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Physical monitoring of Doubtful Sound / Patea: 2025–26

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Physical monitoring of Doubtful Sound / Patea: 2025–26

Paula Casanovas, Romain Chaput, Sara Jamieson

Prepared for Meridian Energy Limited

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Glossary

Term	Definition
28 isohaline	The depth at which salinity reaches 28 practical salinity units. This contour is commonly used to describe the maximum depth of the low-salinity layer.
Conductivity meter	Instrument that measures water's ability to conduct an electrical current due to dissolved ions (e.g. when sodium chloride [salt] is mixed with water, it separates into sodium and chloride ions). The more ions in the water, the higher the conductivity. The meter then calculates the salinity of the water using the conductivity values and temperature measurements.
Linear regression model	Statistical model applied in this report to estimate the values of missing salinity measurements using the measurements recorded immediately above and below. Model performance is evaluated using the coefficient of determination (R^2), which measures the proportion of variability explained by the model, and the associated *p*-value, which indicates the statistical significance of the relationship.
RBR instruments	Conductivity and temperature sensors deployed during the 2-yearly calibration of the Sea-Bird instruments. They are typically deployed for approximately 3 months every 2 years to minimise data gaps.
Sea-Bird 37-Inductive Mooring CT sensors (SBE37-IM)	High-accuracy conductivity and temperature sensors deployed on long-term moorings to collect continuous data.
Tailrace discharge volume and rate	The volume and flow rate of fresh water discharged from Manapōuri Power Station into Deep Cove. Discharge is measured every 30 minutes.
Telemetered communications	Satellite-based communication system that enables data collected by moored instruments to be sent remotely to technical teams.

List of abbreviations

Abbreviation	Definition
2MTT	Second Manapōuri tailrace tunnel
AMP	Adaptive management programme
EFD	Equivalent freshwater depth. The theoretical depth of the surface freshwater layer if all freshwater inputs were to remain unmixed with the underlying seawater.
LSL	Low-salinity layer. A surface layer of water that is enriched with tannins and is less saline than the underlying seawater. It is a defining feature of Aotearoa New Zealand's fiords and forms due to high rainfall and terrestrial run-off. The depth and persistence of the low-salinity layer in Fiordland strongly influences light penetration, hydrodynamic circulation and the distribution of marine species.
MPS	Manapōuri Power Station
MTAD	Manapōuri Tailrace Amended Discharge

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Executive summary

This report presents findings from physical monitoring of near-surface waters (to a depth of 25 m) undertaken as part of the Meridian Energy Doubtful Sound Adaptive Management Programme (AMP) for the monitoring year 1 March 2025 to 28 February 2026. The results presented in this report are intended to build on prior monitoring observations and identify any changes that may be occurring under the ongoing operation of the Manapōuri Power Station (MPS) and following on from the Manapōuri Tailrace Amended Discharge (MTAD).

The MTAD consent was granted in 2010, changing the maximum tailrace discharge allowed into Deep Cove from 510 m^3/s to 550 m^3/s.[1] Prior to MTAD, the station had a 485 m^3/s operational limit so that it did not exceed 510 m^3/s, but it now operates at a maximum set point of 550 m^3/s. In 2021, Meridian's consent conditions were changed, which reduced the physical monitoring from nine to two oceanographic moorings, with additional instruments for measuring temperature and salinity added at 14 m and 25 m depths.[2] The capability of the two moorings (M1 in Milford Sound / Piopiotahi [hereafter Milford Sound] and M4 in Doubtful Sound / Patea [hereafter Doubtful Sound]) was expanded in 2019 by adding the ability to communicate some data remotely via satellite telemetry.

This report covers physical data on the low-salinity layer (LSL) collected during the monitoring year at the two oceanographic monitoring moorings and three meteorological stations. Biological monitoring was not undertaken this year, which is in line with recommendations from reviews of the monitoring programme and the findings of last year's physical report (Schattschneider and Jamieson 2025).

Key findings from the 2025/26 physical monitoring:

- Total rainfall was close to the average total for previous years at Secretary Island and Wilmot Pass (3.6 m vs 3.7 m and 5.7 m vs 5.1 m, respectively), but among the highest recorded at Milford Sound (7.8 m vs average of 6.0 m).
- Average wind speeds and the proportion of the time winds were greater than 10 km/h were slightly higher than averages to date at Secretary Island (17.2 km/h and 59.9%, respectively). Similarly at Milford Sound, mean wind speeds were slightly higher than average (8.5 km/h) and were greater than 10 km/h for 35.8% of the time, compared with an average of 31.5%.
- Total tailrace discharge volume of 11.7 km^3 was equal to the mean of 11.7 km^3 across all monitoring years (equivalent units to 10^9 m^3).
- The rate of tailrace discharge during the 2025/26 monitoring year ranged between a minimum of 99 m^3/s and a maximum of 521 m^3/s based on daily means, and between 74 m^3/s and 536 m^3/s based on half-hourly readings. The mean rate of discharge for the 2025/26 monitoring year was 372 m^3/s, which

[1] While this increase in discharge was granted in 2010, it was not implemented until 23 October 2012. High flows in 2010 were at the request of Environment Southland to reduce the possibility of flooding downstream in the Waiau River, and the flows in 2011 did not exceed 510 m^3/s.

[2] The development of the two moorings was carried out in parallel with the existing system, which continued to provide monitoring data until the consent was granted and the new system could be fully developed.

was close to the mean to date for all monitoring years (371 m^3/s).

- Daily mean discharge rate for the 2025/26 monitoring year exceeded 460 m^3/s on 127 days, which is higher than the mean of 102 days across all monitoring years. The daily mean discharge rate exceeded 485 m^3/s on 108 days during the monitoring year, which was substantially higher than the average of 41 days per annum for all years to date. The daily mean discharge rate exceeded 510 m^3/s on 4 days during the 2025/26 monitoring year, which was lower than the average (11 days) for all years to date (after the MTAD consent was granted).
- Characteristics of the LSL in both Doubtful and Milford Sounds remained broadly within the range observed during previous monitoring years. However, the mean 28 isohaline depth in Doubtful Sound was estimated at 4.9 m in 2025/26, the highest average value. This average value should be interpreted with caution due to considerable gaps in salinity data for Doubtful Sound.
- The maximum depth of the 28 isohaline, which is most relevant to describing the maximum depth to which the LSL penetrates, was well within the range of previous years in both Milford and Doubtful Sounds.
- The disconnect between the rainfall data and the LSL indicators for both Milford and Doubtful Sounds observed in 2024/25 did not occur this year. As would be expected, above-average recorded rainfall totals in Milford Sound were accompanied by slightly lower surface salinity, while average recorded rainfall totals in Doubtful Sound were accompanied by near-average surface salinity.
- Following the marine heatwave conditions between 2022 and 2024 and the relatively cool conditions of 2024/25, mean temperatures during the 2025/26 monitoring year returned to a range comparable to that observed before 2022 in both Doubtful and Milford Sounds. However, the long-term record shows a gradual warming trend consistent with the effects of global climate change, with temperatures in recent years generally remaining higher than those observed at the beginning of the monitoring programme.

Our analyses of the 2025/26 physical monitoring data indicate there are no tailrace-related effects to the Doubtful Sound system beyond those that are already well documented. These findings corroborate previous reports and observations found in the long history of this monitoring programme. To date, the programme has not identified any biological or physical changes that can be attributable to the ongoing operation of the MPS, including since the completion of the second Manapōuri tailrace tunnel (2MTT) or following the increased discharge under MTAD.

We recommend a continuation of current physical monitoring at the M1 and M4 moorings in Milford Sound and Doubtful Sound, respectively, as well as biological monitoring of (intertidal and subtidal) core sites and intertidal transition areas every 5 years. Following these recommendations, the next biological monitoring survey would be in 2029.

It is also recommended that Meridian purchase four spare Sea-Bird 37-Inductive Mooring CT sensors (two per mooring) to help ensure that a full payload of 24 sensors can be in place at all times. Ideally, these instruments would be procured prior to the March 2027 refurbishment trip.

1. Overview of monitoring scope and reporting

This report presents findings from physical monitoring of near-surface waters (to 25 m depth) of Doubtful Sound / Patea (hereafter Doubtful Sound) and Milford Sound / Piopiotahi (hereafter Milford Sound) over the 2025/26 monitoring year (1 March 2025 to 28 February 2026) undertaken as part of the Meridian Energy Doubtful Sound Adaptive Management Programme (AMP). This monitoring is required by Meridian Energy's (Meridian's) operating resource consent conditions for the Manapōuri Power Station (MPS): 96019; details provided in Appendix 1.

Monitoring in relation to the station's tailrace discharge started in 1997; from July 2003, the effects of adding a second Manapōuri tailrace tunnel (2MTT) have been included in the assessment (see previous reports). The Manapōuri Tailrace Amended Discharge (MTAD) consent to change the maximum tailrace discharge into Deep Cove (from flow not exceeding 510 m^3/s to flow not exceeding 550 m^3/s) was granted in 2010 but first exercised on 23 October 2012.

The monitoring programme builds on prior monitoring observations, with the aim of identifying any possible effects of MTAD, along with any long-term changes that may be occurring in the system under the ongoing operation of the MPS. In 2021, Meridian was granted consent to change its monitoring programme (see Dunmore et al. 2015, 2018 and Cornelisen and Dunmore 2020 for additional information on consent changes). This report has been produced for compliance purposes and is not intended to cover the details of the long-term monitoring programme or the findings from the previous reports that assessed the effects of 2MTT and the potential effects of MTAD. This information is available in the reports referenced elsewhere in this document and the annual monitoring reports.

This report follows on from the 2024/25 monitoring report and presents data for the monitoring year period only. However, results from the calendar year data can be provided if required. The content and scope of this report are the same as for previous physical monitoring reports, with text, figures and tables updated to capture the latest observations and statistics.

To maintain consistency with previous reports, the physical characteristics of the LSL in Doubtful and Milford Sounds are presented for the 2025/26 monitoring year using physical data collected at the two oceanographic moorings and three meteorological stations described in Section 2.1. Biological monitoring will next be undertaken in early 2029 as per the findings detailed in the last biological monitoring report (Crossett et al. 2024); this is in line with recommendations from reviews of the monitoring programme (Dunmore et al. 2015, 2018) and last year's monitoring report (Schattschneider and Jamieson 2025).

2. Physical monitoring

2.1 Data collection

Detailed descriptions of the data collected as part of the physical monitoring programme are provided in earlier reports. Briefly, this component of the programme consists of a compilation of meteorological data, data on the rate of freshwater discharge from the tailrace, and salinity and water temperature data collected at two long-established oceanographic moorings: M1 in Milford Sound and M4 in Doubtful Sound (Figure 1).

When undertaken, the biological monitoring typically occurs between late January and late February. To maintain consistency with previous biological and physical monitoring reports, we present results for the physical data in terms of a 'monitoring year'; this encompasses physical conditions leading up to, and including, the biological sampling. The monitoring year thus spans 1 March to 28/29 February the following year.

The main processes affecting the LSL characteristics within Doubtful Sound are the tailrace discharge, rainfall, winds and oceanic influences (Gibbs and Jiang 2005). Hence, data on these related parameters are collected as part of the physical monitoring programme and / or obtained from external sources and collated. Rainfall and wind data from meteorological stations located on Secretary Island and at Milford Sound are provided by MetService. Rainfall data from Wilmot Pass are obtained from the Department of Conservation.

Tailrace discharge rates provided by Meridian are based on average half-hourly values derived from quality-assured data. The rate at which fresh water is discharged from MPS into Deep Cove is estimated using an established relationship between the amount of power generated by the turbines and the flow of water exiting the tunnels. Such relationships are referred to as 'machine ratings'. In April 2005, Meridian began a half-life refurbishment of all seven turbines, which was completed in 2007. As part of this process, new machine ratings were obtained and are now used to estimate the freshwater discharge rate, dating back to when the refurbishment project began. Prior to April 2005, the old machine ratings were applied to estimate discharge.[3]

[3] Note that statistics on tailrace discharge for the years 2005–07 may vary slightly between reports produced prior to the availability of the new ratings and reports written in 2008 and beyond.

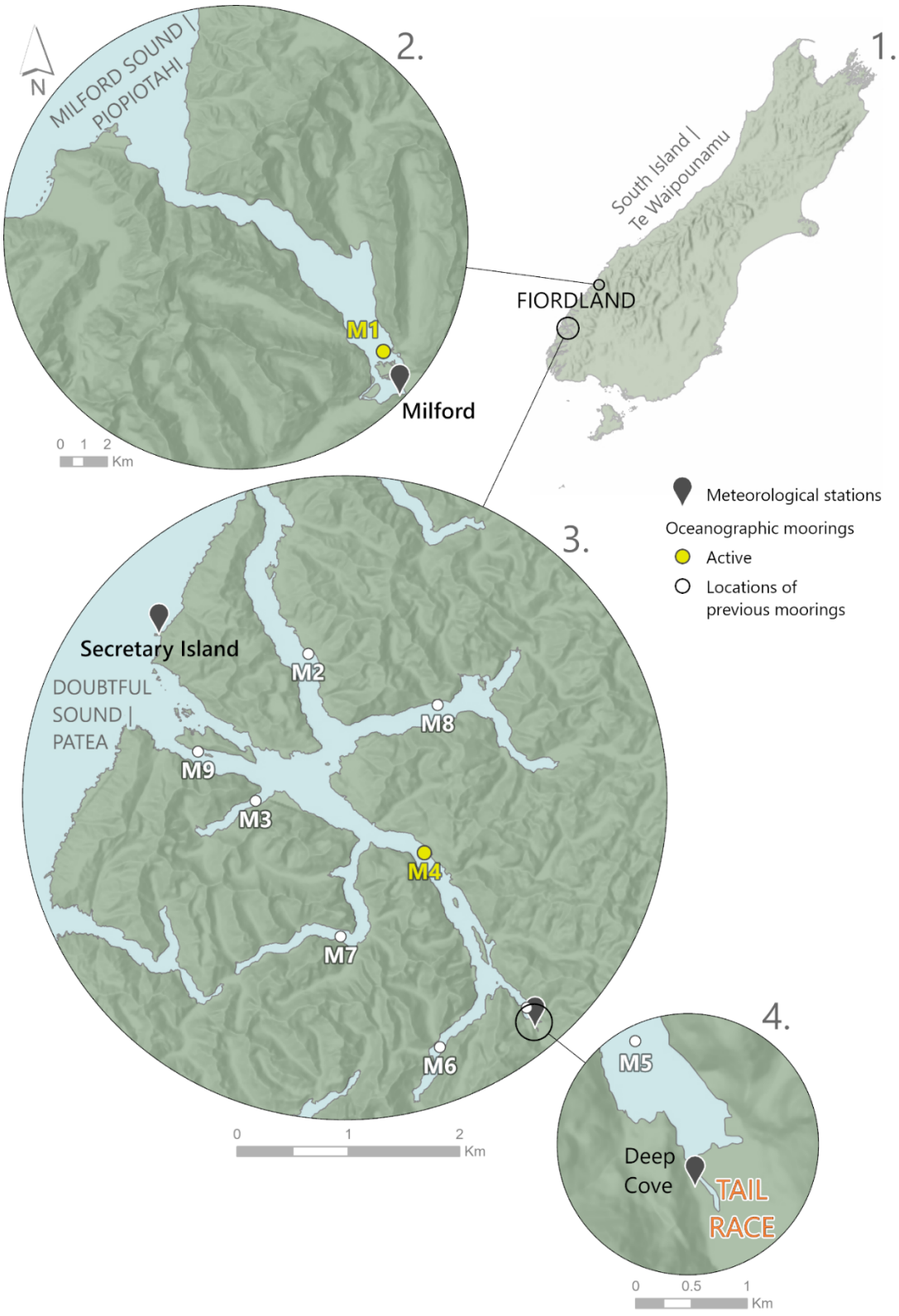


Figure 1. Locations of the active oceanographic moorings (M1 and M4) and those used up until 2021 (M2, M3, M5, M6, M7, M8 and M9). Meteorological stations and the tailrace discharge point are represented in panels 2, 3 and 4. Panel 1 provides a spatial overview of where these features are located in the South Island / Te Waipounamu.

The MPS operates according to set points that have changed over time. Because the power output of the machines varies around a set point, the half-hour flow estimates tend to fluctuate by about 10–15 m^3/s below and above the set point. Prior to obtaining the MTAD consent, Meridian had been operating with a maximum discharge consent limit of 510 m^3/s. With a 510 m^3/s consented maximum discharge, the two tailrace discharge tunnels operated at a maximum set point of approximately 485 m^3/s.[4] This provided a buffer to ensure that the instantaneous maximum did not exceed 510 m^3/s. In 2010, Meridian was granted consent to operate MPS at a set point up to a maximum of 550 m^3/s (MTAD consent), and normal operating fluctuations around this set point would be tolerated.

In this report, discharge is also referred to in terms of the daily average discharge rate (average of half-hour readings over a 24-hour period), which is on a timescale more relevant to the overall hydrography of Doubtful Sound and is the basis of determination of the number of days of higher discharge.

The oceanographic mooring design for M1 and M4 consists of a large surface buoy with a cable attached holding salinity and / or temperature sensors (Sea-Bird Scientific) at the following depths: 0.5 m, 1.0 m, 1.5 m, 2 m, 3 m, 5 m, 7 m, 9 m, 11 m, 14 m, 19 m and 25 m. As part of instrumentation upgrades, every fourth data record is telemetered via satellite from the moorings, which allows for a quality check to confirm that essential systems and instruments are operational. It also ensures that a continuous, albeit reduced, dataset would still be available in the unlikely event of complete loss of one of the moorings. This upgrade was operationally important, given the transition that occurred in 2021 from 3-monthly to annual visits to undertake mooring and monitoring equipment maintenance. The moorings and instrumentation are maintained by Cawthron Institute (Cawthron), with technical and logistical field support provided by Earth Sciences New Zealand (ESNZ, formerly National Institute of Water and Atmospheric Research [NIWA]) and the University of Otago.

Salinity data collected at mooring locations M1 and M4 are used to characterise the LSL in Milford and Doubtful Sounds, respectively. Characteristics of the LSL that are calculated include surface salinity, the thickness of the LSL and the equivalent freshwater depth (EFD) of the LSL. To be consistent with prior monitoring reports, the surface salinity is defined as the salinity measured by the sensor positioned at 1 m depth. The thickness of the LSL is the depth to which the 28 isohaline is estimated to have penetrated below the surface. The EFD is calculated as the depth of fresh water that would be present if there was no mixing between freshwater inputs and the underlying seawater (Bowman 1978).

Calculation of the 28 isohaline and the EFD from a set of salinity measurements at discrete depths is a process of estimation, based on assumptions of salinity at depths between the sensors (using methods of interpolation between data points). At times, measurements of salinity at some depths may be missing due to instrument failure or maintenance, or salinity values may be available at additional depths such as following the redesign of the moored instrumentation array (with the addition of instruments at 14 m and 25 m). The EFD estimation method was further developed in 2020, motivated by the new sensors at additional depths, which increases the accuracy of estimating the LSL thickness during deepening events. For the 2024/25 monitoring report, the refined method was used to re-estimate the EFD time-series from all historical data, as well as from the new data. Thus, the historical EFD values provided in this report may differ from reports provided prior to 2025. Specifically, relativity

[4] 485 m^3/s being the reference point for effects of operation of MPS under the 1996 consent limit (510 m^3/s).

between years within Table 2 is maintained, even if the absolute value of annual EFD estimates has changed between reports.

Periods of missing or compromised data

The monitoring programme has produced an extensive and robust dataset. However, most years feature some period(s) of missing data. Prior to the telemetered buoy upgrade, most periods of missing data at the mooring locations were due to the removal of instruments for maintenance and calibration. Since the upgrade to M1 and M4, the original RBR instruments are used for a 3-month period every 2 years while the Sea-Bird instruments are away being calibrated.[5] This approach has greatly reduced the extent of missing data in recent years. The RBR instruments were deployed between late November 2024 and mid-March 2025 while the Sea-Bird instruments were away being calibrated. For the 2025/26 monitoring year, the RBR instruments provided data between 1 March and 10 March 2025.

During the 2025/26 monitoring year, several sensor issues were encountered across both the M1 and M4 moorings. At M1, the sensor deployed at 0.5 m experienced a battery failure in February 2026, resulting in a loss of data between 21 February and 17 March 2026, when the battery was replaced during the annual maintenance visit. No other data gaps were recorded at this site during the remainder of the 2025/26 monitoring period.

At M4, several more significant issues occurred, as follows:

- During the March 2025 maintenance visit, a communications fault was identified in the newly installed inductive cable; the old cable had been damaged and could not be reused. Given that the sensors had previously reliably been logging and storing data, a decision was made to redeploy all sensors, as they would continue logging and storing data internally, but would be unable to telemeter it back in real time. It was anticipated that communication performance might improve. Telemetered communications did recover partially over time, but only for some of the sensors.
- A battery failure on the 1.5 m sensor on 30 September 2025 resulted in no further data being recorded beyond this date, leading to a loss of data from October 2025 through to March 2026.
- During the March 2026 maintenance visit, the 3 m sensor was found to have a broken CT cell, which becomes more likely with sensor age and possibly occurred during redeployment of the mooring after the 2025 visit. This prevented the collection of any salinity data at this depth for the entire 2025/26 monitoring period.
- A programming issue affected the 5 m sensor on redeployment during the March 2025 visit, which caused a complete loss of both temperature and salinity data at this depth for the duration of the 2025/26 monitoring period; this issue was attributed to the faulty inductive cable, which prevented *in situ* diagnostics during deployment.

With the exception of the broken cell on the 3 m salinity sensor, the issues with the sensors were addressed during the March 2026 service visit. An additional visit was undertaken in June 2026 to

[5] The Sea-Bird instruments are sent to either the United States or Australia for calibration, and the RBR units are calibrated in Canada.

replace the instrument at 3 m depth on M4. The higher than usual loss of data during the 2025/26 period has highlighted the necessity to have additional backup sensors. The sensor issues that contributed to these data gaps also underscore the increasing importance of maintaining adequate spares as the instruments age. The Cawthron technical team is undertaking a thorough review of the factors that contributed to the data gaps. Pending the outcome of this review, additional checks and minor modifications to the buoy set-up may be implemented to help mitigate similar issues in the future. It is recommended that Meridian purchase four spare Sea-Bird 37-Inductive Mooring CT sensors (SBE 37-IMPs; two per mooring); this will help ensure that a full payload of 24 sensors can be in place at all times. Ideally, these instruments would be procured prior to the March 2027 refurbishment trip.

To calculate the necessary statistics for the oceanographic data for the 2025/26 report, we estimated the missing data at M4 using linear regression models developed based on all the previous years of data. These models relate the salinity values at the missing depth to the salinity values recorded at the depths immediately above and below. For the salinity values at 1.5 m, the regression model's adjusted R^2 was 0.87 (p-value < 0.0001), indicating that 87% of the variability in salinity at this depth was explained by the model. For the salinity values at 3 m and 5 m, the regression models were statistically significant (with p-value < 0.0001), but the adjusted R^2 values were lower (0.52 and 0.40, respectively), indicating that the models explained a smaller proportion of the observed variability at these depths.

Calculating the standard LSL parameters (e.g. EFD and 28 isohaline depth) indicated that the estimated salinity values did not substantially affect most summary statistics. However, the estimated 28 isohaline depth in Doubtful Sound differed from values observed in previous years and was inconsistent with the other LSL indicators. This discrepancy is possibly due to the large gap in the salinity profile resulting from missing data at 3 m and 5 m depths, where the 28 isohaline depth commonly occurs. Consequently, the isohaline depth had to be interpolated between measurements at 2 m and 7 m; this vertical spacing provides insufficient resolution to accurately estimate the 28 isohaline depth. Therefore, results involving the 28 isohaline depth should be interpreted with particular caution. Results for the salinity summary statistics with and without estimated data are presented in Table 2 of this report.

2.2 Physical monitoring results

Weather conditions

Annual rainfall totals for the 2025/26 monitoring year were close to the average to date at Secretary Island and Wilmot Pass (3.6 m and 5.7 m, respectively), but the second highest recorded to date at Milford Sound (7.8 m) (Figure 2). Rainfall statistics across all monitoring years are provided in Table A2.1 in Appendix 2.

Mean wind speeds at Secretary Island during the 2025/26 monitoring year (17.2 km/h) were higher than the mean to date of 16.6 km/h observed at this location across previous years (Figure 3). Milford Sound had mean wind speeds of 9.1 km/h during 2025/26, slightly higher than the mean over previous years (8.5 km/h). Wind speed data across all locations are provided in Table A2.1 in Appendix 2. The Wilmot Pass weather station does not collect wind data.

Wind speeds during the 2025/26 monitoring year at Secretary Island showed a similar trend to the 2024/25 data and were stronger than 10 km/h for a slightly higher percentage of time (59.9%) than the mean compared to previous monitoring years (57.2%). In Milford Sound, wind speeds were stronger than 10 km/h for a noticeably higher percentage of time than the mean to date for calendar years (35.8% cf. the 31.5% mean) (summary data are provided in Table A2.1 in Appendix 2).

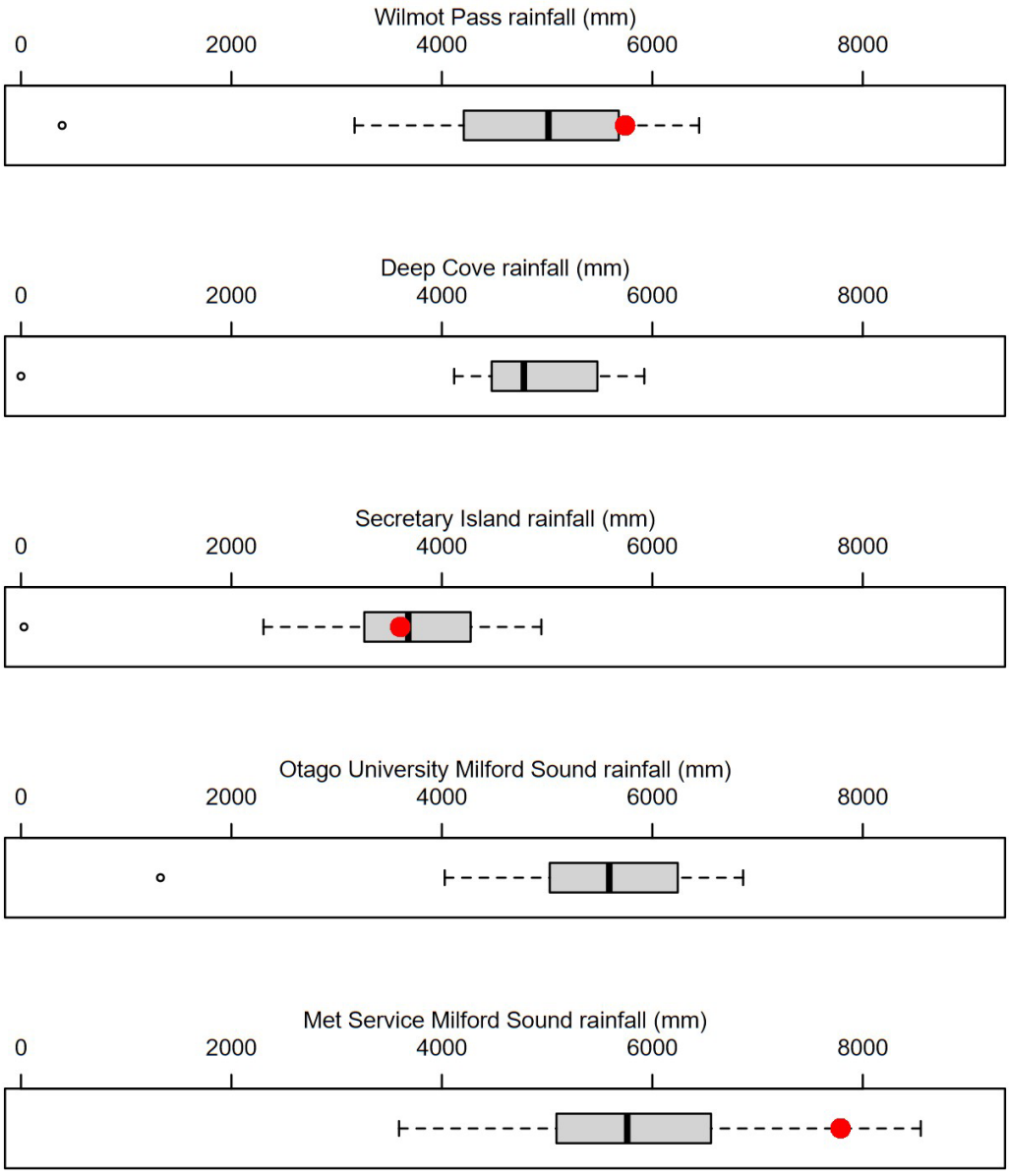


Figure 2. Median and range of total annual rainfall for the monitoring years 2002–24, overlaid with this monitoring year's (2025/26) total rainfall (●), for weather stations located at (top to bottom) Wilmot Pass (Department of Conservation); Deep Cove, Secretary Island and Milford Sound (University of Otago); and Milford Sound (MetService). University of Otago data collected in Deep Cove and Milford Sound are for 2002–18 only. Boxes extend to lower and upper quartiles; thick vertical lines are medians. Horizontal dashed lines extend as far as 1.5× the interquartile range if data are found at those extremes, beyond which extreme values are plotted as separate points. Summary statistics for weather variables are provided in Appendix 2.

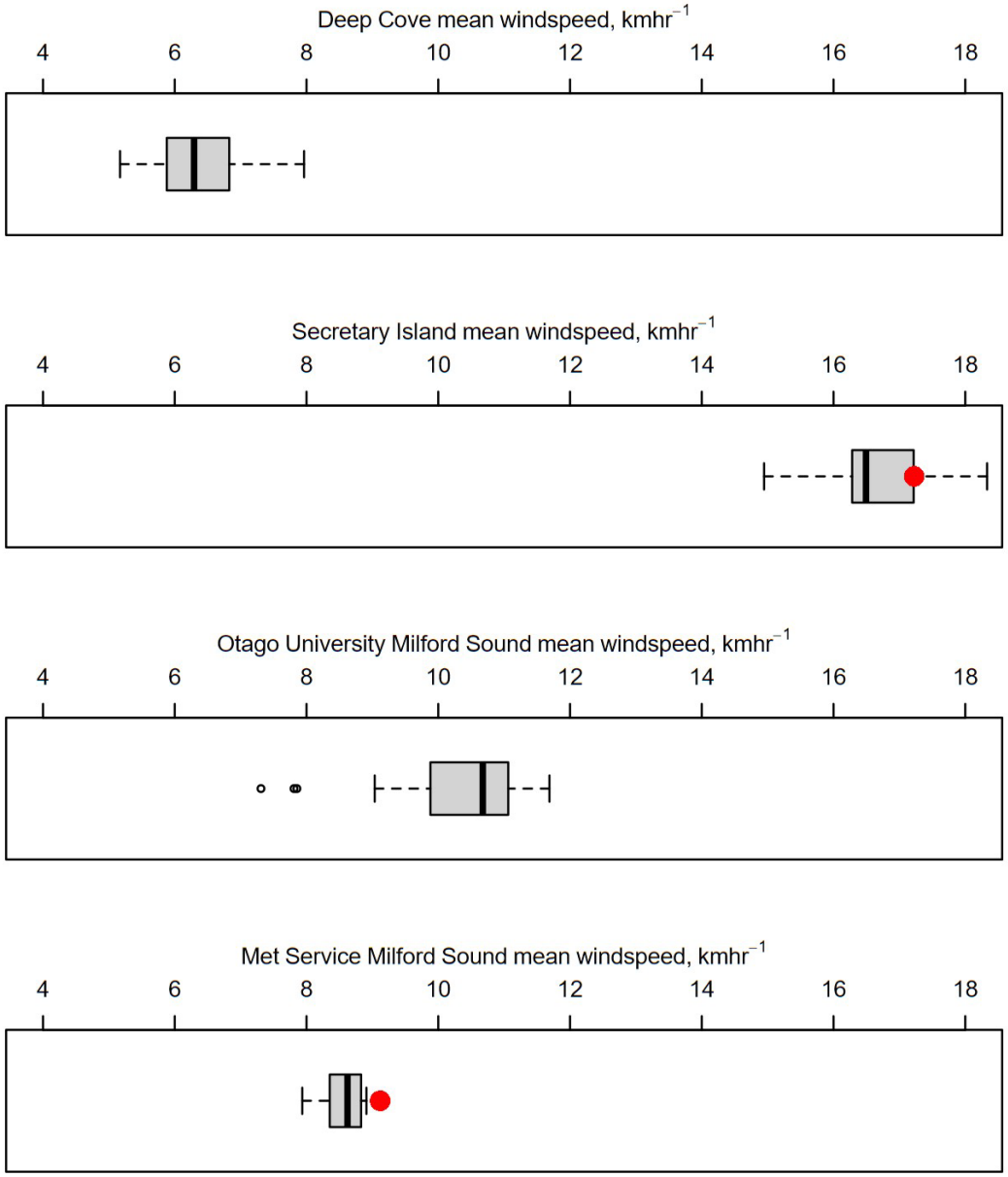


Figure 3. Median and range of mean wind speed for the monitoring years 2002–24, overlaid with this monitoring year's (2025/26) mean wind speed (●), for weather stations located at (top to bottom) Deep Cove, Secretary Island, Milford Sound (University of Otago); and Milford Sound (MetService). Windspeed data are not collected at Wilmot Pass. University of Otago data collected in Deep Cove and Milford Sound are for 2002–18 only. Boxes extend to lower and upper quartiles; thick vertical lines are medians. Horizontal dashed lines extend as far as 1.5× the interquartile range if data are found at those extremes, beyond which extreme values are plotted as separate points. Summary statistics for weather variables are provided in Appendix 2.

Tailrace discharge

The total discharge volume of 11.7 km^3 (equivalent units to 10^9 m^3) for the 2025/26 monitoring year was the same as the average across all monitoring years (equivalent units to 10^9 m^3). The rate of tailrace discharge during the 2025/26 monitoring year ranged between 99 m^3/s and 521 m^3/s based on daily means (Figure 4). Based on half-hourly readings, the discharge rate varied between a low of 74 m^3/s and a high of 536 m^3/s (Figure 5). Summary statistics are provided in Table 1.

The tailrace discharge rate was low, around 200 m^3/s, for the first couple of months of the monitoring period; it then increased and fluctuated slightly below 485 m^3/s between May and July 2025, after which the discharge rate decreased back to 200 m^3/s. In early spring, the discharge rate increased to 485 m^3/s, remaining fairly steady just above this rate until January 2026, after which it decreased again to about 300 m^3/s (Figure 4).

Mean rate of tailrace discharge for the 2025/26 monitoring year was 372 m^3/s, which was close to the means to date for all monitoring years (371 m^3/s) (Table 1). The daily mean discharge rate for the 2025/26 monitoring year exceeded 460 m^3/s on 127 days, which is noticeably higher than a mean of 102 days across all monitoring years. The daily mean discharge rate exceeded 485 m^3/s on 108 days of this monitoring year, which was also substantially higher than the average of 41 days exceedance across all years to date, although not as high as during the 2015–20 period. The daily mean discharge rate exceeded 510 m^3/s on only 4 days during the 2025/26 monitoring year, which is lower than the average of 11 days exceedance across all years to date (Table 1).

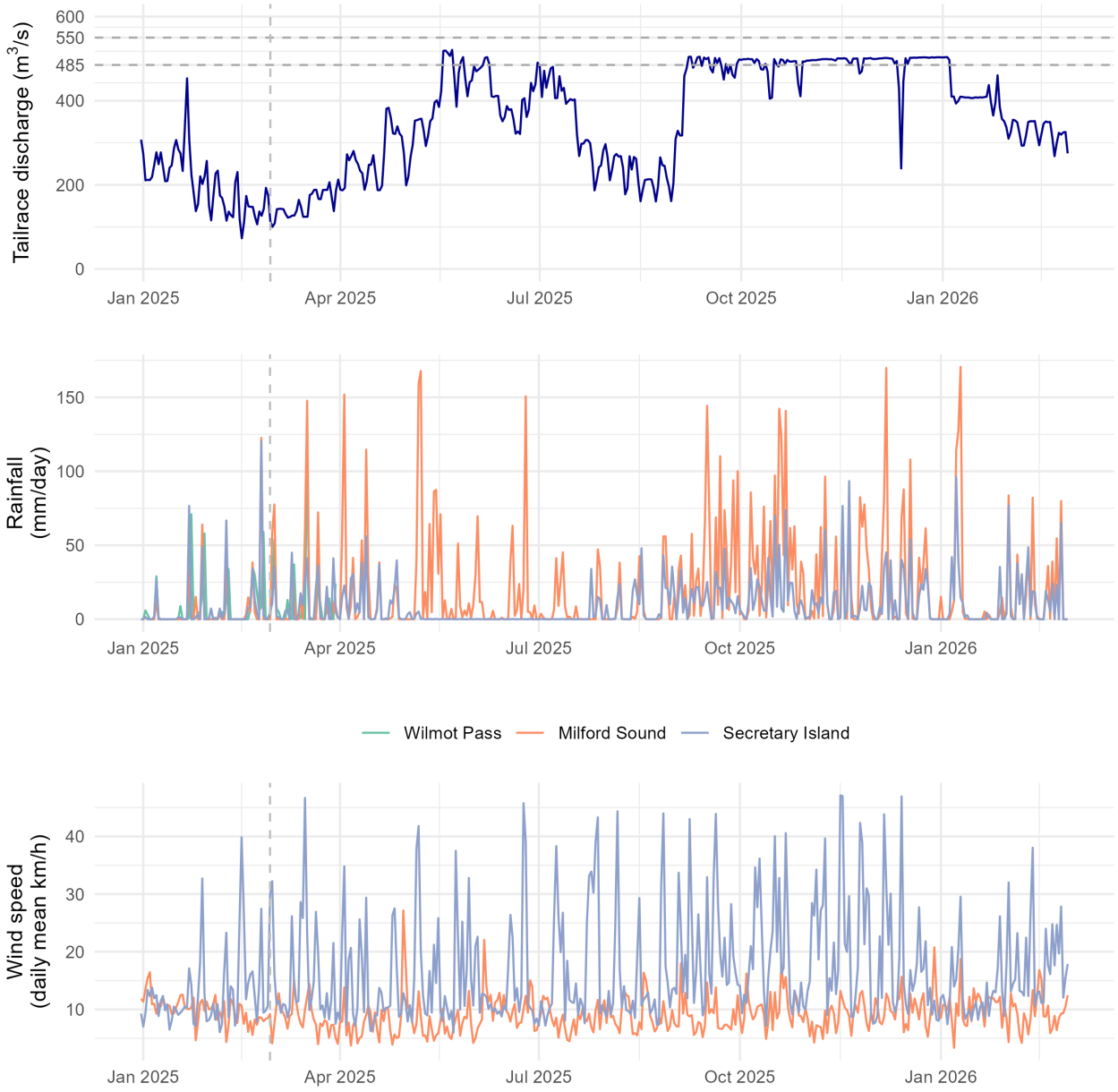


Figure 4. Tailrace discharge, rainfall and wind speed for the 2025/26 monitoring year. The dashed vertical line delineates where the monitoring year begins. Top panel: tailrace discharge daily mean rate (m^3/s) based on half-hourly readings; dashed horizontal lines mark the 485 m^3/s operational set point pre-MTAD and the 550 m^3/s MTAD consent limit. Middle panel: daily total rainfall (mm) at Wilmot Pass, Milford Sound and Secretary Island. Bottom panel: mean wind speed (km/h).

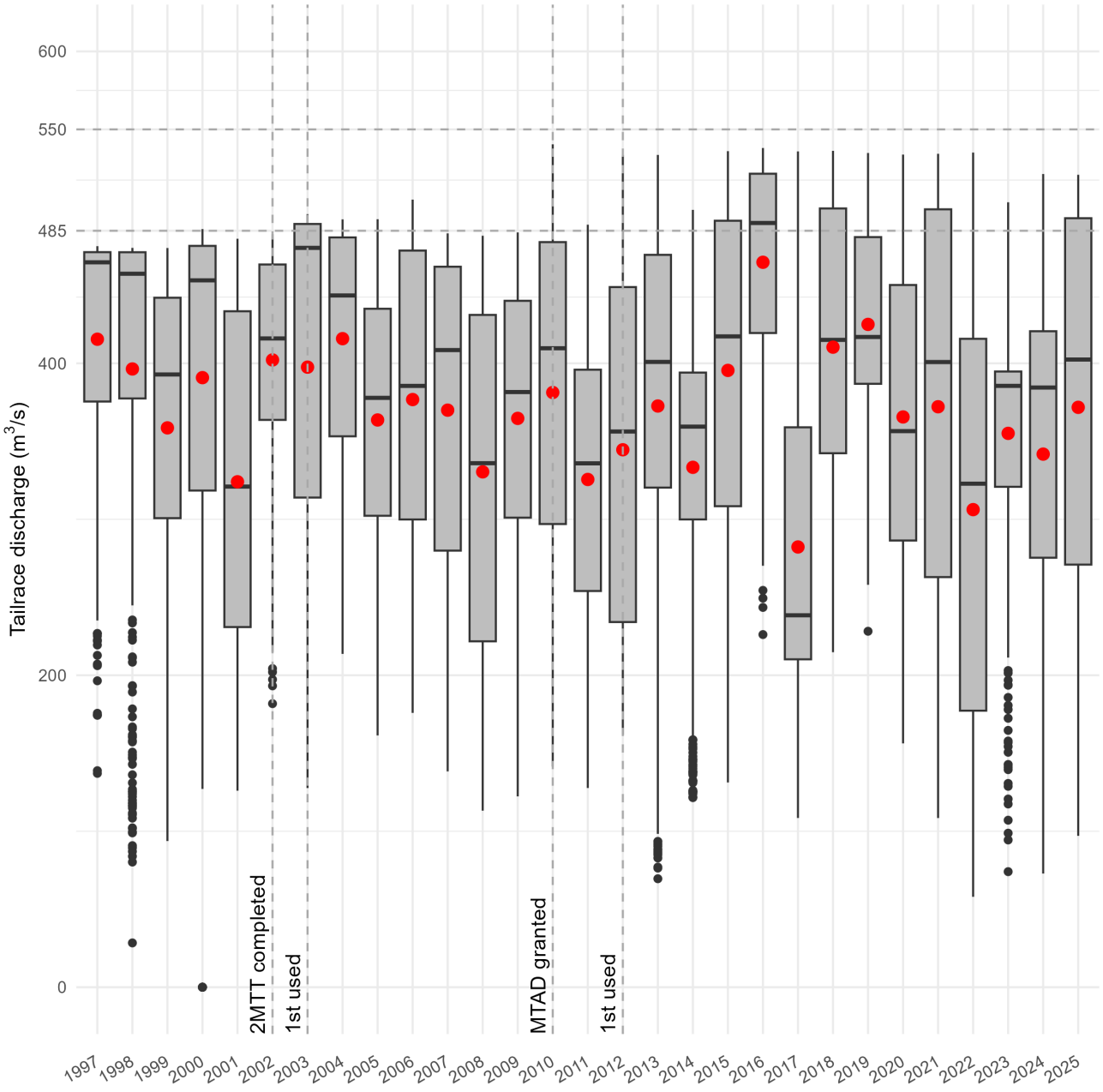


Figure 5. Tailrace discharge rate (m^3/s) for the monitoring years 1997–25, based on half-hour readings. The monitoring year is named for the calendar year in which it starts, e.g. the 2025 monitoring year runs from 1 March 2025 to 28 February 2026. Box extents represent lower and upper quartiles. Medians (—) and means (●) are shown along with quartiles (box extents) and extreme discharges (any points beyond the extent of the dashed lines). The horizontal dashed grey lines mark the 485 m^3/s operational set point pre-MTAD and the 550 m^3/s MTAD consent limit. Dashed vertical lines indicate the year when the second tailrace (2MTT) was completed (May 2002) and first used (July 2003), and when the MTAD consent was granted (July 2010) and first used (October 2012). The x-axis represents the monitoring years.

Table 1. Monitoring year (1997–25) summary statistics for tailrace discharge.

	Total volume discharged (10^9 m^3/yr)	Mean rate (m^3/s)	Max rate (of half-hour readings) (m^3/s)	Max daily mean rate (m^3/s)	No. days with daily mean > 510 m^3/s	No. days with daily mean > 485 m^3/s	No. days with daily mean > 460 m^3/s	Volume when daily mean > 510 m^3/s (10^9 m^3/yr)	Volume when daily mean > 485 m^3/s (10^9 m^3/yr)	Volume when daily mean > 460 m^3/s (10^9 m^3/yr)
1997	13.1	416	482	475	0	0	207	0.00	0.00	8.40
1998	12.5	397	477	474	0	0	185	0.00	0.00	7.52
1999	11.4	359	475	474	0	0	25	0.00	0.00	1.01
2000	12.3	391	498	484	0	0	164	0.00	0.00	6.73
2001	10.2	322	495	480	0	0	24	0.00	0.00	0.97
2002	12.7	402	495	481	0	0	122	0.00	0.00	4.94
2003	12.6	408	513	495	0	131	197	0.00	5.55	8.27
2004	13.1	416	509	490	0	24	168	0.00	1.01	6.97
2005	11.5	364	505	486	0	5	69	0.00	0.21	2.85
2006	11.9	377	614	499	0	7	99	0.00	0.30	4.10
2007	11.7	370	649	483	0	0	121	0.00	0.00	4.89
2008	10.4	331	494	481	0	0	58	0.00	0.00	2.38
2009	11.5	365	499	484	0	0	64	0.00	0.00	2.63
2010	12.0	381	549	539	4	8	136	0.18	0.35	5.63
2011	10.3	326	500	490	0	6	29	0.00	0.25	1.19
2012	10.9	345	545	533	14	32	75	0.64	1.41	3.18
2013	11.8	373	544	534	21	54	112	0.94	2.36	4.74
2014	10.5	334	515	499	0	5	9	0.00	0.21	0.38
2015	12.5	396	552	536	45	132	154	2.06	5.77	6.67
2016	14.7	465	546	538	122	193	220	5.55	8.62	9.73
2017	8.9	282	546	536	16	27	43	0.73	1.20	1.86
2018	12.9	410	543	536	18	128	142	0.82	5.57	6.15
2019	13.4	425	549	531	21	87	115	0.94	3.79	4.93
2020	11.5	366	544	534	25	71	86	1.14	3.12	3.74
2021	11.8	373	548	534	10	103	117	0.45	4.48	5.05
2022	9.7	307	548	535	17	41	54	0.77	1.81	2.34
2023	11.2	355	518	503	0	31	38	0.00	1.34	1.62
2024	10.8	342	533	520	2	3	4	0.09	0.13	0.17
Mean to date	11.7	371	528	507	11	41	102	0.50	1.80	4.29
2025	11.7	372	536	521	4	108	127	0.18	4.66	5.44

Notes:

- Historical values in the table may differ slightly from those given in previous reports due to continuing refinements in processing tailrace data. Within any one table, all years have been processed the same way, but from report to report that process may have changed. Comparisons of years should therefore be made from the data within a single report, rather than taking data for different years from different reports.
- The high 30-minute maxima in 2006 and 2007 are associated with brief pulses during the high-flow trials undertaken under a separate trial discharge consent and not the MTAD consent.
- The high half-hour and high daily average discharge rates in 2010 were at the request of Environment Southland to reduce the possibility of flooding downstream in the Waiau River following heavy rain in May.
- The high maximum in 2012 was the first routine implementation or exercise of the new MTAD consent to discharge at higher rates of flow (23 October 2012).
- The high number of days with daily average flow over 485m^3/s in 2003 was still in compliance with the pre-MTAD consenting, as the flow into the receiving environment did not breach the consented 510 m^3/s maximum. A flow of 460m^3/s is still used as a flow threshold for historical reasons. Pre-MTAD consenting, when the set point of the station was 485 m^3/s, a flow of 460 m^3/s represented a reasonably high rate of flow.

Salinity time-series at M1 and M4

Salinity data collected at moorings M1 in Milford Sound and M4 in Doubtful Sound were within the 'normal' range observed in previous monitoring years, and demonstrate the variability of the depth of the LSL over time and the intermittent deepening events throughout the year (Figure 6). A shallow LSL (approximately 2–3 m deep) within the main channel of Doubtful Sound is a continuous feature in response to the ongoing tailrace discharge, while the LSL in Milford Sound is not present for periods of time between weather events.

Mean values for surface salinity (1 m depth), the thickness of the LSL (defined by the 28 isohaline) and EFD (a measure of the amount of fresh water in the water column) at the M1 and M4 moorings are provided in Table 2 for each monitoring year. As described in previous reports, the primary difference between the two locations is a lower average surface salinity at the M4 mooring in Doubtful Sound than at the M1 mooring in Milford Sound. This is consistent with the maintenance of a persistent shallow LSL as a result of the tailrace discharge in Doubtful Sound.

In Milford Sound, the mean surface (1 m) salinity (18.8) at M1 during the 2025/26 monitoring year was slightly lower than the mean to date (19.1), but still within the 'normal' range for this location. The average depth of the 28 isohaline at M1 (2.5 m) and mean EFD (2.3 m) in Milford Sound during the 2025/26 monitoring year are very similar to the means to date (2.7 m and 2.2 m, respectively).

In Doubtful Sound, mean surface (1 m) salinity at M4 was slightly higher (11.6) than the mean to date (11.2). For Doubtful Sound, the mean depth for the 28 isohaline of 4.9 m and the mean EFD thickness of 3.3 m are higher than their respective means to date (3.9 m and 3.0 m). The EFD thickness sits within the range (2.5–3.6 m) observed over the entire monitoring period. In contrast, the 28 isohaline depth lies outside the range previously recorded (3.6–4.4 m). Salinity values at the 1.5 m, 3 m and 5 m depths were estimated using regression models. While the estimates at 1.5 m were reliable, those at 3 m and 5 m were less accurate because salinity had to be interpolated over a larger depth interval between 2 m and 7 m. As the 28 isohaline depth frequently occurs within this depth range, estimates are particularly sensitive to errors in the reconstructed salinity profile and should therefore be interpreted with caution. This is further supported by the fact that all other parameters for salinity fall within the typical range observed, including the maximum 28 isohaline depth (Table 2).

Contrary to last year, this monitoring year shows the typical relationship observed between the environmental and LSL parameters, i.e. when rainfall is higher than average, we would expect lower-than-average surface salinity values. The surface salinity measurements for 2025/26 fall within the normal range for both Milford and Doubtful Sounds following slightly higher or near-average rainfall totals.

Graphing salinity together with tailrace discharge and weather variables from periods surrounding deepening events in May/June, and October/November 2025 (Figure 7 and Figure 8, respectively) illustrates the similarity in conditions commonly observed in the two fiords. The deepening of the LSL often coincides with periods of high rainfall and an increase in wind speed. The correlation between rainfall and LSL deepening events is not as clear for the Secretary Island rainfall data, most likely due to the location of the rainfall gauge at the entrance to Doubtful Sound, which is some distance from the

M4 mooring location. On occasions, while deepening events occur in both fiords, the correlation with measured environmental variables is not always strong (Figure 8). The bottom two panels of Figure 4 also show that there is not always a strong relationship between the measured environmental variables (i.e. rainfall and wind speed) in the fiords, particularly in a windy location such as Secretary Island.

A visual comparison of annual rainfall, tailrace discharge and LSL attributes illustrates the range of LSL conditions over the duration of the monitoring programme and the frequent correlation between Milford and Doubtful Sounds (Figure 9). LSL attributes of the two fiords follow similar trends and reflect clear rainfall and tailrace discharge patterns. In turn, rainfall and tailrace discharge show similar trends over time since greater volumes of rainfall generally coincide with higher volumes of tailrace discharge. For example, the lower surface salinity with greater mean depth of the 28 isohaline and mean EFD in both Doubtful and Milford Sounds in 2016 coincided with high levels of rainfall and tailrace discharge during the year.

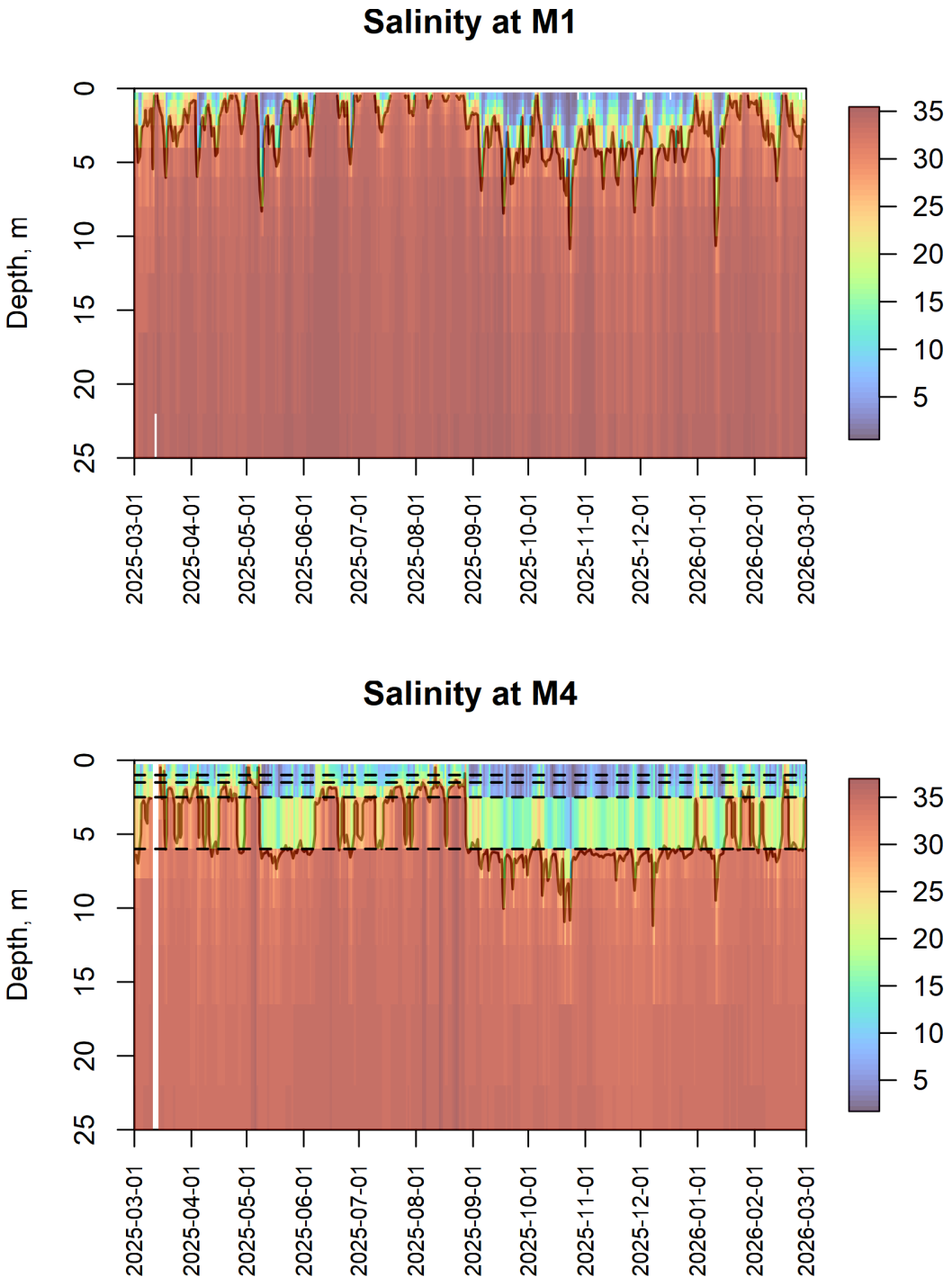


Figure 6. Salinity profiles over the 2025/26 monitoring year for M1 (Milford Sound) and M4 (Doubtful Sound). The brown line shows the 28 isohaline. White areas denote periods when data from a given sensor were not collected, and data between the dashed lines have been estimated (see Section 2.1).

Table 2. Low-salinity layer (LSL) attributes (mean, standard deviation [SD], minimum and maximum) based on data collected at M1 in Milford Sound and M4 in Doubtful Sound during the monitoring years 2005–25. The monitoring year is named for the calendar year in which it starts, e.g. the 2025 monitoring year runs from 1 March 2025 to 28 February 2026.

	Surface salinity (at 1m depth)				28 isohaline depth (m)				Equivalent freshwater depth (m)			
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
M1												
2005	20.1	10.6	0.8	34.8	2.2	1.9	0	12.9	1.8	1.3	0.0	9.6
2006	20.7	11.5	1.2	35.0	1.9	1.9	0	14.7	1.7	1.4	0.0	9.6
2007	18.4	10.7	1.1	34.5	2.6	2.1	0	17.9	2.4	1.5	0.0	14.6
2008	19.0	11.5	0.7	35.0	2.5	2.2	0	13.3	1.8	1.6	0.0	10.5
2009	20.3	11.6	0.8	35.0	2.2	2.1	0	15.4	2.0	1.6	0.0	10.6
2010	20.1	11.9	0.7	35.0	2.6	2.4	0	17.8	2.2	1.9	0.0	14.0
2011	21.1	10.2	1.0	35.0	2.2	2.1	0	18.8	1.9	1.3	0.0	11.2
2012	18.7	11.3	0.7	35.0	2.8	2.3	0	17.5	2.2	1.6	0.1	13.0
2013	18.6	11.4	0.5	35.0	2.5	2.4	0	18.7	2.2	1.8	0.0	15.1
2014	18.5	11.1	0.7	34.8	3.1	3.0	0	19.0	2.5	1.8	0.1	14.7
2015	18.4	11.1	0.5	34.8	2.8	2.5	0	18.9	2.4	1.9	0.0	15.1
2016	13.1	9.4	0.5	33.7	4.4	3.8	0	19.0	3.2	2.0	0.1	15.0
2017	21.8	10.0	1.2	34.8	2.9	3.3	0	19.0	2.3	1.5	0.1	10.0
2018	16.4	10.3	0.9	34.4	3.4	3.2	0	19.0	2.6	1.8	0.1	14.3
2019	18.4	11.0	0.3	34.9	2.7	2.4	0	21.5	2.3	2.0	0.0	15.1
2020	18.8	11.3	0.8	34.7	2.2	1.9	0	12.4	2.1	1.5	0.0	9.8
2021	18.7	10.9	0.7	35.0	2.4	1.9	0	11.7	2.2	1.4	0.0	9.4
2022	21.9	9.9	0.6	34.6	3.0	2.3	0	13.1	2.4	1.4	0.0	10.5
2023	17.9	11.4	0.6	35.0	3.1	2.2	0	16.7	2.6	1.6	0.0	12.7
2024	21.1	10.8	0.7	34.6	2.6	2.8	0	19.0	2.2	1.6	0.1	11.5
Mean To Date	19.1	10.9	0.8	34.8	2.7	2.4	0	16.8	2.2	1.6	0.0	12.3
2025	18.8	11.7	0.5	35.1	2.5	2.1	0	17.9	2.3	1.6	0.0	14.5

	Surface salinity (at 1m depth)				28 isohaline depth (m)				Equivalent freshwater depth (m)			
	Mean	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
M4												
2005	10.6	5.8	1.6	33.4	3.8	1.9	0	17.3	2.8	1.2	0.6	9.4
2006	13.6	7.8	1.8	33.8	3.6	2.2	0	19.0	2.5	1.3	0.3	8.0
2007	11.7	6.5	1.6	33.8	3.8	2.0	0	17.1	3.2	1.2	0.6	10.0
2008	12.3	7.6	1.2	34.6	3.8	2.1	0	18.1	2.9	1.5	0.1	9.2
2009	11.7	6.7	1.8	34.8	3.7	1.9	0	16.4	2.7	1.3	0.3	8.8
2010	11.7	6.8	1.7	34.6	3.8	2.1	0	16.0	2.9	1.4	0.3	8.1
2011	12.0	6.7	2.1	32.7	4.0	1.7	0	18.1	2.8	1.1	0.7	6.9
2012	10.6	6.2	0.0	33.5	3.9	2.0	0	16.4	2.7	1.3	0.3	10.0
2013	11.3	6.6	1.5	34.8	4.0	2.1	0	18.1	3.1	1.3	0.2	9.4
2014	10.2	5.6	1.3	30.7	4.0	2.1	0	16.6	3.1	1.3	0.7	10.4
2015	10.8	6.2	1.4	32.9	4.1	2.2	0	17.8	3.2	1.5	0.5	13.1
2016	8.9	4.7	1.4	31.7	4.4	2.0	0	18.3	3.6	1.4	1.0	11.3
2017	13.5	7.3	1.2	33.5	3.5	2.0	0	14.8	2.7	1.2	0.6	7.7
2018	9.7	5.2	1.8	30.7	4.3	1.9	0	18.6	3.4	1.3	1.1	11.1
2019	8.1	4.4	1.2	30.2	4.3	1.9	0	17.0	3.4	1.4	0.7	11.0
2020	10.6	6.0	1.8	31.5	4.0	2.2	0	16.3	3.0	1.3	0.7	8.8
2021	11.2	6.6	0.0	33.6	3.9	1.9	0	17.9	2.8	1.2	0.0	7.6
2022	14.0	7.9	0.5	34.0	3.4	1.9	0	13.9	2.7	0.9	0.3	8.3
2023	10.5	6.2	1.2	33.5	4.0	2.1	0	14.6	3.0	1.2	0.7	10.3
2024	12.0	6.8	1.3	34.3	3.6	1.8	0	16.7	2.9	1.2	0.4	8.3
Mean To Date	11.2	6.4	1.3	33.1	3.9	2.0	0	17.0	3.0	1.3	0.5	9.4
2025 (estimated data)	11.6	7.1	1.6	34.0	4.9	2.3	0	17.1	3.3	1.4	0.0	11.2
2025	11.6	7.1	1.6	34.0	4.9	2.1	0	17.1	3.3	1.4	0.0	10.9

Notes:

- The equivalent freshwater depth (EFD) values in this table change slightly from year to year due to improvements in data quality assurance processing. Changes are similar for both Milford and Doubtful Sounds.
- Note that a maximum depth of the 28 isohaline of 19.0 m means the 19 m instrument recorded a salinity of 28 or less. The actual depth of the 28 isohaline may be deeper than this, but until 2019 there were no instruments below this depth.
- Data for 2016 are for part of the year at Milford Sound due to instrument maintenance causing a period of missing data, and approximately 5 months of surface salinity data for M4 in 2019 are missing due to instrument failure.
- As a result of significant data missing for the 2025 monitoring year, we have included the statistics calculated with the existing data (labelled '2025') and statistics calculated using estimated data for the missing values, using regression models developed with historical data (labelled '2025 (estimated data))'.

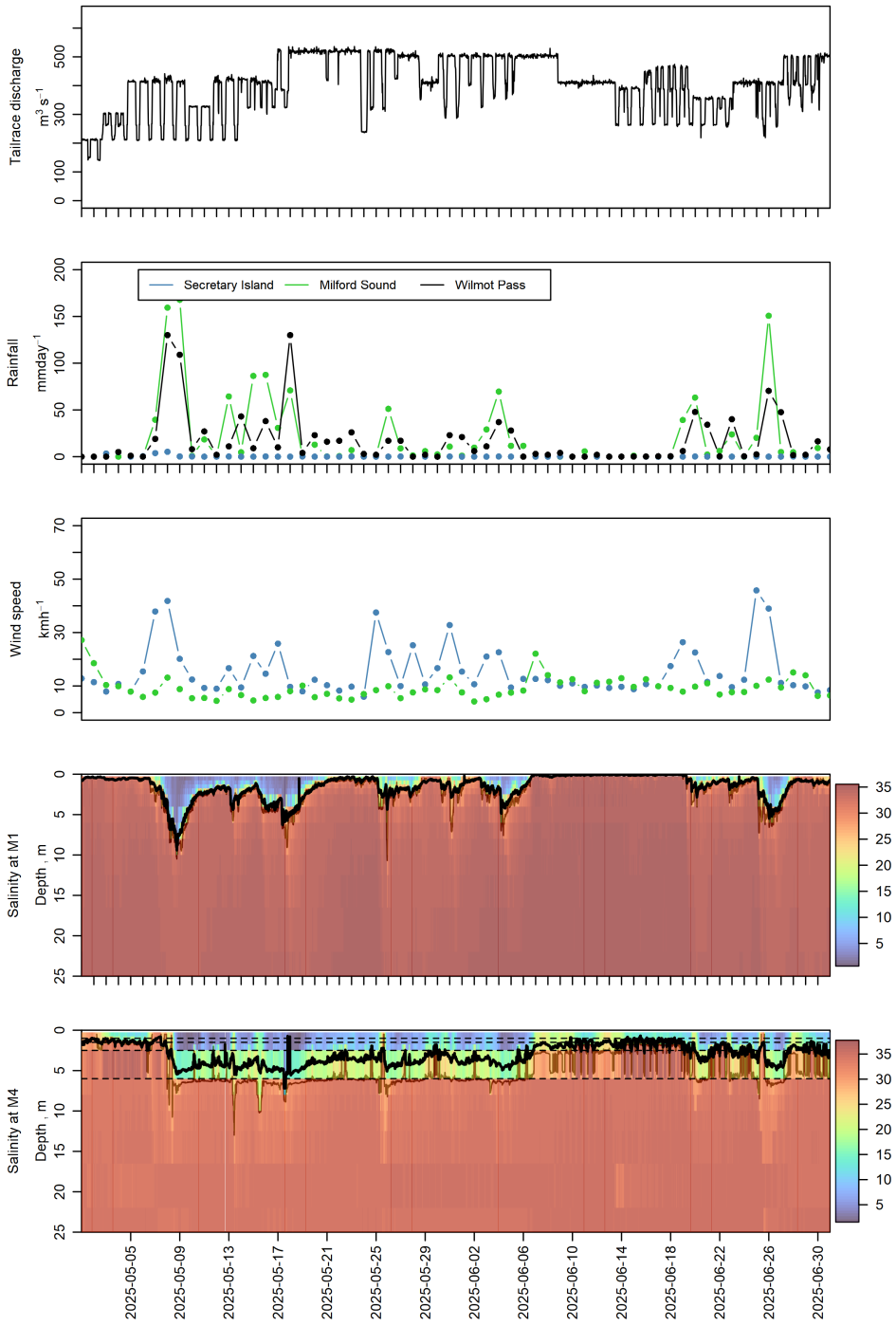


Figure 7. Examples of deepening events in May/June 2025, and details of mean daily tailrace discharge, weather conditions and salinity during the period surrounding LSL deepening events in Milford Sound (M1) and Doubtful Sound (M4). The black lines on the salinity graphs indicate the equivalent freshwater depth (EFD), and the brown line shows the 28 isohaline. White areas denote periods when data from a given sensor were not collected, and data between the dashed lines have been estimated (see Section 2.1).

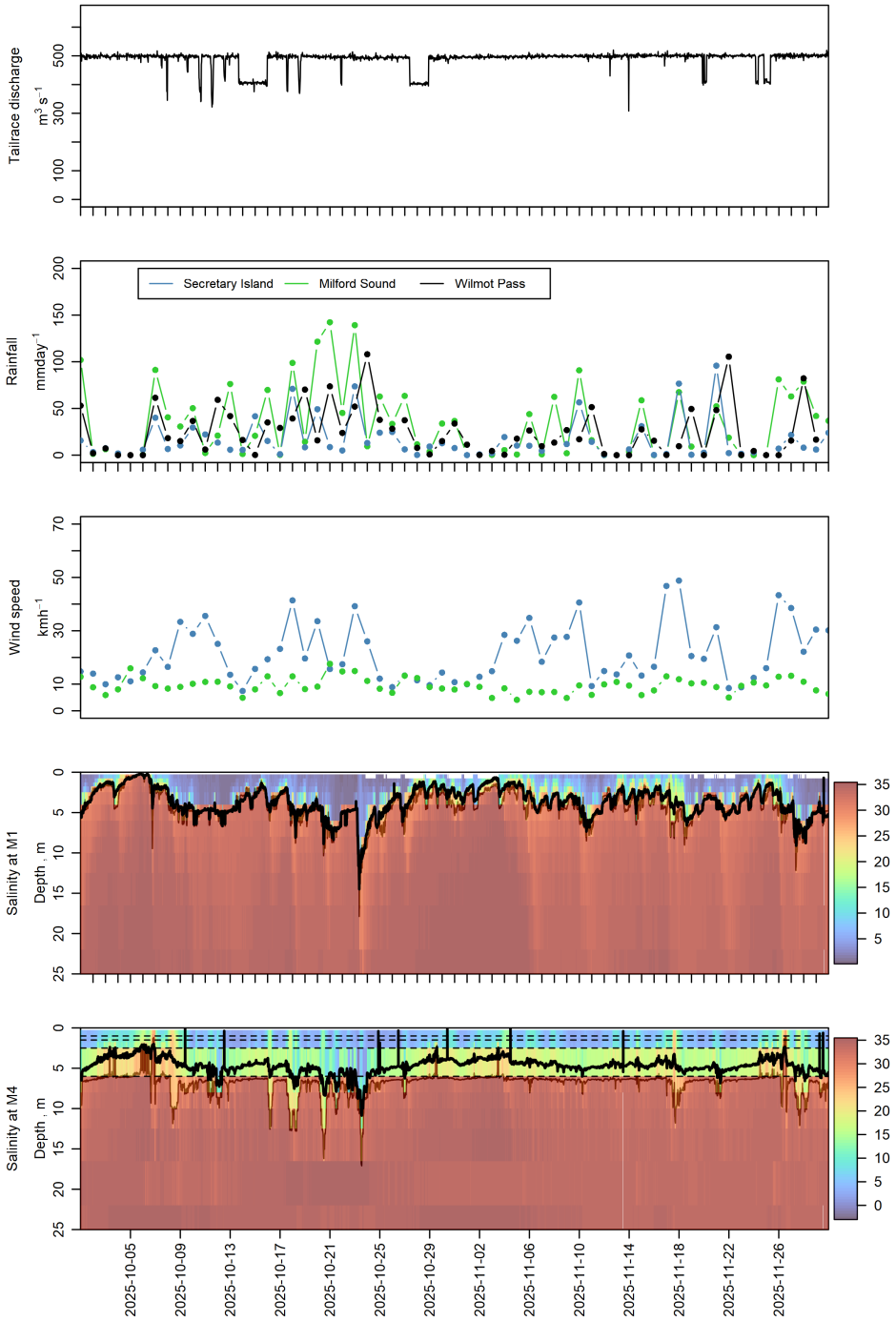


Figure 8. Examples of deepening events in October and November 2025, and mean daily tailrace discharge, weather conditions and salinity during the period surrounding LSL deepening events in Milford Sound (M1) and Doubtful Sound (M4). The black lines on the salinity graphs indicate the equivalent freshwater depth (EFD), and the grey line shows the 28 isohaline. White areas denote periods when data from a given sensor were not collected, and data between the dashed lines have been estimated (see Section 2.1).

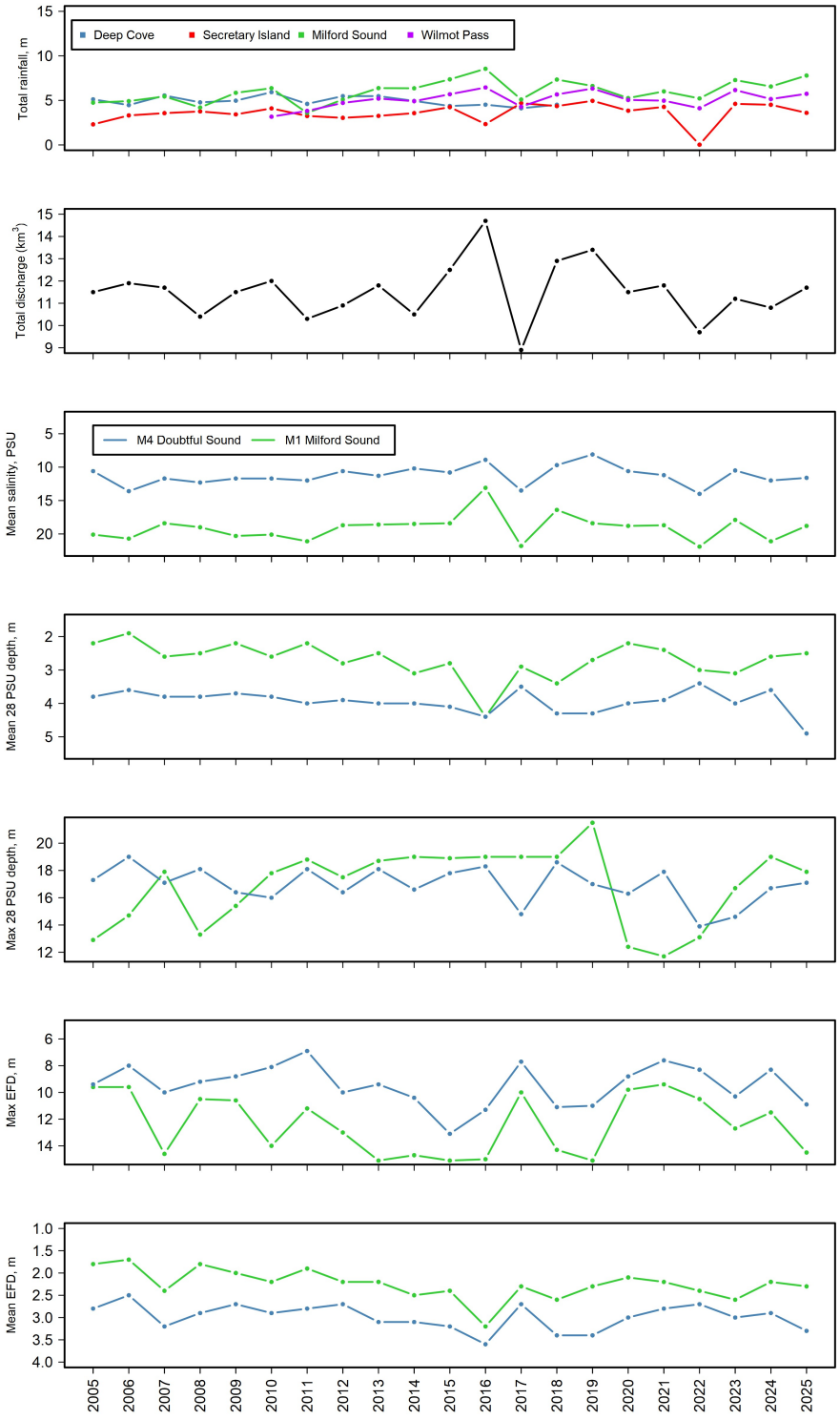


Figure 9. Summary of annual rainfall for each monitoring year (Deep Cove, Secretary Island, Milford Sound and Wilmot Pass), tailrace discharge volume, and LSL attributes at M1 and M4 (mean surface salinity, mean and maximum 28 isohaline depth and maximum equivalent freshwater depth [EFD]; Milford Sound data are green, Doubtful Sound data are blue). Note that rainfall data for Deep Cove in 2015, 2016 and 2019 are not shown because considerable amounts of data are missing for these years due to instrument failure (as described in previous reports). Rainfall data for Secretary Island in 2022 were also unavailable due to an equipment fault at the site.

Water temperature time-series at M1 and M4

Over the course of the 2025/26 monitoring year, water temperatures at M4 in Doubtful Sound and at M1 in Milford Sound showed similar patterns to those observed in previous monitoring reports. The surface waters are cooler than the underlying seawater during winter months (June to November); this is more persistent in Doubtful Sound due to the continuous tailrace discharge (Figure 10). The water column becomes less thermally stratified (more similar in temperature across depths) during the summer months. A detailed analysis of the effects of the tailrace discharge and other drivers such as rainfall and wind on surface water temperature has previously been provided in a separate technical report (Cornelisen and Goodwin 2008) and a peer-reviewed publication (Goodwin and Cornelisen 2012).

In general, patterns in minimum, mean and maximum water temperatures based on daily means across all depths and all calendar years are similar between Doubtful and Milford Sounds (Figure 11). Following a year with lower temperatures (2024/25), mean water temperatures recorded during the 2025/26 monitoring year were slightly higher and more similar to the 2022/23 and 2023/24 monitoring years, especially for the deeper depths, for both M1 and M4 locations. The occurrence of marine heatwaves in the 2022/23 and 2023/24 monitoring years led to maximum temperatures reaching approximately 2–3 °C higher than previously observed prior to 2022 (Crossett et al. 2024); however, this year's maximum temperatures at all depths for both Doubtful Sound and Milford Sound are more consistent with those recorded prior to 2022.

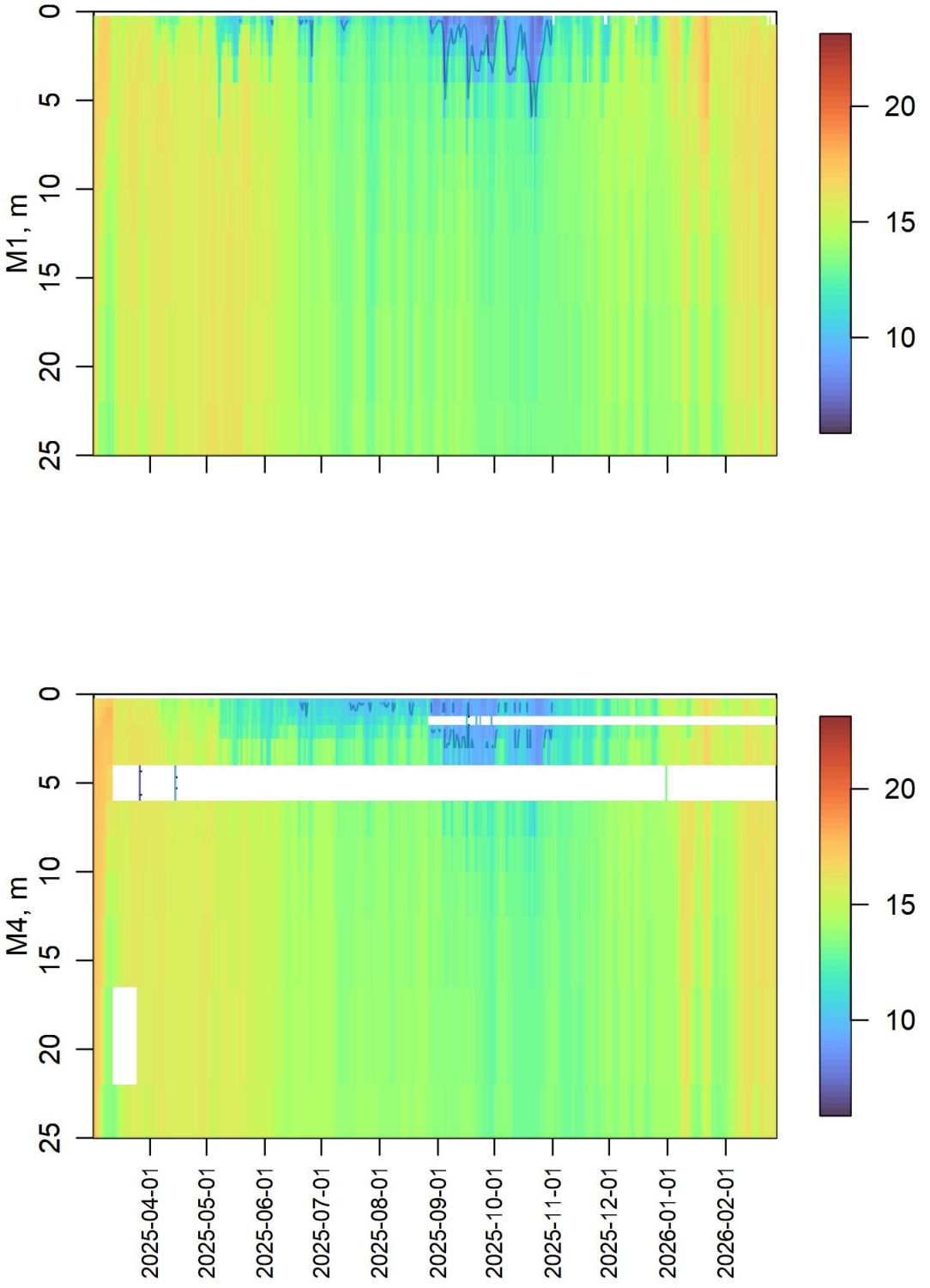


Figure 10. Water temperature profiles with depth at the M1 (Milford Sound) and M4 (Doubtful Sound) locations over the 2025/26 monitoring year. Right-hand scale = degrees Celsius. White areas denote periods when data from a given sensor were not collected (see Section 2.1).

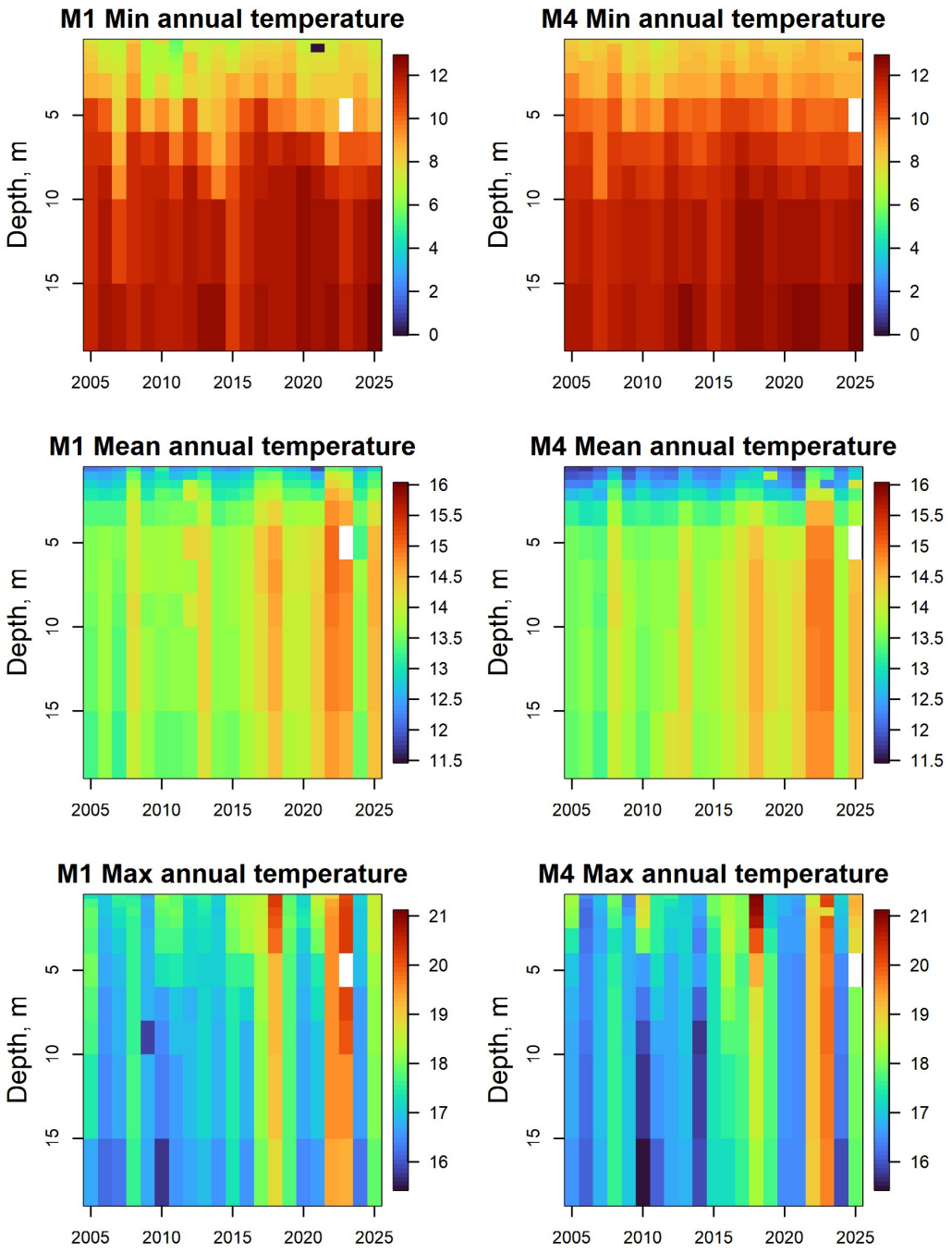


Figure 11. Annual water temperature summaries at the M1 (Milford Sound) and M4 (Doubtful Sound) locations showing minimum, mean and maximum temperatures for each calendar year across depths. Right-hand scale = degrees Celsius. Each column is a calendar year. Averages and maxima may be affected by the missing data periods described in Section 2.1. Note that some missing data have created the artefact at the 1 m depth at M4 in 2019. Additionally, since the 5 m sensor collected data only until 17:00:00 on 18 March 2023, we excluded this depth from the mean, maximum and minimum temperature calculations for the 2023 year due to the incomplete dataset, and we also excluded 5 m depth data for M4 for 2025 (as denoted by the white segment in the 2023 and 2025 columns for M1 and M4, respectively).

3. Conclusions and monitoring recommendations

The physical monitoring data and results for LSL indicators during the 2025/26 monitoring year fell within the 'normal' range observed in previous years. An exception was the mean 28 isohaline depth in Doubtful Sound, which was estimated at 4.9 m, the deepest value recorded during the monitoring programme. However, this result should be interpreted with caution as salinity values at 1.5 m, 3 m and 5 m in Doubtful Sound were estimated values.

The relationship between weather and the LSL indicators was consistent with previous monitoring years, and the disconnect between rainfall data and LSL indicators in Milford and Doubtful Sounds highlighted in 2024/25 was not observed this year. Rainfall totals were slightly above average in Milford Sound and corresponded to slightly lower surface salinity than average, while rainfall totals in Doubtful Sound were near average and corresponded to near-average surface salinity. Differences in minimum and maximum LSL values were within the range of variability previously recorded for both sounds. Overall, the 2025/26 physical monitoring found no evidence of additional physical effects on the LSL attributable to the tailrace beyond those already documented in Doubtful Sound.

Water temperatures in both Doubtful Sound and Milford Sound showed patterns consistent with previous monitoring reports. Mean temperatures during the 2025/26 monitoring year were slightly higher than those observed in 2024/25 and were broadly comparable to the warmer conditions recorded in 2021/22. However, maximum temperatures were lower than those observed during recent marine heatwave years and were more consistent with values recorded prior to 2022. However, the long-term record shows a gradual warming trend consistent with the effects of global climate change, with temperatures in recent years generally remaining higher than those observed at the beginning of the monitoring programme.

As per the monitoring programme review and varied monitoring conditions (Dunmore et al. 2015, 2018; Cornelisen and Dunmore 2020), we recommend a continuation of the current physical monitoring at the M1 and M4 locations in Milford and Doubtful Sounds. In line with the recommendations from the 2023/24 monitoring report (Crossett et al. 2024), we also recommend that the biological monitoring of the (intertidal and subtidal) core sites and intertidal transition areas next be conducted in early 2029.

The technical team is undertaking a thorough review of the factors that contributed to the data gaps. Pending the outcome of this review, additional checks and minor modifications to the buoy set-up may be implemented to help mitigate similar issues in the future. We also recommend that Meridian purchases four spare SBE 37-IMPs (two per mooring) to help ensure that a full payload of 24 sensors can be in place at all times. Ideally, these instruments would be procured prior to the March 2027 refurbishment trip.

In conclusion, the findings from the 2025/26 monitoring year are broadly consistent with previous monitoring undertaken since 2005. Long-term monitoring continues to show no detectable physical changes attributable to the operation of the MPS, including the operation of the 2MTT or increased discharge under MTAD. Continued physical monitoring, together with periodic biological monitoring (approximately every 5 years or as required), will enable the detection and assessment of any cumulative or long-term effects on the Doubtful Sound system.

4. Appendices

Appendix 1. Consent conditions

A. Coastal Permit 96019 to Discharge Water to Deep Cove, Doubtful Sound

Appendix 1 to Consent 96019
Manapouri Power Scheme Resource consents – Monitoring and Management responses

E. Doubtful Sound Marine Environment

Objectives:
To maintain ongoing information about the environmental condition (both physical and biological parameters) of the Doubtful-Thompson-Bradshaw Sounds system during the ongoing operation of the Manapouri Power Station.

To enable the identification of any long-term changes in the environmental condition (both physical and biological parameters) of the Doubtful-Thompson-Bradshaw Sounds system during the ongoing operation of the Manapouri Power Station.

Methods:

1. Each year the Consent Holder shall implement a monitoring programme in accordance with the details set out in Cawthron, Institute Report 3167, Meridian Marine Programme Review (2018 Update), 2018.
2. Following the implementation of each monitoring programme, the Consent Holder shall report to Environment Southland presenting the data collected, a summary of the results of the monitoring, and any recommendations for changes to the monitoring programme for the following year.
3. Any recommended changes to the monitoring programme shall be discussed with the Fiordland Marine Guardians and shall be approved by Environment Southland prior to its implementation in the following year.

Reference:

Dunmore et al. (2018).

B. Coastal Permit 201658 to Discharge Water to Deep Cove, Doubtful Sound

Appendix A to 201658

Monitoring Programme for Manapouri Tailrace Amended Discharge (MTAD) Coastal and Water Permits Consents 206156, 206157 and 206158

A. Deep Cove and Doubtful Sound
(i) Marine Physical and Biological

Objectives:
To maintain ongoing information about the environmental condition (both physical and biological parameters) of the Doubtful-Thompson-Bradshaw Sounds system during the ongoing operation of the Manapouri Power Station.

To enable the identification of any long-term changes in the environmental condition (both physical and biological parameters) of the Doubtful-Thompson-Bradshaw Sounds system during the ongoing operation of the Manapouri Power Station.

Methods:
1. Each year the Consent Holder shall implement a monitoring programme in accordance with the details set out in Cawthron Institute Report 3167, Meridian Marine Programme Review (2018 Update), 2018.
2. Following the implementation of each monitoring programme, the Consent Holder shall report to Environment Southland presenting the data collected, a summary of the results of the monitoring, and any recommendations for changes to the monitoring programme for the following year.
3. Any recommended changes to the monitoring programme shall be discussed with the Fiordland Marine Guardians and shall be approved by Environment Southland prior to its implementation in the following year.

Reference:

Dunmore et al. (2018).

Appendix 2. Meteorological data summary table

Table A2.1. Monitoring year meteorological summaries for Wilmot Pass (WP), Deep Cove (DC), Secretary Island (SI), University of Otago Milford Sound (OU MIL) and MetService Milford Sound (MS MIL) stations. The 'Days of data available' columns detail incomplete records due to instrument failure. Blank cells indicate that data were not collected for that site / year. The 'Mean to Date' value for DC differs from that in previous reports due to an issue found with the code for generating the table. This issue has now been resolved and the 'Mean to Date' values are correct for all locations. Wind speeds are in km/h, so they may also differ from previous reports. The monitoring year is named for the calendar year in which it starts, e.g. the 2025 monitoring year runs from 1 March 2025 to 28 February 2026.

	Days of data available					Total recorded rainfall (m)					Mean wind speed (km/h)				Percentage time wind speed > 10km/h			
Monitoring Year	WP	DC	SI	OU MIL	MS MIL	WP	DC	SI	OU MIL	MS MIL	DC	SI	OU MIL	MS MIL	DC	SI	OU MIL	MS MIL
2003		361	365	364	361		5.8	4.1	6.8	5.9	7.3	16.4	11.0	8.6	29.1	59.1	41.4	31.7
2004		319	364	365	351		4.3	3.8	5.7	4.5	6.8	16.3	10.1	8.4	26.9	57.3	38.5	32.0
2005		365	362	358	354		5.1	2.4	5.9	5.0	6.3	15.5	9.0	7.9	24.3	53.3	33.6	28.2
2006		358	358	365	364		4.5	3.4	6.1	5.1	8.0	15.2	11.3	8.8	34.6	53.9	41.1	33.4
2007		366	365	366	363		5.6	3.7	6.8	5.7	7.4	15.5	9.8	8.3	29.2	53.6	38.0	30.2
2008		362	364	365	363		4.8	4.0	5.3	4.3	6.5	16.8	10.7	8.3	25.9	58.5	41.0	30.7
2009	54	365	364	365	363	0.4	5.0	3.6	6.5	6.1	6.4	16.3	11.2	8.6	26.8	58.1	42.0	32.6
2010	336	365	364	365	363	3.2	5.9	4.3	7.5	6.7	6.0	16.9	10.4	8.3	24.3	58.5	37.0	29.6
2011	343	366	354	366	360	3.8	4.6	3.4	4.4	3.8	6.2	16.4	10.6	8.1	26.5	58.8	39.0	29.4
2012	365	365	364	232	364	4.7	5.5	3.2	4.5	5.3	5.9	16.3	11.0	8.6	24.6	57.1	42.5	29.0
2013	365	364	365	365	358	5.2	5.5	3.4	7.0	6.7	5.9	17.2	11.0	8.6	23.5	61.5	40.4	31.2
2014	365	361	365	365	363	4.9	4.9	3.7	6.6	6.6	5.4	17.6	10.8	8.6	21.7	59.9	40.6	31.7
2015	366	306	366	366	366	5.7	4.4	4.4	7.2	7.7	6.9	17.6	11.7	8.7	28.9	60.0	44.0	32.3
2016	365	290	356	267	362	6.4	4.5	2.4	5.5	8.9	5.7	17.2	10.2	8.1	22.5	59.4	37.9	28.1
2017	365	342	365	328	363	4.3	4.1	4.9	4.6	5.3	6.5	15.0	7.8	8.7	25.9	52.6	26.3	31.4
2018	353	357	361	360	364	5.7	4.5	4.5	7.1	7.6	6.3	16.5	7.8	8.8	24.1	60.0	26.6	33.0
2019	366	59	365	59	366	6.3		5.2	1.4	6.9	5.2	17.1	7.3	8.6	17.5	58.8	24.5	31.4
2020	364		350		362	5.0		4.0		5.5		17.5		8.9		59.9		34.2
2021	365		362		365	5.0		4.5		6.2		18.4		8.8		48.5		33.1
2022	366		342		350	4.2		0.0		5.2		16.4		8.8		58.1		34.2
2023	366		351		350	6.2		4.6		7.3		16.7		8.7		56.4		31.9
2024	364		360		364	5.2		4.5		6.6		15.6		8.8		56.2		33.3
Mean to Date	361	334	361	331	361	5.1	4.9	3.7	5.8	6.0	6.4	16.6	10.1	8.5	25.7	57.2	37.3	31.5
2025	338		365		365	5.7		3.6		7.8		17.2		9.1		59.9		35.8

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