Homestead Bay Wastewater Treatment Options Report

Prepared for

Murphy's Developments Ltd

Prepared by

Lowe Environmental Impact

May 2017

Homestead Bay Wastewater and Land Treatment

Options Report

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1 INTRODUCTION

1.1 Overview

Murphy's Developments Limited (MDL) proposes to develop an area of land for residential use, located on the eastern side of Lake Wakatipu, south of Queenstown, in an area known as Homestead Bay. It is located approximately 8.5 km south of Queenstown Airport and directly to the south of Jacks Point residential area and golf course. Current access to the proposed Homestead Bay subdivision is via the airstrip access road from State Highway 6. The location is denoted by NZMG reference 5560044.9N, 2174807.2E. The Lake Wakatipu locality is an area of cultural, natural, historic, recreational and commercial importance with high value placed on both lake water quality and the natural environment.

The Homestead Bay development area is currently zoned under the Queenstown Lakes District Plan for rural activity. MDL aims to change the activity status to residential via a plan change.

MDL has approached LEI via Clark Fortune McDonald & Associates to prepare this "Options Report" which assesses the viable methods of wastewater (sewage) treatment and disposal or reuse options. This includes assessing effluent land application, the recommended sites, loading rates, land uses, set-backs, management constraints, potential for staging, and pumping to the QLDC Municipal Plant. LEI has also provided rough order costing undertaken to allow comparison of options. The costing includes the major components and likely annual operating costs via a Net Present Cost (NPC) analysis.

1.2 Project Scope

Lowe Environmental Impact (LEI) has been engaged by MDL to provide technical support for the treatment and dispersal of water for the Homestead Bay community. This "Options Report" provides MDL with information on onsite wastewater treatment and effluent land application, discharging to the QLDC Municipal Treatment Plant or to the Jacks Point community treatment plant, along with operating and capital cost expenditure.

The aim of this report is to provide MDL with sufficient information to assess which options are available and economically viable to support a Plan Change. It can also be used to make an informed decision, as to the most suitable method, for the treatment and either disposal or dispersal of effluent to land from the Homestead Bay community.

2 COMMUNITY WASTEWATER TREATMENT OPTIONS

2.1 Population and Design Flow Rates

The Homestead Bay development population and design flow rate is based on 130 dwelling equivalents.

The design of the neighbouring Jacks Point community wastewater treatment scheme based the peak occupancy ratio on 5 people per household. This was derived from a Kingston Morrison population survey (150 houses – approximately 10 % of total properties) over the peak summer weeks in Wanaka for Queenstown Lakes District Council in 1995/1996. The survey showed permanent residents averaged at 1.6 people per household and occupancy peaked at just over 5 people per household for 5 days and over 4 people per household for 16 days.

The Queenstown Lakes District Council (QLDC) Community Plan (2004), states that in 2001 Wanaka had 3,300 permanent residents living in 1,400 dwellings. This equates to an average of 2.3 people per household. In addition to these occupied dwellings, there were around 1,100 dwellings that were not occupied on a permanent basis. During busy periods (summer and winter) the population numbers grow significantly and estimates suggest that residents and visitors could total up to 12,000 people on a peak day. Based on the total dwelling figures this equates to an average of 4.8 people per household.

The average household size in Queenstown Lakes District is 2.5 people, compared with an average of 2.7 people for all of New Zealand (NZ Statistics, 2006 Census). NZS 4404:2010 Land Development and Subdivision Infrastructure recommends that the design flow shall be calculated by the method nominated by the territorial authority. In the absence of such information, then the number of people per dwelling should be based on 2.5 to 3.5 along with the average dry weather flow being between 180 to 250 L/person/day.

AS/NZS 1547:2012 "*On-Site Domestic Wastewater Management*" recommends a typical domestic wastewater flow allowance of 200 L/person/day for reticulated community or a bore water supply.

Table 2.1 summarises the recommended design flow rate and population/flow allowances for Homestead Bay using two methods.

Table 2.1: Design Flow Rate

Number of Dwellings	Population per Dwelling (people)	Flow Allowance (L/person/day)	Design Flow Rate (m^3/day)	Annual Flow Rate (m^3/year)
130	5	200	130	16,624 [a]
130	2.5	200	130 [b]	23,725

(a) Based on 5 people for 5 days, 4 people for 16 and 1.6 people for the remainder
(b) Flows from NZS4404 with 2 x peaking factor for WWF.

There has been a significant amount of population data collected for the Queenstown Lakes District and the design specifications, shown in Table 2.1, are in line with the Kingston Morrison Survey, NZ Statistics data, the Queenstown Lakes District Council (QLDC) Community Plan and NZS4404.

2.2 Sewer Reticulation Options

LEI considers there to be four available sewer reticulation options for the Homestead Bay community wastewater treatment system, as follows:

1. Sedimentation Tank Effluent Pumping (STEP) system;
2. Sump and grinder pump pressure sewer system;
3. Modified gravity system; and
4. Vacuum sewer.

The following sections detail the four reticulation options.

2.2.1 Option 1 – STEP System

Wastewater from each dwelling is collected in an on-lot Sedimentation Tank Effluent Pumping (STEP) Unit. This is a specialist onsite sedimentation (or interceptor) tank fitted with a pumping assembly which will pump liquid waste (effluent only, no solids) to the communal treatment system via the effluent sewer network.

Each interceptor tank would be connected to the wastewater main effluent sewer line via a service connection. This service connection protects the house from back-pressure and allows the house to be isolated from the effluent sewer in an emergency.

Typically the main collection lines will be 63 mm diameter medium density polyethylene. No manholes or minimum gradients are required. The pipe work is generally buried in a common services trench at least 450 mm below ground level at variable grade, i.e. it can follow the contour.

By removing the solids from the wastewater prior to transporting, the collection pipes can be smaller (e.g. 63 mm diameter) and can be laid in shallow trenches without the requirement for minimum gradients and velocities. The system will be effectively sealed meaning the treatment plant can be sized considerably smaller since it does not have to cope with large wet weather flows. A shallow system is desirable in areas of high groundwater.

There are two options available for the installation of a STEP system, as follows:

1. Shared STEP unit per two households.
2. One STEP unit per household.

Savings can be made, without compromising the system performance, by installing one STEP unit for every two dwellings; however, MDL should be aware of the following issues:

1. **Ownership**: Is the sedimentation tank owned equally by each residence, or owned by MDL, or Body Corporate, or vested to QLDC?
2. **Power:** How much of the Power does each residence pay; is this divided on a prorata basis or 50/50 split?
3. **Maintenance:** If maintenance is required due to a system failure, who takes responsibility for the cost of such maintenance. This is important if the failure is a result of poor management on the part of the occupants of one dwelling only. Who pays for septage pump-out at about 10 yearly intervals?
4. **Location:** Which property is the STEP unit sited on, or is it in public areas (roadside)?

It is recommended that a suitable management plan be prepared and that a copy be made available to each household.

2.2.2 Option 2 – Sump and Grinder Pump/Pressure Sewer

Pressure sewerage systems consist of a network of on-lot grinder pumps and medium to high pressure pipes, which integrate to form a collection system.

Gravity lateral pipes from any dwelling connects to an on-lot sump containing a purpose built pump and grinder unit. Wastewater is then discharged in the form of watery, finely ground slurry into small-diameter pressure piping. In a completely pressurised collection system, all the piping downstream from the pumping unit will normally be under pressure (45 m or less). Pipe sizes will start at 40 mm outside diameter polyethylene for property discharge lines.

Polyethylene pipe is usually used for the pipe network, which is fully sealed by electrofusion welding of joints or couplings. Depending on the topography, size of the system and planned rate of build out, appurtenances may include isolation valves, flushing points, air release valves at significant high points (if required), and check and stop valves on the property boundaries at the junction of each property connection with the main.

This system provides watertight reticulation and is similar to that of Option 1 in most facets. Primary treatment can take place at the treatment plant and if required the primary tank can be used as a carbon source for enhanced nitrogen removal. Ownership and maintenance issues are similar to STEP tanks but without the need for a 10 – 15 year pump-out.

2.2.3 Option 3 – Modified Gravity and Central Pumping

Wastewater is reticulated via gravity, from each dwelling, to one or more pump stations (this potentially can be at the sewage treatment plant). This option results in no solids removal prior to the treatment plant, thus pipes need to be larger and laid at sufficient gradient to convey solids. However, the system is modified from that of a conventional sewerage system; the modified sewers involve smaller diameter flexible pipe systems with limited manholes compared to conventional systems.

Modified gravity systems can be prone to stormwater ingress because, whilst utilising flexible pipe and fewer manholes over that of a conventional gravity system, they are not completely sealed and therefore can potentially result in a wet weather in-flow requiring a larger capacity wastewater treatment plant. However, wet weather flows are generally less than conventional gravity systems.

2.2.4 Option 4 – Vacuum Sewer

Vacuum systems operate under the principle of differential air pressure as the driving force. The sewer lines are under a vacuum of -50 kPa to -70 kPa, created by vacuum pump/s located within a vacuum pump station.

The pressure differential between the atmospheric pressure and the vacuum in the sewer lines provides the energy required to open the vacuum interface valves and to transport the sewage. Sewerage flows by gravity from homes into a collection sump. When 40 L accumulates in the sump, the vacuum interface valve located above the sump pneumatically opens and differential air pressure propels the sewage through the valve and into the vacuum main. Sewage flows through the vacuum lines and into a collection tank at the vacuum station. Sewage pumps transfer the sewage from the collection tank to the wastewater treatment facility. There are no electrical connections required at the home. Power is necessary only at the vacuum station.

The differential air pressure propels the sewage at velocities of 4 – 6 m/s, disintegrating solids while being transported to the vacuum station. The valve stays open for 4 – 6 seconds during this cycle. Atmospheric air used for transport enters through the 100 mm screened air inlet on the gravity line. There are no odours at this air inlet due to the small volumes of sewage and short detention times in the sump.

2.3 Wastewater Treatment Plant Options

Three treatment systems were considered for the treatment of the Homestead Bay wastewater. These include the following.

1. Community/decentralised treatment on-site using a package treatment plant, such as a Recirculating Textile Packed Bed Reactor;
2. Connect to the Queenstown Municipal Treatment Plant;
3. Connect to the Jacks Point Community Recirculating Textile Packed Bed Reactors.

There are several types and numerous suppliers of package treatment plants in New Zealand. They are generally variants of activated sludge technology and all meet secondary treatment quality standards. We have used two examples here – Recirculating Packed Bed Reactors (rPBR) and Sequencing Batch Reactor (SBR).

rPBR's are well established in New Zealand for small communities, giving a high-quality effluent and generally function well under fluctuating loads. This type of system is commonly used for community on-site wastewater where a high level of organic treatment, nitrogen reduction and the removal of pathogens are important considerations. An earlier version of what is now available is installed at neighbouring Jacks Point.

Gunn (2012) discusses the option of utilising a SBR; whilst this type of treatment technology could be employed for treatment of the Homestead Bay wastewater and does have advantages over other systems e.g. small foot print and can produce high quality effluent, LEI considers that it is not ideal for the following reasons:

- High volume of sludge production;
- High operation and maintenance requirements; and
- High operating costs.

Table 2.2 provides a summary of the advantages and disadvantages of the SBR and rPBR systems. Each system has been awarded a score of between 1 and 3 (3 indicating most desirable, 1 indicating least desirable).

Table 2.2: Summary of Wastewater Treatment Options (3 = Best, 1 = Least Desirable)

Parameter	SBR		rPBR	
	Description	Score	Description	Score
Capital expenditure	Moderate	2	Moderate	2
Running costs	High	1	Moderately Low	3
Additional carbon dosing	Yes	1	Usually not	2
Power requirement	High	1	Low	3
Maintenance requirement	High	1	Moderate	2
Sludge production	High	1	Low	3
Suitable for intermittent flow regimes	Yes if in parallel or balance tank	3	Yes	3
Noise	Moderate	2	Low	3
Remote servicing and trouble shooting	No, needs operator	1	Yes	3
Visual impact	Moderate	2	Low	3
Operation simplicity	Needs frequent operator input	1	Low operator	3
Odour production	Moderate	2	Low	3
Reliability	Moderate	2	High	3
Effluent treatment	High	3	High	3
Total Score		**23**		**39**

SBR technology requires a high level of operator assistance to ensure the system is maintained and operating to a high standard, otherwise it can be prone to failure and poor effluent quality. SBR's are an aerated technology and therefore requires a high power input, significantly exceeding that of a rPBR system; as a result of the high level aerobic microbial activity a large volume of sludge is produced requiring disposal. rPBR units are able to handle varying inflows through a high recycle ratio, whilst providing high quality effluent using simple systems that require low operation and maintenance requirements.

For the above reasons, LEI has not considered SBR technology further. Other package plants are available, such as submerged aerated filter systems. These have similar advantages and disadvantages as the SBR.

2.3.1 Option 1 – On-site Recirculating Textile Packed Bed Reactor (rPBR)

The recirculating packed bed reactor is a multiple pass packed bed aerobic wastewater treatment system. The packed bed media is an engineered textile, which has a high void capacity allowing for a large surface area. Wastewater enters a processing tank (recirculating tank) where anaerobic digestion and suspended solids removal can take place. Effluent is then pumped to the secondary treatment chamber where it percolates down through a textile media and is collected in the bottom of a filter pod. This process does not utilise forced aeration. From the filter pod, the flow is split (diverted) between the processing tank and the final discharge.

Effluent Quality

The expected effluent quality from a rPBR wastewater treatment plant is summarised in Table 2.3.

Table 2.3: Expected Final Effluent Quality

Parameter	Typical Domestic Raw Wastewater	rPBR[1]
Biological Oxygen Demand (BOD, mg/L)	< 450	< 20
Total suspended Solids (SS, mg/L)	< 350	< 25
Total Nitrogen (TN, mg/L)	< 70	< 35
Total Phosphorus (TP, mg/L)	< 30	< 5
Faecal Coliform (cfu/100 ml)	$10^3 – 10^6$	$< 10^4$

(1) Effluent quality gauged from supplier literature and Rotorua OSET Trial data.

Note that the colder temperatures in Central Otago means that nitrogen reduction in winter is difficult without significant heating or additional removal systems. Land based loading of N should be based on a mean concentration of 50 mg/L.

The rPBR effluent is considered to have been treated to a suitably high standard and is accepted by regulatory authorities as being suitable for land application.

2.3.2 Option 2 – Connect to the Queenstown Municipal Treatment Plant

This option requires the Homestead Bay wastewater to be pumped to the Queenstown Municipal Treatment Plant located on the true right bank of the Shotover River, between the river and the Airport Terrace.

Assuming a pressure sewer (no wet weather flow) to a main pump station, then there is a requirement for a flow rate of 4.5 L/s (peaking factor of 2.5 as per NZS4404) and approximately 10 km pipe run, between Homestead Bay and a manhole near Kelvin Heights, approximately 35 m of headloss across the pipe can be expected for a 100 mm diameter PVC pipe. Assuming a motor and pump efficiency of 60% and the density of wastewater being similar to water at 1000 kg/m^3; the pumping power required would be 3 kW. A duty-standby pumping system would be required, thereby having one pump on standby.

If the nearby Hanley Downs development is reticulated to Queenstown, then there is a possibility of conveying to Hanley Downs and joining that system; a distance of around 4 km.

This has not been discussed with Hanley Downs.

2.3.3 Option 3 – Jacks Point Community Treatment Plant

This option requires Homestead Bay wastewater to be pumped to the Jacks Point Community Treatment Plant located less than 500 m to the north. Only primary settled effluent can be exported to this system, therefore primary treatment would need to occur onsite utilising a STEP system. A community pump station would therefore not be required.

Flows would be buffered by the on-site tanks and would be less than that in Section 2.3.2 above.

This has not been discussed with Jacks Point.

2.4 Available Land Treatment Area Options

Should the option to install a community/decentralised wastewater treatment plant for the development be selected, then land treatment options need to be assessed.

The LEI site investigation looked at the potential land treatment area soils in detail. Sites A, B and C provides 3.4 ha of land usable land. The areas are all on the eastern boundary of the site. Based on the soil types, hydraulic conductivity, available area and terrain LEI considers all the areas identified (Areas A, B and C) to be suitable locations for effluent dispersal for land treatment.

Soil Infiltration

Results of the testing for K_{-40mm} are given in Table 2.1. The reported field measurements refer to clean water irrigation and are not considered to be suitable for continuous and sustained applications of wastewater.

In consideration of a wastewater application rate suitable for the investigation area, a conversion should be made to allow for the application of "enriched" water which has elevated levels of constituents (cations, anions, complex organic molecules). A value of 30% of the K_{-40mm} has been adopted in-line with the recommendations of Crites and Tchobanoglous (1998) to provide a Design Irrigation Rate (DIR); which has been calculated for each site. Average results are presented in Table 2.1.

Table 2.1: Soil Hydraulic Conductivity and Design Irrigation Rate

Sample ID	Soil Type	Phase	K_{sat} (mm/h)	K_{-40mm} (mm/h)	DIR (mm/d) (1)
Site 1	Wakatipu sandy loam	Rolling	76 ±19	3.3 ±1.8	24
Site 2	Eely sandy loam	Undulating	226 ±64	4.5 ±2.4	32
Site 3	Wakatipu sandy loam	Undulating	246 ±100	3.2 ±1.7	23

(1) Design daily irrigation rate based on soil hydraulic conductivity only (30% of K_{-40mm})

The DIR for the site ranges from 23 mm/d to 32 mm/d. The adoption of the lowest DIR for the entire site is recommended. This will further protect the groundwater beneath the development and adjacent waterways including Lake Wakatipu.

LEI considers a design irrigation rate of an average of 5 mm/day to be acceptable and this will result in a land treatment area requirement of 2.6 ha (based on a peak rate of 130 m^3/d). This rate allows the system to be dosed every 3 -4 days at a higher rate, then rested.

2.5 Land Dispersal Options

Based on soil type and soil profile, soil permeability, groundwater levels, required treatment outcomes, the potential quality of the effluent from a secondary treatment plant, and the proposed end use for the land, LEI considers that subsurface irrigation is the most appropriate for the land application of the Homestead Bay effluent.

2.5.1 Land Treatment Area Vegetation

Effluent passing through a soil matrix is subjected to plant and microbial uptake, filtration, sorption and biological and chemical process; all of which reduce the contaminant constituents prior to leaching to groundwater. Plant uptake results in a reduction of nitrogen and phosphorus; both of which are required for plant growth. Nutrients if allowed to enter water, in excess of naturally occurring concentrations, can result in nuisance periphyton growth and potentially eutrophication. An important part of any land application design is choosing the correct vegetation type and maintenance of the established crop. Factors to consider when selecting a vegetation type are:

- Short rotation crops;
- Climatic conditions;
- Soil types;
- Environmental constraints;
- Effluent chemical composition;
- Effluent application system;
- Aesthetic requirements;
- Land use; and
- Nutrient and water uptake requirements.

Plant uptake will be higher during juvenile growth when nutrient requirements peak, therefore managing any crop to maintain this phase is essential. When selecting a plant species consideration must be given to the environmental conditions as well as the hydraulic loading and chemical composition of the effluent. Not all plant species require the same hydraulic or nutrient input for growth; therefore, fast growing species (short rotation crops) that require a high nutrient input is preferable.

Landuse of the land treatment area will generally be via the following three methods stated in order of preference:

1. Cut and Carry.
2. Sheep grazing.
3. Cut and Leave.

Cut and Carry

"Cut" refers to mowing grass or grass type crops, tree felling (replanting with juvenile plants) or pruning vegetation back to stimulate regrowth; "carry" refers to removing plant material off site for sale or grazing elsewhere. If vegetation is not removed offsite, biological decay will result in the transfer of nutrients held within the plant back into the soil matrix, with the net plant uptake being near zero. The most common form is the making of hay, silage or baleage.

Sheep grazing

Sheep grazing removes dry matter (and thus nutrients) and converts it to wool and meat but recycles some back to the soil store; in theory the net input of nutrients from sheep urine and faeces will be less than that carried offsite in a cut and carry regime. Sheep are generally rotated around the site to optimise grazing and vegetation removal.

Cut and Leave

This option is generally only applied to sites that are not easily accessible and for which vegetation removal will be difficult, or are managed as turf areas, e.g. golf courses, bowling greens, etc. The net result is limited nutrient removal offsite; the plant life cycle of regeneration and decay will inevitably result in most nutrients taken up by the plants, re-entering the soil matrix during the decay phase. However, plant uptake will slow the rate of nutrient leaching and nitrogen losses occur due to soil organic matter accumulation and biological denitrification, in addition, evapotranspiration will reduce hydraulic pressure on the soils.

2.5.2 Land Use and Buffers at Homestead Bay

MDL would prefer to have the final landuse as open space pasture. They also accept cut and carry, i.e. shutting up the area to make baleage or similar, with no stock (although putting sheep in following harvesting for a day or two to tidy up around the fence lines is acceptable).

Buffer distances to boundaries are not generally required for subsurface drip, however, to be conservative, a 5 m buffer has been allowed to all external eastern boundaries. Buffer distances to ephemeral waterways of at least 50 m have been allowed for. These reduce the available land area down to 3.04 ha. This is greater than the area required for hydraulic loading.

This results in a nitrogen loading in the order of 395 kg N/ha/yr. Cut and carry systems generally have N loading in the order of 450 – 600 kg N/ha/yr, so the loading should be acceptable for consenting purposes with Otago Regional Council.

2.6 Wastewater Disinfection

Generally, UV disinfection is not a requirement if the method of effluent dispersal is via subsurface land application.

Soils have the ability to reduce pathogens a 1 log cycle for every 150 – 200 mm passage through the soil matrix.

3 COST ESTIMATION

This section provides the approximate capital and operational and maintenance expenditure required for the reticulation and treatment of the Homestead Bay wastewater for each option. UV disinfection has not been allowed for due to the application being subsurface.

The cost estimations summarised in Tables 3.1 to 3.3 have been split into three different categories, as follows:

1. Table 3.1: Land application options:

2. Table 3.2: Within-site reticulation and treatment options:
   - Presents all within-site reticulation and treatment plant options.
   - Includes the land application option (as per Table 3.1) allowing for a complete expenditure analysis.

3. Table 3.3: Within-site reticulation and pumping off-site to QLDC municipal, or Hanley Downs.
   - Presents all within-site reticulation options (as per Table 3.2).
   - Presents the option of discharging to QLDC municipal or Hanley Downs rather than onsite treatment and land application.

Tables 3.2 and 3.3 also provide the 20 year net present cost (NPC) of each option based on a discount rate of 8.75%. The NPC is useful in allowing for a comparison between high capital expenditure/low operating costs and low capital expenditure/high operating cost options.

Note that the NPC analysis assumes that reticulation and treatment are installed on day 1, then annual operating and maintenance costs. However, in reality with the systems proposed, significant staging savings can be made as the systems are generally modular. This may not be the case with the pumped option to the QLDC municipal plant.

It should be noted that only conceptual development plans are available at this early stage in the development process; therefore, the cost estimates provided are a guide with a likely ±30% level of accuracy.

Table 3.1: Homestead Bay Land Application Capital Expenditure

Land Application ($) **Description**	**Area 4**
Subsurface drip irrigation ($50,000/ha)	150,000
Total (Capital Expenditure)	150,000
Capital Expenditure per Lot	1,150
Annual Pumping ($/year)	1,100
Maintenance – annual flushing/replacement ($/year)	3,500
Total (Running Cost, $/year)	4,600
Running Cost per Lot ($/year)	35

Notes:
(1) Pumping costs based on $0.25/kW and 6 hours pumping day.

Table 3.2: Homestead Bay Wastewater Onsite Reticulation and Onsite Treatment

Description	STEP	Pressure Sewer	Gravity	Vacuum Sewer
Onsite Reticulation ($)				
Grinder tank/pump		884,000		
STEP tanks	845,000			
Boundary connection	45,500	78,000	84,500	297,000
Monitoring system				65,000
Low pressure sewer	121,000	121,000	363,000	
Vacuum sewer				262,500
Pump Station			200,000	185,000
Contractors P&G, design, mark-ups etc.	20,000	20,000	97,500	65,000
Total Reticulation (Capital Expenditure)	1,031,500	1,083,300	745,000	874,500
Total (per Lot)	7,935	8,331	5,731	6,727
Onsite rPBR Treatment Plant ($)				
Primary treatment		236,710	236,710	236,710
Pre-anoxic process	56,000	56,000	56,000	56,000
rPBR	540,550	540,550	540,550	540,550
Post anoxic process	57,000	57,000	57,000	57,000
UV disinfection	0	0	0	0
Total Onsite Treatment (Capital Expenditure)	653,550	890,260	890,260	890,260
Total (per Lot)	5,027	6,848	6,848	6,848
Land Application/Treatment ($)				
As per Table 3.1	150,000	150,000	150,000	150,000
Annual Operations and Maintenance ($/year)				
Carbon Dosing (if required)	2,880	1,440	1,440	1,440
Pumping Power Cost	1,463	2,966		2,281
UV disinfection (power/tube replacement/maintenance)	0	0	0	0
rPBR power costs	4,745	4,745	7,120	4,745
Pump station maintenance	n/a	n/a	n/a	3,300
Major service maintenance	3,335	3,335	3,335	3,335
Tank desludging	3,900	n/a	n/a	n/a
Reticulation maintenance	2,200	2,200	26,000	2,200
Treatment plant maintenance	13,000	13,000	13,000	13,000
Miscellaneous (consent compliance, grounds up keep etc.)	15,000	15,000	15,000	15,000
Land Application/Treatment Area (as per Table 3.1)	4,600	4,600	4,600	4,600
Total ($/year)	51,123	47,286	70,495	49,901
Total (per Lot)	393	364	542	384
Total Capital Expenditure ($)	3,040,050	3,328,260	2,990,260	3,119,760
Total Operations and Maintenance ($/year)	51,123	47,286	70,495	49,901
20 year NPC ($)	3,515,163	3,767,710	3,645,407	3,583,519

Table 3.3: Homestead Bay Wastewater Onsite Reticulation and QLDC Municipal Treatment

Description	STEP	Pressure Sewer	Gravity	Vacuum Sewer
Onsite Reticulation (as per Table 3.2) ($)				
Total (Capital Expenditure)	1,031,500	1,083,000	745,000	874,500
Total (per Lot)	7,935	8,331	5,731	6,727
Pumping/Reticulation to QLDC Municipal ($)				
Reticulation to QLDC Municipal (10 km)	900,000	900,000	900,000	900,000
Pump station (duty standby 3 kW pumps/electrical/building)	140,000	140,000	0	140,000
QLDC Municipal connection fees	913,900	913,900	913,900	913,900
Total (Capital Expenditure)	1,953,900	1,953,900	1,813,900	1,953,900
Total (per Lot)	15,030	15,030	13,953	15,030
Annual Operations and Maintenance ($/year)				
Pumping costs	2,190	2,190	4,380	2,190
Pump station maintenance	5,000	5,000	7,500	5,000
Major service maintenance	8,000	8,000	8,000	8,000
Tank desludging	3,900	n/a	n/a	n/a
Reticulation maintenance (including onsite)	52,200	52,200	76,000	52,200
Miscellaneous (consent compliance, grounds up keep etc.)	5,000	5,000	5,000	5,000
QLDC wastewater charges	71,500	71,500	71,500	71,500
Total ($/year)	147,790	143,890	172,380	143,890
Total (per Lot)	84	82	99	82
Total Capital Expenditure ($)	2,985,400	3,036,900	2,558,900	2,828,400
Total Operations and Maintenance ($/year)	147,790	143,890	172,380	143,890
20 year NPC ($)	4,358,891	4,374,146	4,160,918	4,165,646

(1) Estimate is based on topographical maps and further design information and can be considered to have a ±30% error.

(2) Development costs and rates charges have been provided by QLDC (2013) based on current rates and an evaluation of the proposed development. The development contribution is estimated at $7,030/lot. The annual rates contribution was estimated as being between $500 – $600; $550 has been used for the cost estimation shown.

If the wastewater is pumped to Hanley Downs rather than the QLDC reticulation system, then the above capital costs reduce by an estimated $500,000 primarily associated with the reduced reticulation distance.

The STEP system provides primary treatment and therefore the QLDC connection fee and rates charges may potentially be lower than estimated in Table 3.3; however, it cannot be stated with certainty at this early stage in the development process. The STEP primary treatment, will effectively buffer flows and mitigate many of the blockage issues associated with (non-primary treatment) sewer systems, allowing for a smaller rising main pipe diameter. However, the above are not likely to significantly change the outcome shown in Table 3.3.

Whilst the vacuum system does have a relatively low capital expenditure, there are a number of unknowns and it does not have a fully proven track record within NZ due to only two operational schemes having been installed. Experience within Christchurch suggests that the vacuum system may be prone to cost overruns from that stated in Tables 3.2 and 3.3 that were sourced from the equipment supplier. The vacuum system also provides very little in the way of attenuation;

therefore, should a fault arise, the reason for the fault and location must be determined immediately with a quick maintenance response or the system valve pits may overflow.

Table 3.3 specifies a pump station with low pressure reticulation, discharging wastewater to the QLDC municipal treatment plant. It should be noted that a pressure system could be utilised and if the headloss is below 55 m then potentially no pump station is required reducing capital and maintenance expenditure. However, the overriding factor in determining the cost of piping to the QLDC municipal treatment plant are development fees and rates charges.

4 SUMMARY

A number of options are suitable and viable for wastewater within the Homestead Bay site.

Based on the environmental conditions within the Homestead Bay vicinity, the required capital expenditure and operational and maintenance costs, initial investigations indicate that all within-site reticulation is feasible, however, due to issues with the vacuum systems installed in Christchurch City, vacuum is not recommended. LEI recommends either STEP or pressure systems are installed, as a gravity system requires designing the plant and land treatment area for wet weather flows.

Pumping to the QLDC reticulation system has a higher NPC by around $400,000 to $700,000 than onsite treatment and the construction cannot be easily staged; however, it should be noted that potential additional costs such as plant failures, land application issues, landuse for future subdivision, etc. are mitigated by this option and responsibility for treatment is no longer a local community responsibility. It should also be noted that the above costing does not take into account staging and this may change the NPC costing for within-site reticulation and onsite treatment/land application because staging can potentially reduce the initial capital expenditure for some of the options.

It is considered that the area of available land for effluent dispersal, their soils types, slope and depth to groundwater are suitable for effluent land treatment and management should be relatively straight forward. Development can also be undertaken in a staged manner. Generally, Regional Councils consider that a Council run sewerage system is usually the best outcome for the community, as maintenance and ownership issues are easily dealt with.

Should onsite treatment and effluent dispersal be preferred, LEI recommends the option summarised in Table 4.1. LEI consider that the onsite option is consentable through Otago Regional Council.

Table 4.1: Recommended Homestead Bay Community Wastewater Scheme

Vacuum or pressure sewer	STEP or pressure sewer reticulation to treatment plant.
rPBR treatment plant	A recirculating packed bed reactor.
UV disinfection	Not necessary.
Land treatment area	Areas A, B and C all used with 5 m buffer to boundary.
Irrigation method	Subsurface drip irrigation placed 150 – 200 mm beneath the surface.
Vegetation	Grassed and maintained on a cut and carry basis.

5 REFERENCES

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