Tarawera WWTP and Land Disposal System: Concept Design

Prepared for

Rotorua Lakes Council

January 2020

F I N A L D R A F T

PATTLE DELAMORE PARTNERS LTD
Level 5, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Tel +64 9 **523 6900** Fax +64 9 **523 6901**
Website **http://www.pdp.co.nz**
Auckland Tauranga Wellington Christchurch

solutions for your environment

Quality Control Sheet

TITLE	Tarawera WWTP and Land Disposal System: Concept Design
CLIENT	Rotorua Lakes Council
REVISION HISTORY	Version 1 – [8 December 2016] Version 2 – [Reissued 27 April 2017 – incorporating RLC feedback] Final Draft V3 – [issued 21 November 2019 – incorporating constraints mapping exercise for WWTP and LDS locations and information from Rotoiti/Rotoma WWTP construction] Final Draft V4 – [Issued 21 January 2020 – incorporating further feedback from RLC]
ISSUE DATE	21 January 2020
JOB REFERENCE	A03101202
SOURCE FILE(S)	A03101202R001.docx

DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Daniel Garden   Olebogeng Mothelesi

Reviewed and Approved by

SIGNATURE

Daniel Garden

Limitations:

This report has been prepared on the basis of information provided by Rotorua Lakes Council, and others (not directly contracted by PDP for the work). PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Rotorua Lakes Council for the limited purposes described in the report. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

Table of Contents

List of Figures

List of Tables

Appendices

1.0 Introduction

Pattle Delamore Partners Ltd (PDP) was engaged by Rotorua Lakes Council (RLC) in November 2016 to develop a high-level concept design for a membrane bioreactor (MBR) based wastewater treatment plant (WWTP) and rapid infiltration based land disposal system (LDS) for the lakeside community of Tarawera. This WWTP and LDS concept is similar to the recently commissioned Rotoiti/Rotoma WWTP which involves a very high level of treatment (i.e. a very good quality effluent) prior to rapid infiltration to land. Further to the above, in July 2017 PDP presented a constraints mapping exercise which investigated possible locations within the Lake Tarawera catchment that may be suitable for a WWTP and LDS.

This report incorporates the findings of the above two pieces of work into a single technical report and also includes various updates to the WWTP and LDS concept following the completion of the Rotoiti/Rotoma WWTP which was commissioned in 2019.

1.1 Background

Wastewater generated from the lakeside community of Tarawera is presently treated and disposed of using onsite wastewater treatment and land disposal systems, predominantly in the form of septic tanks and disposal trenches. To reduce the public health risk and environmental impact associated with the existing onsite wastewater systems, RLC and the project stakeholders are investigating options for a reticulated sewerage scheme to service the community.

PDP understands that the following two high-level options for the sewerage scheme are presently being considered:

a) Wastewater collection using some form of pressure sewer reticulation (e.g. low-pressure grinder pump (LPGP), septic tank effluent pumping (STEP), or other) and transfer to the Rotorua wastewater reticulation network (at Okareka) and subsequent transfer to the Rotorua WWTP and disposal system; or

b) Wastewater collection using some form of pressure sewer reticulation and transfer to a new centralised “in-catchment” WWTP and LDS.

It should be noted that presently no site has been identified for an in-catchment WWTP and LDS and no preliminary or detailed site investigations have been undertaken to confirm the feasibility of such a site.

1.2 Purpose of Report

The purpose of this report is to provide preliminary technical information with regards to a possible in-catchment WWTP and LDS concept for Tarawera (i.e. Option b) which can be used by RLC and other stakeholders to assist with an assessment of sewerage scheme options for Tarawera. We understand that this report may be used for consultation with mana whenua, tangata whenua, the Tarawera community and other project stakeholders.

1.3 Scope of Work

The scope of work in preparing this report is outlined as follows:

a) Establish design requirements of the WWTP and LDS, including identifying the area of benefit, influent flows and loads and treated effluent characteristics.

b) Develop a process train and preliminary sizing of membrane bioreactor (MBR) equipment configured for biological nutrient removal.

c) Outline appropriate provisions for odour control and sludge management.

d) Outline investigations required to confirm site suitability for the LDS.

e) Develop rough-order capital and operating cost estimates (e.g. in the order of ± 35% accuracy).

f) Identify high-level assessment criteria for potential siting of the WWTP and LDS, obtain GIS information and undertake a constraints mapping exercise to identify potentially suitable sites (if any) within the Lake Tarawera Catchment. This assessment is to focus on technical aspects only.

g) Incorporate various aspects of the recently completed Rotoiti/Rotoma WWTP and LDS, including provision for UV disinfection for possible offsite beneficial reuse of the treated wastewater and updated cost estimates based on actual costs spent to complete the Rotoiti/Rotoma WWTP and LDS.

The development of a conceptual design and cost estimates for the reticulation component of the Tarawera Sewerage Scheme is outside the scope of this report. Confirming the feasibility of consenting and implementing a WWTP and LDS at Tarawera is outside the scope of this report and will require a suitable site(s) to be identified, a comprehensive site investigation programme, stakeholder consultation and a full assessment of environmental effects (AEE).

This report does not cover investigation or further development of Option a), as described in Section 1.1.

2.0 Design Requirements

2.1 Area of Benefit and Wastewater Collection

The area of benefit to be serviced by the proposed Tarawera sewerage scheme has been developed by RLC and includes all residential and non-residential properties highlighted in Figure 1.

The proposed wastewater collection system will utilise pressure sewer reticulation to convey wastewater for treatment and disposal at the WWTP and LDS. Depending on the elevation and length of pipeline to the selected site for the WWTP and LDS, an additional transfer pump station may be required in addition to the on-property pumps at each property.

2.2 Flows

Influent flows to the WWTP have been derived based on the population within the area of benefit which will be serviced by the proposed sewerage scheme.

PDP has utilised 'present' and 'ultimate' household unit equivalent (HUE) figures for the Tarawera area of benefit provided by RLC. The ultimate design horizon is assumed to allow for the full development of some presently unoccupied properties within the area of benefit.

Average and peak occupancy rates provided by RLC have been assumed as follows:

- Annual average: 2.0 persons/HUE.
- Peak summer: 3.8 persons/HUE.

A per person daily flow rate of 220 L/person/d has been assumed (as per RLC's Engineering Standards) together with the above occupancy figures and HUE data to calculate the present and ultimate design average daily flow (ADF) and peak daily flow (PDF) as outlined in Table 1.

Given that the Tarawera reticulation pipework will be pressurised from the on-property LPGPs or STEP system all the way to the WWTP (potentially with an additional pump station on-route depending on the location of the WWTP), stormwater inflows and groundwater infiltration (I&I) into the network will be minor compared with a conventional gravity reticulation system. For the purpose of this report a peak wet weather flow (PWWF) factor of 1.2 has been applied to the PDF (e.g. peak day summer flow) to allow for potential I&I upstream of on-property gully traps, pipework and onsite pump chamber[1].

[1] GHD Ltd. (2014). Prevention is Better than Cure – Do low I&I Sewers Really Work, GHD Ltd, Water NZ Conf.

SOURCE:
1. AERIAL IMAGERY FLOWN 2010/2011 SOURCED FROM THE LINZ DATA SERVICE HTTPS://DATA.LINZ.GOVT.NZ/LAYER/1760-BAY-OF-PLENTY-025M-RURAL-AERIAL-PHOTOS-2011-2012/ AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 3.0 NEW ZEALAND LICENCE.
2. INFORMATION PROVIDED BY ROTORUA LAKES DISTRICT COUNCIL, RECEIVED 21/11/16.
3. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.

FIGURE 1 : AREA OF BENEFIT

SCALE: 1:30,000 (A3)

0 0.25 0.5 1
KILOMETRES

A03101200Z001.mxd DEC 16 ISSUE1

Document Set ID: 20159080
Version: 1, Version Date: 13/02/2024

Table 1: Influent Flows

Design Horizon	HUE[1]	ADF[2]	PDF[3]	PWWF[4]
		m^3/d	m^3/d	m^3/d
Present (2019)	421	185	352	422
Ultimate	544	239	455	546

Notes:

1. *Household unit equivalent data provided by RLC in 2016. Note that these figures may need to be updated to account for any growth which has occurred between 2016 and 2019.*
2. *Average daily flows (ADF) have been derived using an occupancy of 2.0 persons/HUE and a per person flow rate of 220 L/p/d.*
3. *Peak daily flows (PDF) have been derived using an occupancy of 3.8 persons/HUE and a per person flow rate of 220 L/p/d.*
4. *A peak wet weather flow factor of 1.2 has been applied to the PDF to arrive at the PWWF.*

2.3 Influent Characteristics

Influent contaminant concentrations and loads arriving at the WWTP will depend on whether any treatment will be provided onsite as part of the wastewater collection system. For example, if a low-pressure grinder pump system (LPGP) with a 700 L tank at each property was to be adopted then the wastewater characteristics arriving at the WWTP would likely be typical raw wastewater characteristics. Whereas, if a septic tank effluent pumping (STEP) system with a 4,000 L septic tank was to be adopted at each property then influent biochemical oxygen demand ($cBOD_5$) and total suspended solids (TSS) arriving at the WWTP would be reduced, but with similar concentrations of total nitrogen (TN) and total phosphorus (TP) to typical raw wastewater. Therefore, as discussed further in the July 2017 PDP report[2], if a STEP system (or similar) was adopted rather than LPGP then there would be an increased chemical dosing at the WWTP which would increase the operating cost of the WWTP.

Expected influent concentrations and loads arriving at the WWTP on the basis of an LPGG wastewater collection system are presented in Table 2. These concentrations are consistent with medium to strong concentrations presented in the wastewater design text Metcalf and Eddy (20014)[3].

F I N A L D R A F T

[2] Tarawera WWTP and Land Disposal System: Concept Design, PDP (July 2017)

[3] Metcalf & Eddy, G. T. (2014). Wastewater Engineering, Treatment and Reuse, Fifth Edition. McGraw Hill Education.

Table 2: Influent Concentrations and Loads[1]

Parameter[2]	Concentration	Average Daily Load for Ultimate Design Horizon[3]	Peak Daily Load for Ultimate Design Horizon[3]
	g/m^3	kg/d	kg/d
$cBOD_5$	235	56	107
TSS	294	70	134
TN	75	18	34
TP	15	3.6	6.8

Notes:

1. *These influent concentrations and contaminates loads are based on an LPG wastewater collection system. Influent concentrations and loads will differ if a STEP or other form of collection system is adopted, with treatment provided on site.*
2. *$cBOD_5$ = Carbonaceous Biochemical Oxygen Demand, TSS = Total Suspended Solids, TN = Total Nitrogen, TP = Total phosphorus.*
3. *Ultimate average daily and peak daily loads have been calculated based on the assumed influent concentrations and the assumed ADF and PDF as outlined in Table 1.*

2.4 Effluent Characteristics

In the brief for this project RLC prescribed that influent to the WWTP is to be treated using membrane bioreactor (MBR) technology in the ultrafiltration range (i.e. typical operating range of 0.008 to 0.2 microns) prior to disposal to land using a rapid infiltration method.

RLC has indicated that the target effluent quality for the WWTP is the same very high-quality effluent (i.e. well treated) as achieved by the Rotoiti/Rotoma WWTP. The target contaminant removal rates, effluent concentrations and ultimate average annual effluent loads are outlined in Table 3.

Table 3: Target Effluent Quality

Parameter[1]	Removal Target	Effluent	
		Median Concentration[2]	Annual Load
	%	g/m^3	kg/yr
$cBOD_5$	98	5.0	440
TSS	99	2.0	170
TN	93	5.0	440
TP	87	2.0	170
E. coli	>99.99%	<10 cfu/100 mL	N/A

Notes:

1. *$cBOD_5$ = Carbonaceous Biochemical Oxygen Demand, TSS= Total Suspended Solids, TN=Total Nitrogen, TP=Total phosphorus, E. coli= Escherichia coli.*

As per the Rotoiti/Rotoma WWTP, supplementary carbon dosing will be required at the Tarawera WWTP to reliably achieve the low target TN concentration of 5 g/m^3 and alum dosing will be required to achieve the low target TP concentration of 2 g/m^3.

Similarly, as per the Rotoiti/Rotoma WWTP, UV disinfection downstream of the ultrafiltration membrane dosing will be required at the Tarawera WWTP to reliably archive *E.* coli <10 cfu/100 mL to allow for possible controlled offsite reuse of the wastewater for selective low-risk applications (e.g. irrigation of non-edible crops).

2.5 Land Disposal System

For the purpose of this report PDP has assumed that the disposal system is required to accommodate the hydraulic loading requirements only and not provide 'land treatment' of the effluent (i.e. no additional nitrogen or phosphorus uptake by vegetation/soil will occur within the land disposal site). This type of system is commonly referred to as a rapid infiltration system (RIS), whereby rapid disposal of effluent is achieved in a small footprint.

Some discussion around an alternative WWTP and LDS concept, involving a reduced level of treatment at the WWTP but with further treatment provided via the land (i.e. land treatment system) is presented in Section 4.2. However, a comprehensive assessment of this alternative option is outside the scope of this report.

2.6 Additional Design Requirements

The following additional design requirements have been taken into account when developing the concept for the WWTP and LDS:

1. ***Odour:*** provision needs to be made for collection and treatment of objectionable odour generated from odorous areas of the WWTP.
2. ***Visual Impact:*** the design must minimise the visual impact of the WWTP and LDS.
3. ***Noise***: the design will minimise noise and comply with relevant acoustic standards for the site (to be confirmed).
4. ***Operation and Maintenance:*** while an MBR WWTP with chemical dosing is an advanced system which will require operator input and on-going maintenance, the design will minimise operator input and maintenance requirements where possible.

3.0 Wastewater Treatment Plant

Based on PDP's experience at other sites in New Zealand, an appropriately designed MBR based WWTP as briefly outlined in the following sections of this report is expected to achieve the target effluent quality criteria outlined in Table 3. Detailed process design has not been undertaken at this stage but this will need to be undertaken at preliminary design to confirm that the effluent quality is suitable for discharge into the receiving environment and can be reliably achieved.

3.1 Infrastructure Items

Infrastructure items which will be included in the WWTP are outlined as follows:

- Fine screening and grit removal unit (1/0.5 mm aperture), such as a packaged Johnson Screen package (as installed at Maketu);
- A 4-stage Bardenpho biological nutrient removal (BNR) secondary wastewater treatment process, including primary anoxic tank, aeration tank, secondary anoxic tank and MBR tank;
- Supplementary carbon dosing (e.g. acetic acid or sugar) for enhanced biological nitrogen removal (BNR) and alum dosing for chemical removal of phosphorus;
- Supplementary alkalinity dosing (e.g. sodium bicarbonate or other) to maintain adequate pH for biological removal of nitrogen);
- Treated effluent storage tank and irrigation pumps (in the event that gravity discharge to the LDS is not possible);
- UV disinfection reactor unit;
- Emergency/contingency storage tank/basin;
- Membrane cleaning system (including chemical storage and dosing systems);
- Control building including motor control centre (MCC), blower room and chemical storage (in separate rooms);
- Sludge storage tank and solids dewatering system (including polymer dosing), such as small screw press unit; and
- Foul air collection and treatment unit (e.g. bark-bed biofilter).

An indicative process flow diagram showing the arrangement of the process units is shown in Figure 2. A simpler 3-tank Modified Ludzack Ettinger (MLE) BNR configuration could be adopted as an alternative to the 4-tank Bardenpho configuration, however, the 4-tank system is the preferred option to reliably achieve the low effluent nutrient concentrations outlined in Table 3 while minimising carbon dosing.

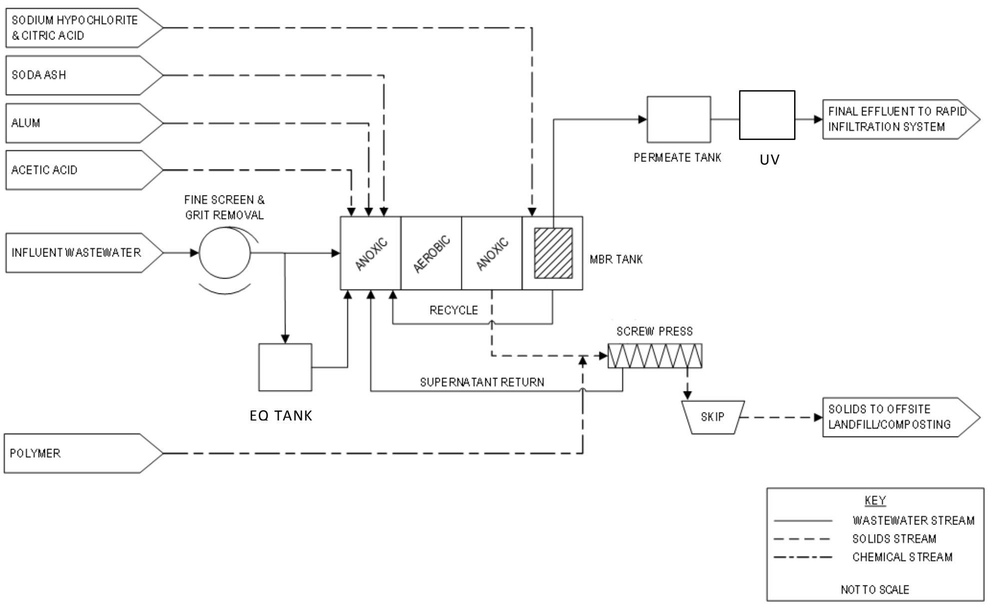


Figure 2: Indicative Process Flow Diagram

3.2 Indicative Process Tank Sizing

Indicative sizing of the key process tanks has been undertaken by applying conservative hydraulic retention times as summarised in Table 4. Detailed process design will be required to confirm tank sizing. For this concept design a maximum tank height of 4.5 m has been assumed.

Table 4: Indicative Process Tank Sizing

Tank	HRT[1] (h)	Volume[2] (m^3)	Plan Area[3] (m^2)
Stage1: Primary Anoxic Zone	3	57	13
Stage 2: Aeration Zone	3	57	13
Stage 3: Secondary Anoxic Zone	3	57	13
Stage 4: MBR Tank	1.5	28	11
Total	**10.5**	**199**	**44**

Notes:

1. *Hydraulic retention times utilised for tank sizing are based on the PDF.*
2. *Tank volumes have been estimated based on design influent flows and typical hydraulic retention times.*
3. *Plan areas have assumed tank depths of 4.5 m apart from the membrane tank which is assumed to be 2.5 m.*

FINAL DRAFT

3.3 Membrane Selection

Selection of membrane equipment has not been undertaken at this conceptual stage. However, Suez ZeeWeed ultrafiltration hollow fibre membranes as presently used at the main Rotorua and Rotoiti/Rotoma WWTPs would be a logical choice as these have proven to be a reliable choice and would ensure commonality between the sites which would simplify operation and maintenance. Typically, the membrane supplier would provide a package of membrane equipment for the WWTP which would include the membrane cassettes, manifolds, permeate pumps, membrane cleaning equipment and air scour system. A typical arrangement of membrane equipment for an MBR WWTP is shown in Figure 3.

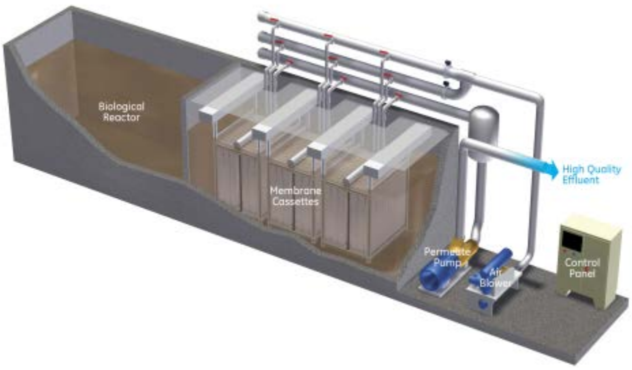


Figure 3: Membrane Equipment Arrangement[4]

3.4 Peak Flow Management

An appropriately designed pressure sewer reticulation system will convey lower peak flows to the WWTP compared with a conventional gravity reticulation system due to minimal wet-weather inflows and infiltration and due to the provision of buffering storage at each property. However, we have assumed that a flow equalisation (EQ) tank will be included to provide diurnal storage upstream of the process tanks.

3.5 Solids Management

Screenings separated at the inlet works to the WWTP would be stored in a wheelie bin or skip and periodically transported offsite for disposal to landfill or composting/vermicomposting.

Secondary solids generated in the biological wastewater treatment process will be pumped to a dedicated waste activated sludge (WAS) tank and subsequently to a dewatering building where it will be dewatered using a screw press or a similar unit to achieve a dry solids concentration of around 15 to 20% with

[4] Source - GE Water and Process Technologies Ltd (now Suez Group)

FINAL DRAFT

polymer dosing (to aid flocculation). The supernatant will be returned to Stage 1 of the MBR process stream and the dewatered solids will be stored on-site in a skip prior to off-site disposal to landfill or to composting / vermicomposting.

3.6 Odour Management

The WWTP will have several sources of odour which will require careful consideration to ensure there is no odour generated at the site.

Odour will largely be attributed to hydrogen sulphide gas (H_2S) released under anaerobic conditions at the following process areas:

- Influent screening/grit removal unit.
- Flow EQ tank.
- Solids dewatering unit and dry solids storage bins.

Given that the reticulation system is to comprise of a pressure sewer system, the retention time in the network is likely to be significant and high concentrations of H_2S will likely be released at the head of the WWTP (Inlet screen). For this reason, enclosure of the inlet screen inside a building will be required to minimise odour release, with foul air extraction and treatment. Alternatively, appropriately designed covers could be installed to an exterior mounted screen unit for foul air collection.

The concept design has assumed that foul air would be extracted by a fan and duct system for treatment in a bark-bed biofilter.

3.7 Corrosion Protection

Influent wastewater entering the WWTP is likely to be corrosive due to the relatively long hydraulic retentions times associated with LPSS promoting release of hydrogen sulphide and subsequent formation of sulphuric acid. Therefore, design of all infrastructure including pipes, tanks, pumps and instrumentation will need to consider appropriate corrosion protection.

3.8 Noise Management

Noise will be generated by mechanical equipment at the WWTP site. Sources of noise at the WWTP and controls are outlined as follows:

- ***Blowers:*** house inside a blower room with acoustic silencers on the inlet and specialised building design; and
- ***Fans:*** may likely require acoustic enclosures.

Acoustic assessment of all sources of noise will be required during detailed design to ensure compliance with RLC's noise limits.

3.9 Chemical/HSNO Requirements

Several chemicals will be used at the WWTP. In order of expected use/cost these are: liquid sugar (supplementary carbon), alum (phosphorus removal), sodium bicarbonate (alkalinity adjustment), sodium hypochlorite and citric acid (membrane cleaning).

The concept design has assumed that liquid sugar will be used to enhance denitrification as adopted at Rotoiti. While sugar is more expensive than ethanol (which is used at other larger scale municipal WWTPs for enhanced denitrification), health and safety requirements are less stringent for sugar than for ethanol. Therefore, given the relatively small quantity of supplementary carbon required at Tarawera, sugar is the preferred choice. A number of HSNO controls will be required at the site for the storage and use of these chemicals (e.g. signage, eyewash stations and emergency showers and spill management controls).

3.10 General Layout and Civil Works

The following general civil works will be required within the WWTP compound:

- Access road suitable for chemical delivery;
- Electricity supply;
- Stormwater management;
- Water supply; and
- Security fence.

A photograph of the recently constructed Rotoiti/Rotoma WWTP which is very similar to that proposed for Tarawera (albeit the Rotoiti/Rotoma WWTP has a capacity of approximately twice that required for the Tarawera WWTP) is shown in Figure 4. Note that while the size of the process tanks, equipment, pipework and pumps will be smaller for the Tarawera WWTP compared the Rotoiti WWTP, the overall footprint would likely be similar.

Figure 4: Photograph of Rotoiti/Rotoma WWTP August 2019

F I N A L D R A F T

FINAL DRAFT

4.0 Land Disposal System

RLC has specified a preference for a trench based rapid infiltration land disposal system (LDS) for Tarawera similar to that proposed at Rotoiti/Rotoma.

As no site has been identified at this stage for the LDS, there is no information presently available to confirm the suitability of the site for treated effluent disposal, to assess the environmental effects of this activity and for sizing of the disposal system infrastructure. However, in the interests of providing an indication of size we have assumed that a suitable site can be found that satisfies the hydrogeological requirements and we have provided some preliminary dimensions based on the Rotoiti/Rotoma LDS.

4.1 Hydrogeological Requirements

The key hydrogeological requirements that determine the feasibility of a rapid infiltration system are:

1. Adequate soil infiltration rate to accommodate the peak design hydraulic loading rate.
2. Avoidance of localised 'daylighting' of disposed effluent at the ground surface due to mounding effects or due to interface flow at low permeability layers.
3. Avoidance of adverse localised nutrient loading (e.g. nitrogen and phosphorous) to a sensitive down-gradient surface water body (e.g. stream or near-lake shore effects) due to insufficient dispersion/mixing of the plume as it migrates through the groundwater to the receiving surface water body.

Site investigations will be required to confirm site suitably as discussed in Section 4.3.

4.2 Concept Design

In the absence of any site information, the following design assumptions have been made to allow indicative sizing of the disposal trenches:

- Ultimate PWWF (design flow): 550 m^3/d (refer to Table 1);
- Trench width: 2.0 m; and
- Assumed infiltration rate: 0.3 m/d (compared to 1.0 m/d for Rotoiti, with a lower infiltration rate selected given that no site investigations have been undertaken at this stage).

Based on the above assumptions a total trench length of 917 m is required. This could consist of 4 No. 230 m long trenches spaced 25 m apart constructed at right angles to the groundwater contour. This will require a total area of around 5 ha for the WWTP and LDS, allowing 50% area for set back to the site boundaries and to provide contingency reserve area for wastewater disposal.

While outside the scope of this report which has investigated an advanced WWTP and rapid infiltration LDS concept, an alternative concept could involve providing less treatment at the WWTP but with additional treatment of the wastewater provided by slow rate irrigation to land. This option would require more land area for wastewater disposal and could be similar to the existing Rotorua spray irrigation of treated wastewater to the Whakarewarewa Forest system or the Taupo spray irrigation to cut-and-carry grass crop. For example, based on an annual average hydraulic loading rate of 2.5 mm/d to cut-and-carry grass crop and with a target effluent total nitrogen (TN) concentration from the WWTP of 40 g/m^3, the total land area required for this concept may be in the order of 15 ha (including 50% additional contingency area). This alternative WWTP and LDS concept has not been investigated further at this stage.

4.3 Investigations

Once a potential site (or a number of potential sites) for the WWTP/LDS have been identified, a staged investigation programme will be required to assess the feasibly of the site(s) for treated effluent disposal.

4.3.1 Initial Site Walkover

It is recommended that an initial walkover of the site(s) is undertaken by a suitably qualified hydrogeologist and engineer to provide a preliminary assessment of the suitability of the site for construction of the WWTP and for implementing and consenting the LDS.

The walkover should assess the general topography of the site, geographical features, proximity to streams and/or other surface water, proximity to neighbouring dwellings, ease of constructing the road access. The walkover should also identify any other potential constraints associated with the site.

4.3.2 Stage 1 – Hydrogeological Investigation

Assuming that a preferred potential site is identified from the initial site walkover(s), the next stage would include preliminary sub-surface ground investigations.

This investigation would include bore-hole investigations, permeability testing, soil infiltration testing and scala penetrometer testing.

4.3.3 Stage 2 – Hydrogeological Investigation

Assuming favourable findings are obtained from the stage 1 investigation, the next stage would involve drilling and installing a number of groundwater monitoring bores in order to collect soil profile data and baseline groundwater level and groundwater quality information. Groundwater level information will confirm the likely groundwater flow direction, and hence the expected flow path of the contaminant plume through the underlying groundwater from the LDS to the receiving environment.

This investigation would include drilling around 5 or 6 bores, including up-gradient and down-gradient bores, to depths below the minimum summer water table level. If the site was at a high elevation above the level of Lake Tarawera, then the depth of the bores at the LDS site and up-gradient bores may need to be significant (for example the bore depths at the Rotoiti/Rotoma LDS are up to 72 m below ground level). These bores could subsequently be used for permeability testing and ongoing groundwater quality monitor once the LDS is operational.

Based on the findings of the Stage 2 Hydrogeological investigation, groundwater modelling would then need to determine the travel time of the treated effluent through the groundwater, the extent of dilution and the expected impact on the groundwater contaminant concentrations.

4.3.4 Ecological Investigation

Assuming favourable findings are obtained from the stage 2 hydrogeological investigation, an ecological investigation would then be required to collect baseline ecological information. The effect of any predicted change to the groundwater quality on the receiving environment as a result of the disposal activity would also need to be considered as part of the ecological investigation.

4.4 Assessment of Environmental Effects

Once the above investigations have been completed then all the findings would need to be compiled into a complete assessment of environmental effects (AEE) which will form part of the discharge consent application for the WWTP and LDS activity.

5.0 Constraints Mapping Assessment of Potential WWTP and Disposal Sites

This constraints mapping exercise is high level only and is based on technical assessment criteria only. Landownership and cultural considerations have not been considered as part of this assessment and discussions with landowners, Iwi and the community will be required to determine the feasibility of constructing a WWTP and land disposal system at any of the general areas described in this report. Furthermore, a comprehensive site investigation programme and a full assessment of environmental effects (AEE) will also be required to confirm the suitability of any site for wastewater disposal.

5.1 Assessment Criteria

Land parcels within the Tarawera assessment area have been investigated for potential sites for rapid infiltration disposal of wastewater to land (refer to Figure B-1 to Figure B-6). The following assessment criteria have been utilised for this assessment:

- Proximity to receptors;
- Distance to proposed reticulation network;
- Site topography;
- Designations;
- Geology; and
- Soil drainage characteristics.

Geographic information system (GIS) data relating to the above criteria has been obtained for the Tarawera assessment area from the Bay of Plenty Regional Council (BoPRC) and Landcare Research's S-Map database. These criteria are briefly discussed in the following sections.

5.1.1 Proximity to Receptors

While the wastewater will be well treated, there is potential for some adverse effects from the disposal activity. Key receptors include neighbouring dwellings/urban areas, cultural/historically significant sites, groundwater users, environment receptors such as rivers and streams, high use stream management areas and ecologically significant sites. Sites with less receptors are preferred. Proximity to residential properties and existing groundwater bores are presented in Figure B-1.

5.1.2 Distance from Proposed Reticulation

The further the site is from the proposed reticulation network, the higher the capital and operating costs to convey the wastewater to the site. Therefore, disposal sites closer to the proposed reticulation are more feasible and are therefore preferred.

5.1.3 Site Topography

Site topography can limit the feasibility and practicality of constructing WWTP and land disposal infrastructure. There is also a higher chance of erosion and surface breakout of wastewater at steeper sites, and/or at steeper sites downgradient of the disposal site. Topography is presented in Figure B-2.

5.1.4 Designations

Various land parcels within the Tarawera assessment area are designated areas of outstanding natural features and landscapes (ONFL) as shown in Figure B-3. Constructing a WWTP and land disposal system on any sites designated as ONFL will be difficult and these areas have therefore been excluded. ONFL areas include the Lake Tarawera foreshore in the vicinity of Kotukutuku Bay, east of the Tarawera residential area on the northern shore of Lake Tarawera, and on the southern shore of Lake Okareka at Playnes Farm.

5.1.5 Geology/Hydrogeology

Rapid infiltration disposal of wastewater typically involves high loading rates (e.g. 300 mm/d in this instance), with the wastewater applied below the upper soil layers direct to the underlying soils and geological formation. Therefore, higher permeability geology is better suited for RI disposal to avoid groundwater mounding beneath the disposal area and reduce the risk of day lighting of the wastewater at the ground surface.

Geological information presented in Figure B-4 shows predominantly rhyolite formation across the assessment area, with Holocene river deposits in places. Observations by PDP during a site visit on 15 May 2017 indicated that a number of the stream channels within the higher ground areas shown in Figure B-4 were dry, indicating the underlying geology may be reasonable permeable.

A hydrogeological investigation is required to confirm site suitability for RI disposal. The investigation will need to establish key parameters of the underlying groundwater system, including determining the depth to groundwater, groundwater flow direction, travel time and soil permeability. Assessment of the potential effects on the hydrogeological system from the wastewater disposal activity would also be required, including assessment of the potential for groundwater mounding and daylighting, and dilution and travel time to the downgradient receiving environment (e.g. the lake or stream).

5.1.6 Soil Drainage Characteristics

Soil drainage is only a constraint if disposal of wastewater is at or near the ground surface (i.e. a key parameter for slow rate irrigation). However, soil drainage is not necessarily a constraint for an RI system discharging to ground at depth. Nevertheless, for completeness, soil drainage is shown in Figure B-5.

The Tarawera assessment area comprises primarily of loamy moderately well drained soils with reasonable drainage characteristics.

5.2 Findings of Constraints Mapping Assessment

As requested by RLC, given the very early stages of consultation and investigation into potential sites for a WWTP and for land disposal of treated wastewater, specific land parcels within the Lake Tarawera Catchment have not been identified and ranked in this report. Instead, general areas have been identified and are discussed as follows.

The built-up residential area along the foreshore of Lake Tarawera is a constraint for RI disposal of wastewater within the assessment area. RI disposal of wastewater in close proximity and/or directly up-gradient of residential properties may be met with opposition from some members of the community, despite a high level of treatment provided at the WWTP. Similarly, RI disposal close to or up-gradient of a culturally or ecologically significant stream is also unlikely to be acceptable (e.g. Wairoa Stream with the noted sites of significance, and which is understood to be an important fish spawning ground). Foreshore areas designated as ONFL areas to the south and north of the Tarawera community are also unlikely to obtain acceptance and approval for wastewater disposal. On this basis, a lot of locations within the assessment area are not considered to be feasible for RI disposal.

A potentially more favourable general location for RI disposal of wastewater is 'Area A' outlined in Figure B-6, located to the north of Spencer Road between the end of Tarawera Road and the start of the residential area at Te Toroa Point. This area could potentially offer a diffuse discharge of treated wastewater to Lake Tarawera via the groundwater while avoiding residential areas and Wairoa Stream.

Less feasible due to the significant distance from the proposed reticulation network, but still potentially feasible, is 'Area B' also outlined in Figure B-6. This area comprises of the plantation forested area south of Kotukutuku Bay. As for 'Area A', this area could also potentially offer a diffuse discharge of treated wastewater to Lake Tarawera via the groundwater while avoiding residential areas and Wairoa Stream.

Landowner discussions and a comprehensive investigation programme are required in order to confirm the feasibility of wastewater disposal at either of these sites.

Although outside the scope of this report, as briefly discussed in Section 4.2, an alternative wastewater disposal option could potentially involve disposal via slow rate irrigation (i.e. land treatment) to around 15 ha of land provided that sufficient suitable land was available within the Lake Tarawera Catchment.

6.0 Project Sequence and Timeframe

A preliminary sequence of tasks required to complete an in-catchment wastewater treatment plant and land disposal facility to service the Lake Tarawera community is outlined as follows:

1. Confirm preliminary cost estimates and project budget requirements;
2. Preliminary discussions with landowner(s) regarding land purchase or lease of potentially feasibly site outlined in this report;
3. Detailed site investigations to confirm feasibility of treated effluent disposal at the identified site;
4. Refine project budget, confirm project feasibility and obtain a memorandum of understanding with landowner;
5. Commence consultation with affected parties, which could include including Iwi, Bay of Plenty Regional Council, Tarawera community, Department of Conservations, Fish and Game and NZ Historic Places Trust;
6. Under further site investigations, analysis and preparation of a comprehensive assessment of environmental effects (AEE);
7. Confirm project feasibility;
8. Secure land purchase or long-term lease;
9. Lodge resource consent application (land use consent and consent to discharge treated wastewater to land);
10. Prepare expert witness statements and additional evidence to support a Hearing for the resource consent, with the possibility of proceeding to the Environmental Court;
11. Assuming that the consents are granted then commence preliminary followed by detailed engineering design of the WWTP and LDS;
12. Call tenders and award a construction contract;
13. Commission the completed WWTP and LDS;
14. Commence operation, maintenance and compliance monitoring.

Based on PDP’s experience assisting with planning, consultation, consenting, design and construction of similar wastewater treatment and disposal systems, we anticipate that the timeframe to the complete the above tasks may be in the order of 5 to 10 years.

7.0 Cost Estimates

PDP has developed 'concept level' indicative estimates of capital expenditure (CAPEX), operating expenditure (OPEX) and 35-year net present value (NPV) estimates for the proposed WWTP and disposal system.

It should be noted that the following cost estimates relate to a WWTP and land disposal system only and exclude costs associated with the wastewater collection system and the pump stations and transfer mains required to convey the wastewater to the WWTP and LDS.

7.1 Capital Cost Estimates

CAPEX estimates are subject to the following assumptions:

- Indicative cost estimates have been developed using a bottom-up approach based on the sum of costs estimates for individual line items. Costs are based on recent quoted or tendered prices for similar type and size of projects adjusted for present (2019) prices where required, including actual costs for the recently constructed Rotoiti/Rotoma WWTP.
- Given the early stage in this project, which is prior to any detailed investigations or design being undertaken, a range of cost estimates have been prepared. The expected costs estimate is reported as "likely" which has been built up as the sum of the expected costs estimates for each line item. The "low" and "high" cost estimates are the lower and upper bound estimates respectively, again built up from the sum of individual low and high cost estimate for each line item. This approach allows for specific risk allowances associated with the individual items to be accounted for.
- It is assumed that a reasonably flat graded site can be found to avoid the need for significant earthworks and retaining.
- Land purchase or leasing costs are excluded.
- Costs general civil works associated with the WWTP are unknown (as the site location has not been identified), however, for the purpose of this report we have assumed that "likely" costs could be similar to actual costs for the Rotoiti/Rotoma WWTP. These costs include work associated with bulk earthworks to construct the site platform and an access road to the site, roading and site stormwater and establishing an electricity and water supply to the site. Costs for these items will vary significantly depending on the location of the WWTP.
- A contingency allowance of 30% has been included as this conceptual/pre-feasibility stage.

- A 15% allowance for professional services has been included.
- Costs for site investigations and consenting are included.
- Internal RLC costs are excluded.
- Costs are based on present (2019) costs and exclude escalation; and
- Costs are in NZD and are exclusive of GST.

A summary of the CAPEX estimate is outlined in Table 5 and a breakdown of these cost estimates is included as Appendix A.

Table 5: Capital Cost Estimate

Cost Item[1,2]	Low	Likely	High
Wastewater Treatment Plant	$4.8M	$5.9M	$7.0M
Land Disposal System	$0.4M	$0.5M	$0.6M
General Civil Works[3]	$0.5M	$2.1M	$4.0M
Investigations and Consenting	$0.4M	$0.6M	$1.0M
Total	**$6.1M**	**$9.1M**	**$12.6M**

Notes:

1. *Costs are in NZD and are exclusive of GST.*
2. *No RLC costs have been included in these estimates.*
3. *The expected costs estimate is reported as "likely" which has been built up as the sum of the expected costs estimates for each line item. The "low" and "high" cost estimates are the lower and upper bound estimates respectively, again built up from the sum of individual low and high cost estimate for each line item. This approach allows for specific risk allowances associated with the individual items to be accounted for.*
4. *General Civil Works include bulk earthworks for constructing a site platform for the WWTP, provision of an access road, site stormwater and establishing an electricity and water supply to the site. "Likely" costs for these items have been assumed to be the actual spent costs associated with these items for the Rotoiti/Rotoma WWTP (800 m long access road at a steep grade).*

As shown in Table 5, the most significant variation in cost between the low, likely and high estimates relate to the general civil works (i.e. bulk earthworks for constructing a site platform for the WWTP, provision of an access road, site stormwater and establishing an electricity and water supply to the site). "Likely" costs for these items have been assumed to be the actual spent costs associated with these items for the Rotoiti/Rotoma WWTP (which included an 800 m long access road at a steep grade).

As a comparison with the CAPEX estimates for the Tarawera WWTP and LDS outlined in Table 5, the CAPEX for the Rotoiti/Rotoma WWTP and LDS, commissioned in 2019 to service a community of 889 HUE (compared with 544 HUE for Tarawera i.e. 60% larger), was $10.5M excluding GST and excluding investigations, consenting and design[5].

[5] Based on information provided by RLC in November 2019

7.2 Operating Cost Estimates

OPEX estimates are shown in Table 6 and a breakdown of the cost estimate is included in Appendix A.

Table 6: OPEX Estimate

Item	Annual Estimate[1]
Electricity	$19K
Chemical Use	$20K
Solids Disposal	$17K
Operator and Consent Compliance	$63K
Maintenance	$62K
Generator Rental	$10K
Total	**$191K**

Notes:

1. *Costs exclude GST.*

7.3 Net Present Value

The estimated net present value (NPV) cost for the scheme is $13.1M based on the ‘likely’ CAPEX of $9.1M, annual OPEX estimate of $191K and a 35-year period and a discount rate of 3.5% which is assumed to be the actual discount rate adjusted for infiltration.

7.4 ‘Likely’ Cost per Household Unit Equivalent

Based on the existing household unit equivalent (HUE) figure outlined in Section 2.1 and the estimated ‘likely’ capital expenditure (CAPEX) and annual operating expenditure (OPEX) outlined above, the estimated per household cost for the WWTP and LDS are summarised in Table 7.

It should be noted that these cost estimates do not include costs associated with the wastewater collection and conveyance systems (e.g. cost estimates do not include the on-property LPGP or STEP units plus transfer pump station(s) and pressure mains to convey the wastewater to the WWTP and LDS).

Table 7: Per Household Cost Estimate for WWTP and LDS

Item	
CAPEX Estimate ('Likely')	$9,100,000
OPEX Estimate	$191,000 per annum
Existing HUE	421
'Likely' CAPEX/Existing HUE	$21,000/HUE
OPEX/ Existing HUE	$450/HUE

Notes:

1. *Costs exclude GST.*

8.0 Summary and Conclusions

PDP has developed a desk-top conceptual design for a wastewater treatment plant (WWTP) and land disposal system (LDS) to service Tarawera utilising membrane bioreactor (MBR) technology and disposal to rapid infiltration trenches. This WWTP concept is similar to the recently constructed Rotoiti/Rotoma WWTP albeit the capacity of the Rotoiti/Rotoma WWTP is approximately 60% larger than that required for the Tarawera WWTP.

A constraints mapping exercise has identified two potentially feasible areas for an in-catchment WWTP and rapid infiltration based LDS. These areas could potentially offer a diffuse discharge of treated wastewater to Lake Tarawera via the groundwater while avoiding residential areas and Wairoa Stream. However, this assessment has been based on technical aspects only, and landowner and community engagement and a cultural assessment will be required to assess non-technical considerations for a local wastewater disposal option. A comprehensive site investigation programme and a full assessment of environmental effects (AEE) will also be required to confirm the suitability of any site for wastewater disposal.

Excluding costs for land purchase or leasing and assuming that costs to construct an access road and establish an electricity and water supply to the site will be similar than for the Rotoiti/Rotoma WWTP, the rough-order estimated CAPEX for the WWTP and LDS is in the range of $6.1M to $12.6M. The estimated annual operating cost is around $191K. Based on the likely mid-range CAPEX estimate, the 35-year net present value of the facility is $13.1M and the per household CAPEX and OPEX is $21K and $450/year respectively.

Section 6 of this report outlines a sequence of tasks to implement an in-catchment WWTP and LDS to service the Tarawera community. Based on PDP’s experience assisting with planning, consultation, consenting, design and construction of similar wastewater treatment and disposal systems, we anticipate that the timeframe to the complete these tasks may be in the order of 5 to 10 years.

Appendix A: Cost Estimates

PE

PRE-DESIGN ESTIMATE

Name: CONCEPT DESIGN OF TARAWERA WWTP AND LDS
Job No. A03101202

CAPEX ESTIMATE				
		Low	Likely	High
MBR Wastewater Treatment Plant	Preliminary and General	$ 420,000	$ 540,000	$ 670,000
	Inlet Works and Solids Management	$ 507,000	$ 626,000	$ 775,000
	Reactor Tanks and Aeration Systems	$ 711,000	$ 824,000	$ 866,000
	Membrane Plant	$ 607,000	$ 740,000	$ 873,000
	Permeate and Chemical Systems	$ 155,000	$ 210,000	$ 265,000
	Compressed Air Systems	$ 25,000	$ 30,000	$ 35,000
	Odour Management	$ 80,000	$ 120,000	$ 160,000
	General Site Works	$ 149,000	$ 185,000	$ 226,000
	Electrical and Control	$ 648,400	$ 803,700	$ 949,900
	SUBTOTAL:	**$ 3,302,000**	**$ 4,079,000**	**$ 4,820,000**
Contingency	30%	$ 990,000	$ 1,220,000	$ 1,450,000
Professional Services	15%	$ 500,000	$ 610,000	$ 720,000
	TOTAL - WWTP:	**$ 4,790,000**	**$ 5,910,000**	**$ 6,990,000**
Rapid Infiltration Trench Land Disposal System	Preliminary and General	$ 40,000	$ 50,000	$ 60,000
	Land Disposal System	$ 234,000	$ 305,000	$ 367,000
	SUBTOTAL:	**$ 274,000**	**$ 355,000**	**$ 427,000**
Contingency	30%	$ 80,000	$ 110,000	$ 130,000
Professional Services	15%	$ 40,000	$ 50,000	$ 60,000
	TOTAL - LDS	**$ 400,000**	**$ 500,000**	**$ 600,000**
General Civil Works[3]	Bulk earthworks and access road	$ 200,000	$ 1,200,000	$ 2,500,000
	Site stormwater	$ 20,000	$ 30,000	$ 50,000
	Electricity supply	$ 80,000	$ 150,000	$ 200,000
	Water supply	$ 20,000	$ 66,000	$ 10,000
Contingency	30%	$ 96,000	$ 433,800	$ 828,000
Professional Services	15%	$ 48,000	$ 216,900	$ 414,000
	TOTAL - Civil Works	**$ 500,000**	**$ 2,100,000**	**$ 4,000,000**
Investigations and Consenting		$ 400,000	$ 600,000	$ 1,000,000
	TOTAL PROJECT	**$ 6,090,000**	**$ 9,110,000**	**$ 12,590,000**
Date of Estimate:	21-Nov-19			
Estimate prepared by:	D Garden			
Estimate reviewed by:	Daniel Kuruppu			

Note: these estimates are concept-level only and are exclusive of escalation and GST.

Appendix B: GIS Figures - Constraints Mapping

KEY :

- BORE AND WELLS
- LAKE TARAWERA CATCHMENT

SOURCE:
1. TOPOGRAPHICAL INFORMATION DERIVED FROM LINZ DATA.
2. BORE AND WELL LOCATIONS SUPPLIED BY ROTORUA LAKES DISTRICT COUNCIL, RECEIVED APR 17.

NO.	REVISION	DATE	APP.
B			
A	FINAL DRAFT	NOV 19	

CLIENT : ROTORUA LAKES COUNCIL Te kaunihera o ngā roto o Rotorua

PROJECT :

TARAWERA WWTP AND LDS CONCEPT DESIGN

TITLE :

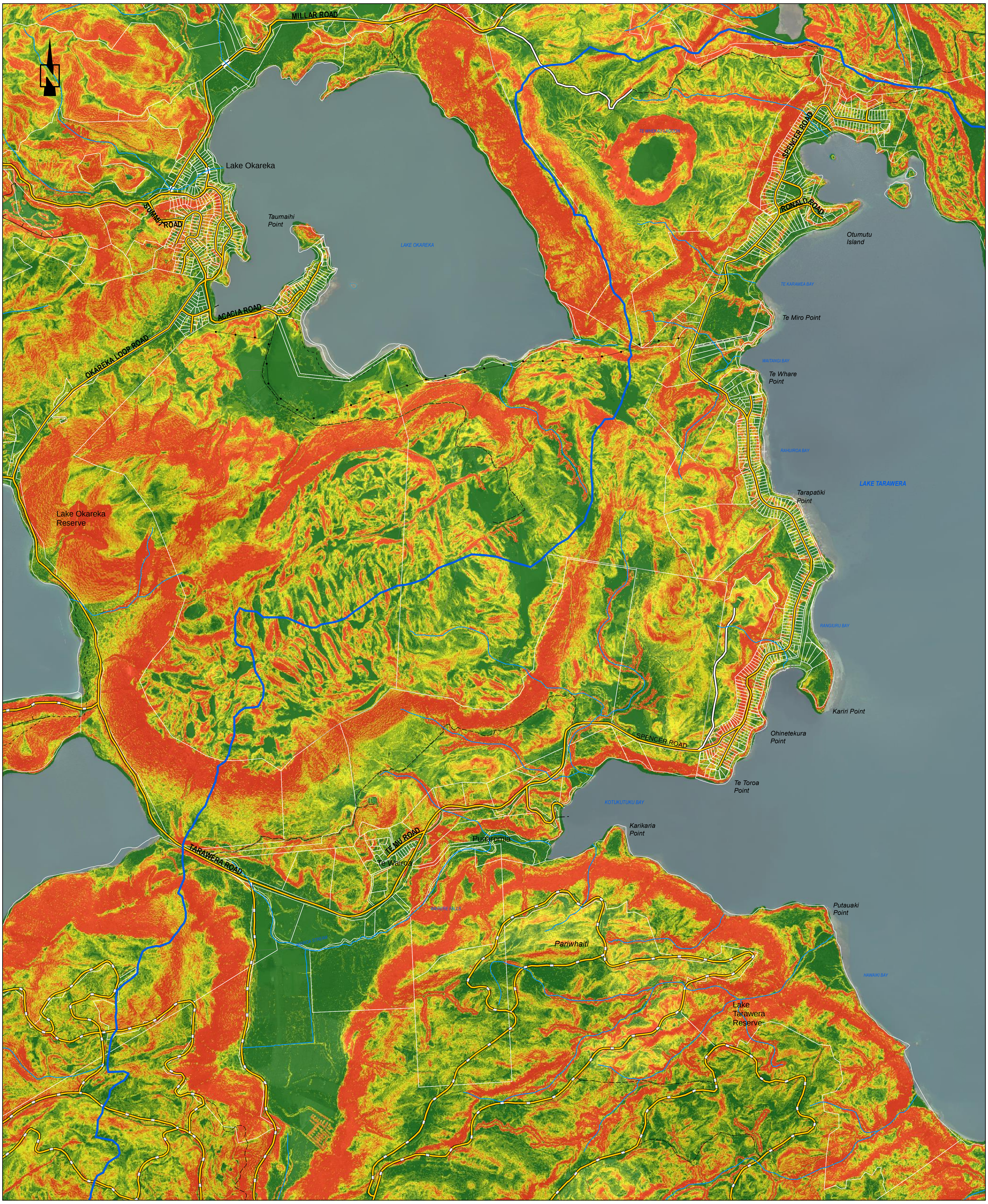
SITE PLAN AND EXISTING GROUNDWATER USERS

pdp solutions for your environment
PATTLE DELAMORE PARTNERS LTD
Auckland Tauranga Wellington Christchurch

SCALE 1:25,000 (A3)
0 0.25 0.5 1
KILOMETRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03101202	B1	B

A03101202Z002_Siteplan.mxd



KEY :

SLOPES (DEGREES)

- 0.3 - 5
- 5.1 - 10
- 10.1 - 15
- 15.1 - 20
- 20.1 - 25
- 25.1 - 30
- 30.1 - 89
- LAKE TARAWERA CATCHMENT

SOURCE:
1. SLOPE LAYER SUPPLIED BY BAY OF PLENTY REGIONAL COUNCIL, DATED 2011.
2. CADASTRAL/TOPOGRAPHICAL INFORMATION DERIVED FROM LINZ DATA.

NO.	REVISION	DATE	APP.
B			
A	FINAL DRAFT	NOV 19	

CLIENT : ROTORUA LAKES COUNCIL
Te kaunihera o ngā roto o Rotorua

PROJECT :

TARAWERA WWTP
AND LDS CONCEPT DESIGN

TITLE :

TOPOGRAPHY

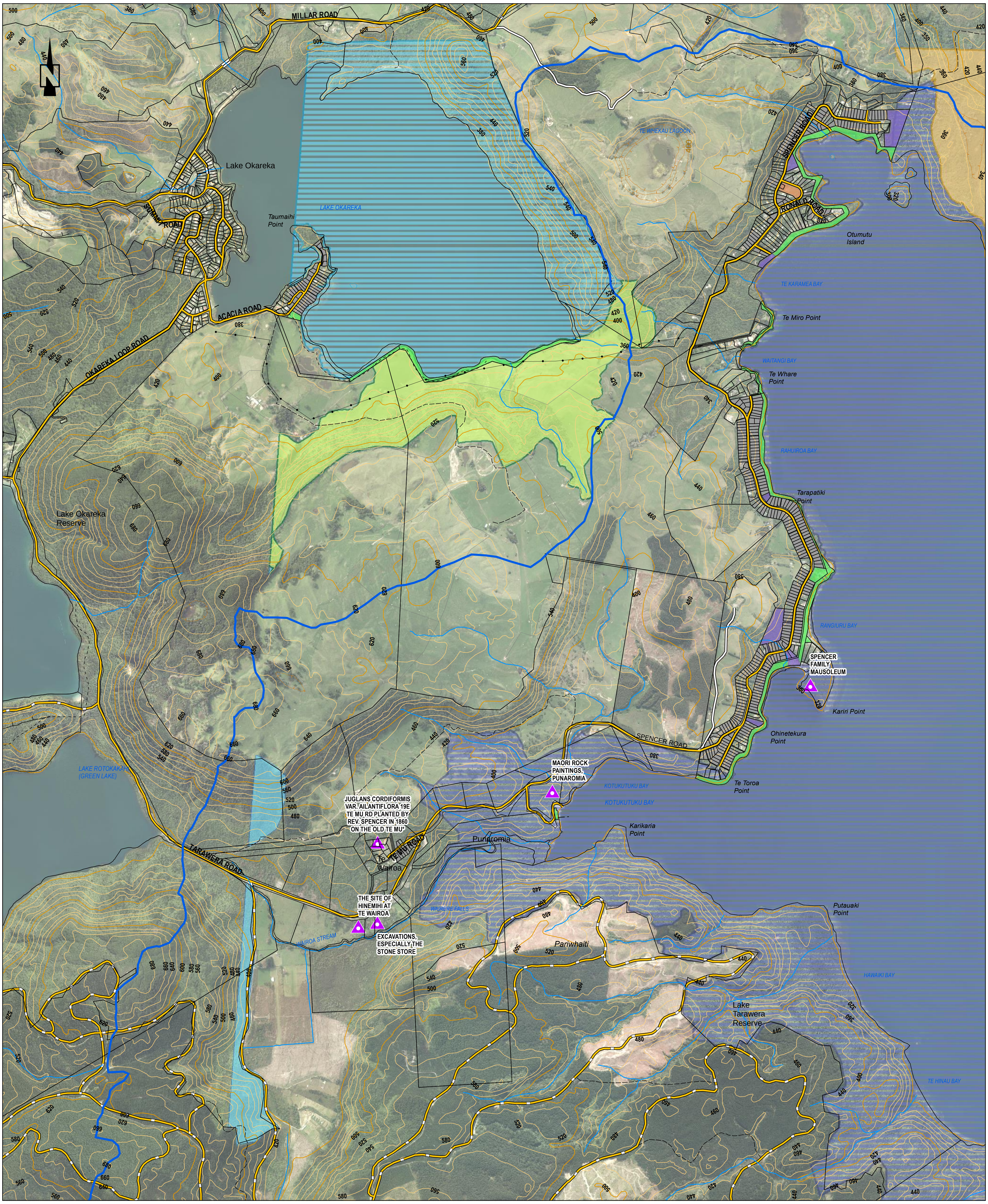
pdp solutions for your environment
PATTLE DELAMORE PARTNERS LTD
Auckland Tauranga Wellington Christchurch

SCALE 1:25,000 (A3)

0 0.25 0.5 1
KILOMETRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03101202	B2	B

A03101202Z005_Slopes.mxd



KEY :

LAKE TARAWERA CATCHMENT

SIGNIFICANTFEATURES

DESIGNATIONS

- RESERVE - DESTINATION
- RESERVE - GREEN SPACE
- RESERVE - NEIGHBOURHOOD
- BUILTUP_AREA

OUTSTANDING NATURAL FEATURES AND LANDSCAPES

- ARATAHA
- LAKE ROTOKŭKAHI
- LAKE TARAWERA
- LAKE TIKITAPU
- LAKE ëKAREKA
- ëKARAKA SOUTHERN HILL SLOPES AND LAKE MARGINS

SOURCE:
1. DESIGNATION INFORMATION SUPPLIED BY ROTORUA LAKES DISTRICT COUNCIL, RECEIVED APR 17.
2. CADASTRAL/TOPOGRAPHICAL INFORMATION DERIVED FROM LINZ DATA.

NOTE:
DESIGNATION INFORMATION TO THE WEST NOT AVAILABLE AT THE TIME OF PRINT.

NO.	REVISION	DATE	APP.
B			
A	FINAL DRAFT	NOV 19	

CLIENT :

ROTORUA LAKES COUNCIL
Te kaunihera o ngā roto o Rotorua

PROJECT :

TARAWERA WWTP AND LDS CONCEPT DESIGN

TITLE :

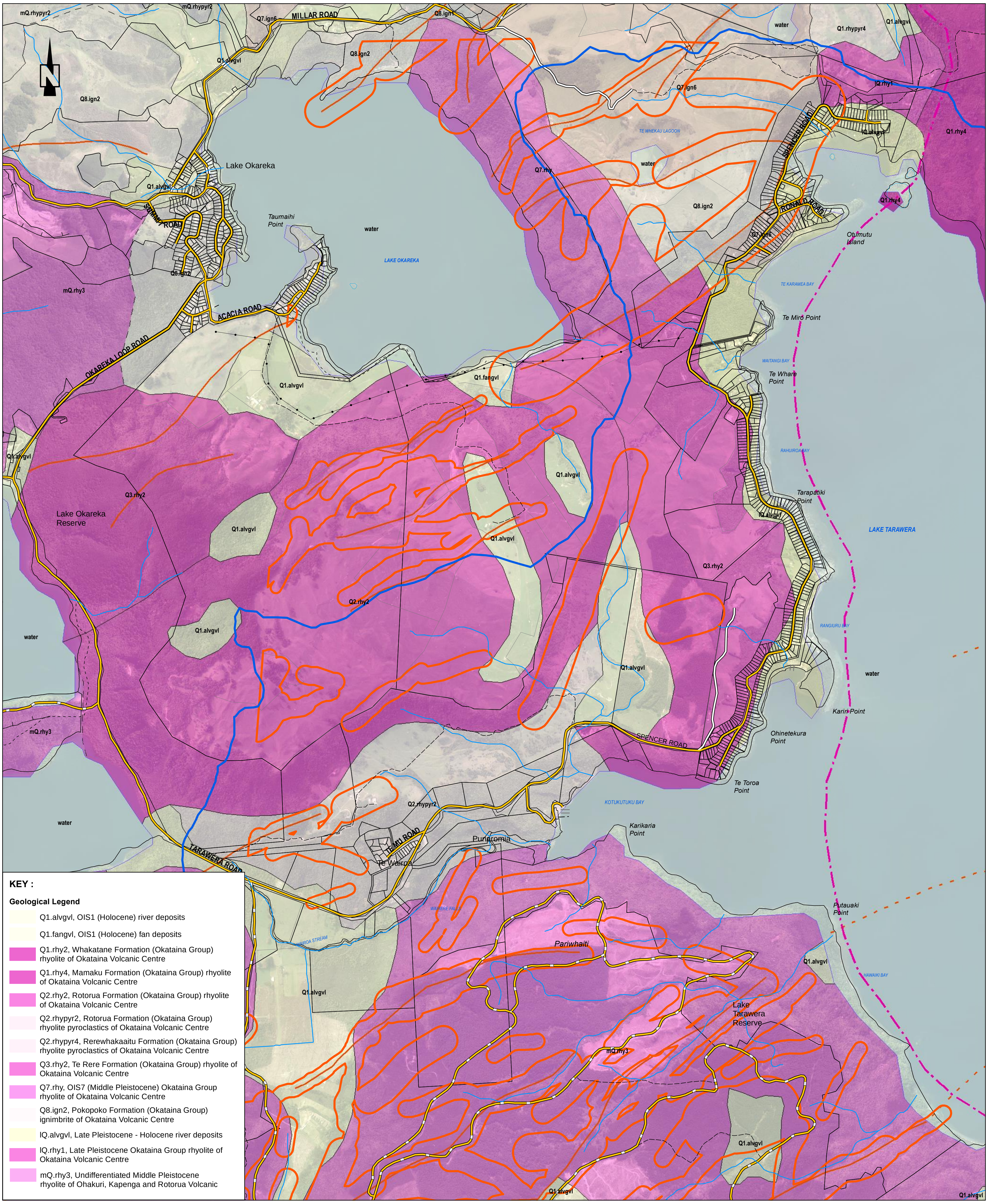
DESIGNATIONS

pdp — solutions for your environment
PATTLE DELAMORE PARTNERS LTD
Auckland Tauranga Wellington Christchurch

SCALE 1:25,000 (A3)
0 0.25 0.5 1
KILOMETRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03101202	B3	B

A03101202Z003_Designations.mxd



KEY :

LAKE TARAWERA CATCHMENT
FAULTLINES (RLDC)

GEOLOGICAL BOUNDARY
- ACCURATE, CONTACT
- ACCURATE, FAULT
- ACCURATE, WATER
- APPROXIMATE, CONTACT

ACTIVE FAULTS
- ACCURATE FAULT
- CONCEALED FAULT
- OKATAINA CALDERA

SOURCE:
1. GEOLOGICAL MAP SUPPLIED BY GNS. (C) GNS SCIENCE 2014 HERON, D.W. (CUSTODIAN) 2014: GEOLOGICAL MAP OF NEW ZEALAND 1:250 000. GNS SCIENCE GEOLOGICAL MAP 1. LOWER HUTT, NEW ZEALAND. GNS SCIENCE.
2. FAULTLINES AND TARAWERA CATCHMENT SUPPLIED BY ROTORUA LAKES DISTRICT COUNCIL, RECEIVED 2 MAY 17.
3. CADASTRAL/TOPOGRAPHICAL INFORMATION DERIVED FROM LINZ DATA.

NO.	REVISION	DATE	APP.
B			
A	FINAL DRAFT	NOV 19	

CLIENT : ROTORUA LAKES COUNCIL Te kaunihera o ngā roto o Rotorua

PROJECT :
TARAWERA WWTP AND LDS CONCEPT DESIGN

TITLE :
GEOLOGY

PATTLE DELAMORE PARTNERS LTD
solutions for your environment
Auckland Tauranga Wellington Christchurch

SCALE 1:25,000 (A3)
0 0.25 0.5 1
KILOMETRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03101202	B4	B

A03101202Z004_Geology.mxd

KEY :

S-MAP SOIL TEXTURE (AUGUST 2018 RELEASE)

- LOAMY
- SANDY
- LAKE TARAWERA CATCHMENT

SOURCE:
1. S-MAP DATA SUPPLIED BY LANDCARE RESEARCH.
2. CADASTRAL/TOPOGRAPHICAL INFORMATION DERIVED FROM LINZ DATA.

NO.	REVISION	DATE	APP.
B			
A	FINAL DRAFT	NOV 19	

CLIENT : ROTORUA LAKES COUNCIL Te kaunihera o ngā roto o Rotorua

PROJECT : TARAWERA WWTP AND LDS CONCEPT DESIGN

TITLE : SOIL TYPES

pdp solutions for your environment
PATTLE DELAMORE PARTNERS LTD
Auckland Tauranga Wellington Christchurch

SCALE 1:25,000 (A3)
0 0.25 0.5 1
KILOMETRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03101202	B5	B

A03101202Z001_Soils.mxd

KEY :

- POTENTIALLY FEASIBLE SITES RAPID INFILTRATION DISPOSAL OF WASTEWATER TO LAND
- LAKE TARAWERA CATCHMENT

SOURCE:
1. TOPOGRAPHICAL INFORMATION DERIVED FROM LINZ DATA.
2. BORE AND WELL LOCATIONS SUPPLIED BY ROTORUA LAKES DISTRICT COUNCIL, RECEIVED APR 17.

NO.	REVISION	DATE	APP.
B			
A	FINAL DRAFT	NOV 19	

CLIENT : ROTORUA LAKES COUNCIL
Te kaunihera o ngā roto o Rotorua

PROJECT :
TARAWERA WWTP AND LDS CONCEPT DESIGN

TITLE :
POTENTIALLY FEASIBLE SITES RAPID INFILTRATION DISPOSAL OF WASTEWATER TO LAND

pdp solutions for your environment
PATTLE DELAMORE PARTNERS LTD
Auckland Tauranga Wellington Christchurch

SCALE 1:25,000 (A3)
0 0.25 0.5 1
KILOMETRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03101202	B6	B

A03101202Z008_Infiltration.mxd