Takapau Community Wastewater Discharge Conceptual Design

(LEI, 2021:T:C.15)

Prepared for

Central Hawke's Bay District Council

Prepared by

Lowe Environmental Impact

April 2021

Takapau Community Wastewater – Discharge Conceptual Design

(LEI, 2021:T:C.15)

Central Hawke's Bay District Council

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1.0	14/04/2021	HL	Draft for client review
	27/04/2021	KB	Updated report for consenting

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1 EXECUTIVE SUMMARY

Central Hawke's Bay District Council (CHBDC) are responsible for the management of wastewater from the community of Takapau. Currently the towns wastewater is collected and conveyed to an oxidation pond treatment system located on Burnside Road, Takapau. The treated wastewater is then discharged to a wetland alongside the Makaretu River and eventually to the Makaretu River near the Burnside Road bridge.

Consent to discharge the wastewater from Takapau is due to expire in October 2021. Following engagement with the wider Central Hawke's Bay community and direct consultation with the Takapau community a strong direction to develop a land based discharge for long term consent was given. This report describes the design concept for a staged development of a new wastewater discharge for the Takapau community which includes discharge to land for agronomic benefit and discharge to a high rate land passage system (HRLP) to manage seasonal wastewater flow highs. This report describes the design regime which is the most reasonable and appropriate system after an evaluation of alternatives.

An extensive process that has included technical reporting and community consultations has been undertaken to identify:

- The available options for a long term discharge;
- Following identification of land discharge as the preferred option, a location for discharge; and
- A suitable discharge regime.

The discharge system described reflects the reasonable and appropriate balance between the social, cultural, environmental and economic considerations.

A detailed discussion of the treatment system, and how the wastewater design parameters were determined, is set out in the Beca report (Beca, 2020:T:C.10a). The discharge environment has been evaluated to determine key design objectives such as:

- Makaretu River water quality and values;
- Groundwater interaction with surface water;
- The ability of the soil and plant system to assimilate water and nutrients from wastewater.

The development of the discharge system for Takapau's wastewater is proposed to be staged. This allows for a rapid reduction in the amount of treated wastewater discharged via the current discharge system to the Makaretu River, while managing the costs to the Council and the time for procurement and construction to occur. A summary of the proposed stages is as follows:

- **Stage 0** allows for the current discharge to occur for up to three years while the subsequent stages are enacted;

- **Stage 1** involves the provision of 2,000 m^3 of storage within the treatment system and development of a minimum 5 ha of irrigation, allowing for irrigation of approximately 60% of the **current** average annual wastewater discharge volume to irrigation and 40 % to the high rate discharge system when river flows exceed half median flow.

  The discharge regime assumes that currently occurring wastewater flows occurs, up to 2,000 m^3 of storage is available in the treatment pond and discharge to the HRLP system can occur only when river flows are above half median;

- **Stage 2** involves development of an additional 15 ha and up to 25 ha of irrigation. A new storage pond is to be built adjacent to the existing treatment system with a capacity of 18,000 m^3. The changes allow for irrigation of approximately 90% of the **future (2048)** average annual wastewater discharge volume to irrigation and 10 % to the high rate discharge system when river flows exceed median flow.

The management characteristics used for the conceptual design are summarised in Table 1.1.

Table 1.1: Discharge and Management Summary

Parameter	Current (Stage 0)	Stage 1	Stage 2
Storage volume (m^3)	None	2,000	18,000
Average annual outflow from TWWTP (m^3)	~60,000	~60,000	~93,000
High Rate Land Passage			
HRLP Maximum application rate per event (m^3)	750	200	200
HRLP Volume per year (m^3)	~60,000	~20,900	~8,600
HRLP N mass loading from wastewater (kg/y)	857	316	130
HRLP P mass loading from wastewater (kg/y)	221	81	33
Irrigation			
Irrigation regime	Nil	Deferred, non-deficit	Deferred, non-deficit
Landform	Nil	Lower terrace	Upper and lower terraces
Total area – including non irrigated (ha)	42.4	42.4	42.4
Wastewater irrigated area (ha)	0	5	20
Irrigation event application (mm/event)	0	up to 20	up to 20
Average annual irrigation volume (m^3/y)	0	36,300	83,500
Average annual application depth (mm)	0	480	360
Wastewater Nitrogen load (kg N/ha/y)[3]	0	140	84
Wastewater Phosphorus load (kg P/ha/y)[3]	0	60	34
Upper Terrace			
Farm Management current/proposed	Rotational cropping, cut and carry	Rotational cropping, cut and carry	Rotational cropping, cut and carry
Vegetation current/proposed	Cropping (e.g. barley, peas oats, turnips, ryegrass)	Cropping (e.g. barley, oats, maize, ryegrass)	Cropping (e.g. barley, oats, maize, ryegrass)
Lower Terrace			
Farm Management current/proposed	Low intensity grazing	Low intensity grazing	Low intensity grazing
Vegetation current/proposed	Ryegrass pasture	Ryegrass pasture	Ryegrass pasture

In summary, the discharge system is proposed to consist of the following components:

- 2,000 m^3 of storage at the WWTP for Stage 1;
- 18,000 m^3 of storage in a new pond for Stage 2;
- Irrigation pump station located at the WWTP built during Stage 1;
- 660 m rising main to irrigation system;
- A maximum 460 m centre pivot boom; and
- Wet well and pumping to:
    - High rate land passage system (all stages);
    - 5 ha at Stage 1; and
    - 25 ha additional area at Stage 2.

2 INTRODUCTION

2.1 Purpose

This report describes the design concept for a staged development of a new wastewater discharge for the Takapau community which includes discharge to land for agronomic benefit and discharge to a high rate land passage system (HRLP) to manage seasonal wastewater flow highs. This report describes the design regime which is the most reasonable and appropriate system after an evaluation of alternatives. This report provides information to support the consenting process, specifically details of the proposed activity and information to support the land and water assessments of environmental effects (LEI, 2021:T:D.10 and Beca, 2021:T:D.25).

2.2 Background

Central Hawke's Bay District Council (CHBDC) are responsible for the management of wastewater from the community of Takapau. Currently the towns wastewater is collected and conveyed to an oxidation pond treatment system located on Burnside Road, Takapau. The treated wastewater is then discharged to a wetland alongside the Makaretu River and eventually to the Makaretu River near the Burnside Road bridge.

Consent to discharge the wastewater from Takapau is due to expire in October 2021. Following engagement with the wider Central Hawke's Bay community and direct consultation with the Takapau community a strong direction to design a land based discharge for long term consent was given. This report summarises the discharge regime and design concept for a long term discharge to land via irrigation and HRLP (to replace the wetland discharge).

2.3 Scope

This Conceptual Design report contains the following information:

- Section 3 describes the development of the discharge concept;
- Section 4 characterises the wastewater to be discharged;
- Section 5 outlines the key receiving environment properties to be addressed by the system design;
- Section 6 explains the management considerations for the irrigated area;
- Section 7 describes the proposed discharge regime and key inputs and outputs from the system; and
- Section 8 summarises the conceptual design and outlines the next step in the design and consenting process for the long term discharge of Takapau's treated wastewater.

This report describes the system concept of the Project. It does not address the potential environmental effects of the Project, except where the design has been informed by a need to avoid or mitigate potential adverse environmental effects.

Criteria and parameters adopted in this report are conservative and there may be scope for refinement at the detailed design stage. Detailed design is not able to be completed until resource consents are decided.

3 DEVELOPMENT OF THE CONCEPT

3.1 Existing Reporting

A programme of information gathering, consultation, data processing and evaluation, and scenario development precedes the conceptual design. A range of source material has been used in the development of the discharge conceptual design. Information specific to the Site and relied upon for this report are included within this consent package.

Information in the reports included within this consent package are not repeated in full in this report and so it is recommended that the reader consults the reports included for further information in the first instance.

3.2 Design Aim

The intention of the design concept is to develop a reasonable and appropriate discharge regime which considers and incorporates the social, cultural, environmental and economic needs of the community. The system needs to be able to be sustainably operated for the foreseeable future, both in terms of the treatment of wastewater, and in terms of ensuring that the integrity of the land and surface water is not compromised by long term, repeated application of wastewater.

3.3 System Concept

The discharge of wastewater could continue to be to surface water, as it has historically throughout New Zealand, or to land, as is increasingly being adopted for small inland communities. The key drivers to move to a land based discharge system are community wellbeing (social and cultural), and potential environmental improvements, in particular in waterway health. The design of a land discharge system is typically based around achieving measurable beneficial environmental outcomes, for instance, a reduction in nitrate levels in the receiving water. Having a quantifiable parameter assists design since changes can be predicted and measured.

In the case of the Takapau WWTP, it has been identified that the existing discharge does not have a measurable impact on the receiving water, specifically the Makaretu River at flows above median flow, but at flows below MALF, phosphorus faecal coliforms and *E.coli* show a moderate increase (Beca, 2020:T:B.24). It is acknowledged that the current discharge contributes to an overall nutrient and contaminant load to the Makaretu River and the Tukituki Catchment and the local community deems this to be unacceptable.

This means that decisions about the future discharge of Takapau's wastewater are driven by both water quality factors and on factors which are not easily quantified, being in many cases non-tangible community preferences. In developing the conceptual design CHBDC has considered the social, cultural, environmental and economic wellbeing of the district. An extensive consultation process has been undertaken to determine what values the stakeholders, which include community members, iwi representatives, special interest groups and statutory partners, have for the management of the wastewater in the district. This includes dedicated consultation with the Takapau community and tangata whenua. Details of the consultation are given in the Consultation Summary (LEI, 2021:T:C.34).

During the consultation process new ideas were proposed, some issues were agreed upon and some issues were unable to be resolved to all parties' agreement. Where possible, points raised through the process have been incorporated into the key design decisions. Key design decisions determined through the investigation and consultation process relate to:

1. Wastewater treatment options;
2. Options for the discharge; and
3. Location of the discharge.

An attempt has been made in the development of this conceptual design to develop a reasonable and appropriate balance between the social, cultural, environmental and economic considerations.

In the absence of a quantifiable surface water improvement target (as the existing discharge's effects cannot be measured), the conceptual design has been based on the ability for the land to accept the wastewater. The design has also aimed to address the community's desire to see ideally 100 % of the discharge being applied to land, albeit noting that during wet conditions this may be problematic.

3.4 Tangata Whenua Concerns

Issues for consideration with regard to cultural concerns are being been identified and described in a Cultural Impact Assessment (CIA) which is being prepared Heperi (2021:T:D.50). This report will add to the collective knowledge surrounding the maori world view on wastewater management, which is described in How, (2020:T:B.42).

While commissioned and not yet available at the time of writing this report, specific issues raised in the CIA will be addressed an any subsequent consent applications.

3.5 Summary of Concept Development

An extensive process that has included technical reporting and community consultation has been undertaken to identify:

- The available options for a long term discharge;
- Following identification of land discharge as the preferred option, a location for discharge; and
- A suitable discharge regime.

The discharge system described in Section 7 in this report reflects the reasonable and appropriate balance between the social, cultural, environmental and economic considerations.

4 DISCHARGE CHARACTERISTICS

4.1 General

A detailed discussion of the treatment system, and how the wastewater design parameters were determined, is set out in the Beca report (Beca, 2020:T:C.10a). This Section lists the key wastewater parameters adopted for the conceptual design and describes how they have influenced the design.

4.2 Wastewater Flows

A reliable flow data set was available for the Takapau WWTP for the period 1/1/08-30/11/19. This data was evaluated, along with predicted changes to the wastewater flows in future due to population change, infiltration and stormwater inflow works and trade waste discharges (Beca, 2021:T.B.31c). A long term (10 year) flow data set was generated based on flow predictions (LEI, 2021).

The data set gives a daily wastewater outflow from the plant for a 12 year period. This daily outflow was used in the development of Takapau discharge scenarios and in the refined option on which the conceptual design is based. A flow summary is included in Table 4.1. Figure 4.1 shows the distribution of flows through an average year.

Table 4.1: Daily Flow Record adjusted for 2048 predicted flows (after Beca, 2021:T:B.31c)

Year	2019	2028	2048
Population	620	790	1,093
Projection Type	Actual	Actual	Actual
Dry Weather Inflow (ADWF) (m^3/d)	67	85	118
Average Daily Flow (m^3/d)	180	229	317
99%ile Flow (m^3/d)	595	653	756
Maximum Flow (m^3/d)	750	807	910

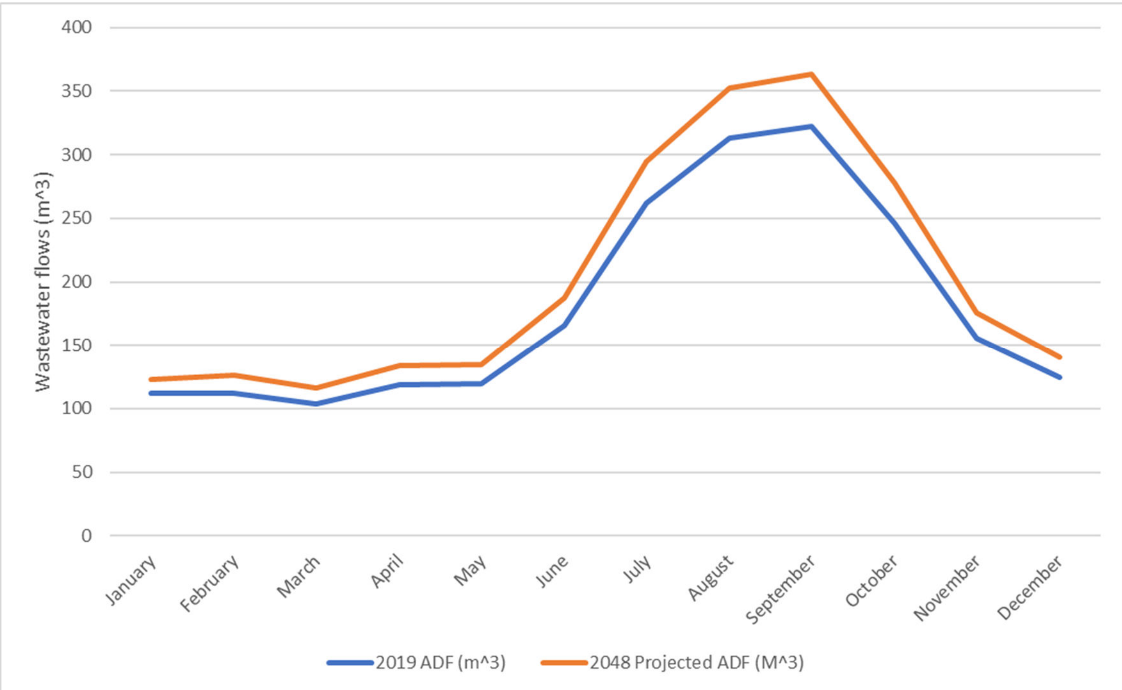

Figure 4.1: Average daily wastewater flows per month

Wastewater outflow rates have been used for the determination of the discharge to the irrigated land and HRLP design since these represent the flows that require discharge on any day.

4.3 Wastewater Quality

A detailed analysis of the wastewater influent quality and treated wastewater quality is given in the Beca report (Beca, 2020:T:C.10a, Sections 3.4 and 4.4). The performance and suitability of the existing treatment plant to continue to be used is provided in the treatment plant performance summary (Beca, 2020:T:C.10a, Section 3.4). This report highlights that no improvements are needed in the performance of the existing wastewater treatment plant if irrigation is to be used. However, it would be of benefit for the irrigation management to incorporate fine filtration (sprinkler blockage) and disinfection (health and safety) of flows to irrigation.

Constituents of the treated wastewater to be irrigated that are considered in the conceptual design are predominantly due the potential environmental or public health risk. The key parameters are summarised in Table 4.2.

Table 4.2: Key Wastewater Parameters, Takapau WWTP (Jan 1999 to Aug 2020)

Parameter	Units	n	Mean	Median	95th Percentile	Range
$ScBOD_5$	g O_2/m^3	354	32	28	72	1 to 98
TSS	g/m^3	238	72	70	140	2.5 to 433
TN*	g/m^3	20	15.6	15.4	24.3	5.8 to 26.8
Ammoniacal N*	g/m^3	20	4.6	0.09	19.9	0.005 to 20.9
DIN*	g/m^3	21	7.6	7.4	19.95	0 to 21
TP*	g/m^3	20	3.9	3.9	5.3	1.9 to 5.9
DRP	g/m^3	20	2.7	2.5	3.797	1.3 to 3.93
Faecal Coliforms	cfu/100 mL	356	14,695 (geomean)	15,900	140,000	74 to 410,000
*E. coli**	cfu/100 mL	20	13,178 (geomean)	18,000	72,950	100 to 110,000

* Sampling to these analytes began in February 2019

4.4 Provision of Storage

To assist with managing the development and operation of a land application system the provision of storage is recommended, especially to avoid the need for a direct surface water discharge and to enable a greater volume of water to be beneficially used.

The BPO report (LEI, 2021:T:C.12) summarises the staging of the discharge regime. This results in the progressive increase in storage capacity. The storage requirements are as follows.

- **Stage 1 – Modify existing treatment pond to allow 2,000 m^3 of active storage:** This is expected to be achieved by raising the pond by up to 300 mm. Sufficient treatment capacity will be retained in the pond at all times. Following the development of additional storage at Stage 2, this extra volume will become treatment volume to account for increasing inflow over time.

- **Stage 2 – New storage:** An additional 18,000 m^3 of storage is proposed to be provided in a new pond at the commencement of Stage 2. CHBDC intend to purchase land for the construction of a pond. The preferred location is given in Figure 4.2. A final site and design is subject to a flood plain assessment and geotechnical investigations.

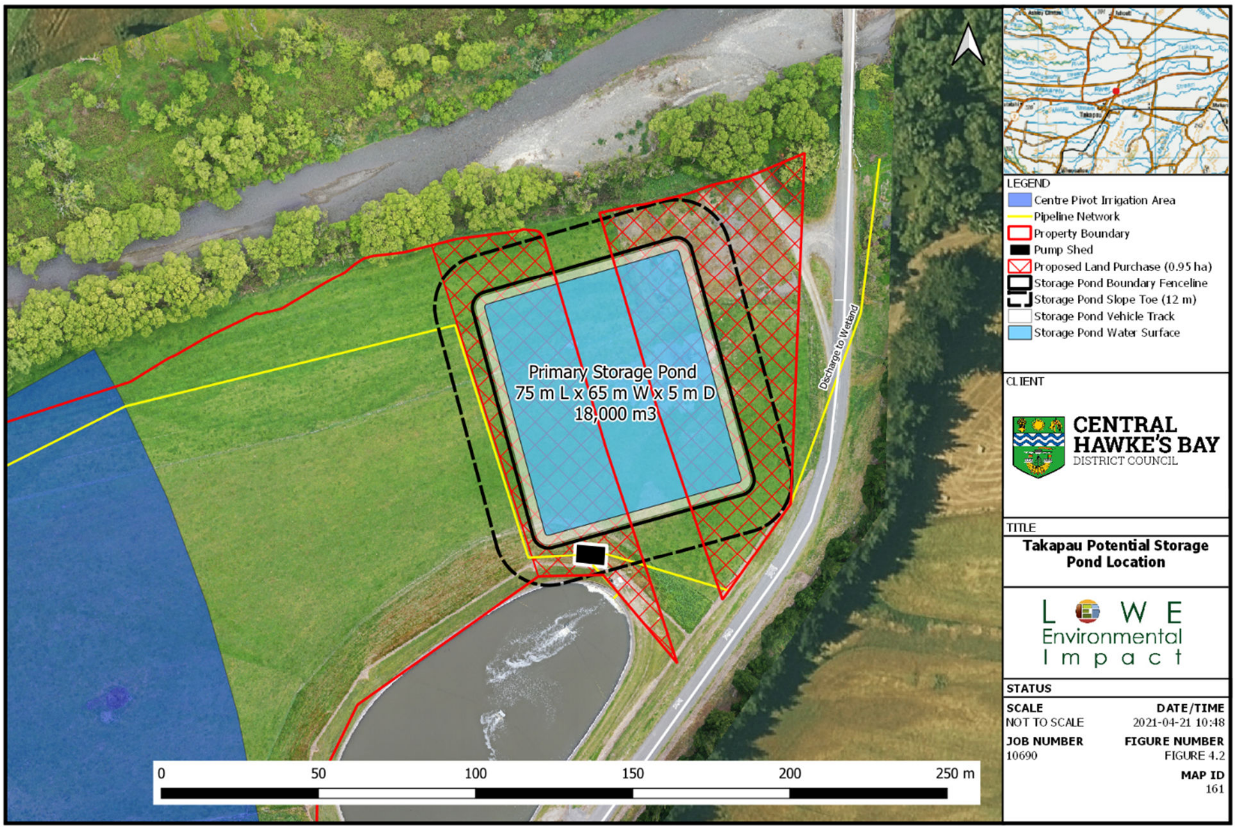

Figure 4.2: Potential Storage Pond Location

5 DISCHARGE ENVIRONMENT

5.1 General

The discharge from the WWTP will all go to land; being a mix of irrigation at a low rate and land passage at a high rate. This follows a strong desire to avoid any direct discharge to surface water that was expressed by all parties during the consultation process. In considering the design of the scheme, the avoidance of discharges directly to water is key, and so an understanding of the surface water environment as well as the land environment is needed. This includes an understanding of the groundwater as it is effectively the conduit between land and surface water.

A series of reports details these environments including literature studies and field investigations. These reports are included within this consent package.

5.2 Land Environment

Takapau and its WWTP are located on the Ruataniwha Plains within the Central Hawke's Bay District. The plains lie between the axial Ruahine ranges to the west and tertiary aged argillite, sandstone and limestone ridges to the east. The landforms in the vicinity of the WWTP reflect the drainage of water from the western ranges across the plains and are dominated by flood plain and older river terraces.

There are two key sites for the discharge from Takapau WWTP being, the site to receive irrigation for agronomic benefit and the HRLP system.

5.2.1Land for Irrigation

The land for irrigation is managed (being both owned and leased) by the Drummond family and is described as the "Site". A detailed evaluation of the Site is given in the report Evaluation of Soils to Receive Takapau Wastewater (LEI, 2020:T:B.15).

The Site is located on a river plain adjacent to the Makaretu River. The bulk of the site is located on an upper terrace. The area adjacent to the river is on a lower terrace around 4-5 m lower than the rest of the site. Six soil types were identified on-site being:

- Ashburton Sandy Loam (13 ha) – lower terrace;
- Tikokino Shallow and Stony Silt Loam (10 ha) – elevated terrace;
- Ruataniwha Silt Loam (7 ha) – elevated terrace;
- Tikokino Silt Loam (7 ha) – elevated terrace;
- Takapau Silt Loam (4 ha) – elevated terrace; and
- Oronoko Silt Loam (2 ha) – terrace edge.

Soil hydraulic characteristics and soil chemistry were determined in the site investigation (LEI, 2020:T:B.15). This information will assist in combining land areas that are subjected to similar management, which are further described in Section 6.6.

5.2.2High Rate Land Passage

The HRLP site is located across Burnside Road and beside the bridge on land leased by CHBDC. The site is on the lower terrace landform and is underlain by the Ashburton Sandy Loam soil.

5.3 Surface Water Environment

Available information about the surface water environment has been presented and evaluated in the reports:

- Water Quality Assessment – Makaretu River (Beca, 2020:T:B.24).

Beca (2020: T:B.24) notes that:

- *The Makaretu River sub-catchment sits within Tukituki catchment management zone 3 – Ruataniwha South – and is subject to the catchment-specific management objectives set out in Hawke's Bay Regional Resource Management Plan, Policy Plan Change 6 (HBRC RRMP PC6).*

And that:

- *The Makaretu River is considered to be in a good state relative to the wider Tukituki River catchment zone and national bottom lines. Historical ecological investigations undertaken with regard to the consent conditions indicate that the Makaretu River has generally low levels of periphyton and algal cover both upstream and downstream of the treated wastewater discharge. Further, while MCI results indicate that the Makaretu River is representative of a good ecological habitat (MCI >100), it consistently scores below the HBRC RRMP PC 6 target score of 120.*

In order to model the river discharge a gauging site with a lengthy and continuous flow rcord was needed. Beca (2020) notes that "*Tukituki River at Tapairu Road correlated to Makaretu River at Speedy Road Bridge spot gauging measurements at a ratio of 0.98*".

5.4 Summary

Table 5.1 below summarises the main constraints that were identified in previous reports.

Table 5.1: Key Constraints for Irrigation and High Rate Discharge

Subject	Constraint	Design Solution	Reference
Land assimilative capacity	Free draining nature of the lower terrace indicates that nutrient loading is likely to a limiting factor for the low terrace.	Apply a limit for irrigation based on an agronomic requirement. Assess discharge to HRLP as if no nutrient attenuation occurs.	Section 7.10
Land prioritisation	Land available land is predominantly Zoned as B indicating that there are minimal limitations to land discharge of wastewater.	Irrigation design optimised to obtain maximum benefit from the wastewater with minimum adverse effects to the land and surface water	Section 3.2
Soil description	Soil hydraulic conductivity indicates that water depth of application will be limiting on the soils of the elevated terrace.	Apply instantaneous and discharge event limits that are based on measure soil unsaturated hydraulic conductivity.	Section 7.6.3
Flood hazard	The lower terrace may be inundated in a 1 in 100 year flood event.	Ability to use HRLP discharge and land on the elevated terrace	See Figure 6.1 for management block layout
Existing environmental conditions	The existing discharge has not caused any adverse effects to the environment.	Discharge to land will enable beneficial use	Section 7.6.3

Subject	Constraint	Design Solution	Reference
	The existing environment is well suited to land application.		
Tangata whenua considerations	To be determined based on forthcoming CIA.	-	-
Archaeology	No sites of significance are known on the Site.	Have accidental discovery protocol in place for works related to the discharge.	-
Landscape and natural character	Farming and irrigation (centre pivot, travelling irrigator) are predominant landscape features near the Site.	Land management will be in keeping with the surrounding are. Centre pivot is proposed which fits with the visual amenity of the area.	-
Ecology	The Makaretu River has typically good ecological habitat value and this should be maintatined. Terrestrial habitat is predominantly occupied by farming activities. Riparian margins (adjacent to the Makaretu River may have additional habitat values.	Minimise discharge to the HRLP Retaining farming and cropping, maintain riparian areas related to HRLP.	Section 7.3

6 LAND MANAGEMENT

6.1 General

To operate a successful discharge regime on the Site the management of irrigation rates, cropping and/or grazing rotation and protection of landforms and cultural sites is needed. Land management considerations are as follows.

6.2 Land Ownership and Management Responsibility

The owners of the land available for irrigation and high rate discharge at the time of preparing this conceptual design are given in Table 6.1.

Table 6.1: Land Ownership

	Irrigation		HRLP
	Manager Owned	**Manager Leased**	**CHBDC Leased**
Owner	Drummond Family	Mike Dalby	Ian Ellis
Legal description	Part Lot 1 DP 15623	Lot 1 DP 16445	Part of Lot 3 DP9943
Property address	45 Burnside Road	4292 State Highway 2	Burnside Road
Map ref, centre of site	1886370.7, 5565315.0	1885953.1, 5565134.3	1886769.3 5565743.9
Area (ha)	23.5	18.9	0.1053

It is acknowledged that the diligent management of the land, including the irrigation, is critical to achieve no more than minor adverse effects on the environment. It is also noted that use of land not owned by Council comes with the attendant risk of uncertainty of land tenure.

It is important that the wastewater irrigation fits in with the land management. The day to day operation and maintenance of the system will be the responsibility of the land owner. CHBDC as consent holder will monitor to ensure that the irrigation is being managed to comply with conditions of consent.

6.3 Current Land Use

Currently the land application site can be described as a low intensity cattle finishing block, with higher intensity rotational cropping, predominantly of barley, peas, oats and ryegrass occurring. Irrigation with river water currently occurs, albeit seasonally limited by periods of low flow in the Makaretu River. The leased land is largely used for cut and carry purposes of ryegrass, with cropping on the higher terrace paddocks, adjacent to SH2. A summary of the current farming system is provided within LEI (2020:T:B.13).

6.4 Future Land Use

Following wastewater application, there are two land use scenarios that may be adopted for the farm. These are a 'business and usual' cropping regime and a cut and carry system. A summary of each of these regimes is provided within LEI, 2021:T:C.14a.

6.5 Management of Cropping and/or Animal Grazing

For future management following wastewater application, existing cropping is to be primarily restricted to paddocks on the higher terrace owned by the Drummonds. Crops grown under wastewater application, are not to be exported for human consumption. The crops can include barley, oats, maize and ryegrass, etc.

Animal grazing is to be restricted to pasture blocks. Animal grazing will predominantly occur on lower terrace pasture paddocks. Animals will be predominately excluded from cropping paddocks on the higher terrace due to pasture/crops being for export off site. It will be expected that animals will be grazed on the higher terrace to tidy up paddocks following pasture cuts and where pasture is included in the cropping rotation.

6.6 Land Management Units

For the purposes of modelling, a series of land management units have been created. These units are outlined as follows:

Not all of the site will receive wastewater irrigation. Buffers are proposed from sensitive areas or areas which are unsuitable due to a soil management issue such as drainage limitations. However, the wastewater infrastructure may be used to apply clean irrigation water in which case the buffer limitations will not apply.

	Area (ha)	Landform	Proximity to features	Mgmt type	Mgmt challenges
Grazed – Irrigated	9.8	Lower terrace	This unit is located adjacent to the Makaretu River on the lower terrace and encompasses Blocks 1, 2 and 4 IRRIG blocks shown within Figure 6.1.	Grazed pasture and low intensity cattle grazing.	Risk of flooding on lower terrace.
Grazed – Non Irrigated	4.9	Lower terrace	Similarly to the Grazed – Irrigated unit, this unit is located adjacent to the Makaretu River and encompasses Blocks 1 and 5 NON-IRRIG blocks shown within Figure 6.1.	Grazed pasture and low intensity cattle grazing.	Risk of flooding on lower terrace.
Cropped – Irrigated	10.9	Higher terrace	This unit is Block 2 IRRIG from Figure 6.1 and is located 180 m from the Makaretu River at its closest point.	Intensive cropping	Best practice land management will be required to reduce nutrient losses.
Cropped – Non Irrigated	1	Higher terrace	This unit is Block 2 NON IRRIG from Figure 6.1 and is located 240 m from the Makaretu River at its closest point.	Intensive cropping	Best practice land management will be required to reduce nutrient losses
Cut & Carry – Irrigated	9	Higher terrace	This unit is Block 3 IRRIG from Figure 6.1 and is located 50 m from the Makaretu River at its closest point.	Ryegrass pasture – cut and carry only (minimal animals)	Ensuring cuts are done at appropriate times to maximise plant uptake of nutrients. The idea is for the plant to receive wastewater when it is actively growing.
Cut & Carry –	5.4	Higher terrace	This unit is Block 3 NON IRRIG from Figure 6.1 and is located 50	Ryegrass pasture – cut and carry	Paddock Size and Layout

Non Irrigated			m from the Makaretu River at its closest point.	only (minimal animals)	

Across the two land parcels, Figure 6.1 represents how blocks were divided for the purposes of the OverseerFM assessment detailed within Section 7 and LEI (2021:T:C.14). These blocks were determined based on future irrigated vs non-irrigated, alongside pasture vs cropping management. For land areas, differing in cropping regimes, these blocks had to be separated further.

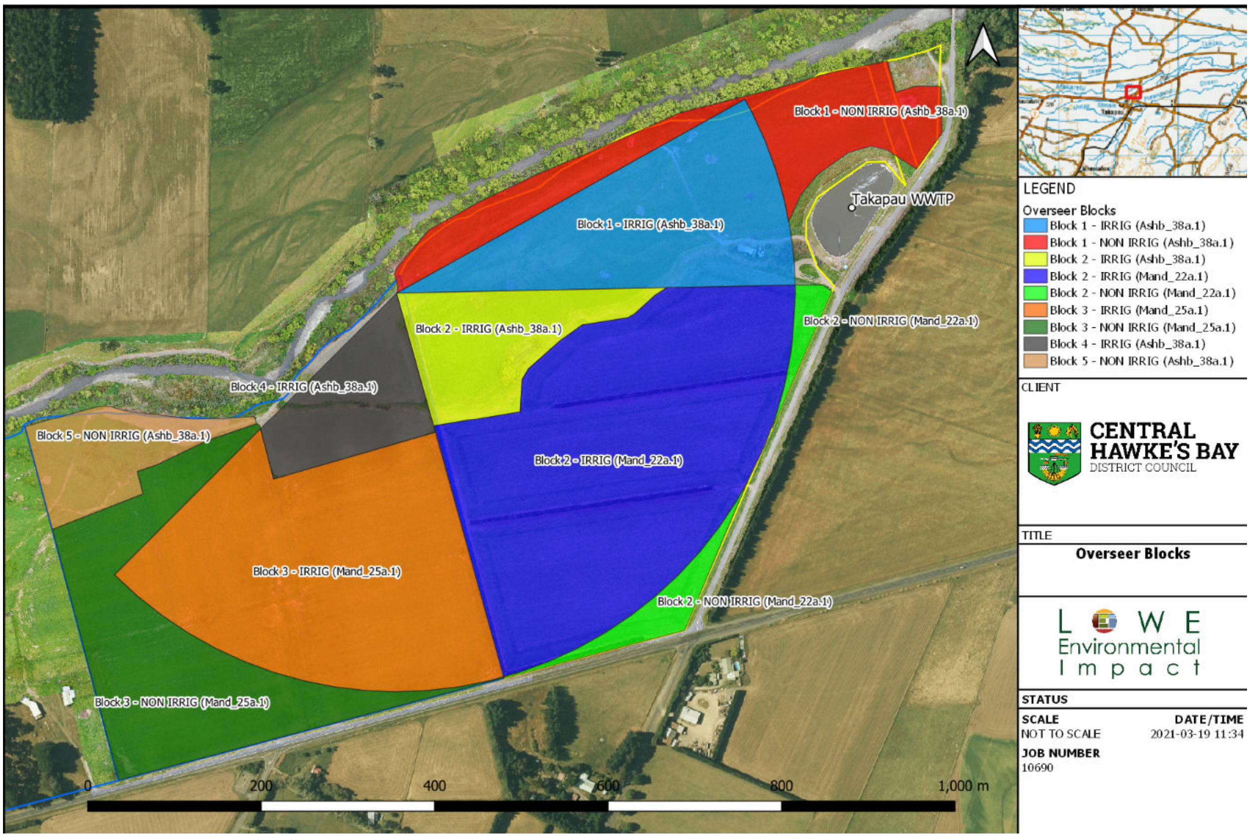

Figure 6.1: Block Distribution for Wastewater Application

6.6.1Stock Rotation

Under a future 'business as usual' approach, stock will predominantly graze over pasture only blocks on the lower terrace. Grazing will occur on the higher terrace to tidy up paddocks following removal events and where pasture is included in the cropping rotation. Stock will be restricted from intensive cropping blocks on the higher terrace and existing cut and carry blocks due to this product all being for export from the site.

6.6.2Cropping Rotation

Under a future 'business as usual' approach, cropping will occur and may include crops such as barley, oats, maize and ryegrass, etc. Previous crops grown by the Drummonds such as peas and turnips will be ceased. No crops shall be grown for human consumption.

7 DISCHARGE SYSTEM

7.1 System Summary

In summary, the discharge system is proposed to consist of the following components:

- 2,000 m^3 of storage at the WWTP for Stage 1;
- 18,000 m^3 of storage in a new pond for Stage 2;
- Irrigation pump station located at the WWTP;
- 660 m rising main;
- A maximum 460 m centre pivot boom; and
- Wet well and pumping to:
  - High rate land passage system (all stages);
  - 5 ha at Stage 1; and
  - 25 ha additional area at Stage 2.

Further detail is provided below.

7.2 System Description

Treated wastewater from the storage located on (to be) CHBDC land as described in Section 4.4 is to be transferred to a wet-well from which it can be either directed to the HRLP system, most likely under gravity (Beca, 2021: T:C.14a); or pumped a distance of around 660 m to the centre of the irrigation area. A potential route for the pipe is shown in Figure 1, Appendix A. From this central point wastewater will be irrigated, most likely via a centre pivot irrigator.

The site layout including the irrigated area is shown in Figure 1, Appendix A. Buffer distances of 20 m from sensitive receptors or environments and from property boundaries (and a separate buffer of 150 m from the dwellings) will also be incorporated into the wastewater irrigation layout design. Note that there is scope to also use clean water from the river and when this occurs the buffers can be reduced.

The wastewater irrigation system will result in a low rate of irrigation and low production of aerosols.

River flow, soil moisture conditions and rainfall will be monitored and used to determine whether irrigation is suitable each day. Key decision triggers will include consideration of storage pond levels, daily wastewater flows, climatic conditions, soil conditions and river flows.

The infrastructure for the land application system will include the following key components:

- Storage pond and pumping system at the Takapau WWTP;
- Irrigation system, most likely a maximum single 460 m span centre pivot unit;
- Conveyance pipeline from the treatment and storage to irrigation; and
- Existing conveyance to a high rate land passage discharge.

The visual impact of these components is in keeping with the rural environment, existing infrastructure and equipment used on neighbouring farms and currently visible from SH2.

7.3 Proposed Staging of Discharge Development

The development of the discharge system for Takapau's wastewater is proposed to be staged. This allows for a rapid reduction in the amount of treated wastewater discharged via the current discharge system to the Makaretu River, while managing the costs to the Council and the time for procurement and construction to occur. A summary of the proposed stages is as follows:

- **Stage 0** allows for the current discharge to occur for up to three years while the subsequent stages are enacted;
- **Stage 1** involves the provision of 2,000 m^3 of storage within the treatment system and development of a minimum 5 ha of irrigation, allowing for irrigation of approximately 60% of the **current** average annual wastewater discharge volume to irrigation and 40 % to the high rate discharge system when river flows exceed half median flow;
- **Stage 2** involves development of an additional 15 ha and up to 25 ha of irrigation. A new storage pond is to be built adjacent to the existing treatment system with a capacity of 18,000 m^3. The changes allow for irrigation of approximately 90% of the **future (2048)** average annual wastewater discharge volume to irrigation and 10 % to the high rate discharge system when river flows exceed median flow.

Details of the Stage 0, existing discharge are given in the report (Beca, 2019: T:C.40a) and are not discussed further here.

An evaluation of treated wastewater flows to be discharged to land at each stage has been made on the basis of the historical record of wastewater flows and climatic conditions. A summary of the discharge regime for each stage is given in the following sections.

7.4 Determination of Design Irrigation Rate

In October 2020 LEI conducted a detailed site investigation of the Site with key parameters summarised in Section 5.4 above. An appropriate irrigation application depth has been determined from field testing of soil unsaturated hydraulic conductivity ($K_{-40\ mm}$). The most conservative $K_{-40\ mm}$ as determined in the Site Investigation report (LEI, 2020:T:B.15) is 5 mm/h which corresponds to a design irrigation application depth of 29 mm/d using the method of Crites and Tchobanoglous (1998). For practical irrigation purposes and to be protective of groundwater this value has been adjusted to 20 mm/d.

Using the design irrigation application depth of 20 mm/d will restrict irrigation water movement through the soil to matrix flow, thereby maximising the travel time in the soil and contact with soil particles. This is intended to maximise sorption, filtration and plant removal of applied nutrients and pathogens. Maximising soil treatment is further enhanced using an irrigation rate not exceeding the lowest K_{-40mm} of 5 mm/h for the Site. This will also assist to avoid ponding and run-off.

The design irrigation depths and rates discussed here are the maxima for the Site however, there is potential to reduce the per event application rate to fit in with land management requirements and to optimise the discharged volumes. This is discussed further below.

7.5 Determination of Discharge Regime

In order to determine the proportion of wastewater that can be applied to a land area, and the amount of storage required, a water balance approach has been used to develop a land application regime. This section summarises the methodology used to build the regime.

7.5.1Water Balance Principle

There are a number of processes to be considered when applying treated wastewater to land. The use of a water balance enables these processes to be quantified and then considered together. This water balance approach is based on an empirical water and nutrient budget for a land discharge system. In the case of the stages presented here, actual data (typically daily) is used and so the outputs represent how the system would have operated for the period of the dataset.

7.5.2Water Balance Key Inputs

Specific input data used includes:

- **Daily wastewater outflow volume:** This was the shortest data set available and therefore is the limiting parameter in terms of the length of time represented by the scenarios. Gaps in data sets were populated with estimates based on previous outflow and current inflow data. Data was available for the period 1 January 2008 to 30 November 2019. As noted in Section 4.2, flows were adjusted for future growth in Takapau;
- **Mean wastewater quality:** While wastewater quality is expected to vary across a year, nutrient data is considered in the context of yearly loads and so mean values for total N and total P are considered to be appropriate for the water balance. Values are summarised in Table 4.1;
- **Daily rainfall data** (for additions to the pond surface and for scheduling irrigation): From the nearest climate station with a complete daily data set. In this case the data was sourced from the Waipukurau Climate Station (HBRC) for the period 22/04/1997 to 30/11/2019;
- **Daily Priestly-Taylor Potential Evapotranspiration** (for losses from the land application area): From the nearest climate station with a complete daily data set. In this case the Waipukurau Climate Station (HBRC) as for rainfall; and
- **Daily open-pan evaporation** (for losses from the storage pond surface): From the nearest climate station with a complete daily data set, also from the Waipukurau Climate Station (HBRC) as for rainfall.

7.5.3Variable Inputs to Water Balance

There are many variables for the system which, when manipulated individually, can produce multitudinous outcomes. The variables represent possible day-to-day management decisions such as:

- River flow criteria including flow limits and mass loading limits;
- Irrigation event application depth;
- Area available for irrigation on any day;
- Irrigation limits based on month (% of maximum);
- Irrigation return period;
- Limit to application volume based on amount of rainfall received over preceding days;
- Soil moisture content trigger to start irrigation;
- Soil permeability and available water holding capacity;
- Inclusion of surface water or rapid infiltration discharge limited by nutrient or hydraulic load;
- Pond dimensions; and
- Minimum volume to be retained in storage.

In order to work with a manageable number of scenarios some decisions have been made as to which variables to fix. These decisions are based on an understanding of the assimilative capacity of the local environment and a need to discharge as much of Takapau's wastewater to land as possible in a sustainable manner, without having a detrimental impact on the land.

The parameters adopted are as determined in the Site Investigation (LEI, 2020: T:B.15) and Water Quality (Beca, 2020: T:B.24) reports.

7.5.4 Processing of Data

The water balance considers the system as a series of separate reservoirs and then as interacting systems. The process can be summarised as follows:

- Determine what volume of wastewater is available for discharge (stored volume and inflow);
- Determine if the soil moisture status criteria are met. This a function of the rainfall and/or irrigation received previously, the evapotranspiration for that day and drainage that may have occurred;
- If sufficient wastewater is available and soil moisture status allows, apply wastewater to land area at the prescribed irrigation rate;
- If insufficient wastewater is available from inflow or in storage then no discharge occurs and inflows are directed to storage;
- If there is not sufficient capacity in the soil to receive wastewater (high soil moisture) and the river flow exceeds the flow trigger (1/2 median flow at Stage 1 and median flow at Stage2), direct TWWTP outflows to the high rate system; and
- If land irrigation and high rate discharge is not possible then direct outflows to storage.

Where multiple land areas are defined i.e. where they have different criteria to allow discharge to occur, or if there are alternative discharges such as surface water or rapid infiltration then the water balance progressively assesses and discharges the wastewater to each management unit sequentially. The order is determined by the priority for each unit – in the case of TWWTP the land irrigation units are the priority before storage or high rate discharge.

7.5.5 Outputs

The water balance produces a daily record of discharges to each of the management units. From this data a summary of the discharge regimes can be produced, including:

- Average annual discharge volume to land irrigation and to high rate discharge;
- Average annual land application depth;
- Days of discharge, both the number of days that discharge could occur (due to soil moisture conditions) and the number of days that the discharge did occur (due mostly to stored volume available);
- Nitrogen (N) and phosphorus (P) load received by the land application area; and
- The maximum storage volume needed to operate a full time land treatment system.

These outputs are given below for the Stages described earlier.

7.6 Stage 1 Discharge Regime (current flows)

Details of the management of the Takapau WWTP discharge at Stage 1 are as follows.

7.6.1 Treatment Plant and Storage

Works to enable Stage 1 to commence will include (Beca, 2021:T:C.41a):

- Develop active storage in existing treatment pond (Section 4.4); and
- Develop wet well, pump shed including filtration with potential disinfection (UV).

Wastewater is to be retained in storage if irrigation to land is unable to occur due to soil moisture conditions and river flows (Tukituki @ Tapairu Road) are **below half median flow**.

7.6.2 Discharge to High Rate Land Passage

Following commencement of Stage 1 the preference for discharge will be to irrigation. If soil conditions are unsuitable for irrigation, discharge to the HRLP system can occur if flows in the Tukituki River at Tapairu Road are above the half median flow (4,735 L/s for 2011 to 2019).

Over the modelled period this results in and average of 105 days where up to 200 m^3 per day would be discharged to the HRLP. This drops to 49 days for a dry year and is up to 145 days for a wet year.

7.6.3 Discharge to Irrigation

Following the commencement of Stage 1 it is proposed that irrigation will be applied to an area no less than 5 ha. It is expected that the area to receive wastewater irrigation at Stage 1 will be the lower terrace on the Drummond owned block. Site investigation results indicate an instantaneous rate of application not exceeding 6 mm/h and an application event rate of 29 mm/d is protective of the soil of the site. To minimise the risk of excessive drainage to groundwater and ultimately via groundwater to surface water, a rate informed by the soils available water holding capacity is recommended. The proposed rate of discharge per event is **up to 20 mm/d** where a sufficient soil moisture deficit exists.

The soil is likely to be able to remove all solids and assimilate all BOD applied from the Takapau WWTP wastewater. The proposed discharge regime will result in some drainage from the site due to the adoption of application criteria which allows a discharge beyond the soil field capacity. Details of the drainage amounts are given in Section 7.8 below.

To maximise the removal of nutrients from wastewater, the following decision criteria are recommended to determine on any day whether application to land irrigation can occur:

- **Deferred, non-deficit:** Represents a regime which maximises the volume of discharge to land while protecting the land from damage by over-watering and avoiding excessive leaching to groundwater or surface water. A portion of the applied nitrogen will be transported to groundwater and surface water by leaching, but it will enter surface water as a diffuse discharge and at a substantially lower mass loading than would occur due to direct discharge from the Takapau WWTP. The criteria to discharge are:
    - **Soil moisture status:** Irrigation will not cause the soil to exceed field capacity by more than 2 mm per 400 mm of soil depth per event;
    - **Application rate control:** Vary the discharge rate to match the soil moisture criteria;
    - **Depth to groundwater:** Irrigation should not occur when the groundwater table is less than 1 m from the soil surface;
    - **Wind speed and direction:** Irrigation may occur only if wind speed is less than 12 m/s, or 4 m/s in the direction of any dwelling within 300 m of the irrigated area;
    - **Previous rainfall:** Irrigation may occur if less than 20 mm rain has fallen in the 24 hours prior to commencement of irrigation; and
    - **Crop condition / harvest schedule / animal rotation:** Harvest or grazing should not occur within 48 h of irrigation ceasing, and irrigation should not be commenced within 24 h of completion of harvest or removal of stock. In practice irrigation is unlikely to occur in the week leading up to harvest and until obvious

crop growth is visible however this limit is to manage environmental effects of the irrigation.

All described criteria for the adopted regime should be met before irrigation is allowed to occur. As a result of these criteria, discharge will not occur on every day. For an average year, the regime management outcomes are given in Table 7.1. The regime outcomes assume that currently occurring wastewater flows occurs, up to 2,000 m^3 of storage is available in the treatment pond and discharge to the HRLP system can occur only when river flows are above half median.

Table 7.1: Stage 1 – Discharge Management Outcomes

Regime	Average Year	Wet year	Dry Year
IRRIGATION			
Annual application depth (mm)	730	830	560
Maximum application rate per event	20 mm/d	20 mm/d	20 mm/d
Volume per year	36,300 m^3	41,500 m^3	27,800 m^3
N mass loading (from wastewater)	140 kg N/ha/y	166 kg N/ha/y	111 kg N/ha/y
P mass loading (from wastewater)	60 kg P/ha/y	66 kg P/ha/y	45 kg P/ha/y
HIGH RATE SYSTEM			
Maximum application rate per event	200 m^3	200 m^3	200 m^3
Volume per year	20,935 m^3	28,900 m^3	9,800 m^3
N mass loading (from wastewater)	316 kg N/y	436 kg N/y	148 kg N/y
P mass loading (from wastewater)	81 kg P/y	112 kg P/y	38 kg P/y

During a dry year the discharge to land for this regime is in the order of 74 % of that years annual wastewater flows. For a wet year this reduces to 59 % even though the total discharged is higher. While there is potential for a greater volume to be discharged to land, the amount of wastewater available to discharge on any day is controlled by the outflow from the Takapau WWTP and the volume available in storage.

7.7 Stage 2 Discharge Regime (future flows)

Details of the management of the Takapau WWTP discharge at Stage 1 are as follows.

7.7.1Treatment Plant and Storage

No changes to the treatment system are proposed for Stage 2 but reconfiguring of the outlet may be required to accommodate the flow from a new storage pond. Stage 2 will commence following the construction of a storage pond of capacity up to 18,000 m^3 (Section 7.7.4 and Section 8.2).

Wastewater is to be retained in storage if irrigation to land is unable to occur due to soil moisture conditions and river flows (Tukituki @ Tapairu Road) are below **median flow**.

7.7.2Discharge to High Rate Land Passage

Following commencement of Stage 2 the preference for discharge will be to irrigation as for Stage 1. If soil conditions are unsuitable for irrigation, discharge to the HRLP system can occur if flows in the Tukituki River at Tapairu Road are above the median flow (9,470 L/s for 2011 to 2019).

Over the modelled period this results in and average of 43 days where up to 200 m^3 per day would be discharged. This drops to 1 day for a dry year and gets up to 83 days per year over the modelled period.

7.7.3Discharge to Irrigation

Following the commencement of Stage 2 an additional, at least, 15 ha and up to 25 ha will be available for discharge. The proposed discharge and management regime is the same as adopted for Stage 1. For an average year, the regime management outcomes are given in Table 7.2.

Table 7.2: Stage 2 – Discharge Management Outcomes

Regime	Average Year	Wet year	Dry Year
IRRIGATION			
Annual application depth (mm)	421	507	281
Maximum application rate per event	20 mm/d	20 mm/d	20 mm/d
Volume per year	83,500 m^3	101,500 m^3	56,300 m^3
N mass loading (from wastewater)	84 kg N/ha/y	101 kg N/ha/y	56 kg N/ha/y
P mass loading (from wastewater)	34 kg P/ha/y	41 kg P/ha/y	23 kg P/ha/y
HIGH RATE SYSTEM			
Maximum application rate per event	200 m^3	200 m^3	200 m^3
Volume per year	8,600 m^3	10,034 m^3	160 m^3
N mass loading (from wastewater)	130 kg N/y	152 kg N/y	2 kg N/y
P mass loading (from wastewater)	33 kg P/y	39 kg P/y	1 kg P/y

The available volume of treated wastewater increases at Stage 2 to allow for future growth of the Takapau township. The volumes detailed in Table 7.2 are not expected to eventuate until the end of the consent term (2040-48) but have been considered here to ensure the regime can be operated sustainably for at least 35 years. The applied depth of wastewater and associated nutrient loading reduces at Stage 2 due to the increase in available land, even though the total wastewater volume discharged to land increases. The nutrient loading from wastewater is below a standard agronomic loading and so is not limiting to the land management.

7.7.4Storage of Treated Wastewater

At Stage 2, it is proposed that dedicated storage will be provided for the treated wastewater. The storage will be actively managed to ensure that there is capacity available during periods when no discharge to land can occur due to high soil moisture or rainfall and river flow is below median.

The provision of storage has a number of advantages for the scheme which include:

- Ensuring the discharge to land is sustainable by directing wastewater to storage during wet periods when discharge to land might cause land damage;
- Minimising the need to discharge wastewater directly to high rate land passage which results in less reduction of contaminants than irrigation to land; and
- Enabling the discharge to land to occur when maximum productive benefit can be achieved i.e. by storing wastewater during wet winter months when highest flows enter the WWTP, it is able to be used during the summer (water short) months when inflow to the WWTP are unable to meet the plant requirements for water.

The amount of storage required is determined from the water balance and is based on daily data as described in Section 7.5.2. Figure 7.1 shows how the volume of wastewater in storage varies over time. The data assumes that a 176 % increase in average daily wastewater inflow will occur by 2048, but shows how the storage would have operated for those higher flows over the period 2011 to 2019. Peaks occur during the winter wet months when there are high inflows to the WWTP.

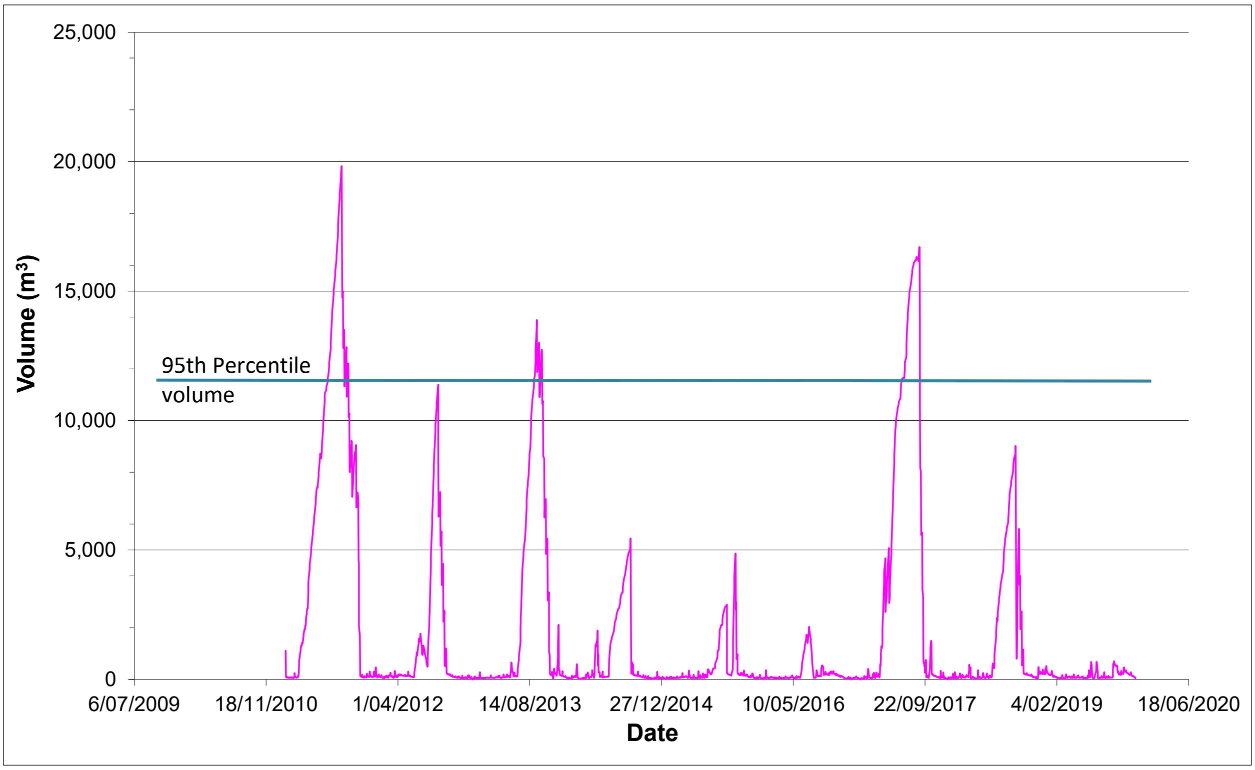

Figure 7.1: Daily treated wastewater in storage for Stage 2

The maximum storage volume needed varies from year to year as a result of wastewater inflow and climatic variations. Figure 7.1 shows that the maximum storage required in most years is less than the 18,000 m^3 proposed. The storage will need to be engineered to manage periods with minimal wastewater in storage. If contingency discharge is required (i.e. the storage pond is full and river flows are low), it is possible to irrigate in conditions outside of the criteria given in Section 7.6 with modification to land management and for short periods. This can be controlled through a contingency provision in the discharge management plan(s).

7.8 Drainage Water Impacts of Wastewater Irrigation

The adoption of a deferred, non-deficit irrigation regime will avoid excessive drainage from the site, however there will be more drainage than would occur if there was no irrigation, or if a deficit irrigation regime was used. The impact on the annual drainage volume from the site is given in Table 7.3. These drainage volumes assume that any water passing below 600 mm is considered drained.

Table 7.3: Average Annual Drainage from Wastewater Irrigation

ID	Area (ha)	Current (Stage 0)		Stage 1		Stage 2	
		Drainage depth (mm)	Volume (m^3)	Drainage depth (mm)	Volume (m^3)	Drainage depth (mm)	Volume (m^3)
Stage 1 irrigated	5.0	57	2,850	502	25,100	277	13,854
Stage 2 additional irrigated	15.0	57	8,550	57	8,550	230	34,549
Buffer, non-irrigated	22.4	57	12,768	57	12,768	57	12,768
Total	42.4	NA	24,168	NA	46,418		61,171
Increase in annual drainage			NA		22,250 m^3 or 190 %		37,003 m^3 or 250 %

While some irrigation occurs on the site currently, it has been assumed for this analysis that no drainage occurs. Compared to the current situation and over the entire site, the drainage will increase by an estimated 190 % following the commencement of Stage 1 in an average year. For Stage 2, the change in drainage volume from the site is 250 %.

7.9 Nutrient Impacts of Stage 2

Some nutrient loss is expected from the site and management of the irrigation and land will be designed to avoid excessive loss. The proposed regime is intended to be sustainable for the lifetime of the land application scheme.

The nutrient losses from the site are considered here as they relate to the combined operation of both the wastewater discharge and the management of the farm. A detailed description of the farming system modelled using Overseer™ is given in LEI (2021: T:B.13, T:C.14a). Note that farming losses are the same for Stages 1 and 2. This is due to the use of other sources of water and the supply of agronomic rates of nutrients to support the cropping regime operated by the land owners. This may continue if there is insufficient wastewater volume for irrigation or plant nutrient requirements.

Table 7.4: Nutrient Loss Summary

	HRLP / Wetland		Farm		Totals	
	N (kg/y)	P (kg/y)	N (kg/y)	P (kg/y)	N (kg/y)	P (kg/y)
Current (Stage 0)	857	221	2,097	10	2,954	231
Stage 1	316	81	2,530	20	2,846	101
Stage 2	130	33	2,530	20	2,660	53

7.9.1Nitrogen Losses

The nitrogen losses via leaching have been evaluated using Overseer™ and are detailed in LEI (2021: T:C.14a). Table 7.4 gives nitrogen leaching estimates for the irrigation site and nitrogen loss via the HRLP. The nitrogen leaching estimates assume that supplementation of nitrogen from wastewater will be needed i.e. the nitrogen loading includes both wastewater nitrogen and fertiliser application.

The nitrogen loss from drainage and HRLP discharge is equivalent to 130 % of the applied nitrogen at Stage 0. This occurs from the farming site due to loss of nitrogen from the soil organic pool associated with cultivation across the site.

At Stage 1 and 2 the nitrogen loss from drainage and HRLP discharge is equivalent to 38 % and 36 % of the applied nitrogen from all sources. Assuming that all leached nitrogen eventually enters the surface water environment, then the land application results in a substantial reduction of nitrogen currently discharged to surface water from the land management and from the current direct discharge of wastewater to the Makaretu River. There is likely to be additional attenuation of nitrogen in the groundwater environment prior to reaching surface water and so the reduction in nitrogen reaching surface water is expected to be greater than that described here (Beca, 2021: T:B.14).

Nitrogen leaching losses in drainage are predicted to increase by up to 20 % compared to the existing land use and farm management. It should be noted that, while there is a net increase in nitrogen leached from the Site, there is actually a significant reduction in the nitrogen entering the water catchment due to the removal of direct discharge of wastewater to surface water.

7.9.2 Phosphorus Losses

The primary mechanism for phosphorus loss is via overland flow. Projected phosphorus losses are given in Table 7.4. For the HRLP it has been assumed that no removal of phosphorus will occur, and that phosphorus entering water is at the rate that it is discharged from the WWTP.

Phosphorus loss from the irrigated site will be avoided by the maintenance of suitable buffers from waterways, and by application of wastewater using an instantaneous application rate that is less than the soils unsaturated hydraulic conductivity i.e. so that water on the site goes into the soil and does not pond or flow across the surface. Plant requirements for phosphorus is in the order of 130-160 kg P/ha/y if cut and carry pasture is grown, or 52-64 kg P/ha/y if grazed pasture is maintained on the Site. Based on the current cropping regime 21 kg P/ha/y is incorporated to plant matter. For all Stages the annual phosphorus loading will be removed from the Site through plant uptake or retained in the soils of the site.

The surface soils of the Site have low to medium phosphorus retention (15-50 %). However, it is known that the soils on the elevated terrace are high in allophane in the sub-surface and likely to have a high capacity for sorbing applied phosphorus. The soil’s capacity for sorbing phosphorus is likely to be 1,500-1,800 mg/kg of soil. This equates to 4,800-5,760 kg/ha of P storage for 0.4 m of soil depth. The rate of phosphorus application will result in plant uptake, with soil sorption likely to be negligible. As such, the site life for phosphorus around 360 years under the proposed application regime.

7.10 Summary of Discharge Regime

The key parameters of the discharge regime are given in Table 7.5.

Table 7.5: Land Discharge and Management Summary

Parameter	Current (Stage 0)	Stage 1	Stage 2
Storage volume (m^3)	None	2,000	18,000
Average annual outflow from TWWTP (m^3)	~60,000	~60,000	~93,000
High Rate Land Passage			
HRLP Maximum application rate per event (m^3)	750	200	200
HRLP Volume per year (m^3)	~60,000	~20,900	~8,600
HRLP N mass loading from wastewater (kg/y)	857	316	130
HRLP P mass loading from wastewater (kg/y)	221	81	33
Irrigation			
Irrigation regime	Nil	Deferred, non-deficit	Deferred, non-deficit
Landform	Nil	Lower terrace	Upper and lower terraces
Total area – including non irrigated (ha)	42.4	42.4	42.4
Wastewater irrigated area (ha)	0	5	20
Irrigation event application (mm/event)	0	up to 20	up to 20
Average annual irrigation volume (m^3/y)	0	36,300	83,500
Average annual application depth (mm)	0	480	360
Wastewater Nitrogen load (kg N/ha/y)[3]	0	140	84
Wastewater Phosphorus load (kg P/ha/y)[3]	0	60	34
Upper Terrace			
Farm Management current/proposed	Rotational cropping, cut and carry	Rotational cropping, cut and carry	Rotational cropping, cut and carry
Vegetation current/proposed	Cropping (e.g. barley, peas oats, turnips, ryegrass)	Cropping (e.g. barley, oats, maize, ryegrass)	Cropping (e.g. barley, oats, maize, ryegrass)
Lower Terrace			
Farm Management current/proposed	Low intensity grazing	Low intensity grazing	Low intensity grazing
Vegetation current/proposed	Ryegrass pasture	Ryegrass pasture	Ryegrass pasture

8 CONSTRUCTION AND ESTABLISHMENT

8.1 Design Features

Specific design features are proposed to ensure the irrigation system and its operation do not have adverse effects. In particular, attention has been paid to the investigations to date to ensure that a system is fit for purpose and irrigated areas and associated infrastructure avoid areas of significance or higher risk at compromising known values that should be protected.

As stated in Section 7 above, the irrigation will consist of low rate irrigation methods delivering an application rate of less than 5 mm/hr. Centre pivot irrigation is proposed and is a well established technology in the area, as can be seen at numerous properties along SH2 in the vicinity of the Site.

A single buried main from the wastewater storage and pumping site to the irrigation headworks, situated on the elevated terrace is required.

8.2 Earthworks

No recontouring (bulk earthworks) for irrigation purposes is proposed. The method of irrigation allows for flexibility to ascend and descend slopes.

Irrigation earthworks will involve trenching to install piping. Trenches will be typically 0.6 m wide and up to 1.2 m deep.

There is the potential that the rising main may be in the order of 660 m long. Based on a trench width of 0.6 m the area of earthworks disturbance would be 396 m^2. This is approximately 0.1 % of the 42.4 ha site.

While design and dimensions are not yet confirmed, a new storage pond is to be constructed adjacent to the existing WWTP. The pond will potentially be 80 m long and 70 m wide, covering an area of some 5,600 m^2.

All earthworks will require the preparation of a Construction Management Plan (CMP) and an Erosion and Sedimentation Control Plan (ESCP). These plans will detail construction methodology and how construction related effects will be managed.

8.3 Staging

The development and implementation of the **Project** will be in a series of Stages. These stages are detailed below in Table 8.1 along with an overview of the works involved:

Table 8.1: Implementation of the Takapau WWTP Project

Phase	Activity	Description	**Timing** within date of consent being granted
0	**Resource Consenting**	-HBRC consents -CHBDC consents as required	
E	**Detailed Design**	-irrigation design -storage design -wet well, pump station and UV design -construction management plans -sediment and erosion control plans -monitoring and management plans	6 months
F	**WWTP Pumping**	-installation of a pump wet well -installation of irrigation pump system and controls -installation of UV system	12 months
F	**Tendering and Irrigation Installation**	-preparation of tender documents -letting of contracts -installation of irrigation rising main -installation of irrigation laterals and sprinklers	12 months
F	**WWTP Storage (Stage 1)**	-preparation of tender documents -letting of contracts -modify pond wall as needed to create design storage volume -replace wave bands -modify metering and telemetry as needed	24 months
F	**New Storage (Stage 2)**	-preparation of tender documents -letting of contracts -construction of new storage pond	36 months

9 SUMMARY AND CONCLUSIONS

The intention of the design concept is to develop a reasonable and appropriate discharge regime which considers and incorporates the social, cultural, environmental and economic needs of the Takapau and wider Central Hawke's Bay community. The system needs to be able to be sustainably operated for the foreseeable future, both in terms of the treatment of wastewater, and in terms of ensuring that the integrity of the land is not compromised by long term, repeated application of wastewater.

To address the social, cultural, environmental and economic needs of the community an extensive process of technical reporting and community consultations has been undertaken to identify:

- The available options for a long term discharge;
- Following identification of land discharge as the preferred option, a location for discharge; and
- A suitable discharge regime.

The current discharge to surface water has a negligible impact on the water quality of the Makaretu River (Beca 2020: T:B.24) and correspondingly, the Tukituki catchment. Despite this, the discharge contributes to the cumulative load in surface water. Application of wastewater to land will reduce this load and the use of the HRLP is to be excluded during low flow conditions when the surface water environment is particularly sensitive.

The diligent management of the land, including the irrigation, is critical to achieve no more than minor adverse effects on the environment. The current land owners will manage the Site with a mixed cropping and grazing regime.

The development of the scheme has been divided into stages to enable progressive reduction in the discharge to the high rate land passage system. Site investigations have determined that non-deficit, deferred irrigation is well suited to the site. A summary of the characteristics for the conceptual design for each Stage is given in Section 7.11.

In summary, the discharge system is proposed to consist of the following components:

- 2,000 m^3 of storage at the WWTP for Stage 1;
- 18,000 m^3 of storage in a new pond for Stage 2;
- Irrigation pump station located at the WWTP;
- 660 m rising main;
- A maximum 460 m centre pivot boom; and
- Wet well and pumping to:
    - High rate land passage system (all stages);
    - 5 ha at Stage 1; and
    - 25 ha additional area at Stage 2.

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11 APPENDICES

Appendix A Figures

APPENDIX A

Figures

Figure 1: Design Concept