



*Masterton District Council*

# **Riversdale Sewage Scheme Denniston and Tatham Options**

## **SITE FEASIBILITY STUDY**

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## 1 Executive Summary

On 27 March 2006, Masterton District Council (MDC) commissioned Opus to carry out a site feasibility study of sewage treatment and disposal systems located on Denniston and Tatham properties near Riversdale Beach. The aim of the study was to investigate options and ultimately recommend a preferred single site for the treatment and disposal of sewage including a pump station and rising main from Riversdale Beach

Preliminary assessments from geotechnical, ecological, planning and hydrogeological data were carried out and are included in this report. The assessments were used to develop land disposal options at both sites including three pipe route options that were considered for the rising main alignment.

The main finding from the report is that both the Denniston and Tatham properties are suitable sites for a sewage treatment and disposal scheme. Both sites have sufficient land area in excess of the minimum 10ha required for treatment and land disposal. Short rotation, coppicing forestry (eg eucalyptus) will assist with the disposal of treated effluent which can be applied using surface or subsurface irrigation.

A two stage pump station in a duty-assist-standby arrangement is required to deliver reticulated sewage from Riversdale Beach to both sites. A dual rising main arrangement made up of two 100mm diameter polyethylene pipes provides the best cost and operational flexibility to a rising main delivery system.

Capital cost estimates for the treatment and land disposal infrastructure, including pump station, rising main and ancillaries indicate that the range with a 20 year NPV is \$13.6 million to \$14.4 million. The Tatham treatment site with 2.9km of rising main over East Leigh property provides the lowest cost option.

Opus recommends that MDC purchase Tatham property as a preferred land disposal and treatment site and gain easement access for rising main services over East Leigh property. Furthermore, Opus recommends that MDC obtain a designation for the treatment and pump station sites and rising main, so that Resource Consents will not be required for these works. Resource consents from Greater Wellington Regional Council will be required for the discharge of sewage and possibly bulk earthworks.

Detailed design of a single treatment and rising main option will provide the opportunity to optimise the design and costing.

## 2 Introduction

Masterton District Council (MDC) has commissioned Opus to investigate the feasibility of siting wastewater treatment and disposal systems on one of two sites to the south west of Riversdale. These are described in the following report as the Denniston and Tatham properties.

The system concept consists of:

- A reticulation scheme throughout the Riversdale Beach community
- A pump station at the south end of Riversdale and rising main to the treatment site,
- A sewage treatment plant consisting of a pond system with buffering of peak flows,
- A treated wastewater disposal system consisting of a pump station, pipework to the disposal area and land disposal via irrigation.

The rising main will have to cross East Leigh property and will thus require the gaining of easements. The treatment and disposal systems will be on Denniston and /or Tatham property. The areas that have been considered in this study are shown in the layout drawing attached as Appendix 1.

## 3 Denniston Property

### 3.1 Suitability for siting of:

#### 3.1.1 Sewage Treatment Plant

The potential treatment plant location is shown as Possible Pond Location 1 in Appendix 1 and also shown in the photos in Appendix 2.

The location is in a gully behind the existing farm pond which will be decommissioned and become part of the treatment pond structure. Preliminary geotechnical and ecological assessments of the area (refer Appendices 3 and 4) have not identified any significant issues with this site.

#### 3.1.2 Land Disposal

The proposed land disposal areas are shown as Disposal areas 1 and 2 in Appendix 1 and also shown in the photos in Appendix 2. Land disposal options are discussed in Appendix 6.

The locations are on the flatter tops adjacent to and behind the existing farm pond. Preliminary geotechnical and ecological assessments of the area (refer Appendices 3 and 4) have not identified any significant issues with this site, although some instability in the hillsides was noted at the edges of site 2. This will require further

investigation during detailed design and may require that irrigation be set back from these areas.

During times of low evapotranspiration, irrigated water is expected to seep into gullies that drain the irrigation areas (refer to the preliminary Hydrogeological assessment, Appendix 5). Excessive nutrient loadings from the irrigated effluent could have adverse effects on the quality of water courses. However, the dense clay soil structure is expected to slow seepage and provide additional treatment of the effluent. In addition the ecological assessment identifies a number of possible mitigation measures to reduce the impact of this seepage on downstream areas including planting of the gullies and the irrigated areas.

### **3.2 High level scheme design:**

#### **3.2.1 Size of plants and associated infrastructure**

An indicative site layout plan is attached in Appendix 1. The treatment plant will consist of:

- A fine screen to remove gross solids from the sewage and dewater them for disposal. Alternatively this item may be sited at the Riversdale end of the rising main.
- A buffer/facultative pond system. The level of the buffer will be maintained between 1 and 2 m deep to buffer peak summer flows and to allow for periods when irrigation is not possible due to inclement weather. The first part of the buffer can be fitted with aerators which will operate during peak summer periods to maintain an aerobic surface to reduce odours.
- A series of four maturation ponds to improve the effluent quality, especially in terms of pathogen removal. These will have a constant 1m depth.
- The pond system will require a gross land area of approximately 2.4 hectare.
- Between the facultative and maturation ponds a flow control valve will regulate flow out of the facultative pond. Inflows in excess of the outflow will therefore be buffered in the facultative pond.
- A pump station and filter will remove solids from the treated effluent prior to it being piped to the disposal fields.
- The existing road access will need to be improved to allow heavy vehicle access for construction.
- It is proposed that the existing power lines running adjacent to the site be used for power supply.

#### **3.2.2 Areas of Land Required and Easements**

- The areas identified on the drawing in Appendix 1 are:

- Pond Location 1      2.4 hectare
- Disposal Area 1      4 hectare
- Disposal Area 2      8 hectare

A minimum of 10 Hectare should be set aside for treatment and disposal. Hence it should be possible to install the treatment and disposal system on Denniston land with some reserve for future development.

- Easements will be required for the rising main from Riversdale to the treatment site through East Leigh land.

### **3.2.3 Analysis of farming/agricultural options for land disposal**

Due to site constraints the most feasible options for the Denniston site are short rotation forestry with trickle irrigation or cut and carry grasses with subsurface irrigation. The site is not expected to be compatible with spray irrigation due to potential drift issues, thus making crops which require ploughing an unfeasible option (as this would damage the sub surface trickle irrigation system). Grazing is not recommended due to restrictions applied to stock raised on land irrigated by effluent. This option also has high management requirements (several separate paddocks, regular stock rotation) and reduced infiltration due to pugging.

Recommended plantation forestry would be short rotation, coppicing, and water loving species such as eucalyptus. The product would be low quality timber for pulp or firewood. Pine and high value crops are not recommended due to the long establishment time required prior to irrigation and uncertainty in the quality of intensively irrigated trees. Another viable option is native forestry, as it requires low maintenance and has high ecological value. Both native and harvest forestry will improve the stability of the hillsides potentially allowing irrigation closer to the slope and/or reducing the chance of a failure. Irrigation would be via surface drip or subsurface irrigation installed with a mole plough.

Cut and carry grasses would be perennials with subsurface irrigation probably installed by mole plough. Harvesting would be required 3-5 times per year. For this option to be feasible a potential market would need to be identified close to the site. This option has higher management requirements but also higher expected returns if a market can be found.

A more detailed discussion of the options is contained in Appendix 6.

### **3.2.4 Cost estimate for each plant**

The capital cost estimate for the infrastructure required for this option, including pump station, rising main, treatment, disposal and ancillaries is \$.14.4 million. This is exclusive of GST but includes engineering fees.

## **4 Tatham Property**

### **4.1 Suitability for siting of:**

#### **4.1.1 Sewage Treatment Plant**

The potential treatment plant location is shown as Possible Pond Location 2 in Appendix 1 and also shown in the photos in Appendix 2.

The location is on a relatively flat terrace currently used by the Tathams for fodder crops. Preliminary geotechnical and ecological assessments of the area (refer Appendices 3 and 4) have not identified any significant issues with this site. The geotechnical engineer notes that of the two sites, he would recommend this site over the Denniston.

#### **4.1.2 Land Disposal**

The proposed land disposal areas are shown as Disposal areas 3 and 4 in Appendix 1 and also shown in the photos in Appendix 2.

The locations are on the land adjacent to the proposed pond. Disposal area 4 is separated from Area 3 by a steep gully that will require to be crossed by the irrigation pipework. Preliminary geotechnical and ecological assessments of the area (refer Appendices 3 and 4) have not identified any significant issues with this site. The geotechnical engineer notes that of the two sites, he would recommend this site over the Denniston.

During times of low evapotranspiration, irrigated water is expected to seep into gullies that drain the irrigation areas (refer to the preliminary Hydrogeological assessment, Appendix 5). Excessive nutrient loadings from the irrigated effluent could have adverse effects on the quality of water courses. However, the dense clay soil structure is expected to slow seepage and provide additional treatment of the effluent. In addition the ecological assessment identifies a number of possible mitigation measures to reduce the impact of this seepage on downstream areas including planting of the gullies and the irrigated areas.

Some alterations would also be required to an existing drainage system to reduce the risk of effluent “short circuiting” to the gullies.

### **4.2 High level scheme design:**

#### **4.2.1 Size of plants and associated infrastructure**

An indicative site layout plan is attached as Appendix 1. The treatment plant will be the same as the Denniston option, except that:

- The existing road access is poorer but shorter than that for Denniston and will require improvement to allow heavy vehicle access for construction. A

right of way may need to be negotiated with the landowner to guarantee future access.

- It is proposed that new power lines will be installed from Homebush Road which will require an easement from Tatham.

#### 4.2.2 Areas of Land Required and Easements

- The areas identified on the drawing in Appendix 1 are:
  - Pond Location 2      2 hectare
  - Disposal Area 3      13 hectare (includes the 2 hectare above)
  - Disposal Area 4      4 hectare

A minimum of 10 Hectare should be set aside for treatment and disposal. Hence it should be possible to install the treatment and disposal system on Tatham land with some reserve for future development.

- Easements will be required for the rising main from Riversdale to the treatment site across East Leigh and depending on the pipe route option, East Leigh and Denniston land.

#### 4.2.3 Analysis of farming/agricultural options for land disposal

The Tatham site has the same options as the Denniston, but also includes cropping. This is due to the higher quality of the soil and reduced slope of the land.

Cereal crops are expected to yield higher returns than forestry. However it is uncertain if the increased returns will offset the greater management and transportation costs. The magnitude of these returns should also be weighed against the overall budget of the project to determine relative importance. Spray irrigation is expected to be feasible on this site although this will need further investigation if this option is to be considered further. Cropping will also require a greater land area or storage capacity than other options due to harvesting requirements.

For both forestry and grass crops it is expected that surface or subsurface irrigation would still be used due to reduced land areas required for buffer zones and consenting issues.

A more detailed discussion of the options is contained in Appendix 6

#### 4.2.4 Cost estimate

The capital cost estimate for the infrastructure required for this option, including pump station, rising main, treatment, disposal and ancillaries is \$13.6 million to \$14.2 million. This is exclusive of GST but includes engineering fees.

## 5 Rising Main

### 5.1 Pipe Route Options

Three rising main pipe route options were considered for alignment of the rising main to the two treatment sites (pond locations). The pond locations are discussed in Sections 3 & 4. Please refer to Appendix 1 for pipe route alignment options.

Pipe Route Option	Estimated Length	Highest Reduced Level On Pipeline (Static Head)
Pond Location 1 via East Leigh and Denniston property.	2910m	90m
Pond Location 2 via East Leigh, Denniston and Tatham property.	4040m	100m
Pond Location 2 via East Leigh, and Tatham property only.	2890m	60m

### 5.2 Pipe Selection

Rising main pipes materials have been assessed for robustness, pressure rating, ease of construction and cost. Polyethylene PE100 pipe material was selected and recommended in Phase V of the feasibility scheme design. PE100 is still the preferred pipe material for this project and allows for a complete range of installation options that the physical works contractor may consider.

Pressure ratings of PN12 (120mH) to PN16 (160mH) were selected and have been included in the cost estimates. PN16 rated pipe will be required for the two higher static head pipelines since a greater dynamic pumping head is also required for these two pipe route options. Optimised pipe material and diameter selection will be required for costs at the detailed design phase.

The pipe diameter must be optimised on a cost basis to achieve minimum pipe cleansing velocity of 1m/s whilst minimising headloss and pumping costs. Pipe installation costs must also be considered for ease of construction.

The following three pipe arrangements were assessed to compare different pumping costs for each pipe route option.

Pipe Arrangement Option	Diameter
One single pipe	150 – 200mm
Two pipes of same diameter	80 – 100mm
Two pipes of different diameter	40 – 150mm

Significant benefits and pump cost savings were found with a dual pipe rising main option. A dual pipe installation can be achieved in one pipe trench with the pipes lying side by side with a nominal gap. Operational flexibility can be made with normally shut valve connections between the two pipes at the lower and upper reaches of the rising main. A dual pipe arrangement is further discussed below.

### 5.3 Design Flows and Pumping Head

The rising main system has been preliminary designed to cope with the expected high unscreened raw sewerage flows during the peak summer holiday period (December through January). The preliminary design values used for pump selection are as follows:

Design Input	Preliminary Design Value
Peak Summer Population	3930 pe
Average Waste per person	0.15 m <sup>3</sup> /d
ADWF to rising main	590 m <sup>3</sup> /d (6.8 l/s)
PWWF to rising main	1875 m <sup>3</sup> /d (21.7 l/s)
Combined Peak Factor	3.17

The static pumping head required to reach the high point along each pipe route option is relatively high when compared to the design flows. Rising main pipe diameters and the resulting head losses during pumping, require high pumping heads to deliver sewage to the elevations of the treatment ponds.

A balanced system of pumping, pipe length and diameter must be optimised for long term costs. To achieve the minimum whole of life cost requires a balance to be struck between pumping and pipe costs. The most feasible rising main and pumping system has been investigated and optimised for preliminary design. However, the detailed design stage of this project will need to be optimised on a whole of life basis.

### 5.4 Pump Selection

Pump selections were made for each pipe route and the three pipe arrangement options discussed above.

Fixed speed pumping with soft starters were considered the most appropriate system for lifting sewage flows from sea level to the Denniston and Tatham treatment site options. Variable speed drives are not necessary for the scheme and were not considered.

Differing high lift pumping arrangements were considered to lift the reticulated sewage to the various high points along the three pipe route options. Total dynamic lifting heads of 80 to 140mH, coupled with the summer peak wet weather flows of 21.7 l/s was found to be a limiting range for many pumps considered.

Single stage pumping was considered with both progressive cavity and centrifugal pumps. Single stage pumping was unachievable with centrifugal pumps due to the high lift required. Progressive cavity pumps were ruled out due to maintenance issues and the cost of additional equipment that would be required for grinding and/or screening the sewage prior to pumping.

Dual pipe arrangements require a pumping system for each rising main and provide excellent operational flexibility between the pumps and rising mains with a two stage pumping system. Two stage pumping with two pump sets in series is achievable with either two 22kW or two 15kW centrifugal pumps on each pipe. A combination of submersible followed by dry mounted centrifugal pumps provided the most cost effective solution while allowing for good operational flexibility between pumps and motors. Minimum pipe cleansing velocities can be maintained over the wide variation in seasonal peak flows with a two stage pumping arrangement combined with a dual pipe rising main system.

## 5.5 Operations and Maintenance Considerations / Benefits

A two or dual pipe option adds the operational advantage of being able to flush and clean the rising main under gravity with tertiary treated wastewater from the maturation ponds.

Pigging or scouring the rising main(s) is a maintenance measure to minimise headloss and pumping costs. The cost of adding a pigging system onto the rising main concept has not been allowed for. A rough order cost estimate of \$10,000 for installation of a pigging system can be added onto the cost estimate if MDC wish to allow a cost for pigging.

Standby pumping was considered for all pumping arrangements during maintenance and emergency operations. Standby pumping during the winter season for a dual pipe - two stage pumping system (total 4 pumps), can be easily achieved with the two redundant pumps (normally in assist mode).

A fifth standby pump will be required during the summer peak season as a standby for the possible peak wet weather flow. Some pump suppliers offered a two stage duty-assist pump arrangement with the same pump motor which would only require one standby submersible pump. Excellent system flexibility is available with a standby pump in this situation since it could be used to replace either submersible pump or the standby pump motor could be interchanged with the dry mounted pump motor.

## 6 Planning Assessment

A planning assessment for identifying resource consent issues was prepared for this study and is detailed in Appendix 7.

The main recommendation of the planning assessment is that MDC should make every effort to obtain a designation for the treatment and pump station sites and rising main. This is recommended so that Resource Consents will not be required for these works. However, Resource Consents from Greater Wellington Regional Council will be required for the discharge of sewage and possibly bulk earthworks.

## 7 Comparative Cost Estimates

The table below summarises the cost estimates for 3 treatment and rising main options at 2006 prices. The costs for treatment, disposal, pump station and rising main items are based on previous reports for the Riversdale Beach Sewerage Scheme. Please note that the cost estimates include a common allowance to all 3 options, for the cost of a combined reticulation catchment to serve Riversdale Beach and the East Leigh development (\$6.6M).

### 7.1 Denniston Cost Estimate

<b>Option 1: Item Description</b>	<b>Cost Estimate</b>	<b>Comments</b>
Treatment and land disposal on Denniston property. Pond Location 1.	\$4.4M	The Denniston location and shape of the existing land requires more earthworks to construct the ponds.
Cost of pump station and dual rising main to Denniston property via East Leigh property. Pipe Route A+B.	\$1.7M	The pipe length and elevation (RL90) for this site is greater than for the locations considered in previous concepts. This results in a longer pipe length and requires a more powerful pump station (4x 22kW pumps).
Cost of reticulation	\$6.6M	Includes East Leigh reticulation
Operating costs + Life Cycle cost	\$1.7M	20yr NPV
<b>Total Denniston Property</b>	<b>\$14.4M</b>	

### 7.2 Tatham Cost Estimates

<b>Option 2: Item Description</b>	<b>Cost Estimate</b>	<b>Comments</b>
Treatment and land disposal on Tatham property. Pond Location 2.	\$4.0M	Similar to the Denniston property at Pond Location 1, except that the existing land is flatter and requires less earthworks for construction of the treatment plant.
Cost of pump station and dual rising main to Tatham property via East Leigh and Denniston property. Pipe Route A+B+C.	\$1.9M	The length of pipe required to reach Tatham property via Denniston and East Leigh property is significantly longer. Same pump station as above.
Cost of reticulation	\$6.6M	Includes East Leigh reticulation
Operating costs + Life Cycle cost	\$1.7M	20yr NPV
<b>Total Tatham Property 1</b>	<b>\$14.2M</b>	

<b>Option 3: Item Description</b>	<b>Cost Estimate</b>	<b>Comments</b>
Treatment and land disposal on Tatham property. Pond Location 2.	\$4.0M	Similar to the Denniston property at Pond Location 1, except that the existing land is flatter and requires less earthworks for construction of the treatment plant.
Cost of pump station and dual rising main to Tatham property via East Leigh property only. Pipe Route A+D.	\$1.4M	Less cost than above since the pipe route is direct to Tatham property and 1150m shorter. This pipe route requires a smaller pump station than the options above. (4x15kW).
Cost of reticulation	\$6.6M	Includes East Leigh reticulation
Operating costs + Life Cycle cost	\$1.6M	20yr NPV
<b>Total Tatham Property 2</b>	<b>\$13.6M</b>	

### 7.3 Discussion on Cost Estimates

#### 7.3.1 Capital Costs

The capital cost to construct treatment ponds on Tatham property is less when compared to the Denniston property because the Tatham site is more level and will require less earthworks. Pipe route A+D is significantly shorter in length than pipe route A+B+C. This makes a direct pipe route to Tatham property over Eastleigh property a more cost effective option.

#### 7.3.2 Operational Costs

The operational cost to pump sewage from Riversdale Beach to Tatham property is less for pipe route option A+D when compared to the alternative pipe route options. Please refer to Section 5.5 for other operational benefits not directly related to cost in the comparison above.

## 8 Conclusion

Opus has considered treatment and disposal of sewerage on Denniston and Tatham owned property for Phase VIII of the Riversdale Beach Sewerage Scheme.

Opus concludes the following:

- Both the Denniston and Tatham sites offer suitable alternative treatment and disposal sites to those discussed in earlier reports.
- Of the two sites considered, the Tatham site is preferred in terms of ease of construction and management.
- A dual-pipe rising main to supply sewage from proposed Pump Station 5, located at Riversdale Beach is the preferred system. A two stage pump station with a duty – assist – standby arrangement will be required.
- Easement access over East Leigh property to Tatham property is preferred for rising main services.
- Primary treatment by screening at the treatment site is preferred.
- The use of short rotation, coppicing forestry (eg eucalyptus) as a crop to which the treated effluent can be applied using surface or subsurface irrigation will aid land disposal of the treated effluent.
- A specific designation for the planned activities associated with the pump station, treatment and disposal sites is necessary so that a Resource Consent is not required.

The conclusions of this report are also included in the Riversdale Sewage Scheme Recommendation Report which compares all the considered options for a treatment and land disposal scheme to date.

## **Appendix 1: Layout Plan**