Milford Opportunities Project - Stage 3

THREE WATERS INFRASTRUCTURE CONDITION AND FUTURE STATE ASSESSMENTS

CONTRACT SSI-O-406

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TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

ABBREVIATIONS

ASP	Activated Sludge Plant
BATNEC	Best Available Technology Not incurring Excessive Cost
BOD	Biological Oxygen Demand
DOC	Department of Conservation
DWQAR	Drinking Water Quality Assurance Rules
GSM	Global System for Mobile Communications
HAIL	Hazardous Activities and Industries List
MBBR	Moving Bed Bioreactor
MBR	Membrane Bioreactor
MOP	Milford Opportunities Project
MSI	Milford Sound Infrastructure
MSTL	Milford Sound Tourism Ltd
PE	Polyethylene
PMF	Porous Media Filter
RBC	Rotating Biological Contactor
SDC	Southland District Council
TF	Trickling Filter
UV	Ultraviolet
WWTP	Wastewater Treatment Plant
WTP	Water Treatment Plant

EXECUTIVE SUMMARY

WSP has been commissioned by the Milford Opportunities Project to assess the feasibility of the three waters component of the proposals in the Masterplan. This includes reviewing the existing three waters infrastructure in Milford Sound Piopiotahi and along the Milford Road, estimating what is required once the Masterplan is developed and providing commentary on the feasibility of any required upgrades.

Key findings of this assessment and cost estimates for upgrades to support the proposals in the Masterplan are provided by node below. The cost estimates provided are suitable for a feasibility study with an accuracy of +50 to -30%. As each project is developed, the cost estimate can be refined, and the accuracy will increase. Estimates provided are construction costs with total project costs compiled in the Stage 2 Cost Estimation report.

TE ANAU HUB

Te Anau's existing water supply and wastewater networks are owned and operated by Southland District Council (SDC). The final location for the Visitor Centre and Transportation Interchange has not been selected and will be confirmed as the project is developed. There is capacity within the water and wastewater treatment plants to accommodate the anticipated flows from both sites and SDC has hydraulic models of both networks which can be used to assess serviceability of the selected locations. It is noted that the water supply model does not currently include booster pressure zones in Sandy Brown Road and Kepler Heights and Patience Bay and therefore updates may be required to assess sites in these areas.

SDC's stormwater masterplan for Te Anau recommends that any new developments outside the current urban limits manage stormwater by treatment and disposal to onsite soakage systems. We anticipate the Transportation Interchange will be in this area. For areas within the urban boundary being redeveloped the stormwater masterplan recommends opportunities to reduce hardstand areas and incorporation of rain gardens and swales be investigated. We anticipate the Visitor Centre will be in this area. The incorporation of on-site stormwater management systems into the proposed sites is estimated to cost $500,000.

UPOKORORO EGLINTON REVEAL AND MIRROR LAKES SHORT STOP

It is recommended that the proposed toilet facilities at Upokororo Eglinton Reveal consist of non-flush toilets and containment tanks. Total containment tanks are recommended over a small treatment system which would require substantial maintenance. With containment tanks, non-flush toilets have been selected to minimise the volume of wastewater that needs to be transported to a treatment facility. The estimated cost for toilet facilities at Upokororo Eglinton Reveal is $410,000.

The most suitable wastewater servicing option for the Mirror Lakes Short Stop is non-flush toilets and containment tanks. The estimated cost for toilet facilities at Mirror Lakes is $230,000.

A containment tank level monitoring system is recommended at both locations.

TE HUAKAUE KNOBS FLAT

The Te Huakaue Knobs Flat water treatment plant provides potable water to the existing buildings and has recently been upgraded. Due to changing drinking water standards the treatment plant will require some minor upgrades (monitoring instrumentation and chlorination). Storage of

50 m^3 of treated water will be required as well as a new water supply pipeline to service development at Kiosk Creek. The estimated cost of water supply upgrades at Te Huakaue Knobs Flat and Kiosk Creek is $800,000.

It is recommended that the existing wastewater treatment plant at Te Huakaue Knobs Flat be replaced with a higher capacity system that can achieve higher effluent quality standards that are likely to be expected in the future. New wastewater conveyance infrastructure is required to convey wastewater from Kiosk Creek to the Te Huakaue Knobs Flat wastewater treatment plant and to service development in Te Huakaue Knobs Flat. The new packaged wastewater treatment system installed in 2023 meets current resource consent conditions, but future flow and environmental needs would require a significant plant upgrade. This is dependent on the Assessment of Environmental Effects at time of consenting. The estimated cost of wastewater upgrades Te Huakaue Knobs Flat and Kiosk Creek is $10,300,000.

CASCADE CREEK Ō-TĀPARA

At Cascade Creek Ō-Tāpara, the existing non-potable water supply that collects rainwater from shelters is insufficient to meet demand of campers. This water is not treated which makes it unsuitable for drinking. It is recommended that a more reliable bore water supply and treatment system be installed. To meet current regulations, the treatment system must consist of cartridge filtration and UV light disinfection, which will require a power supply. The estimated cost of the upgraded water supply is $540,000.

No increase to the existing wastewater containment tank capacity is proposed at the Cascade Creek Ō-Tāpara toilets. It is recommended a level monitoring system is installed on all existing tanks, having an estimated cost of $20,000.

THE DIVIDE/ WHAKATIPU TRAILS HEAD, GERTRUDE VALLEY, AND THE CHASM

Architectural concept drawings for the proposed shelter at the Divide show 5 additional vaulted toilet units and hand washing (Wyatt Gray Architects, 2019). An assessment of historical rainfall versus the anticipated water demand for hand washing facilities indicates rainwater harvesting is likely a sufficient source. However, a more detailed analysis of climate data will be required to optimise rainwater catchments areas and storage capacity to ensure there is sufficient water during dry periods.

Non-flush toilets with containment tanks are also recommended for the proposed toilets at Whakatipu Trails Head, Gertrude Valley and The Chasm. Tank level monitoring systems are recommended at all locations.

The estimated cost of the upgrades at the four sites is $1,055,000.

MILFORD SOUND PIOPIOTAHI

Upgrades to the existing water treatment plant in Milford Sound Piopiotahi will be required to meet the projected demand and comply with drinking water regulations. The upgrades required include online monitoring of water quality through the process, chlorination of the treated water and an extra 150 m^3 of treated water storage for resilience. The estimated cost of this upgrade is $650,000.

It is recommended that the existing wastewater treatment plant be upgraded to meet increased wastewater generation rates and achieve future quality standards. The estimated cost of this upgrade is $10,300,000.

There are opportunities to reduce water demand by reuse of high-quality effluent from the wastewater treatment plant for toilet flushing and other non-potable uses across Milford Sound Piopiotahi. It is noted that as water is considered plentiful in this region, reuse may not be considered necessary, and the cost of new infrastructure may outweigh the cost of increased water supply.

1 BACKGROUND

1.1 MASTERPLAN

The Milford Opportunities Project involves exploring ways to do tourism differently at Milford Sound Piopiotahi and along the Milford Road Corridor for the benefit of people and place. To date, this project has been through two stages with the third currently underway. Project stages include the following:

- Stage 1: establishing context, vision and objectives (completed in September 2018).
- Stage 2: consultation, engagement and research to develop a Milford Opportunities Masterplan from Stage 1 (Masterplan launched in July 2021).
- Stage 3: Phase 1 (current phase): testing the feasibility of the masterplan's recommendations. Phase 2: design, planning and implementation.

The factsheet from Stage 2 MOP Masterplan is included in Appendix A, setting out the key pillars, core concepts and objectives of MOP.

1.1.1 CURRENT STAGE 3

Stage 3 focuses on assessing the feasibility of the Masterplan, considering the capacity and condition of existing infrastructure along the Milford Road Corridor and regulatory requirements. Where existing infrastructure is insufficient to meet objectives of the Masterplan, details of new infrastructure have been developed and cost estimates produced.

The Masterplan hubs, nodes and short stop experiences that are being considered in the Stage 3 assessments are shown on Figure 1-1

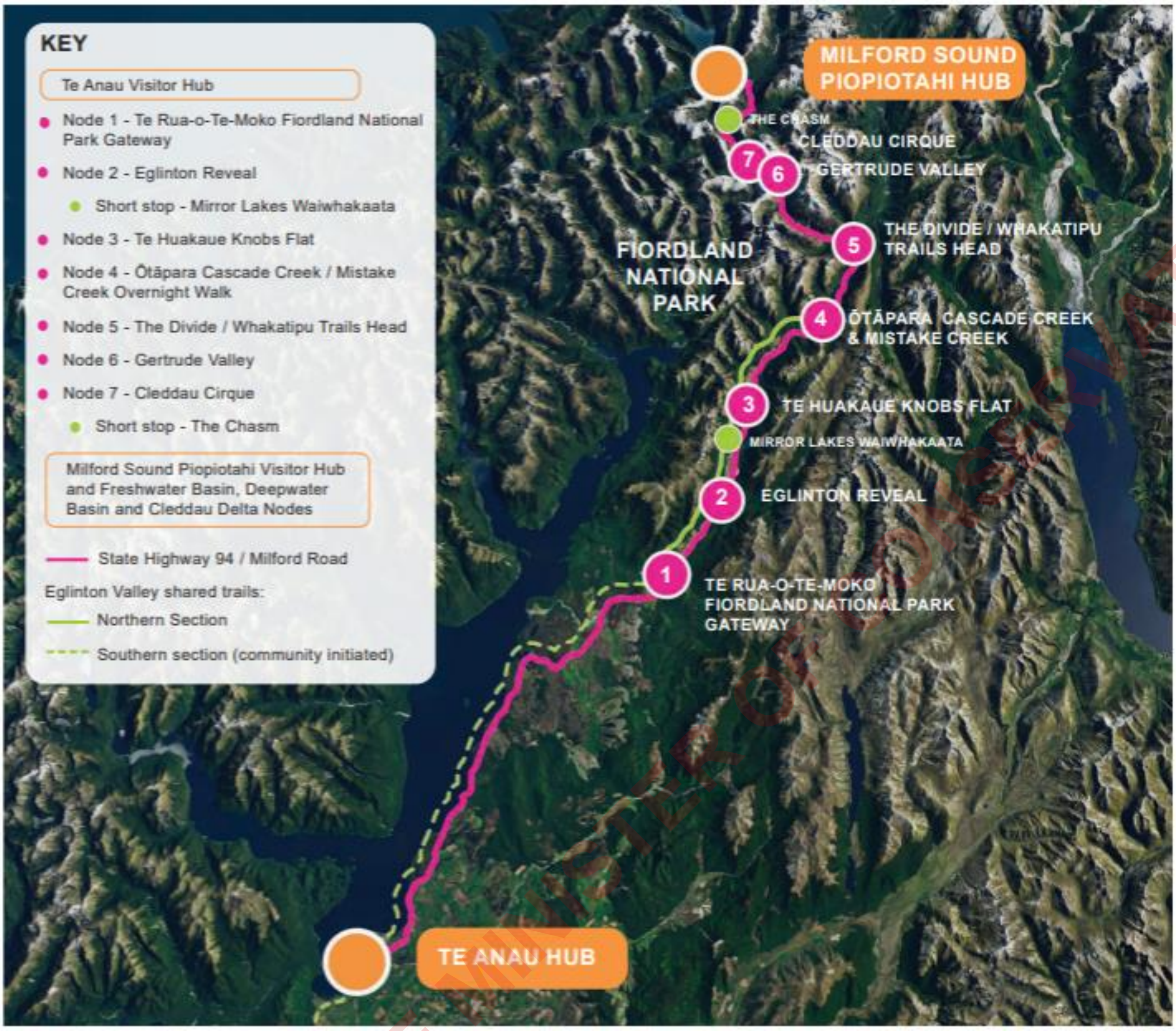

Figure 1-1: Milford Opportunities hubs, nodes and short stop experience sites.

1.2 STAGE 2 INFRASTRUCTURE REPORT

The Stage 2 Infrastructure Report (Stantec, 2021) provided a summary of existing infrastructure along the Milford Road Corridor and at Milford Sound Piopiotahi. This report aimed to establish a baseline of existing infrastructure, to identify the necessary upgrades to meet the objectives outlined in the Masterplan. This assessment considered three waters infrastructure, power/gas, and transportation infrastructure. In addition to the Milford Road Corridor, the Stage 2 Infrastructure Report also considered Manapouri and Doubtful Sound which are beyond the scope of this Stage 3 assessment.

Below, we detail the relevant aspects of the three waters infrastructure for the nodes being considered in Stage 3, acknowledging that several infrastructure upgrades have been completed along the corridor since the Stage 2 report was completed.

1.2.1 WATER SUPPLY

The Te Anau water supply is owned and operated by Southland District Council. Water for the supply is abstracted from three shallow bores along Lake Te Anau and a bore along the Upukerora

River (back up source). Water is treated including chlorine dosing before being distributed to customers. The main treated water reservoir has a volume of 1,020 m^3.

There is a low-pressure restricted water supply along Milford Road that delivers drinking water to the small suburb of Patience Bay.

The Milford Sound Piopiotahi water supply is owned and operated by Milford Sound Infrastructure Ltd. Water for the supply is primarily sourced from the hydro scheme penstock at Bowen River but can also be drawn from a bore or an emergency pond. The water is filtered and passed through UV disinfection before being distributed to customers. Treated water is stored in two large storage tanks of 85 and 45 m^3 capacity.

There was no information provided on the existing water treatment processes at Te Huakaue Knobs Flat in the Stage 2 Infrastructure report.

1.2.2 WASTEWATER

The Te Anau wastewater network is owned and operated by Southland District Council. The network consists of a combination of gravity sewers, pump stations and rising mains that discharge to the wastewater treatment plant (WWTP) at the northeast of the township. Wastewater treatment includes screening, an aerated oxidation pond and two maturation ponds. At the time of writing of the Stage 2 Infrastructure Report there was an ongoing upgrade at the WWTP, which included the addition of membrane filtration from the final pond and changing the treated effluent disposal location to the North Kepler Block near Te Anau Airport. This upgrade aimed to reduce the environmental impact of the WWTP through land-based discharge and accommodate growth in Te Anau.

The Milford Sound Piopiotahi wastewater network is owned and operated by Milford Sound Tourism Ltd. Treated wastewater from Milford Sound Village is discharged to water at Deepwater Basin. There was no information provided on the existing wastewater treatment processes in the Stage 2 Infrastructure report.

Milford Sound Tourism Ltd also owns and operates wastewater treatment facilities at Te Huakaue Knobs Flat. There was no information provided on the existing wastewater treatment processes in the Stage 2 Infrastructure report.

1.2.3 STORMWATER

Te Anau's total stormwater catchment area is approximately 336 ha, discharging to Lake Te Anau, the Upukerora River or to ground. Some newer subdivisions manage stormwater through on-site disposal rather than discharging to a public reticulation network. Stormwater quality treatment is only provided for stormwater from the town centre catchment.

There is limited stormwater infrastructure within Milford Village, consisting of sumps, laterals, manholes, pipes and outlets. No stormwater treatment is provided.

1.2.4 SUMMARY

The above sections describe the baseline infrastructure at the time of writing of the Stage 2 Infrastructure report. Long listed options were then developed for each of the three waters for further development.

This report aims to build on the Stage 2 Infrastructure report and provide a more defined scope at each node.

1.3 TOURISM REPORT

The Tourism Report (Visitor Solutions Ltd and Fresh Info Ltd, 2021) has been used as a key input for assessing future demand on water supply and wastewater infrastructure. This report states that of the 869,000 annual visitors, 27% arrive in January to February giving a monthly average peak visitor number of 3,976 per day. This is projected to increase over the next 30 years to 1.5 million per year. On the same proportion of visitors in peak months this gives an estimated number of visitors as 6,864 per day. An estimated potential peak day visitor number of 7,000 has been used in calculations and factored as appropriate for the various nodes.

It is noted that other reports have used average daily visitor numbers of 6,000 with a peak of 8,000. Assumptions of visitors or users of facilities at each node have been assumed however the solutions proposed are not especially sensitive and the difference in peak day visitor numbers does not change the recommendations.

For each location an estimate of population serviced and the nature of water volumes of are determined based on expected water usage. At this time in the master planning development there are several options for several locations that may change the needs of the water services provided. As example, should a park and ride be created at Upokororo Eglinton Reveal, additional water and wastewater assets will be required to service visitors using facilities at this location.

Estimates of water and wastewater are explained in the relevant sections below, but are only estimates based on information available at the time of this assessment. Once plans are finalised on other developments, these flows and loads will require review and the plans indicated below revisited.

2 STAGE 3 INPUTS

2.1 DOCUMENTATION

The following information has been provided to WSP to inform the three waters assessment described in this report:

- Milford Opportunities Project Stage 2 Tourism Infrastructure Report (Stantec, 2021)
- Milford Opportunities Project Stage 2 Tourism Report (Visitor Solutions Ltd and Fresh Info Ltd, 2021)
- Milford Sound Village Water Supply Schematic (JM McCutcheon, 2023)
- Cleddau Water Supply Schematic (JM McCutcheon, 2023)
- Cleddau River Flood Protection As built Service Plan Reticulated Water and Power (Downer, 2011)
- Milford Sound Main Water Supply and Treatment Schematic (JM McCutcheon, 2023)
- Milford Sound Drinking Water Safety Plan (2022)
- Milford Sound Development Authority, Services Plan Layout (MWH, 2010)
- Milford Sound Development Authority, Milford Sound Sewerage Scheme Operating & Maintenance Manual (Milford Sound Development Authority, 2014)
- Milford Sound Tourism Limited Sewerage Scheme Extract from report (John Cocks Ltd , 2018)
- Milford Sound Tourism Limited Milford Sound WWTP Effluent Results (sampling results for years 2019 to 2024)
- Milford Sound Tourism Limited Milford Sound WWTP Flowmeter data (Inflow (PS2) from 6/01/2023 to 12/01/2024 and outflow (discharge flowmeter 1/01/2023 to 22/01/2024).
- Knobs Flat WWTP – Treated Wastewater Quality (Lowe Environmental Impact, 2024)
- Knobs Flat Wastewater Treatment Plant Advantex O&M Manual (Innoflow Technologies (NZ) Ltd., 2023)
- Milford Sound Tourism Limited Knobs Flat Eco Lodge Wastewater Management Assessment of Treatment Options, Final Report (John Cocks Limited, 2019)
- Knobs Flat Site Development, Knobs Flat, Te Anau-Milford Hwy (SH94), Fiordland National Park Survey (Bonisch Consultants, 2018)
- Wastewater Disposal Site Geotechnical Investigation Knobs Flat, Te Anau-Milford Highway, Fiordland (GeoSolve, 2019)
- Knobs Flat Water Treatment Prelim Design & Budget (Marshall Projects, 2018)
- Knobs Flat Toilets & Camp, AdvanTex Wastewater Treatment Plant (Innoflow Technologies (NZ) Ltd., 2023)
- Knobs Flat water treatment plant details (Milford Sound Tourism Limited, 2024)

WSP also prepared concurrent reports as part of Stage 3 for other disciplines. These have been referred to where relevant.

2.2 EXTERNAL BRIEFINGS

Several briefings/meetings were held with infrastructure managers and MOP staff along the Milford Road corridor. Details of these briefings are provided in Table 2-1.

Table 2-1: Briefings with External Parties

PERSON	ORGANISATION	DATE	ITEMS
Tom Hopkins	Milford Opportunities Project	16/11/2023	Initial Client Briefing
John Cocks	John Cocks Ltd and Milford Sound Tourism Limited	20/12/2023	Te Huakaue Knobs Flat Water Supply and Wastewater Infrastructure, Milford Sound Piopiotahi Wastewater Infrastructure
Jock Edmondson	Milford Opportunities Project	20/12/2023	Visitor Modelling
John McCutcheon	Milford Sound Infrastructure	16/1/2024	Milford Sound Water Supply Infrastructure
Tom Hopkins	Milford Opportunities Project	6/3/2024	Draft document review briefing.

3 SITES WITH PROPOSED THREE WATERS INFRASTRUCTURE

The hubs, nodes and short stops in Stage 2 of the Masterplan along the Milford Road Corridor form the basis for this report. Table 3-1 summarises three waters infrastructure proposed at these locations.

Table 3-1: Three waters infrastructure required along Milford Road Corridor

LOCATION	WATER SUPPLY	WASTEWATER	STORMWATER
Te Anau Hub	✓	✓	✓
Node 1 Te Rua-o-te-moko Fiordland National Park Gateway			
Node 2 Upokororo Eglinton Reveal		✓*	✓
Node 3 Te Huakaue Knobs Flat/Mirror Lakes Short Stop	✓	✓	✓
Node 4 Cascade Creek Ō-Tāpara Campsite/Countess Range Hut	✓	✓*	
Node 5 Whakatipu Trails Head/The Divide Short Stop	✓	✓*	
Node 6: Gertrude Valley	✓	✓*	
Node 7 Cleddau Cirque and The Chasm Short Stop		✓*	
Milford Sound Piopiotahi Visitors Hub	✓	✓	✓

* denotes sites with toilets serviced by containment tanks (non-flushing)

The above table is based on the developments proposed by the Masterplan. WSP has not considered adding toilets at locations not proposed in the Masterplan or removing toilets where there are nearby toilets. It is assumed that the number and locations of toilets can be refined during the design phase.

4 METHODOLOGY

4.1 DESIGN FLOWS

Design flows adopted in design of water supply and wastewater infrastructure are summarised in Table 4-1.

Table 4-1: Water Supply and Wastewater Design Flows

SOURCE	PER CAPTIA WATER DEMAND (L/DAY)	PER CAPTIA WASTEWATER GENERATION RATE (L/DAY)	REFERENCE/ ASSUMPTIONS
Flush toilet	5	5	Estimated volume for single toilet flush and hand washing
Day Visitor (with Flush Toilet)	10	10	Estimated volume for two toilet flushes and hand washing
Day Visitor (with Non-Flush Toilet)	0	0.2	Estimated volume for human waste only
Day Visitor (with Non-Flush Toilet and Drinking Water Fill Point)	1	0.2	Estimated volume for one drink bottle fill and human waste only
Café User	12	12	Estimated volume for two toilet flushes, hand washing and one beverage/ drink bottle fill.
Campground User without Potable Water (Overnight)	10	10	Estimated non-potable water camper use (rainwater supply)
Campground User with Potable Water (Overnight)	80	80	Sourced from British Water (2013)
Basic Accommodation and Staff Accommodation (Overnight)	150	150	Sourced from British Water (2013)
Luxury Accommodation (Overnight)	250	250	Sourced from British Water (2013)

Peaking factors are applied to the above design flows as is described later in this report.

4.2 WATER TREATMENT OPTIONS

Potable water supplies in New Zealand are required to comply with the Water Services Act 2021. The requirement to comply with the Water Services (Drinking Water Standards) Regulations 2022 and the Drinking Water Quality Assurance Rules 2022 are most relevant to this report.

The Drinking Water Quality Assurance Rules (DWQAR) outlines the requirements for water treatment and supply. The DWQAR defines the rules relevant to the supply depending on the population served and complexity of the supply. These are broken down into General rules that apply to all supplies, as well as Source, Treatment and Distribution rules. Additionally, there are two relevant Acceptable Solutions for roof water and spring and bore water supplies that can be applied for supplies that serve less than 500 people for most of the year. The Acceptable Solutions are more prescriptive than the DWQAR but require less documentation and operational requirements which is preferable for small and isolated supplies.

All potable water systems suggested in the report meet the requirements of either the DWQAR or the Acceptable Solution and have been selected to provide the best fit for the site. In general, we have considered future populations to determine the required upgrades and these works may not need to occur until the population increases or other upgrades are completed.

It is our interpretation that the population served is the number of people who will use a supply on a peak or near peak day and thus includes day visitors, who might only use the supply briefly. This does have the effect of significantly raising the population when compared to a more conservative assumption but in the event of a contamination event is a more realistic number for the people affected. Near peak population is used where there is a benefit to considering a slightly lower population than at the peak. In particular, the Acceptable Solutions can be applied to populations of 500 or lower but this can be exceeded for 60 days, which is likely to be the case for or some of the sites along the corridor.

4.3 WASTEWATER MANAGMENT OPTIONS

Wastewater management/treatment options have been assessed for small- and large-scale sites along the Milford Road Corridor. Large sites offer overnight lodging and have flushing toilets, producing a significantly higher amount of wastewater each day. Small sites serve as day stops with toilet facilities only and generate a low volume of wastewater daily.

For this assessment Te Anau, Te Huakaue Knobs Flat and Milford Sound Piopiotahi are categorised as large sites and all remaining sites as small sites. At all sites, wastewater must either be removed from the National Park or treated to an appropriate standard before disposal.

4.3.1 SMALL SITES

There are several wastewater management options for small sites along the Milford Road Corridor. Table 4-2 summarises options available and presents a qualitive options assessment to select the preferred option for all small sites.

Table 4-2: Wastewater Management Options for Small Sites

WASTEWATER MANAGEMENT OPTION	ADVANTAGE	DISADVANTAGE	COMMENT
Pit Toilet	• Lowest capital cost of all options. • Easy to install. • Suitable for remote sites with low user numbers. • Number of units can be installed to match demand.	• Odour issues. • Limited volume. • Can leach contaminants to the environment. • Must be relocated when full.	• Not suitable for toilets that have high user numbers. • Will require consent in most cases as discharge will exceed allowed volumes. • More suitable for locations not accessible by road. • Poor user experience. • Other options available that are more environmentally friendly.
Composting Toilet	• Low odour and environmentally friendly. • Suitable for remote sites with low user numbers. • Number of units can be installed to match demand.	• Single unit capacity is limited, likely requiring many units to meet expected demand. • Odour issues if user numbers exceed capacity. • Public is not familiar with this type of toilet. • High maintenance requirements (adding carbon-rich materials, removing compost, and draining excess liquid).	• Not suitable for toilets that have high user numbers. • Will require consent in most cases as discharge will exceed allowed volumes. • More suitable for locations not accessible by road. • Poor user experience.
Vaulted/ Containment Toilet	• No treated effluent is discharged to the environment. • Number of units/ tank volume can be installed to match demand	• Tanks need to be emptied and wastewater transported to a suitable treatment facility.	• Recommended option for small sites where transport to an existing WWTP is feasible.
Septic Tank	• Inexpensive method of onsite treatment. • Tank volume can be installed to match demand	• Periodic sludge removal required. • Treated effluent is discharged to the environment. • Effluent quality likely to be poor, resulting in adverse effects on receiving environment. • Odour risk.	• Will require resource consent which will be difficult given with poor quality effluent discharge and suitable alternatives. • This option is not suitable as multiple discharges require consenting, monitoring and higher level of maintenance than other options.

WASTEWATER MANAGEMENT OPTION	ADVANTAGE	DISADVANTAGE	COMMENT
Secondary Treatment and Disposal	• Higher effluent quality compared to septic tank.	• Highest cost of all options. • Highest operational and maintenance requirements of all options. • Treated effluent is discharged to the environment.	• Requires resource consent. • Highest capital, operational and maintenance costs. • Would create several small sites requiring maintenance. Suitable for larger sites only.

The above table summarises the available options for managing wastewater at the small nodes. The findings are similar to the current management along the corridor, where toilets are high use and have road access, containment toilets are the most appropriate. These are pumped out and septage hauled to a suitable WWTP for treatment. It is recommended that total containment toilets are used at small sites.

To minimise the volume and frequency that wastewater needs to be transported away from these sites, it is recommended that handwashing and flushing toilets are not provided. Not providing water for handwashing and toilets will also remove the need for extra infrastructure and reduce the demand on water sources. Hand sanitiser will need to be provided at all locations.

As a world-class visitor experience, it may be decided in the future that handwashing be required at all stops, including small nodes. Where water supply is not currently recommended, additional provisions will be necessary to supply approximately 1 L per user and the recommended option of containment tanks and offsite treatment should be reassessed.

Wastewater management details specific to each site are included in their respective sections later in this report.

4.3.2 LARGE SITES

The increase in visitors identified in the Masterplan will result in an increase in flows to the existing WWTPs at Te Huakaue Knobs Flat and Milford Sound Piopiotahi. To increase capacity and protect the environmentally sensitive receiving environment, upgrades or new wastewater management strategies are needed.

For large sites, transport of wastewater for treatment at a suitable WWTP outside of the National Park is not a practical management strategy and therefore on-site treatment with local effluent disposal is needed. WWTP effluent quality targets and technology options are described below.

4.3.2.1 EFFLUENT QUALITY

Owing to the environmentally sensitive nature of Te Rua-o-Te-Moko Fiordland ecosystems, the quality of effluent discharged is important. To achieve standards that do not adversely affect the local ecology, water quality or pose a risk to public health, it is proposed that WWTPs provide at a minimum secondary treatment, nutrient removal and disinfection.

There are currently no national or local standards for contaminant concentrations in WWTP effluent. Minimum standards for WWTP effluents are being developed by Taumata Arowai at present and are expected to be in place by the time of future plant upgrades.

The future level of treatment required under these new standards is unknown at this time and therefore effluent quality standards have been adopted in this report that are considered most appropriate for minimal environmental effect. WWTPs described in this report are recommended to achieve the following effluent quality standards (95% percentile):

- BOD (Organic content) < 10 mg/l
- TSS (solids) <20 mg/l
- NH3 (ammonia) < 5 mg/l
- Total Nitrogen < 20 mg/l
- E coli <10 cfu/100ml

The above effluent quality standards will be determined by the local conditions and determined as part of the Assessment of Environmental Effects that will accompany the resource consent application for any plant capacity upgrades. The assumed standards are set at a high level to reflect the largely unmodified environment of the national park and to have the least impact on the surrounding streams and groundwater. Tighter standards are possible to be achieved but will require additional investment in technology and may be difficult to achieve the standards. This challenge is due to rapidly changing strength and volume of wastewater associated with both rainfall and changes in population and due to very cold climate in winter. The standards above can be achieved consistently under all conditions with the solutions recommended.

Higher standards for wastewater treatment can be achieved if required, but the standard given above recognises that the plants will be subject to substantial day to day and seasonal variation which can result in a lesser effluent quality. This can be overcome with higher levels of online monitoring, computer control and greater operator attendance at the site. Therefore, the standard provided and assumed in this review is the best practicable effluent performance.

In addition to the above, the concept of total pollutants and their effect on the environment should be considered. The increase in visitors identified in the Masterplan will result in an increase in flows to WWTP's, meaning that even if the effluent quality remains the same, the total pollutant load to the receiving environment will increase proportionally. To limit the effect of an increase in effluent discharge volume, it is preferred that the total pollutant load being discharged decreases or remains the same.

Therefore, it is expected that the discharge from the WWTPs will require a plant upgrade to deal with increased flow, load and to meet more stringent conditions of effluent quality to prevent deterioration of the groundwater and local streams and to protect the health of visitors.

4.3.2.2 WASTEWATER TREATMENT OPTIONS

To achieve the effluent quality parameters above, preliminary, primary (depending on configuration), secondary and tertiary treatment are required. These stages of treatment include:

- Preliminary treatment: Physical removal of gross solids and organic material (eg: screening),
- Primary treatment: Using settling processes to remove organic solids.
- Secondary treatment: the use of biological processes to degrade soluble organic material and nutrients, usually with a secondary solids removal process to capture the bioconverted organic solids produced by the process.
- Tertiary treatment: Advanced treatment to improve effluent quality through filtration and/ or disinfection.

The following discussion identifies commonly available systems that can be implemented for secondary treatment.

ROTATING BIOLOGICAL CONTACTOR (RBC)

Following a septic tank, a Rotating Biological Contactor (RBC) consists of vertical disks mounted on a horizontal shaft that rotate through the wastewater. Biological growth is attached to the surface of the discs, forming a biofilm which is aerated as the discs rotate. This is a low rate process and will require multiple units to remove ammonia and provide adequate capacity. These units require a secondary clarifier to capture biosolids and often are provided with tertiary filtration. This was the previous solution at Te Huakaue Knobs Flat prior to being upgraded.

MOVING BED BIOREACTOR (MBBR)

Following a septic tank, a Moving Bed Bioreactor is an aerated tank with a suspension of plastic media on which the bacteria grow. A secondary clarifier is required to capture the biosolids. This is one of the more energy intensive systems as air is constantly required to mix the media.

Generally, package MBBR systems do not include an anoxic recycle which would reduce total nitrogen and gain more alkalinity which is required for ammonia removal.

MEMBRANE BIOREACTOR (MBR)

Membrane Bioreactors contain a suspension of bacteria that rapidly adapt to changing load conditions. The mixed process is fed with air to power the bacteria. After the main treatment tank, the flow passes through a membrane that filters suspended solid, most bacteria and some viruses. UV disinfection may be required to give greater surety of disinfection but is not essential. No secondary clarifier is required as the membrane is a very efficient filter.

The aeration system requires aeration blowers to provide the air for the bacteria. These are acoustically enclosed to reduce noise and can be located in a site building for further noise reduction.

This option has no septic tank, so odour generation is very low compared to other options.

This technology is good for all scenarios as it can produce a very high-quality effluent consistently. The MBR is globally regarded as the Best Available Technology Not Incurring Excessive Cost (BATNEC) although compared to other levels of treatment is considered expensive as it is more complex.

MBR tanks are commonly built for above ground or part buried systems.

TRICKLING FILTER

The existing WWTP at Milford Sound Piopiotahi is a trickling filter.

Following a primary settlement tank or septic tank, the trickling filter is a low energy treatment approach where wastewater is distributed across the surface of the stone media with to which biological growth is attached.

However, this trickling arm is prone to winter freezing and damage during high winds. Due to the hydraulic profile of the unit with vertical flow occurring, the bed is typically 2 m above ground level and may generate flies in summer.

The biofilm system is slow to adapt to changes in loading and in cold conditions may not achieve enough ammonia removal. A large plant footprint is required to meet high quality standards and secondary clarifiers are required to capture the biosolids produced.

POROUS MEDIA FILTER

The existing WWTP at Te Huakaue Knobs Flat includes a porous media filter.

These systems as exemplified by the Innoflow system consists of recirculating flows across a textile packed bed. The system can be configured and sized to meet a range of load and performance criteria. This can include additional modules of treatment tanks to remove ammonia and recirculation of effluent to denitrify. Depending on how stringent requirements are for discharge of treated effluent this may be a viable solution to improve discharge quality and treat additional flows. A large footprint is required for multiple tanks.

A summary of the options, including expected effluent quality, advantages, disadvantages, and site-specific comments are provided in Table 4-3. For all treatment options incorporate a biological component. The activity of these biological processes is influenced by temperature: slowing down in cold conditions and speeding up in warm conditions. Seasonal population changes typically mean that periods of lower activity due to cold temperatures align with times of lower population, thus maintaining water quality. However, some WWTPs are particularly sensitive to low temperatures and may even freeze, resulting in a complete loss of treatment capabilities. These cases are detailed in Table 4-3.

Table 4-3: Wastewater Management Options for Large Sites

WASTEWATER TREATMENT OPTION	EXPECTED AVERAGE EFFLUENT QUALITY	ADVANTAGES	DISADVANTAGES	SITE SPECIFIC CONSIDERATIONS
Tanker Wastewater for Treatment at Suitable WWTP	N/A	• Inexpensive operational costs during low usage. • Inexpensive capital costs. • Simple to operate (onsite operators not required). • No power required. • Minimum new infrastructure required. • Low maintenance. • No effluent discharges on site. • Low odour (sealed tanks). • Not susceptible to changes in temperature (with no treatment)	• Expensive operational costs with multiple tankers required per day during peak usage. • Storage for 2 days requires tanks above or below ground. • High greenhouse gas emissions during transport.	• Unlikely to procure the number of tankers to remove wastewater at peak usage. • Volumes requiring treatment may impact the receiving WWTP. • Te Anau WWTP does not accept sludge from third parties, potentially requiring transport to Invercargill or Queenstown (consultation required). • High greenhouse gas emissions due to substantial tanker use and distance to suitable WWTP.
Septic Tank (with outlet filter)	BOD 100 mg/L TSS 150 mg/L NH_3 40 mg/L TN 40 mg/L	• Inexpensive. • Simple to operate. • No power required. • Resilient to changes in usage (fluctuation in user numbers). • Low maintenance. • Low frequency of operator attendance.	• Odour risk but covered tank. • Treatment efficiency reduced in cold weather. • Lower effluent quality impacts level of disinfection. • Higher risk of blockage in effluent disposal system. • Poor viral removal. • Primary Treatment only.	• Odour may be an issue due to proximity of accommodation and day users to septic tank. • Low-quality effluent may impact receiving environment (may not be suitable for obtaining future resource consent). • Not suitable for larger scale soakage field or river disposal due to poor quality effluent. • Risk to public if in contact with low-quality effluent.
Septic Tank, Rotating BioContactor (RBC) (Similar to Previous Knobs	BOD 10 mg/L TSS 20 mg/L NH_3 5 mg/L TN 40 mg/L	• Low power requirements. • Simple to operate. • Low maintenance. • Integral clarifier with open tanks on site. • Low odour from plant (covered). • Small footprint.	• Occasional high TSS in effluent. • Odour risk from septic tank. • Less resilient to changes in usage (fluctuation in users) due to low rate of biofilm growth. • Unable to remove Total N.	• Odour may be an issue due to proximity of accommodation and day users to septic tank. • Low-quality effluent may impact receiving environment (may not be suitable for obtaining future resource consent).

WASTEWATER TREATMENT OPTION	EXPECTED AVERAGE EFFLUENT QUALITY	ADVANTAGES	DISADVANTAGES	SITE SPECIFIC CONSIDERATIONS
Flat Te Huakaue WWTP before 2023 upgrade)		• Low frequency of operator attendance.	• Vulnerable to prolonged power outages (can cause uneven biofilm growth and damage).	• Risk to public if in contact with low-quality effluent.
Septic Tank, Moving Bed Bioreactor	BOD 15 mg/L TSS 30 mg/L NH_3 5 mg/L TN 40 mg/L	• System can be installed above or below grade. • Septic tank acts as screen. • Resilient to changes in usage (fluctuation in user numbers) due to completely mixed tank. • Low odour (covered). • Quick recovery from power outage. • Simple to operate. • Low frequency of operator attendance.	• Requires clarifier. • Highest power usage of all options (continuous aeration). • Can produce very fine non-settleable TSS in effluent. • Odour risk from septic tank • Requires shed for controls and blowers. • Unable to remove Total N. • Low levels of noise from blowers and moving media.	• Odour and noise may be an issue due to proximity of accommodation and day users to septic tank. • High Total N in effluent may not be suitable for obtaining future resource consent.
Septic Tank and Porous Media Filter (e.g. Innoflow) (Current Knobs Flat Te Huakaue WWTP)	BOD 10 mg/L TSS 25 mg/L NH_3 5 mg/L TN 20 mg/L	• Low visual impact. • Low power requirements. • Septic tank acts as screen. • Low odour (covered). • Simple to operate and maintain (current operator knows process).	• Odour risk from septic tank. • Single point of failure in recirculation system (single pump). • Prolonged power outage can lead to loss of biomass.	• Similar to current system, but with additional septic tanks, media units and greater recycling for nitrogen removal. • Suitable for subsurface land discharge as low TSS effluent • No odour reported for current Knobs Flat Te Huakaue system.
Conventional Activated Sludge	BOD 10 mg/L TSS 20 mg/L NH_3 – 1 to 10 mg/L (depending on design) TN 20 mg/L	• Can be built above or below grade. • Small footprint. • Primary treatment not required. • No odour in normal operation. • Good denitrification (Up to 80%). • Resilient to changes in usage (fluctuation in user numbers) due	• Weekly maintenance checks required. • Clarifier scraper system prone to failure in freezing conditions. • Screening recommended. • Higher skilled operator required. • Moderate power requirements. • Vulnerable to sludge bulking (TSS loss).	• Open tanks increase risk of public contact. • Suitable for subsurface land discharge as low TSS.

WASTEWATER TREATMENT OPTION	EXPECTED AVERAGE EFFLUENT QUALITY	ADVANTAGES	DISADVANTAGES	SITE SPECIFIC CONSIDERATIONS
		to completely mixed tank and high diversity of bacteria. • Quick recovery from power outage.	• Vulnerable to rising sludge in clarifier at low flows (TSS loss). • Requires small shed for controls and blowers.	
Membrane Bioreactor	BOD <1 mg/L TSS < 1 mg/L NH_3 <1 mg/L TN 10 mg/L	• Can be built above or below grade. • Small footprint. • No primary settlement required. • Modular, allowing for partial shutdown during low usage periods or for maintenance. • Resilient to changes in usage (fluctuation in user numbers) due to completely mixed tank and high diversity of bacteria. • No risk from TSS loss. • Capable of removing bacteria and many viruses (with UV). • Quick recovery from power outage. • High quality effluent is suitable for reuse. • Best available technology not entailing excessive costs (BATNEC).	• Higher specification of inlet screening than other treatment options. Increase in costs is not prohibitive. • Higher skilled operator needed. • Small shed for controls and blowers. • Small quantities of hypochlorite (approx. 20 L) need to be stored on site. • Additional sludge thickening equipment (however reduces operational/disposal costs).	• Compact plant with low space requirements and can be concealed within site. • High quality effluent with little/ no effect on surface water and suitable for reuse. • No risk from accidental public contact. • Low odour. • Can be built out of ground, increasing resiliency to flooding and high groundwater levels. • Small pipes may freeze but can be managed by installing all small pipework in an enclosure with local heating.

WASTEWATER TREATMENT OPTION	EXPECTED AVERAGE EFFLUENT QUALITY	ADVANTAGES	DISADVANTAGES	SITE SPECIFIC CONSIDERATIONS
Septic Tank / Primary Tank and Biological Trickling Filter (Similar to existing Milford Sound Piopiotahi WWTP)	BOD 10 mg/L TSS 15 mg/L NH_3 5 mg/L TN 40 mg/L	• Usually built out of ground for air circulation. • Simple to operate. • Low power requirements (recycle pump and screen only). • Media can be plastic or locally sourced gravels.	• Prone to freezing in winter. • Requires a clarifier for TSS removal. • May generate fly nuisance. • Screening essential. • Less resilient to changes in usage (fluctuation in users) due to low rate of biofilm growth. • Odour risk from septic tank. • Needs to be fenced to prevent public access. • Large footprint. • Vulnerable to high winds (damage to trickling arms). • Vulnerable to power loss (drying out of media during prolonged power outage may result in loss of biomass). • Splashing can increase risk of aerosol transfer to public in the area.	• Very large footprint. • Health risk to public from splashing of wastewater being sprayed on media. • Vulnerable to low temperatures and freezing.

The Septic Tank does not meet the proposed effluent quality requirements. This option is not considered further. The treatment options Rotating BioContactor, Moving Bed Bioreactor, and Biological Trickling Filter do not meet the proposed total nitrogen requirement, however, they have been assessed as there is potential for denitrification processes that could be added on the back end. The Porous Media Filter treatment system does not meet the expected effluent quality for TSS however, the existing WWTP at Knobs Flat Te Huakaue has not had a TSS result above 20 mg/L since the upgrade. While marginal the proposed effluent quality from a PMF is achievable.

4.3.2.3 SELECTION OF WASTEWATER TREATMENT OPTION

The use of a Multi-Criteria Analysis was used to select the preferred WWTPs for Te Huakaue Knobs Flat and Milford Sound Piopiotahi (see Table 7-6 and Table 12-5 later in this report). This assessment for both sites has considered the following criteria:

- Health and Safety
- Cost – Capital Expenditure
- Cost – Operational Expenditure
- Resilience to local climate
- Effluent quality
- Cultural Acceptability
- Adaptability to changing load
- Constructability - Footprint
- Operator Skill Level

All scores are relative to the base solution of the MBR with a scoring range of +5 to -5. Positive scores are given for when the parameter for a particular option is better than the base solution parameter and negative when the parameter is worse. No criteria weighing is proposed (all equally weighted).

The final scores are then tallied the preferred option being the highest score and least preferred the lowest score. If the Base solution is preferred then the highest score will be zero.

4.3.2.4 EFFLUENT DISPOSAL

The approach generally expressed by iwi in New Zealand is that it is a cultural preference to dispose of a well-treated and disinfected effluent through the land. The passing of the water through the land will restore Te Mana o te Wai. Disposal to water is not preferred and is a non-complying activity in Environment Southland's Water and Land Plan. Any discharges to water that are currently consented are unlikely to be authorised with the same parameters when consents are renewed.

A summary of a range of land disposal systems are discussed in Table 4-4, including advantages, disadvantages, and site-specific comments.

Table 4-4: Land Disposal Wastewater Management Options for Large Sites

LAND DISPOSAL OPTION	ADVANTAGES	DISADVANTAGES	SITE SPECIFIC CONSIDERATIONS
Spray Irrigation	• Inexpensive. • Technology has been successfully applied across New Zealand.	• Aerosols make unsafe for use in areas near public. • Above ground parts are prone to freezing. • Odour risk. • Large area required for land application. Best practice is an additional 50% land application area for long-term maintenance. • Grounds maintenance required (ex: landscaping) • Tertiary filtration required. • Requires pumping.	• Not suitable in close proximity to public. • Visual impact.
Subsurface Drip Line	• Not visible from above ground. • No public health risk from exposure. • Buried pipes have low risk of freezing. • No odour.	• Vehicles driving on subsurface lines may cause damage. • Buried lines have high installation and maintenance costs. • More complex controls than spray irrigation. • Large area required for land application. Best practice is to increase application area to twice land capacity for long-term maintenance. • Grounds maintenance required (ex: landscaping) • Prone to clogging which requires excavation to repair. Tertiary filtration required to minimize TSS in effluent.	• Requires fencing to prevent access by vehicles. • All options except MBR require tertiary filtration.
Surface Drip Line	• Second most inexpensive (lower cost than subsurface drip line)	• Potential public health risk from exposure. • Above ground parts are prone to freezing.	• Not suitable for either location as risk of public exposure. • Groundwater monitoring at Te Huakaue Knobs Flat (2018/19)

LAND DISPOSAL OPTION	ADVANTAGES	DISADVANTAGES	SITE SPECIFIC CONSIDERATIONS
		• Odour risk from stale effluent in pipelines. • Prone to clogging. Tertiary filtration required to minimize TSS in effluent. • Best practice to increase application area beyond land capacity to allow for long-term maintenance.	found high groundwater levels, heavily influenced by rainfall and proximity to the Eglinton River. • Soils at Te Huakaue Knobs Flat (west of highway) composed of silts, sands and gravels. • Visual impact unless drip lines installed in vegetated area.
Open Soakage Channel	• Low-cost solution • Easy to maintain with no buried parts. • Can provide habitat for wildlife. • Tertiary filtration not required.	• Potential public health risk from exposure. • Soakage capacity limited by high groundwater and rainfall. • Longer-term odour issues because of sludge accumulation. • Best practice is an additional 100% soakage area for long-term maintenance.	• Very high quality effluent is needed to prevent public exposure risk. • May require overflow through gabions to manage wet periods. • Groundwater monitoring at Te Huakaue Knobs Flat (2018/19) found high groundwater levels, heavily influenced by rainfall and proximity to the Eglinton River. • Soils at Te Huakaue Knobs Flat (west of highway) composed of silts, sands and gravels.
Gravel Soakage Channel	• No public health risk from exposure. • Tertiary filtration not required.	• Prone to clogging over long term (usually managed by multiple channels to allow for maintenance). • Best practice is an additional 100% soakage area for long-term maintenance.	• May require overflow through gabions to manage wet periods. • Groundwater monitoring at Te Huakaue Knobs Flat (2018/19) found high groundwater levels, heavily influenced by rainfall and proximity to the Eglinton River. • Soils at Te Huakaue Knobs Flat (west of highway) composed of silts, sands and gravels.
Gabion Basket	• Low-cost solution • Provides land contact before discharge to stream. • Low maintenance	• No post-treatment enhancement of quality. • Effluent discharge to watercourse requires iwi	• Requires very high quality effluent to reduce public exposure risk and impacts to receiving environment.

LAND DISPOSAL OPTION	ADVANTAGES	DISADVANTAGES	SITE SPECIFIC CONSIDERATIONS
	• Low area required, no backup application for use during system maintenance required. • No spare area required.	engagement to consider te mana o te wai.	
Constructed Wetland	• Provides additional nutrient removal in summer. • Can provide habitat for wildlife. • Perceived as green solution.	• Large area required with additional area needed for long term maintenance. • Grounds maintenance required to maintain flow paths (ex: landscaping). • Reduced performance in winter with plant dieback. • Effluent discharge to watercourse requires iwi engagement to consider te mana o te wai.	• Requires iwi engagement on te mana o te wai for direct discharge to watercourses.
Combined Gravel Soakage Channel with Gabion Overflow	• Suitable for all flow conditions (high level gabion outflow will allow for controlled overflow if flow exceeds soakage capacity). • No public health risk from exposure during normal operation (within capacity of soakage channel). • Low-cost solution. • Low maintenance.	• Requires iwi engagement on te mana o te wai (discharge to watercourses at high flow). • Consent required for disposal to land and stream. • Requires high effluent quality for stream discharge.	• Suitable for both Piopiotahi Milford Sound and Te Huakaue Knobs Flat. • Provides an effluent management solution for sites with limited land availability.

From the above options a combined gravel soakage channel with gabion overflow is the recommended disposal option. It is noted that a high quality effluent is required for this option. Engagement with iwi required to confirm soakage of treated wastewater effluent is acceptable.

4.3.2.5 WASTEWATER TREATMENT SLUDGES

The wastewater treatment processes described above all produce a waste sludge that is a combination of organic material from the wastewater and the result of biological growth as soluble organic waste and nutrients are removed. Where a septic tank is provided the sludge from the secondary process will be cosettled in the septic tanks and exported from site periodically. For the MBR process there is no septic tank so sludge can be mechanically thickened and held in a storage tank for regular removal from site. These sludges will be taken outside of Southland DC for disposal at another wastewater treatment site. For this report we have only considered the volumes and likely cost of tankering and disposal of these sludges, and do not include for capital upgrades at the receiving site.

4.4 STORMWATER TREATMENT OPTIONS

4.4.1 OVERVIEW

There is limited existing stormwater infrastructure along the Milford Road Corridor nodes. There is some infrastructure in Milford Village, consisting of sumps, laterals, manholes and pipes which discharge untreated stormwater to watercourses.

There is opportunity to incorporate stormwater quality management features into the proposed bus drop off / car park areas and other impervious surface at the Milford Road Corridor nodes. Bus drop off / car parks are proposed at Upokororo Eglinton Reveal, Te Huakaue Knobs Flat, Cascade Creek Ō-Tāpara, Whakatipu Trails Head, The Divide, Gertrude Valley, and The Chasm.

4.4.2 STORMWATER TREATMENT SYSTEMS

Features that can be included in bus drop off / car parks and other impervious surfaces are described below. In additional to improvements to the quality of stormwater runoff, these features can be incorporated in landscaping.

1. Permeable Pavement and Sidewalks: Using porous materials for parking surfaces to allow water to infiltrate into the ground, reducing runoff and filtering pollutants.
2. Bioswales: Vegetated channels designed to concentrate and convey runoff while removing debris and pollution. These can include natural or constructed flow channels that slow, disperse and filter stormwater.
3. Filter Strips: Strips of vegetation along the edges of the parking lot can filter pollutants from runoff before it enters the drainage system.
4. Rain Gardens: Shallow, vegetated basins that collect and absorb runoff from impervious areas like parking lots.
5. Oil and Grit Separators: Devices installed to treat runoff by trapping sediment, oil, and grease from the parking lot surface.
6. Tree and Shrub Planting: Trees and shrubs can absorb stormwater and pollutants, and provide shade to reduce surface temperature and evaporation.

7. **Green Roofs:** Installing green roofs on nearby structures can help manage and filter rainwater.
8. **Stormwater Wetlands:** Constructed wetlands specifically designed to treat polluted stormwater.
9. **Educational Signage:** Signs to educate the public about stormwater pollution and the measures taken to mitigate it.
10. **Proactive Maintenance:** Regular maintenance of stormwater management features to ensure their effectiveness. Regular removal of debris and pollutants from the parking lot surface.

4.5 COST ESTIMATES

For each upgrade an indicative physical works cost estimate has been developed. As the options presented in this report require refinement, and may change during detailed design, there is some uncertainty associated with these estimates.

The cost estimates provided are suitable for a feasibility study with an estimated accuracy of +50 to -30%. As each project is developed, the cost estimate can be refined, and the accuracy will increase. These estimates are for physical works only and exclude professional services, consenting, and contingency.

4.6 CARBON FOOTPRINT

There are several aspects that will influence the carbon footprint of the recommended infrastructure to meet objectives of the Masterplan, including the materials and their quantities (embodied carbon), chemicals, energy use, transportation requirements and process emissions (methane and nitrous oxide from WWTPs).

In comparing WWTP options, operational emissions from the wastewater treatment have been considered using the Water NZ guidelines (Water New Zealand, 2021) which are based on Intergovernmental Panel on Climate Change guidance. Although the carbon footprint of each option can be calculated, this is not an accurate estimate due to uncertainty on exact size of WWTPs, suppliers' materials, locations and pumps and pipework. This should be developed further within the design development.

5 TE ANAU VISITOR HUB

The Te Anau Hub will consist of a Visitor Centre and Transportation Interchange. The Visitor Centre will have an information centre as well a range of facilities and services, including ticketing, café and toilets. The Transportation Interchange will serve as a starting point for visitors to board buses that will take them into the Milford Road Corridor. A satellite support hub, including longer-term parking and bus depot is proposed to be serviced by hop on/hop off buses at the start and end of trips.

The locations of the Visitor Centre and Transportation Interchange within Te Anau are yet to be confirmed. There are reticulated water supply, wastewater and stormwater networks in Te Anau owned and operated by Southland District Council (SDC) which can be used for servicing these sites.

A review of 2018 census data shows that the off-peak population of Te Anau is 2,760 people. This is based on 1,038 residential properties occupied and 573 unoccupied at time of census. SDC have advised that 138 building consents have been issued since 2019, with some being for multiple dwellings, likely indicating at least 150 new dwellings have been constructed since the census. In the summertime peak, it is estimated the population will be 5,508, assuming all holiday houses and new builds have an occupancy rate of 4 people per property.

The draft Milford Sound Park and Ride Design Report (Beca Limited, 2024) on options for Park and Ride linked to the Te Anau visitor Hub, estimates the number of daily users could be 2,700 users per day during peak use in addition to the overnight population.

5.1 WATER SUPPLY

The location of both facilities in Te Anau has not been finalised and a detailed assessment of the water supply network capacity has not been undertaken. Extension of the supply to service the Transportation Interchange may be required. Water infrastructure servicing requirements will need to be confirmed as the concept is developed. SDC have previously developed a hydraulic model of the water supply system in Te Anau (WSP, 2019). The network currently operates at close to its operational capacity in peak periods.

There are two areas in the network where pressure is boosted by pump stations, being the upper terrace of Sandy Brown Road and Kepler Heights as well as Patience Bay. These were not configured accurately in the model due to the information available and were excluded. If the Visitor Centre or Transportation Interchange were located in these boosted areas then supply may not be available without network upgrades to meet the required level of service. If the locations are outside of the boosted pressure areas, then the model can be updated to assess any effects on the network.

A breakdown of the anticipated water demand for the Visitor Centre and Transportation Interchange is presented in Table 5-1. The combined peak daily water demand for the Te Anau hub is 118 m^3 per day.

Table 5-1: Te Anau Visitors Hub Water Demand Breakdown

	WATER DEMAND (L/DAY)	POPULATION	DAILY VOLUME (M³)
Visitor Centre			
Day Visitors	10	7,000	70
Café	12	1,750*	21
Total Daily Volume (L)			**91**
Transportation Interchange			
Day Visitors (Park and Ride)	10	2,700	27
Total Daily Volume (L)			**27**

*Assumes 25% of day visitors go to Café

5.2 WASTEWATER

Similar to water supply, a detailed assessment of the existing wastewater network in Te Anau to accommodate flows from both facilities has not been undertaken as their locations have not been finalised. Extension of the network or on-site wastewater disposal may be required if a remote location is selected. It is noted that SDC have undertaken modelling of their wastewater reticulation network which identified several network upgrades required to service growth (WSP, 2023). When the location is confirmed, the impact additional flows on the network can be assessed using the hydraulic model.

A breakdown of the anticipated wastewater volumes for both facilities is presented in Table 5-2. The combined peak daily water demand for the Te Anau hub is 118 m^3 per day.

Table 5-2: Te Anau Visitors Hub Wastewater Flows

	WATER DEMAND (L/DAY)	POPULATION	DAILY VOLUME (M³)
Visitor Centre			
Day Visitors	10	7,000	70
Café	12	1,750*	21
Total Daily Volume (L)			**91**
Transportation Interchange			
Day Visitors	10	2,700	27
Total Daily Volume (L)			**27**

*Assume 25% of day visitors go to Café

SDC have confirmed that following the upgrade of their WWTP that they do not have concerns with plant operational capacity at peak loading. They do not have concerns with the additional demand created by the proposed Visitor Centre and Transportation Interchange.

SDC have advised that the sludges from Te Huakaue and Piopiotahi Milford Sound and waste collected from vaulted toilets are not received at Te Anau WWTP and instead hauled to other sites.

Sites known to receive these materials are located at Invercargill and Shotover, Queenstown. No assessment of the ability and capacity to receive these wastewaters has been included in this report and should be considered in the next stage of the project.

5.3 STORMWATER

SDC recently developed a stormwater network Masterplan for Te Anau (WSP, 2022). For new developments beyond the existing urban area (likely site of the Transportation Interchange), the Masterplan recommended all new developments manage stormwater through onsite treatment and disposal to soakage systems. For redevelopment sites in town (likely site of the Visitor Centre), it was recommended that opportunities to reduce hardstand areas and incorporation of rain gardens and swales be investigated.

The Te Anau Hub should allow for stormwater attenuation, treatment, and soakage on site. There are opportunities to incorporate stormwater management features into the design of both facilities in carparks, buildings and green spaces. Table 5-3 presents an estimated cost for the stormwater management features only (does not include other site components such as buildings, paved surfaces, etc).

Table 5-3: Estimated Cost of Stormwater Management for Te Anau Hub

ITEM	ESTIMATED COST
Stormwater management (incorporated into carpark and greenspaces)	$400,000
Project overheads and delivery	$100,000
Total	**$500,000**

5.4 FEASIBILTY

The estimated peak water demand and wastewater discharge rate for both facilities in Te Anau is 118 m^3 per day (91 m^3 per day Visitor Centre and 27 m^3 per day Transportation Interchange). Te Anau has established water and wastewater reticulation and treatment plants. The existing treatment plants have capacity, however the serviceability of sites via existing reticulation should be confirmed when a final location is selected.

The proposed Te Anau Hub is considered feasible. The next best alternative has not been considered as this is expected to be developed once the locations have been confirmed.

6 NODE 2: UPOKORORO EGLINTON REVEAL AND MIRROR LAKES SHORT STOP

6.1 OVERVIEW

It is proposed that managed access to the Milford Road Corridor will begin at Upokororo Eglinton Reveal with no further access allowed without the appropriate permit. The concept layout for Upokororo Eglinton Reveal is shown on Figure 6-1, which includes a carpark with stopping and turning area, a shelter, and public toilets. The Mirror Lakes short stop is approximately 5 km north of Upokororo Eglinton Reveal and is proposed to have toilet facilities. A reticulated water supply or drink bottle fill points are not planned for this node and short stop.

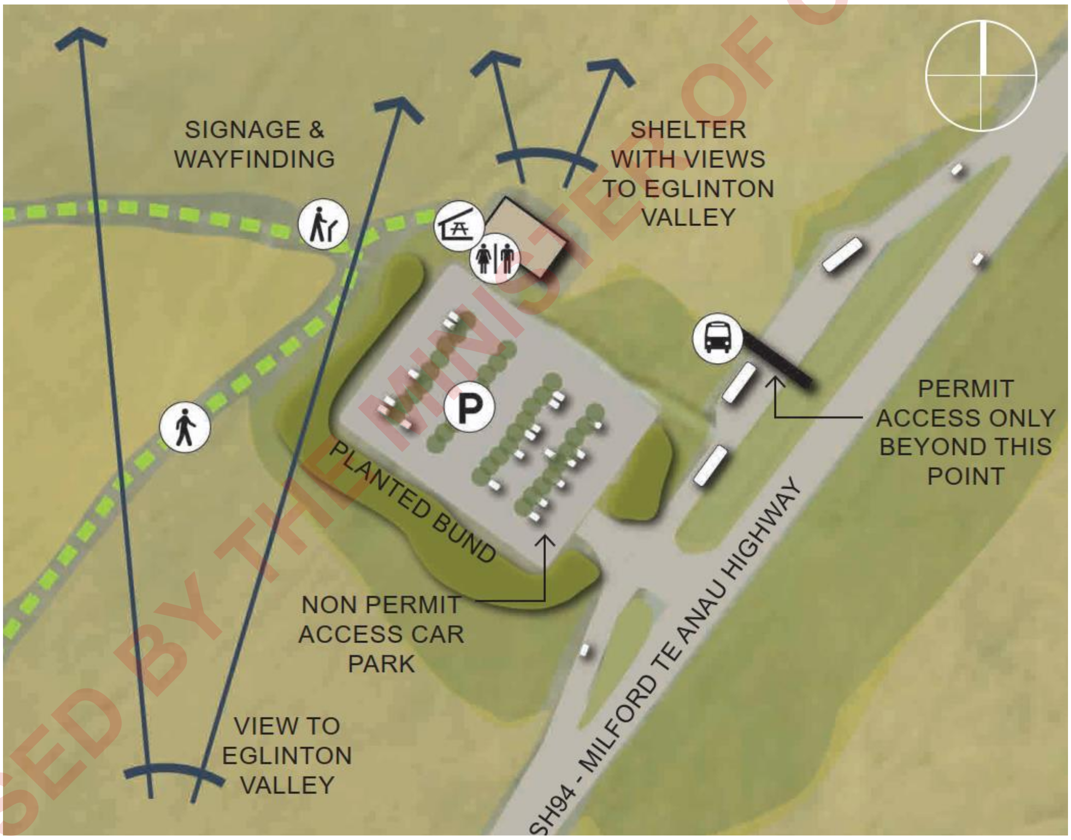

Figure 6-1: Node 2: Upokororo Eglinton Reveal Conceptual Layout

6.2 UPOKORORO EGLINTON REVEAL WASTEWATER

Four new toilets are proposed for Upokororo Eglinton Reveal.

Table 6-1 presents estimated wastewater generation rates with 1,000 uses per day using containment tanks.

Table 6-1: Upokororo Eglinton Reveal Estimated Wastewater Generation Rates

SCENARIO	PER CAPITA CONTRIBUTION (L/DAY)	DAILY WASTEWATER VOLUME (M^3/DAY)
Containment Tank Only	0.2	0.2

To meet this demand, it is recommended four 4.5 m^3 total containment units, along with a toilet building, be installed. Tanks are to be periodically emptied by septage tanker. This setup will ensure 80 days of storage capacity during peak use periods, based on the assumption that the tanks will be emptied once 4 m^3 of waste have accumulated in each. As hand washing facilities are not recommended at this small site, hand sanitiser will need to be provided.

A solar level monitoring probe on each tank with Global System for Mobile Communications (GSM) link to notify of high level is recommended.

An estimated cost for incorporating toilets into the planned shelter is presented in Table 6-2.

Table 6-2: Upokororo Eglinton Reveal Containment Tanks Estimated Cost

ITEM	ESTIMATED COST
Containment and toilet building	$300,000
Level monitoring	$10,000
Project overheads and delivery	$100,000
Total	**$410,000**

6.2.1 FEASBILITY

It is recommended that the Upokororo Eglinton reveal wastewater system is a total containment tank as described above. This option is considered feasible.

The next best alternative is to provide total containment with water supplied for hand washing only. Water for hand washing can be harvested from the roof of the shelter. This option would require optimising rainwater catchments areas to onsite water storage. This would have the added benefit as stormwater discharge from the shelter roof is collected and would not need to be discharged.

The nearby Mackay Creek is also an option depending on the volumes required.

6.3 UPOKORORO EGLINTON REVEAL STORMWATER

The proposed development at Upokororo Eglinton Reveal includes a 900 m^2 unsealed carpark. It is expected that bioswales would be appropriate at this location. It is assumed the cost of bioswales is included in the estimate for the carpark earthworks and landscaping as this is similar work.

6.4 MIRROR LAKES WASTEWATER

Two new toilets are proposed at the existing Mirror Lakes short stop.

Table 6-3 presents estimated wastewater generation with 500 users per day at this stop.

Table 6-3: Mirror Lakes Wastewater Generation Rates

WASTEWATER SCENARIO	PER CAPITA CONTRIBUTION (L/DAY)	DAILY WASTEWATER VOLUME (M^3/DAY)
Containment tank only	0.2	0.1

It is recommended two 3 m^3 total containment units and toilet building. Tanks to be emptied periodically by septage tanker. As hand washing facilities are not recommended at this small site, hand sanitiser will need to be provided.

A level monitoring probe on each tank with GSM link to notify of high level is recommended.

An estimated cost for this option is presented in Table 6-4.

Table 6-4: Mirror Lakes Containment Tanks Estimated Cost

ITEM	ESTIMATED COST
Containment and toilet building	$150,000
Level monitoring	$5,000
Project overheads and delivery	$75,000
Total	**$230,000**

6.4.1 FEASBILITY

It is recommended that the Mirror Lakes short stop wastewater system is a total containment tank with two pans as described. This option is considered feasible.

7 NODE 3: TE HUAKAUE KNOBS FLAT

7.1 OVERVIEW

Te Huakaue Knobs Flat has visitor accommodation in the form of cabins and non-powered campervan sites, DOC staff accommodation, amenity buildings and public toilets which are used by tour buses. The Kiosk Creek Campsite is approximately 500m to the north, having 10 non-powered campsites and a toilet facility.

The redevelopment of Te Huakaue Knobs Flat proposed in the Masterplan includes a range of accommodation, including cabins, and camper van and tent sites. Kiosk Creek is to have additional accommodation added, including a lodge with 25 beds and cabins added.

It is estimated in the Milford Opportunities Project Tourism Report (Visitor Solutions Ltd and Fresh Info Ltd, 2021) that the current number of day visitors is 2,000 and in calculations it has been assumed this will increase to 3,500 per day (half of daily visitors to Milford Sound Piopiotahi). The site will have accommodation to support up to 150 campers overnight.

Appendix B contains a layout drawing of existing three waters services in Te Huakaue Knobs Flat.

7.2 WATER SUPPLY

7.2.1 EXISTING WATER SUPPLY

Milford Sound Tourism Ltd owns and operates the existing water supply at Te Huakaue Knobs Flat.

Water from the supply is abstracted from hydro penstock which draws water from an unnamed tributary of Kiosk Creek. There is a Water Permit (AUTH-202503) which allows for abstraction of 30,000 L/day to supply to a tourist facility at Te Huakaue Knobs Flat. The consent expires 11 October 2045.

There is a water treatment system at Te Huakaue Knobs Flat that treats the water drawn from the Kiosk Creek tributary. The untreated water drawn from the tributary is stored in two 30,000 L PE tanks. The water from the tank is supplied to the water treatment plant, where it is filtered through 1 μm cartridge filters before passing through a UV reactor for disinfection. The treated water is provided to the site on demand, with no treated water storage tanks.

Considering the proposed development at Te Huakaue Knobs Flat and Kiosk Creek as well as day visitors who may use drink bottle fill points, the water supply will likely be classified as large under Taumata Arowai's Drinking Water Quality Assurance Rules (servicing a population of greater than 500 people).

There is a single ring main that services existing buildings on the site. The size and material of this watermain is unknown.

7.2.2 WATER DEMAND

A breakdown of the estimated current and future water demand for the proposed Masterplan projects at Te Huakaue Knobs Flat is summarised in Table 7-1.

Table 7-1: Te Huakaue Knobs Flat Water Demand Breakdown

SOURCE	CURRENT			FUTURE		
	Per Capita Demand (L/day)	Population	Daily Volume (m^3)	Per Capita Demand (L/day)	Population	Daily Volume (m^3)
Te Huakaue Knobs Flat Campground	80	50	4	80	150	12
Te Huakaue Knobs Flat Cabins	150	14	2.1	150	30	4.5
Kiosk Creek Campsite	-	20	-	80	50	4
Kiosk Creek Lodge	-	-	-	150	50	7.5
Te Huakaue Knobs Flat Public Toilet	5	2,000	10	5	3,500	17.5
DOC Accommodation	150	6	0.9	150	6	0.9
Total Daily Volume (m^3)			**17.0**			**46.4**
Average Demand (L/s)			0.20			0.54
Peak Demand (L/s)			0.60			1.61

As water for the Te Huakaue Knobs Flat supply is drawn from the hydro penstock, the quantity of source water is not seen as a constraint for the development of the three waters servicing for this site. However, a larger water take will require a new resource consent or permit. Instead, the capacity of the wastewater treatment system to handle higher flows that will result from the introduction of a potable water supply represents the primary limitation.

7.2.3 TREATMENT UPGRADES

As there is no existing treated water storage at Te Huakaue Knobs Flat, it is recommended that sufficient storage for 24 hours peak demand be provided for security of supply. As shown in Table 7-1, a total treated water storage volume of no less than 50 m^3 is recommended. The water storage could be either a longer life and more durable bolted steel tank or cheaper PE tanks.

The following upgrades will be needed for the water treatment to meet the large supply (>500 people served) requirements under the DWQAR:

- Turbidity, pH, and conductivity monitoring of the raw water.
- Differential pressure measurement across the cartridge filters.
- Flow, turbidity and UVT monitoring for the UV reactor.
- Chlorine dosing system.
- Flow, turbidity, pH and free available chlorine monitoring for the treated water.

A cost estimate for upgrade of the Te Huakaue Knobs Flat and Kiosk Creek water supply is provided in Table 7-2. This estimate assumes water storage tanks are bolted steel.

Table 7-2: Te Huakaue Knobs Flat and Kiosk Creek Water Supply Upgrade Estimated Cost

ITEM	ESTIMATED COST
Upgrade of Water Storage (50 m^3)	$180,000 – Bolted steel tank

ITEM	ESTIMATED COST
Treatment Plant Upgrades	$120,000
Water Supply Pipeline to Kiosk Creek (below River)	$500,000
Total	$800,000 – bolted steel tank

No allowance for the upgrade of the existing ring main has been provided. WSP has not been provided with any history on any bursts or repairs on this main. As such its condition is assumed to be suitable.

The provision for treated water storage provides contingency during WTP outages and if the penstock intake is damaged. It is noted that if the penstock is damaged, there would be no power at the site and likely requiring evacuation until the power supply is repaired.

7.2.4 FEASIBILITY

The proposed upgrades to the water supply at Te Huakaue Knobs Flat are considered feasible.

The next best alternative would be to utilise PE tanks for water storage which would cost an estimated $30,000 and provide cost savings of approx. $150,000. It is noted that plastic tanks are affected by UV which can cause degradation. Steel tanks will have longer life. Both will last >20 years and the estimated life of each depends on several factors. Steel is preferred.

7.3 WASTEWATER

7.3.1 EXISTING WASTEWATER SYSTEM

Milford Sound Tourism Ltd owns and operates the existing wastewater system at Te Huakaue Knobs Flat. The network consists of a small, reticulated network which services the public toilets, a camp kitchen, ablution block and DOC staff accommodation. The size and materials of the existing sewers, manholes and cleaning eyes is unknown but expected to be 100 or 150mm in diameter. Kiosk Creek campground has toilets with containment tanks.

7.3.1.1 WASTEWATER TREATMENT

The current WWTP has been recently upgraded. This system, installed in 2023 is an Innoflow package system consisting of septic tanks, media textile biological stage, recirculation system, and UV disinfection with discharge to two soakage trenches. The resource consent permits up to 40 m^3/d of treated effluent discharge. Data presented by Lowe Environmental shows good removal of BOD and TSS through the summer period (Lowe Environmental Impact, 2024).

Flows are reported to average 15.3 m^3/d during the peak tourist season (for the period of 25 October 2023 to 8 Feb 2024) With a peak day of 27 m^3/d at around the new year period.

The current WWTP is designed to achieve the effluent limits in Table 7-3 based on the consent conditions.

Table 7-3: Te Huakaue Knobs Flat WWTP Consented Effluent Discharge Quality Limits

PARAMETER	EFFLUENT LIMITS
Total suspended solids	30 mg/l (in 3 of 4 samples)
BOD	30 mg/l (in 3 of 4 samples)
Total suspended solids	< 50 mg/l upper limit
BOD	< 50 mg/l upper limit
E Coli	< 200 (in 3 of 4 samples)

Effluent quality data provided shows the WWTP regularly does not achieve E coli and BOD requirements.

Effluent monitoring data from 2023 shows that the upgraded WWTP is performing well for TSS removal and regularly achieves consent requirements.

Prior to the recent upgrades, effluent with 70 mg/L of ammonia (as N) was being discharged to bore soakage areas (Milford Sound Tourism Limited Knobs Flat Eco Lodge Wastewater Management Assessment of Treatment Options, John Cocks Limited, 2019). This level of ammonia is harmful to many species of aquatic life and effluent should be treated to a much higher standard. The O&M manual for the upgraded WWTP (Innoflow, 2023) shows the system was not designed for nutrient removal, so high levels of ammonia are expected in effluent, however Ammonia is not currently monitored. (Lowe Environmental, 2024).

7.3.1.2 EFFLUENT DISPOSAL

Two new effluent soakage trenches were constructed as part of the recent WWTP upgrade. It is assumed that ground conditions were deemed to be suitable given the new construction.

Investigations by Geosolve in 2019, as part of MSTL's proposed redevelopment of the site, assessed the areas for suitable land disposal. Permeability tests showed a variety of soil types in the area, which are composed of alluvial deposits, so have areas of sand, sandy silty and silt. The sand areas have greater permeability and are more suitable for land disposal. Underlying the fluvial deposits are glaciated bedrock and hummocks which may form a barrier to disposal, noting that where the water is unable to permeate to depth, localized tracking may occur resulting in indirect flow into the watercourse. This substratum means that a wastewater discharge will permeate to a shallow depth and then track laterally and may indirectly enter local streams. Usually there will be high dilution from rainfall contribution to groundwater and dilution in the stream, but in extended dry periods there is potential for effect on the receiving aquatic environment.

However, the impact of high ammonia concentrations as described above may have impact on the local aquatic environment and the same pathway may contribute human derived bacteria to surface water. It is therefore recommended that any WWTP upgrades produces a high quality of effluent that minimises impact of ammonia and human derived bacteria.

Wastewater Flows

Table 7-4 provides an estimate of the future flows as based on the expansion plans in the Masterplan. Peak volume estimate is based on 2 x DWF. This assumes the network is constructed to a high standard with limited infiltration and ingress through network.

This is considered reasonable given the small size of the network and corresponds with the flow data provided. For existing conditions, the peak day volume approximately matches the observed peak 27 m^3/d reported above.

The upgrades proposed in the masterplan will increase the estimated peak dry weather flow to approximately 100 m^3/d. Increase in visitors to public toilets are assumed to be proportional to total visitor number increase. While there are additional toilets proposed at other nodes proposed in the masterplan, Te Huakaue Knobs Flat has a reputation of being the last flush toilet before Milford Sound Piopiotahi and is a popular stop for coaches. This is expected to continue with the increase in visitors. The estimated future flow is above the current operational capacity of the existing WWTP.

It is understood that MSTL had previously developed plans for alternate development at Te Huakaue Knobs Flat. This assessment considers the masterplan proposal only.

Table 7-4: Existing Estimated Dry Weather Wastewater Flow at Te Huakaue Knobs Flat and Kiosk Creek

SOURCE	CURRENT		
	PER CAPITA CONTRIBUTION (L/DAY)	POPULATION	DAILY VOLUME (M^3)
Te Huakaue Knobs Flat Campground	80	50	4
Te Huakaue Knobs Flat Cabins	150	14	2.1
Kiosk Creek Campground	-	-	-
Kiosk Creek Cabins	-	-	-
Te Huakaue Knobs Flat Public Toilet	5	2,000	10
DOC Accommodation	150	6	0.9
Total Volume (m^3/d)			**17.0**
Estimated Peak Flow (m^3/d)			**34.4**

It is noted that the existing flow estimate corresponds to the recorded flows.

Table 7-5: Future Estimated Dry Weather Wastewater Flow at Te Haukaue Knobs Flat and Kiosk Creek

SOURCE	FUTURE		
	PER CAPITA CONTRIBUTION (L/DAY)	POPULATION	DAILY VOLUME (M^3)
Te Huakaue Knobs Flat Campground	80	150	12
Te Huakaue Knobs Flat Cabins	150	30	4.5
Kiosk Creek Campsite	80	50	4
Kiosk Creek Lodge	150	50	7.5

SOURCE	FUTURE		
	PER CAPITA CONTRIBUTION (L/DAY)	POPULATION	DAILY VOLUME (M^3)
Te Huakaue Knobs Flat Public Toilet	5	3,500	17.5
DOC Accommodation	150	6	0.9
Total Volume (m^3/d)			46.4
Estimated Peak Flow (m^3/d)			92.8

7.3.2 WASTEWATER NETWORK UPGRADES

The Stage 2 Infrastructure report (Stantec, 2021) identifies the wastewater at Kiosk Creek and at Te Huakaue Knobs Flat as separate systems. WSP recommend that to minimise capital and operational costs of facilities that these be integrated into one wastewater system. For wastewater this will require a transfer pump station to reach the location of the wastewater treatment system. This approach also increases the flexibility of the location of a WWTP which will be dictated by the availability of suitable land for disposal trenches.

7.3.3 WASTEWATER TREATMENT PLANT UPGRADES

7.3.3.1 LEVEL OF TREATMENT

As described in Section 4.3.2.1, there are currently no national or local standards for wastewater treatment processes or contaminant concentrations in effluent. Therefore, effluent quality standards have been adopted in this report that are considered most appropriate for minimal environmental effect (and most likely to achieve future consent conditions).

Recent performance data and O&M information (LEI 2024, and Innoflow 2024) indicates that the WWTP is suitable for carbonaceous treatment only (removal of organic carbon compounds). It is not designed to lower nitrogen levels by nitrification and denitrification. It is therefore expected that continuing to use the existing system will not meet the proposed criteria. There are add-ons to the existing WWTP system that can reduce nitrogen, however it cannot be confirmed these will meet the proposed requirements.

7.3.3.2 SELECTION OF PREFFERED TREATMENT OPTION

There are several treatment options available which were described in Section 4.3.2.2 that would be suitable for the treatment of wastewater at Te Huakaue Knobs Flat. In order to select the appropriate treatment option, a Multi-Criteria Analysis was undertaken.

This review considered the following options:

- Tankering wastewater offsite for treatment at suitable WWTP.
- Septic tank and Rotating Biological Contactor (RBC).
- Septic tank and Moving Bed Bioreactor (MBBR).
- Septic tank and porous media filter (PMF) (similar to existing Innoflow system).

- Septic tank and trickling filter (TF).
- Membrane Bioreactor (MBR).

The below table presents scoring for each criterion based on the advantages and disadvantages of each treatment option. All scores are relative to the base solution of the MBR as this system is the only solution that meets the minimum environmental performance criteria that was identified in Section 4.3.2.1. No criteria weighing has been applied (all equally weighted). There is additional discussion below.

Table 7-6: Multi-Criteria Assessment Scoring for Te Huakaue Knobs Flat and Kiosk Creek

PARAMETER	MBR	TANKER AWAY	SEPTIC TANK AND RBC	SEPTIC TANK AND MBBR	SEPTIC TANK AND PMF	SEPTIC TANK AND TRICKLING FILTER
Health and Safety	0	0	0	0	0	-1
Cost – Capital Expenditure	0	4	2	2	3	2
Cost – Operational Expenditure	0	-5	1	-2	-1	-1
Resilience to local climate	0	0	0	0	-1	-3
Effluent quality	0	0	-3	-2	-1	-2
Cultural Acceptability	0	0	-3	-2	-1	-2
Adaptability to changing load	0	-2	-2	-1	-1	-2
Constructability - Footprint	0	0	-2	-2	-4	-4
Operator Skill Level	0	2	3	2	2	2
Total Score	0	-1	-4	-5	-4	-9

Health and Safety

All new plants will be designed and constructed to provide a safe workplace with all reasonably practicable risks managed. All new plants have therefore been scored to a similarly high level.

The trickling filter is scored slightly lower due to the increased health risks from splashing wastewater arising from the distribution of water onto the stone filters.

Cost – Capital Expenditure

The MBR option has been costed and is known to be a relatively high-cost solution. All other options are scored relative to the MBR capital cost, with each point (positive or negative) representing an estimated $1m difference. The estimates of capital expenditure costs indicate that the MBR is the more expensive outcome but is not substantially greater than several other options that can produce a lesser quality outcome.

Cost - Operational Expenditure

An estimate of operational costs for each option is presented below. This has considered the nature of the wastewater sludge produced, its quantity, tankering costs and disposal, power at average conditions and operator attendance.

Assumptions made in the operational costs estimated are as follows:

- Power and sludge are calculated based on peak monthly average population. Annual average is assumed as 1/3 of this rate.
- Tanker away is based on peak dry day flow and assumes annual average is 1/3 of this rate.
- Labour includes operator attendance on site, grounds maintenance, equipment maintenance and sampling. The MBR has a higher attendance on site as 4 hours/ week for site checks and sludge thickening.
- Sludge tankering and disposal cost of $200/m^3$
- All operator hours are the time spent on site and exclude travel.
- Tanker volume is 10 m^3.
- Expected cost for MBR membrane replacement is $100,000, assumed to be required every 10 years.

Table 7-7: Estimated Operational Costs - Te Huakaue Knobs Flat and Kiosk Creek

ITEM	UNIT	MBR	TANKER AWAY	SEPTIC TANK	SEPTIC TANK AND RBC	SEPTIC TANK AND MBBR	SEPTIC TANK AND PMF	SEPTIC TANK AND TRICKLING FILTER
Daily Peak Volume	m^3	1.4	95	2	3	3	3	3
Tankers Per Year	$	17	1156	24	37	37	37	37
Tanker Cost	$	$ 34,070	$ 2,311,670	$48,670	$73,000	$73,000	$73,000	$73,000
Power Cost (@40c/kwh)	$	$ 14,020	$0	$0	$11,680	$23,360	$14,020	$9,450
Operator Hours/yr	hrs	408	120	132	232	376	252	356
Operator Cost @100/hr	$	$40,800	$12,000	$13,200	$23,200	$37,600	$25,200	$35,600
Membrane Replacement (Annualised)	$	$10,000	-	-	-	-	-	-
Total Opex	$	$98,890	$ 2,323,670	$61,870	$107,880	$133,960	$112,220	$117,950

The estimates of operational expenditure costs indicate that the MBR is the more expensive than other treatment options which produce a lesser quality outcome.

Resilience to Local Climate

This criterion is scored on the resilience of the process and susceptibility to cold weather. Nutrient removal is vulnerable when the treatment process drops below 5°C and in some cases may take several weeks to fully recover from zero-degree conditions. Many processes are more resilient to changes in temperature as the bacteria are submerged in warmer water, but the PMF and trickling filter are considered more vulnerable to cooling as the treatment bacteria are exposed to air in the process. Trickling filters are known to freeze in the distributer arms which can lead to poor treatment.

Effluent Quality

As described in the report previously, it is assumed that a very high effluent quality with low organic and nutrient content and fully disinfected is required. The MBR is capable at all times of achieving a very high standard. Although the PMF is able to be configured for nutrient removal, this is not as high a standard as the MBR. The trickling filter and MBBR are unable to achieve a total nitrogen standard, but are able to achieve very good levels of ammonia removal. The RBC, if sized appropriately can achieve reasonable ammonia removal, but unable to remove total nitrogen.

Cultural Acceptability

For all options it is assumed that the discharge is passed to a land disposal system. The second consideration is the effect of the effluent on traditional kai practices and other water use. Higher levels of bacteria and viruses may still lead to kai unfit for consumption, and waters unsafe for recreation or consumption. Only the MBR can guarantee almost absolute pathogen removal and with tertiary UV provide additional viral removal.

Adaptability to Changing Load

Te Huakaue Knobs Flat has greatly varying population, with influences from season, daily weather forecast and public holidays. This can result in significantly varying flow and load to the treatment process. The fixed film processes of RBC and trickling filter adapt slowly to changes in loading as the bacteria are slow growing, particularly the ammonia removal bacteria. The submerged MBBR is more resilient, but the greatest adaptability is seen in the MBR.

Constructability - Footprint.

The treatment solution for this site will ideally be located at the site of the existing WWTP as this avoids redesignation and additional consenting or loss of use of existing site areas. The smallest plant options have advantages in minimizing land required and remediation work. The smaller site needs will have lesser local environmental impacts and to reduce the level of tree screening required to not be visually obtrusive.

The MBR option can be constructed on the existing site adjacent to existing assets. This may require a temporary shut down and removal of some of the treatment process, but the septic tanks can be retained over an off peak period with tanker emptying during construction. A modular plant may be assembled in 4-6 months. Larger footprint options will require people to be relocated off site for construction, so are scored lower.

Operator Skill Level

The current WWTP consists of septic tanks, PMF, recirculation pumps and UV. These components will be familiar to the operational team and little upskilling required. The more complex automated plants will require a greater level of skill that can be provided as part of the project delivery through on and off-site training. The more complex plants are therefore scored lower.

The MBR is the recommended solution for Knobs Flat Te Huakaue. This system will achieve the highest quality of effluent, which will be suitable for disposal to land or directly to surface water with no risk to public health. Furthermore, the WWTP will have a small footprint and best fit within site constraints. The system will require mechanical screens and power a reliable power connection.

The key driver of the preferred in selected the preferred WWTP system is effluent quality. If the assessment of environmental effects for the resource consent does not require as stringent effluent quality standard as will be produced by the MBR, a lesser standard can be achieved by activated sludge, moving bed bioreactor or porous media filter treatment plants. The selection of an alternative treatment system will need to consider the available space, power requirements and effluent disposal systems (size and method).

7.3.3.3 RECOMMENDED TREATMENT OPTION

The recommended WWTP at Te Huakaue Knobs Flat is an MBR, consisting of the following:

- New inlet balance tanks to buffer peak loading.
- Inlet pumps to feed the treatment plant.
- 2 mm fine screens, mounted over the treatment reactor.
- An anoxic zone and aerated reactor zone.
- Membrane modules
- Washwater and backwash storage tanks.
- Pipe, pump and blower room.
- UV disinfection.
- Control building with operations facility and sludge thickener.

Figure 7-1 presents the indicative site layout. The existing septic tanks could be repurposed for sludge storage.

This location has been selected as the indicative site of the new WWTP as it is currently designated for wastewater treatment and is considered large enough for construction of the new plant with good vehicle access. The site layout for Te Huakaue Knobs Flat and Kiosk Creek are not finalised and other locations may create visual or perceived nuisance to those plans.

It will be necessary to decommission the existing WWTP during construction, so may be managed through either retaining a single tank or use of a temporary tank for buffering and removal by tankering. This work should be undertaken off-peak to minimise the wastewater being removed from site, allow for safer working and minimise disturbance.

Figure 7-1: Te Huakaue Knobs Flat Indicative Wastewater Treatment Plant Layout

7.3.3.4 RECOMMENDED EFFLUENT DISPOSAL OPTION

Section 4.3.2.4 presents a review of effluent disposal methods. For Te Huakaue Knobs Flat it is recommended that high quality effluent from the MBR be discharged to land through gravel infiltration trenches. Due to varying groundwater, and if inflows exceed soakage capacity during wet periods, these trenches should be designed to overflow to a gabion channel before discharge to surface water. Effluent land contact before discharge to surface water is a cultural preference. Iwi engagement on Te Mana o te Wai is recommended for all effluent discharges. This approach minimises the land requirements and the visual impact.

Surface irrigation was considered but is not considered suitable. There is unlikely to be public acceptance of spraying effluent and there are increased risks of odour. Furthermore, due to low winter temperatures and low volumes discharged, surface irrigation is impractical as the equipment may freeze.

Subsurface dripline irrigation may be possible but would require large areas which will be off limits to the public. Subsurface dripline irrigation requires high effluent quality at all times and regular maintenance is required to prevent clogging and loss of capacity.

It is noted from the reports provided that the ground conditions are variable. An indicative layout is provided below on Figure 7-2. Testing of gravel fan deposits found soakage rates of 6×10^{-5} to 1×10^{-4} m/s (Geosolve 2019). Assuming a site soakage rate of 1.73 m/day (6×10^{-5} m/s with a factor of safety of 3), the minimum required footprint to discharge 100 m^3 of effluent per day is approximately 60 m^2. This is suggested feasible if located west of the highway. This may be constructed as a series of 1 m wide trenches running parallel to the contours. Selecting the final location for effluent soakage will require further assessment during design development to confirm soakage rates and avoid non suitable areas.

Figure 7-2 presents an indicative layout of the proposed effluent soakage system layout. No Hazardous Activities and Industries List (HAIL) sites have been identified at the indicative soakage locations shown below (WSP, 2024).

Figure 7-2: Te Huakaue Knobs Flat Indicative Effluent Disposal System Layout Plant Layout

7.3.4 DESIGN NEXT STEPS

During the development of the indicative WWTP and effluent disposal system, reference has been made to available information and assumptions have been made. The following next steps are recommended in developing the WWTP design for Te Huakaue Knobs Flat:

- The selected WWTP location is indicative only and has been selected as it is currently designated for wastewater treatment and is expected to be large enough for construction of the new plant. As the final layout for Te Huakaue Knobs Flat and Kiosk Creek is developed it should be confirmed this site is appropriate.
- Further characterisation of wastewater flows and loads should be undertaken for sizing treatment processes that can achieve performance criteria for the variable wastewater flows throughout the year. Monitoring at peak periods of flow and visitor numbers of each category will be required to calibrate the design. Alternatively, a conservative estimate may be used.
- Further geotechnical investigations are required confirm the indicative soakage location shown is appropriate and to develop details of this system.

- An Assessment of Environmental Effects of treated effluent discharges will be required. This document links to resource consent application, and demonstrates the expect impacts on the receiving environment as surface water, groundwater and odour emissions on water quality and ecology and the risks to public health.
- Hazards associated with construction, operation, maintenance, decommission and possible effects on the public are considered through a safety by design process.
- Engagement with iwi is required to confirm soakage of treated effluent to ground is acceptable at this location.

7.3.5 FEASIBILITY

The increase in wastewater volume as a result of the Masterplan proposal will require a larger capacity WWTP to meet future wastewater flows. The proposed effluent quality requirements will also require an upgrade. An MBR system was used in the estimate as this provides the highest quality discharge. This is considered to be feasible and is considered BATNEC (Best Available Technology Not Incurring Excessive Cost). A breakdown of the estimated cost for this upgrade is provided in Table 7-8.

Table 7-8: Kiosk Creek and Te Huakaue Knobs Flat Wastewater Upgrades Estimated Cost

ITEM	ESTIMATED COST
New WWTP (MBR)	$8,800,000
Wastewater network (includes pumping from Kiosk Creek)	$500,000
Land disposal upgrade	$1,000,000
Total	**$10,300,000**

The next best alternative to a new plant is to upgrade the existing Innoflow WWTP with additional reactor beds to handle the additional flow and additional tanks for denitrification. This will likely to be required at an alternative location to the existing plant due to space limitations. While the existing footprint is relatively small the additional area required for denitrification and additional capacity is much larger than existing. A breakdown of the estimated cost for this alternative upgrade is provided in Table 7-9.

Table 7-9: Kiosk Creek and Te Huakaue Knobs Flat Wastewater Upgrades Estimated Cost - Next Best Alternative

ITEM	ESTIMATED COST
Upgrade Existing Innoflow WWTP	$1,500,000
Wastewater network (includes pumping from Kiosk Creek)	$500,000
Land disposal upgrade	$1,000,000
Total	**$3,000,000**

The selection of which technology is most suitable for future needs will be made during an Assessment of Environmental Effects during the consent renewal process.

The cost estimates have been prepared bottom up, based on a similar sized project constructed in 2023. The cost estimate includes:

- Equipment purchase.
- Installation.
- Civil, mechanical, electrical, structural, piping and controls.
- Buildings.
- Gravel access road.
- Land disposal earthworks.
- P&G at 15%.

7.4 CONSIDERATION OF NATURAL HAZARDS

The MOP Natural Hazard Assessment Part B: Basic Risk Assessment (WSP, 2024) has identified for this location that potential slips can and have occurred at this location. Should a significant landslip occur, the debris is expected to create a fan around the area of the Kiosk Creek Stream. This could result in loss of much of the campground, cabins and other facilities. In this scenario the WWTP would receive little or no flow, but could be buffered by an earth bank to divert the slide.

Alternative locations have been considered for the WWTP and disposal but these have not been progressed as will require relocation away from the site at significant cost and outside of the area of planned usage. In the event of a significant event impacting the WWTP, the site will become unoccupied, so additional resilience is not recommended at this time as wastewater will stop.

The location of water supply assets will result in the water quality being inappropriate for consumption and potential loss of treatment assets. Being closer to the area of potential slip, this will result in a loss of water supply. Relocation of this asset to another nearby location is impractical as the slip risk occurs throughout the valley.

7.5 STORMWATER

There is existing stormwater infrastructure at Te Huakaue Knobs Flat. Improvements to these networks can be made to improve the quality of the stormwater discharge. Options here could include bioswales, stormwater wetlands or oil and grit separators. These options are considered feasible and should be considered when designs are being developed.

No estimate has been provided as there is no requirement to undertake improvements and the cost to implement can vary significantly.

8 NODE 4: CASCADE CREEK Ō-TĀPARA

8.1 OVERVIEW

Cascade Creek Ō-Tāpara Campsite currently consists of 120 non-powered campervan and camping sites. There are two open shelters which campers can use for cooking.

No increase to the current campsite capacity is proposed in the Masterplan, however visitor traffic will likely increase with the construction of new walking and cycling tracks.

There is currently no water available at this location other than two 2 m^3 rainwater tanks capturing runoff from each of the shelters. This water is untreated and not intended for drinking.

Grey water currently is managed by self-contained campers, or by uncontrolled ground disposal.

8.2 WATER SUPPLY

Both shelters at Cascade Creek Ō-Tāpara collect rainwater in two small polyethylene tanks (2 m^3 each) which campers can use. The collected rainwater is currently not treated and is not suitable for drinking.

8.2.1 WATER DEMAND

A breakdown of the peak estimated water demand at Cascade Creek Ō-Tāpara is summarised in Table 8-1. This is expected over the peak summer period only.

Table 8-1: Cascade Creek Ō-Tāpara Water Demand Breakdown

SOURCE	WATER DEMAND (L/DAY)	POPULATION	DAILY VOLUME (L)
Campers (4 per site)	10	480	4,800
Day Visitors (Assumed)	4	100	400
Total Daily Volume (L)			5,200

The estimated roof area of the shelters at Cascade Creek Ō-Tāpara Campsite is 110 m^2. Table 8-2 summarises rainwater that can be collected from the existing shelters, showing there is a substantial shortfall to meet demand.

Table 8-2: Rainwater Available from Existing Shelters

MONTH	HISTORICAL AVERAGE DAILY RAINFALL (MM)	AVERAGE DAILY VOLUME COLLECTED (M^3)
January	15.2	1.67
February	10.9	1.20
March	14.6	1.61
April	7.6	0.84
May	13.5	1.49
June	13.8	1.52
July	9.5	1.05
August	9.3	1.02
September	19.4	2.13
October	14.0	1.54
November	17.8	1.96
December	16.2	1.78

8.2.2 *WATER SUPPLY OPTIONS*

8.2.2.1 ROOF WATER

To meet the full demand of the site with roof water, there would need to be a significant increase in roof area. The roof area would need to double along with installation of more storage tanks. The exact amount of roof area and storage tanks is interdependent as the more roof area available the less storage required and vice versa. On this basis we suggest a moderate amount of both. This could be achieved by adding two further shelters for a further 110 m^2 of roof area and having two 30,000 L tanks for each shelter for a total storage of 240,000 L. This would also mean reticulation from the shelters to the treatment plant.

Assuming the user population is above 500 people for no more than 60 days per year, the Drinking Water Acceptable Solution for Roof Water Supplies could be used instead of the DWQAR rules, which would reduce cost and complexity. An on-demand treatment system consisting of filtration and UV disinfection could be used to supply treated water to a single supply point/building. As the site does not currently have power, a new power supply would be needed.

Reticulation would need to be connected to each the four shelters (two existing and two proposed) in order to connect the storage.

Table 8-3: Cascade Creek Ō-Tāpara Roof Water Supply Upgrade Options Estimated Cost

ITEM	ESTIMATED COST
Additional Roof Area (Assumed 110 m^2)	$110,000
Upgrade of Water Storage (Assumed 240 m^3 Additional Storage Required)	$60,000
Reticulation	$150,000
Treatment Plant Upgrades (including shed)	$250,000
New Power Supply	$20,000
Total	$590,000

8.2.2.2 BORE WATER

Instead of roof water, a bore could be drilled to provide water to the campsite. This would allow water storage to be reduced compared to the roof water solution. Consents will be required for the construction and use of the bore.

The existing water storage would be sufficient to provide 1 days' water storage. Like the roof water option, assuming the user population is above 500 people for no more than 60 days per year, the Drinking Water Acceptable Solution for Spring and Bore Water Supplies could be used instead of the DWQAR rules, which would reduce cost and complexity. An on-demand treatment system consisting of filtration and UV disinfection could be used to supply treated water to a single supply point/building. As the site does not currently have power, a new power supply would be needed. The bore would require a larger power supply than the roof water but is unlikely to make a material difference. In addition, the bore and treatment plant could be located in a discrete location with reticulation supplied to each shelter.

Table 8-4: Cascade Creek Ō-Tāpara Bore Water Supply Upgrade Options Estimated Cost

ITEM	ESTIMATED COST
Bore Installation	$150,000
Reticulation	$100,000
Treatment Plant Upgrades (including shed)	$250,000
New Power Supply	$20,000
Total	$520,000

8.2.2.3 SURFACE WATER

Another potential source is a direct draw from the Creek. The water quality from the surface water sources in the area is good however may have quality issues during heavy rain. This is considered to be the poorest quality water of the three source options and therefore require the most treatment. This option would also be the most difficult to implement from an environmental perspective as it would require installing down or through the banks of the creek and into the creek itself. From this perspective we do not recommend that the surface water source is utilised.

8.2.3 FEASIBILTY

The upgrade to provide potable water to users of the Cascade Creek Ō-Tāpara is considered feasible with water being sourced using a bore and supplied to each of the existing shelters.

The next best alternative would be to provide a supply using rainwater harvesting.

8.3 WASTEWATER

In 2017 DOC installed 4 double toilet blocks with each having an accessible toilet. There are several other single vault toilets around the camping ground. All toilets are total containment and are regularly emptied by septic tank trucks.

WSP have considered the population served the Cascade Creek Ō-Tāpara campsite and visitor toilets. As no population data is available, the analysis of the wastewater removal data indicates that around 218 m^3 of wastewater was removed from the campground location annually, which equates to approximately 1,100 uses of toilets.

It is considered that by installing GMS linked level sensors the existing assets can be used to provide a more optimized service, so removing the need for additional facilities.

If hand washing was included at all facilities the estimated annual wastewater volume would increase to 1,800 m^3. This volume is both impractical for tankering and will increase demand on water sources. The inclusion of hand washing facilities is not recommended and therefore hand sanitiser will need to be provided.

Table 8-5: Cascade Creek Ō-Tāpara Wastewater Estimated Cost

ITEM	ESTIMATED COST
Level Monitoring	$20,000
Total	**$20,000**

8.4 COUNTESS RANGE HUT

The Countess Range hut is proposed as either a 20 or 40 bed development with non-flushable toilets and rainwater supply as per other DOC huts. There will be limited access due to the remote nature of the proposed huts and septage is expected to be flown out via helicopter.

It is proposed to provide rainwater stored in tanks for dish washing.

The cost is assumed to be included in the Hut estimate provided by others (see Walking & Cycling Experiences report - Tim Dennis, 2024).

9 NODE 5: THE DIVIDE/WHAKATIPU TRAILS HEAD

9.1 OVERVIEW

The Divide will continue serve as an access point to short walking trackers and longer multi-day hikes such as the Routeburn, Greenstone/Caples and Key Summit. This location has three existing long drop and vaulted toilet units with no water provided for hand washing. Architectural concept drawings have been provided for a new shelter planned at the Divide, which includes 5 additional vaulted toilet units. Hand washing basins are included in architectural drawings; however, no details of the water supply are provided (Wyatt Gray Architects, 2019).

At the Whakatipu Trails Head a wānanga/living classroom will be constructed. The final location for this node has not been selected but is estimated to be at the start of the Lake Marian track on the Lower Hollyford Road. It has been assumed that toilet facilities will be provided at this location as well as potable water.

9.2 THE DIVIDE WATER SUPPLY

9.2.1 WATER DEMAND

A new shelter with hand washing is proposed for The Divide. It is assumed the existing vaulted toilets will remain in service with no provision of water for hand washing. Water provided at the shelter will be untreated, for hand washing only and not suitable for drinking.

The feasibility of using rainwater collected from the shelter roof for hand washing has been investigated using historical rainfall data. The anticipated water demand for hand washing is presented in Table 9-1 assuming 1,000 users per day.

Table 9-1: The Divide Water Demand

SCENARIO	DAULY USERS	PER CAPITA DEMAND (L/DAY)	DAILY DEMAND (M^3/DAY)
Hand Washing Only	1,000	1	1

9.2.2 RAINWATER HARVESTING

The average daily rainwater volume that can be harvested from The Divide Shelter is presented on Table 9-2, indicating the available roof catchment is likely feasible to meet demand. This calculation assumes 1,000 users per day and a shelter roof area of 140 m^2 (as indicated on architectural drawings).

Table 9-2: The Divide Shelter Rainwater Harvesting Volumes

MONTH	HISTORICAL AVERAGE DAILY RAINFALL (MM)	AVERAGE DAILY VOLUME OF RAINWATER HARVESTED (M^3)
January	15.2	2.1
February	10.9	1.5
March	14.6	2
April	7.6	1.1
May	13.5	1.9
June	13.8	1.9
July	9.5	1.3
August	9.3	1.3
September	19.4	2.7
October	14	2
November	17.8	2.5
December	16.2	2.3

As rainwater harvesting is likely sufficient to meet the demand for hand washing, other options for water supply at this site have not been investigated. A more detailed analysis of climate data will be required to optimise rainwater catchments areas and storage capacity to ensure there is sufficient water during dry periods. Consideration will also need to be given to pumping requirements.

9.3 THE DIVIDE WASTEWATER

9.3.1 WASTEWATER DESIGN FLOWS

The Divide has three existing vaulted toilet units, and there are plans to add an additional five as part of the proposed shelter. As above, preliminary architectural drawings for this site include hand washing basins in the new toilets.

Table 9-3 presents estimated wastewater generation with 1,000 uses per day at this stop.

Table 9-3: The Divide Estimated Wastewater Generation Rates

SCENARIO	PER CAPITA CONTRIBUTION (L/DAY)	DAILY WASTEWATER VOLUME (M^3/DAY)
Containment Tank Only	0.2	0.2

SCENARIO	PER CAPITA CONTRIBUTION (L/DAY)	DAILY WASTEWATER VOLUME (M^3/DAY)
Containment Tank with Hand Washing	1	1

We consider total containment to be the most suitable wastewater management strategy for this site, considering costs, maintenance requirements, the sensitive receiving environment and respecting cultural values. We would assume that 4.5m^3 septic tanks are installed in each toilet. This provides 22.5 m^3 of storage.

For the wastewater generation rates presented in Table 9-3, the new toilet facilities will require emptying every 110 days (3.5 months) if handwashing is not provided and once every 22 days (once every 3 weeks) if hand washing is provided.

As recommended for other sites, level monitoring of the containment tanks should be installed regardless of the water supply scenario to allow for remote management of the asset and inform if additional toilets are required.

9.3.2 COST ESTIMATE

It is recommended that a level monitoring system is included in the shelter design as well as the existing toilets. The estimated cost for installation of this system is $20,000.

9.3.3 FEASIBILITY

The Divide wastewater management system shown on preliminary architectural drawings for the new shelter is sufficient to meeting the anticipated usage for this site. In addition to what is shown on drawings, it is recommended that water collected from the shelter roof is used for hand washing (untreated) and a tank level monitoring system is installed.

This option should be progressed by optimising rainwater catchments areas (shelter roof) to onsite water storage.

Toilets with handwashing facilities are considered feasible.

The next best alternative would be to provide toilets with no handwashing.

9.4 WHAKATIPU TRAILS HEAD

9.4.1 OVERVIEW

There is limited information available on the planned wānanga/living classroom at Whakatipu Trails Head. The indicative location is on Lower Hollyford Road near the Lake Marian Trial.

A potable water supply has been requested and it is expected toilet facilities will be installed.

9.4.2 WATER SUPPLY

It is expected that water at this stop will be sourced from rainwater harvesting. Assuming the user population is above 500 people for no more than 60 days per year, the Drinking Water Acceptable Solution for Roof Water Supplies is proposed instead of the DWQAR rules. An on-demand treatment system consisting of filtration and UV disinfection is proposed to supply treated water to the wānanga. It is assumed that power would be provided as part of the building.

Table 9-4: Whakatipu Trails Head Water Supply Estimated Cost

ITEM	ESTIMATED COST
Filter and UV Treatment	$40,000
PE tanks	$20,000
Project overheads and delivery	$15,000
Total	**$75,000**

The cost of the building and any internal water plumbing is assumed to be included in the wānanga building costs.

9.4.3 WASTEWATER

There is currently one existing containment toilet at this location that is emptied 3 times per year which is approx. 9m³ annually. This equates to around 200 uses per day during peak summer season. It is recommended that wastewater systems consist of containment tanks and treated rainwater collected from rooftops is provided for hand washing only. Table 9-5 presents the combined water demand and wastewater generation rates for Whakatipu Trails Head, assuming 1,000 users per day. This is based on 4 pans included in the wānanga.

Table 9-5: Whakatipu Trails Head Water Demand and Wastewater Generation Rates

SCENARIO	PER CAPITA CONTRIBUTION (L/DAY)	DAILY VOLUME (M³/DAY)
Containment Tank with Hand Washing	1	1

A review of historical rainfall data shows indicates a minimum rainwater catchment area to meet water demand for handwashing is 50 m^2. A more detailed analysis of climate data will be required to optimise rainwater catchments areas and storage capacity to ensure there is sufficient water during dry periods. Consideration will also need to be given to pumping requirements.

As recommended for other sites, level monitoring of the containment tanks should be installed to allow remote management of the asset and inform if additional toilets are required.

An estimated cost for toilet facilities with handwashing at Whakatipu Trails Head is presented in Table 9-6.

Table 9-6: Whakatipu Trails Head Containment Tanks Estimated Cost

ITEM	ESTIMATED COST
Containment and toilet building	$300,000
Level monitoring	$10,000

ITEM	ESTIMATED COST
Project overheads and delivery	$100,000
Total	$410,000

This is considered to the toilet component of the overall wānanga building. The cost of building is assumed to be included elsewhere.

9.4.4 FEASIBILITY

The supply of potable water and toilets with hand washing at the Whakatipu Trails Head is considered feasible.

As the design for the wānanga/living classroom is progressed, rainwater catchments should be optimised to the onsite storage.

The next best alternative is to consider the flush toilets at the wānanga building. This would result less users being able to use the facility, however is feasible with current users. This would require emptying every fortnight in peak summer season.

10 NODE 6: GERTRUDE VALLEY

10.1 OVERVIEW

This node will provide access to the Gertrude Valley walk and a new looped nature walk which is proposed. To support access to these tracks, a shelter, toilets and bus drop off / car park are proposed. MOP staff have advised that a potable water supply is required at this node to alleviate demand on the nearby Homer Hut where day visitors currently collect untreated water. There is no information available on the planned shelter.

10.2 WATER SUPPLY

10.2.1 WATER DEMAND

The estimated water demand for at the Gertrude Valley node is summarised in Table 10-1. It is assumed that there are 500 visitors per day, with 25% utilising the potable water for filling a drink bottle or drinking.

Table 10-1: Gertrude Valley Water Demand

SCENARIO	PER CAPITA DEMAND (L/DAY)	DAILY WATER DEMAND (M^3/DAY)
Day Visitors	1	0.125

10.2.2 WATER SUPPLY

It is expected that the water supply could be met utilising rainwater from the shelter and toilet block. A 10 m^3 tank will provide for at least 2 months of storage.

As the user population less than 500 people, the Drinking Water Acceptable Solution for Roof Water Supplies can be used instead of the DWQAR rules. An on-demand treatment system consisting of filtration and UV disinfection is recommended to supply treated water. As the site does not currently have power, a new power supply would be needed. This is expected to be small scale solar.

The estimated cost for a water supply incorporated into the shelter is provided in Table 10-2.

Table 10-2: Gertrude Valley Water Supply Estimated Cost

ITEM	ESTIMATED COST
Storage Tank (10,000 litre)	$20,000
Treatment Plant Upgrades (including shed)	$50,000
New Power Supply	$20,000
Project Overheads and Delivery	$20,000
Total	**$110,000**

10.3 WASTEWATER

The Gertrude Valley Short Stop has proposed toilets. It is assumed that 2 toilets are provided.

Table 10-3 presents estimated wastewater generation rates with 500 uses per day using containment tanks.

Table 10-3: Gertrude Valley Estimated Wastewater Generation Rates

SCENARIO	PER CAPITA CONTRIBUTION (L/DAY)	DAILY WASTEWATER VOLUME (M^3/DAY)
Containment Tank Only	0.2	0.1

With 4.5m^3 septic tanks in each toilet these tanks would need emptied once every 3 months. There is capacity for growth at this site. As hand washing facilities are not recommended at this small site, hand sanitiser will need to be provided.

There is potential for level monitoring in these toilets which would allow the volume to be monitored remotely and volumes recorded. This would allow better management of the asset and inform if additional toilets are required.

The estimate for the toilets is provided below. The costs of the shelter are excluded as they are assumed to be included elsewhere. There is a possibility that these are part of one larger building.

Table 10-4: Gertrude Valley Containment Tanks Estimated Cost

ITEM	ESTIMATED COST
Containment and toilet building	$150,000
Level monitoring	$5,000
Project overheads and delivery	$75,000
Total	**$230,000**

10.4 FEASIBILITY

The proposed toilets and water supply at Gertrude Valley are considered feasible.

The next best available option would be for water to be made available for handwashing. This would increase the frequency of septic tank emptying and require additional water storage but would provide a better level of service.

11 NODE 7: CLEDDAU CIRQUE AND THE CHASM SHORT STOP

It is proposed that two containment toilets are provided at The Chasm. There are no toilets proposed for Cleddau Cirque.

11.1 WASTEWATER

Table 11-1 presents estimated wastewater generation with 500 toilet uses per day at this stop.

Table 11-1: The Chasm Wastewater Generation Rates

WASTEWATER SCENARIO	PER CAPITA CONTRIBUTION (L/DAY)	DAILY WASTEWATER VOLUME (M^3/DAY)
Containment tank only	0.2	0.1

If each toilet has a 4.5m^3 containment tank for storage, then the tanks will need emptied every 3 months. As hand washing facilities are not recommended at this small site, hand sanitiser will need to be provided.

A level monitoring system should be installed to allow volumes to be tracked remotely and emptying arranged when full.

Table 11-2: The Chasm Containment Tanks Estimated Cost

ITEM	ESTIMATED COST
Containment and toilet building	$150,000
Level monitoring	$5,000
Project overheads and delivery	$75,000
Total	**$230,000**

11.2 FEASIBILITY

It is recommended that The Chasm wastewater system is a total containment tank as described above. This option is considered feasible.

The next best available option would be for water to be made available for handwashing. This would increase the frequency of septic tank emptying and require additional water storage but would provide a better level of service.

12 MILFORD SOUND PIOPIOTAHI

12.1 OVERVIEW

The redevelopment of Milford Sound Piopiotahi proposed in the Masterplan includes the following:

- Co-located visitor and marine research centres on the existing raised hotel site.
- Replacing the existing hotel with an eco-concept hotel that offers premium and standard accommodation (100 beds).
- Improved new accommodation (280 to 320 beds).
- New tourist experiences such as a cable car, walks and lookouts, and improved marine interfaces.
- Upgrades and expansion to existing three waters and electricity infrastructure.
- A new heliport and decommissioning of the existing runway.

Appendix B contains a layout drawing of existing three waters services in Milford Sound Piopiotahi.

12.2 WATER SUPPLY

12.2.1 EXISTING WATER SUPPLY

The existing Milford Sound Piopiotahi water supply is maintained and operated by Milford Sound Infrastructure. This supply services all properties in Milford Sound Piopiotahi, except for Milford Sound Lodge who source and treat water from their own bore.

Water for the supply is abstracted from hydro penstock which draws water from the Bowen River. Milford Power Holdings Limited holds a Water Permit (AUTH-20191733-01) to take and use surface water for the purpose of hydro-electric power generation and community water supply. This consent allows for a maximum abstraction rate of 313 L/s to a maximum volume of 27,000 m^3/day and 7,884,000 m^3/year. The consent expires 5 June 2045.

As needed, the supply can be supplemented by water from a bore located to the east of the main carpark. This source is used during maintenance of the hydro penstock or if required, during low flow periods in the Bowen River or when turbidity is high. Milford Sound Infrastructure holds a Water Permit (AUTH-20202219) to take groundwater from this bore at a maximum flowrate of 4 L/s, to a maximum volume of 346 m^3/day and 34,560 m^3/year no more than 80 days per year and for a continuous period of no more than 20 days. The consent expires 15 March 2047.

MSI has advised the peak demand on the water supply during peak summertime is 2.3 – 3 L/s. We assume the peak demand is for the treatment system rather than the supply from the tanks based on the expected peaks and population.

The supply has continuous online turbidity monitoring of the source water and when turbidity exceeds 3.5 NTU, this triggers an automatic switch over to the bore supply. Milford Sound Infrastructure staff have advised this has happened once since the bore was brought into service in 2022.

12.2.2 WATER DEMAND

A breakdown of the estimated future water demand at Milford Sound Piopiotahi is summarised in Table 12-1.

Table 12-1: Milford Sound Piopiotahi Future Water Demand Breakdown

SOURCE	WATER DEMAND (L/PERSON/DAY)	POPULATION	DAILY VOLUME (M^3)
Accommodation - Visitors	250	200*	50
Accommodation - Staff	150	320	48
Day Visitors	10	7,000	70
Café/ Visitors Centre	12	1,750**	21
Total Daily Volume (m^3)			189
Average Flow (L/s)			2.2

*Assume 2 people per bed

**Assume 25% of day visitors go to Café/ Visitors Centre

As water for the Milford Sound Piopiotahi supply is typically drawn from the hydro penstock, the quantity of source water is not seen as a constraint for the development. Furthermore, the projected water demand is well within the limits of the existing water permit for the hydro intake. The projected water demand is also within the limits of the bore water take permit, provided it is only used for the maximum consecutive and total days permitted.

The existing water treatment plant utilises filtration and UV disinfection. The flow through the UV is limited to 11.5 m^3/h, which limits the daily maximum water production to 276 m^3/day with no downtime.

There is currently 114 m^3 of treated water storage split between two tanks of 76 m^3 and 38 m^3. This provides about 0.6 days' storage of treated water. We would suggest increasing this to a full days' storage. To meet the future demand, we recommend adding 75 m^3 of additional storage. This could either be using a single large bolted-steel tank which would be more resilient and durable or multiple PE tanks which would be cheaper.

12.2.3 TREATMENT UPGRADES

To meet the compliance requirements for a large water supply (>500 people) under the DWQAR, the WTP needs to be upgraded. The compliance upgrades required are:

- Chlorination and monitoring equipment.
- Source water monitoring equipment (conductivity and pH).
- Flow monitoring through the UV.
- UVT and turbidity monitoring before or after the UV.
- Additional filter and UV capacity may be required depending on water demand.

Table 12-2: Milford Water Supply Upgrade Options Estimated Cost

ITEM	ESTIMATED COST
Treatment Plant Upgrades	$200,000
Water Storage Upgrade	$450,000 – Bolted Steel Tank Option ($38,000 – PE Tank Option – Next best alternative)
Total	**$650,000 – Bolted Steel Tank Option** ($238,000 – PE Tank Option - Next best alternative)

12.2.4 NETWORK UPGRADES

The reticulated water supply network services Cleddau Village and Milford Sound Piopiotahi. It is recommended that a detailed assessment of the existing network's capacity to service redevelopment be undertaken as the final layout is developed.

12.3 WASTEWATER

12.3.1 EXISTING WASTEWATER SYSTEM

12.3.1.1 RETICULATION

The Milford Sound Piopiotahi wastewater network was constructed in 1997 and has since grown to service development and new connections as septic tanks were decommissioned. The boat terminal is at the top end of the network. Wastewater from the boat terminal is pumped to a 300 mm PVC-U pipe that runs along State Highway 94 from the public toilets, below the runway to the Cleddau Village pumping station (also servicing Cleddau Village). Wastewater is pumped from Cleddau Village pumping station into the WWTP. Several minor pumping stations pump into this main line, servicing the dump station, airport, Milford Sound Lodge and Deepwater Basin Facilities.

The Cleddau Village pumping station was designed for a peak wastewater flow of 16 L/s.

12.3.1.2 WASTEWATER TREATMENT AND DISPOSAL

The WWTP consists of a number of septic tanks which then have flow pumped to a trickling filter and clarifier. Treated effluent passes through a UV disinfection before being discharged. The resource consent permits a discharge of up to 1,000 m^3/d of treated effluent into the Deepwater Basin.

12.3.2 WASTEWATER FLOWS

Table 12-3 presents a breakdown of the estimated current wastewater flows to the WWTP.

Table 12-3: Milford Sound Piopiotahi Current Wastewater Flow Breakdown at Peak Population

SOURCE	PER CAPITA CONTRIBUTION (L/DAY)	POPULATION	DAILY VOLUME (M^3/D)
Cleddau Village Resident	210	260	54.6
Other overnight	210	250	52.5
Day Visitors	10	4,000	40
Café/ Visitors Centre*	12	1,000	12
Total			159.1
Average Flow (L/s)			1.8
Peak Flow (5 x ADWF) (L/s)			9.2

*Assume 25% of day visitors go to Café/ Visitors Centre

**Assume 2 people per bed

In addition to the flows presented in Table 12-3 there are several small sources including the dump station, airport and Deepwater Basin toilets, which are estimated to have a total daily contribution of around 3 m^3/d (Stantec 2018). The calculated flows have been compared to recent observed data. The flow data from 2023 provided shows an average dry peak daily flow of 142 m^3/day (November to February) and a maximum of 692 m^3/day (8 l/s) which is 4.9 times the average flow. This shows reasonable correlation with the current estimates for existing conditions.

Instantaneous peak flows are not reported and should be considered in the next stage of investigation as will influence system design. Additionally, as part of the next stage detailed analysis of flow should be undertaken to understand diurnal peaking and fluctuations, which can be obtained by logging flow data at 5-minute intervals.

Table 12-4 presents a breakdown of the estimated future wastewater flows to the WWTP.

Table 12-4: Milford Sound Piopiotahi Future Wastewater Flow Breakdown at Peak Population

SOURCE	WATER DEMAND (L/PERSON/DAY)	POPULATION	DAILY VOLUME (M^3)
Accommodation - Visitors	250	200*	50
Accommodation - Staff	150	320	48
Day Visitors	10	7,000	70
Café/ Visitors Centre	12	1,750**	21
Total Daily Volume (m^3)			189
Average Flow (L/s)			2.2
Peak Flow (5 x ADWF) (L/s)			10.9 (941 m^3/d)

*Assume 2 people per bed

**Assume 25% of day visitors go to Café/ Visitors Centre

The current resource consent sets a maximum flow through the WWTP of 1000 m^3/day. It is noted that the current plant has a capacity of 800m^3/day. The estimated peak flow is not estimated to exceed the current flow limit but may exceed the process plant capacity.

It is noted in the Milford Opportunities Project Stage 2 Infrastructure Report (Stantec, 2021) that there may be some infiltration and ingress into the wastewater network and at times the network is unable to pass all flow through the treatment works. New connections should be built to a high standard so have lower infiltration and ingress levels which should lower the overall peak flow.

12.3.3 NETWORK UPGRADES

Extension and reconfiguration of the existing wastewater network will likely be needed to service projects proposed in the Masterplan. It is recommended that an assessment of the existing network's capacity and suitability to service redevelopment is undertaken when the final layout for Milford Sound Piopiotahi is developed and preferred locations of critical infrastructure are selected.

The anticipated future peak flow to the Cleddau wastewater pumping station (including a peaking factor of 5 as shown in Table 12-3) is below its design capacity of 16 L/s. As the capacity and flows to smaller pumping stations that service the dump station, airport, Milford Sound Lodge and Deepwater Basin facilities are unknown, it is not possible to determine if they require upgrade. It is recommended that this also be considered part of a more comprehensive network assessment.

12.3.4 TREATMENT UPGRADES

12.3.4.1 EXISTING CAPACITY

Effluent quality data provided by MSTL show that generally the quality of BOD and TSS compared to the resource consent are good. However, at times the reported levels are significantly elevated, that may coincide with peak wastewater flows.

Based on current BOD load estimates derived from population, with 10% reduction through the WWTP septic tank stage, this will give a loading rate of 0.3 kg/m^3/d on the existing trickling filter. A typical trickling filter loading rate will depend on the media, its roughness and the ambient air temperature. For a rough stone media with 120 m^2/m^3 area, this loading rate is < 0.15 kgBOD/m^3/d to achieve < 25 mg/L BOD (Yorkshire Water Services design guidance (unpublished)). This indicates that in peak summer the trickling filter is likely overloaded, but in winter is suitably loaded. Loading rates of < 0.1 kg/BOD/m^3/d are required to remove ammonia consistently. Where high concentrations of ammonia are expected, particularly where high numbers of day visitors occur will require additional recirculation to achieve better quality. On this basis to meet a higher ammonia standard at peak loading rates, the biological trickling filter will need to be 3 times larger than the existing system. To accommodate future loads, a further 4 trickling filters will be required. The footprint of this option will be limited.

If not upgraded the trickling filter will be excessively loaded and the media will block, leading to discharge of poorly treated wastewater through the outfall to Deepwater Basin. Odours are also likely.

High concentrations of ammonia may have localized toxic effects on fish and other aquatic life. It is expected that more stringent standards for BOD, suspended solids ammonia and probably total nitrogen will be applied for effluent on a future resource consent. The current treatment technology is not able to achieve this consistently.

12.3.4.2 SELECTION OF TREATMENT OPTION

There are several treatment options available which were described in Section 4.3.2.2 that would be suitable for the treatment of wastewater at Milford Sound Piopiotahi. In order to select the appropriate treatment option, a Multi-Criteria Analysis was undertaken.

- Tankering wastewater offsite for treatment at suitable WWTP.
- Septic tank and Rotating Biological Contactor (RBC).
- Septic tank and Moving Bed Bioreactor (MBBR).
- Septic tank and porous media filter (PMF) (similar to existing Innoflow system).
- Septic tank and trickling filter (TF).
- Membrane Bioreactor (MBR).

The below table presents scoring for each criterion based on the advantages and disadvantages of each treatment option. All scores are relative to the base solution of the MBR and no criteria weighing has been applied (all equally weighted). There is additional discussion below.

Table 12-5: Multi-Criteria Assessment Scoring for Milford Sound Piopiotahi

PARAMETER	MBR	TANKER AWAY	SEPTIC TANK AND RBC	SEPTIC TANK AND MBBR	SEPTIC TANK AND PMF	SEPTIC TANK AND TRICKLING FILTER
Health and Safety	0	0	0	0	0	-1
Cost – Capital Expenditure	0	4	2	2	3	2
Cost – Operational Expenditure	0	-5	1	-2	-1	-1
Resilience to local climate	0	0	0	0	-1	-3
Effluent quality	0	0	-3	-2	-1	-2
Cultural Acceptability	0	0	-3	-2	-1	-2
Adaptability to changing load	0	-2	-2	-1	-1	-2
Constructability - Footprint	0	0	-2	-2	-4	-4
Operator Skill Level	0	2	3	2	2	2
Total Score	0	-1	-4	-5	-4	-9

Health and Safety

All new plants will be designed and constructed to provide a safe workplace with all reasonably practicable risks managed. All new plants have therefore been scored to a similarly high level.

The trickling filter is scored slightly lower due to the increased health risks from splashing wastewater arising from the distribution of water onto the stone filters.

Cost – Capital Expenditure

The MBR option has been costed and is known to be a relatively high-cost solution. All other options are scored relative to the MBR capital cost, with each point (positive or negative) representing an estimated $1m difference.

Cost - Operational Expenditure

Each point is an estimate of operational costs for each option is presented below. This has considered the nature of the wastewater sludge produced, its quantity, tankering costs and disposal, power at average conditions and operator attendance.

Assumptions made in the operational costs estimated are as follows:

- Power and sludge are calculated based on peak monthly average population. Annual average is assumed as 1/3 of this rate.
- Tanker away is based on peak dry day flow and assumes annual average is 1/3 of this rate.
- Labour includes operator attendance on site, grounds maintenance, equipment maintenance and sampling. The MBR has a higher attendance on site as 4 hours/ week for site checks and sludge thickening.
- Sludge tankering and disposal cost of $200/m^3$.
- All operator hours are the time spent on site and exclude travel.
- Tanker volume is 10 m^3.
- Expected cost for MBR membrane replacement is $200,000, assumed to be required every 20 years.

Table 12-6: Estimated Operational Costs - Milford Sound Piopiotahi

ITEM	UNIT	MBR	TANKER AWAY	SEPTIC TANK AND RBC	SEPTIC TANK AND MBBR	SEPTIC TANK AND PMF	SEPTIC TANK AND TRICKLING FILTER
Daily Peak Volume	m^3	1.73		3	3	3	3
Tankers Per Year	-	21	11,449	37	37	37	37
Tanker Cost	$	$ 42,097	$ 22,897,670	$ 73,000	$ 73,000	$ 73,000	$ 73,000
Power Cost (@40c/kwh)	$	$ 35,040	0	$ 17,520	$ 46,720	$ 23,360	$ 17,520
Operator Hours	Hr	1416	120	432	532	492	700
Operator Cost (@$100/hr)	$	$ 141,600	$12,000	$ 43,200	$ 53,200	$49,200	$ 70,000

ITEM	UNIT	MBR	TANKER AWAY	SEPTIC TANK AND RBC	SEPTIC TANK AND MBBR	SEPTIC TANK AND PMF	SEPTIC TANK AND TRICKLING FILTER
Membrane Replacement (Annualised)	$	$20,000	-	-	-	-	-
Total Opex	$	$ 238,737	$ 22,909,670	$ 133,720	$ 172,920	$ 145,560	$ 160,520

Resilience to Local Climate

This criterion is scored on the resilience of the process and susceptibility to cold weather. Nutrient removal is vulnerable when the treatment process drops below 5°C and in some cases may take several weeks to fully recover from zero-degree conditions. Many processes are more resilient to changes in temperature as the bacteria are submerged in warmer water, but the PMF and trickling filter are considered more vulnerable to cooling as the treatment bacteria are exposed to air in the process. Trickling filters are known to freeze in the distributer arms which can lead to poor treatment.

Effluent Quality

As described in the report, it is assumed that a very high effluent quality with low organic and nutrient content and fully disinfected is required. The MBR is capable at all times of achieving a very high standard. Although the PMF is able to be configured for nutrient removal, this is not as high a standard as the MBR. The trickling filter and MBBR are unable to achieve a total nitrogen standard, but are able to achieve very good levels of ammonia removal. The RBC, if sized appropriately can achieve reasonable ammonia removal, but unable to remove total nitrogen.

Cultural Acceptability

For all options it is assumed that the discharge is passed to a land disposal system. The second consideration is the effect of the effluent on traditional kai practices and other water use. Higher levels of bacteria and viruses may still lead to kai unfit for consumption, and waters unsafe for recreation or consumption. Only the MBR can guarantee almost absolute pathogen removal and with tertiary UV provide additional viral removal.

Adaptability to Changing Load

Milford Sound Piopiotahi has greatly varying population, with influences from season, daily weather forecast and public holidays. This can result in significantly varying flow and load to the treatment process.   The fixed film processes of RBC and trickling filter adapt slowly to changes in loading as the bacteria are slow growing, particularly the ammonia removal bacteria. The submerged MBBR is more resilient, but the greatest adaptability is seen in the MBR.

Constructability - Footprint.

The treatment solution for this site will ideally be located at the site of the existing WWTP as this avoids redesignation and additional consenting or loss of use of existing site areas. The smallest plant options have advantages in minimizing land required and remediation work. The smaller site needs will have lesser local environmental impacts and to reduce the level of tree screening required to not be visually obtrusive.

The MBR option can be constructed on the existing site adjacent to existing assets. This may require a temporary shut down and removal of some of the treatment process, but the septic tanks can be retained over an off peak period with tanker emptying during construction. A modular plant may be assembled in 4-6 months. Larger footprint options are scored lower.

Operator Skill Level

The current WWTP consists of septic tanks, trickling filters, clarifier, and UV. These components will be familiar to the operational team and little upskilling required. The more complex automated plants will require a greater level of skill that can be provided as part of the project delivery through on and off-site training. The more complex plants are therefore scored lower.

From consideration of the advantages and disadvantages presented above, the membrane bioreactor is the recommended solution for Piopiotahi Milford Sound. This treatment system is resilient to changes in load and temperature, and is able to consistently produce very high quality effluent. Effluent from the treatment plant will be suitable for disposal to land or directly to surface water and not pose a risk to human health. The approximate height of the system is 5 m above ground, which can be visually screened by trees. The WWTP will include fine screens, a treatment reactor and membranes and an offline sludge thickening process to minimize the volume sludge that needs to be exported from site.

Solutions that require units to be built in ground near the existing location will not be resilient to changing sea levels and high groundwater levels and should be avoided. The recommended alternative solution for Piopiotahi Milford Sound is a conventional activated sludge treatment plant, if the resource consent quality standards permit. Our recent experience across New Zealand indicates similar capital costs for membrane systems as for conventional treatment systems.

12.3.4.3 RECOMMENDED TREATMENT OPTION

The recommended WWTP at Milford Sound Piopiotahi is an MBR, consisting of the following:

- New inlet balance tanks to buffer peak loading.
- Pumps to feed treatment plant.
- 2 mm fine screens, mounted over the treatment reactor.
- An anoxic zone and aerated reactor zone.
- Membrane modules
- Washwater and backwash tanks
- Pipe, pump and blower room.
- UV disinfection.
- building with operations facility and sludge thickener.
- Reuse of septic tanks for sludge storage.
- The entire system should be constructed on a raised platform/earth mound.

Figure 12-1 presents the indicative site layout. The existing septic tanks could be repurposed for sludge storage.

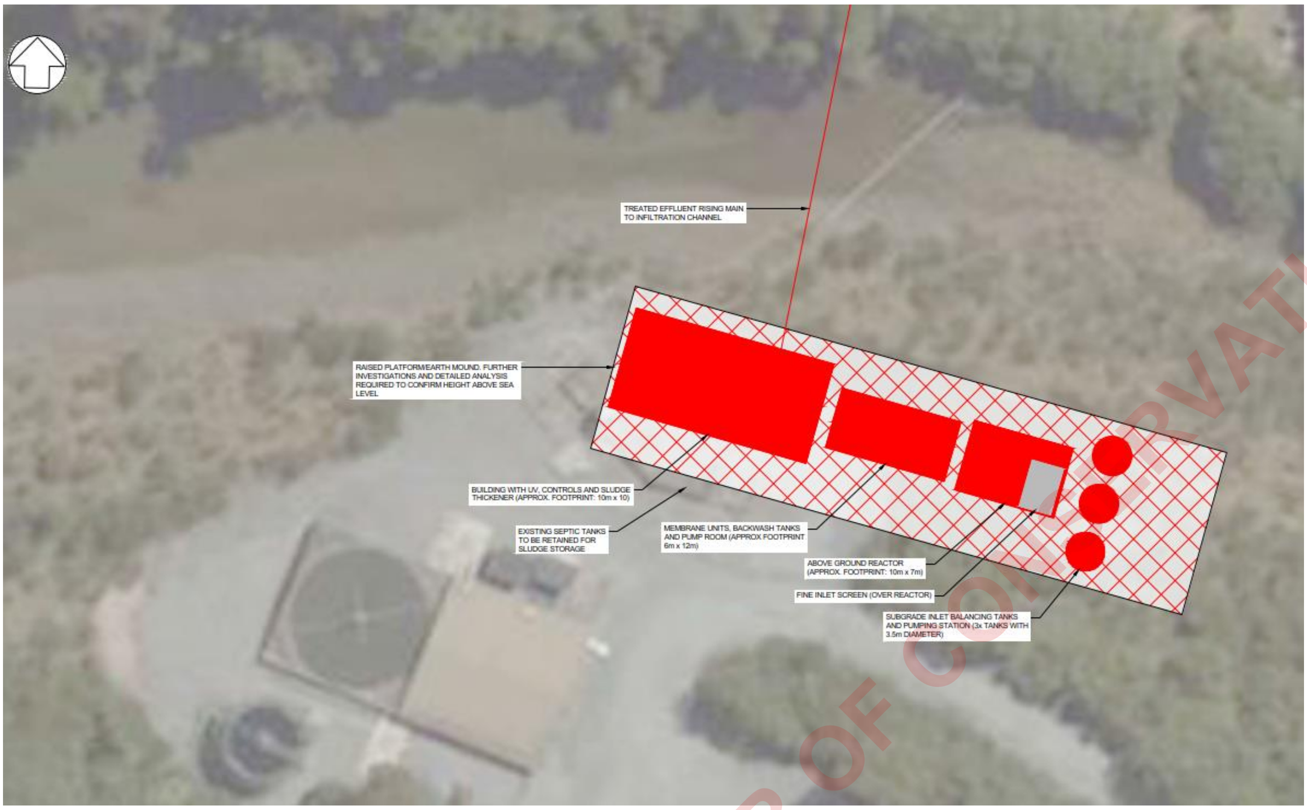

Figure 12-1: Milford Sound Piopiotahi Indicative Wastewater Treatment Plant Layout

12.3.4.4 RECOMMENDED EFFLUENT DISPOSAL OPTION

Land is constrained at Milford Sound Piopiotahi and increases in sea level will further reduce the available area. Section 4.3.2.4 presents a review of effluent disposal methods. For Milford Sound Piopiotahi the preferred option is an infiltration trench. The Cleddau Delta is largely sands and gravels with a shallow groundwater level that is influenced by tides. We have assumed a soakage rate of 300 mm/d can be achieved, therefore requiring a 350 m long, 1.5 m wide trench. This trench may be open (as water is disinfected before entry) but may be filled with cobbles to reduce the risk of public exposure.

Due the high groundwater levels, and if inflows exceed soakage capacity during wet periods, the trench should be designed to overflow to a gabion channel before discharge to the ocean. Effluent land contact before discharge to water is a cultural preference. Iwi engagement on Te Mana o te Wai is recommended for all effluent discharges. This approach minimises the land affected and the visual impact.

Figure 12-2 presents an indicative layout of the proposed effluent soakage system adjacent to the airport. There are several other locations that the soakage system could be located, and the final location should be determined as the design is developed and the final layout of the Masterplan is confirmed.

It is noted that there are several sites listed in the HAIL register in proximity to the proposed system that should be considered when selecting the final location. These include the extent of the airport itself, a historic refuelling compound on the southside of the runway and the old airport control tower (possible lead paints) (WSP, 2024). These sites present a potential risk that should be investigated as the preferred location of the effluent soakage is developed.

Additionally, previous studies have identified that the north-western end of the runway is affected by high groundwater levels during high tides, impacting drainage of the runway. These investigations recommended that this section of runway be raised to a minimum RL of 2.6 m to mitigate drainage issues (Stantec, 2022). The indicative soakage location requires the runway to be raised to this level to prevent groundwater inundation to the soakage system; if the elevation increase does not occur, an alternative location for soakage should be considered.

Figure 12-2: Milford Sound Piopiotahi Indicative Effluent Disposal System Layout

12.3.5 OPPORTUNITIES FOR EFFLUENT REUSE

The technology recommended (MBR) will consistently produce a very high quality of effluent, with very low risk to public health. This is considered the BATNEC solution, and this also provides the opportunity for treated effluent reuse.

Although New Zealand does not have specific standards, guidance is available for Australia, which shows that the water produced from this process is “A” grade, suitable for many applications. These include toilet flushing, vehicle washing, watering public spaces and many agricultural uses.

Table 12-7 presents the estimated total water is used in toilet flushing each day in peak tourist season. This is for future demand over 100 m^3/d, approximately one third of the total demand. If this water was replaced with recycled effluent, it will not reduce the water to be treated at the WWTP but will lower the water demand in the overall community allowing greater resilience and improved sustainability in water supply.

However, as water is considered plentiful in this region, reuse may not be considered necessary, and the cost of new infrastructure may outweigh the cost of increased water supply.

Table 12-7: Milford Sound Piopiotahi Estimated Future Toilet Water Usage

SOURCE	PER CAPITA USAGE (L/DAY)	POPULATION	VOLUME (M^3/D)
Accommodation - Visitors	40	200*	8
Accommodation - Staff	40	320	12.8
Day Visitors	8	7,000	56
Total Daily Volume			**76.8**

*Assume 2 people per bed

**Assume 25% of day visitors go to Café/ Visitors Centre

12.3.6 FEASABILITY

The increase in wastewater volume as a result of the Masterplan proposal will require a larger capacity WWTP to meet future wastewater flows. The proposed effluent quality requirements will also require an upgrade. An MBR system was used in the estimate as this provides the highest quality discharge. This is considered to be feasible and is considered BATNEC. A breakdown of the estimated cost for this upgrade is provided in Table 12-8.

Table 12-8: Milford Sound Piopiotahi Wastewater Treatment Upgrade Estimated Cost

ITEM	ESTIMATED COST
Treatment Plant Upgrades	$10,300,000

The selection of which technology is most suitable for future needs will be made during an assessment of environmental effects during the resource consent renewal process.

The cost estimates have been prepared bottom up, based on a similar sized project constructed in 2023. The cost estimate includes:

- Equipment purchase.
- Installation.
- Civil, mechanical, electrical, structural, piping and controls.
- Buildings.
- Gravel access road.
- Land disposal earthworks.
- P&G at 15%.

The next best alternative solution for Piopiotahi Milford Sound is a conventional activated sludge treatment plant, if the resource consent quality standards permit. Our recent experience across New Zealand indicates similar capital costs for membrane systems as for conventional treatment systems.

12.3.7 DESIGN NEXT STEPS

During the development of the indicative WWTP and effluent disposal system, reference has been made to available information and assumptions have been made. The following next steps are recommended in developing the WWTP design for Piopiotahi Milford Sound:

- The selected WWTP location is indicative only and has been selected as it is currently designated for wastewater treatment and is expected to be large enough for construction of the new plant. As the final layout is developed it should be confirmed this site is appropriate.
- Further characterisation of wastewater flows and loads should be undertaken for sizing treatment processes that can achieve performance criteria for the variable wastewater flows throughout the year. Monitoring at peak periods of flow and visitor numbers of each category will be required to calibrate the design. Alternatively, a conservative estimate may be used.
- The selected effluent disposal system location is indicative only and has been sized based on assumed soakage rates for sands and gravels present on the Cleddau Delta (no field testing). Geotechnical investigations are required confirm the indicative location selected is appropriate and to confirm the footprint required. Consideration will also need to be given to higher coastal water levels.
- The indicative selected effluent disposal system location is adjacent to the airfield. There are proposals to change the usage of the airfield, and there are localised low spots are prone to flooding and a high water table. These should be considered in developing the effluent disposal system layout.
- An Assessment of Environmental Effects of treated effluent discharges will be required. This document links to resource consent application, and demonstrates the expect impacts on the receiving environment as surface water, groundwater and odour emissions on water quality and ecology and the risks to public health.
- The long term viability and risks associated with the dump station in Piopiotahi Milford Sound will require specific consideration. The discharge of "Blue Loo" may have implications in the treatability of wastewater.
- Hazards associated with construction, operation, maintenance, decommission and possible effects on the public are considered through a safety by design process.
- Engagement with iwi is required to confirm soakage of treated effluent to ground is acceptable at this location.

12.4 STORMWATER

There is existing stormwater infrastructure at Milford Sound Piopiotahi. Improvements to these networks can be made to improve the quality of the stormwater discharge. Options here could include bioswales, stormwater wetlands or oil and grit separators. These options are considered feasible and should be considered when designs are being developed.

No estimate has been provided as there is no requirement to undertake improvements and the cost to implement can vary significantly.

12.5 CONSIDERATION OF NATURAL HAZARDS

The Milford Opportunities Project Natural Hazard Assessment part B: Basic Risk Assessment (8 May 2024) has identified for this location that the water assets may be impacted by several natural hazards.

Landslips may have effect on water supply. However, the strategy is for 2 water supply sources to limit risk.

Landslips in the valley have potential to generate tsunami. Even a relatively small 2 m event could impact on the WWTP. Greater events would be catastrophic as will cause extensive damage to the village, visitor centre, quayside and hotels and accommodation. In a small scenario, the WWTP being built above ground offers resilience in the main assets, although some damage may occur to electrical equipment. a more significant event could displace the modular units and lose all treatment. However, this also would remove the population from Milford and so there would be no wastewater to treat in the immediate term.

Sea Level rise is predicted as 1.5 m increase in level. The existing WWTP is at risk, so future assets will be designed with an elevated ground level to maintain operation under all flood conditions. The exact location of the discharge trench will need to be confirmed with topographic surveys to maintain discharge.

13 ESTIMATES

A summary of the estimates for the proposed upgrades are detailed in the below table.

Table 13-1: Estimated Costs of Three Waters Upgrades

NODE	ESTIMATED COST
Te Anau Hub	$500,000
Node 1 Te Rua-o-te-moko Fiordland National Park Gateway	No Three waters infrastructure proposed.
Node 2 Upokororo Eglinton Reveal	$640,000
Node 3 Te Huakaue Knobs Flat/Mirror Lakes Short Stop	$11,100,000
Node 4 Cascade Creek Ō-Tāpara Campsite	$540,000
Node 5 Whakatipu Trails Head/The Divide Short Stop	$485,000
Node 6: Gertrude Valley	$340,000
Node 7 Cleddau Cirque and The Chasm Short Stop	$230,000
Milford Sound Piopiotahi Visitors Hub	$10,950,000
Total	**$24,785,000**

The estimates provided are rough order costs and exclude contingency. The expected accuracy is +50%/ - 30%.

The estimates are physical works only and exclude professional services, consenting and construction monitoring.

These estimates are to be read in conjunction with the report Milford Opportunities Project Transport & Infrastructure Stream (Stage 3) - Stage 2 Review of Cost Estimates (WSP, 2024)

14 CONCLUSIONS

14.1 WATER SUPPLY

The existing water treatment plant in Te Anau has capacity for the proposed Te Anau Hub and is also due for an upgrade in the medium term (next 5 years). The water reticulation network has capacity however there may be issues if the Hub is sited in a boosted pressure zone or outside of the reticulation area. A water supply for the Te Anau Hub is considered feasible.

The existing water supplies at Te Huakaue Knobs Flat and Milford Sound Piopiotahi will need upgrading because of the development proposed in Masterplan. These upgrades are feasible and can be undertaken as and when required depending on the timeline of development. It is recommended that these upgrades align to the dates when resource consent renewal are required for the plants, so incorporate future development.

New potable water supplies are proposed at Cascade Creek Ō-Tāpara, Whakatipu Trails Head, and Gertrude Valley. These are small supplies and can be constructed as each node is developed. These supplies are considered feasible with optimising of storage and roof area needed for developed design.

Non-treated water is proposed for handwashing at The Divide. This takes advantage of the roof area of the proposed shelter. Potable water is proposed to be available for handwashing at Whakatipu Trails Head. This is takes advantage of the requirement for potable water at this node with a reasonable increase in containment tank emptying. The handwashing water proposed is considered feasible.

14.2 WASTEWATER

It is recommended wastewater from toilets at small sites is collected in containment tanks and tankered to a suitable WWTP for treatment. Total containment toilets are proposed at:

- Upokororo Eglinton Reveal
- Mirror Lakes Short Stop
- Cascade Creek Ō-Tāpara Campsite
- Whakatipu Trails Head
- The Divide Short Stop
- Gertrude Valley
- The Chasm Short Stop

To minimise the volume and frequency that wastewater needs to be transported away from other sites, it is recommended that handwashing and flushing toilets are not provided. Not providing water for handwashing and toilets will also remove the need for extra infrastructure and reduce the demand on water sources. Hand sanitiser will need to be provided at all locations. Hand sanitiser will need to be provided at all the above locations.

At the Divide Short Stop, there are three existing toilets (with containment tanks) and a further five with water supplied for handwashing are proposed as part of shelter upgrades. Our assessment has shown sufficient rainwater can be collected to provide for handwashing (untreated) and wastewater volumes required transport for offsite treatment are reasonable.

If it is decided in the future that handwashing is required at all stops, including small sites, additional water supply provisions will be required, and the recommended option of containment tanks and offsite treatment should be reassessed.

The WWTP in Te Anau has recently been upgraded and SDC have no concerns regarding the capacity of their plant to receive wastewater from the proposed Te Anau Hub. It is unknown if the reticulation has capacity as the location is not yet known. As SDC has a network model there is an opportunity for the MOP to check the network prior to committing to a site. This is considered feasible.

The WWTP at Te Huakaue Knobs Flat has recently been upgraded based on current demand. As the flows increase as a result of the Masterplan, and to meet anticipated effluent quality standards, upgrade the plant will need to be upgraded or replaced. WSP have recommended full replacement with plant that treats effluent to an extremely high standard. This is higher than the existing plant and current discharge permit. WSP considers the upgrade to be feasible however have provided the next best available option of using the same treatment system as recently constructed with add-ons for nutrient removal. Several next steps are recommended to verify design assumptions and information relied upon are appropriate as the final layout of this site is progressed.

The Milford Sound Piopiotahi wastewater treatment plan will require replacement based on the future flows as a result of the Masterplan developments and to meet anticipated future effluent quality standards. The treated effluent currently discharges into the Sound. WSP recommends that the effluent is treated to a higher standard than currently permitted and provide land contact to restore Te Mana o te Wai. This is considered feasible. As noted for Te Huakaue Knobs Flat, several next steps are recommended to verify design assumptions and information relied upon are appropriate as the final layout of this site is developed.

14.3 STORMWATER

The Te Anau Hub will need consideration of stormwater and its management as the design is developed. This should be considered as the site is selected to ensure there is sufficient area to construct an on-site stormwater management system. As this information is known before a site is selected, the management of stormwater is considered feasible.

The proposed development at Upokororo Eglinton Reveal will result in a large area of gravel for parking. It is expected that bioswales would be appropriate at this location. This is considered feasible.

There is existing stormwater infrastructure at Te Huakaue Knobs Flat and Milford Sound Piopiotahi. Improvements to these networks can be made to improve the quality of the stormwater discharge. Options here could include bioswales, stormwater wetlands or oil and grit separators. These options are considered feasible and should be considered when designs are being developed.

15 LIMITATIONS

This report ('Report') has been prepared by WSP exclusively for Milford Opportunities ('Client') in relation to three waters infrastructure condition and Future State Assessments ('Purpose') and in accordance with the Contract SSI-O-406 dated 11 October 2023. The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

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Assumptions

The review of existing three waters infrastructure has been undertaken using the available data and several assumptions have been made for the purpose of ascertaining the appropriate solutions and high-level budget estimates. The accuracy of scope cannot be guaranteed owing to gaps in information.

Before design can commence, accurate local records are required for the water and wastewater treatment plants and reticulation networks. For treatment plants, this should include sampling and analysis of flow data. Information regarding the reticulated three waters networks has been obtained from existing plans as available. Additional data collection on assets, such as surveys, may be necessary to verify capacity as the designs for each node are progressed. Wastewater Treatment upgrades at Te Huakaue Knobs Flat and Piopiotahi Milford Sound will be subject to new resource consents. The associated Assessment of Environmental Effects at time of upgrade will determine the quality requirements, and thus the technology to be applied. For this report, a very high quality of effluent is assumed as an upper standard assuming, low nutrient discharge to the local environment, and low faecal bacteria levels that may potentially affect other water use.

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APPENDIX A – MOP FACTSHEET

- Milford Opportunities Masterplan launched today
- Project started in 2017.
- Project governance group made up of representatives from Southland, Queenstown Lakes District Councils, DOC, MBIE, Waka Kotahi NZTA, mana whenua, tourism businesses, and led by independent chair Dr Keith Turner.
- Project in three stages – one and two now complete, stage three is about to get under way.
- Milford Opportunities vision: Piopiotahi – New Zealand as it was, forever.

Milford Opportunities pillars:

1. Mana whenua values woven through
2. A moving experience
3. Tourism funds conservation and community
4. Effective visitor management
5. Resilient to change and risk
6. Conservation
7. Harness innovation and technology

Milford Opportunities objectives:

1. The role of Ngāi Tahu, as mana whenua and Treaty partner, is acknowledged and Te Ao Māori values are embedded throughout.
2. Milford Sound Piopiotahi is protected now and into the future, recognising its World Heritage Status
3. The visitor experience is world class and enhances conservation and community.
4. Infrastructure is effective, efficient, resilient and sustainable (including access methods).
5. Visitors benefit the communities of Te Anau, Southland and Otago.

Milford Opportunities core concepts:

1. Recognise and develop landscape conservation and cultural experience
2. Establish a new governance model
3. Facilitate broader Murihiku and Southland benefits
4. Charge international visitors an access fee
5. Introduce a zero-emission coach-based park and ride, hop-on/hop-off transport model
6. Establish a new Te Anau hub and enhanced local experience choices
7. Develop multiple experiences along the corridor structured around key nodes
8. Encourage sustainable practices and use of green technology
9. Reorganise Milford Sound Piopiotahi to remove visitor conflicts
10. Modernise infrastructure at Milford Sound Piopiotahi

What will it achieve?

1. Te Anau as the gateway
2. Slows the journey
3. Spread the visitor load, avoid midday crush
4. Multiple experiences on the corridor
5. Intertwine iwi culture and history at every touch point
6. A zero carbon world reference wilderness experience

Ten technical reports (1600 pages) supported the preparation of the masterplan. They are:

1. Conservation impact analysis report
2. Governance, management and legislation report
3. Hazards and visitor risk review report
4. Infrastructure assessment report
5. Land analysis report
6. Mana whenua aspirations and values report
7. Te Anau Basin study
8. Tourism report
9. Transport and access report
10. Communications and engagement report

MILFORD OPPORTUNITIES

- Cost of project so far:
  $3.25 million from central Government

- Engagement began in September 2018 with stage one, with extensive engagement through stage two, including public meetings in Te Anau, Milford Sound Piopiotahi, Invercargill and Queenstown, surveys, reference groups, update email newsletters, social media, a school competition, one on one interviews and two nationwide surveys, with nationwide advertising campaigns along them.

APPENDIX B – LARGE SITES - SITE LAYOUTS

LEGEND

- HYDRO PENSTOCK
- WATER MAIN
- WATER MANHOLE
- WATER VALVE
- MONITORING WELL
- STORMWATER
- CULVERT
- WASTEWATER PIPE
- WASTEWATER MANHOLE
- CLEANING EYE
- INFILTRATION TRENCHES
- LAND CONTACT BED

1:1250@ A1 1:2500@ A3 0 20 40 60 80 100 120 m

REVISION	AMENDMENT	APPROVED	DATE

MILFORD OPPORTUNITIES

wsp
Dunedin Office
+64 3 471 5500
Private Bag 1913
Dunedin 9016
New Zealand

CIVIL

SCALES: 1:1250@A1, 1:2500@A3
ORIGINAL SIZE: A1
DRAWN: J.W
DESIGNED:
APPROVED: A.B
DRAWING VERIFIED: M.D
DESIGN VERIFIED:
APPROVED DATE: 17/05/2024

EXISTING SERVICES PLAN

PROJECT
MILFORD OPPORTUNITY PROJECT
KNOBS FLAT, TE HUAKAUE
THREE WATERS INFRASTRUCTURE ASSESSMENT

TITLE
THREE WATERS

WSP PROJECT NO. (SUB-PROJECT): 6-VO060.00
SHEET NO.: C01
REVISION: B

Original sheet size A1 (841x594) Plot Date 2024-05-17 at 11:48:33 am \\corp.pbwan.net\ANZ\ProjectsNZ\6v\6-VO060.00 Milford Opportunities Project - Transpor\Home\03_Tech_Docs\02_Tech_Out\01_WIP\05_Reports\04 - Three Waters\DWG plans\01. Knobs flat\6-VO060.00 - Knobs Flat 3 Waters.dwg C01

LEGEND

- WATER MAIN
- WASTEWATER GRAVITY MAIN
- WASTEWATER RISING MAIN
- INFILTRATION TRENCHES
- LAND CONTACT BED

NOTE: THE LOCATION OF ALL SERVICES IS INDICATIVE ONLY

1:2500@ A1
1:5000@ A3
0 40 80 120 160 200 240 m

REVISION	AMENDMENT	APPROVED	DATE

MILFORD OPPORTUNITIES

wsp
Dunedin Office
+64 3 471 5500
Private Bag 1913
Dunedin 9016
New Zealand

CIVIL

SCALES 1:2500@A1, 1:5000@A3		ORIGINAL SIZE A1
DRAWN J.W	DESIGNED	APPROVED A.B
DRAWING VERIFIED M.D	DESIGN VERIFIED	APPROVED DATE 17/05/2024

EXISTING SERVICES PLAN

PROJECT
MILFORD OPPORTUNITY PROJECT
MILFORD SOUND
THREE WATERS INFRASTRUCTURE ASSESSMENT

TITLE
THREE WATERS

WSP PROJECT NO. (SUB-PROJECT)	SHEET NO.	REVISION
6-VO060.00	C04	B

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