MILFORD OPPORTUNITIES

MILFORD OPPORTUNITES PROJECT

Infrastructure Assessment Report

3 March 2021

Stantec

Stantec NZ Limited

FINAL

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Document Quality Assurance

Bibliographic reference for citation: Stantec NZ Ltd 2021. *Milford Opportunities Project*: *Infrastructure Assessment Report*. Prepared by Stantec NZ Limited for Milford Opportunities Project		
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Status: FINAL	Revision / version: 4	Issue date: 3 March 2021

Template revision: 20200422 0000

File ref: Infrastructure Assessment Report.docx

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EXECUTIVE SUMMARY

Milford Sound Piopiotahi is a global iconic visitor attraction, which (prior to covid-19) drew nearly 1 Million visitors per year, or roughly 6,000 on the busiest day. Physical infrastructure is required to service the needs of both visitors and the supporting businesses. Without adequate infrastructure, Milford Sound Piopiotahi cannot accommodate growth or meet the expectations of visitors.

Therefore, one of the seven pillars / values identified for the project is the need for the plans, activities, infrastructure and visitor experience to be **resilient to change and risk**, whilst still enabling an increase in the connection of people with nature and the landscape.

This report describes the existing infrastructure, providing a baseline to consider what changes may be required to accommodate the aspirations of the project.

3 WATERS INFRASTRUCTURE

- **Wastewater:** Te Anau, Manapouri and a large portion of Milford village are each serviced by a reticulated wastewater scheme. The Te Anau and Manapouri schemes are undergoing upgrades, which include some capacity for future growth. The Milford Sound Piopiotahi wastewater system is privately owned and operated by Milford Sound Tourism Ltd, which holds a discharge consent for up to 1,000 m^3 per day. Further investment is likely to be required in all schemes (networks, treatment, and discharge infrastructure) to both cater for population growth and to ensure future consent compliance.

- **Potable Water:** Te Anau, Manapouri and Milford Sound Piopiotahi, along with some rural schemes, have reticulated potable water. While Te Anau draws water from groundwater, other communities draw from surface water sources. These are unsecure sources and treatment is required to comply with the Drinking Water Standards. All schemes are likely to require process upgrades to meet increasingly strict drinking water regulations. The Milford Sound Piopiotahi scheme is run of river and includes only limited storage, which will need to be addressed to allow for increased visitor numbers and to improve the reliability and resilience of this scheme.

- **Stormwater:** Te Anau and Manapouri are served by reticulated stormwater networks, though with limited stormwater treatment. The stormwater system in Milford Sound Piopiotahi generally serves small catchments, with typically short lengths of pipelines to a discharge point. Consideration will need to be made for any stormwater management systems developed within the built environment to integrate treatment facilities to meet discharge quality standards.

POWER/GAS SUPPLY AND TELECOMMUNICATIONS

- **Te Anau / Manapouri:** The Power Company Limited have a zone substation to supply Te Anau and Manapouri, and rural farms. The security classification of this zone substation is AAA – the highest rating and meets the required standards. Reticulated power (PowerNet) reaches to just north of Te Anau Downs on SH94-about 32km from Te Anau. Mobile coverage is limited or intermittent within this area to just beyond Te Anau Downs. After this point no consistent mobile coverage is currently available.

- **Milford Sound Piopiotahi:** Electricity is generated at Milford Sound Piopiotahi from hydroelectric and diesel sources by Milford Power Holdings Ltd. Milford Power Holdings Ltd hold a resource consent to take and discharge 2,700 cubic metres of water per hour from the Bowen River for hydro-electric power generation. This is supplemented by 4 diesel standby generators. Electricity distribution, water retailing, and distribution and gas retailing and distribution are managed by Milford Sound Infrastructure Ltd.

  There is no cell phone coverage at Milford Sound Piopiotahi, and only limited coverage on the Milford Road. Under the Mobile Blackspot Program operated by Crown Infrastructure Partners, coverage will be rolled out to tourist destinations and state highways, including Milford Sound Piopiotahi, Doubtful Sound, Knobs Flat and the Milford Road (among others). Completion is scheduled for 2022. Key locations along the route have been selected as future base stations for cell phone coverage. This will be limited but will provide cell phone reception in specific blackspots and tourism destinations. Telephone services are available at Knobs Flat (card-phone), from the Homer Tunnel (satellite phone for emergency use only) and from Milford Sound Piopiotahi (card-phone).

TRANSPORTATION

- **Te Anau Airport Manapouri:** Located between Te Anau and Manapouri, and owned / managed by Southland District Council, this airport comprises a sealed runway (and grassed cross runway) along with a terminal building. No scheduled commercial flights (pre-COVID-19) although chartered flights do run out of the facility during summer months.

- **Milford Aerodrome:** The Milford aerodrome (under the ownership of the Ministry of Transport) has a 792m long sealed airstrip but no facilities such as a terminal or toilets. The capacity of the aerodrome is limited by the runway length and geographical constraints limiting extending the runway. At present the aerodrome is suitable for light to small aircraft and helicopters only. It caters for inbound tourist flights, capped per day under the national park management plan.

- **Berths – Te Anau:** Commercial facilities on the Te Anau lakefront include several wharves associated with private and commercial activities, launch services, boat hire and a helipad. Public facilities include a boat harbour, moorings for boats and several launching ramps.

- **Berths – Manapouri:** There is a public boat ramp in the township of Manapouri at Pearl Harbour, which launches into the lower Waiau River. Manapouri boating club have a private boat ramp for members only.

- **Berths – Milford Sound Piopiotahi:** Located at Freshwater Basin is the main terminal for transferring passengers on to boat trips out to Milford Sound Piopiotahi and for water taxis/transfers for the Milford Track walkers. This is managed and mostly leased to the Milford Sound Tourism Ltd. On the southern side of the delta at Deepwater Bain are berthing facilities and landward infrastructure for the Fiordland cray-fishing fleet, sea kayaking and ecotourism ventures.

- **Walking Tracks:** A range of DOC walking tracks are located in and around the community hubs of Te Anau, Manapouri and along the corridor through to Milford Sound Piopiotahi (10, 9 and 22 respectively). These tracks vary in length, accessibility, and terrain to accommodate a range of potential visitors.

KEY CONSIDERATIONS FOR INFRASTRUCTURE DEVELOPMENT

There are some key considerations to be made with respect to infrastructure to service short listed options across the workstreams:

- Power Supply: while principally from renewable energy sources (small scale hydro schemes) the current network capacity is limited, and continuity of supply is a risk.

- Asset Configuration: if a complex option such as reshaping the layout of the Milford Sound Piopiotahi tourism hub is selected, then the layout should consider whether existing assets such as pipelines and ducting could be reused on current alignment or new assets are required. Each approach comes with a cost whether it be compromises to the building layouts or relocation of existing services.

- Network Capacity: While most infrastructure has been sized and can meet existing usage, the expansion of services and possible increase in demands may exceed current provisions.

- Sustainability: from an infrastructure perspective as it relates to possible changes to the configuration of corridor, less is more. All infrastructure should be designed, where viable, to minimise the footprint both physically and environmentally.
- Installation Costs: The remote location will mean that the installation rates for any works will be higher with labour charges (travel time and accommodation) and freight costs. We have applied an initial assumption of 10% premium being paid in Milford Sound Piopiotahi as compared to similar works in an urban centre, an additional 5% for Preliminary and General contract activities, and 20% for scope of works uncertainties for use in the masterplan. These factors may need to be refined through further design stages.

RECOMMENDED OPTION

The recommended option for the Master Plan includes the following key infrastructure elements:

In Milford Sound Piopiotahi:

Visitor Hub	• Buildings encompassing a Visitor Hub, Marine Interpretation Centre, Accommodation for Visitors and Staff • Arrival Bus Stop and Walkway • Features including feature landscaping, viewing deck walkway, new vehicle access corridor, waterfront walkways • Associated wastewater, water, and power modifications
Freshwater Basin	• New facilities at the existing terminal • Safety Refuge • Pontoon walkway to Bowen Falls
Deep Water Basin	• Commercial operations upgrade • Experience hub including provision for food vendors and landscaping • Kayak landing point • Safety Refuge
Cleddau Delta	• Shuttle Operations Centre • Long term parking and Helicopter landing pads • Delta Walkways and walking connection to the Tutoko river • Safety Refuges

In the Corridor:

Knobs Flat Hub	• Buildings encompassing a cabin and campground accommodation, Knobs Flat interpretation building, accommodation for visitors (Kiosk Creek lodge) • Knobs Flat Interpretation Structures • Features including able bodied and accessible walkways • Associated wastewater and potable water modifications
Super Track Head	• New Experience Hub

	• 7 new or modified tracks ranging in difficulty levels and length • Associated wastewater, potable water, and power management
The Corridor Experience	• New / Developed viewing area at Cleddau Cirque • Fiordland National Park (FNP) formal entrance / Eglinton Reveal • Cycleways developed focussing on Knobs Flat and connecting to Cascade Creek • Mistake Creek Walking Track Development • Enhancements to Cascade Creek Campground • Bus shelters at designated Hop on / Hop off locations

At Te Anau:

- Visitor Experience Hub including a building, short term parking, and feature landscaping.
- Modification to local roads to facilitate vehicle movements.
- A bus fleet operations centre and park-and-ride facility for visitors (remote from Visitor Experience Hub).

1 PROJECT BACKGROUND / DEFINITION

PURPOSE OF PROJECT

1.1 The purpose of the Milford Opportunities Project (MOP) is to develop a collaborative Master Plan for the Milford corridor and Milford Sound Piopiotahi sub-regional area to ensure:

"that Milford Sound Piopiotahi maintains its status as a key New Zealand visitor 'icon' and provides a 'world class' visitor experience that is accessible, upholds the World Heritage status, national park and conservation values and adds value to Southland and New Zealand Inc."

PROJECT AMBITION

1.2 The Milford Opportunities Project Master Plan must be world class, ambitious and creative. It should not be constrained simply by what can be done now within the current rules, instead it must consider what needs to be done and what the most appropriate outcome will be. The project is about making a substantive change and creative 'outside the box' thinking is needed before it is filtered by practical operational realities. The outcome must be:

- Consistent with the project's purpose and objectives.
- Consider a time frame of at least 50 years.
- Able to significantly enhance both conservation and tourism.

1.3 The Master Plan must give effect to the seven pillars (or values) identified in Stage One of the project and be supported by robust assessment and analysis.

PROJECT PILLARS

1) MANA WHENUA VALUES WOVEN THROUGH

Iwi's place in the landscape and guardianship of mātauranga Māori me te taiao (Māori knowledge and the environment) are recognised. Authentic mana whenua stories inform and contribute to a unique visitor experience.

2) A MOVING EXPERIENCE

Visitors experience the true essence, beauty and wonder of Milford Sound Piopiotahi and Murihiku/Southland through curated storytelling, sympathetic infrastructure and wide choices suited to a multi-day experience

3) **TOURISM FUNDS CONSERVATION AND COMMUNITY**

The visitor experience will become an engine for funding conservation growth and community prosperity.

4) **EFFECTIVE VISITOR MANAGEMENT**

Visitor are offered a world class visitor experience that fits with the unique natural environment and rich cultural values of the region.

5) **RESILIENT TO CHANGE AND RISK**

Activities and infrastructure are adaptive and resilient to change and risk, for instance avalanche and flood risks, changing visitor trends, demographics and other external drivers.

6) **CONSERVATION**

Manage Fiordland National Park to ensure ongoing protection of pristine conservation areas, while enabling restoration of natural ecological values in less pristine areas.

7) **HARNESS INNOVATION AND TECHNOLOGY**

Leading technology and innovation is employed to ensure a world class visitor experience now and into the future.

PROJECT OBJECTIVES

1.4 The objectives for the MOP are:

a) Protect and conserve the place now and into the future.

b) Recognise iwi's place in the landscape, guardianship and values.

c) Increase the effectiveness, efficiency and resilience of infrastructure.

d) The visitor experience funds conservation growth and community prosperity.

e) Reduce visitor exposure and risk to natural hazards.

f) Increase the connection of people with nature and the landscape.

g) Offer a world class visitor experience that is unique and authentically New Zealand.

h) Identify sustainable access opportunities into Milford Sound Piopiotahi.

i) Identify parts of the built environment that are surplus to requirements or could be shifted to improve visitor function and resilience.

j) Identify opportunities to create additional economic benefit for the communities of Southland and Otago including Queenstown via the pulling power of Milford Sound Piopiotahi.

k) Develop a Master Plan that:

   i. Creates and encapsulates a unique experience.

   ii. Is culturally, environmentally and physically appropriate and sustainable.

   iii. Clearly articulates what is acceptable and what is not acceptable visitor management and development within the identified value framework.

   iv. Considers the impacts of climate change at place.

   v. Supports the economic stability of Te Anau, Queenstown, Southland and NZ Inc.

   vi. Portrays a clear future for investment.

   vii. Informs the review processes for Fiordland National Park Plan and Southland Coastal Plan.

   viii. Sets out the ideal governance and management structure to ensure successful delivery on the objectives.

NATURAL DISASTERS AND COVID-19 IMPACTS

1.5 MOP stage 2 approach was impacted significantly by the 2020 Fiordland floods and then the COVID-19 pandemic.

1.6 Strategically, the consultant project team were required to be flexible in our approach and creative in our delivery. As a response to changing conditions we proposed methodologies to make allowance for factors such as lack of visitors, an initial inability to undertake site visits, and at times a restricted or reduced availability of staff from external organisations.

WORKSTREAM OBJECTIVES

1.7 These Objectives were refined from Stage 1 and were agreed with the Governance Group during Stage 2. The application of the Objectives within this Workstream is shown in the table below.

Table 1: Application of Stage 2 Objectives.

#	Stage Two Objective	Application to Infrastructure
1	Ngāi Tahu's role as mana whenua and Treaty partner is acknowledged and Te ao Māori values are embedded throughout.	The cultural identity of Ngai Tahu is to be expressed in the built environment. Traditional designs are to be woven into the fabric of the development. Sustainable practices are to be adopted that are of mutual benefit for the environment and its setting.
2	Milford Sound Piopiotahi is protected and conserved as required by its World Heritage status.	Any built infrastructure will be sensitive to environment into which it sits, fitting in with the surroundings, making the Milford Sound Piopiotahi and the Fiordland National Park the focus
3	The visitor experience is world class and enhances conservation of natural and cultural heritage values and community.	Development to feature intregrated storyboards and themes, modern and adaptable designs, all aligned to the provide all visitors an insight into the signficance of the region.
4	Infrastructure is effective, efficient, resilient, and sustainable (including access methods).	All infrastructure will be built with the environment in mind. Inclusion of the natural resilient materials, green star rated buildings, contingency measures, and efficient use of all resources will be paramount.
5	Visitors benefit communities, including Ngāi Tahu, communities of Te Anau, Southland, and Otago.	Outside of the economic benefits of visitors within the region, the supporting infrastructure will be developed to incorporate Ngāi Tahu and community needs as multi use facilties.

2 SCOPE OF WORK – INFRASTRUCTURE ASSESSMENT

2.1 The scope of works for Infrastructure Assessment includes the following:

a) Understand the existing provision of infrastructure.

b) Assess future infrastructure needs and to plan/provide integrated infrastructure solutions that meet the needs of visitors and community, including identification of redundant or inappropriate infrastructure.

c) Planning for and providing coherent integrated infrastructure that meets the needs of visitors and the community is needed to inform decision making for the Master Plan.

d) Infrastructure includes but isn't limited to; transport, wastewater, water, stormwater, energy (power, gas, etc), car parking areas, roads (bridges, culverts, tunnels, etc), airports (Milford and Te Anau Basin/Manapouri), communications, pedestrian walkways, walking tracks, public toilets, residential accommodation, commercial accommodation, wharves, boat ramps, ferry terminal, and commercial storage.

2.2 The key outcomes of this report are to:

- Assess key infrastructure at Milford Sound Piopiotahi and Te Anau Basin (including Manapouri), and along the Southern Scenic Route and the road corridor from Queenstown to Milford Sound Piopiotahi.
- Identification of areas with infrastructure capacity and areas that are constrained and the reasons why.
- An analysis of existing infrastructure capacity, level of demand, issues and options associated with existing infrastructure including capacity and lifespan (where known).
- High-level assessment of future infrastructure needs based on predicted visitor numbers based on Master Plan options.
- An estimate of the costs of providing for the above.
- Contribute information to the Master Plan that enables the identification and development of strategic options.

3 BASELINE: 3 WATERS INFRASTRUCTURE

3.1 The following sections describe the 3 Waters Infrastructure serving Te Anau, Manapouri and Milford Sound Piopiotahi.

3.2 Infrastructure plans for the three waters within Te Anau and Manapouri have been established by Southland District Council (ref: Southland District Council Activity Management Plan 2018 -2028), to accommodate growth projections as listed. Where available this information has been documented below.

WASTEWATER

TE ANAU

3.3 The Te Anau wastewater scheme consists of a combination of gravity sewers, pump stations and rising mains, discharging to a wastewater treatment plant located to the north-east of the township.

3.4 The Te Anau wastewater treatment plant upgrade is currently underway. This $27million upgrade includes new membrane filtration facilities in the final pond, a new 18.5km conveyance main for treated effluent and a 120ha subsurface drip irrigation field located to the north of the Manapouri/Te Anau airport (the 'Kepler Block'). The upgrade has included allowance for future growth in Te Anau, although some additional investment may be required to support this growth (for example, booster pump stations on the conveyance main). Further wastewater treatment processes may also be required to meet future discharge standards.

Figure 1: Te Anau WW network and WWTP

Table 2: Te Anau WW Network and WWTP

Item	Te Anau Wastewater
Asset Owner	Southland District Council
Population	In 2018, Te Anau had an estimated resident population of approximately 2,538 people[1]. The wastewater scheme includes 2,621 total equivalent connections including domestic, commercial, and light industrial wastes[2].

[1] Stats NZ, retrieved from https://www.stats.govt.nz/tools/2018-census-place-summaries/te-anau

[2] The Southland Economic Project: Urban and Industry Report, Southland Regional Council, May 2018.

Item	Te Anau Wastewater
Reticulation	The Te Anau gravity sewers were built between 1967 - 1975 to service the commercial area and north western residential area. The sewers have continued to expand as further development occurs. Gravity mains range in size from 50 mm to 525 mm in diameter and are generally at a flat grade. Most pipelines are uPVC and asbestos cement. Approximately 8,786 m of the reticulation has been CCTV inspected and found to be in fair condition. Blockages are an increasing problem in the network5. SDC have an ongoing programme to manage Inflow and Infiltration (I&I) in the network. The Mokonui Street rising main is a 300 mm diameter uPVC PN12, which is connected to a 475 mm diameter falling main approximately 900 m from the wastewater treatment plant. The rising main was renewed in two stages: the first coincided with resealing work in the Town Centre in 2003, the final section in Mokonui Street was completed in 2007.
Pump Stations	Five pump stations collect wastewater from localised catchments and elevate discharge to common gravity mains which flow to the main pump station. Wastewater is pumped through a common rising main to the treatment plant in the north east of the township.
Flow to Wastewater Treatment	Summer average daily flow (2010 – 2017): 1,165 m^3/day Winter average daily flow (2010 – 2017): 836 m^3/day Peak wet weather flow (2010 – 2017): up to 3,300 m^3/day The upgraded wastewater scheme will have capacity for up to 4,500 m^3/day[3], a significant increase on the existing capacity. This could be potentially increased to 6,000m^3/day with minor changes to infrastructure (i.e. addition of booster pump station or similar)[4], noting that this would remain limited to 4,500 m^3/day to be compliant with the existing consent
Wastewater Treatment	Treatment is provided through screening, a single oxidation pond with aerators and two maturation ponds[5][6]. The Te Anau Wastewater Treatment Plant Upgrade ($27M)[7] is currently being undertaken. This includes adding membrane filtration from the final pond.
Wastewater Disposal	The wastewater treatment plant currently discharges treated wastewater to land through the base of a wetland and to the Upukerora River. Construction is underway for an alternative subsurface drip irrigation system. This alternative discharge system is located at the North Kepler Block near Te Anau Airport, 15 km to the south of Te Anau. The intended outcomes of the land disposal system and WWTP upgrade is to reduce the impact on the environment by discharging via land and to allow for increased population.
Consent Compliance	Consent 20157778-01 is a short-term discharge consent to Upukerora River, which expires in 2020. Full consent compliance was achieved in 2016 – 2019 with respect to the 'discharge to water' consented limits and monitoring

[3] Te Anau Treated Wastewater Scheme Basis of Design, report prepared by Stantec for Southland District Council, September 2018.

[4] Ibid.

[5] SDC WW Asset Management Plan 2015 – 2045 (2014).

[6] SDC WW strategy stage 1: Information Summary (2017).

[7] SDC Long Term Plan (2018). Retrieved from: https://www.southlanddc.govt.nz/assets/Uploads/SDC-Final-LTP-2018-2028-Entire-Document-Web-Version.pdf

Item	Te Anau Wastewater
	requirements. However, the consented average monthly discharge flow limit was breached on six occasions in the 2018/19 period[8]. Consent 302625-01 is for the long-term discharge to Kepler Block. This consent is not yet active.
Level of service changes	The upgraded scheme will reduce impacts on the environment by removing the discharge to the Upukerora River, replacing this with a discharge to land at the Kepler Block[9].

MANAPOURI

3.5 The Manapouri wastewater scheme includes gravity sewers, pump stations and rising mains, discharging to a wastewater treatment plant to the south-east of the township.

Figure 2: Manapouri WW Network and WWTP

Table 3: Manapouri WW Network and WWTP

Item	Manapouri Wastewater
Asset Owner	Southland District Council
Population	The Manapouri community has an estimated 2013 resident population of 228[10].
Reticulation	The gravity sewers serving Manapouri were built between 1969 - 70 and consist of mostly 100-150 mm diameter uPVC pipes. The sewer condition was last inspected in 2004, at which time the network was generally in good condition[11]. The terminal rising main to the WWTP will require replacement to cater for future population growth.
Pump Stations	Three wastewater pump stations collect wastewater from localised catchments and elevate it to gravity mains which flow to the main pump station in View Street (PS1). Wastewater from the whole reticulation network is received at PS1 and is pumped through a rising main to the oxidation pond approximately 300 m to the south of Home Creek.

[8] Environmental Compliance Monitoring Report 2018/19, report by Environment Southland Compliance Team. Retrieved from https://www.es.govt.nz/repository/libraries/id:26gi9ayo517q9stt81sd/hierarchy/environment/compliance/compliance-monitoring-reports/documents/2018-19%20Compliance%20Monitoring%20Report.pdf

[9] Te Anau Treated Wastewater Scheme Basis of Design, report prepared by Stantec for Southland District Council, September 2018.

[10] Stats NZ, retrieved from: http://archive.stats.govt.nz/Census/2013-census/profile-and-summary-reports/quickstats-about-a-place.aspx?request_value=15136&parent_id=15113&tabname=&sc_device=pdf

[11] Volume 1 – Wastewater Strategy, Stage 1 Information Summary. Report prepared for Southland District Council by Stantec, July 2017.

Item	Manapouri Wastewater
Flow to Wastewater Treatment	Average daily flow: 92 m^3/day (33,580 m^3 per year).[5]
Wastewater Treatment	Treatment is provided by a single 1.85 ha oxidation pond which is located to the south east of Manapouri. Growth pressures are driving a review of treatment and disposal options. The SDC Long Term Plan has $1.4M allocated during 2023-2025 for Manapouri Wastewater Treatment Plant Upgrade[7]. Although details of the upgrade are not available at this time, a new membrane filtration plant was recommended under the Southland District Council wastewater strategy. Some strategic work has also been completed to investigate transfer of treated wastewater from Manapouri WWTP to the Kepler Block.
Wastewater Disposal	Discharge is generally to land via the base of the unlined pond and is seldom directed to Home Creek[12]. The current resource consent states SDC are permitted to discharge treated wastewater and stormwater from the Manapouri oxidation pond to land via seepage from the base of the oxidation pond.
Consent Compliance	Consent 201812 is held by Southland District Council for the discharge of treated wastewater from Manapouri WWTP and expires in 2024[13]. Compliance was achieved in 2018/19 with respect to consented effluent quality and receiving water limits and daily discharge flows[14].
Level of service changes	While upgrades to the reticulation are not required to address issues with pipeline condition, upgrades may be required to the wastewater network to meet both the increased level of service due to growth and/ or discharge quality.

MILFORD SOUND PIOPIOTAHI

3.6 The wastewater network and wastewater treatment plant in Milford Sound Piopiotahi is owned and maintained by Milford Sound Tourism Ltd. Some properties have private septic tank systems and are not connected to the wastewater network.

Table 4: Milford Village WW network configuration

Item	Milford Village Wastewater
Asset Owner	Owned and operated by Milford Sound Tourism Ltd (formerly Milford Sound Tourism Ltd).
Population	Milford Sound Piopiotahi has a resident population of approximately 120 people. Although visitor numbers during peak season could approach 6,000 people per day.
Reticulation	A concession (PAC-14-04-68) is held by the Milford Sound Tourism Ltd for the right to drain sewage and a right of way. This incorporates the collection of pressure and gravity mains that service the various parts of the Milford village.
Flow to Wastewater Treatment	No information was available regarding current daily flows. Milford Sound Tourism hold consent AUTH-204873 to discharge up to 1,000 cubic metres per day of treated sewage effluent to water at Deepwater Basin.

[12] Volume 1 – Wastewater Strategy, Stage 1 Information Summary. Report prepared for Southland District Council by Stantec, July 2017.

[13] Ibid.

[14] Compliance Monitoring Report 2018/19, Environment Southland.

Wastewater Treatment	The wastewater treatment plant is in the Deepwater Basin area.  Figure 3: Deepwater Basin WW Treatment
Wastewater Disposal	Treated wastewater is discharged to water at Deepwater Basin[15]. There is an additional discharge of wastewater to land at Sandfly Point (Milford Track), of up to 1800L/day. The consent for this activity is held by the Department of Conservation (AUTH-201033)[16].
Consent Compliance	The wastewater system was fully compliant with consent conditions in 2018/19[17]. The consent expires in 2028.
Level of service changes	Milford Sound Tourism Ltd is currently underway with repairs and upgrades to the wastewater treatment system after damage caused in the February 2020 flooding[18].

DOUBTFUL SOUND

3.7 Deep Cove Outdoor Education Trust hold a permit (AUTH-203114) to discharge up to 50 cubic metres of treated sewage effluent per day into coastal waters, at the Meridian wharf at Deep Cove, Doubtful Sound. The wastewater treatment plant was recently upgraded, including new septic tanks and aeration tank with trickling filter system (Figure 4).

Figure 4: Wastewater treatment plant at Deep Cove

[15] Environment Southland Compliance Monitoring Report 2019-2019. Retrieved from: https://www.es.govt.nz/repository/libraries/id:26gi9ayo517q9stt81sd/hierarchy/environment/compliance/compliance-monitoring-reports/documents/2018-19%20Compliance%20Monitoring%20Report.pdf

[16] Environment Southland GIS.

[17] Environment Southland Compliance Monitoring Report 2019-2019. Retrieved from: https://www.es.govt.nz/repository/libraries/id:26gi9ayo517q9stt81sd/hierarchy/environment/compliance/compliance-monitoring-reports/documents/2018-19%20Compliance%20Monitoring%20Report.pdf

[18] Personal communication Tony Woodham, 18 June 2020.

TE ANAU / MILFORD SOUND CORRIDOR

3.8 Milford Sound Tourism Ltd own and operate the wastewater treatment facilities at Knobs Flat and hold a resource consent (AUTH-20147339) to discharge up to 30 cubic metres per day of treated wastewater to land at Knobs Flat. In 2017/18 and 2018/19, Milford Sound Tourism Ltd were non-compliant with their consent conditions. Milford Sound Tourism Ltd is investigating significant upgrades to the treatment and disposal system to resolve the non-compliances with the discharge consent.

POTABLE WATER

TE ANAU

3.9 The Te Anau potable water scheme consists of a combination of sources (shallow groundwater bores and a supplementary bore), treatment, reservoir storage, and reticulation.

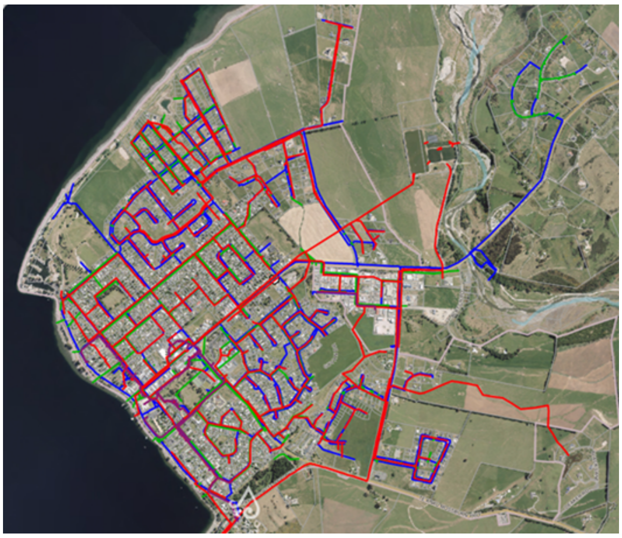
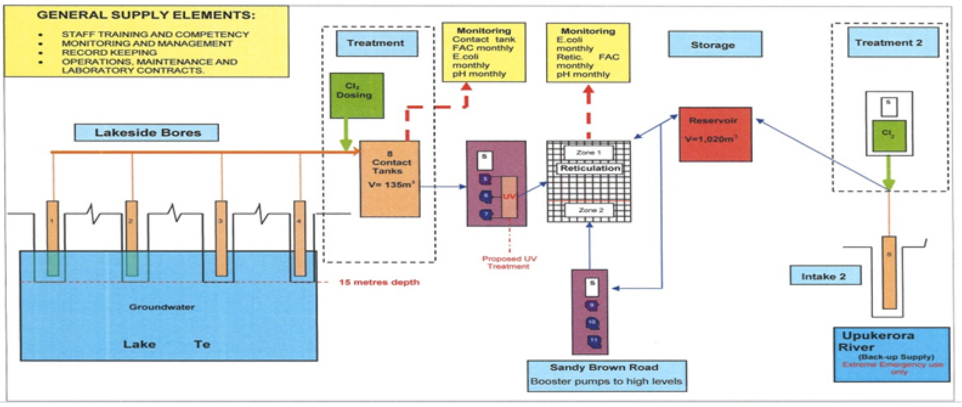


Figure 5: Te Anau Potable Water network

Table 5: Te Anau Water Supply network configuration

Item	Te Anau Water Supply
Asset Owner	Southland District Council
Installation Date	From 1966
Process Description	Groundwater is drawn from three shallow bores adjacent to Lake Te Anau (north-west of town) and an Upukerora bore (used as a secondary source). Raw water passes through a treatment plant before being pumped through the reticulation to the main reservoir. Treated water gravitates back to the reticulation network supplying Te Anau, which is an urban supply on mains pressure. There is also a low-pressure restricted water supply along Milford Road.

Item	Te Anau Water Supply
	
Consents	The current consent allows for groundwater take and use of no more than 6,500 m³/day from the three shallow bores adjacent to Lake Te Anau, and 2,100 m³/day of groundwater from the Upukerora bore[19]. Consent expires 5 July 2024. The water supply scheme meets the current Drinking Water Standards. When the Upukerora River is in flood there are water quality issues with the supply from the Upukerora bore[20].
Treatment	Treatment is provided at the lakeside water treatment plant by the injection of chlorine immediately prior to 8 x 22.7 m³ concrete contact tanks. Some degree of treatment is provided by the gravel/sand media surrounding the wells. However, the level of this treatment is not known. Continuous chlorine monitoring was installed in 2001 and is linked to the SCADA telemetry system. Plant upgrade completed 2014.
Pump Stations	The contact tanks are connected to high lift pumps which deliver water into the reticulation system, with the excess continuing to the reservoir. New pumps (3 no.) were installed in 2006. A booster station with 30 m³ storage was constructed in 2004 as part of a service extension in Sandy Brown Road. This pump station provides the required pressure and flow to the upper terrace area while buffering any fluctuations from the town supply.
Storage	The main reservoir has a capacity of 1,020 m³ and is a 15m diameter concrete tank located to the east of Te Anau, on a terrace approximately 28 m above the Upukerora source.
Reticulation	Piped reticulation networks supply all Te Anau properties on the lower terraces. Most commercial and out of town consumers are metered or are on restricted flow supplies. Rising mains are PVC. Gravity mains are PVC, asbestos cement, and PE. The reticulation system consists of two ring-main systems with a series of sub-main branches. A delivery pipe extends from the lakefront high lift pumps to the reticulation system at the northwest end of Bligh Street and from the intersection of Milford Road and Howden Street to the reservoir. This delivery pipe is a combination of 300 mm and 200 mm diameter PVC. Water mains installed in the 1960s (particularly ageing AC) are starting to need renewal.
Proposed Upgrades	The SDC Long Term Plan has $1.0M allocated for Te Anau RWS Water Lateral Replacements and $8.4M allocated during 2038-2048 to Te Anau Water Pipe, Treatment and Pump Renewals. The long-term plan acknowledges within the next 10 to 30 years pipes in Te Anau will start to reach the end of their useful life and will need to be replaced. Current potable water loss is estimated at 46% in Te Anau. Some of this leakage will be addressed through scheduled pipe renewals.

[19] SDC Water Supply Activity Management Plan (2018)

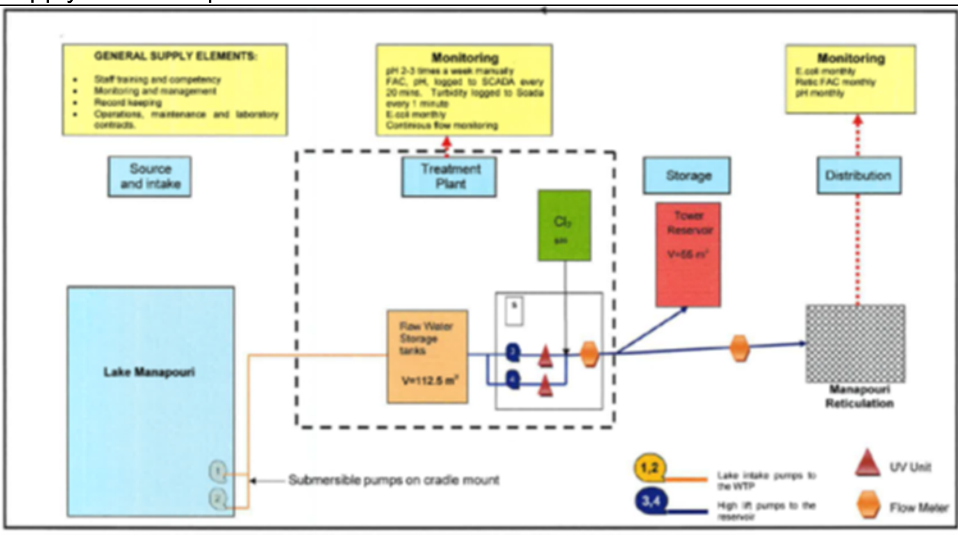
[20] SDC Urban and Industry Report

MANAPOURI

3.10 The Manapouri potable water scheme consists of a source (via lake intake), treatment, reservoir storage, and pressurised reticulation.

Figure 6: Manapouri Potable Water network

Table 6: Manapouri Water Supply network configuration

<table>
<tr><th>Item</th><th>Manapouri Water Supply</th></tr>
<tr><td>Asset Owner</td><td>Southland District Council</td></tr>
<tr><td>Installation Date</td><td>From 1969 [19]</td></tr>
<tr><td>Process Description</td><td>Water is pumped from Lake Manapouri to the treatment plant. Treated water is lifted to the Tower Reservoir and the reticulated network, which is an urban supply on mains pressure.</td></tr>
<tr><td></td><td>
</td></tr>
<tr><td>Consents</td><td>Water Permit 201796 allows for up to 865 m3/day from Lake Manapouri. Consent expires 4 August 2023. The system does not meet 2008 Drinking Water Standards due to bacteriological issues. The reticulation network does not meet firefighting standards at some locations.</td></tr>
<tr><td>Treatment</td><td>The treatment plant is located under the tower reservoir and consists of disinfection using chlorine gas and contact tanks.</td></tr>
<tr><td>Pump Stations</td><td>Two pumps (an original 5.5 kW Brown Brothers pump and a new Goulds pump) are fixed to a cradle on the bed of Lake Manapouri. At normal lake level they lie in approximately 6-7 m of water. A sealed electrical supply extends from the</td></tr>
</table>

Item	Manapouri Water Supply
	lakeside to the pumps. Separate 50 mm diameter polyethylene rising mains extend from each pump to the lake shore where they join into a single 100 mm diameter asbestos cement rising main which extends 44 m (vertical) to the treatment plant.
Storage	Five concrete contact tanks provide 112.5 m3 of contact storage. The tower reservoir has a capacity of 55 m3 is constructed of steel and elevated approximately 18 m above ground.
Reticulation	Rising mains are asbestos cement and PE. Gravity mains are PVC, polyethylene, and asbestos cement. Firefighting capacity is poor in Manapouri. Few of the hydrants in Manapouri satisfy the minimum flow requirements of 25 L/s. The Tower Reservoir can provide water for approximately 25 minutes of concurrent Class E and average daily flows (if starting at 80% full). The minimum requirement is one-hour standby flow for Type E fire zones. If the contact tanks are considered part of the available storage, then approximately one hour and 25 minutes of concurrent Class E at average daily flows (if starting at 80% full) can be provided.
Proposed Upgrades	The SDC Long Term Plan has allocated $1.0M during 2019-2021 for upgrades to the Manapouri Water Treatment Plant. Current potable water loss is estimated at 20% in Manapouri.

MILFORD SOUND PIOPIOTAHI

3.11 The Milford Sound Piopiotahi water scheme consists of a run of river source, treatment, storage, and reticulation.

Table 7: Milford Sound Piopiotahi Water Supply network configuration.

Item	Milford Sound Piopiotahi Water Supply
Asset Owner	Milford Sound Infrastructure Ltd owns and operates the water supply system within Milford village[21]. Tourism Holdings Ltd undertakes all routine operations and maintenance for the water supply network.
Installation Date	Unknown
Process Description	Water is primarily sourced from the hydro scheme penstock at Bowen River, filtered and treated with UV disinfection. It is stored then reticulated around the village. A limited amount of water can be drawn off Milford River creek in an emergency where the penstock supply is not available, and the storage tanks have been depleted. A bore (5L/s) has recently been installed to provide a supplementary water source. There are currently several resource consents to install bores for the purpose of taking water for supply to Milford Sound Piopiotahi community and tourist vessels[22].
Consents	Milford Power Holdings Ltd hold consent AUTH-99024 for the take of up to 2,700 cubic meters of water per hour from the Bowen River for electricity generation[23]. Water is also taken for potable use under this consent. The consent expires this year (2020). Milford Sound Infrastructure Ltd hold consent AUTH-20191526-01for the supplementary water supply bore (well CB08/0002).
Treatment	The water is filtered, and UV treated, and the sully is compliant with current NZ Drinking Water Standards. Chlorination may be required in addition to existing

[21] Retrieved from https://milfordinfrastructure.co.nz/

[22] Environment Southland GIS.

[23] Ibid.

Item	Milford Sound Piopiotahi Water Supply
	supplies if activities expand beyond current levels. There is a registered water laboratory in Milford Sound Piopiotahi and all water sampling and compliance is out of that laboratory.
Pump Stations	Milford Sound Infrastructure has two emergency water pumps that can transfer a limited amount of water to the storage tanks in the event of a major hydro penstock failure[24].
Storage	Water is stored in two large storage tanks of 85,000 and 45,000 litres capacity. At peak times there is approximately 12 hours storage in addition to storage provided for firefighting for Milford Village buildings. Several of the operators maintaining staff accommodation in Milford Sound Piopiotahi (for example Real Journeys) have water storage tanks which act as a backup when the main water supply is unavailable or unsuitable for use.
Reticulation	Water is reticulated via a network of water mains and laterals. Milford Sound Lodge continues to utilise their own bore. The main supply pipe to the water storage tanks has recently been replaced with a new high pressure main from the Mitre Peak Lodge valve pit[25]. Most of the water network has been replaced over the past 20 years.
Proposed Upgrades	No upgrades are currently planned

OTHER SCHEMES WITHIN THE STUDY AREA

3.12 SDC has several rural residential water supply schemes. Council owns and manages the following rural water supply schemes at Duncraigen, Homestead, Kakapo, Mount York, Princhester, Ramparts and Takitimu, locations illustrated in the following figure. All the rural schemes within proximity to Manapouri and Te Anau are used for stock water supply.

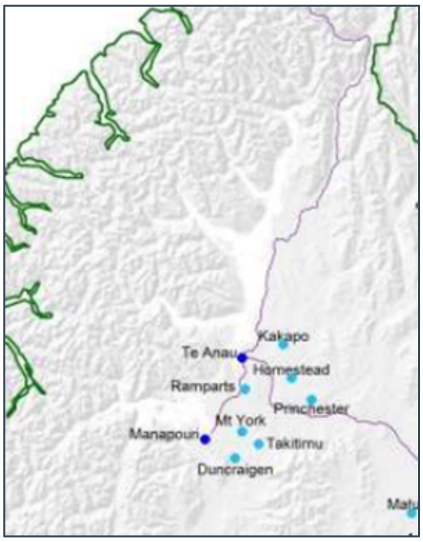


Figure 7: Southland District Water Reticulation locations surrounding Te Anau and Manapouri

[24] Milford Sound Infrastructure, retrieved from https://milfordinfrastructure.co.nz/replacement-water-main-to-storage-tanks/

[25] Ibid.

STORMWATER

TE ANAU

3.13 Te Anau is served by a reticulated stormwater network, although there is limited information about the number of connections to this scheme. It is likely that many private residences discharge to private soakage pits rather than to the reticulated network.

3.14 The stormwater network has developed progressively as the town has grown, with the oldest parts of the network in the town centre dating to the 1960s/70s[26].

3.15 Te Anau's total stormwater catchment area is approximately 336ha, with discharges into Lake Te Anau, the Upukerora River or to ground. Some newer subdivisions have installed on-site disposal rather than connecting to the reticulated stormwater network.

3.16 The town centre catchment area is treated through a filter that removes gross pollutants. The remainder of the network is not treated.

3.17 The service provided by the system is generally accepted as being adequate at present. The progressive urbanisation of Te Anau and increase in impervious areas may result in significant under-capacity and surface flooding in several areas following heavy rainfall. The surface flooding does recede quickly upon the cessation of rain.

3.18 There are ongoing issues with gravel build up at the stormwater discharge into the Upukerora River, which restricts stormwater outflow and causes backing up through the pipeline.

3.19 With regulation changes pending for stormwater discharges and increasingly stringent water quality standards, it may be necessary to improve of Te Anau's stormwater discharges in the future.

MANAPOURI

3.20 Manapouri is served by a reticulated stormwater network, although there is limited information about the number of connections to this scheme. It is likely that many private residences discharge to private soakage pits rather than to the reticulated network.

3.21 Manapouri's total catchment area is approximately 80 ha. Manapouri has three natural watercourses which receive stormwater run-off: Lake Manapouri, Home Creek, and Waiau River.

3.22 SDC hold a generic resource consent to discharge stormwater to land and to water from reticulated stormwater drains in the Dipton, Edendale, Manapouri, Nightcaps, Ohai, Otautau, Tuatapere and Wallacetown townships.

3.23 Most sumps in the network are thought to have siphon type traps which assist in the point source collection of sediment and floating debris. There is no other stormwater treatment in the system.

3.24 The service provided by the system is generally accepted as being adequate, although there have been instances of surcharging of manhole covers.

3.25 With regulation changes pending for stormwater discharges and increasingly stringent water quality standards, it may be necessary to improve of Manapouri's stormwater discharges in the future.

MILFORD SOUND PIOPIOTAHI

3.26 There is limited stormwater infrastructure within Milford Village. The stormwater system consists of sumps, laterals, manholes, connecting pipework and outlets to watercourses.

[26] Southland Economic Project,

Figure 8: Stormwater Infrastructure within Milford Sound Piopiotahi

3 WATERS INFRASTRUCTURE LIMITATIONS AND RISK

3.27 The Te Anau and Manapouri wastewater networks are in fair to good condition. These networks may require upgrades or extensions to cater for population growth.

3.28 Upgrades are scheduled or underway for both Te Anau and Manapouri wastewater treatment plants.

3.29 The Te Anau wastewater treatment plant upgrade includes some allowance for projected population growth but does not cater for the 'ultimate' projected population. Additional investment is likely to be required to cater for population growth, including a booster pump station on the discharge conveyance main; network upgrades within the town; additional storage to balance flows to the treatment plant; etc.

3.30 Money is set aside under the Southland District Council Long Term Plan for the Manapouri wastewater treatment plant upgrade, but details of the upgrade are not available at this time. A new membrane filtration plant was recommended under the Southland District Council wastewater strategy, but this is unlikely to be affordable under the current funding allocation ($1.4M). Some strategic work has also been completed to investigate transfer of treated wastewater from Manapouri WWTP to the Kepler Block.

3.31 Both Te Anau and Manapouri wastewater treatment plants may require further upgrades in future to comply with new wastewater regulations scheduled to be introduced under Taumata Arowai, the new drinking water regulator. The new regulator is expected to mandate stricter discharge quality requirements and reduced tolerance for overflows. This could require further process improvements, more storage in the network, and/or restrictions on the quantity and quality of wastewater discharged to land or to water. These changes may limit the capacity of the wastewater treatment system to cater for future growth beyond the horizon of the current consent.

3.32 The stormwater networks of both Te Anau and Manapouri are also likely to be affected by increasingly stringent discharge regulations under the new regulator. This may require upgrades to the networks, including improvement to stormwater treatment.

3.33 All three waters infrastructure will need to comply with the requirements in Environment Southland's Water and Land Plan (in draft form with submissions being heard in 2020). The plan has an emphasis on the management of activities that may adversely affect freshwater.

3.34 Little information was found for the Milford Sound Piopiotahi wastewater network, treatment plant and discharge structure. Upgrades are currently underway to repair damage sustained in a February 2020 flood event. Although the plant is currently compliant with all consent conditions, we anticipate that process upgrades will be required in future when the discharge consent comes up for renewal (year 2028), to meet increasingly strict discharge quality requirements.

3.35 The Milford Sound Piopiotahi stormwater network is also likely to require upgrades to meet more stringent discharge quality requirements in future, such as the addition of stormwater treatment facilities for road and carparking stormwater systems likely integrated with landscaping features.

3.36 Upgrades are scheduled for the both the Te Anau ($8.4M) and Manapouri ($1M) water treatment plants. No details were found for the proposed upgrades. However, the Manapouri WTP is at risk of non-compliance against drinking water standards due to high turbidity. Resolution of this issue is part of current planned upgrades. Both plants are likely to need process upgrades to meet increasingly strict drinking water quality requirements under Taumata Arowai.

3.37 $1M has been allocated for water renewals in Te Anau. The water networks for both towns are likely to need upgrades in future to cater for population growth, and to replace ageing water infrastructure.

3.38 The potable water supply system in Milford Sound Piopiotahi is likely to require process improvements and network upgrades to cater for population growth and to meet more stringent quality requirements under Taumata Arowai.

3.39 The Hazards and Visitor Risk report includes details of natural hazards potentially affecting three waters infrastructure within the project area.

4 BASELINE: POWER SUPPLY AND TELECOMUNICATIONS

TE ANAU AND MANAPOURI

4.1 The Power Company Limited have a zone substation to supply Te Anau, Manapouri, and surrounding rural areas. The substation is a 66kV structure with two 66kV circuit breakers, supplying two 66/11kV 9/12MVA transformers. The system is part of the northern 66kV ring supplied from Heddon Bush. The substation has AAA security classification, the highest rating.

4.2 Reticulated power (PowerNet) reaches to just north of Te Anau Downs on SH94, about 32km from Te Anau.

4.3 Spark and Vodafone mobile coverage is available in Manapouri [27, 28.] and Te Anau. Spark and Vodafone mobile coverage extends just beyond Te Anau downs [29, 30.].

4.4 The SDC wastewater pipeline route from Te Anau to Manapouri is immediately adjacent to an existing 11kV cable. The cable will be relocated and upgraded to provide additional capacity, as part of the Te Anau wastewater upgrade project.[31]

MILFORD SOUND PIOPIOTAHI

4.5 Electricity is generated at Milford Sound Piopiotahi from a hydroelectric scheme on the Bowen River, with backup diesel generation. They hydroelectric scheme is operated by Milford Sound Power Holdings. Milford Power Holdings Ltd hold a resource consent to take and discharge 2,700 cubic metres of water per hour from the Bowen River for the scheme.

4.6 The scheme comprises of two hydro gensets: 500KVA and 360KVA. Both hydro gensets utilise the Bowen River as a run-of-river scheme (no storage). The hydro intake stilling well requires debris removal about twice per month. Power is supplied 24/7 and is managed utilising a remote-control scheme. The scheme includes four diesel standby gensets: Cummins 500KVA, Onan 360KVA, Iveko 210KVA and Iveko mobile unit 100KVA.

4.7 Power is distributed through a 3.3kV backbone network feeding 240v 3-phase cables. The whole network is underground. The network is a star configuration with no duplication however is very reliable with most cables being installed within the past 20 years. Fault conditions can be mitigated by back feeding utilising generation located around Milford Sound Piopiotahi.

4.8 The Milford Infrastructure website notes the observed load growth – *"this winter (2019) we have experienced some very high electricity peak loads and the recently installed load monitoring system is proving valuable in understanding the load patterns*". Some peaks have reached 480KW.[32] There are around 3 dozen commercial customers served by the scheme.

4.9 There are two extraordinary projects pending related to the hydro scheme: replacement of the penstock and reconditioning of the hydro turbine and generator.

4.10 Knobs Flat camp SH94 has mains power available from a local hydro scheme and engine-alternator system.[33]

[27] Spark NZ network coverage. Retrieved from: https://www.spark.co.nz/shop/mobile/network.html

[28] Vodafone NZ network coverage. Retrieved from: https://www.vodafone.co.nz/network/coverage/

[29] Spark NZ network coverage. Retrieved from: https://www.spark.co.nz/shop/mobile/network.html

[30] Vodafone NZ network coverage. Retrieved from: https://www.vodafone.co.nz/network/coverage/

[31] PowerNet Asset Management Plan Update 2019 – 2029. Retrieved from: https://powernet.co.nz/uploads/2019/04/TPCL-AMP-Update-2019-29.pdf

[32] Milford Sound Infrastructure Website. Retrieved from: https://milfordinfrastructure.co.nz/

[33] Briefing on Provincial Growth Fund (PGF) fibre optic build projects: Te Anau- Milford Sound (2019). Retrieved from: https://www.crowninfrastructure.govt.nz/wp-content/uploads/2019/04/CIP-South-Westland-Milford-Briefing.pdf

4.11 The telephone system into Milford Sound Piopiotahi is owned and operated by Chorus. Currently the system operates on a microwave link with multiple repeaters at high alpine locations, plus a fibre cable from Mt Prospect to Te Anau (see Figure 9). The radio link has limited band width of 2Mb/s total supporting up to 30 simultaneous phone calls for the 76 customers and does not provide an internet connection. The high-altitude repeaters can only be serviced using helicopter access. This system is built reasonably robustly but relies on solar panels, with batteries for approximately 10 days backup. Sometimes the stations or solar panels get hit by lightning, broken by strong wind gusts, or covered in snow.

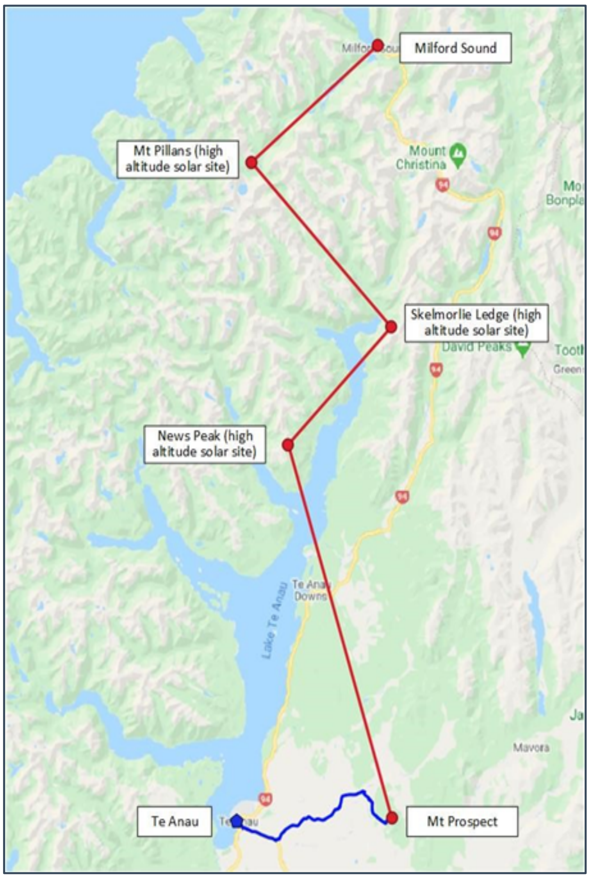


Figure 9: Chorus radio link to Milford Sound Piopiotahi. Source: Chorus

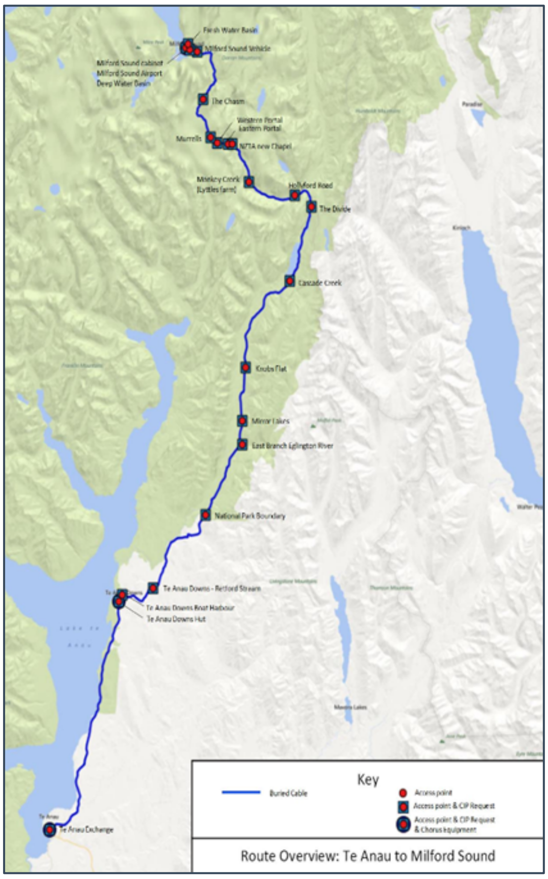


Figure 10: Proposed breakout positions for new Fibre. Source: MBIE

4.12 Additional supplementary telephone services are available at Knobs Flat (card-phone), Homer Tunnel (satellite phone for emergency use only) and from Milford Sound Piopiotahi (card-phone).[34]

4.13 There is currently no cell phone coverage at Milford Sound Piopiotahi, and only limited coverage on the Milford Road. Under the Mobile Blackspot Program operated by Crown Infrastructure Partnersi, coverage will be rolled out to tourist destinations and state highways including Milford Sound Piopiotahi, Doubtful Sound, Knobs Flat and the Milford Road (among others). Completion is scheduled for 2022[35].

4.14 Many of the locations on SH94 and SH6 do not have reticulated power so it is likely short-range cell sites will be installed to reduce power requirements. The cell phone coverage will not be continuous along the routes. The locations presented in Figure 10 are based on break up highway blackspots from a safety perspective and provide services at popular tourism locations.

4.15 There is a reticulated LPG network servicing the Cleddau Residential area, Deep Water Basin and Milford Sound Lodge. The gas network was installed in 2011. Gas is trucked to Milford Sound

[34] Milford Sound Tourism, The Milford Road. Retrieved from: https://milfordsoundtourism.nz/themilfordroad

[35] Email Correspondence Abby Cheeseman, MBIE, August/September 2020

Piopiotahi from Invercargill. The main liquid LPG storage is backed up with two banks of vapour bottles to cover a fault in the gas vaporiser unit. MSI has an LPG bottle storage compound that always holds a minimum of two weeks supply. MSI supplies 45kg bottled gas to 3 standalone facilities in Milford Sound Piopiotahi and supplies 18kg bottles to NZ Walks that operate the Hollyford Track huts.

POWER SUPPLY AND TELECOMMUNICATIONS INFRASTRUCTURE LIMITATIONS AND RISK

4.16 A discussion on asset risks is identified within the “Hazard and Visitor Risk” is reported upon within work package T10.

4.17 The power provisions for Milford Sound Piopiotahi centre on a hydropower plant, with limited capacity, with emergency provisions in the form of backup diesel generators. These assets are susceptible to natural hazards, whether seismic or climate induced.

4.18 Any expansion of services within Milford Sound Piopiotahi will require review and upgrade of the current power generation capacity or alternative generation sources identified.

4.19 Planned improvements to cell phone coverage under the Mobile Blackspot Program and extension of the national fibre optic network within the study area will, in part, address issues with communications. There will remain, as with the provisions for power supply, a risk to the fixed assets installed from natural hazards, whether seismic or climate induced.

5 BASELINE: TRANSPORTATION INFRASTRUCTURE

5.1 Car parking and corridor assessment for vehicle traffic is reported upon within package T04. This package includes infrastructure relating to airfields, berthing facilities, and walking tracks.

AIRFIELDS

TE ANAU AIRPORT

5.2 Te Anau Airport is located between Te Anau and Manapouri townships (Figure 11). The airport was constructed in the 1960s by Mt Cook Airlines as a base for the Manapouri power station project. The airport was sold to Southland District Council in 2002, who made improvements to the runway and airport facilities.

5.3 No scheduled airlines operate to Te Anau at the present time, although regular charter flights operate during summer.[36] Scenic flight operators are also based at the airport. The airport also provides air-based emergency access.[37]

5.4 Facilities available include:

- Sealed runway and grass cross runway.
- Precision approach path indicator (APAPI) system.
- Terminal building.
- No runway lighting.
- Non-directional radio beacon (NDB) is located 2.5NM/6.5KM NE of the airport.

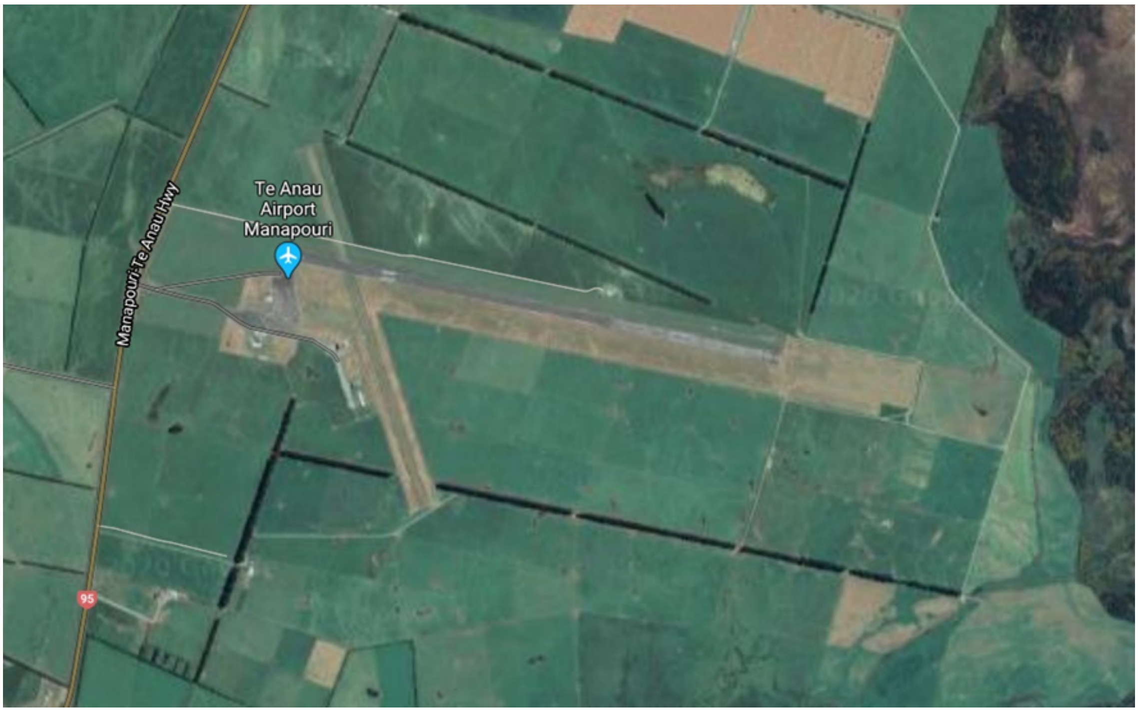


Figure 11: Te Anau Airport Manapouri Aerial Image (Google, 2020)

[36] Te Anau Airport Manapouri Website. Retrieved from: https://fiordlandaeroclub.weebly.com/te-anau-airport-manapouri.html

[37] Te Anau Airport Activity Management Plan (Part B – Asset based) (2018). Retrieved from: https://www.southlanddc.govt.nz/assets/LTP2018/AMP/19-AMP-Te-Anau-Airport-Manapouri-2018-2028-DRAFT-FEB-18.pdf

5.5 There is a low fly zone to the north of Te Anau township used by the Fiordland Aero Club for training purposes (Figure 12)[38].

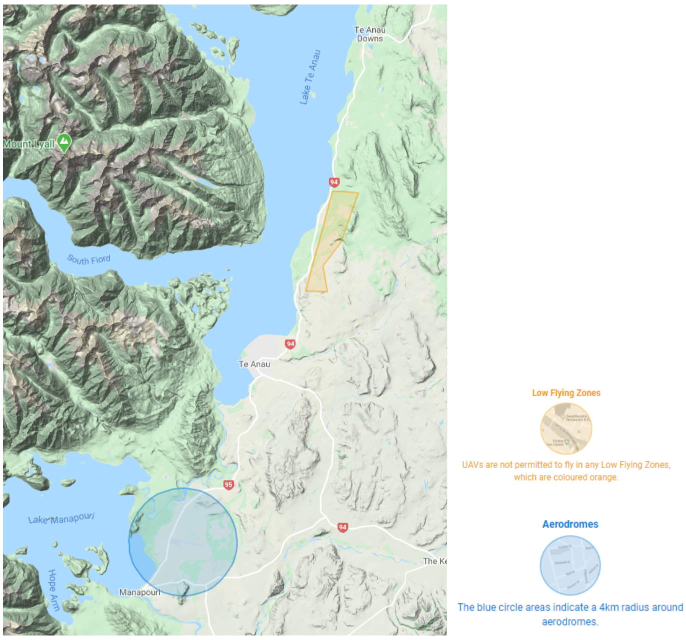


Figure 12: Te Anau Airport Manapouri Airspace Zones

MILFORD SOUND PIOPIOTAHI

5.6 Milford Aerodrome is located on the Deepwater Basin delta (Figure 13). The aerodrome is surrounded by water on three sides, and steep mountains on the remaining side.

Figure 13: Milford Aerodrome location

5.7 The Ministry of Transport manages operations at the aerodrome. Airways Corporation of New Zealand Ltd (Airways) provides a flight information service. The Department of Conservation

[38] AIP New Zealand. Other hazardous airspace document. Retrieved from: http://www.aip.net.nz/pdf/ENR_5.3.pdf

administers the aerodrome land and caps the number of flights able to land at the aerodrome under the national park management plan.[39].

5.8 Most of the flights into Milford Sound Piopiotahi are tourist flights scheduled to meet boat sailings and other organised activities during favourable weather conditions. The aerodrome is almost exclusively used for general aviation operations under visual flight rules. There is an area of controlled airspace in a 4km radius surrounding the aerodrome as illustrated in Figure 14.

5.9 The sealed airstrip is 792m in length. There are no facilities for tourists such as a terminal or toilets at the aerodrome[40].

5.10 The capacity of the aerodrome is limited by the runway length and geographical constraints. The western portion of the runway is subject to inundation during King Tide events, which would be exacerbated by any degree of sea level rise in the future. At present the aerodrome is suitable for light to small aircraft and helicopters only.

5.11 There is a restricted area in the interests of aviation safety surrounding the Homer Tunnel. The vertical limit of this is from surface to 8,500 ft. The administering authority is Downer NZ[41].

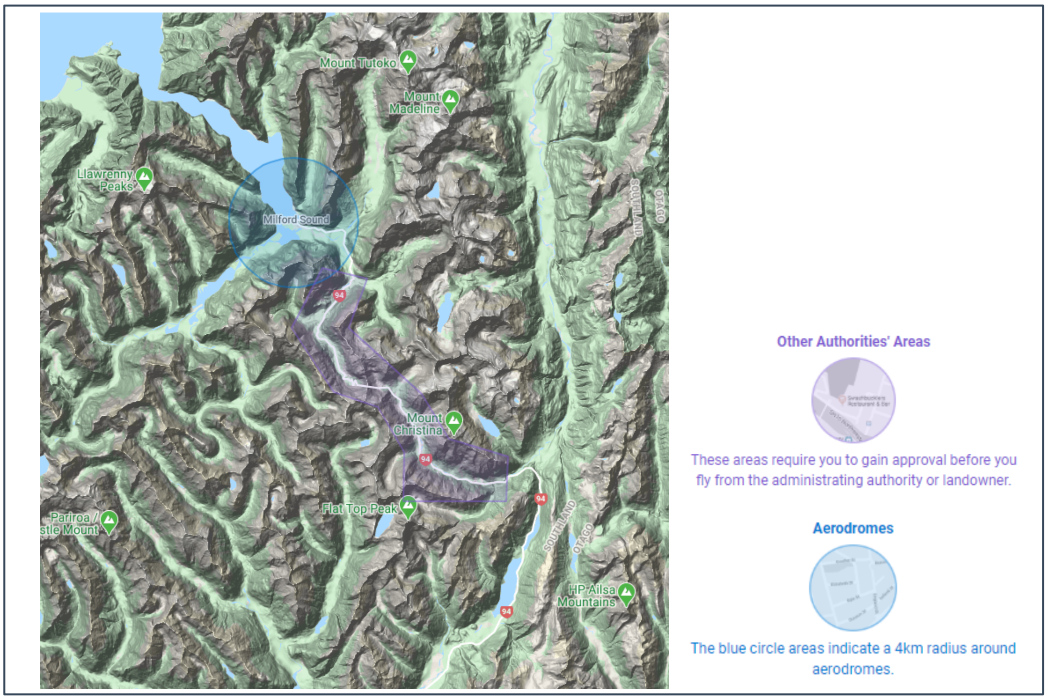


Figure 14: Milford Airspace Zones

SEA LEVEL RISE AND ITS POTENTIAL IMPACT ON THE RUNWAY

5.12 The north-western end of the runway is the lowest elevation (just over 1.5m above mean sea level at the very end), so the last 300m in particular would be subject to increasingly frequent waterlogging and damage of foundations and tarmac from rising sea levels. This area would need raising to reach in the order of 2.1m as a minimum (Representative Concentration Pathway (RCP) 8.5 on top of a circa 2-year Average Recurrence Interval (ARI level) or preferably 2.4m (circa 100-year ARI), ideally with freeboard added on top, and all this tied into existing runway elevations. The middle of the runway and apron area is at around 3.0m above mean sea level so from that point eastwards flooding from the sea is less of an issue. There would also be ingress of groundwater associated with the Cleddau River to higher levels (than those in the sea), via water pressure through the alluvial gravels. The exact levels/frequency/extents of lateral water ingress are complex as they depend on water levels at both ends (river and sea), and on material

[39] MOT Milford Sound Piopiotahi Aerodrome. Retrieved from: https://www.transport.govt.nz/air/nzmf/

[40] Australian Aviation News. Retrieved from: https://australianaviation.com.au/2019/03/turbulence-in-paradise-for-flightseeing-operators-at-milford-sound/

[41] AIP New Zealand. Prohibited, restricted and danger areas document. Retrieved from: http://www.aip.net.nz/pdf/enr_5.1.pdf

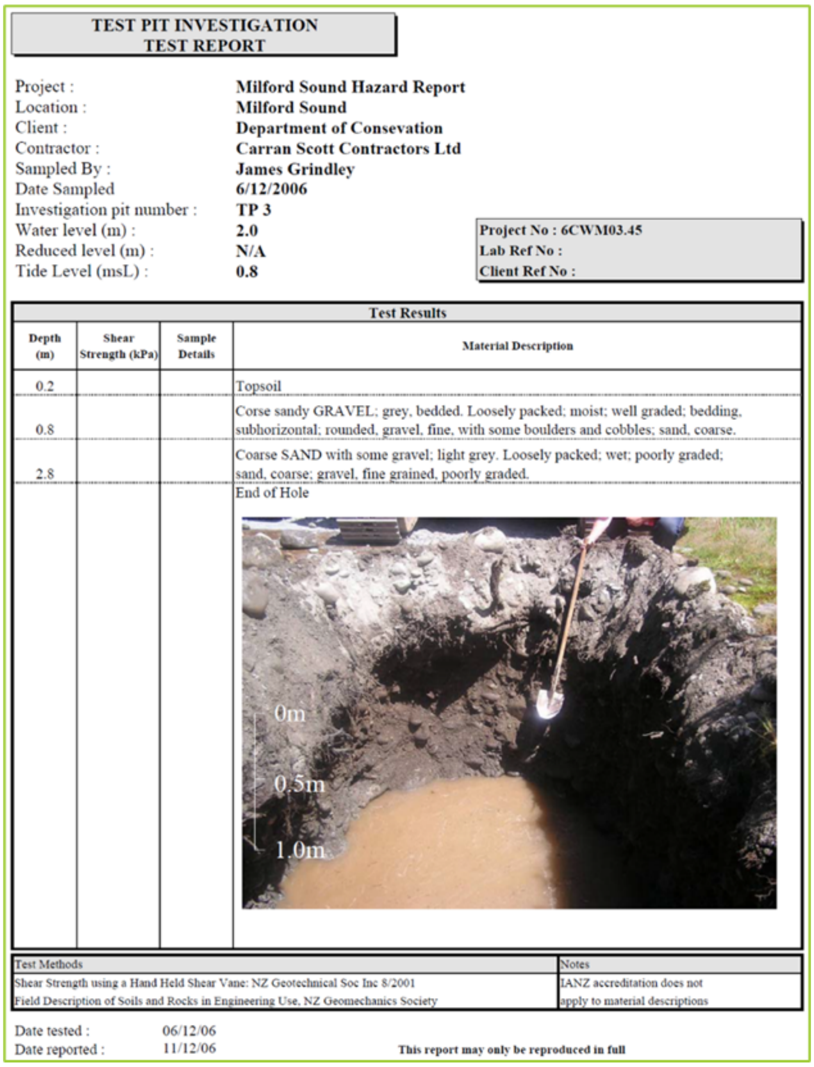
composition (mostly coarse sand and gravels, some organic material, limited fines, some variation and preferential pathways may also exist).

5.13 There are also known issues with the foundation layers not having been well prepared historically, causing depressions and potholes in places, and water occasionally rises up through the pavement seal. Symptomatic remedies (patching where problems occur) can be costly due to the frequency and variable depth/size of repairs needed (when digging commences it can require removal of more wood and other weak material and can be difficult to reach a sufficiently stable layer, as the underlying layers are waterlogged). This may suggest a falling weight deflectometer and possibly supplemented by below-surface survey (GPR or similar plus some physical sampling) of the entire pavement to map weaker areas to deal with as a package. This sort of patchy intervention is likely to be required increasingly frequently due to age and climate change impacts and associated deterioration of the foundations, which may indicate an overhaul of the entire runway depending on the results of the pavement assessment.

5.14 The indicative foundation material being predominantly coarse indicates medium risk of liquefaction damage in an AF8 scenario, despite its location on the alluvial fan. This is because finer grained sands have a greater risk of liquefaction than coarse or mixed grade. Test pitting for the Cleddau Village (Cleddau village natural hazards assessment report – Opus/WSP 2007) suggests limited depths/extents of fine material, as shown below for Test Pit 3 taken near runway side of Cleddau village (refer Figure 15). This assessment based on a limited number of test pits may not be representative of the entire delta.

AERODROME MAINTENANCE COSTS / CHALLENGES IN THE MEDIUM AND LONGER TERM

5.15 Medium Term: based on evidence in 2020, there were a number of potholes and depressions to fix and water coming up through the runway seal in places. This suggests that the underlying ground conditions are poor, at least in some locations but probably widespread. On-site investigations identified areas where organic material exists below the formed pavement with the structure being compromised (refer Figure 15). All the signs lead to the airstrip being built on either a limited or a deteriorating foundation. These issues will be exacerbated by increasing water tables and future more frequent inundation due to climate change impacts on fluvial flows and sea levels.



TEST PIT INVESTIGATION
TEST REPORT

Project :	**Milford Sound Hazard Report**
Location :	**Milford Sound**
Client :	**Department of Consevation**
Contractor :	**Carran Scott Contractors Ltd**
Sampled By :	**James Grindley**
Date Sampled	**6/12/2006**
Investigation pit number :	**TP 3**
Water level (m) :	**2.0**
Reduced level (m) :	**N/A**
Tide Level (msL) :	**0.8**

Project No : 6CWM03.45
Lab Ref No :
Client Ref No :

Test Results

Depth (m)	Shear Strength (kPa)	Sample Details	Material Description
0.2			Topsoil
0.8			Corse sandy GRAVEL; grey, bedded. Loosely packed; moist; well graded; bedding, subhorizontal; rounded, gravel, fine, with some boulders and cobbles; sand, coarse.
2.8			Coarse SAND with some gravel; light grey. Loosely packed; wet; poorly graded; sand, coarse; gravel, fine grained, poorly graded.
			End of Hole

Test Methods	Notes
Shear Strength using a Hand Held Shear Vane: NZ Geotechnical Soc Inc 8/2001 Field Description of Soils and Rocks in Engineering Use, NZ Geomechanics Society	IANZ accreditation does not apply to material descriptions

Date tested : 06/12/06
Date reported : 11/12/06

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Figure 15: Cleddau Village Test Pit Summary

5.16 Long term: the runway appears to have limited remaining life. It will likely suffer further failure and require rehabilitation/large scale repairs. Capital requirements to improve structural resilience in the face of climate change are very significant and would have other impacts as well.

5.17 The aerodrome is understood to operate on a cost-recovery model covering both aerodrome operation and AFIS provided by Airways. At a very basic level of service, it achieves this now but with the relatively low passenger numbers it would struggle to meet the costs of needed capital improvements at the airport. This may comprise a complete rebuild of the runway and apron areas, together with a constructed terminal building. An estimate for the runway construction alone would be in the order of $21.6M to develop[42]. In addition to the cost involved in the runway rebuild, consideration should also be given to the period of time required to complete the works. Given the location and limited construction window due to the environmental conditions and groundwater tables, the total period could extend over two financial years where the runway would not be accessible.

[42] Preliminary calculations: Uplifted rate of $800/m2 (includes subbase (AP65) depth 500 mm, basecourse M/4 AP40 depth 150 mm, two coat chip seal, standard drainage, contingency, fees, Contractor P&G, scope uncertainty, location allowance, and geotextile wrapped foundation materials) – 1.6ha runway and 1.1ha for associated hard standing for planes equates to $12.8M + $8.8M = ~$21.6M assuming deconstruction of the existing pavement can be completed within the project contingency. Note this does not include the cost of additional infrastructure such as airport buildings.

BERTHING FACILITIES

TE ANAU

5.18 Commercial facilities on the Te Anau lakefront include several wharves associated with private and commercial activities, launch services, boat hire and a helipad.

5.19 Public facilities include a boat harbour, moorings for boats and several launching ramps.

5.20 The Te Anau Boating Club has a sheltered harbour on the eastern shore of Lake Te Anau, and the following facilities to members: 150 berths up to 12.5 meters in length; launching ramp for up to 3 simultaneous trailer boats and 3 floating jetties for gear and passengers.

5.21 Moorings are used for boats which cannot be accommodated in the boat harbour because of size or because the opportunity to do so is not available for private/commercial berthing.

5.22 There are nine current resource consents to occupy and/or erect wharves and mooring structures on the waterfront and foreshore. There are two current permits to dredge the lakebed for maintenance[43].

MANAPOURI

5.23 There is a public boat ramp in the township of Manapouri at Pearl Harbour, which launches into the lower Waiau River. Manapouri boating club have a private boat ramp for members only and a mooring system along the lakeshore.[44] There are eight current resource consents at Lake Manapouri to erect structures and occupy the foreshore and riverbank[45].

TE ANAU TO MILFORD SOUND PIOPIOTAHI CORRIDOR

5.24 Te Anau Downs is currently an access point for boating operations servicing the Milford Track and provides other access opportunities around the lake. Boating facilities include a boat ramp and jetty.

MILFORD SOUND PIOPIOTAHI

5.25 Boating infrastructure at Milford Sound Piopiotahi is located in Deepwater Basin and Freshwater Basin.

5.26 The main terminal for transferring passengers on to boat trips out to Milford Sound Piopiotahi is in Freshwater Basin.

5.27 A $6.2million upgrade of the terminal facilities was completed in 2012, including relocation of the existing breakwater, dredging to enlarge the harbour, replacement and realignment of floating wharves and extension of the visitor terminal deck.

5.28 On the southern side of the delta at Deepwater Basin are berthing facilities and landward infrastructure for the Fiordland cray-fishing fleet, sea kayaking and ecotourism ventures. Deepwater Basin is also the base of operations for water taxis/transfers for the Milford Track walkers. Private boat owners and commercial kayak operators are able to use the Milford Sound Piopiotahi boat ramp (a concrete dual access ramp, with parking available) at Deepwater Basin Road.

5.29 The Department of Conservation (Invercargill) hold a current coastal permit to occupy the coastal marine area with a commercial berthage facility of 30 berths, a five-pile mooring and a wharf, predominantly utilised by the fishing industry, and to occupy part of the coastal marine area with an existing boat ramp at Deepwater Basin.

[43] Environment Southland Resource Consent GIS Portal. Retrieved from: http://gis.es.govt.nz/

[44] Manapouri Boating Club. Retrieved from: http://www.manapouriboatclub.co.nz/

[45] Environment Southland Resource Consent GIS Portal. Retrieved from: http://gis.es.govt.nz/

5.30 Milford Sound Tourism hold a resource consent to carry out maintenance dredging in Freshwater Basin.

5.31 In total there are 52 coastal related activities resource consents currently held in Milford Sound Piopiotahi.

5.32 The DOC business case report also highlights issues with the current boat ramp relating to breaching consent conditions due to the condition of the structure. A report was compiled by Opus (2018) evaluating options to repair[46].

WALKING TRACKS

Figure 16: Te Anau Walking Tracks Map

Figure 17: Manapouri Walking Tracks Map

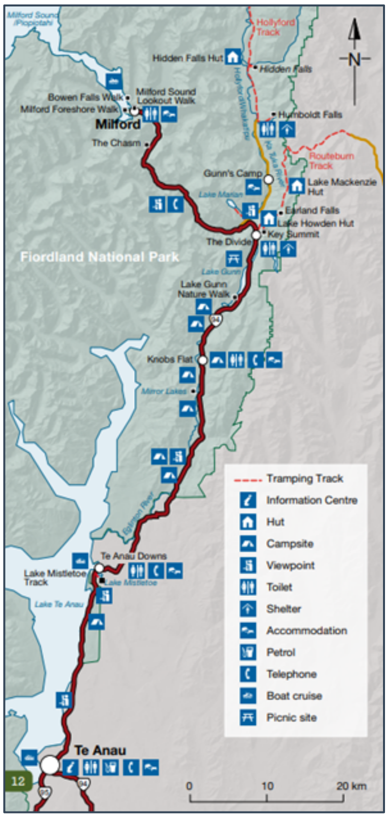

Figure 18: Milford Sound Piopiotahi Walking Tracks Map

TE ANAU AND SURROUNDS

5.33 DOC website lists 10 walking and tramping tracks around the Lake Te Anau area, ranging from easy access short walks (wheelchair accessible) to tramping tracks (mostly unformed but with track directional markers, poles, or cairns).

5.34 Parks and Recreation Facilities provided, complementing walkways, include:

- Heritage Subdivision Reserves
- Fiordland Estate Reserves
- Luxmore Greenbelt
- Kepler Heights Reserves
- Delta Subdivision Reserves
- Blatch Road Reserve
- Henry Street Playground
- McGregor Court Reserve
- Lions' Park
- MacDonald Park

[46] DOC Deepwater Basin Development Indicative Business Case

- Te Anau Boat Harbour
- Sports Fields Addition
- Te Anau Waterfront / Foreshore
- Te Anau Golf Course
- Water Park
- Earl Place
- Ivan Wilson Park, Te Anau
- Lynwood Historic Reserve, Te Anau
- Tui Bay Walkway Reserve
- Little Lake Te Anau
- Te Anau Gardens
- Te Anau Town Centre Reserves
- Dalhousie Place

MANAPOURI AND SURROUNDS

5.35 DOC website lists 9 walking and tramping tracks around the Lake Manapouri area ranging from short walks to tramping tracks.

5.36 Parks, Beautification, Recreation Facilities provided, complementing walkways, include:

- Cathedral Drive Reserve, Manapouri
- Manapouri Village Green
- Manapouri Swimming Pool and Tennis Courts
- Frasers Beach Recreation Reserve, Manapouri
- Te Aika Reserve, Manapouri

MILFORD SOUND PIOPIOTAHI AND SURROUNDS

5.37 DOC website lists 22 walking and tramping tracks along the Milford Road and Milford Sound Piopiotahi area, ranging from easy access short walks to tramping tracks. The DOC reporting suggests that there are limited walking tracks within Milford Sound Piopiotahi and no pedestrian connections to the other scenic locations along the road. Within the DOC report it was recommended that the walking network is extended to provide safe pedestrian routes between all scenic viewing points within about 5km of the cruise terminal. A medium to long term action was to extend walking track network to link all existing activities with potential future activities [47]

HOMER TUNNEL

5.38 A key feature on State Highway 94 between Te Anau and Milford Sound Piopiotahi is the Homer Tunnel [48]. The Tunnel was constructed between 1934 and 1953 and is 1.27km in long and has a 10% gradient and varies in width from 6.5 to 7.5m. It is single lane access which therefore requires vehicles to be queued on the approaches from either the east or west until the way forward is clear.

[47] Report prepared by TDG for Milford Sound Tourism Transport Infrastructure Review: Traffic Management Strategy (2017)

[48] Asset information retrieved from "https://www.nzta.govt.nz/projects/sh94-homer-tunnel-safety-improvements-investigation/"

6 LONG LIST: SUPPORTING INFRASTRUCTURE

INTRODUCTION

6.1 The development of infrastructure for this project is driven by the directions provided through the various workstreams. Under each of the long-listed options for regional development there are basic services that need to be provided in the context of the associated environment. For instance, a fully serviced accommodation complex within the Fiordland National Park could not be developed without suitable mechanism for the provision of power and potable water, and treatment and disposal of wastewater. The long listing options summarised in the following sections are associated with possible enabling works that would service the proposed development options.

6.2 Options for each of the services for Potable Water, Wastewater, and Power Supply have been assessed and summary tables have been provided (refer Appendix A). The following sections provide a high-level summary of the contents of these tables.

6.3 Overarching all options presented in the sections below, consideration and consultation with all stakeholders will be paramount. As such the infrastructure options would therefore be discussed across all discipline streams associated with this project.

6.4 Mana Whenua aspirations with respect to infrastructure in the context of this project are defined within Workstream 3 reporting “Mana Whenua Aspirations and Values”, August 2020, and recorded below for completeness. This forms part of the consideration of all infrastructure options.

Project Objective	Mana Whenua Aspirations
Infrastructure is effective, efficient, resilient, and sustainable (including access methods)	The cultural identity of Ngai Tahu is to be expressed in the built environment. Development should restore and enhance the mana of Te Rua o te Moko. Development is to be deliberate, concentrated, and redevelopment options considered. The overall outcome sought for development is utu, a mutual benefit for the environment and its setting. Sustainable practices are to be promoted and supported, and considered ki uta ki tai, within te hauora o te taiao (the wellbeing of the environment). The Milford Opportunities Project is to draw manuhiri to experiences and places that Mana Whenua want them to see, rather than the project define ‘no go’ areas (with the exception of Ōhupōkeka (Anita Bay) – possibly becoming a Mana whenua controlled area).

POTABLE WATER

SUPPLY

6.5 Options for the provision of potable water include the following:

- Surface Water (lake, river, of stream).
- Lake / Riverbank Bores (groundwater under the direct influence of surface water).
- Ground Water - Non-secure bores.

- Ground Water - Secure bores.
- Roof Water.
- Reclaimed wastewater (direct or indirect potable reuse).

6.6 The selection of the preferred option for each discrete Idea will depend on the volume and degree of treatment of water required (i.e. the supply to a five star hunting lodge will be different to that required for a camping site). Surface water may be the most accessible source of water, but it is susceptible to turbid flows (higher treatment required or backup storage) and continuity of supply. Allowances will need to be made to mitigate these risks in the determining the ultimate solution.

PROCESS TREATMENT

6.7 Options for treating source water include the following:

- Microstrainer.
- Riverbank Filtration (Lakeside Bores).
- Slow Sand Filtration.
- Amiad ® AMF backwashable microfibre filters.
- Cartridge Filtration.
- Granular Media Filtration (gravity or pressure).
- Granular Activated Carbon Filtration.
- Dissolved Air Flotation (DAF) and Filtration (granular / membrane).
- Ballasted sand flocculation and sedimentation followed by Granular Filtration.
- Low Pressure Membrane Filtration (Micro / Ultrafiltration).
- High Pressure Membrane Filtration (Nanofiltration).
- UV Disinfection.
- Ozonation.
- Chlorination.
- Do nothing.

6.8 The level of treatment required at each site will need to be determined to align the most appropriate treatment solution. A balance would need to be reached that meets or exceeds the compliance requirements for the settlement or site, minimises operations and maintenance including power requirements, and aligns with the constraints of each location. For instance, slow sand filtration, provided sufficient land is available and storage is available, is a relatively low cost (capital and O&M) solution when compared to cartridge-based treatment options.

WASTEWATER

SOURCE MANAGEMENT

6.9 One aspect of wastewater management and treatment is considering at-source processes to minimise flows and, in isolated locations, meet specific site demands. The options listed below can be appropriate for small sites where the demand is not high:

- Composting toilets
- Composting toilets with urine separation
- Vermiculture toilets
- Containment/vault systems

6.10 These source management options are generally waterless solutions and low to no power requirements. The risk of odour and ongoing maintenance / management would need to be considered in determining the most appropriate solution for any one site.

WASTEWATER TREATMENT – PROCESS

6.11 Options for treating wastewater fall into two general categories:

- Mechanical plants.
- Natural systems.

6.12 A selection of mechanical / civil structural treatment options for wastewater include the following:

- Usage of existing treatment systems.
- Septic tank units.
- Aerobic treatment units.
- Intermittent sand filters.
- Trickling filters.
- Recirculating biofilters.
- Membrane bioreactors.
- Nutrient removal process (as additional treatment step to above processes).
- UV Disinfection.
- Chlorination.
- Higher level of treatment to enable potable reuse (e.g. reverse osmosis).

6.13 A selection of natural / civil earthworks treatment options for wastewater include the following:

- Worm farm.
- Constructed wetlands.
- Oxidation ponds and aerated lagoons.
- Infiltration soil treatment units.

6.14 The compliance requirements of the treated wastewater discharge will, in part, determine selection of the process that will be included. Generally, the footprint of mechanical plants is smaller than those of natural systems which aligns to situations where the sites are constrained and/or the aesthetics / visual impact is to be minimised. The compromise is having a treatment solution that has a higher ongoing cost both in labour and power requirements.

WASTEWATER TREATMENT – DISPOSAL/REUSE

6.15 The receiving environment is a fundamental consideration in selection of the wastewater treatment solution, as the acceptance of the treated wastewater within the environment will dictate the level of treatment required. Options for disposal of treated wastewater include the following:

- Discharge to land - Conventional bed/trench infiltration.
- Discharge to land - Rapid rate infiltration (e.g., Rapid Infiltration Basins).
- Discharge to land - Slow rate infiltration (e.g., drip dispersal/drip irrigation).
- Discharge to surface water / water body.
- Discharge to groundwater - deep bore injection.
- Beneficial use of reclaimed wastewater.

6.16 An assessment of environmental effects will need to be conducted to determine the implication of treatment solutions. This will form part of the overarching consultation process required in any new application of resource consent for treated wastewater discharge.

6.17 As previously stated, consulting with mana whenua and alignment with established guiding principles will influence the selection of preferred options. At this long listing stage, options will be considered on the basis of limiting the footprint of treatment process, focussing on land-based discharge solutions and mitigating or eliminating effects on traditional food gathering areas.

POWER SUPPLY

6.18 The remote nature of the various sites within the Milford Sound Piopiotahi corridor means that the provision of power and continuity of supply needs to be carefully considered. Options for power supply include the following:

- Hydrogeneration.
- Wind.
- Tidal.
- Solar.
- Battery Storage.
- Diesel Generation.
- Main Grid Connection.
- Biogas.

6.19 The reliability of supply will dictate the configuration of the power supply at any one location. Except for Main Grid Connection (for the most part), each of the options presented are limited by either environmental conditions or a continuity of supply of a fuel source. The selected option therefore would likely be a combination of solutions dictated by the level of risk to be accepted by site.

OTHER INFRASTRUCTURE OPTIONS

STORMWATER

6.20 Consideration of the treatment and disposal of stormwater is aligned closely with those for wastewater disposal. There will be locations such as carparks within the study area where possible contaminants from built environment will exist and treatment solutions will be required. Options for on-site stormwater treatment and management include the following:

- Retention basins – end of catchment solutions that retain flows, principally the first flush from a hardstanding area, to settle out contaminants such as heavy metals prior to discharge.
- Rain gardens / Swales – either separately or in combination with retention basins, these options are localised solutions and therefore can be integrated with designs for the built environment.
- Contaminant removal systems – civil structures that have a smaller footprint than land based treatment solutions but may have a limited scope just as oil separator in areas associated with refuelling of vehicles, or vortex grit removal systems to drop out coarse contaminants.

6.21 Stormwater management will need to be included in any design of hardstanding areas or building works and would be specific to the available footprint, assessment of contributing catchment and the sensitivity of the receiving environment.

TELECOMMUNICATIONS

6.22 Options for maintaining telecommunications include the following:

- Satellite Phones.
- Fibre Cables.
- Repeater Stations.
- Dedicated Cable.

6.23 As previously discussed, the current provision of principle telecommunications is via repeater stations with limited band width and a risk of continuity associated with the power supply to each of those stations. With the completion of the fibre network within this corridor, the reliability and extent of service will improve.

GOVERNANCE

6.24 The current governance model involves the built environment assets being owned, operated, and maintained independently. Concessions within Milford Sound Piopiotahi are held by separate entities with different organisations tasked with the operation and maintenance of the infrastructure. This model means that changes to one aspect of the community, such as increased commercial development / service requirements, will have an impact on other infrastructure such as power supply and wastewater management.

6.25 Built assets such as the 3 waters, roading and power within Manapouri and Te Anau are generally owned and operated by Southland District Council, PowerNet or Waka Kotahi NZ Transport Agency. These authorities have dedicated asset management plans associated with their assets that look not only ongoing operation, maintenance and renewal but also planning for long term growth.

6.26 Should a revised governance structure be considered, then the asset management processes of these more established organisations should replicated. The benefit would be an integrated approach to planning and management across all services.

KEY CONSIDERATIONS FOR INFRASTRUCTURE DEVELOPMENT

6.27 **Alignment to Project Pillars**: the selection of process for short listed options needs to align with the project pillars as stated within Section 2, namely:

- Mana Whenua values woven through
- A moving experience
- Tourism funds conservation and community
- Effective visitor management
- Resilient to change and risk
- Conservation
- Harness innovation and technology

6.28 **Power Supply**: while principally from renewal energy sources (small scale hydro schemes) the current network capacity is limited, and continuity of supply is a risk. Any developments will need to be cognisant of restrictions in power supply (beyond Te Anau Downs, currently only available in limited capacity at Milford Sound Piopiotahi and Knobs Flat) and potential consideration of alternative power supplies required.

6.29 **Asset Configuration**: where short listed items require reconfiguration of key tourism operations, there would also likely be a flow on effect to the built infrastructure. This could range from something as simple as installing a new wharf but could be as complex as reshaping the layout of the Milford Sound Piopiotahi tourism hub. For the latter, the layout should consider whether existing assets such as pipeline and ducting could be reused on current alignment or new assets are required. Each approach comes with a cost.

6.30 **Network Capacity:** where available, the capacity of the existing infrastructure is summarised within Sections 4, 5 and 6. While most infrastructure has been sized and can meet existing usage, the expansion of services and possible increase in demands may exceed current provisions. For each short listed option, the variance in the levels of services will need to be assessed.

6.31 **Sustainability:** from an infrastructure perspective as it relates to possible changes to the configuration, less is more. All infrastructure should be designed to limit the footprint both physically and environmentally. This links to the pillars of the project but also has a cost implication.

6.32 **Installation Costs:** The remote location will mean that the installation rates for any works will be higher with labour charges (travel time and accommodation) and freight costs. We have applied an initial assumption ranging from a 10% premium being paid in Milford Sound Piopiotahi to 5% premium in Te Anau, as compared to similar works in an urban centre. This uplift is addition to 15% for Preliminary and General contract activities and 20% for Scope of Works uncertainties.

6.33 **Ground conditions**: the development of structures within Milford Sound Piopiotahi, both the location and cost will be influenced by the ground conditions to establish firm foundations and resilience to natural hazards. An aerial image from 1938 with a sketched overlay of the current development is presented in Figure 19. The current accommodation hub appears to be constructed on natural landforms suggesting good foundation materials to build upon. However, the aerodrome is founded on the Cleddau Delta using reclaimed materials suggesting, at best, variable ground conditions. This is evidenced by the test pit seen in Figure 15.

Figure 19: Milford Sound Piopiotahi from 1938

7 RECOMMENDED OPTION

DEVELOPMENT PHILOSOPHY

7.1 The proposed modifications to and development of infrastructure contributing towards the Master Plan are based on enabling the preferred configuration. The preferred suite of infrastructure options has been developed based on meeting the Project Pillars, with specific elements below:

- Weaving through Mana Whenua values and principles reflected in structural designs, landscaping, layouts and storyboards (*Mana Whenua values woven through*)
- Minimising the footprint of infrastructure and maximising use of existing infrastructure (*Conservation / Resilient / A Moving Experience*).
- Non-obtrusive, fitting in with the natural landscape and environment (*Conservation / A Moving Experience*)
- Minimising the resources to be used, ideally using local materials, assets, and services *(Conservation / Resilient / Harness Innovation and Technology*)
- Developing energy and resource efficient, durable designs (*Resilient / Harness Innovation and Technology*)
- Designing specifically for the hazards and risks likely to be encountered (*Resilient / Harness Innovation and Technology*)

7.2 The following sections describe elements of infrastructure proposed within Milford Sound Piopiotahi, Te Anau, and the experience between the two destinations (the Corridor). For reference the estimated capital cost of elements of the Master Plan are summarised in the tables within this section. These cost estimates, and the estimates for deconstruction of existing structures, are presented in Appendix 2 and the build up of costs described in Section 8.4.

7.3 There are consistent approaches that are proposed within the recommended options for the developed infrastructure which, while not necessarily specifically stated in the summary tables, have been allowed for or should be adopted/incorporated in the next stage of development. These include:

- Provision of Power: the primary option considered for the generation of power has been small scale hydro scheme development in the locations required. Other options such as wind power or solar generation is not considered viable at large scale in the corridor due to reliability of continuous supply throughout the year. This is consistent with the approach at Milford Sound Piopiotahi and Knobs Flat.
- Wastewater Management: while various options for treatment of the wastewater exist, the critical consideration within the pristine environment is determining a viable method of disposal of treated effluent. Where there are few connections (isolated toilet facilities of 2-3 pans) we have allowed for vaulted systems where there would be an ongoing operation costs but would minimise the risk to the local environment. Development of wastewater treatment and disposal systems would solely be used at areas for overnight accommodation.
- Potable Water: the provision for potable water within the corridor will be aligned with the locations assigned as accommodation hubs. At these locations, the degree of treatment will need to comply with the NZDWS for small communities. This will likely include the filtration, and UV / Chlorine dosing.
- Walking Tracks: A range of walking track experiences will need to be provided within the study area. The walking tracks proposed under the recommended options fall into three general categories:
  Able-body walkways similar to those used in the great walks, developed to fit in with the

natural environment and have a range of designs and quality depending upon the location. These tracks are generally within steep terrain and designed to integrate with natural features.
Accessible walkways would be developed for less abled individuals and would generally be shallow grade be prepared to a higher quality. These services would be accessible for wheelchairs, or similar, to allow range of experience for all Visitors.
Feature walkways would be aligned to the Visitor experiences, prepared to incorporate landscaping features and specifically designed surface treatments. An example would be the concourse area surrounding the Milford Sound Piopiotahi Visitor hub.

- Building Efficiency: the structures will need to be specifically designed to withstand rigors of the natural hazards expected particularly earthquake and potential landslide-induced tsunami wave inundation risks, with enhanced foundations and structural members to perform under expected conditions. For populated buildings such as the Visitor Hub and accommodation within Milford Sound Piopiotahi, the structures will need to be Green Star rated to be energy efficient and minimise water use. Any structural design will need to fit closely in with the natural environment, ideally within the footprint of the previously disturbed areas. Established natural features and flora should be designed around as far as possible rather than disturbed.

- Integration: before any alterations to the built environment are undertaken, a cultural heritage/ archaeological assessment will need to be made. This will identify any possible heritage sites where it is not appropriate to modify, destroy or obscure the view. Where feasible the existing structures, features and landforms that align with the development philosophy of the Master Plan should also be integrated into the final design.

- Refuges: a feature of the recommended options is establishment of refuges at various locations along the corridor and within Milford Sound Piopiotahi where people will congregate, and a level of protection needs to be provided. These structures will be designed as safe havens from natural hazards, while being aware that the engineered arrangement will need to fit in with the natural terrain. The feature buildings will act as refuges but small structures at critical junctions will also be provided. Where possible these refuges will have a dual purpose for posting of information boards and other interpretation elements. This would extend to providing interactive displays and wireless features should power, cell phone and/or fibre coverage permit. A number of the bus shelter and refuge sites along the corridor align with proposed repeater stations for the cellular network which would facilitate interactive displays.

- Interpretive Features: careful consideration should be given in the development and presentation of all interpretive features and the naming conventions for elements within the study area to align with Treaty Partner aspirations. This outlines that tūturu wāhi ingoa (traditional place names) should be promoted to the point of becoming the default names used within Te Rua o te Moko.

INFRASTRUCTURE COST ESTIMATES

7.4 Capital Cost estimates have been developed for the options listed within this document (refer Appendix 2). They have developed using a baseline estimate defined based on the envisaged scope in comparison to existing, available industry references with the addition of the following:

20%	for uncertainty associated with the scope of works (Concept Stage only)
15%	for Contractor Preliminary and General elements
5-10%	to account for additional transportation and staff movement costs. This is an extra over cost graduating from 5% in Te Anau to 10% in Milford Sound Piopiotahi
6%	for design fees of general, non-complex infrastructure
10%	for design of Buildings and Structures
2%	for consenting and tendering
6%	for Construction period monitoring and administration
20%	for Contingencies

7.5 The Master Planning team has exercised the reasonable skill, care, and diligence of a consulting professional in the preparation of our opinion of these costs. We have no control over costs of labour, materials, competitive bidding environments and procedures, unidentified field conditions, financial and/or market conditions, or other factors likely to affect the ultimate cost of the works, all of which are and will unavoidably remain in a state of change. We cannot, and do not, make any warranty, promise, guarantee, or representation, either express or implied, that proposals, bids, project construction costs, or cost of operation or maintenance will not vary substantially from these good faith preliminary cost estimates.

MILFORD SOUND PIOPIOTAHI

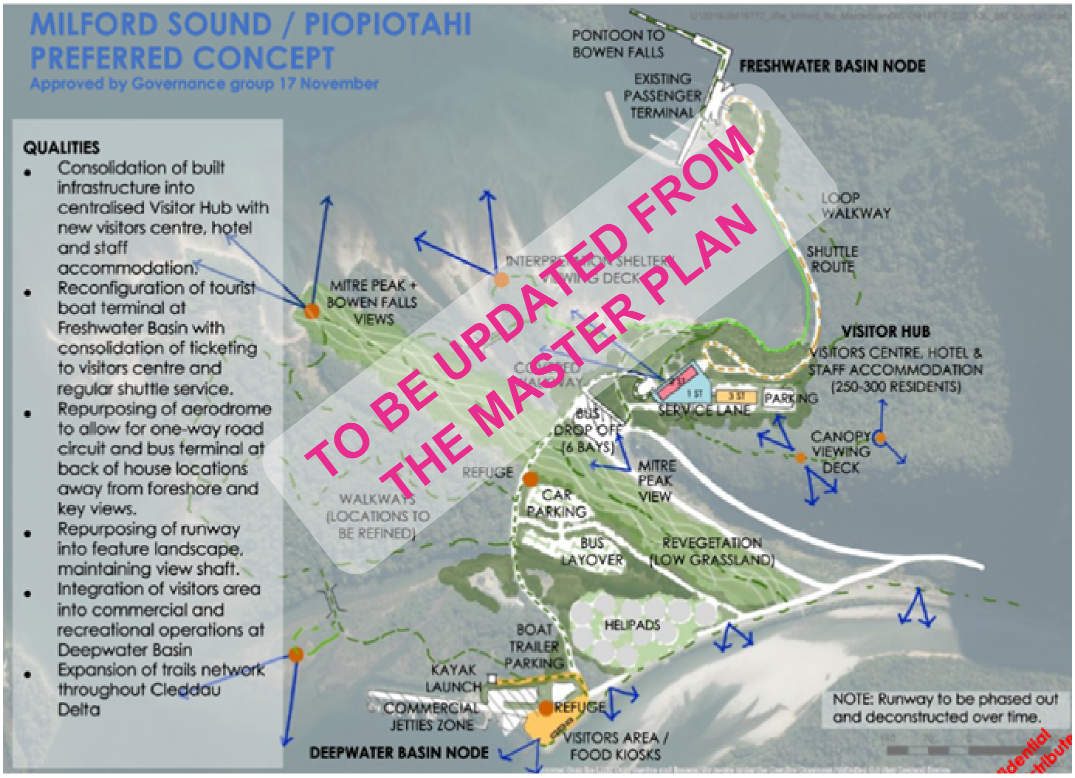

Figure 20: Milford Sound Piopiotahi Preferred Concept

7.6 The proposed infrastructure within Milford Sound Piopiotahi can be split into the various regions or nodes, being:

- The Visitor Hub (located centrally).
- Freshwater Basin.
- Deep Water Basin.
- Cleddau Delta.

7.7 In instances where new infrastructure is proposed, the existing structures that occupy the space may need to be deconstructed. For the recommended option we have allowed for the deconstruction of the existing central hub hotel complex, the existing accommodation area, the aerodrome pavement, and (if selected) the existing ferry terminal. The staging of construction will need to be considered carefully as this will impact the ability to service the area i.e., removal of the accommodation area can only follow once alternative staff quarterings are provided. Where possible, the materials removed due to deconstruction should be included within the construction of new facilities; for example, the backfill material removed as part of deconstruction of the aerodrome could be used as the base course or similar for walkways or for foundations of structures.

VISITOR HUB

7.8 Subject to the sequencing of the deconstruction of the existing structures/ buildings within the central experience area within Milford Sound Piopiotahi, the future infrastructure in the following table is proposed.

Buildings		
Visitor Hub	$21.3M	Facility developed to act as the focal point for the overall experience. Ticketing (customer service), interactive displays, information, services. Proposed adjacent to or including Marine Interpretive Centre. Resilient to withstand extreme events and act as a refuge
Accommodation - Visitors	$21.1M	Visitor accommodation targeting overnight stays, styled as an eco-experience 3 Star Hotel, resilient to withstand extreme events and act as a refuge.
Accommodation - Staff	$43.4M	280-320 bed accommodation for staff, some single units, and some shared rooms, resilient to withstand extreme events and act as a refuge.
Marine Interpretive Centre - Milford Sound Piopiotahi	$11.2M	Facility developed to enhance visitor interaction. Touch pool, working lab, concourse/display area, back of house. Proposed adjacent to or part of Visitor Hub. Resilient to withstand extreme events and act as a refuge.
Structures		
Bus Stop - Milford Sound Piopiotahi arrival	$0.7M	Open sided Shelter / Refuge style of development acting as an arrival / departure point for buses. Located a short distance from the Visitor Hub.
Covered Walkway - Milford Sound Piopiotahi arrival **~170m**	$0.7M	Covered Walkway from Bus Arrival to Visitor Hub.
Features		
Pavements - Realignment (Arrival)	$1.4M	New access into Milford Sound Piopiotahi established to bring the road (as a one-way system) onto the alignment of the existing taxiway. This is to act as a focal point and opens up the view on arrival.
Milford Sound Piopiotahi Viewing Deck Walkway **~300m**	$1.3M	Redevelopment of the existing walkway up the ridge line above the hub to including treetop canopy viewing platforms and a link to the Visitor Hub. Allowance of feature walkway / bridge from the top of the Visitor Hub to the start of the walkway.
Landscaping - Visitor Hub	$7.8M	Waterfront development - to provide an enhanced environment including boardwalks, paving, and landscaping surrounding the Visitor Hub. To include departure / arrival areas for shuttles taking visitors to the ferry terminal.
Walking Track - Accessible (Premium)	$1.0M	Wheelchair accessible Track (corridor access around the Visitor Hub not otherwise covered under the waterfront development).

~1,000m		
Services		
Milford Sound Piopiotahi Interpretation	$2.0M	Budget allowance for the establishment of interpretive materials throughout Milford Sound Piopiotahi (Signage, Displays, Services), along with minor modifications to landscaping features.
Wastewater	$2.3M	Allowance for alteration of the existing wastewater network to accommodate the proposed developments within Milford Sound Piopiotahi. Upgrade to the current plant provided for with a higher rate and quality treatment to meet potential revised consent requirements (the current consent is subject to renewal by 2028 and this will likely require a revised treatment train.
Potable Water	$1.6M	Allowance for alteration of the existing potable water network to accommodate the proposed developments within Milford Sound Piopiotahi. Increased storage (500m3) provided for to increase the resilience of the system to outages.
Power Supply	$5.0M	Allowance for replacement of the existing turbines and generators (and equipment) to accommodate the proposed developments within Milford Sound Piopiotahi.

7.9 In addition to the infrastructure stated in the table above, elements for visitor interpretation and information will be required throughout Milford Sound Piopiotahi. This may include context (location) linked information via mobile devices.

7.10 The constraints of the location have motivated the position of these elements of significant infrastructure. The footprint allowed will be the main congregation point within Milford Sound Piopiotahi and it is expected that, other than water based tours, this would be the location where most visitors will spend the majority of their time. The elevated position, combined with assessment of slope stability above the site, make this the most viable location to develop principal infrastructure in the medium to long term. Further assessments such as the foundation conditions and wave modelling will be needed to inform resilience under extreme conditions such as earthquakes, liquefaction, and potential landslide-induced tsunami.

FRESHWATER BASIN

7.11 Subject to the sequencing of the deconstruction of the existing structures/ buildings within Freshwater Basin, the future infrastructure in the following table is proposed.

Buildings		
Ferry Terminal - Renovation	$0.5M	Modification and renovation of the existing Ferry Terminal to be used just prior to boarding pre-assigned / ticketed Ferry trips.
Structures		
Visitor Protection Refuge	$0.8M	Shelter / Refuge for hazards at Freshwater Basin. Doubles as information centre and potential observation points. Smaller than the current terminal but built to withstand more extreme cases.
Features		
Bowen Falls Pontoon to Walkway	$0.8M	Pontoon walkway connecting Ferry Terminal to the lower Bowen Falls Walkway.

7.12 Consideration has been given to the ability for visitors to access the lower Bowen Falls Walkway area away from the current location. Provision of a pontoon walkway from the northern most jetty will provide a separation distance from the existing hill face without significantly compromising the number of berths available. There will remain an option for visitors to take a water taxi across to this location but making available a walk structure will open the area to greater numbers.

DEEP WATER BASIN

7.13 The infrastructure in the following table is proposed, which tie in with the existing established commercial operations.

Buildings		
Operations - Commercial port	$2.4M	Renewal of the existing building that houses the operations for the Commercial Port
Structures		
Visitor Protection Refuge	$0.8M	Shelter / Refuge for hazards at Deep Water Basin. Doubles as information centres and potential observation points.
Features		
Deepwater Basin Experience Hub	$2.9M	Focus for tourist activities within Deep Water basin. To include a pavilion, boardwalk, food stalls (area to set up), pavement and landscaping.
Kayak Landing point	$0.3M	Developed based on a floating pontoon. This could optionally be developed as a modified concrete boat ramp instead. This is to be located in the back channel behind the current commercial operations to remove the point of conflict from the motorised vessels.

CLEDDAU DELTA

7.14 For the purposes of the reporting, areas outside of Freshwater Basin, Deep Water Basin and the Visitor Hub have been gathered under the heading of the Cleddau Delta. Subject to the completion of the deconstruction of the aerodrome pavement and existing staff accommodation area, the infrastructure in the following table is proposed.

Buildings		
Shuttles - Base of Operations	$4.6M	Area for the operation and maintenance of shuttles that take visitors from the hub to the terminal. Includes facilities for Bus driver resting, shuttle maintenance, charging and overnight housing.
Structures		
Long Stay Parking	$3.1M	Long stay parking and bus layover area. To be established within the footprint of the existing staff accommodation area adjacent to the Shuttles – Base of Operations. To be a combination of the sealed and metalled surfaces.
Visitor Protection Refuge (2)	$1.5M	Shelter / Refuge for hazards at Long Stay Parking and in Cleddau Delta (Walkway). Doubles as information centres and potential observation points.
Features		
Delta Walking Track **~ 3,600m**	$3.0M	Accessible walking track developed through the Cleddau Delta being mindful to minimise the physical footprint of the works / disturbance of the natural environment.
Walking Track - Milford Lodge to Tutoko Bridge / River **~ 6,000m**	$3.3M	Great Walks Style of Track (ref DOC estimates, integrating development within virgin terrain, variable conditions, and hazards). Along SH94 alignment for 2,000m and then 4,000m upgrade alongside the Tutoko River.

7.15 Deconstruction the existing aerodrome runway will enable the development and eventual rehabilitation of the Cleddau Delta west of the Long-term Parking area. This area is currently flood prone and would need to be built up if any form of the engineered structure or facility is to be located there. East of this location the vacated area will be developed to house up to 15 helicopter pads for future air support and visitor landings. This responds to an opportunity to reduce the impact of noise on the Visitor Hub and more closely associate it with other commercial operating environments, such as the commercial marina.

7.16 There are existing underground services throughout the area of the existing staff accommodation. These services will need to the capped or removed if returned to solely acting as a service area for shuttles and long-term parking. Services corridors for power, water and wastewater will still need to be maintained and should be considered as detailed designs are progressed.

THE CORRIDOR

7.17 The offerings within the corridor between Te Anau and Milford Sound Piopiotahi are to be enhanced with improvements to existing services and facilities and development of new assets and destinations. There are key nodes to be developed at Knobs Flat and the Whakatipu Super Track Head (current Hinepipiwai Lake Marian carparking), with supporting destinations at the Homer Tunnel, Cascade Creek, the Eglinton Reveal, and other short stops along the way.

KNOBS FLAT NODE

Figure 21: Knobs Flat Preferred Concept

7.18 The infrastructure to be developed focuses on two areas in the vicinity of Knobs Flat. Firstly, complementing the existing development, accommodation, services, and facilities at Knobs Flat. Secondly, planning and establishment of a small-scale lodge at Kiosk Creek. The infrastructure in the following table is proposed.

Buildings		
Accommodation - Cabins	$2.5M	Basic cabins established at Knobs Flat to complement the existing facilities. Allowing for 4 new structures within the development.
Accommodation - Camping development	$3.9M	Development of the camp offering in the area surrounding the cabins including landscaping and upgraded services / facilities. Non-powered sites.
Knobs Flat Interpretive Building	$0.8M	Interpretive building providing temporary shelter, hall style with single level to potentially act as a community facility. Built as a Shelter / Refuge style of development and acting as an arrival point for buses.
Kiosk Creek Accommodation - Lodge	$5.6M	25 bed (assumed 30% of footprint of accommodation at Milford Sound Piopiotahi) at Kiosk Creek. The ability to service this development with respect to wastewater management, water supply and power will modify the extent of development that can be achieved.
Structures		

Knobs Flat Interpretive Structures	$1.5M	Facilities (2) located within Knobs Flat providing education / information.
Flood Protection - Maintenance	$0.1M	Maintenance of adjacent stream channel required for Knobs Flat Accommodation protection (removal and placement of stream borne materials).
Features		
Walking Track - Abled Body **~2,400m**	$1.9M	Great Walks Style of Track (ref DOC estimates, integrating development within virgin terrain, variable conditions, and hazards).
Walking Track – Accessible **~1,000m**	$0.6M	Wheelchair accessible Track (assumes establishment on existing cut, ease of access and flat at Knobs Flat).
Services		
Potable Water	$0.2M	Additions to the existing potable water distribution network to support proposed development.
Wastewater	$0.9M	Additions to the existing wastewater collection network to support proposed development within Knobs Flat, including new toilet block and enhancement of treatment.
Kiosk Creek Accommodation - Wastewater	$2.4M	Wastewater treatment system based on small catchment and disposal to ground, noting that there are poor conditions, and a vaulted system may be required.

7.19 It has been assumed that the current potable water supply and small-scale hydro scheme are sufficient for the planned future development at Knobs Flat, and by extension Kiosk Creek. This will be one of the key locations within the corridor as one of the only spots for overnight stays. However, the experience is to be low key and not developed as hotels/motels located in Te Anau and Milford Sound Piopiotahi.

7.20 It is feasible to enhance the existing power and potable water services to support development of new accommodation at Kiosk Creek. However, there is currently limited information on the spare capacity due to existing demands in order to determine the level of upgrades required. This will influence the style and extent of development at Kiosk Creek and would need to be determine through detailed investigation at concept design stage. As a baseline the buildings and services will need to be designed along the principles of sustainability, limiting the footprint, energy and water use on site.

7.21 Wastewater management will determine the extent of the development that is viable. The mechanisms for treated effluent disposal are limited and the soil structure and high groundwater table are not conducive to large scale / high demand developments. While we have allowed for the establishment of a 25-bed lodge at Kiosk Creek, and an associated wastewater treatment and disposal system, this would still require detailed investigation to confirm. An alternative would be to manage wastewater as a vaulted system, collecting waste and transporting it to treatment and disposal at either Te Anau or Milford Sound Piopiotahi. However, this would come at a significant ongoing operational cost.

WHAKATIPU SUPER TRACK HEAD NODE

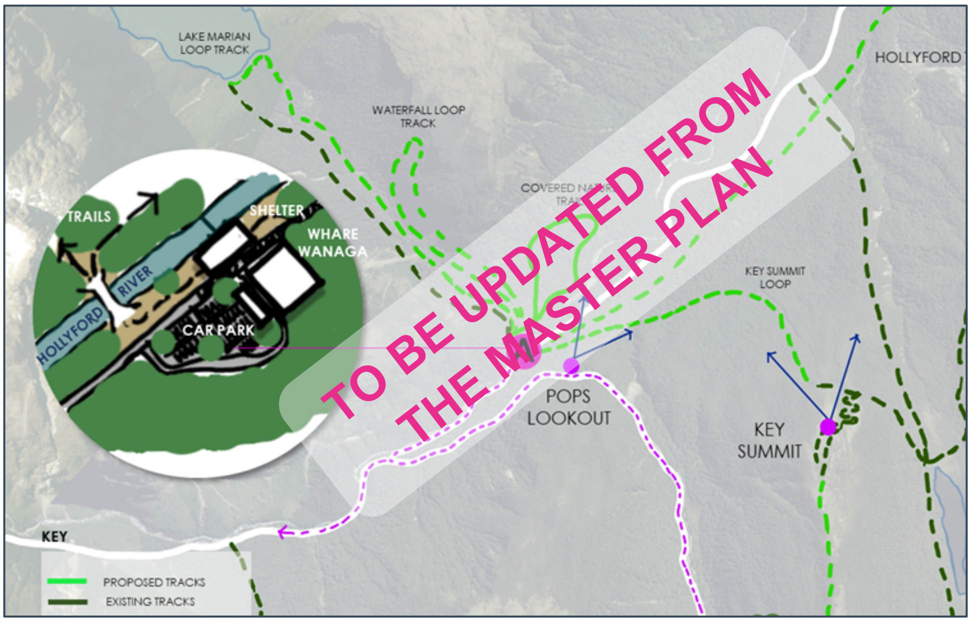

Figure 22: Super Track Head Preferred Concept

7.22 The concept of the Whakatipu Super Track Head is to a point of focus for multiple trails and for providing an interpretation point for the region. The footprint of development is expected to remain within the development area of the existing Hinepipiwai Lake Marian carpark with the reduction in parking balanced by the revised access arrangements (bus hop on / hop off system). An experience hub is to be allowed for which would likely comprise an enclosed, single level building with a floor area of approximately 200m^2.

7.23 The infrastructure in the following table is proposed.

Buildings		
Experience Node	$2.0M	Whakatipu Super Track Head - Facility associated with the exposing visitors to the history and significance of the area to Mana Whenua, provide an information centre for the local region.
Features		
Parking Area	$0.2M	Whakatipu Super Track Head - Parking for Hinepipiwai Lake Marian walkway/ track head. Enhancement of the existing parking area.
Walking Track – Hinepipiwai Lake Marian Loop	$2.5M	(From Track Head) Great Walks Style of Track (ref DOC estimates, integrating development within virgin terrain, variable conditions, and hazards). ~ 3,100m addition to the existing track to develop a complete loop.
Walking Track - Waterfall Loop	*$2.0M*	(From Track Head) Great Walks Style of Track (ref DOC estimates, integrating development within virgin terrain, variable conditions, and hazards). ~2,900m for a total of 3,800m (25% of track in common with Lake Marion Loop).
Walking Track - Nature Loop	$1.9M	(From Track Head) Great Walks Style of Track (ref DOC estimates, integrating development within virgin terrain, variable conditions, and hazards) ~ 2,300m, accessible style of track along the Hollyford River with low grades.

Walking Track - Track Head to Key Summit	$2.2M	(From Track Head) Great Walks Style of Track (ref DOC estimates, integrating development within virgin terrain, variable conditions, and hazards) ~2,700m new track.
Walking Track - Cascade Creek to Key Summit	$10.5M	(From Track Head) Great Walks Style of Track (ref DOC estimates, integrating development within virgin terrain, variable conditions, and hazards) ~12,900m new track.
Walking Track - Lake Howden - Upgrade	$1.8M	(From Track Head) Great Walks Style of Track (ref DOC estimates, integrating development within virgin terrain, variable conditions, and hazards) Upgrade only of approx. 4,500m.
Walking Track - Track Head to Hollyford Track	$5.7M	(From Track Head) Great Walks Style of Track (ref DOC estimates, integrating development within virgin terrain, variable conditions, and hazards) ~7,000m.
Services		
Potable Water	$1.3M	Package water supply and treatment for servicing the Track Head, with intake from the Hollyford River. To meet NZDWS compliance requirements.
Wastewater	$0.8M	Vaulted collection system, with 3-4 pans (toilet block). Conditions for onsite treatment are not considered viable given the footprint required and the sensitivity of the environment.
Power Supply	$4.5M	Allowance for establishment of a small-scale low head hydro system (turbine, generator, and equipment) to accommodate the proposed development. Subject to review of viability on tributary to the Hollyford River.

THE CORRIDOR EXPERIENCE

7.24 The balance of the corridor has discrete nodes that are to be developed to complement the principle hubs and offer visitors a selection of the alternative experiences.

7.25 The infrastructure in the following table is proposed.

Structures		
Homer Tunnel – Cleddau Cirque	$1.7M	Parking Area enhancement at the second loop from the western portal of the Homer Tunnel - including a robust shelter, 900 m^2 parking, up to 75m of retaining wall.
FNP Entrance / Departure	$0.7M	Constructed entrance developed along lines of kiosk and remote monitoring. Either at the Eglinton Reveal or nearby.
Eglinton Reveal Carpark	$1.3M	Parking Area at Eglinton Reveal- including a shelter, 900 m^2 parking (unsealed), and 4 vaulted toilets.
Features		
Walking Track - Mistake Creek Destination	$16.9M	(From Track Head) Great Walks Style of Track (ref DOC estimates, integrating development within virgin terrain, variable conditions, and hazards). ~ 20,700m.
Tramping Hut - Mistake Creek Destination	$2.8M	80 bed fully contained facility for overnight stays at location to be determined.

Cycleway - Knobs Flat to Cascade Creek	$16.1M	Established cycleway approx. 1.5-2m compacted fill, typically off road, between the two locations ~12,700m.
Cycleway - Knobs Flat towards FNP Threshold	$14.6M	Established cycleway approx. 1.5-2m compacted fill, typically off road ~ 11,500m allowed. Provision to establish secondary cycle routes if corridor long track is viable.
Cascade Creek - Modifications to Existing Campgrounds	$2.4M	Development of the camp offering in the area surrounding the existing facilities. Non-powered sites, vaulted WW system. Maintain/improve landscaped flood defences in relevant zones.
Services		
Corridor Interpretation	$1.3M	Budget allowance for the establishment of interpretive materials throughout Corridor (Signage, Displays, Services), along with minor modifications to landscaping features such as the Gertrude Valley access.
Bus Shelter – Light (5)	$0.7M	Simple shelter either waterproof stretch awning attached between poles in peak season or simple solid roof (site dependant), with a single sealed vault toilet. Internet /Wi-Fi / mobile connection allowed for (site dependant).
Bus Shelter – Minor (5)	$2.0M	Timber lined structure and interpretation boards. Waterproof stretch side awning attached in peak season to increase capacity, with a single sealed vault toilet. Internet /Wi-Fi / mobile connection allowed for (site dependant).

7.26 The location of the bus shelters, outside of the principle hubs and the corridor experience structures will generally align with the designated access points for fibre and telecommunications summarised in Figure 10.

TE ANAU

Figure 23: Te Anau Preferred Concept

7.27 The physical location of pivotal infrastructure within Te Anau has yet to be fully determined. There are two elements that need to be accommodated, namely an arrival and departure point, and a location for management of vehicles and the bus fleet.

7.28 The preferred configuration would involve development of a Visitor Experience Hub acting as the launching point for all activities within the Fiordland National Park. The preferred location would be adjacent to the Te Anau Holiday Park on the outskirts of the existing urban centre but with ease of access to the State Highway network and the lake. The proposed infrastructure reflects this approach, along with enabling services. A short/long term park-and-ride facility, combined with an operation and maintenance depot for buses, could then be established remotely.

7.29 The infrastructure in the following table is proposed.

Buildings		
Te Anau Hub- Visitor Experience	$10.3M	Facility developed to act as the focal point for the overall experience in Te Anau. Ticketing, interactive displays, information, services. The visitor hub would include a history of the wider Fiordland area, potentially encompassing a museum style of experience.
Buses - Base of Operations	$16.8M	Area for the operation and maintenance of buses to take visitors from Te Anau to Milford Sound Piopiotahi. Includes facilities for Bus driver resting, bus maintenance, charging and overnight housing.
Structures		
Bus Stop - Te Anau Departure	$0.7M	Open Sided Shelter / Refuge style of development acting as a departure point for buses. Located adjacent to Te Anau Hub.
Te Anau Hub- Pavements	$1.0M	Parking provided for drop off and short term carparking and for Bus Transfers. Allowance for the equivalent of 60 vehicle parks.
Te Anau Hub - Jetty	$0.8M	Allocation for Jetty facility in support of the Te Anau Hub. Developed based on demand at location. Scale of Jetty development would practically be subject to confirming acceptable proximity to Te Anau hub through site selection process. A final commercial decision would need to be reached to avoid duplication of the assets currently established in the centre of town.
Te Anau Hub- Carriageway	$3.4M	Allowance for the realignment of roadways in the vicinity of the Te Anau hub and intersection upgrades for the movement of buses etc within Te Anau. Scope would require definition based on final selected location.
Park and Ride - Pavements	$16.8	Car Parking (Spaces) for Park and Ride. To be established adjacent to the Base of Operations for buses to make use of shared facilities, and to optimise the use of the pavement areas (peak season the bus storage area can be used for overflow parking).
Features		
Landscaping - Visitor Experience Hub	$5.0M	Provision for an enhanced environment including paving and landscaping surrounding the Te Anau Hub.

Te Anau Interpretation	$1.0M	Budget allowance for the establishment of interpretive materials throughout Te Anau (Signage, Displays, Services, incl. within Te Anau hub).
Services		
Wastewater	$0.2M	Modification required to the wastewater systems in the vicinity of the Te Anau Hub including connection costs to the Council Network .
Potable Water	$0.2M	Modification required to the potable water systems in the vicinity of the Te Anau Hub including connection costs to the Council Network .

7.30 The proposed configuration within Te Anau will require to identification of land for and establishment of an area to house and maintain the bus fleet for servicing the corridor. Likewise, land will be required for the establishment of a Park and Ride facility for visitors. Preferably these facilities would be adjacent to one another. This would mean, at peak periods, the bus fleet storage area can double as overflow parking for visitors. Land still needs to be identified and purchased.

7.31 A circulating bus service will be established to link the accommodation facilities with the Visitor Hub. This service will double as a community public transport system, based on the circuit defined for accommodation to minimise both resident and tourist traffic on the roads around Te Anau.

7.32 Where the bus fleet is electric, then charging is to be from the national grid. A full assessment of demand has not been carried out as it will depend on the selection process for the vehicle. It has therefore been assumed that the sufficient capacity exists within the existing network, with allowance for a transformer allocated adjacent to the base of operations for the buses.

7.33 The selection of the bus fleet would be subject to constant review throughout the renewal cycles of the assets. Over time, the initial vehicle selection may be eclipsed by those with a more sustainable energy source. For example, the technology for efficient hydrogen plant production may reach a point that the fleet could be converted, at the time of renewal, to this alternative energy source. As a baseline, we have assumed that an electric vehicle fleet would be established, replacing existing diesel buses as the renewal cycles permit.

8 SUMMARY AND CONCLUSION

CONNECTION TO PILLARS

8.1 There is a direct connection between the development of the built environment and project pillars. Each element within the recommended option set has the pillars as the foundation for their selection. Some examples are provided below.

8.2 **Mana Whenua values woven through**: - The Mana Whenua narrative is to form the basis for interpretive features from the outset of the journey to the reveal in Milford Sound Piopiotahi. The structures will incorporate mana whenua stories and connections to the land and seascape, with the configurations to tie into the natural environment. These features will be reflected particularly in the Visitor Hubs at Milford Sound Piopiotahi and Te Anau, and the experience centre at the Whakatipu Super Track Head.

8.3 **A Moving Experience**: - the alignment of the arrival and layout of the Visitor Hub is proposed based on making the destination the focus and not the supporting infrastructure. Structures are recessed into the natural environment, current roadways and pavements give way to landscaped features, options are given for a variety of activities while minimising the footprint of man-made infrastructure. Additional walkways, tracks and accommodation options are provided within the corridor to broaden the options for visitors that wish to stay longer within the area.

8.4 **Tourism funds Conservation and Community / Effective Visitor Management**: - The recommended option set, the infrastructure defined, is the mechanism with which to facilitate success of these pillars. All infrastructure proposed enable the governance structures to be placed around it to realise the potential of the funding growth and providing a world class experience.

8.5 **Resilient to Change and Risk:** - As described in the Hazard and Visitor Risk Review, February 2021, key infrastructure has been proposed where environmental risks to visitors from flooding and avalanche are reduced, elevated to be resilient to groundwater and sea level changes, and to be built to resist other natural hazards such as landslide induced tsunamis. Where feasible, the building would be designed in modular fashion to enable future expansion if required. This is best represented in the proposed base of operations for buses in Te Anau where the parking facilities could be expanded subject to demand.

8.6 **Conservation:** - The footprint of all the developments has been considered in the layouts presented. Alignment of paths, position of buildings and configuration of the structures have been aligned to be, where feasible, only within areas that have been previously disturbed. The structures are set back into and against the natural environment to minimise its visual impact. All structures are to be green star rated, designed such that they are energy and water efficient, making best use of existing resources.

8.7 **Harness Innovation and Technology:** - As noted above, buildings are to be designed to be energy efficient. Interpretive features will be included within the refuges and bus shelters proposed, potentially connected to the fibre network, to allow for advanced displays and reporting. The bus fleet, while proposed as being electrically powered, will have a renewal cycle that will allow for alternative fuel source vehicles, such as hydrogen powered, to be considered.

CONCLUSIONS

8.8 The proposed modifications to and development of infrastructure are based on enabling the preferred configuration within the Master Plan. The preferred suite of infrastructure options has been developed based on:

- Weaving through Mana Whenua values and principles reflected in structural designs, landscaping, layouts and storyboards (*Mana Whenua values woven through*)
- Minimising the footprint of infrastructure and maximising use of existing infrastructure (*Conservation / Resilient / A Moving Experience*).

- Non-obtrusive, fitting in with the natural landscape and environment (*Conservation / A Moving Experience*)
- Minimising the resources to be used, ideally using local materials, assets, and services (*Conservation / Resilient / Harness Innovation and Technology*)
- Developing energy and resource efficient, durable designs (*Resilient / Harness Innovation and Technology*)
- Designing specifically for the hazards and risks likely to be encountered (*Resilient / Harness Innovation and Technology)*

8.9 Specific limitations that effect the recommended options for infrastructure include:

- Wastewater – limited to areas where wastewater can effectively be managed by way of treatment and disposal.
- Power – limited to areas where a viable reliable renewable source is available, typically by way of a small-scale hydro scheme.
- Environmental and Cultural footprint – built infrastructure needs to fit in with the established environment primarily aligning with areas which have previously been disturbed.

8.10 The infrastructure defined within Section 8 is the recommended option for the Master Plan for Milford Sound Piopiotahi, the corridor and Te Anau associated with this project. These elements may change when fully scoped in detailed design but do form the basis for current considerations and determining the way forward.

APPENDIX 1: LONG LIST OPTION TABLES

POTABLE WATER

WASTEWATER

POWER SUPPLY

FINAL

LONG LIST OPTIONS: WATER SUPPLY

Process / Equipment	Pros	Cons	Power Input	Footprint	Capital Cost	Application
Source						
Surface Water • lake, river, stream	• Easily accessible.	• Water quality is susceptible to elevated turbidity events and contamination, particularly following rain events, requiring higher levels of treatment. • Organic material may need to be removed, if so needs to be done in a way that mitigates the formation of Disinfection By-products (DBPs).				☒ Community ☒ Settlement ☒ Small Site
Lake / Riverbank Bores • Groundwater under the direct influence of surface water	• Typically, better quality than surface water • Typically, more readily treated than surface water with simpler technologies (water quality dependent).	• Considered as a surface water source under DWSNZ, so higher levels of treatment are required. • Susceptible to elevated turbidity events and surface water contamination (depending on substrates).				☒ Community ☒ Settlement ☐ Small Site
Ground Water • Non-secure bore	• Typically, better quality than surface water • Typically, more readily treated than surface water with simpler technologies (water quality dependent).	• Considered as a surface water source under DWSNZ, so higher levels of treatment are required. • May be susceptible to elevated turbidity events and surface water contamination (depending on substrates). • May have iron and / or manganese requiring treatment.				☒ Community ☒ Settlement ☐ Small Site
Ground Water • Secure bore	• Typically, best quality water. • Typically, most easily treated with UV and chlorination, although not currently mandatory under DWSNZ. • Least susceptible to turbidity events.	• Sampling and hydrogeological investigations along with borehead protection works required to demonstrate secure bore status. • Secure bores may lose status in the future with revisions to the DWSNZ, and hence require higher level of treatment. • May have iron and / or manganese requiring treatment.				☒ Community ☒ Settlement ☐ Small Site
Roof Water	• Generally good quality water. • Easily accessible.	• Susceptible to contamination from birds, windblown material, or moss grown in rainwater pipes / gutters. • Considered as a surface water source under DWSNZ if supplying more than a single household. • Supply is weather dependent, hence requires storage.				☐ Community ☐ Settlement ☒ Small Site
Reclaimed wastewater (direct or indirect potable reuse)	• Beneficial reuse of treated wastewater that would otherwise be discharged	• Requires a very high level of treatment • Whilst proven internationally, not currently used in New Zealand • Potential resistance from regulatory authorities, iwi and public				
Treatment Process						
Microstrainer • 15-50 µm nominal particle size cut-off	• Can remove 40-70% of bulk algae. • Can remove 5-20% of turbidity. • Simple low maintenance equipment. • Chemical free algae removal.	• Zero protozoa log credits • Cannot remove individual cells / small algae species / reproductive forms of algae. • Sliming and blinding of media requires NaOCl or continuous UV irradiation. • Challenged with fluctuations in flow and / or load. • Has not been used for drinking water treatment in recent times.	☐ High ☐ Medium ☒ Low	☐ Large ☐ Medium ☒ Small	☐ High ☐ Medium ☒ Low	☒ Community ☒ Settlement ☐ Small Site
Riverbank Filtration (Lakeside Bores)	• 0.5-log protozoa credit (7.5 m setback) • 1-log protozoa credit (15 m setback) • Provides potential turbidity and algae attenuation. • Chemical free solution. • No maintenance required to retain log credit.	• Substrate surrounding the bores must meet geological and turbidity requirements to receive the log credit. • Bores have been in operation for at least 2-years to receive log credit. • May lose status in future revisions to the DWSNZ.	☐ High ☐ Medium ☒ Low	☐ Large ☐ Medium ☒ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☐ Small Site
Slow Sand Filtration	• 2.5-log protozoa credit • Affordable to design, build, maintain, and replace. • Simple to operate and maintain. • Chemical free solution. • Biological activity can consume some organics.	• Requires a large footprint. • Takes time to establish biological capacity. • Requires lots of storage	☐ High ☐ Medium ☒ Low	☒ Large ☐ Medium ☐ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☐ Small Site
Amiad ® AMF backwashable microfibre filters • 1.5-3 µm nominal particle size cut-off	• 1-log protozoa credit • 20-100% algal biovolume removal. • Up to 70% turbidity removal. • Chemical free solution, but compatible with filter aid polymers. • Suited for small schemes with low turbidity and colour.	• Cassette replacement every 2-3 years (as per preliminary MoH requirements). • Limited case history in drinking water treatment. • Incomplete turbidity removal.	☐ High ☒ Medium ☐ Low	☐ Large ☐ Medium ☒ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☐ Small Site
Cartridge Filtration	• 2-log protozoa credit • Chemical free solution. • Affordable to design and build. • Suited for clean and low particle containing water.	• Susceptible to blinding and frequent filter replacements since it cannot be backwashed. • Does not provide organics removal. • Higher Operator labour required for non-backwashable filter types.	☐ High ☒ Medium ☐ Low	☐ Large ☐ Medium ☒ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☒ Small Site

Process / Equipment	Pros	Cons	Power Input	Footprint	Capital Cost	Application
	• Cost effective and reasonably sustainable if filters are replaced no more than twice per year. • Suited for small schemes with low turbidity and colour.					
Granular Media Filtration (gravity or pressure)	• Affordable to replace media. • 63-75% algal cell removal. • Chemical free solution • Compatible with chemical coagulants for direct filtration to obtain 2.5-log credits	• May see blinding and sliming of granular filter media without coagulant addition. • May require coagulation and flocculation to be effective. • Zero log protozoa credit on its own.	☐ High ☒ Medium ☐ Low	☐ Large ☒ Medium ☐ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☒ Small Site
Granular Activated Carbon Filtration	• Affordable to design and build. • Effective at removing dissolved organics and reducing colour.	• High cost for GAC media replacement. • Zero log protozoa credit	☐ High ☒ Medium ☐ Low	☐ Large ☒ Medium ☐ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☒ Small Site
Dissolved Air Flotation (DAF) and Filtration (granular / membrane)	• Proven process for algae removal. • Smaller footprint than conventional treatment. • 3-log credit when DAF is followed by granular filtration • 4-log credit when DAF is followed by membrane filtration	• Requires chemical coagulant and / or polymer. • Higher energy requirement for compressed air.	☒ High ☐ Medium ☐ Low	☒ Large ☐ Medium ☐ Small	☒ High ☒ Medium ☐ Low	☒ Community ☐ Settlement ☐ Small Site
Ballasted sand flocculation and sedimentation followed by Granular Filtration	• Up to 99.9% algal cell removal. • Smaller footprint than conventional treatment. • Best suited for high turbidity water. • 3-log protozoa credit	• Requires coagulant, polymer, and microsand. • Not preferred as pre-treatment for membranes due to abrasive microsand.	☒ High ☐ Medium ☐ Low	☐ Large ☒ Medium ☐ Small	☐ High ☒ Medium ☐ Low	☒ Community ☐ Settlement ☐ Small Site
Low Pressure Membrane Filtration (Micro / Ultrafiltration) • 0.02-0.5 µm absolute particle size cut-off	• 100% algal cell and biovolume removal. • Can operate without coagulant (water quality dependent). • Small footprint for high throughput. • 4-log protozoa credit	• 10-15 year membrane replacement (depends on manufacturer, water quality, cleaning regime). • Wastewater generated by chemical cleaning requires blending / management prior to disposal. • More complex and requires high level of automation.	☒ High ☐ Medium ☐ Low	☐ Large ☒ Medium ☐ Small	☒ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☐ Small Site
High Pressure Membrane Filtration (Nanofiltration) • 0.001 µm absolute particle size cut-off	• Yields a coagulant free effluent. • Can operate without coagulant (water quality dependent). • 4-log protozoa credit	• Could require an MF/UF membrane pre-treatment. • 4-5 times more expensive than low pressure membrane systems. • Requires brine waste management / treatment.	☒ High ☐ Medium ☐ Low	☐ Large ☒ Medium ☐ Small	☒ High ☐ Medium ☐ Low	☒ Community ☐ Settlement ☐ Small Site
UV Disinfection	• Chemical free solution. • 3-log protozoa credit	• May require pre-treatment to remove turbidity and UV light absorbing constituents (water quality dependent).	☐ High ☒ Medium ☐ Low	☐ Large ☐ Medium ☒ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☒ Small Site
Ozonation	• Chemical residual free solution. • Promotes biological filtration and organics removal. • Up to 3-log protozoa credit	• High operational costs (liquified oxygen, electricity). • Reduces the biological stability of the finished water if not followed by biological filtration. • Ozone can damage algae cell walls releasing polysaccharides and toxins into the water that would need to be removed. • High power consumption to generate ozone. • High efficiency ozone generators require liquified oxygen.	☒ High ☐ Medium ☐ Low	☐ Large ☒ Medium ☐ Small	☒ High ☐ Medium ☐ Low	☒ Community ☐ Settlement ☐ Small Site
Chlorination	• Required for bacteriological compliance (although not currently mandatory under DWSNZ). • Cost effective solution for virus inactivation (potential future MoH requirement).	• May require pre-treatment to remove turbidity and chlorine consuming constituents and reduce risk of disinfection by products (water quality dependent). • Requires adequate contact time (e.g. contact tank) • Zero protozoa credit	☐ High ☐ Medium ☒ Low	☐ Large ☒ Medium ☐ Small	☐ High ☐ Medium ☒ Low	☒ Community ☒ Settlement ☐ Small Site
Do nothing	• Cheapest option.	• Water is non-potable (depending on existing system) and signage required to alert visitors. • Permanent Boil Water Notice required (depending on existing system).	☐ High ☐ Medium ☒ Low	☐ Large ☐ Medium ☒ Small	☐ High ☐ Medium ☒ Low	☐ Community ☐ Settlement ☒ Small Site

LONG LIST OPTIONS: WASTEWATER

Process / Equipment	Pros	Cons	Power Input	Footprint	Capital Cost	Application
Wastewater Generating Facilities						
Composting toilets	• Can be waterless • At source treatment • No conveyance system required • Production of compost as resource • Long-term onsite storage capacity • Compost production for beneficial reuse	• Odour / vector attraction potential if not managed correctly • Requires bulking agent • Regular compost removal required • Human waste compost applications limited and stigmatized	☐ High ☐ Medium ☒ Low ☒ None	☐ Large ☐ Medium ☒ Small	☐ High ☒ Medium ☐ Low	☐ Community ☒ Settlement ☒ Small Site
Composting toilets with urine separation	• Can be waterless • At source treatment • No bulking agent required due to urine separation • Significant nitrogen load reduction due to urine separation • No conveyance system required • Production of compost as resource • Long-term onsite storage capacity • Compost production for beneficial reuse	• Odour / vector attraction potential if not managed correctly • Regular compost removal required • Human waste compost applications limited and stigmatized • Collection, conveyance/transport, and on- or offsite treatment of urine • Separate treatment and disposal system for greywater (if produced)	☐ High ☐ Medium ☒ Low ☒ None	☐ Large ☐ Medium ☒ Small	☐ High ☒ Medium ☐ Low	☐ Community ☒ Settlement ☒ Small Site
Vermiculture toilets	• Can be waterless • At source treatment • No conveyance system required • Vermicast production for beneficial reuse	• Odour / vector attraction potential if not managed correctly • Requires bulking agent and specific worms • Regular vermicast removal required • Human waste vermicast applications limited and stigmatized • Separate treatment and disposal system for greywater (if produced)	☐ High ☐ Medium ☒ Low ☒ None	☐ Large ☐ Medium ☒ Small	☐ High ☒ Medium ☐ Low	☐ Community ☒ Settlement ☒ Small Site
Containment/vault systems	• Waterless • No environmental impacts associated with discharge to land/water at site from human waste • Low-or no power option	• Odour / vector attraction potential if not managed correctly • Regular pump-out required • Separate treatment and disposal system for greywater (if produced)	☐ High ☐ Medium ☐ Low ☒ None	☐ Large ☐ Medium ☒ Small	☐ High ☐ Medium ☒ Low	☐ Community ☐ Settlement ☒ Small Site
Wastewater Treatment – Mechanical Systems						
Usage of existing treatment systems	• No further development of treatment systems required	• Capacity review necessary • Agreement with system owner required • Compliance check with resource consent required and potential future regulatory requirements	☐ High ☐ Medium ☒ Low ☐ None	☐ Large ☐ Medium ☒ Small	☐ High ☐ Medium ☒ Low	☒ Community ☒ Settlement ☐ Small Site
Septic tank units	• Simple, reliable, and proven technology • Reduction of separated solids via in tank digestion (if pump-out frequency between 3-5 years) • Can be used for mixed wastewater or blackwater treatment • Low-or no power option	• Primary treated wastewater quality, i.e. solids removal only • Limited nutrient and pathogen removal • Regular pump-out required • Transport and offsite disposal of separated solids • Potential consenting issues with disposal of primary treated wastewater in sensitive environment	☐ High ☐ Medium ☒ Low ☒ None	☐ Large ☐ Medium ☒ Small	☐ High ☐ Medium ☒ Low	☒ Community ☒ Settlement ☒ Small Site
Aerobic treatment units	• Produces higher treated wastewater quality compared to septic tank • Removes nutrients to an extent • Process is controllable through operator input (chemical dosing, aeration intensity, etc)	• Solids separation as pre-treatment required • Clarification stage for biological solids separation post-treatment required • Only partial nutrient removal achievable without further treatment or intermittent aeration • Chemical dosing may be required • Ongoing process supervision and operation may be required	☐ High ☒ Medium ☐ Low ☐ None	☒ Large ☒ Medium ☐ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☒ Small Site
Intermittent sand filters	• Produces higher treated wastewater quality compared to septic tank • Removes nutrient to an extent	• Solids separation as pre-treatment required • Only partial nutrient removal achievable without further treatment • Chemical dosing may be required • Ongoing process supervision and operation may be required	☐ High ☐ Medium ☒ Low ☒ None	☐ Large ☒ Medium ☐ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☒ Small Site
Trickling filters	• Produces higher treated wastewater quality compared to septic tank	• Solids separation as pre-treatment required • Further nutrient removal may be required	☐ High	☐ Large	☐ High	☒ Community

Process / Equipment	Pros	Cons	Power Input	Footprint	Capital Cost	Application
	• Removes nutrient to an extent	• Process cannot be controlled by chemical dosing or aeration • Ongoing process supervision and operation may be required	☐ Medium ☒ Low ☐ None	☒ Medium ☐ Small	☒ Medium ☐ Low	☒ Settlement ☐ Small Site
Recirculating biofilters	• Produces higher treated wastewater quality compared to septic tank • Removes nutrients to a higher extent than above processes	• Solids separation as pre-treatment required • Further nutrient removal may be required • Ongoing process supervision and operation may be required	☐ High ☒ Medium ☐ Low ☐ None	☐ Large ☒ Medium ☐ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☐ Small Site
Membrane bioreactors	• Produces higher treated wastewater quality than above processes • Process is controllable through operator input (chemical dosing, aeration cycling and intensity, etc) • Physical barrier to remove treated wastewater solids	• Solids separation as pre-treatment required • Further nutrient removal may be required • Backwash water required • Chemical dosing may be required • Ongoing process supervision and operation required	☒ High ☐ Medium ☐ Low ☐ None	☐ Large ☒ Medium ☐ Small	☒ High ☐ Medium ☐ Low	☒ Community ☒ Settlement ☐ Small Site
Nutrient removal process (as additional treatment step to above processes)	• Produces higher treated wastewater quality than above processes in terms of nutrients • Process is controllable through design and operator input	• Pre-treatment by one or more of the above processes required • Chemical dosing may be required • Ongoing process supervision and operation required	☒ High ☐ Medium ☐ Low ☐ None	☒ Large ☒ Medium ☐ Small	☒ High ☐ Medium ☐ Low	☒ Community ☐ Settlement ☐ Small Site
UV Disinfection	• Inactivation of pathogens • Tertiary treatment • Depending on pre-treatment, treated wastewater quality may be suitable for reuse	• Pre-treatment by one or more of the above processes required • Clarification stage for biological solids separation required	☒ High ☐ Medium ☐ Low ☐ None	☐ Large ☐ Medium ☒ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☐ Small Site
Chlorination	• Inactivation of pathogens • Tertiary treatment • Depending on pre-treatment, treated wastewater quality may be suitable for reuse	• Pre-treatment by one or more of the above processes required • Potential consenting issues due to disinfection by products and public perception	☒ High ☐ Medium ☐ Low ☐ None	☐ Large ☐ Medium ☒ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☐ Small Site
Higher level of treatment to enable potable reuse (e.g. reverse osmosis)	• Beneficial reuse of wastewater as it is treated to a very high quality	• not considered practicable at this stage due to cost and associated residual solids handling	☒ High ☐ Medium ☐ Low ☐ None	☒ Large ☒ Medium ☐ Small	☒ High ☐ Medium ☐ Low	☒ Community ☐ Settlement ☐ Small Site
Wastewater Treatment – Natural Systems						
Worm farm	• Produces higher treated wastewater quality compared to septic tank • Removes nutrient to an extent • Natural treatment system	• Solids separation as pre-treatment required • Further nutrient removal may be required • Process cannot be controlled by chemical dosing • Ongoing process supervision and operation may be required	☐ High ☐ Medium ☐ Low ☐ None	☐ Large ☒ Medium ☐ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☐ Small Site
Constructed wetlands	• Produces higher treated wastewater quality compared to septic tank • Removes nutrient to an extent • Natural treatment system • Can provide ecosystem for native flora and fauna • Low-or no power option	• Solids separation as pre-treatment required • Further nutrient removal may be required • Process cannot be controlled by chemical dosing or aeration	☐ High ☐ Medium ☒ Low ☒ None	☒ Large ☒ Medium ☐ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☐ Small Site
Oxidation ponds and aerated lagoons	• Produces higher treated wastewater quality compared to septic tank • Removes nutrient to an extent • Natural treatment system • Low-or no power option	• Further nutrient removal may be required • Seasonal variability in treated wastewater quality, particularly solids due to algal growth	☐ High ☐ Medium ☒ Low ☒ None	☒ Large ☒ Medium ☐ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☐ Small Site
Infiltration soil treatment units	• Produces higher treated wastewater quality compared to septic tank • Removes nutrient and pathogens depending on soil type and hydraulic loading rate • Natural treatment system • Low-or no power option	• Solids separation as pre-treatment required • Process cannot be controlled by chemical dosing or aeration • Treated wastewater testing difficult • Potential consenting issues due to difficulty demonstrating final treated wastewater quality • Groundwater mounding potential • Minimum separation to groundwater needs to be maintained	☐ High ☐ Medium ☒ Low ☒ None	☒ Large ☐ Medium ☐ Small	☒ High ☒ Medium ☒ Low	☒ Community ☒ Settlement ☒ Small Site
Treated Wastewater Disposal/Reuse						
Discharge to land - Conventional bed/trench infiltration	• Acts as infiltration soil treatment unit depending on soil type and infiltration rate	• Groundwater mounding potential	☐ High ☐ Medium	☒ Large ☒ Medium	☐ High ☐ Medium	☐ Community ☒ Settlement

Process / Equipment	Pros	Cons	Power Input	Footprint	Capital Cost	Application
	• Evaporation/soil treatment/plant nutrient uptake • Low-or no power option	• Minimum separation to groundwater needs to be maintained	☒ Low ☒ None	☐ Small	☒ Low	☒ Small Site
Discharge to land - Rapid rate infiltration (e.g. Rapid Infiltration Basins)	• Higher hydraulic loading rates than conventional bed/trench system • Limited soil treatment • Smaller footprint than conventional bed/trench system	• High hydraulic loading rates increase groundwater mounding potential • Minimum separation to groundwater needs to be maintained	☐ High ☐ Medium ☒ Low ☒ None	☐ Large ☒ Medium ☐ Small	☒ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☐ Small Site
Discharge to land - Slow rate infiltration (e.g. drip dispersal/drip irrigation)	• Beneficial reuse of treated wastewater (e.g. landscape irrigation) • Evaporation/soil treatment/plant nutrient uptake	• Lower hydraulic loading rates than conventional bed/trench system results in bigger footprint than conventional bed/trench system	☐ High ☐ Medium ☒ Low ☐ None	☒ Large ☐ Medium ☐ Small	☐ High ☒ Medium ☐ Low	☒ Community ☒ Settlement ☒ Small Site
Discharge to surface water	• No land requirement • Low-or no power option	• Potential consenting issues due to stringent requirements for discharge into pristine water bodies • Treatment to a very high standard likely to be required	☐ High ☐ Medium ☐ Low ☒ None	☐ Large ☐ Medium ☒ Small	☐ High ☐ Medium ☒ Low	☒ Community ☒ Settlement ☒ Small Site
Discharge to groundwater - Deep bore injection	• Minimal land requirement • Groundwater recharge	• Potential consenting issues due to stringent requirements for discharge into aquifer and level of investigations / information required • Treatment to a very high standard likely to be required	☐ High ☒ Medium ☒ Low ☐ None	☐ Large ☐ Medium ☒ Small	☒ High ☐ Medium ☐ Low	☒ Community ☐ Settlement ☐ Small Site
Beneficial use of reclaimed wastewater	• No land requirement • Reduces potable water demand	• Treatment to a very high standard required depending on water use	☐ High ☐ Medium ☒ Low ☒ None	☐ Large ☐ Medium ☒ Small	☐ High ☐ Medium ☒ Low	☒ Community ☐ Settlement ☐ Small Site

LONG LIST OPTIONS: POWER SUPPLY

Process / Equipment	Pros	Cons	Energy production	Footprint	Capital Cost	Application
Hydro Hydroelectric schemes use gravity to drive water through turbines, converting that energy into electricity. Constructing a new, separate hydro generation scheme to supplement existing	• Renewable power source	• Local environmental effects, diverting stream through section • Rainfall dependent (inconsistent supply) • Requires battery storage • Very high CAPEX cost	☒ High ☐ Medium ☐ Low	☐ Large ☐ Medium ☒ Small	☒ High ☐ Medium ☐ Low	☒ Community ☐ Settlement ☐ Small Site
Wind Wind turbines to generate electrical energy.	• Renewable power source	• Local environmental effects, noise pollution, potential wildlife impacts • Wind dependent (inconsistent supply) • Requires battery storage	☐ High ☐ Medium ☒ Low	☐ Large ☒ Medium ☐ Small	☒ High ☐ Medium ☐ Low	☒ Community ☐ Settlement ☒ Small Site (turbine at end of the tunnel)
Tidal Tidal movement to generate electrical energy.	• Renewable power source • Low visual effect (underwater) • Predictable tides consistent supply	• Local environmental effects, potential to change immediate tidal cycle, reduces ocean kinetic energy, potential marine wildlife impacts • Can only produce energy (10/24h) not continual supply • Requires battery storage	☐ High ☒ Medium ☐ Low	☐ Large ☐ Medium ☒ Small	☒ High ☐ Medium ☐ Low	☒ Community ☐ Settlement ☐ Small Site
Solar Solar panels to generate electrical energy.	• Renewable power source	• Sunlight dependent (inconsistent supply) • Requires battery storage	☐ High ☒ Medium ☐ Low	☒ Large ☐ Medium ☐ Small	☐ High ☒ Medium ☐ Low	☒ Community ☐ Settlement ☐ Small Site
Battery Storage	• Allows for storage, and consistent supply	• Requires secondary source of supply to charge	☒ High ☐ Medium ☐ Low	☐ Large ☒ Medium ☐ Small	☒ High ☐ Medium ☐ Low	☒ Community ☐ Settlement ☐ Small Site
Diesel Generation Using a diesel engine to generate electrical energy. Would require transportation of diesel to Milford Sound Piopiotahi. Consider biogas as a fuel.	• Reliable (assuming supply of diesel is available) • Very high OPEX cost	• Non-renewable. Fossil fuels (diesel) required, harmful emissions • Local environmental effects, noise pollution	☒ High ☐ Medium ☐ Low	☐ Large ☒ Medium ☐ Small	☐ High ☒ Medium ☐ Low	☒ Community ☐ Settlement ☐ Small Site
Main Grid Connection Connecting to the NZ national grid would involve constructing a transmission line from Te Anau downs to Milford Sound Piopiotahi.	• Consistent supply	• Transmission line, prone to natural hazards • High visual impact	☒ High ☐ Medium ☐ Low	☐ Large ☐ Medium ☒ Small	☐ High ☒ Medium ($200k/km) ☐ Low	☒ Community ☐ Settlement ☐ Small Site
Biogas Biogas works by breaking down organic matter in an anaerobic environment, releasing natural gases which can be used as fuel for a combustion generator to produce electricity	• Provides efficient means of managing environmental waste	• Local environmental effects, noise pollution, odour • Inconsistent, low supply of organic matter	☐ High ☐ Medium ☒ Low	☐ Large ☒ Medium ☐ Small	☒ High (for conversion to electricity) ☒ Medium (for gas generation) ☐ Low	☒ Community ☐ Settlement ☐ Small Site

APPENDIX 2: CAPITAL COST ESTIMATES

Replace Page with Appendix 2 PDF (Cost estimates)