

Croskell PSP Proposed Drainage Strategy

Desktop Geotechnical Assessment

Prepared for Melbourne Water

Prepared by Water4Good

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Contents

1	Introduction.....	1
1.1	Purpose and objectives	1
1.2	Site description	1
2	Regional Geology	2
3	Ground Condition Discussion.....	3
4	Conclusions and Recommendations	6
4.1	Summary of likely geotechnical conditions.....	6
4.2	Geotechnical suitability and potential construction issues	6
4.3	Future geotechnical investigations	7
5	Important Information About This Report.....	8
	Appendix A – Summary of VVG historical borehole information	
	Appendix B – Important information about this report.....	
	 Figure 1 – Site location	2
	Figure 2 – Excerpt of published geological surface map of Berwick (1:25,000 scale).....	3
	Figure 3 – Excerpt from VVG government online database showing bores containing drillers logs.....	4
	Figure 4 – Nearmap 2013 image during construction of The Avenue Wetlands.....	4
	Figure 5 – Location of nearby boreholes from historical geotechnical investigation undertaken for the Avenue Wetland.....	5
	Figure 6 – Excerpt of geotechnical test results from the Avenue Wetland report	6

Revision History

Revision N°	Prepared By	Description	Date
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Document Acceptance

Action	Name	Signed	Date
Prepared by	Trevor O'Shannessy		25/05/22
Reviewed by	Darren Paul		25/05/22
Approved by	Zaki Matar		01/06/22
on behalf of	Water4Good		

1 Introduction

Melbourne Water has commissioned Water4Good to undertake a desktop geotechnical assessment for the Croskell Precinct Structure Plan (PSP) Proposed Drainage Strategy Project (the Project). The Project involves completing a drainage concept options assessment and functional design of major drainage assets (retarding basin, wetland and new waterway alignment) for the Croskell PSP.

We understand that the proposed project will include:

- Horizontal realignment of existing open drain as well as possible deepening/widening
- Construction of a new wetland retarding basin feature adjacent to Thompsons Road
- Possible construction of a concrete box culvert, connecting the new drainage and wetland works with the existing wetlands on the north side of Thompsons Road or modification upgrade of existing culvert. We understand that the requirement for a new culvert is subject to further design and flood modelling tasks, with a preference to utilize the existing road culvert infrastructure where possible.

As part of these works, this desktop geotechnical study has been undertaken to assist in characterising the ground conditions at the site.

1.1 Purpose and objectives

The objectives of this assessment are to:

- Provide a preliminary characterisation of geotechnical conditions at the site
- Comment on the geotechnical suitability of the proposed retarding basin / wetland feature
- Provide recommendations for geotechnical investigations
- Provide preliminary commentary on potential geotechnical constructability issues

1.2 Site description

The Croskell PSP area (the study area) is located within the suburbs of Cranbourne East and Clyde North, approximately 45 km south-east of Melbourne's CBD, within the south-eastern growth corridor. The study area occurs in the City of Casey Local Government Area (LGA) and is bounded by Thompson's Rd in the north, Berwick-Cranbourne Rd in the east, Narre Warren Rd in the west and Linsell Blvd and mix of residential streets in the south.

The location of the site along with an indication of the areas proposed for the drainage and wetland works is presented in Figure 1.

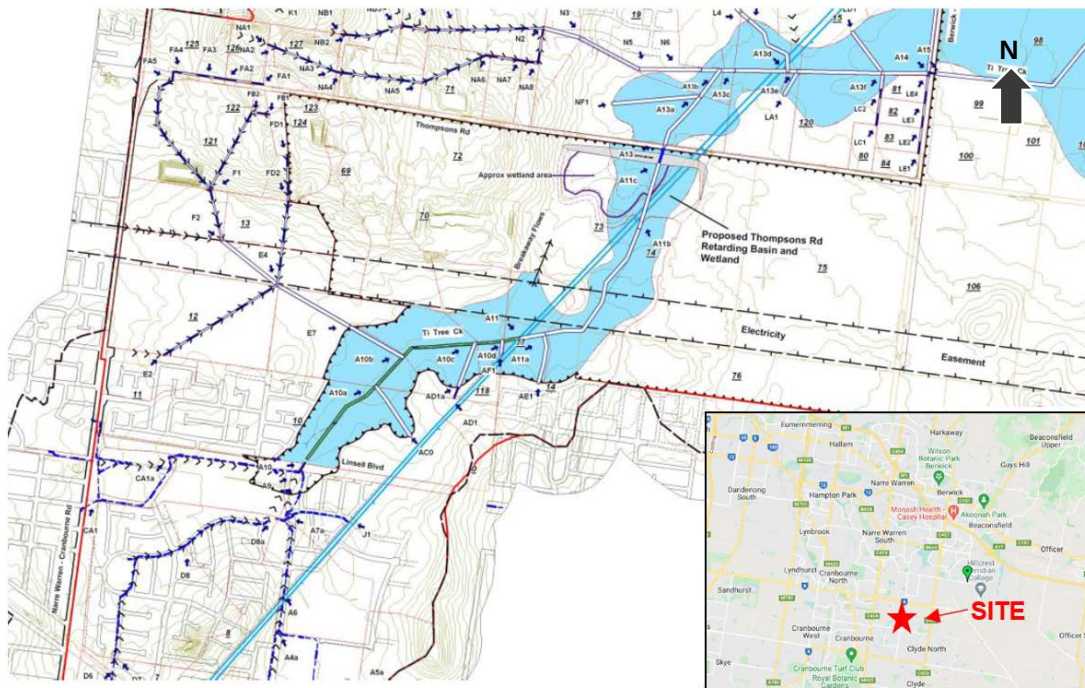


Figure 1 – Site location

2 Regional Geology

The Geological Survey of Victoria (GSV) 1:25,000 scale 'Berwick' map sheet indicates that multiple geological units are present in the project area.

The following geological units are mapped as occurring within the project area (from oldest to youngest):

- Silurian Sedimentary Rock (S): siltstone, sandstone bedrock and associated residual soils
- Older Volcanics unit (Tvo): basalt rock and associated residual soils
- Baxter Formation (Tpb)¹: sandy clay, sand, clayey sand and minor gravel
- Quaternary Aeolian (Qrd): dune sands; sand, silty sand and clayey sand
- Quaternary Alluvium (Qrm): swamp deposits; clay, silt and sandy clay

The surface distribution of the published geology is shown in Figure 2.

Former extractive sand quarry industries are denoted as historically occurring within the green shaded Qrd unit.

¹ Unit is also referred to as Brighton Group and in more recently Sandringham Sandstone in geological published literature.

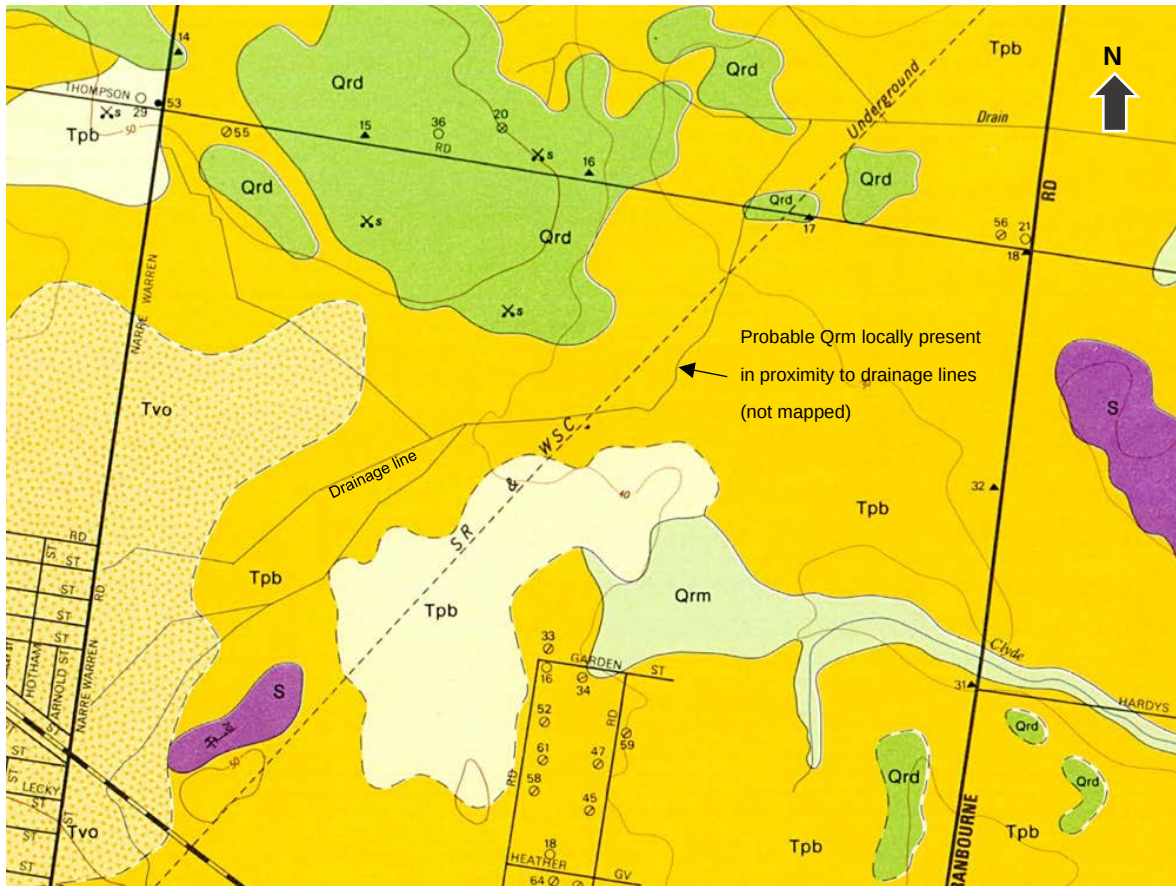


Figure 2 – Excerpt of published geological surface map of Berwick (1:25,000 scale).

3 Ground Condition Discussion

There is generally limited historical borehole information within the project area with which to characterise the site conditions. Where information is available, it is typically near the edges of the site or needs to be extrapolated from further distances within the same geology.

The government web site Visualising Victoria's Groundwater (VVG) depicts several bores near to the site, however only a small selection of these bore records contain information on the soils encountered. Relevant borehole test sites having recorded summary information about the soils encountered are circled in Figure 3. Records of the driller's borehole logs are presented in Appendix A.

Although the drillers logs contain summary information only and do not contain detailed descriptions, there is generally sufficient information to broadly characterise the likely ground conditions. The available information combined with insights from the published geological map (Figure 2) would appear to suggest the following:

- Sandy dune soils (Qrd) are present in the elevated part of the site, broadly between Narre Warren Road and William Thwaites Boulevard, overlying Tertiary clays and sands (Tpb). This area is unlikely to interact with the main retarding basin and channel works which are situated within low lying areas of the site
- Localised weak Quaternary clays (Qrm) in the lower part of the site near to existing drainage channels (refer Figure 2), which overlie Tertiary clays and sands (Tpb)
- Within the west and south west part of the site basalt (Tvo) geology is interpreted to occur. This material is generally deeply weathered, being chemically decomposed to a high plasticity clay soil in its upper part. Historical borehole information suggests that the thickness of weathered clay is in the order of 1.5 m (bore 57426) to greater than 20 m (bore WRK041421) but is more typically around 10 m thickness.

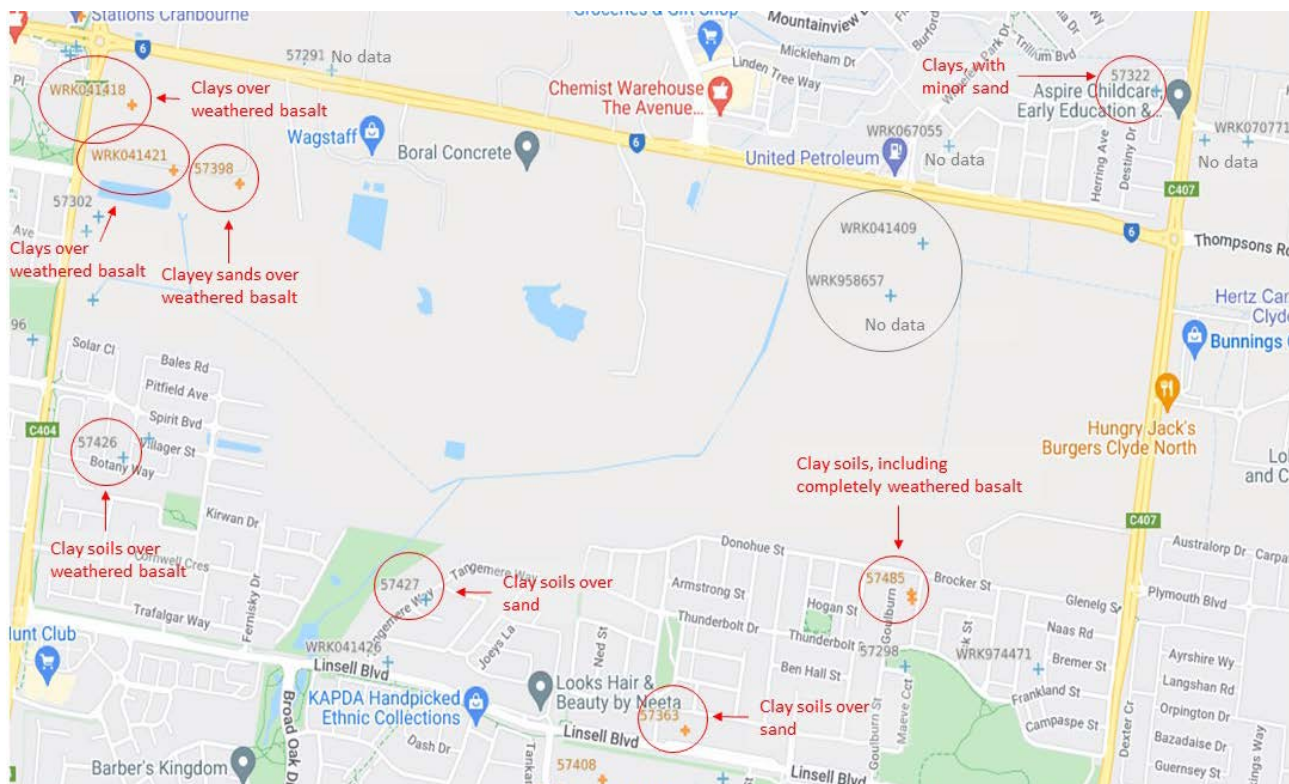


Figure 3 – Excerpt from VVG government online database showing bores containing drillers logs

Investigations undertaken for the Hallam Valley Main Sewer in 2003 within similar geology 3.5 km north of the site next to the existing Berwick Town Drain (north of Greaves Road and east of Montebello Boulevard), generally found a thick layer of clay soils. The soil profile in this area generally consisted of a stiff upper 'crust' of high plasticity clay, which was underlain by soft to firm clay, becoming firm consistency below approximately 2.5 m depth. Groundwater was generally measured to be between 1.5 m and 2.0 m depth in the open standpipe wells installed for this project.

Information on ground conditions can also be inferred from the 'The Avenue Wetlands' located to the north of Thompsons Road. Construction of this feature was undertaken between approximately 2012 and 2014. This feature appears to have been constructed using cut batters in existing natural soil materials for the basin as can be seen in Figure 4.

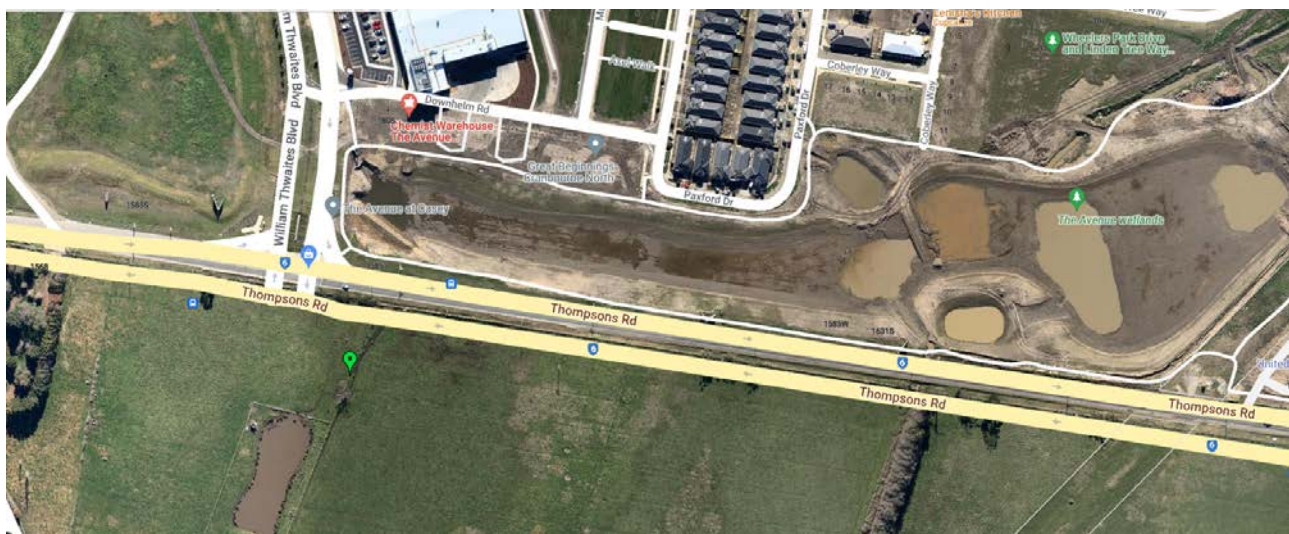


Figure 4 – Nearmap 2013 image during construction of The Avenue Wetlands.

Melbourne Water has supplied a copy of the following geotechnical report pertaining to the Avenue Wetlands site:

- 'Geotechnical Investigation for Wetlands and Waterway, The Avenue, Cranbourne North, Vic.' Prepared by Lane Piper, dated February 2010 (doc ref: 209089Report01.1)

The above historical investigation consisted of eleven boreholes drilled to a maximum depth of 4.2 m. The most relevant (closest) bores to the subject site are BH1, BH10 and BH11, which were drilled to the immediate north of Thompsons Road (refer Figure 5).

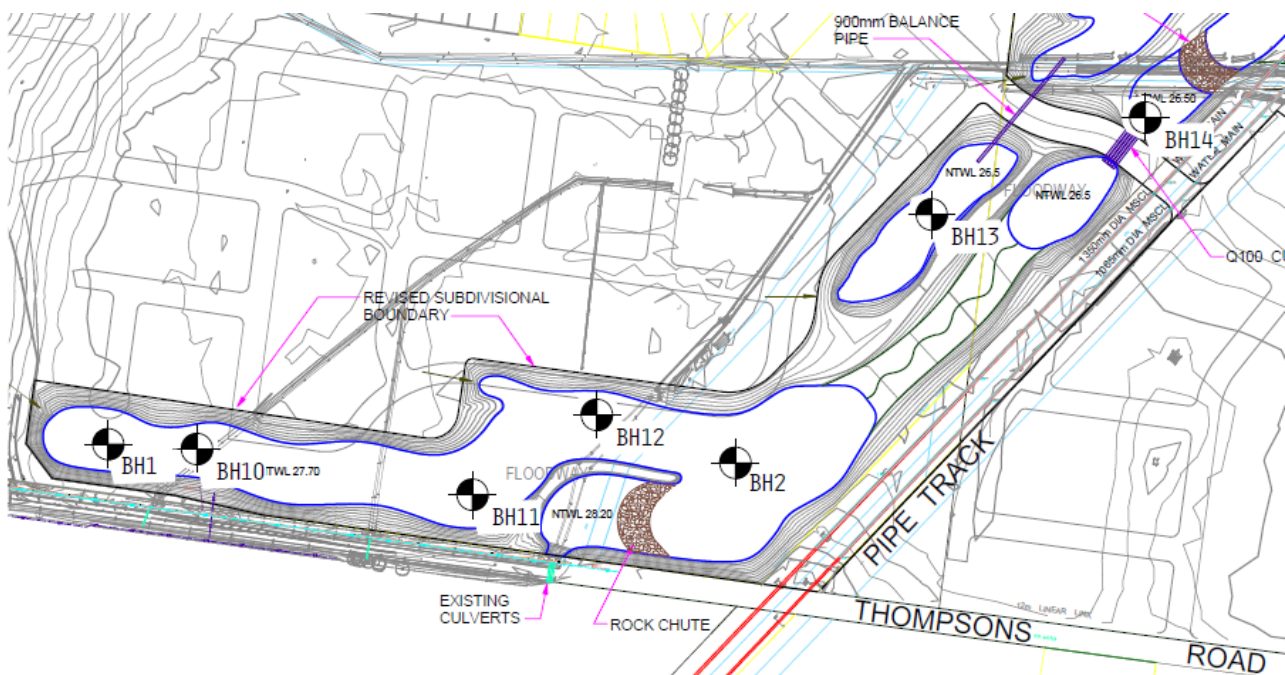


Figure 5 – Location of nearby boreholes from historical geotechnical investigation undertaken for the Avenue Wetland

These boreholes generally found a thin layer of silty topsoil and subsoil (approximately 50 mm to 300 mm thickness), overlying high plasticity clay soils. The clay in its upper part was generally described as being fissured and becoming sandier below approximately 2.0 m. The clay soils in these boreholes were logged as being moist and stiff in the near surface, however they were noted as being very moist or wet below approximately 1.4 m to 2.0 m depth. In BH1 the soil consistency is logged as changing from stiff to soft consistency below 1.4 m depth, coincident with the increase in soil moisture content.

Geotechnical laboratory testing on selected soil samples from across all eleven investigation test sites included:

- Atterberg limit testing
- Soil moisture content testing
- Compaction testing
- Emerson crumb testing (in tap water)
- Pinhole dispersion testing
- Permeability testing (falling head method, on clay samples recompacted to 95% standard maximum dry density)

An excerpt of the results is presented in Figure 6 below:

Table 6-2: Summary of Laboratory & Field Results

Borehole No.	Depth (m)	Subgrade Description	Field Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Max Dry Density (t/m ³)	Optimum Moisture Content (%)	Emerson Class No.	Pinhole Dispersion Designation	Coefficient of Permeability at 20°C (m/s)
BH10	2.0 – 2.4	Silty CLAY	37.3	70	49	1.64	21.0			2.5×10^{-10}
BH11	1.0	Silty CLAY I						Class 6		
BH12	1.3	Silty CLAY	23.1							
BH14	0.6 – 1.0	Silty CLAY				1.75	19.0		ND1	3.4×10^{-10}
BH15	2.2	Silty CLAY	26.8							
BH17	1.5 – 1.9	Silty CLAY		62	42	1.72	19.0		ND1	3.4×10^{-10}
BH20	0.4	Silty CLAY						Class 5		
BH20	3.8	Silty CLAY	34.2							

The permeability tests were conducted on samples remoulded and recompacted to about 95% Standard dry density ratio and close to the Optimum Moisture content. The Emerson, Pinhole and permeability testing were all carried out using Melbourne tap water which was measured to have a TDS of 48 mg/L.

Figure 6 – Excerpt of geotechnical test results from the Avenue Wetland report

The following commentary can be drawn from the geotechnical laboratory results:

- The tested clay soils are of high plasticity, with high liquid limit values
- Compaction testing indicates the moisture content of the in situ soils is generally significantly in excess (wet) of the optimum condition (OMC). For example, BH10 is approximately +15% wet of OMC
- Emerson Crumb and Pinhole testing generally indicate non dispersive soil characteristics
- The permeability remoulded (recompacted) permeability of the clay soils tested is generally low (10^{-9} m/sec to 10^{-10} m/sec range).

4 Conclusions and Recommendations

4.1 Summary of likely geotechnical conditions

Based on the information reviewed, the ground conditions within the proposed channel and wetland basin area are likely to predominantly comprise of clay in the upper part of the soil profile.

The depth of the clay soil profile relative to the design floor depth of the proposed wetland is subject to some uncertainty. However, we would expect that the clay layer would be at least approximately 3 m thick. This approximation is supported by the existing historical borehole information, as well as review of supplementary information pertaining to the adjacent 'The Avenue' wetlands to the north of Thompsons Road.

Strong rock is not expected to be encountered, however depending on the design excavation depth for the proposed drainage channel network, residual clay soils and weathered basalt may be encountered within the southern part of the site.

Groundwater is expected to be shallow and may occur within 2 m to 3 m depth within the low-lying part of the site (i.e. near to the proposed channels and wetland). Groundwater is likely to require management (via sumps and pumping) if encountered during construction of deeper features such as the wetland basin and culvert works.

4.2 Geotechnical suitability and potential construction issues

The proposed site is generally considered suitable for the development of the proposed wetland basin, and ancillary channel and culvert works, however there are some geotechnical issues that may require management, such as:

- Shallow groundwater conditions, which will require management during construction via sumps and pumping.
- High moisture content clays and potential difficulties with achieving compaction targets and/or weak foundation soils which may cause compaction difficulties for placing overlying soil liner materials, etc. This may require selective harvesting of materials to be reused (for example select clay liner materials), and/or drying back of existing soils. (For example, soil testing from the Avenue Wetland area found the samples to be significantly wet of optimum and therefore likely to be problematic if reuse is attempted at the natural moisture state).
- Erosion (batter rilling, or scour). This will require controls including adopting gentle batter angles to reduce surface run-off impacts, the application of protective layers (geosynthetics) and establishment of vegetation.
- Based on the laboratory results from the adjacent Avenue Wetlands site, the clay site soils are likely to be non-dispersive.
- Weak founding soils for the box culvert works, which may require over excavation and replacement with a suitable layer of compacted engineered fill to provide firm base support for the structure.
- Assessment of soil contamination (for example for excess soil disposal) and Potentially Acid Sulfate Soil (PASS) types.

Further investigations will be required to provide an informed assessment of some of the potential geotechnical issues listed above. Our recommended approach to future investigations is described in the following section.

4.3 Future geotechnical investigations

We recommend a staged investigation approach to provide site specific geotechnical information to inform future design and construction work.

We recommend that a preliminary intrusive investigation be undertaken as part of early project stages (for example feasibility or concept design).

This investigation should include as a minimum:

- Approximately 12 test pits excavated within the footprint of the proposed wetland basin area and at the south side of the proposed culvert crossing under Thompsons Road.
- One borehole drilled to approximately 6 m depth through the road on the northern lanes on Thompsons Road under traffic management. This borehole would collect information on the founding conditions for the culvert as well as the existing pavement make-up.
- One borehole drilled to approximately 6 m depth on the south side of Thompsons Road to assess the culvert crossing. This borehole should be installed with an open standpipe groundwater well upon completion to allow for the measurement of groundwater levels.
- Geotechnical testing on collected soil samples for:
 - Field moisture content
 - Standard compaction
 - Atterberg limits
 - Particle size distribution
 - Emerson class
 - Pinhole dispersion
 - Quick undrained triaxial strength (for culvert area)
- Chemical tests
 - For soil waste disposal (i.e. IWRG – 1828)
 - Acid sulfate soil testing
- Groundwater quality testing (e.g. salinity)

5 Important Information About This Report

Your attention is drawn to the document titled – “Important Information Relating to this Report”, which is included in Appendix B of this report. The statements presented in that document are intended to inform a reader of the report about its proper use. There are important limitations as to who can use the report and how it can be used. It is important that a reader of the report understands and has realistic expectations about those matters. The Important Information document does not alter the obligations Water4Good and Golder has under the contract between it and its client.

Appendix A – Summary of VVG historical borehole information

Bore ID	From (m)	To (m)	Lithology
57363	0	0.3	BROWN STRONG CLAY
57363	0.3	3.66	RED AND YELLOW
57363	3.66	6.7	REDDISH GREY DCLAY
57363	6.7	8.53	BROWN SAND

Bore ID	From (m)	To (m)	Lithology
57398	0	1.3	SANDY SOIL
57398	1.3	21.3	FINE CLAYEY SAND
57398	21.3	23.5	MEDIUM HARD PARTLY DECOMPOSED BASALT
57398	23.5	25.5	FIRM CLAYEY BASALT PEAT AND SOME SAND
57398	25.5	30.5	FIRM GRANITE SAND
57398	21.3	30.5	GRANITE

Bore ID	From (m)	To (m)	Lithology
57426	0	0.15	BROWN HEAVY SOIL
57426	0.15	0.76	BROWN CLAY
57426	0.76	1.52	DECOMPOSED BASALTIC CLAY
57426	1.52	2.13	BROWN BASALT
57426	2.13	6.7	HARD BLACK BASALT
57426	6.7	10.06	VERY HARD BLACK BASALT
57426	10.06	13.11	GREY SAND CLAY
57426	13.11	13.71	SAND COARSE AND FINE
57426	13.71	15.54	SAND
57426	14.02	15.54	SAND

Bore ID	From (m)	To (m)	Lithology
57485	0	0.3	TOPSOIL
57485	0.3	2	ORANGE AND GREY CLAY
57485	2	9	VOLCANIC CLAY
57485	9	12	WHITE CLAY
57485	12	12.2	SANDY DRIFT
57485	12.2	16.8	LIGHT GREY CLAY
57485	16.8	17.5	MEDIUM SAND
57485	16	17.5	SAND

Bore ID	From (m)	To (m)	Lithology
WRK041418	0	0.3	SURFACE SOIL
WRK041418	0.3	10.7	CLAY
WRK041418	10.7	17.7	DECOMPOSED BASALT AND IRONSTONE PIECES
WRK041418	17.7	26.2	WEATHERED BASALT
WRK041418	26.2	29.8	BASALT
WRK041418	29.8	38.7	VERY HARD BASALT
WRK041418	38.7	41.5	LIGNITE AND BROWN CLAY

Bore ID	From (m)	To (m)	Lithology
WRK041421	0	21.3	FIRM BROWN CLAY
WRK041421	21.3	22.4	MEDIUM HARD PARTLY DECOMPOSED BASALT
WRK041421	22.4	24.5	MEDIUM HARD BASALT
WRK041421	24.5	33.5	HARD BASALT (BLUE)
WRK041421	33.5	39.6	PEAT BROKEN FIRM
WRK041421	39.6	41	CLAYEY PEAT AND SOME SAND
WRK041421	41	71.5	MEDIUM HARD SANDSTONE (SHALE) FRACTURED

Bore ID	From (m)	To (m)	Lithology
57427	0	9.1	MOTTLED BROWN CLAY
57427	9.1	16.4	WHITE CLAY
57427	16.4	18.8	SAND
57427	18.8	21	BROWN CLAY
57427	16.4	19.2	SAND

Bore ID	From (m)	To (m)	Lithology
57322	0	0.15	TOP SOIL
57322	0.15	4	SOFT GREY CLAY
57322	4	6	YELLOW CLAY
57322	6	7	SANDY DRIFT
57322	7	9	YELLOW CLAY
57322	9	13	GREY CLAY
57322	13	16	ORANGE CLAY
57322	16	16.05	FINE WHITE SAND
57322	16.05	18.5	MUDSTONE

Appendix B – Important information about this report



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