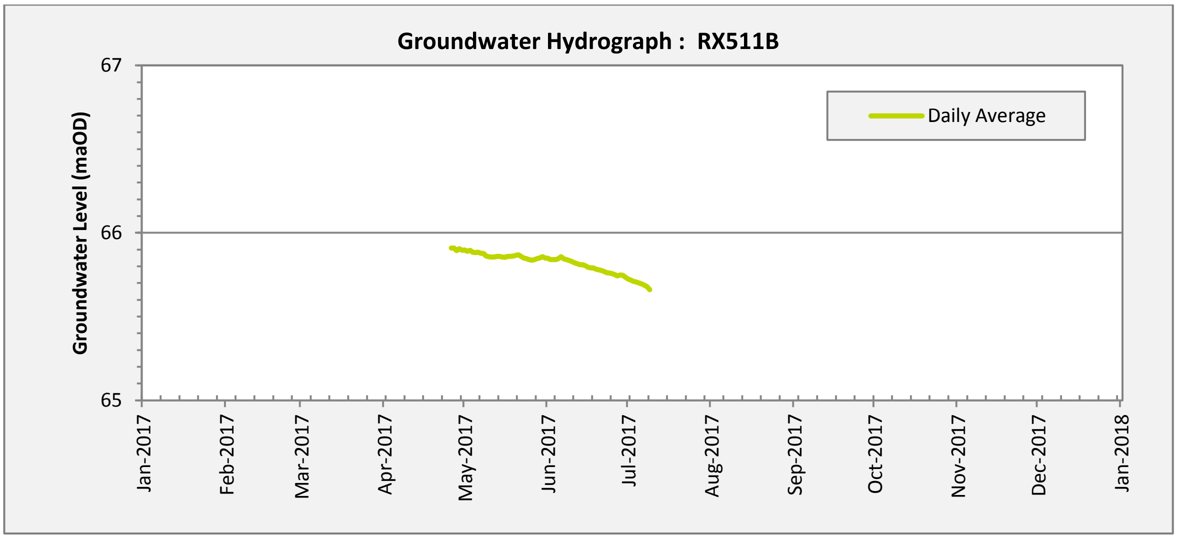
Photo	Location	Orientation	Comment
	West of Amesbury, on the public footpath in Land Parcel 78/16 (ref HE551506-AA-HGT -D_SWI-FN-CX-000004), around the proposed cluster of boreholes near borehole R142.	South	Downward gradient towards the River Avon.
	West of Amesbury, on the public footpath in Land Parcel 78/16 (ref HE551506-AA-HGT -D_SWI-FN-CX-000004), around the proposed cluster of boreholes near borehole R142.	South-East	
	West of Amesbury, on the public footpath in Land Parcel 78/16 (ref HE551506-AA-HGT -D_SWI-FN-CX-000004), around the proposed cluster of boreholes near borehole R142.	South-West	

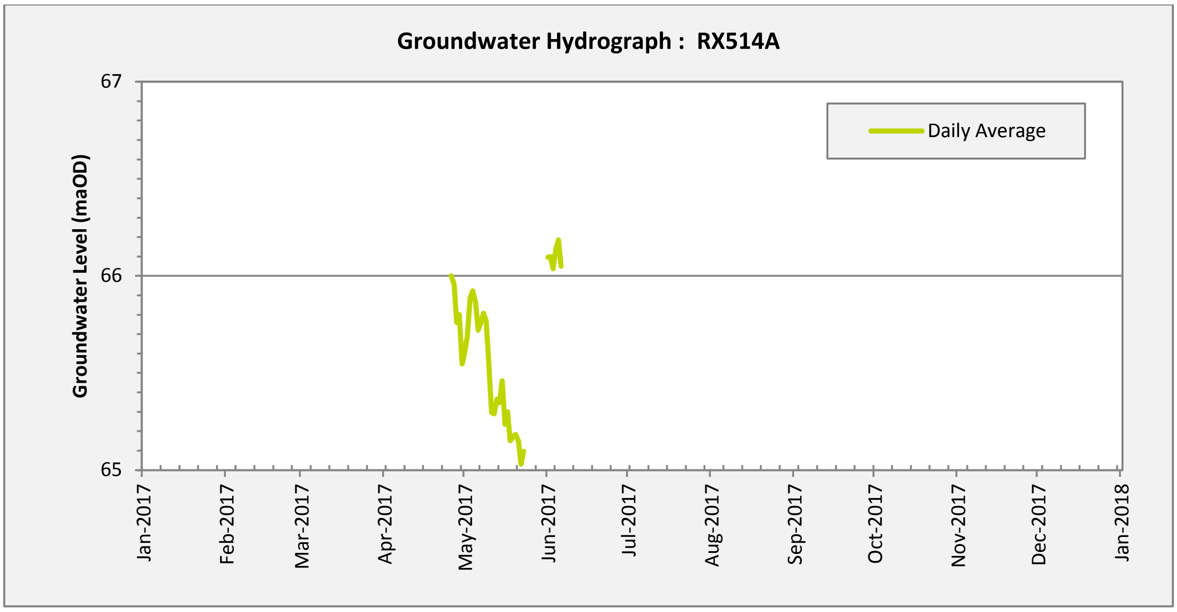
Photo	Location	Orientation	Comment
	West of Amesbury, on the public footpath in Land Parcel 78/16 (ref HE551506-AA-HGT -D_SWI-FN-CX-000004), around the proposed cluster of boreholes near borehole R142.	West	View towards the valley (Stonehenge Bottom).

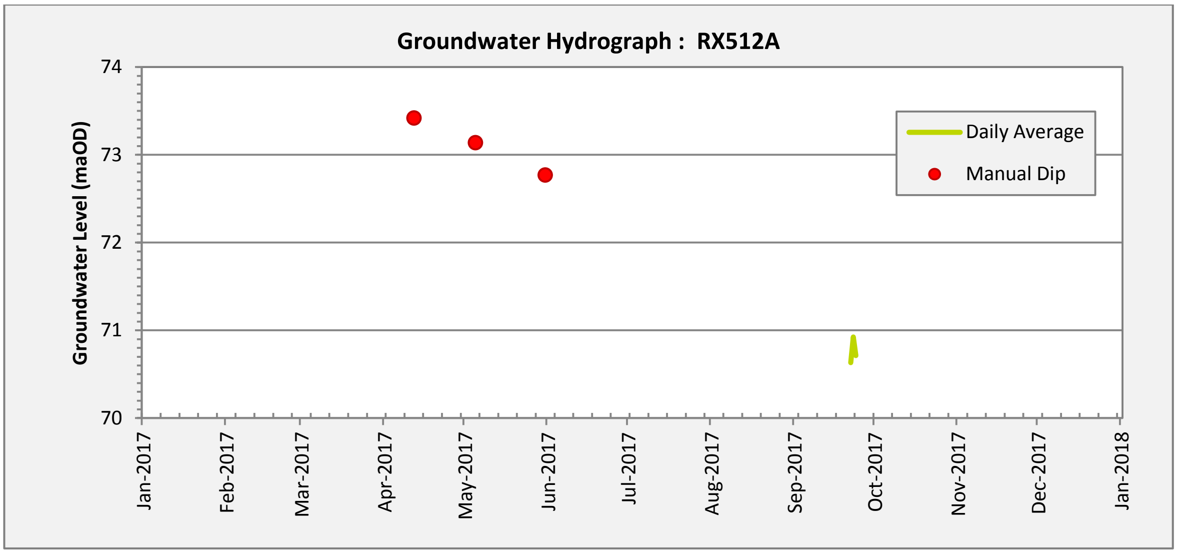
Appendix C Hydrographs

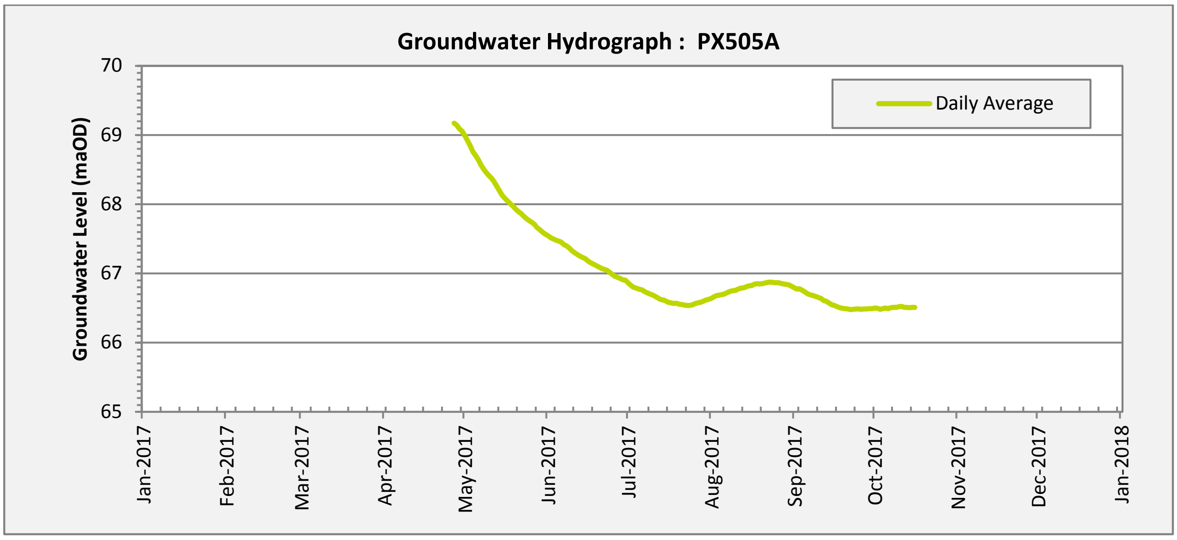
C.1 2017 Monitoring - Hydrographs

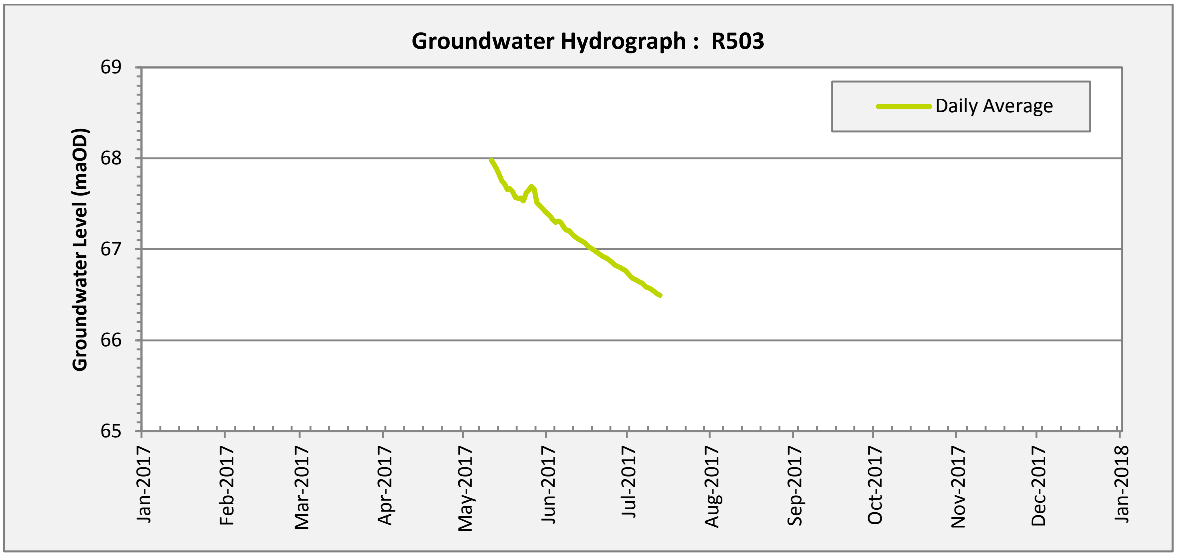
Note that level data from RX506, R507A, RX510A, RX514A locations may be incorrect.

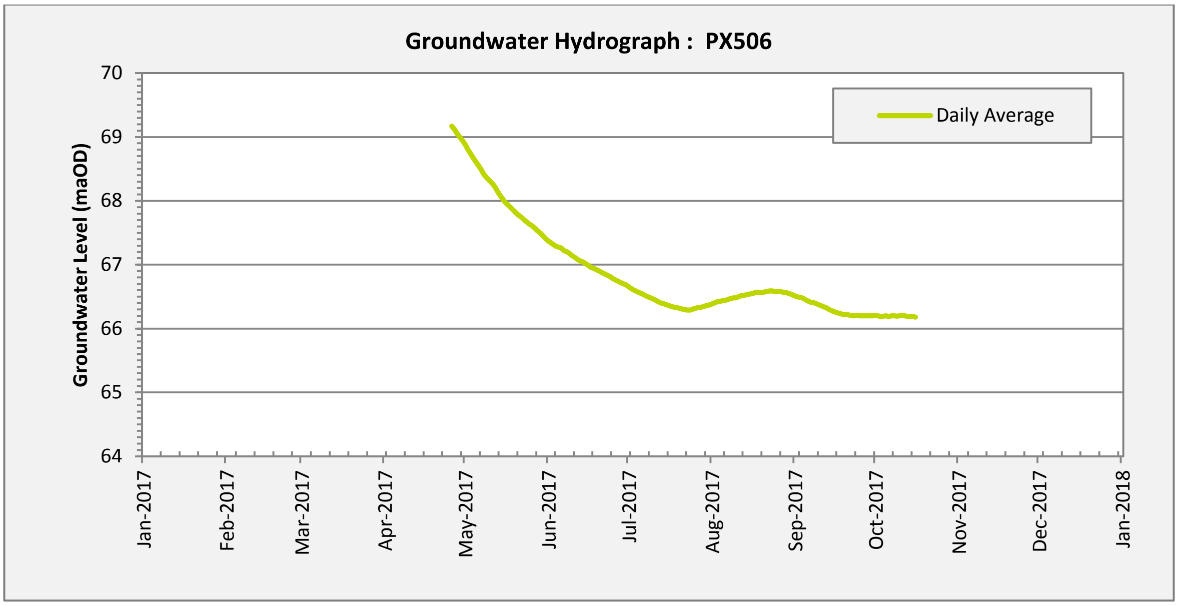




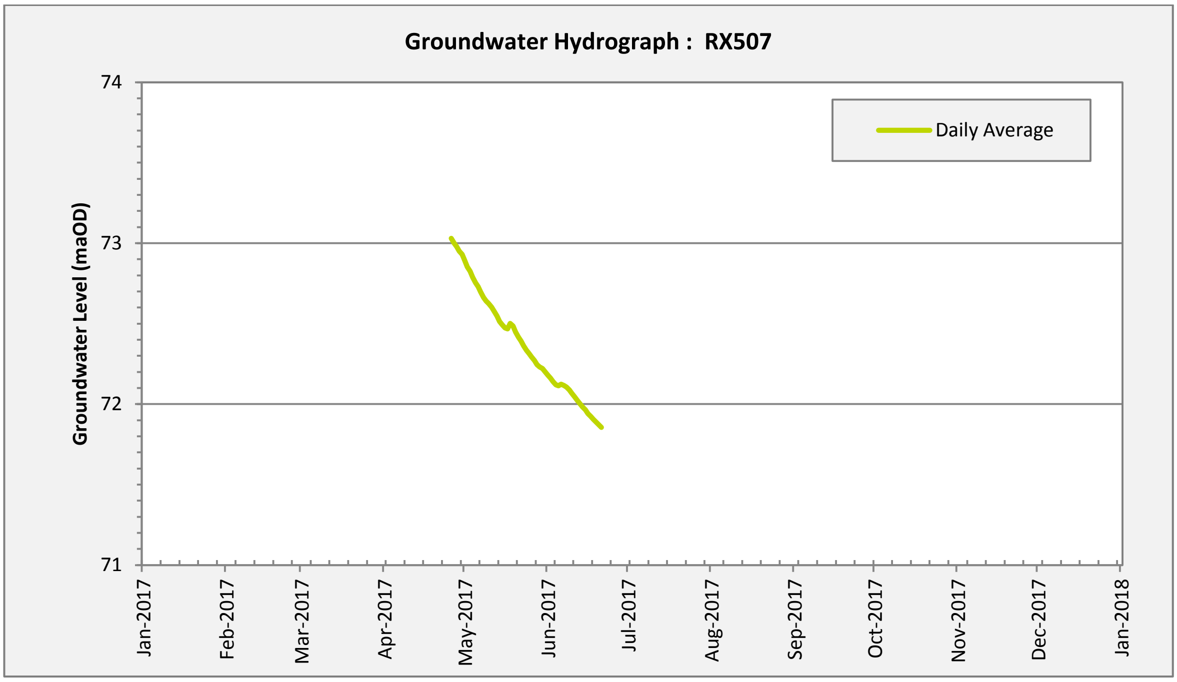

Groundwater Hydrograph : RX512A
Groundwater Level (maOD)
74
73
72
71
70
Daily Average
Manual Dip
Jan-2017
Feb-2017
Mar-2017
Apr-2017
May-2017
Jun-2017
Jul-2017
Aug-2017
Sep-2017
Oct-2017
Nov-2017
Dec-2017
Jan-2018


Groundwater Hydrograph : PX505A
Groundwater Level (maOD)
70
69
68
67
66
65
Daily Average
Jan-2017
Feb-2017
Mar-2017
Apr-2017
May-2017
Jun-2017
Jul-2017
Aug-2017
Sep-2017
Oct-2017
Nov-2017
Dec-2017
Jan-2018

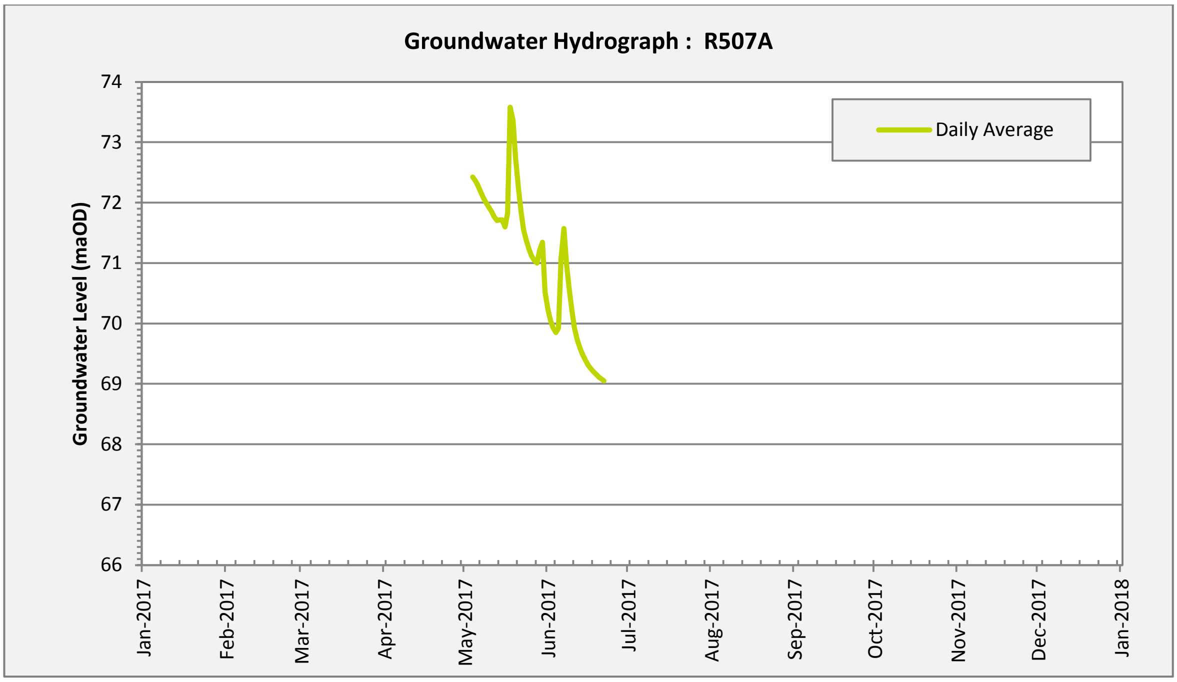

Groundwater Hydrograph : R503
Groundwater Level (maOD)
69
68
67
66
65
Daily Average
Jan-2017
Feb-2017
Mar-2017
Apr-2017
May-2017
Jun-2017
Jul-2017
Aug-2017
Sep-2017
Oct-2017
Nov-2017
Dec-2017
Jan-2018



Groundwater Hydrograph : PX506
Groundwater Level (maOD)
70
69
68
67
66
65
64
Daily Average
Jan-2017
Feb-2017
Mar-2017
Apr-2017
May-2017
Jun-2017
Jul-2017
Aug-2017
Sep-2017
Oct-2017
Nov-2017
Dec-2017
Jan-2018



Groundwater Hydrograph : RX507
Groundwater Level (maOD)
74
73
72
71
Daily Average
Jan-2017
Feb-2017
Mar-2017
Apr-2017
May-2017
Jun-2017
Jul-2017
Aug-2017
Sep-2017
Oct-2017
Nov-2017
Dec-2017
Jan-2018


Groundwater Hydrograph : R507A
Daily Average
Groundwater Level (maOD)
74
73
72
71
70
69
68
67
66
Jan-2017
Feb-2017
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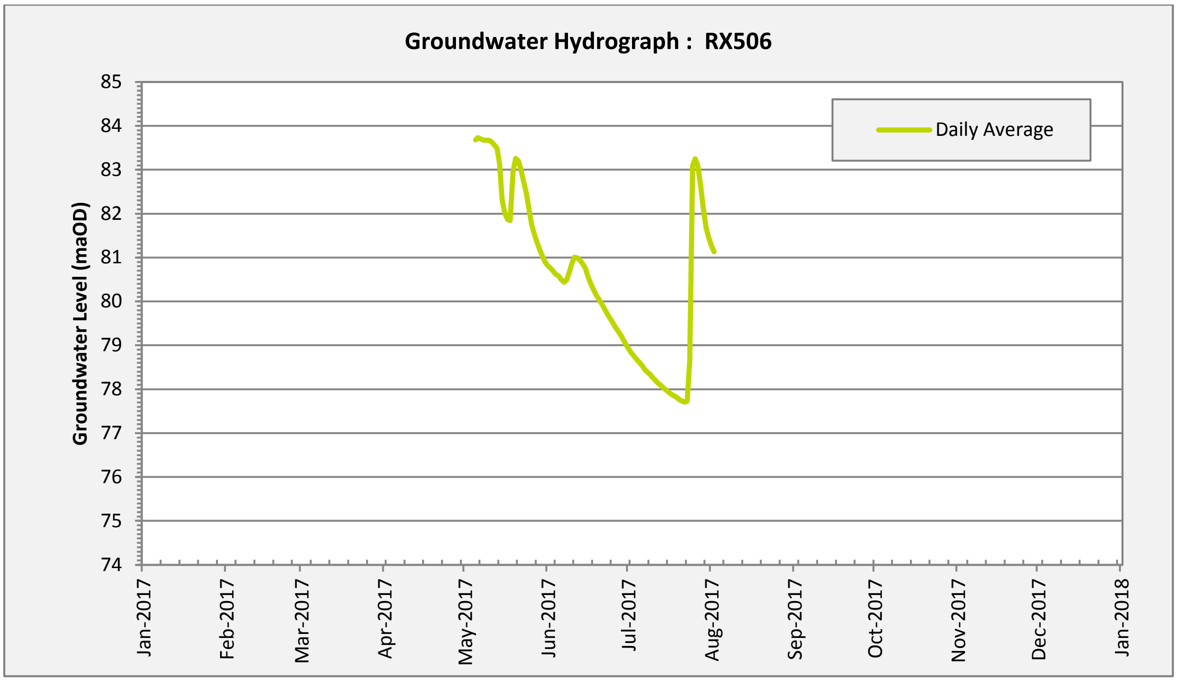
Nov-2017
Dec-2017
Jan-2018


Groundwater Hydrograph : RX506
Daily Average
Groundwater Level (maOD)
85
84
83
82
81
80
79
78
77
76
75
74
Jan-2017
Feb-2017
Mar-2017
Apr-2017
May-2017
Jun-2017
Jul-2017
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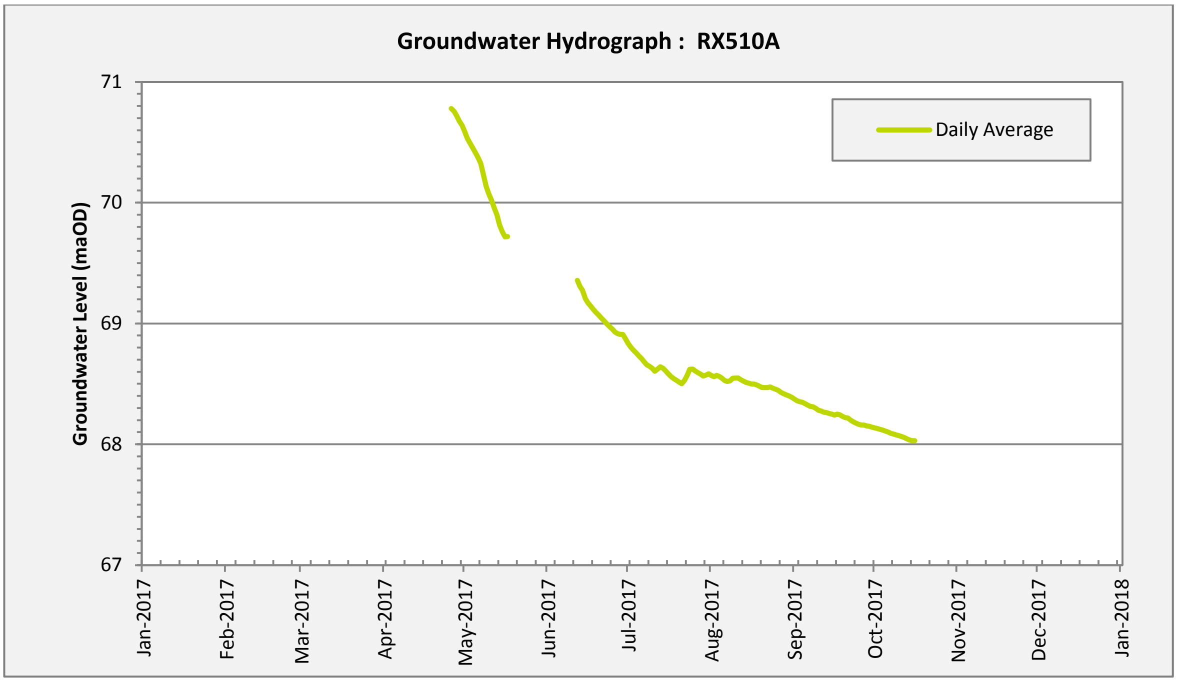
Nov-2017
Dec-2017
Jan-2018


Groundwater Hydrograph : RX510A
Daily Average
Groundwater Level (maOD)
71
70
69
68
67
Jan-2017
Feb-2017
Mar-2017
Apr-2017
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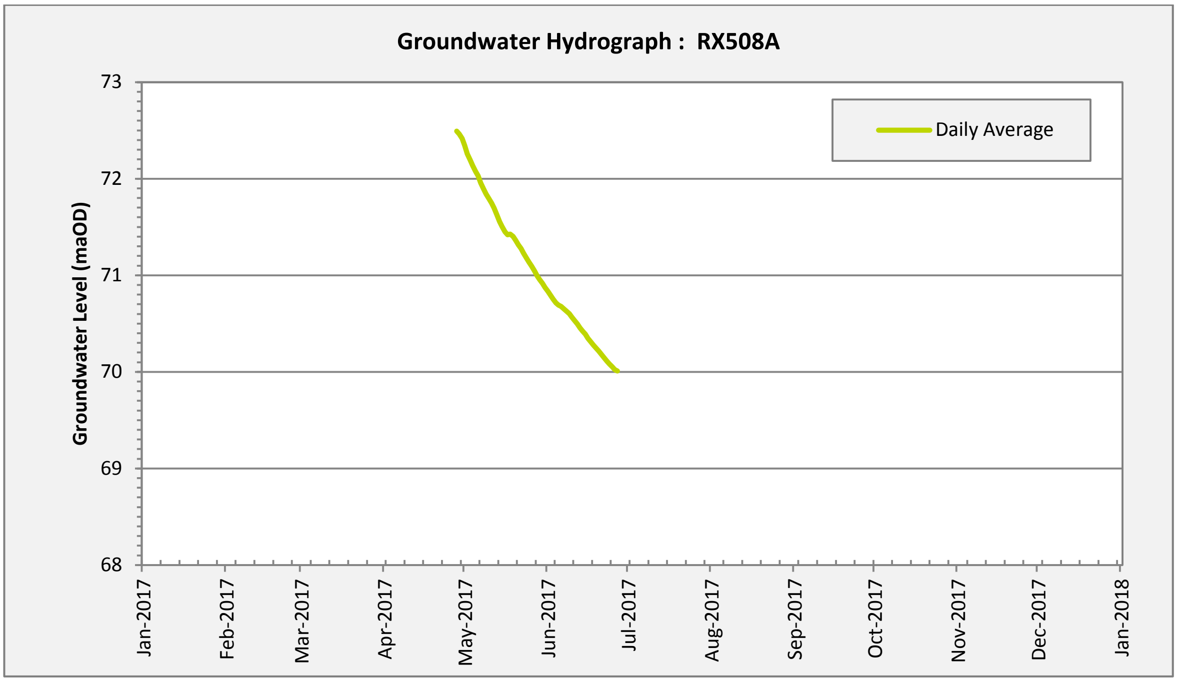
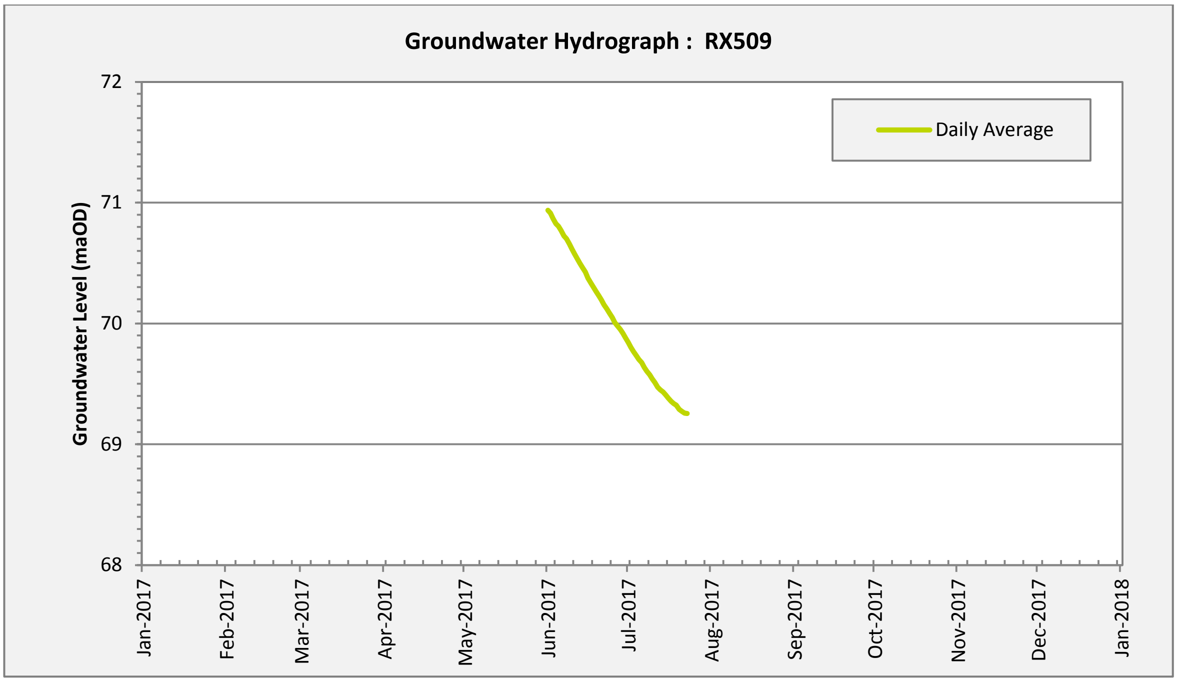
Oct-2017
Nov-2017
Dec-2017
Jan-2018


Groundwater Hydrograph : RX508A
Daily Average
Groundwater Level (maOD)
73
72
71
70
69
68
Jan-2017
Feb-2017
Mar-2017
Apr-2017
May-2017
Jun-2017
Jul-2017
Aug-2017
Sep-2017
Oct-2017
Nov-2017
Dec-2017
Jan-2018


Groundwater Hydrograph : RX509
Groundwater Level (maOD)
72
71
70
69
68
Daily Average
Jan-2017
Feb-2017
Mar-2017
Apr-2017
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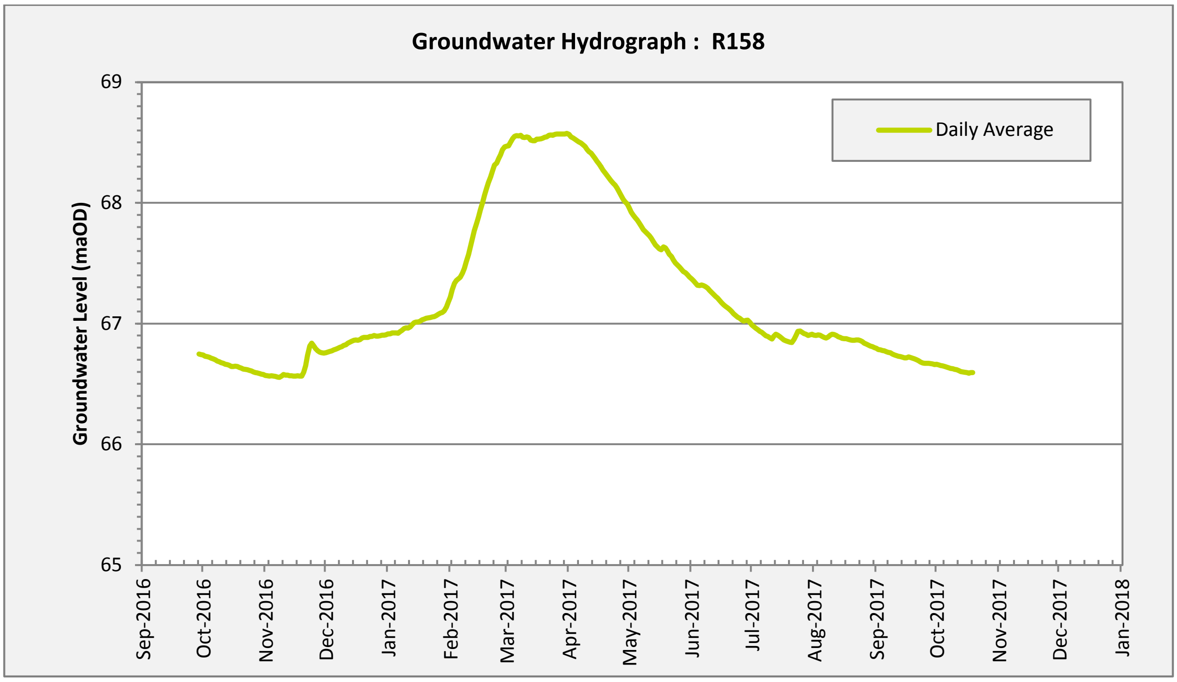
Nov-2017
Dec-2017
Jan-2018


Groundwater Hydrograph : R158
Groundwater Level (maOD)
69
68
67
66
65
Daily Average
Sep-2016
Oct-2016
Nov-2016
Dec-2016
Jan-2017
Feb-2017
Mar-2017
Apr-2017
May-2017
Jun-2017
Jul-2017
Aug-2017
Sep-2017
Oct-2017
Nov-2017
Dec-2017
Jan-2018

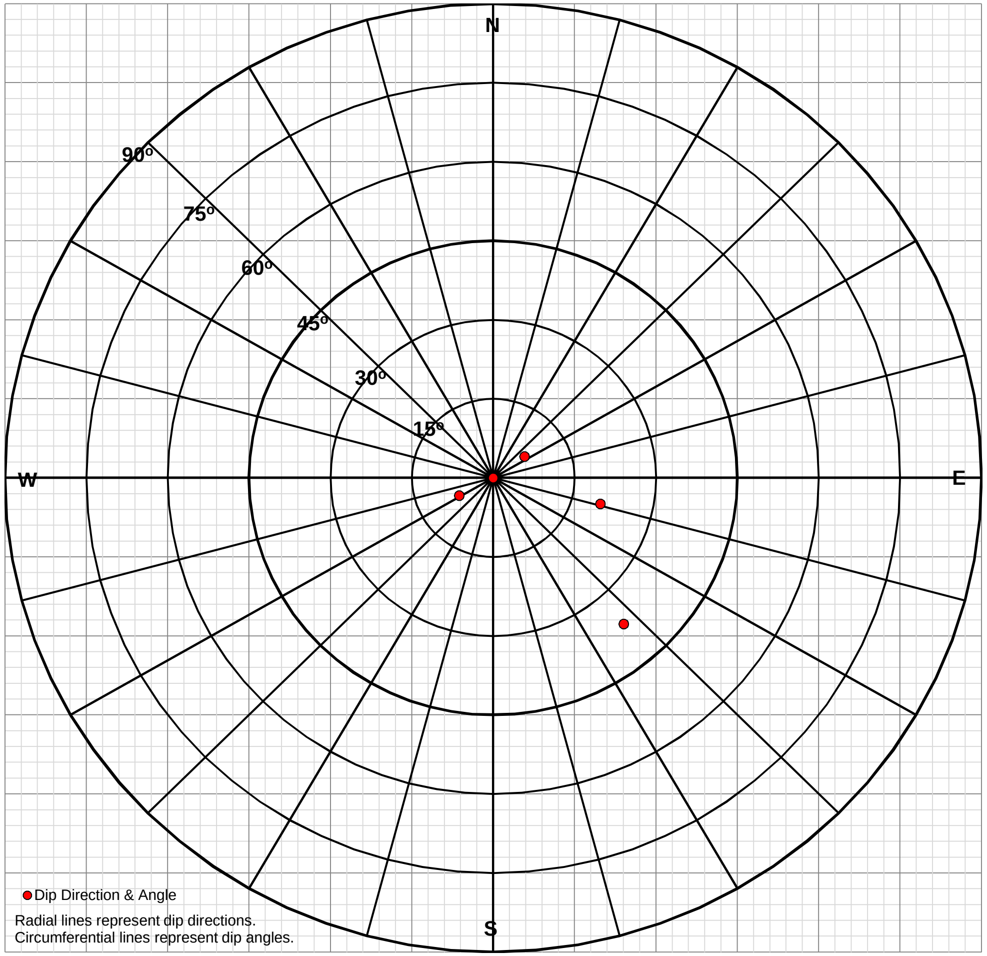
Appendix D OPTV Discontinuity Direction and Dip Angle

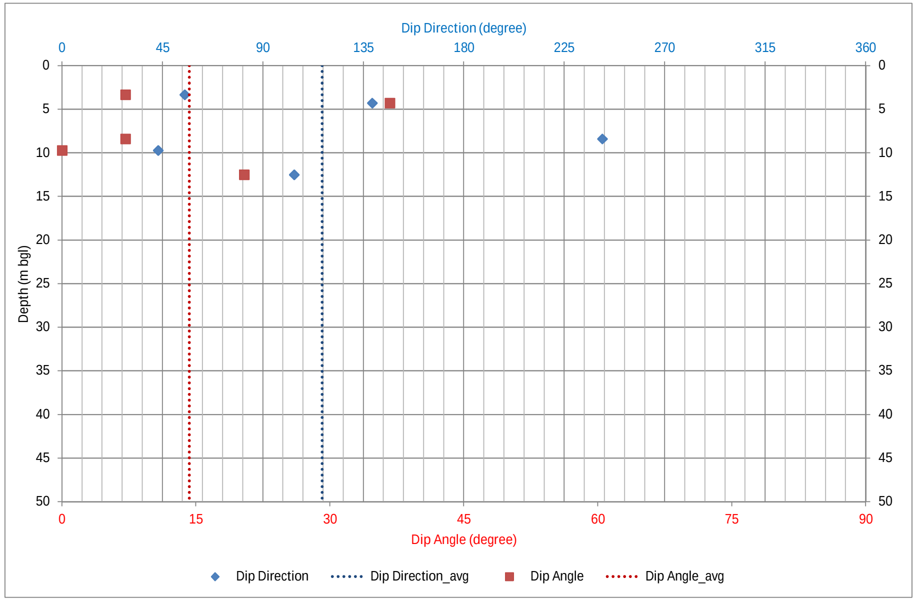
Exploratory Hole ID	21762-R129

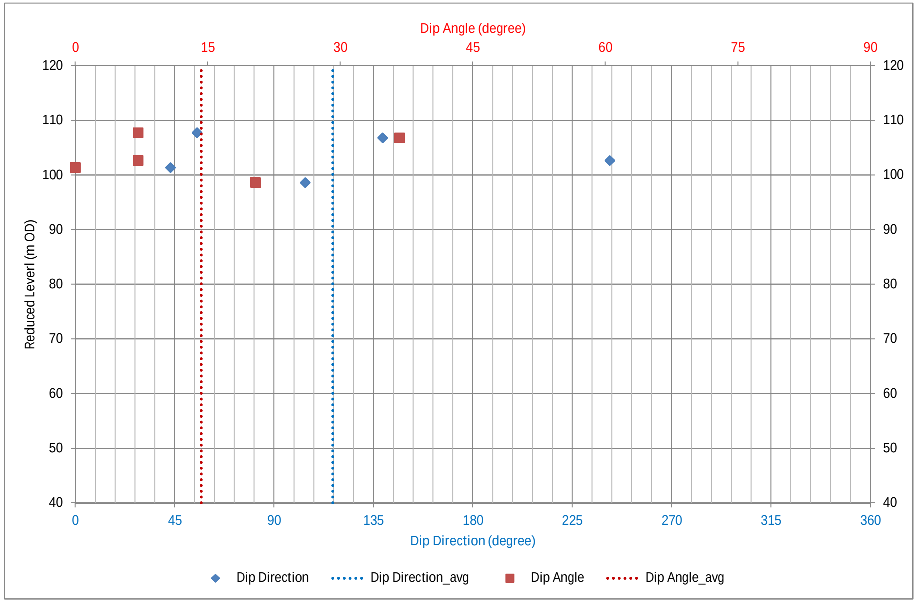
Chainage (m)	6026
Offset (m)	35

	From	To
Surveyed Depth (m bgl)	3.3	12.5
Surveyed Level (m OD)	107.8	98.6

	min	max	avg	stdev
Dip Direction	43	242	117	72
Dip Angle	0	37	14	13





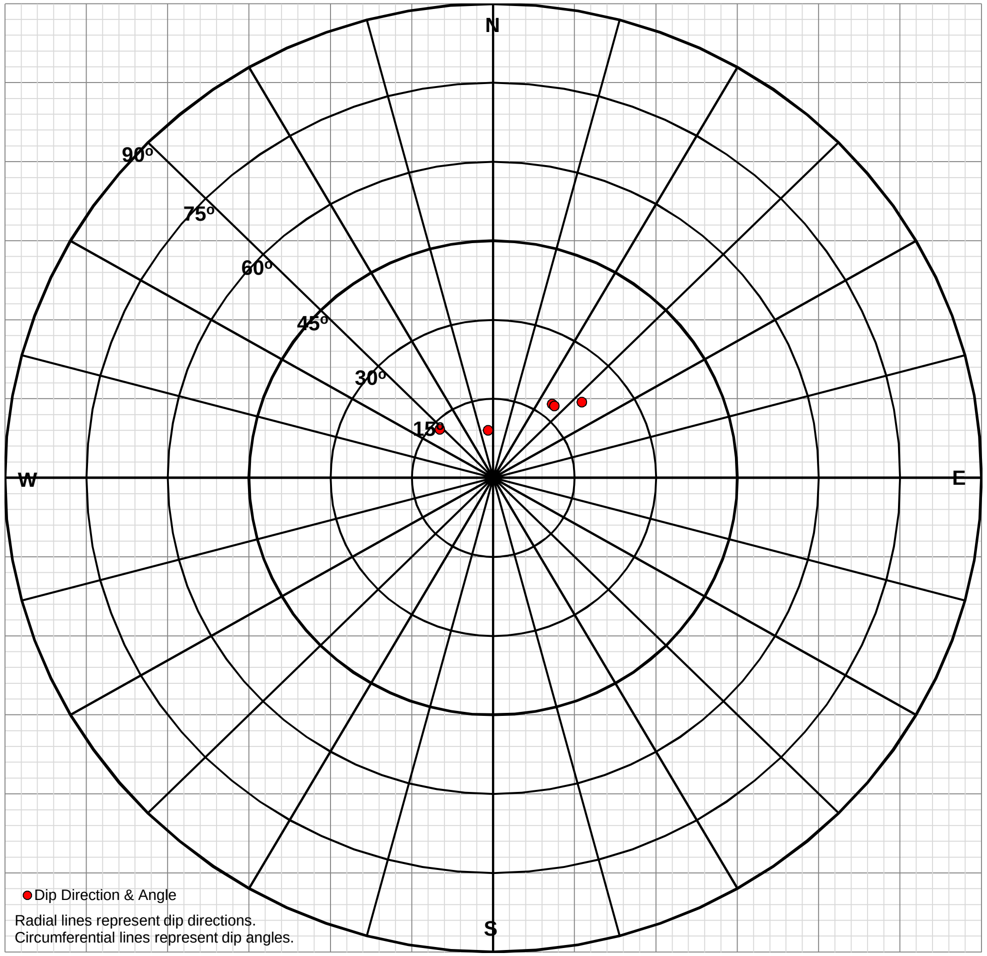


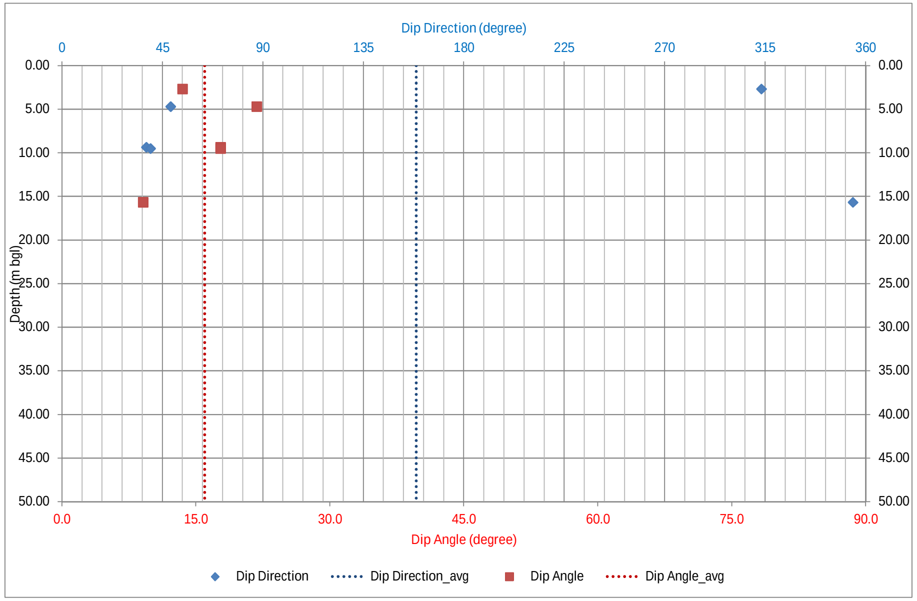
Exploratory Hole ID	21762-R130

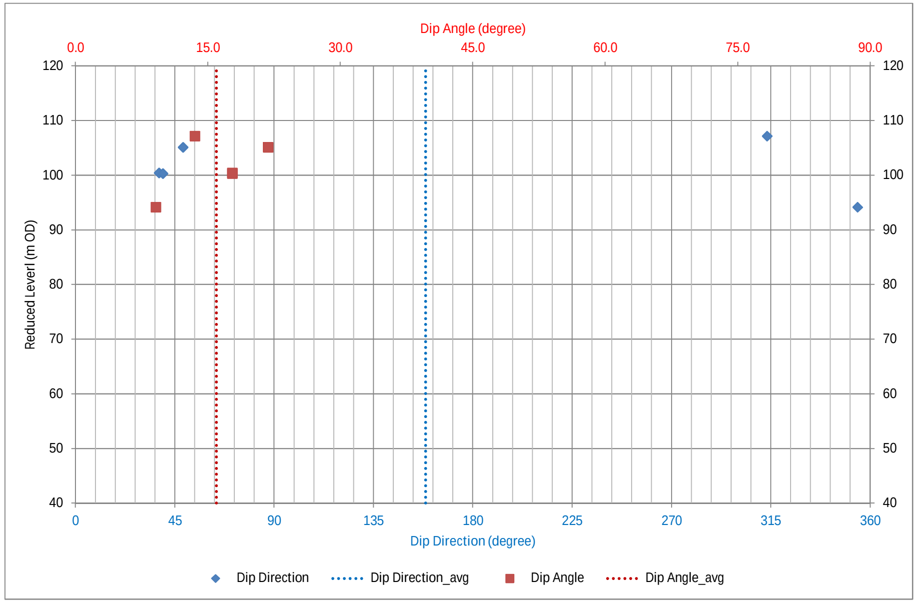
Chainage (m)	6187
Offset (m)	47

	From	To
Surveyed Depth (m bgl)	2.7	15.7
Surveyed Level (m OD)	107.2	94.2

	min	max	avg	stdev
Dip Direction	38	354	159	144
Dip Angle	9	22	16	4





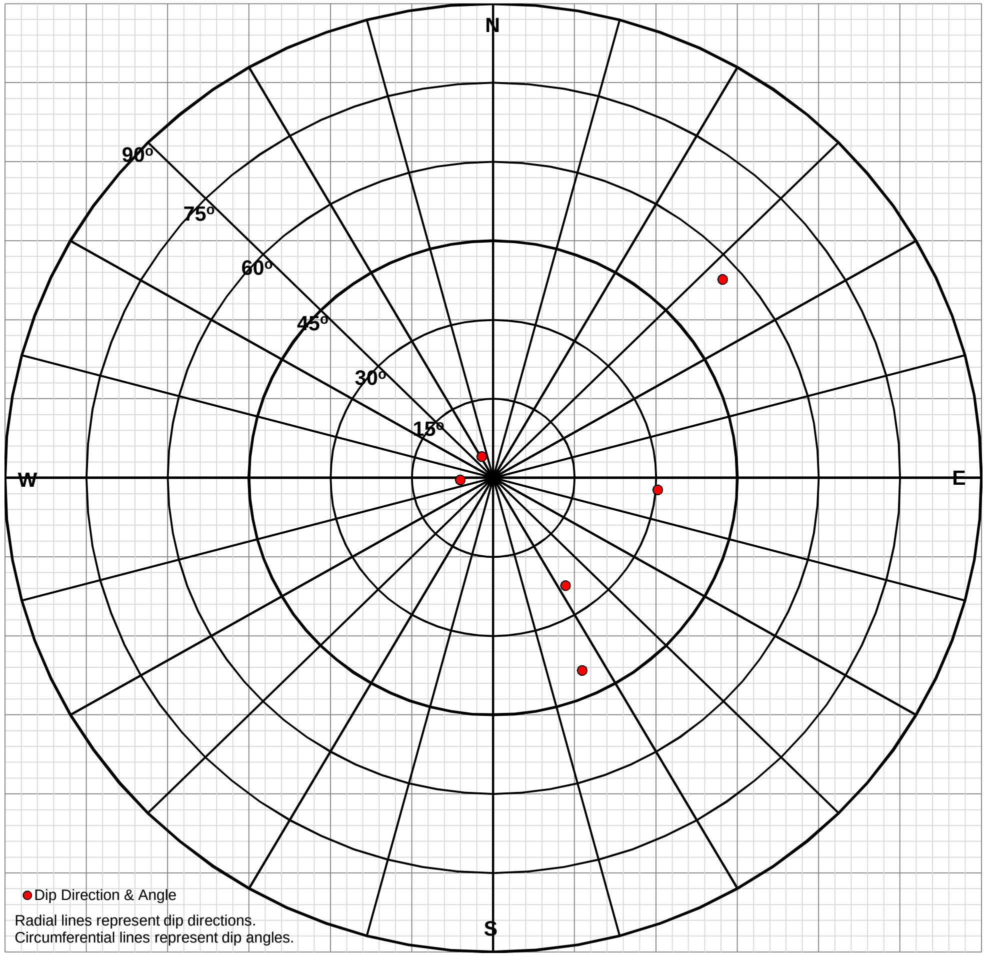


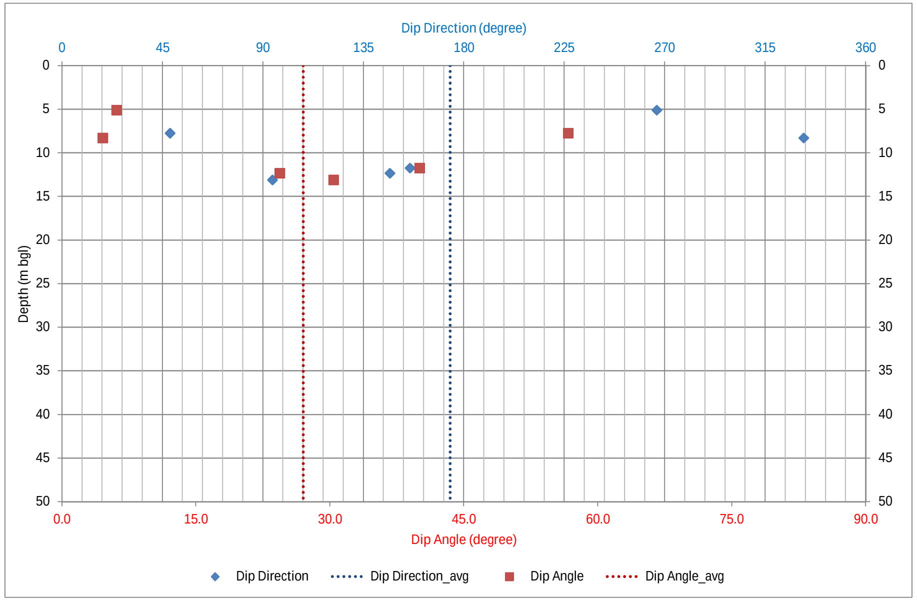
Exploratory Hole ID	**21762-R132**

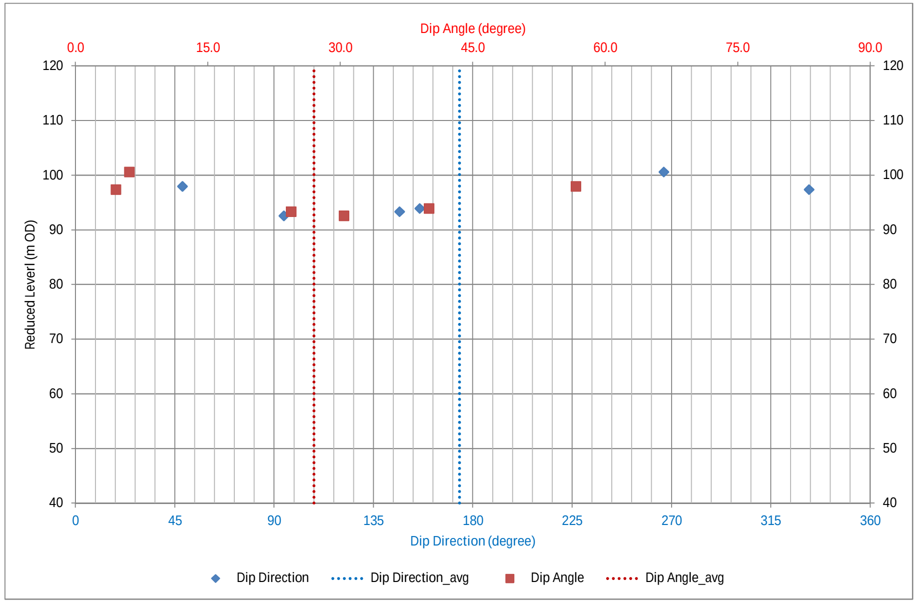
Chainage (m)	6543
Offset (m)	88

	From	To
Surveyed Depth (m bgl)	5.1	13.1
Surveyed Level (m OD)	100.6	92.6

	min	max	avg	stdev
Dip Direction	48	332	174	97
Dip Angle	5	57	27	18





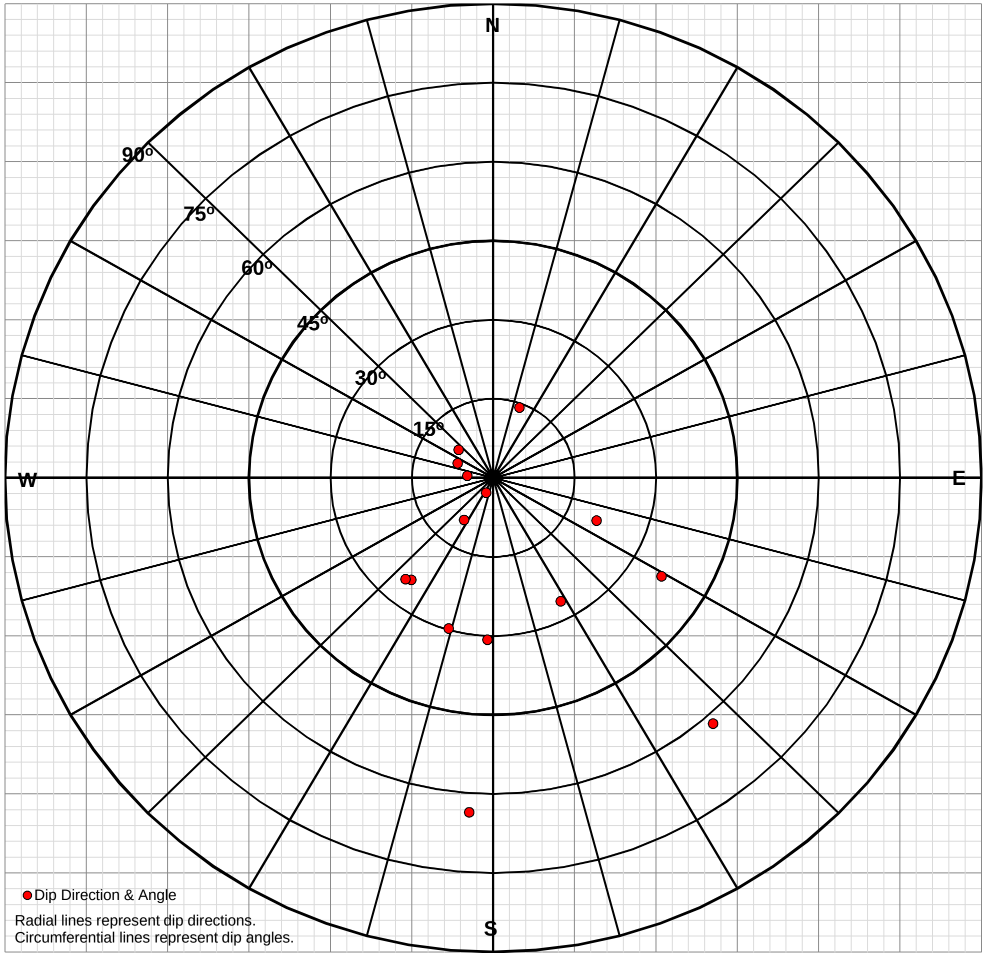


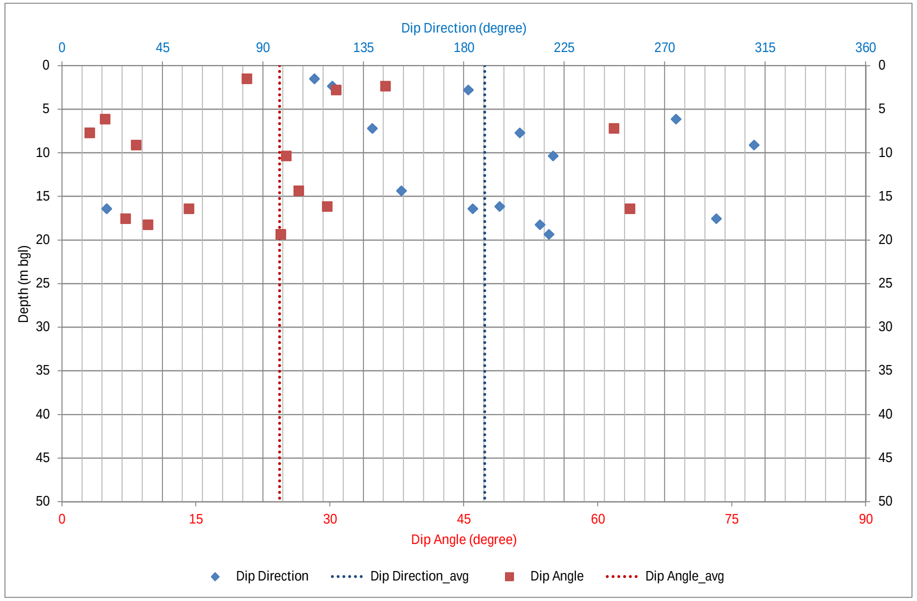
Exploratory Hole ID	16175-R4

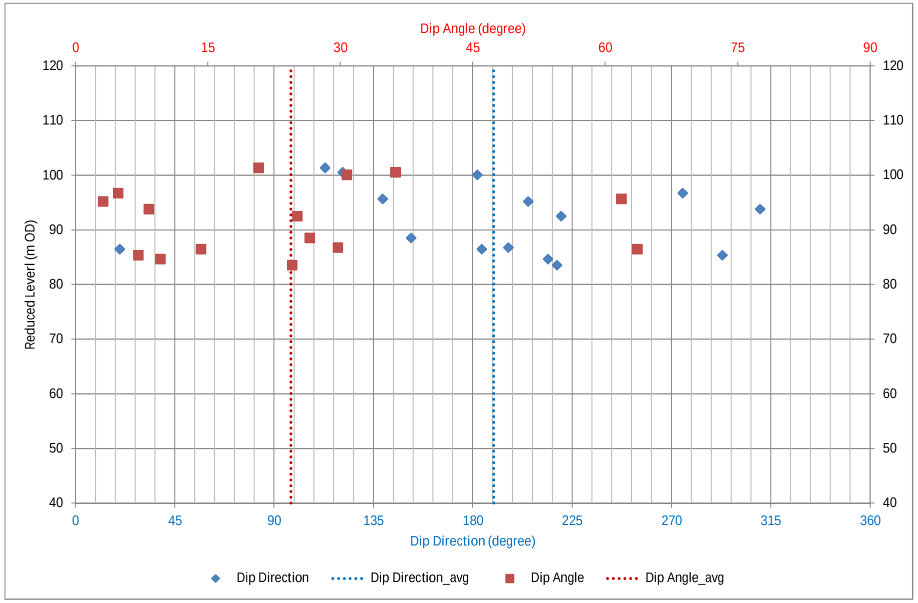
Chainage (m)	7543
Offset (m)	28

	From	To
Surveyed Depth (m bgl)	1.5	19.3
Surveyed Level (m OD)	101.4	83.6

	min	max	avg	stdev
Dip Direction	20	310	189	72
Dip Angle	3	64	24	18





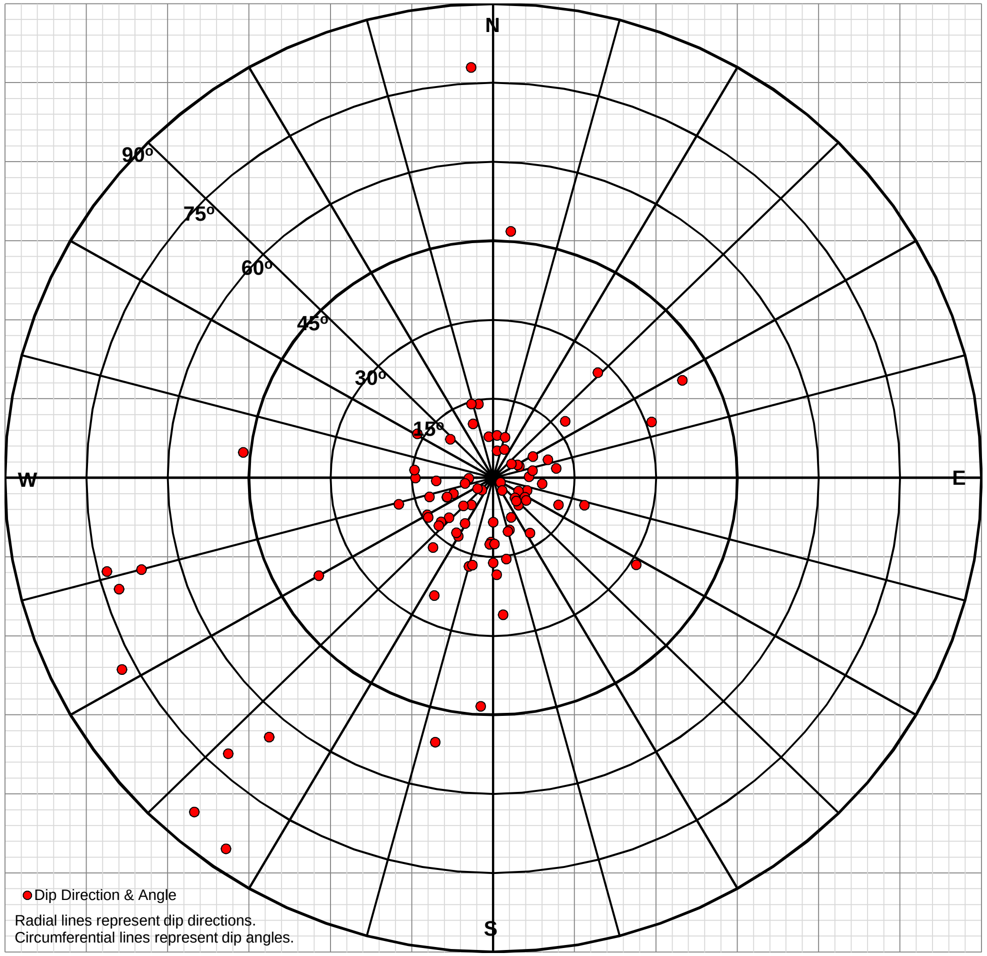


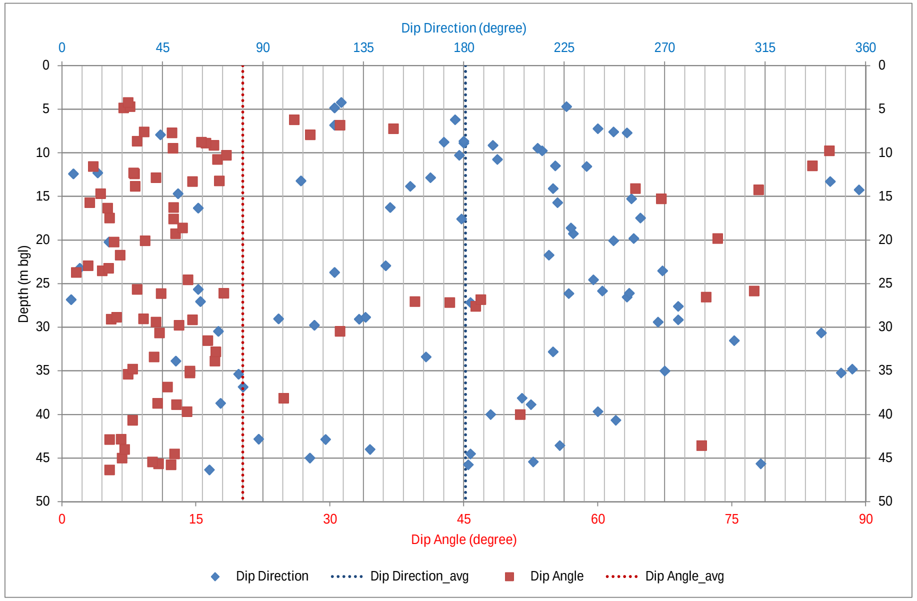
Exploratory Hole ID	29779-R503B

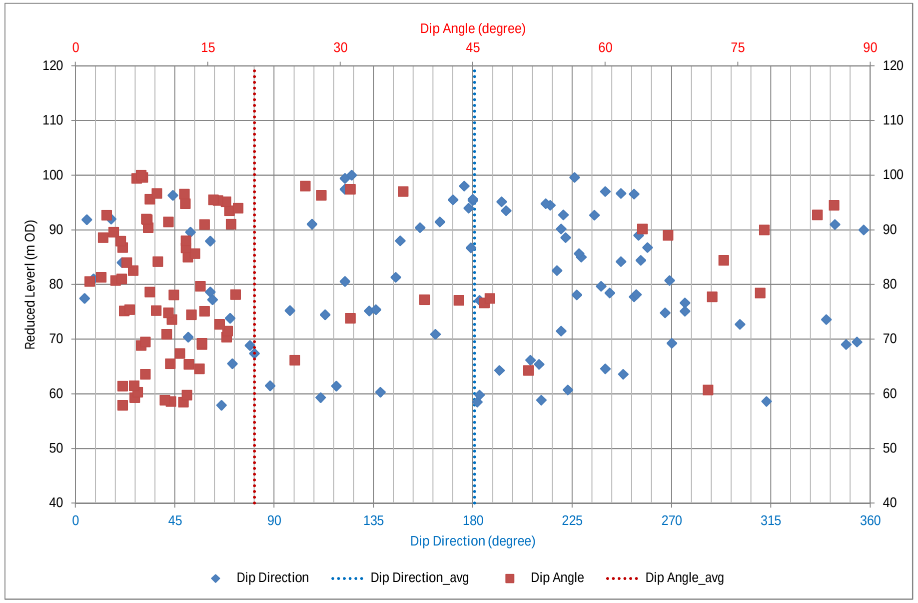
Chainage (m)	7679
Offset (m)	410

	From	To
Surveyed Depth (m bgl)	4.2	46.3
Surveyed Level (m OD)	100.1	58.0

	min	max	avg	stdev
Dip Direction	4	357	181	87
Dip Angle	2	86	20	21





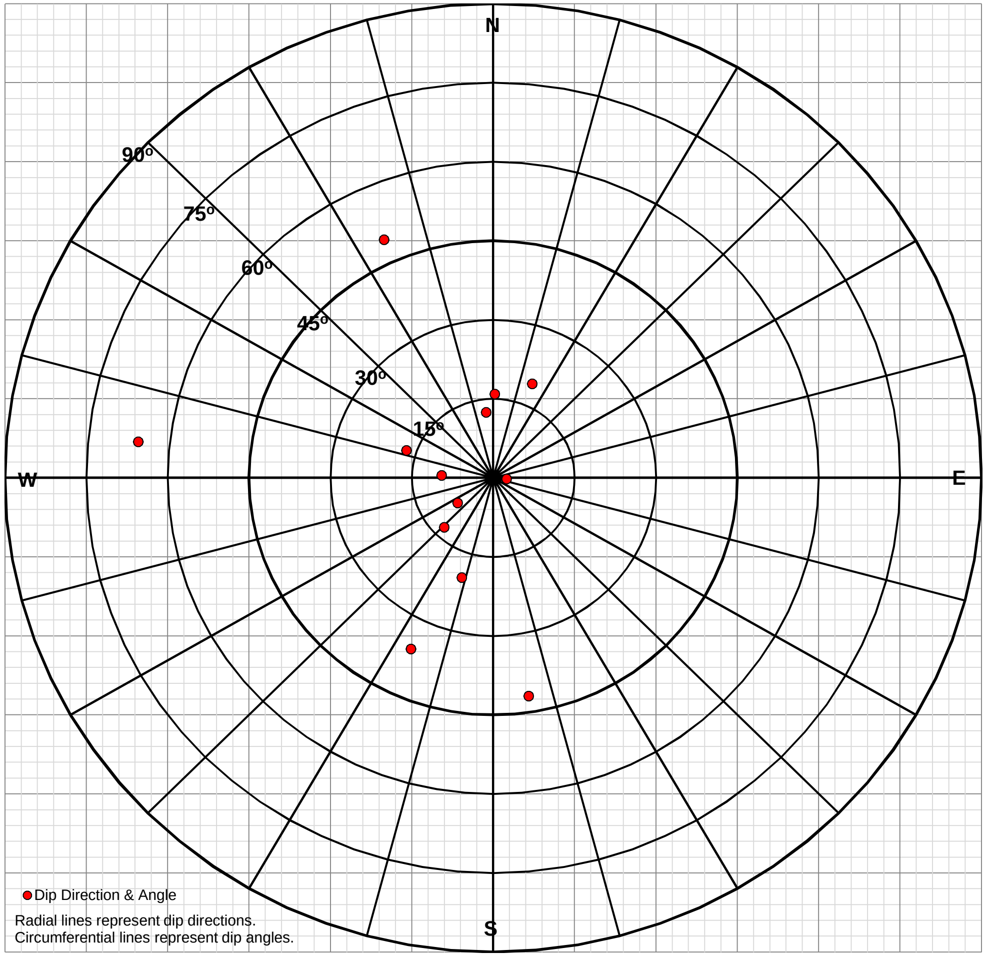


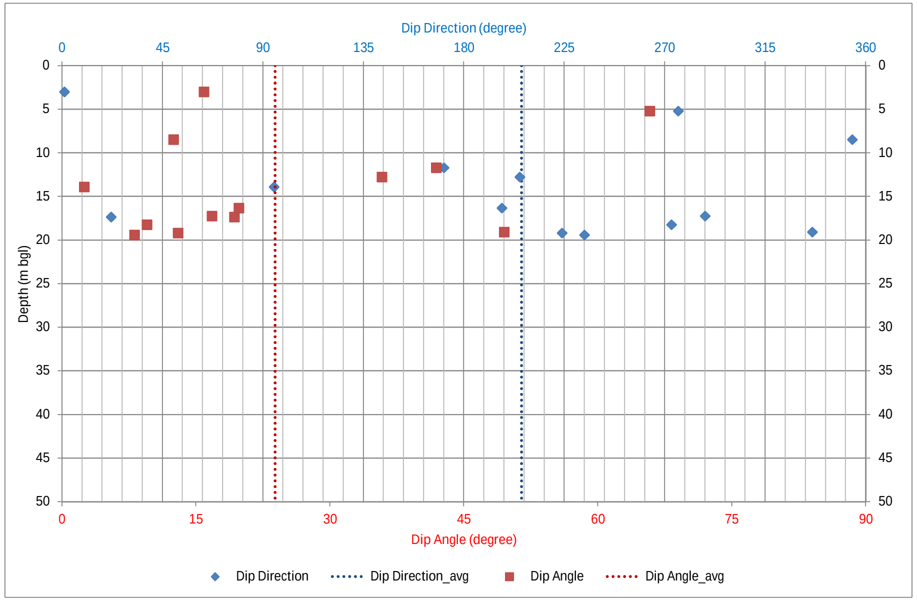
Exploratory Hole ID	16175-R5

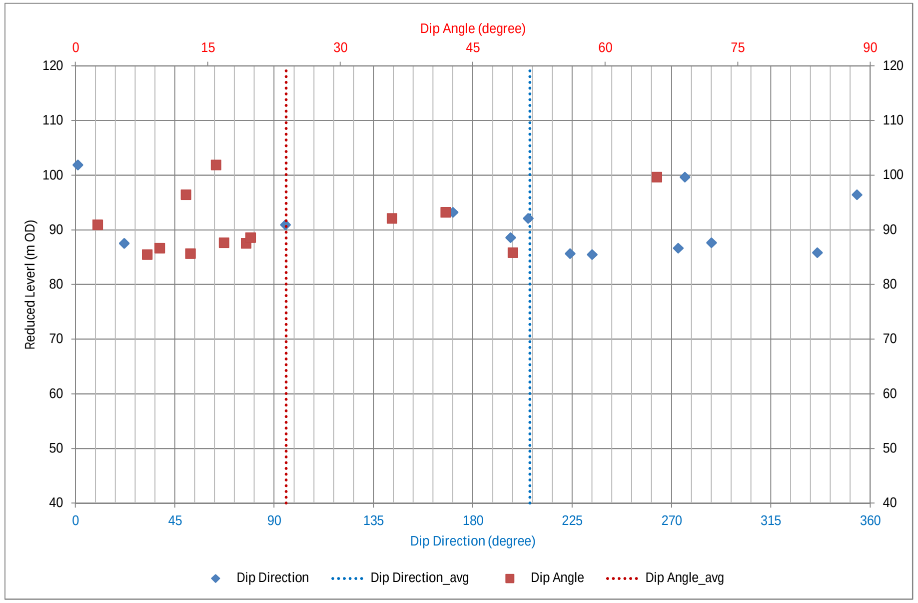
Chainage (m)	7697
Offset (m)	16

	From	To
Surveyed Depth (m bgl)	3.0	19.4
Surveyed Level (m OD)	101.9	85.5

	min	max	avg	stdev
Dip Direction	1	354	206	106
Dip Angle	3	66	24	18





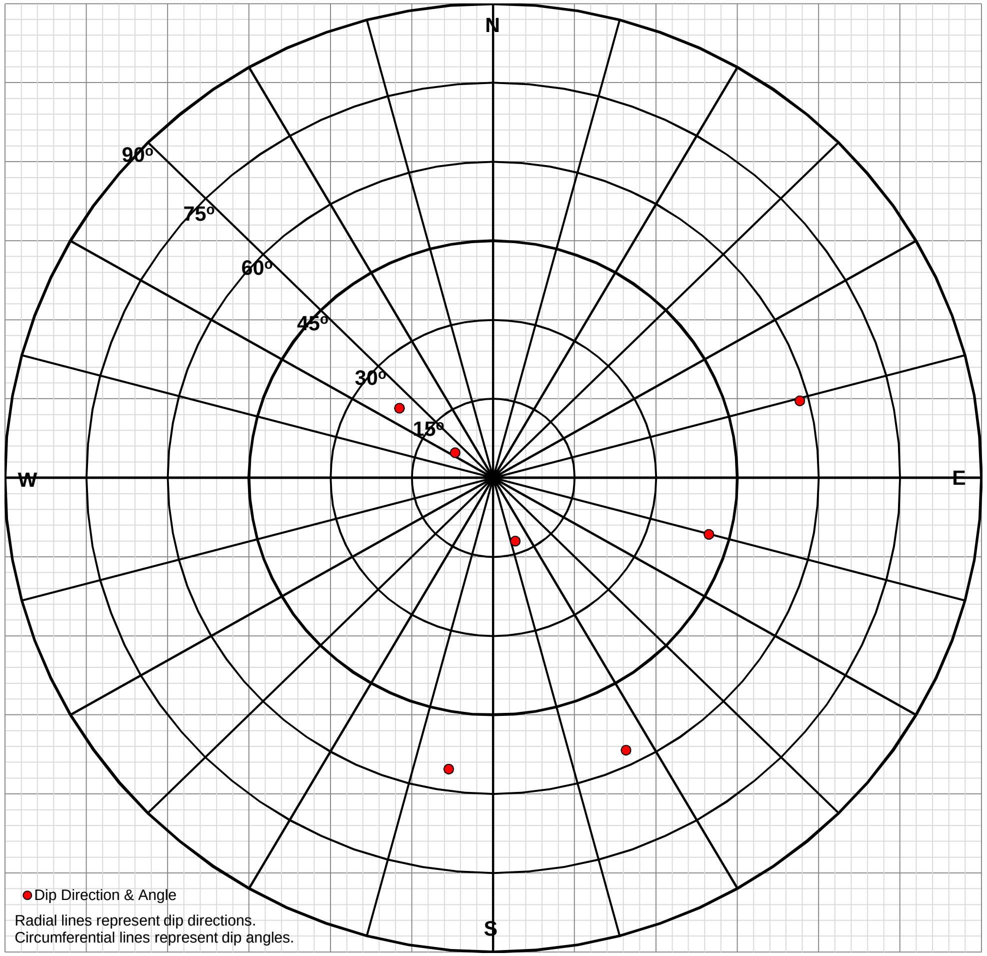


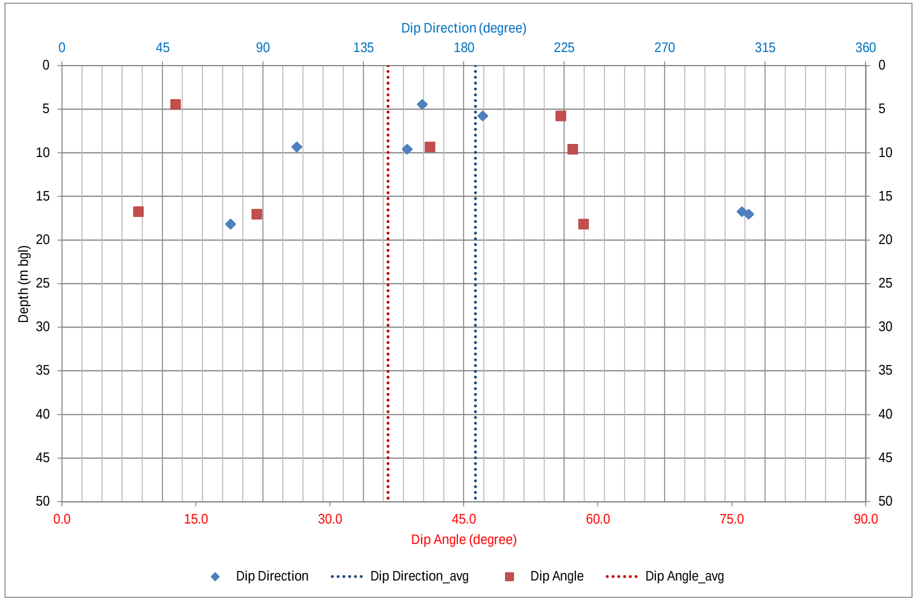
Exploratory Hole ID	21762-R135

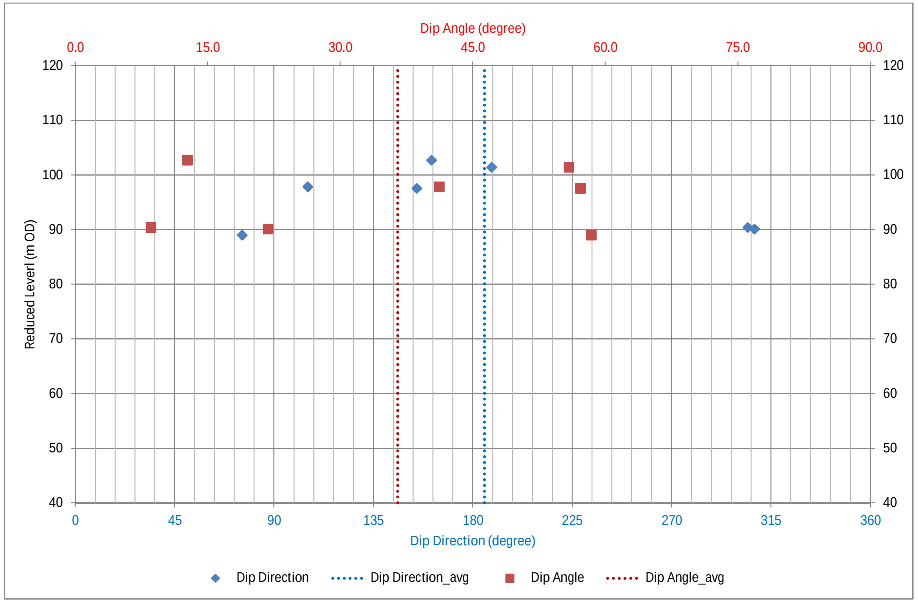
Chainage (m)	7788
Offset (m)	21

	From	To
Surveyed Depth (m bgl)	4.4	18.2
Surveyed Level (m OD)	102.7	89.0

	min	max	avg	stdev
Dip Direction	76	307	185	84
Dip Angle	9	58	37	20





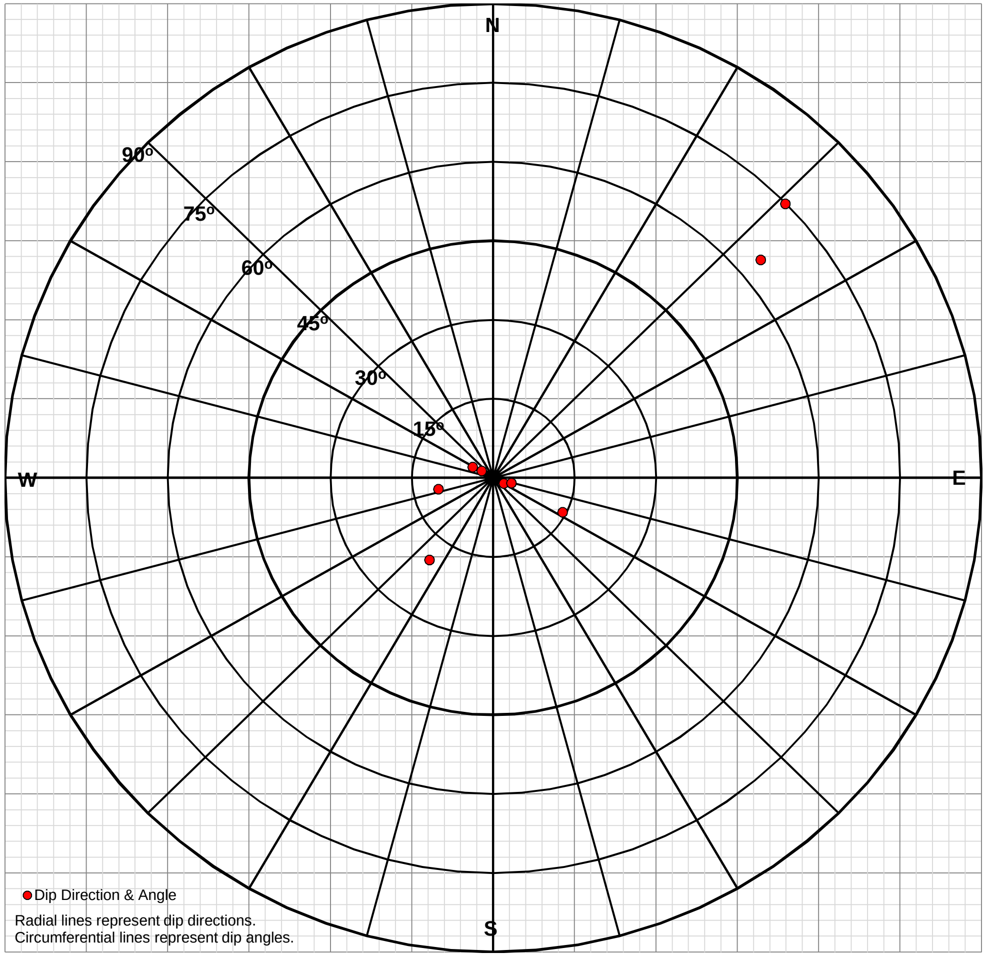


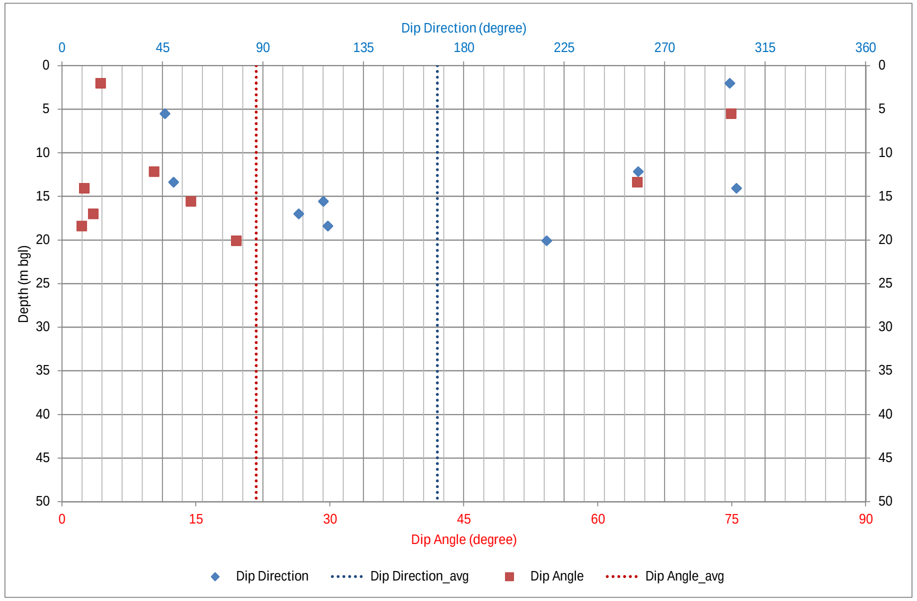
Exploratory Hole ID	16175-R6

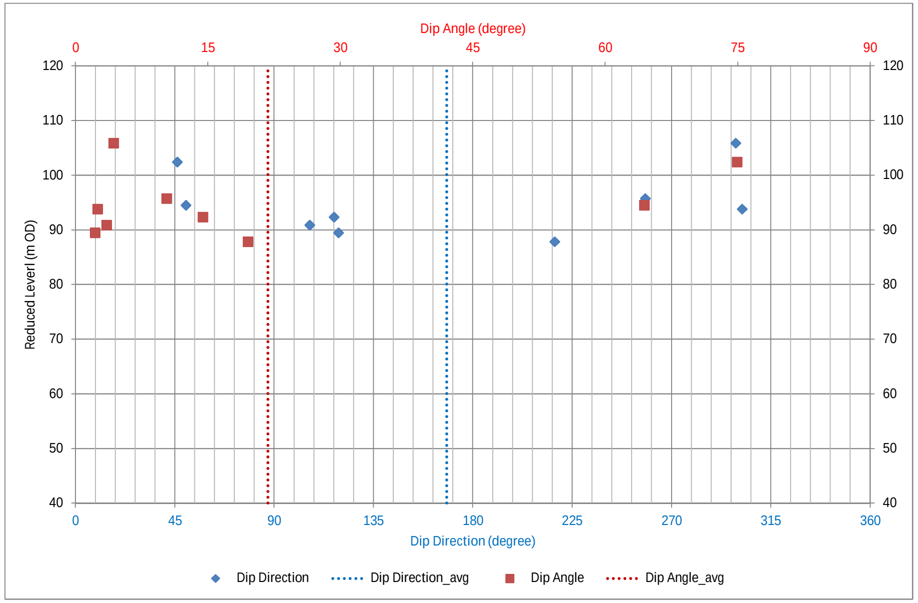
Chainage (m)	7837
Offset (m)	12

	From	To
Surveyed Depth (m bgl)	2.0	20.0
Surveyed Level (m OD)	105.9	87.9

	min	max	avg	stdev
Dip Direction	46	302	168	96
Dip Angle	2	75	22	26





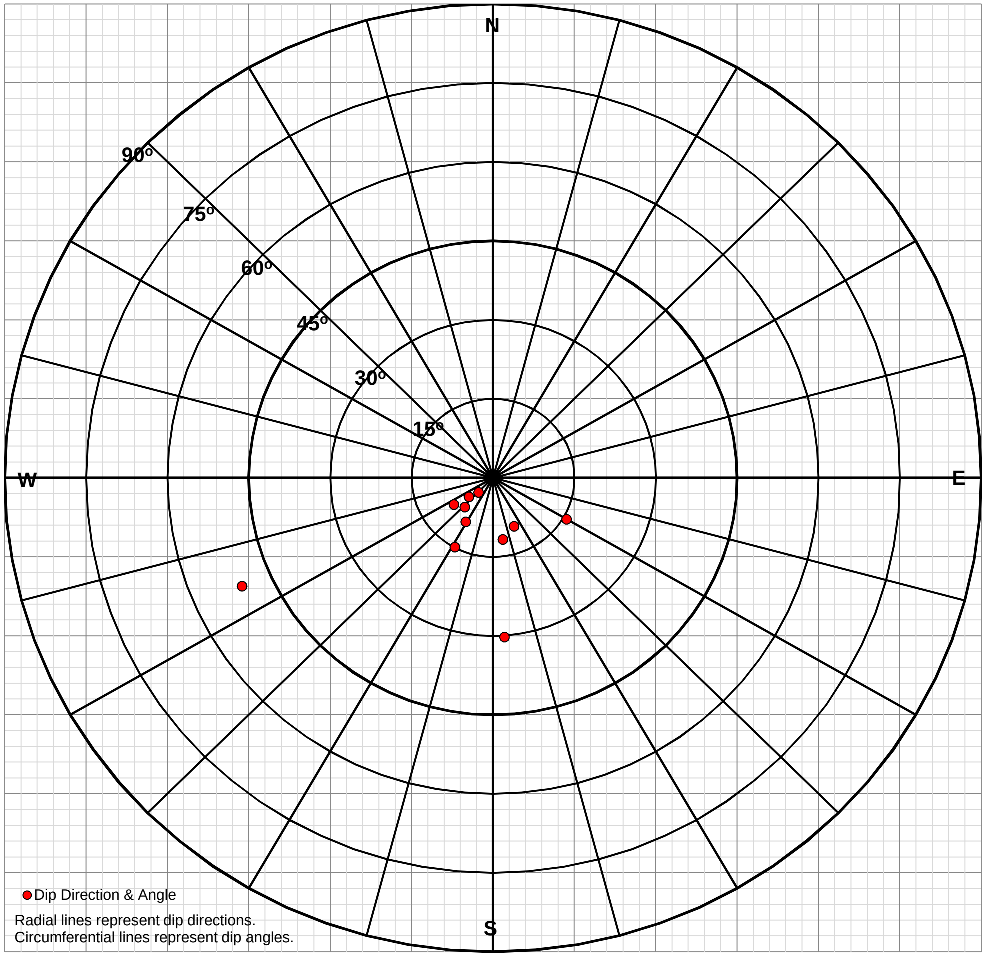


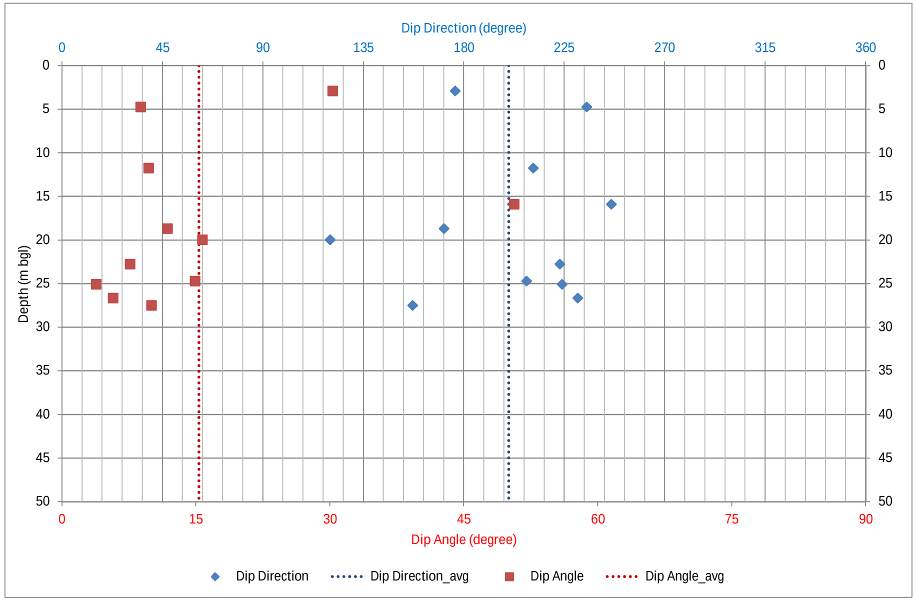
Exploratory Hole ID	16175-R7

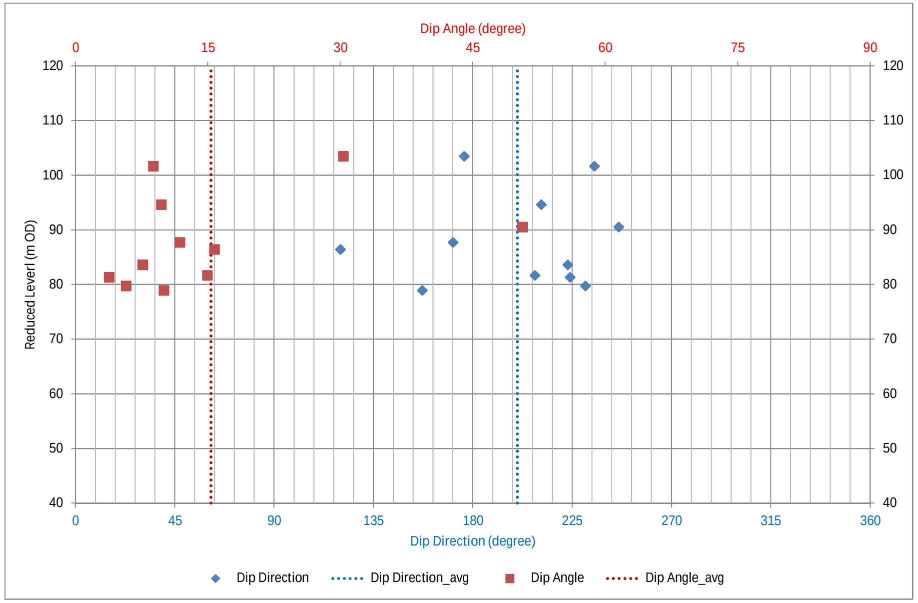
Chainage (m)	7998
Offset (m)	4

	From	To
Surveyed Depth (m bgl)	2.9	27.5
Surveyed Level (m OD)	103.5	78.9

	min	max	avg	stdev
Dip Direction	120	246	200	37
Dip Angle	4	51	15	13





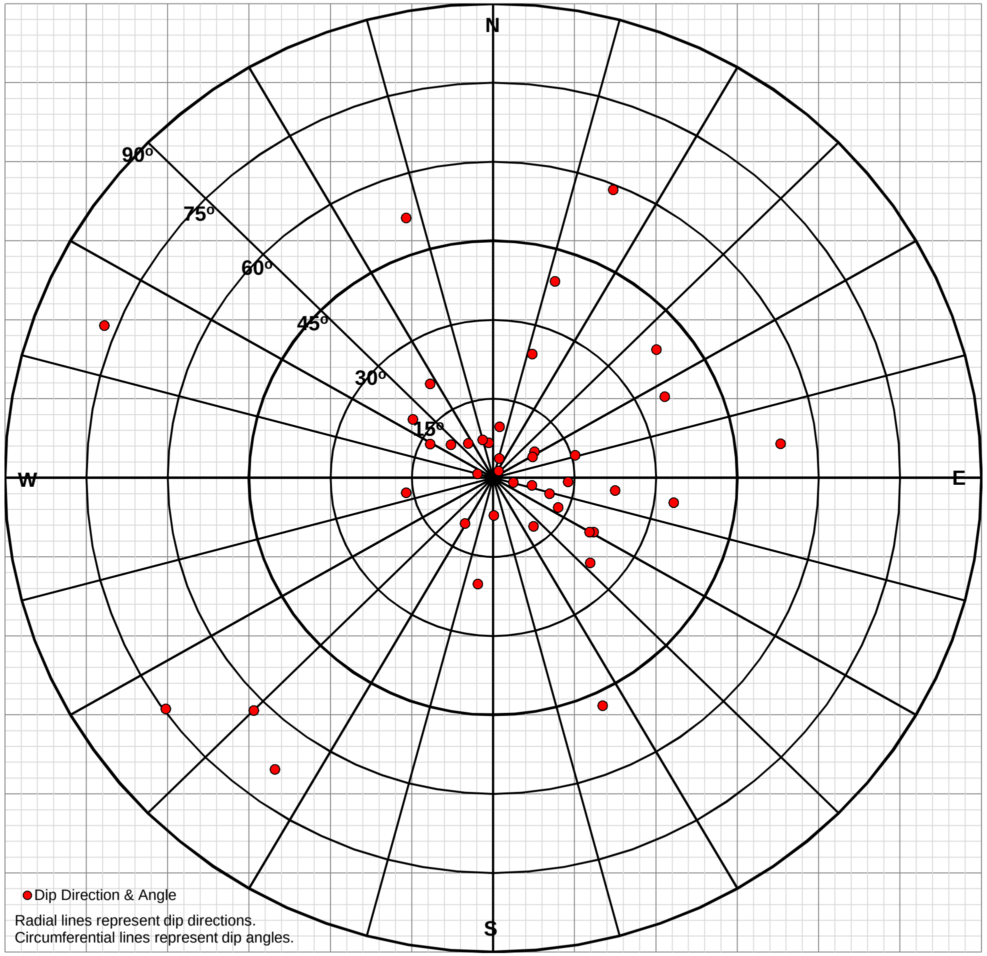


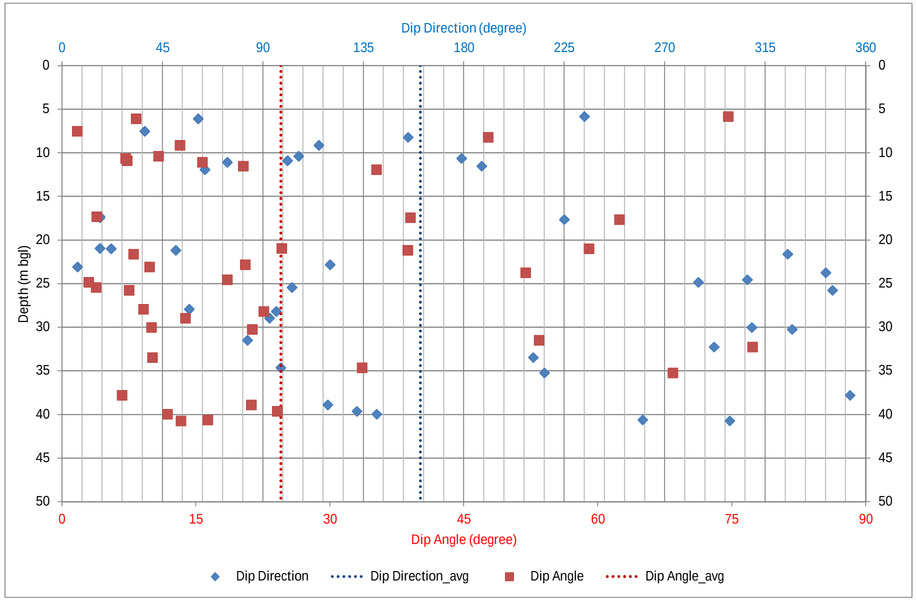
Exploratory Hole ID	29779-PX505A

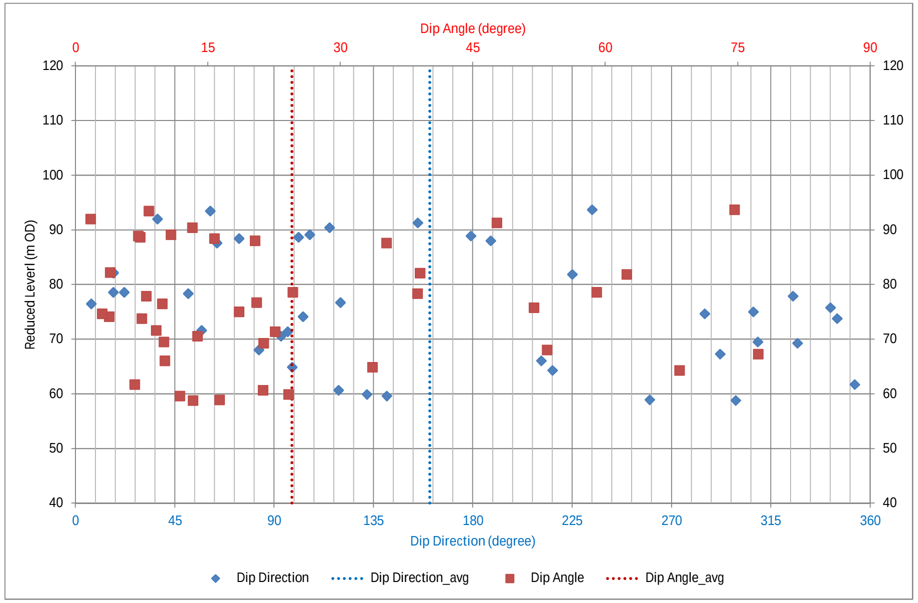
Chainage (m)	8031
Offset (m)	344

	From	To
Surveyed Depth (m bgl)	5.8	40.7
Surveyed Level (m OD)	93.7	58.8

	min	max	avg	stdev
Dip Direction	7	353	161	109
Dip Angle	2	77	25	21





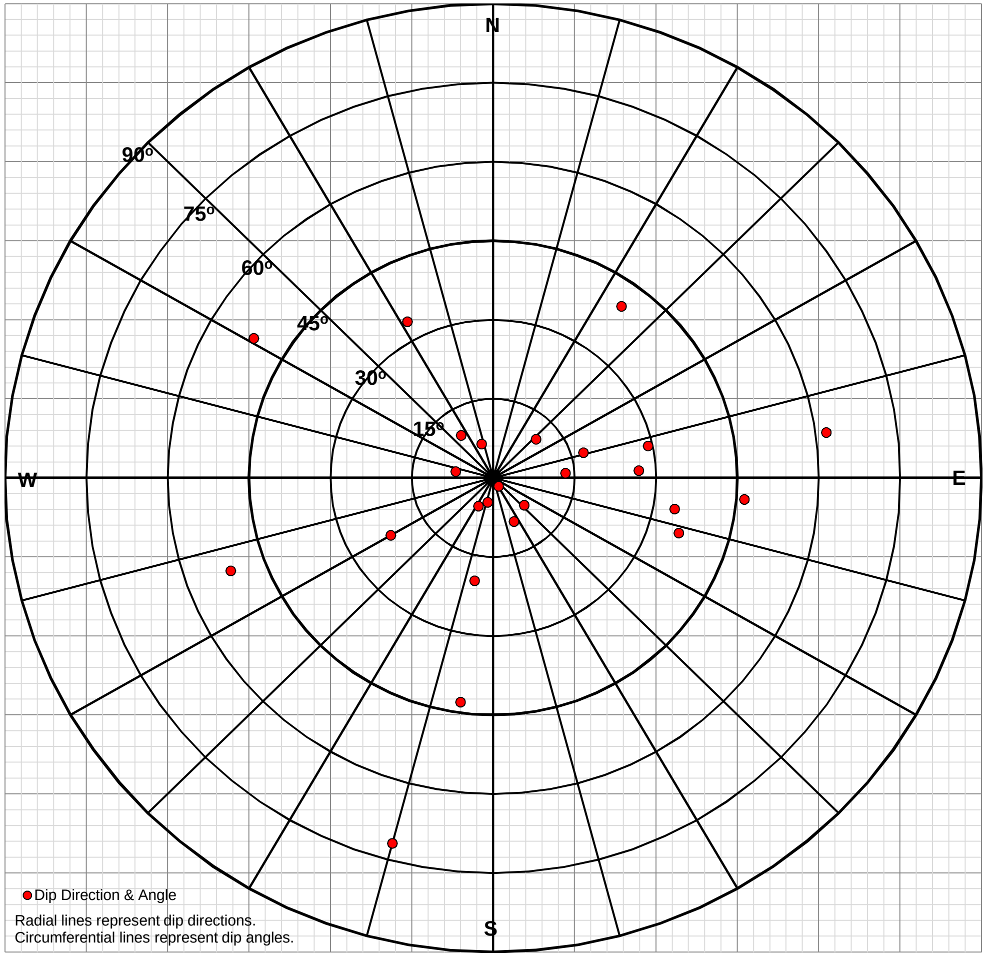


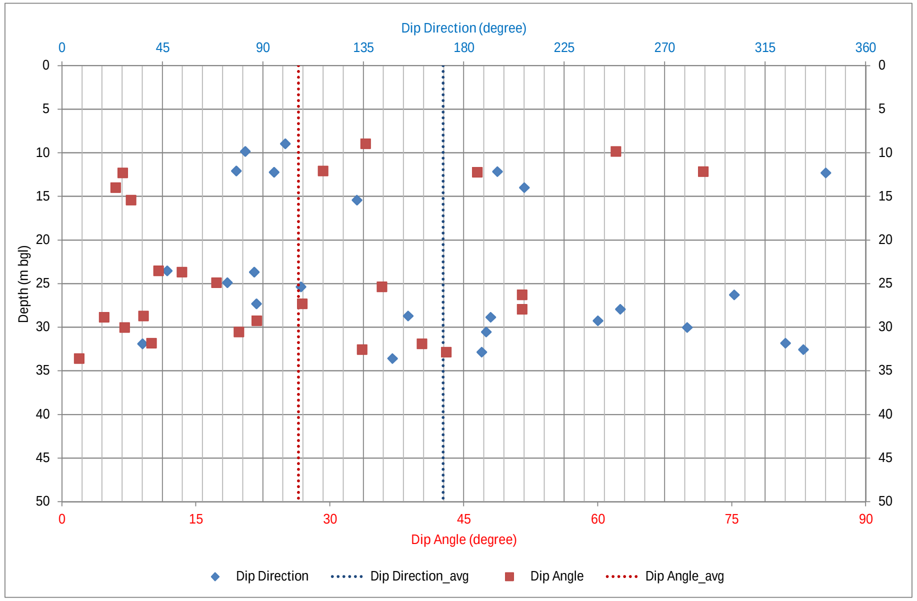
Exploratory Hole ID	16175-R8

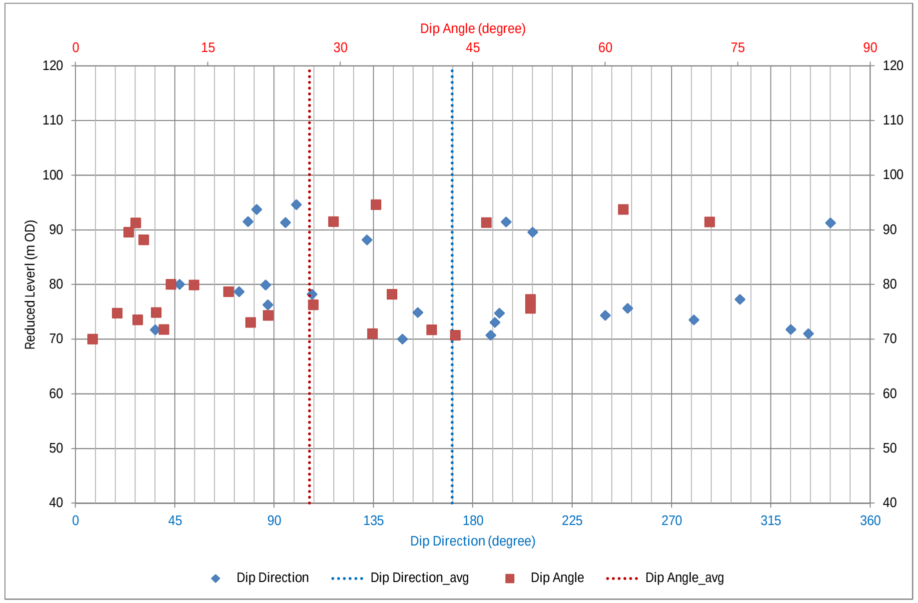
Chainage (m)	8148
Offset (m)	5

	From	To
Surveyed Depth (m bgl)	8.9	33.6
Surveyed Level (m OD)	94.7	70.0

	min	max	avg	stdev
Dip Direction	36	342	171	92
Dip Angle	2	72	26	19





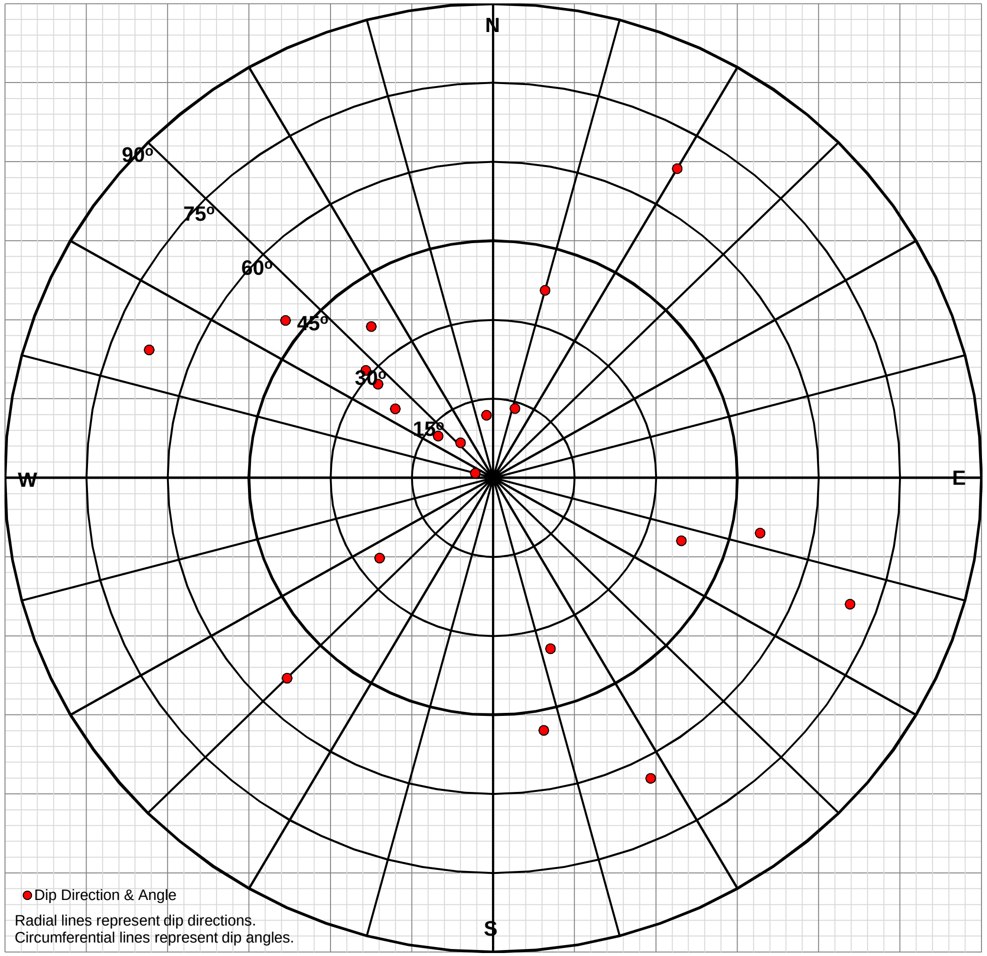


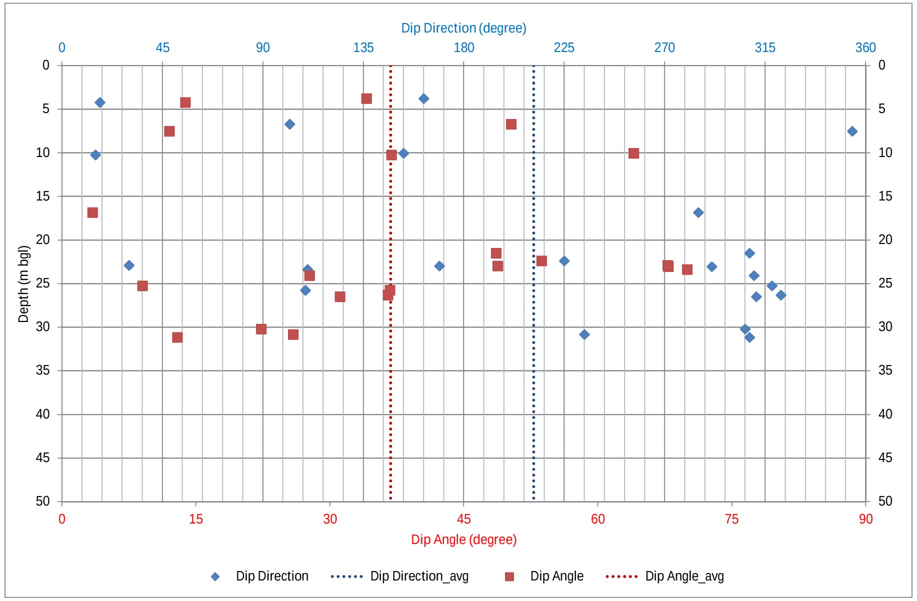
Exploratory Hole ID	16175-R9

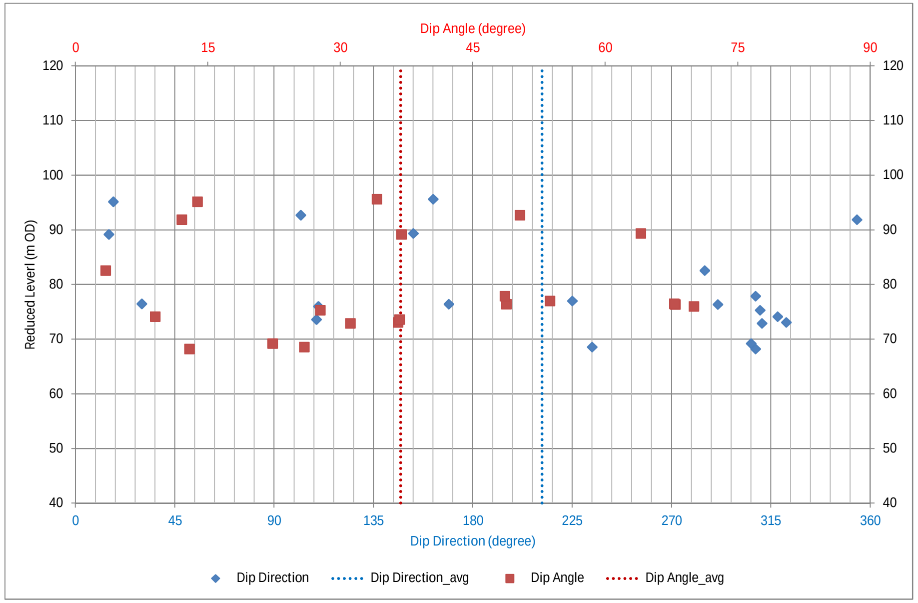
Chainage (m)	8332
Offset (m)	12

	From	To
Surveyed Depth (m bgl)	3.8	31.2
Surveyed Level (m OD)	95.6	68.2

	min	max	avg	stdev
Dip Direction	15	354	211	110
Dip Angle	3	70	37	20





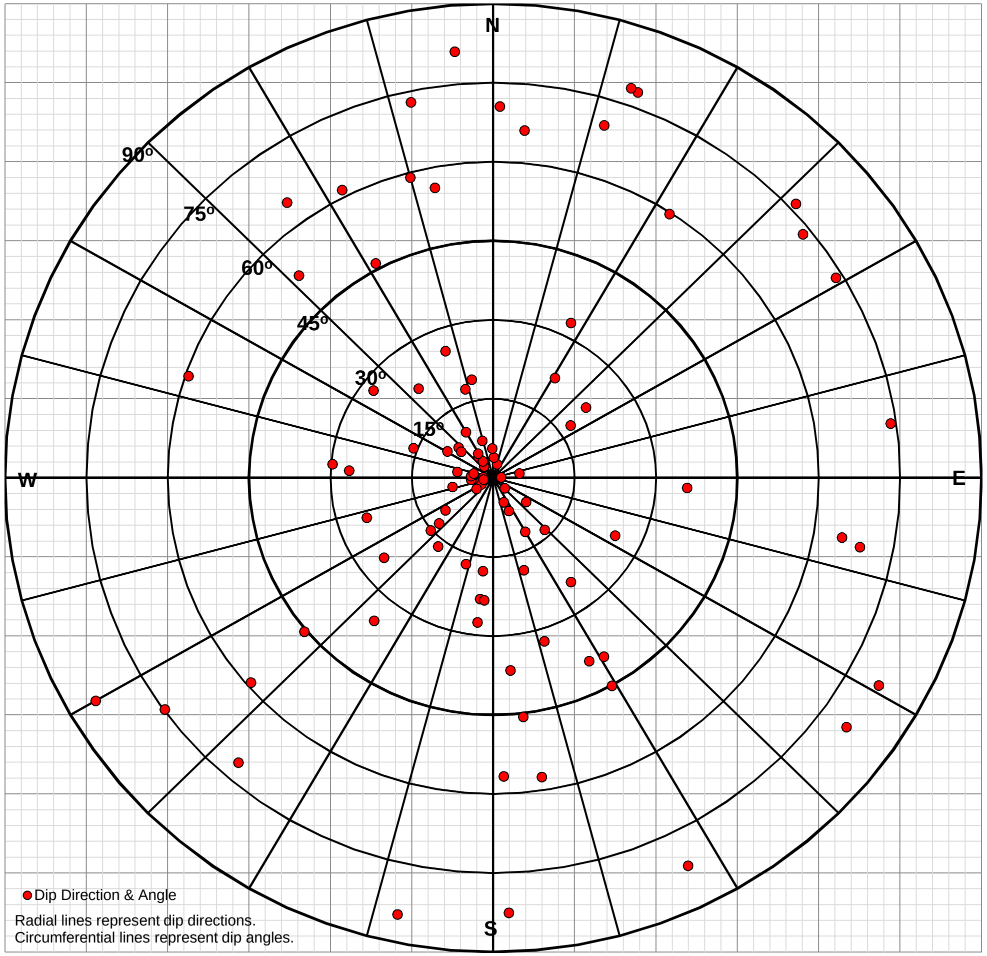


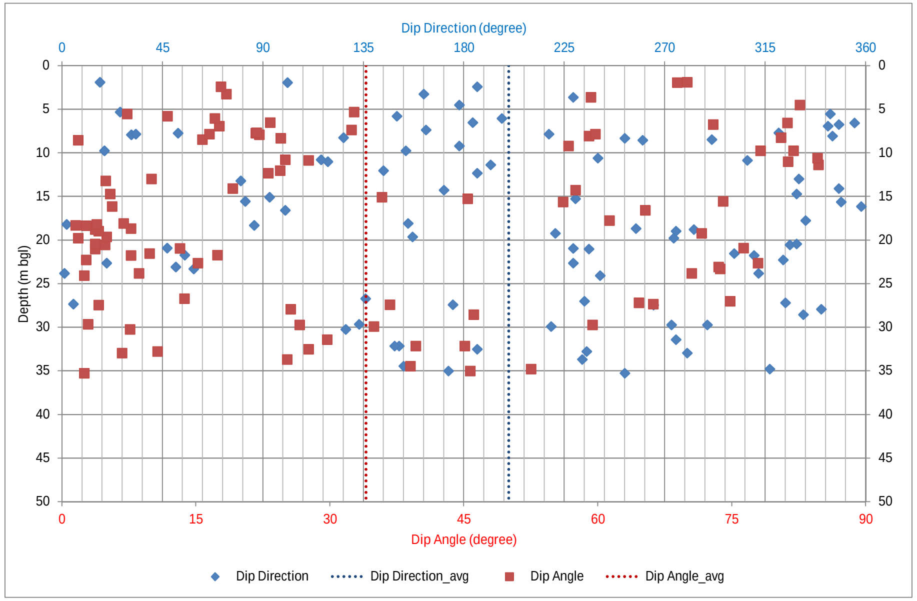
Exploratory Hole ID	17439-P1

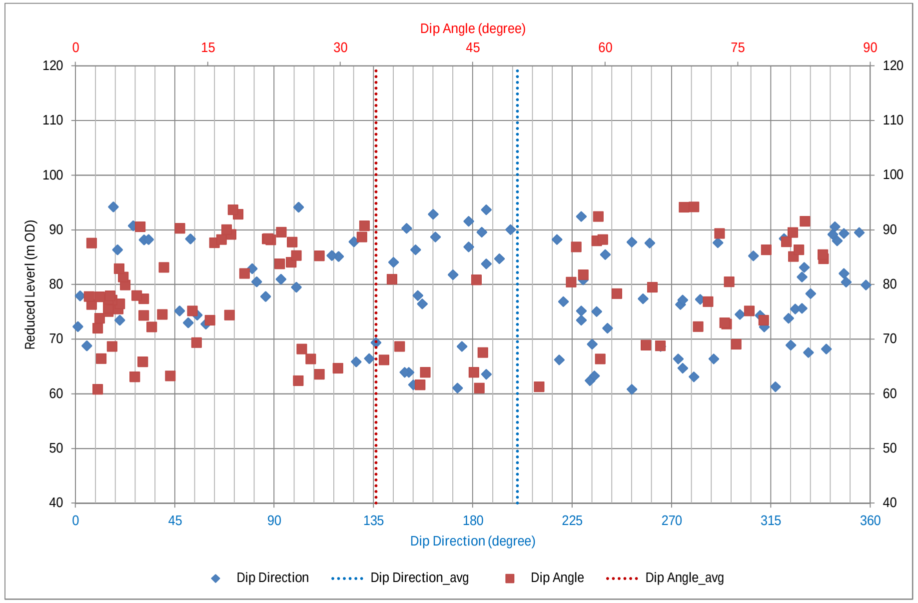
Chainage (m)	8526
Offset (m)	20

	From	To
Surveyed Depth (m bgl)	1.9	35.3
Surveyed Level (m OD)	94.2	60.9

	min	max	avg	stdev
Dip Direction	1	358	200	105
Dip Angle	2	85	34	28





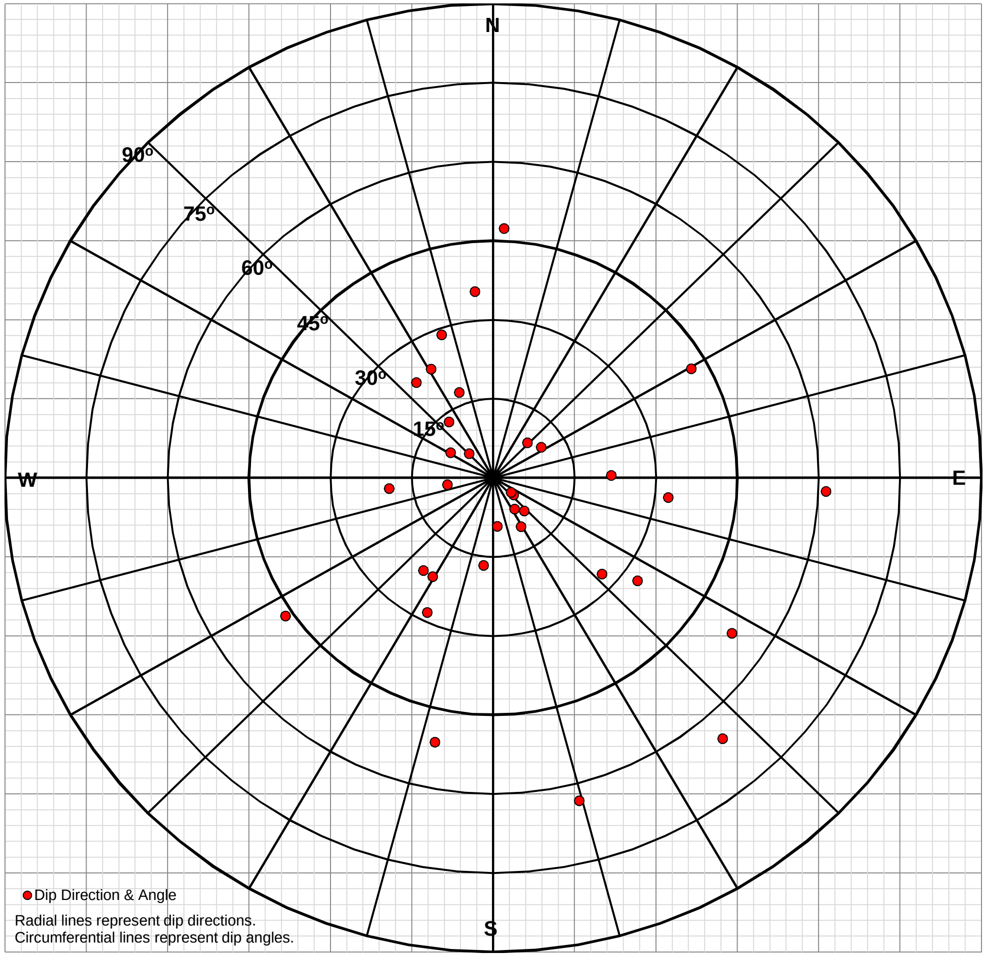


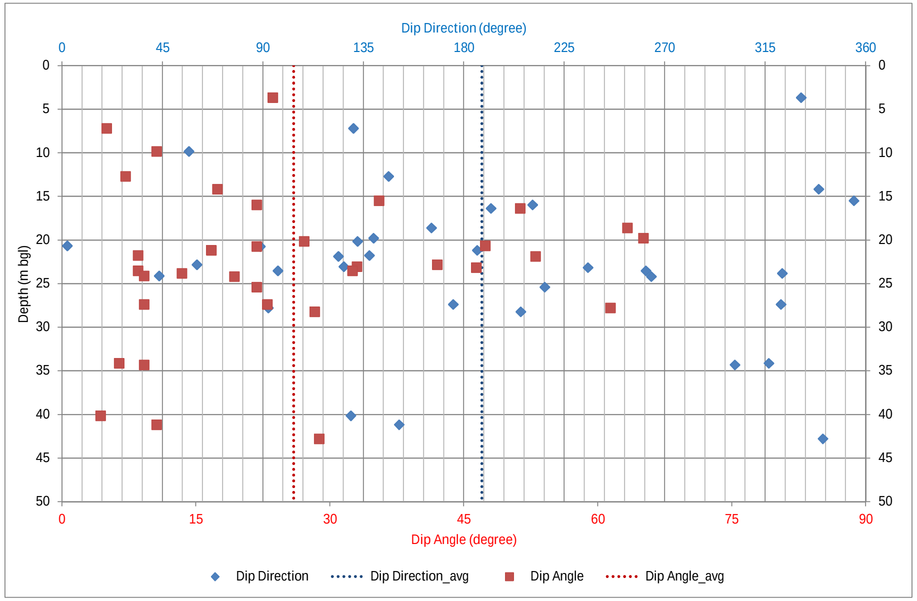
Exploratory Hole ID	21762-R142

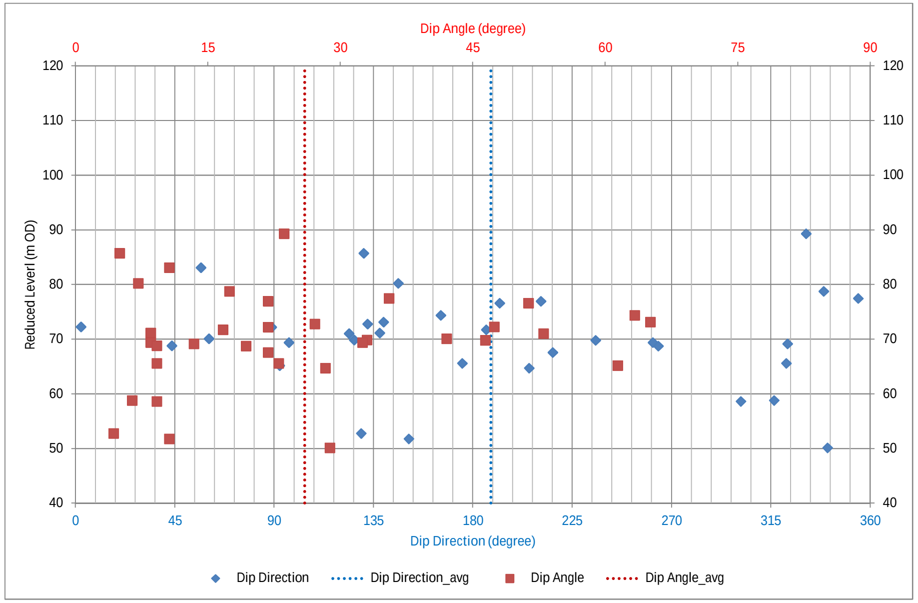
Chainage (m)	8638
Offset (m)	52

	From	To
Surveyed Depth (m bgl)	3.7	42.8
Surveyed Level (m OD)	89.3	50.2

	min	max	avg	stdev
Dip Direction	2	355	188	97
Dip Angle	4	65	26	18





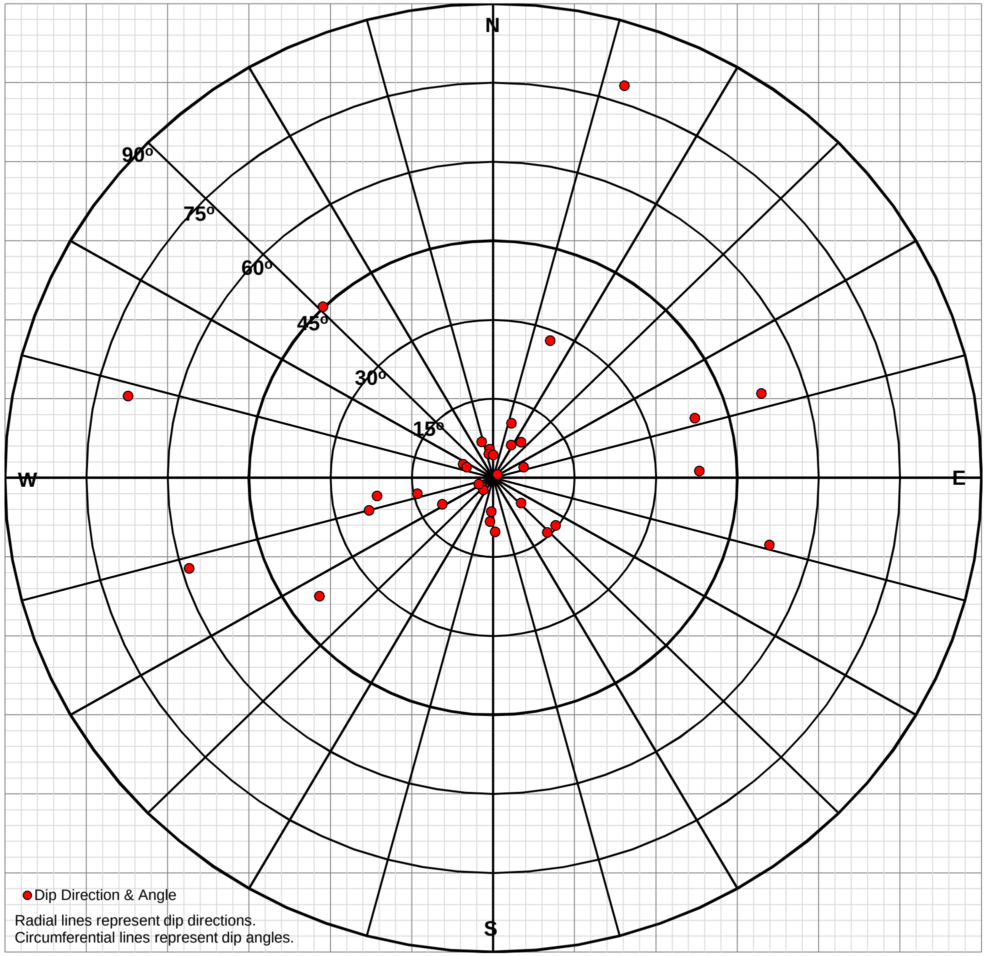


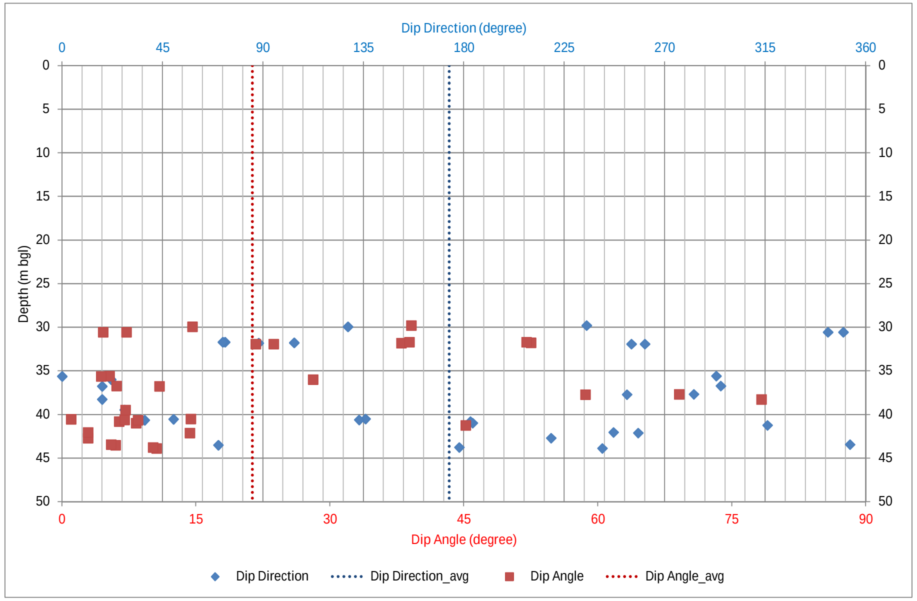
Exploratory Hole ID	16175-R11

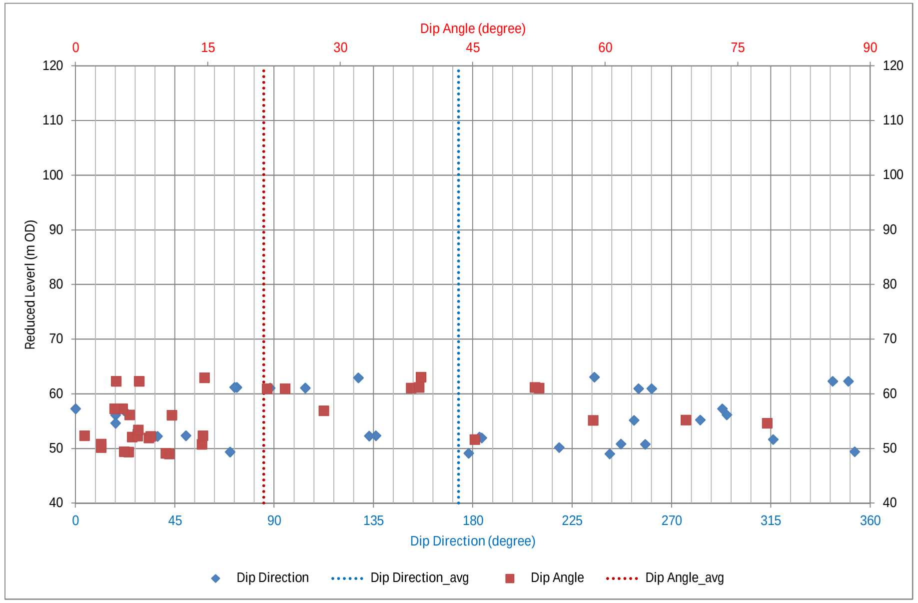
Chainage (m)	8696
Offset (m)	64

	From	To
Surveyed Depth (m bgl)	29.8	43.9
Surveyed Level (m OD)	63.1	49.0

	min	max	avg	stdev
Dip Direction	0	353	173	110
Dip Angle	1	78	21	21





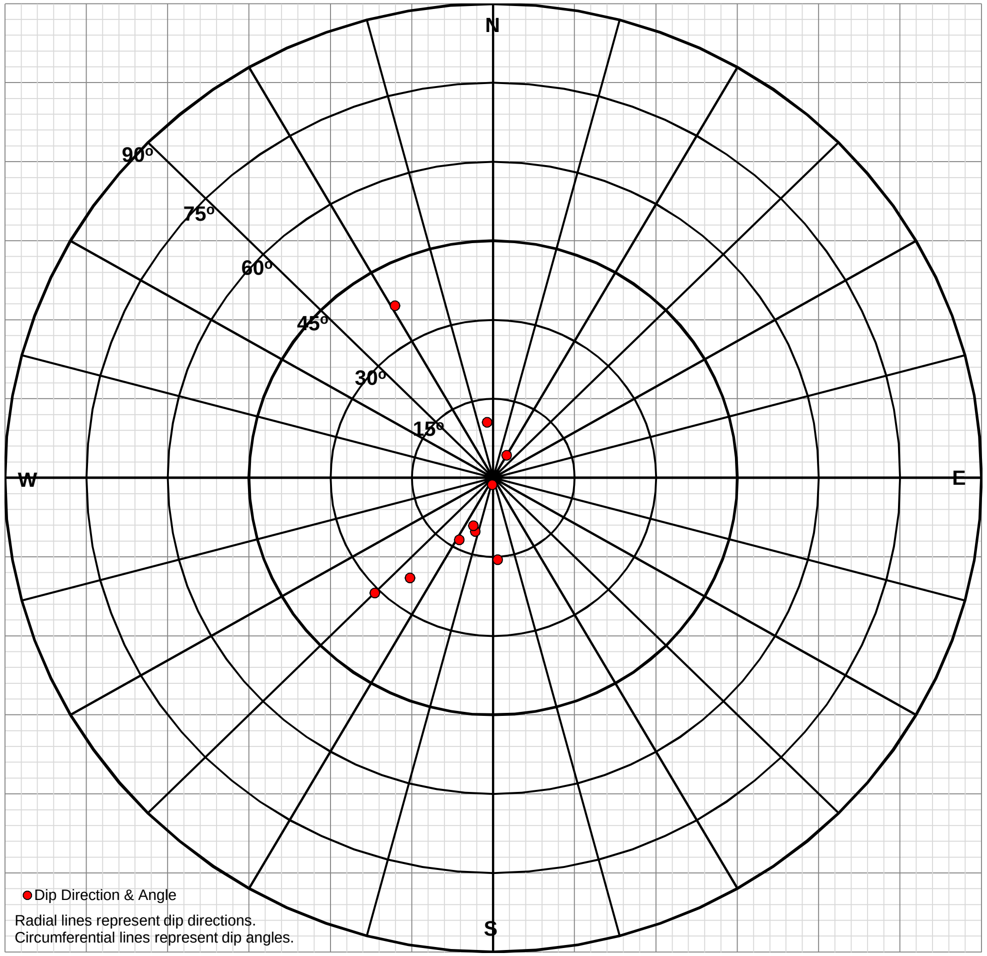


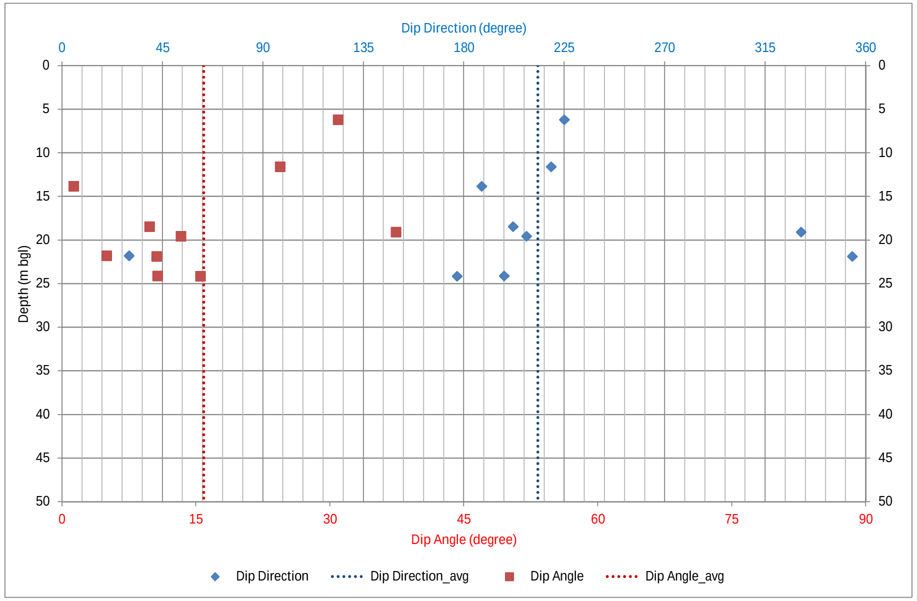
Exploratory Hole ID	**16175-R10**

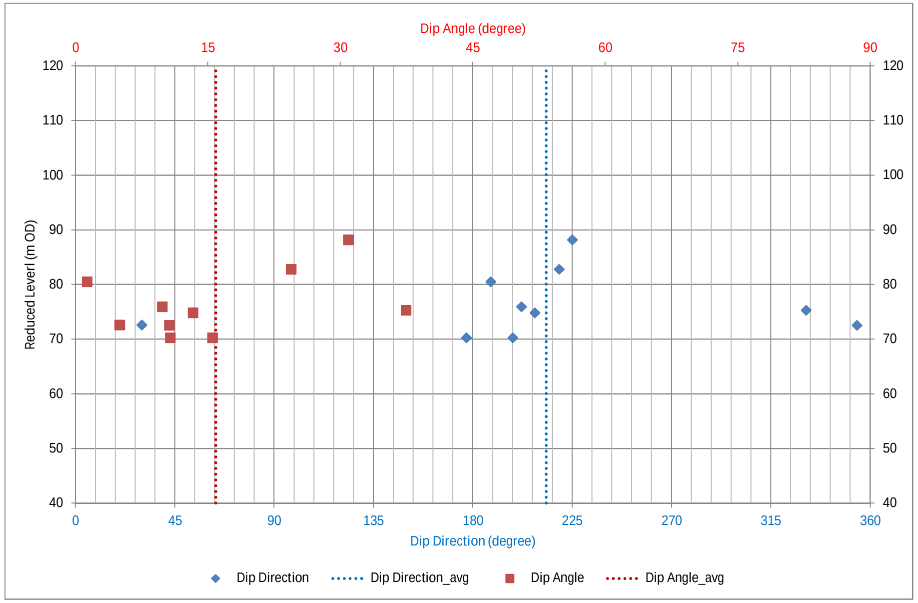
Chainage (m)	8723
Offset (m)	37

	From	To
Surveyed Depth (m bgl)	6.2	24.1
Surveyed Level (m OD)	88.2	70.3

	min	max	avg	stdev
Dip Direction	30	354	213	84
Dip Angle	1	37	16	11





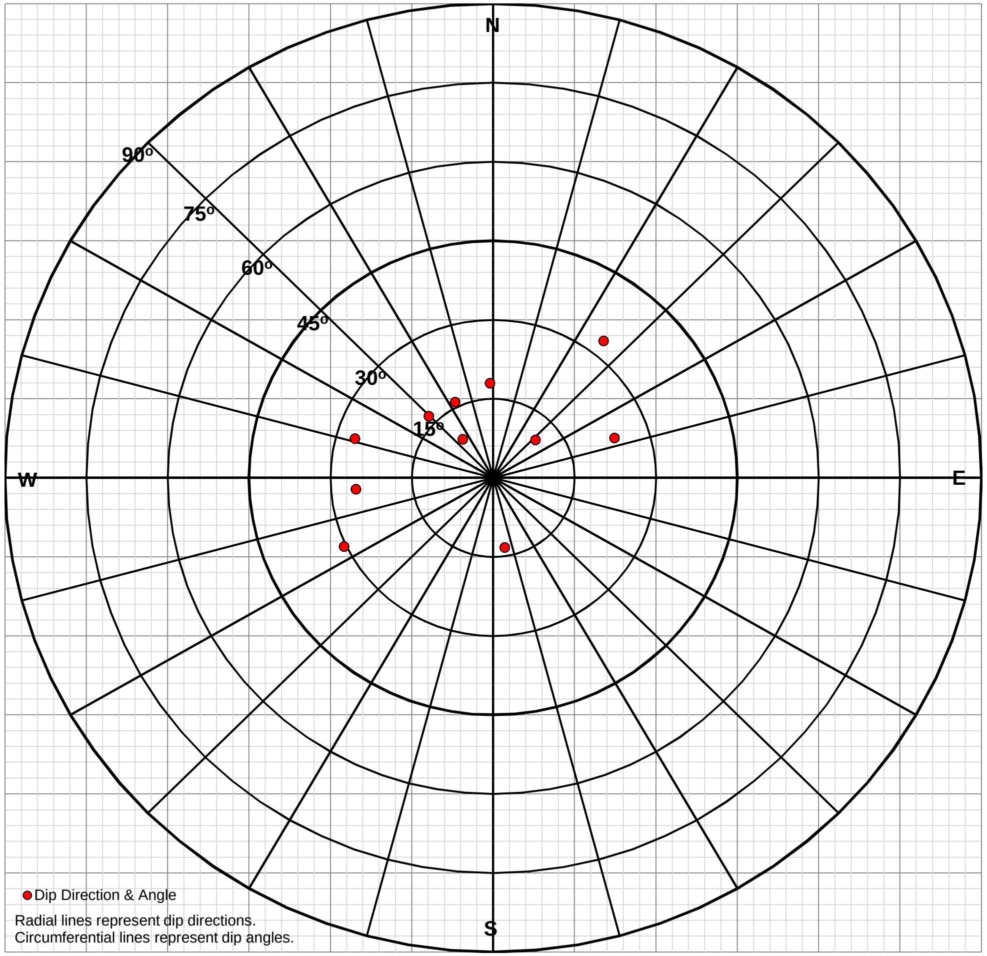


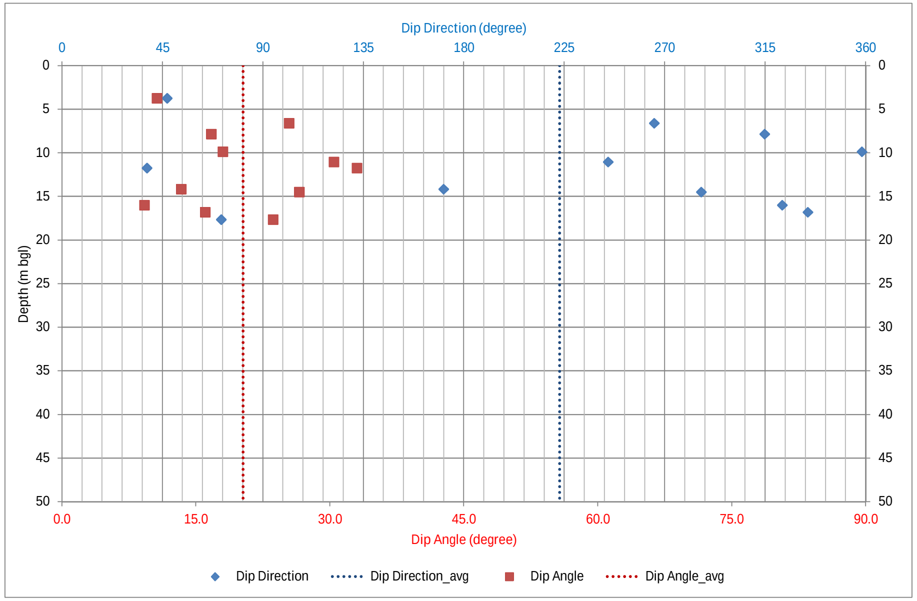
Exploratory Hole ID	21762-R146

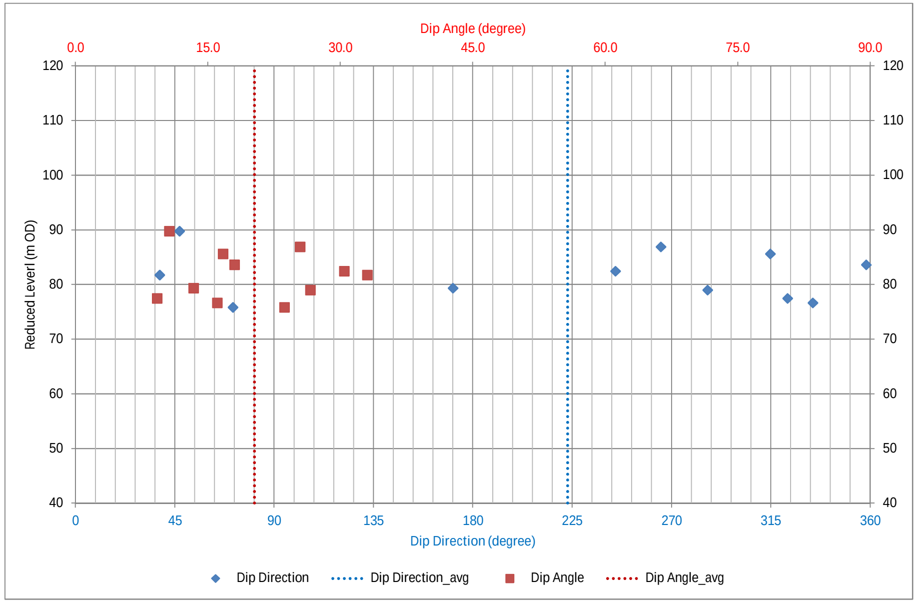
Chainage (m)	8785
Offset (m)	39

	From	To
Surveyed Depth (m bgl)	3.7	17.7
Surveyed Level (m OD)	89.8	75.9

	min	max	avg	stdev
Dip Direction	38	358	223	115
Dip Angle	9	33	20	8





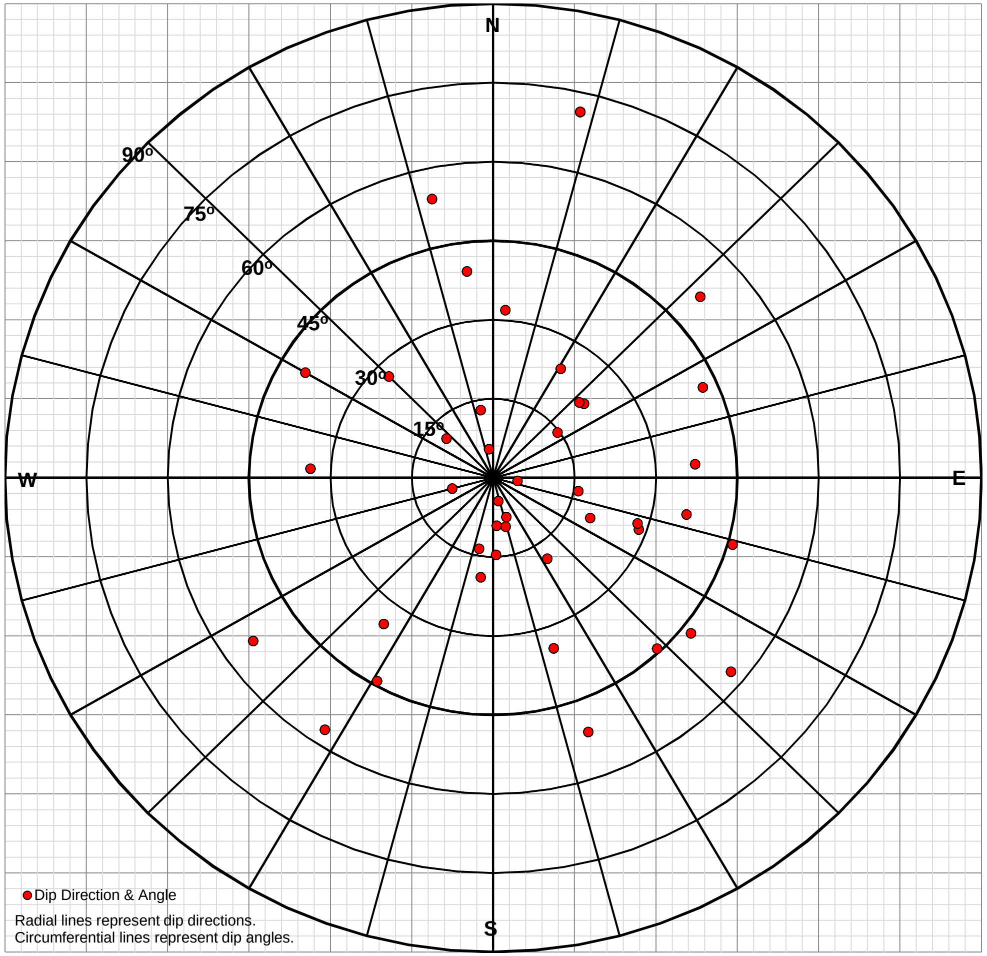


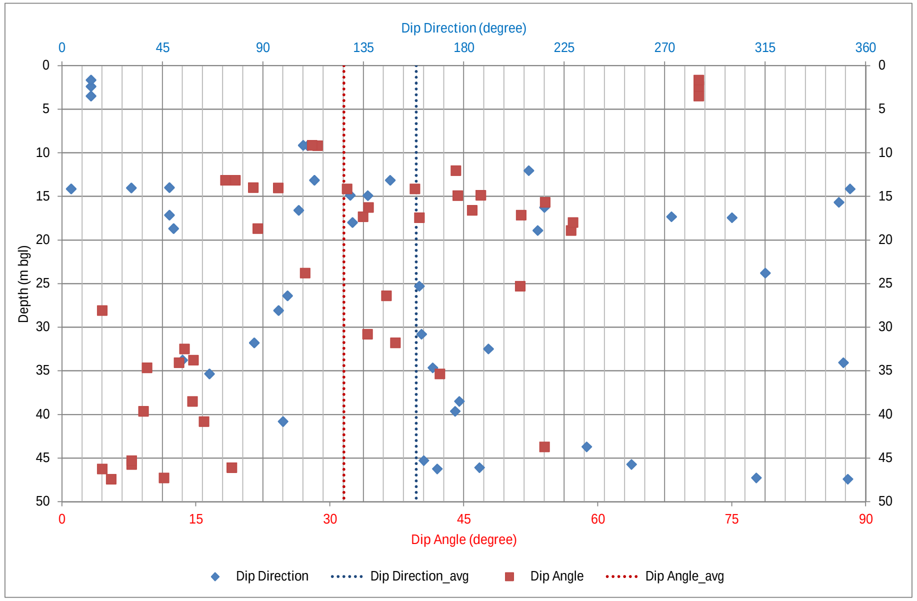
Exploratory Hole ID	16175-R13

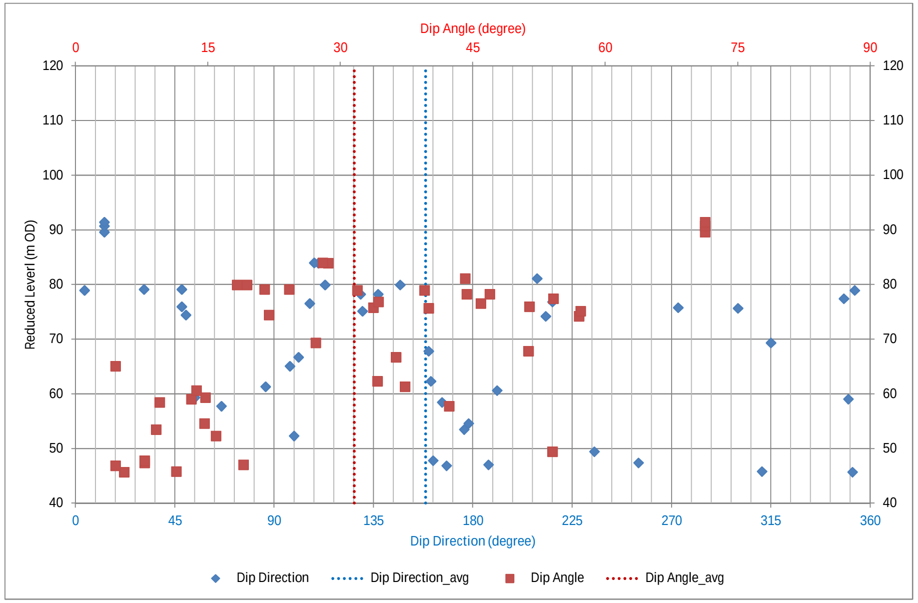
Chainage (m)	8844
Offset (m)	66

	From	To
Surveyed Depth (m bgl)	1.6	47.4
Surveyed Level (m OD)	91.5	45.7

	min	max	avg	stdev
Dip Direction	4	353	159	100
Dip Angle	5	71	32	19





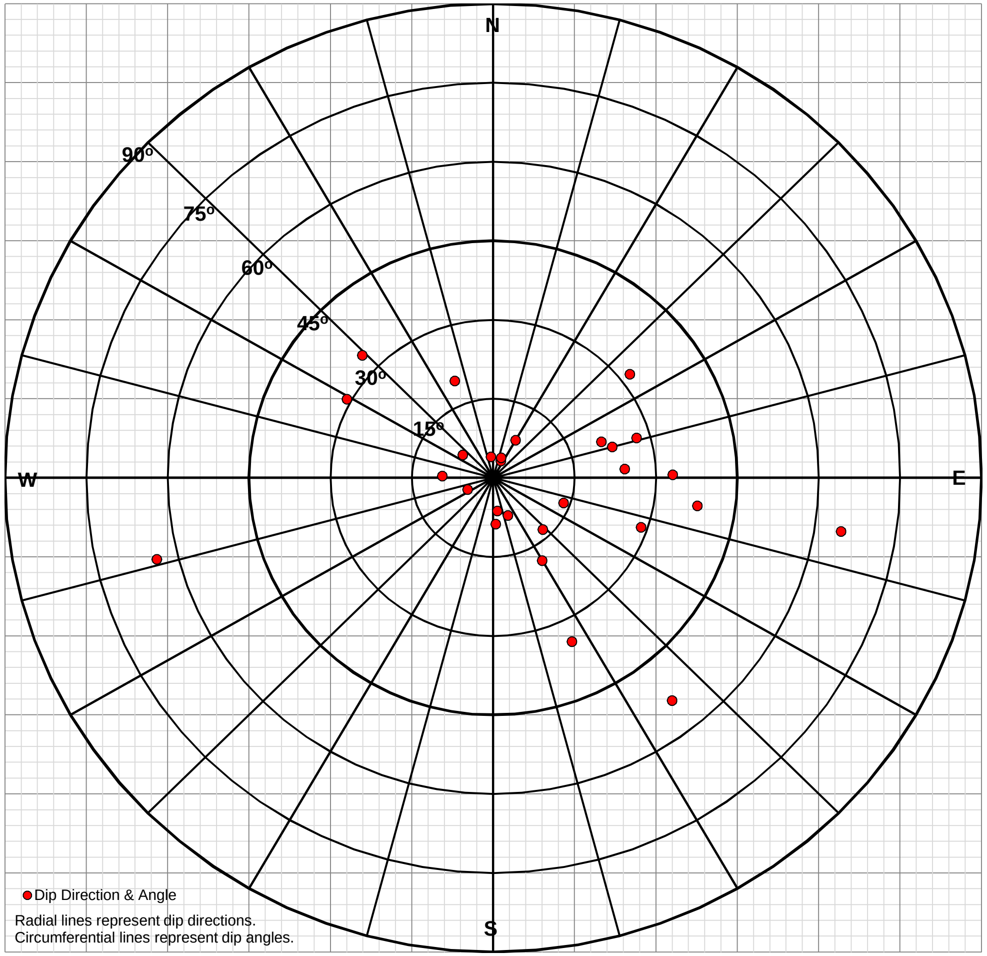


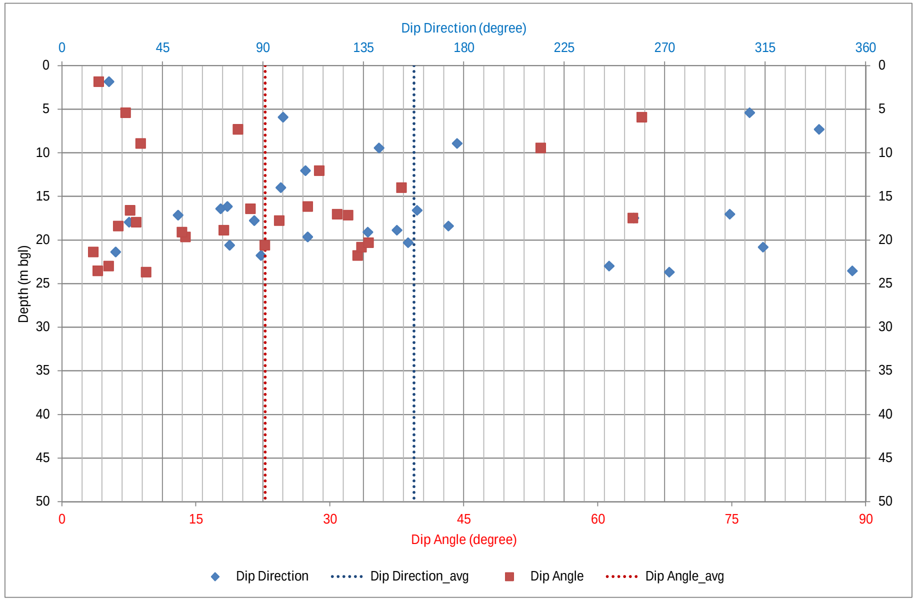
Exploratory Hole ID	16175-R12

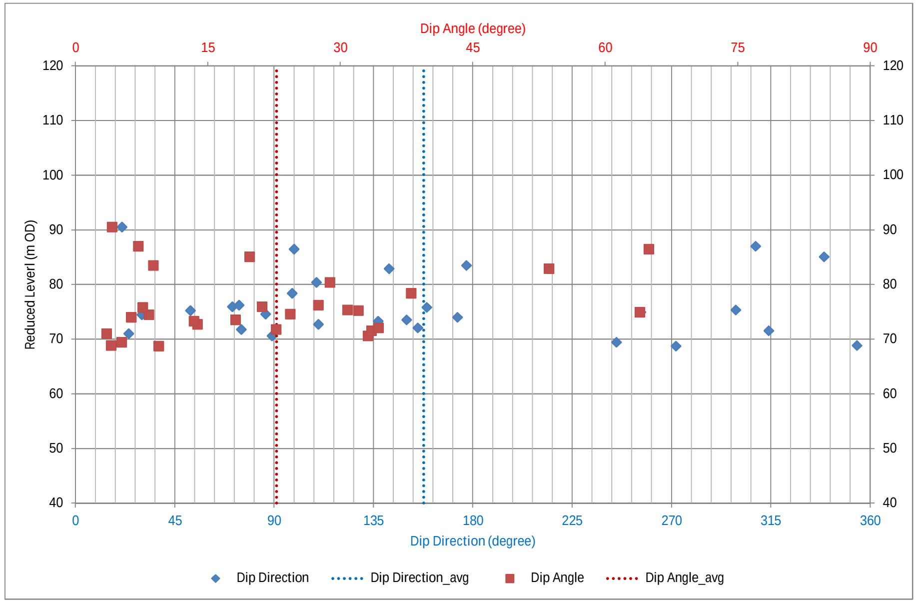
Chainage (m)	8867
Offset (m)	37

	From	To
Surveyed Depth (m bgl)	1.8	23.6
Surveyed Level (m OD)	90.6	68.8

	min	max	avg	stdev
Dip Direction	21	354	158	99
Dip Angle	4	65	23	17





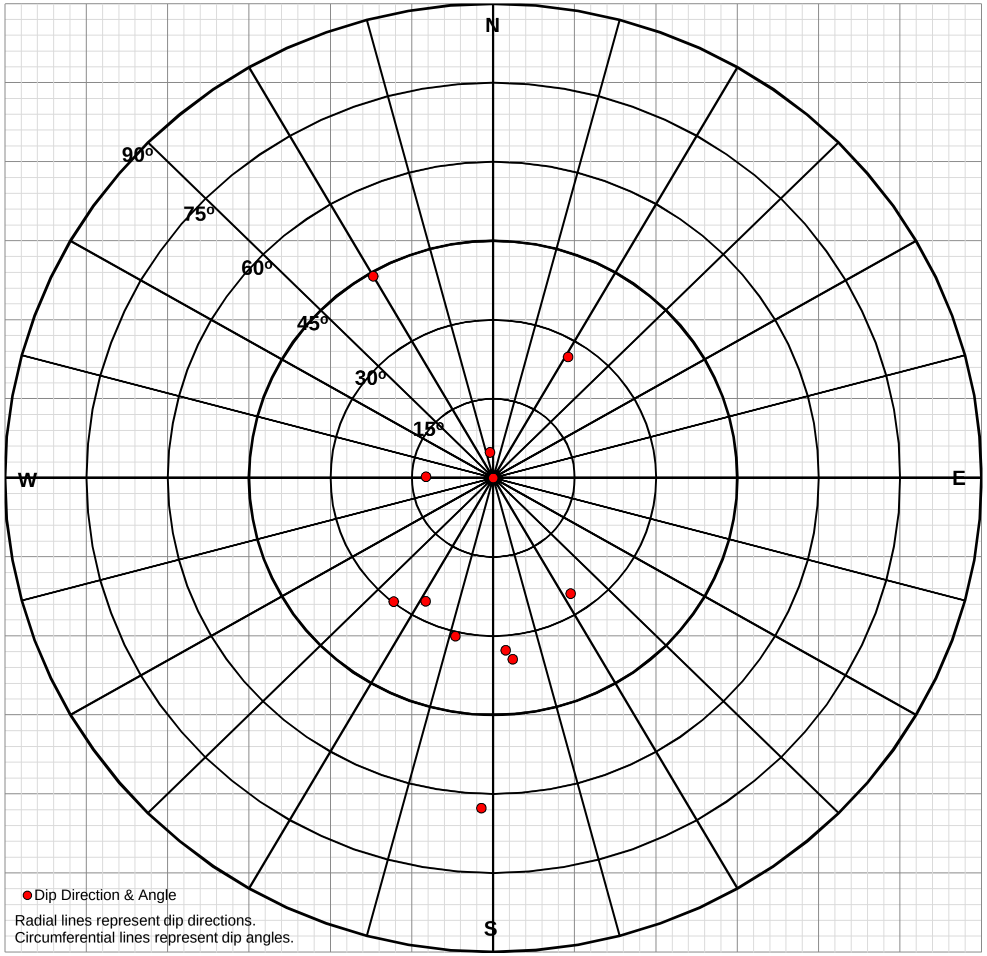


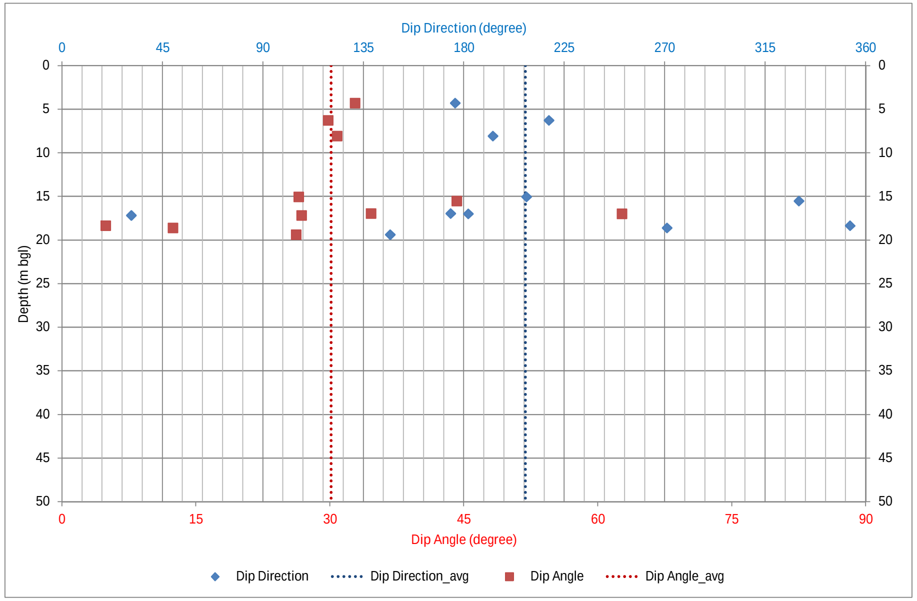
Exploratory Hole ID	16175-R14

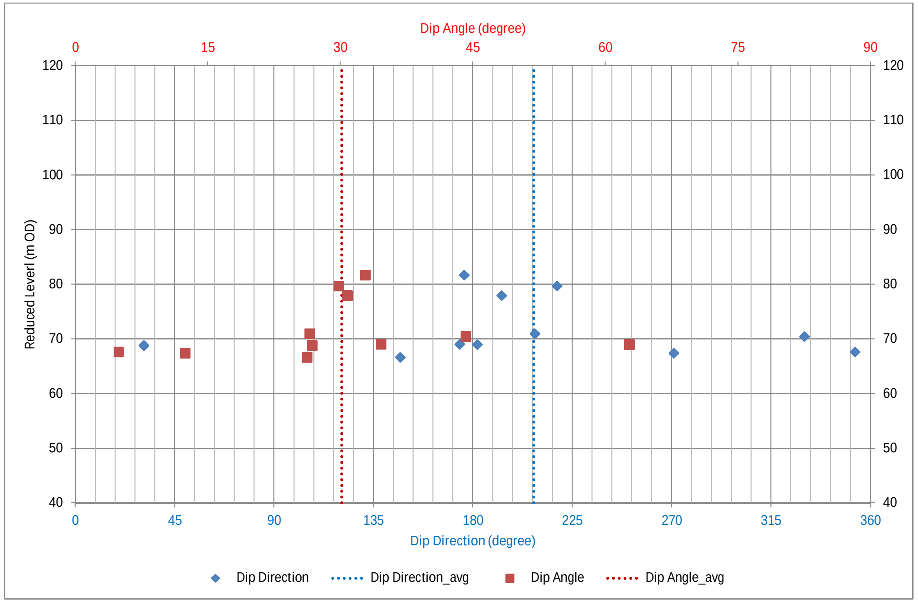
Chainage (m)	9021
Offset (m)	36

	From	To
Surveyed Depth (m bgl)	4.3	19.4
Surveyed Level (m OD)	81.7	66.6

	min	max	avg	stdev
Dip Direction	31	353	208	84
Dip Angle	5	63	30	14





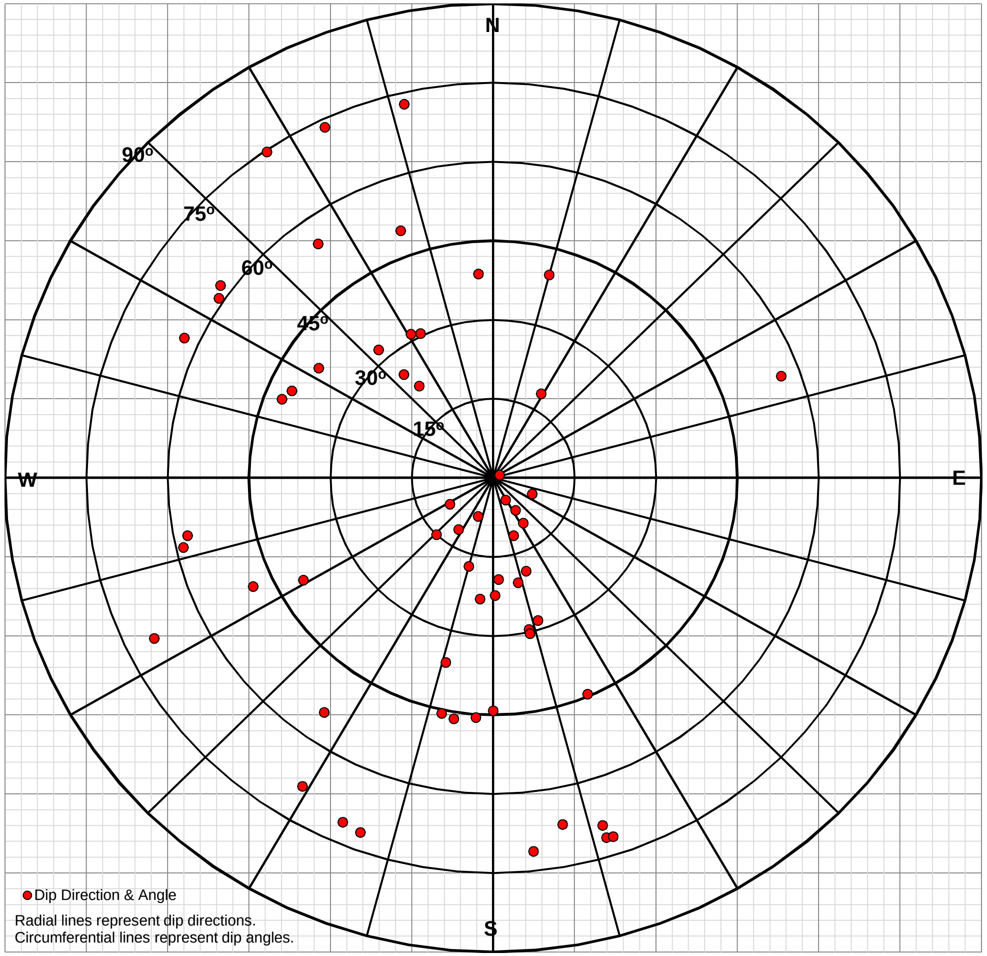


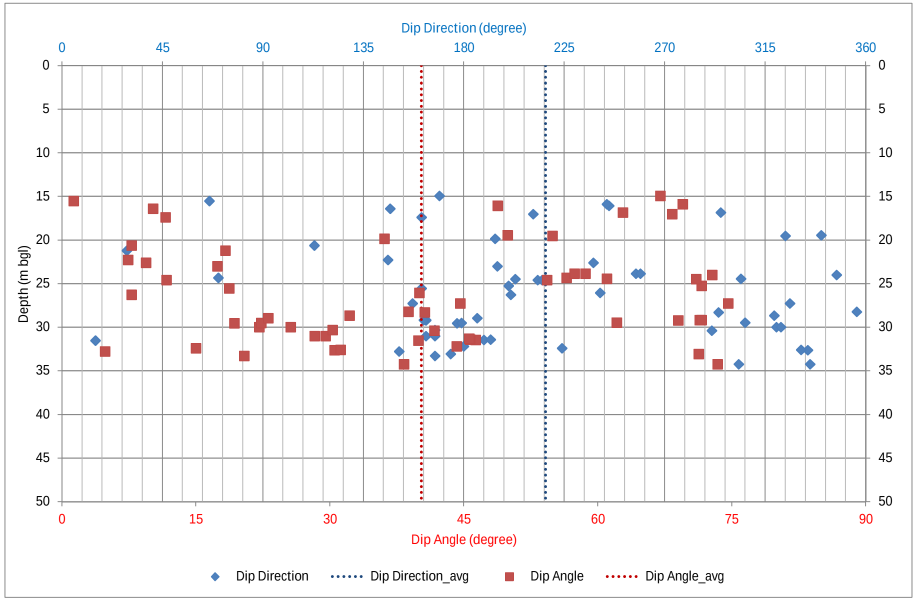
Exploratory Hole ID	17439-P2

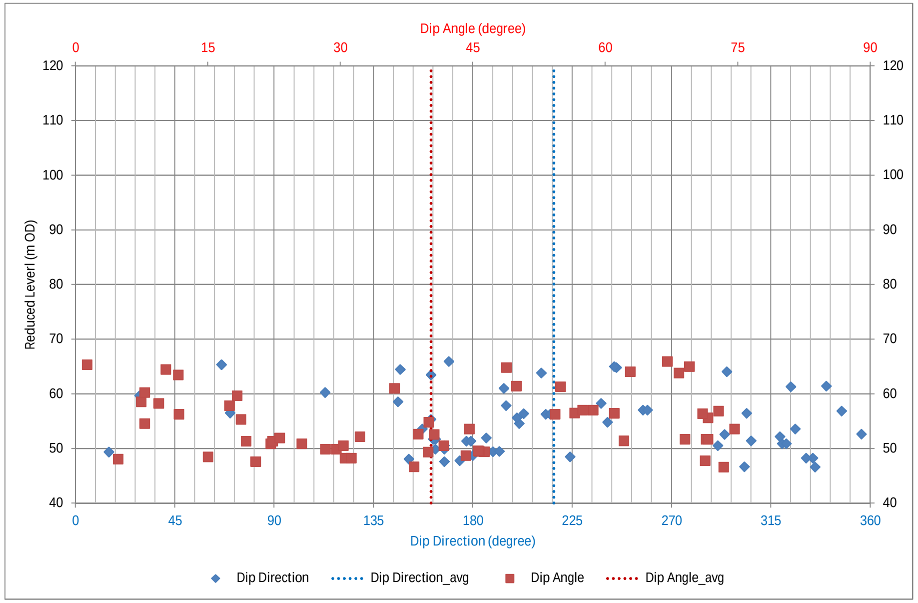
Chainage (m)	9108
Offset (m)	55

	From	To
Surveyed Depth (m bgl)	14.9	34.2
Surveyed Level (m OD)	65.9	46.6

	min	max	avg	stdev
Dip Direction	15	356	217	80
Dip Angle	1	75	40	22





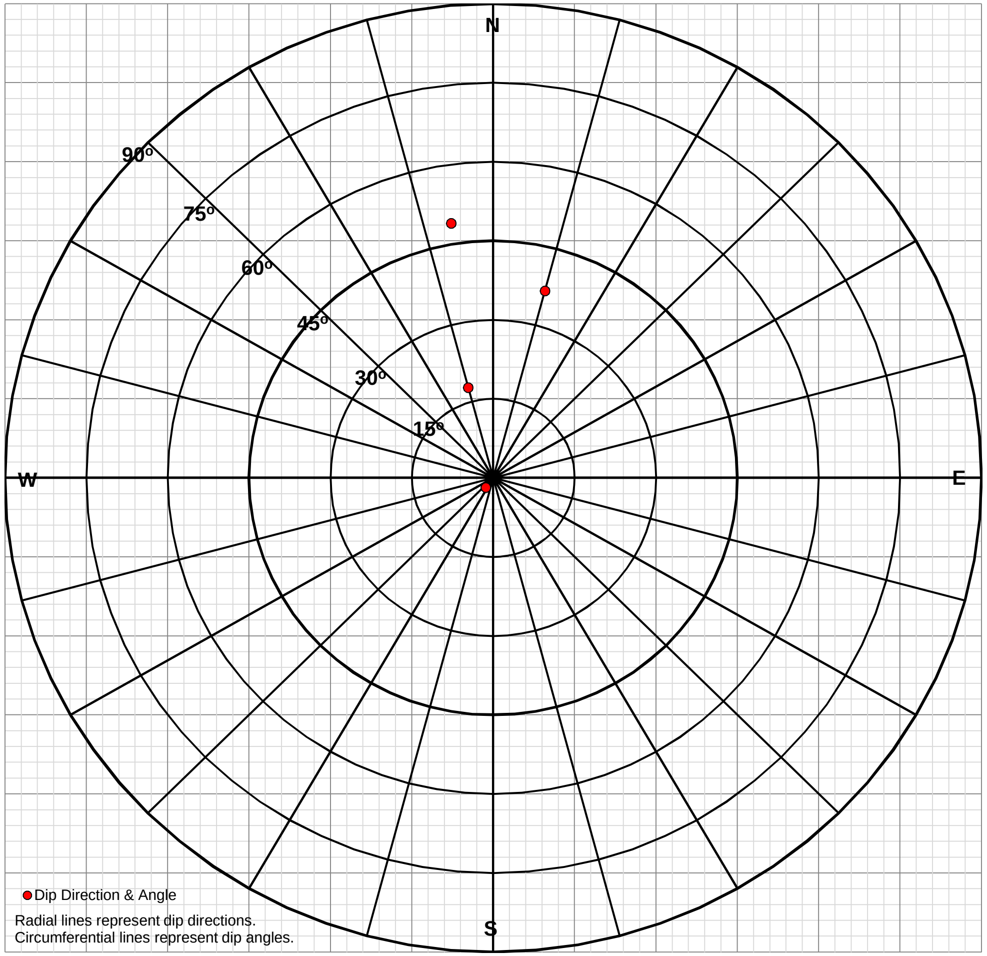


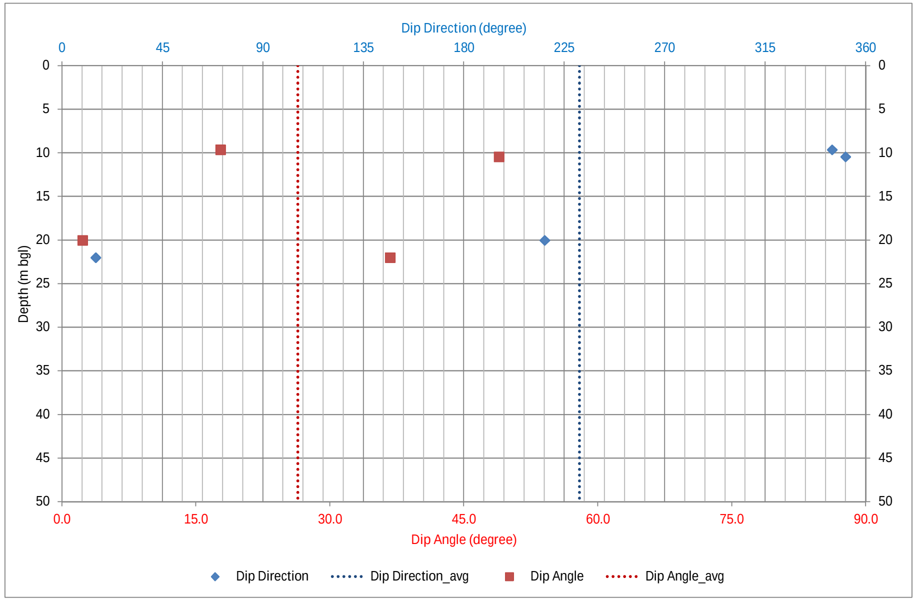
Exploratory Hole ID	21762-R157

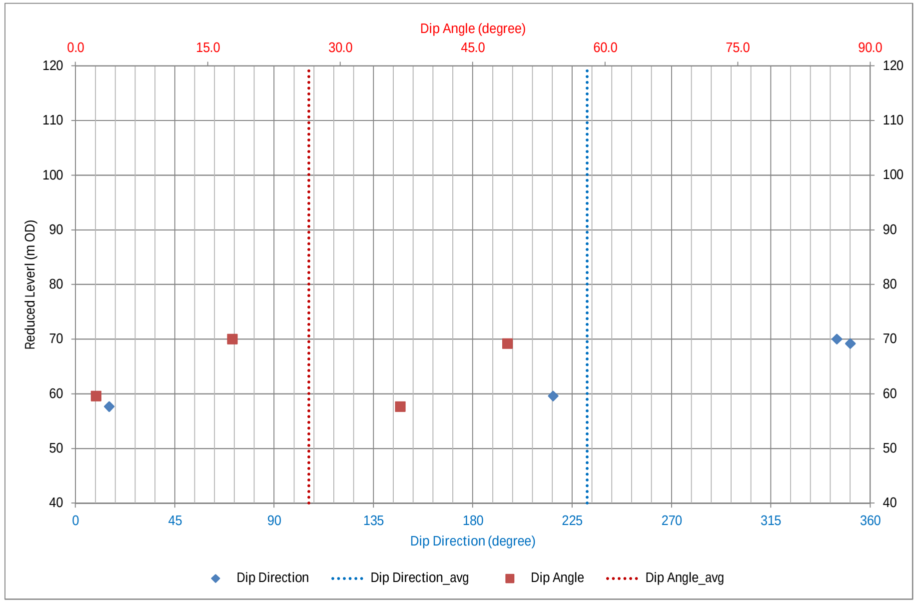
Chainage (m)	9173
Offset (m)	50

	From	To
Surveyed Depth (m bgl)	9.6	22.0
Surveyed Level (m OD)	70.0	57.7

	min	max	avg	stdev
Dip Direction	15	351	232	136
Dip Angle	2	49	26	18





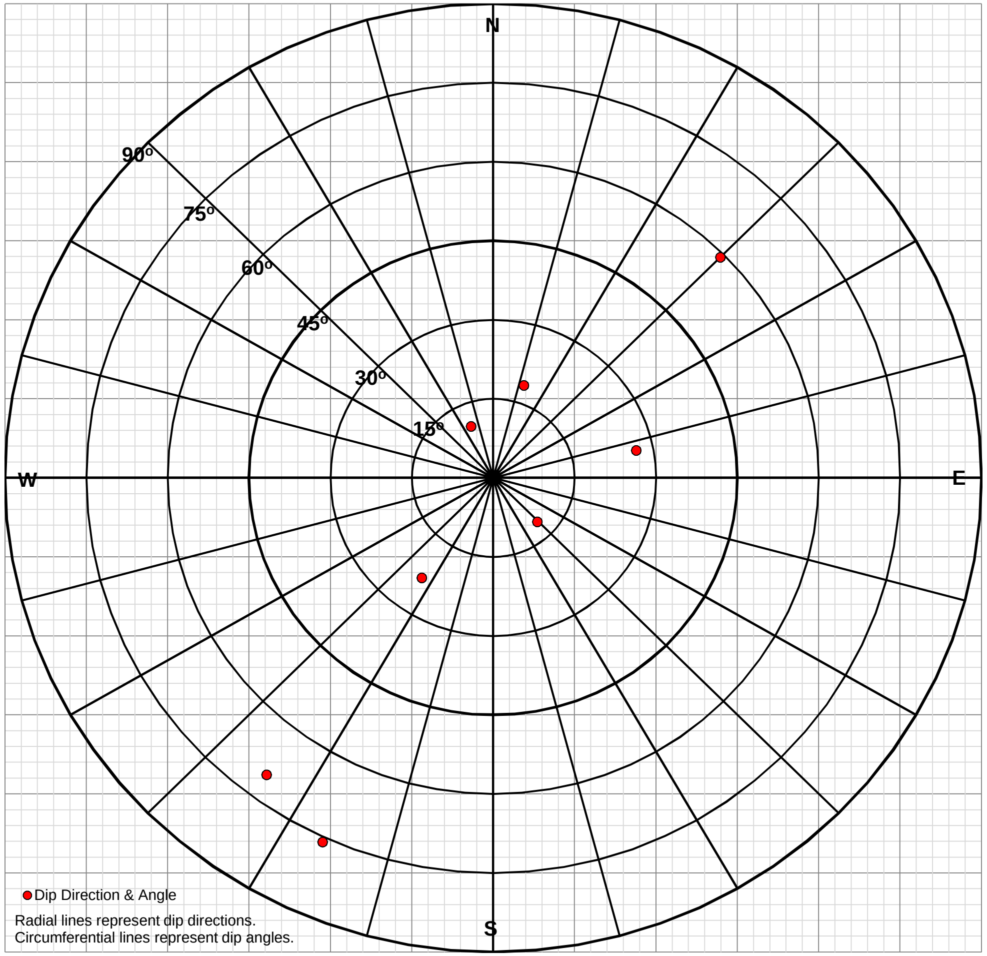


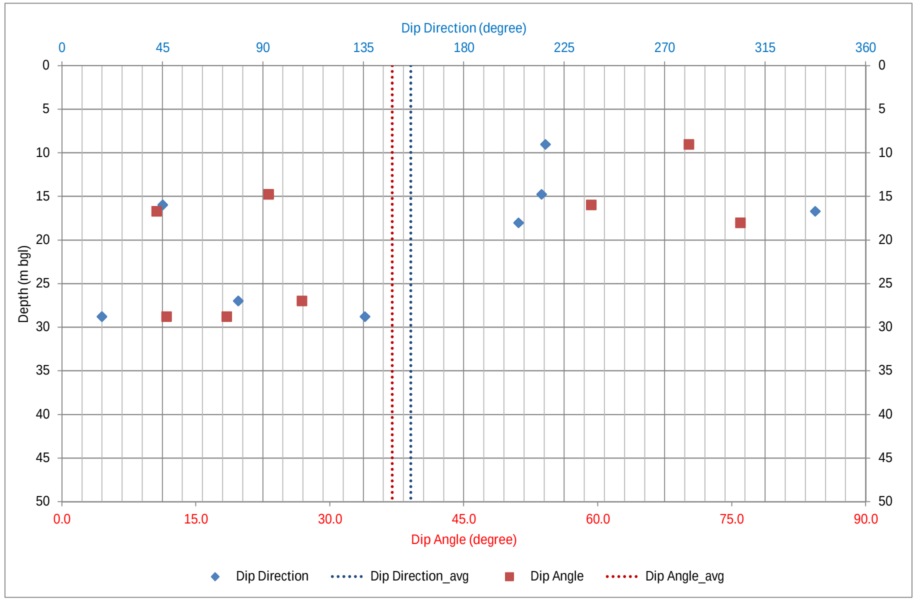
Exploratory Hole ID	21762-R154

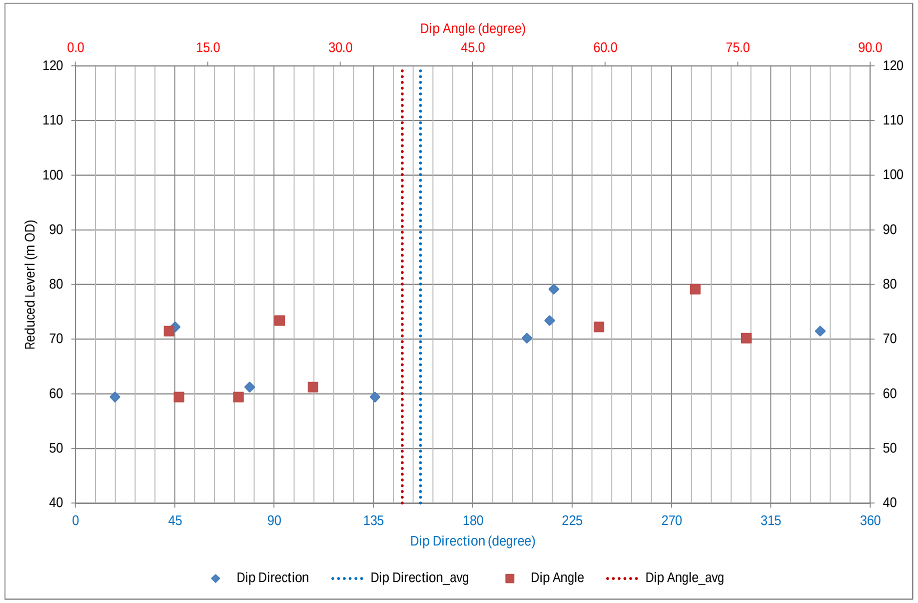
Chainage (m)	9209
Offset (m)	68

	From	To
Surveyed Depth (m bgl)	9.0	28.8
Surveyed Level (m OD)	79.2	59.4

	min	max	avg	stdev
Dip Direction	18	337	156	100
Dip Angle	11	76	37	25





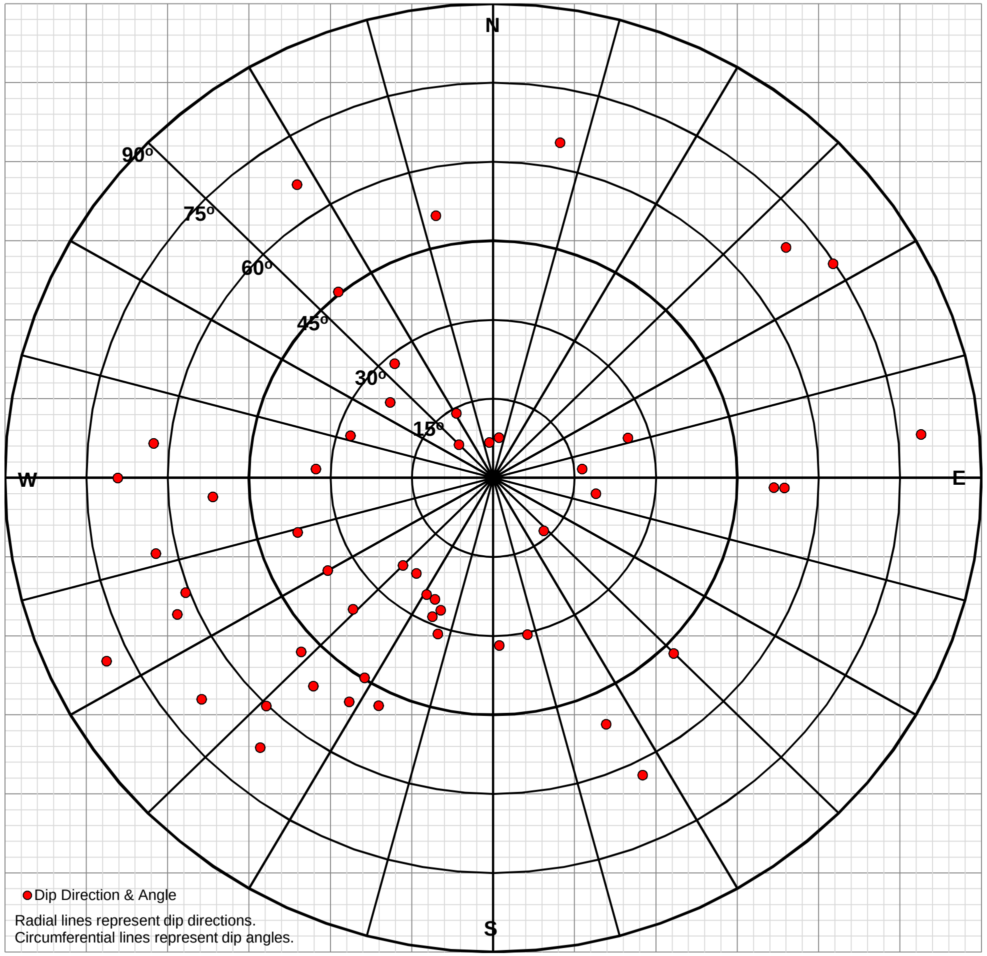


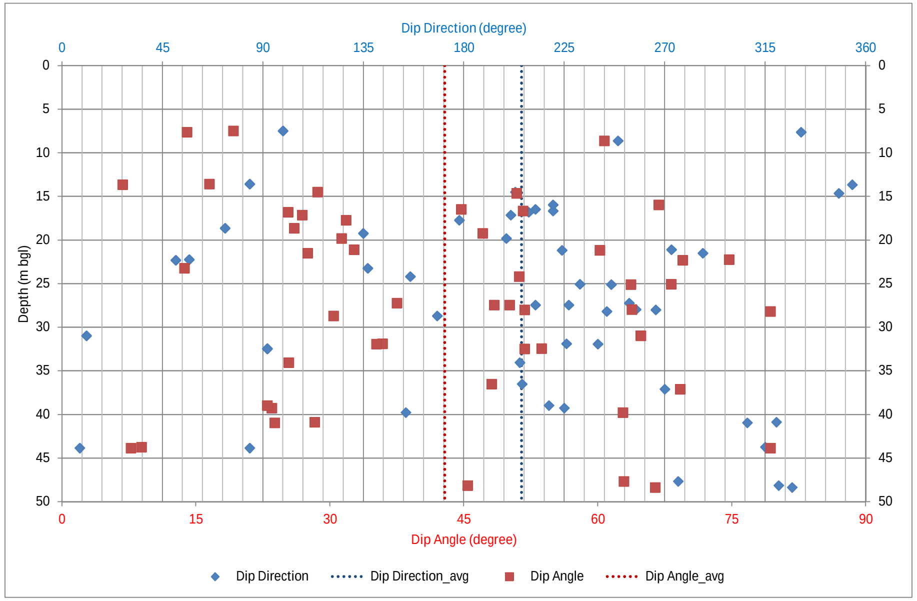
Exploratory Hole ID	16175-R18

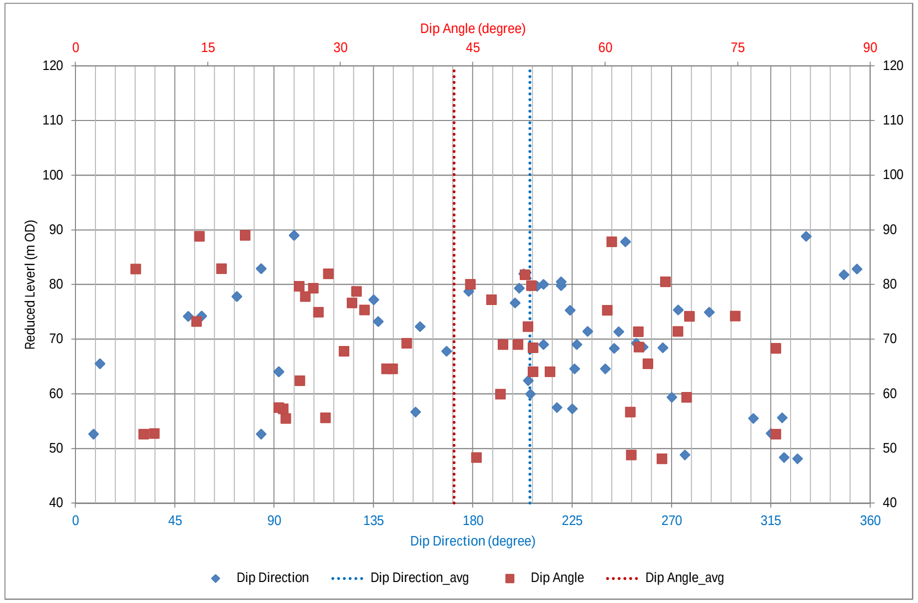
Chainage (m)	9282
Offset (m)	83

	From	To
Surveyed Depth (m bgl)	7.5	48.3
Surveyed Level (m OD)	89.0	48.2

	min	max	avg	stdev
Dip Direction	8	354	206	87
Dip Angle	7	79	43	20





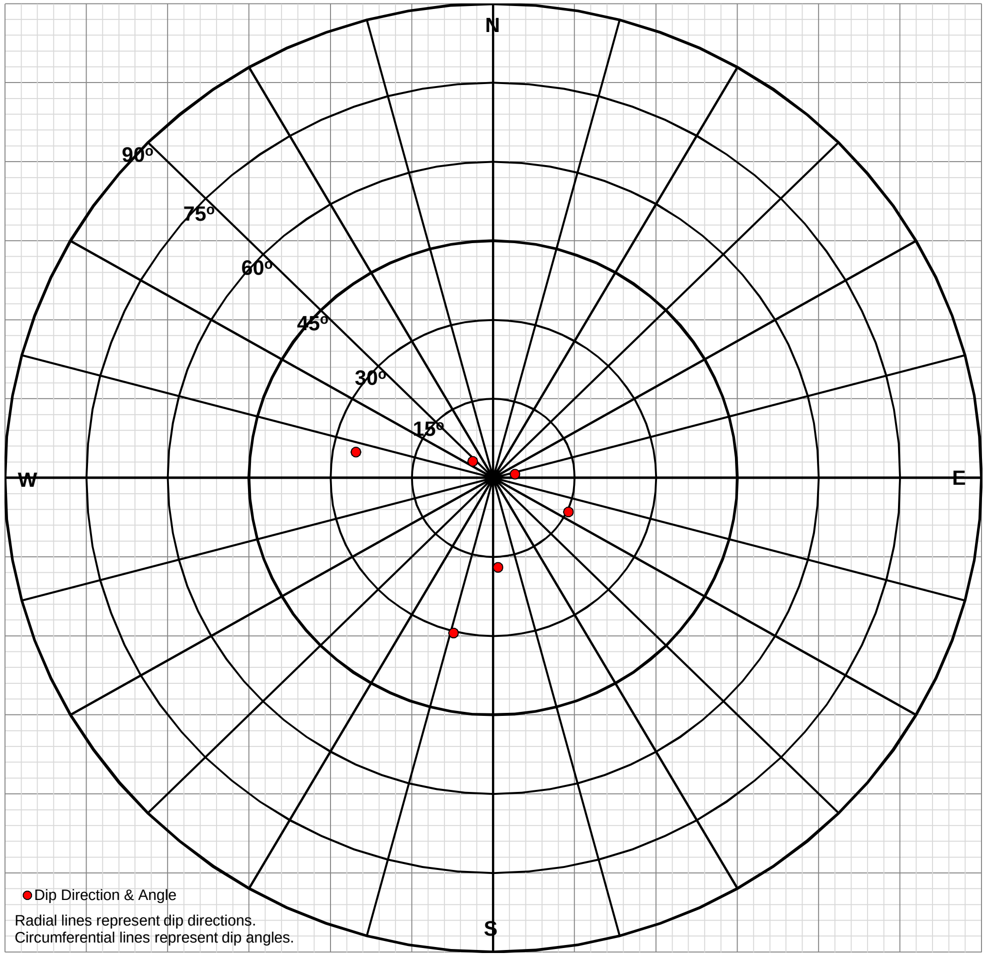


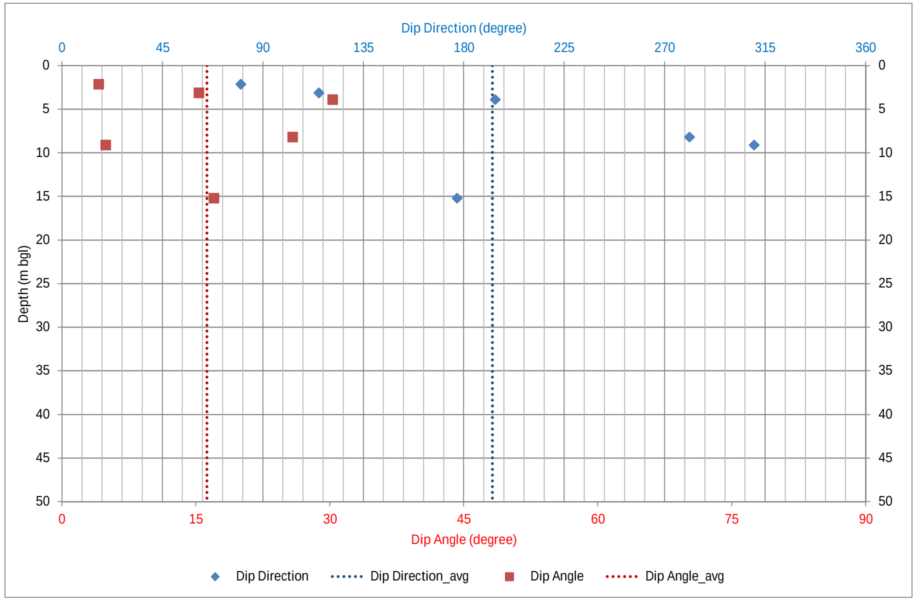
Exploratory Hole ID	**16175-R17**

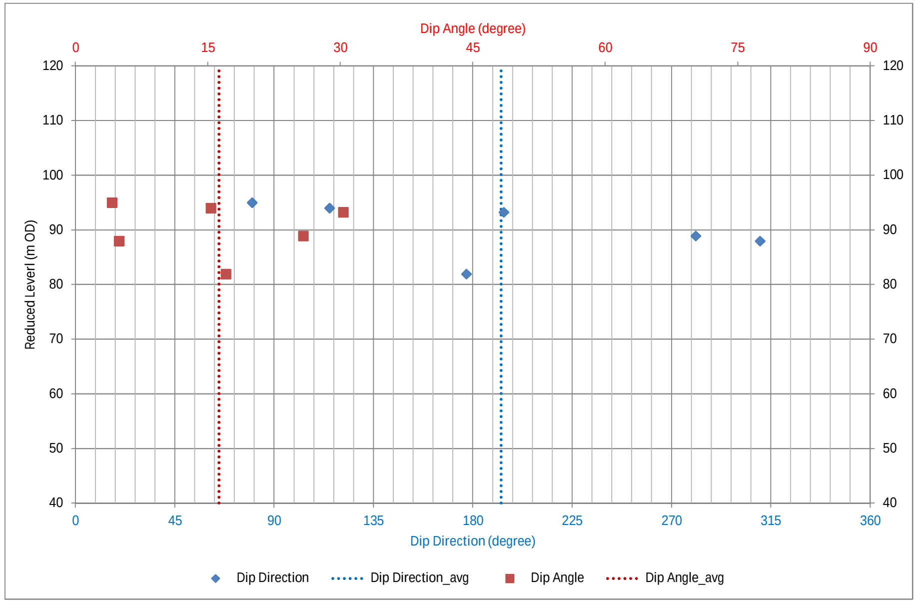
Chainage (m)	9285
Offset (m)	22

	From	To
Surveyed Depth (m bgl)	2.1	15.2
Surveyed Level (m OD)	95.0	81.9

	min	max	avg	stdev
Dip Direction	80	310	193	82
Dip Angle	4	30	16	10





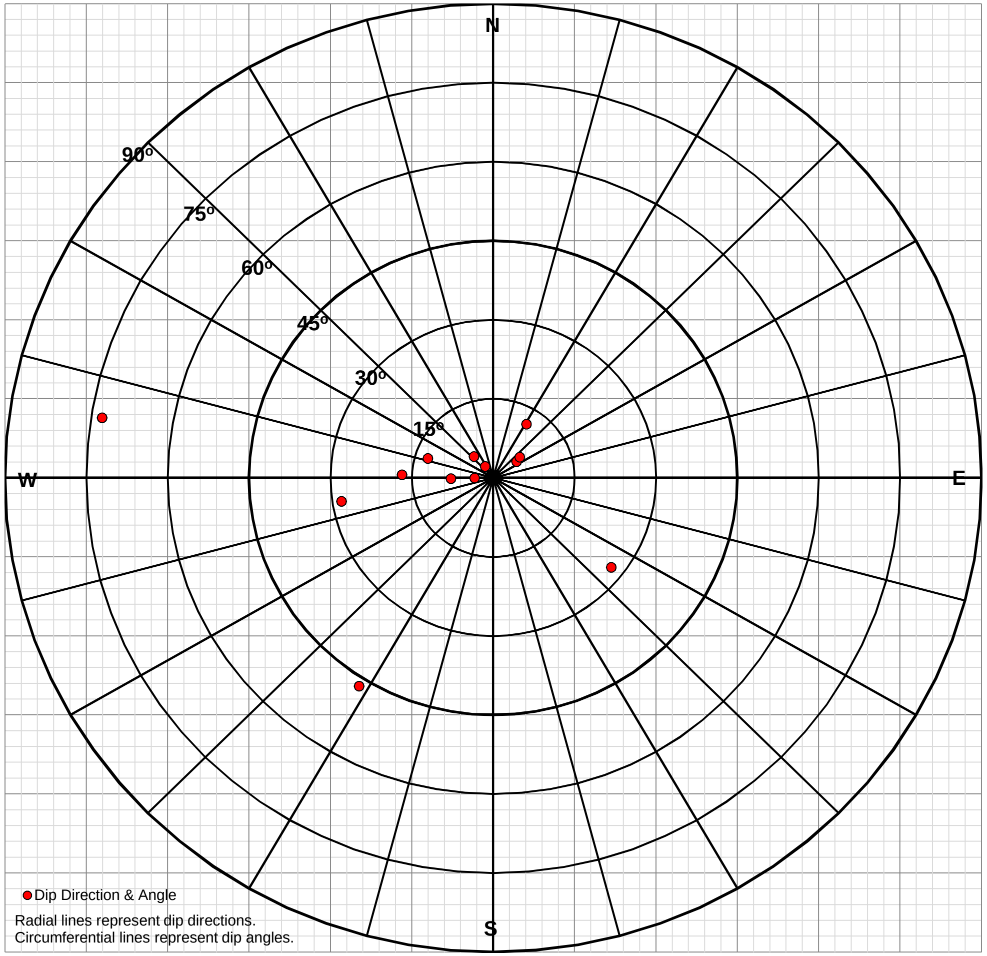


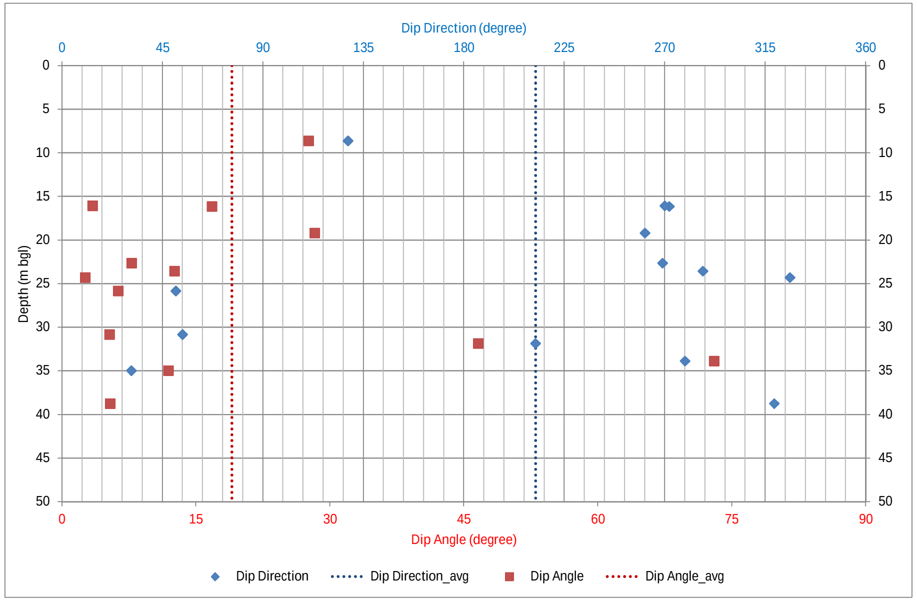
Exploratory Hole ID	16175-R19

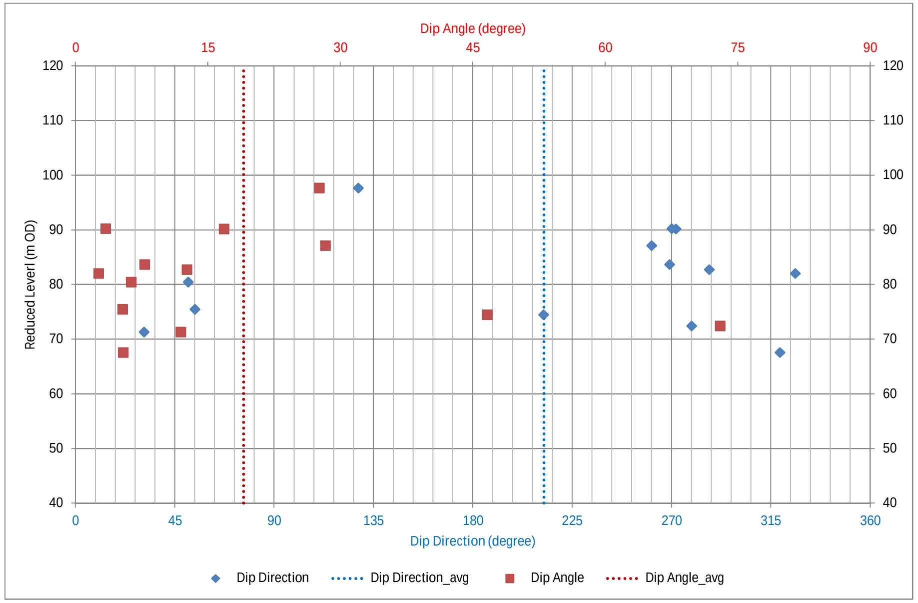
Chainage (m)	9478
Offset (m)	23

	From	To
Surveyed Depth (m bgl)	8.6	38.7
Surveyed Level (m OD)	97.7	67.6

	min	max	avg	stdev
Dip Direction	31	326	212	103
Dip Angle	3	73	19	20





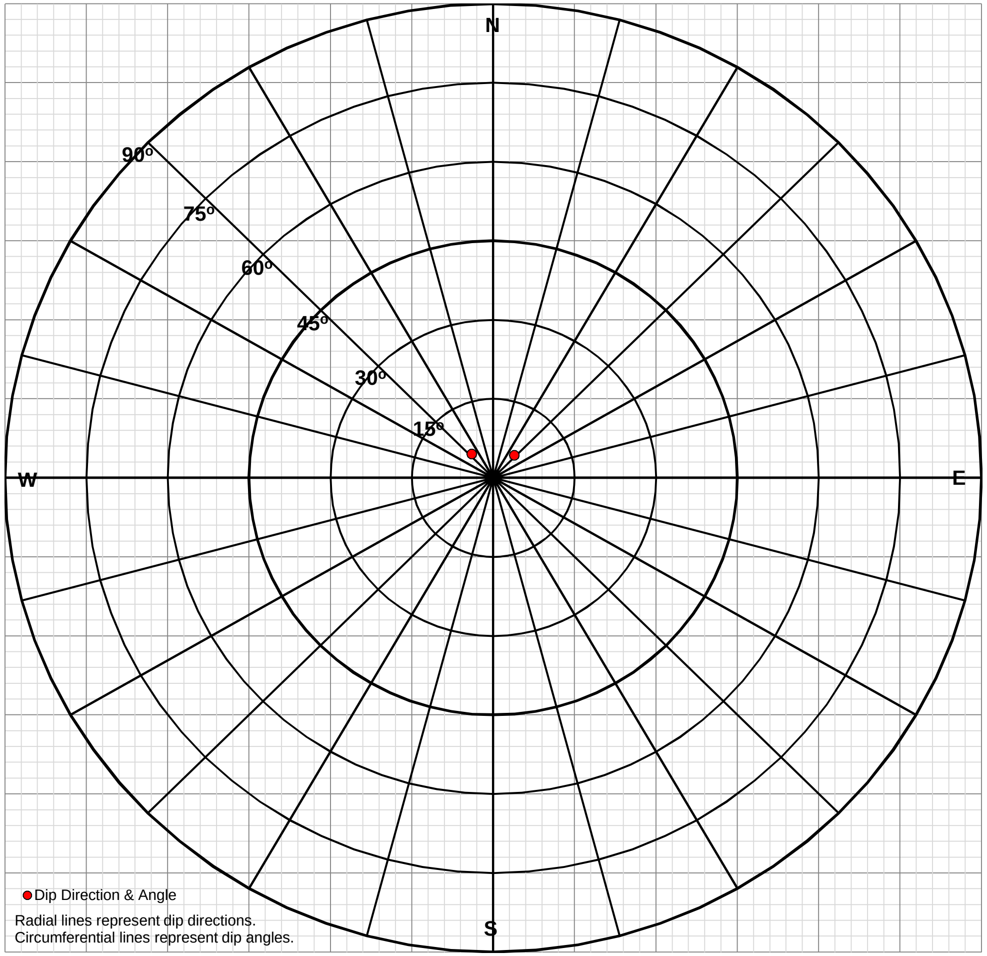


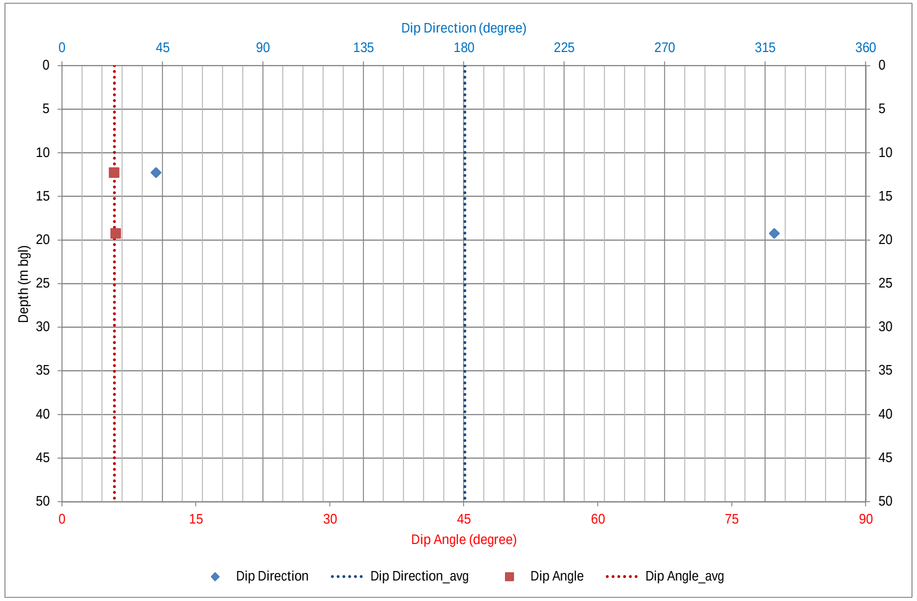
Exploratory Hole ID	**16175-R21**

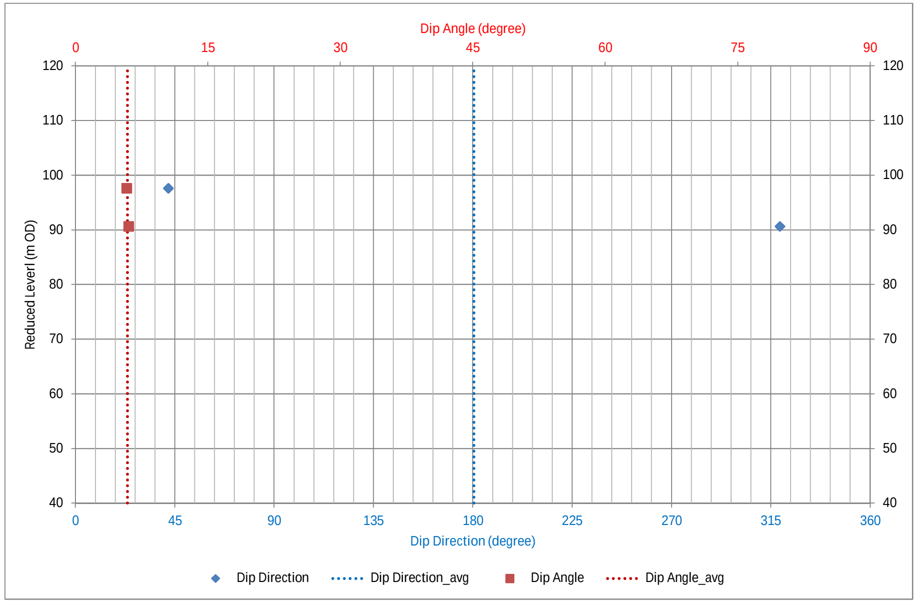
Chainage (m)	9947
Offset (m)	93

	From	To
Surveyed Depth (m bgl)	12.3	19.2
Surveyed Level (m OD)	97.6	90.7

	min	max	avg	stdev
Dip Direction	42	319	181	139
Dip Angle	6	6	6	0





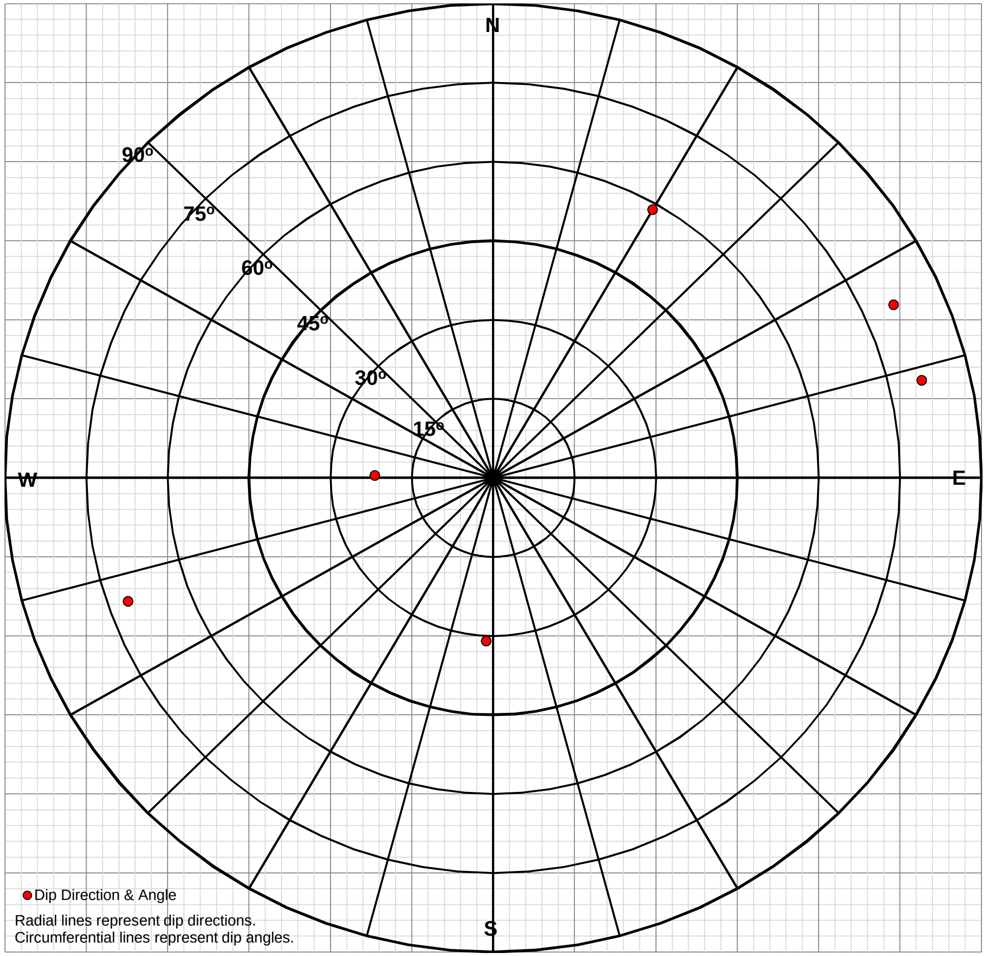


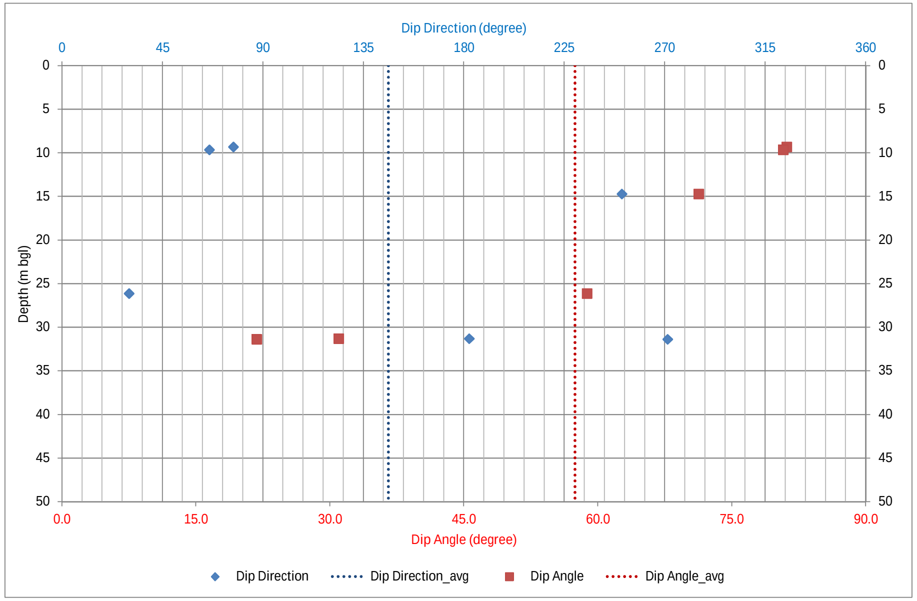
Exploratory Hole ID	21762-R158

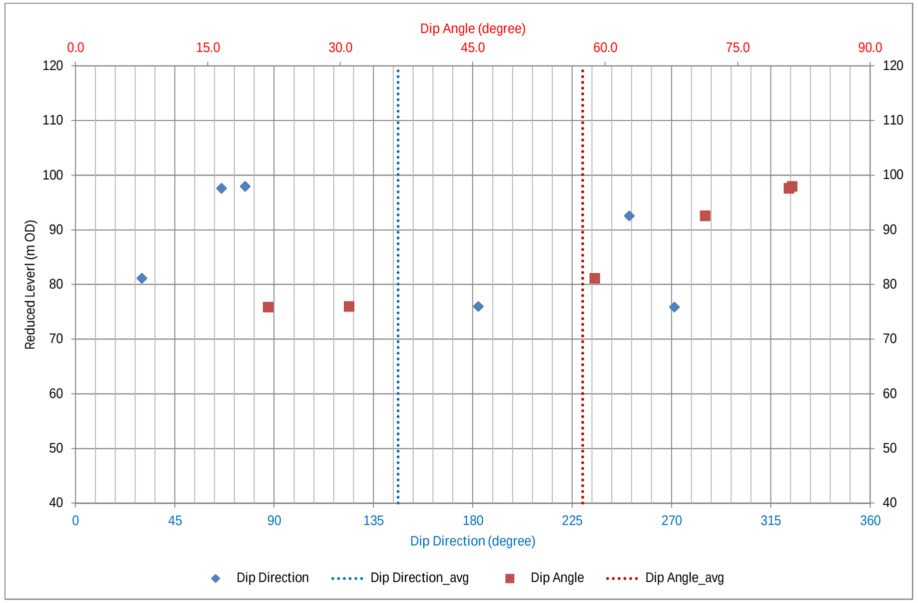
Chainage (m)	10096
Offset (m)	92

	From	To
Surveyed Depth (m bgl)	9.3	31.4
Surveyed Level (m OD)	98.0	75.9

	min	max	avg	stdev
Dip Direction	30	271	146	94
Dip Angle	22	81	57	23





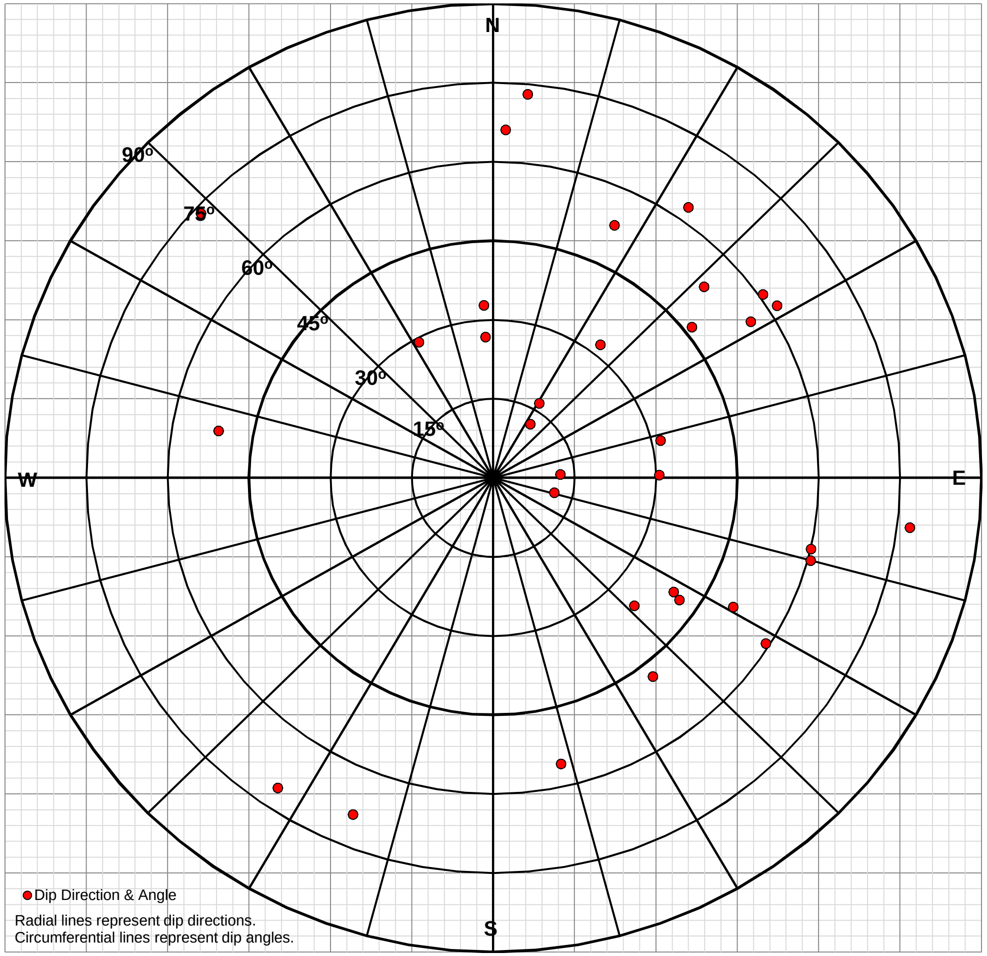


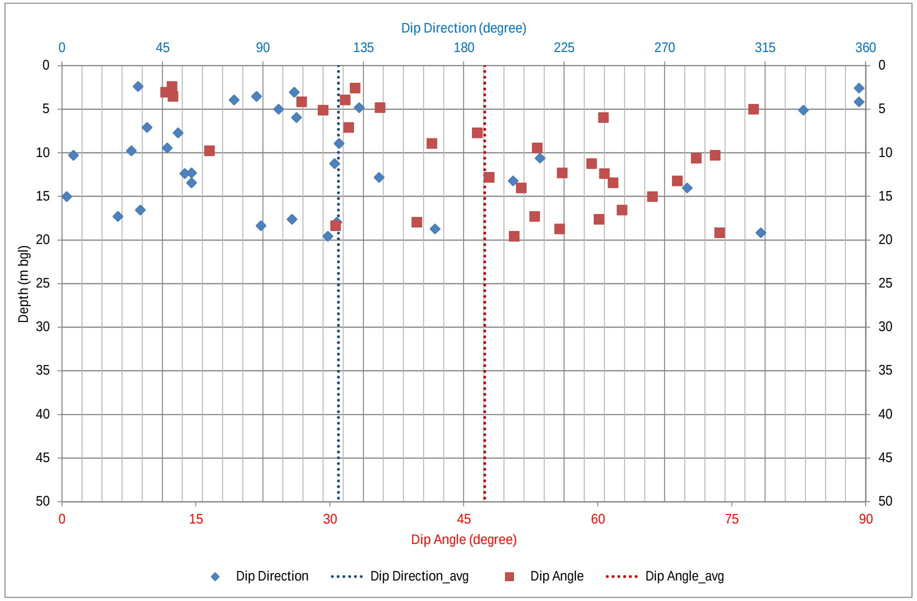
Exploratory Hole ID	16175-R22

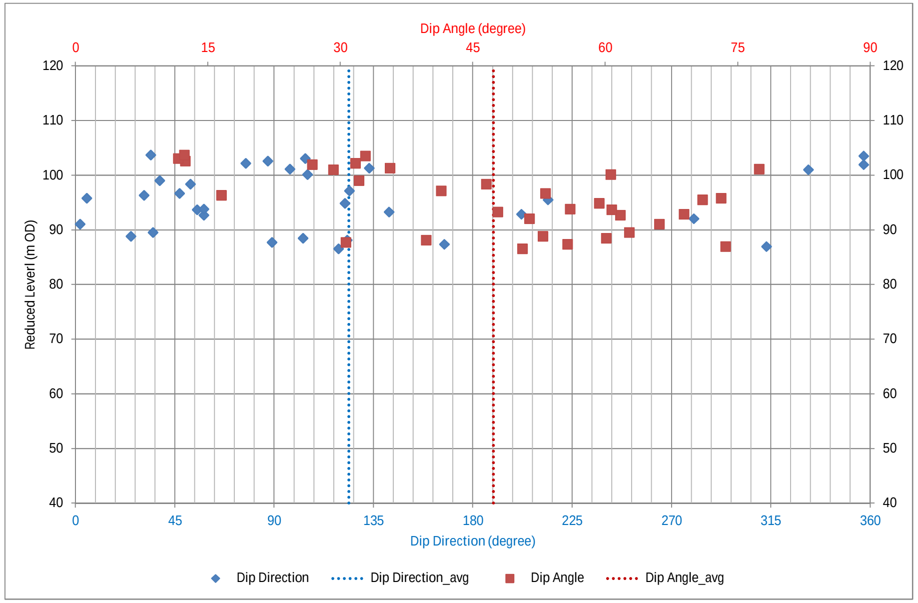
Chainage (m)	10129
Offset (m)	103

	From	To
Surveyed Depth (m bgl)	2.4	19.5
Surveyed Level (m OD)	103.7	86.6

	min	max	avg	stdev
Dip Direction	2	357	124	100
Dip Angle	12	77	47	19





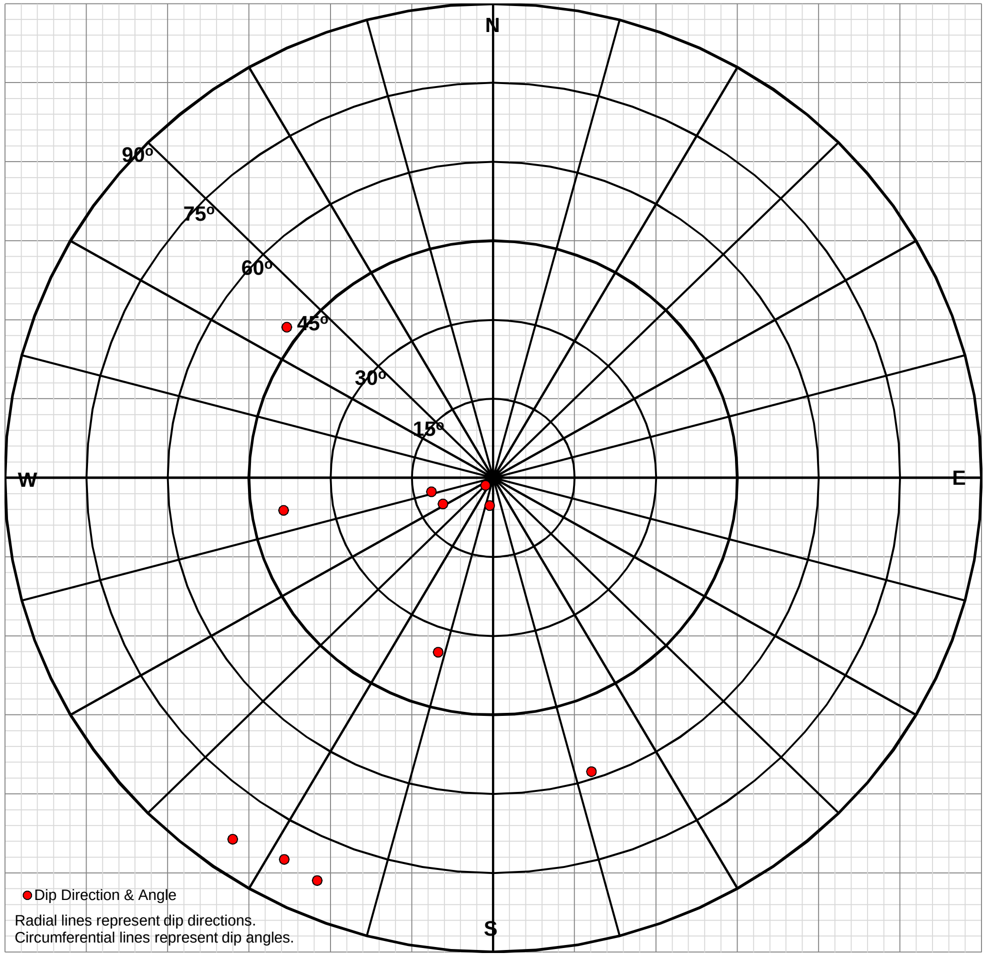


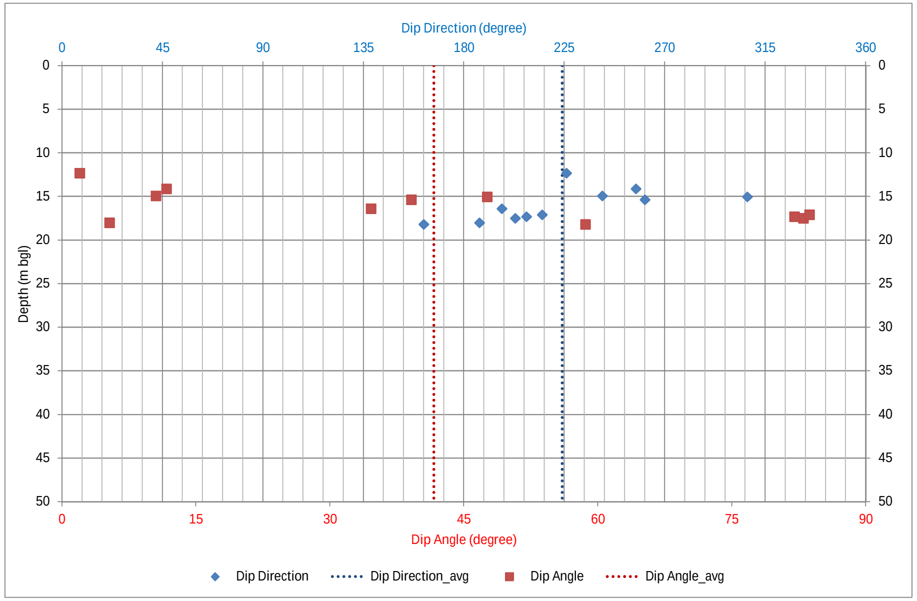
Exploratory Hole ID	**16175-R23**

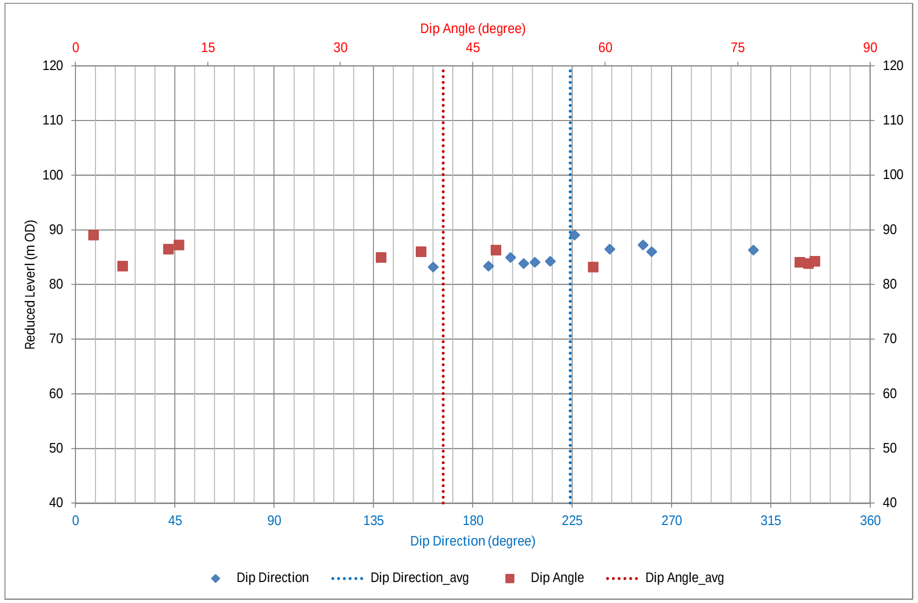
Chainage (m)	10281
Offset (m)	104

	From	To
Surveyed Depth (m bgl)	12.3	18.2
Surveyed Level (m OD)	89.1	83.2

	min	max	avg	stdev
Dip Direction	162	307	224	39
Dip Angle	2	84	42	31





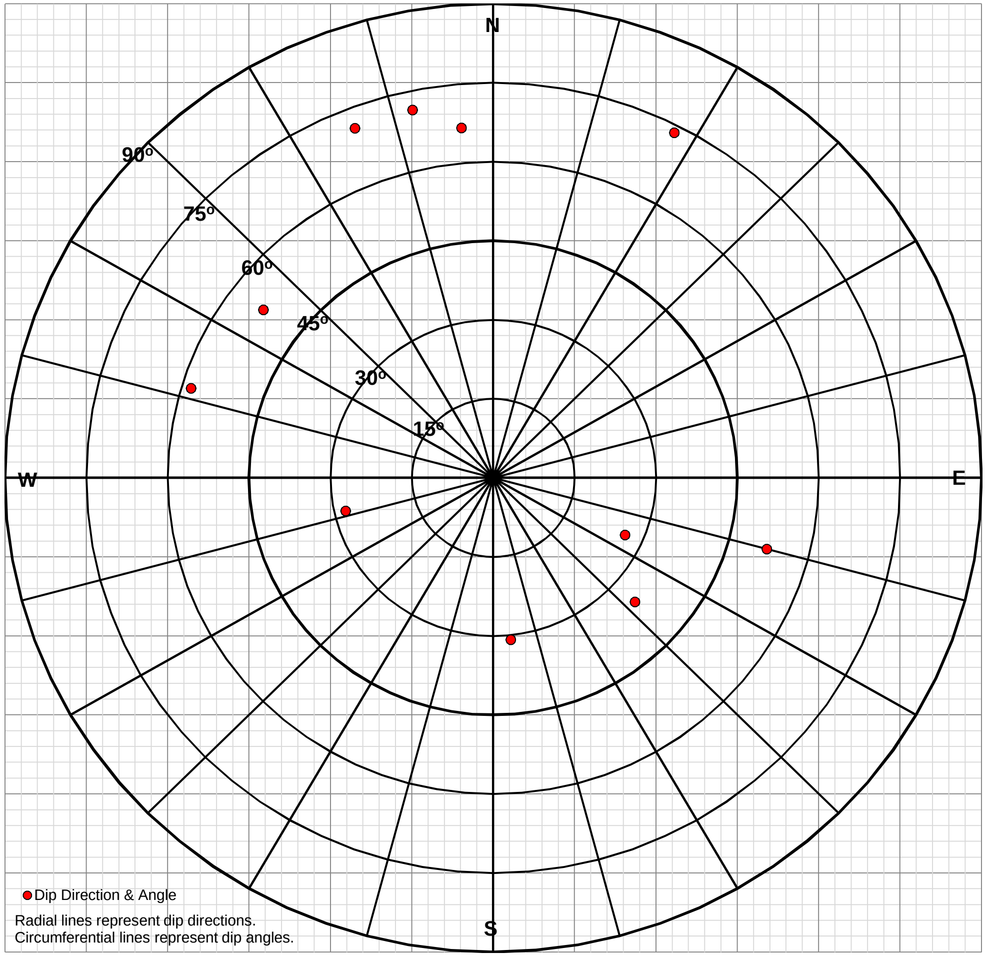


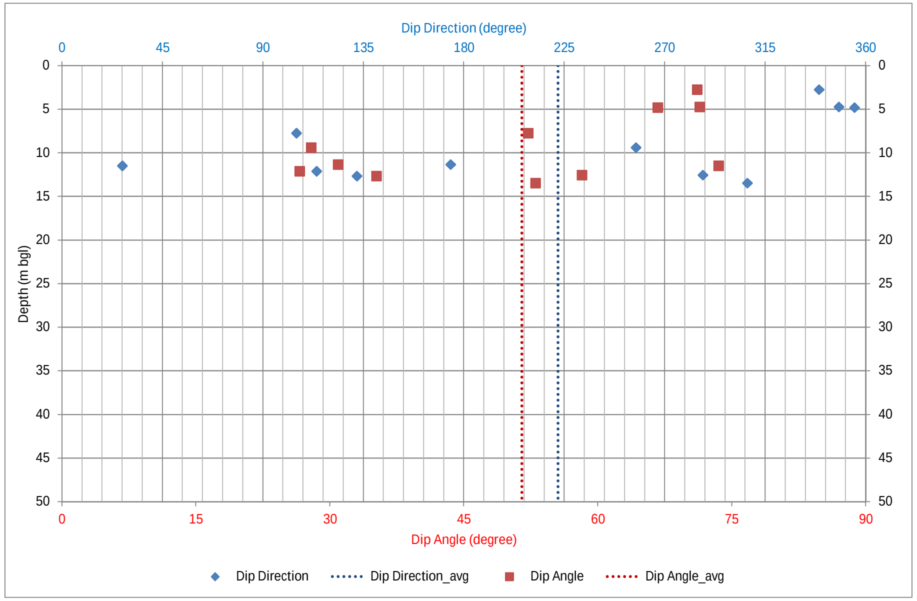
Exploratory Hole ID	**16175-R24**

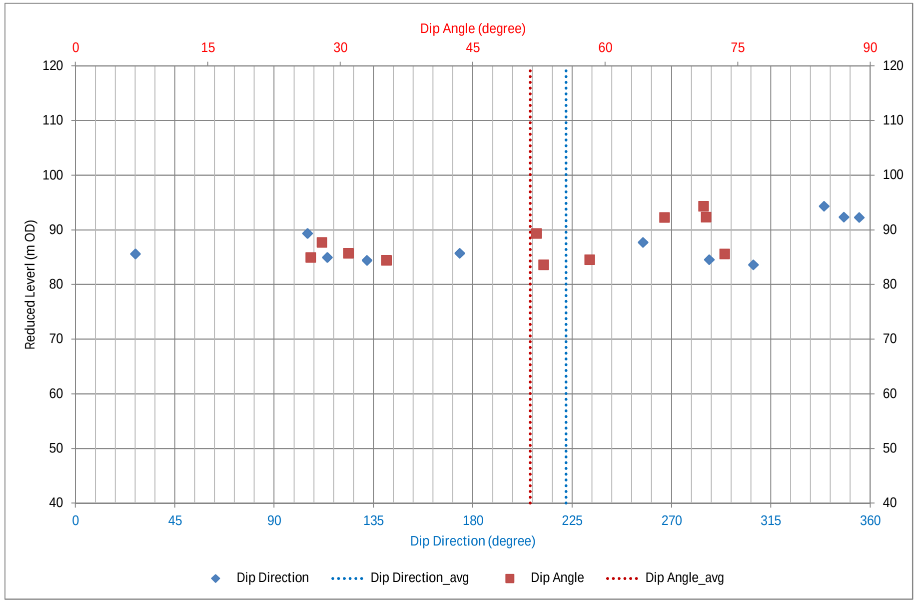
Chainage (m)	10438
Offset (m)	83

	From	To
Surveyed Depth (m bgl)	2.7	13.4
Surveyed Level (m OD)	94.4	83.7

	min	max	avg	stdev
Dip Direction	27	355	222	110
Dip Angle	27	74	52	18





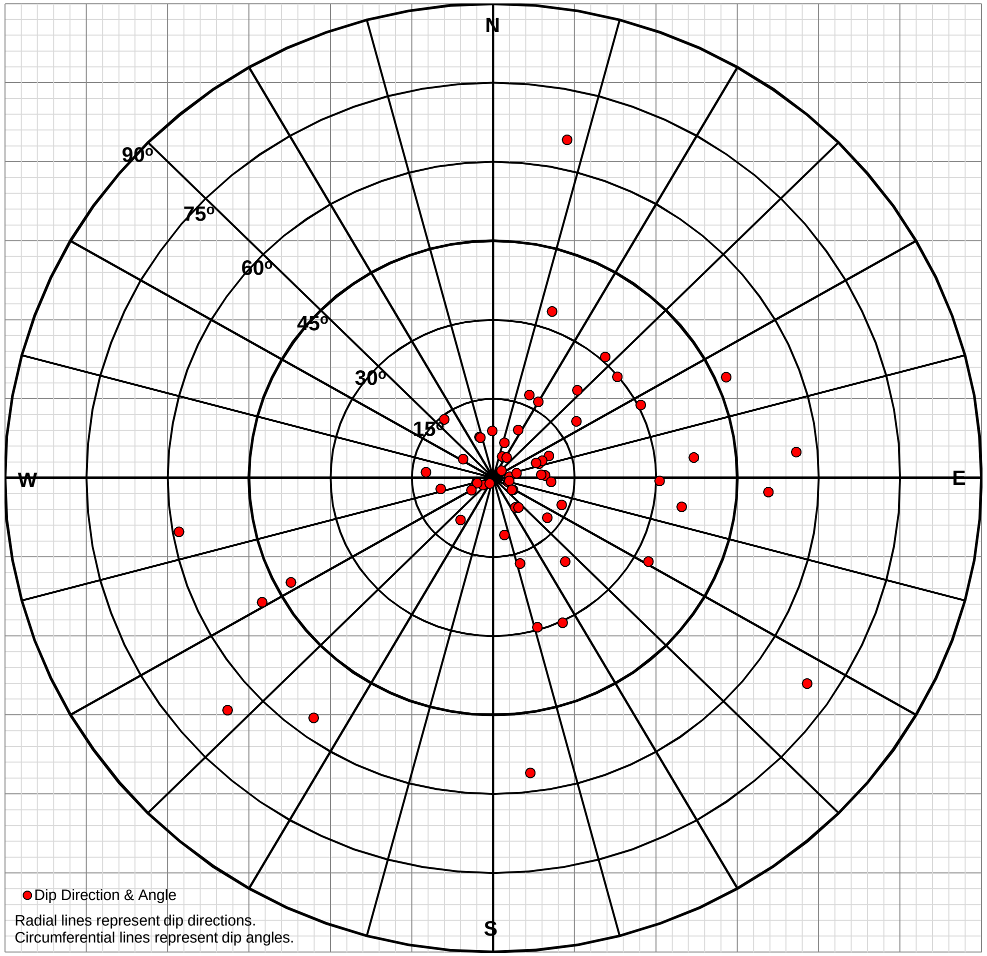


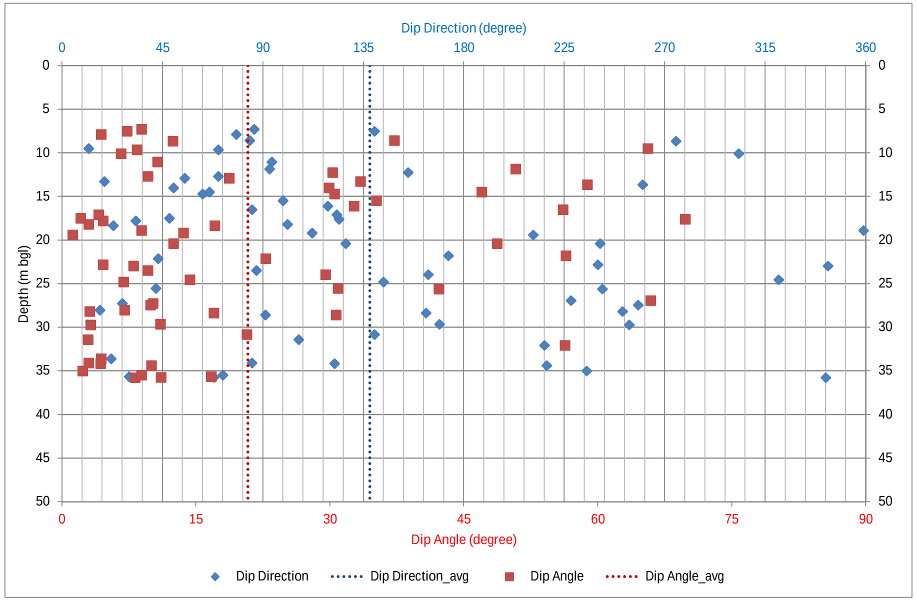
Exploratory Hole ID	29779-R507A

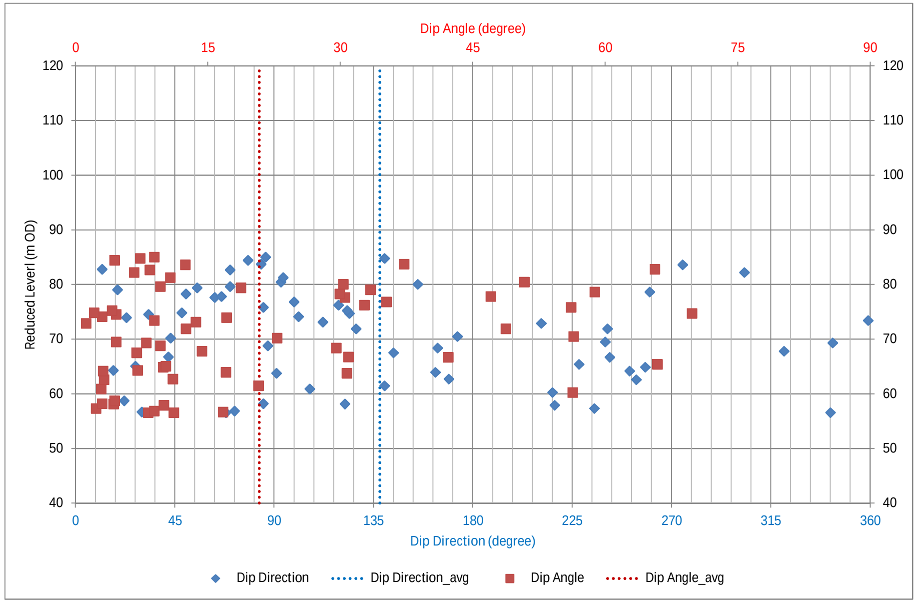
Chainage (m)	10497
Offset (m)	22

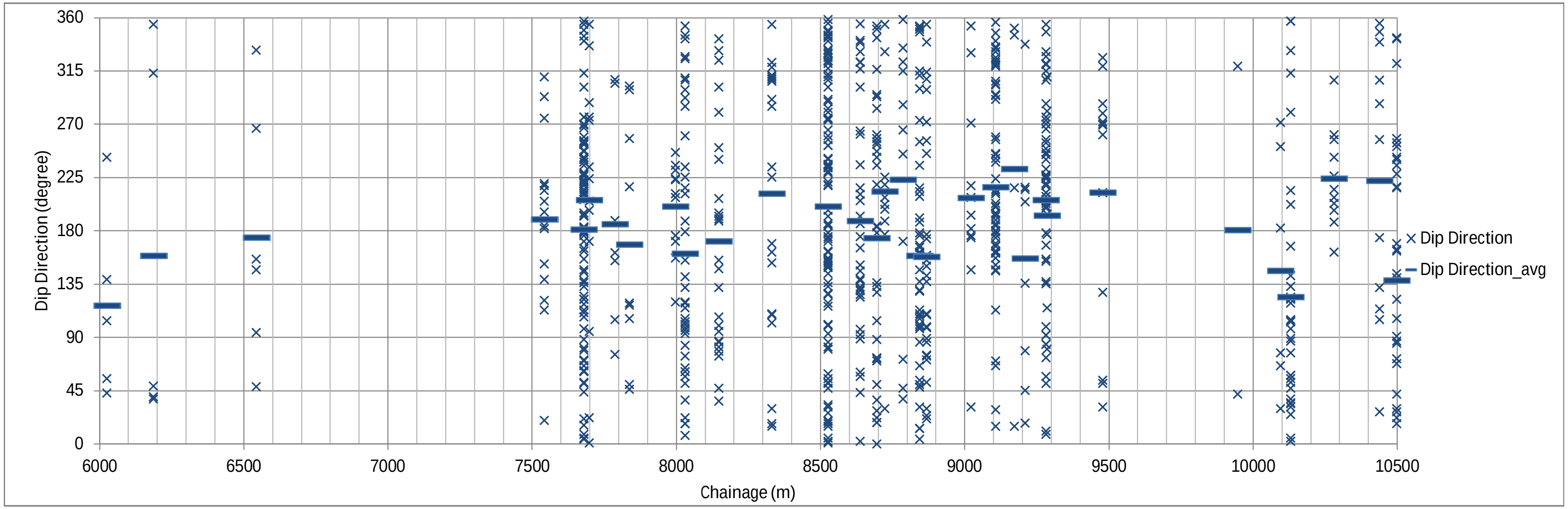
	From	To
Surveyed Depth (m bgl)	7.3	35.8
Surveyed Level (m OD)	85.0	56.6

	min	max	avg	stdev
Dip Direction	12	359	138	93
Dip Angle	1	70	21	19

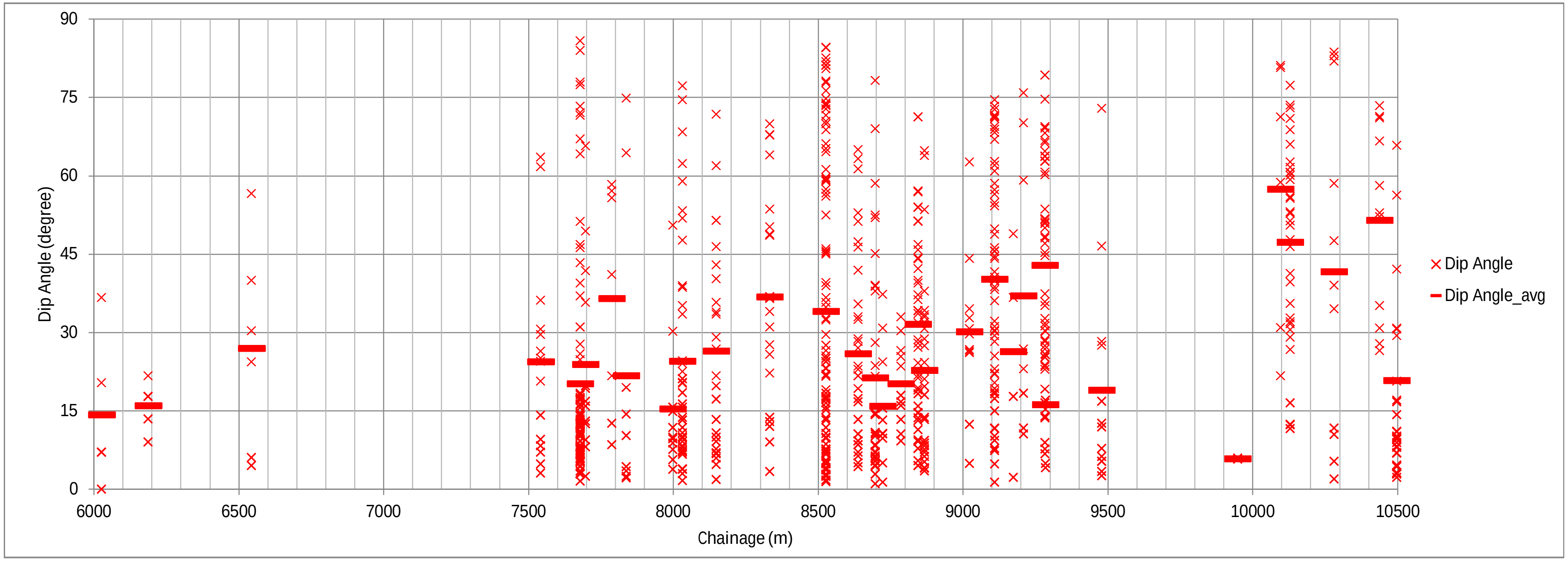








Dip Direction (degree)
Chainage (m)
Dip Direction
Dip Direction_avg



Dip Angle (degree)
Chainage (m)
Dip Angle
Dip Angle_avg

Appendix E Additional Phosphatic Chalk Testing Results

CONCEPT LIFE SCIENCES
DELIVERING SCIENCE

Concept Life Sciences is a trading name of Concept Life Sciences Analytical & Development Services Limited registered in England and Wales (No 2514788)

Concept Life Sciences

Certificate of Analysis

Hadfield House
Hadfield Street
Cornbrook
Manchester
M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2468

Report Number: Supplemental to 715633-1

Date of Report: 26-Mar-2018

Customer: AECOM Infrastructure & Environment UK Limited
St George's House
2nd floor
5 St George's Road
Wimbledon
London
SW19 4DR

Customer Contact: Mr Chris Parker

Customer Job Reference: 60547200
Customer Purchase Order: 60547200
Customer Site Reference: A303 Amersbery to Berwick
Date Job Received at Concept: 14-Feb-2018
Date Analysis Started: 19-Feb-2018
Date Analysis Completed: 23-Feb-2018

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.

This report should not be reproduced except in full without the written approval of the laboratory

Tests covered by this certificate were conducted in accordance with Concept Life Sciences SOPs

All results have been reviewed in accordance with Section 25 of the Concept Life Sciences, Analytical Services Quality Manual

Report checked
and authorised by :
Aleksandra Pacula
Senior Customer Service
Advisor

Issued by :
David Catterall
Laboratory Manager

[redacted]

Concept Reference: 715633
Project Site: A303 Amersbery to Berwick
Customer Reference: 60547200

Leachate to BS EN 12457-2 (10:1) Analysed as Water
Leachate Suite

				Concept Reference	715633 001	715633 002	715633 003	715633 004	715633 005
				Customer Sample Reference	RS01-S1	RS01-S2	RS01-S3	RS01-S4	RS01-S5
				Bottom Depth	14.4	15.2	16.6	17.4	18.9
				Date Sampled	12-FEB-2018	12-FEB-2018	12-FEB-2018	12-FEB-2018	12-FEB-2018
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
orthophosphate	T11	10:1	0.05	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05
Phosphorus (Total)	T6	10:1	1	mg/l	<1	<1	(IS)	<1	(IS)
Chloride	T11	10:1	0.05	mg/l	**1.2**	**0.91**	**1.2**	**0.70**	**0.81**
Sulphate	T11	10:1	0.05	mg/l	**9.4**	**11**	**4.4**	**3.2**	**2.4**
Calcium	T6	10:1	0.1	mg/l	**18**	**19**	(IS)	**16**	(IS)
Magnesium	T6	10:1	0.1	mg/l	<0.1	**0.1**	(IS)	**0.1**	(IS)
Potassium	T6	10:1	0.1	mg/l	**0.1**	**0.1**	(IS)	**0.1**	(IS)
Sodium	T6	10:1	0.1	mg/l	**0.4**	**0.5**	(IS)	**0.5**	(IS)
Alkalinity expressed as Bicarbonate	T85	10:1	10	mg/l	**35000**	**46000**	**47000**	**47000**	**49000**
Alkalinity expressed as CaCO3	T22	10:1	10	mg/l	**17000**	**7500**	**7700**	**7800**	**8000**

Concept Reference: 715633
Project Site: A303 Amersbery to Berwick
Customer Reference: 60547200

Leachate to BS EN 12457-2 (10:1) Analysed as Water
Leachate Suite

				Concept Reference	715633 006	715633 007	715633 008	715633 009	715633 010
				Customer Sample Reference	RS01-S6	RS01-S7	RS01-S8	RS01-S9	RS01-S10
				Bottom Depth	20.1	21.8	23.6	24.8	26.1
				Date Sampled	12-FEB-2018	12-FEB-2018	12-FEB-2018	12-FEB-2018	12-FEB-2018
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
orthophosphate	T11	10:1	0.05	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05
Phosphorus (Total)	T6	10:1	1	mg/l	<1	<1	(IS)	<1	<1
Chloride	T11	10:1	0.05	mg/l	**0.93**	**3.0**	**2.2**	**1.4**	**0.95**
Sulphate	T11	10:1	0.05	mg/l	**2.1**	**1.5**	**4.0**	**5.7**	**4.6**
Calcium	T6	10:1	0.1	mg/l	**11**	**13**	(IS)	**16**	**14**
Magnesium	T6	10:1	0.1	mg/l	**0.2**	**0.2**	(IS)	**0.1**	<0.1
Potassium	T6	10:1	0.1	mg/l	**0.2**	<0.1	(IS)	**0.1**	<0.1
Sodium	T6	10:1	0.1	mg/l	**0.5**	**0.5**	(IS)	**0.7**	**0.5**
Alkalinity expressed as Bicarbonate	T85	10:1	10	mg/l	**46000**	**47000**	**48000**	**47000**	**46000**
Alkalinity expressed as CaCO3	T22	10:1	10	mg/l	**7500**	**7800**	**7900**	**7800**	**7600**

Concept Reference: 715633
Project Site: A303 Amersbery to Berwick
Customer Reference: 60547200

Leachate to BS EN 12457-2 (10:1) Analysed as Water
Leachate Suite

				Concept Reference	715633 011	715633 012	715633 013	715633 014	715633 015
				Customer Sample Reference	RS01-S11	RS01-S12	RS01-S13	RS01-S14	RS01-S15
				Bottom Depth	27.8	29.8	31.3	32.6	08.45
				Date Sampled	12-FEB-2018	12-FEB-2018	12-FEB-2018	12-FEB-2018	12-FEB-2018
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
orthophosphate	T11	10:1	0.05	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05
Phosphorus (Total)	T6	10:1	1	mg/l	<1	<1	<1	<1	<1
Chloride	T11	10:1	0.05	mg/l	**1.4**	**2.4**	**0.95**	**1.0**	**3.2**
Sulphate	T11	10:1	0.05	mg/l	**4.5**	**3.7**	**1.9**	**1.2**	**4.6**
Calcium	T6	10:1	0.1	mg/l	**15**	**12**	**9.3**	**8.4**	**13**
Magnesium	T6	10:1	0.1	mg/l	**0.2**	**0.1**	**0.2**	**0.1**	**0.1**
Potassium	T6	10:1	0.1	mg/l	**0.2**	**0.1**	**1.0**	<0.1	<0.1
Sodium	T6	10:1	0.1	mg/l	**0.8**	**0.7**	**0.5**	**0.3**	**0.5**
Alkalinity expressed as Bicarbonate	T85	10:1	10	mg/l	**47000**	**52000**	**47000**	**55000**	**52000**
Alkalinity expressed as CaCO3	T22	10:1	10	mg/l	**7700**	**8500**	**7800**	**9000**	**8500**

Concept Reference:	715633
Project Site:	A303 Amersbery to Berwick
Customer Reference:	60547200
Leachate to BS EN 12457-2 (10:1)	Analysed as Water
Leachate Suite	

				Concept Reference	**715633 016**
				Customer Sample Reference	**RS01-S16**
				Bottom Depth	**09.15**
				Date Sampled	**12-FEB-2018**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**	
orthophosphate	T11	10:1	0.05	mg/l	<0.05
Phosphorus (Total)	T6	10:1	1	mg/l	<1
Chloride	T11	10:1	0.05	mg/l	**1.5**
Sulphate	T11	10:1	0.05	mg/l	**2.0**
Calcium	T6	10:1	0.1	mg/l	**12**
Magnesium	T6	10:1	0.1	mg/l	**0.1**
Potassium	T6	10:1	0.1	mg/l	<0.1
Sodium	T6	10:1	0.1	mg/l	**0.3**
Alkalinity expressed as Bicarbonate	T85	10:1	10	mg/l	**54000**
Alkalinity expressed as CaCO3	T22	10:1	10	mg/l	**8800**

Index to symbols used in Supplemental to 715633-1

Value	Description
10:1	Leachate to BS EN 12457-2 (10:1)
IS	Insufficient Sample
N	Analysis is not UKAS accredited

Notes

Supplemental report to include revised Orthophosphate results done on undiluted samples.

Method Index

Value	Description
T6	ICP/OES
T22	Titration
T11	IC
T85	Calc

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	Concept References
orthophosphate	T11	10:1	0.05	mg/l	N	001-016
Phosphorus (Total)	T6	10:1	1	mg/l	N	001-016
Chloride	T11	10:1	0.05	mg/l	N	001-016
Sulphate	T11	10:1	0.05	mg/l	N	001-016
Calcium	T6	10:1	0.1	mg/l	N	001-016
Magnesium	T6	10:1	0.1	mg/l	N	001-016
Potassium	T6	10:1	0.1	mg/l	N	001-016
Sodium	T6	10:1	0.1	mg/l	N	001-016
Alkalinity expressed as Bicarbonate	T85	10:1	10	mg/l	N	001-016
Alkalinity expressed as CaCO3	T22	10:1	10	mg/l	N	001-016

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VICTORIA SQUARE
BIRMINGHAM B2 4AJ

V674

Please quote above code for all enquiries

EHS AND REMEDIATION

CHALK

FERTILISER ANALYSIS REPORT

Laboratory References	
Report Number	91332
Sample Number	26720

Sample Reference :

R503B 8.45M

Sample Matrix : FERT

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P2O5	<0.1	% w/w
NAC Soluble Phosphorus as P2O5	<0.1	% w/w
Neutralising Capacity as CaCO3	97.6	% w/w
Neutralising Value as CaO [TNV]	54.7	% w/w
Dry Matter	99.8	% w/w

Released by ....Stephen Butler.................... Date ....21/02/18....

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1ST FLOOR VICTORIA
SQUARE HOUSE
VICTORIA SQUARE
BIRMINGHAM B2 4AJ

V674

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EHS AND REMEDIATION

CHALK

FERTILISER ANALYSIS REPORT

Laboratory References	
Report Number	91332
Sample Number	26721

Sample Reference :

P505 9.15M

Sample Matrix : FERT

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P2O5	5.91	% w/w
NAC Soluble Phosphorus as P2O5	<0.1	% w/w
Neutralising Capacity as CaCO3	84.4	% w/w
Neutralising Value as CaO [TNV]	47.4	% w/w
Dry Matter	99.6	% w/w

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CHALK

FERTILISER ANALYSIS REPORT

Sample Reference :

R501 14.4M

Sample Matrix : FERT

Laboratory References	
Report Number	91332
Sample Number	26722

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P2O5	16.0	% w/w
NAC Soluble Phosphorus as P2O5	<0.1	% w/w
Neutralising Capacity as CaCO3	58.8	% w/w
Neutralising Value as CaO [TNV]	33.0	% w/w
Dry Matter	99.3	% w/w

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FERTILISER ANALYSIS REPORT

Laboratory References	
Report Number	91332
Sample Number	26723

Sample Reference :

R501 15.2M

Sample Matrix : FERT

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P2O5	16.4	% w/w
NAC Soluble Phosphorus as P2O5	<0.1	% w/w
Neutralising Capacity as CaCO3	58.1	% w/w
Neutralising Value as CaO [TNV]	32.6	% w/w
Dry Matter	99.2	% w/w

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FERTILISER ANALYSIS REPORT

Laboratory References	
Report Number	91332
Sample Number	26724

Sample Reference :

R501 16.6M

Sample Matrix : FERT

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P_2O_5	7.56	% w/w
NAC Soluble Phosphorus as P_2O_5	<0.1	% w/w
Neutralising Capacity as $CaCO_3$	78.1	% w/w
Neutralising Value as CaO [TNV]	43.8	% w/w
Dry Matter	99.5	% w/w

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FERTILISER ANALYSIS REPORT

Laboratory References	
Report Number	91332
Sample Number	26725

Sample Reference :

R501 17.4M

Sample Matrix : FERT

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P2O5	8.82	% w/w
NAC Soluble Phosphorus as P2O5	<0.1	% w/w
Neutralising Capacity as CaCO3	75.8	% w/w
Neutralising Value as CaO [TNV]	42.5	% w/w
Dry Matter	99.5	% w/w

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FERTILISER ANALYSIS REPORT

Laboratory References	
Report Number	91332
Sample Number	26726

Sample Reference :

R501 18.9M

Sample Matrix : FERT

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P2O5	4.22	% w/w
NAC Soluble Phosphorus as P2O5	<0.1	% w/w
Neutralising Capacity as CaCO3	88.9	% w/w
Neutralising Value as CaO [TNV]	49.9	% w/w
Dry Matter	99.7	% w/w

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FERTILISER ANALYSIS REPORT

Sample Reference :

R501 20.1M

Sample Matrix : FERT

Laboratory References	
Report Number	91332
Sample Number	26727

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P2O5	4.86	% w/w
NAC Soluble Phosphorus as P2O5	<0.1	% w/w
Neutralising Capacity as CaCO3	86.8	% w/w
Neutralising Value as CaO [TNV]	48.7	% w/w
Dry Matter	99.6	% w/w

Released by Stephen Butler Date 21/02/18

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FERTILISER ANALYSIS REPORT

Laboratory References	
Report Number	91332
Sample Number	26728

Sample Reference :

R501 21.0M

Sample Matrix : FERT

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P2O5	3.35	% w/w
NAC Soluble Phosphorus as P2O5	<0.1	% w/w
Neutralising Capacity as CaCO3	90.1	% w/w
Neutralising Value as CaO [TNV]	50.5	% w/w
Dry Matter	99.8	% w/w

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FERTILISER ANALYSIS REPORT

Laboratory References	
Report Number	91332
Sample Number	26729

Sample Reference :

R501 23.6M

Sample Matrix : FERT

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P2O5	15.0	% w/w
NAC Soluble Phosphorus as P2O5	<0.1	% w/w
Neutralising Capacity as CaCO3	64.7	% w/w
Neutralising Value as CaO [TNV]	36.3	% w/w
Dry Matter	99.3	% w/w

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FERTILISER ANALYSIS REPORT

Laboratory References	
Report Number	91333
Sample Number	26730

Sample Reference :

R501 24.8M

Sample Matrix : FERT

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P2O5	14.0	% w/w
NAC Soluble Phosphorus as P2O5	<0.1	% w/w
Neutralising Capacity as CaCO3	67.6	% w/w
Neutralising Value as CaO [TNV]	37.9	% w/w
Dry Matter	99.4	% w/w

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FERTILISER ANALYSIS REPORT

Sample Reference :

R501 26.1M

Sample Matrix : FERT

Laboratory References	
Report Number	91333
Sample Number	26731

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P2O5	16.9	% w/w
NAC Soluble Phosphorus as P2O5	<0.1	% w/w
Neutralising Capacity as CaCO3	59.0	% w/w
Neutralising Value as CaO [TNV]	33.1	% w/w
Dry Matter	99.3	% w/w

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FERTILISER ANALYSIS REPORT

Laboratory References	
Report Number	91333
Sample Number	26732

Sample Reference :

R501 27.8M

Sample Matrix : FERT

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P2O5	16.7	% w/w
NAC Soluble Phosphorus as P2O5	<0.1	% w/w
Neutralising Capacity as CaCO3	77.2	% w/w
Neutralising Value as CaO [TNV]	43.3	% w/w
Dry Matter	99.5	% w/w

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FERTILISER ANALYSIS REPORT

Laboratory References	
Report Number	91333
Sample Number	26733

Sample Reference :

R501 29.8M

Sample Matrix : FERT

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P2O5	4.58	% w/w
NAC Soluble Phosphorus as P2O5	<0.1	% w/w
Neutralising Capacity as CaCO3	86.8	% w/w
Neutralising Value as CaO [TNV]	48.7	% w/w
Dry Matter	99.7	% w/w

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FERTILISER ANALYSIS REPORT

Laboratory References	
Report Number	91333
Sample Number	26734

Sample Reference :

R501 31.3M

Sample Matrix : FERT

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P2O5	13.1	% w/w
NAC Soluble Phosphorus as P2O5	<0.1	% w/w
Neutralising Capacity as CaCO3	68.6	% w/w
Neutralising Value as CaO [TNV]	38.5	% w/w
Dry Matter	99.3	% w/w

Released by Stephen Butler

Date 21/02/18

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FERTILISER ANALYSIS REPORT

Laboratory References	
Report Number	91333
Sample Number	26735

Sample Reference :

R501 32.6M

Sample Matrix : FERT

Date Received	14-FEB-2018
Date Reported	21-FEB-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Phosphorus as P2O5	0.57	% w/w
NAC Soluble Phosphorus as P2O5	<0.1	% w/w
Neutralising Capacity as CaCO3	98.5	% w/w
Neutralising Value as CaO [TNV]	55.2	% w/w
Dry Matter	99.9	% w/w

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Appendix F NORM Monitoring Calibration Certificate

Tracerco

Providing Insight Onsite

CALIBRATION CERTIFICATE FOR RADIATION CONTAMINATION MONITORING EQUIPMENT

Owner	**Tracerco Rental Monitor**
Tracerco Unique Ref. No.	MC/2017/07/3526
Plant ID	N/A
Instrument Type	Tracerco NORM Monitor IS GM-ATEX
Monitor Serial Number	134256
Probe Type	Tracerco NORM Probe IS GM-ATEX
Type of Test (i)	Re-Test after repair of defect
Result of Test (ii)	Satisfactory
Date of Test	10 July 2017
Recommended Next Test Due (iii)	10 July 2018

Test Carried Out By:

Name: **Aaron Luther**

[redacted]

Signature

Qualified Person:

Name: **Dave Brown**

[redacted]

Signature

(i) Indicates whether first test, period test or retest after repair of a defect which could affect the accuracy of the equipment (deleted as applicable)

(ii) The result of 'satisfactory' indicates that the monitor is consistent with type test performance criteria.

(iii) ACOP Guidance to Regulation 19(2) of IRR99 states that Radiation Monitoring Equipment should normally be tested and thoroughly examined at least once per year.

Explanatory Note

1. This certificate includes details of approved test/ calibration particulars, which have been performed in pursuance of ACOP Guidance to Regulation 19(2) of the Ionising Radiation Regulations 1999.
2. This record must be retained for 2 years from the date of the last entry and it must be available for inspection by an Inspector of the Health and Safety Executive.
3. Tests have been performed against specified large surface area (10cm x 10cm and 10cm x 15cm) traceable sources.
4. All measurements are quoted with an accuracy of +/- 20% or better.

Please note depending on the end user's geographical location there may be a requirement for specific local approval when using this radiation monitor. The operator is advised to ensure such requirements are met whenever the radiation monitor is deployed.

Measurement Technology Centre, The Moat,
Belasis Hall Technology Park, Billingham TS23 4ED UK
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tracerco@tracerco.com www.tracerco.com

TEST / CALIBRATION SHEET FOR RADIATION CONTAMINATION MONITOR

Tracerco

DETAILS			
Tracerco Unique Ref No.	MC/2017/07/3526	**Probe Area**	15 cm^2
Instrument Type	Tracerco NORM Monitor IS GM-ATEX	**Probe Type**	Tracerco NORM Probe IS GM-ATEX
Monitor Serial Number	134256	**Probe Serial Number**	149430
Background Reading (cps)	0.56		

USEFUL OPERATIONAL GUIDANCE DATA	RESPONSE FACTOR ($Cps/Bq/cm^2$)
LEAD-210 MONITORING - Source Ref: UR 505	
Lead-210 Monitor Alpha & Beta Response (Simulates Dry Measurement Conditions)	**7.0**
Lead-210 Monitor Beta Only Response (Simulates Wet Measurement Conditions)	**3.4**
RADIUM-226 MONITORING - Source Ref: E3-085	
Radium-226 Monitor Alpha & Beta Response (Simulates Dry Measurement Conditions)	**13.2**
Radium-226 Monitor Beta Only Response (Simulates Wet Measurement Conditions)	**9.3**
URANIUM-238 MONITORING - Source Ref: OW740□*	
Uranium-238 Monitor Alpha & Beta Response	**10.6**
BETA TRACEABLE STANDARD*	
Chlorine-36 Beta Response (source ref: CK473)	**5.6**
Strontium-90/Yttrium-90 Beta Response (source ref: MI324 & MI325)	**11.7**
Carbon-14 Beta Response (source ref: MZ551 & MZ552)	**0.9**
ALPHA TRACEABLE STANDARD*#	
Americium-241 Average Monitor Alpha Response (source ref: MI321, MI322 & MI323)	**1.9**

* The response factor in counts per Becquerel's cm^2 is calculated from a uniform deposition of the radioactive material on a metal plaque. The plaques are traceable to the UK National Standard. Details available on request.

□ Assumes presence of naturally occurring Uranium-234/ Uranium-235 and daughters.

Linearity of response based on Americium-241 is correct for this instrument with a response factor of **1.9** $cps/Bq/cm^2$ and an estimated uncertainty of less than +/- 10% and provides a level of confidence of approximately 95%.

THE FOLLOWING CHECKS HAVE BEEN COMPLETED ON THIS MONITOR			
Cleaned	Yes	**Button/ Knob function**	Yes
Audio function	Yes	**Visual inspection**	Yes
Lights function	Yes		

COMMENT ON CONDITION OF EQUIPMENT OR NATURE OF REPAIRS/ADJUSTMENTS UNDERTAKEN FOLLOWING INSPECTION
Description of Repairs
Other Comments

Appendix G Stage 2 Screening Tables

	Units	Human Health Public Open Space (park) GAC	Location	29779-STP501		29779-SA501		29779-SA502		29779-SA503A		24930-TP1 (Longbarrow)	24930-TP2 (Longbarrow)	24930-TP4 (Longbarrow)	29779-SA504		29779-R503B		29779-P502B			29779-P505		29779-P510
			Chainage	2900		4600		5300		6200		6200	6200	6200	7300		7700		7800			8200		8800
			Strata	Head	Chalk	Topsoil	Chalk	Topsoil	Head	Topsoil	Chalk	Made Ground	Made Ground	Made Ground	Topsoil	Chalk	Topsoil	Chalk	Topsoil	Chalk	Chalk	Topsoil	Chalk	Chalk
			Depth (m)	0.5	1	0.2	1	0.1	0.5	0	0.5	0.3	0.3	0.2	0.175	0.5	0.05	6.2	0.05	0.8	3.2	0.15	0.5	0.5
			Date	27/02/2017	27/02/2017	09/03/2017	09/03/2017	09/03/2017	09/03/2017	14/03/2017	14/03/2017	28/01/2010	28/01/2010	28/01/2010	08/03/2017	08/03/2017	24/02/2017	17/03/2017	14/03/2017	14/03/2017	15/03/2017	05/01/2017	05/01/2017	13/12/2016
PAH																								
Naphthalene	mg/kg	1.200[#2]		<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.02	0.04	0.14	0.09	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Acenaphthylene	mg/kg	29.000[#2]		<0.01	<0.01	<0.01	<0.01	0.07	<0.01	<0.01	<0.01	0.2	0.05	0.97	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthene	mg/kg	29.000[#2]		<0.01	<0.01	<0.01	<0.01	0.07	<0.01	<0.01	<0.01	0.04	0.11	0.34	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	mg/kg	20.000[#2]		<0.01	<0.01	<0.01	<0.01	0.06	<0.01	<0.01	<0.01	0.02	0.09	0.29	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	mg/kg	6.200[#2]		<0.03	<0.03	<0.03	<0.03	1.92	<0.03	<0.03	<0.03	1.01	1.84	6.04	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Anthracene	mg/kg	150.000[#2]		<0.02	<0.02	<0.02	<0.02	0.37	<0.02	<0.02	<0.02	2.27	0.26	8.43	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fluoranthene	mg/kg	6.300[#2]		<0.08	<0.08	<0.08	<0.08	6.75	<0.08	<0.08	<0.08	3.53	3.59	15.3	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Pyrene	mg/kg	15.000[#2]		<0.07	<0.07	<0.07	<0.07	5.76	<0.07	<0.07	<0.07	2.9	3.1	13.4	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
Benzo(a)anthracene	mg/kg	49[#2]		<0.04	<0.04	<0.04	<0.04	2.68	<0.04	<0.04	<0.04	2.71	2.18	8.85	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Chrysene	mg/kg	93[#2]		<0.06	<0.06	<0.06	<0.06	2.51	<0.06	0.09	<0.06	2.85	3.35	11.3	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Benzo(a) pyrene	mg/kg	11[#2]		<0.04	<0.04	<0.04	<0.04	3.15	<0.04	<0.04	<0.04	1.01	2.47	5.34	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Indeno(1,2,3-c,d)pyrene	mg/kg	150[#2]		<0.03	<0.03	<0.03	<0.03	2.24	<0.03	0.04	<0.03	1.06	1.8	3.71	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Dibenz(a,h)anthracene	mg/kg	1.1[#2]		<0.04	<0.04	<0.04	<0.04	0.38	<0.04	<0.04	<0.04	0.35	0.25	0.48	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Benzo(g,h,i)perylene	mg/kg	1.400[#2]		<0.05	<0.05	<0.05	<0.05	2.09	<0.05	<0.05	<0.05	2.56	2.72	8.66	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(b)fluoranthene	mg/kg	13[#2]		<0.05	<0.05	<0.05	<0.05	3.83	<0.05	<0.05	<0.05	2.69	1.65	8.32	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(k)fluoranthene	mg/kg	370[#2]		<0.07	<0.07	<0.07	<0.07	1.2	<0.07	<0.07	<0.07	1.56	1.35	3.32	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
Benzo(b)&(k)fluoranthene	mg/kg			<0.12	<0.12	<0.12	<0.12	5.03	<0.12	<0.12	<0.12	4.25	3	11.64	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12
PAHs (sum of 4)	mg/kg			<0.2	<0.2	<0.2	<0.2	9.36	<0.2	0.21	<0.2	7.87	7.52	24.01	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
PAH 16 Total	mg/kg			<0.08	<0.08	<0.08	<0.08	33.1	<0.08	0.13	<0.08	-	-	-	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
PAH 17 Total	mg/kg			<0.08	<0.08	<0.08	-	35	<0.08	0.24	<0.08	-	-	-	<0.08	<0.08	<0.08	-	-	<0.08	-	<0.08	-	<0.08
benzo(g,h,i)perylene + indeno(1,2,3-cd)pyrene	mg/kg			<0.08	<0.08	<0.08	<0.08	4.33	<0.08	0.09	<0.08	3.62	4.52	12.37	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
SVOC																								
2-methylnaphthalene	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Bis(2-chloroethoxy) methane	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Bis(2-chloroethyl)ether	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Carbazole	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	0.106	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Dibenzofuran	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Hexachlorocyclopentadiene	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Hexachloroethane	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Bis(2-chloroisopropyl) ether	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Perylene	mg/kg			<0.1	<0.1	<0.1	<0.1	0.621	0.872	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Phenolics																								
2-methylphenol	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
2-nitrophenol	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
2,4-dimethylphenol	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
4-chloro-3-methylphenol	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
4-methylphenol	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
4-nitrophenol	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Phenol	mg/kg	440[#2]		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
2-chloronaphthalene	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Phenols	mg/kg			<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	6.9	0.6	<0.2
Fungicides																								
Quintozene; (PCNB)	ug/kg			<50	<50	<50	<50	<50	<50	<50	<50	-	-	-	<50	<50	<50	<50	<50	<50	-	<50	<50	<50
Triadimefon	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Herbicides																								
Pendimethalin	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.184	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Triallate	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Trifluralin	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Atrazine	mg/kg	2.300[#2]		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Simazine	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Ametryn	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Atraton	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Prometon	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Prometryn	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Propazine	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Simetryn	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Terbutylazine	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Terbutryn	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Pesticides																								
Isodrin	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Parathion	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Pirimiphos-methyl	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Cyfluthrin	mg/kg			-	-	<0.1	<0.1	-	-	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<1	<0.1	<0.1	-	-	-	-
Cyhalothrin/Karate	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<1	<0.1	<0.1	-	<0.1	<0.1	<0.1
Cypermethrins(total)	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<1	<0.1	<0.1	-	<0.1	<0.1	<0.1
Deltamethrin	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<1	<0.1	<0.1	-	<0.1	<0.1	<0.1
Fenvalerate	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<1	<0.1	<0.1	-	<0.1	<0.1	<0.1
Permethrin I	µg/kg			<50	<50	<50	<50	<50	<50	<50	<50	-	-	-	<50	<50	<50	<50	<50	<50	-	<50	<50	<50
Permethrin II	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Permethrin	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<1	<0.1	<0.1	-	<0.1	<0.1	<0.1
Aldrin+Dieldrin+Endrin+Isodrin	mg/kg			<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	<0.2	<0.2
Organochlorine Pesticides																								
Aldrin	mg/kg	30[#2]		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
a-BHC	mg/kg	47[#2]		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
b-BHC	mg/kg	15[#2]		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Chlorothalonil	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Chlordane (cis)	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Dieldrin	mg/kg	30[#2]		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Endosulfan I	mg/kg	2.400[#2]		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Endosulfan II	mg/kg	2.400[#2]		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Endosulfan sulphate	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Endrin	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Heptachlor	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Heptachlor epoxide	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05

	Units	Human Health Public Open Space (park) GAC	Location	29779-STP501		29779-SA501		29779-SA502		29779-SA503A		24930-TP1 (Longbarrow)	24930-TP2 (Longbarrow)	24930-TP4 (Longbarrow)	29779-SA504		29779-R503B		29779-P502B			29779-P505		29779-P510
			Chainage	2900		4600		5300		6200		6200	6200	6200	7300		7700		7800			8200		8800
			Strata	Head	Chalk	Topsoil	Chalk	Topsoil	Head	Topsoil	Chalk	Made Ground	Made Ground	Made Ground	Topsoil	Chalk	Topsoil	Chalk	Topsoil	Chalk	Chalk	Topsoil	Chalk	Chalk
			Depth (m)	0.5	1	0.2	1	0.1	0.5	0	0.5	0.3	0.3	0.2	0.175	0.5	0.05	6.2	0.05	0.8	3.2	0.15	0.5	0.5
			Date	27/02/2017	27/02/2017	09/03/2017	09/03/2017	09/03/2017	09/03/2017	14/03/2017	14/03/2017	28/01/2010	28/01/2010	28/01/2010	08/03/2017	08/03/2017	24/02/2017	17/03/2017	14/03/2017	14/03/2017	15/03/2017	05/01/2017	05/01/2017	13/12/2016
o,p''-DDE	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
o,p-DDD	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
o,p''-Methoxychlor	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
p,p-DDT	µg/kg			<50	<50	<50	<50	<50	<50	<50	<50	-	-	-	<50	<50	<50	<50	<50	<50	-	<50	<50	<50
o,p DDT	µg/kg			<50	<50	<50	<50	<50	<50	<50	<50	-	-	-	<50	<50	<50	<50	<50	<50	-	<50	<50	<50
4,4-DDE	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Methoxychlor	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Tecnazene	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Telodrin	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
DDD	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Chlordane (trans)	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Aldrin + Dieldrin	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1
DDT+DDE+DDD	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Organophosphorous Pesticides																								
Azinphos Ethyl	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Azinophos methyl	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Carbophenothion	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Chlorfenvinphos	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Chlorpyrifos	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Chlorpyrifos-methyl	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Diazinon	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Dichlorvos	mg/kg	26#2		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Dimethoate	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Ethion	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Etrimphos	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Fenitrothion	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Fenthion	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Malathion	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Methyl parathion	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Mevinphos (Phosdrin)	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Propetamphos	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Phosalone	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Triazophos	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Disulfoton	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Amino Aliphatics																								
N-nitrosodi-n-propylamine	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Explosives																								
2,4-Dinitrotoluene	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
2,6-dinitrotoluene	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Nitrobenzene	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Halogenated Benzenes																								
Chlorobenzene	mg/kg	1,300#2		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Bromobenzene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
2-chlorotoluene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
4-chlorotoluene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
1,3-dichlorobenzene	mg/kg	390#2		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
1,4-dichlorobenzene	mg/kg	36,000#2		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
1,2-dichlorobenzene	mg/kg	24,000#2		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
1,2,4-trichlorobenzene	mg/kg	1,700#2		<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	-	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-
1,2,3-trichlorobenzene	mg/kg	770#2		<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	-	-	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-
Hexachlorobenzene	mg/kg	30#2		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	<0.1	<0.1	<0.05	<0.1	<0.05	<0.05	<0.1	<0.1	<0.1	<0.05
Halogenated Hydrocarbons																								
Dichlorodifluoromethane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Bromomethane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Trichlorofluoromethane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
1,2-dibromoethane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Halogenated Phenols																								
2-chlorophenol	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
2,4-dichlorophenol	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
2,4,5-trichlorophenol	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
2,4,6-trichlorophenol	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Pentachlorophenol	mg/kg	110#2		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Phthalates																								
Bis(2-ethylhexyl) phthalate	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Butyl benzyl phthalate	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Di-n-butyl phthalate	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Di-n-octyl phthalate	mg/kg			<0.1	<0.1	2.04	2.08	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.5	<0.1	<0.1	<0.5	<0.1	<0.1	-
Diethylphthalate	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Dimethyl phthalate	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Solvents																								
Carbon disulfide	mg/kg	1,300#2		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Isophorone	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Metals																								
Antimony	mg/kg			<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	-	-	-	<0.01	<0.01	<0.01	-	-	<0.01	-	<0.01	-	<5
Arsenic	mg/kg	170#2		<1	<1	3	<1	3	3	3	<1	5	5	4	1	<1	3	<1	1	<1	<1	3	<1	<1
Barium	mg/kg			47	14	32	14	58	50	102	28	-	-	-	37	7	56	12	52	11	8	73	18	15
Beryllium	mg/kg	63#2		<1	<1	<1	<1	<1	1	1	<1	-	-	-	<1	<1	1	<1	1	<1	<1	1	<1	<1
Boron (Water Soluble)	mg/kg			1.2	<1	1.1	<1	1	1	2.3	<1	-	-	-	2.2	<1	1.8	<1	1.7	<1	<1	1.2	<1	<1
Cadmium	mg/kg	560#2		0.7	<0.5	<0.5	<0.5	0.6	0.6	1.1	<0.5	0.5	0.7	0.5	0.9	<0.5	1	<0.5	1.1	<0.5	<0.5	1.6	0.5	<0.5
Chromium (III+VI)	mg/kg	33,000#2		11	3	10	2	13	17	34	9	12	20	10	12	2	15	2	19	2	2	23	4	4
Copper	mg/kg	44,000#2		7	2	8	2	8	4	10	2	13	10	9	7	<1	8	1	9	1	2	7	1	2
Iron	mg/kg																							
Lead	mg/kg			8	<1	16	2	85	8	21	3	25	30	42	12	1	20	<1	16	2	1	15	3	2
Manganese	mg/kg			647	187	476	227	503	476	898	285	-	-	-	695	227	683	282	800	215	166	864	280	244
Mercury	mg/kg	240#2		0.42	0.77	0.43	0.73	0.38	0.29	0.45	1.23	0.8	0.66	0.71	0.27	0.93	0.61	1.06	0.38	1.17	0.93	<0.17	0.39	0.74

Table G1
Soil Human Health Analytical Results
A303 Stonehenge

	Units	Human Health Public Open Space (park) GAC	Location	29779-STP501		29779-SA501		29779-SA502		29779-SA503A		24930-TP1 (Longbarrow)	24930-TP2 (Longbarrow)	24930-TP4 (Longbarrow)	29779-SA504		29779-R503B		29779-P502B			29779-P505		29779-P510
			Chainage	2900		4600		5300		6200		6200	6200	6200	7300		7700		7800			8200		8800
			Strata	Head	Chalk	Topsoil	Chalk	Topsoil	Head	Topsoil	Chalk	Made Ground	Made Ground	Made Ground	Topsoil	Chalk	Topsoil	Chalk	Topsoil	Chalk	Chalk	Topsoil	Chalk	Chalk
			Depth (m)	0.5	1	0.2	1	0.1	0.5	0	0.5	0.3	0.3	0.2	0.175	0.5	0.05	6.2	0.05	0.8	3.2	0.15	0.5	0.5
			Date	27/02/2017	27/02/2017	09/03/2017	09/03/2017	09/03/2017	09/03/2017	14/03/2017	14/03/2017	28/01/2010	28/01/2010	28/01/2010	08/03/2017	08/03/2017	24/02/2017	17/03/2017	14/03/2017	14/03/2017	15/03/2017	05/01/2017	05/01/2017	13/12/2016
Molybdenum	mg/kg			<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	mg/kg	**800#2**		11	3	7	4	11	14	23	7	9	12	8	9	2	10	2	10	3	3	22	5	3
Phosphorus (available)	mg/l			11	<5	8	<5	26	8	198	119	-	-	-	11	<5	152	6	163	100	<5	20	<5	6
Selenium	mg/kg	**1,800#2**		<1	<1	<1	<1	<1	<1	2	<1	1	1	1	1	<1	<1	<1	1	<1	<1	<1	<1	<1
Vanadium	mg/kg	**5,000#2**		15	3	15	3	19	24	51	12	-	-	-	19	4	23	4	28	3	2	35	6	5
Zinc	mg/kg	**170,000#2**		47	9	38	12	53	39	73	17	61	86	66	34	11	87	19	42	11	11	47	13	13
Chromium (hexavalent)	mg/kg	**220#2**		<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium (Trivalent)	mg/kg	**33,000#2**		11	3	10	2	13	17	34	9	-	-	-	12	2	15	2	19	2	2	23	4	4
Organics																								
Organic Matter	%			1.7	0.1	3	0.1	3.3	1.2	6.2	0.3	-	-	-	4.5	<0.1	5.9	<0.1	8.6	0.4	0.2	4.9	0.5	0.3
Fraction Organic Carbon	%			1.02	0.07	1.77	0.07	1.9	0.69	3.61	0.14	-	-	-	2.63	0.05	3.42	0.05	5	0.2	0.14	2.81	0.29	0.17
Inorganics																								
Nitrate as N	mg/kg																							
Nitrite	mg/kg																							
Ammoniacal Nitrogen	mg/kg																							
Cyanide (Free)	mg/kg			<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Thiocyanide	mg/kg																							
Fluoride	mg/kg			3	<1	2	-	3	4	4	3	-	-	-	5	<1	<1	-	-	2	-	4	-	1
Sulphate	mg/kg			<10	<10	<10	-	<10	<10	<10	<10	0.02	0.04	0.01	<10	<10	<10	-	-	<10	-	<10	-	32
Chloride	mg/kg			<10	<10	<10	-	<10	<10	11	<10	-	-	-	<10	14	<10	-	-	<10	-	<10	-	19
Cyanide Total	mg/kg			<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sulphate (soluble)	g/l			<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03
pH (Lab)	pH_Units			8.2	8.74	8.18	8.87	8.28	8.24	7.9	8.51	-	-	-	8.25	8.8	8.12	8.7	8.05	8.83	8.95	7.86	8.41	8.28
TDS	mg/kg			455	275	614	-	622	424	844	460	-	-	-	676	279	982	-	-	293	-	637	-	528
Biological																								
Intestinal Enterococci	cfu/g																							<10
E coli	cfu/g																							420
Coliform	cfu/g																							420
Asbestos Screen																								
Asbestos Identification	None			0	0	0	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0

Comments
#1 USEPA RSL (May 2016)
#2 LQM/CIEH S4ULs 2014
#3 EIC/AGS/CL:AIRE
#4 Defra C4SL 12/2014
GAC: Generic Assessment Criteria
(blank): No assessment criteria available
- : Not analysed
HH: Human Health

Key
XXX Exceedance of Human Health Public Open Space (Park) GAC

Table G1
Soil Human Health Analytical Results
A303 Stonehenge

	Units	Human Health Public Open Space (park) GAC	Location	29779-R506A		29779-R507A			29779-SA505			24822-BH1 (Countess)	24822-BH2 (Countess)	24822-TP1 (Countess)	24822-TP2 (Countess)	24822-TP3 (Countess)	24822-TP4 (Countess)	24822-TP7 (Countess)	24822-TP8 (Countess)	24822-TP9 (Countess)	24822-TP10 (Countess)	24822-TP11 (Countess)	29779-SA506	
			Chainage	9100		10100			11500			11700	11700	11700	11700	11700	11700	11700	11700	11700	11700	11700	11900	
			Strata	Topsoil	Chalk	Topsoil	Chalk	Chalk	Topsoil	Alluvium	Chalk	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Topsoil	Alluvium
			Depth (m)	0.35	0.75	0.025	0.75	3.9	0.075	0.8	1	0.5	0.5	0.2	0.5	0.2	0.6	0.5	0.5	0.5	0.5	0.5	0.125	0.6
			Date	13/02/2017	13/02/2017	13/02/2017	13/02/2017	14/02/2017	28/02/2017	28/02/2017	28/02/2017	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	01/03/2017	01/03/2017
TPH																								
>C08-C10	mg/kg			-	-	-	-	-	-	-	-	2	2	2	2	2	57.8	2	2	2	2	2	-	-
>C10-C12	mg/kg			-	-	-	-	-	-	-	-	2	2	2	2	2	788	2	2	2	2	2	-	-
>C12-C16	mg/kg			-	-	-	-	-	-	-	-	3	2	2	5.2	2	4,120	2	3	2	2	8.69	-	-
>C16-C21	mg/kg			-	-	-	-	-	-	-	-	24.2	2	13.6	40.8	13.1	4,840	2	18.9	2	2	2	-	-
>C21-C35	mg/kg			-	-	-	-	-	-	-	-	156	27	223	438	171	3,830	23.7	156	35.4	5.37	12	-	-
>C5-C6 Aliphatics	mg/kg	95,000[#2]		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
>C6-C8 Aliphatics	mg/kg	150,000[#2]		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
>C8-C10 Aliphatics	mg/kg	14,000[#2]		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
>C10-C12 Aliphatics	mg/kg	21,000[#2]		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
>C12-C16 Aliphatics	mg/kg	25,000[#2]		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
>C16-C21 Aliphatics	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
>C16-C35 Aliphatics	mg/kg	450,000[#2]		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	-	-	-	-	-	-	-	-	-	-	<0.2	<0.2
>C21-C35 Aliphatics	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
>EC5-EC7 Aromatics	mg/kg	76,000[#2]		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
>EC7-EC8 Aromatics	mg/kg	87,000[#2]		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
>EC8-EC9 Aromatics	mg/kg			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
>EC9-EC10 Aromatics	mg/kg			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
>EC10-EC12 Aromatics	mg/kg	9,200[#2]		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
>EC12-EC16 Aromatics	mg/kg	10,000[#2]		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
>EC16-EC21 Aromatics	mg/kg	7,600[#2]		<0.1	<0.1	<0.1	2.2	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
>EC21-EC35 Aromatics	mg/kg	7,800[#2]		<0.1	<0.1	<0.1	30.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Gasoline Range Organics	mg/kg			-	-	-	-	-	-	-	-	0.2	0.2	0.2	0.2	0.2	80.96	1.12	1.8	0.2	0.2	0.2	-	-
Diesel Range Organics	mg/kg																							
Mineral Oil (C10-C40)	mg/kg			-	-	<10	41	-	<10	-	<10	-	-	-	-	-	-	-	-	-	-	-	<10	-
TPH (Ali & Aro)	mg/kg			<0.1	<0.1	<0.1	32.5	<0.1	<0.1	<0.1	<0.1	207	33	301	573	222	13,900	32	203	40	<12.3	25	<0.1	<0.1
Total Aliphatics	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Total Aromatics	mg/kg			<0.1	<0.1	<0.1	32.5	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
BTEX																								
Benzene	mg/kg	90[#2]		<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
Toluene	mg/kg	87,000[#2]		<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
Ethylbenzene	mg/kg	17,000[#2]		<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
Xylene (m & p)	mg/kg			<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
Xylene Total	mg/kg	17,000[#2]		<0.02	<0.02	<0.02	<0.002	<0.02	<0.02	<0.02	<0.02	-	-	-	-	-	-	-	-	-	-	-	<0.02	<0.02
Xylene (o)	mg/kg	17,000[#2]		<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
Total BTEX	mg/kg			<0.05	<0.05	<0.01	<0.01	<0.05	<0.01	<0.05	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.05
Oxygenates																								
MTBE	mg/kg			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
Chlorinated Hydrocarbons																								
Chloromethane	mg/kg			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
Vinyl chloride	mg/kg	4.8[#2]		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Chloroethane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,1-dichloroethene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Dichloromethane	mg/kg			<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	-	-	-	-	-	-	-	-	-	<0.005	<0.005
trans-1,2-dichloroethene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,1-dichloroethane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
cis-1,2-dichloroethene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Chloroform	mg/kg	2,600[#2]		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,1,1-trichloroethane	mg/kg	57,000[#2]		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Carbon tetrachloride	mg/kg	190[#2]		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Trichloroethene	mg/kg	70[#2]		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,1,2-trichloroethane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Tetrachloroethene	mg/kg	810[#2]		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Sum of PCE and TCE	mg/kg			<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	-	-	-	-	-	-	-	-	-	<0.002	<0.002
TCE+DCE+VC	mg/kg			<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	-	-	-	-	-	-	-	-	-	<0.005	<0.005
PCE+TCE+DCE+VC	mg/kg			<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	-	-	-	-	-	-	-	-	-	-	-	<0.006	<0.006
VOC																								
2,2-dichloropropane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Bromochloromethane	mg/kg			<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	-	-	-	-	-	-	-	-	-	<0.005	<0.005
1,1-dichloropropene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,2-dichloroethane	mg/kg	21[#2]		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	-	-	-	-	-	-	-	-	-	<0.002	<0.002
1,2-dichloropropane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Dibromomethane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Bromodichloromethane	mg/kg			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
cis-1,3-dichloropropene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
trans-1,3-dichloropropene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,3-dichloropropane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Chlorodibromomethane	mg/kg			<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	-	-	-	-	-	-	-	-	-	-	<0.003	<0.003
1,1,1,2-tetrachloroethane	mg/kg	1,500[#2]		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Styrene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Bromoform	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Isopropylbenzene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,1,2,2-tetrachloroethane	mg/kg	1,800[#2]		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,2,3-trichloropropane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
n-propylbenzene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,3,5-trimethylbenzene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
tert-butylbenzene	mg/kg			<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	-	-	-	-	-	-	-	-	-	<0.002	<0.002
1,2,4-trimethylbenzene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
sec-butylbenzene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
p-isopropyltoluene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
n-butylbenzene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,2-dibromo-3-chloropropane	mg/kg			<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	-	-	-	-	-	-	-	-	-	<0.002	<0.002
Hexachlorobutadiene	mg/kg	48[#2]		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,2-Dichloroethene	mg/kg			<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	-	-	-	-	-	-	-	-	-	<0.002	<0.002
Trihalomethanes	mg/kg			<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	-	-	-	-	-	-	-	-	-	-	-	<0.015	<0.015

Table G1
Soil Human Health Analytical Results
A303 Stonehenge

Location	Units	Human Health Public Open Space (park) GAC	29779-R506A		29779-R507A			29779-SA505			24822-BH1 (Countess)	24822-BH2 (Countess)	24822-TP1 (Countess)	24822-TP2 (Countess)	24822-TP3 (Countess)	24822-TP4 (Countess)	24822-TP7 (Countess)	24822-TP8 (Countess)	24822-TP9 (Countess)	24822-TP10 (Countess)	24822-TP11 (Countess)	29779-SA506	
Chainage			9100		10100			11500			11700	11700	11700	11700	11700	11700	11700	11700	11700	11700	11700	11900	
Strata			Topsoil	Chalk	Topsoil	Chalk	Chalk	Topsoil	Alluvium	Chalk	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Topsoil	Alluvium
Depth (m)			0.35	0.75	0.025	0.75	3.9	0.075	0.8	1	0.5	0.5	0.2	0.5	0.2	0.6	0.5	0.5	0.5	0.5	0.5	0.125	0.6
Date			13/02/2017	13/02/2017	13/02/2017	13/02/2017	14/02/2017	28/02/2017	28/02/2017	28/02/2017	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	01/03/2017	01/03/2017
PAH																							
Naphthalene	mg/kg	**1.200[#2]**	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.09	0.09	0.09	0.15	0.09	9.03	0.09	0.09	0.09	0.1	0.1	<0.03	<0.03
Acenaphthylene	mg/kg	**29.000[#2]**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.25	0.09	0.09	1.37	0.1	3.39	0.09	0.25	0.09	0.1	0.1	<0.01	<0.01
Acenaphthene	mg/kg	**29.000[#2]**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.17	0.09	0.09	0.2	0.09	16.1	0.09	0.13	0.09	0.1	0.1	<0.01	<0.01
Fluorene	mg/kg	**20.000[#2]**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.16	0.09	0.09	0.15	0.09	16.8	0.09	0.1	0.09	0.1	0.1	<0.01	<0.01
Phenanthrene	mg/kg	**6.200[#2]**	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	2.51	0.13	0.09	1.81	0.44	77.7	0.12	1.78	0.09	0.1	0.1	<0.03	<0.03
Anthracene	mg/kg	**150.000[#2]**	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.01	0.09	0.09	1.7	0.25	26.1	0.09	0.76	0.09	0.1	0.1	<0.02	<0.02
Fluoranthene	mg/kg	**6.300[#2]**	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	6.01	0.51	0.27	9.75	1.63	106.4	0.32	4.89	0.29	0.1	0.1	<0.08	<0.08
Pyrene	mg/kg	**15.000[#2]**	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	4.94	0.42	0.24	8.16	1.32	81	0.27	4.1	0.26	0.1	0.1	<0.07	<0.07
Benzo(a)anthracene	mg/kg	**49[#2]**	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	2.62	0.27	0.18	6.02	1.08	45.2	0.26	2.53	0.24	0.1	0.1	<0.04	<0.04
Chrysene	mg/kg	**93[#2]**	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	2.4	0.3	0.25	6.43	1.06	34.9	0.27	2.26	0.22	0.1	0.14	<0.06	<0.06
Benzo(a) pyrene	mg/kg	**11[#2]**	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	2.73	0.25	0.19	7.64	1.11	**43.8**	0.15	2.78	0.22	0.1	0.1	<0.04	<0.04
Indeno(1,2,3-c,d)pyrene	mg/kg	**150[#2]**	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	1.54	0.19	0.17	5.72	0.76	30.5	0.1	1.87	0.14	0.1	0.1	<0.03	<0.03
Dibenz(a,h)anthracene	mg/kg	**1.1[#2]**	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.42	0.09	0.09	**1.38**	0.18	**5.59**	0.09	-	0.09	0.1	0.1	<0.04	<0.04
Benzo(g,h,i)perylene	mg/kg	**1.400[#2]**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.75	0.23	0.27	6.05	0.83	26.7	0.1	1.88	0.15	0.1	0.1	<0.05	<0.05
Benzo(b)fluoranthene	mg/kg	**13[#2]**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	2.92	0.33	0.29	9.23	1.38	**50.1**	0.21	3.11	0.27	0.1	0.15	<0.05	<0.05
Benzo(k)fluoranthene	mg/kg	**370[#2]**	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	1.34	0.18	0.1	3.32	0.51	17.2	0.09	1.23	0.1	0.1	0.1	<0.07	<0.07
Benzo(b)&(k)fluoranthene	mg/kg		<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	4.26	0.51	0.39	12.55	1.89	67.3	0.3	4.34	0.37	0.2	0.25	<0.12	<0.12
PAHs (sum of 4)	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	7.55	0.93	0.83	24.32	3.48	124.5	0.5	8.09	0.66	0.4	0.45	<0.2	<0.2
PAH 16 Total	mg/kg		<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	-	-	-	-	-	-	-	-	-	-	-	<0.08	<0.08
PAH 17 Total	mg/kg		-	-	<0.08	<0.08	-	<0.08	-	<0.08	-	-	-	-	-	-	-	-	-	-	-	<0.08	-
benzo(g,h,i)perylene + indeno(1,2,3-cd)pyrene	mg/kg		<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	3.29	0.42	0.44	11.77	1.59	57.2	0.2	3.75	0.29	0.2	0.2	<0.08	<0.08
SVOC																							
2-methylnaphthalene	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Bis(2-chloroethoxy) methane	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Bis(2-chloroethyl)ether	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Carbazole	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Dibenzofuran	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Hexachlorocyclopentadiene	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Hexachloroethane	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Bis(2-chloroisopropyl) ether	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Perylene	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Phenolics																							
2-methylphenol	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
2-nitrophenol	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
2,4-dimethylphenol	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
4-chloro-3-methylphenol	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
4-methylphenol	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
4-nitrophenol	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Phenol	mg/kg	**440[#2]**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
2-chloronaphthalene	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Phenols	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	-	-	-	-	-	-	-	-	-	-	<0.2	<0.2
Fungicides																							
Quintozene; (PCNB)	ug/kg		<50	<50	<50	<50	<50	<50	<50	<50	-	-	-	-	-	-	-	-	-	-	-	<50	<50
Triadimefon	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Herbicides																							
Pendimethalin	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Triallate	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Trifluralin	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Atrazine	mg/kg	**2.300[#2]**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Simazine	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Ametryn	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Atraton	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Prometon	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Prometryn	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Propazine	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Simetryn	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Terbutylazine	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Terbutryn	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Pesticides																							
Isodrin	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Parathion	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Pirimiphos-methyl	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Cyfluthrin	mg/kg		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyhalothrin/Karate	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Cypermethrins(total)	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Deltamethrin	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Fenvalerate	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Permethrin I	µg/kg		<50	<50	<50	<50	<50	<50	<50	<50	-	-	-	-	-	-	-	-	-	-	-	<50	<50
Permethrin II	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Permethrin	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Aldrin+Dieldrin+Endrin+Isodrin	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	-	-	-	-	-	-	-	-	-	-	<0.2	<0.2
Organochlorine Pesticides																							
Aldrin	mg/kg	**30[#2]**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
a-BHC	mg/kg	**47[#2]**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
b-BHC	mg/kg	**15[#2]**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Chlorothalonil	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Chlordane (cis)	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Dieldrin	mg/kg	**30[#2]**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Endosulfan I	mg/kg	**2.400[#2]**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Endosulfan II	mg/kg	**2.400[#2]**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Endosulfan sulphate	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Endrin	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Heptachlor	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Heptachlor epoxide	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05

Table G1
Soil Human Health Analytical Results
A303 Stonehenge

	Units	Human Health Public Open Space (park) GAC	Location	29779-R506A		29779-R507A			29779-SA505			24822-BH1 (Countess)	24822-BH2 (Countess)	24822-TP1 (Countess)	24822-TP2 (Countess)	24822-TP3 (Countess)	24822-TP4 (Countess)	24822-TP7 (Countess)	24822-TP8 (Countess)	24822-TP9 (Countess)	24822-TP10 (Countess)	24822-TP11 (Countess)	29779-SA506	
			Chainage	9100		10100			11500			11700	11700	11700	11700	11700	11700	11700	11700	11700	11700	11700	11900	
			Strata	Topsoil	Chalk	Topsoil	Chalk	Chalk	Topsoil	Alluvium	Chalk	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Topsoil	Alluvium
			Depth (m)	0.35	0.75	0.025	0.75	3.9	0.075	0.8	1	0.5	0.5	0.2	0.5	0.2	0.6	0.5	0.5	0.5	0.5	0.5	0.125	0.6
			Date	13/02/2017	13/02/2017	13/02/2017	13/02/2017	14/02/2017	28/02/2017	28/02/2017	28/02/2017	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	01/03/2017	01/03/2017
o,p''-DDE	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
o,p-DDD	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
o,p''-Methoxychlor	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
p,p-DDT	µg/kg			<50	<50	<50	<50	<50	<50	<50	<50	-	-	-	-	-	-	-	-	-	-	-	<50	<50
o,p DDT	µg/kg			<50	<50	<50	<50	<50	<50	<50	<50	-	-	-	-	-	-	-	-	-	-	-	<50	<50
4,4-DDE	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Methoxychlor	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Tecnazene	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Telodrin	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
DDD	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Chlordane (trans)	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Aldrin + Dieldrin	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
DDT+DDE+DDD	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Organophosphorous Pesticides																								
Azinphos Ethyl	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Azinophos methyl	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Carbophenothion	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Chlorfenvinphos	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Chlorpyrifos	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Chlorpyrifos-methyl	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Diazinon	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Dichlorvos	mg/kg	26[#2]		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Dimethoate	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Ethion	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Etrimphos	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Fenitrothion	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Fenthion	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Malathion	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Methyl parathion	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Mevinphos (Phosdrin)	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Propetamphos	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Phosalone	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Triazophos	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Disulfoton	mg/kg			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Amino Aliphatics																								
N-nitrosodi-n-propylamine	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Explosives																								
2,4-Dinitrotoluene	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
2,6-dinitrotoluene	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Nitrobenzene	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Halogenated Benzenes																								
Chlorobenzene	mg/kg	1.300[#2]		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Bromobenzene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
2-chlorotoluene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
4-chlorotoluene	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,3-dichlorobenzene	mg/kg	390[#2]		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,4-dichlorobenzene	mg/kg	36.000[#2]		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,2-dichlorobenzene	mg/kg	24.000[#2]		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,2,4-trichlorobenzene	mg/kg	1.700[#2]		<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	-	-	-	-	-	-	-	-	-	-	<0.003	<0.003
1,2,3-trichlorobenzene	mg/kg	770[#2]		<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	-	-	-	-	-	-	-	-	-	-	<0.003	<0.003
Hexachlorobenzene	mg/kg	30[#2]		<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Halogenated Hydrocarbons																								
Dichlorodifluoromethane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Bromomethane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Trichlorofluoromethane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
1,2-dibromoethane	mg/kg			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Halogenated Phenols																								
2-chlorophenol	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
2,4-dichlorophenol	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
2,4,5-trichlorophenol	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
2,4,6-trichlorophenol	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Pentachlorophenol	mg/kg	110[#2]		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Phthalates																								
Bis(2-ethylhexyl) phthalate	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Butyl benzyl phthalate	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Di-n-butyl phthalate	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Di-n-octyl phthalate	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Diethylphthalate	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Dimethyl phthalate	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Solvents																								
Carbon disulfide	mg/kg	1.300[#2]		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
Isophorone	mg/kg			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
Metals																								
Antimony	mg/kg			-	-	<0.01	<0.01	-	<0.01	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	-
Arsenic	mg/kg	170[#2]		<1	2	<1	<1	<1	<1	3	2	2.9	6.8	4.4	4.4	4.9	2.5	<1.8	2.4	2	2	2	3	2
Barium	mg/kg			18	12	45	9	13	18	62	9	-	-	-	-	-	-	-	-	-	-	-	44	43
Beryllium	mg/kg	63[#2]		<1	<1	<1	<1	<1	<1	1	<1	-	-	-	-	-	-	-	-	-	-	-	1	1
Boron (Water Soluble)	mg/kg			<1	<1	1.9	2.1	<1	<1	<1	<1	-	-	-	-	-	-	-	-	-	-	-	<1	<1
Cadmium	mg/kg	560[#2]		0.7	0.7	0.9	<0.5	<0.5	<0.5	1.3	<0.5	0.52	0.18	0.5	0.41	0.58	0.43	0.49	0.59	0.5	0.63	0.63	1.4	1.4
Chromium (III+VI)	mg/kg	33.000[#2]		5	2	11	2	2	7	24	2	10.8	14.3	16.9	15.9	12.6	16	3.4	8.2	6.5	3	3	22	24
Copper	mg/kg	44.000[#2]		1	<1	8	1	<1	3	4	2	3.3	4.6	14	8.1	13	13.8	<2.7	3.7	3	3	3	10	4
Iron	mg/kg																							
Lead	mg/kg			6	2	20	1	<1	7	17	1	14.5	8.5	29	20.5	63.5	23.6	7.2	10.6	5.7	3.5	4.9	27	16
Manganese	mg/kg			364	269	538	231	233	107	407	246	-	-	-	-	-	-	-	-	-	-	-	258	293
Mercury	mg/kg	240[#2]		<0.17	0.67	0.32	0.6	1.03	<0.17	<0.17	0.64	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	<0.17	<0.17

Table G1
Soil Human Health Analytical Results
A303 Stonehenge

	Units	Human Health Public Open Space (park) GAC	29779-R506A		29779-R507A			29779-SA505			24822-BH1 (Countess)
Chainage			9100		10100			11500			11700
Strata			Topsoil	Chalk	Topsoil	Chalk	Chalk	Topsoil	Alluvium	Chalk	Made Ground
Depth (m)			0.35	0.75	0.025	0.75	3.9	0.075	0.8	1	0.5
Date			13/02/2017	13/02/2017	13/02/2017	13/02/2017	14/02/2017	28/02/2017	28/02/2017	28/02/2017	21/08/2009
Molybdenum	mg/kg		<1	<1	<1	<1	<1	<1	<1	<1	-
Nickel	mg/kg	**800#2**	5	6	9	2	2	4	17	4	9
Phosphorus (available)	mg/l		9	<5	27	<5	<5	11	24	7	-
Selenium	mg/kg	**1,800#2**	<1	<1	<1	<1	<1	<1	<1	<1	0.5
Vanadium	mg/kg	**5,000#2**	8	7	15	3	3	7	24	4	-
Zinc	mg/kg	**170,000#2**	19	16	40	11	11	18	44	10	49.9
Chromium (hexavalent)	mg/kg	**220#2**	<1	<2	<1	<1	<1	<1	<1	<1	-
Chromium (Trivalent)	mg/kg	**33,000#2**	5	2	11	2	2	7	24	2	-
Organics											
Organic Matter	%		0.3	0.3	0.7	0.4	0.1	3.1	2	<0.1	-
Fraction Organic Carbon	%		0.21	0.2	0.37	0.21	0.08	1.79	1.14	<0.03	-
Inorganics											
Nitrate as N	mg/kg										
Nitrite	mg/kg										
Ammoniacal Nitrogen	mg/kg										
Cyanide (Free)	mg/kg		<1	<1	<1	<1	<1	<1	<1	<1	-
Thiocyanide	mg/kg										
Fluoride	mg/kg		-	-	2	<1	-	1	-	1	-
Sulphate	mg/kg		-	-	101	<10	-	<10	-	<10	48
Chloride	mg/kg		-	-	<10	<10	-	<10	-	<10	-
Cyanide Total	mg/kg		<1	<1	<1	<1	<1	<1	<1	<1	-
Sulphate (soluble)	g/l		<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	-
pH (Lab)	pH_Units		7.83	8.61	7.97	8.45	9.02	7.75	7.98	8.73	-
TDS	mg/kg		-	-	496	357	-	793	-	368	-
Biological											
Intestinal Enterococci	cfu/g		1700	<10							
E coli	cfu/g		<10	<10							
Coliform	cfu/g		1900	240							
Asbestos Screen											
Asbestos Identification	None		0	0	0	0	0	0	0	0	0

	24822-BH2 (Countess)	24822-TP1 (Countess)	24822-TP2 (Countess)	24822-TP3 (Countess)	24822-TP4 (Countess)	24822-TP7 (Countess)	24822-TP8 (Countess)	24822-TP9 (Countess)	24822-TP10 (Countess)	24822-TP11 (Countess)	29779-SA506	
Chainage	11700	11700	11700	11700	11700	11700	11700	11700	11700	11700	11900	
Strata	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Topsoil	Alluvium
Depth (m)	0.5	0.2	0.5	0.2	0.6	0.5	0.5	0.5	0.5	0.5	0.125	0.6
Date	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	21/08/2009	01/03/2017	01/03/2017
Molybdenum	-	-	-	-	-	-	-	-	-	-	<1	<1
Nickel	6.9	14.9	13.9	11.8	9.2	5.7	12.1	7.7	6.8	4.6	11	11
Phosphorus (available)	-	-	-	-	-	-	-	-	-	-	66	48
Selenium	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	<1	<1
Vanadium	-	-	-	-	-	-	-	-	-	-	20	23
Zinc	55.5	128.1	70.5	101	366.5	37	46.4	31.6	31.6	31.7	51	32
Chromium (hexavalent)	-	-	-	-	-	-	-	-	-	-	<1	<1
Chromium (Trivalent)	-	-	-	-	-	-	-	-	-	-	22	24
Organics												
Organic Matter	-	-	-	-	-	-	-	-	-	-	4.9	1.3
Fraction Organic Carbon	-	-	-	-	-	-	-	-	-	-	2.83	0.75
Inorganics												
Nitrate as N												
Nitrite												
Ammoniacal Nitrogen												
Cyanide (Free)	-	-	-	-	-	-	-	-	-	-	<1	<1
Thiocyanide												
Fluoride	-	-	-	-	-	-	-	-	-	-	2	-
Sulphate	36	59	86	53	117	41	33	30	26	40	<10	-
Chloride	-	-	-	-	-	-	-	-	-	-	<10	-
Cyanide Total	-	-	-	-	-	-	-	-	-	-	<1	<1
Sulphate (soluble)	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
pH (Lab)	-	-	-	-	-	-	-	-	-	-	7.63	7.7
TDS	-	-	-	-	-	-	-	-	-	-	710	-
Biological												
Intestinal Enterococci												
E coli												
Coliform												
Asbestos Screen												
Asbestos Identification	-	0	-	0	-	0	-	0	-	0	0	0

Comments
#1 USEPA RSL (May 2016)
#2 LQM/CIEH S4ULs 2014
#3 EIC/AGS/CL:AIRE
#4 Defra C4SL 12/2014
GAC: Generic Assessment Criteria
(blank): No assessment criteria available
- : Not analysed
HH: Human Health

Key
XXX Exceedance of Human Health Public Open Space (Park) GAC

Table G2
Soil Controlled Waters Analytical Results
A303 Stonhenge

	Units	Drinking Water Standard	Environmental Quality Standard (Freshwater)	**Location**	29779 - P502B	29779 - P505	29779 - R503B	29779 - R506A	29779 - R507A	29779 - SA501	29779 - SA503A	29779 - SA504	29779 - SA505	29779 - SA506	29779 - STP501
				Strata	Topsoil	Topsoil	Chalk	Topsoil	Chalk	Chalk	Chalk	Chalk	Alluvium	Topsoil	Head
				Average Depth (m)	0.05	0.15	6.2	0.35	0.75	1	0.5	0.5	0.8	0.25	0.5
				Date	14/03/2017	05/01/2017	17/03/2017	13/02/2017	13/02/2017	09/03/2017	14/03/2017	08/03/2017	28/02/2017	01/03/2017	27/02/2017
TPH															
>C5-C6 Aliphatics	µg/L	15.000[#2]			<1	<2	<1	<1	<1	<1	<1	<1	<1	<1	<4
>C6-C8 Aliphatics	µg/L	15.000[#2]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
>C8-C10 Aliphatics	µg/L	300[#2]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
>C10-C12 Aliphatics	µg/L	300[#2]			<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
>C12-C16 Aliphatics	µg/L	300[#2]			<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
>C16-C21 Aliphatics	µg/L	300[#2]			<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
>C16-C35 Aliphatics	µg/L				<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
>C21-C35 Aliphatics	µg/L	300[#2]			<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
>EC5-EC7 Aromatics	µg/L	1[#1]	**10[#8]**		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
>EC7-EC8 Aromatics	µg/L	700[#2]	**74[#7]**		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
>EC8-EC9 Aromatics	µg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
>EC9-EC10 Aromatics	µg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
>EC10-EC12 Aromatics	µg/L	90[#2]			<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
>EC12-EC16 Aromatics	µg/L	90[#2]			<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
>EC16-EC21 Aromatics	µg/L	90[#2]			<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
TPH (Ali & Aro)	µg/L				<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Total Aliphatics	µg/L				<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Total Aromatics	µg/L				<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
BTEX															
Benzene	µg/L	1[#1]	**10[#8]**		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	700[#3]	**74[#7]**		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ethylbenzene	µg/L	300[#3]	**20[#12]**		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Xylene (m & p)	µg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Xylene Total	µg/L	500[#3]	**30[#12]**		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Xylene (o)	µg/L	190[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total BTEX	µg/L				<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Oxygenates															
MTBE	µg/L	1.800[#15]	**5.100[#13]**		<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<2
Chlorinated Hydrocarbons															
Chloromethane	µg/L	190[#10]			<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Vinyl chloride	µg/L	0.5[#1]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloroethane	µg/L	21.000[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-dichloroethene	µg/L	140[#3]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Dichloromethane	µg/L	20[#3]	**20[#8]**		<5	<5	<5	<5	<5	<5	<5	<10	<20	<15	<25
1,1-dichloroethane	µg/L	2.8[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
cis-1,2-dichloroethene	µg/L	3[#3]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	100[#1]	**2.5[#8]**		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1,1-trichloroethane	µg/L	2.000[#3]	**100[#12]**		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbon tetrachloride	µg/L	3[#1]	**12[#8]**		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Trichloroethene	µg/L	10[#1]	**10[#8]**		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1,2-trichloroethane	µg/L	0.28[#10]	**400[#12]**		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Tetrachloroethene	µg/L	10[#1]	**10[#8]**		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sum of PCE and TCE	µg/L	10[#1]			<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
TCE+DCE+VC	µg/L				<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
PCE+TCE+DCE+VC	µg/L				<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
VOC															
2,2-dichloropropane	µg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bromochloromethane	µg/L	83[#10]			<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,1-dichloropropene	µg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2-dichloroethane	µg/L	3[#1]	**10[#8]**		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
1,2-dichloropropane	µg/L	40[#3]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Dibromomethane	µg/L	8.3[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bromodichloromethane	µg/L	83#1			<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
cis-1,3-dichloropropene	µg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
trans-1,3-dichloropropene	µg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,3-dichloropropane	µg/L	370[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chlorodibromomethane	µg/L	100#1			<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
1,1,1,2-tetrachloroethane	µg/L	0.57[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Styrene	µg/L	20[#3]	**50[#12]**		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bromoform	µg/L	100[#1]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Isopropylbenzene	µg/L	450[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1,2,2-tetrachloroethane	µg/L	0.076[#10]	**140[#7]**		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2,3-trichloropropane	µg/L	0.00075[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
n-propylbenzene	µg/L	660[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,3,5-trimethylbenzene	µg/L	120[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
tert-butylbenzene	µg/L	690[#10]			<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
1,2,4-trimethylbenzene	µg/L	15[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
sec-butylbenzene	µg/L	2.000[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
p-isopropyltoluene	µg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
n-butylbenzene	µg/L	1.000[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2-dibromo-3-chloropropane	µg/L	1[#3]			<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Hexachlorobutadiene	µg/L	0.1[#1]	**0.6[#6]**		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2-Dichloroethene	µg/L	50[#3]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2-Dibromomethane	µg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Trihalomethanes	µg/L	100[#1]			<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
trans-1,2-Dibromoethene	µg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
PAH															
Naphthalene	µg/L	6[#15]	**2[#8]**		0.15	<0.02	<0.02	<0.02	<0.02	0.14	0.4	<0.02	<0.02	<0.02	0.62
Acenaphthylene	µg/L	18[#15]			<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Acenaphthene	µg/L	18[#15]			0.03	<0.02	<0.02	<0.02	<0.02	<0.02	0.11	0.06	0.06	<0.02	0.08
Fluorene	µg/L	12[#15]			<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.04	0.05	0.04	<0.02	0.04
Phenanthrene	µg/L	4[#15]			<0.02	<0.02	<0.02	<0.02	0.05	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
Anthracene	µg/L	90[#15]	**0.1[#8]**		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fluoranthene	µg/L	4[#3]	**0.0063[#8]**		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	**0.02**	**0.08**	<0.02	**0.07**
Pyrene	µg/L	9[#15]			<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	0.07	<0.02	0.05
Benz(a)anthracene	µg/L	3.5[#15]			<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chrysene	µg/L	7[#15]			<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02
Benzo(a) pyrene	µg/L	0.01[#1]	**0.00017[#8]**		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

Table G2
Soil Controlled Waters Analytical Results
A303 Stonhenge

	Units	Drinking Water Standard	Environmental Quality Standard (Freshwater)	Location	29779 - P502B	29779 - P505	29779 - R503B	29779 - R506A	29779 - R507A	29779 - SA501	29779 - SA503A	29779 - SA504	29779 - SA505	29779 - SA506	29779 - STP501
				Strata	Topsoil	Topsoil	Chalk	Topsoil	Chalk	Chalk	Chalk	Chalk	Alluvium	Topsoil	Head
				Average Depth (m)	0.05	0.15	6.2	0.35	0.75	1	0.5	0.5	0.8	0.25	0.5
				Date	14/03/2017	05/01/2017	17/03/2017	13/02/2017	13/02/2017	09/03/2017	14/03/2017	08/03/2017	28/02/2017	01/03/2017	27/02/2017
Indeno(1,2,3-c,d)pyrene	µg/L	0.1[#1]	**0.0422[#9]**		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dibenz(a,h)anthracene	µg/L	0.07[#15]			<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benzo(g,h,i)perylene	µg/L	0.1[#1]	**0.0082[#6]**		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benzo(b)fluoranthene	µg/L	0.1[#1]	**0.017[#6]**		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benzo(k)fluoranthene	µg/L	0.1[#1]	**0.017[#6]**		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benzo(b)&(k)fluoranthene	µg/L				<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
PAHs (sum of 4)	µg/L	0.1[#1]			<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
PAH 16 Total	µg/L				0.18	<0.02	<0.02	<0.02	0.07	0.14	0.55	0.18	0.25	<0.02	0.91
benzo(g,h,i)perylene + indeno(1,2,3-cd)pyrene	µg/L				<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Coal Tar (Bap as surrogate marker)	µg/L				<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
SVOC															
2-methylnaphthalene	µg/L	36[#10]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
4-bromophenyl phenyl ether	µg/L				<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Bis(2-chloroethoxy) methane	µg/L	59[#10]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Bis(2-chloroethyl)ether	µg/L	0.014[#10]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Carbazole	µg/L				<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Dibenzofuran	µg/L	7.9[#10]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Hexachlorocyclopentadiene	µg/L	0.41[#10]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Hexachloroethane	µg/L	0.33[#10]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Perylene	µg/L				<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Phenolics															
2-methylphenol	µg/L	930[#10]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
2-nitrophenol	µg/L				<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
2,4-dimethylphenol	µg/L	360[#10]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
4-chloro-3-methylphenol	µg/L	1.400[#10]	**40[#12]**		<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
4-methylphenol	µg/L	1.900[#10]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
4-nitrophenol	µg/L				<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Phenol	µg/L	5.800[#10]	**7.7[#7]**		<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
2-chloronaphthalene	µg/L	750[#10]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Phenols	µg/L				-	<10	-	-	<10	-	<10	<10	-	<10	<10
Amino Aliphatics															
N-nitrosodi-n-propylamine	µg/L	0.011[#10]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Explosives															
2,4-Dinitrotoluene	µg/L	0.24[#10]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
2,6-dinitrotoluene	µg/L	0.049[#10]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Nitrobenzene	µg/L	8 to 63[#3]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Halogenated Benzenes															
Chlorobenzene	µg/L	300[#3]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bromobenzene	µg/L	62[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
2-chlorotoluene	µg/L	240[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
4-chlorotoluene	µg/L	250[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,3-dichlorobenzene	µg/L				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,4-dichlorobenzene	µg/L	300[#3]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2-dichlorobenzene	µg/L	1.000[#3]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2,4-trichlorobenzene	µg/L	0.1[#1]	**0.4[#9]**		<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
1,2,3-trichlorobenzene	µg/L	0.1[#1]	**0.4[#9]**		<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Hexachlorobenzene	µg/L	0.1[#1]	**0.05[#6]**		<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Halogenated Hydrocarbons															
Dichlorodifluoromethane	µg/L	200[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bromomethane	µg/L	7.5[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Trichlorofluoromethane	µg/L	5.200[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Halogenated Phenols															
2-chlorophenol	µg/L	91[#10]	**50[#12]**		<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
2,4-dichlorophenol	µg/L	46[#10]	**4.2[#7]**		<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
2,4,5-trichlorophenol	µg/L	1.200[#10]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
2,4,6-trichlorophenol	µg/L	200[#3]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Pentachlorophenol	µg/L	9[#3]	**0.4[#8]**		<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Phthalates															
Bis(2-ethylhexyl) phthalate	µg/L	8[#3]	**1.3[#8]**		<4	<20	<4	<4	<20	<4	<4	<4	<4	<4	<4
Butyl benzyl phthalate	µg/L	16[#10]	**7.5[#7]**		<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Di-n-butyl phthalate	µg/L	900[#10]	**8[#12]**		<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Di-n-octyl phthalate	µg/L	200[#10]	**20[#12]**		<10	<50	<10	<10	<50	<10	<10	<10	<10	<10	<10
Diethylphthalate	µg/L	15.000[#10]	**200[#12]**		<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Dimethyl phthalate	µg/L		**800[#12]**		<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Solvents															
Carbon disulfide	µg/L	810[#10]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Isophorone	µg/L	78[#10]			<2	<10	<2	<2	<10	<2	<2	<2	<2	<2	<2
Metals															
Antimony	µg/L	5[#1]			-	<1	-	-	<1	-	<1	<1	-	<1	<1
Arsenic	µg/L	10[#1]	**50[#7]**		<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1
Barium	µg/L	1.300[#3]			-	5	-	-	9	-	6	3	-	10	18
Beryllium	µg/L	12[#3]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Boron	µg/L	1.000[#1]	**2.000[#12]**		14	23	<10	27	<10	<10	<10	<10	<10	16	10
Cadmium	µg/L	5[#1]	**0.08[#8]**		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Calcium	mg/L				31	48	10	51	24	7	17	6	24	48	18
Chromium (III+VI)	µg/L	50[#1]			<1	2	<1	<1	<1	<1	<1	<1	<1	<1	<1
Copper	µg/L	2.000[#1]	**1[#7]**		1	1	<1	**3**	<1	<1	<1	<1	<1	**2**	<1
Lead	µg/L	10[#1]	**1.2[#8]**		<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1
Magnesium	mg/L				<1	<1	<1	1	<1	<1	<1	<1	<1	1	<1
Manganese	µg/L	50[#1]	**123[#7]**		6	1	<1	3	<1	1	1	<1	<1	<1	<1
Mercury	µg/L	1[#1]	**0.07[#6]**		<0.1	**0.2**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.1**	<0.1	<0.1
Molybdenum	µg/L	70[#3]			<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1
Nickel	µg/L	20[#1]	**4[#8]**		<1	<1	<1	2	1	<1	<1	<1	<1	2	<1
Phosphorus	µg/L	316414#10			73	61	<20	141	<20	73	177	<20	68	133	45
Selenium	µg/L	10[#1]			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Zinc	µg/L	6.000[#10]	**10.9[#7]**		4	5	3	**13**	10	2	1	2	2	6	<1
Potassium	mg/L				2	<1	2	5	<1	<1	<1	<1	1	<1	1
Chromium (hexavalent)	µg/L	50[#1]	**3.4[#7]**		<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Chromium (Trivalent)	µg/L	50[#1]	**4.7[#7]**		<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Organics															

Table G2
Soil Controlled Waters Analytical Results
A303 Stonhenge

	Units	Drinking Water Standard	Environmental Quality Standard (Freshwater)												
				Location	29779 - P502B	29779 - P505	29779 - R503B	29779 - R506A	29779 - R507A	29779 - SA501	29779 - SA503A	29779 - SA504	29779 - SA505	29779 - SA506	29779 - STP501
				Strata	Topsoil	Topsoil	Chalk	Topsoil	Chalk	Chalk	Chalk	Chalk	Alluvium	Topsoil	Head
				Average Depth (m)	0.05	0.15	6.2	0.35	0.75	1	0.5	0.5	0.8	0.25	0.5
				Date	14/03/2017	05/01/2017	17/03/2017	13/02/2017	13/02/2017	09/03/2017	14/03/2017	08/03/2017	28/02/2017	01/03/2017	27/02/2017
Dissolved Organic Carbon	mg/l				4.9	2.3	0.7	7.9	1.8	1.1	2.1	0.7	1.1	5.1	4.6
Inorganics															
Ammoniacal Nitrogen	mg/L	0.4	**0.3**		<0.02	<0.02	<0.02	0.15	<0.02	0.04	<0.02	<0.02	0.1	**0.76**	0.03
Sodium	mg/L	200#1			3	3	2	4	2	<1	<1	<1	1	2	<1
Cyanide (Free)	mg/L	0.001#1	**0.001#12**		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Fluoride	mg/L	1.5#1	**1#12**		-	0.42	-	-	0.24	-	0.4	0.2	-	0.25	0.45
Sulphate	mg/L	250#4	**400#12**		<1	<1	1.29	10.03	3.8	<1	<1	<1	1.28	<1	<1
Chloride	mg/L	250#1	**250#12**		1.39	2.06	1.59	3.56	1.31	<1	<1	1.02	<1	<1	<1
Nitrate (as NO3-)	mg/L	50#1			2.47	2.77	<0.1	9.42	7.65	<0.1	0.71	7.71	<0.1	38.61	2.8
Nitrite (as NO2-)	mg/L	0.5#1			0.89	0.92	<0.1	0.67	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cyanide Total	mg/L	0.05#1	**0.001#7**		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
TDS	mg/L				-	109	-	-	107	-	77	59	-	91	77
Biological															
Intestinal Enterococci	cfu/100ml	0			0	0	0	0	0	0	0	0	0	0	0
E coli	cfu/100ml	0			0	0	0	0	0	0	0	0	0	0	0
Coliform	cfu/100 ml	0			1	0	0	300	0	0	0	4	0	14	0

Comments
#1 WS Regs 2016 (Eng/Wal)
#2 WHO Petroleum DWG 2008
#3 WHO DWG 2017
#4 WHO 2017 - Taste
#5 WHO 2017 - Odour
#6 WFD England/Wales. 2015 - MAC-EQS Inland
#7 WFD England/Wales. 2015 - Freshwater Standards
#8 WFD England/Wales. 2015 - AA-EQS Inland
#9 Water Env't Regs (Scotland) 2015. AA-EQS Inland
#10 USEPA RSL (tapwater) [May 2016]
#11 SEPA WAT-SG-53 Fresh EQS - MAC - 2015
#12 SEPA WAT-SG-53 Fresh EQS - AA - 2015
#13 PNEC (EU REACH) - Freshwater
#14 California Draft health protective concentration
#15 AECOM DWG (WHO method)
GAC: Generic Assessment Criteria
(blank): No assessment criteria available
- : Not analysed
DWS: Drinking Water Standard
EQS: Environmental Quality Standard

Key

XXX	Exceedance of CW/WE Water. DWS - England/Wales
XXX	Exceedance of CW/WE Water. Aquatic Toxicity - England/Wales - Freshwater

Table G3
Groundwater Controlled Waters Analytical Results
A303 Stonehenge

	Units	Drinking Water Standard	Drinking Water Standard	Location	16175 - PC P2	29779 - PX505A	29779 - R503B	29779 - R507A	16175 - RC 16	16175 - RC P01	16175 - RC R13
				Screen strata	Chalk	Chalk	Chalk	Chalk	Chalk	Chalk	Chalk
				Date	24/04/2001	05/04/2017	27/03/2017	26/04/2017	24/04/2001	24/04/2001	24/04/2001
Field											
pH	pH_Units				-	7.56	7.62	7.69	-	-	-
Dissolved Oxygen	mg/L				-	9.7	9.8	9.9	-	-	-
TPH											
>C5-C6 Aliphatics	µg/L	15.000[#2]			-	<1	<1	<1	-	-	-
>C6-C8 Aliphatics	µg/L	15.000[#2]			-	<1	<1	<1	-	-	-
>C8-C10 Aliphatics	µg/L	300[#2]			-	<1	<1	<1	-	-	-
>C10-C12 Aliphatics	µg/L	300[#2]			-	<5	<5	<5	-	-	-
>C12-C16 Aliphatics	µg/L	300[#2]			-	<5	<5	<5	-	-	-
>C16-C21 Aliphatics	µg/L	300[#2]			-	<5	<5	<5	-	-	-
>C16-C35 Aliphatics	µg/L				-	<10	<10	<10	-	-	-
>C21-C35 Aliphatics	µg/L	300[#2]			-	<5	<5	<5	-	-	-
>EC5-EC7 Aromatics	µg/L	1[#1]	**10[#8]**		-	<1	<1	<1	-	-	-
>EC7-EC8 Aromatics	µg/L	700[#2]	**74[#7]**		-	<1	<1	<1	-	-	-
>EC9-EC10 Aromatics	µg/L				-	<1	<1	<1	-	-	-
>EC10-EC12 Aromatics	µg/L	90[#2]			-	<5	<5	<5	-	-	-
>EC12-EC16 Aromatics	µg/L	90[#2]			-	<5	<5	<5	-	-	-
>EC16-EC21 Aromatics	µg/L	90[#2]			-	<5	<5	<5	-	-	-
Gasoline Range Organics	µg/L				<100	-	-	-	<100	<100	<100
Diesel Range Organics	µg/L				<100	-	-	-	<100	<100	<100
Total Aliphatics	µg/L				-	<5	<5	<5	-	-	-
Total Aromatics	µg/L				-	<5	<5	<5	-	-	-
TPH (Ali & Aro)	µg/L				-	<5	<5	<5	-	-	-
BTEX											
Benzene	µg/L	1[#1]	**10[#8]**		-	<1	<1	<1	-	-	-
Toluene	µg/L	700[#3]	**74[#7]**		-	<1	<1	<1	-	-	-
Ethylbenzene	µg/L	300[#3]	**20[#12]**		-	<1	<1	<1	-	-	-
Xylene (m & p)	µg/L				-	<1	<1	<1	-	-	-
Xylene Total	µg/L	500[#3]	**30[#12]**		-	<2	<2	<2	-	-	-
Xylene (o)	µg/L	190[#10]			-	<1	<1	<1	-	-	-
Total BTEX	µg/L				-	<5	<5	<5	-	-	-
Oxygenates											
MTBE	µg/L	1.800[#15]	**5.100[#13]**		-	<1	<1	<1	-	-	-
Chlorinated Hydrocarbons											
Chloromethane	µg/L	190[#10]			-	<10	<10	<10	-	-	-
Vinyl chloride	µg/L	0.5[#1]			-	<1	<1	<1	-	-	-
Chloroethane	µg/L	21.000[#10]			-	<1	<1	<1	-	-	-
1,1-dichloroethene	µg/L	140[#3]			-	<1	<1	<1	-	-	-
Dichloromethane	µg/L	20[#3]	**20[#8]**		-	<5	<5	<5	-	-	-
trans-1,2-dichloroethene	µg/L	3[#3]			-	<1	<1	<1	-	-	-
1,1-dichloroethane	µg/L	2.8[#10]			-	<1	<1	<1	-	-	-
cis-1,2-dichloroethene	µg/L	3[#3]			-	<1	<1	<1	-	-	-
Chloroform	µg/L	100[#1]	**2.5[#8]**		-	<1	<1	<1	-	-	-
1,1,1-trichloroethane	µg/L	2.000[#3]	**100[#12]**		-	<1	<1	<1	-	-	-
Carbon tetrachloride	µg/L	3[#1]	**12[#8]**		-	<1	<1	<1	-	-	-
Trichloroethene	µg/L	10[#1]	**10[#8]**		-	<1	<1	<1	-	-	-
1,1,2-trichloroethane	µg/L	0.28[#10]	**400[#12]**		-	<1	<1	<1	-	-	-
Tetrachloroethene	µg/L	10[#1]	**10[#8]**		-	<1	<1	<1	-	-	-
Sum of PCE and TCE	µg/L	10[#1]			-	<2	<2	<2	-	-	-
TCE+DCE+VC	µg/L				-	<5	<5	<5	-	-	-
PCE+TCE+DCE+VC	µg/L				-	<6	<6	<6	-	-	-
VOC											
2,2-dichloropropane	µg/L				-	<1	<1	<1	-	-	-
Bromochloromethane	µg/L	83[#10]			-	<5	<5	<5	-	-	-
1,1-dichloropropene	µg/L				-	<1	<1	<1	-	-	-
1,2-dichloroethane	µg/L	3[#1]	**10[#8]**		-	<2	<2	<2	-	-	-
1,2-dichloropropane	µg/L	40[#3]			-	<1	<1	<1	-	-	-
Dibromomethane	µg/L	8.3[#10]			-	<1	<1	<1	-	-	-
Bromodichloromethane	µg/L	100[#1]			-	<10	<10	<10	-	-	-
cis-1,3-dichloropropene	µg/L				-	<1	<1	<1	-	-	-
trans-1,3-dichloropropene	µg/L				-	<1	<1	<1	-	-	-
1,3-dichloropropane	µg/L	370[#10]			-	<1	<1	<1	-	-	-
Chlorodibromomethane	µg/L	100[#1]			-	<3	<3	<3	-	-	-
1,1,1,2-tetrachloroethane	µg/L	0.57[#10]			-	<1	<1	<1	-	-	-
Styrene	µg/L	20[#3]	**50[#12]**		-	<1	<1	<1	-	-	-
Bromoform	µg/L	100[#1]			-	<1	<1	<1	-	-	-
Isopropylbenzene	µg/L	450[#10]			-	<1	<1	<1	-	-	-
1,1,2,2-tetrachloroethane	µg/L	0.076[#10]	**140[#7]**		-	<1	<1	<1	-	-	-
1,2,3-trichloropropane	µg/L	0.00075[#10]			-	<1	<1	<1	-	-	-
n-propylbenzene	µg/L	660[#10]			-	<1	<1	<1	-	-	-
1,3,5-trimethylbenzene	µg/L	120[#10]			-	<1	<1	<1	-	-	-
tert-butylbenzene	µg/L	690[#10]			-	<2	<2	<2	-	-	-
1,2,4-trimethylbenzene	µg/L	15[#10]			-	<1	<1	<1	-	-	-
sec-butylbenzene	µg/L	2.000[#10]			-	<1	<1	<1	-	-	-
p-isopropyltoluene	µg/L				-	<1	<1	<1	-	-	-
n-butylbenzene	µg/L	1.000[#10]			-	<1	<1	<1	-	-	-
1,2-dibromo-3-chloropropane	µg/L	1[#3]			-	<2	<2	<2	-	-	-
Hexachlorobutadiene	µg/L	0.1[#1]	**0.6[#6]**		-	<1	<1	<1	-	-	-
1,2-Dichloroethene	µg/L	50[#3]			-	<2	<2	<2	-	-	-
Trihalomethanes	µg/L	100[#1]			-	<15	<15	<15	-	-	-
PAH											
Naphthalene	µg/L	6[#15]	**2[#8]**		<10	<0.01	<0.01	<0.01	<10	<10	<10

Table G3
Groundwater Controlled Waters Analytical Results
A303 Stonehenge

	Units	Drinking Water Standard	Drinking Water Standard	Location	16175 - PC P2	29779 - PX505A	29779 - R503B	29779 - R507A	16175 - RC 16	16175 - RC P01	16175 - RC R13
				Screen strata	Chalk	Chalk	Chalk	Chalk	Chalk	Chalk	Chalk
				Date	24/04/2001	05/04/2017	27/03/2017	26/04/2017	24/04/2001	24/04/2001	24/04/2001
Acenaphthylene	µg/L	18[#15]			<10	<0.01	<0.01	<0.01	<10	<10	<10
Acenaphthene	µg/L	18[#15]			<10	<0.01	<0.01	<0.01	<10	<10	<10
Fluorene	µg/L	12[#15]			<10	<0.01	<0.01	<0.01	<10	<10	<10
Phenanthrene	µg/L	4[#15]			<10	<0.01	<0.01	<0.01	<10	<10	<10
Anthracene	µg/L	90[#15]	**0.1[#8]**		<10	<0.01	<0.01	<0.01	<10	<10	<10
Fluoranthene	µg/L	4[#3]	**0.0063[#8]**		<10	<0.01	<0.01	<0.01	<10	<10	<10
Pyrene	µg/L	9[#15]			<10	<0.01	<0.01	<0.01	<10	<10	<10
Benz(a)anthracene	µg/L	3.5[#15]			<10	<0.01	<0.01	<0.01	<10	<10	<10
Chrysene	µg/L	7[#15]			<10	<0.01	<0.01	<0.01	<10	<10	<10
Benzo(a) pyrene	µg/L	0.01[#1]	**0.00017[#8]**		<10	<0.01	<0.01	<0.01	<10	<10	<10
Indeno(1,2,3-c,d)pyrene	µg/L	0.1[#1]	**0.0422[#9]**		<10	<0.01	<0.01	<0.01	<10	<10	<10
Dibenz(a,h)anthracene	µg/L	0.07[#15]			<10	<0.01	<0.01	<0.01	<10	<10	<10
Benzo(g,h,i)perylene	µg/L	0.1[#1]	**0.0082[#6]**		<10	<0.01	<0.01	<0.01	<10	<10	<10
Benzo(b)fluoranthene	µg/L	0.1[#1]	**0.017[#6]**		<10	<0.01	<0.01	<0.01	<10	<10	<10
Benzo(k)fluoranthene	µg/L	0.1[#1]	**0.017[#6]**		<10	<0.01	<0.01	<0.01	<10	<10	<10
Benzo(b)&(k)fluoranthene	µg/L				-	<0.02	<0.02	<0.02	-	-	-
PAHs (sum of 4)	µg/L	0.1[#1]			-	<0.04	<0.04	<0.04	-	-	-
PAH 16 Total	µg/L				-	<0.01	<0.01	<0.01	-	-	-
benzo(g,h,i)perylene + indeno(1,2,3-cd)pyrene	µg/L				-	<0.02	<0.02	<0.02	-	-	-
SVOC											
2-methylnaphthalene	µg/L	36[#10]			-	<1	<1	<1	-	-	-
4-bromophenyl phenyl ether	µg/L				-	<1	<1	<1	-	-	-
Bis(2-chloroethoxy) methane	µg/L	59[#10]			-	<1	<1	<1	-	-	-
Bis(2-chloroethyl)ether	µg/L	0.014[#10]			-	<1	<1	<1	-	-	-
Carbazole	µg/L				-	<1	<1	<1	-	-	-
Dibenzofuran	µg/L	7.9[#10]			-	<1	<1	<1	-	-	-
Hexachlorocyclopentadiene	µg/L	0.41[#10]			-	<1	<1	<1	-	-	-
Hexachloroethane	µg/L	0.33[#10]			-	<1	<1	<1	-	-	-
Perylene	µg/L				-	<1	<1	<1	-	-	-
Phenolics											
Trimethylphenols	µg/L				<100	-	-	-	<10	<10	<10
2-methylphenol	µg/L	930[#10]			-	<1	<1	<1	-	-	-
2-nitrophenol	µg/L				-	<1	<1	<1	-	-	-
2,4-dimethylphenol	µg/L	360[#10]			-	<1	<1	<1	-	-	-
4-chloro-3-methylphenol	µg/L	1.400[#10]	**40[#12]**		-	<1	<1	<1	-	-	-
4-methylphenol	µg/L	1.900[#10]			-	<1	<1	<1	-	-	-
4-nitrophenol	µg/L				-	<1	<1	<1	-	-	-
Phenol	µg/L	5.800[#10]	**7.7[#7]**		<100	<1	<1	<1	<10	<10	<10
2-chloronaphthalene	µg/L	750[#10]			-	<1	<1	<1	-	-	-
Amino Aliphatics											
N-nitrosodi-n-propylamine	µg/L	0.011[#10]			-	<1	<1	<1	-	-	-
Amino Aromatics											
Dimethylphenethylamine	µg/L				100	-	-	-	10	10	10
Explosives											
2,4-Dinitrotoluene	µg/L	0.24[#10]			-	<1	<1	<1	-	-	-
2,6-dinitrotoluene	µg/L	0.049[#10]			-	<1	<1	<1	-	-	-
Nitrobenzene	µg/L	8 to 63[#3]			-	<1	<1	<1	-	-	-
Halogenated Benzenes											
Chlorobenzene	µg/L	300[#3]			-	<1	<1	<1	-	-	-
Bromobenzene	µg/L	62[#10]			-	<1	<1	<1	-	-	-
2-chlorotoluene	µg/L	240[#10]			-	<1	<1	<1	-	-	-
4-chlorotoluene	µg/L	250[#10]			-	<1	<1	<1	-	-	-
1,3-dichlorobenzene	µg/L				-	<1	<1	<1	-	-	-
1,4-dichlorobenzene	µg/L	300[#3]			-	<1	<1	<1	-	-	-
1,2-dichlorobenzene	µg/L	1.000[#3]			-	<1	<1	<1	-	-	-
1,2,4-trichlorobenzene	µg/L	0.1[#1]	**0.4'[#9]**		-	<3	<3	<3	-	-	-
1,2,3-trichlorobenzene	µg/L	0.1[#1]	**0.4'[#9]**		-	<3	<3	<3	-	-	-
Hexachlorobenzene	µg/L	0.1[#1]	**0.05[#6]**		-	<1	<1	<1	-	-	-
Halogenated Hydrocarbons											
Dichlorodifluoromethane	µg/L	200[#10]			-	<1	<1	<1	-	-	-
Bromomethane	µg/L	7.5[#10]			-	<1	<1	<1	-	-	-
Trichlorofluoromethane	µg/L	5.200[#10]			-	<1	<1	<1	-	-	-
1,2-dibromoethane	µg/L	0.4[#3]			-	<1	<1	<1	-	-	-
Halogenated Phenols											
2-chlorophenol	µg/L	91[#10]	**50[#12]**		-	<1	<1	<1	-	-	-
2,4-dichlorophenol	µg/L	46[#10]	**4.2[#7]**		-	<1	<1	<1	-	-	-
2,4,5-trichlorophenol	µg/L	1.200[#10]			-	<1	<1	<1	-	-	-
2,4,6-trichlorophenol	µg/L	200[#3]			-	<1	<1	<1	-	-	-
Pentachlorophenol	µg/L	9[#3]	**0.4[#8]**		-	<1	<1	<1	-	-	-
Phthalates											
Bis(2-ethylhexyl) phthalate	µg/L	8[#3]	**1.3[#8]**		-	<10	<10	<10	-	-	-
Butyl benzyl phthalate	µg/L	16[#10]	**7.5[#7]**		-	<1	<1	<1	-	-	-
Di-n-butyl phthalate	µg/L	900[#10]	**8[#12]**		-	<1	<1	<1	-	-	-
Di-n-octyl phthalate	µg/L	200[#10]	**20[#12]**		-	<10	<10	<10	-	-	-
Diethylphthalate	µg/L	15.000[#10]	**200[#12]**		-	<1	<1	<1	-	-	-
Dimethyl phthalate	µg/L		**800[#12]**		-	<1	<1	<1	-	-	-
Solvents											
Carbon disulfide	µg/L	810[#10]			-	<1	<1	<1	-	-	-
Isophorone	µg/L	78[#10]			-	<1	<1	<1	-	-	-
Metals											
Antimony	µg/L	5[#1]			-	<1	<1	<1	-	-	-
Arsenic	µg/L	10[#1]	**50[#7]**		<1	<1	<1	<1	<1	1	<1
Beryllium	µg/L	12[#3]			-	<1	<1	<1	-	-	-

Table G3
Groundwater Controlled Waters Analytical Results
A303 Stonehenge

	Units	Drinking Water Standard	Drinking Water Standard	**Location**	16175 - PC P2	29779 - PX505A	29779 - R503B	29779 - R507A	16175 - RC 16	16175 - RC P01	16175 - RC R13
				Screen strata	Chalk	Chalk	Chalk	Chalk	Chalk	Chalk	Chalk
				Date	24/04/2001	05/04/2017	27/03/2017	26/04/2017	24/04/2001	24/04/2001	24/04/2001
Boron	µg/L	1,000[#1]	**2,000[#12]**		<50	<10	10	18	<50	<50	<50
Cadmium	µg/L	5[#1]	**0.08[#8]**		<1	<0.2	<0.2	<0.2	<1	<1	<1
Calcium	mg/L				103	87	82	89	122	141	1,110
Chromium (III+VI)	µg/L	50[#1]			<1	6	7	10	5	9	8
Copper	µg/L	2,000[#1]	**1[#7]**		**20**	**3**	**2**	**10**	**16**	**11**	**7**
Iron (Total)	µg/L				<100	-	-	-	70	530	3630
Iron (dissolved)	µg/L	200[#1]	**1,000[#7]**		<100				<100	<100	<100
Lead	µg/L	10[#1]	**1.2[#8]**		<1	<1	<1	<1	<1	**13**	1
Magnesium	mg/L				1.22	4	7	1	1.45	1.23	4.63
Manganese	µg/L	50[#1]	**123[#7]**		-	<1	<1	<1	-	-	-
Mercury	µg/L	1[#1]	**0.07[#6]**		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	µg/L	70[#3]			-	<0.5	<0.5	<0.5	-	-	-
Nickel	µg/L	20[#1]	**4[#8]**		2	<1	<1	<1	2	4	3
Selenium	µg/L	10[#1]			<1	<1	<1	<1	<1	<1	1
Zinc	µg/L	6,000[#10]	**10.9[#7]**		**26**	3	2	1	10	**35**	10
Potassium	mg/L				0.63	<1	<1	<1	0.71	0.37	0.36
Chromium (hexavalent)	µg/L	50[#1]	**3.4[#7]**		<10	<0.01	<0.01	<0.01	<10	<10	<10
Chromium (Trivalent)	µg/L	50[#1]	**4.7[#7]**		-	<0.01	<0.01	0.01	-	-	-
Organics											
Dissolved Organic Carbon	mg/l				-	0.5	1.4	1	-	-	-
Inorganics											
Ammoniacal Nitrogen	mg/L		**0.3**		0.2	0.1	0.07	0.05	0.1	0.1	0.1
Nitrate (undifferentiated)	mg/L				9.3	-	-	-	6.3	4.9	10.8
Nitrite (undifferentiated)	mg/L				0.1	-	-	-	0.1	0.1	0.1
BOD	mg/L				0.2	-	-	-	2	2	2
Sodium	mg/L	200[#1]			7.43	9	15	8	7.72	6.08	6.33
Cyanide (Free)	mg/L	0.05#1	**0.001[#12]**		<0.1	<0.005	<0.005	<0.005	<0.1	<0.1	<0.1
Fluoride	mg/L	1.5[#1]	**1[#12]**		0.1	-	-	-	0.2	0.2	0.2
Sulphate	mg/L	250[#4]	**400[#12]**		-	8	11	16	-	-	-
Chloride	mg/L	250[#1]	**250[#12]**		15	22	35	13.31	16	14	20
Nitrate (as NO3-)	mg/L	50[#1]			9.3	85.13	33.19	9.77	6.3	4.9	10.8
Nitrite (as NO2-)	mg/L	0.5[#1]			-	<0.1	<0.1	<0.1	-	-	-
Sulphide	mg/L				0.2	-	-	-	0.2	0.2	0.2
Phosphate	µg/L	970000#10			<100	-	-	-	<100	<100	<100
Cyanide Total	mg/L	0.05[#1]	**0.001[#7]**		<0.1	<0.005	<0.005	<0.005	<0.1	<0.1	**0.6**
Thiocyanate	mg/L	0.004[#10]			<0.1	-	-	-	<0.1	<0.1	<0.1
Sulphite as SO3-	µg/L				20	-	-	-	<10	<10	<10
COD	mg/L				7	-	-	-	<5	<5	<5
TDS	mg/L				312	-	-	-	320	324	307
Phosphorus total (dissolved)	mg/L	316414#10			-	<0.02	<0.02	0.036	-	-	-
Other											
PCB	mg/L				<0.005	-	-	-	<0.005	<0.005	<0.005
Biological											
E coli	cfu/100ml	0			-	0	0	0	<1	2	<1
Intestinal Enterococci	cfu/100ml	0			-	0	0	1	-	-	-
Coliform	cfu/100 ml	0			-	1	1	0	<1	200	200

Comments
#1 WS Regs 2016 (Eng/Wal)
#2 WHO Petroleum DWG 2008
#3 WHO DWG 2017
#4 WHO 2017 - Taste
#5 WHO 2017 - Odour
#6 WFD England/Wales. 2015 - MAC-EQS Inland
#7 WFD England/Wales. 2015 - Freshwater Standards
#8 WFD England/Wales. 2015 - AA-EQS Inland
#9 Water Env't Regs (Scotland) 2015. AA-EQS Inland
#10 USEPA RSL (tapwater) [May 2016]
#11 SEPA WAT-SG-53 Fresh EQS - MAC - 2015
#12 SEPA WAT-SG-53 Fresh EQS - AA - 2015
#13 PNEC (EU REACH) - Freshwater
#14 California Draft health protective concentration
#15 AECOM DWG (WHO method)
GAC: Generic Assessment Criteria
(blank): No assessment criteria available
- : Not analysed
DWS: Drinking Water Standard
EQS: Environmental Quality Standard

Key

XXX	Exceedance of CW/WE Water. DWS - England/Wales
XXX	Exceedance of CW/WE Water. Aquatic Toxicity - England/Wales - Freshwater

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