Stormwater Management Strategy

177 Bonnyvale Road, Ocean Grove

May 2026

Loetis Pty Ltd
Version: Rev02

City of Greater Geelong, Statutory Planning - Date Received 08/05/2026

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Document Control

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Report Title	**Stormwater Management Strategy**
Loetis Reference	**J10361**
Author	[redacted]
Approved By	[redacted]

Disclaimer

Contents

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1 Background

1.1 Introduction

Loetis has been engaged by Collendina Holiday Park Pty Ltd to complete a stormwater assessment and prepare a Stormwater Management Strategy to accompany the planning permit application for a proposed extension of the existing Collendina Holiday Park located at 177 Bonnyvale Rd, Ocean Grove. This property will be herein referred to as the 'subject site'.

The existing title is approximately 29.3 hectares with the existing Holiday Park occupying approximately 7.5 hectares. The proposed expansion area, the subject site, is approximately 2.28 hectares bring the total Holiday Park site to approximately 9.8 hectares. The site is situated to the east of the Ocean Grove residential area, directly north of the Lorne – Queenscliff Coastal reserve. The property contains an existing crest within the sites northeastern corner resulting in the property falling to the east and south. The subject site falls within the City of Greater Geelong municipality and is currently zoned as Farm Zone.

The property is bound on the north and western boundaries by existing Farm Zone properties and on the south by the existing Collendina Holiday Park access road. The eastern boundary borders the existing Holiday Park development.

The subject site currently contains a large shed within the southwest corner and minimal other known infrastructure. Development of the site proposes to expand the existing holiday park further west within the parent title.

The subject site and its proximity to the adjacent features described above are indicated in Figure 1 below.

Figure 1 - Site Location and Existing Context (Image courtesy QGIS)

The proposed expansion will result in an increase in impervious surface area comparative to the existing conditions, which if not mitigated will result in an increase in stormwater runoff volumes, flowrates and contaminant loading. This report demonstrates a stormwater assessment based on proposed development expectations and discusses the water quality, quantity and conveyance systems proposed to be implemented to ensure the development delivers best practice stormwater treatment objectives and in accordance with local council and the planning scheme requirements.

2 Study Objectives

The objective of this Stormwater Assessment is to demonstrate that a compliant solution is available for the development in a manner that accords with local authority and best practice guidelines for stormwater quality and stormwater quantity treatment and flow conveyance. This will enable the expansion to meet anticipated conditions and requirements to be set in the planning permit for stormwater management and ensure that stormwater quality and quantity targets are achieved and maintained.

The site is located within City of Greater Geelong municipality boundary, as such stormwater objectives are based on local regulatory requirements as outlined in the Infrastructure Design Manual (IDM) and our professional understanding of Council's preferred infrastructure delivery mechanisms for stormwater treatment in infill developments.

Stormwater runoff generated within the site will be captured and conveyed via a combination of the underground drainage network and overland flow paths to the integrated stormwater treatment nodes prior to discharge to the site Legal Point of Discharge (LPOD).

Specific objectives are detailed below.

2.1 Site Stormwater Objectives

The site stormwater objectives are:

1. Best Practice reductions for Water Quality

    - 80% reduction in Suspended solids (SS)
    - 45% reduction in total nitrogen (TN)
    - 45% reduction in total phosphorus (TP)
    - 70% reduction in gross pollutants (GP)

2. Stormwater Conveyance

    Conveyance of flows up to and including the 1% AEP flows.

3. Stormwater Quantity

    Ensuring no increase in stormwater rates discharging from the Legal Point of Discharge (LPOD) for events up to and including the 1% AEP flows.

The following stormwater management strategy will provide details on the stormwater treatment infrastructure and associated infrastructure requirements for the mitigation of runoff from the development to ensure stormwater discharge targets are achieved before the designated LPOD.

2.2 Limitations

At this stage of the development process, initial geotechnical investigations have been completed however no feature survey has been undertaken. The stormwater management strategy presented here is therefore based on limited site investigations and publicly available data to assess the potential stormwater mitigation options for the site.

As more detailed, site-specific information becomes available—particularly survey —it is expected that this strategy and the associated recommendations will be refined and updated accordingly.

3 Catchment Assessment

3.1 Existing Site Conditions

The proposed expansion site is approximately 2.28-hectare land parcel bounded by existing property to the north and west, Collendina Holiday Park access road to the south and the existing Collendina Holiday Park to the east. The site ranges in elevation from a crest located within the northwest portion of the at 3.4m AHD centrally and falls to the south, southeast and east frontages to a level of 2.2m AHD, 3.0m AHD and 2.0m AHD respectively. The existing fall to the boundaries is relatively flat, varying in grade falling at between 1V:300H and 1V:70H.

The existing land parcel contains minimal infrastructure with a large shed and other outbuildings located within the subject sites southeast corner, with a formalised access off Bonnyvale Road forming the southern boundary. The Lidar survey of the site is provided in Figure 2 below.

Figure 2 – Existing Site Flow Regime

Bonnyvale Road contains the closest known City of Greater Geelong drainage assets, with no drainage infrastructure within the site or site frontage, including no open drains or channels. Figure 3 indicates the known drainage assets surrounding the subject site.

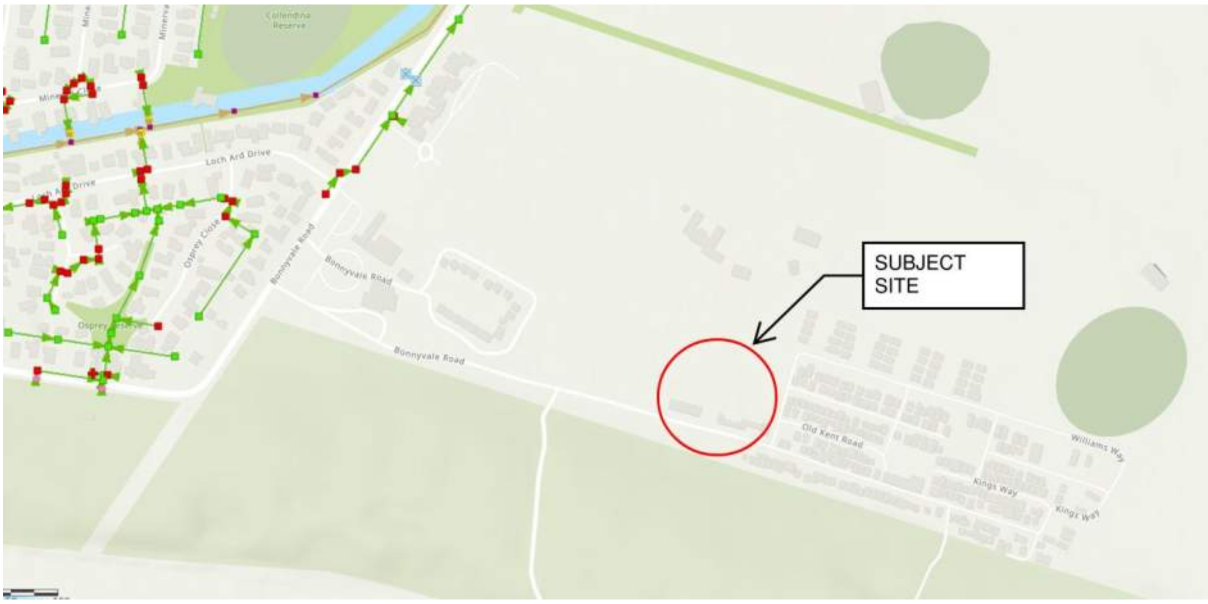


Figure 3 – Existing Drainage Assets (Courtesy of https://cogggis.geelongcity.vic.gov.au)

Table 1 provides the adopted existing catchment parameters for the subject site.

Table 1 – Existing Site Catchment Parameters

Catchment	Total (m^2)	Impervious area (m^2)	Pervious area (m^2)	Impervious area (%)	Pervious area (%)
Subject Site	**22,800**	**1,140**	**21,660**	**5**	**95**

3.2 Developed Site Conditions

Development of the site will include the addition of additional cabins, playgrounds, associated carpark park and roadways as well as amenities areas. The proposed development layout is provided in Figure 4.

Figure 4 – Proposed Development Layout (Image courtesy Ellis Group Architects)

The proposed development drainage parameters are provided Table 2 below. A 60% impervious fraction has been adopted for the site. This aligns with conditions typically observed in comparable holiday parks. These sites generally contain extensive landscaped areas alongside significant hardstand surfaces—such as internal roads, parking areas, cabins, and communal buildings. This proportion reflects the mixed-use layout and provides a reasonable, conservative estimate of runoff for design purposes.

Table 2 – Developed Site Catchment Parameters

Catchment	Total (m^2)	Impervious area (m^2)	Pervious area (m^2)	Impervious (%)	Pervious area (%)
Subject Site	22,800	13,680	9,120	60	40

3.3 Legal Point of Discharge (LPOD)

Due to the lack of surrounding capable drainage infrastructure, it is proposed to formalise discharge to crate based infiltration systems. In rainfall events above the major event, overflows will be directed via overland flow paths to the existing roadways.

To inform the initial development of the stormwater strategy, regional geological mapping has been utilised to obtain confidence that suitable soils exist to allow this approach.

Regional geotechnical mapping has indicated that the site likely consist of R2 Swamp/Alluvial Soils and/or R3 Raised Coastal Deposits.

Swamp/Alluvial Soils (sand, silt) generally represents low-lying, water-affected deposits formed in swamp and stream environments, typically made up of sand and silt.

Raised Coastal Deposits (siliceous and calcareous sands, shell beds, guano), consist of uplifted former coastal or shoreline materials, including quartz-rich and shell-derived sands, shell accumulations, and organic layers typical of coastal or island settings.

Both classes, particularly the sandy coastal deposits in R3, are typically associated with high infiltration capacity, with R2 also allowing good infiltration where sand dominates. As a result, the mapped geology suggests favourable conditions for on-site infiltration-based stormwater management.

Regional Geological Mapping is provided in Appendix A.

Percolation testing was subsequently undertaken at the site and is provided in Appendix E. Findings from the percolation testing confirmed the suitability of site soil conditions for stormwater infiltration.

4 Stormwater Mitigation Strategy

Due to the lack of suitable surrounding drainage infrastructure and the significant distance to the nearest formal drainage network, the site does not have a practical option for new drainage connections or downstream extensions. As a result, no new external drainage connections are proposed.

Instead, the concept design recommends formalising discharge to an onsite infiltration-based system or systems, where runoff conveyed to these systems will infiltrate into the surrounding soil profile rather than being transported to a regional catchment outfall.

The following section demonstrates compliance with general expectations, planning provisions and the planning scheme.

4.1 Stormwater Quantity

Development of the subject site will increase the total impervious area within the subject site. The development proposes to integrate a crate-based infiltration system capable of dissipating flows up to the 1% AEP (100 Year ARI) storm event. Due to the proposed infiltration of 100% of stormflows to the surrounding soil profile, outflows below predeveloped flowrates are achieved.

4.2 Stormwater Infiltration

Stormwater generated within the site is proposed to be directed to infiltration systems consisting of a crate-based storage and infiltration system. To undertake system design, an Infiltration Rate of 100mm/hr has been adopted. This adopted rate is 20mm/hr lower than that determined during onsite testing ensuring (as provided in Appendix E) a conservative design approach during this initial stage of project progression

The following summarises a single system, designed to service the proposed expansion area. It is expected that during detail design multiple infiltration systems may be adopted around the site, as opposed to the single system design documented herein. Should multiple systems be proposed, system design should be reviewed.

The input parameters and resultant infiltration system details are provided below in Table 3.

Table 3 – Infiltration System Properties

Location	AEP	Design Infiltration Rate (mm/hr)	Proposed Storage Volume (m^3)	System Dimensions (LxWxH)	Proposed Storage Method
Whole Site	1%	100mm/hr	584	15m x 50m x 0.78m	Crate based system

Accompanying infiltration system calculations are provided in Appendix C. Details of an underground storage system, namely the 'Atlan Cube' are provided in Appendix D. Results of the site percolation testing are provided in Appendix E

It should be noted, that for this stormwater management plan, several percolation tests were undertaken to inform this report. Should the ultimate site design propose alternative locations it is recommended that subsequent percolation tests are undertaken at each of the proposed locations.

4.3 Stormwater Quality Modelling

To demonstrate compliance with stormwater quality objectives, MUSIC6 software has been utilised to model the above mentioned infiltration system. The model has generally been produced in accordance with Melbourne Water's MUSIC Modelling Guidelines (2018). Refer below for the assigned model parameters.

4.3.1 Rainfall Data

The COGG supplied 087133_GeelongNorth_1971-1980_6min_infilled was utilised for the project in accordance with City of Greater Geelong MUSIC Guidelines. Reference years 1/11971 – 31/12/1980

4.3.2 Rainfall Runoff Parameters

The characteristics of the catchment modelled in MUSIC are detailed in Table 4. The presented values have been compiled using the parameters nominated within City of Greater Geelong Design Notes No.3.

Table 4 - MUSIC Simulations – Catchment Properties

Catchment Characteristics	
Catchment Name	Subject Site
Catchment Area (m^2)	22,800
Zoning/Surface Type	Mixed
Impervious Area (%)	60
Pervious Area (%)	40
Impervious Area Properties	
Rainfall Threshold (mm/day)	1.00
Pervious Area Properties	
Soil Storage Capacity (mm)	120
Initial Storage (% of Capacity)	30
Field Capacity (mm)	50
Infiltration Capacity Coefficient - a	200
Infiltration Capacity Coefficient – b	1
Groundwater Properties	
Initial Depth (mm)	10
Daily Recharge Rate (%)	25
Daily Baseflow Rate (%)	5
Daily Deep Seepage Rate (%)	0

4.4 Stormwater Quality Treatment Train

The proposal for the development consists of a

- Gross Pollutant Trap prior to infiltration system
- Infiltration System

Should infiltration system product specifications recommend additional treatment prior to the system inlet, detail design shall follow the manufactures recommendations.

A screenshot of the MUSIC model simulation is provided below.

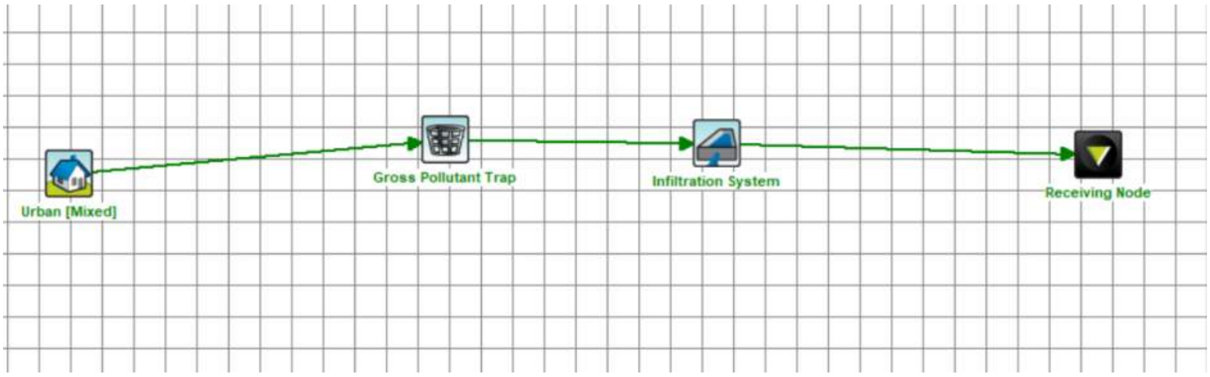


Figure 5 - MUSIC Model Simulation (prepared by Atlan Stormwater)

Product details for the Atlan product and general arrangement are enclosed with the Appendix D.

Table 5 and Table 6 below describes the parameters of the proposed treatment train modelled in MUSIC.

Table 5 – Proprietary Treatment – MUSIC Inputs (GPT)

	GPT*	
Inlet Properties		
Low Flow By-pass (m^3/s)	0.0	
High Flow By-pass (m^3/s)	0.0	
Efficiencies	**Input (mg/l)**	**Output (mg/l)**
Flow	1	1
Suspended Solids	1000	290
Total Phosphorous	100	100
Total Nitrogen	100	100
Gross Pollutants	15	0.75

*For the purpose of this stage of the project modelling, removal efficiency data specific to an Atlan Ecoceptor has been utilised

Table 6 – Infiltration System – MUSIC Inputs

	Lot 1 (Church)
Inlet Properties	
Low Flow By-pass (m^3/s)	0.0
High Flow By-pass (m^3/s)	100.0
Storage Properties	
Surface Area (m^2)	750
Extended Detention Depth (m)	0.73
Exfiltration Rate (mm/hr)	100
Evaporation Loss as % of PET	0
Outlet Properties	
Low Flow Pipe Diameter (mm)	5
Overflow Weir Width (m)	2
Notational Detention Time (Hrs)	$3.06x10^3$

4.4.1 Modelling Results

The end-of-line efficiencies for the treatment train described above are as follows:

Table 7 – Stormwater Quality Treatment Efficiencies

	Reduction (%)	
Criteria	**Result**	**Target**
Total Suspended Solids (kg/yr)	100	*80*
Total Phosphorus (kg/yr)	100	*45*
Total Nitrogen (kg/yr)	100	*45*
Gross Pollutants (kg/yr)	100	*70*

4.5 Stormwater Conveyance

To accommodate the stormwater runoff generated during storm events, a provision for conveyance will be necessary. It is envisioned that all site flows, originating from building roofs and carpark areas, will be directed into infiltration systems via a combination of underground drainage lines for minor storm events and overland flow paths for major events.

Flows in excess of the infiltration system capacity will follow the topography of the land into the respective transport corridors.

5 Conclusion & Recommendations

The site stormwater objectives for the development of the subject site can be achieved by adopting a treatment train and new stormwater infrastructure as follows:

- Infiltration pretreatment. Minimum Gross Pollutant Trap. (Pending manufacture specifications)
- Infiltration System. Approximate Dimensions 15m wide x 50m long x 0.78m deep. Approximate volume 584m^3
  - Distributed infiltration may be adopted pending civil design and detailed geotechnical investigation

It is expected that additional survey and geotechnical investigation may be undertaken at the site to validate this stormwater assessment at the post permit detail design phase.

If required, refinement of modelling calculations should be completed for both stormwater quality, stormwater quantity and infiltration system design models during the detailed design phase. This will allow for optimised delivery requirements which can be tailored to meet specific development constraints that are raised as the development progresses and additional investigations are undertaken.

5.1 Delivery Mechanism

It is suggested that the above recommendations should be adopted and that the future planning permit include conditional requirement for delivery of stormwater infrastructure in accordance with this Stormwater Management Strategy. Detailed design specifications will be subject to Engineering approval prior to works commencing.

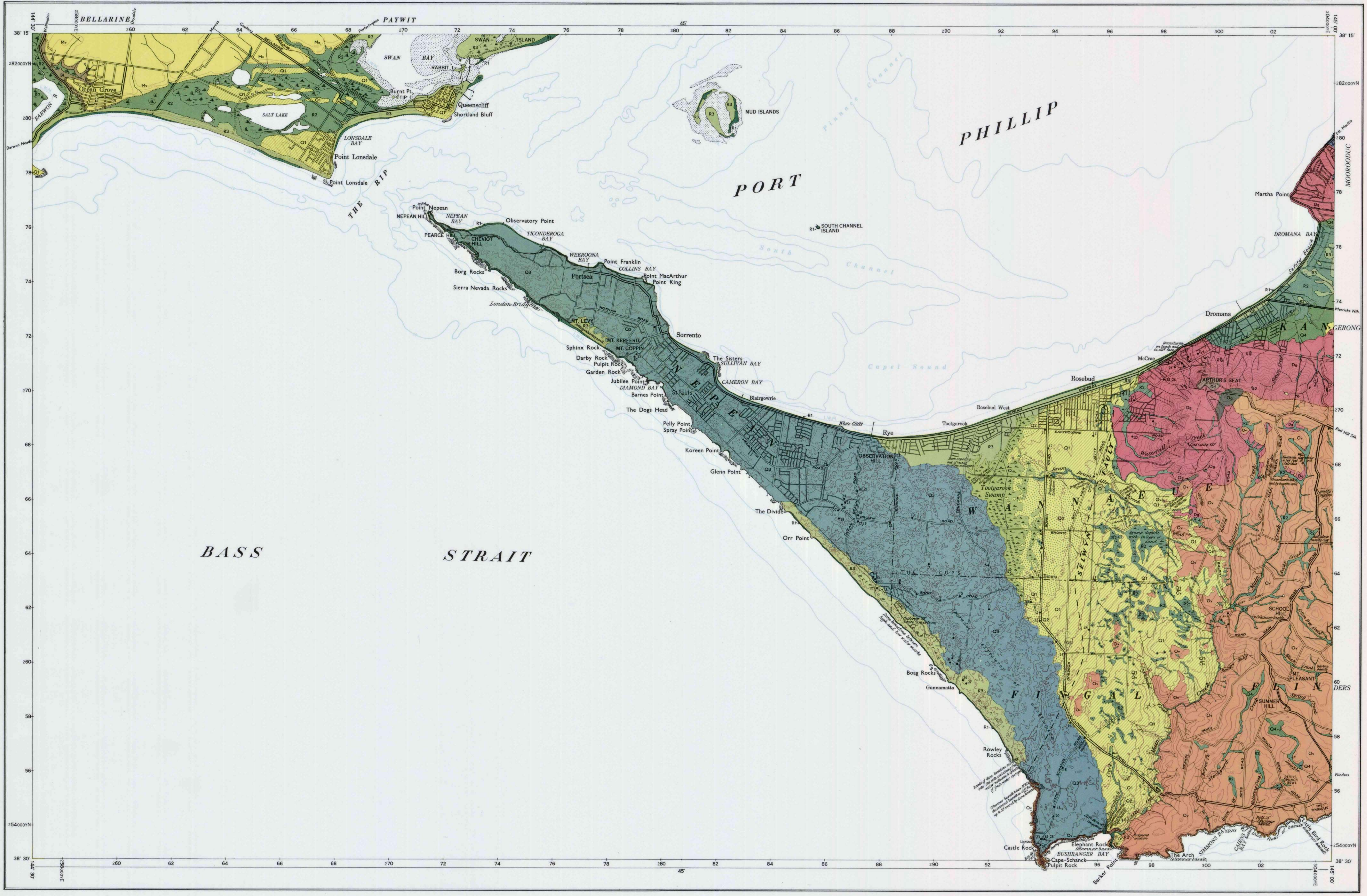
Appendix A – Regional Geotechnical Mapping

AUSTRALIA 1:63,360

SORRENTO

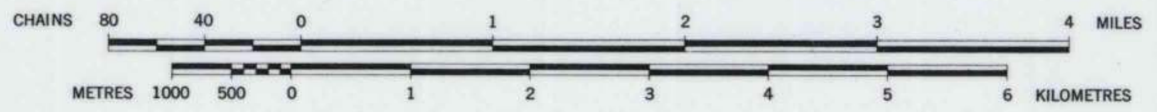
GEOLOGICAL SURVEY OF VICTORIA

NO. 867 ZONE 7



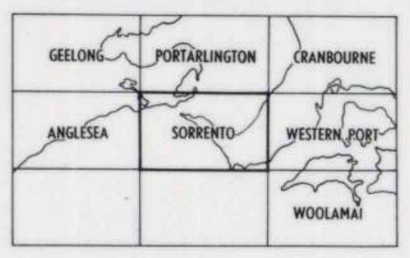
Quaternary	Recent to Pleistocene	R1	Coastal deposits: siliceous sand, shell beds
		R2	Swamp deposits, stream alluvium: sand, silt
		R3	Raised coastal deposits, siliceous and calcareous sand, shell beds, guano (Mud Islands)
		Q4	Fluviatile deposits: clay, silt, sand, gravel
		Q3	Aeolian deposits —high level irregular dunes: siliceous and calcareous sand
		Q2	Aeolian deposits —subdued dunes: siliceous and calcareous sand, aeolianite
		Q1	Aeolian deposits —older dune and sheet sands: siliceous sand, aeolianite
Tertiary	Lower Pliocene	Q	Lagoonal deposits: sandy and concretionary limestone, calcareous and ligneous clay
		Mv	Moorarbool Viaduct Sands: sand, clay, gravel, clayey sand, ferruginous sandstone
	Miocene	Ba	Baxter Sandstone: ferruginous sandstone, sand, gravel, sandy clay
		Bf	Fyansford Clay: silt, silty clay, sandy clay, marl, limestone—fossiliferous
	Oligocene	Og	Gravel
	Eocene	Ov	Older Volcanics: basalt, tuff
Palaeozoic	Upper Devonian ?	Dg	Granodiorite, granite
		Dd	Hornblende dacite
	Lower Ordovician	Lo	Slate, sandstone, chert

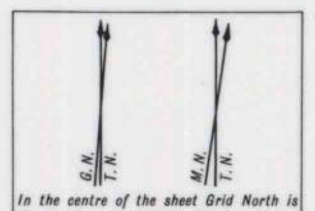
Scale 1 Mile to 1 Inch



Contour interval 50 feet

INDEX TO ADJOINING SHEETS





In the centre of the sheet Grid North is 0° 9' 1" east of True North and the magnetic declination from True North is approximately 10°30'

Geological boundary, position approximate
Dyke
Quarry Q.
Dam
Spring, well •S
Mines Department bore 18
Trig. station △
Pier, jetty or wharf
Water channel, drain
Cliff (foreshore area)
Rock platform exposed at low tide
Highway, main road
Other roads
Railway line and station
Parish boundary
Parish name PAYWIT
Mud (foreshore area)
Swamp deposits
Low water mark L.W.M.
Fathom line
Depression contours 50
Contours 250 200 150

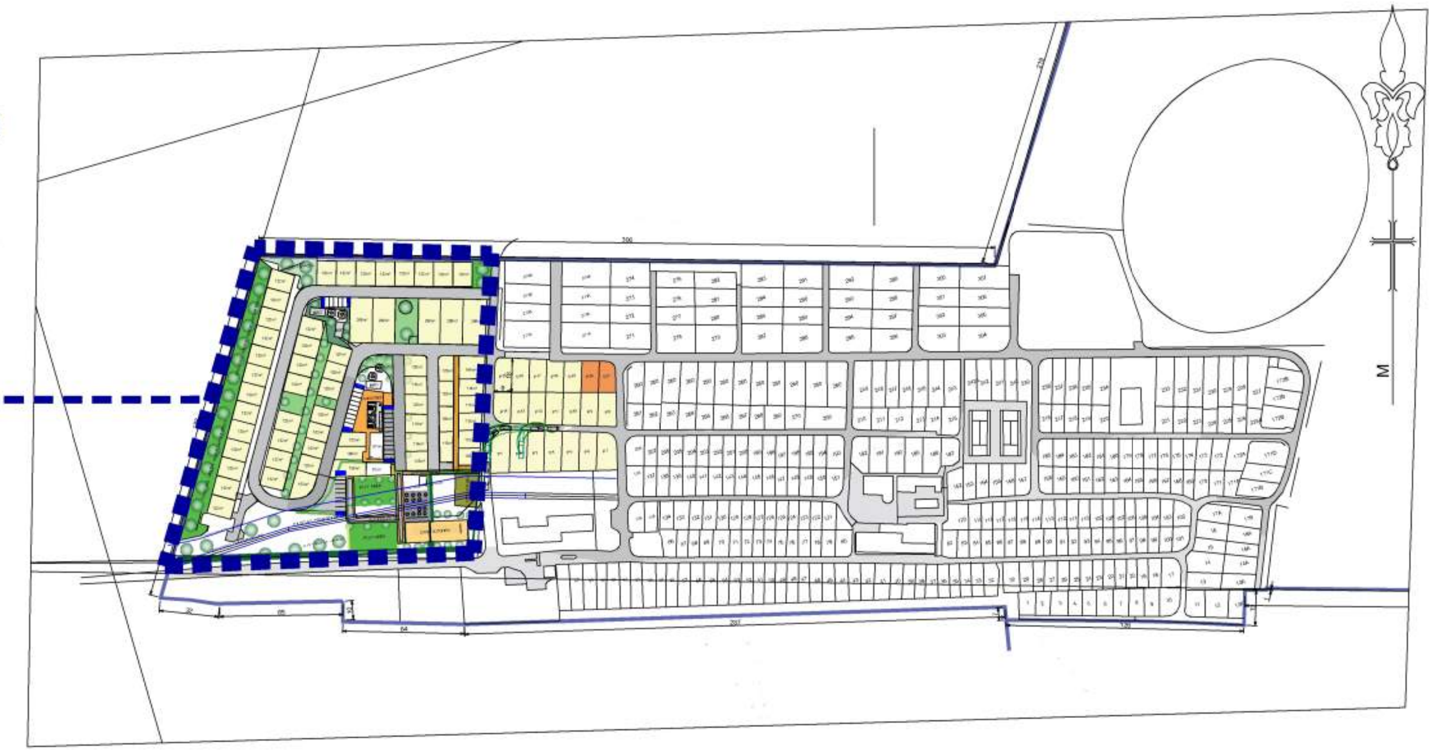
Mornington Peninsula previously geologically surveyed by R. A. Keble.
Revised by J. J. Jenkin, M.Sc., Ph.D., 1965.
Bellarine Peninsula geologically surveyed by D. Spencer-Jones, B.Sc., Ph.D., 1965.
D. E. Thomas, D.Sc., F.A.A., Director of Geological Survey.
Drawn for reproduction in the Department of Mines, Melbourne, Victoria, by D. W. McInnes, M.A.I.C., Chief Draughtsman, 1967.
Issued by E. J. Condon, LL.B., Secretary for Mines, under the authority of the Hon. J. C. M. Balfour, M.L.A., Minister of Mines.
A. C. Brooks, Government Printer.

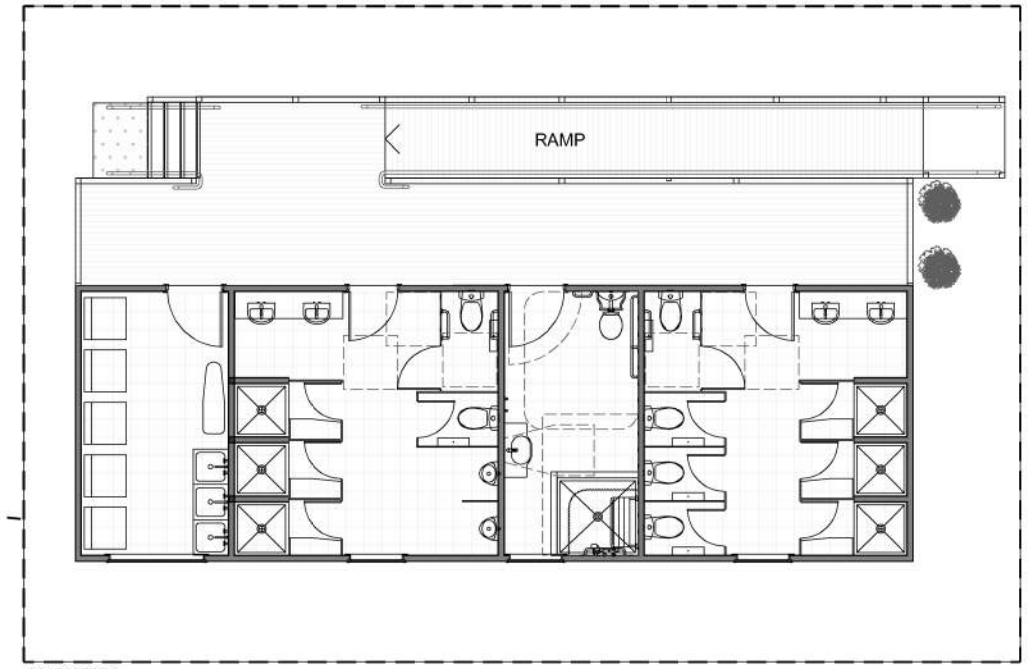
SORRENTO

NO. 867 ZONE 7

Appendix B – Proposed Layout Plan

PROPOSED NEW
DEVELOPMENT 5.63 ACRES





AMENITIES
MANUFACTURED

NOTE : - INDIVIDUAL SITE BOUNDARYS ARE APPROX ONLY

CONCEPT ONLY

COLLENDINA HOLIDAY PARK
177 BONNYVALE RD, OCEAN GROVE VIC 3226
PROPOSED NEW SITES (63)

CLIENT:		DRAWN: THARANGA LAKPRIYA .	
SCALE: NTSAT A3	SHEET: A3	JOB:	DATE: 25/06/2025

Appendix C – Infiltration System Design

Project : Collendina Caravan Park
Ref. No. : J10361
Description : Whole Site
Designer T.Davis

Geotechnical Info	0.000028	m3/sec/m2
	0.000028	m/sec
	0.028	mm/sec
	100.8	mm/hr

Catchment Area	2.28	ha
Volumetric Runoff Coefficient	0.6	Assumed due to no confirmed layout
Design ARI	100	year

Input Parameters

∀	See Givin Storm Duration	Inflow Volume (m3)
k(h)	0.000028000	soil saturated hydraulic conductivity (m/s)
k(h)	100.8	soil saturated hydraulic conductivity (mm/hr)
U	1.0	soil hydraulic conductivity moderating factor
D	See Givin Tc	Storm Duration
es	0.95	void space
L	See Givin Storm Duration	trench length (m)
b	15.0	trench width (m)
d/H	0.8	trench depth (m)
A(inf)	See Givin Storm Duration	
P	See Givin Storm Duration	Perimeter length of the infiltration area (m)
Qout	24.24	l/sec when full
Total Surface Area	865.55	m2
Critical Area	762.82	
Critical Perimeter	131.71	

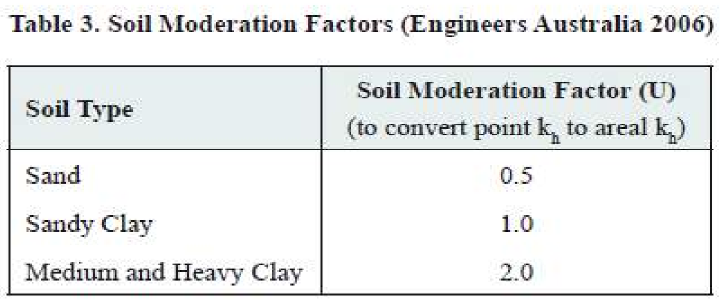


Table 3. Soil Moderation Factors (Engineers Australia 2006)

Soil Type	Soil Moderation Factor (U) (to convert point k_h to areal k_h)
Sand	0.5
Sandy Clay	1.0
Medium and Heavy Clay	2.0

750

Description	Time of Concentration, Tc (mins)	Coeff. of Runoff, C	ARI (yrs)	Intensity, I (mm/hr)	Catchment Area, (ha)	Developed Storm Flow, Q (cumecs)	Inflow Volume (m3)	Outflow Volume (m3)	Required Storage (m3)	Infiltration Trench Length (m)	Infiltration Trench Area A(inf) (m2)	Infiltration Trench Perimeter (m)
Whole Site	5	0.60	100	168.90	2.28	0.6418	192.546	2.368088869	200.1872749	17.12391265	256.8586897	64.24782529
Whole Site	10	0.60	100	123.34	2.28	0.4687	281.2152	6.751352591	288.9093131	24.72536284	370.8804426	79.45072568
Whole Site	15	0.60	100	99.06	2.28	0.3764	338.7852	12.00673967	343.9773267	29.45233989	441.7850984	88.90467979
Whole Site	30	0.60	100	65.43	2.28	0.2486	447.5412	30.52367917	438.9658114	37.63805798	564.5708698	105.276116
Whole Site	45	0.60	100	50.44	2.28	0.1917	517.5144	51.16581847	490.8932437	42.14806975	632.2210462	114.2961395
Whole Site	60	0.60	100	41.68	2.28	0.1584	570.1824	72.78234987	523.5790001	45.01566044	675.2349066	120.0313209
Whole Site	120	0.60	100	25.93	2.28	0.0985	709.4448	161.09972	577.2053474	49.89897046	748.4845569	129.7979409
Whole Site	180	0.60	100	19.54	2.28	0.0743	801.9216	246.2093185	584.9602963	50.85451549	762.8177323	131.709031
Whole Site	360	0.60	100	12.07	2.28	0.0459	990.7056	470.03948	548.0696	48.50961216	727.6441825	127.0192243
Whole Site	720	0.60	100	7.56	2.28	0.0287	1241.0496	810.9207879	452.7671706	41.74297152	626.1445728	113.485943
Whole Site	1440	0.60	100	4.80	2.28	0.0182	1575.936	1272.682908	319.2137816	32.59670072	488.9505107	95.19340143
Whole Site	2880	0.60	100	3.02	2.28	0.0115	1983.0528	1825.826001	165.5018936	23.17246671	347.5870007	76.34493342

Appendix D – Infiltration System – Atlan Cube

Atlan®
STORMWATER

AtlanCube®

Modular stormwater storage & detention

Modular & Scalable Geocellular OSD

A versatile geocellular tank design for stormwater detention, retention, reuse, and infiltration, easily customisable to meet site-specific tank volume requirements.

Multistack Configurations

AtlanCube is available in single, double and triple stack vertical profiles ranging from 780mm height to 2340mm height.

Reduced Footprint & Subsurface OSD

Compact OSD solution for below ground installation, designed to maximise land yield and performance.

Efficient Storage Capacity

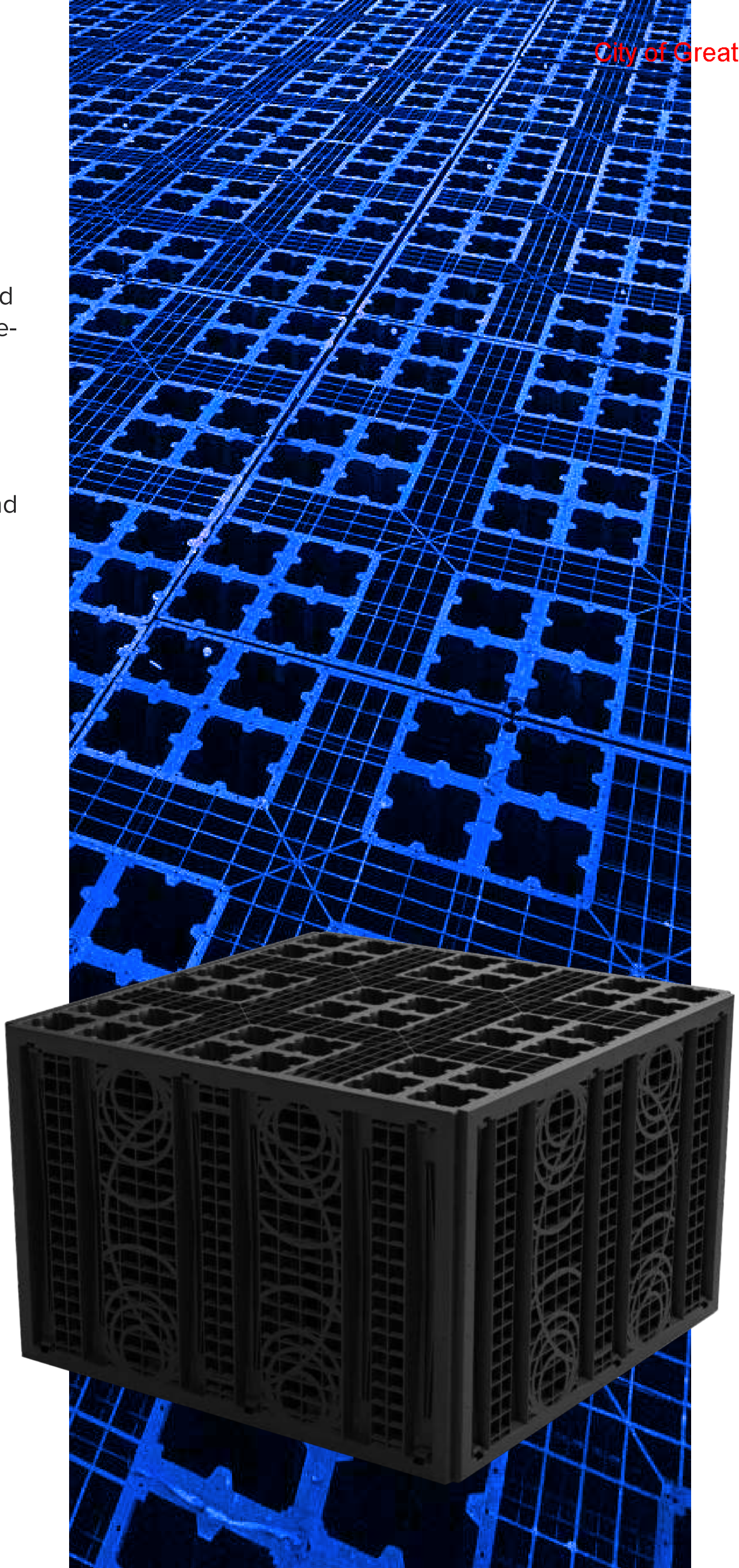
Two components per 1,000L of module storage capacity.

Durable Construction

Built from robust, long-lasting polypropylene (PP) for increased service life in stormwater management applications.

Low Maintenance

Compatible with treatment devices. Easy maintenance with simplified cleaning and maintenance procedures, reducing operational downtime and costs.



Cost-Effective

Reduced excavation, freight, and lifting requirements contribute to significant cost savings across project timelines.

Sustainable and Eco-Friendly

Made from 100% recycled PP, contributing to reduced carbon footprint and supporting eco-friendly stormwater management.

Reduced Excavation

Eliminates the need for gravel or rock in storage areas, reducing excavation and installation costs.

Quick Installation

Modular, lightweight components ensure fast and efficient installation, expediting project timelines - no crane requirements.

Trafficable Design

Rated for Class D loading, designed for robust load capacity and full trafficability.

Watertight Construction

Option for encasing the system in a welded, pressure-tested LLDPE liner to ensure water tightness - ideal for retention applications.

The AtlanCube® is a modular, underground cube tank system that is suited to detention, retention, reuse and infiltration applications. Meeting site specifications for stormwater harvesting and flood mitigation, it is a scalable, sustainable, and versatile solution for water quantity management in freestanding configurations or in combination with other WSUD assets.

Locally manufactured, AtlanCube's unique cellular design results in efficiently engineered void spaces with a 97% storage ratio that provide high performance in stormwater retention and detention scenarios. Requiring no gravel or rock within the tank storage area, its modular, lightweight components feature expedited install times, CO^{2} reductions, freight efficiency and reduced excavation requirements.

Maximising lot yield through subsurface installation, AtlanCube is designed for robust load capacity and full trafficability.

AtlanCube	Height (mm)	Min. Installed Depth (mm)
Single Stack	780	1380
Double Stack	1560	2160
Triple Stack	2340	2940

Applications

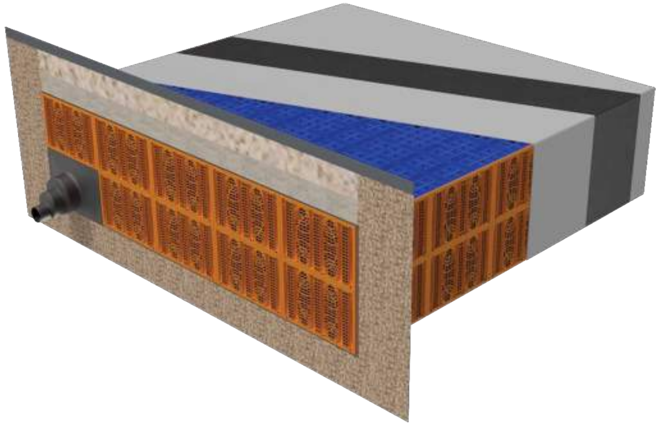
- Car parks
- Landscaping
- Hardstands

Pretreatment system devices

Primary treatment is recommended for incoming stormwater flows prior to their entry into the AtlanCube system. This reduces the conveyance of gross pollutants and sediments from upstream catchments and decreases the build-up of these pollutants in the tank chambers – which impact the asset's storage capacity, service life, and optimal performance.

This ability to pretreat pollutants greatly reduces the maintenance load on downstream tank systems. Pretreatment limits the requirements for routine maintenance of the AtlanCube to cleaning out the primary treatment system. This cost-effective approach ensures maintenance overheads are reduced, compared to a full maintenance schedule having to be performed on the entire tank chambers. However, it is critical that these pretreatment assets are maintained in a regular, routine fashion.

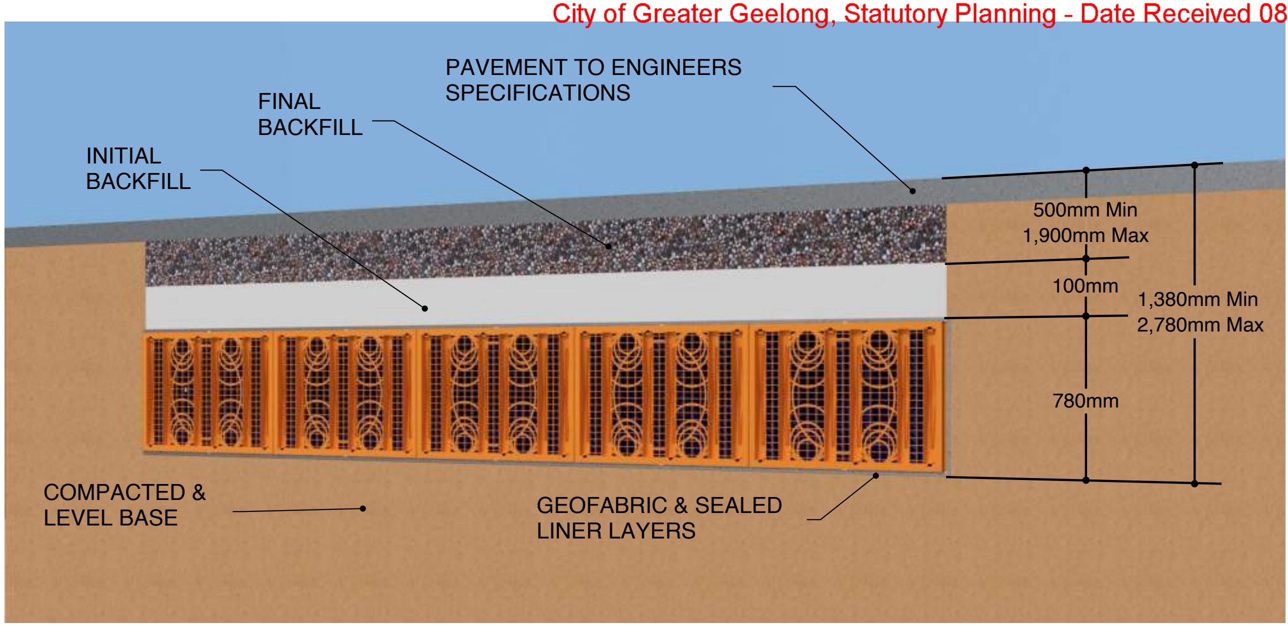
Atlan has multiple Primary Treatment Systems that are recommended for this solution. Our in-house design team can help you to explore the options available for your site's catchment pollutant loads and developmental requirements.



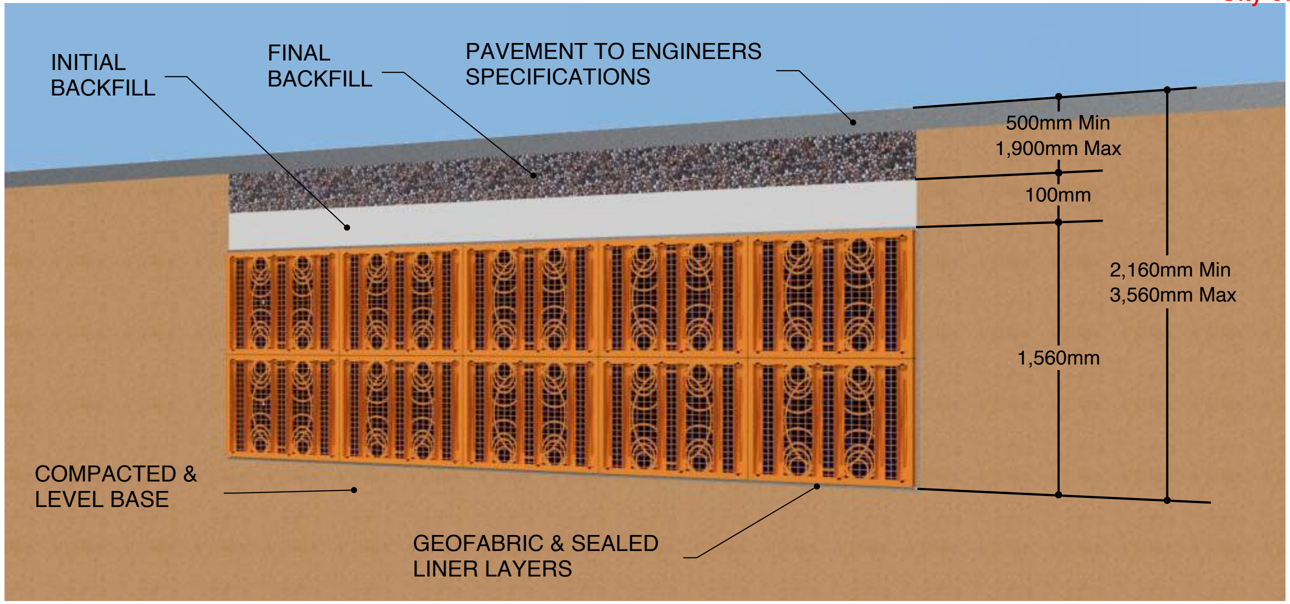
City of Greater Geelong, Statutory Planning - Date Received 08/05/2026

AtlanCube Single Stack

- Height: 780mm
- Min. installed depth: 1380mm
- Max. installed depth: 2780mm



		ATLANCUBE WIDE QUANTITY (WIDTH)									
	QTY	1 (1.2M)	2 (2.35m)	3 (3.5m)	4 (4.65m)	5 (5.8m)	6 (6.95m)	7 (8.1m)	8 (9.25m)	9 (10.4m)	10 (11.55M)
ATLANCUBE LONG QUANTITY (LENGTH)	1 (1.2m)	1m3	2m3	3m3	4m3	5m3	6m3	7m3	8m3	9m3	10m3
	2 (2.35m)	2m3	4m3	6m3	8m3	10m3	12m3	14m3	16m3	18m3	20m3
	3 (3.5m)	3m3	6m3	9m3	12m3	15m3	18m3	21m3	24m3	27m3	30m3
	4 (4.65m)	4m3	8m3	12m3	16m3	20m3	24m3	28m3	32m3	36m3	40m3
	5 (5.8m)	5m3	10m3	15m3	20m3	25m3	30m3	35m3	40m3	45m3	50m3
	6 (6.95m)	6m3	12m3	18m3	24m3	30m3	36m3	42m3	48m3	54m3	60m3
	7 (8.1m)	7m3	14m3	21m3	28m3	35m3	42m3	49m3	56m3	63m3	70m3
	8 (9.25m)	8m3	16m3	24m3	32m3	40m3	48m3	56m3	64m3	72m3	80m3
	9 (10.4m)	9m3	18m3	27m3	36m3	45m3	54m3	63m3	72m3	81m3	90m3
	10 (11.55m)	10m3	20m3	30m3	40m3	50m3	60m3	70m3	80m3	90m3	100m3
	11 (12.7m)	11m3	22m3	33m3	44m3	55m3	66m3	77m3	88m3	99m3	110m3
	12 (13.85m)	12m3	24m3	36m3	48m3	60m3	72m3	84m3	96m3	108m3	120m3
	13 (15m)	13m3	26m3	39m3	52m3	65m3	78m3	91m3	104m3	117m3	130m3
	14 (16.15m)	14m3	28m3	42m3	56m3	70m3	84m3	98m3	112m3	126m3	140m3
	15 (17.3m)	15m3	30m3	45m3	60m3	75m3	90m3	105m3	120m3	135m3	150m3
	16 (18.45m)	16m3	32m3	48m3	64m3	80m3	96m3	112m3	128m3	144m3	160m3
	17 (19.6m)	17m3	34m3	51m3	68m3	85m3	102m3	119m3	136m3	153m3	170m3
	18 (20.75m)	18m3	36m3	54m3	72m3	90m3	108m3	126m3	144m3	162m3	180m3
	19 (21.9m)	19m3	38m3	57m3	76m3	95m3	114m3	133m3	152m3	171m3	190m3
	20 (23.05m)	20m3	40m3	60m3	80m3	100m3	120m3	140m3	160m3	180m3	200m3
	21 (24.2m)	21m3	42m3	63m3	84m3	105m3	126m3	147m3	168m3	189m3	210m3



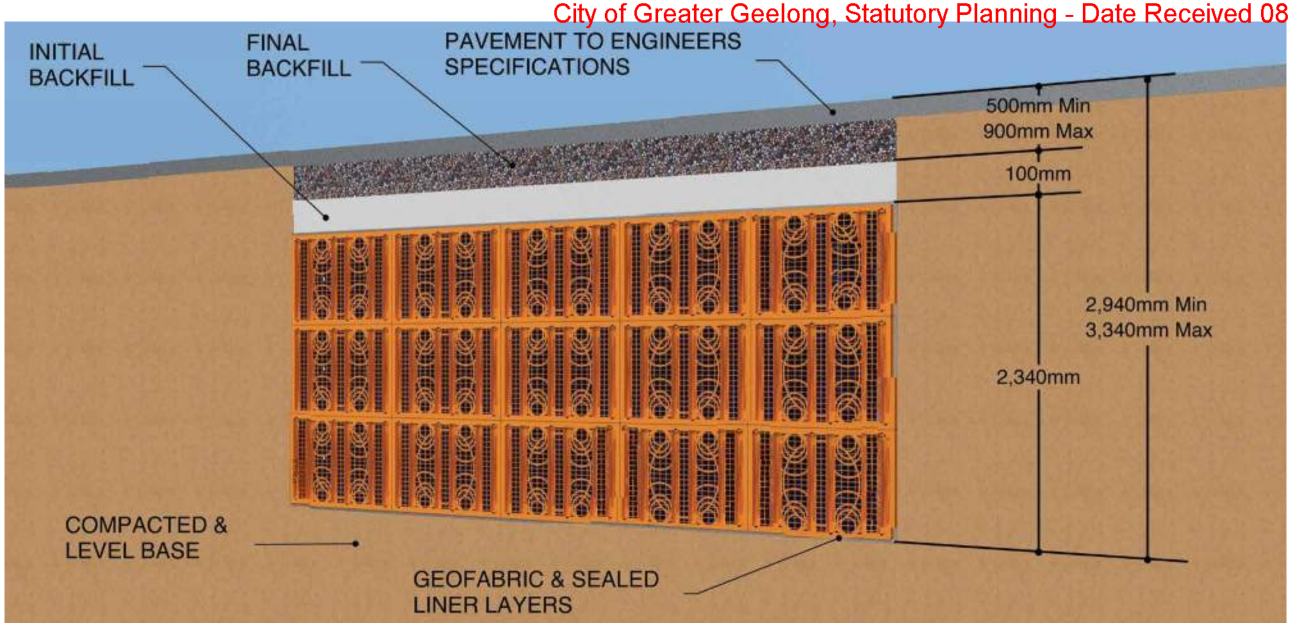
		ATLANCUBE WIDE QUANTITY (WIDTH)									
	QTY	1 (1.2M)	2 (2.35m)	3 (3.5m)	4 (4.65m)	5 (5.8m)	6 (6.95m)	7 (8.1m)	8 (9.25m)	9 (10.4m)	10 (11.55M)
ATLANCUBE LONG QUANTITY (LENGTH)	1 (1.2m)	2m3	4m3	6m3	8m3	10m3	12m3	14m3	16m3	18m3	20m3
	2 (2.35m)	4m3	8m3	12m3	16m3	20m3	24m3	28m3	32m3	36m3	40m3
	3 (3.5m)	6m3	12m3	18m3	24m3	30m3	36m3	42m3	48m3	54m3	60m3
	4 (4.65m)	8m3	16m3	24m3	32m3	40m3	48m3	56m3	64m3	72m3	80m3
	5 (5.8m)	10m3	20m3	30m3	40m3	50m3	60m3	70m3	80m3	90m3	100m3
	6 (6.95m)	12m3	24m3	36m3	48m3	60m3	72m3	84m3	96m3	108m3	120m3
	7 (8.1m)	14m3	28m3	42m3	56m3	70m3	84m3	98m3	112m3	126m3	140m3
	8 (9.25m)	16m3	32m3	48m3	64m3	80m3	96m3	112m3	128m3	144m3	160m3
	9 (10.4m)	18m3	36m3	54m3	72m3	90m3	108m3	126m3	144m3	162m3	180m3
	10 (11.55m)	20m3	40m3	60m3	80m3	100m3	120m3	140m3	160m3	180m3	200m3
	11 (12.7m)	22m3	44m3	66m3	88m3	110m3	132m3	154m3	176m3	198m3	220m3
	12 (13.85m)	24m3	48m3	72m3	96m3	120m3	144m3	168m3	192m3	216m3	240m3
	13 (15m)	26m3	52m3	78m3	104m3	130m3	156m3	182m3	208m3	234m3	260m3
	14 (16.15m)	28m3	56m3	84m3	112m3	140m3	168m3	196m3	224m3	252m3	280m3
	15 (17.3m)	30m3	60m3	90m3	120m3	150m3	180m3	210m3	240m3	270m3	300m3
	16 (18.45m)	32m3	64m3	96m3	128m3	160m3	192m3	224m3	256m3	288m3	320m3
	17 (19.6m)	34m3	68m3	102m3	136m3	170m3	204m3	238m3	272m3	306m3	340m3
	18 (20.75m)	36m3	72m3	108m3	144m3	180m3	216m3	252m3	288m3	324m3	360m3
	19 (21.9m)	38m3	76m3	114m3	152m3	190m3	228m3	266m3	304m3	342m3	380m3
	20 (23.05m)	40m3	80m3	120m3	160m3	200m3	240m3	280m3	320m3	360m3	400m3
	21 (24.2m)	42m3	84m3	126m3	168m3	210m3	252m3	294m3	336m3	378m3	420m3

AtlanCube Double Stack

- Height: 1560mm
- Min. installed depth: 2160mm
- Max. installed depth: 3560mm

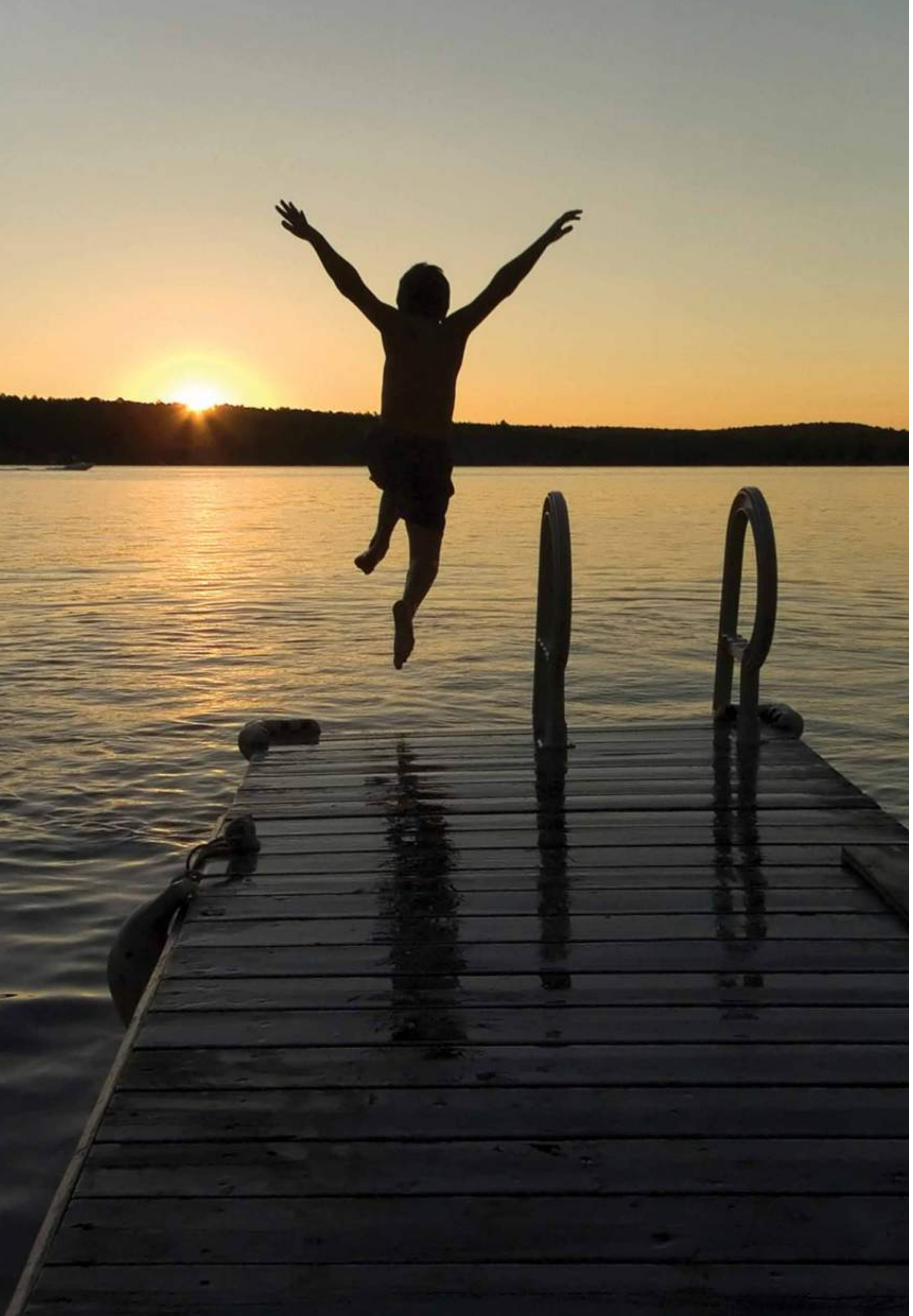
AtlanCube Triple Stack

- Height: 2340mm
- Min. installed depth: 2940mm
- Max. installed depth: 3340mm



		ATLANCUBE WIDE QUANTITY (WIDTH)									
	QTY	1 (1.2M)	2 (2.35m)	3 (3.5m)	4 (4.65m)	5 (5.8m)	6 (6.95m)	7 (8.1m)	8 (9.25m)	9 (10.4m)	10 (11.55M)
ATLANCUBE LONG QUANTITY (LENGTH)	1 (1.2m)	3m3	6m3	9m3	12m3	15m3	18m3	21m3	24m3	27m3	30m3
	2 (2.35m)	6m3	12m3	18m3	24m3	30m3	36m3	42m3	48m3	54m3	60m3
	3 (3.5m)	9m3	18m3	27m3	36m3	45m3	54m3	63m3	72m3	81m3	90m3
	4 (4.65m)	12m3	24m3	36m3	48m3	60m3	72m3	84m3	96m3	108m3	120m3
	5 (5.8m)	15m3	30m3	45m3	60m3	75m3	90m3	105m3	120m3	135m3	150m3
	6 (6.95m)	18m3	36m3	54m3	72m3	90m3	108m3	126m3	144m3	162m3	180m3
	7 (8.1m)	21m3	42m3	63m3	84m3	105m3	126m3	147m3	168m3	189m3	210m3
	8 (9.25m)	24m3	48m3	72m3	96m3	120m3	144m3	168m3	192m3	216m3	240m3
	9 (10.4m)	27m3	54m3	81m3	108m3	135m3	162m3	189m3	216m3	243m3	270m3
	10 (11.55m)	30m3	60m3	90m3	120m3	150m3	180m3	210m3	240m3	270m3	300m3
	11 (12.7m)	33m3	66m3	99m3	132m3	165m3	198m3	231m3	264m3	297m3	330m3
	12 (13.85m)	36m3	72m3	108m3	144m3	180m3	216m3	252m3	288m3	324m3	360m3
	13 (15m)	39m3	78m3	117m3	156m3	195m3	234m3	273m3	312m3	351m3	390m3
	14 (16.15m)	42m3	84m3	126m3	168m3	210m3	252m3	294m3	336m3	378m3	420m3
	15 (17.3m)	45m3	90m3	135m3	180m3	225m3	270m3	315m3	360m3	405m3	450m3
	16 (18.45m)	48m3	96m3	144m3	192m3	240m3	288m3	336m3	384m3	432m3	480m3
	17 (19.6m)	51m3	102m3	153m3	204m3	255m3	306m3	357m3	408m3	459m3	510m3
	18 (20.75m)	54m3	108m3	162m3	216m3	270m3	324m3	378m3	432m3	486m3	540m3
	19 (21.9m)	57m3	114m3	171m3	228m3	285m3	342m3	399m3	456m3	513m3	570m3
	20 (23.05m)	60m3	120m3	180m3	240m3	300m3	360m3	420m3	480m3	540m3	600m3
	21 (24.2m)	63m3	126m3	189m3	252m3	315m3	378m3	441m3	504m3	567m3	630m3


CAT



Joy in water

‘We believe clean waterways are a right, not a privilege and we work to ensure a Joy in Water experience for you, with your family & friends.’

Andy Hornbuckle, CEO

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INTERNATIONAL
atlanstormwater.com

LOETIS

Appendix E – Soil Permeability Testing – St Quentin

St Quentin

Soil Permeability Report

177 Bonnyvale Road, Ocean Grove

April 2026

Version 1

St Quentin

St Quentin Consulting Pty Ltd
ABN: 45 120 048 857
www.stqc.com.au
[redacted]

Document Control

Document Title: Soil Permeability Report

Client: Collendina Holiday Park Pty Ltd

Job No: 18725G

Version No:	Date Created	Prepared by	Reviewed by
1	29/04/2026	O.R.	C.F.

	Version No.			
	1	2	3	4
Issued to	Client			

Contents

Appendices

1.0 Scope Of Report

We have been commissioned by the client Collendina Holiday Park Pty Ltd to conduct a limited geotechnical investigation at the address shown to examine the soil profile conditions and to conduct testing for in-situ permeability testing for the purposes of designing an on-site stormwater management system.

2.0 Site Description

The proposed development site currently features a large shed. The proposed construction site is on the north side of the caravan park access street. The site is virtually flat. Site surface drainage is fair to good. The site is clear of trees. A satellite view of the site is presented in Figure 1.

Figure 1: Aerial photograph of the site and surrounding area, nearmap.com.

3.0 Testing Program and Results

3.1 Data gathering – desk top studies

In preparation of conducting a field investigation of the site, preliminary data was gathered from the following sources:

- Department of Primary Industries – the GeoVic website has details on geological features and mapping and the Victorian Resources Online website has information about soil properties.
- Aerial photos and maps published by Google and Nearmap.
- Previous investigations and reports in the nearby area prepared by us and other consultants both published and unpublished.

3.2 Field Investigation

Four (4) boreholes were drilled to a maximum depth of 1.50m at the locations nominated on the site plan. Disturbed soil samples were collected and hand classified.

The approximate locations are shown on the borehole location plan presented in Appendix A. Descriptions of the soils encountered during testing are shown in the attached borehole logs presented in Appendix B. Refer to Appendix C for raw data and permeability calculations.

Our testing has revealed that the natural soil profile comprises manly silty sands with deeper thin layers of sandy clay predominately developed from Quaternary age sediments **(Bridgewater Formation)**. Limestone bands approximately 50 mm thick were encountered, along with refusal on thicker limestone horizons. The site does not have imported fill. Geology mapping with contours is presented in Figure 2.

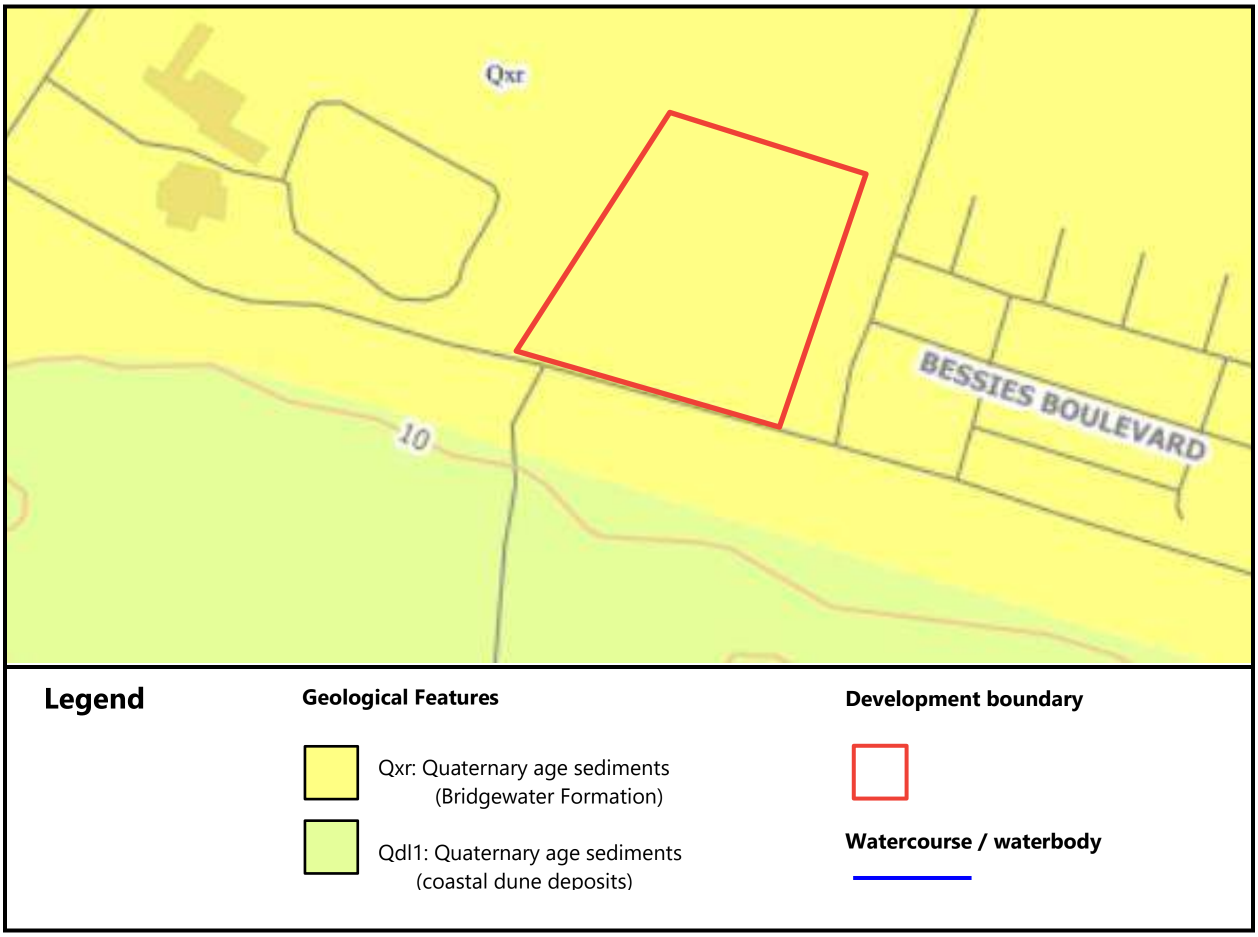

Figure 2: Site geology, source: geovic.vic.gov.au

4.0 Conclusions and Recommendations

4.1 Permeability testing

In-situ permeability testing was performed using the "constant head method". Depth measurements were taken until stable infiltration rates were recorded. Testing was undertaken at three locations, as shallow refusal encountered in Borehole 4 did not permit testing at that location. Table 1 presents a summary of the test results.

Table 1: Summary of permeability test results

Testing location	Material	In-situ Measured Hydraulic Conductivity (K)	Calculated Saturated Hydraulic Conductivity (Ksat)
Borehole 1	Silty Sand	2.0 x 10^{-3} m/sec	1.0 x 10^{-5} m/sec
Borehole 2	Silty Sand	8.3 x 10^{-3} m/sec	3.4 x 10^{-5} m/sec
Borehole 3	Silty Sand	1.1 x 10^{-2} m/sec	5.6 x 10^{-5} m/sec

The onsite percolation tests in the silty sand revealed a mean soil percolation rate of 8.3 x 10^{-3} m/sec which equates to a Saturated Hydraulic Conductivity (K) Value of approximately 3.4 x 10^{-5} m/sec. This equates to a K value of approximately **120 mm/hr.**

4.2 Location of infiltration systems

Infiltration systems should not be placed near building footings. Moisture ingress into the footing area is known to cause edge heave (lifting) or settlement depending on the footing type.

Minimum setbacks defined by Engineers Australia (2003) suggest a minimum distance form structures and property boundaries of 1.0m.

5.0 Report Limitations

The purpose of this report is to conduct a limited and preliminary geotechnical investigation. Where any variation or anomalies are encountered we recommend additional investigation and reporting by us to resolve any potential issues.

This report has been prepared by qualified persons and based on current available standards.

Recommendations are based on information regarding the site and development type provided by the client Collendina Holiday Park Pty Ltd. If information supplied is not accurate or if significant changes are required our report may be inappropriate. We cannot accept responsibility for significant changes and anticipate additional fees should further tests or report update be required.

We have prepared this report for this project at 177 Bonnyvale Road, Ocean Grove in accordance with the scope of works provided by the client. This report has been prepared for the sole use of Collendina Holiday Park Pty Ltd or authorised agents. Therefore, it should not be used for any other different purpose or used by a non authorised agent or third party.

Recommendations are based on the assumption that limited test positions are representative of the sub-surface profile. Whilst care has been taken to accurately report on the sub-surface conditions across the site it is not possible to anticipate unexpected sub-surface variations given the limited testing performed.

Therefore, further testing may be required where significant variations on sub-surface conditions are encountered.

St Quentin Consulting does not accept responsibility for our report where it has been altered or not reproduced in full, including addendum.

Changes in legislative policy may require report update or additional testing.

5.1 General Comments

Dimensions, slope, test locations are approximate only and must not be used for calculation of positioning.

Offset distance to any subsurface excavations must not exceed the minimum angle of repose for the in-situ naturally occurring soil. We estimate the maximum angle of repose for sand is 30 and 45 for clay soils. We do not recommend steeper angles unless competent rock is encountered.

We trust this information meets your requirements.

Prepared by:

[redacted]

Geotechnical Engineer
St. Quentin Consulting Pty Ltd

NATIONAL ENGINEERING REGISTER
NER

Reviewed by:

[redacted]

Geotechnical Manager
St. Quentin Consulting Pty Ltd

NATIONAL ENGINEERING REGISTER
NER

CHARTERED
CPEng

Appendix A

Borehole Location Plan

Borehole Locations

Legend:

⌖	**Borehole Locations**
▬	**Development Site**

Notes:

1. Actual location of boreholes was determined by the presence of underground services, drainage assets, property access and structures present in the site.
2. Dimensions and areas shown are approximate only

St. Quentin

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P.O. Box 919 Geelong 3220
P: (03) 5201 1811 **F**: (03) 5229 2909
www.stqc.com.au ABN: 45 120 048 857

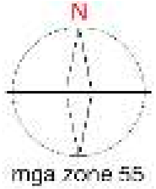
Borehole Location Plan

Location: 177 Bonnyvale Road
Ocean Grove, Victoria

Source: nearmap.com - March 2026

Project No: 18725G
Inv. date: 27/04/2026
Drawing No: 1
Scale: NOT TO SCALE

Drawn by: O.R.
Date: 28/04/2026
Approved by: C.F.
Date: 28/04/2026



Appendix B

Borehole Logs

Soil and Rock Symbols

Soil and Rock Descriptions

BOREHOLE LOG

St. Quentin

Client:	Collendina Holiday Park Pty Ltd	**Project No.:**	18725G	**Sheet:**	1 of 1
Location:	177 Bonnyvale Road	**Borehole No:**	BH 1	**Logged by:**	O.R.
	Ocean Grove, Victoria	**Inv. Date:**	27/04/2026	**Checked by:**	C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Classification	Consistency / Density	Moisture	Geology and additional observations	Allowable Bearing Pressure
0.2 0.4	0.20 0.40	Silty SAND Brown Fine grained Loose, moist Becoming light grey with depth	SP	L	M	Quaternary age sediments Bridgewater Formation (Qxr)	Not tested
0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2		Borehole 1 refused at 0.4m on Limestone band					

Moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering:

XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	Very Soft	Fb	Friable
S	Soft	VL	Very Loose
F	Firm	L	Loose
St	Stiff	MD	Medium Dense
VSt	Very Stiff	D	Dense
H	Hard	VD	Very Dense

Method:

☑ Hand Auger
☐ Auger Drilling
☐ Roller/Tricone
☐ Washbore
☐ Non Destructive Digging

BOREHOLE LOG

St. Quentin

Client: Collendina Holiday Park Pty Ltd
Location: 177 Bonnyvale Road
Ocean Grove, Victoria

Project No.: 18725G
Borehole No: BH 2
Inv. Date: 27/04/2026

Sheet: 1 of 1
Logged by: O.R.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Classification	Consistency / Density	Moisture	Geology and additional observations	Allowable Bearing Pressure
		Silty SAND Grey Fine grained Loose, moist	SP	L	M	Quaternary age sediments Bridgewater Formation (Qxr)	Not tested
0.2	0.20	Becoming light grey and medium dense with depth					
0.4							
0.6							
0.8	0.80	Becoming fine to medium grained and grey to light yellow with depth					
1.0	1.10						
1.2	1.30	Sandy CLAY Dark yellow Medium plasticity Stiff, moist	CI	St	M		
1.4	1.50	Silty SAND Yellow Fine to medium grained Medium dense, moist					
1.6		Borehole 2 terminated at 1.5m					
1.8							
2.0							
2.2							

Moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering:

XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	Very Soft	Fb	Friable
S	Soft	VL	Very Loose
F	Firm	L	Loose
St	Stiff	MD	Medium Dense
VSt	Very Stiff	D	Dense
H	Hard	VD	Very Dense

Method:

- ☑ Hand Auger
- ☐ Auger Drilling
- ☐ Roller/Tricone
- ☐ Washbore
- ☐ Non Destructive Digging

BOREHOLE LOG

St. Quentin

Client: Collendina Holiday Park Pty Ltd
Location: 177 Bonnyvale Road
Ocean Grove, Victoria

Project No.: 18725G
Borehole No: BH 3
Inv. Date: 27/04/2026

Sheet: 1 of 1
Logged by: O.R.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Classification	Consistency / Density	Moisture	Geology and additional observations	Allowable Bearing Pressure
0.2	0.20	Silty SAND Grey Fine grained Loose, moist	SP	L	M	Quaternary age sediments Bridgewater Formation (Qxr)	Not tested
0.4 0.6	0.60	Becoming light grey and medium dense with depth					
	0.70	Limestone band					
0.8 1.0	1.00						
1.2	1.20	Sandy CLAY Dark yellow Medium plasticity Stiff, moist	CI	St	M		
1.4	1.50	Silty SAND Yellow Fine to medium grained Medium dense, moist					
1.6 1.8 2.0 2.2		Borehole 3 terminated at 1.5m					

Moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering:

XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	Very Soft	Fb	Friable
S	Soft	VL	Very Loose
F	Firm	L	Loose
St	Stiff	MD	Medium Dense
VSt	Very Stiff	D	Dense
H	Hard	VD	Very Dense

Method:

- ☑ Hand Auger
- ☐ Auger Drilling
- ☐ Roller/Tricone
- ☐ Washbore
- ☐ Non Destructive Digging

BOREHOLE LOG

St. Quentin

Client: Collendina Holiday Park Pty Ltd
Location: 177 Bonnyvale Road
Ocean Grove, Victoria

Project No.: 18725G
Borehole No: BH 4
Inv. Date: 27/04/2026

Sheet: 1 of 1
Logged by: O.R.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Classification	Consistency / Density	Moisture	Geology and additional observations	Allowable Bearing Pressure
0.2	0.20 0.30	Silty SAND Brown Fine grained Loose, moist Becoming light grey with depth	SP	L	M	Quaternary age sediments Bridgewater Formation (Qxr)	Not tested
0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2		Borehole 4 refused at 0.3m on Limestone band					

Moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering:

XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

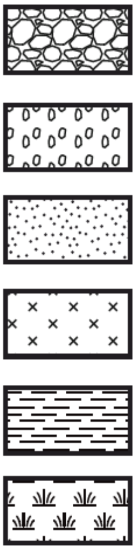
VS	Very Soft	Fb	Friable
S	Soft	VL	Very Loose
F	Firm	L	Loose
St	Stiff	MD	Medium Dense
VSt	Very Stiff	D	Dense
H	Hard	VD	Very Dense

Method:

- ☑ Hand Auger
- ☐ Auger Drilling
- ☐ Roller/Tricone
- ☐ Washbore
- ☐ Non Destructive Digging

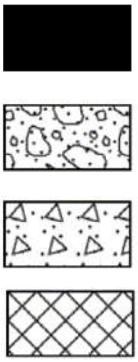
GEOLOGICAL SYMBOLS FOR SOIL AND ROCK

SOILS



- Boulders & Cobbles
- Gravel
- Sand
- Silt
- Clay
- Peat

FILL

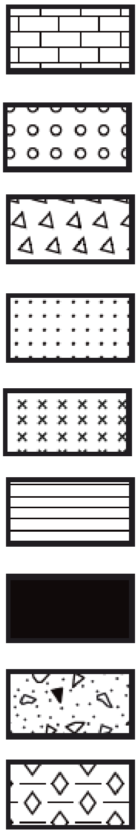


- Asphalt / Sprayed Seal
- Crushed Rock
- Concrete
- Fill

METAMORPHIC ROCKS

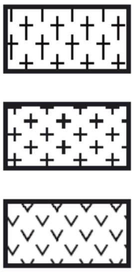
- Coarse grained
- Medium grained
- Fine grained

SEDIMENTARY ROCKS



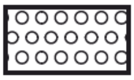
- Limestone
- Conglomerate
- Breccia
- Sandstone
- Siltstone
- Mudstone
- Coal
- Tuff
- Gypsum

IGNEOUS ROCKS



- Coarse grained
- Medium grained
- Fine grained

WEATHERED ROCK



- Weathered profile

SOIL DESCRIPTIONS - Explanation Sheet (1 of 2)

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726:2017 Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Fraction	Component	Subdivision	Size (mm)
Oversize	Boulders		> 200
	Cobbles		63 - 200
Coarse Grained Soil	Gravel	Coarse	19 - 63
		Medium	6.7 – 19
		Fine	2.36 – 6.7
	Sand	Coarse	0.6 - 2.36
		Medium	0.21 – 0.6
		Fine	0.075 – 0.21
Fine Grained Soil	Silt		0.002 - 0.075
	Clay		< 0.002

Soil Geological Origin

Weathered in place soils:

- Residual soil: Formed from in-situ weathering of the underlying rock, no visible structure or fabric of parent rock;
- Extremely weathered material: Formed directly from in-situ weathering of the underlying rock, visible structure or fabric of parent rock

Transported soil:

- Alluvial soil: River and stream deposits
- Estuarine soil: Tidal river and stream deposits
- Marine soils: Marine deposits
- Lacustrine soil: Freshwater lake deposits
- Aeolian soil: Wind deposits
- Colluvial soil: Soil and rock debris transported down slopes by gravity
- Topsoil: Surface and/or near-surface soil defined by high levels of organic material
- Fill: Any soil moved by man

Moisture Condition

Term	Description
Dry	Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.
Moist	Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.
Wet	As for moist but with free water forming on hands when handled.

Soil Structure

Term	Description
Zoning	
Layer	Continuous across exposure or sample
Lens	Discontinuous layers of lenticular shape
Pocket	Irregular inclusions of different material
Interbedded	Layers of alternating soil types are too thin to describe individually
Cementing	
Weakly cemented	Easily broken up by hand in air or water.
Moderately cemented	Effort is required to break up the soil by hand in air or water

Fine Grained (Cohesive) Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength terms are defined as follows:

Consistency	Abbreviation	Indicative undrained shear strength (kPa)
Very soft	VS	≤ 12
Soft	S	> 12 and ≤ 25
Firm	F	> 25 and ≤ 50
Stiff	St	> 50 and ≤ 100
Very Stiff	VSt	> 100 and ≤ 200
Hard	H	> 200

Secondary Soil Components

The proportions of secondary constituents of soils are described as:

Designation of components	% Sand/gravel	Terminology
Minor	≤ 15	Add 'trace'
	> 15, ≤ 30	Add 'with sand/gravel'
Secondary	> 30	Prefix soil name as 'sandy' or 'gravelly'

Plasticity of fine grained soils:

Descriptive term	Range of liquid limit for silt	Range of liquid limit for clay
Non-plastic	Not applicable	Not applicable
Low plasticity	≤ 50	≤ 35
Medium plasticity	Not applicable	> 35 and ≤ 50
High plasticity	> 50	> 50

Coarse Grained (Cohesionless) Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density. The relative density terms are given below:

Density	Abbreviation	Density Index (%)
Very loose	VL	≤ 15
Loose	L	> 15 and ≤ 35
Medium Dense	MD	> 35 and ≤ 65
Dense	D	> 65 and ≤ 85
Very dense	VD	> 85

Secondary Soil Components

The proportions of secondary constituents of soils are described as:

Designation of components	% Fines	Terminology	% Accessory coarse fraction	Terminology
Minor	≤ 5	Add 'trace clay/silt'	≤ 15	Add 'trace clay/silt'
	> 5, ≤12	Add 'with clay/silt'	> 15, ≤ 30	Add 'with sand/gravel'
Secondary	> 12	Prefix soil name as 'silty' or 'clayey'	> 30	Prefix soil name as 'sandy' or 'gravelly'

Particle characteristics of coarse grained soils:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

ROCK DESCRIPTIONS - Explanation Sheet (1 of 2)

Rock Strength

Rock strength is defined by the Point Load Strength Index (Is(50)) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $I_{s(50)}$ (MPa)	Approximate Unconfined Compressive Strength (MPa)
Very Low Strength	VL	> 0.03 and ≤ 0.1	> 0.6 and ≤ 2
Low Strength	L	> 0.1 and ≤ 0.3	> 2 and ≤ 6
Medium Strength	M	> 0.3 and ≤ 1	> 6 and ≤ 20
High Strength	H	> 1 and ≤ 3	> 20 and ≤ 60
Very High Strength	VH	> 3 and ≤ 10	> 60 and ≤ 200
Extremely High Strength	EH	> 10	> 200

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual soil	RS	Material has soil properties, i.e. it can be remoulded and classified as a soil. Texture of the original rock is no longer visible.
Extremely weathered	XW	Rock has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still visible.
Highly weathered	HW	Colour and strength of original fresh rock is not recognisable. Porosity and strength may be altered as a result of leaching or deposition of weathering products in pores.
Moderately weathered	MW	Rock is discoloured, usually by iron staining
Slightly weathered	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock
Fresh Rock	FR	Rock shows no signs of decomposition or staining

Guide to Naming Sedimentary Rocks

<table>
<tr><th rowspan="2">Grain size (mm)</th><th rowspan="2" colspan="2">Deposited rock type</th><th colspan="2">At least 90% of rock is carbonate</th><th rowspan="2">Ejected from a volcano</th></tr>
<tr><th>Low porosity</th><th>Porous</th></tr>
<tr><td>> 2</td><td colspan="2">Conglomerate (rounded grains)</td><td rowspan="5">Limestone or Dolomite</td><td rowspan="2">Calcirudite</td><td>Agglomerate (rounded grains)</td></tr>
<tr><td></td><td colspan="2">Breccia (angular / irregular fragments)</td><td>Volcanic Breccia (angular / irregular fragments)</td></tr>
<tr><td>0.06 - 2</td><td colspan="2">Sandstone</td><td>Calcarenite</td><td>Tuff</td></tr>
<tr><td>0.002 - 0.06</td><td rowspan="2">Mudstone</td><td>Siltstone</td><td>Calcisiltite</td><td rowspan="2">Fine Grained Tuff</td></tr>
<tr><td>< 0.002</td><td>Claystone</td><td>Calcilutite</td></tr>
</table>

Guide to Naming Igneous Rocks

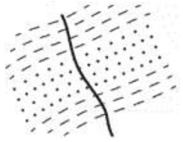
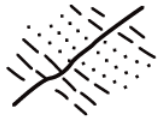
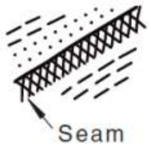
<table>
<tr><th rowspan="2">Grain size (mm)</th><th colspan="3">Massive crystalline</th></tr>
<tr><th>Much quartz (felsic)</th><th>⟷</th><th>Little quartz (mafic)</th></tr>
<tr><td>Coarse (> 2)</td><td>Granite</td><td>Diorite</td><td>Gabbro</td></tr>
<tr><td>Medium (0.06 – 2)</td><td>Microgranite</td><td>Microdiorite</td><td>Dolerite</td></tr>
<tr><td>Fine (< 0.06)</td><td>Rhyolite</td><td>Andesite</td><td>Basalt</td></tr>
</table>

ROCK DESCRIPTIONS - Explanation Sheet (2 of 2)

Guide to Naming Metamorphic Rocks

Grain size (mm)	Foliated	Non-foliated
Coarse (> 2)	Gneiss: Well developed but often widely spaced foliation	Marble: Crystalline calcium carbonate
Medium (0.06 – 2)	Schist: Well developed with much mica	Quartzite: Fused quartz grains
Fine (< 0.06)	Phyllite: Slightly undulose foliation	Serpentinite: Usually grey and green
	Slate: Well developed planar cleavage	Hornfels: Fine grained rock formed by thermal metamorphism

Rock Defect Types

Type	Sub-type	Definition	Diagram
Parting		A surface or crack across which the rock has little or no tensile strength. Parallel or sub parallel to layering (e.g. bedding) or a planar anisotropy in the rock substance (e.g. cleavage). May be open or closed.	
Joint		A surface or crack with no apparent shear displacement and across with the rock has little or no tensile strength, but which is not parallel or sub-parallel to layering or to planar anisotropy in the rock material. May be open or closed.	
Sheared surface		A near planar, curved or undulating surface which is usually smooth, polished or slickensided and which shows evidence of shear displacement.	
Sheared zone		Zone of rock material with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge-shaped blocks.	
Seams	Sheared	Seam of soil material with roughly parallel almost planar boundaries, composed of soil material with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some defects are usually curved and intersect to divide the mass into lenticular or wedge-shaped blocks.	
	Crushed	Seam of soil material with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock substance which may be more weathered than the host rock. The seam has soil properties.	
	Infilled	Seam of soil material usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1mm thick may be described as veneer or coating on joint surface.	
	Extremely weathered	Seam of soil material, often with gradational boundaries. Formed by weathering of the rock material in place.	

Appendix C

Permeability Calculation Sheets

Soil Permeability
Field Record Sheet

St. Quentin

Project number:	18725G	Date:	27/04/2026
Operator:	[redacted]		
Site location:	177 Bonnyvale Road, Ocean Grove		
Vegetation at test site:	Good grass cover		

Test site #:	**BH1**		**BH2**	
Depth of auger hole (D):	40	cm	50	cm
Depth of water in auger hole (H):	20	cm	25	cm
Average radius of auger hole (r):	5.5	cm	5	cm
Depth to any impermeable layer (S):	> 100	cm	> 100	cm
Depth to water table:	> 100	cm	> 100	cm
Soil moisture status at time of excavation:	Moist		Moist	
Time elapsed between first filling hole and start of measurement:	0	min	0	min

Comments: (seasonal waterlogging, soil structure, burrowing animal or root pores etc)

Permeameter water level and time readings (minutes/seconds)

Test # BH1			Test # BH2		
Time (min)	Level in tube (cm)	Drop in level (cm)	Time (min)	Level in tube (cm)	Drop in level (cm)
0	95	-	0	122	-
1	86	9	0.5	100	22
1.5	80	6	1	50	50
2	75	5	1.5	0	
2.5	69	6			
3	64	5			
3.5	59	5			
4	53	6			
4.5	48	5			
5	43	5			
5.5	39	4			
6	35	4			

Soil Permeability Calculation Sheet

St. Quentin

Test # **BH1**

Time after start (min)	Level in Tube (cm)	Drop of Level (cm)	Rate of Water Level Drop (cm/min)
0	95.0	-	-
1	86.0	9.0	9.0
1.5	80.0	6.0	12.0
2	75.0	5.0	10.0
2.5	69.0	6.0	12.0
3	64.0	5.0	10.0
3.5	59.0	5.0	10.0
4	53.0	6.0	12.0
4.5	48.0	5.0	10.0
5	43.0	5.0	10.0
5.5	39.0	4.0	8.0
6	35.0	4.0	8.0
Selected Steady Rate of Water Level Drop		(cm/min)	12.0
		(m/sec)	2.0E-03
Rate of Loss of Water from Reservoir		(cm^3/min)	88.9

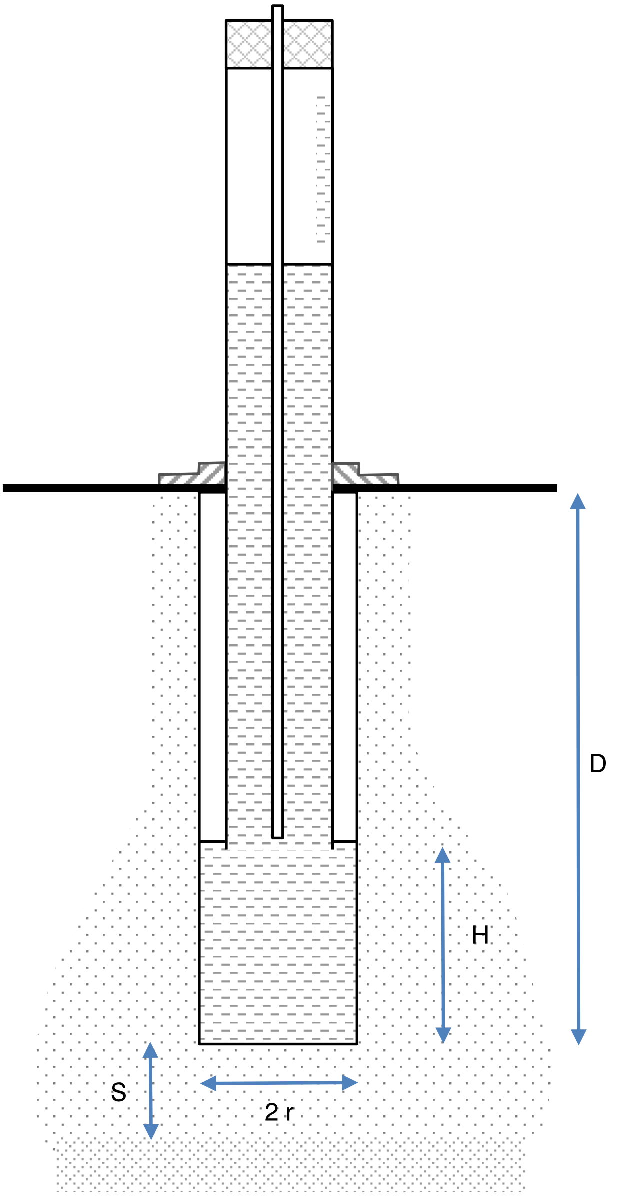
Select Steady Rate of Water Level Drop from Rate of Water Level Drop Column and enter in red cell.
This value should be the average of three consecutive values with no more than 10% variation

$$K_{sat} = \frac{4.4Q\left[0.5\sinh^{-1}\left(\frac{H}{2r}\right) - \sqrt{\left\{\left(\frac{r}{H}\right)^2 + 0.25\right\}} + \frac{r}{H}\right]}{2\pi H^2}$$

Soil Permeability Calculation Sheet

St. Quentin

Parameter	**Symbol**	**Value**
Depth of Water in Test Hole (cm)	H	20
Radius of Test Hole (cm)	r	5.5
Inner Tube External Diameter (cm)	D_i	0.9
Outer Tube Internal Diameter (cm)	D_o	3.2
Rate of Water Level Drop (cm/min)	L	12.0
Inner Tube Cross Sectional Area (cm^2)	A_i	0.64
Outer Tube Cross Sectional Area (cm^2)	A_o	8.04
Flowrate (cm^3/min)	Q	88.88
Saturated Hydraulic Conductivity (cm/min)	K_{sat}	0.0597
Saturated Hydraulic Conductivity (m/day)	K_{sat}	0.8603
Saturated Hydraulic Conductivity (m/sec)	K_{sat}	1.0E-05
Saturated Hydraulic Conductivity (mm/hr)	K_{sat}	35.8



Soil Permeability Calculation Sheet

St. Quentin

Test # **BH2**

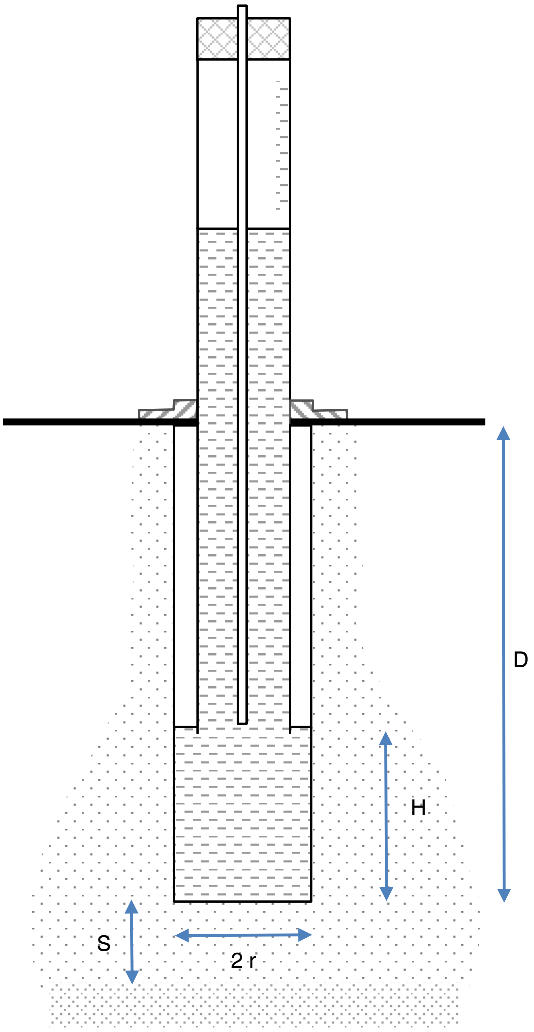
Time after start (min)	Level in Tube (cm)	Drop of Level (cm)	Rate of Water Level Drop (cm/min)
0	122.0	-	-
0.5	100.0	22.0	44.0
1	50.0	50.0	100.0
1.5			
Selected Steady Rate of Water Level Drop		(cm/min)	50.0
		(m/sec)	8.3E-03
Rate of Loss of Water from Reservoir		(cm^3/min)	370.3

Select Steady Rate of Water Level Drop from Rate of Water Level Drop Column and enter in red cell. This value should be the average of three consecutive values with no more than 10% variation

$$K_{sat} = \frac{4.4Q\left[0.5\sinh^{-1}\left(\frac{H}{2r}\right) - \sqrt{\left\{\left(\frac{r}{H}\right)^2 + 0.25\right\}} + \frac{r}{H}\right]}{2\pi H^2}$$

Soil Permeability Calculation Sheet	St. Quentin

Parameter	**Symbol**	**Value**
Depth of Water in Test Hole (cm)	H	25
Radius of Test Hole (cm)	r	5
Inner Tube External Diameter (cm)	D_i	0.9
Outer Tube Internal Diameter (cm)	D_o	3.2
Rate of Water Level Drop (cm/min)	L	50.0
Inner Tube Cross Sectional Area (cm^2)	A_i	0.64
Outer Tube Cross Sectional Area (cm^2)	A_o	8.04
Flowrate (cm^3/min)	Q	370.32
Saturated Hydraulic Conductivity (cm/min)	K_{sat}	0.2013
Saturated Hydraulic Conductivity (m/day)	K_{sat}	2.8984
Saturated Hydraulic Conductivity (m/sec)	K_{sat}	3.4E-05
Saturated Hydraulic Conductivity (mm/hr)	K_{sat}	120.8



Soil Permeability **Field Record Sheet**	St. Quentin

Project number:	18725G	Date:	27/04/2026
Operator:	Omar Reyes		
Site location:	177 Bonnyvale Road, Ocean Grove		
Vegetation at test site:	Good grass cover		

Test site #:	**BH3**	
Depth of auger hole (D):	40 cm	
Depth of water in auger hole (H):	20 cm	
Average radius of auger hole (r):	5.5 cm	
Depth to any impermeable layer (S):	> 100 cm	
Depth to water table:	> 100 cm	
Soil moisture status at time of excavation:	Moist	
Time elapsed between first filling hole and start of measurement:	0 min	

Comments: (seasonal waterlogging, soil structure, burrowing animal or root pores etc)

Permeameter water level and time readings (minutes/seconds)

Test # BH3			Test #		
Time (min)	Level in tube (cm)	Drop in level (cm)	Time (min)	Level in tube (cm)	Drop in level (cm)
0	136	-	0		-
1	125	11			
1.5	91	34			
2	59	32			
2.5	23	36			

Soil Permeability Calculation Sheet

St. Quentin

Test # **BH3**

Time after start (min)	Level in Tube (cm)	Drop of Level (cm)	Rate of Water Level Drop (cm/min)
0	136.0	-	-
1	125.0	11.0	11.0
1.5	91.0	34.0	68.0
2	59.0	32.0	64.0
2.5	23.0	36.0	72.0
Selected Steady Rate of Water Level Drop		(cm/min)	68.0
		(m/sec)	1.1E-02
Rate of Loss of Water from Reservoir		(cm^3/min)	503.6

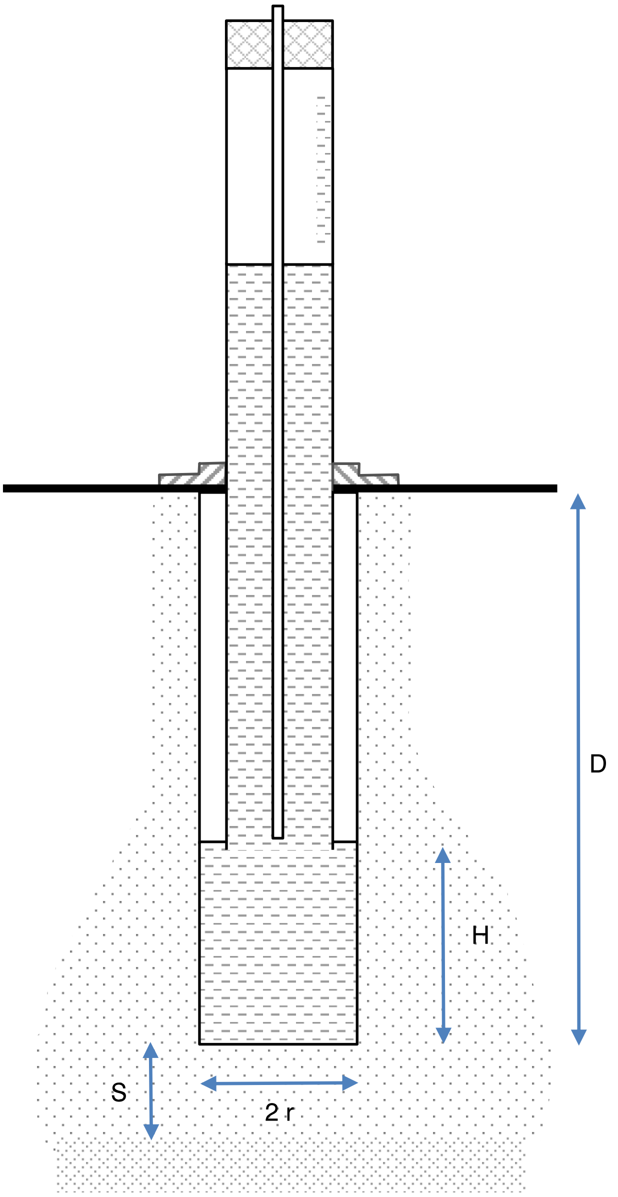
Select Steady Rate of Water Level Drop from Rate of Water Level Drop Column and enter in red cell.
This value should be the average of three consecutive values with no more than 10% variation

$$K_{sat} = \frac{4.4Q\left[0.5\sinh^{-1}\left(\frac{H}{2r}\right)-\sqrt{\left\{\left(\frac{r}{H}\right)^2+0.25\right\}}+\frac{r}{H}\right]}{2\pi H^2}$$

Soil Permeability Calculation Sheet

St. Quentin

Parameter	Symbol	Value
Depth of Water in Test Hole (cm)	H	20
Radius of Test Hole (cm)	r	5.5
Inner Tube External Diameter (cm)	D_i	0.9
Outer Tube Internal Diameter (cm)	D_o	3.2
Rate of Water Level Drop (cm/min)	L	68.0
Inner Tube Cross Sectional Area (cm^2)	A_i	0.64
Outer Tube Cross Sectional Area (cm^2)	A_o	8.04
Flowrate (cm^3/min)	Q	503.63
Saturated Hydraulic Conductivity (cm/min)	K_{sat}	0.3386
Saturated Hydraulic Conductivity (m/day)	K_{sat}	4.8753
Saturated Hydraulic Conductivity (m/sec)	K_{sat}	5.6E-05
Saturated Hydraulic Conductivity (mm/hr)	K_{sat}	203.1



St. Quentin

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