Martinborough WWTP Land Discharge Scenarios and Assessment of Environmental Effects

Prepared for

South Wairarapa District Council

Prepared by

LOWE Environmental Impact

March 2014

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Martinborough WWTP Land Discharge Scenarios

South Wairarapa District Council

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Ref: RE-10071-SWDC-Scenario_AEE_MB_130809-KBv2

Job No.: 10071

Date: March 2014

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1 EXECUTIVE SUMMARY

South Wairarapa District Council (SWDC) is responsible for the provision and management of wastewater treatment for the South Wairarapa District. Currently SWDC are reviewing the wastewater treatment and discharge systems at a number of its communities. This includes Martinborough. This report follows on from previous desktop and field investigations conducted by Lowe Environmental Impact (LEI) for SWDC for the Martinborough wastewater treatment plant (MWWTP).

This report evaluates the proportion of MWWTP flows and storage requirements for a range of land treatment scenarios. The scenarios consider land owned by SWDC which has had on site investigations undertaken.

This report is based on an empirical water and nutrient budget for a land treatment system. In the case of the scenarios presented here, actual data (typically daily) is used and so the scenarios represent how the system would have operated for the period of the dataset available.

The scenarios evaluated for the MWWTP are:

Land Only
- Scenario 1A – Pain Farm;
- Scenario 1B – MWWTP adjacent site;
- Scenario 1C – Pain Farm and MWWTP adjacent site;
- Scenario 1D – Martinborough Golf Course; and
- Scenario 1E – Martinborough Golf Course and MWWTP Adjacent site.

Combined Land and Water
- Scenario 2A – Pain Farm and discharge to river above half median flow (HMF);
- Scenario 2B – Pain Farm and discharge to river above three times median flow (FRE3);
- Scenario 2C – MWWTP Adjacent site and discharge to river above FRE3; and
- Scenario 2D – Martinborough Golf Course and discharge to river above FRE3.

Water Only
- Scenario 3A – discharge to river above HMF; and
- Scenario 3B – discharge to river above FRE3.

A summary of key out puts is as follows:

Discharge Environment	Wastewater proportion to LAND	Wastewater proportion to WATER	Maximum STORAGE (000 m^3)
Land Only	100 %	0 %	63-154
Land and Water	42 % - 84 %	16 % - 58 %	35-62
Water Only (deferred discharge)	0 %	100 %	30-218

There is scope to refine preferred scenarios based on management inputs to obtain the optimum values for a management regime and for the storage volume required.

The following key conclusions can be drawn from this assessment of the scenarios for wastewater discharges from the MWWTP:

- The limitation for land treatment of Martinborough's wastewater is the hydraulic loading rather than the wastewater quality. This means that improvements to the WWTP performance are unlikely to result in changes to the land area or storage requirements.

- Of the identified land areas:
  - Pain Farm is capable of receiving the entire yearly flow from MWWTP;
  - Martinborough Golf Course is capable of receiving 90 % of the entire yearly flow;
  - MWWTP Adjacent land is capable of receiving 24 % of the yearly flow; and
  - The Golf Course and MWWTP combined is capable of receiving the entire yearly flow from MWWTP.

- Combining Pain Farm and MWWTP results in reduced storage requirements.

- Including a water discharge component reduces storage required.

- A water only discharge with substantially reduced environmental impacts is possible if a deferred discharge based on river flows and nutrient loading is adopted.

- The analysis provided is limited by the length of the shortest data set.

An assessment of the preferred options has been undertaken to assess the effects to the receiving environment of three of the evaluated scenarios. The scenarios assessed reflect Stages proposed for consenting by SWDC. The scenarios which correspond to the Staged improvements in the MWWTP discharge are as follows:

- Stage 1: includes the discharge of a portion (24 %) of the wastewater to MWWTP adjacent land under a deferred, non-deficit regime and is equivalent to Scenario 2C;
- Stage 2a: prior to the commissioning of additional storage a portion (42 %) of the wastewater would be discharged to Pain Farm under a deficit regime and is equivalent to Scenario 2A; and
- Stage 2b: following the provision of additional storage, all wastewater flows from MWWTP would be discharged to Pain Farm and is equivalent to Scenario 1A.

Section 8 details the assessment of potential environmental effects of Scenarios 2C, 2A and 1A and concludes that:

The proposed loading rate of the wastewater discharge to the MWWTP adjacent site (Stage 1 land treatment) and to Pain Farm (Stage 2 land treatment) will enable soil remediation and plant uptake of applied contaminants including:

- Filtration and incorporation of TSS;
- Assimilation of BOD;
- Plant uptake, microbe use, and soil occlusion of nitrogen and phosphorus, and gaseous loss of nitrogen;
- Filtration and attrition of pathogens; and
- Water application to the plantation site will occur at such times and rates as to avoid ponding or run-off.

The discharge of municipal wastewater to land is expected to have effects on the receiving soil, shallow groundwater, the Ruamahanga River, and on water quality, habitat values, amenity, community, cultural and heritage values and air quality that are not more than minor. No adverse effect from the proposed discharge, both in terms of Stage 1 and Stage 2, has been identified that is more than minor.

2 INTRODUCTION

2.1 Background

South Wairarapa District Council (SWDC) is responsible for the provision and management of wastewater treatment for the South Wairarapa District. Currently SWDC are reviewing the wastewater treatment and discharge systems at a number of its communities. This includes Martinborough.

As part of developing long term sustainable wastewater discharge options for Martinborough, there is a need to progressively establish sound factual information that describes the limitations and management considerations for discharges. A number of investigations into future wastewater treatment have been initiated by SWDC. This report follows on from previous desktop and field investigations conducted by Lowe Environmental Impact (LEI) for SWDC for the Martinborough wastewater treatment plant (MWWTP).

SWDC has engaged Lowe Environmental Impact (LEI) to determine the proportion of MWWTP flows and storage requirements for a range of land treatment scenarios and to assess the environmental effects of the preferred option. The scenarios only consider land owned by SWDC which has had on site investigations undertaken.

2.2 Scope

This report presents a range of logical scenarios for discharges from MWWTP. It provides a conceptual analysis to indicate the variation in requirements and outcomes when considering the options.

The report covers:

- Section 3 describes the setting for the evaluation;
- Section 4 summarises the methodology used for the evaluation of discharge volumes and storage requirement;
- Section 5 outlines the scenarios examined and their outcomes;
- Section 6 describes some considerations for the use of the data generated;
- Section 7 draws conclusions and outlines recommendations to proceed; and
- Section 8 provides an assessment of the effects likely from preferred options.

It should also be noted that there will be variation around the estimates of discharge durations, discharge volumes, storage requirement, loading rates and land area requirements. This is because the datasets used are of limited duration and will not cover all combinations of climatic, river flow and soil moisture conditions. As a result, the areas used and volumes discharged should be considered **indicative at this concept design stage and used as a relative comparison** when evaluating the various scenarios.

As a result of the uncertainty from the data quality and data set length the 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 THE SETTING

3.1 Existing Reporting

Four reports utilised in this assessment have been produced by LEI, including:

- Martinborough Wastewater Treatment Plant – Land Application Option Assessment: LEI, January 2012.
- Evaluation of Potential Land Treatment Sites – Pain Farm Site: LEI, April 2013 (a).
- Evaluation of Potential Land Treatment Sites – Martinborough Golf Course Site: LEI, April 2013(b).
- Evaluation of Potential Land Treatment Sites – Martinborough Wastewater Treatment Plant Site: LEI, April 2013(c).

The first report provides a desktop assessment of the suitability of land in the Martinborough area for receiving treated wastewater based on soil and hydrological parameters. The second, third and fourth reports detail the outcomes of field investigations into specific land areas, and their capacity to assimilate applied wastewater.

A further report has been produced describing wastewater land treatment scenarios for nearby Featherston. This report follows a similar format for consistency, and utilises a comparable methodology.

3.2 Wastewater Design Parameters

Martinborough is a community of some 1,470 people (2013 Census) located towards the southern end of the Wairarapa Valley. It has a steady year round population. Wastewater from Martinborough is piped to a facultative pond followed by 4 maturation cells and UV disinfection. The treatment system has a hydraulic retention time of 47 days under average flow conditions, reducing to around 13 days under peak flow conditions. Average annual daily inflow is 574 m^3/day, with a measured peak of 2,960 m^3/day (data 1/12/2007 to 10/11/2011). After 7/12/2011 the flow meter has been relocated to the WWTP outlet. Inflow and outflow data as available (inflow data ceases in late 2011) are considered for the period 1/12/2007 to 31/01/2013 the average wastewater flows are 608 m^3/day for the MWWTP.

Treated wastewater enters the Ruamahanga River via a boulder outfall. Typical wastewater quality is routinely measured by SWDC. For this report parameters of interest are total nitrogen (TN) and total phosphorus (TP). The available data set is summarised as follows:

Table 1: Martinborough Wastewater Quality (AWT, 2013)

	TN (mg/L)	TP (mg/L)
Average	17.8	4.1
90th percentile	50.4	11.7
10th percentile	4.3	0.8

3.3 Discharge Environments

Wastewater can be discharged to land and to water. While the preference for Martinborough is a full time land discharge, a comprehensive examination of the options should include discharges to the Ruamahanga River where assimilative capacity exists.

3.3.1 Land

Land in the vicinity of MWWTP has been evaluated using a desktop assessment (LEI, 2012). The assessment differed from the equivalent evaluation for Featherston due to the adoption of additional parameters relevant to Martinborough and the exclusion of slope as a parameter. There is a mix of land types in the Martinborough area. Land in the vicinity of MWWTP was predominantly Zone B, having minor limitations for wastewater land treatment, and Zone C, having limitations requiring careful management.

Zone B soils are typically associated with recent alluvium from rivers and streams, and are well to excessively drained and suitable for wastewater irrigation. Zone C soils are typically associated with the uplifted Martinborough terrace and have finer textured soils due to aeolian material (wind-blown, loess). These areas tend to have a drainage restriction and limitations for irrigation that require careful management.

Three blocks within the vicinity of MWWTP which are owned by SWDC have been identified. Field investigations were undertaken on those sites (LEI, 2013 a, b and c). Key information for those sites is summarised as follows:

Pain Farm – The land within Pain Farm corresponds to Zone C land, having a restriction of both subsoil permeability and seasonal high groundwater. The block is referred to in this report as "Pain Farm". Investigations have determined that the site has an irrigable area (i.e. excluding buffer setbacks) of 53 ha, and is capable of assimilating up to 9.6 mm/day of wastewater.

Martinborough Golf Course – The desktop evaluation (LEI, 2012) indicated that the golf course falls into Zone B land, however the site investigation identified subsurface drainage limitations (argillic pan, fragipan) which suggest the land corresponds to Zone C. The site is referred to in this report as "Golf Course". The Golf Course has a minimum irrigable area (i.e. excluding buffer setbacks) of 33 ha, and is capable of assimilating up to 3.6 mm/day of wastewater.

MWWTP adjacent – A block of land is located directly adjacent to the MWWTP and is referred to as "MWWTP adjacent". Investigations have determined that the site has an irrigable area (i.e. excluding buffer setbacks) of around 5.3 ha, and is capable of assimilating a minimum of 30 mm/day of wastewater.

3.3.2 Water

The Ruamahanga River is located directly adjacent to the MWWTP and is the likely receiving water environment for any future discharge to water. Key terms and values for river flow used in this assessment are as follows:

- Half median flow (HMF) – half of the annual median flow below which conditions are referred to as low flow conditions. For the Ruamahanga River at Waihenga Bridge HMF is 26,105 L/s;
- Median flow (MF) – annual median flow conditions; and
- Three times median flow (FRE3) – Above this flow rate the river bed is considered to be mobile and not subject to limitations due to nutrient effects on nuisance organism growth. For the Ruamahanga River at Waihenga Bridge HMF is 149,274 L/s.

Typically lower river flows occur in summer and through into April. However, historical river conditions suggest that low flow river conditions can occur throughout the year, but the frequency and duration of low flows are less in the winter period. Similarly, high flows can occur due to summer high rainfall events in December and January.

The assimilative capacity of the Ruamahanga River near to MWWTP is discussed in the consent master document. Historically, both soluble inorganic nitrogen (SIN) and dissolved reactive phosphorus (DRP) frequently exceed the river assimilative capacity in the vicinity of MWWTP. Historically, the river has received contaminant inputs from a number of wastewater discharges and from farming activities throughout the catchment. These discharges, particularly those associated with community wastewater discharges, are undergoing improvements and reduced loadings into the river which can be expected to result in improvements in the Ruamahanga River water quality in the future.

Given the challenges of predicting future water quality of the Ruamahanga River an acceptable load to the river has not been established. Instead, for the purpose of this report it is assumed that phosphorus (P) is the limiting nutrient as is common in catchments with similar characteristics to the Ruamahanga River Catchment. P loading that results in no detectable change beyond the mixing zone has been adopted for determination of acceptable discharge between HMF and FRE3. For the current analytical methodology used this corresponds to a change in river water concentration of no more than 0.002 mg/L.

Under lower flow conditions, being below HMF, there would be no river discharge. When the flow is less than FRE3 the discharge would be adjusted to ensure the mass loading of contaminants in the wastewater did not result in unacceptable elevations in wastewater constituent concentrations. At higher surface water flows (exceeding FRE3), the effects would be less pronounced and a greater mass could be discharged.

4 METHODOLOGY

4.1 General

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.

4.2 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 report is based on an empirical water and nutrient budget for a land discharge system. In the case of the scenarios presented here, actual data (typically daily) is used and so the scenarios represent how the system would have operated for the period of the dataset.

4.3 Key Inputs

Specific 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 estimated based on previous outflow and current inflow data;
- Mean wastewater quality: While the wastewater quality is known to vary, 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;
- Daily rainfall data: From the nearest climate station with a complete daily data set;
- Daily Priestly-Taylor Potential Evapotranspiration: From the nearest climate station with a complete daily data set; and
- Daily open-pan evaporation (for losses from the storage pond surface): From the nearest climate station with a complete daily data set.

4.4 Variable Inputs

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

- Land application depth;
- Area available for irrigation on any day;
- Soil moisture content trigger to allow irrigation;
- Soil permeability;
- 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 MWWTP wastewater to land as possible without damaging the land. There is scope to vary these parameters in later iterations of the preferred scenarios. The intent is that the variations between scenarios will provide a comparative summary of the scenarios which can be refined at a later stage if needed.

4.5 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 – both rapid macropore drainage and slower percolation;
- If sufficient wastewater is available and soil moisture status allows, apply wastewater to land area at the prescribed irrigation rate; and
- If insufficient wastewater is available then it is stored;
- If there is not sufficient capacity in the soil to receive wastewater then river flow conditions are assessed and discharge to river to meet criteria of maximum P loading between HMF and FRE3, or maximum discharge volume above FRE3; and
- If no discharge to river is possible then wastewater is stored.

For a number of scenarios additional discharge methods or locations may occur i.e. the inclusion of additional land area or rapid infiltration. In which case prior to directing flows to storage a check is made to determine if discharge criteria for other discharge methods and where discharge criteria are met then discharge via those other methods occurs.

4.6 Outputs

Key outputs from the water balance include:

- Average annual discharge volume;
- 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 to the land application area; and
- The maximum storage volume needed to operate a full time land treatment system.

These outputs are given for the scenarios examined in Section 5.

5 LAND TREATMENT SCENARIOS

5.1 General

This section describes the outcomes of scenarios created utilising the methodology outlined in Section 4.

5.2 Scenario 1 – Full Time Land Application

As described in Section 3.3 above three properties have been identified as potentially suitable for discharge of MWWTP wastewater. Utilising information from the site investigations, the methodology described in Section 4 has been applied to Pain Farm, MWWTP adjacent and Golf Course land. Irrigation scenarios for each property individually and for combinations of land have been evaluated. The scenarios are identified as follows:

- Scenario 1A – Pain Farm;
- Scenario 1B – MWWTP adjacent land;
- Scenario 1C – Pain Farm and MWWTP adjacent;
- Scenario 1D – Golf Course; and
- Scenario 1D – Golf Course and MWWTP.

The combination of Pain Farm and the Golf Course is not considered at this stage since the extra reticulation required will likely result in no benefit to SWDC.

Figure 5.1 shows the volume of storage required for each day over the period of the data set for each land area.

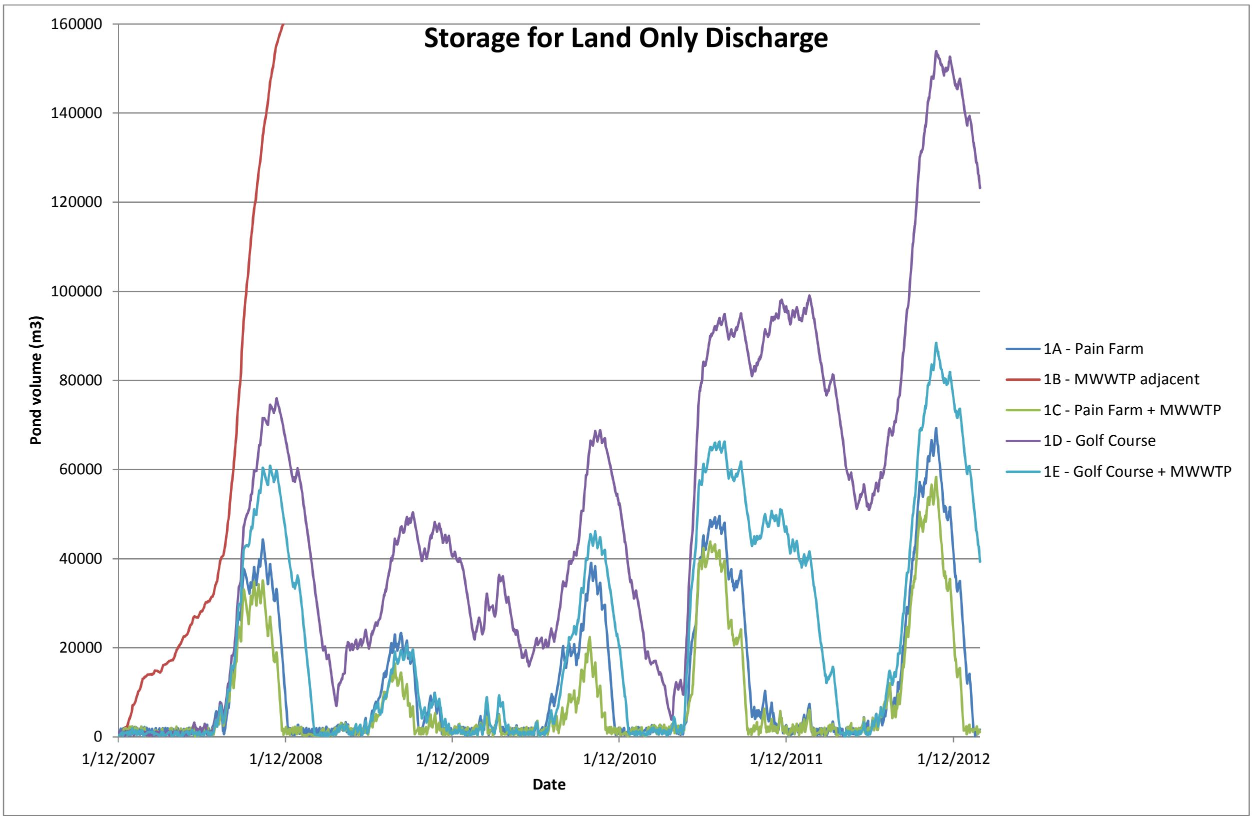

Figure 5.1: Scenario 1 - Wastewater Volume in Storage Pond

For the period of data available the evaluation indicates that with sufficient storage, Pain Farm is likely to be able to take all flows from MWWTP. The MWWTP adjacent site is unable to receive all of the flows from MWWTP and so the required storage volume becomes infinite. The Golf Course appears to be able to accept all MWWTP flows on most years, but further data is needed to project the irrigation volume to the Golf Course over a longer period to provide a higher degree of certainty. The inclusion of MWWTP adjacent land with the Golf Course is likely to result in a sufficient land area for discharge of all MWWTP flows. The inclusion of MWWTP adjacent land with Pain Farm reduces the total volume of storage required.

For all the land only scenarios the nutrient loading to the land treatment area is below a typical requirement for intensive crop production, including pasture. Nitrogen loading varies from 60-104 kg N/ha/y. Phosphorus loading varies from 14-24 kg P/ha/y. The average number of irrigation days over the period of available data are from 110 (Pain Farm and MWWTP adjacent) to almost 200 (Golf Course).

5.3 Scenario 2 – Combined Land and Water Discharge

The scenarios described above indicate that a full time land discharge is possible for the MWWTP discharge. The storage requirement to avoid a discharge to water is large. An alternative to full time land discharge would be the inclusion of a water discharge element. A water discharge would occur under conditions which resulted in no more than minor effects to the receiving waterway.

The scenario adopted is conservative with regard to the river assimilative capacity i.e. a discharge should not cause a measurable increase in DRP beyond the zone of mixing. Land application is set as the preferred discharge route. If this scenario is considered further there is potential to increase the river discharge without exceeding the river assimilative capacity, especially if discharge occurred during high river flows.

Figure 5.2 shows the pond volume required for storage of MWWTP for a combined land a water discharge for Pain Farm plus discharge to river either at flows above HMF or at flows above FRE3.

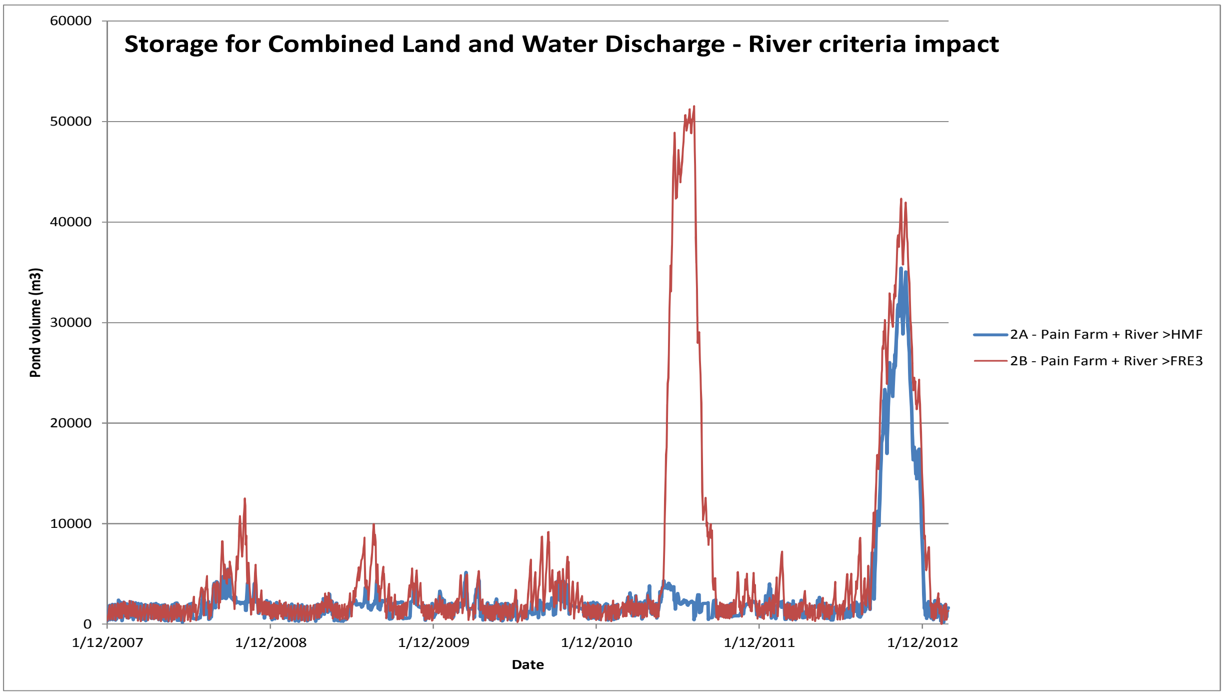

Figure 5.2: Scenario 2 –Storage Requirement for Varying River Discharge Criteria

The pond storage requirement for a system which allows discharge above HMF has a smaller storage requirement than for water discharge allowed only above FRE3. However, the increase in storage resulting from a lesser discharge to water results in a higher volume of wastewater being available for irrigation to land and correspondingly a better agronomic outcome for Pain Farm (higher dry matter production) is expected under this option.

The storage required for each land area when a discharge above FRE3 is allowed is shown in Figure 5.2.

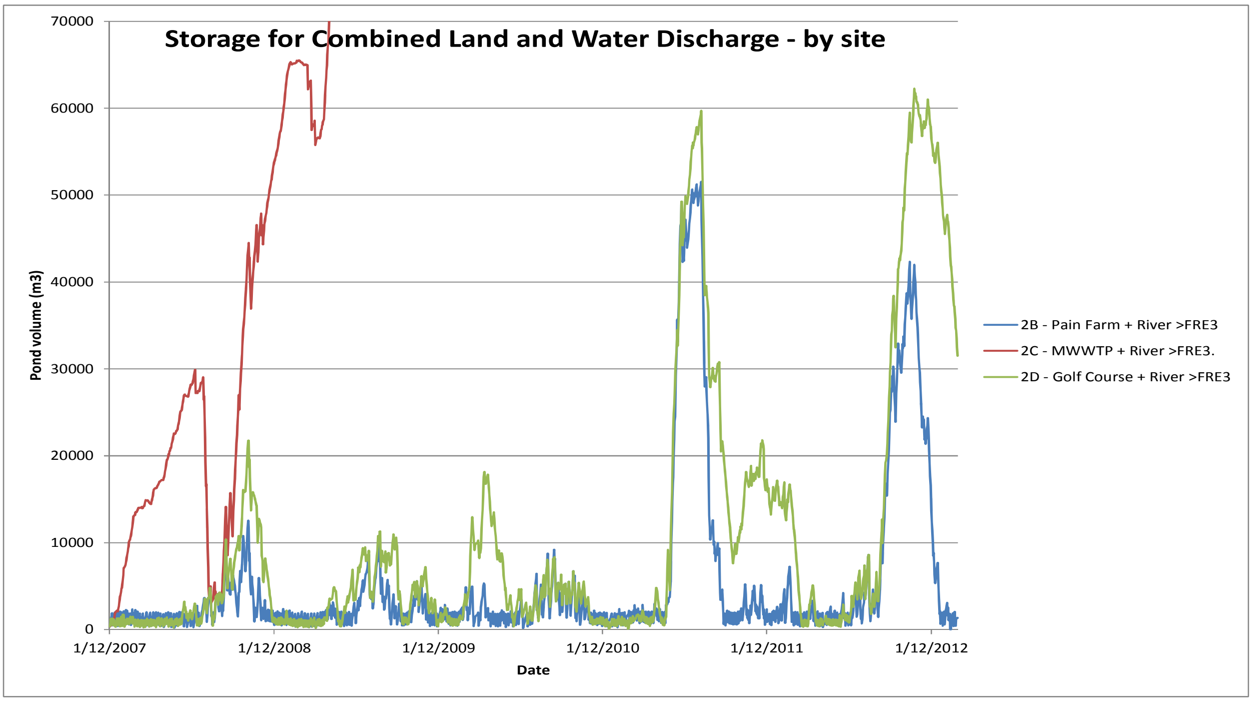

Figure 5.2: Scenario 2 – Storage Requirement for Various Land Areas

The overall storage requirements for Scenario 2 are less than for Scenario 1. The trends shown are similar to Scenario 1, in that the MWWTP adjacent land is insufficient for discharge Scenario 2. The Golf Course has a higher storage requirement than for Pain Farm.

For all the combined land and water scenarios the nutrient loading to the land treatment area is below a typical requirement for intensive crop production, including pasture. Nitrogen loading varies from 28-177 kg N/ha/y. Phosphorus loading varies from 6-41 kg P/ha/y. The average number of irrigation days over the period of available data are from 51 (Pain Farm with river discharge above HMF) to almost 200 (Golf Course). The variation is largely due to the availability of wastewater in a storage pond for discharge to land, **and NOT the ability to irrigate**. Days of discharge to the river vary from 212 for discharge above HMF to 20-34 days where discharge occurs only above FRE3. Wastewater volume discharged to the river varies from an average of 129,000 m^3 for discharge above HMF to 34,600-95,401 m^3 where discharge occurs only above FRE3.

5.4 Scenario 3 – Deferred Discharge to Water

A clear preference from the community is for the existing full time discharge to river to be ceased. Land discharge has been identified as the method to achieve this. For completeness and comparative purposes this report has included Scenario 3 which looks at a total river discharge which is likely to result in an improvement in the effects to the river.

Figure 5.3 shows the storage requirements were the existing river discharge to be continued, but with discharge deferred to limit potential environmental impacts as described in Section 3.3.2.

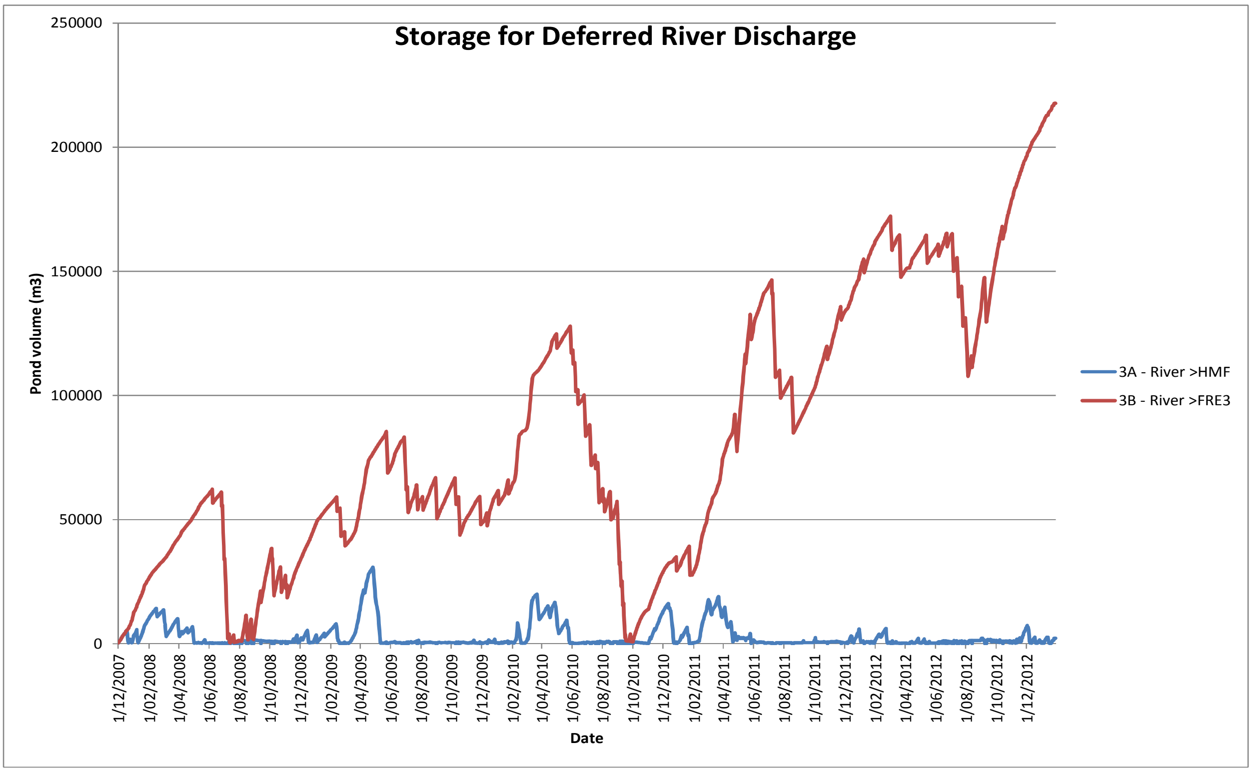

Figure 5.3: Pond volume – Deferred Discharge to River

For discharges above HMF (Scenario 3A), and which are controlled by P loading, a maximum pond volume around 31,000 m^3 is required. This pond volume is dedicated storage and is in addition to the existing treatment ponds.

Where discharge is limited to when river flows exceed FRE3 (Scenario 3B), and using no nutrient based flow limitation and up to a maximum daily discharge of 6,000 m^3, there are insufficient discharge days to discharge the total flows from MWWTP. Increasing the daily discharge rate during times of flows greater than FRE3 could assist in reducing pond size.

5.5 Summary of Scenarios

The Scenarios evaluated for the Featherston WWTP discharge indicate that Pain Farm is able to receive the entire yearly flow from MWWTP (Scenario 1A). The golf course is capable of receiving around 90 % of the yearly flows (Scenario 1D), and MWWTP adjacent land can receive 24 % of the flows (Scenario 1B). Combinations of MWWTP Adjacent land with either Pain Farm (Scenario 1C) or the Golf Course (Scenario 1E) result in all wastewater being discharged to land and a reduced storage volume requirement.

The inclusion of a water discharge component (Scenarios 2A-2D), along with land discharge results in further reductions in storage requirements, but also fewer irrigation days and correspondingly lower nutrient loads to land areas.

Nutrient loading to land for land treatment is at or below typically acceptable levels for the surrounding pastoral land uses. This indicates that the limitation for land treatment of MWWTP wastewater is the hydraulic loading rather than the wastewater quality. This means that improvements to the WWTP are unlikely to result in changes to the land area or storage requirements. Table 5.1 below summarises the key outputs for each scenario. There is scope to refine preferred scenarios based on variables outlined in Section 4.4 to obtain the optimum values for a management regime and for the storage volume required.

Table 5.1 below shows different percentile values for the storage volume. These percentile values show that storage required for 90 % of the time is almost half that required to capture the maximum storage required. The maximum storage volume periods are likely to correspond to wet periods in the lower and possibly mid catchment while it remains drier in the upper catchment i.e. soil conditions are too wet for irrigation but river flows are not high enough to discharge to river.

Due to the substantial cost and land area implications of storage it may be more feasible to develop a contingency discharge method for flows above the 90th percentile storage requirement since this additional volume is required only 10 % of the time and so would normally be empty. It should be noted that percentile storage values should be considered in the context of the available data set due to the short duration of the data set.

Table 5.1: Summary of Martinborough Scenario Outputs

	Land only					Land and water				River only	
Scenario	1A	1B	1C	1D	1E	2A	2B	2C	2D	3A	3B
Land area decription	Pain Farm	MWWTP	Pain Farm + MWWTP	MGC	MGC + MWWTP	Pain Farm	Pain Farm	MWWTP	MGC	NA	NA
Land area (ha)	53	5	58	34	39	53	53	5	34	NA	NA
Volume to land (m3/y)	222,374	52,731	199,700/18,550	199,008	180,600/28,500	93,208	187,814	52,731	165,774	NA	NA
Yearly application depth (mm/y)	370	994	331/350	331		155	313	994	276	NA	NA
Depth per application (mm)	3D	5ND	3D/5ND	3D	3D/5ND	3D	3D	5ND	3D	NA	NA
Days of land application (#/y)	123	199	110	195	177	51	104	199	162	NA	NA
Land N load (kg/ha/y)	66	177	60	104	95	28	56	177	87	NA	NA
Land P load (kg/ha/y)	15	41	14	24	22	6	13	41	20	NA	NA
Storage											
Storage volume max (m3)	69,300	NA	62,800	154,000	94,700	35,000	52,000	NA	62,300	30,800	217,600
Storage volume 99th%ile (m3)	63,100		57,600	151,000	89,500	30,700	49,400		59,500	28,900	83,000
Storage volume 95th%ile (m3)	47,700		50,500	138,000	74,400	11,100	32,800		54,000	13,900	78,700
Storage volume 90th%ile (m3)	37,400		37,600	96,000	69,200	3,700	12,800		38,300	10,100	70,800
River											
River Cut-off	NA	NA	NA	NA	NA	HMF	FRE3	FRE3	FRE3	HMF	FRE3
Nutrient Loading Limit	NA	NA	NA	NA	NA	D	D	D	D	D	D
Volume to river, HMF-20FEP (m3/y)	NA	NA	NA	NA	NA	120,797	0	0	0	178,029	0
Volume to river, >20FEP (m3/y)	NA	NA	NA	NA	NA	8,374	34,622	95,401	51,006	40,075	204,177
Total volume to river (m3/y)	NA	NA	NA	NA	NA	129,171	34,622	95,401	51,006	218,104	204,177
Days of river discharge (#/y)	0	0	0	0	0	212	20	34	25	248	175
N load (kg/y)	NA	NA	NA	NA	NA	2,299	616	1,698	908	3,882	3,634
P load (kg/y)	NA	NA	NA	NA	NA	530	142	391	209	894	837

6 USE OF DATA

6.1 Limitations

The scenarios presented provide a comparative evaluation of land treatment options for the MWWTP discharge. Some limitations exist which mean these scenarios are suitable for the conceptual design stage, but are not intended for engineering design. A discussion of the limitations and appropriate next steps follow.

6.2 Scenario Optimisation

It is possible to adjust management factors such as minimum pond volume, soil discharge criteria and the minimum land area to be irrigated on any day. These adjustments can be used to optimise the scenarios. The process is iterative and it is not considered that the scale of any variations would alter the comparative differences between the scenarios described above. Instead, it is considered that a limited number of scenarios are nominated for further investigation by SWDC prior to optimisation.

6.3 Length of Data Sets

The scenarios presented are based on a limited data set. As a result outputs of the scenario modelling are limited to describing this period. To account for longer term climatic variation that may be expected for the life time of a land treatment system, data sets need to be extended. This would involve the generation of artificial wastewater flow data based on the existing data set. A period of not less than 20 years is recommended for additional discharge modelling as part of any detailed design.

6.4 Variation Between WWTP Inflow and Outflow

Examination of the inflow and outflow data sets indicate that outflows are typically higher than inflows. It is likely that this represents a calibration error with the inflow meter.

7 SCENARIOS – CONCLUSIONS AND RECOMMENDATIONS

The following key conclusions can be drawn from this assessment of the scenarios for wastewater discharges from MWWTP:

- The limitation for land treatment of Martinborough's wastewater is the hydraulic loading rather than the wastewater quality. This means that improvements to the WWTP performance are unlikely to result in changes to the land area or storage requirements.

- Of the identified land areas:
  - Pain Farm is capable of receiving the entire yearly flow from MWWTP;
  - Martinborough Golf Course is capable of receiving 90 % of the entire yearly flow;
  - MWWTP Adjacent land is capable of receiving 24 % of the yearly flow; and
  - The Golf Course and MWWTP combined is capable of receiving the entire yearly flow from MWWTP.

- Combining Pain Farm and MWWTP Adjacent land results in reduced storage requirements.

- Including a water discharge component reduces storage required.

- A water only discharge with substantially reduced environmental impacts is possible if a deferred discharge based on river flows and nutrient loading is adopted.

- The analysis provided is limited by the length of the shortest data set.

The recommended process to determine and refine the preferred scenario is as follows:

1. Assess the scenarios presented and determine a preferred scenario(s) to refine and optimise. This may involve the consideration of technical aspects in addition to those presented in this report, such as consentability, costs and community acceptability.

2. Refine the preferred scenario(s), including the impact of extreme wet and dry periods on the calculations for land area, river discharge duration and storage requirements. This would provide a sensitivity analysis to assess their impact and the need for more or less land for discharge and/or storage. Generation of a long term (artificial) wastewater flow data set would be needed.

3. Undertake a preliminary cost estimate for establishment of a land application system, storage, associated reticulation and any treatment plant modifications.

4. Compare the preferred Scenario with the wider wastewater strategy investigations (wastewater treatment upgrades, combined systems, etc) to enable a preferred wastewater upgrade option to be finalised, and a programme of works to be prepared.

The scenarios given here can be used to evaluate potential effects on the environment due to the establishment of a land treatment scheme.

8 PREFERRED OPTION: ASSESSMENT OF EFFECTS – LAND TREATMENT

8.1 Background

SWDC have proposed a programme of changes to the existing full time river discharge over the course of a long term consent. The Stages correspond to different scenarios analysed as part of the preceding evaluation. The scenarios which correspond to the Staged improvements in the MWWTP discharge are as follows:

- Stage 1: includes the discharge of a portion (24 %) of the wastewater to MWWTP adjacent land under a deferred, non-deficit regime and is equivalent to Scenario 2C;
- Stage 2a: prior to the commissioning of additional storage a portion (42 %) of the wastewater would be discharged to Pain Farm under a deficit regime and is equivalent to Scenario 2A. It should be noted that this Stage assumes sufficient storage above treatment level exists in the treatment system to enable no discharge below HMF to the river; and
- Stage 2b: following the provision of additional storage all wastewater flows from MWWTP would be discharged to Pain Farm and is equivalent to Scenario 1A.

The effects of the discharge of wastewater to land under these scenarios are assessed below. A summary of the key parameters of each land treatment regime are given in Table 9.

Table 9: Summary of Land Discharge Parameters and Outcomes

Parameter	Stage 1 – Scenario 2C	Stage 2a (no additional storage) – Scenario 2A	Stage 2b – Scenario 1A
	Average Year (non-deficit)	Average Year (deficit)	Average Year (deficit)
Irrigable area – Site A Only (ha)	5.3	53	53
Limiting parameter	Nutrient to groundwater	Hydraulic	Hydraulic
Soil moisture trigger to allow application	5 mm above FC* after application	1 mm below FC* following irrigation	1 mm below FC* following irrigation
Application Rates			
Average daily rate over the year (mm/d)	2.7	0.4	1.0
Maximum application per event (mm/d)	15	9	9
Maximum application per event – June, July, August (mm/d)	0	9	9
Yearly application depth (mm)	995	155	370
Yearly application Volume (m^3)	52,731	93,208	222,374
Drainage in excess of natural (mm/y)	840	76	272
Nutrients			
N applied from wastewater (kg N/ha/y)	177	28	66
P applied from wastewater (kg P/ha/y)	41	6	15
Plant uptake N/P (kg N/ha/y)	300/40		

Parameter	Stage 1 – Scenario 2C	Stage 2a (no additional storage) – Scenario 2A	Stage 2b – Scenario 1A
	Average Year (non-deficit)	Average Year (deficit)	Average Year (deficit)
Soil retention N/P (kg N/ha/y)	0/108		
Na applied (kg Na/ha/y)	995	155	370

* FC = field capacity where, below FC no drainage occurs.

8.2 Receiving Environment

The receiving environment for the discharge to land is detailed in reports as follows:

- Evaluation of Potential Land Treatment Sites – Pain Farm Site. LEI, 2013a;
- Evaluation of Potential Land Treatment Sites – MWWTP Adjacent Site. LEI, 2013b.

The assessment below details the likely contaminants, and the impact of the proposed discharge to land on those receiving environments.

The immediate receiving environments for the discharged treated wastewater are the soils in the application areas (MWWTP adjacent land and Pain Farm), where the irrigation infrastructure will be placed. Any wastewater components that move beyond the soil have the potential to impact groundwater, or surface water in unnamed tributaries of the Ruamahanga River or the Ruamahanga River itself.

8.3 Sensitivity of Receiving Environment

Environmental risk depends on three major factors, these are:

- Source and type of contaminant;
- Migration pathways; and
- Receptors.

If one of these factors is absent, then the potential risk is greatly reduced. By removing the contaminant source, by containing or limiting the contaminant, or by the absence or removal of the receptor, the environmental risk is able to be significantly reduced.

Treated municipal wastewater from the MWWTP contains a range of contaminants, with their concentration determined by the degree of treatment received before application to land.

The migration pathway being through and potentially over land to ground water and surface water will be limited by the adoption of a carefully designed, managed and monitored irrigation regime.

Receptors for the discharge are the organisms, animals and people which live in or utilise the receiving environment. For the proposed discharge potential receptors are considered to be:

- Soil and aquatic organisms;
- Animals which consume or contact surface water and abstracted groundwater;
- Humans who rely on the water for drinking or irrigation of food crops; and
- Contact recreation users of surface water.

This assessment considers the impacts at two separate sites. Whilst they are separated by some distance (around 2 km) and have different immediate receiving environments, the effects and management of the effects at the two sites is similar, and hence unless otherwise stated in the following sections, the effects are considered to be the same.

8.4 Wastewater Properties of Potential Concern

The treated wastewater to be irrigated onto the application site will have the following properties of potential environmental concern:

- Organic solids as measured by biochemical oxygen demand (BOD);
- Nitrogen (N as ammoniacal nitrogen (NH_4-N) and nitrite/nitrate nitrogen (NO_x-N) and organically bound nitrogen);
- Total and dissolved reactive phosphorus (TP, DRP);
- Pathogens; and
- Excess water.

8.5 Effects of the Discharge on Soil and Plants

The soil is the primary receiving environment for the discharge. The wastewater discharge is to be applied via irrigation to land at an irrigation rate of:

- up to 15 mm/event at a frequency equivalent to an average daily application of 2.7 mm/d for Scenario 2C (Stage 1);
- up to 9 mm/event at a frequency equivalent to an average daily application of 0.4 mm/d for Scenario 2A (Stage 2a);
- up to 9 mm/event at a frequency equivalent to an average daily application of 1.0 mm/d Scenario 1A (Stage 2b).

The potential impact of the discharge on the soil and plant system may be on soil structure, erosion potential, contamination, and nutrient uptake and removal. These are discussed below with regard to the properties of potential environmental concern identified in Section 8.4 above.

8.5.1 Effects of Organic Solids on Soil and Plants

Potential adverse effects of organic solids as measured by BOD on the soil and plants of the sites include the generation of anaerobic conditions in the soil as oxygen is consumed. This is an important aspect of land treatment systems, as the production of anaerobic conditions in the soil can result in surface slimes with the associated problems of:

- Plant die off;
- Degraded visual appearance;
- Production of odour;
- Degradation of soil structure; and
- Reduced soil infiltration capacity.

A healthy soil environment can assimilate up to 600 kg BOD/ha/day (NZLTC, 2000). The application of treated wastewater is to be at up to 15 mm/event for Stage 1 and 9 mm/event for Stage 2a and 2b, and the mean concentration of BOD from the existing treatment system is 40.6 g BOD/m^3 (see consent master document). Total annual wastewater production is typically around 222,000 m^3 of which between 53,000 m^3 **(Stage 1)** and 222,000 m^3 **(Stage 2b)** would be applied to land. At 40.6 g/m^3 BOD loading, this is equivalent to up to 404 kg BOD/ha/year (~ 1.1 kg BOD/ha/d) over the land treatment area of 5.3 ha for Stage 1.

For Stage 2b (maximum discharge to land) if the entire wastewater volume was discharged to Pain Farm only the BOD load would be 9,011 kg BOD/y, equivalent to 150 kg BOD/ha/y (~ 0.4 kg BOD/ha/d). In both cases the BOD applied is substantially lower than 600 kg/ha/day (i.e.

219,000 kg/ha/y) and therefore the effects of BOD on soil and plants within both the proposed application areas are expected to be less than minor.

8.5.2 Effects of Nitrogen on Soil and Plants

Potential adverse effects of high N loading on soil and plants may include:

- Oversupply of N in excess of plant requirements, leading to leaching and/or run-off to water; and
- Plant damage due to high ammonia concentrations.

Much of the N will be removed by soil microbe use, plant uptake, short-term soil storage and gaseous losses (volatilisation and denitrification). A level of ammonia volatilisation has been shown to occur as a result of the spraying action during irrigation. This can result in the removal of 2 to 5 % and up to 15 % of total N (Myers et al, 1999) depending on its chemical form, ambient conditions and irrigation operation.

For Stage 1: the proposed rate of application of treated wastewater is up to 15 mm/event throughout the year, for an annual volume of 9,950 m^3/ha/y. The irrigable portion of the land treatment area is 5.3 ha in size and is covered with pasture. In future a range of crops could be grown. The proposed loading of N to the site from wastewater is 177 kg N/ha/yr.

For Stage 2: (maximum application to land) the proposed rate of application of treated wastewater is up to 9 mm/event throughout the year, for an annual volume of 3,700 m^3/ha/y. The irrigable portion of the land treatment area is 53 ha in size and is covered with pasture. In future a range of crops could be grown. The proposed loading of N to the site from wastewater is 66 kg N/ha/yr.

Both Stages: The pasture is capable of removing 186 - 437 kg N/ha/yr from the effluent as explained in Barton et.al (2005). Despite the low N loading rate, limited leaching may still occur due to the function of natural systems (inhomogeneity, rainfall extremes, etc.). However, the proposed conservative rates will enable a level of confidence that leaching will not be more, and typically will be less than occurs under the surrounding land use that receives animal excreta and fertiliser application. As a result the effects are expected to be less than minor on the soil. The impact on ground and surface water is discussed in subsequent sections.

Due to the low nitrogen loading that is proposed under the application regime, plant needs are unlikely to be adequately supplied to maintain or optimise the plant cover on the site. The use of additional nitrogen sources may be needed, with potential supplies from additional wastewater application or synthetic fertiliser. If the plant N needs were to be supplied by additional wastewater irrigation the depth of drainage would increase to 1,200 mm in excess of natural drainage. This is considered not to be a practical solution for the site.

It has been determined that the site's N requirements can be met by application of 300 kg N/ha/yr. This results in between 123 (Stage 1) and 234 kg N/ha/yr (Stage 2a) potentially being applied from additional sources. The supplementary nutrients will be applied in accordance with best practice (NZFMRA, 2007) to minimise losses. The effects of this additional nitrogen will be positive for the soil and plant system by allowing maximum growth. The impact of this greater loading, whether it be more wastewater or synthetic fertiliser will be effects that are expected to be less than minor for soil and plants. The implication for water ways is discussed in Sections 8.5.2 and 8.6.2.

8.5.3 Effects of Phosphorus on Soil and Plants

The discharge contains P, which is unlikely to have an adverse effect on the soils of the site. Phosphorus is known to lead to the eutrophication of waterways. However, soil transformation and plant uptake of the applied P is expected to remove most applied P.

The application rate of the treated wastewater on the land treatment area is up to 15 mm/event for Stage 1 and 9 mm/event for Stages 2a and 2b. The concentration of total phosphorus discharged to land would provide an average input of **41 kg P/ha/yr (Stage 1)** and **15 kg P/ha/yr (Stage 2b, maximum discharge to land)** on the land treatment area over the irrigation period. P uptake by plants is in the range of 130 - 160 kg P/ha/yr for NZ ryegrass pasture (Morton *et al.,* 2000) in an intensively managed cut and carry pasture system. Realistically for the sites proposed it is likely that plant P removal will be 40 to 70 kg/ha/yr, and more than applied in the wastewater.

It is expected that all P applied in wastewater will be able to be utilised by the plants on the site. Any P not removed by the plant and animal system is expected to be adsorbed to the soil or incorporated into the soil organic matter. The soil is estimated to have a capacity to sorb applied P in the top 0.4 m of the sites soil of 1,320 - 2,200 kg/ha. The applied P from wastewater is well within the capacity of the soil to store, and of the plants to utilise, so the effect of phosphorus is expected to be no more than minor.

For both stages, as for nitrogen above, phosphorus requirements of the plant system may not be adequately supplied by the wastewater. The addition of more wastewater or supplementary phosphorus from fertiliser or other sources up to 40 kg P/ha/yr would result in 0 to 44 kg P/ha/yr supplementary P applied. At this rate the plant system is expected to remove the entire applied amount. The effects of this additional phosphorus will be positive for the soil and plant system and so adverse effects due to phosphorus application are expected to be less than minor for soil and plants. The implication for water ways is discussed in Sections 8.5.3 and 8.6.3.

8.5.4 Effects of Pathogens on Soil and Plants

UV disinfection of wastewater flows from the MWWTP currently occurs. This results in a significant reduction in pathogen concentration, as indicated by *E. coli* or faecal coliforms (FC). Following disinfection the concentration of *E. coli* s expected to have a median of 100 MPN/100 mL.

<u>**Both Stages:**</u> For the remaining pathogens, the main mechanisms that operate within the soil matrix to ensure pathogen removal are filtration, adsorption and natural attrition. It is understood that 92 - 99.9 % of applied microbes are removed in the top 10 mm of the soil (Crane and Moore, 1984; Gunn, 1997). As shown by Aislabie *et al.* (2001) and McLeod *et al.* (2001) sandy, well drained soils with predominantly matrix flow, such as those seen on the site, are very efficient removers of microbial contaminants even at application rates 7-10 times higher than the proposed 9-15 mm/d. It is expected that the effect of pathogens on soil and plants will be less than minor.

8.5.5 Effects of Water on Soil and Plants

There is the potential for over-application of water to lead to saturation of the soil, resulting in pugging, erosion, and loss of soil structure.

<u>**Stage 1:**</u> During Stage 1 the MWWTP adjacent land will be irrigated. The irrigation rate is proposed to be 2.7 mm/d on average with a 15 mm/event maximum. Due to the sandy texture of the predominant soil at the site it is not likely to be susceptible to pugging. In addition, the

sandy texture results in gravity drainage of water when it passes below the topsoil. The soil is capable of receiving greater than 30 mm/hr without causing saturation, ponding or run-off (LEI, 2013a). The low application rate planned at 15 mm/application which when applied over no less than 1 hour is expected to ensure that the risk of saturation and erosion are minimised. The adverse effects of the application of water on the soil will be not greater than minor.

Stage 2a and b: Following the commencement of Stage 2 Pain Farm will be irrigated. Soils on this site have limitations for water movement. The irrigated wastewater is to be applied to coincide with plant demand for water on the site (deficit regime). This results in minimal drainage in excess of natural drainage. Using a deficit regime results in irrigation seldom being applied during winter months when the soil is most susceptible to damage due to wet conditions. The rate of application of wastewater will not exceed 3 mm/hr which is the measured rate at which water can infiltrate and permeate through the soil of the Pain Farm site (LEI 2013b). At this rate ponding and run-off will be avoided.

The effects of water on the soils and plants of both sites are expected to be no more than minor.

8.6 Effects of the Discharge on Groundwater

Contaminants applied to the land have the potential to enter groundwater. On the land application site the discharge will be applied at the surface of the soil which has the potential to eventually leach into the groundwater.

A bore search over a 3 km radius around Pain Farm (Stage 2) from GWRC shows no down gradient groundwater takes.

Groundwater from the MWWTP adjacent site (Stage 1) is expected to discharge to the Ruamahanga River close to the site. There are not considered to be any down gradient groundwater users from this site.

8.6.1 Effects of BOD on Groundwater

Potential adverse effects of BOD on groundwater occur when groundwater discharges to the wider environment, in this case to the Ruamahanga River, or to the unnamed water courses through Pain Farm. High BOD causes a reduction in dissolved oxygen, leading to anaerobic conditions, mortality of river flora and fauna, and growth of undesirable flora and fauna.

Both Stages: As described in 8.4.1 above, the BOD added to the soil is expected to be ameliorated by the soil due to the low average rate of application of up to 1.1 kg BOD/ha/day and maximum event rate of 6.1 kg BOD/ha/event. BOD entering groundwater will be negligible and the effect of BOD on groundwater is expected to be less than minor.

8.6.2 Effects of Nitrogen on Groundwater

Potential adverse effects of nitrogen on groundwater in this situation would become apparent when groundwater enters surface water, or when it is abstracted from a bore for use.

Stage 1: During Stage 1 the discharge of wastewater to the MWWTP adjacent land is expected to be at a rate which may result in some leaching of N. On average 177 kg N/ha/yr will be applied evenly over the site per year. An additional 123 kg N/ha/y may be applied discretionarily as fertiliser to maximise plant growth. The shallowest measured depth to groundwater over the site is more than 4 m below ground level. Based on the average total N in wastewater of 27.1 g/m^3 and average yearly discharge to the site of 52,731 m^3 the adopted deferred irrigation regime (i.e. irrigating when soil conditions are suitable) is expected to maximise uptake of N. Fertiliser applied N may result in short term flushes of N through the soil, however this will be minimised by adopting best practice for nutrient application (NZFMRA, 2007). Assuming no grazing of animals occurs on the site an average drainage N concentration of 3 mg/L is considered to be the maximum expected from the site.

At the proposed drainage N concentration the yearly N loss from the site would be 212 kg N. Taking into account the total area of the site (8 ha) the losses are equivalent to 27 kg N/ha/y. This value is comparable to surrounding land uses and therefore the effects due to N on groundwater beneath the site are considered to be no more than occurs from permitted land uses.

In addition there are not considered to be any downgradient receptors for the groundwater due to its proximity and hydraulic connectivity to the Ruamahanga River. As a result adverse effects due to nitrogen from the proposed activity are expected to be no more than minor for groundwater.

Stage 2a and b: For Stage 2 wastewater will be applied to Pain Farm. The low nitrogen application rate, applied only during conditions which do not favour drainage, ensures that a substantial proportion of applied N will be taken up by plants, sequestered by soil, or volatilised/denitrified.

The low rate application system proposed will ensure that the nitrogen is utilised within the soil. The use of the storage capacity, initially within the existing treatment system and eventually dedicated storage provides assurance that the wastewater can be stored if needed and applied in a manner and at a rate which ensures the effect of nitrogen from wastewater on groundwater is expected to be less than minor.

Where additional nitrogen is applied to meet plant requirements there is an elevated risk of nitrogen being transported to groundwater. The amount lost to groundwater can be minimised by adopting best practice for nutrient application (NZFMRA, 2007). The supply of nutrients and water at a rate to meet plant needs will enable a level of confidence that leaching will not be more than occurs under the surrounding land use that receives fertiliser application.

In addition there are not considered to be any downgradient receptors for the groundwater due to its interception by a surface water course at the property boundary. Movement to deeper groundwater is minimised due to the presence of a pan in the soil across the site. As a result adverse effects due to nitrogen from the proposed activity are expected to be no more than minor for groundwater.

8.6.3 Effects of Phosphorus on Groundwater

Potential adverse effects from phosphorus occur when groundwater enters surface water, under which conditions it can contribute to eutrophication. Due to plant uptake and the occlusion of minor amounts of P by the soil, it is anticipated that P entering groundwater as a result of the wastewater application system will be negligible and the effect of P on groundwater will be less than minor at both sites (MWWTP adjacent and Pain Farm).

Both Stages: The hydraulic application rate of the wastewater will be sufficiently low at both sites to avoid a high rate of leaching through the soil profile to the underlying groundwater. Therefore the risk of P entering the groundwater is expected to be less than minor.

8.6.4 Effects of Pathogens on Groundwater

Potential adverse effects from pathogen contamination of groundwater arise from the risk to human and animal health. As described in Section 8.4.4 above, most applied pathogens perish within 10 mm of the soil surface.

Both Stages: The likelihood of pathogens entering the groundwater from the site is low as a result of the wastewater application rates proposed, and the already well treated wastewater. This is due to the fact that there is a relatively low level of pathogens in the wastewater and the soil profile should remove the great majority of the pathogens present in the wastewater. It is expected that the effect of pathogens from the discharge on groundwater will not be more than minor.

8.6.5 Effects of Water on Groundwater

There is the potential for over-application of water to lead to localised elevation of the groundwater table known as mounding. Mounding influences the flow direction and rate of shallow groundwater movement. Some drainage to groundwater in excess of the natural drainage from the MWWTP adjacent site, and from Pain Farm is predicted. Drainage in an average year will increase from a predicted 497 mm to 1,337 mm (increase of 840 mm) for the MWWTP adjacent site **(Stage 1)**. For Pain Farm **(Stage 2a and b)** drainage in an average year will increase from a predicted 459 mm to 731 mm (increase of 272 mm).

Stage 1: For the MWWTP adjacent site on average the depth of water that reaches groundwater is equivalent to 2.3 mm day. The underlying aquifer (the Ruamahanga River aquifer) has a direct hydraulic connection to the Ruamahanga River. With a transmissivity in the range of 3,000 m^2/d – 6,000 m^2/d the addition of this depth of water is expected to be undetectable and to not cause cumulative effects. Effects of water from the discharge on groundwater are expected to be negligible.

Stage 2a and b: For Pain Farm (Stage 2) the low annual application rate planned (1 mm/d) and a peak of up to 9 mm/event, is expected to ensure that through-flow is minimised. The water which drains from Pain Farm is likely to be intercepted by a pan in the soil and to be moved laterally into surface water rather than draining downward to the Martinborough Terrace aquifer. Adverse effects of the application of water on the groundwater will be not greater than minor.

8.7 Effects of the Discharge on Surface Water Quality

The Ruamahanga River is the largest surface fresh water body in the vicinity of the land application area. There are no surface waterways passing through the MWWTP adjacent land. There are several small ephemeral waterways which travel Southeast to Northwest across the Pain farm site to a permanent waterway which is a tributary of the Ruamahanga River.

Both Stages: The proposed low rate of discharge to land and proposed buffer setbacks to surface waters is intended to minimise impacts on the surface water environment for the land discharge area. Further, the use of a land discharge will result in a reduction of over 20 % of the direct discharge (in Stage 1) and therefore contaminant load to the surface water environment (Ruamahanga River). Over the course of the consent the amount discharged to river will reduce to no discharge for nine out of ten years. The impact of removing the discharge and applying to land is significantly greater due to the focus on removing the discharge from surface water at low flows. This is discussed in further detail in the consent master document.

8.7.1 Effects of BOD on Surface Water Quality

The potential adverse effect of BOD on surface waters is a reduction in the dissolved oxygen content of the water. This leads to stress on the ecosystem and mortality of river flora and fauna. Reducing conditions may occur in the sediment, leading to release of nutrients into the water.

As discussed in Section 8.4.1 above, the soil of the site is expected to assimilate the applied BOD, and it is unlikely that the discharge will lead to any deterioration in water quality in surface water. The effects of BOD from land treatment of wastewater on surface water are expected to be not more than minor.

8.7.2 Effects of Nitrogen on Surface Water Quality

Potential adverse effects of nitrogen on surface waters may include:

- Excessive growth of nuisance aquatic plants;
- Reduction in dissolved oxygen;
- Alteration of river flow due to blockage by macrophytes;
- Change in biodiversity; and
- Reduction in recreation amenity.

Both Stages: As described in Section 8.4.2 above the applied nitrogen from the land application areas is expected to be removed by the soil and pasture. If the applied nitrogen is not retained in the soil, in a form able to be taken up by plant or microbes, for long enough to be occluded by soil microbes or plants then, there is potential for nitrogen containing drainage water to enter surface water. The wastewater will be applied in a manner which results in no overland flow and so any nitrogen from the land application area will enter the surface water environment via groundwater.

Expected nitrogen loss from the sites in drainage is described in Section 8.5.2 above. As indicated the nitrogen entering surface waters due to application of wastewater and additional fertiliser is unlikely to be detected over and above the current land use-induced background. In addition, application of wastewater to land will reduce the direct discharge of wastewater to surface water. Correspondingly the mass loading of nitrogen to surface water will be lower. It is expected that the application of wastewater to land will have a net positive effect on nitrogen mass loading in the Ruamahanga River and therefore the potential for adverse effects due to the discharge is negligible.

8.7.3 Effects of Phosphorus on Surface Water Quality

Potential adverse effects of phosphorus on surface waters are similar to those described for nitrogen. Due to plant uptake and soil occlusion, it is anticipated that phosphorus entering surface waters from the land application system will be negligible. Thus the effect of wastewater-applied phosphorus on surface water from Stages 1, 2a and 2b will be less than minor.

8.7.4 Effects of Pathogens on Surface Water Quality

The presence of pathogens in surface water is an indicator of contamination. The potential adverse effects of pathogens in surface water are a risk to human, animal and ecosystem health, and a reduction in recreational amenity.

As described in Section 8.4.4 above, most applied pathogens are attenuated within 10 mm of the soil surface, so they are not expected to enter groundwater, much less surface water.

It is expected that the effect of pathogens from the discharge to land for Stages 1, 2a and 2b on surface water will be less than minor and most likely de minimus.

8.7.5 Effects of Water on Surface Water Quality

While discharged water itself may be regarded as having negligible effect, it is as a vector for the conduit of contaminants from the application site to surface water that applied water needs to be considered. Over-application of wastewater has the potential to cause through-flow to groundwater, or surface ponding and run-off, either of which could lead to the transport of contaminants into surface water.

The planned wastewater application to land is to be at a rate that will minimise through-flow to groundwater, and will prevent any direct surface flow. Thus the effect of applied water on surface water for Stages 1, 2a and 2b may be considered to be less than minor.

8.8 Effects of the Discharge on Habitats

The habitats of trout, indigenous fish species, macroinvertebrates and periphyton in the Ruamahanga River are unlikely to be affected by the proposed discharge to land. The discharge of the wastewater at a suitable rate for the soil type increases the absorption, treatment and utilisation of applied contaminants from the wastewater within the site. The land treatment of wastewater is unlikely to affect the ecology of the local environment. The removal of wastewater from the surface water environment, in particular during low flow conditions, is expected to have a net positive effect on surface water habitats for all stages (Stage 1, 2a nad 2b).

8.9 Effects of the Discharge on Amenity, Community, Cultural and Heritage Values

The Mauri of Ruamahanga River is of relevance and significance to Iwi. The river provides a visual amenity for members of the public recreating in, on, and alongside it. There is no particular heritage value identified in the immediate locality, or that could be affected by the proposed discharge to land.

The discharge of wastewater to land is considered to not have an adverse effect on the Mauri of the surface water environment. By reducing the discharge to the Ruamahanga River, its Mauri is acknowledged, and as the system moves to a full time land discharge the Mauri of the Ruamahanga River will be protected. The adoption of a discharge rate tailored to the soil types of each site reduces the likelihood of contaminants reaching groundwater or surface water, so amenity and community values are unlikely to be affected to more than a very minor extent.

The application sites are to be established near adjoining properties, as listed in the consent master document, and this could be considered to affect community and amenity values. However, the adoption of separation distances in accordance with district plan rules help to ensure that any effect of the discharge on the amenity and community values of the neighbouring properties is expected to be less than minor.

8.10 Effects of Land Discharge on Air Quality

The irrigation of wastewater has the potential to release odour and aerosols into the air that can travel and affect people beyond the irrigation area. However, as the wastewater will be aerobic there is not expected to be a release of odour. It is proposed that the irrigation lines will be flushed following periods greater than 21 days of no irrigation. Pathogen transport by aerosols will be mitigated by the use of UV treatment at the WWTP.

Other preventive measures will be that the land application areas will have a 25 m surrounding buffer zone. As is typical for modern wastewater irrigation schemes, automatic shut-down of the irrigators will occur when wind gusts 12 m/s or higher are detected. When wind conditions with sustained wind speeds of 4 m/s for more than 15 minutes occur it is proposed that a buffer to the property boundary of 125 m will be enacted. Management of the system under these wind speed limits can be automated. This will not compromise the ability of the scheme to discharge when soil conditions are suitable since only 2 hours per day are required to discharge the daily maximum application rate sustainably. The wind speed shut-down enables discharge to be targeted to low wind conditions.

The effects are considered likely to be no more than minor at the property boundary. This is supported by other land based wastewater application systems around the country which can and have operated with limited odour and aerosol problems.

8.11 Summary of Effects of Land Discharge

The proposed loading rate of the wastewater discharge to the MWWTP adjacent site (Stage 1) and to Pain Farm (Stage 2a and 2b) will enable soil remediation and plant uptake of applied contaminants including:

- Filtration and incorporation of TSS;
- Assimilation of BOD;
- Plant uptake, microbe use, and soil occlusion of nitrogen and phosphorus, and gaseous loss of nitrogen;
- Filtration and attrition of pathogens; and
- Water application to the plantation site will occur at such times and rates as to avoid ponding or run-off.

The discharge of municipal wastewater to land is expected to have effects on the receiving soil, shallow groundwater, the Ruamahanga River, and on water quality, habitat values, amenity, community, cultural and heritage values and air quality that are not more than minor. No adverse effect from the discharge has been identified that is more than minor.