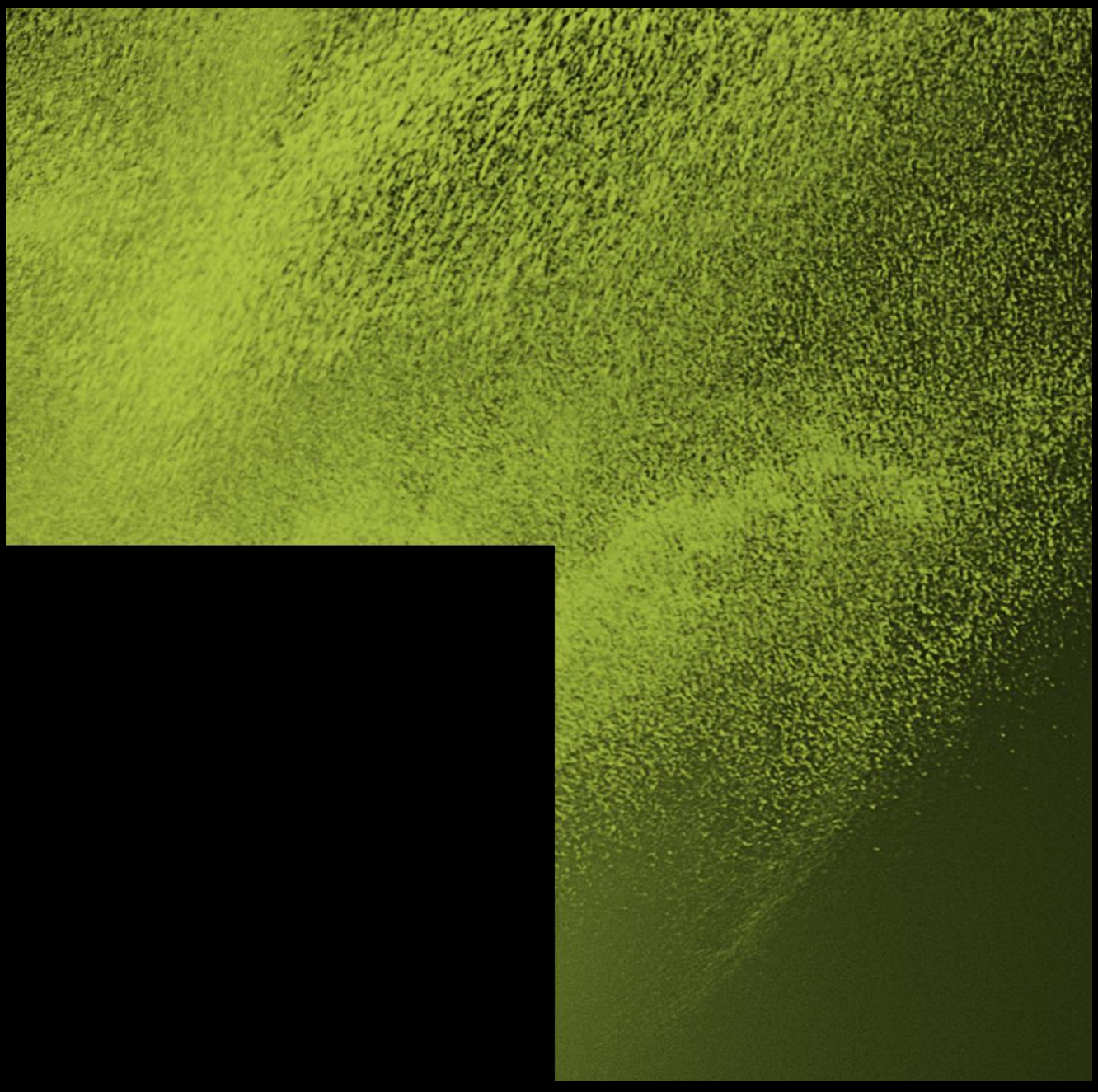
MANGAWHAI WASTEWATER SCHEME

Potential Effluent Disposal Options

Kaipara District Council



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EXECUTIVE SUMMARY

INTRODUCTION

Harrison Grierson has been engaged by Kaipara District Council (KDC) to carry out an independent review of the Effluent Disposal options (a "Fresh Look") for the communities of Mangawhai and Mangawhai Heads. Optimal expansion of the system capacity with minimal capital expenditure is very important to Council.

The scope of this report does not include a review of the capacity or adequacy of the existing Wastewater Treatment Plant (WWTP).

The existing disposal system at the Lincoln Downs Farm (Brown Road) consists of a 170ML storage lagoon, effluent pumping station and approximately 25ha of existing irrigation. The irrigation area has the ability to be increased to 60ha or possibly 65ha. When the scheme was initially envisaged, it was intended to continue to operate the farm as a working dairy farm. The dairy equipment has since been removed from the farm, and the grass is currently cut to waste, or grazed by dry stock between irrigation periods. As a result, the farm operates at a substantial loss.

LAND IRRIGATION OPTIONS

In late 2013, a number of organisations had expressed potential interest in using the treated effluent;

- Mangawhai Golf Course, near the WWTP indicate that though they are currently not in a position to irrigate effluent on the golf course, they would be keen to use effluent in a wetland area.
- Te Arai Golf Course in the planning/construction phase (serving a high end residential development). As it is located approximately 10km from the nearest point on the effluent pipeline, it is unlikely to be viable due to the distance
- Tovolea Farms (Mr Bill Bygraves) – this family owns several farms nearby to the Lincoln Downs Farm, however, they indicate that they are currently not able to irrigate effluent, following initial discussions with Fonterra.

EFFLUENT QUALITY

The WWTP, consisting of an SBR with tertiary filtration and disinfection, produces a relatively high quality treated effluent, with low suspended solids, BOD_5, Nitrogen. Effluent is then pumped 10km to a storage lagoon at the Lincoln Downs Farm. The WWTP effluent *e-coli* count is typically less than 1 MPN/100mg, however, the lagoon e-*coli* is not as good, with an average over 600 MPN/100mg.

Fonterra's current policy for the irrigation of treated human effluent to pasture grazed by lactating dairy cows is based on California Law Title 22, which in summary, states the 7 day median total coliforms shall not exceed MPN 23 *Total cfu*/100ml.

Based on current records, the current WWTP effluent quality is unlikely to consistently be of a quality that would enable irrigation at a dairy farm supplying Fonterra.

POSSIBLE DISCHARGE TO NATURAL WATER

Council has specifically requested that water discharge options be explored in this study, at high level. Several potential locations for a partial (seasonal) water discharge have been identified:

- The estuary adjacent to the WWTP,
- The estuary near the main harbour or the harbour mouth or the ocean.
- The Hakaru River or Cook Creek, along the pipeline.

- A Wetland at the Mangawhai Golf Course

All of the options could present some challenges in obtaining a resource consent. If able to be consented, for the estuary or harbour mouth options, discharge would be likely to be restricted to the high or outgoing tide. For the river discharge, a possible flow-proportional discharge when the river is flowing at elevated levels would be most likely.

An Assessment of Environmental Effects (AEE) process would be required to demonstrate that the effects were no more than minor.

The likely advantages of a discharge to water would be:

- Discharge during wet periods when irrigation is minimal.
- Possibly greater discharge during wet years, assisting the scheme economics.
- Reduced storage requirements.
- Relative social acceptability when compared to very high land disposal costs.

Some options would allow discharge from a short extension to the existing effluent pipeline, for instance where the pipeline crosses the Hakaru River.

EFFLUENT IRRIGATION MODELLING

The existing farm irrigation and conceptual irrigation extensions have been modelled by BMT WBM Pty Ltd. Their conclusions are "In the current operational mode, the site is being significantly over irrigated and this can be observed in the irrigation records." Based on effluent nutrient concentrations and application rates, historical nitrogen loading to the pasture is low compared to demand from a productive pasture. It is possible that water uptake of pasture could be improved through further provision of nitrogen.

This indicates that if the current irrigation area was to be operated according to deficit irrigation criteria, a larger area would be required, as stated, "*...if deficit irrigation is to be continued with a largely unmanaged pasture, the full 60ha of irrigation will be needed soon with additional land or discharge to water likely to be essential somewhere between 2024 – 2035*".

DISCUSSIONS

Of all options, the land disposal options would be most readily consented.

The primary issue with all land disposal only options is that rainfall is highest in the winter season, when evapotranspiration is lowest. There is much more potential for effluent irrigation during summer, when rainfall is generally lower and evapotranspiration is highest. This necessitates a large volume of winter effluent storage.

The seasonal imbalance is exacerbated during wetter than normal years, particularly if there is a wet autumn/spring.

Twelve broad high-level options costed are:

Option 1 - Lincoln Downs Farm and other areas - Deficit Irrigation

Increase area at Lincoln Downs Farm and other areas with deficit Irrigation. A large area (80ha) would be required in addition to the 65ha at Lincoln Downs Farm. This option would not eliminate either over-irrigation or overtopping of the storage lagoon during very wet years.

Option 2 - Lincoln Downs Farm - Maximised deficit Irrigation

Increase area at Lincoln Downs Farm and change irrigation to maximise deficit irrigation by harvesting and maximising growth. It has been assumed cutting and baling equipment would need to be purchased to ensure harvesting is not delayed by competing farms.

Option 3 - Lincoln Downs Farm - combination of Deficit Irrigation, Maximised Irrigation and Subsurface Drip LTS

Increase area at Lincoln Downs Farm using a combination of deficit irrigation, maximised high-performance deficit irrigation and Slow Rate Land Treatment System using Subsurface Drip Irrigation (SDI). The subsurface drip would operate all through the year offering greater disposal. Cropping and harvesting of the maximised and SDI has been assumed.

Option 4 - Ocean Outfall (no irrigation)

All WWTP effluent would be discharged to an ocean outfall. Irrigation to Lincoln Downs Farm would not be continued.

Option 5 - Harbour Mouth Outfall (no irrigation)

All WWTP effluent would be discharged to an outfall at the harbour mouth from high tide for up to 4 hours. Irrigation to Lincoln Downs Farm would not be continued.

Option 6 - Mid-Estuary Outfall and Irrigation

Discharge would be on outgoing tide, May to October only, to avoid discharge when recreational use is highest. The discharge would be of higher quality WWTP effluent only.

Option 7 - Upper-Estuary Outfall and Irrigation

Discharge would be on outgoing tide, May to October only to avoid discharge when recreational use is highest. The discharge would be of higher quality WWTP effluent only.

Discharge would have a high impact on the estuary, so quality would be an issue.

Option 8 - Hakaru River Discharge and Irrigation

Discharge to the Hakaru River when the river is high in proportion to flow to minimise effects. Only the WWTP effluent would be discharged, not the lagoon effluent.

To maximise the potential effluent discharge, the effluent storage tank volume could be increased in later stages of development, to allow a prolonged high rate of pumping of treated effluent during and after storm events, to use the high dilution available.

Option 9 - Golf Course and Irrigation

Wetland discharge, initially 160m^3/d all year round, rising to 320m^3/d in Stage 3. Possible irrigation of fairways by the Golf course during drier summer months.

Pipe will supply water to the Constructed wetland inlet. Effluent will flow through the lined constructed wetland of 1 day minimum retention, then be mixed with surface water from the Golf Course, and discharge the combined flow into the natural wetland.

This option will also require some expansion of irrigation at the Lincoln Downs Farm.

Option 10 - Golf Course, Hakaru River Discharge and Irrigation

Wetland discharge, initially 125m3/d all year round, rising to 250m3/d in Stage 3

Possible irrigation of fairways by the Golf course during drier summer months

Pipe will supply water to the Constructed wetland inlet. Effluent will flow through the lined constructed wetland of 1 day minimum retention, then be mixed with surface water from the Golf Course, and discharge the combined flow into the natural wetland.

Discharge to the Hakaru River when river is high. Store water in tank at WWTP until river is high, then discharge over a few days. Discharge of WWTP effluent only.

Conceptually, this option will not require any expansion of the irrigation at the Lincoln Downs Farm.

Option 11 - Golf Course and Hakaru River Discharge (no irrigation)

Discharge to the Hakaru River when river is high. Store water in tank at WWTP until river is high, then discharge over a few days. Excess effluent would be stored in the Lincoln Downs Farm lagoon when the river is unable to accept discharge, and later filtered, disinfected and discharged when river flows are higher.

Wetland discharge, initially 210m^3/d all year round, rising to 420m^3/d in Stage 3

Possible irrigation of fairways by the Golf course during drier summer months

A pipe will supply water to the Constructed wetland inlet. Effluent will flow through the lined constructed wetland of 1 day minimum retention, then be mixed with stormwater from the Golf Course, and discharge the combined flow into the natural wetland.

The basis of this option is that it will not require any irrigation at the Lincoln Downs Farm.

Option 12 - Golf Course Only (no irrigation)

Wetland discharge, initially an average of 375m^3/d, rising to around 650m^3/d during the summer peak period (2-3 weeks). In Stage 3, the average discharge to the wetland would be 640m^3/d, rising to around 1,000m^3/d, during the summer peak.

There could be possible irrigation of fairways by the Golf course during drier summer months

A pipe will supply water to the Constructed wetland inlet. Effluent will flow through the lined constructed wetland of 1 day minimum retention, then be mixed with stormwater from the Golf Course, and discharge the combined flow into the natural wetland.

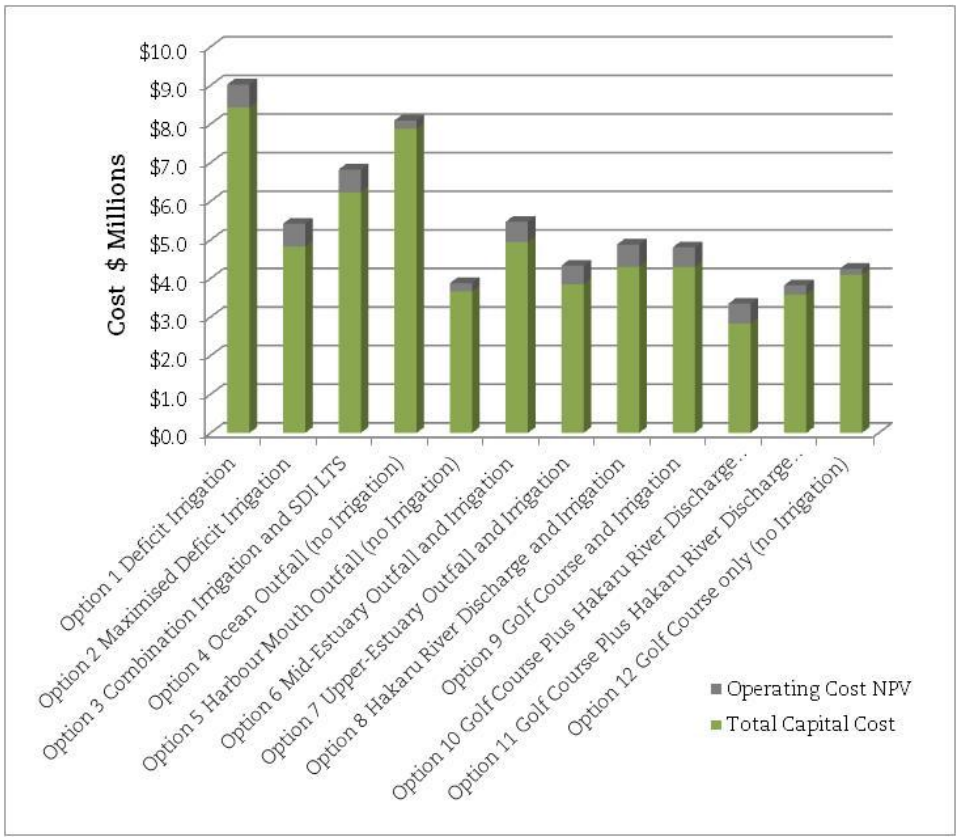
The basis of this option is that it will not require any irrigation at the Lincoln Downs Farm.

COSTS AND MULTI-CRITERIA ANALYSIS

It should be noted that all estimates are broad-brush "order of" comparative estimates only, for the purposes of assisting Council to determine the best way forward from here. The estimates should **not** be relied on for capital works budgetary purposes at this stage. Further more detailed cost estimates need to be carried out for selected options to arrive at more reliable costs for budgeting purposes.

Refer to the report for the full details of the inclusions and exclusions in the cost estimates. Land sale and purchase, consenting and consultation is not included.

Broad-brush capital and operating cost preliminary estimates have been carried out, and an NPV analysis. Following this, a Multi-Criteria Analysis matrix was used to determine the best overall options and eliminate the least satisfactory options. The results are shown graphically below.



Short List of Favoured Options

The most favoured Options are Options 9, 10 & 11.

Second ranked would be Options 5 and 8.

RECOMMENDATIONS

- Further investigation be undertaken into Options 5, 10 and 11, due to favourable cost and reasonable non-price attributes.
- Investigate the potential future value of the Lincoln Downs Farm for possible future resale (by Kaipara District Council), and hence potential reduced cost for Options 5 & 11.
- Options 8 & 9 may warrant further investigation

Refer to the report for further recommendations.

1.0 INTRODUCTION

Harrison Grierson has been engaged by Kaipara District Council (KDC) to carry out an independent review of the Effluent Disposal options for the communities of Mangawhai and Mangawhai Heads.

The scope of this report does not include a review of the capacity or adequacy of the existing Wastewater Treatment Plant (WWTP).

FIGURE 1: Mangawhai General Location - Source: NZ Topo, Crown Copyright Reserved

Harrison Grierson has had no involvement with the project previously, and is approaching this study in a fresh, independent manner.

The project brief is included in **Appendix 1.**

2.0 BACKGROUND

It is well known that the original project was fraught with considerable cost overruns. Our brief is to develop options for optimal expansion of the system capacity with minimal capital expenditure, which is important to Council. Harrison Grierson and BMT WBM have teamed up to achieve this for Council.

From discussions with Council the following information has been obtained:

The project was initially to be a BOOT scheme, but as this could not legally be done by Council, it was renegotiated to a Design-Build, Finance and Operate contract.

Water Infrastructure Group (WIG), (initially Earth Tech) completed the project, and are now in a 10 year operation period, which ends late 2019, with one possible extension of 5 years.

KDC own the infrastructure, including the Lincoln Downs Farm at Brown Road. This property has 200ha, of which 60-65ha is suitable for irrigation, currently about 25ha is irrigated. The property was a former working dairy farm, but it is now just operated as a dry stock farm and all of the dairy equipment has been removed.

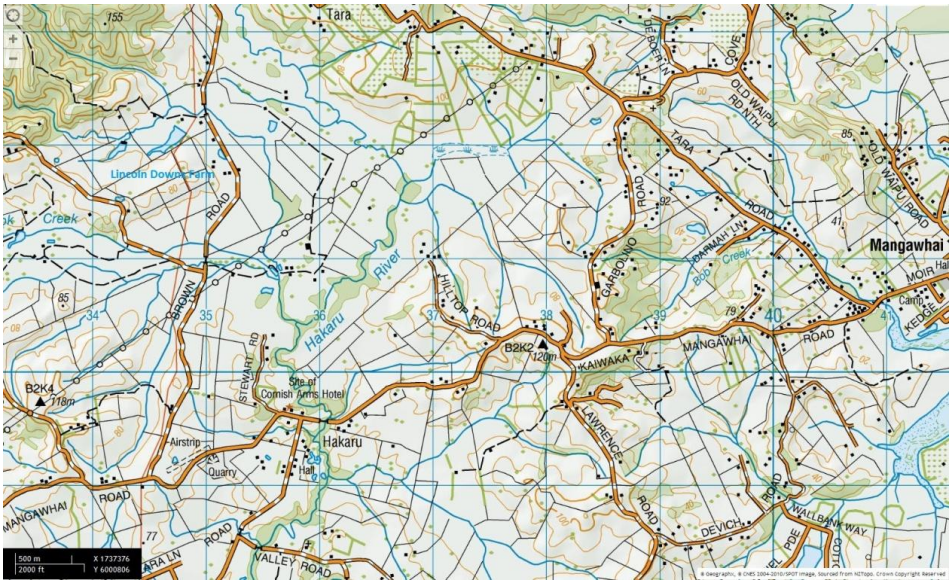


FIGURE 2: Mangawhai (Right), Brown Road, Lincoln Downs Farm (Left), - Source: NZ Topo, Crown Copyright Reserved

KDC has a variation to the resource consent to change the type of irrigation from "deficit" irrigation (which does not lead to runoff) to "irrigation to runoff", where runoff may occur when required in a wetter-than-normal season.

The summer of 2011/2012 was too wet to irrigate, in April/May, the irrigation approach was changed to irrigation to runoff.

KDC want a "Fresh look" at options for increasing the effluent disposal capacity. There are three potential organisations that could be willing to take the effluent;

a) Mangawhai Golf Course, 50ha.

b) Te Arai Golf Course (high end residential development, in the planning/construction phase). In Auckland Council are.

c) Tovolea Farms Ltd (Mr Bill Bygraves) – this family owns several farms nearby.

d) There could be others.

KDC would need an agreement with certainty – a real commitment from any third party to take water for the long term.

An option is to extend the irrigation on the Lincoln Downs farm. There is a ring main around some of the paddocks. The farm has above ground irrigators mounted on wooden posts. Some have been broken by cattle. If the ground gets too wet (by irrigation to runoff), pugging of the soil will occur.

The Mangawhai sewer reticulation is a mix of pressure and gravity. There is not much infiltration, but there is inflow, when the rainfall intensity is > 25mm/hr ingress goes up, and above 45mm/hr, it results in a very high inflow at the WWTP!

Water supply for Mangawhai is serviced by water tanks and some bores, and there are currently no plans to provide a community water supply in the future.

In the new District Plan there were new Fire service standards adopted. This means if anyone builds, they have to provide fire storage tanks.

Growth in Mangawhai is currently slow and there are approximately 500 - 600 sections ready to be built on. There are currently only around 50 houses per year being built in Mangawhai.

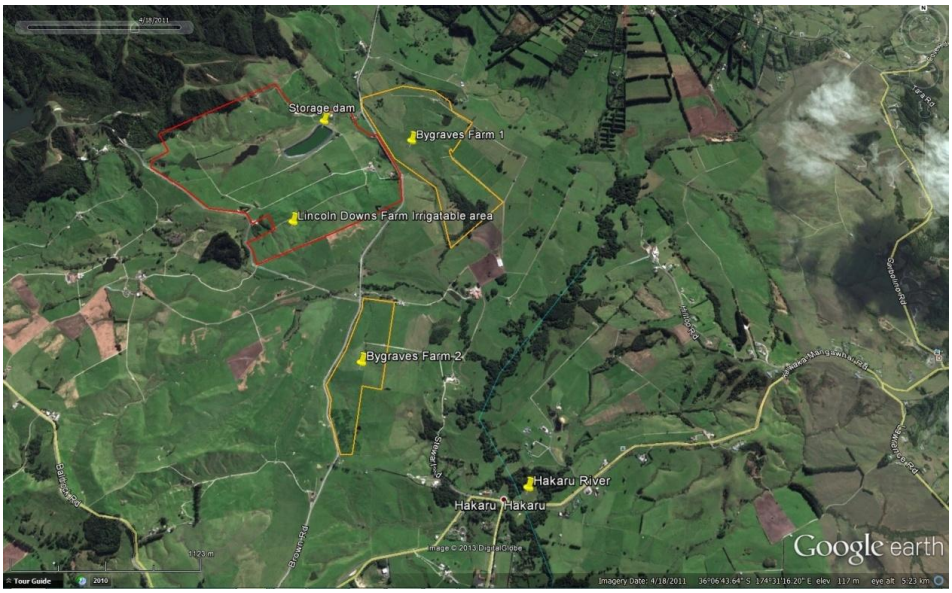


FIGURE 3: Location of Lincoln Downs Farm (Top Left), Bygraves Farm, and Hakaru River. Mangawhai is to the east. - Source: Google Earth

Council completed a spreadsheet of flows and future growth, ultimately up to 4,500 connections. For the purposes of this report, Council is looking at potential sections in the zoned area (ultimate).

There are currently 1600 connections to the scheme (December 2013) with approximately 500-600 vacant sections and a future potential of up to 4,500 connectable lots.

The WWTP is of a modular construction, and can be expanded, by adding another cell in the future. The scope of this report does not include expansion of the WWTP.

The capacity of the DN200mm PVC pipeline from the WWTP to the Lincoln Downs Farm is approximately 70L/s design flow. Current daily flows are typically 250 m³/d (200 m³/d (drought), and up to 1000-1200 m³ /d around Christmas/New Year period.

Prior to harvesting the grass crop, a rest period is needed after irrigation. Grass is simply cut to waste at present.

No Lidar is available for the area, only in the built-up areas.

Some soils information, including permeability tests, and/or geotechnical borelogs is available from previous reports. At this stage, further investigations are not envisaged.

Council are interested in considering discharges to natural water as an option. Potential options for effluent discharge to natural water are:

a) Estuary near plant

b) Main Mangawhai estuary

c) Ocean Outfall

d) Creek, Hakaru River

e) Wetland

Council also wish to include options that result in the Lincoln Downs Farm no longer being required and possibly sold to defray further costs.

These will be discussed later in the report.

2.2 LIST OF PREVIOUS REPORTS

The following reports were provided to Harrison Grierson, listed in date order.

- Mangawhai Treated Effluent Disposal – Assessment of Land Disposal Options, URS New Zealand Limited, March 2006
- Mangawhai EcoCare Project Hydrogeological Investigastion – Water Reuse Area, Tonkin & Taylor, September 2006
- Mangawhai EcoCare Project - Assessment of Treatment & Disposal Options, Earth Tech Engineering Pty Ltd, March 2007
- EcoCare Mangawhai WWTP- Design Report, Water Infrastructure Group, April 2009 (extract only provided, page 3, Design Flows and Loads)
- Eco-Care Irrigation Shceme Operators Manual – Stage 1 Works, Water Force, 6 December 2009
- Kaipara District Council, Mangawhai EcoCare Project
  Environmental Management Plan – Lincoln Downs
  Amended Final Report, RMCG Consultants, Bendigo, Victoria April 2010
- Resource Consent CON 20121496901, Granted to Kaipara District Council and Water Infrastructure Group, Northland Regional Council, November 2011
- Soil Analysis for Brown Road Irrigation Plan, Author not stated, 14 December 2011

3.0 EXISTING TREATMENT AND DISPOSAL SYSTEM

The existing WWTP consists of fine screens, a dual SBR aerobic treatment plant, packaged pressure sand filters followed by chlorine dosing. UV disinfection equipment is also provided, though is currently not used due to maintenance issues with cleaning and replacement of the lamps.

FIGURE 4: Mangawahi Wastewater Treatment Plant off Thelma Road (top centre) - Source: Google Earth

The treated disinfected effluent is stored in a covered 400m^3 storage tank, and then pumped by high head centrifugal pumps via a 10km long pipeline to a 170ML lined storage lagoon at the Lincoln Downs Farm (Brown Road).

FIGURE 5: Effluent Storage Lagoon, Lincoln Downs Farm - Harrison Grierson

At the Lincoln Downs Farm, an effluent pumping station conveys the stored lagoon effluent to approximately 25ha of existing irrigation. The irrigation area can be increased to at least 60ha, and possibly to 65ha. Although the total area of the farm is 200ha, large parts of the farm are not suitable for irrigation (too steep, or covered in bush).

FIGURE 6: Lincoln Downs Farm – Typical Pole-mounted Irrigators - Harrison Grierson

The WWTP produces a relatively high quality tertiary treated effluent, with average suspended solids of 3.4mg/L, $CBOD_5$ of 3.1mg/L, Total Nitrogen of 13.6mg/L and Total Phosphorus of 8.9mg/L. The Total Dissolved Solids average 390mg/L.

The WWTP effluent *e-coli* are typically less than 1 MPN/100mg, although occasional spikes of up 1700 have occurred. The Lagoon effluent *e-coli* average 619 MPN/100mg, with spikes of up to 3600. Further influent and effluent data are given in **Appendix 2**.

When the scheme was initially envisaged, it was intended to continue to operate the Lincoln Downs farm as a working dairy farm. However, due to the deterioration of effluent quality in the open storage lagoon, the effluent quality when irrigated does not meet the Fonterra requirement to comply with California Law Title 22 standards, as identified in **Appendix 4**. The dairy equipment has since been removed from the farm, and the farm was intended to be operated as a dry-stock farm. However, we understand that the grass is currently cut mainly to waste or periodically grazed to control pasture height. This results in significant operating costs, with little or no revenue, and as a result the farm operates at a loss.

4.0
EXISTING AND PROJECTED POPULATION AND FLOWS

Population and flow projections are based on Kaipara District Council rates projections of the number of rateable properties, as given in Council's 10 Year Plan. Beyond this, two growth scenarios are considered, a high growth at 2.5% p.a. and a conservative growth rate of 1.5% p.a. these growth scenarios are depicted in Figure 7 below.

At the time of this study, there were approximately 2100 rateable properties, of which 1622 were connected to the scheme, producing an annual average flow of 300 m^3/day. The graphs and figures in this report are based on connected properties that contribute wastewater to the system. The population varies considerably during the year, as a high proportion of properties are not permanently occupied (holiday homes).

For the purposes of this study, a 30 year growth period at the higher growth rate of 2.5% p.a. is used, which results in 3460 connected properties in 2044, and a predicted future flow of 640 m^3/day.

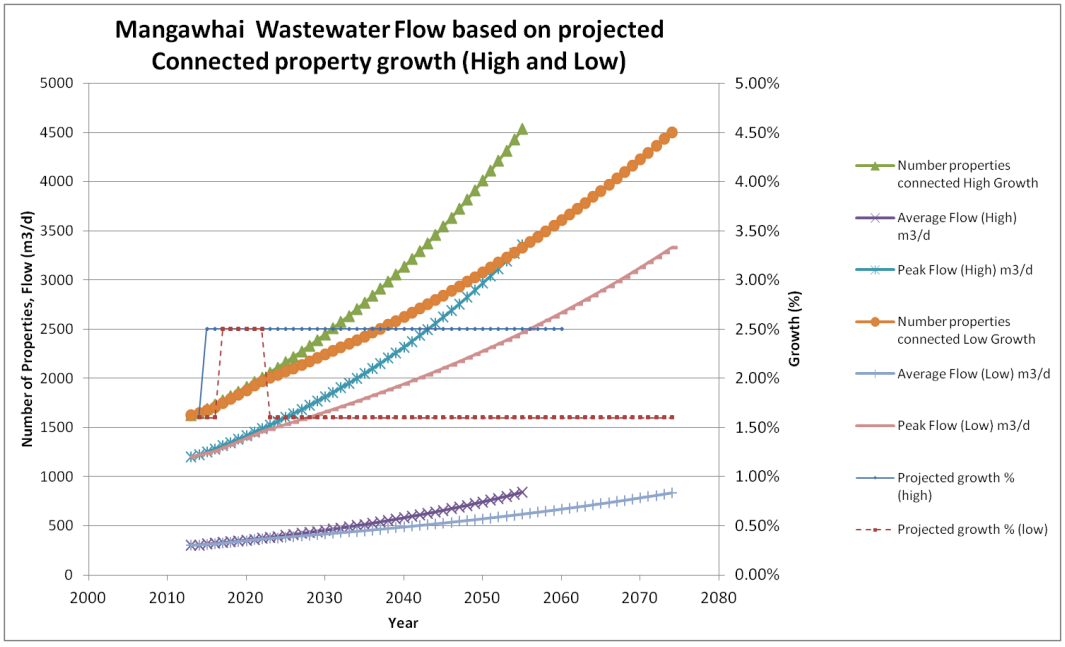


FIGURE 7: Mangawhai Growth Projections

The annual average wastewater flow is assumed to be proportional to the population, as shown in Table 1 and Figure 8.

TABLE 1: MANGAWHAI PROPERTY AND WASTEWATER FLOW GROWTH SCENARIOS

GROWTH PWERIOD	STAGE	NUMBER OF CONNECTED PROPERTIES	AVERAGE FLOW	PEAK FLOW	ANNUAL FLOW	YEAR (LOW GROWTH)	YEAR (HIGH GROWTH)
			m^3/d	(m^3/d)	(ML/yr)		
Current		1622	300	1200	110	2013	2013
Interim Growth 1	Stage 1	2036	375	1500	137	2024	2023
Interim Growth 2	Stage 2	2425	450	1800	164	2035	2030
Interim Growth 3		4180	600	2400	219	2053	2041
Report Horizon	Stage 3	3460	640	2560	234	2057	2044

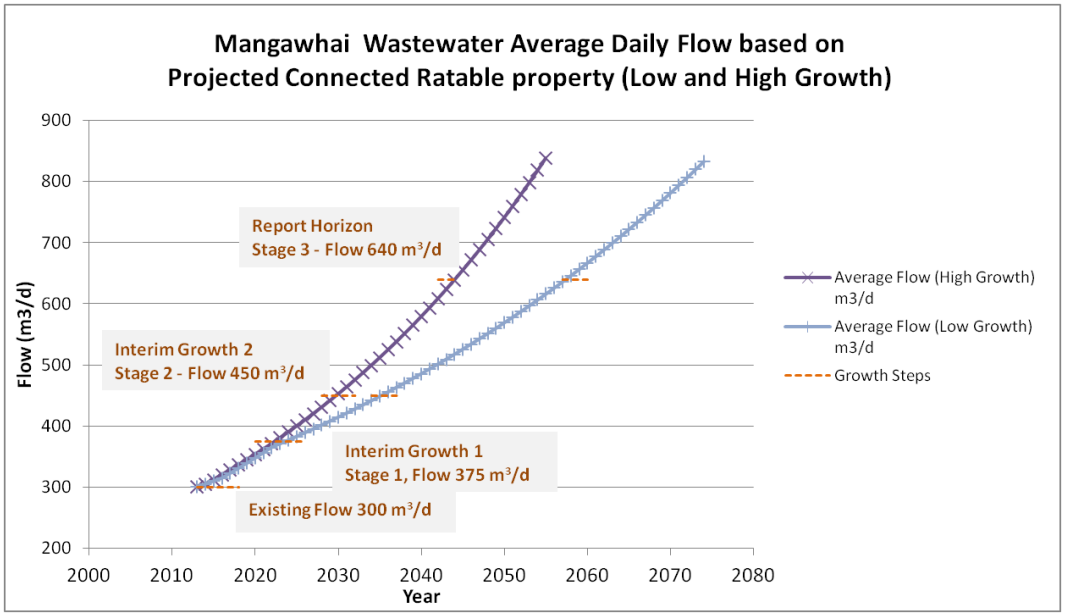


FIGURE 8: Wastewater Flow Projections

The report considers costs for three Growth Periods, Interim Growth 1 (Stage 1), Interim Growth 2 (Stage 2) and the Report Horizon (Stage 3).

5.0 EFFLUENT IRRIGATION MODELLING

5.1 BASIS OF MODELLING

The existing farm irrigation and conceptual irrigation extensions have been modelled by BMT WBM Pty Limited, and their report is attached in **Appendix 3**. Note that the system has been modelled to operate as a "Deficit" irrigation system, defined as the application of water below full crop-water requirements (evapotranspiration), except when irrigation to runoff may be carried out to avoid overflow of the effluent storage lagoon. Comments from this report are shown below in *italics*.

The modeller has noted the following comments in relation to the existing irrigation system;

- *"Details of any water balance modelling completed as part of the design and consent of the scheme are not provided. The assumptions surrounding the irrigation capacity of pasture, woodlot and golf course are difficult to validate but appear optimistic in the current context.*
  (This statement indicates the irrigation area provided is less than that theoretically required to assure a deficit irrigation system).

- *Based on effluent nutrient concentrations and application rates, historical nitrogen loading to the pasture is low compared to demand from a productive pasture. It is possible that water uptake of pasture could be improved through further provision of nitrogen.*

- *The typical irrigation demands for pasture in the region (quoted in the EMP) of 4 (range of 3-5) ML/ha/year are representative of an actively managed pasture being grown for profit through the optimisation of growing conditions (including plant available water, nutrients) and less emphasis on maximising opportunities for irrigation or limiting impacts on receiving waters. This is not reflective of the current operation of Lincoln Downs but may be an option (subject to local advice on fodder production)."*

The points noted above indicate that current irrigation at Lincoln Downs is in excess of that required for plant growth, and not indicative of deficit irrigation. Further comments expand on this conclusion, in particular, the comment on page 4,

> *"It is not possible to achieve 100% reuse (i.e. 0% overflow from the dam) from a deficit irrigation scheme in this climate. It is almost impossible in all but arid environments. In the absence of clear guidelines we have adopted a maximum number of overflows of 3 in 30 years (i.e. 10% of years). This typically achieves 95%+ beneficial reuse in a volumetric sense".*

The only way a zero discharge can be achieved in all years (including wet years) is by allowing significant over-irrigation when climatic conditions and storage limitations place the irrigation system under stress. Provision of more storage is not a viable (or economic) option, as larger storage lagoons only serve to increase the volume of effluent requiring disposal during wet years, due to excess rainfall.

Under a deficit scenario, the key question relates to the ability to cost effectively establish and maintain a more productive pasture that would enable a significant increase in annual irrigation volumes on Lincoln Downs.

Kaipara District Council has attempted to establish more productive pasture in the past, but this has been difficult to maintain and does not appear to be economic in the current location and period. This has been due to the following issues:

- The pasture cannot be irrigated for a period of several days prior to harvesting to ensure the moisture content is acceptable.

- The availability of mowing contractors to carry out the cutting and baling at the optimum time has been problematic in the past. Often, the mowing contractor is busy on other farms when weather conditions are ideal, and may not get to Lincoln Downs before rain occurs, which means a further period of waiting is required before harvest. This results in lost opportunity to irrigate those areas, while waiting for harvesting.
- When conditions are normal, (i.e. not a 'drought') demand for harvested pasture is low, resulting in low demand and little or no return.
- The produce is not able to be used to feed lactating cows supplying Fonterra.

"In the current operational mode, the site is being significantly over irrigated and this can be observed in the irrigation records."

This indicates that if the current irrigation area was to be operated according to deficit irrigation criteria, a larger area would be required, as stated, "*...if deficit irrigation is to be continued with a largely unmanaged pasture, the full 60ha of irrigation will be needed soon with additional land or discharge to water likely to be essential somewhere between 2024 – 2035*".

5.2 SUMMARY OF MODELLING RESULTS

TABLE 2: SUMMARY OF WATER BALANCE MODELLING RESULTS

		EXISTING FLOW	INTERIM 2 STAGE 2	REPORT HORIZON STAGE 3
Flow ADWF	m^3/day	300	450	640
Storage	ML	170	170	170
Deficit Irrigation				
Irrigation Type		Fixed Spray	Fixed Spray	Fixed Spray
Pasture Type		Existing mixed pasture	Existing mixed pasture	Existing mixed pasture
Total Area Required	ha	55	85	145
Excess Volume	ML/yr	-	26	93
Maximised Deficit Irrigation				
Irrigation Type		Fixed Spray	Fixed Spray	Fixed Spray
Pasture Type		High performance pasture	High performance pasture	High performance pasture
Total Area Required	ha	30	43	65
Excess Volume	ML/yr	-	-	-
Mixed Deficit Irrigation and Subsurface Drip Land Treatment				
Irrigation Type 1		Deficit - Fixed Spray	Deficit - Fixed Spray	Deficit - Fixed Spray
Pasture Type		Existing mixed pasture	Existing mixed pasture	Existing mixed pasture
Total Area Required	ha	25	35	35
Irrigation Type 2		Subsurface Drip	Subsurface Drip	Subsurface Drip
Pasture Type		Slow Rate Land Treatment	Slow Rate Land Treatment	Slow Rate Land Treatment
Total Area Required	ha	11	16	29
Excess Volume	ML/yr	-	-	-

The above table shows that significant additional disposal area will be required, unless a highly managed maximised deficit irrigation system is adopted, including optimised

cropping of produce, to maximise evapotranspiration and uptake of nutrients. As described previously, this is problematic at Mangawhai, but will be included as a possible option.

6.0 POTENTIAL ADDITIONAL DISPOSAL SITES

Potential additional disposal site options, both to land and to water, are listed below, together with a brief explanation. All the options and issues associated with each option are discussed in further detail in Section 6 below.

6.1 POTENTIAL LAND DISPOSAL SITE OPTIONS

In late 2013, a number of individuals and organisations had expressed potential interest in using the treated effluent from the Mangawhai Wastewater Treatment plant:

- Mangawhai Golf Course, located near the WWTP.
- Te Arai Golf Course in the planning/construction phase (serving a high end residential development).
- Tovolea Farm Ltd (Mr Bill Bygraves) – his family owns several farms nearby
- Other sites that could be identified.

6.1.2 MANGAWHAI GOLF COURSE

This site has the advantage of being relatively close to the WWTP. An additional pipeline, valves and flowmeter from the WWTP would be required.

Based on the suggested fairway and general irrigation area in the URS report (15ha), (refer Section 2.1), a net effluent uptake of approximately 900m³/d was predicted over the summer months. This could therefore equate to approximately 80-100ML/year depending on weather conditions.

Recent communications with the Golf Course indicate that though they have offered to store effluent in a wetland area, they are currently not in a position to irrigate effluent on the golf course, as per their letter in **Appendix 5**.

FIGURE 9: Mangawhai Golf Course with Mangawahi WWTP (lower centre) source – Google Earth

A meeting was held with the Golf Course committee in June 2014, at which the proposal to utilise the natural wetland area was discussed further and explored on site. The outcome of this meeting was very promising, with the possibility of developing a small constructed wetland which would discharge into the natural wetland.

The golf course considers this to be a benefit in terms of tidying up the area, and providing a permanent water area to enhance the golf course appearance.

This has to be balanced with the fact that, unlike the hill country to the west, the Golf Course is predominantly located on very permeable sandy soil, and any excess effluent will flow into the groundwater, and ultimately end up in the upper Mangawhai estuary.

The quantity of effluent that could be disposed of to the golf course in a sustainable and environmentally acceptable manner would need to be determined by further study and the effects identified by an Assessment of Environmental Effects (AEE) study, and may be significantly lower than that indicated in the URS report.

6.1.3 TE ARAI GOLF COURSE

This golf course is in the planning/construction phase, and the developers have expressed interest in sourcing treated effluent for golf course irrigation from the plant. However, the golf course is located approximately 11.6km from the WWTP and 10km from the nearest point on the effluent pipeline. There would be considerable cost associated with the construction of a treated effluent pipeline over the intervening distance, and a strong case would have to be developed to verify the commercial viability of this option.

Based on preliminary assessment of the golf course development proposals, the golf course covers an area of approximately 250 to 300m wide by 600 to 900m long. Assuming only the fairways would require irrigation, the area could be in the order of 10-15ha, therefore an area of up to 12ha could conceivably be available for irrigation. At similar rates to the Mangawhai golf course, approximately 720m³/d of effluent could be required over the summer months, depending on weather conditions.

FIGURE 10: Location Mangawhai and Te Arai - Source – NZ Topo. Crown Copyright Reserved

An approach has been made to the Te Arai Golf Course, but a reply has not yet been received. However, in view of the distance to the golf course, disposal at this site is not considered to be viable.

6.1.4 TOVOLEA FARMS (BILL BYGRAVES)

Tovolea Farms Ltd owns several blocks of land in the vicinity of Mangawhai with an area in excess of 300ha north of the Kaiwaka-Mangawhai Road. The effluent pipeline route traverses some of this property.

Based on just part of the available land area, and making allowance for buffers and non-farming areas, over 300ML of effluent could potentially be irrigated over the summer months, 20 October to 20 March. This could be at a rate of up to 1,000m³/d.

However, recent communications with Tovolea Farms indicate that they are currently not interested in irrigating effluent, following their initial discussions with Fonterra. This is due to the very strict controls Fonterra need to have over the quality of milk sourced from farms and destined for the international milk products export market.

Fonterra do allow irrigation of appropriately treated human effluent to pasture grazed by lactating dairy cows, and this is discussed further in Section 6.3.

6.2 OTHER SITES

Due to the length of the effluent pipeline, there are a number of farms en-route that could potentially be interested in taking effluent. If the smaller properties are discounted (as the regulatory requirements would render smaller blocks uneconomic) there may be a few properties within a reasonable distance of the pipeline

- K S Freckleton & P I Trappitt- Allotment 253 PSH OF Mangawhai, 67ha.
- D D & B J Wintle, Lot 1 Deposited Plan 205425, 24ha.
- P G Wintle, Lot 2 Deposited Plan 437133, 56ha.

No investigation of these properties has been carried out at this point in time.

6.3 BENEFICIAL IRRIGATION TO DAIRY FARMS

The irrigation of treated effluent to dairy farms could potentially result in a win-win situation where the farm is able to increase milk production due to irrigation over the summer, and the effluent is beneficially reused. However, there are stringent requirements that must be met and potential risks to consider.

A business case would need to be developed to determine if irrigation to dairy farms, or conversion of Council's Lincoln Downs Farm to dairy, is viable. However, in view of the relatively small scale of the operation, and the stringent rules relating to compliance, irrigation to dairy farms is unlikely to be economically viable.

6.3.1 EFFLUENT QUALITY STANDARD

Fonterra was contacted in relation to their current policy for the irrigation of treated human effluent to pasture grazed by lactating dairy cows supplying Fonterra. Their policy is attached in **Appendix 4**, along with extracts from California Law Title 22 documents, on which their policy is based.

The current storage lagoon effluent does not comply with this standard, and would not be suitable for irrigation to dairy farms without significant further treatment, due to bacterial content.

The current treatment plant effluent *may* be compliant with California Title 22 requirements, although KDC do not measure *Total Coliforms* of the WWTP effluent. *E.coli* of

the WWTP effluent is currently measured, with a median value of 1. *Total coliforms* include *e.coli*, and typically would be around 10 times the *e.coli* count.

The California Title 22 requirements stipulate the 7 day median shall not exceed MPN 23 *Total cfu*/100ml, and only one sample per 30 days can exceed the maximum of MPN 240 *Total cfu*/100ml.

The current WWTP effluent is usually <1 *e.coli*, but occasionally exceeds 100, with a maximum of 1733 *e.coli* on 28 Sept, 2012. As *Total coliforms* will be around several times greater than *e.coli*, the current effluent may not consistently comply with the maximum 30 day results. It is not known what could be causing these periodic exceedances.

KDC have commenced sampling and testing for Total coliforms for the treatment plant effluent, and over time this data should show whether the current plant effluent meets California Title 22 requirements.

Effluent quality reliability is important not only for possible compliance with California Title 22, but also for other discharge options.Management Plan

Fonterra state that the applicable district council would be responsible for the production and implementation of an effluent Irrigation Management Plan, which must be independently verified on an on-going basis for Fonterra to consider accepting milk from farms irrigating treated sewage effluent.

6.3.2 RISK MANAGEMENT

In view of the above, there would be considerable set-up and compliance costs associated with the irrigation of treated effluent to dairy farms, and very strict effluent quality control would be necessary. If a non-compliant effluent was produced by the WWTP, and Fonterra refused to accept milk for a period of time from a private farm using effluent provided by Kaipara District Council , there would be considerable financial losses by the farm.

It is likely that no farmer would therefore agree to accept effluent unless Council guarantee the effluent quality as being acceptable to Fonterra, and agree to financially compensate the farm for loss of income in the event that the effluent results in a temporary embargo on milk from that farm.

Such compensation could be considerable, and would need to be taken account of, and insured against in any analysis of a business case.

6.4 GENERATION OF INCOME FROM LINCOLN DOWNS FARM

The existing and future expansion of irrigation to the Lincoln Downs Farm owned by Council could generate an income stream if converted to dairy, or if some other useful cash crop could be produced and harvested from the site.

The potential options are:

- Conversion to dairy
- Production of cattle feed from pasture
- Maize crop
- Other crop

In the immediate area of Mangawhai, council advise that demand exists for feed for dairy cattle, although the requirements of the Fonterra policy must be met.

The production of feed would be preferred, as intensive irrigation softens the soil, which leads to ‘pugging’ if large animals walk over the surface. Cropping will reduce damage to the soil

A business case would need to be developed to determine if conversion of Council's Lincoln Downs Farm to dairy or another crop, is viable. AgResearch has been contacted and could present a proposal to Council if this is considered worth pursuing. A copy of their proposed approach is given in **Appendix 8**.

Some of the factors that could be considered could be increasing yields, changing pasture species, possible fertiliser application, optimising cutting frequency and times, reducing harvesting costs.

6.5 POTENTIAL SURFACE WATER DISPOSAL SITE OPTIONS

The Earthtech report "Assessment of Treatment and Disposal Options" of 2006 ruled out any form of effluent discharge to water as not being viable or sustainable, citing likely difficulty in obtaining resource consents, the effect of nutrient rich effluent. In addition, strong public opposition could be expected.

Council has specifically requested that water discharge options be explored in this study, and so the issues relating to this will be explored at high level. Several factors that may not have existed at the time the scheme was developed could result in a water discharge being more readily acceptable than at the inception of the scheme.

- The very high cost of the current scheme and burden on ratepayers.
- Very strong public dissatisfaction with the cost of the current wastewater scheme.
- The high cost associated with developing additional irrigation area on the farm.
- No operating revenue from the farm.
- The nature of the soils make winter irrigation not practical, requiring a large storage volume. Additional storage would therefore be required in the future.

Due to high public dissatisfaction with the costs associated with the current scheme, the public may possibly be more accepting of a partial discharge to water under stringent conditions if it would result in significant cost savings to Council, and more particularly, to reduce future charges for existing and future residents, when compared to land-only scheme costs. The logistics of this would need to be explored more fully by Council, and are beyond the scope of this study.

The Northland Regional Council would be consulted to gauge potential acceptability of water discharge proposals. There have been a number of wastewater disposal schemes in various parts of the country over recent years that incorporate a partial discharge of effluent to water, either during winter, on the outgoing tide, or during high river flow conditions, which may indicate a greater willingness to balance the conflicting requirements of environmental protection, cost and public perception.

It is also possible that some improvement in effluent quality, particularly nutrients, may reduce the effects of a water discharge and facilitate the granting of a consent. This is not considered further in this report as the effects have not been quantified, but may be identified as part of an Assessment of Environmental Effects study.

Any discharge to surface water (by way of a wetland, infiltration bed or sub-surface diffuser) would be likely to be a secondary discharge only (after land disposal of all effluent cannot be achieved) and would be likely to be subject to conditions. It is likely that the system would be engineered so that a low discharge would be required during dry years, and higher discharges in wet years, particularly during a wet autumn/winter.

Several potential locations for water discharge have been identified:

- The estuary adjacent to the WWTP,
- The estuary near the main harbour,

- The harbour mouth or,
- The ocean.
- The Hakaru River or Cook Creek, along the pipeline.
- Wetland discharge at the Mangawhai Golf Course

Refer to Figures 11-16. All of the options could present challenges in obtaining a resource consent. If able to be consented, for the estuary or harbour mouth options, discharge would be likely to be restricted to the high or outgoing tide.

For the river discharges, a possible flow-proportioned discharge, higher when the river is flowing at elevated levels.

An Assessment of Environmental Effects (AEE) process would be required to demonstrate that the effects were no more than minor.

The likely advantages of a discharge to water would be:

- Discharge during winter or wet periods when irrigation is minimal.
- Possibly greater discharge during wet years, assisting the scheme to be more economical.
- Reduced storage requirements.
- Social acceptability when very high land disposal costs are considered.
- Some options would allow discharge from a short extension to the existing effluent pipeline.

7.0 DEVELOPMENT OF DISPOSAL OPTIONS

7.1 BASIS OF OPTIONS

All options presented in this report are conceptual at this stage, and are subject to further engineering investigation and an AEE. The AEE may well affect the viability, cost and practicality of some options. In particular, the options for discharge of effluent to water (wetland, river, ocean or harbour) may need to be revisited following the AEE process.

Of all options, the land disposal options are likely to be most readily consented. However, Council has requested that water disposal options also be considered.

The options are divided into two groups; those that discharge effluent only to land and those that discharge effluent to both land and water, as follows.

7.2 DISCHARGE TO LAND ONLY vs DISCHARGE TO LAND AND WATER

7.2.1 DISADVANTAGES OF DISCHARGE TO LAND ONLY

The primary issue with all land disposal only options in areas of plentiful rainfall in New Zealand where is that rainfall is normally highest in the winter season, when evapotranspiration is lowest. In addition, soils in Northland, including around Mangawhai are predominantly silt and clay based, and in many areas surface layers can become saturated with poor drainage in winter.

This means that there is much more potential for effluent irrigation during summer, when rainfall is generally lower and evapotranspiration is highest, than the winter. This necessitates a large volume of winter effluent storage to avoid discharge.

The seasonal imbalance is exacerbated during wetter than normal years, particularly if there is a wet autumn/spring when less irrigation is possible. In addition, there may be slightly greater effluent volume due to inflow into the reticulation system and rainfall on the storage lagoon during heavy rainfall.

Thus, a very large storage volume must be provided if a discharge of effluent to water is to be avoided during wet years. However the larger the storage lagoon area, the greater the volume of rainfall captured with the effluent.

For the Managwhai scheme a situation occurred during 2012, which was wetter than usual, and the effluent lagoon was higher than desired in the autumn. Council applied to increase the irrigation rate from "deficit conditions" to "saturation to runoff", in order to avoid overtopping the storage lagoon during the winter. This is in accordance with the consent. Without this provision, it is possible that the storage lagoon may have overtopped.

7.2.2 ADVANTAGES OF A DISCHARGE TO BOTH LAND AND WATER FOR MANGAWHAI

A potential scheme whereby some higher quality effluent from the WWTP (not the lagoon effluent, which is of poorer quality) is discharged to water, particularly during the winter months, would work well if combined with the current land irrigation scheme, which irrigates effluent primarily during the summer months.

There is the potential for a partial discharge to water at times when the environmental impact would have the least effect, as stream flows are higher and recreational use is lower. Discharge to streams, rivers the estuary and the ocean could all be considered.

Such a scheme could significantly reduce the overall requirements for winter storage and greater irrigation area, when compared with a land only irrigation scheme. This could result in considerable cost savings to the community and greater efficiency of the overall disposal system.

A year round discharge to fresh water may be more difficult to consent, and the most likely scenario would be a partial discharge to water when river flows are high, tied to storage level and climate outlook. This would mean a greater discharge to water may be able to occur during wetter than normal years, and/or when river flows are high. An AEE would be required to establish whether this could be done in a manner that would result in an effect that is no more than minor. The question of whether this will be acceptable to the Northland Regional Council (NRC) and to the community would need to be determined by consultation and robust peer review.

Thus, this study will therefore consider both land only disposal schemes and schemes that include a partial discharge to water at times when the environmental impact would have the least effect.

7.3 DISCHARGE TO LAND ONLY SCHEMES – OPTIONS 1, 2 & 3

The existing disposal area of Lincoln Downs Farm is limited and will not be sufficient for the ultimate development of Mangawhai.

It was hoped that further irrigation areas indicated in Section 5.1 could become available to supplement the Lincoln Downs Farm, possibly providing a lower cost alternative.

Preliminary discussions and investigations are not promising. The Te Arai golf course is too far away. The Mangawhai golf course is very close, but may not be suitable for the disposal of large quantities of effluent, for the reasons outlined in Section 6.1.2.

Similarly, although Tolovea Farms has currently declined interest in the irrigation of effluent, discussion with them should continue, to ensure all issues are fully understood.

In the short term, the only consented land based option available to Council is disposal at Lincoln Downs Farm. Any other option would be unlikely to be available until AEE and consent requirements are carried out, which could take several years.

Three potential options are considered for discharge to land only:-

Expansion of the Lincoln Downs Farm as the existing, expanding to additional land as required. This is described in Section 3.1 of Appendix 3 as identified by BMT WBM – **Option 1**.

Expansion of the Lincoln Downs Farm while optimising all irrigation to maximise uptake of the water by pasture – "Maximised Deficit Irrigation", as identified by BMT WBM in Section 3.2 of Appendix 3 – **Option 2**.

Expansion of the Lincoln Downs Farm, with some areas being irrigated year-round with slow rate subsurface drip irrigation as identified by BMT WBM in Section 3.3 of Appendix 3 – **Option 3**.

Summary of Options 1-3

TABLE 3: IRRIGATION TO LAND – OPTIONS 1-3

OPTION NUMBER AND DESCRIPTION	1 DEFICIT IRRIGATION	2 MAXIMISED DEFICIT IRRIGATION	3 MIXED DEFICIT IRRIGATION & SUBSURFACE DRIP LAND TREATMENT
Total Daily Flow (Report Horizon)	640 m^3/d	640 m^3/d	640 m^3/d
Deficit Irrigation Area	170ha	-	12ha
Average Flow*	640m^3/d	-	60m^3/d
Maximised Deficit Irrigation Area (High Performance Pasture)	-	65ha	30ha
Average Flow*	-	640 m^3/d	290m^3/d
Subsurface Drip Land Treatment	-	-	20ha
Average Flow*	-	-	290m^3/d

* Daily flow is based on the annual average, and would vary throughout the year.

7.4 DISCHARGE TO LAND AND PARTIAL DISCHARGE TO WATER SCHEMES

The potential partial water discharge options divide into two groups, sea-based and freshwater based. It should be stressed that all options are conceptual at this stage, and subject to further study and AEE processes.

7.4.1 DISCHARGE TO OCEAN OR ESTUARY (SALT WATER)

Options for discharge to the estuary, unlike the ocean outfall, would rely on tidal flushing, and there is likely to be strong public opposition to these options, particularly for discharges during the summer months, due to high recreational use. Figure 11 below shows suggested locations of the possible ocean or estuary discharges.

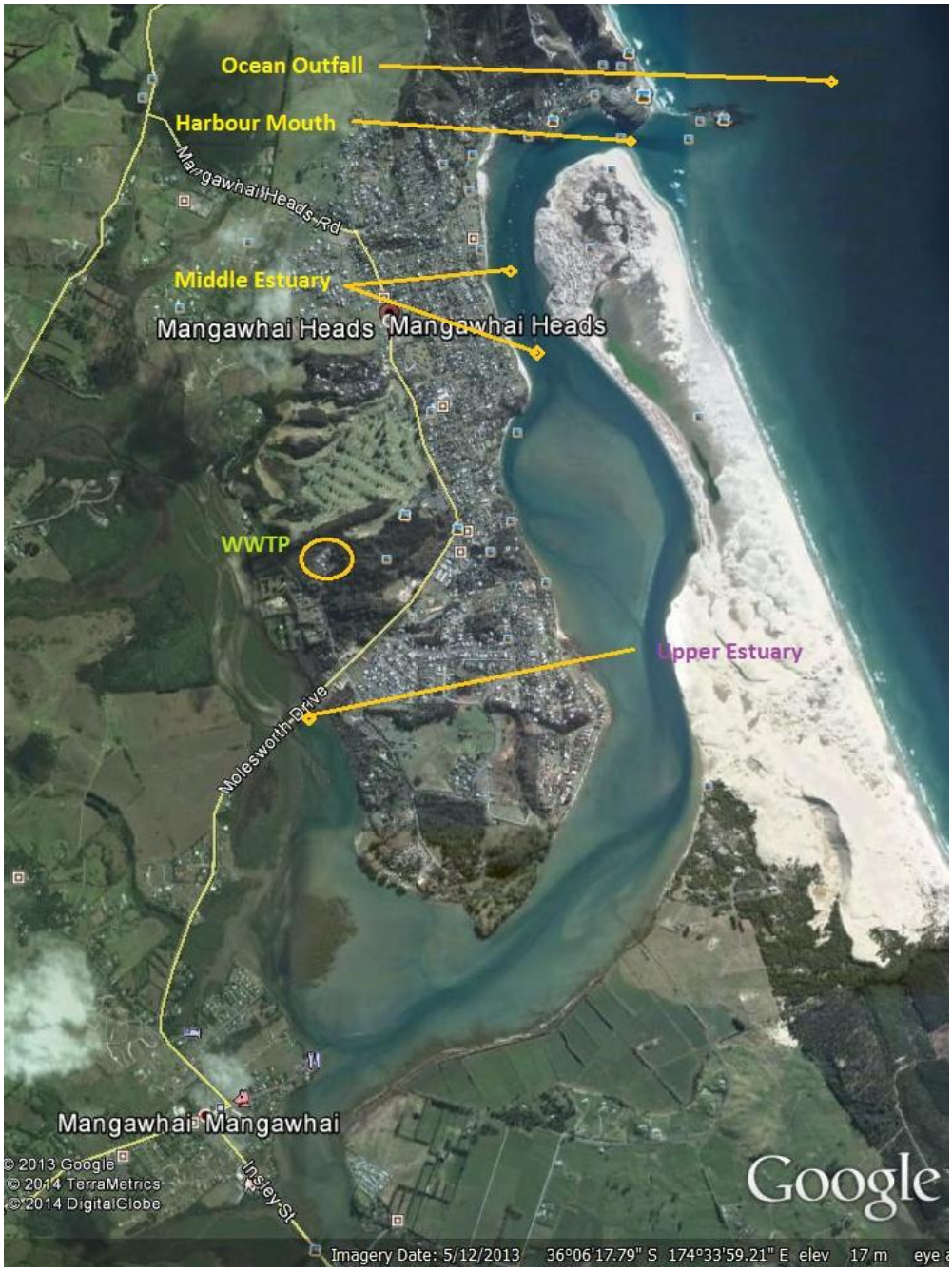


FIGURE 11: Possible Estuary and Ocean Discharges at Mangawhai - Source Google Earth

THE OCEAN – OPTION 4

There are several potential options here. At the Heads, there is a rock outcrop protruding about 400m from land into the sea. A 4.4km long pipeline from the WWTP could be installed adjacent to this rock outcrop, and from there into water approximately 15 m deep.

As the discharge is beyond the shoreline, tidal effects may not need to be considered, and conceptually, this option could consist of a low, continuous discharge of say 10-15L/s year round. Modelling of the discharge would be required to assess the environmental effects.

There is also a possible alternative pipeline route approximately 3km long with a portion directionally drilled under the estuary to the estuary entrance via the sand banks opposite Mangawhai. From there, an outfall could be constructed to water approximately 15m deep off the sand dune beach.

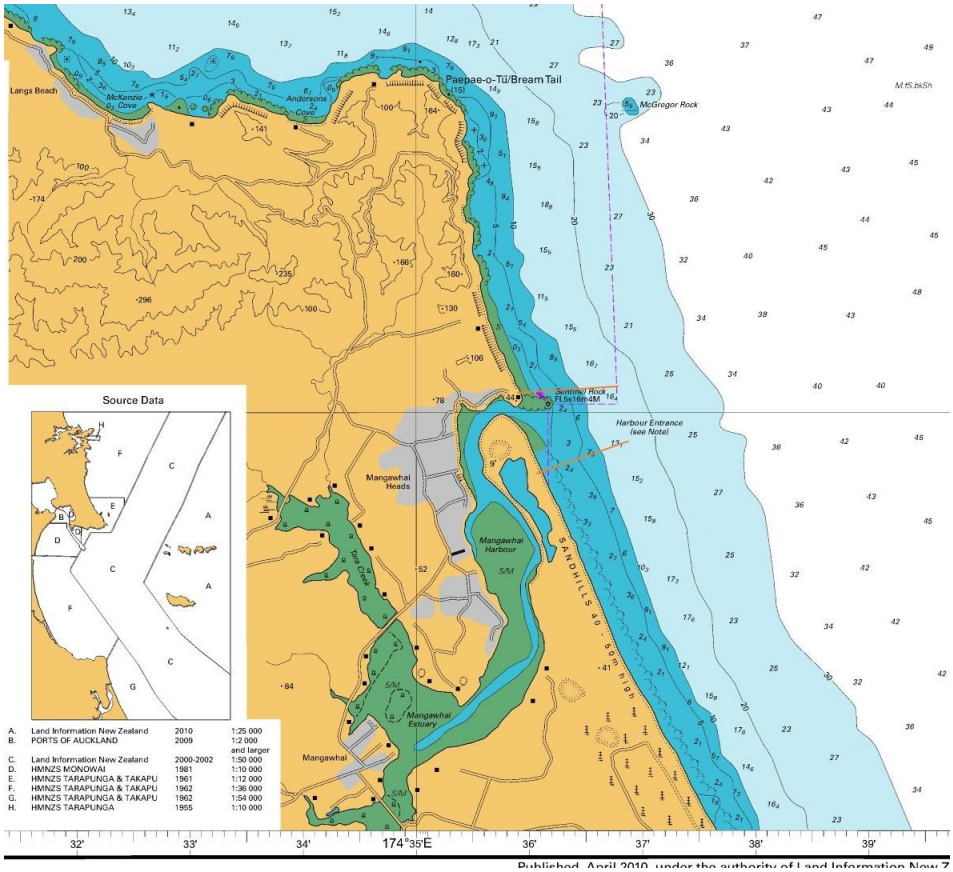


FIGURE 12: Possible Ocean Outfall Locations (Shown in orange) - Source LINZ

A discharge to the open sea, via an ocean outfall with a diffuser would provide good dispersal and mixing with the ocean water. If this option were to proceed, all of the effluent could be discharged to the ocean and irrigation to the Lincoln Downs Farm would no longer be required, potentially enabling the farm to be sold.

An environmental impact of this discharge would need to be assessed through the AEE process, but given the relative high quality of the WWTP effluent, it is likely to be relatively low. The cost of this option, however, would be relatively high.

There are considerable risks associated with ocean outfall construction in an area exposed to ocean swells, and this would be reflected in tendered prices for the work.

THE HARBOUR MOUTH – OPTION 5

At the harbour mouth, there is a deep, narrow channel to the open sea. A discharge in this location only on the fast flowing outgoing tide could provide reasonable assurance that all of the effluent would be discharged to the open sea, with only a minimal diluted flow returning to the estuary on the incoming tide.

A discharge at this location would require a 4km pipeline from the WWTP, and a short outfall into the deep channel. Some of this route would be along difficult, rocky terrain. There is a possible alternative pipeline route approximately 3km long with a portion directionally drilled under the estuary to the estuary entrance via the sand banks opposite Mangawhai.

Conceptually, this option could consist of a discharge of say 70L/s for 4 hours twice per day on the outgoing tide. Due to the lower impact of the harbour mouth discharge, it is assumed disposal could take place year round. If this option were to proceed, all of the effluent could potentially be discharged to the ocean on the outgoing tide. Therefore,

irrigation to the Lincoln Downs Farm would no longer be required and the farm could potentially be sold.

The environmental impact of this discharge would need to be assessed through the AEE process, but there is still a very high recreational use of the area at Mangawhai Heads and in the immediate area of open sea adjacent to the entrance. Therefore it is likely that this option may face some opposition, particularly from the general public, although it should not be completely discounted at this stage.

THE MIDDLE ESTUARY - OPTION 6

A discharge at this location would require a 1.5 to 2km pipeline from the WWTP, and a short outfall into the channel.

As the discharge would have an environmental impact on the estuary, effluent quality would be an issue. Conceptually, this option could consist of a discharge of say 35L/s for 3 hours twice per day on the outgoing tide, May to October. Discharge would be of higher quality WWTP effluent only.

Discharge in this area into the deeper main tidal channel will provide good mixing and flushing, however, the distance to the open sea is quite long. It is likely a large proportion of the effluent will remain in the estuary even if effluent is discharged on the outgoing tide. To limit discharges to the estuary, irrigation to the Lincoln Downs Farm would be likely to need to be expanded.

While this option is included as **Option 6**, it is unlikely to be considered further.

THE UPPER ESTUARY ADJACENT TO THE WWTP – OPTION 7

There is a small tidal inlet not far from the WWTP. The effluent pipeline crosses this estuary on a bridge at Molesworth Drive, refer to Figure 11.

A discharge at this location could be relatively inexpensive to implement, as the pipeline crosses this bridge, and the additional infrastructure would be minor.

This site is in the upper reaches of the estuary and is remote from the main body of water in the Mangawhai Estuary. It is a considerable distance from the sea, and even if effluent is discharged on the outgoing tide, tidal flushing for this area of water would be limited. The effluent discharge will predominantly be transferred to the main estuary, which is unlikely to be acceptable for the community.

As the discharge would potentially have a significant impact on the estuary, effluent quality would be an issue. Conceptually, this option could consist of a discharge of say 35L/s for 3 hours twice per day on the outgoing tide, May to October. Discharge would be of the higher quality WWTP effluent only. The viability of this option may be able to be enhanced if additional treatment, or flow through a constructed wetland was carried out. To limit discharges to the estuary, irrigation to the Lincoln Downs Farm may need to be expanded.

While this option is included as **Option 7**, it is unlikely to be considered further.

7.4.2 FRESHWATER DISCHARGES

There are not many sizable streams or rivers in the vicinity of the Mangawhai WWTP or effluent pipeline. The most significant is the Hakaru River which drains into a middle arm of the Kaipara Harbour. Close to the Lincoln Downs Farm site is the Cook Creek, which is a tributary of the Hakaru River.

Any discharge point to freshwater would need to undergo an AEE and consenting process.

COOK CREEK NEAR THE PIPELINE.

Approximately 850m south from the point at which the effluent pipeline crosses Brown Road, the Cook Creek meets Brown Road. Although this is relatively close to the effluent pipeline, and in public land, this location is not favoured as the upstream catchment area is not as large as the Hakaru River, and therefore the effect would be greater.

This option is therefore not considered further.

THE HAKARU RIVER – OPTION 8

All options for a discharge to the Hakaaru River presented in this report are conceptual at this stage, and subject to further engineering investigation and an AEE. The outcome of the AEE may well affect the viability, cost and practicality of the river discharge options.

In particular, the discharge to the Hakaru River will depend on the level of contaminants (Nitrogen, Phosphorus, Ammonia, *e-Coli*) present in the river after mixing with the effluent. Flow information was not available for the Hakaru River at the location where the discharge is proposed. Water quality information from the NRC website shows the Hakaru River does not usually meet ANZEEC guideline values for water quality.

The effluent pipeline crosses the Hakaru River at chainage 7,650m, in private land. Access to this point is by private roads and then along farmland. Council indicate this location would be favourable, subject to landowner approval.

FIGURE 13: Location of Cook Creek, the Effluent Pipeline and the Hakaru River - Source Google Earth

The Kaiwaka-Mangawhai Road crosses the Hakaru River via a bridge further downstream below the confluence of the Hakaru River and the Cook Creek. At this location, the catchment area of the Hakaru River is significantly greater, and the location is on a major road, facilitating access. The distance from the effluent pipeline to the Hakaru River bridge is approximately 3.1km.

FIGURE 14: The Hakaru River, Downstream of Mangawhai-Kaiwaka Road Bridge - Source Google Street View

There would be other locations along the Hakaru River that could also be suitable if access could be attained.

River flows in Northland from low-lying streams and rivers in permeable soils respond quickly to high rainfall, and so elevated flows could occur at any time of the year when heavy rain is experienced[1]. Therefore, a flow-proportional discharge during elevated flows is considered to be more appropriate than a consent to discharge during winter only. During dry winters, flows can be quite low, whereas, summer storms could result in very high flows. This approach will enable effluent discharge opportunities to be maximised while environment al effects are minimised.

It is proposed that discharge would occur at a low rate when river flows are above a trigger level (to be determined in the AEE process) and conceptually increase to the maximum pumping rate for the pipeline (approximately 70L/s) during high flow or flood conditions when sufficient dilution would be available. Thus the quantity that could be discharged during high river flows would be limited to the daily effluent flow, and any effluent stored in the effluent storage tank at the WWTP.

To maximise the potential effluent discharge, the effluent storage tank volume could be increased in later stages of development, to allow a prolonged high rate of pumping of treated effluent during and after storm events.

This option is conceptually based on a discharge where the effluent pipeline crosses the Hakaru River at chainage 7,650m. A tee would be installed on the pipeline, with manual and automated valves, and a flowmeter.

A river level gauging station would measure river levels, and then allow discharge at a rate permitted by the consent. The flowrate and the total volume discharged would be measured by a flowmeter.

The system could be powered by solar panels and storage batteries, and would be independent of mains power. A relayed telemetry link to Council's telemetry system would be provided, so the discharge could be monitored and controlled remotely. The automated valve should be programmed to fail closed in the event of any system malfunction.

[1] Annual Monitoring Report 2005-2006, Hydrology, Northland Regional Council

As a safeguard, a check valve would be installed at the lagoon, to ensure lagoon effluent could not be discharged to the river.

Using this concept, effluent could potentially be disposed of to the Hakaru River during high flow events at any time of the year. The particular advantage of this concept is that during wet years when less effluent can be irrigated, more effluent will be able to be safely discharged to the river. Conversely, less effluent would be able to be discharged during dry years, but at these times, more effluent would be able to be irrigated.

Thus, a river discharge would dovetail very well with a land disposal scheme, such as at Mangawhai. However, due to limited or no discharge potential at low river flows, this option would not be suitable to dispose of all of the effluent year round.

Summary of Options 4-8

TABLE 4: DISPOSAL TO OCEAN, ESTUARY OR RIVER - OPTIONS 4-8

OPTION NUMBER AND DESCRIPTION	4 OCEAN OUTFALL ONLY	5 HARBOUR ENTRANCE OUTFALL ONLY	6 IRRIGATION AND DISCHARGE TO MIDDLE ESTUARY	7 IRRIGATION AND DISCHARGE TO UPPER ESTUARY	8 IRRIGATION AND HAKARU RIVER
Total Daily Flow (Report Horizon)	640	640	640	640	640
Deficit Spray Irrigation Area	-	-	65ha	65ha	36ha
SSD Irrigation Area	-	-	-	-	10ha
Flow to Irrigation*	-	-	340	340	340
Flow to Ocean Outfall*	640	-	-	-	-
Flow to Harbour Entrance Outfall*	-	640	-	-	-
Flow to Estuary *	-	-	300	300	-
Flow to Hakaru River*	-	-	-	-	300

* Daily flow is based on the annual average, and would vary throughout the year.

WETLAND DISCHARGE AT THE MANGAWHAI GOLF COURSE – OPTION 9

A wetland discharge at the Mangawhai Golf Course could be established to augment the land based irrigation at Lincoln Downs Farm. Based on discussions with the Golf Course, an area of natural wetland is available for use, and the Golf Course are keen to develop this area into a water/vegetation feature in the middle of the golf course.

For effluent disposal a small constructed wetland, lined with an impermeable liner and planted with a range of water tolerant species would be formed. A long, serpentine flow path would be formed in the wetland to maximise plug flow and limit short-circuiting.

A constructed wetland would be primarily a high-rate effluent polishing system, which would be expected to result in a modest reduction in nitrogen, limited reduction in phosphorus, and a likely increase in *e-coli*, primarily due to wildlife in the wetland.

Due to the high quality of the WWTP effluent, loading rates at the high end of reported data (i.e. one day minimum hydraulic retention time) are proposed for the Mangawhai constructed wetland prior to release to the natural wetland.

FIGURE 15: Location of Cook Creek, the Effluent Pipeline and the Hakaru River - Source Google Earth

Effluent would exit the constructed wetland and flow into a water feature in the natural wetland, to promote natural mixing of the effluent with surface and groundwater prior to further transport through the natural wetland for further treatment prior to final discharge.

A low permeability liner would be provided in the mixing area to reduce soakage to ground until the combined effluent and natural water enter the natural wetland.

As an initial concept, for every 100 m^3/day to be discharged to the wetland, a net volume of 150 m^3 has been assumed at an average depth of 0.3m, with 33% wet area. This would then dictate approximately 1,000m^2 of total area for every 100 m^3 to be discharged. The constructed wetlands could be built in two or more stages, to stager costs. some tentative indicative layouts are shown in **Appendix 9**.

Due to the permeable nature of the sandy soils under the golf course area, most of the effluent discharged to the golf course wetland will either enter the groundwater or flow into the small stream that discharges from the golf course to the upper Mangawhai estuary.

Ultimately, nearly all of this effluent will flow to the estuary, after further treatment through the wetland and soils. Some reduction of nutrients may occur though the wetland, but generally an increase in total bacterial levels will occur.

An AEE would be required to assess the effects of such a discharge. Until this has been completed, it is not possible to assess the full effects of the wetland options.

The golf course may potentially wish to take effluent for irrigation of fairways during the summer months, but this volume would be likely to be low and may not be reliable during wet years. Therefore, this has not been included in the calculations.

If viable, this could, however, be an important water source for the Golf Course, as the fairways often suffer from lack of rain in the summer, and irrigation would greatly benefit the appearance of the course. Only WWTP effluent (not wetland effluent) should be used for irrigation of the fairways, and it would need to be carried out at night. This would also be a very beneficial form of effluent reuse, and so should not be discounted at this stage.

COMBINATIONS OF WETLAND, RIVER AND IRRIGATION OPTIONS 9-12

Several variations of options for partial discharge to the wetland, irrigation, the Hakaru River or the wetland only are considered, as below.

Option 9 is based on approximately similar distribution of flow to the wetland and to irrigation. Irrigation at the Lincoln Downs Farm would need to be expanded.

This option would limit the total discharge to the wetland and potential effects on the upper estuary.

Option 10 is based on maintaining the existing irrigation area at a sustainable rate, and discharging part of the effluent to the Hakaru River, and part to the wetland. No expansion of the irrigation at Lincoln Downs would be required.

This option would limit the total discharge to the wetland, enable discharge to the Hakaru River when feasible, and would also limit potential effects on the upper estuary.

Option 11 is based on no irrigation to the Lincoln Downs Farm, discharging most of the effluent to the wetland and the remainder of the effluent to the Hakaru River.

Effluent would be stored in the Lincoln Farm lagoon when the river is unable to accept discharge, and later filtered, disinfected and discharged when river flows are higher.

This option would increase the total discharge to the wetland and potential effects on the upper estuary, but would free up most of the Lincoln Downs Farm for possible sale.

Option 12 is based on no irrigation to the Lincoln Downs Farm and discharging all of the effluent to the wetland.

The large storage volume at the Lincoln Downs Farm storage lagoon would not be available for this option, and the full flow would need to be discharged to the wetland. A smaller 2.8M tank would be provided at the WWTP to balance peak flows.

During the summer peak, and wet periods, higher daily flows would need to be discharged to the wetland. For this reason, the wetland area would need to be greater.

This option would increase the total discharge to the wetland and potential effects on the upper estuary, but would free up the entire Lincoln Downs Farm for possible sale. The potential effects on the estuary would be greatest, and would need to be considered carefully, as there would be no alternative means of disposal for this option. There is no guarantee that all of the effluent could be disposed of to the wetland. Nevertheless, it is included in the costings.

Summary of Options 9-12

TABLE 5: WETLAND, RIVER AND IRRIGATION - OPTIONS 9-12

OPTION NUMBER AND DESCRIPTION	9 IRRIGATION AND WETLAND	10 IRRIGATION WETLAND AND HAKARU RIVER	11 WETLAND AND HAKARU RIVER	12 WETLAND ONLY
Total Daily Flow (Report Horizon)	640	640	640	640
Flow to Irrigation	320	134	-	-
Flow to Hakaru River	-	256	250	-
Flow to Wetland	320	250	390	640
Deficit Spray Irrigation Area	54ha	25ha	-	-
SSD Irrigation Area	6ha	-	-	-
Area of Constructed Wetland	3200 m2	2500 m2	4200 m2	12000 m2

8.0
COST ESTIMATES AND OPTIONS ANALYSIS

Conceptual high-level capital and operating cost estimates have been carried out with an expected accuracy of +/- 30%. The estimates do not include GST consenting or consultation, but include non-work costs (engineering and construction administration) and a contingency (30%).

It should be noted that any land sale or purchase costs are not included in these estimates, as valuation needs to be carried out. This would increase the cost of Option 1, and decrease the cost of Options 4, 5, 11 & 12. In addition, consenting and consultation can be substantial costs, so an indication of low, medium or high is given with each option. It is not feasible to estimate these costs at this stage.

It should be further noted that all estimates are broad-brush "order of" comparative estimates only, for the purposes of assisting Council to determine the *best path forward* from here. The estimates should **not** be relied on for capital works budgetary purposes at this stage. Further more detailed cost estimates need to be carried out for selected options to arrive at more reliable costs for budgeting purposes.

The estimates are subject to many assumptions made to ensure the estimates are as realistic as practical. If these assumptions change later, the estimates may change, however the overall ranking of the options should be similar.

8.1 BASIS OF STAGING FOR ESTIMATES

Estimates are prepared for three stages of growth:

Interim Growth Stage 1, - (2,036 connected properties, Annual Average Flow, 375m^3/day)

Interim Growth Stage 2, - (2,425 connected properties, Annual Average Flow, 450m^3/day)

Report Horizon, - (3,460 connected properties, Annual Average Flow, 640m^3/day)

The twelve broad high-level options costed are:

Option 1 - Lincoln Downs Farm and other areas - Deficit Irrigation

Increase area at Lincoln Downs Farm and other areas with deficit Irrigation based on effluent irrigation modelling, **Appendix 3**. This would not include managed high performance pasture, intensive cropping or optimisation of irrigation. A large area (80ha) would be required in addition to the 65ha at Lincoln Downs Farm, as per Table 1 in Appendix 3. This option would not eliminate either over-irrigation or overtopping of the storage lagoon during very wet years. Land purchase cost not included.

Option 2 - Lincoln Downs Farm - Maximised deficit Irrigation

Increase area at Lincoln Downs Farm and change irrigation to maximise deficit Irrigation by harvesting and maximising growth, based on modelling. This increases water and nutrient uptake and crop yield, but requires cutting to be carried out on demand, in order to maximise irrigation. It has been assumed cutting and baling equipment would be purchased to ensure harvesting is not delayed by competing farms.

While not currently favoured by Council due to operational difficulties, this option has been included to enable comparison with other options.

Option 3 - Lincoln Downs Farm - combination of Deficit Irrigation, Maximised Irrigation and Subsurface Drip Land Treatment System (LTS)

Increase area at Lincoln Downs Farm using a combination of deficit irrigation, Maximised high-performance deficit irrigation and Slow Rate Land Treatment System using Subsurface Drip Irrigation (SDI), as identified in **Appendix 3**. The subsurface drip would

operate at 1.5mm/d all through the year including winter, thus offering greater disposal, but at a higher cost/ha.

Cropping and harvesting of the maximised and SDI has been assumed. The maximised high-performance irrigation area should be a minimum of 30ha, to create a suitable economy of scale to improve viability.

Option 4 - Ocean Outfall (no irrigation)

All WWTP effluent would be discharged to an ocean outfall. Irrigation to Lincoln Downs Farm would not be continued. The sale of Lincoln Downs Farm is not included.

Option 5 - Harbour Mouth Outfall (no irrigation)

All WWTP effluent would be discharged to an outfall at the harbour mouth from high tide for up to 4 hours. Irrigation to Lincoln Downs Farm would not be continued. The sale of Lincoln Downs Farm is not included.

Option 6 - Mid-Estuary Outfall and Irrigation

Discharge would be on outgoing tide, May to October only, to avoid discharge when recreational use is highest. The discharge would be of higher quality WWTP effluent only.

Option 7 - Upper-Estuary Outfall and Irrigation

Discharge would be on outgoing tide, May to October only to avoid discharge when recreational use is highest. The discharge would be of higher quality WWTP effluent only.

Discharge would have a high impact on the estuary, so quality would be an issue.

Option 8 - Hakaru River Discharge and Irrigation

Discharge to the Hakaru River when the river is high in proportion to flow to minimise effects. Only the WWTP effluent would be discharged, not the lagoon effluent.

To maximise the potential effluent discharge, the effluent storage tank volume could be increased in later stages of development, to allow a prolonged high rate of pumping of treated effluent during and after storm events, to use the high dilution available.

Option 9 - Golf Course and Irrigation

Wetland discharge, initially 160m^3/d all year round, rising to 320m^3/d in Stage 3

Possible irrigation of fairways by the Golf course during drier summer months

Pipe will supply water to the Constructed wetland inlet. Effluent will flow through the lined constructed wetland of 1 day minimum retention, then be mixed with surface water from the Golf Course, and discharge the combined flow into the natural wetland.

This option will also require some expansion of irrigation at the Lincoln Downs Farm.

Option 10 - Golf Course, Hakaru River Discharge and Irrigation

Wetland discharge, initially 125m3/d all year round, rising to 250m3/d in Stage 3. Possible irrigation of fairways by the Golf course during drier summer months.

Pipe will supply water to the Constructed wetland inlet. Effluent will flow through the lined constructed wetland of 1 day minimum retention, then be mixed with surface water from the Golf Course, and discharge the combined flow into the natural wetland.

Discharge to the Hakaru River when river is high. Store water in tank at WWTP until river is high, then discharge over a few days. Discharge of WWTP effluent only.

Conceptually, this option will not require any expansion of the irrigation at the Lincoln Downs Farm.

Option 11 - Golf Course and Hakaru River Discharge (no irrigation)

Discharge to the Hakaru River when river is high. Store water in tank at WWTP until river is high, then discharge over a few days. Excess effluent would be stored in the Lincoln Downs Farm lagoon when the river is unable to accept discharge, and later filtered, disinfected and discharged when river flows are higher.

Wetland discharge, initially 210m^3/d all year round, rising to 420m^3/d in Stage 3. Possible irrigation of fairways by the Golf course during drier summer months

A pipe will supply water to the Constructed wetland inlet. Effluent will flow through the lined constructed wetland of 1 day minimum retention, then be mixed with stormwater from the Golf Course, and discharge the combined flow into the natural wetland.

The basis of this option is that it will not require any irrigation at the Lincoln Downs Farm. This would be subject to further investigation. The sale of Lincoln Downs Farm is not included.

Option 12 - Golf Course Only (no irrigation)

Wetland discharge, initially an average of 375m^3/d, rising to around 650m^3/d during the summer peak period (2-3 weeks). In Stage 3, the average discharge to the wetland would be 640m^3/d, rising to around 1,000m^3/d, during the summer peak.

There could be possible irrigation of fairways by the Golf course during drier summer months

A pipe will supply water to the Constructed wetland inlet. Effluent will flow through the lined constructed wetland of 1 day minimum retention, then be mixed with stormwater from the Golf Course, and discharge the combined flow into the natural wetland.

The basis of this option is that it will not require any irrigation at the Lincoln Downs Farm. This would be subject to further investigation. The sale of Lincoln Downs Farm is not included.

8.2 CAPITAL COST ESTIMATES

It should be further noted that all estimates are broad-brush "order of" comparative estimates only, for the purposes of assisting Council to determine the best way forward from here. The estimates should not be relied on for capital works budgetary purposes at this stage. Further more detailed cost estimates need to be carried out for selected options to arrive at more reliable costs for budgeting purposes.

Capital cost estimates are given in Table 6 below.

TABLE 6: ESTIMATED CAPITAL COSTS ($ MILLIONS)

	STAGE 1	STAGE 2	REPORT HORIZON	TOTAL
Connected Properties	2036	2425	3460	
Average Flow m^3/day	375	450	640	
Option 1 Deficit Irrigation	$2.8	$1.0	$4.59	**$8.4**
Option 2 Maximised Deficit Irrigation	$1.7	$1.4	$1.7	**$4.8**
Option 3 Combination Irrigation and SDI LTS	$2.0	$2.05	$2.2	**$6.2**
Option 4 Ocean Outfall (no Irrigation)	$7.4	$0.2	$0.3	**$7.9**
Option 5 Harbour Mouth Outfall (no Irrigation)	$3.3	$0.2	$0.2	**$3.7**
Option 6 Mid-Estuary Outfall and Irrigation	$2.3	$1.0	$1.7	**$4.9**
Option 7 Upper-Estuary Outfall and Irrigation	$1.2	$1.0	$1.7	**$3.9**
Option 8 Hakaru River Discharge and Irrigation	$2.2	$0.6	$1.4	**$4.3**

TABLE 6: ESTIMATED CAPITAL COSTS ($ MILLIONS)

	STAGE 1	STAGE 2	REPORT HORIZON	TOTAL
Option 9 Golf Course and Irrigation	$2.7	$0.6	$1.4	**$4.3**
Option 10 Golf Course Plus Hakaru River Discharge and Irrigation	$2.3	$0.2	$0.4	**$2.8**
Option 11 Golf Course Plus Hakaru River Discharge (no Irrigation)	$2.9	$0.5	$0.2	**$3.6**
Option 12 Golf Course only (no Irrigation)	$3.2	$0.2	$0.7	**$4.1**

A breakdown of the capital cost estimates is given in **Appendix 6**.

8.3 OPERATING COST ESTIMATES

Operating costs have been based on estimates of power to pump effluent and costs associated with irrigation management, cutting, baling and sale of harvested pasture. These costs are approximate, and subject to market pressures. In some years there may be a better market for baled pasture than others.

Based on the advice from Council and WIG at Lincoln Downs farm over recent years in the Kaiwaka-Mangawhai area, the average returns have matched the costs of harvesting and baling with minimal overall profit. It is suggested that to increase profitability, the irrigated and harvested area would have to be significantly larger, and the focus would need to shift to pasture production rather than effluent disposal.

This is typical for effluent disposal schemes, where the primary focus is disposal. At this stage it is considered prudent to not include a significant income stream from intensively irrigated and cropped land (Options 2 and 3), as to proceed with an option on the basis of relying on this income could result in significant financial costs to council if the income stream did not materialise.

Operating cost estimates are given in Table 7 below, and shown graphically in Figure 16. A summary of the operating cost estimates is given in **Appendix 6**.

TABLE 7: ESTIMATED OPERATING COSTS

OPTION	ANNUAL COST ($ THOUSANDS)	NPV ($ THOUSANDS)	TOTAL CAPITAL PLUS NPV ($ MILLIONS)
Option 1 Deficit Irrigation	$65.6	$594	**$9.0**
Option 2 Maximised Deficit Irrigation	$65.6	$594	**$5.4**
Option 3 Combination Irrigation and SDI LTS	$65.6	$594	**$6.8**
Option 4 Ocean Outfall (no Irrigation)	$23.7	$214	**$8.1**
Option 5 Harbour Mouth Outfall (no Irrigation)	$23.7	$214	**$3.9**
Option 6 Mid-Estuary Outfall and Irrigation	$57.7	$523	**$5.5**
Option 7 Upper-Estuary Outfall and Irrigation	$53.0	$480	**$4.3**
Option 8 Hakaru River Discharge and Irrigation	$64.0	$580	**$4.9**
Option 9 Golf Course and Irrigation	$55.9	$506	**$4.8**
Option 10 Golf Course Plus Hakaru River Discharge and Irrigation	$56.4	$511	**$3.3**
Option 11 Golf Course Plus Hakaru River Discharge (no Irrigation)	$26.4	$239	**$3.8**
Option 12 Golf Course only (no Irrigation)	$16.9	$153	**$4.3**

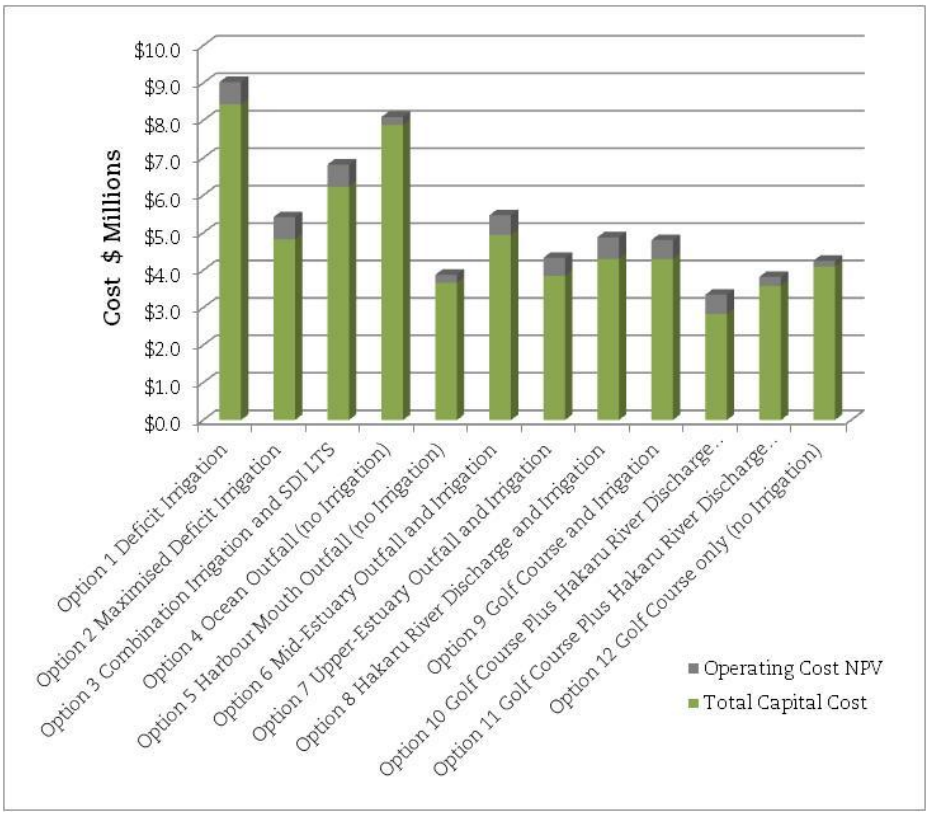


FIGURE 16: Capital and Operating Cost Estimates

Further non-price analysis of the options is given below.

8.4 OPTION MULTI-CRITERIA MATRIX

A Multi-Criteria evaluation matrix (MCA) has been prepared to allow evaluation of all options on a holistic basis. The matrix compares the cost (with a 33% weighting), consenting issues, construction issues, land required, and resilience in wet and dry years to give a single numerical value for each option. Although somewhat subjective, it provides a valuable tool for eliminating some of the options on non-price attributes.

The MCA Matrix in included in **Appendix 7**, and the outcome is presented graphically in Figure 17 below, along with the NPV of capital and operating cost.

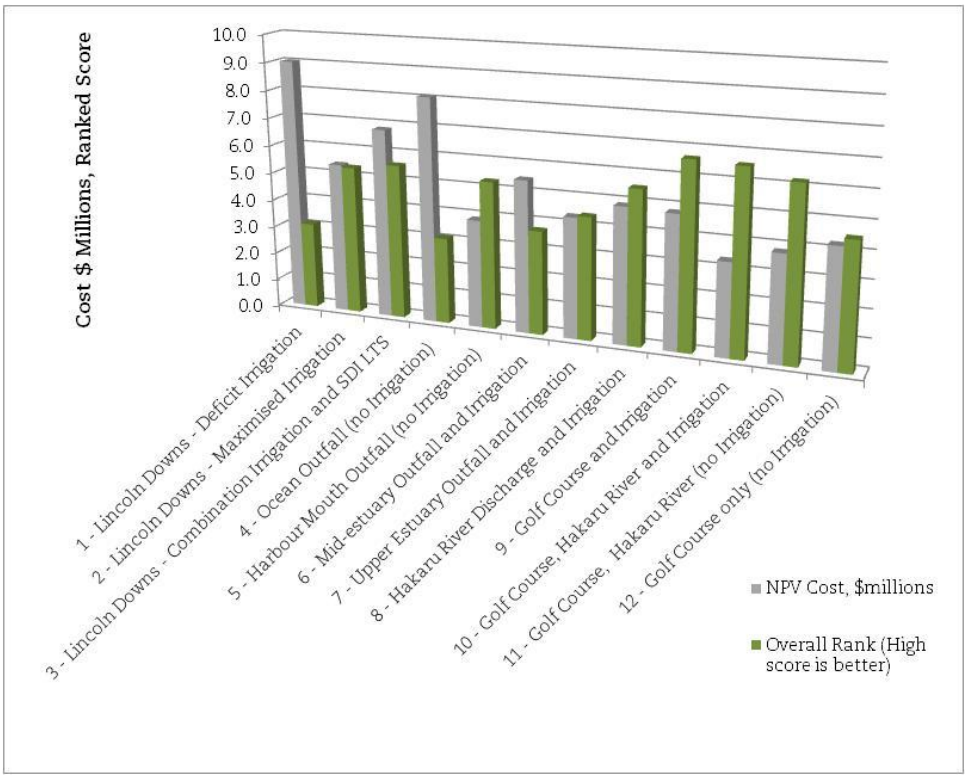


FIGURE 17: Multi-Criteria Matrix Analysis Outcome

In view of the above analysis, it can be seen that some options have a significantly higher capital cost. The NPV of the operating costs do not significantly affect the order of the options. It can also be seen that the MCA changes the order of some options when significant non-price aspects of options are taken into account.

The three favoured options with an MCA score of 6.7 – 6.2 are (highest scoring first):

1. Option 9 Golf Course and Irrigation (Cost 6th)
2. Option 10 Golf Course Plus Hakaru River Discharge and Irrigation (Cost - lowest)
3. Option 11 Golf Course Plus Hakaru River Discharge (no Irrigation) (Cost 3rd)

Options 9, 10 & 11 are clearly ranked higher than the other options, and option 10 has the lowest cost. These options should therefore be favoured.

The next group of four favoured options with an MCA score of 5.6 – 5.3 are (highest scoring first):

1. Option 3 Combination Irrigation and SDI LTS (Cost 10th)
2. Option 8 Hakaru River Discharge and Irrigation (Cost 7th)
3. Option 2 Maximised Irrigation (Cost 8th)
4. Option 5, Harbour Mouth Outfall (Cost 2nd)

Of the seven top options, 2 and 3 are the most expensive, and could be put aside at this stage.

Options 5 and 11 may also result in the Lincoln Downs Farm being available for sale at some time in the future. This has not been taken account of in the MCA analysis, as the viability of these options is yet to be proven and the value of the farm has not yet been determined, and could vary significantly, depending on the state of the market. Therefore, they should be considered due to potential benefit of the sale of the farm.

There is a larger gap to the MCA scores for the lower ranked options 1, 4, 6, 7 and 12 (scores (4.5 – 3.1), and these five options could be put aside at present.

Short List of Favoured Options

- The most favoured Options are Options 9, 10 & 11.
- Second ranked would be Options 5 and 8.

If the Lincoln Down Farm is sold, Options 5 and 11 would be ranked higher.

Some of the options would gain higher public acceptance than others. Before consultation is carried out the list of options should be narrowed down to three or four.

A sensitivity analysis showed that if cost was given a higher 50% weighting, Options 9, 10 & 11 would be highest ranked, followed by options 5 & 8, which is similar to the above ranking. In addition, if the sale of the farm was accounted for, Options 9, 10, 11 and 5 would be favoured, and possibly 12.

Thus, the above short list of options would be most favoured for a range of variables.

9.0 RECOMMENDATIONS

It is recommended that

- Further investigation in greater detail should be undertaken into Options 5, 10 and 11, due to favourable cost and reasonable non-price attributes.
- Investigate the potential future value of the Lincoln Downs Farm for possible future resale (by Kaipara District Council), and hence potential reduced cost for Options 5 & 11.
- Options 8 & 9 may warrant further investigation as variation of Options 10 and 11.
- Options 1, 3 & 4 should be no longer considered due to price and unfavourable non-price attributes.
- Options 6 and 7 should be no longer considered due to unfavourable non-price attributes.

It is considered that the **Next Stage** of the project should be to hold discussions with the Northland Regional Council at a regulatory and technical level in relation to consenting requirements for irrigation to other sites, and partial discharge to water (Options 5, 8, 9, 10 and 11).

Following these discussions, revise the MCA, and if necessary update the cost estimates for the options being considered, to arrive at a short list of two to four options for feasibility investigations.

In addition to the above, the following minor recommendations are given:

- For some of the options, irrigation of Lincoln Downs Farm will continue, and ways to reduce costs and possibly increase revenue could be considered. Request a priced proposal from AgResearch (**Appendix 8**) to carry out a Business Case study to determine the feasibility of generating income from the Lincoln Downs Farm by changing cropping or production methods.
- Public consultation should not take place until further initial work, including feasibility investigations for short-listed options, and environmental scoping assessments have been carried out.
- Continue to test the treatment plant effluent for Total Coliforms for at least 12 months in total, to gain enough data for analysis to establish compliance with California Title 22 requirements, to support possible future irrigation to dairy farms.

- Investigate the cause of periodic out-of-spec WWTP effluent coliform test results, to ensure high non-conforming results are rare and of short duration (a single sample only).
- Continue to collate and record accurate costs for the operation of the current operation at Lincoln Downs Farm to enable accurate comparison with other options.

10.0 LIMITATIONS

10.1 GENERAL

This report is for the use by the Kaipara District Council and the Northland Regional Council only, and should not be used or relied upon by any other person or entity or for any other project.

This report has been prepared for the particular project described to us and its extent is limited to the scope of work agreed between the client and Harrison Grierson Consultants Limited. No responsibility is accepted by Harrison Grierson Consultants Limited or its directors, servants, agents, staff or employees for the accuracy of information provided by third parties and/or the use of any part of this report in any other context or for any other purposes.

10.2 ESTIMATES

Should this report contain estimates for future works or services, physical or consulting, those estimates can only be considered current and will only reflect the extent to which the detail of the project is known to the consultant (feasibility, concept, preliminary, detailed, tender etc) at the time given.

The client is solely responsible for obtaining updated estimates from the consultant as the detail of the project evolves and/or as time elapses.