Moturau and Te Ana-au (Lakes Manapōuri and Te Anau) October-November 2025 high lake levels and effects on lakeshore geomorphology



East of Upukerora River mouth, Lake Te Anau (site T23) – Top - 2020, Bottom – 2026

Prepared for

Meridian Energy Ltd

Dr Martin Single

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Shore Processes and Management Ltd

Address: 1/15a Lothian St Christchurch, New Zealand
Phone: (021) 790797 or (03) 351 4041
E-mail: beachdr@slingshot.co.nz

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Acknowledgements

Fieldwork was carried out with assistance of Nick Key from Wilderness Technical, Manapouri. Lake level and weather data was supplied by Meridian Energy Limited (Ed Stead).

Executive Summary

Major rainfall in the spring and early summer of 2025 resulted in high lake levels in Lakes Manapōuri and Te Anau. The high lake levels resulted in departures from the *Operating Guidelines for Levels of Lakes Manapouri and Te Anau* (the Guidelines) requirements set out for maximum durations in the High Operating Range.

Surveys and inspection of the beach and shoreline monitoring sites of Lakes Te Anau and Manapōuri were carried out between the 3rd and 6h January 2026. Survey sites and methods of measurement and inspection were consistent with previous five-yearly monitoring surveys and other annual inspections. All historic profiles were surveyed and photographed.

The most noticeable geomorphological effects were concentrated on north-facing shores on Lake Te Anau, and west-facing shores on Lake Manapōuri. Minor effects included gravel movement on the beaches of Lake Te Anau resulting in accretion of the crest of the beach around Patience Bay, Te Anau, and sand movement in both on- and off-shore directions on the upper foreshore of sandy beach sites on both lakes, with deposition above the limit of vegetation.

Erosion presented as a hazard adjacent to the Te Anau Yacht Club and Marakura Wharf and in Lake Manapōuri, along Frasers Beach Road. Erosion at the Te Anau Yacht Club caused about 4 m retreat of the backshore and about 1 m of the edge of the access road to the wharf. The erosion along Frasers Beach Road exacerbated old erosion scarps and caused retreat of the backshore to the road edge in a number of discrete pockets along a 200 m stretch of the shore.

Both erosion hazards required remediation of the backshore. By January 3rd 2026, rocks had been placed as a revetment alongside the wharf access road and erosion to the west of the Yacht Club building had been infilled with gravel. Erosion scallops along Frasers Beach Road had also been infilled with gravel as had a section of the beach and picnic area access road at the northern end of Frasers Beach. It is not known who carried out this work.

Along the cliff shore opposite Pearl Harbour, at the outlet from Lake Manapōuri, there was erosion of the talus sediments along sections of the base of the erosional cliff. This was most prevalent where there was no protection afforded by vegetation at the water level. Erosion of these cliffs results as a combination of terrestrial slope development processes such as overloading by vegetation and groundwater flows along with removal of material from the base of the cliff by flows of the Waiau River.

The road protection along Frasers Beach Road is likely to require further maintenance and may require bolstering with rock placed at the base of the backshore slope and/or planting of vegetation to dissipate the energy of breaking waves and swash that may occur at levels within the top part of the operating range.

The effects of the 2025 high water level event were similar in character but of a greater magnitude than after the December 2019 event due to the coincidence of high-energy waves when the lake levels were near the event maximum. The effects were similar to those observed from the long duration high level event of October/November 1988.

The effects on the shore geomorphology are not out of natural character for this level event as evidenced by erosion and depositional shore geomorphology features in the backshore around both lakes that predate the control of the lake levels.

1. Introduction

1.1 Preamble

A number of intense rainfall events during September and October 2025 resulted in high lake levels in Lakes Manapōuri and Te Anau that persisted through to late December 2025. The high levels resulted in departures from the *Operating Guidelines for Levels of Lakes Manapouri and Te Anau* (the Guidelines) maximum durations.

Table 1.1 shows the gazetted operating guidelines for the High Operating Ranges in water level including the maximum durations for specified ranges for each of the lakes.

Table 1.1 Gazetted operating guidelines for the High Operating Ranges of Lakes Manapouri and Te Anau

5. The High Operating Ranges-(1) Meridian Energy Limited shall use its best endeavours to:

(a) not exceed the maximum durations; and

(b) achieve the specified ratio in relation to the ranges of level set out in subclause (2) of this clause, where the actual interval (in days) between the Lake moving below a particular range of level and returning to within that range of level is divided by the actual duration (in days) that the Lake was originally within that range of level.

(2) Subject to subclause (3) of this clause, the High Operating Ranges are:

(a) for Lake Manapouri, above 178.6m, in accordance with the following maximum durations, minimum intervals, and specified ratios for the ranges of level set out:

Level (m)	*Maximum Duration.*	*Minimum Interval*	*Specified Ratio*
At 180.5	1	100	100.00
Above 180.4	3	100	33.33
Above 180.1	9	100	11.11
Above 179.8	22	80	3.64
Above 179.5	35	40	1.14
Above 179.2	44	40	0.91
Above 178.9	99	20	0.20
Above 178.6	119	20	0.17

(b) for Lake Te Anau, above 202.7m, in accordance with the following maximum durations, minimum intervals, and specified ratios for the ranges of levels set out:

Level (m)	*Maximum Duration.*	*Minimum Interval*	*Specified Ratio*
At 204.3	7	100	14.29
Above 204.2	10	100	10.00
Above 203.9	15	60	4.00
Above 203.6	22	30	1.36
Above 203.3	39	30	0.77
Above 203.0	65	30	0.46
Above 202.7	125	20	0.16

(3) Where the ratio derived from dividing the interval between the lake level moving below a particular range of level and returning to that range of level by the duration that the lake was in that range of level immediately prior to the interval:

(a) results in a ratio greater than or equal to the specified ratio, then the guidelines are deemed to be complied with.

(b) results in a ratio less than the specified ratio, then subject to subclause (4) of this clause, the interval occurring after a particular duration shall be added to that duration along with the duration occurring after that interval, in order to determine the duration for which the specified ratio must be achieved.

(4) The period of duration within any range of level, including accumulations as provided for in paragraph (b) of subclause (3) of this clause, shall not exceed the relevant maximum duration.

(5) The parties record that:

(a) High Operating Range guidelines were reviewed in 2001 and are based on the mean of the three extreme events during the period of natural and synthetic record from 1933 to 2000.

(b) the 1988 flood was excluded from this review because of its damaging high levels and extended duration. Extreme natural floods have occurred historically, e.g. 1988: Lake Te Anau 205.41m, Lake Manapouri 182.15m. It is accepted that guideline breaches may occur on rare occasions despite the best endeavours of the power station operator.

Table 1.2 summarises the departures from the Guidelines during this period of high lake levels. All departures were exceedances of the maximum durations in the high range bands as shown in Table 1.1.

Table 1.2 Departures from High Operating Ranges for Lakes Te Anau and Manapōuri during September - December 2025 (duration in calendar days derived from hourly lake level data supplied by Meridian Energy Ltd).

Lake Te Anau
Above 204.3m for 9 days from 23-Oct-2025 to 31-Oct-2025 - Maximum is 7 days;
Above 203.6m for 70 days from 23-Sep-2025 to 1-Dec-2025 - Maximum is 22 days;
Above 203.3m for 84 days from 19-Sep-2025 to 11-Dec-2025 - Maximum is 39 days;
Above 203.0m for 103 days from 18-Sep-2025 to 29-Dec-2025 – Maximum is 65 days.

Lake Manapouri
Above 180.5m for 6 days from 24-Oct-2025 to 29-Oct-2025 - Maximum is 1 day;
Above 180.4m for 7 days from 24-Oct-2025 to 30-Oct-2025 - Maximum is 3 days;
Above 180.1m for 12 days from 22-Oct-2025 to 2-Nov-2025 - Maximum is 9 days;
Above 179.2m for 50 days from 25-Sep-2025 to 13-Nov-2025 - Maximum is 44 days.

Meridian Energy Limited is required by its resource consents ***"to assess the effects of the lake level management regime on the beach stability of Lakes Manapouri and Te Anau***", as the operation of Manapouri Power Station is one of several factors that may affect shoreline stability. Monitoring of the physical shoreline processes of the lakes has included annual inspections and five-yearly surveys of beach profiles. The most recent survey prior to the high levels was carried out in January 2021, while the 2026 five-yearly survey was carried out in January 2026 (Single 2021 and Single 2026).

The 2025 departures from the Guidelines triggered "event-driven" monitoring as described in *Appendix 1: Manapouri Power Scheme Resource Consents - Monitoring & Management Responses* as below.:

- **2. Beach Sediments**

Objective: To assess the effects of the lake level management regime on the beach stability of lakes Manapouri and Te Anau.

Methods: Monitoring will be undertaken using the sites and transects as set out in recent monitoring report for Lakes Te Anau and Manapouri (Single, 2008). Methods of data collection and analysis are to be the same as set out in the Single, 2008, monitoring report so that the results are directly comparable. Any alterations to the sites or transects shall be discussed with the Guardians of Lakes Manapouri, Te Anau and Monowai, and shall require approval from Environment Southland prior to implementation.

Re-inspection of the sites and re-measurement of the transects at Lakes Manapouri and Te Anau undertaken by Single (2008) will occur at 5-yearly intervals, with the next monitoring being undertaken in 2016. Re- inspection of the sites and re-measurement of the transects may also occur if the lake operating guidelines have been breached ("event driven" monitoring).

For "event-driven" monitoring surveys, the number of shoreline monitoring sites and transects, and whether or not any of the transects are required to be re-measured, may vary from those required for the 5- yearly monitoring, depending on the nature and extent of the "event", as agreed with Environment Southland and following consultation by the consent holder with the Guardians of Lakes Manapouri, Te Anau and Monowai.

References:
Single, M.B. 2008, Beach changes on Lakes Manapouri and Te Anau and cliff erosion at Pearl Harbour Manapouri June 2002 – October 2006

1.2 2025 high lake level event inspection program

An initial inspection was carried out by Nick Key (Wilderness Technical) at various times between 23 October and 2 November 2025. Photographs were taken of effects around the shore of Te Anau township and along Frasers Beach on Lake Manapōuri. Nick is an experienced boat skipper working on Lakes Manapōuri and Te Anau and is familiar with the shore geomorphology assessments through working with Shore Processes and Management Ltd on past monitoring and event-driven surveys on these lakes.

A full assessment of the effects of the event, as described in *Appendix 1: Manapouri Power Scheme Resource Consents - Monitoring & Management Responses* could not be undertaken until the level of the lakes dropped sufficiently to enable an inspection and/or measurement of the shore. The 2025 event had a long duration and water levels did not drop below the high operating range until 18-December 2025 for Lake Manapōuri and 2-January 2026 for Lake Te Anau. As the five-year monitoring survey for the lakes was already programmed for early January 2026 (Single 2026), the event-driven survey and a full assessment of the effects of the event was undertaken in conjunction with the field program at the same time. This allowed for the lake levels to drop so that the foreshore and backshore could be surveyed and assessed in detail. Surveys were extended into the backshore to ensure the landward extent of effects were measured and noted. Other effects such as landslips into the lake, and changes to river and stream outlets were also assessed.

The objective of the five-yearly monitoring is to assess the condition of the shore in light of the operation of the power scheme. The methods involve recourse to the baseline information from earlier surveys and photograph records, through:

- Inspection and photography of all sites in the network, including new sites added in 2010 and 2011 as part of the MTAD baseline assessment and other sites around the lakes. This includes beach profile sites M1 to M17 on Lake Manapōuri, and T1 to T24 on Lake Te Anau, and cliff (river bank) sites PH1 to PH5 between Lake Manapōuri and Pearl Harbour;
- Comparison of inspection findings with earlier records, including photographs from the last high level event in 2020 and the last five-yearly survey in 2021; and
- Analysis of lake water level and weather data for the period since the last inspection (10^{th} to 13^{th} January 2021).

In the completed five-yearly monitoring report, Single (2026) provides a summary of observations, and assessment using survey monitoring data, of changes to the shore sediments and shoreline geomorphology since January 2021. While the five-yearly report includes changes resulting from the high-level event of September through December 2025, this report focuses on providing an assessment as to the significance of those changes to the shore geomorphology.

1.3 Basis of assessment

Measurement of the beach profile and inspection of the shoreline monitoring sites of Lakes Te Anau and Manapōuri were carried out between the 6^{th} and 9^{th} January 2026.

All beach profiles in the five-yearly monitoring program were surveyed and photographed from at least three angles from the beach, meaning that all sites were also included in the event-driven survey (i.e. the potential option of only surveying a sub-set of sites was not exercised). Other sections of the shore were photographed from the water. These included the shoreline between beach profile sites on both lakes, the shores of West Arm, North Arm and Surprise Bay on Lake Manapōuri, and sites accessible by road around the southern end of Lake Te Anau. Weather conditions were generally calm and partially overcast to clear. During the assessment the water level on Lake Te Anau dropped from 202.44 m and 201.31 m, and rose on Lake Manapōuri from 178.20 m to 178.36 m.

The beach profile measurement sites on Lake Manapōuri and Lake Te Anau are shown on Figures 1.1 and 1.2. Additional photographs were taken of the shores around major tributaries to Lake Manapōuri, and of tributaries in the southern section of Lake Te Anau.



Figure 1.1 Location of beach profile sites on Lake Manapouri. Additional shore observations and/or photographs were also made in Surprise Bay and Shallow Bay, and of the mouths of the Idrus Burn, and the river mouths of North Arm. 17



Figure 1.2 Location of beach profile sites on Lake Te Anau

The inspection party comprised Martin Single (Shore Processes and Management Ltd), Nick Key (Wilderness Technical) and field assistants. Martin and Nick are very familiar with the shores of these lakes, with Martin having carried out all of the monitoring surveys and shoreline inspections between 1988 and 2026, and Nick being in the field team for all monitoring surveys and most of the annual inspections since 2002. Recourse was also made to various reports and monitoring photographs dating back to 1988 (especially Kirk 1988 and Kirk *et al.*1989). Photographs taken in September, October and November 2025 by Nick Key also provided a useful reference of the high lake levels and wave conditions despite not being part of a formal re-survey or inspection.

Regular assessment of the shore involves consideration of the observed and measured "changes" in the profile form and shore appearance since the last inspection in January 2021. Determination of the cause of those changes is made from an examination of the total water

level record and an assessment of the range of energy in the wave environment since the last inspection.

Understanding the specific "effects" of the 2025 high water level event requires being able to identify these as being separate from other processes such as storm waves at high lake levels at a time other than the 2025 high water level event (including effects of the 2019 high water level event) and human activities such as foreshore vegetation clearance and landscaping along Frasers Beach, Lake Manapōuri, and sediment placement west of the Upukerora River mouth. This is done by assessing shore change within the context of expected variability of the shore and beaches to changes in water level and wave conditions that might have occurred pre-control.

A descriptive term is attributed to the assessment relating to the scale of measured or observed change. These terms have been applied consistently for previous assessments of change and effects on other lakes in New Zealand. The terms can be interpreted as follows:

- "None" indicates that there was either no observed or measured change, or that changes were not attributable to the high lake level event;
- "Minor" is measurable but not out of character with historically observed change;
- "Moderate" is visible change to the beach form and sediments that is quantifiable but within historically measured inter-survey change; and
- "Significant" is visible and measured change that is greater than historically measured changes to the shore type.

2. 2025 High Water Level Event

Figures 2.1 and 2.2 show the lake level plots for Lakes Te Anau and Manapōuri for the period 1st September 2025 and 28th January 2026. During the period from 0800 on 23rd to 0900 on 31st October 2025, the level of Lake Te Anau exceeded 204.3 m amsl for a total period of 8 days (Figure 2.1). The maximum lake level reached was 204.732 m, about 0.43 m above the maximum of the gazetted high range.

The level of Lake Manapōuri exceeded 180.5 m amsl for the period from 1200 on 23rd to 2200 on 29th October for a total of 6 days (Figure 2.2). The maximum lake level reached was 180.808 m, about 0.31 m above the upper limit of managed operation under the Guidelines.

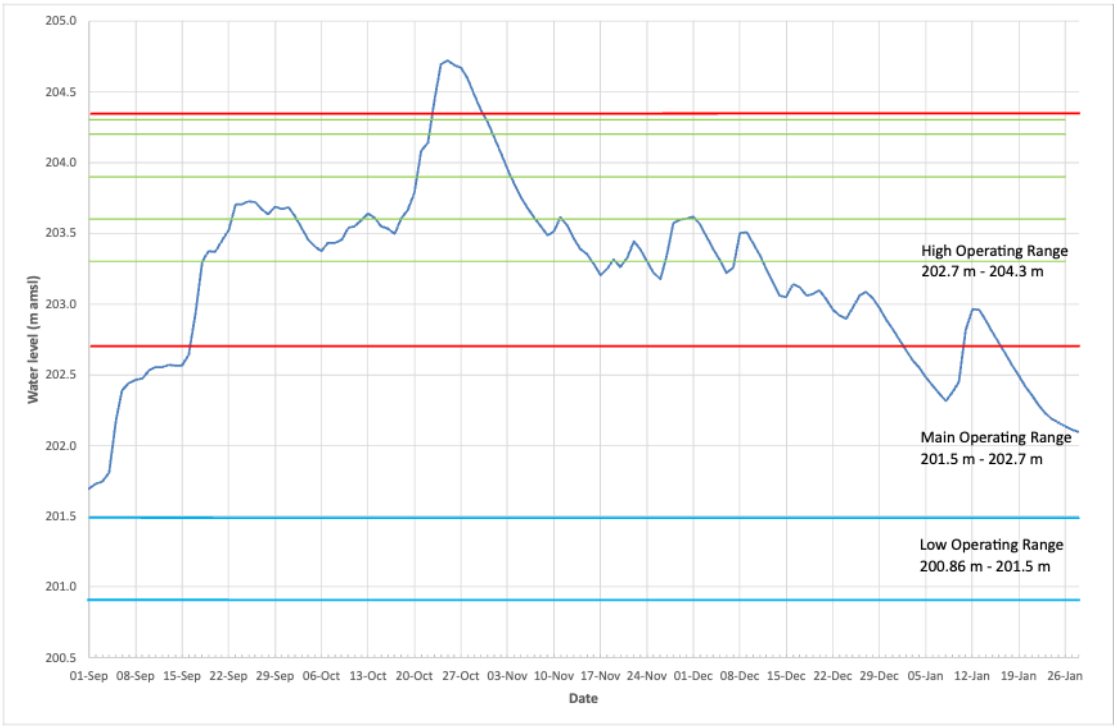


Figure 2.1 Plot of the water level for Lake Te Anau for the period 1st September 2025 to 26th January 2026 (data supplied by Meridian Energy Ltd). Blue and red lines denote the boundaries of the low, main and high operating ranges as set out in the gazetted operating guidelines. The green lines denote exceedance level boundaries.

The maximum lake levels for this event were the fifth highest recorded for Lake Te Anau since control of the lake level operating regime (Table 2.1) and the third highest on record for Lake Manapōuri. The highest event occurred in October/November 1988, with the level of Lake Te Anau above 204.3 m for a period of about 25 days, reaching a maximum of 205.11 m, and the level of Lake Manapouri above 180.5 m for a period of about 25 days, reaching a maximum of 181.54 m (Kirk *et al.* 1989).



Figure 2.2 Plot of the water level for Lake Manapouri for the period 1st September 2025 to 26th January 2026 (data supplied by Meridian Energy Ltd). Blue and red lines denote the boundaries of the low, main and high operating ranges as set out in the gazetted operating guidelines. The green lines denote duration exceedance level boundaries within the upper band as defined in the Guidelines.

The levels above the upper limit of managed operation under the Guidelines in 2025 persisted for a similar duration to the December 2019 event, but the maximum levels reached were lower than the 2019 maximum levels (Table 2.1).

Table 2.1 Comparative level and duration (rounded to nearest whole day) data for water level episodes above 204.3 m for Lake Te Anau and 180.5 m for Lake Manapōuri

Maximum lake level (m amsl)							
Lake	Oct-1928	Apr-1975	Jan-1983	**Nov-1988**	Apr-2010	Dec-2019	**Oct-2025**
Te Anau	204.81	204.79	204.67	**205.11**	204.92	204.94	**204.73**
Manapōuri	No data	180.72	180.74	**181.54**	180.53	180.92	**180.81**
Duration (days) above 204.3 m (Te Anau) and 180.5 m (Manapōuri)							
Lake	Oct-1928	Apr-1975	Jan-1983	**Nov-1988**	Apr-2010	Dec-2019	**Oct-2025**
Te Anau	9	8	13	**25**	10	9	**7**
Manapōuri	No data	7	10	**25**	2	7	**6**

With regard to effects on shore geomorphology, the maximum level of the lakes is important, as is the co-incidence of wave conditions that may result in sediment movement and alteration of the geomorphology of the beaches. The longer the lakes are at high levels, the more potential there is for wave conditions to occur over that same time period.

Figure 2.3 shows wind speeds and directions from Manapōuri Airfield for the main period of the high water level event. High-energy wind events from the west to east-northeast quarters coincided with rising lake levels from 20th to 23rd October. When the wind direction was from the northwest during those conditions, the resulting wave generation was down the long axis of Lake Te Anau, with breaking waves, high on the foreshore of north-facing beaches. On Lake Manapōuri, the westerly and northwest winds are channelled by the surrounding topography to generate waves across the lake from the west, eastward of Pomona Island. These waves expend energy in breaking on west facing shores.

The October wind and wave events resulted in high-energy waves acting on west and north-facing shorelines of both lakes. Figure 2.4 shows waves breaking onto the upper foreshore and backshore of Frasers Beach (Lake Manapōuri) on the afternoon of 23rd October (wind from the west at an hourly average wind speed of about 6.5 m/s, having died down from 11.3 m/s two hours earlier).

Figure 2.5 shows pockets of erosion on the southern shore of Lake Te Anau. These are likely to have been formed during the wind and wave event on or before 23rd October. Subsequent higher lake level between 23rd and 27th October has resulted in deposition of driftwood by less energetic waves.

At both the Frasers Beach and Te Anau Yacht Club sites, a combination of small and large waves breaking and running up to the backshore resulted in formation of erosion scarps. Subsequent waves impacted against the vertical erosion scarps resulting in erosion and retreat of the scarp face and movement of sediment lakeward. During this type of event, wave run-up across lower sloped backshores and over the top of beach ridge crests carry sediment (and flotsam such as leaves, branches and logs) up the foreshore and deposit sediment landward of the normal limit of wave action. This can also occur at higher lake levels with gentle wave action. The leading edge of the wave run-up can also cause turf vegetation[1] that has formed on fine sediment deposits sitting on underlying beach gravel, to peel and roll landward.

[1] Shoreline vegetation comprising species less than a centimetre high that form a highly diverse mat in soft sediments.

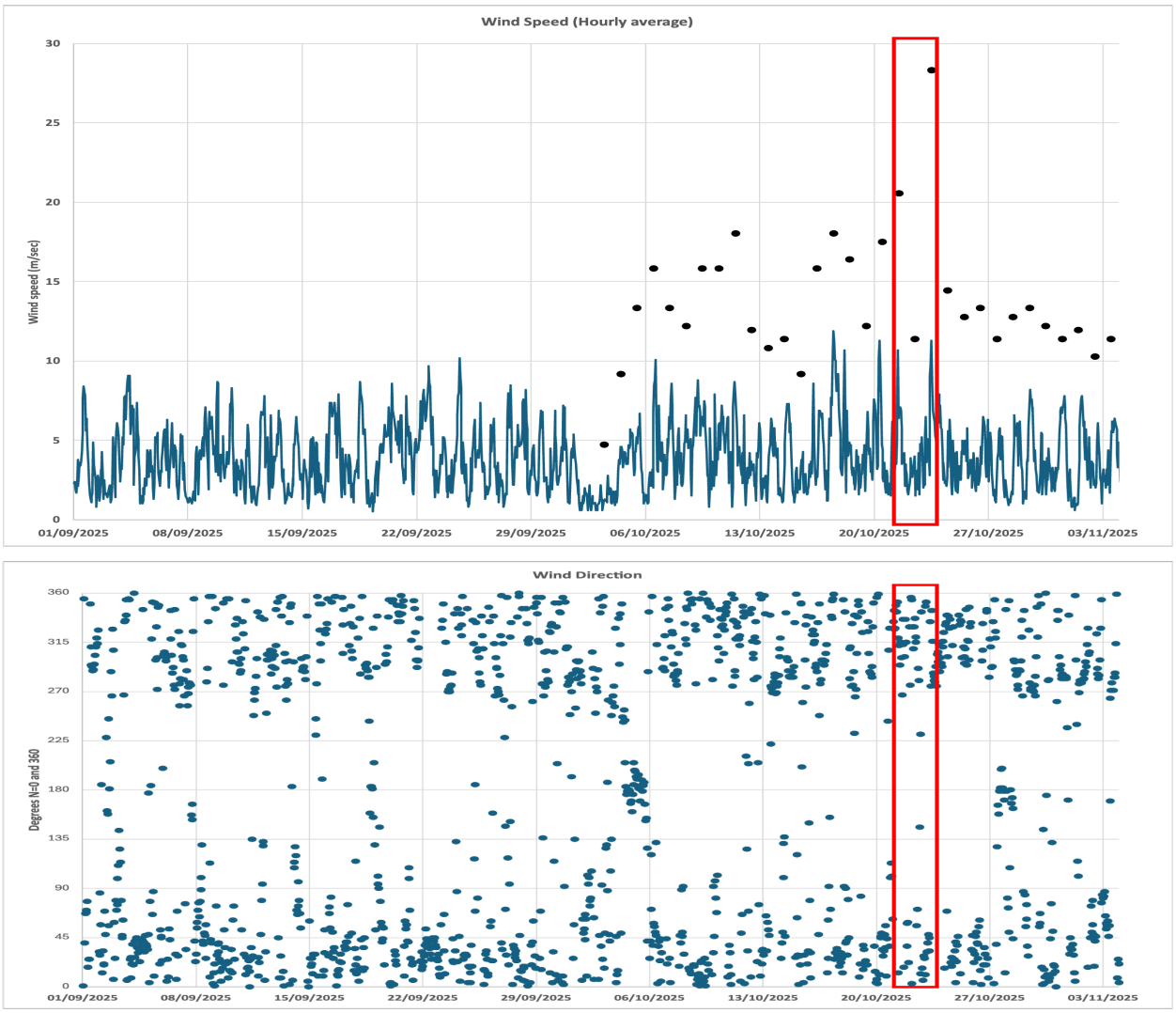


Figure 2.3 Hourly wind speed and direction data from Manapōuri Airport, September through early November 2025 (Maximum daily wind gust speed is indicated by black dots)



Figure 2.4 Waves breaking along Frasers Beach, Lake Manapōuri, 23rd October 2025 – top: southern end of the beach; bottom: picnic area near northern end of the beach (Photography: Nick Key, Wilderness Technical) (Lake level ~180.6 m)



Figure 2.5 Erosion scarps to the east (top) and west (bottom) of the Te Anau Yacht Club and Marakura Wharf (submerged), Lake Te Anau, 27th October 2025 (Photography: Nick Key, Wilderness Technical) (Lake level ~204.65 m)

Figures 2.6 and 2.7 show the water levels of Lakes Te Anau and Manapouri since the beach profile surveys in January 2021. The lake level range extended through the high, main and low operating ranges over the five-year intersurvey interval. Although the level of both lakes got to within 0.5 m of the maximum level prior to 2025, the effects on the shoreline of levels in the upper part of the high operating range (June 2023, September 2023 and September 2024)

have been obscured by wave processes during September through December 2025. However, some effects of the December 2019 high water level event are potentially visible in the geomorphology of the backshore, on shores that were sheltered from the high-energy wave events during the 2025 event.

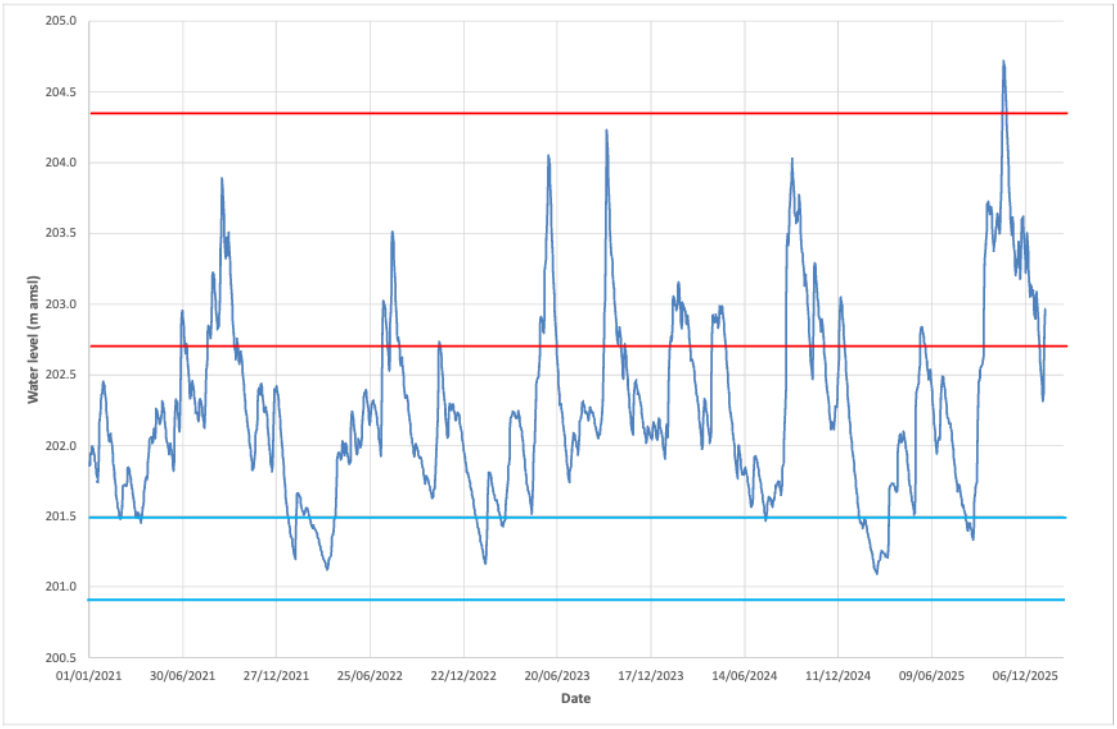


Figure 2.6 Plot of the water level for Lake Te Anau for the period 1st January 2021 to 12th January 2026 (data supplied by Meridian Energy Ltd). Blue and red lines denote the boundaries of the low, main and high operating ranges

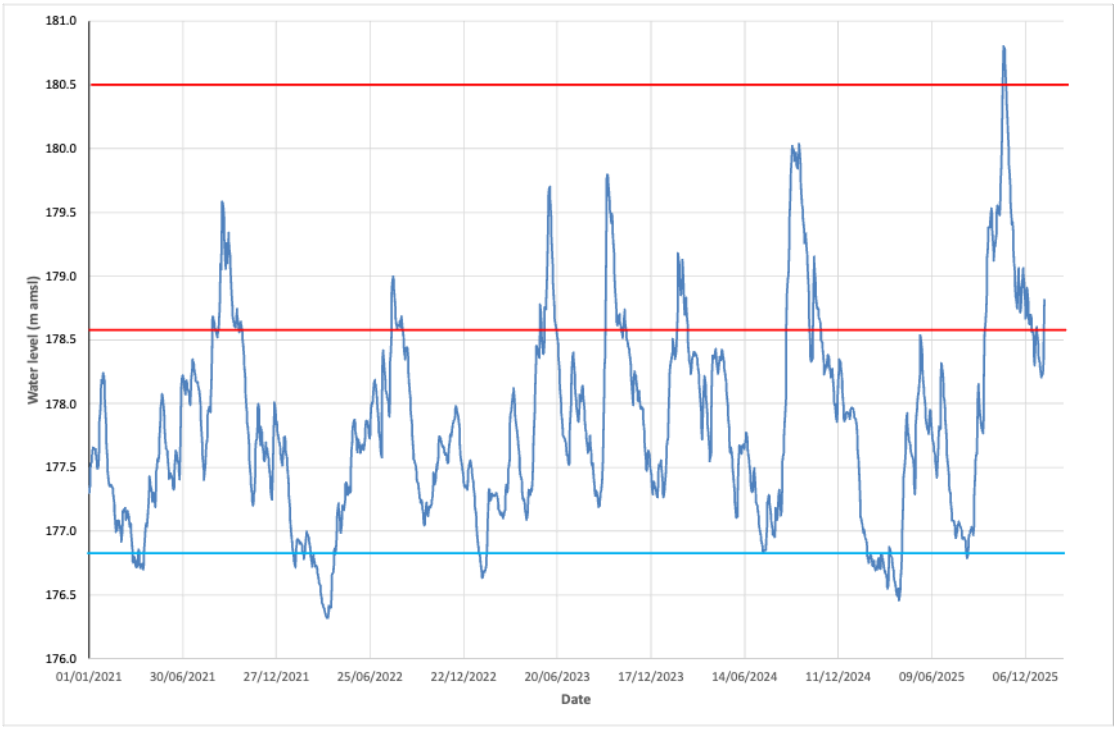


Figure 2.7 Plot of the water level for Lake Manapouri for the period 1st January 2021 to 12th January 2026 (data supplied by Meridian Energy Ltd). Blue and red lines denote the boundaries of the low, main and high operating ranges

3. Observations from the September – December 2025 event

3.1 Overview

Observed effects and assessments of magnitude of change of the high water level event were noted and are tabulated in Appendix 1 to this report. Site locations are shown in Figures 1.1 and 1.2. Appendix 2 contains photographs showing examples of many of the features described.

The complete set of diagrams of the beach profile surveys is presented in Single's (2026) five-yearly survey report which includes an analysis of changes since 2021. Profile plots that illustrate measurable change as a consequence of the high water level event are included in Appendix 4 in that report.

Generally, changes to the shore and beach geomorphology are consistent with those that occurred with the December 2019 event. Overtopping of low elevation beach ridge crests resulted in deposition of sediment onto the backshore. Beaches near sources of sediment from rivers and streams show accretion to the upper foreshore and distribution of sediment along the shore away from the sediment source (for example, at site T23). As with the December 2019 event, visual changes to the beaches were limited to those with a northerly or westerly aspect. There was less deposition of driftwood and other floating debris on the shore than from the 2019 event.

Site specific erosion of the backshore along Frasers Beach and Ruby Bay on Lake Manapōuri, and adjacent to the Te Anau Yacht Club and east of Te Anau Lake Control was a noticeable departure from the effects of the 2019 event but had also occurred after the November 1988 high water level event. This erosion presented a hazard to access along Frasers Beach Road and to the Te Anau Yacht Club building (Appendix 2, Figures 13 and 3, and Figure 2.5 above). Erosion remediation had been put in place by the time of the January 2026 inspection.

3.2 Effects on Lake Te Anau

The high water level event through September -December 2025 resulted in effects similar to those of the December 2019 event in that inundation of sheltered beaches caused little to no geomorphological change to the shores. However, shores exposed to waves from the north and west showed evidence of erosion at elevations related to water levels above the maximum operating range.

On sheltered sites, the active beach was overtopped by the elevated water level, causing changes in the amount and position of driftwood on the backshore, landward of the vegetation line and beach ridge crest. Where sand sized sediment was available, thin layers of sand were deposited above the historically active beach, indicative of swash from low-energy waves. These effects did not result in a change to the beach character or form.

At sites facing to the northern and western quarters, wave action and wind set-up meant the water reached levels higher than the lake level itself. Wave action caused sediment movement along the shore above the historically active beach along the eastern shore of Patience Bay, and overtopping of the beach crest by debris-laden wave run-up along the north-facing

shoreline between the Upukerora River and Bluegum Point. Flooding of the low-lying hinterland was evident at sites T24 and T1 (along the northern shore of Te Anau) where driftwood was deposited landward of the beach crest. The shoreline adjacent to the Te Anau Shoreline Cycleway is subject to overtopping near the Kaipo Drive ponds and the Delta Pond Reserve near Takitimu Avenue/South Arm Drive. The area near Kaipo Drive was also subject to significant overtopping in December 2019. The beach crest elevation in this area is between 203.9 to 204.3 m amsl at the lowest point, adjacent to the shore access trail from Kaipo Drive. This is the lowest section of the cycleway between the Upukerora River and Blue Gum Point. The beach crest was reconstructed after the 2019 event with gravel placed on the lakeward side of the cycleway. Deposition of sediment across the cycle way was again significant as of 3 November 2025 (Appendix 2, Figures 7 and 8). It is unclear if the origin was sediment carried by wave run-up overtopping the beach or if it was material previously placed purposefully in the area to mitigate flooding. Regardless of origin , as shown in Appendix 2, Figures 7 and 8, it is evident that wave run-up has reworked this sediment along and across the low section of the cycleway.

Sediment movement along the upper foreshore, from the north to the south, was also evident at sites T2 and T3, north of Bluegum Point. The upper foreshore was cleared of grasses, and the old erosion scarp was freshened, but the wave action did not cause further erosion to the backshore (Appendix 2, Figure 1).

The town foreshore north of the Department of Conservation site to past the Real Journeys wharf is artificial, comprising a near-vertical rock revetment. This section of shore remained stable. However, there are small areas of erosion of the grassed backshore and retreat of the low existing scarp at the landward extent of the main operating range along the shore north of Lions Park to the Te Anau Marina.

The most noticeable adverse change to the beach morphology on Lake Te Anau was erosion in discrete localities north and west of Steamer Beach (Appendix 2, Figures 2 and 3, and Figure 2.5 above). Erosion of the backshore adjacent to the Te Anau Yacht Club resulted in loss of part of the access road as the backshore scarp retreated by about 5 m. Retreat of the shore west of the building occurred in localised points, with retreat of 3 to 5 m along a 20 m section of shore. Remedial measures had been undertaken at the sites around the Yacht Club by 6th January 2026 (as shown in Appendix 2, Figure 4) to provide road access to the building and protect against further erosion.

Overwash deposits along Steamer Beach (site T7) shown in Appendix 2, Figure 5, are indicative of the elevated wave run-up to above 204.5 m during a period of high wave energy with the lake levels at about 204.3 m. Wave run-up deposited gravel sediment high on the backshore along a 130 m length of shore. The shallow turf layer was also peeled back in places. There was also deposition of sediment at the slipway east of the site shown in Appendix 2, Figure 5.

Sand movement from north to south was evident at Garden Point (sites T14 and T15) where sediment removed from site T15 was deposited at site T14. This type of transfer around Garden Point has been observed in the past and natural sand replenishment to the foreshore at site T15 has occurred historically after such events.

Deposition of sediment to high elevations on the beach at site T23 is shown in Appendix 2, Figure 6 (and report cover photos). This effect is likely to be a long-term, persistent change to the beach form as this area of the beach can only be worked on by waves when the lake is at high levels.

No noticeable effects of the high lake levels were noted for the stream and river mouths in the southern part of Lake Te Anau.

3.3 Effects on Lake Manapouri

The geomorphological effects of the high water level event on the beaches and shoreline of Lake Manapōuri were dominated by the high-energy wave event when the lake level was near the peak during 17th to 23rd October 2025. Effects were most significant along Frasers Beach (sites M16, M14 and M15) and the southern end of Ruby Bay (site M12), and included extensive erosion and retreat of the backshore, reactivating old erosion scarps.

At sites that are sheltered from waves from the north to northwest, the high water levels resulted in inundation of the backshore and movement of sediment up the beach profile to be deposited within the bush fringing the backshore. Examples of this effect for Circle Cove (site M2), at the head of Calm Bay (site M8) and at the northern end of Ruby Bay (site M10) are shown in Appendix 2, Figures 9, 10 and 11. The effects from the 2025 event were evident on top of depositional berms from the December 2019 event. Although deposition was evident across the foreshore, old erosion scarps in the backshore were also exposed and reworked, as shown for Bullins Beach (site M3) in Appendix 2, Figure 12. Stream channels have also incised into the softer deposited sediments across the foreshore as the lake level has dropped.

Sites along Fraser Beach exhibited high run-up elevations and significant geomorphological effect due to the high-energy wave action. Old erosion scarps were re-activated along the southern section of the shore (Appendix 2, Figures 13, 14 and 15), resulting in a hazard to use of the road. Infill on the eroded scarp had been carried out by January 2026 (Appendix 2, Figures 15 and 16).

Similar pockets or erosion, but with a lower backshore, occurred along the northern section of Frasers Beach (Appendix 2, Figures 17 and 18). Infill of the erosion pocket had been carried out where the erosion presented a hazard to the road.

Driftwood and other floating debris were deposited high above the beach at site M14 (Appendix 2, Figure 19), where large tussock and boulders provide some protection against erosion by dissipating wave energy.

3.4 Effects on the southern shoreline of Pearl Harbour

The effects of the high water level event were noticeable on the shoreline opposite the mooring area of Pearl Harbour. Removal of basal talus was evident where sections of the shore were not protected by vegetation. At site PH2 there was evidence of fresh erosion from the cliff face and exposure of pockets of tunnelling related terrestrial erosion processes, groundwater throughflow and removal of sediment supporting the base of the slope (Appendix 2, Figure 20). At other sites there was a combination of processes resulting in cliff erosion. These included some loss of the base talus slope plus toppling of trees from the top of the slope (Appendix 2, Figure 21).

4. Conclusions and discussion

In October and November 2025 departures occurred from the Guidelines' High Operating Range maximum durations for Lake Te Anau and Lake Manapōuri, resulting in required "Event Driven Monitoring".

The event resulted in a combination of generally small magnitude changes to the lakeshore geomorphology of both lakes on shores that are sheltered from wave action from the north and northwest, to significant erosion of the backshore at the southern end of Lake Te Anau

and along Frasers Beach and Ruby Bay on Lake Manapōuri, and erosion of the talus sediments below exposed sections of the cliff shore opposite Pearl Harbour.

Geomorphological effects were largely confined to north-facing shores on Lake Te Anau, and west-facing shores on Lake Manapōuri. Gravel movement on the beaches of Lake Te Anau resulted in accretion of the crest of the beach, while sand moved in both on- and off-shore directions on the upper foreshore, with deposition above the limit of vegetation at sandy beach sites.

Erosion presented as a hazard adjacent to the Te Anau Yacht Club and Marakura Wharf and along Frasers Beach Road. Erosion at the Te Anau Yacht Club caused about 4 m retreat of the backshore and about 1 m of the edge of the access road to the wharf. The erosion along Frasers Beach Road exacerbated old erosion scarps and caused retreat of the backshore to the road edge in a number of discrete pockets along a 200 m stretch of the shore.

Both erosion hazards required remediation of the backshore. By January 3rd 2026, rocks had been placed as a revetment alongside the wharf access road and erosion to the west of the Yacht Club building had been infilled with gravel. Erosion scallops along Frasers Beach Road had also been infilled with gravel as had a section of the beach and picnic area access road at the northern end of Frasers Beach.

The road protection along Frasers Beach Road is likely to require further maintenance and may require bolstering with rock placed at the base of the backshore slope and vegetation planted to provide additional protection to the base of the slope and to dissipate the energy of breaking waves and swash that may occur at levels within the top part of the operating range.

Overall, the effects of the 2025 high water level event were similar in character but of a greater magnitude than the effects of the December 2019 event due to the coincidence of a high-energy wave event when the lake levels were near the peak of the event maximum. The effects were similar to those observed from the precedent high level event of October/November 1988. However, the effects on the shore geomorphology are not out of character with what would be expected with the lake level and energy processes experienced as evident by erosion and depositional shore geomorphology features in the backshore around both lakes that predate the control of the lake levels.

5. References

Kirk, R.M. 1988; Single, M.B. *Beach Changes and Lake Level Operating Guidelines on Lakes Manapōuri and Te Anau, 1973-1988* Report to The Guardians of Lakes Manapōuri and Te Anau, and to Electricity Corporation of New Zealand Ltd., July 1988. 31pp

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Single, M.B. 2020 *Meridian Energy Limited Manapōuri HEP: Lakes Manapōuri and Te Anau high water level event shoreline inspection and survey – March 2020* A report to Meridian Energy Ltd. April 2020. 55pp

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6. Appendix 1 Observations from field inspection and photograph comparison of shoreline monitoring sites

The magnitude of effects relates to the scale of change in measured terms or in consideration of observed and measured changes since 1973 that could be attributed to the high lake levels of September - December 2025, where:

"None" indicates that there was either no observed or measured change, or that changes were not attributable to the high lake level event;

"Minor" is measurable but not out of character with historically observed change;

"Moderate" is visible change to the beach form and sediments that is quantifiable but within historically measured inter-survey change; and

"Significant" is visible and measured change that is greater than historically measured changes to the shore type.

Significant effects were limited to Frasers Beach on Lake Manapōuri.

Table 1a Summary of observations of the effects of high water levels on the beach and shore geomorphology for sites on the shoreline of Lake Te Anau. Sites are listed in a clockwise order starting east of the Upukerora River mouth (see Figure 1.2).

Site Name	Magnitude of Effects	Shoreline Morphology	Type of Change	Comments from Site Visit: 6th and 8th January 2026
T23	Moderate	Linear gravel barrier beach overlying cobble lag deposit	Deposition lakeward and higher than 2021 beach ridge	- large volume of deposition to higher beach crest level and build-up of berm and overwash deposits (crest 205.16 m) indicative of high wave runup - no change in beach character - wrack/driftwood over beach crest and on intermediate berm at about 204.0 m
T24	Moderate	Linear gravel barrier beach overlying cobble lag deposit	Deposition to crest Smoothing of intermediate berm at 204 m	- deposition on crest and across profile (crest 205.33 m) - crest overtopping west of site, coastal flooding into pond - sand layers and gravel on beach surface; mid and upper foreshore - secondary berm at 203.4 m (early December 2025 high level)
T1	Moderate	Linear gravel barrier beach overlying cobble lag deposit	Deposition above upper foreshore Small erosion scarp below crest of barrier beach	- minor changes to profile – no change to crest height (205.56 m) - deposition of gravel and driftwood to near crest (205.3 m) and above erosion scarp in track bund (204.8 to 205 m) - intermediate berm crest at 204.0 m - cobble movement on mid-foreshore - human activities - tractor tracks and burnt line of driftwood (also at T24)
T2	Moderate	Linear gravel beach overlying cobble lag deposit	Deposition above upper foreshore Small erosion scarp below	- minor changes to profile – no change to crest height (205.56 m) - small erosion scarp in backshore (204.8 to 205 m) - no change to beach appearance, although evidence of gravel movement alongshore across the mid and upper foreshore

Site Name	Magnitude of Effects	Shoreline Morphology	Type of Change	Comments from Site Visit: 6th and 8th January 2026
			crest of barrier beach	
T3	Minor	Linear gravel beach overlying cobble lag deposit	Alongshore movement of gravel on mid- and upper foreshore	- minor changes to profile - deposition to intermediate berm 204.1 m, and across mid to lower foreshore - no change in beach character - gravel deposited to base of old scarp
T4	Minor	Coarse sand barrier beach	Erosion from around tree roots	- no change in beach character - beach was fully inundated during high water level
T5	Moderate	Cobble lag deposit with narrow linear gravel beach	Erosion of backshore and scarp formed into slope	- erosion into backshore slope and exposure of cobbles in bank, placed after previous erosion episodes - increase in sand volume on upper foreshore
T19	Minor	Cobble lag deposit, narrow gravel upper foreshore	Minor erosion of vegetation edge	- minor change to profile - cobble movement on foreshore - sand deposition upper foreshore to 204.2 m - freshening of erosion scarp into grass edge (0.2m high)
T6	None	Artificial boulder bank, narrow gravel foreshore	None	- no change to profile or beach - evidence of gravel movement along the shore (from north) - possible movement of boulders within banked revetment
T7	None	Linear fine gravel beach	Deposition of fine gravel to upper foreshore	- minor changes to profile - fine gravel in surface sediment otherwise no change in character - gravel deposited onto backshore over old 204.2 m berm
T20	None	Sandy, gravel embayment beach	Increase in sand cover over upper foreshore	- minor change to profile - minor visible change to beach character with deposition of sand sediment
T21	Moderate	Sandy pocket beach above muddy lower foreshore	Erosion and scarp formed into backshore	- erosion across mid- foreshore (sand sediments) and lower foreshore (muddy) - erosion of backshore grassed bank, 0.3 m high scarp formed - manuka trees undermined and fallen
T8	None	Gravel beach on cobble lag deposit	Movement of cobbles and gravel across foreshore	- deposition of driftwood to grassed backshore (205.2m) - cobble and gravel movement on mid to upper foreshore - no change to character of beach

Site Name	Magnitude of Effects	Shoreline Morphology	Type of Change	Comments from Site Visit: 6th and 8th January 2026
T9	None	Coarse sandy cuspate foreland	None	- deposition on lower foreshore and nearshore shelf, deposition to nearshore slope (steep face) - no change to character of beach
T10	Minor	Sandy linear beach	Deposition of sand to upper foreshore	- deposition on upper and lower profile and lowering of mid-foreshore - no change to general sandy character
T11	Minor	Boulder stream foreshore with full sediment range in interstices	Increase in fine sediments, channel incision across beach	- lowering of all of foreshore by channel crossing the shore, no change in nearshore - wrack and driftwood high on beach - very active stream channel movement of position
T12	Minor	Narrow linear sand beach	Deposition of sand across mid- and lower foreshore	- minor retreat of backshore scarp - deposition of sand across whole profile including nearshore - many incised channels across the beach - large driftwood on upper foreshore and beyond bush line - no change to general character of shore
T13	Moderate	Sandy pocket beach	Erosion of sand from across profile	- lowering of surface across profile, especially mid-foreshore, deposition on nearshore shelf - profile is near bottom of long-term envelope of change but above 2020 post-event survey - sand deposited to 205 m elevation in bush - no change to general sandy character
T14	Minor	Sandy cuspate foreland	Deposition of sand	- deposition across all of profile - no change to sandy character, loss of bracken from upper beach
T15	Moderate	Sandy cuspate foreland	Erosion from upper foreshore	- lower surface level across profile, loss of upper foreshore berm and small scarp at bush line - deposition into bush - no change to nearshore - less sand on beach surface, more small cobbles exposed
T16	Minor	Sandy pocket beach	Deposition to upper and mid-foreshore	- deposition across all of profile - no change in sediment character - sand deposit beyond bush line - stream incised across beach
T17	Moderate	Linear gravel beach	Lowering of beach surface	- lowering to upper and lower foreshore surface - no change to character of beach although more sand present on surface of upper foreshore
T18	Minor	Linear gravel beach	Loss of gravel from beach surface	- lowing of beach surface across profile similar to 2020 survey - sand lenses on surface of upper foreshore

Site Name	Magnitude of Effects	Shoreline Morphology	Type of Change	Comments from Site Visit: 6th and 8th January 2026
T22	Minor	Linear gravel barrier beach overlying cobble lag deposit	Deposition of gravel across all of foreshore	- deposition across upper foreshore and to beach ridge - no change to character of beach - more sand present on surface - driftwood and wrack floated to upper beach

Table 1b Summary of observations of the effects of high water levels on the beach and shore geomorphology for sites on the shoreline of Lake Manapouri. Sites are listed in a clockwise order starting from Pearl Harbour/Waiau River (see Figure 1.1)

Site Name	Magnitude of Effects	Shoreline Morphology	Type of Change	Comments from Site Visit: 7th and 9th January 2026
Surprise Bay	None	Damsite formation, turf and rock outcrops	No visible effect on geomorphology	- no change to shore character
M1	Minor	Sandy bayhead beach	Deposition of sand	- deposition on mid-foreshore and onto the backshore, small berm at 180.9 m - lowering of surface of lower foreshore - no change to character of beach - wrack deposition landward of the Bench Mark
M2	Minor	Sandy bayhead beach	Deposition of sand	- lowering of beach surface across lower foreshore - no change to beach character - wrack and sand deposited to 181.2 m and beyond bush line
M3	Moderate	Narrow sandy beach	Deposition across foreshore	- freshening of old erosion scarp - wrack removed from foreshore - some pushed beyond old landward erosion scarp - deposition of sand across foreshore to lower foreshore
M4	Minor	Sandy bayhead beach	Erosion of lower foreshore, sand deposition above mid-foreshore	- lowered beach surface lower foreshore, deposition upper foreshore to 180.6 m - wrack pushed landward and/or removed from beach - sand pushed landward
M5	Minor	Sandy bayhead beach	Lowering of lower foreshore	- minor changes to profile - deposition to 180.3 m - incised stream channel moved laterally along the foreshore - very little volume of driftwood present on foreshore
M6	None	Narrow linear gravel beach	none	- minor movement of fine gravel on foreshore - sheltered from waves, so inundation only
South Arm	None	River fan, vegetated	None	- no change to character of shore
M7	Minor	Linear sandy beach	Deposition of sand to backshore	- fallen tree has rotted, nearly gone from the beach - sand cover on lower foreshore over boulders - fresh sand to upper foreshore to 180.8 m
North Arm	Minor	River fans and incised channels upstream of mouth	Erosion of high river banks	- no change in character since 2021 - continued erosion to true left bank of the Awe Burn associated with fluvial processes rather than lake level

Site Name	Magnitude of Effects	Shoreline Morphology	Type of Change	Comments from Site Visit: 7th and 9th January 2026
M8	Moderate	Gravel barrier beach near stream mouth	Deposition of sandy gravel berm	- deposition to upper foreshore, back shore overwash and lower foreshore - berm built to 178.7 m unlikely to be a result of high lake level event - deposition on upper beach appears to be gravel and coarse sand, similar to 2021
M9	None	Damsite formation	None	- minor change to profile - no change in visual character
Idris Burn	None	Large river mouth with barrier beaches	None	- no obvious visual effect to geomorphology and no change to character
M17	Minor	Linear sandy gravel beach	Movement of sand up the profile	- accretion berm at limit of wave run-up 181.8 m - lowering of beach profile surface, no change in nearshore - no change in beach character - large driftwood to top of beach
Upper Waiau R Mouth	None	Wide river mouth with delta deposits	No visible change	- potential extension of shoaling at mouth and submarine delta extent as seen after 2019 event
M10	Minor	Linear gravel beach	Deposition to foreshore	- deposition to upper and lower foreshore - no change to beach character - bands of sand and gravel - gravel pushed landward of grass to bush line to 181.25 m
M11	Moderate	Linear gravel and cobble beach	Erosion from around tree roots	- minor accretional change to beach profile to 181.1 m - no change to beach character - wrack to old low scarp near bush line - gravel landward of 2020 survey limit
M12	Moderate	Linear sand, gravel and cobble beach	Erosion from around tree roots	- accreted beach surface across profile, no change in nearshore - no retreat of backshore scarp - cobbles with narrow gravel lenses make up surface sediments - gravel deposited landward of 2020 survey to 181.2 m
M16	Significant	Linear sandy beach	Erosion of grassed edge of backshore	- extensive erosion scarp (200-300 mm high) at edge of grass at discrete points along 200 m of shore - reworking and retreat of old erosion scarps from 2019 - deposition on foreshore, possible lowering of nearshore shelf surface - no change to general character of beach or surface sediments
M14	Significant	Boulder and gravel, tussocks at waterline	Overwash into vegetation, lowering of foreshore	- deposition of gravel and wrack through limit of historical events (181.3 m elevation, 10m landward of Bench Mark) - minor deposition on backshore - erosion of mid-and lower foreshore of sand built up between 2020 and 2021 surveys

Site Name	Magnitude of Effects	Shoreline Morphology	Type of Change	Comments from Site Visit: 7th and 9th January 2026
				- no significant change to beach character
M15	Significant	Linear sandy gravel beach	Erosion from profile and backshore to north	- lowering of beach surface across profile to lower foreshore - run up to grass bank in backshore and erosion scarps at discrete point along 250 m of shore to north of profile - hazard to road edge, retreat of bank by up to 2 m at sites activated during 2019 event - no change to beach character

Table 1c Summary of observations of changes to the beach and shore geomorphology, and the effects of high water levels for sites on the shoreline of Pearl Harbour. Sites are listed from Lake Manapouri downstream

Site Name	Magnitude of Effects	Shoreline Morphology	Type of Change	Comments from Site Visit: 9th January 2026
PH1	Moderate	Eroded river bank, cliff with steep shore	Erosion of base of talus slope	- erosion of base of cliff and removal of old slope debris/talus - sparse amounts of driftwood/logs at base of cliff trees toppled from cliff top since 2021
PH2	Minor	Eroded river bank, collapsing cliff, sandy shore sediments, vegetated shore	Erosion of talus slope	- overhanging cliff top - more undercut of root mat some collapse since 2021 - erosion and clearance of old talus debris - exposure of internal collapse of cliff face “tunnel”
PH3	None	Eroded river bank, vegetated base of cliff and shore	None	- no visible change to shore, foreshore protected by vegetation - possible cliff erosion from slope processes, ground water throughflow and overflow
PH4	Minor	Eroded river bank, vegetated base of cliff and shore	Clearing of talus slope	- no change to cliff top - minor removal of talus debris at base of cliff, patchily protected by vegetation
PH5	Minor	Eroded river bank, vegetated shore with narrow steep beach	Erosion of base of talus slope	- no change to cliff top - minor removal of talus debris at base of cliff, where not protected by vegetation

7. Appendix 2 Examples of effects



Figure 1 Shore adjacent to the Te Anau Marina, north of Bluegum Point (Photography: Nick Key, Wilderness Technical, 6th November 2025 lake level ~203.75m)



Figure 2 Scalloped erosion between areas of tussock north of the Department of Conservation site on the southern shore of Lake Te Anau (2nd January 2026, lake level ~ 202.6 m)



Figure 3 Erosion of the backshore and access road to the Te Anau Yacht Club and Marakura Wharf on the southern shore of Lake Te Anau (Photography: Nick Key, Wilderness Technical, 6th November 2025 lake level ~203.75m)



Figure 4 Remediation of erosion at the Te Anau Yacht Club (for comparison with Figure 2.5 in main text and Figure 3 above) (5th January 2026, lake level ~ 202.46 m)



Figure 5 Washover deposit of driftwood and gravel at Steamer Beach, Lake Te Anau (Photography: Nick Key, Wilderness Technical, 6th November 2025 lake level ~203.75m)



Figure 6 Gravel deposit across and higher than the 2021 beach crest at site T23, east of the Upukerora River mouth (5th January 2026, lake level ~202.48 m)



Figure 7 Sediment deposition and flooding across the Te Anau Shoreline Cycleway adjacent to Kaipo Dr (Photography: Nick Key, Wilderness Technical, 6th November 2025, lake level ~203.75m)



Figure 8 Detail of sediment deposition adjacent to the Te Anau Shoreline Cycleway (5th January 2026, lake level ~202.48 m)



Figure 9 Overwash deposit of sand and driftwood at Circle Cove (site M2), Lake Manapouri (4th January 2026, lake level ~178.25 m)



Figure 10 Overwash deposit of fine gravel at Calm Bay (site M8), Lake Manapouri (4th January 2026, lake level ~178.25 m)



Figure 11 Overwash deposit of gravel and driftwood at Ruby Bay (site M10), Lake Manapouri (4th January 2026, lake level ~178.25 m)



Figure 12 Exposed old erosion scarp, recent sand deposits across the foreshore and incised stream channel at Bullins Beach (site M3), Lake Manapouri (4th January 2026, lake level ~178.25 m)



Figure 13 Erosion scarp southern end of Frasers Beach Road, north of site M15, Lake Manapouri, (Photography: Nick Key, Wilderness Technical, 6th November 2025 lake level ~179.75m) – Note two trees near green box on side of the road referred to in following figures.



Figure 14 Erosion scarp north of M15, Frasers Beach, Lake Manapouri, March 2020 – tree is rightmost tree in Figure 13 above



Figure 15 Erosion scarp north of M15, Frasers Beach, Lake Manapouri, January 2026, showing infill of erosion scarp since November 2025 – trees are those noted in Figure 13 above

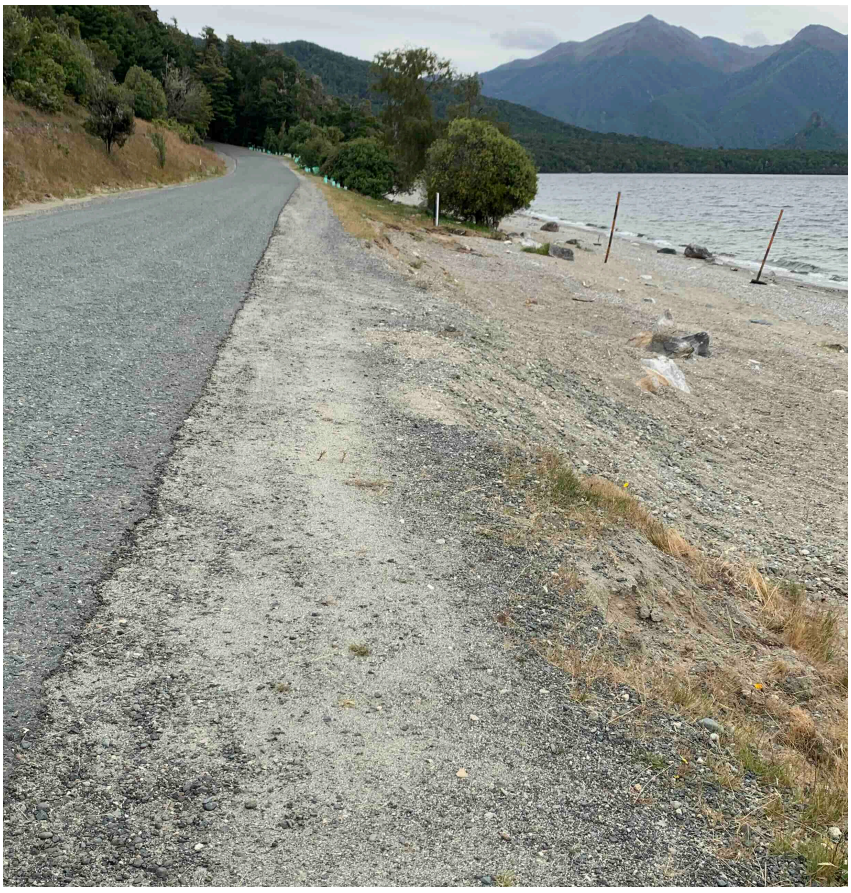


Figure 16 Erosion scarp north of M15, Frasers Beach, Lake Manapouri, January 2026, showing infill of erosion scarp since November 2025 – area is to the right of trees noted in Figure 13 above



Figure 17 Picnic area along northern stretch of Frasers Beach Road (Photography: Nick Key, Wilderness Technical, 6th November 2025 lake level ~179.75m)



Figure 18 Picnic area along northern stretch of Frasers Beach Road, 6th January 2026 – note the erosion through the road beside the far picnic bench evident in Figure 17 has been filled



Figure 19 Backshore at site M14 showing inundation deposition of driftwood and other floating debris during high lake levels.



Figure 20 Exposed cliff, showing overhanging trees and tunnel erosion of talus from base of cliff near site PH5, opposite Pearl Harbour, 5th January 2026, lake level ~178.2 m



Figure 21 Exposed cliff, fallen trees and erosion of talus from base of cliff near site PH5, opposite Pearl Harbour, 5th January 2026, lake level ~178.2 m