Contract Properties Pty Ltd
C/- Nordon Jago Architects

Wastewater Management Plan: Proposed Eco-Tourism Development – 71 Fig Hill Lane, Dunmore, NSW

martens consulting engineers

ENVIRONMENTAL

WATER

WASTEWATER

GEOTECHNICAL

CIVIL

PROJECT MANAGEMENT

P1907197JR03V02
October 2020

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All enquiries regarding this project are to be directed to the Project Manager.

Contents

1 Introduction

1.1 Overview

This onsite wastewater management plan has been prepared for Contract Properties Pty Ltd to support a development application (DA) for the construction of an eco-tourism facility and associated infrastructure at 71 Fig Hill Lane, Dunmore, NSW ('the Site'). Map 1 in Attachment A shows the Site location.

1.2 Aims and Objectives

The aims and objectives of this assessment are:

1. Assess land capability for effluent disposal.
2. Identify areas available for effluent disposal.
3. Estimate wastewater generation rates.
4. Provide recommendations for onsite wastewater treatment and effluent management area (EMA).

1.3 Development Proposal

We understand that the proposed development consists of:

1. Accommodation comprising 33 'lodges' located on three separate levels.
2. Restaurant and licensed bar facilities.
3. Gymnasium.
4. Day spa / beauty therapy rooms.
5. Reception area.
6. Car park and site access.
7. Associated infrastructure.
8. Conference rooms.
9. Swimming pool.

1.4 Relevant Standards and Policies

Guidelines and standards considered in this study include:

1. State Environmental Planning Policy (Coastal Management) 2018.
2. Standards Australia (2012) *Australian / New Zealand Standard 1547: On-site domestic wastewater management.*
3. Shellharbour City Council (2013) *Development Control Plan*.
4. Department of Environment and Conservation (2004) *Environmental Guidelines – Use of Effluent by Irrigation.*
5. NSW Department of Local Government (1998) *On-site Sewage Management for Single Households.*
6. NSW Health (2001) *Septic Tank and Collection Well Accreditation Guideline*.

2 Site Description

2.1 Site Details and Conditions

General site details are summarised in Table 1 with site plans provided in Attachment A.

Table 1: Summary of site details.

Item	Comment
Address / Lot / DP	71 Fig Hill Lane, Dunmore, NSW (Lot 3 DP 717776).
Local Government Area	Shellharbour City Council.
Site area (ha)	Approximately 59.2 ha (NSW LPI). Study area comprises approximately 2 ha located at the northern end of the lot.
Existing Development	Site contains an existing dwelling, retaining walls, driveway, water tank, gazebo, onsite wastewater management system and other infrastructure (e.g. telecommunications, electricity).
Typical slopes, aspect, elevation	Slopes in development area are generally <5% (see Map 2 and Map 4 in Attachment A).
Vegetation	Grass in the vicinity of the existing dwelling.
Adjacent environment	Rural-residential properties to the north and west and Riverside Drive to the north and east, the Minnamurra River and Kiama Golf Course to the east and south.
Drainage	Minnamurra River and associated wetland at the base of the site slope. A coastal wetland is located adjacent to the Minnamurra River to the south (Map 3 in Attachment A).
Sub-surface soil / rock units	The Kiama 1:100,000 Geological Sheet 9028 (Hazelton, 1993) maps the site as being Bombo soil type in the vicinity of the existing dwelling, consisting of sandy clay loams overlying sandy light to medium clays then Bumbo Latite bedrock. The lower portion of the site is mapped as being Mangrove Creek soil type.
Groundwater	Groundwater inflow was not observed in boreholes to 4.5 mBGL. A search of the WaterNSW groundwater bore database noted no existing bores within 250 m of potential effluent irrigation areas.
Climate	The nearest rainfall station with an appropriately long daily rainfall record is Albion Park (Wollongong Airport) (station 068241) and the nearest station with appropriate evaporation records is Nowra RAN (station 068076). Median rainfall is approximately 870 mm/year, median evaporation is 1,700 mm/year.

3 Land Capability Assessment

3.1 Soil Profile and Effluent Application Rates

Twelve boreholes were excavated on the Site in the areas considered most suitable for effluent disposal. Borehole logs are provided in Attachment B and location presented in Map 5 (Attachment A). Soil profiles and design irrigation rates are summarised in Table 2.

Table 2: Summary of sub-surface profiles and design irrigation rates based on AS/NZS 1547 (2012).

Layer	Depth (m) [1]	Texture	Structure	Agricultural Classification	Soil Permeability Category [2]	Indicative permeability (K_{sat}) (m/d)	Design Irrigation Rate (DIR) (mm/d)
TOPSOIL	0.3 – 0.7	Fill – Silt LOAM	Moderate	SiL	3a	0.5 – 1.5	4.0
SUBSOIL	0.4 – 0.7	CLAY LOAM	Weak	CL	4b	0.12 – 0.5	3.5

Notes:

1. Soil depth varies.
2. In accordance with Table 8 of NSW Department of Local Government *et al*. (NSW DLG, 1998).

3.2 Landform and Soil Constraints Assessment

Landform and soil constraints for onsite wastewater management are assessed in accordance with NSW DEC (2004) and summarised in Table 3. The assessment assumes secondary treated effluent being applied.

Table 3: Summary site and soil suitability for sub-surface effluent irrigation, according to NSW DEC (2004).

Site Characteristic	Details of Irrigation Areas	Limitation
Flood potential	None or rare	Nil
Slope (%)	5 - 10%[1]	Moderate (surface spray) Nil (sub-surface)
Landform	Side slope	Nil
Erosion potential	No signs present	Nil
Site drainage	No signs of surface dampness	Nil
Buffer to surface water	> 100 m	Nil
Buffer to groundwater well	> 250 m	Nil
Rock outcrop	0 %	Nil
Geology	No major discontinuities	Nil
Exchangeable sodium percentage (%)	1.3	Nil
Electrical conductivity (dS/m)	0.14	Nil
Soil pH	8.4	Moderate
Depth to bedrock (m)	0.7 – 1.4 m	Moderate
Depth to water table (m)	> 3.0 m	Nil
Saturated hydraulic conductivity (mm/hr)	5 - 20 mm/hr	Moderate
Cation exchange capacity (cmol+/kg)	26	Nil
Emerson aggregate test	4, 5, 7	Nil
Phosphorus sorption (kg/ha)[2]	5,900	Nil

Notes:

1. In vicinity of proposed effluent management areas.
2. Assumed soil bulk density of 1.6 t/m^3 and 0.5 m average soil depth.

Land and soils capability indicates that the area proposed to incorporate the site EMA is generally suited for the application of treated effluent, with a few constraints, namely total depth of soil profile and high soil pH. These constraints are not, however, sufficient to preclude effluent reuse on site by subsurface irrigation.

3.3 State Environmental Planning Policy (Coastal Management) 2018

Coastal wetlands and the proximity area for coastal wetlands are provided on Map 3. These areas are outside of the development footprint and therefore do not constrain the effluent disposal field.

3.4 Effluent Reuse Buffers

Recommended setbacks from effluent disposal areas are provided in NSW DEC (2004) and NSW DLG *et al.* (1998) guidelines and summarised in Table 4.

Table 4: Adopted buffer distances.

Site Feature	NSW DEC (m) (2004)	NSW DLG (m) (1998)	Buffer Distance Adopted[1] (m)
Natural waterbodies.	50	100 (permanent surface waters) 40 (intermittent waterways)	100
Property Boundaries	-	6/3[1]	3/1[2]
Buildings	-	6/3[1]	6/3[1]
Paths & Walkways	-	6/3[1]	6/3[1]
Stormwater System	-	-	3/1[2]
Domestic well used for household water supply	250	250	250

Note:

1 X/Y = Downslope/Upslope of effluent management area.

2. Reduced boundary setback acceptable for constrained sites where high grade effluent is disposed of by sub-surface irrigation. Confirmed by Beavers-Gardner pathogen transport model (Section 4.6

3.5 Available Area for Effluent Irrigation

By adopting buffers as outlined in Table 4 a total of 4,500 m^2 is available on the Site for effluent management, with these areas shown on Map 5.

4 Onsite Wastewater Management

4.1 Site Wastewater Generation Rates

Wastewater generation rates given in NSW Health (2001) have been adopted in preference to AS/NZS 1547 (2012) and Sydney Water (2003) WSA guidelines, which do not contain specific wastewater generation rates for all proposed development components. To reflect the assumption that Site laundry requirements will be outsourced, Victorian EPA (2016) figures for hotels without laundry services were also adopted.

Design wastewater loads for the Site are summarised in Table 5 and Table 6.

Table 5: Summary of design wastewater loads.

Development element	Rate[1]	Maximum adopted value	Design maximum daily wastewater load (kL/day)	Design daily wastewater load (70% occupancy) (kL/day)
Lodges	120 L/person/day	33 rooms, 2 person/room 66 persons	7.9	5.5
Restaurant	28 L/patron/day	50 patrons	1.4[2]	1.0
Bar / licensed lounge	14 L/patron/day	50 patrons	0.7[3]	0.5
Gym	33 L/person/day	60 persons	0.0[4]	0.0
Conference rooms	43 L/person/day	20 persons	0.0[4]	0.0
Staff – living onsite	100 L/staff/day	2 staff	0.2	0.2
Staff – permanent daytime only	36 L/staff/day	9 staff Fri – Sun 6 Mon – Thurs	0.3	0.3
Total wastewater	-	-	8.27 kL/day (flow balanced average week)	

Notes:

1. Based on NSW Health (2001) guidelines, except for lodges and permanent onsite staff which are based on Victorian EPA (2016) guidelines for hotels without laundry facilities, modified in accordance with Council requirements.
2. Friday and Saturday for dinner, Sunday for lunch – allowance for additional 50 patrons at each sitting.
3. Friday and Saturday for dinner, Sunday for lunch – allowance for additional 50 patrons at each sitting.

4. Gym, beauty spa and conference rooms are for guests only and hence wastewater load is included in the volume of wastewater generated by lodge use.

Table 6: Summary of design wastewater loads for swimming pool and spa use.

Development element	Rate[1]	Design maximum daily wastewater load (L/day)
Swimming pool	900 L/month	30
Spa	900 L/month	30

The above design wastewater loads could be further reduced through non-potable reuse of wastewater for toilet flushing. Discussions with Nicholas Johnson of Wood and Grieve Engineers has determined that anticipated toilet flushing demand for lodges is estimated to be 50 L/room/day, assuming 4.5 / 6 L per flush water closets.

Assuming an average water use of 5.4 L / use and that restaurant patrons from the public use the amenities an average of once per sitting, the total estimated non-potable re-use demand for toilet flushing is calculated to be 2.2 kL/day approximately at peak times and 1.9 kL/day with flow balancing (assuming public patrons in the restaurant and bars on three days / week only). This would reduce the peak volume of wastewater to be irrigated to approximately 6.37 kL/day, flow balanced across the week.

4.2 Influent Wastewater Strength

Sewage generated at the development will be primarily of a domestic character. Any kitchen wastewater will be subject to pre-treatment using grease traps. On this basis, it is expected that influent wastewater will likely have the following characteristics:

1. BOD_5: 350 – 400 mg/L
2. Suspended solids: 350-450 mg/L
3. Total nitrogen: 40 -60 mg/L
4. Total phosphorus: 8 – 12 mg/L

4.3 STP Effluent Criteria

Subsurface effluent disposal systems are typically designed to accept secondary treated effluent. In this instance, the proposed effluent quality nominated is high grade tertiary treatment. This is to:

1. Ensure the long-term performance of the disposal system.

2. Allow for the re-use of treated effluent for non-potable purposes (e.g. toilet flushing) at the development.

3. To protect downslope sensitive environments from any adverse impacts associated with irrigation of treated effluent on the site.

On this basis, the STP effluent quality criteria adopted are in accordance with those specified in DWE 2008 for high level human contact, including residential dual reticulation, agricultural irrigation, external landscaping irrigation, and unrestricted urban access. Criteria are provided in Table 7.

Table 7: STP effluent performance criteria for non-potable (toilet flushing) re-use.

Parameter	Effluent Target (mg/L)[1]	Monitoring[4]
E. coli (cfu/100 mL)	< 1	2 times/week
Coliphages (cfu/100 mL)	< 1	Weekly
Clostridia (cfu/100 mL)	< 1	Weekly
BOD_5 (mg/L)	< 10	2 times/week
Total Suspended Solids (mg/L)	< 10	2 times/week
pH	6.5 – 8.5	Continuous on-line
Turbidity (NTU)	< 2 (95^{th} ile, < 5 max)[2]	Continuous on-line
Chlorine (mg/L)	0.2 – 2.0 residual	Continuous on-line
Total Nitrogen[3] (mg/L)	< 20	Quarterly
Total Phosphorus[3] (mg/L)	< 7	Quarterly

Notes:

1. Based on DWE 2008 except for TN and TP.
2. Target not required if sub-surface disposal only.
3. Nutrient targets desirable but not mandatory.
4. Only quarterly monitoring required if disposal only to sub-surface irrigation.

We note that if internal non-potable reuse for toilet flushing is not to be undertaken, then only the TN and TP specification in Table 7 would apply.

4.4 Effluent Management

We expect that the effluent management process will broadly follow that described in Figure 1.

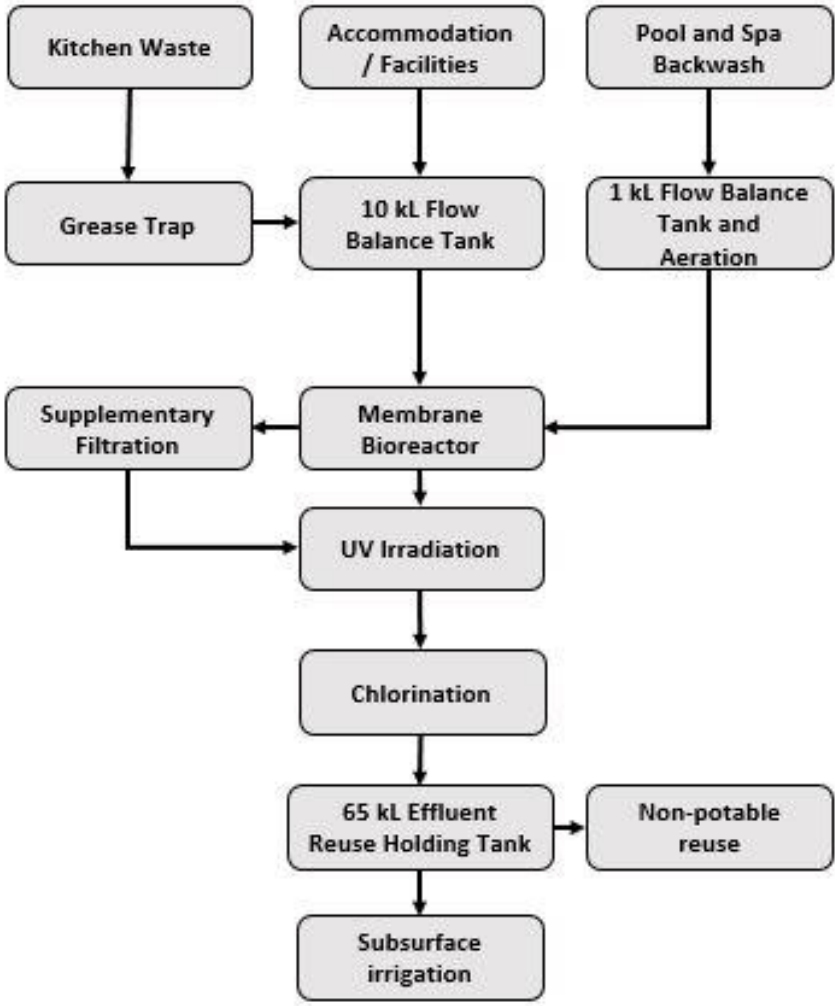

Figure 1: Wastewater management scheme configuration.

4.5 Effluent Management Area Sizing

The effluent management area is sized based on DIRs given in Table 2 and the above wastewater generation rates provided in Section 4.1. Water and nutrient balance assessments have been completed and are detailed in Attachment C. Required irrigation area for the two effluent use scenarios are summarised in Table 8.

Table 8: Summary of effluent management area sizing.

Parameter	Irrigation only (m^2)	With non-potable reuse (m^2)
Hydraulic	2,070	1,600
Water balance	1,480[1]	1,090[1]
Nutrients	2,610	2,010
Design	2,610	2,010

Notes:

1. Includes 100 kL wet weather storage.

4.6 Virus Transport

The minimum setback between any subsurface irrigation area and the site stormwater system is assessed using the Beavers Gardner virus transport model. The assessment has assumed that effluent will be treated to a secondary standard with disinfection as per the recommendations in this report. Initial virus concentrations are assumed based on available data (Corpuz *et al,* 2020). Results of the modelling are provided at Attachment E and indicate that based on a 7% hydraulic gradient, a minimum separation distance to stormwater drains of 3 m is recommended. Proposed positioning of the EMA shows that this criteria is able to be met.

4.7 Preliminary Effluent Management Area Requirements

We recommend that the EMA be a sub-surface drip irrigation system designed in accordance with AS/NZS 1547 (2012) to minimise risks of human / effluent contact in the event of non-compliant effluent quality and to remove the requirement to fence EMAs to prevent unauthorised access. A subsurface drip irrigation EMA will also maximise potential for effluent to be used across a wide area at the top of the hill and minimise risk of effluent becoming concentrated (as may occur with a mound or absorption trench style system). This in turn minimises risk to sensitive downslope receiving environments.

The total EMA is to be not less than 2,610 m^2 within the identified area shown on Map 6 in Attachment A.

Where required, we recommend the placement of clean, free-draining loam topsoil to achieve a minimum soil depth of 600 mm in all proposed EMAs.

Minimum preliminary EMA requirements are summarised in Table 9.

Table 9: Minimum preliminary EMA requirements.

Parameter	Requirements
Minimum area	2,610 m^2
Irrigation system	Sub-surface drip irrigation.
Minimum system specifications	Dripline specifically designed to irrigate treated effluent (e.g. 16 mm Netafim) to be installed into soil at a depth of 0.15 m. Laterals are to be placed at minimum 1 m centres and laid generally parallel to site contours. Laterals are to be connected to 40 mm distribution laterals and 40 mm flushing mains. Flushing mains are to include appropriate vacuum / air release valves and manual flushing valves. EMAs to include flushing absorption trenches, appropriately sized to accommodate volume from 5 minute flushing of all irrigation driplines in EMA (to be sized at construction certificate stage). An effluent filtration system is to be installed prior to irrigation with a design screen size of 120 µm. EMAs to be revegetated with typical lawn species and maintained on a regular basis to encourage vegetation to use irrigated nutrients. No consumable vegetables are to be grown using effluent due to potential risks to health.

4.8 Odour Management

Odour at the onsite treatment system may be managed through the use of sealed tanks and appropriate activated carbon odour filters or similar.

4.9 System Summary

The wastewater management system shall consist of:

1. A STP capable of tertiary treatment of effluent with suitable odour control.

2. An effluent disposal field not less than 2,610 m^2 in size and minimum specifications as per Table 9.

4.10 Impact on Coastal Management Wetlands

The proposed EMA is outside of the minimum 100 m required buffer to the downslope mapped Coastal Wetland. Detailed nutrient balance modelling shows that all nutrients applied to the EMA will be assimilated outside of this buffer area. It is therefore demonstrated that the EMA shall have no impact on the downslope Coastal Wetland.

4.11 Further Approvals, System Operation and Maintenance

Prior to installation of the preferred system, a Section 68 application pursuant to the *Local Government Act 1993* (NSW) to Shellharbour City Council to install the onsite wastewater management system is required. An approval to operate is required prior to system commissioning.

We recommend that prior to construction certificate stage, an operations manual be developed for the onsite wastewater management system, including details of: system maintenance and operational requirements for the STP; and EMAs; effluent quality and flow monitoring; data collection and testing; telemetry testing and verification; visual inspection; staff training; log book maintenance and annual system reporting requirements.

We recommend that the following documentation be prepared as part of the construction certificate process for the wastewater management system:

1. Final design of the internal sewer network, including the locations and design of any pump station(s).

2. Final plans of the STP, effluent wet weather storage tank and EMAs. This should include a list of key inspection 'hold points' where an appropriately qualified environmental engineer will need to inspect the works prior to progressing the construction.

3. An operations and maintenance manual including the monitoring regime and data management system.

4. The operations log book.

5. A construction management plan detailing inspections / certification regime for quality control of construction works.

6. A sediment and erosion control plan for all civil works.

5 References

https://maps.six.nsw.gov.au/

http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=SEPP_CoastalManagement

Coastal Management Act (2016)

Australian / New Zealand Standard 1547 (2012), *On-site domestic wastewater management.*

Department of Local Government, NSW Environment Protection Authority, NSW Health Department, NSW Department of Land and Water Conservation and the NSW Department of Urban Affairs and Planning (1998), *Environment and Health Protection Guidelines, On-site Sewage Management for Single Households.*

Hazelton P.A. (1993) *Soil Landscapes of the Kiama1:100,000 Sheet.*

NSW DEC (2004) *Use of Effluent by Irrigation.*

NSW Health (2001) *Septic Tank and Collection Well Accreditation Guideline.*

Shellharbour City Council (2013) *Development Control Plan.*

Victorian Environmental Protection Agency (2016) *Code of Practice – Onsite Wastewater Management.*

6 Attachment A – Site Plans

0 50 100 150 200 250 m

1:5000 @ A4

Project No: P1907197 Model: P1907197QGIS01 Projection: MGA Map Set: MS01-R01

Map Title / Figure:

Site Location

Map 01	Map
71 Fig Hill Lane, Dunmore, NSW	Site
Eco-Tourism Development	Project
Wastewater Management Plan	Sub-Project
Contract Properties Pty Ltd	Client
21/10/2020	Date

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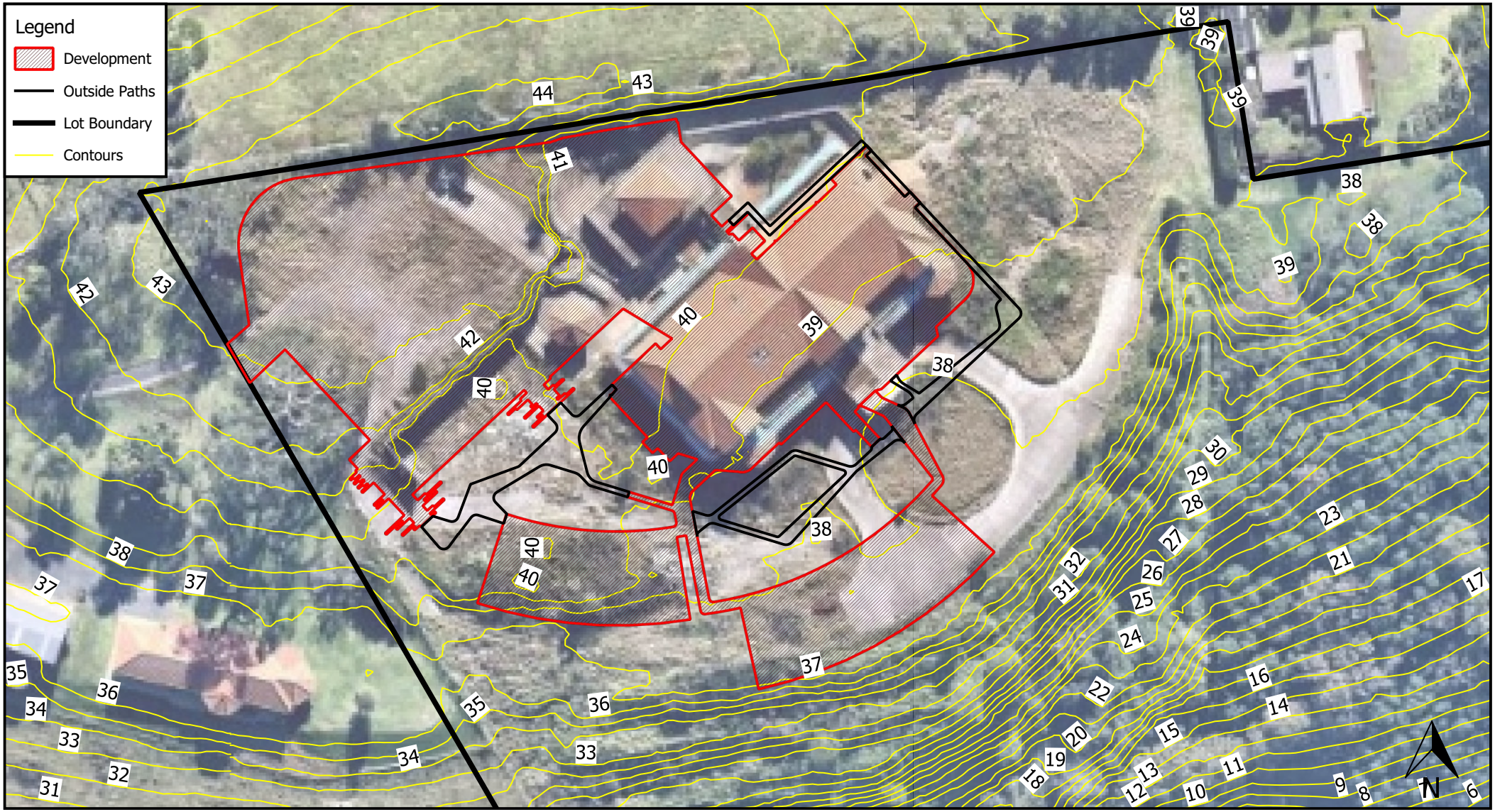

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Map Title / Figure:

Site Plan and Topography

Map 02	Map
71 Fig Hill Lane, Dunmore, NSW	Site
Eco-Tourism Development	Project
Wastewater Management Plan	Sub-Project
Contract Properties Pty Ltd	Client
21/10/2020	Date

Project No: P1907197 Model: P1907197QGIS01 Projection: MGA Map Set: MS01-R01

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Project No: P1907197 Model: P1907197QGIS01 Projection: MGA Map Set: MS01-R01

Map Title / Figure:

Coastal Wetlands

Map 03	Map
71 Fig Hill Lane, Dunmore, NSW	Site
Eco-Tourism Development	Project
Wastewater Management Plan	Sub-Project
Contract Properties Pty Ltd	Client
21/10/2020	Date

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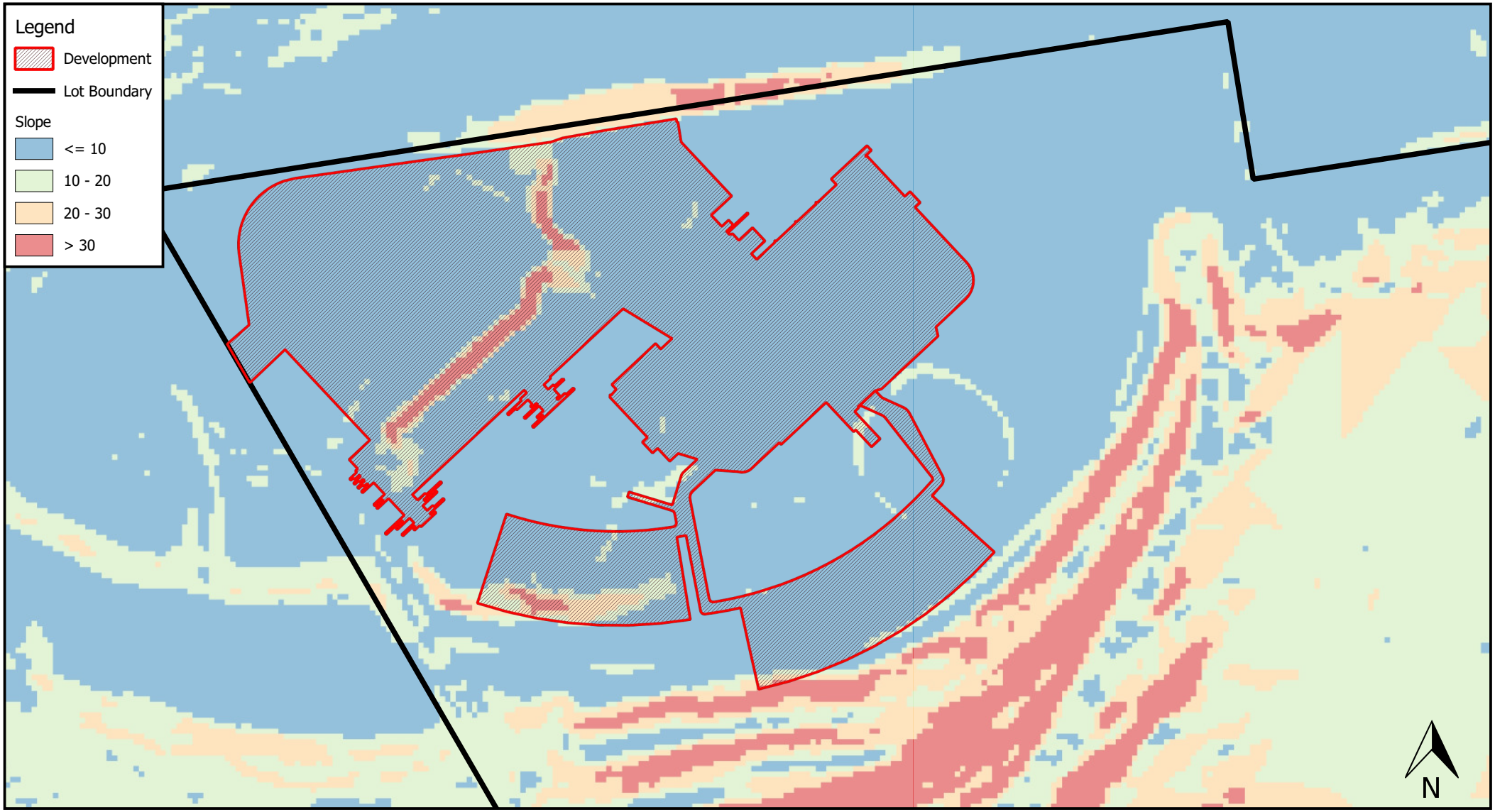

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Project No: P1907197 Model: P1907197QGIS01 Projection: MGA Map Set: MS01-R01

Map Title / Figure:

Slopes

Map 04	Map
71 Fig Hill Lane, Dunmore, NSW	Site
Eco-Tourism Development	Project
Wastewater Management Plan	Sub-Project
Contract Properties Pty Ltd	Client
21/10/2020	Date

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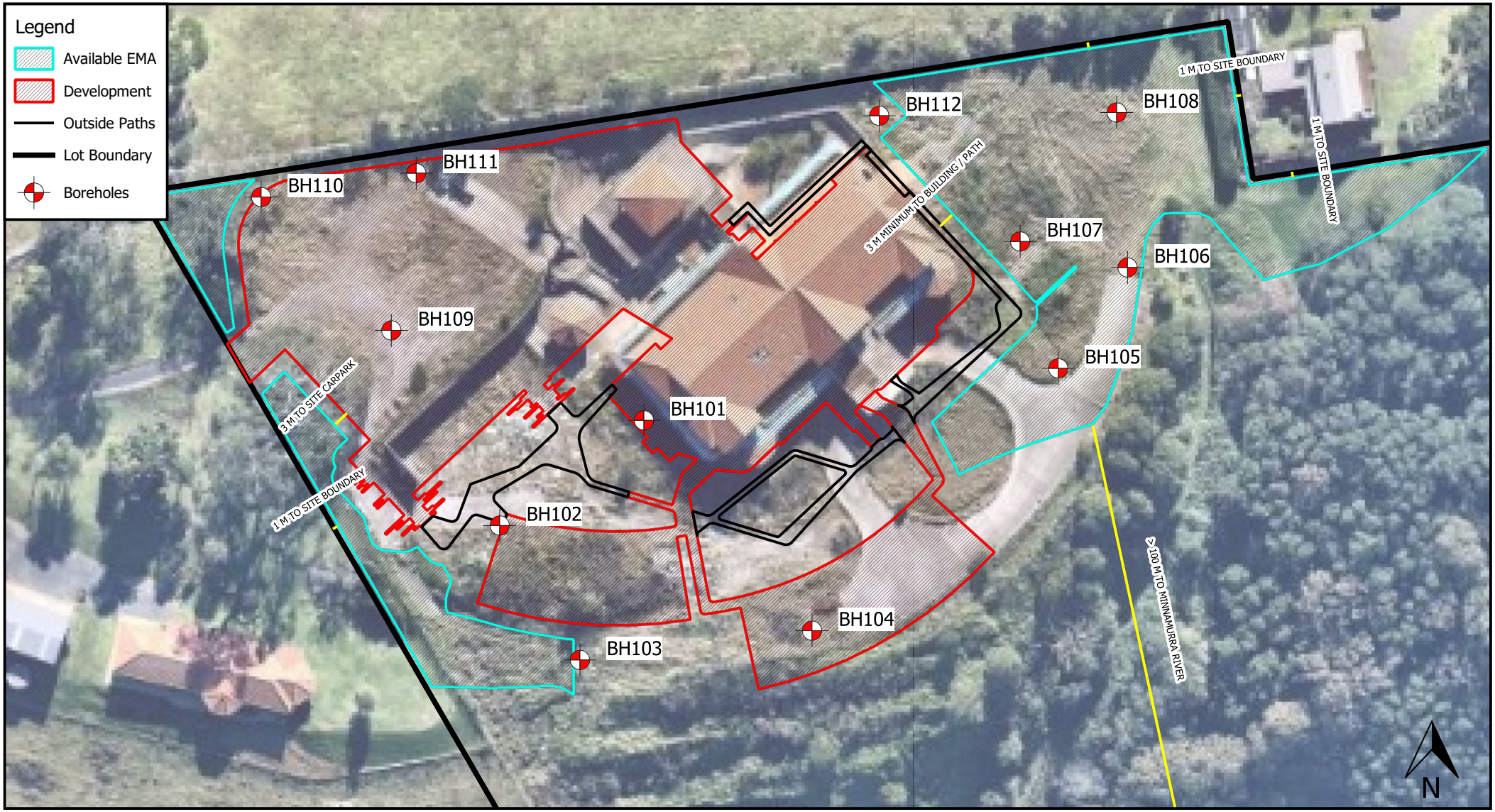

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Map Title / Figure:

Available Effluent Management Areas and Boreholes

Map 05	Map
71 Fig Hill Lane, Dunmore, NSW	Site
Eco-Tourism Development	Project
Wastewater Management Plan	Sub-Project
Contract Properties Pty Ltd	Client
21/10/2020	Date

Project No: P1907197 Model: P1907197QGIS01 Projection: MGA Map Set: MS01-R01

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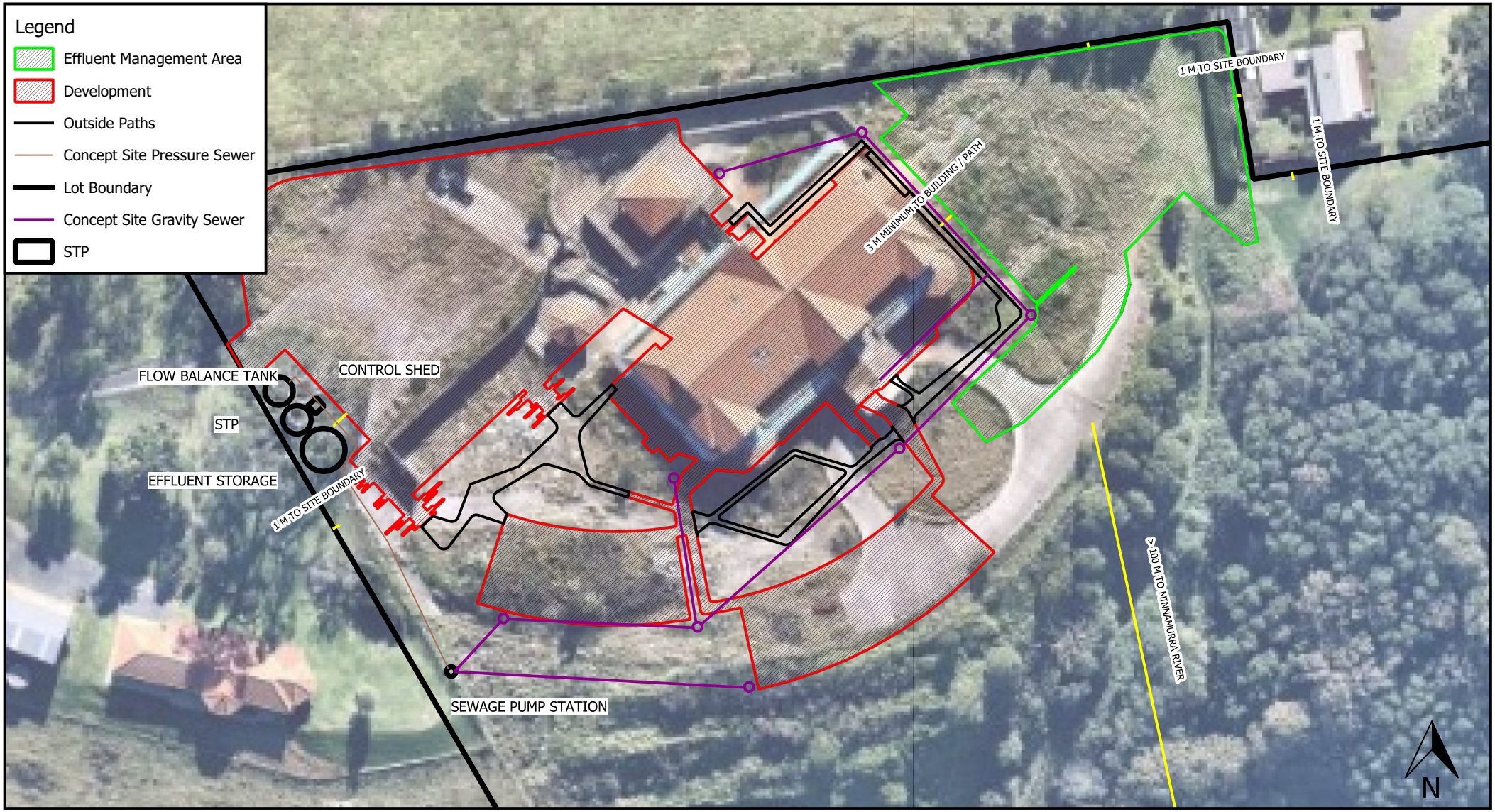

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Project No: P1907197 Model: P1907197QGIS01 Projection: MGA Map Set: MS01-R01

Map Title / Figure:

Wastewater Management Plan

Map 06	Map
71 Fig Hill Lane, Dunmore, NSW	Site
Eco-Tourism Development	Project
Wastewater Management Plan	Sub-Project
Contract Properties Pty Ltd	Client
21/10/2020	Date

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7 Attachment B – Site Borehole Logs

CLIENT	Contract Properties Pty Ltd		COMMENCED	23/05/2019	COMPLETED	23/05/2019	**REF BH101**
PROJECT	Wastewater Assessment		LOGGED	WX	CHECKED		Sheet 1 OF 1
SITE	71 Fig Hill Lane, Dunmore, NSW		GEOLOGY	Latite	VEGETATION	Grass	PROJECT NO. P1907197
EQUIPMENT		4WD ute mounted hydraulic drill rig	EASTING	150.841824	RL SURFACE	40 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 4.50 m depth	NORTHING	-24.622225	ASPECT	Southeast	SLOPE 2

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	M	Not Encountered	0.5	40.00				SiCL	FILL: Silty LOAM, dark brown; with moderate structure; 10% gravels (10mm).	M (<<PL)	S St	FILL
	H			*0.70* 39.30				GC	FILL: CLAY LOAM; brown; weakly structured; 25% gravels (30mm).		H	
			1.0	*1.00*								1.00: V-bit refusal.
			1.5									
			2.0									
			2.5									
			3.0									
			3.5									
			4.0									
			4.5						Hole Terminated at 4.50 m			

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	Contract Properties Pty Ltd		COMMENCED	23/05/2019	COMPLETED	23/05/2019	**REF BH102**
PROJECT	Wastewater Assessment		LOGGED	WX	CHECKED		Sheet 1 OF 1
SITE	71 Fig Hill Lane, Dunmore, NSW		GEOLOGY	Latite	VEGETATION	Grass	PROJECT NO. P1907197
EQUIPMENT		4WD ute mounted hydraulic drill rig	EASTING	150.841824	RL SURFACE	40 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 1.60 m depth	NORTHING	-24.622225	ASPECT	Southeast	SLOPE 2

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	M	Not Encountered	0.5	40.00				GC	FILL: CLAY LOAM; brown; weakly structured; 25% gravels (30mm).	M (<PL)	S / St	FILL
			1.0	*0.40*								0.40: V-bit refusal.
			1.5						Hole Terminated at 1.60 m			
			2.0									
			2.5									
			3.0									
			3.5									
			4.0									
			4.5									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	Contract Properties Pty Ltd		COMMENCED	23/05/2019	COMPLETED	23/05/2019	**REF BH103**
PROJECT	Wastewater Assessment		LOGGED	WX	CHECKED		Sheet 1 OF 1
SITE	71 Fig Hill Lane, Dunmore, NSW		GEOLOGY	Latite	VEGETATION	Grass	PROJECT NO. P1907197
EQUIPMENT		4WD ute mounted hydraulic drill rig	EASTING	150.841824	RL SURFACE	40 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 0.40 m depth	NORTHING	-24.622225	ASPECT	Southeast	SLOPE 2

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	M	Not Encountered		40.00				GC	FILL: CLAY LOAM; brown; weakly structured; 25% gravels (30mm).	M (<PL)	S / St	FILL
				0.30								0.30: V-bit refusal.
			0.5						Hole Terminated at 0.40 m			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									
			3.5									
			4.0									
			4.5									

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Engineering Log - BOREHOLE

CLIENT	Contract Properties Pty Ltd		COMMENCED	23/05/2019	COMPLETED	23/05/2019	**REF BH104**
PROJECT	Wastewater Assessment		LOGGED	WX	CHECKED		Sheet 1 OF 1
SITE	71 Fig Hill Lane, Dunmore, NSW		GEOLOGY	Latite	VEGETATION	Grass	PROJECT NO. P1907197
EQUIPMENT		4WD ute mounted hydraulic drill rig	EASTING	150.841824	RL SURFACE	40 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 1.30 m depth	NORTHING	-24.622225	ASPECT	Southeast	SLOPE 2

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	M	Not Encountered	0.5	40.00				SiCL	FILL: Silty LOAM, dark brown; with moderate structure; 10% gravels (10mm).	M (<PL)	S St	FILL
	H			*0.70* 39.30				GC	FILL: CLAY LOAM; brown; weakly structured; 25% gravels (30mm).		H	
			1.0	*1.00*								1.00: V-bit refusal.
			1.5						Hole Terminated at 1.30 m			
			2.0									
			2.5									
			3.0									
			3.5									
			4.0									
			4.5									

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CLIENT	Contract Properties Pty Ltd		COMMENCED	23/05/2019	COMPLETED	23/05/2019	**REF BH105**
PROJECT	Wastewater Assessment		LOGGED	WX	CHECKED		Sheet 1 OF 1
SITE	71 Fig Hill Lane, Dunmore, NSW		GEOLOGY	Latite	VEGETATION	Grass	PROJECT NO. P1907197
EQUIPMENT		4WD ute mounted hydraulic drill rig	EASTING	150.841824	RL SURFACE	40 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 1.00 m depth	NORTHING	-24.622225	ASPECT	Southeast	SLOPE 2

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	M	Not Encountered	0.5	40.00				SiCL	FILL: Silty LOAM, dark brown; with moderate structure; 10% gravels (10mm).	M (<PL)	S St	FILL
	H			*0.70* 39.30				GC	FILL: CLAY LOAM; brown; weakly structured; 25% gravels (30mm).		H	
			1.0	*1.00*					Hole Terminated at 1.00 m			1.00: V-bit refusal.
			1.5									
			2.0									
			2.5									
			3.0									
			3.5									
			4.0									
			4.5									

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Engineering Log - BOREHOLE

CLIENT	Contract Properties Pty Ltd		COMMENCED	23/05/2019	COMPLETED	23/05/2019	**REF BH106**
PROJECT	Wastewater Assessment		LOGGED	WX	CHECKED		Sheet 1 OF 1
SITE	71 Fig Hill Lane, Dunmore, NSW		GEOLOGY	Latite	VEGETATION	Grass	PROJECT NO. P1907197
EQUIPMENT		4WD ute mounted hydraulic drill rig	EASTING	150.841824	RL SURFACE	40 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 0.80 m depth	NORTHING	-24.622225	ASPECT	Southeast	SLOPE 2

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	M H	Not Encountered	0.5	40.00 *0.70* 39.30 *0.80*				SiCL	FILL: Silty LOAM, dark brown; with moderate structure; 10% gravels (10mm).	M (<PL)	S St H	FILL
								GC	FILL: CLAY LOAM; brown; weakly structured; 25% gravels (30mm). Hole Terminated at 0.80 m			0.80: V-bit refusal.
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									
			3.5									
			4.0									
			4.5									

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CLIENT	Contract Properties Pty Ltd		COMMENCED	23/05/2019	COMPLETED	23/05/2019	**REF BH107**
PROJECT	Wastewater Assessment		LOGGED	WX	CHECKED		Sheet 1 OF 1
SITE	71 Fig Hill Lane, Dunmore, NSW		GEOLOGY	Latite	VEGETATION	Grass	PROJECT NO. P1907197
EQUIPMENT		4WD ute mounted hydraulic drill rig	EASTING	150.841824	RL SURFACE	40 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 4.50 m depth	NORTHING	-24.622225	ASPECT	Southeast	SLOPE 2

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	M	Not Encountered	0.5	40.00				SiCL	FILL: Silty LOAM, dark brown; with moderate structure; 10% gravels (10mm).		S St	FILL
				0.70 39.30				GC	FILL: CLAY LOAM; brown; weakly structured; 25% gravels (30mm).	M (<<PL)	H	
AD/T	H		1.0 1.5 2.0 2.5 3.0 3.5 4.0	*1.40* 38.60					LATITE: fine grained; brown; medium strength; distinctly weathered.			WEATHERED ROCK 1.40: V-bit refusal.
			4.5	*4.50*					Hole Terminated at 4.50 m			

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Engineering Log - BOREHOLE

CLIENT	Contract Properties Pty Ltd		COMMENCED	23/05/2019	COMPLETED	23/05/2019	**REF BH108**
PROJECT	Wastewater Assessment		LOGGED	WX	CHECKED		Sheet 1 OF 1
SITE	71 Fig Hill Lane, Dunmore, NSW		GEOLOGY	Latite	VEGETATION	Grass	PROJECT NO. P1907197
EQUIPMENT		4WD ute mounted hydraulic drill rig	EASTING	150.841824	RL SURFACE	40 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 1.60 m depth	NORTHING	-24.622225	ASPECT	Southeast	SLOPE 2

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	H	Not Encountered	0.5	40.00	7197/BH108/0.0-0.2/S/1 D 0.00 m			SiCL	FILL: Silty LOAM, dark brown; with moderate structure; 10% gravels (10mm).			FILL
				0.30								
				39.70	7197/BH108/0.3-0.5/S/1 D 0.30 m			GC	FILL: CLAY LOAM; brown; weakly structured; 25% gravels (30mm).	M (<<PL)	H	
				0.70								
AD/T	M-H		1.0	39.30	7197/BH108/0.8-1.0/S/1 D 0.80 m				LATITE: fine grained; brown; medium strength; distinctly weathered.			WEATHERED ROCK
			1.5	*1.60*								
			2.0						Hole Terminated at 1.60 m			
			2.5									
			3.0									
			3.5									
			4.0									
			4.5									

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Engineering Log - BOREHOLE

CLIENT	Contract Properties Pty Ltd		COMMENCED	23/05/2019	COMPLETED	23/05/2019	**REF BH109**
PROJECT	Wastewater Assessment		LOGGED	WX	CHECKED		Sheet 1 OF 1
SITE	71 Fig Hill Lane, Dunmore, NSW		GEOLOGY	Latite	VEGETATION	Grass	PROJECT NO. P1907197
EQUIPMENT		4WD ute mounted hydraulic drill rig	EASTING	150.841824	RL SURFACE	40 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 0.40 m depth	NORTHING	-24.622225	ASPECT	Southeast	SLOPE 2

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	H	Not Encountered		40.00				CL	FILL: Silty LOAM, dark brown; with moderate structure; 10% gravels (10mm).	M (<<PL)	H	FILL
				0.40					Hole Terminated at 0.40 m			
			0.5									
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									
			3.5									
			4.0									
			4.5									

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Engineering Log - BOREHOLE

CLIENT	Contract Properties Pty Ltd		COMMENCED	23/05/2019	COMPLETED	23/05/2019	**REF BH110**
PROJECT	Wastewater Assessment		LOGGED	WX	CHECKED		Sheet 1 OF 1
SITE	71 Fig Hill Lane, Dunmore, NSW		GEOLOGY	Latite	VEGETATION	Grass	PROJECT NO. P1907197
EQUIPMENT		4WD ute mounted hydraulic drill rig	EASTING	150.841824	RL SURFACE	40 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 1.30 m depth	NORTHING	-24.622225	ASPECT	Southeast	SLOPE 2

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	M	Not Encountered	0.5	40.00 ***0.50*** 39.50				SiCL	FILL: Silty LOAM, dark brown; with moderate structure; 10% gravels (10mm).	M (<<PL)	VSt - H	FILL
AD/T	H		1.0	***1.00*** 39.00 *1.30*				GC	FILL: CLAY LOAM; brown; weakly structured; 25% gravels (30mm).		H	
									LATITE: fine grained; brown; medium strength; distinctly weathered.			WEATHERED ROCK
			1.5						Hole Terminated at 1.30 m			1.30: TC-bit refusal.
			2.0									
			2.5									
			3.0									
			3.5									
			4.0									
			4.5									

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Engineering Log - BOREHOLE

CLIENT	Contract Properties Pty Ltd		COMMENCED	23/05/2019	COMPLETED	23/05/2019	**REF BH111**
PROJECT	Wastewater Assessment		LOGGED	WX	CHECKED		Sheet 1 OF 1
SITE	71 Fig Hill Lane, Dunmore, NSW		GEOLOGY	Latite	VEGETATION	Grass	PROJECT NO. P1907197
EQUIPMENT		4WD ute mounted hydraulic drill rig	EASTING	150.841824	RL SURFACE	40 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 1.00 m depth	NORTHING	-24.622225	ASPECT	Southeast	SLOPE 2

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	H	Not Encountered	0.5	40.00				SP	FILL: Silty LOAM, dark brown; with moderate structure; 10% gravels (10mm).	D	MD	FILL
				0.70 39.30				CL	FILL: CLAY LOAM; brown; weakly structured; 25% gravels (30mm).	M (<<PL)	H	
			1.0	*1.00*					Hole Terminated at 1.00 m			1.00: TC-bit refusal.
			1.5									
			2.0									
			2.5									
			3.0									
			3.5									
			4.0									
			4.5									

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Engineering Log - BOREHOLE

CLIENT	Contract Properties Pty Ltd		COMMENCED	23/05/2019	COMPLETED	23/05/2019	**REF BH112**
PROJECT	Wastewater Assessment		LOGGED	WX	CHECKED		Sheet 1 OF 1
SITE	71 Fig Hill Lane, Dunmore, NSW		GEOLOGY	Latite	VEGETATION	Grass	PROJECT NO. P1907197
EQUIPMENT		4WD ute mounted hydraulic drill rig	EASTING	150.841824	RL SURFACE	40 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 0.80 m depth	NORTHING	-24.622225	ASPECT	Southeast	SLOPE 2

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V		Not Encountered	0	40.00				SiCL	FILL: Silty LOAM, dark brown; with moderate structure; 10% gravels (10mm).			FILL
				0.30								
AD/T	H		0.5	39.70				GC	FILL: CLAY LOAM; brown; weakly structured; 25% gravels (30mm).	M (<<PL)		
				0.80								
			1.0						Hole Terminated at 0.80 m			
			1.5									
			2.0									
			2.5									
			3.0									
			3.5									
			4.0									
			4.5									

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8 Attachment C – Water and Nutrient Balance Assessment

Effluent Disposal Field - Annual Nutrient Balance Assessment

Method ST-14 Revised 20.3.2007

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PROJECT DETAILS

Project	Ecotourism Development, 71 Fig Hill Lane, Dunmore, NSW			Ref. No.	P1907197
Author	MGD	Reviewed	DMM	Date Created	27/09/2019

Scenario 1: No re-use for non-potable demands.

STEP 1 : ENTER SITE AND FIELD CHARACTERISTICS

FACTOR	Enter Data	Unit
Treatment System	STP	-
Effluent flow rate	8266	L/day
Effluent N	20.0	mg/L
Effluent P	7.0	mg/L
Design soil depth	0.50	m
Soil P-sorption	370.0	mg/kg
Plant N uptake	240.0	kg/ha/year
Plant P uptake	20.0	kg/ha/year

STEP 2 : ASSESSMENT

NITROGEN BUDGET FOR RE-USE FIELD

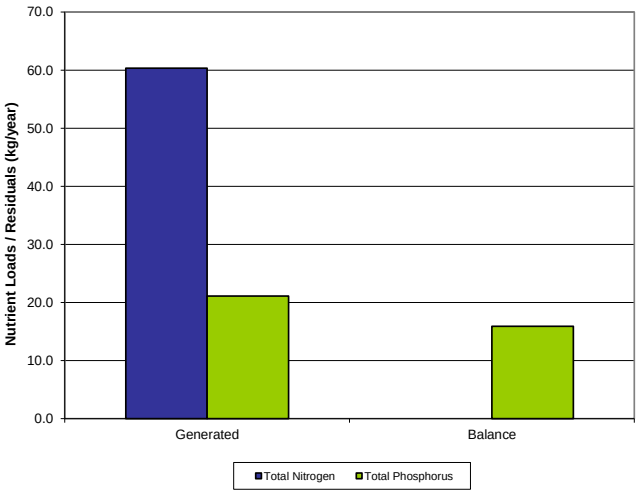
N generated	60.34	kg/year
N consumed	60.34	kg/year
N balance	0.00	kg/year
Min Area	2514	m^2

PHOSPHORUS BUDGET FOR RE-USE FIELD

P generated	21.12	kg/year
P consumed	5.21	kg/year
P balance	15.91	kg/year
P sorption	795.4	kg P/design soil depth
Field life (for P)	50.0	Years
Min Area	2606	m^2

MINIMUM NUTRIENT ASSIMILATION AREA

Minimum Area	**2606**	m^2



Effluent Disposal Field - Water Balance Assessment

Method ST-XX Revised 11.8.2010

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PROJECT DETAILS **Scenario: C - Projected site visitor rate, extended wastewater management system**

Project	Wastewater Assessment: 71 Fig Hill Lane, Dunmore, NSW			Ref. No.	P1907197
Author	MGD	Reviewed	DMM	Date Created	1/08/2019

Required irrigation area with 100 kL wet weather storage.

STEP 1 : ENTER SITE AND FIELD CHARACTERISTICS

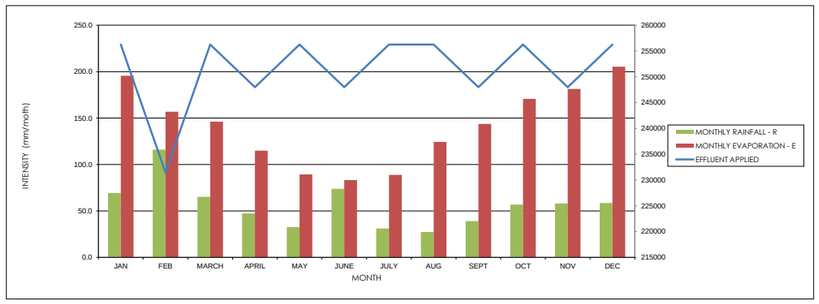
FACTOR	Enter Data	Unit
Runoff Factor - RF	0.35	%
Daily Effluent Load (Summer) - DELS	8266.3	
Daily Effluent Load (Winter) - DELS	8266.3	L
Effluent Disposal Area - A	1480.0	m^2
Design Percolation Rate (DPR)	4.0	mm/day

Peak Design Irrigation Rate - DIR	5.6	mm/day
Wet-Weather Storage (KL)	96.8	KL

STEP 2 : ENTER CLIMATE DATA

Source(s): Albion Park Airfield (68241), Nowra RAN (68076)

MONTH	MONTHLY RAINFALL - R Enter Data	MONTHLY EVAPORATION - E Enter Data
JAN	69.20	195.60
FEB	116.00	156.80
MARCH	65.20	146.20
APRIL	47.30	114.90
MAY	32.60	89.30
JUNE	73.80	83.20
JULY	31.10	88.80
AUG	27.30	124.30
SEPT	39.00	143.70
OCT	56.80	170.70
NOV	58.10	181.40
DEC	58.60	205.40



STEP 3 : ASSESSMENT

MONTH	NUMBER OF DAYS	MONTHLY RAINFALL (mm)	RETAINED RAINFALL	MONTHLY EVAPORATION	CROP FACTOR	EVAPO-TRANSPIRATION RATE	DESIGN PERCOLATION	AVAILABE IRRIGATION CAPACITY	EFFLUENT APPLIED	APPLICATION RATE	INCREASE IN PONDING DEPTH OF EFFLUENT	CUMULATIVE PONDING DEPTH OF EFFLUENT FROM PREVIOUS MONTH	DEPTH OF EFFLUENT	PONDING DEPTH OF EFFLUENT	WET-WEATHER STORAGE REQUIRED
-	(days)	(mm/month)	(mm/month)	(mm/month)	-	(mm/month)	(mm/day)	(mm/month)	(L/month)	(mm/month)	(mm)	(mm)	(mm/month)	(mm)	(KL)
-	DAY	R	RR = R x (1- RF)	E	CF	ETR = E x CF	DP = DPR x DAYS	AIC = ETR - RR +DP	EA = DEL x DAY	AR = EA / A	D = (AIC - AR)	CPD = PD from previous month	DE = D + CPD	PD	WWS
JAN	31	69.20	45.0	195.60	0.80	156.5	124.0	235.5	256255	173.1	-62.4	22.6	-39.8	**0.0**	**0.0**
FEB	28	116.00	75.4	156.80	0.80	125.4	112.0	162.0	231456	156.4	-5.7	0.0	-5.7	**0.0**	**0.0**
MARCH	31	65.20	42.4	146.20	0.80	117.0	124.0	198.6	256255	173.1	-25.4	0.0	-25.4	**0.0**	**0.0**
APRIL	30	47.30	30.7	114.90	0.80	91.9	120.0	181.2	247989	167.6	-13.6	0.0	-13.6	**0.0**	**0.0**
MAY	31	32.60	21.2	89.30	0.65	58.0	124.0	160.9	256255	173.1	12.3	0.0	12.3	**12.3**	**18189.9**
JUNE	30	73.80	48.0	83.20	0.65	54.1	120.0	126.1	247989	167.6	41.5	12.3	53.7	**53.7**	**79536.1**
JULY	31	31.10	20.2	88.80	0.65	57.7	124.0	161.5	256255	173.1	11.6	53.7	65.4	**65.4**	**96764.0**
AUG	31	27.30	17.7	124.30	0.65	80.8	124.0	187.1	256255	173.1	-13.9	65.4	51.5	**51.5**	**76185.3**
SEPT	30	39.00	25.4	143.70	0.80	115.0	120.0	209.6	247989	167.6	-42.0	51.5	9.4	**9.4**	**13951.5**
OCT	31	56.80	36.9	170.70	0.80	136.6	124.0	223.6	256255	173.1	-50.5	9.4	-41.1	**0.0**	**0.0**
NOV	30	58.10	37.8	181.40	0.80	145.1	120.0	227.4	247989	167.6	-59.8	0.0	-59.8	**0.0**	**0.0**
DEC	31	58.60	38.1	205.40	0.80	164.3	124.0	250.2	256255	173.1	-77.1	0.0	-77.1	**0.0**	**0.0**

9 Attachment D – Soil Laboratory Results

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CERTIFICATE OF ANALYSIS 219056

Client Details

Client	Martens & Associates Pty Ltd
Attention	Michael Dumas, Gray Taylor, William Xu
Address	Suite 201, 20 George St, Hornsby, NSW, 2077

Sample Details

Your Reference	**P1907197: NSW**
Number of Samples	3 Soil
Date samples received	05/06/2019
Date completed instructions received	05/06/2019

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	14/06/2019
Date of Issue	26/06/2019

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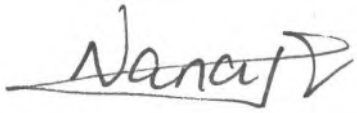
Results Approved By
Ken Nguyen, Reporting Supervisor
Loren Bardwell, Senior Chemist
Nick Sarlamis, Inorganics Supervisor

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil				
Our Reference		219056-1	219056-2	219056-3
Your Reference	UNITS	7197/BH101/0-0.2/S/1	7197/BH107/0.3-0.5/S/1	7197/BH108/0-0.2/S/1
Date Sampled		24/05/2019	24/05/2019	24/05/2019
Type of sample		Soil	Soil	Soil
Date prepared	-	06/06/2019	06/06/2019	06/06/2019
Date analysed	-	06/06/2019	06/06/2019	06/06/2019
pH 1:5 soil:water	pH Units	7.3	9.4	8.6
Electrical Conductivity 1:5 soil:water	µS/cm	81	200	140
Emerson Class No.	-	5.0	4.0	7.0

CEC				
Our Reference		219056-1	219056-2	219056-3
Your Reference	UNITS	7197/BH101/0-0.2/S/1	7197/BH107/0.3-0.5/S/1	7197/BH108/0-0.2/S/1
Date Sampled		24/05/2019	24/05/2019	24/05/2019
Type of sample		Soil	Soil	Soil
Date prepared	-	07/06/2019	07/06/2019	07/06/2019
Date analysed	-	07/06/2019	07/06/2019	07/06/2019
Exchangeable Ca	meq/100g	9.5	32	26
Exchangeable K	meq/100g	0.2	0.3	0.3
Exchangeable Mg	meq/100g	5.5	1.1	3.4
Exchangeable Na	meq/100g	0.39	0.33	0.13
Exchangeable Al	meq/100g	<0.1	0.2	0.5
Cation Exchange Capacity	meq/100g	16	34	30

Phosphorus Sorption				
Our Reference		219056-1	219056-2	219056-3
Your Reference	UNITS	7197/BH101/0-0.2/S/1	7197/BH107/0.3-0.5/S/1	7197/BH108/0-0.2/S/1
Date Sampled		24/05/2019	24/05/2019	24/05/2019
Type of sample		Soil	Soil	Soil
Date prepared	-	26/06/2019	26/06/2019	26/06/2019
Date analysed	-	26/06/2019	26/06/2019	26/06/2019
Phosphorus Buffer Index	mg/kg	100	590	730
Phosphorus Sorption Capacity	mg/kg	520	980	730
Phosphorus (Clowell)	mg/kg	52	16	51

Method ID	Methodology Summary
Ext-037	Analysed by Sydney Environmental & Soil Laboratory
Ext-062	Analysed by East West Enviroag
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Metals-009	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			06/06/2019	1	06/06/2019	06/06/2019		06/06/2019	[NT]
Date analysed	-			06/06/2019	1	06/06/2019	06/06/2019		06/06/2019	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	7.3	7.3	0	101	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	81	80	1	102	[NT]
Emerson Class No.	-	0	Ext-037	[NT]	1	5.0	[NT]		[NT]	[NT]

QUALITY CONTROL: CEC						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			07/06/2019	[NT]	[NT]	[NT]	[NT]	07/06/2019	[NT]
Date analysed	-			07/06/2019	[NT]	[NT]	[NT]	[NT]	07/06/2019	[NT]
Exchangeable Ca	meq/100g	0.1	Metals-009	<0.1	[NT]	[NT]	[NT]	[NT]	88	[NT]
Exchangeable K	meq/100g	0.1	Metals-009	<0.1	[NT]	[NT]	[NT]	[NT]	99	[NT]
Exchangeable Mg	meq/100g	0.1	Metals-009	<0.1	[NT]	[NT]	[NT]	[NT]	89	[NT]
Exchangeable Na	meq/100g	0.1	Metals-009	<0.1	[NT]	[NT]	[NT]	[NT]	93	[NT]
Exchangeable Al	meq/100g	0.1	Metals-009	<0.1	[NT]	[NT]	[NT]	[NT]	86	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Report Comments

Phosphorus sorption capacity and emerson class analysed by East West. Report no. EW191103

10 Attachment E – Beavers Gardner Virus Transport Model

Virus Transport Model (Beavers Gardner)

Martens & Associates Pty Ltd

Contaminant boundary conditions

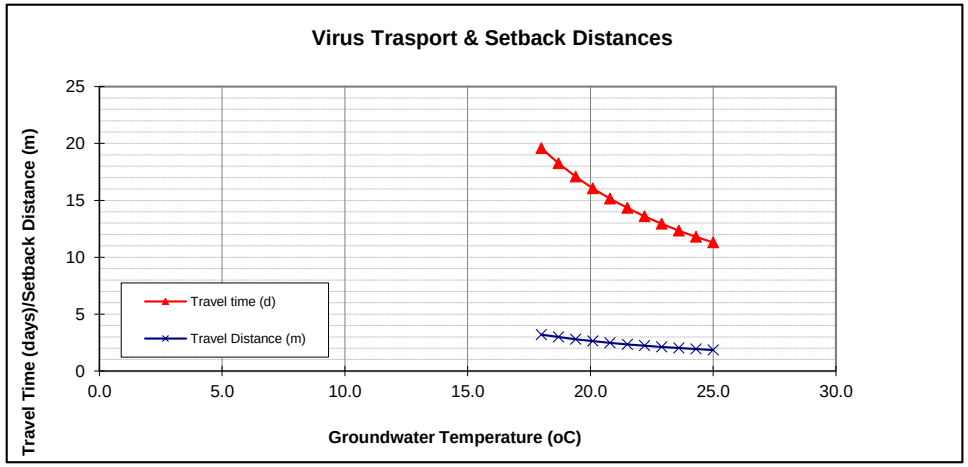
M_o	1.00E+05	Initial concentration (viruses/L)
M_t/M_o	1.00E-04	Magnitude of reduction ratio

Aquifer boundary conditions

T_l	18	Minimum groundwater temperature (^oC)
T_h	25	Maximum groundwater temperature (^oC)
K	0.35	Saturated hydraulic conductivity (m/day)
i	0.07	Hydraulic gradient (m^{-1})
n_e	0.15	Effective porosity of the aquifer

Modelled Predictors

Groundwater Temperature (^oC)	k	M_t	Travel time (d)	Travel Distance (m)
18.0	0.470	10	20	3
18.7	0.505	10	18	3
19.4	0.539	10	17	3
20.1	0.574	10	16	3
20.8	0.608	10	15	2
21.5	0.643	10	14	2
22.2	0.677	10	14	2
22.9	0.712	10	13	2
23.6	0.746	10	12	2
24.3	0.781	10	12	2
25.0	0.815	10	11	2



k	Decay rate coefficient
M_t	Final concentration (viruses/L)
t	Travel time (days)
D	Setback distance (m)