Hydrology Assessment Mimihau Stream Catchment

Contact Energy Limited

RILEY

Hydrology Assessment
Mimihau Stream Catchment

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1.0 Introduction

Contact Energy's proposed Southland Wind Farm development is located in the upper Mimihau Stream catchment. During wind farm construction there will be a water requirement for earthworks, concrete batching, and dust suppression.

This report assesses the hydrology at selected locations within the catchment to determine the suitability of these locations to meet the wind farm construction water demands.

The hydrological analysis undertaken includes:

- The determination of a long-term flow record in the lower Mimihau Stream catchment at Stewarts Bridge (see Figure 1).
- Establish a relationship between the flow at Stewarts Bridges and the identified locations in the upper Mimihau Stream catchment where wind farm water demands could be met.
- Produce synthetic flow records at these locations.
- Assess the wind farm water demands during low flow conditions.

The Southland Regional Council (SRC) requirements around water allocation is summarised from information provided by planning consultancy Mitchell Daysh.

2.0 Background

2.1 Location

The proposed Southland Wind Farm will be located in the upper part of the Mimihau Stream catchment, Southland District. The lower part of this wind farm development is 13km east of Wyndham, the upper location spreading a further 10km east (Figure 1 and Appendix A: Figure A-2). The 228km^2 Mimihau Stream catchment is a tributary of the Mataura River. At the confluence with the Mataura River, just north of the town of Wyndham, the Mataura River catchment area is 4,626km^2.

2.2 Land-Use and Geology

The lower part of proposed wind farm catchment is used for pastoral farming, with exotic forestry and regenerating native bush comprising most of the remaining catchment. The proposed wind farm is located predominantly in the Mimihau Stream catchment, with a small portion located in the catchment (Figure 1). A prominent escarpment at 600m-700m elevation is the main divide between the two catchments, with peaks to 658m (the Cairn) and 713m (Mokoreta).

The Mimihau Stream has two main branches - the *Mimihau Stream South Branch* and the *Mimihau Stream North Branch*. These flow in a general easterly direction, with the tributaries to these streams, draining in a northerly direction. These tributaries are small, and the landform is characterised by series of ridges and gullies gently sloping to the north.

The geology and soils of the catchment is typically "variably weathered sandstone bedrock, covered with a variable depth of wind-blown (loess) and slope wash (colluvial) deposits. Ground conditions variable laterally and vertically across the catchment (Riley, 2023a). The ground profile consists of variable sequences of near-surface 'unconsolidated soils' underlain by more weathered 'lower-strength' bedrock. These units are underlain by less-weathered 'higher-strength' bedrock (also referred to as 'blue-rock'). Two ground sequences differentiated include a 'deep mantle' and a 'shallow mantle'. The 'deep mantle' has a cumulative thickness of soils and 'lower-strength' to generally over 6m depth. The 'shallow mantle' combined thickness is approximately 1m to 2m and locally up to 4m.

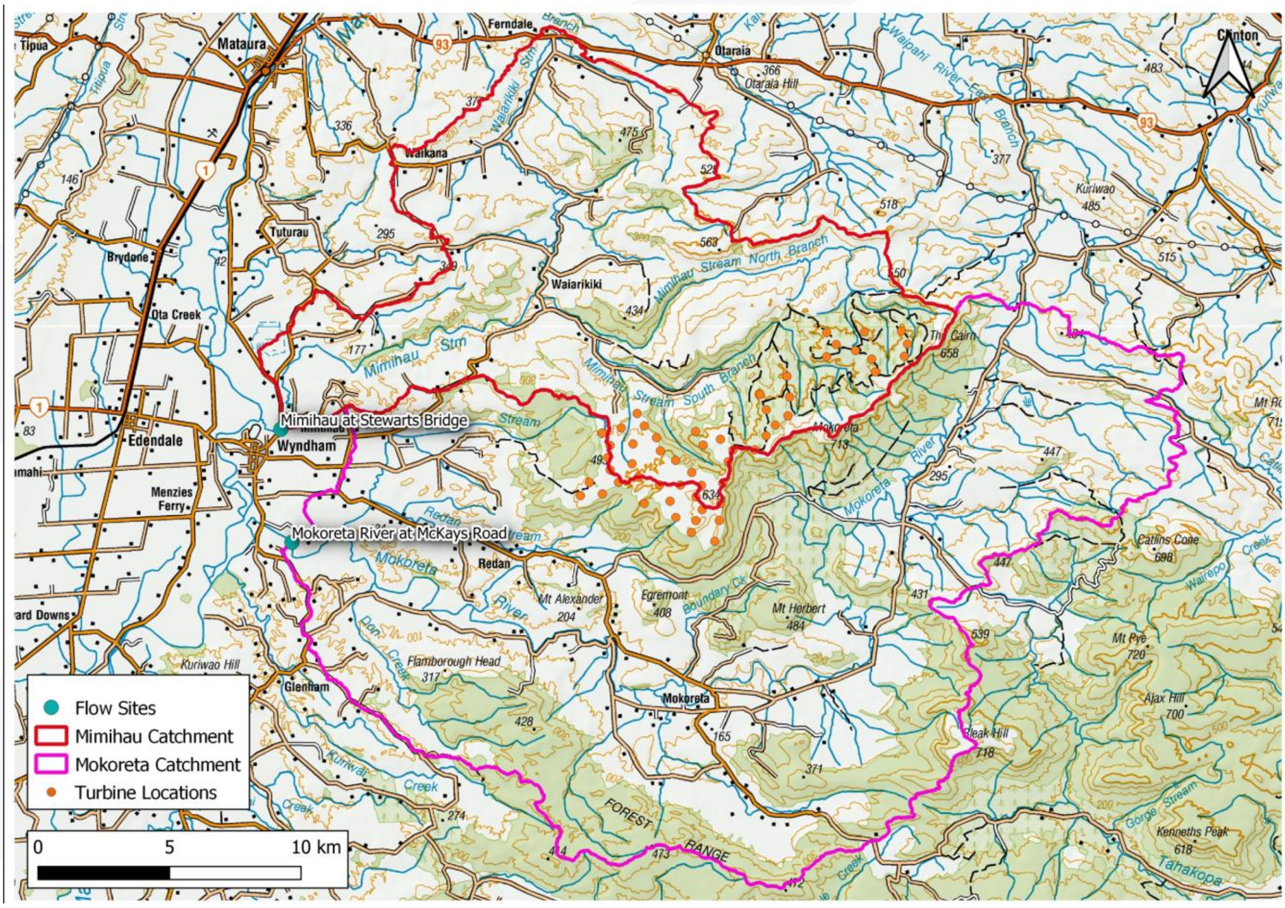

Figure 1: Mimihau and Mokoreta catchments and proposed wind-turbine locations

2.3 Climate

The dominant wind direction for Invercargill is from the westerly quarter, and for Gore from a westerly quarter and NE direction (Macara, 2013). June and July are the coldest months and January and February the warmest. Gore receives maximum rainfall over the summer (30% of annual average) and minimum rainfall in winter (20% of average) with an average annual rainfall of 945mm for the period 1981 to 2010.

Rainfall data provided by Southland Regional Council for three locations near the Mimihau catchment (Appendix A: Figure A-2) recorded an average annual rainfall of 981 to 1191mm (Table 3). The Mean Annual Rainfall (MAR) for the Mimihau catchment to Stewarts Bridge is 1199mm and for Mokoreta catchment to McKays is 1315mm (Figure 2). There is a north-west to south-east rainfall gradient across both catchments, with annual rainfall ranging from 1100mm in the north-west to 1400mm in the south-east.

3.0 Available Hydrologic Data

Flow and rainfall time-series along with gauging data were obtained from Southland Regional Council (SRC) and NIWA. The location of SRC monitoring locations are identified in Appendix A: Figure A-2 and site details are summarised in Table 1 to Table 3.

Several same day gaugings have been undertaken in the catchment (Appendix A, Table A-1). These were reviewed when assessing flow yield across the catchment. Most of Mimihau catchment gaugings are at the lower stream location of Mimihau at Stewarts Bridge (same site as Mimihau at Wyndham) (Table 2).

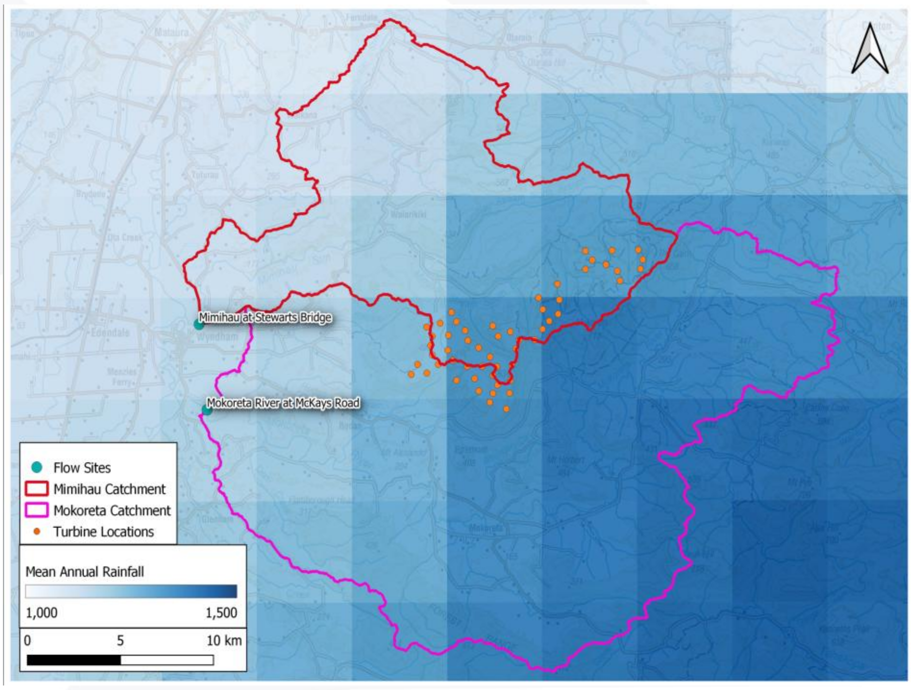

Figure 2: Mean Annual Rainfall map for the Mimihau and Mokoreta catchments. Source: MfE (2016)

Table 1: Available Flow Time-Series

Station ID	Site Name	Catchment Area (km²)	Record Period	Source
77524	Mimihau at Stewarts Bridge	225	22 Dec 1975 to 23 May 1978	SRC
77526	Mokoreta at Crescent Bridge *(renamed from Wyndham Stream at Glenham Bridge)*	370	24 Dec 1974 to 13 Jul 1981	SRC
77527	Mokoreta at McKays Road	418	20 Mar 1981 to 2023 *(replaces site 77526)*	SRC
77523	Waikaka Stream at Willowbank Bridge	288	25 Feb 1975 to 2 Aug 1983	SRC
77528	Waikaka Stream at Willowbank	318	22 May 1983 to 4 Feb 2020 *(replaces site 77523)*	SRC
77518	Mataura at Mataura Island Bridge	5074	5 Oct 1973 to 17 Jun 1980	NIWA
77519	Mataura at Seawards Downs	5109	19 Jun 1980 to 2023 *(replaces site 77518)*	SRC

Table 2: Mimihau Stream Gaugings (Source: SRC)

Location	Catchment Area (km²)	No. of Gaugings
Mimihau South Branch at Venlaw Road	12.3	6
Mimihau Stream Tributary at Venlaw Forest	4.5	2
Mimihau Stream at Venlaw Station	90.5	4
Mimihau Stream at Waiarikiki Bridge	95.2	6
Mimihau Stream at White Bridge	221.5	1
Mimihau Stream at Wyndham (Stewarts Bridge)	225 (222.5/227)	49

Table 3: Monthly Rainfall Time-Series (Source: SRC)

Name	Record Period	Annual Rainfall (2012 to 2021)
Mokoreta at Mt Alexander	Jan 2012 to Dec 2021	1191mm
Edendale at Coal Pit Road	Jan 2012 to Dec 2021	981mm
Ferndale at Waddle Road	Jan 2012 to Dec 2021	1009mm

Analysis of the Mimihau at Stewarts Bridge flow time-series identified a period of erroneous record from mid-January 1978, where the derived flow record was considerably lower than the same day gaugings (Figure 3). It is most likely the digitised level record is in error and so the level series was adjusted, and a new flow record determined (also presented in Figure 3). This resulted in the minimum flow over this period that was slightly lower than gauged on the 26 April 1978. The 26 April 1978 gauged flow was 841L/s (compared to 148L/s from the unadjusted flow record). This low flow from the unadjusted Mimihau record of 148L/s, is in error.

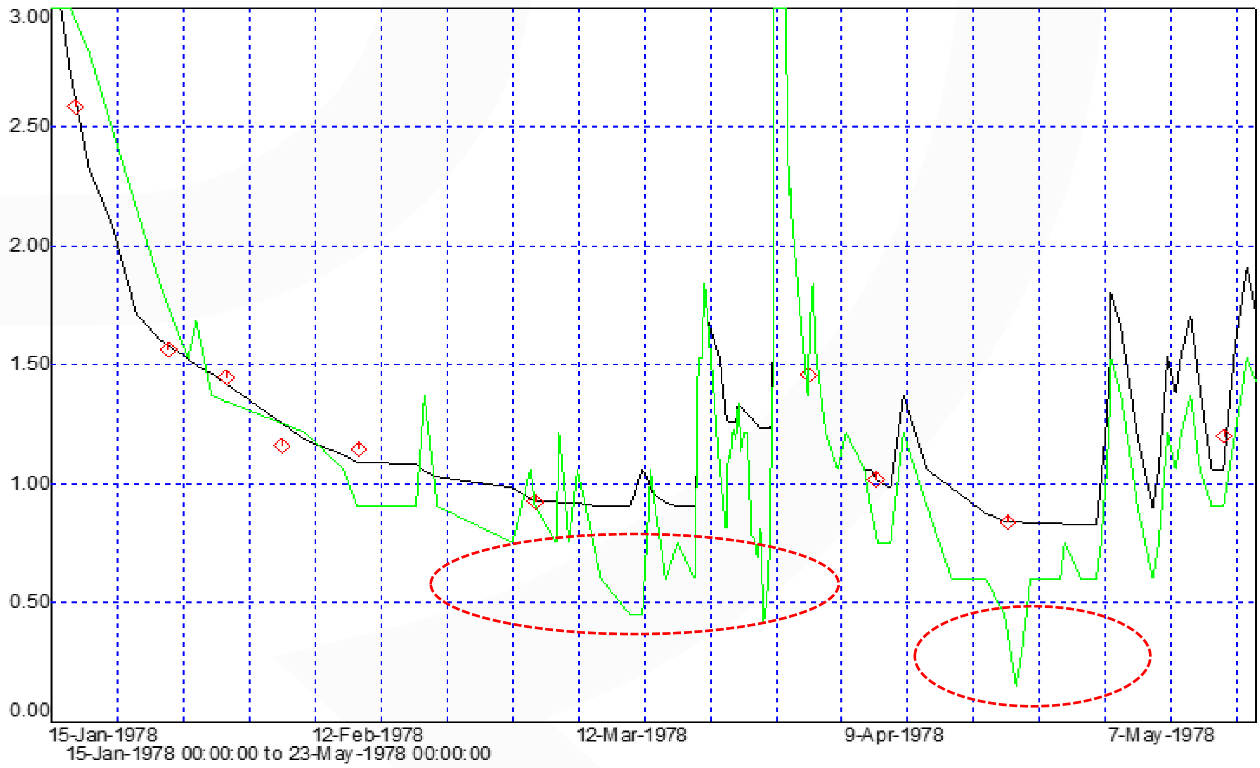

Figure 3: Mimihau at Stewarts Bridge gauged flow (red diamonds), unadjusted flow (green) and adjusted flow (black trace). Flow in m³/s. Hashed area outlines the unadjusted erroneous flow data.

A similar assessment on the Mokoreta at Crescent Bridge gauged and recorded flow, indicated that for the January to May 1978 period the measured record was typically higher than that gauged (Figure 4 and Appendix A: Figure A-1). This 1978 period has the lowest flow over the 1975 to 1978 overlapping record for both the Mimihau and Mokoreta Streams. The relationship between the two series will influence low flow periods derived for the synthetic record from 1978 to 1981. Instead of adjusting the Crescent Bridge data, the concurrent flow gauging for the sites were compared and they approximated the ratio between the two catchment areas (Appendix B: Figure B-4). This relationship is used in extending the Mimihau flow record for the period May 1978 to July 1981. The Mokoreta River at McKays record is used to extend the Mimihau record from July 1981. This is discussed further in the following section.

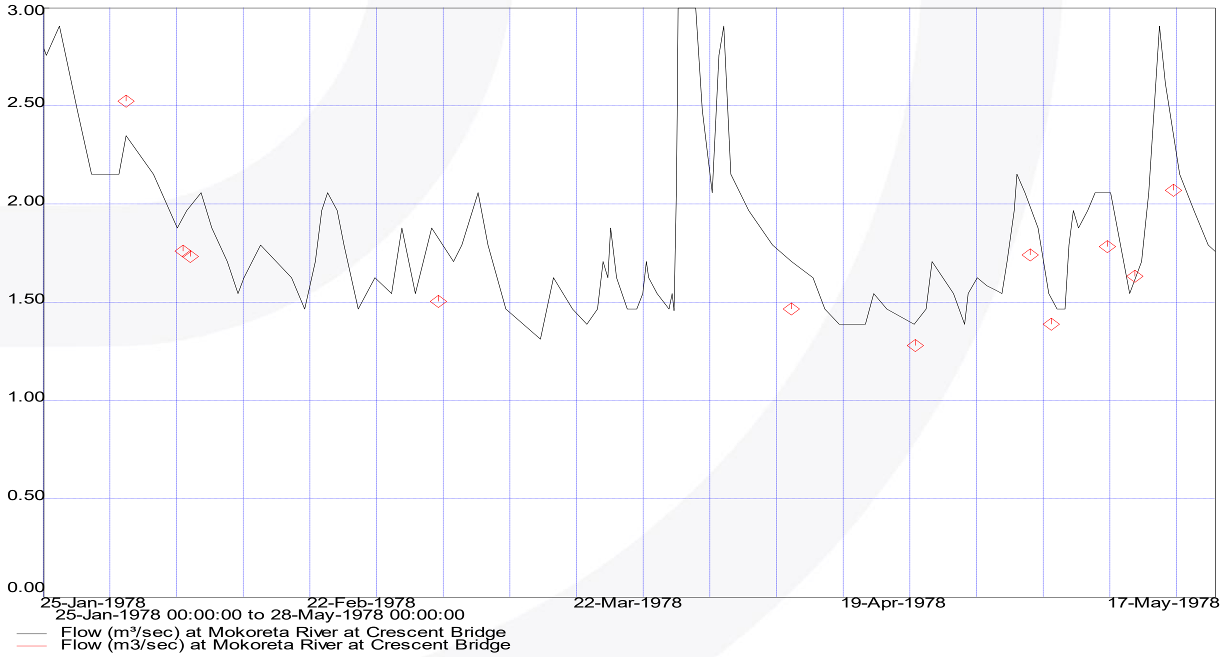

Figure 4: Mokoreta at Crescent Bridge gauged flow (red) and recorded flow (black trace). Flow in m^3/s.

The stage, gauging and rating information for the Mimihau at Stewarts Bridge and Mokoreta at McKays Road is presented in Appendix A. The 1974 to 1978 Mimihau record has two ratings, the second rating and gaugings from November 1977 covers the low flow period over the 1977/78 summer (Appendix A: Figure A-3). The Mokoreta at McKays control changes over time with 28 ratings over the period of record (Appendix A: Figure A-4).

There are over 130 gaugings associated with the long-term Mokoreta at McKay Road flow record; 50 of these gaugings below 2.5m^3/s (Appendix A: Figure A-5). There appears sufficient gaugings and ratings, and the good match between the gauged and associated flow record (Appendix A: Figure A-5) indicates that the Mokoreta at McKays is a suitable (long-term) flow record to use for this analysis.

4.0 Hydrological Assessment

4.1 Flow Regressions

Available flow records were analysed and used to derive a long-term flow for the Mimihau Stream at Stewarts Bridge. This location will be used as a reference site to derive flow time-series and statistics for locations in the Mimihau catchment.

There is only a short period of Mimihau Stream flow record (Figure 5 and Appendix A: Figure A-3), measured at the lower catchment location of Stewarts Bridge, about 1km upstream of its confluence with the Mataura River. There is an overlapping period of flow record with the Mokoreta and Waikaka Streams (Figure 5); both these Stream catchments are larger than the Mimihau catchment (Table 1).

The Mokoreta Stream catchment is adjacent and south of the Mimihau catchment. The Waikaka catchment is ~30km to the north, draining in a southerly direction where it joins the Mataura River at Gore. The earlier Mokoreta and Waikaka records (Mokoreta at Crescent Bridge and Waikaka Stream at Willowbank Bridge) were later replaced with sites further down the respective stream catchments (Mokoreta at McKays Road and Waikaka Stream at Willowbank; Table 1).

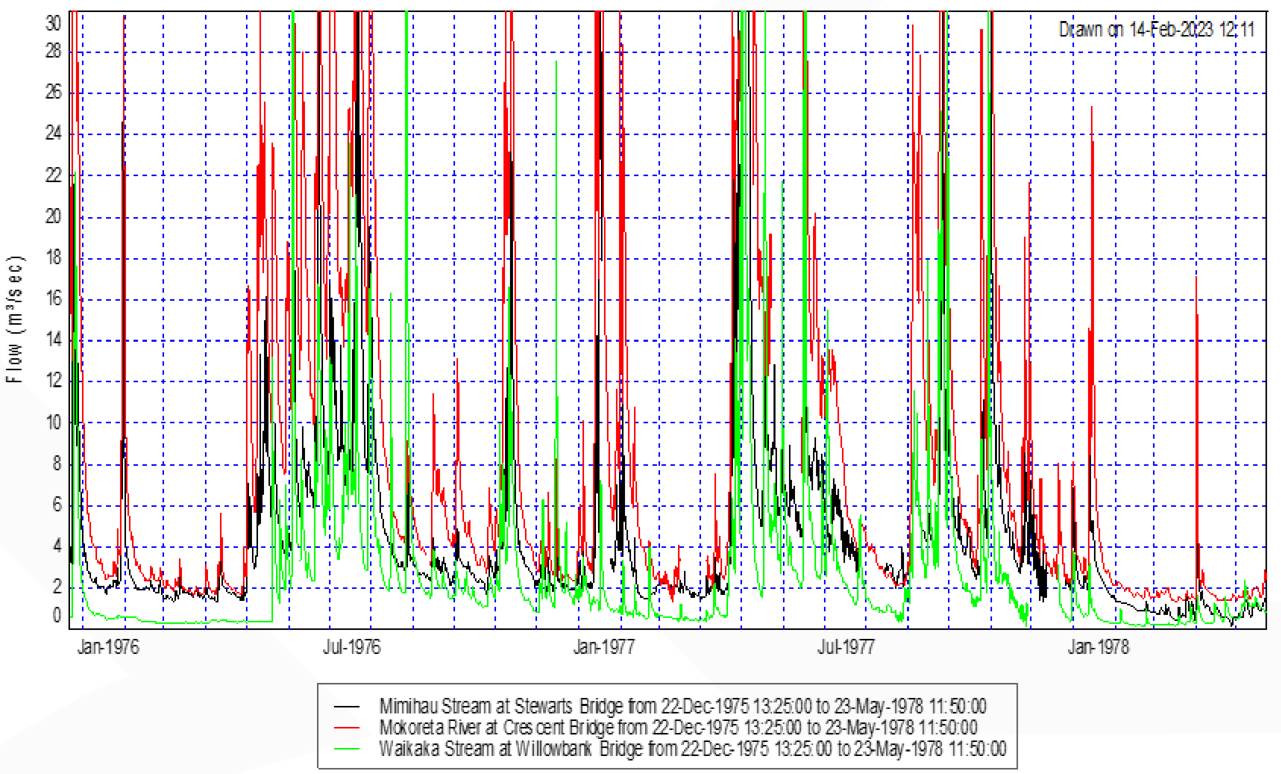

Figure 5: Mimihau, Mokoreta and Waikaka Stream overlapping flow record (to 30m³/s).

The regression analysis to derive a long-term Mimihau Stream record is described in Appendix B. In summary:

- The Mokoreta River flow records provided a better flow relationship with the available Mimihau Stream flow record and with the Mimihau Stream gauged data, than that of the Waikaka Stream record.
- A flow relationship is derived with the short period of early Mimihau flow record with the Mokoreta at Crescent Bridge. These two records combine for a measured and regressed flow record from December 1974 to July 1981.

The long-term Mokoreta at McKays Road flow record does not overlap with the Mimihau at Stewarts Bridge record. This Mokoreta record commences in March 1981. The Mimihau gauged record (from 2003 to 2019) was compared with the Mokoreta flow record. This indicated that a ratio based on catchment area (0.54) to represent the Mimihau at Stewarts Road Bridge would under-estimate Mimihau flow (Appendix B: Figure B-6). A relationship of "0.57 Mokoreta flow + 0.25 m³/s" better represents this relationship with Mimihau and is used to derive Mimihau flow from July 1981 to 2023.

In terms of low flow assessment, the series scaled directly from the Mokoreta at McKay's record may eliminate some of the uncertainty with the accuracy of the earlier (1976 to 1978) record. This still provides a long-term record for assessment (from March 1981). To note, the short period of Mimihau record has a period of low flow over February to May 1978.

4.2 Mimihau at Stewarts – Simulated Flow

The measured and simulated Mimihau at Stewarts Bridge flow is presented in Figure 6 and relevant flow statistics summarised in Table 4. The Mimihau record from July 1981 has been derived from the Mokoreta River at McKays flow record.

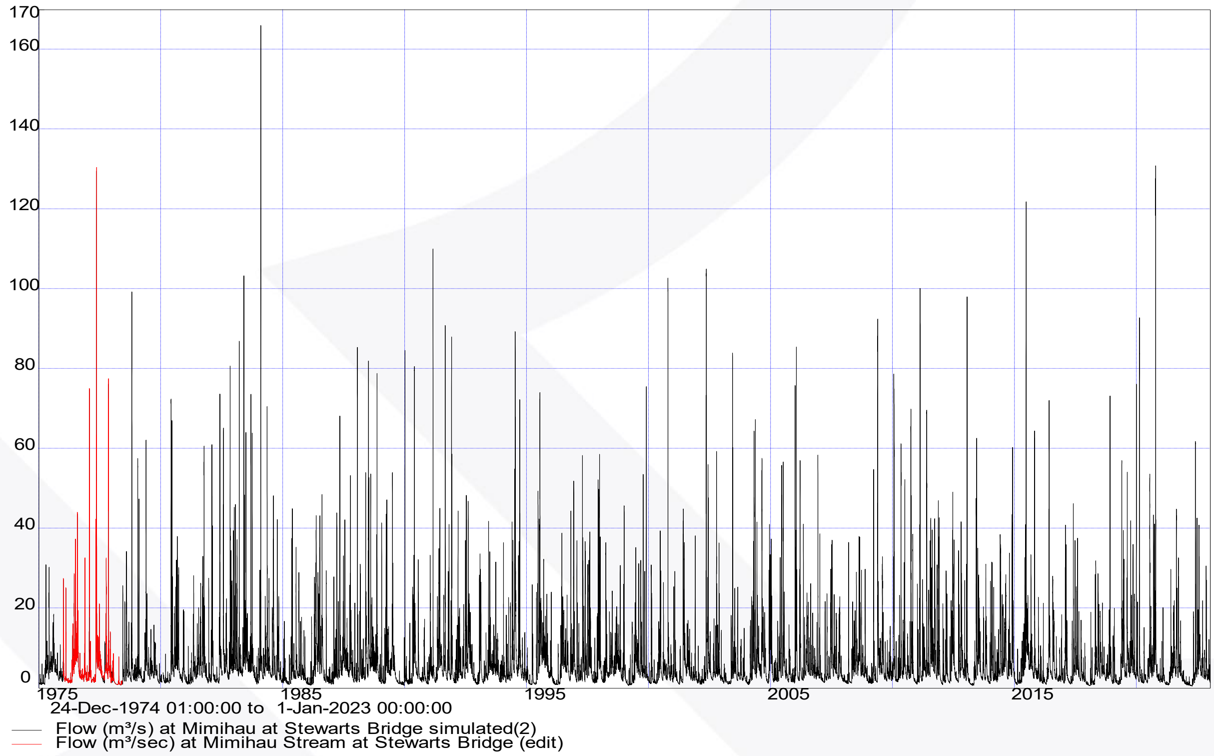

Figure 6: Mimihau at Stewarts Bridge measured (red) and simulated flow (black). Flows in m^3/s.

The simulated flow is compared against Mimihau gauged flow (Appendix C: Figure C-1 and Figure C 2) which illustrates that there is some inaccuracy around the simulated Mimihau flow compared to the Mimihau gauged record. However, there is good agreement with the lower end flows (<1.5m^3/s). Overall, the simulated time-series averages within 4% of the Mimihau gauged flow.

Appendix C: Figure C-3 illustrates the annual 7-day low flow for the period since 1975. Also included are the annual 7-day flows derived directly by catchment area with Mokoreta at McKays. Because of the lower ratio, the catchment scaled minima are lower.

An hourly Mimihau at Stewarts Bridge flow series based on measured and regressed data from Mokoreta River is used in this assessment. For the lowest Mimihau gauged flow on record, 0.72m^3/s on 22 January 2018, the simulated flow from the Mokoreta at McKays record is 0.72m^3/s. The corresponding measured Mokoreta at McKay flow was 0.82m^3/s.

4.3 Mimihau at Stewarts Flow Statistics

The simulated Mimihau at Stewarts Bridge 1-day and 7-day MALF for the 1975 to 2022 is presented as Figure 7 (July to June years). The 1974/75 to 2021/22 7-day MALF is 1.21m^3/s (Table 4). The difference between the annual 1-day and 7-day low flow varies from 1% to 27% with the average 8%. The lowest flow period occurred over March-April 2022; the 7-day low flow averaged 600L/s. The corresponding Mokoreta at McKays recorded 7-day flow was 615L/s; the lowest on the 1975 to 2022 record.

In the last 12 years, there have been 10 years with 7-day low flows below the long-term MALF (Figure 7).

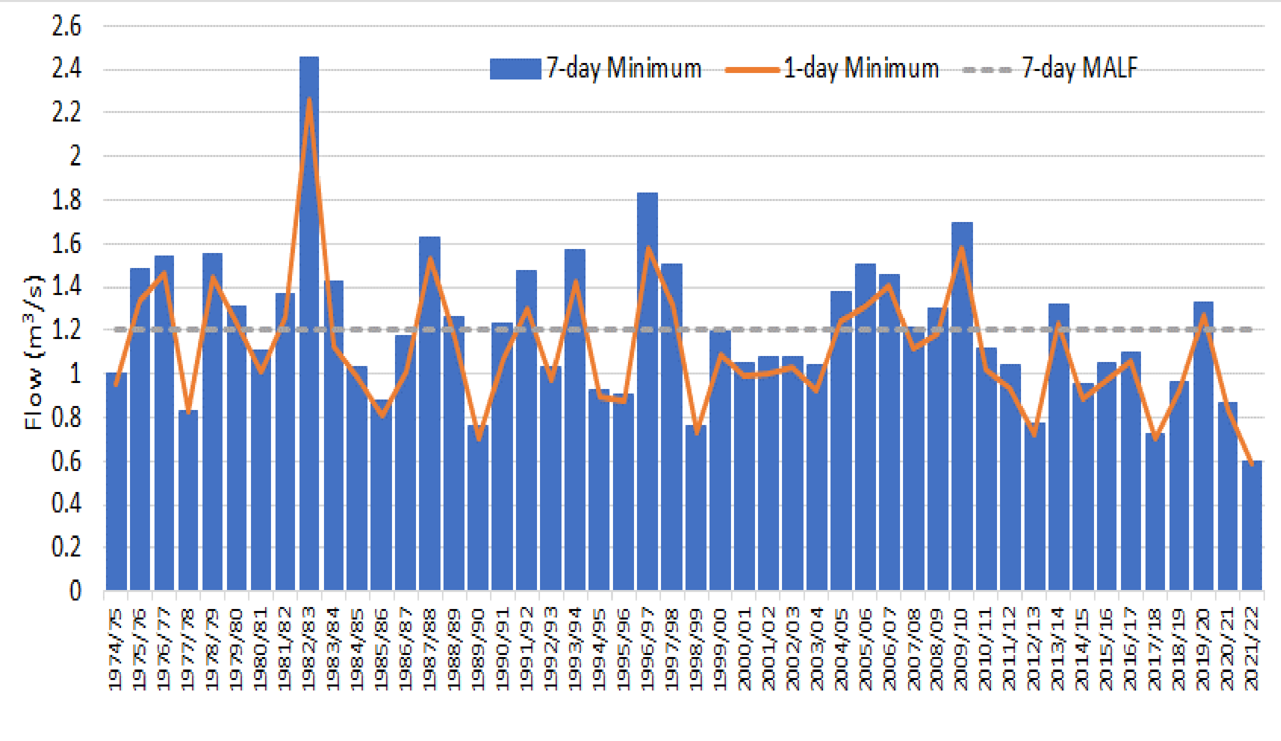

Figure 7: Mimihau at Stewarts Bridge simulated annual 7-day and 1-day low flow. July to June years.

Table 4: Mimihau at Stewarts Bridge 1975 to 2022 Flow Statistics (m^3/s)

Record	Measured 22 Dec 1975 to 23 May 1978	Simulated Record 1 Jan 1975 to 1 Jan 2023
Median flow	2.9	3.6
Mean Flow	4.9	5.6
MALF – 1 day(1)	1.2	1.1
MALF – 7 day(1)	1.3	1.2

Note (1) – July to June years.

Monthly average data (Appendix C: Figure C-4) and cumulative flows distributions (Appendix C: Figure C-5) illustrate that on average, lowest flows occur in February and March, although dry periods can occur from November to April. Highest flows are observed from May to July. Figure 8 illustrates the different flow characteristics between the dry and wet months. Over the period of record, flows are at or below the MALF (1.2m³/s) for 5% of the time, and typically within the December to April months.

Mean flow over 1975 to 2022 was 5.6m³/s, and annually this ranged from 3.7m³/s (2003) to 7.6m³/s (2011) (Figure 9).

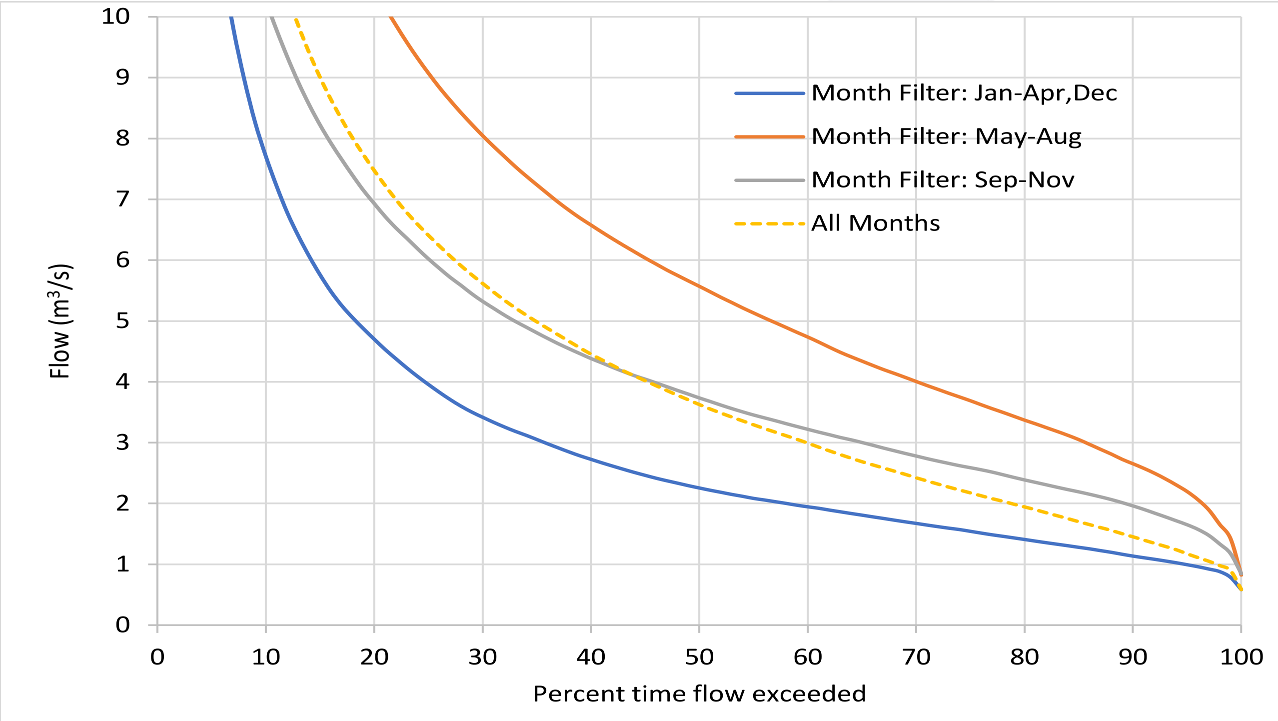

Figure 8: Cumulative flow distribution by monthly grouping for the Mimihau Stream at Stewarts Bridge simulated data. Hourly data for the period 1 January 1975 to 31 December 2022.

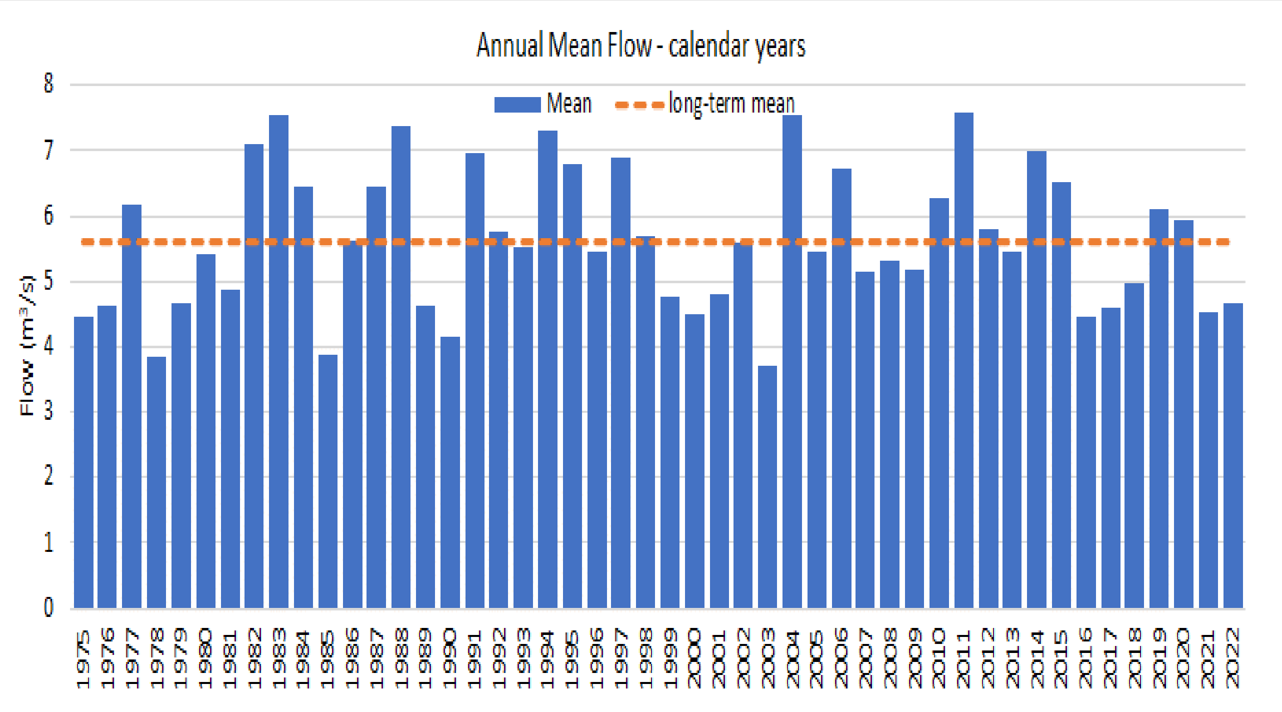

Figure 9: Mimihau at Stewarts Bridge simulated annual mean flow

4.4 Mimihau Sub-Catchment Flow

Flow within the Mimihau Stream catchment was scaled directly based on catchment area with the Mimihau at Stewart Road simulated record. Summary statistics are provided in Table 5 for locations in the catchment. As example, the Mimihau South Branch at Upper Bridge has a catchment area of 12.9km^2, equivalent to 5.7% of the catchment area to the Stewarts Road bridge location. The derived MALF for this location is 69L/s. It is likely that the flow yield within the catchment will vary due to land use (forestry, farming) soils, geology, and topography. This can only be ascertained with flow measurements. The simulated Mimihau Stream at Waiarikiki Bridge compared well with the few available gaugings (Figure 10). The other Mimihau South Branch upper catchment gaugings were not such a good match to the simulated record (Figure 11). There appears to be some inconsistency with the records. As an example, the same day flows (Appendix A: Table A-1) for the South Branch flow at Venlaw station are higher than for the South Branch at Venlaw Road although the latter site is much further down the catchment (Appendix A: Figure A-2).

Table 5: Mimihau Catchment flow statistics derived from the simulated Mimihau at Stewarts Bridge 1975 to 2022 record

Location	Area (km^2)	Ratio to Stewarts	Mean flow (m^3/s)	7-day MALF (m^3/s)	Lowest 7-day (m^3/s)
Mimihau at Stewarts Bridge	225	100%	5.6	1.20	0.60
Mimihau Waiarikiki Bridge	95.2	42.3%	2.37	0.51	0.25
Mimihau South Branch at North Branch confluence	51.7	23.0%	1.29	0.28	0.14
Mimihau South Branch Venlaw Road	24.7	11.0%	0.61	0.13	0.066
M2 – South Branch upper Bridge	12.9	5.7%	0.32	0.069	0.034
M1 – Mimihau South Branch tributary (near JED18)	4.6	2.0%	0.11	0.025	0.012

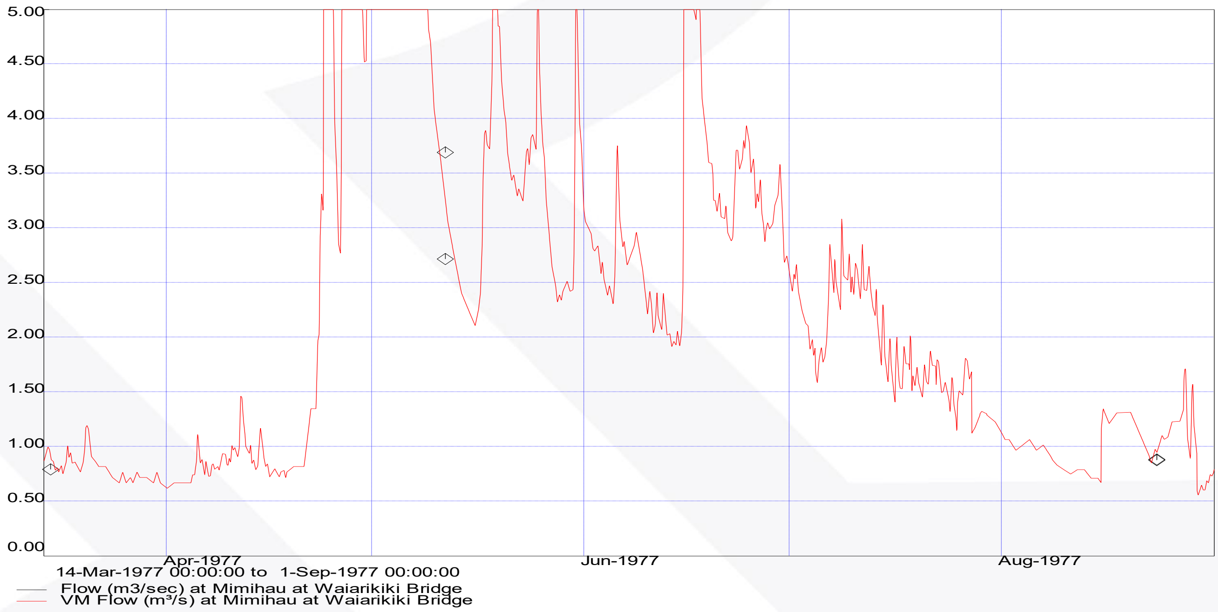

Figure 10: Mimihau Stream at Waiarikiki Bridge simulated (red) and gauged flow (black)

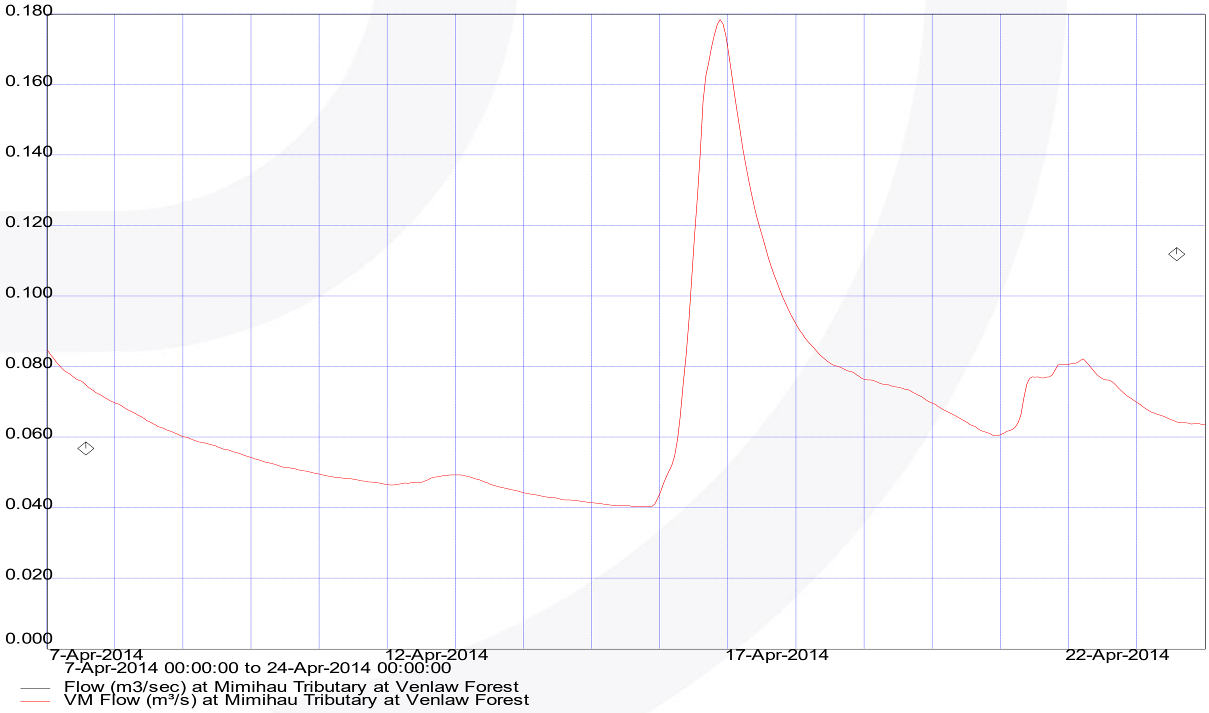

Figure 11: Mimihau Stream tributary at Venlaw Forest simulated (red) and gauged flow (black)

4.5 Site Visit and Upper Catchment Flow Gaugings

Water level monitoring was established within the catchment and gaugings undertaken on 29-30 March 2023. This visit is covered in the hydrological monitoring memo (Riley, 5 April 2023; appended as Appendix F) and the gaugings are summarised in Table 6. The monitoring equipment will remain in place up until and during construction. This monitoring equipment can be upgraded to provide actual on-site real time information on the stream flows which will be helpful in managing water takes and compliance with rules during low flow conditions.

The Mokoreta at McKays flow data was provided by SRC and used to extend the simulated Mimihau record. However, both catchments experienced a fresh flow over these days (Appendix C: Figure C-6). Prior to these fresh events, flows over the summer by February and March were at or near the lowest levels observed over the 1981-2022 record.

Site M1 is a tributary of the Mimihau South Branch and is located at the Thornhill Road ford (a location near the proposed JED18 turbine within Jedburgh Station). This Stream is favoured as the source for a potential water take. The 29 March 2023 gauged flow is near that simulated for this location (Table 6 and Appendix C: Figure C-7). Clearly there will be flow travel times difference between the lower site of Mokoreta at McKays and this upper catchment location. The simulated flow for Site M2 is a reasonable match to the gauged flow, but for the site M3 and the Waiarikiki Bridge location the gauged flows are around 30% lower. Site M2 within Matariki Forest is also a potential water take location. Site M3 is not associated with a proposed water take (but flow assessment and hydraulic modelling will be used to inform a culvert design for the stream crossing).

Table 6: Mimihau Stream Gauged and Simulated Flow

Location	Date	Time (NZST)	Gauged Flow (L/s)	Catchment Area (km^2)	Flow Based on Relationship with Mokoreta Flow (L/s)
M1 (within Jedburgh Station)	29/03/23	1034-1117	96	4.6	90
M2 (within Matariki Forest)	29/03/23	1325-1403	209	12.3	231
M3 (within Port Blakely Forest)	30/03/23	0938-1010	167	17.5	243
Waiarikiki Road Bridge	29/03/23	1514-1553	1247	95.2	1730

5.0 Water Requirement

5.1 Construction Activities

The likely maximum daily water requirement for construction activities is estimated at up to 500m^3 (Table 7). However, it is unlikely that all activities will occur concurrently and as such the typical maximum daily demand will likely be between 250-350m^3/day.

Table 7: Southland Wind Farm Construction Daily Maximum Water Requirement (Source: Contact Energy)

Water Use Activity	Maximum Daily Quantity (m^3)
Earthworks for road construction and turbine platforms	140
Aggregate Crushing	40
Concrete Batching	200
Dust Control	100
General activities	20
Totals	**500**

Current permitted water abstraction is 5L/s per land holding to a maximum of 10m^3/day (Section 5.2). Clearly, the water demands anticipated during construction exceed the permitted 10m^3/day water abstraction limit.

5.2 Allocation

5.2.1 Water Take Permitted Activities

The Mitchell Daysh memo to Riley (appended in Appendix D) summarised relevant Plans and rules that apply to water abstraction for the Mimihau catchment[1]. These included:

- Mataura River Water Conservation Order (1997);
- Current (operative) Southland Regional Water Plan, and
- The Proposed Southland Water and Land Plan

[1] Further detail was provided by Mitchell Daysh by email- appended in Appendix E.

The Mataura River Water Conservation Order (1997) requires that 95% of the River flow remains in the "protected waters" above the Mataura Island Road bridge. The catchment above Gore is over-allocated, however, below Gore (includes Mimihau) allocation is available in the southern portion of the catchment.

The Operative Southland Regional Water Plan allows permitted take of up to 10m^3/day (per landholding) at a rate not exceeding 5L/s (Rule 18). Also, the abstraction and use does not result in adverse effects on existing water users, aquatic ecosystems or water quality; and fish are prevented from entering the reticulation system. Any exceedance of the above would trigger a consenting obligation.

The Proposed Southland Water and Land Plan outlines several conditions around a permitted (take) activity with a daily volume up to 100m^3, at a rate not exceeding 15L/s. However, the abstraction can only be maintained for 45-minutes, with at least 30-minutes between multiple takes.

Neither the Operative nor the Proposed permitted daily water takes are large enough to meet the maximum daily wind farm construction requirements. To ensure sufficient water for wind farm construction activities, Contact Energy intend to pump water to water storage facilities located within the wind farm. Contact Energy advise that the water storage volume may need to be approximately 10,000m^3 to cover wind farm construction water demands during what is anticipated to be a worst-case scenario of prolonged low flow stream conditions. The water take from the streams would be limited to a maximum of 5L/s, or 10% of the stream flow, whichever is the lower. Based on the Operative Plan limit of 10m^3/day, a consent will be required to allow higher daily abstraction volumes during the construction period.

Contact Energy intends, given the size and extent of the wind farm, to have two batching plant and water storage facilities. The exact locations will be identified during detailed design, however 'envelope' areas within which the batching plant and water storage facilities could be located as identified on Figure A-6 in Appendix A. One is located approximately 3km south-south-west of M1 and 1km south-south-west of M2.

The Southland Regional Council advised that their consents database contains no existing surface water takes within the Mimihau and Mokoreta Catchments (email dated 20 February 2023). There are some groundwater takes for farming operations in the adjacent Mokoreta catchment(Appendix A: Figure A-2).

5.2.2 Guidelines on Ecological Flows and Water Allocation

As discussed, Southland Regional Council has defined allocation limits, albeit these are in review. The Ministry for the Environment (MfE) draft Guidelines for the Selection of Methods to Determine Ecological Flows (MfE, 2008), provides several methods to assess the impact of hydrological alteration on rivers. The report notes that:

- The risk of abstraction decreasing available habitat depends on stream size and the species present in the stream, with higher risks of deleterious effects in small streams than in larger streams and rivers.

- The extent to which abstraction affects the duration of low flows is a useful measure of the degree of hydrological alteration. A high degree of hydrological alteration is assumed to occur when abstraction increases the duration of low-flow conditions to 30 days or more, with moderate and low levels of hydrological alteration corresponding to increases of about 20 days and 10 days, respectively.
- The 7-day MALF statistic as an indication of low flow.
- Abstraction of up to 10% of the MALF is unlikely to result in significant biological effects in any stream. Abstraction of more than 40% of MALF, or any flow alteration using impoundments would be considered a high degree of hydrological alteration, irrespective of region or source of flow.
- The degree of hydrological alteration was classified as low for total abstraction that ranged from <15% to <20% of MALF for high baseflow streams. Mimihau would be classified as a high baseflow stream as the mean flow is less than 20 times the MALF.

More clarification and detail is provided in the MFE (2008) report.

5.2.3 Water Allocation Under Low Abstraction Thresholds

A maximum take rate of 10% and 20% of MALF were assessed for locations in the upper catchment. Such allocations would allow for maximum allocation take at the M1 location of 2.5L/s (10% allocation) to 5L/s (20% allocation) and 6.9L/s (10% allocation) to 13.8L/s (20% allocation) at the M2 location (Table 8). These M1 location rates are within the range of the permitted activity thresholds for surface water takes within either the existing (Operative) or proposed plan. The M2 location rates are within the range for the proposed plan.

Allocatable water was only available above MALF. The full availability of water for pumping was assessed as 83% of the time (10% allocation) for the dry months (December to April). This reduced to 77% of the time for the 20% allocation. As previously noted, the MALF occurs over the 1975 to 2022 record for 12% of the time for the months December to April.

Table 8: Mimihau South Branch Water Availability for the months December to April

Location	7-day MALF (L/s)	10% of MALF (L/s)	% Time Flow Available	20% of MALF (L/s)	% Time Flow Available
M1 - Mimihau South Branch tributary (near JED18)	25	2.5	83%	5	77%
M2 - South Branch upper Bridge (Matariki Forest)	69	6.9	83%	13.8	77%

Given the above MALF conditions, Contact Energy proposes to take water from site M1 and M2 on the following conditions:

- the water take cannot exceed 10% of the Stream flow, and
- the water take cannot exceed 5L/s.

Based on the 7-day MALF estimates described in Table 8, these conditions would limit the water take at M1 to 2.5L/s during MALF conditions.

A water take of 5L/s would provide 432m^3/day should water be taken continuously over a 24-hour period, and half this (216m^3/day) at a 2.5L/s rate.

Based on the MfE (2008) draft guidelines the degree of hydrological alteration is likely to be low. 4Sight Consulting (4SIGHT, 2023) summarised that "the development and implementation of an ESCP[2] (including water quality monitoring), fish screening, and restrictions on the amount of water that is taken, will ensure that the existing freshwater ecology values of the Mimihau Stream South Branch are protected while water is taken for the construction of the Southland Wind Farm".

6.0 Summary

During construction, the proposed Southland Wind Farm will require access to surface water within the catchment for activities such as earthworks, concrete batching, and dust suppression. The maximum daily water volume required is estimated at up to 500m^3, although typically the daily demand will be between 250-350m^3/day. The construction period is estimated to take 24 months.

There is only a short period of Mimihau Stream flow record, augmented by sporadic gauging data from around the catchment, but predominantly in the lower catchment at Stewarts Bridge. Erroneous record was identified with the 1978 Mimihau low flow period, including the lowest flow on record (148L/s). Flow gaugings completed during this period indicates this low flow is around 840L/s.

Reasonable flow relationships were obtained with the adjacent Mokoreta Stream catchment, although there is only a short period of overlapping record.

Flow relationships were obtained with the long-term flow site of Mokoreta at McKays Road initially by scaled catchment ratio, and then via relationship between the measured Mokoreta flow record and gauged Mimihau flow.

These relationships were used to derive a long-term Mimihau flow record.

The simulated 1975 to 2022 Mimihau at Stewarts Bridge record was scaled based on catchment area to derive Mimihau Stream record for various locations in the catchment. There will be some inaccuracy in these derived records as most of the record is derived from the adjacent and larger Mokoreta catchment, and in-catchment differences in flow yield due to land-use, topography, and soils.

To better assess hydrology in the upper catchment, monitoring equipment was installed in late March 2023 to record stream level at the two identified locations of potential water take (M1 and M2), as well as a third location (M3) where a culvert design will be required.

The Operative Regional Water Plan for the Southland region allows for a maximum permitted abstraction per land holding of 10m^3/day at a maximum rate of 5L/s. With the proposed plan this rate may increase to 100m^3 and 15L/s (plus other criteria). However, water demands during wind farm construction exceed these daily permitted volumes and as such consent will be required.

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[2] Erosion and Sediment Control Plan.

Contact Energy proposes to take water at two locations (referred to as M1 and M2 in this report) during wind farm construction. Site M1 is within Jedburgh Station and site M2 is within the Matariki Forest. Contact Energy propose that the water take cannot exceed 5L/s at either site, or 10% of the Stream flow, whichever is lower. A maximum rate of take of 5L/s corresponds to a (maximum) daily volume of 432m^3.

To compensate for the reduced take during low flow conditions water storage is proposed within the two properties of water take. The exact locations of these will be determined during detailed design. However, indicative 'envelope areas' within which the water storage (and concrete batching facilities) will be located are identified on Figure A-6 in Appendix A.

7.0 Limitation

This report has been prepared for Contact Energy Limited (Contact), to inform the Expert Consenting Panel's consideration of Contact's application for approvals under the Fast-track Approvals Act 2024 and any subsequent regulatory processes.

The hydrological analyses and recommendations contained in this report are based on our understanding and interpretation of the available information. The recommendations are therefore subject to the accuracy and completeness of the information available at the time of the study. Should any further information become available, the analyses and findings of this report should be reviewed accordingly.

8.0 References

4SIGHT, 2023. Preliminary freshwater ecology report.

Macara, G.R. 2013. The Climate and Weather of Southland.

MfE, 2008. Draft Guidelines for the Selection of Methods to Determine Ecological Flows.

Ministry for the Environment (MfE, 2016). 1961-2011 Mean Annual Rainfall GIS layer from the MfE website.

Riley, 2023a. Geotechnical Assessment for Resource Consent. Southland Wind Farm, Southland - draft report.

Riley, 2023b. Mimihau Hydrological Monitoring Site Visit memo (draft memo).

Appendix A

Data and Ratings

Appendix A: Data and Ratings

Table A-1: Mimihau Stream Same Day Gaugings

Site Name	Date	Flow (L/s)	Velocity	CA (km²)
Mimihau Stream at Waiarikiki Bridge	15/03/1977 0:12	795	0.231	95.2
Mimihau Stream at Venlaw Station	15/03/1977 13:35	589	0.199	90.5
Mimihau Stream at Venlaw Station	15/03/1977 14:10	299	0.209	90.5
Mimihau South Branch at Venlaw Road	15/03/1977 15:10	89	0.099	12.3
Mimihau South Branch at Venlaw Road	11/05/1977 13:10	1475	0.453	12.3
Mimihau Stream at Venlaw Station	11/05/1977 13:45	2008	0.542	90.5
Mimihau Stream at Waiarikiki Bridge	11/05/1977 14:45	3695	0.633	95.2
Mimihau Stream at Waiarikiki Bridge	11/05/1977 15:40	2719	0.626	95.2
Mimihau Stream at Waiarikiki Bridge	23/08/1977 14:20	882	0.246	95.2
Mimihau Stream at Waiarikiki Bridge	23/08/1977 14:45	877	0.244	95.2
Mimihau Stream at Waiarikiki Bridge	27/01/1978 12:15	851	0.238	95.2
Mimihau Stream at Venlaw Station	27/01/1978 14:30	355	0.208	90.5
Mimihau South Branch at Venlaw Road	27/01/1978 15:20	96	0.111	12.3
Mimihau South Branch at Venlaw Road	7/01/2009 13:12	501	0.279	12.3
Mimihau Stream at Wyndham	7/01/2009 14:37	1540	0.216	225
Mimihau Stream at Wyndham	7/04/2014 11:33	2934	0.372	225
Mimihau Stream Tributary at Venlaw Forest	7/04/2014 13:24	57	0.222	4.5

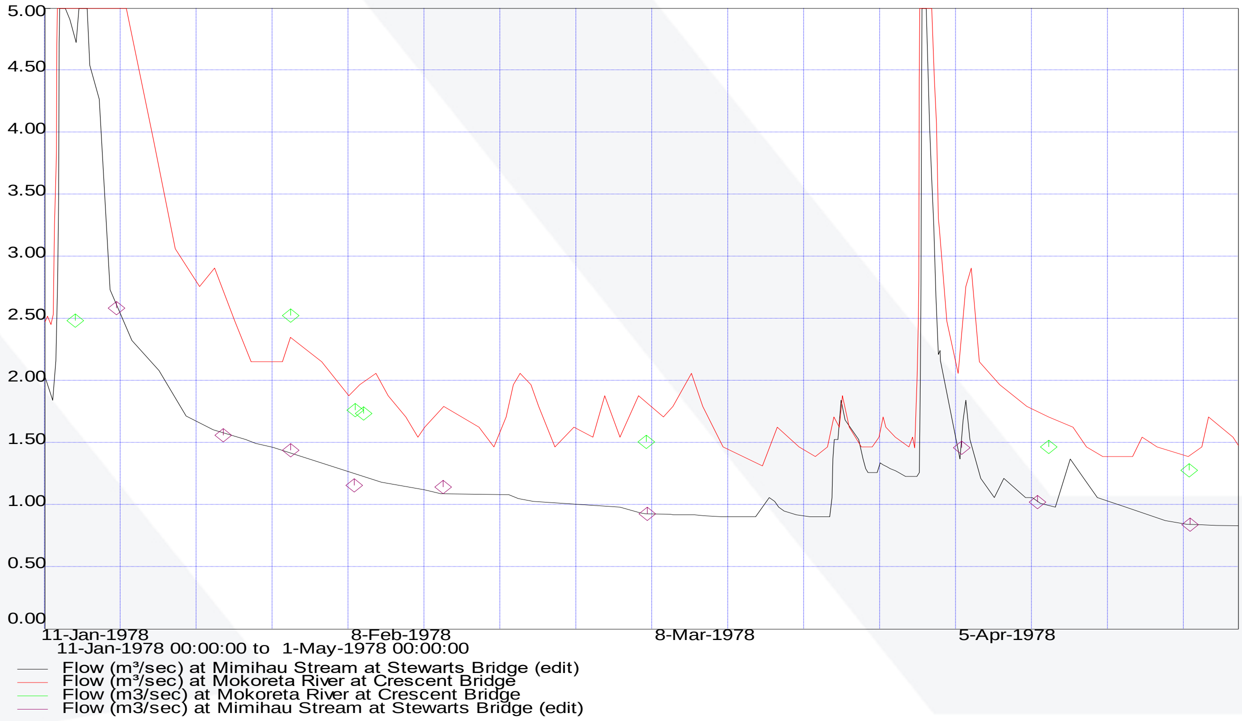


Figure A-1. Mimihau Stream gauged and adjusted flow and Mokoreta at Crescent Bridge gauged and recorded flow (11 January 1978 to 23 May 1978).

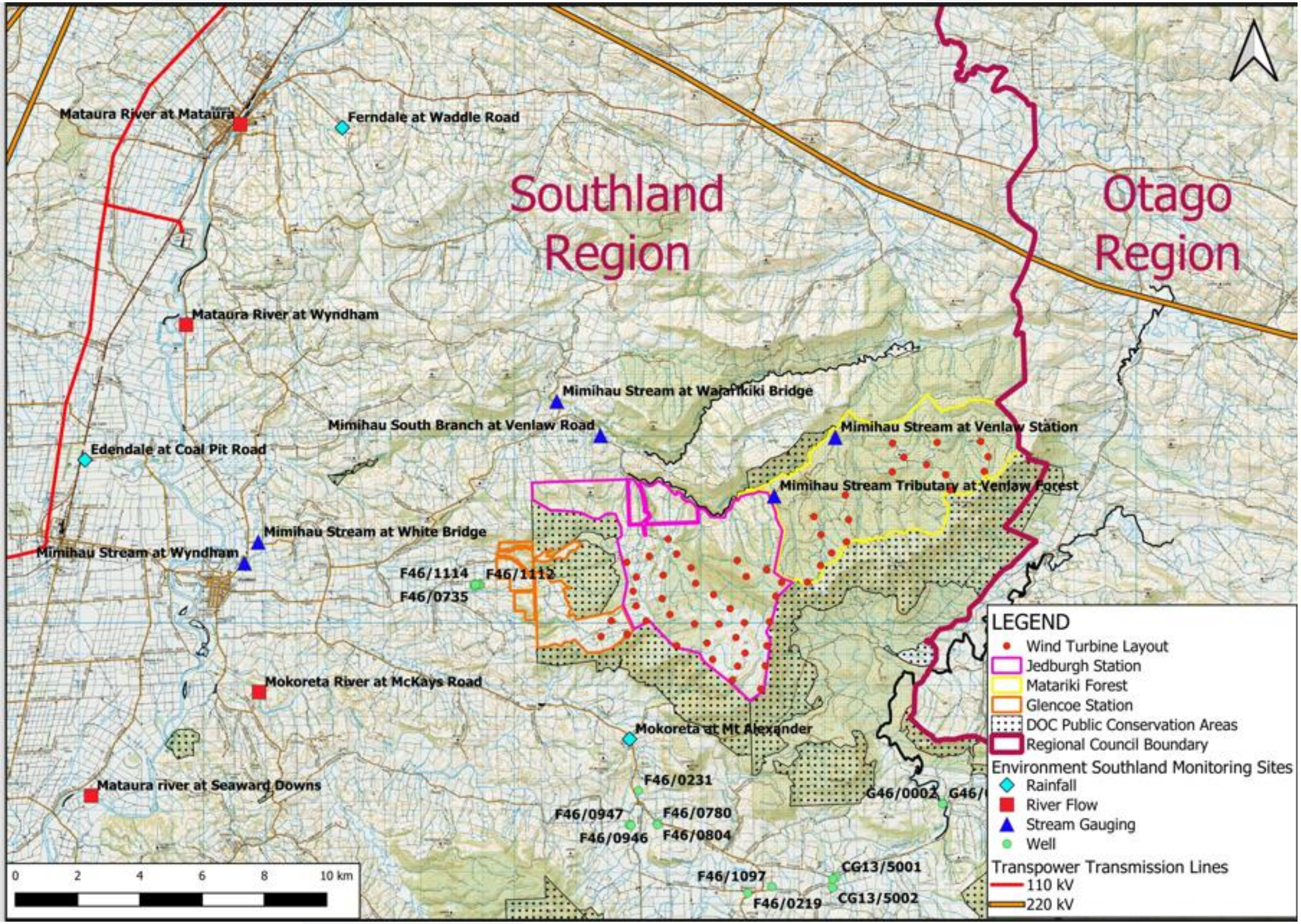


Figure A-2: Proposed Southland Wind Farm Location and the Southland Regional Council monitoring locations. (Source: Contact Energy)

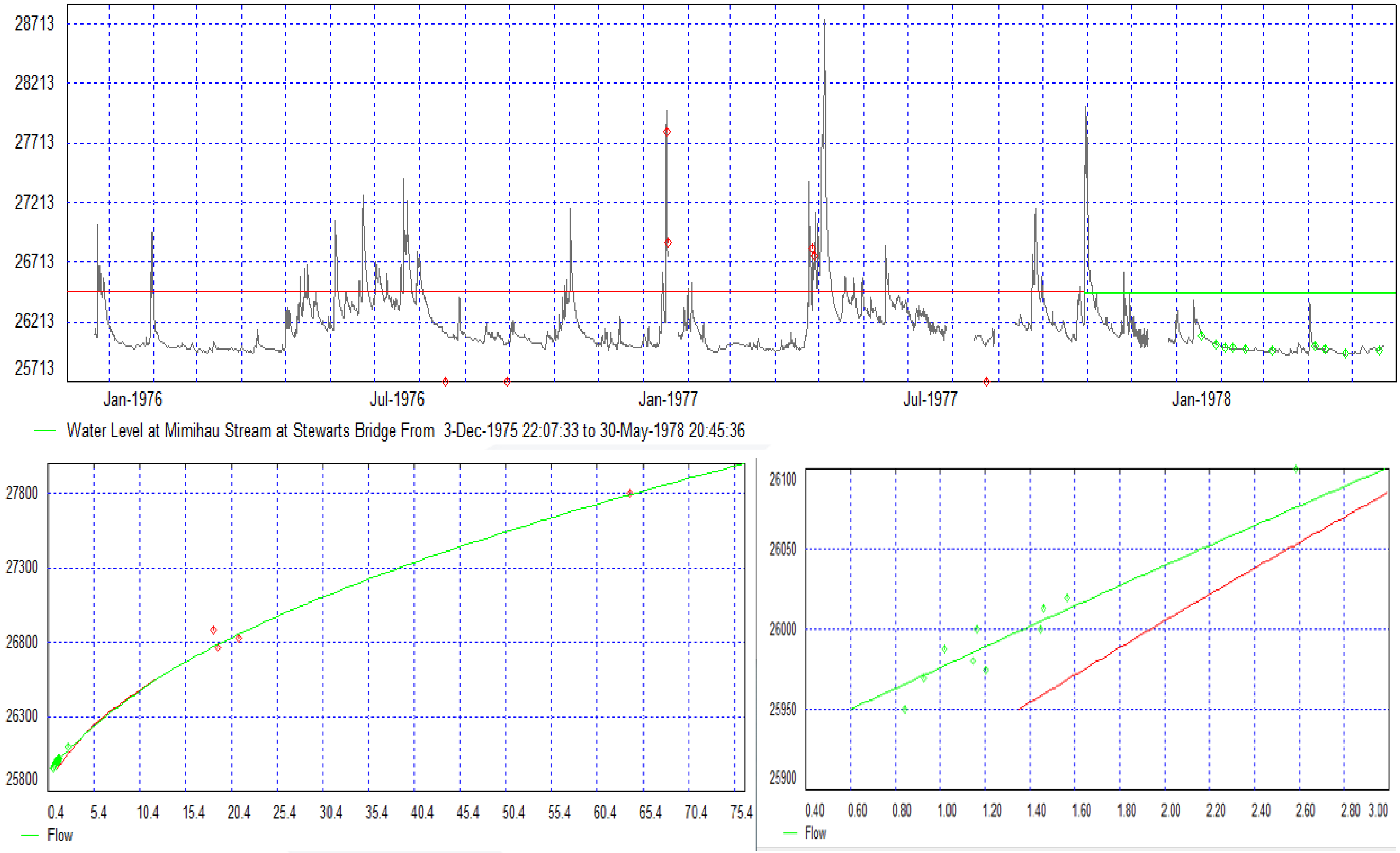


Figure A-3: Mimihau Stream at Stewarts Bridge stage and gaugings (top) and stage verse flow ratings and gaugings (bottom)

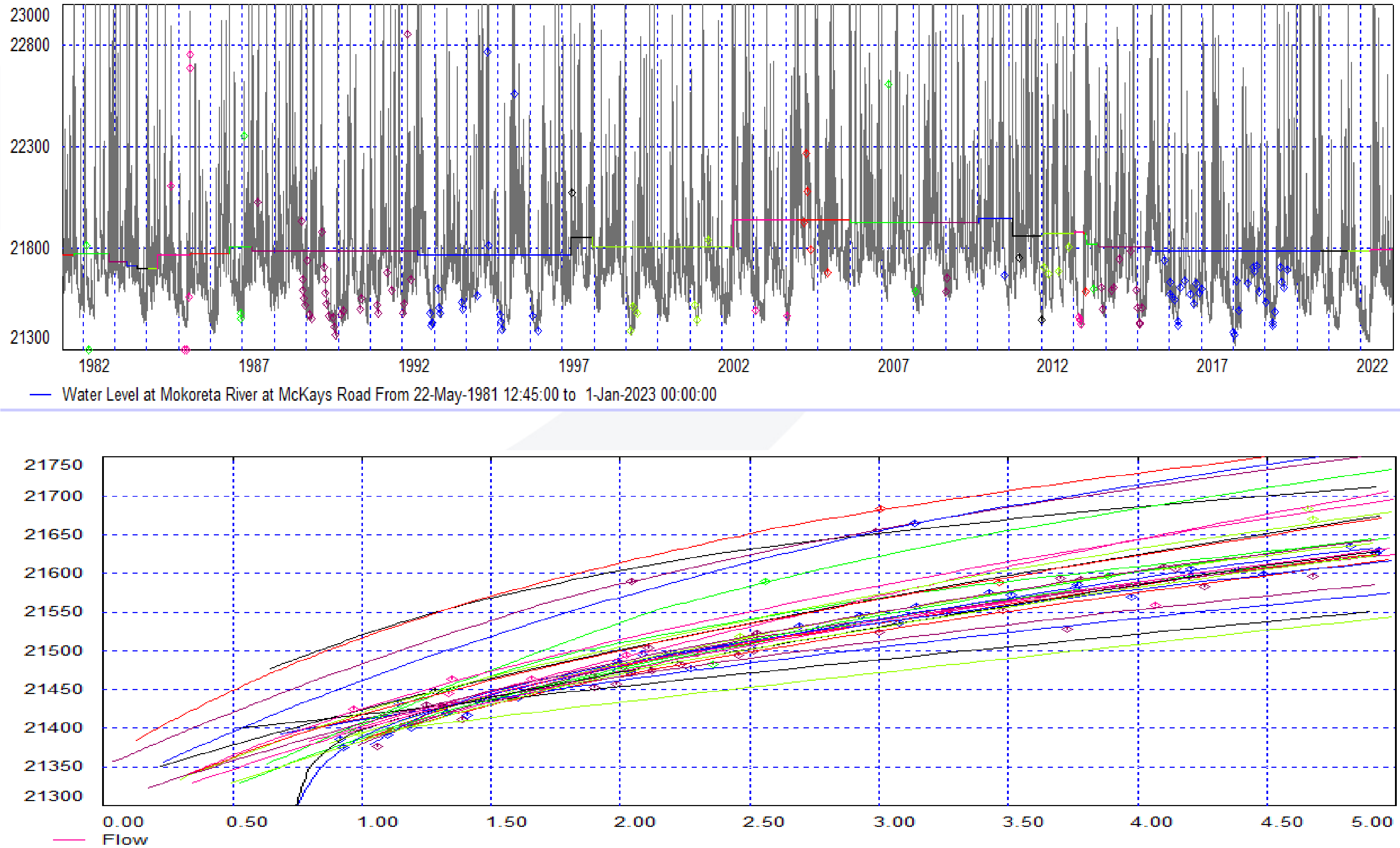


Figure A-4: Mokoreta River at McKays stage and gaugings (top) and stage verse flow ratings with gaugings (bottom)

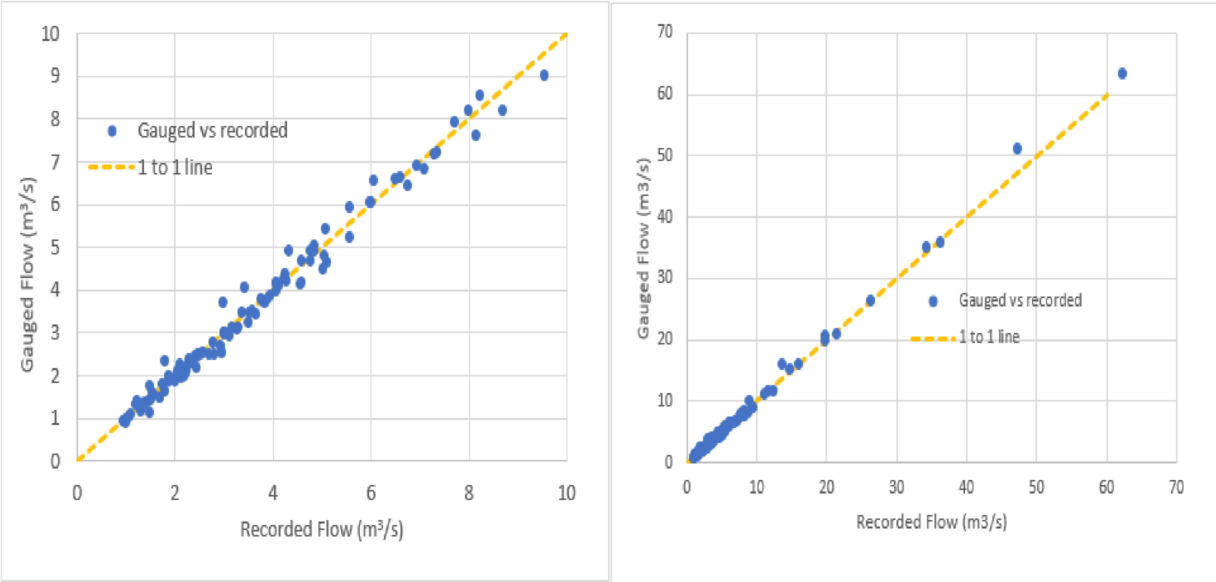


Figure A-5: Graphs of the Mokoreta at McKays recorded flow and gauged flow (graphs have different scales). Note three "outlier" pairs removed from analysis – associated with higher flows.

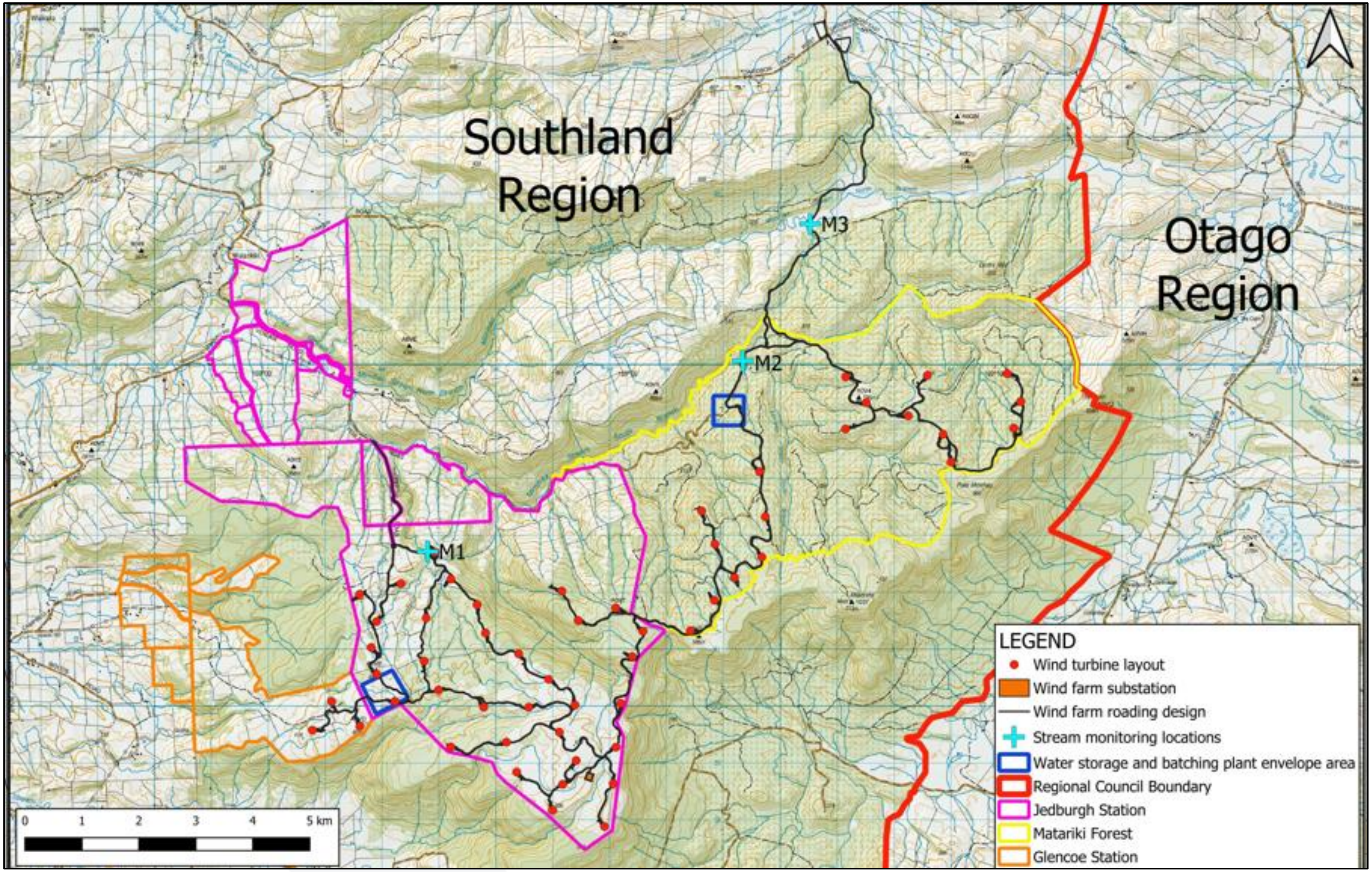


Figure A-6. Proposed Southland Wind Farm Location Map showing 2023 installed stream monitoring locations and proposed batching areas. (Source: Contact Energy)

Appendix B

Flow Regressions

Appendix B: Flow Regressions

Available flow records were analysed and used to derive a long-term "reference site" for the Mimihau Stream flow at Stewarts Bridge.

The December 1975 to May 1978 Mimihau Stream flow record has a short period of overlapping record with the Mokoreta and Waikaka Streams. This earlier Mokoreta and Waikaka record (Mokoreta at Crescent Bridge and Waikaka Stream at Willowbank Bridge) were later replaced with sites further down the respective stream catchments (Mokoreta at McKays and Waikaka at Willowbank).

Flow relationship with the Mimihau at Stewarts Bridge record was obtained with the Mokoreta at Crescent Bridge (Figure B-1 and Figure B-2) and Waikaka at Willowbank Bridge record (Figure B-3). A ratio based on the Mimihau and Mokoreta recorded data was better than based on catchment area (flows scaled by catchment area would over-estimate Mimihau flow for Mokoreta flows above 5m^3/s. Because of inaccuracies with the respective recorded flow data (covered in Section 3), the relationship was adjusted (based on catchment area) to better reflect flows below 5m^3/s (B-2). This could represent differences in flow characteristics between the catchments (at different flow) or potential inaccuracies with the respective rating curves or level measurements over this early period of record. A short period of concurrent Mimihau and Mokoreta low flow gaugings over February to May 1978, indicates a relationship based on catchment area is appropriate (Figure B-4).

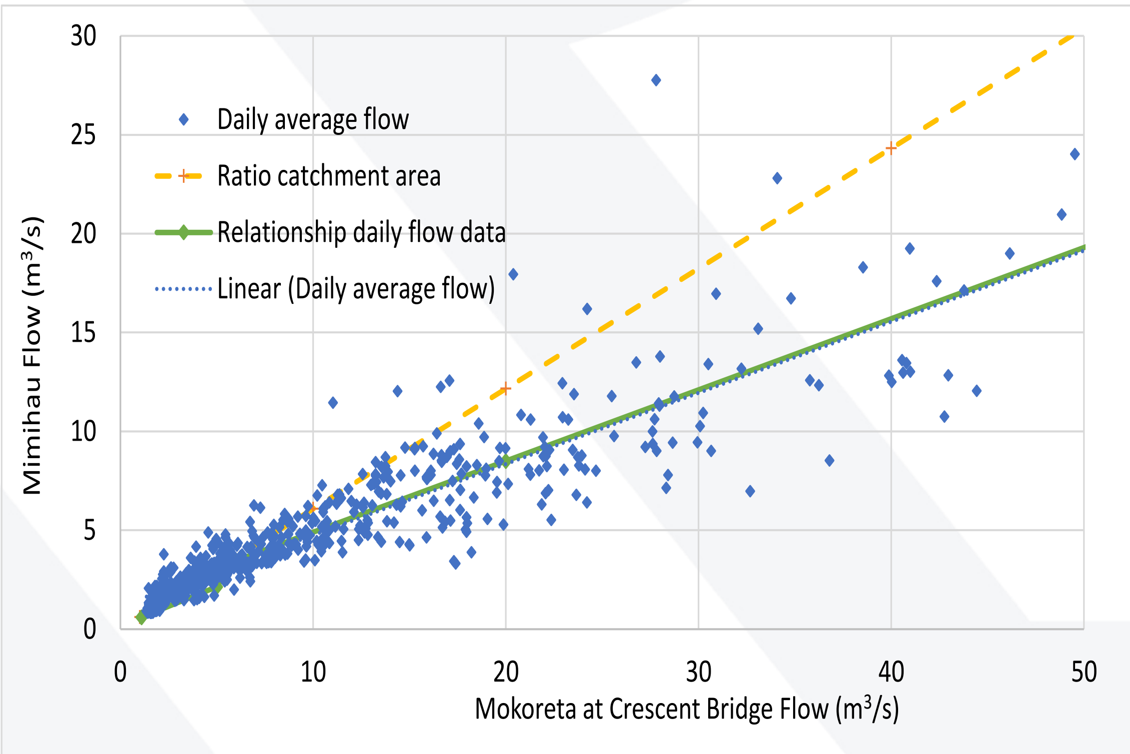


Figure B-1: Mimihau Stream flow (data adjusted) relationship with Mokoreta River at Crescent Bridge.

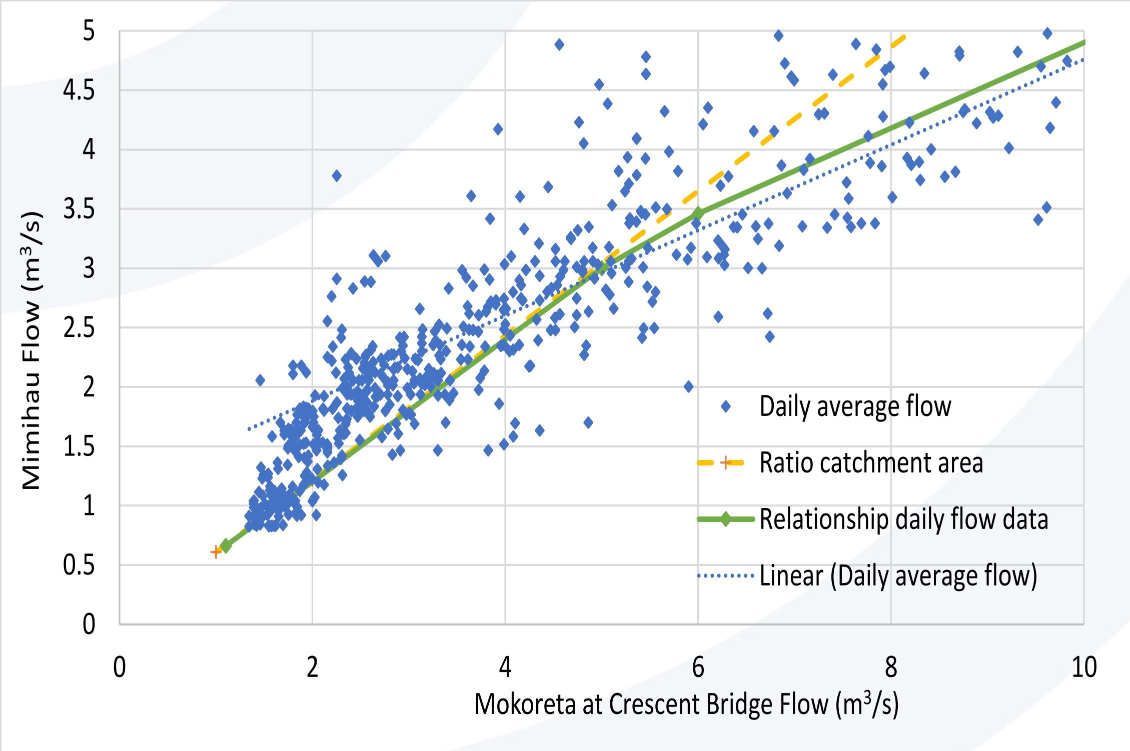


Figure B-2: Mimihau Stream flow relationship with Mokoreta River at Crescent Bridge (daily data from 22 December 1975 to 23 May 1978).

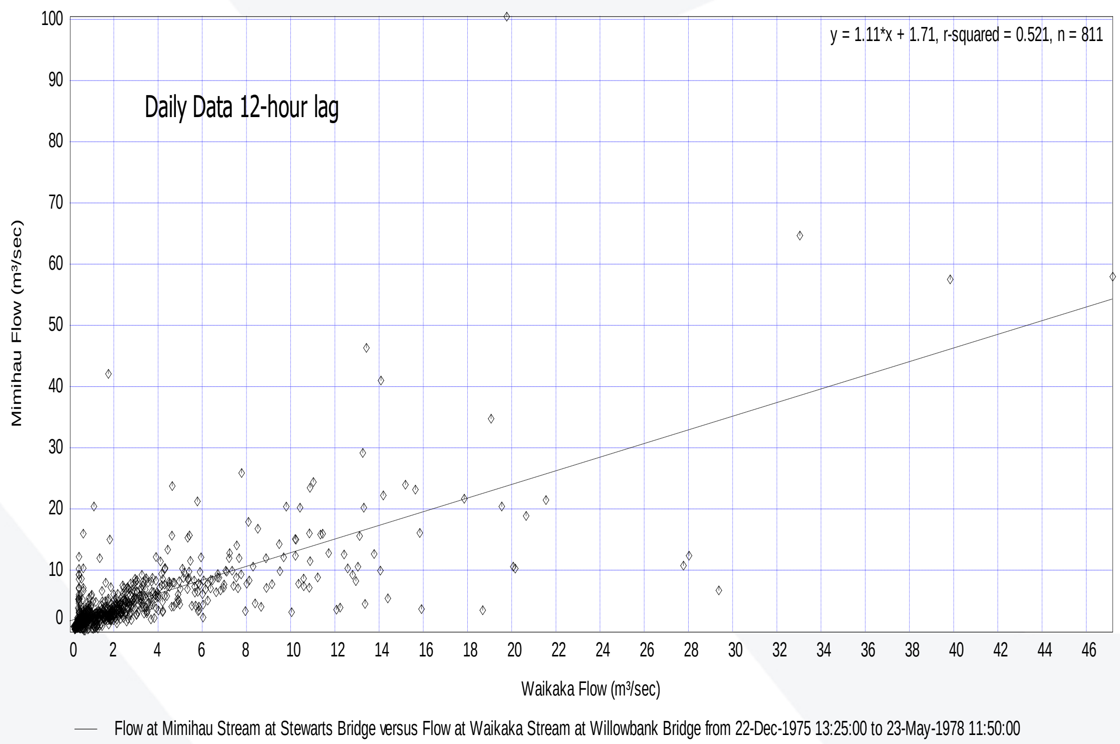


Figure B-3: Mimihau Stream flow relationship with Waikaka Stream at Willowbank Bridge (22 December 1975 to 23 May 1978).

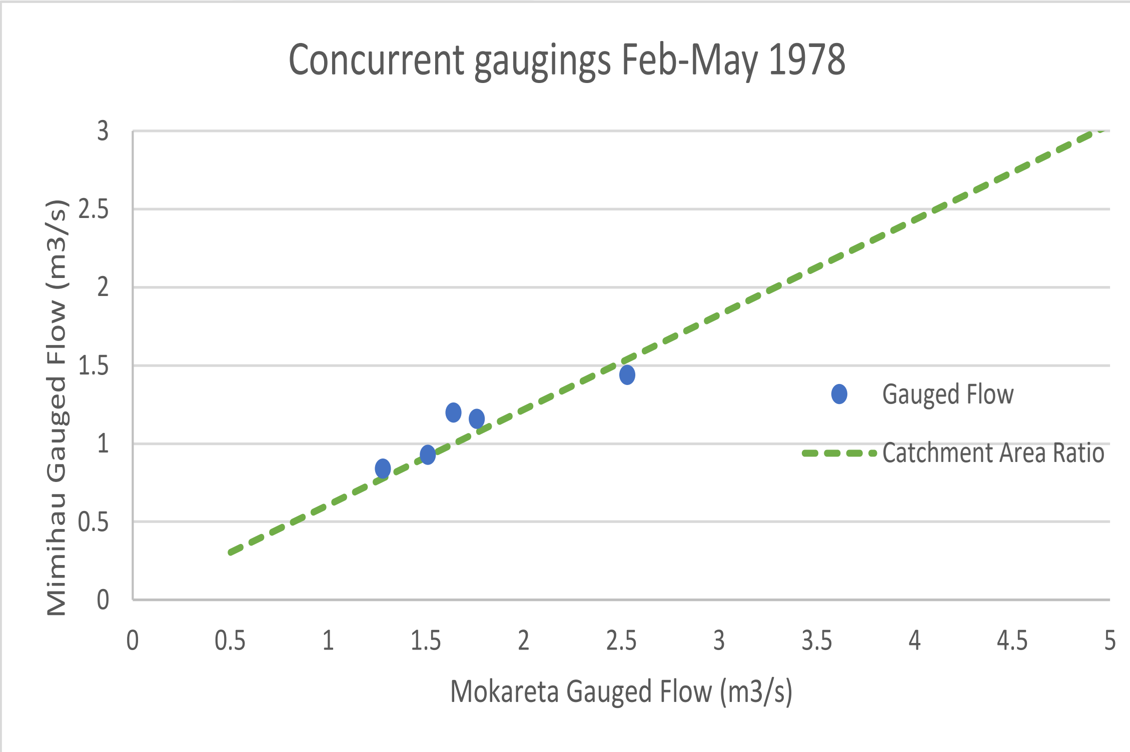


Figure B-4: Gauged flow relationship between Mimihau Stream with Mokoreta Stream at Crescent Bridge (2 February to 19 May 1978).

The short period of overlapping Mokoreta River flow record (Figure B-5) indicated that a relationship based on recorded flow (0.95) was better than the ratio based on catchment area (0.89). A relationship based on catchment area would under-represent the Crescent Road data. It is expected that the lower catchment would have a lower yield, but again, inaccuracy with the respective level measurements or flow ratings may explain some of this variation. The Mokoreta at Crescent Bridge recorded scaled by 0.95 will be ~7% higher than if scaled based on catchment area. However, the Mimihau record from July 1981 will be scaled directly from the Mokoreta at McKays record.

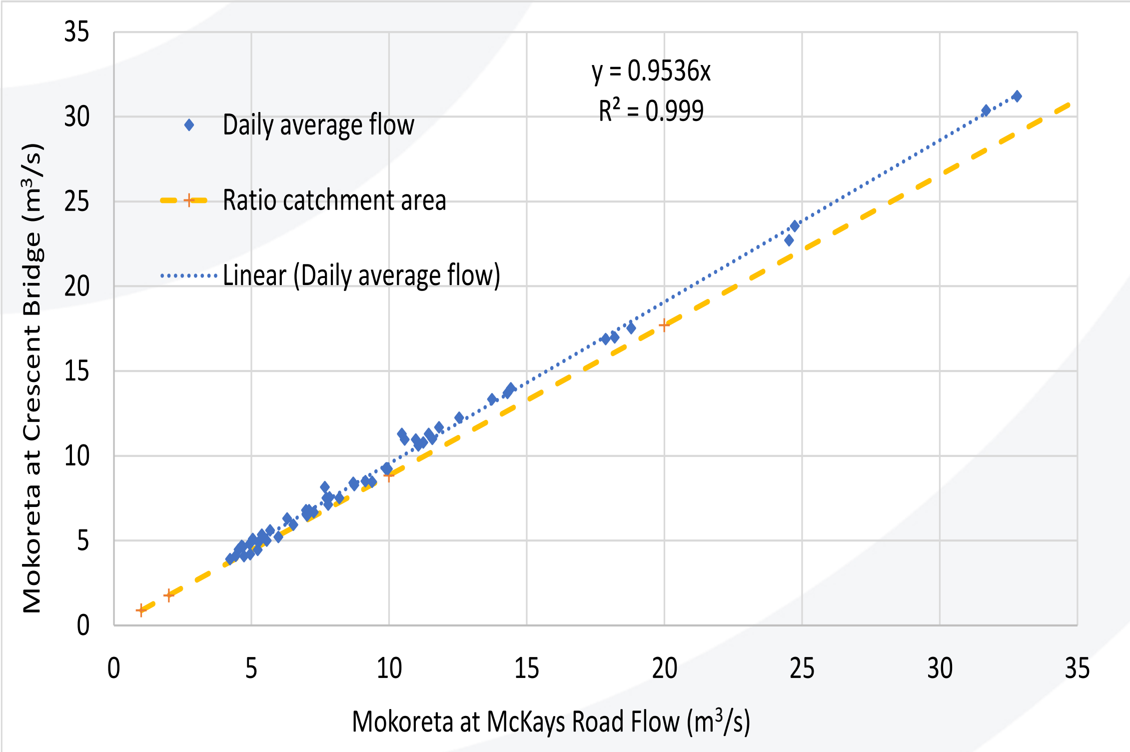


Figure B-5: Flow relationship between the Mokoreta River at Crescent Bridge and Mokoreta River at McKay Road record. Period of overlapping record 22 May 1981 to 12 July 1981.

The long term Mokoreta at McKays Road flow record does not overlap with the Mimihau record. Therefore, the Mimihau gauged record (2003 to 2019) was compared with the Mokoreta flow record. This indicated that a ratio based on catchment area (0.54) to represent the Mimihau at Stewarts Road Bridge from the McKays flow, would under-estimate Mimihau flow (Figure B-6, left graph). A relationship of "0.57 Mokoreta flow + 0.25 m^3/s" better represents this relationship (Figure B-6, right graph).

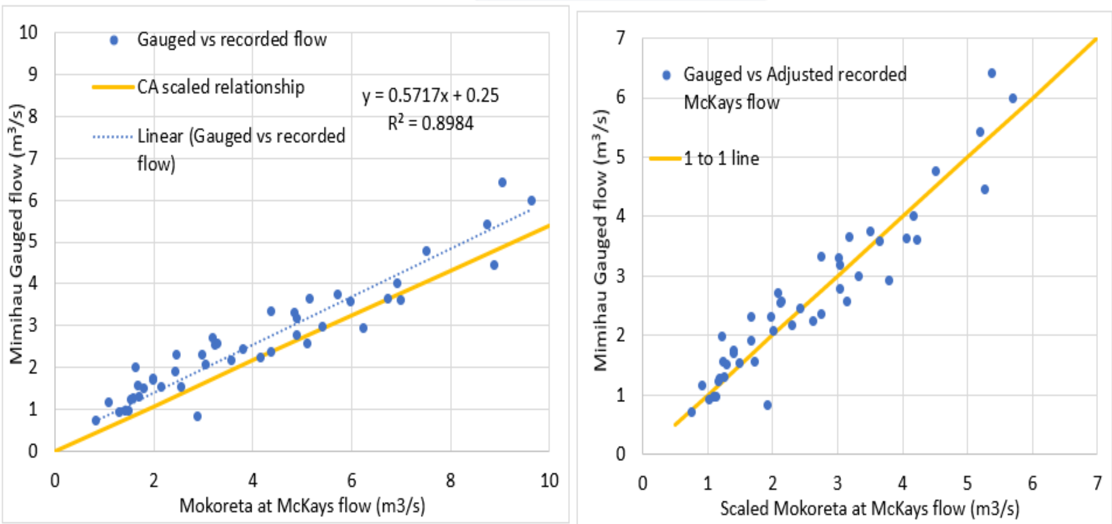


Figure B-6: Graph of the Mokoreta at McKays recorded flow and Mimihau gauged flow (left graph) and right Mokoreta flow scaled to better represent the gauged data. Data from 2003 to 2019.

The flow relationships used to derive an extended Mimihau flow at Stewarts Bridge are provided in Table B-1. Effectively the early record before 13 July 1981 is derived from the measured Mimihau at Stewarts Bridge or regressed from the Mokoreta at Crescent Bridge record. The record from 13 July 1981 is derived solely from the Mokoreta at McKays Road record.

Table B-1: Mimihau Flow Record Determination

Record	Relationship	Record Period
Mokoreta at Crescent Bridge (x_1)	$0.61x_1$ (flow <=$5m^3/s$) $0.36x_1 + 1.3$(flow >$5m^3/s$)	24 Dec 1974 to 22 Dec 1975
Mimihau at Stewarts Bridge	As recorded to 1 February 1978	22 Dec 1975 to 23 May 1978
Mokoreta at Crescent Bridge (x_1)	$0.61x_1$ (flow <=$5m^3/s$) $0.36x_1 +1.3$ (flow >$5m^3/s$)	23 May 1978 to 13 Jul 1981
Mokoreta at McKays Road (x^2)	$0.57x_2 + 0.25$	13 Jul 1981 to 2023

The derived Mimihau record based on Table B-1 relationship commences 24 December 1974.

The specific yield in the Mimihau and the adjacent Mokoreta catchments, especially for low flows, should be similar. In terms of low flow assessment, the series scaled directly from the Mokoreta at McKay's record may eliminate some of the uncertainty with the accuracy of the earlier record used to develop the flow relationships. For mid-range to flood flows, scaling by catchment area will derive much higher fresh and flood flows i.e. as illustrated in Figure B-1.

Appendix C

Flow Assessment

Appendix C: Flow Assessment

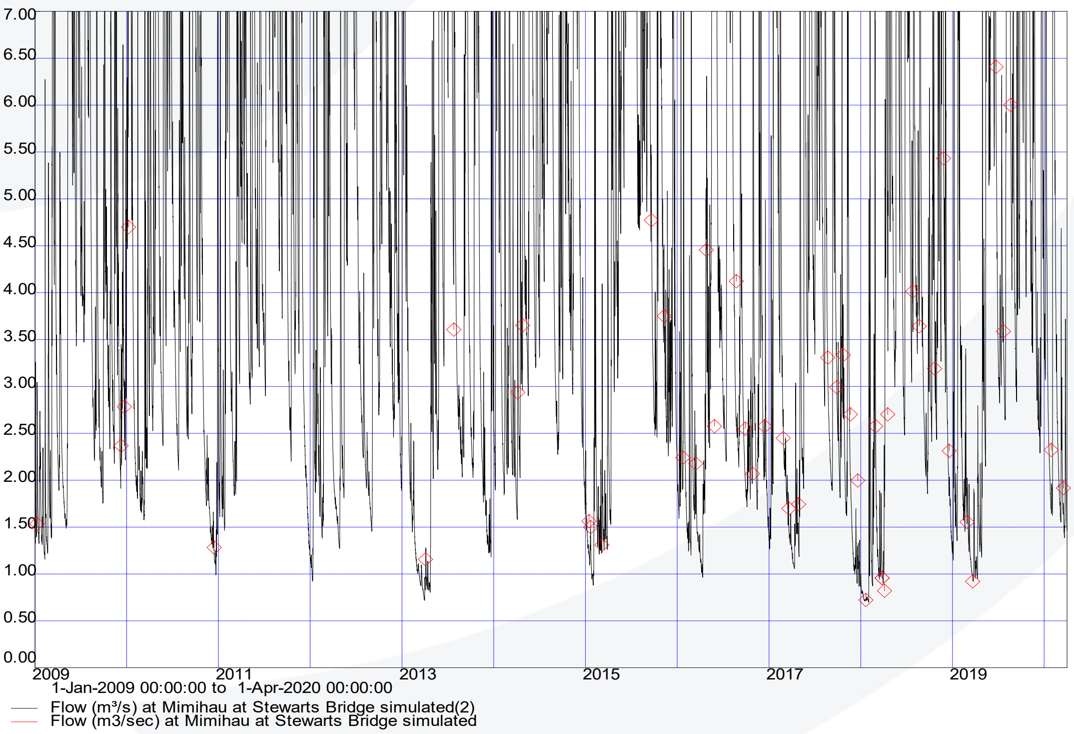


Figure C-1: Mimihau Stream at Stewarts Bridge gauged (red) and simulated data (black) by regression with Mokoreta at McKays. Period 1 January 2009 to 1 April 2020.

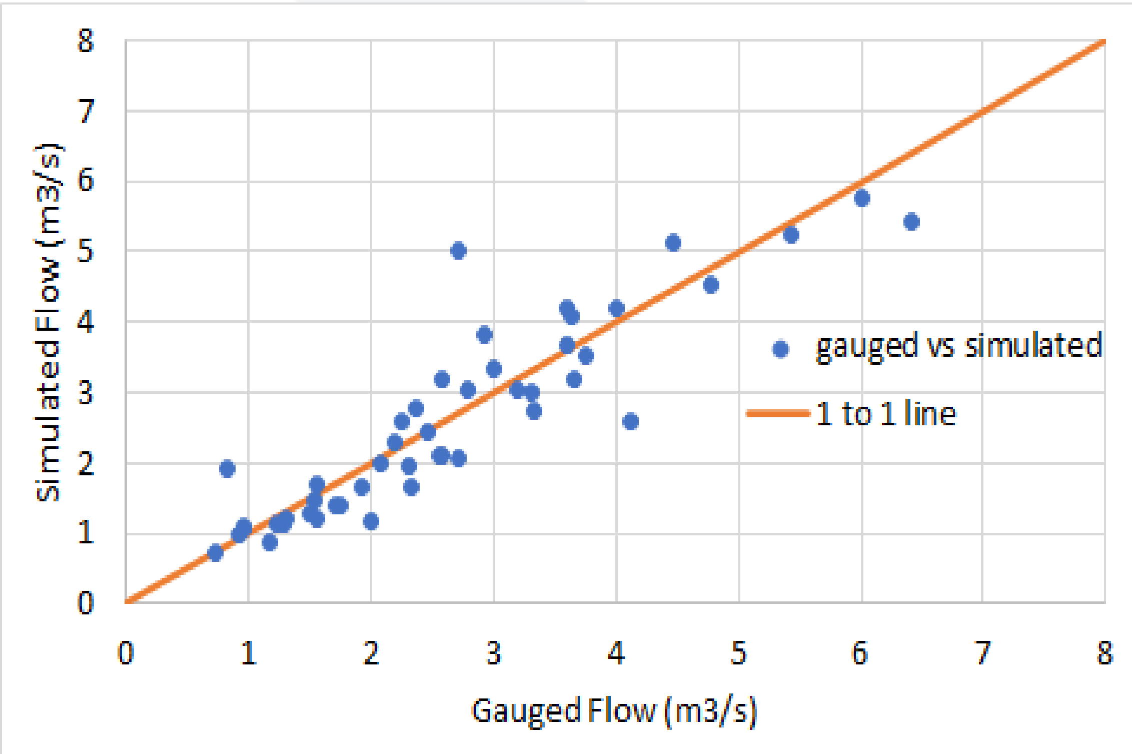


Figure C-2: Mimihau Stream at Stewarts Bridge gauged flow against the simulated data (by regression with Mokoreta at McKays). Period 25 March 2003 to 16 March 2020.

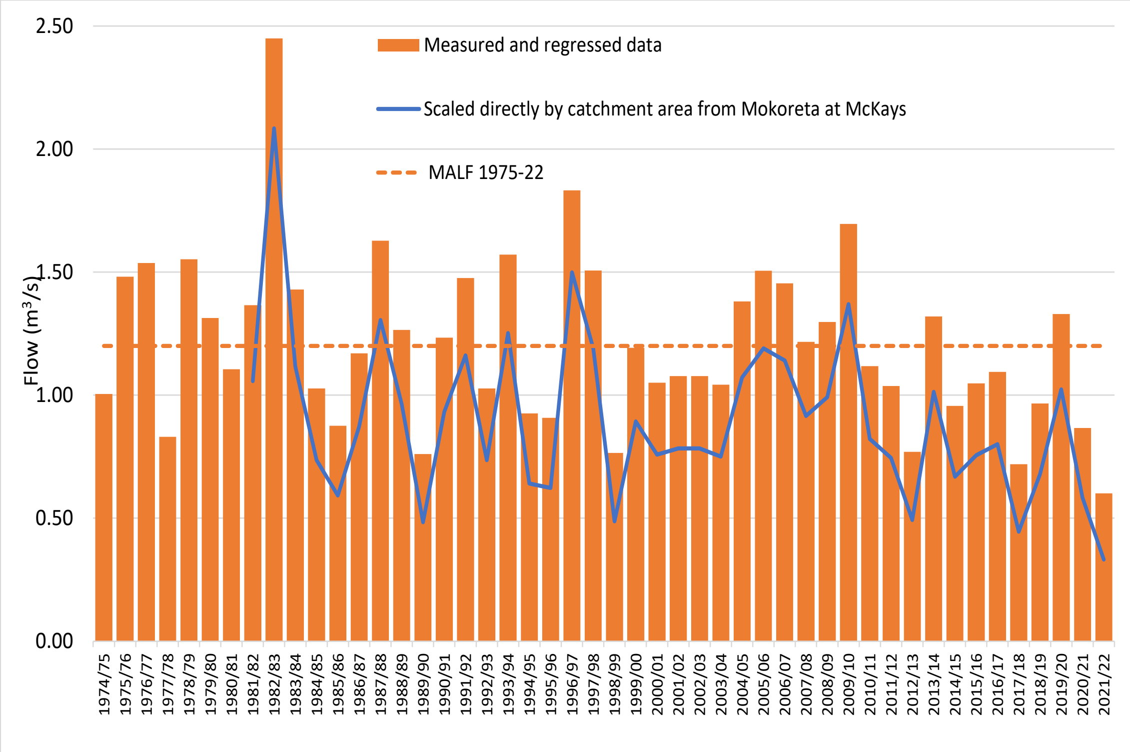


Figure C-3: Annual 7-day low flow from "measured and preferred regressions" and scaled by catchment area with Mokoreta at McKays. Period 1 January 1975 to 31 December 2022.

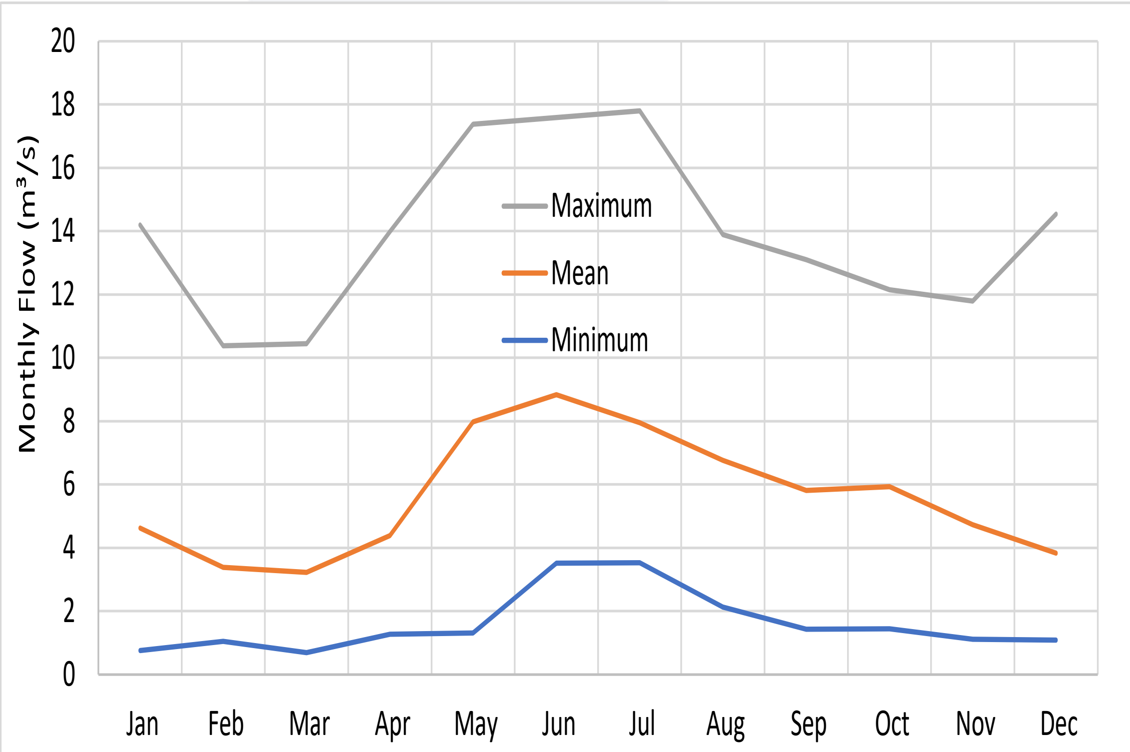


Figure C-4: Maximum, mean and minimum monthly flow by month for the Mimihau Stream at Stewarts Bridge simulated data. Period 1 January 1975 to 31 December 2022.

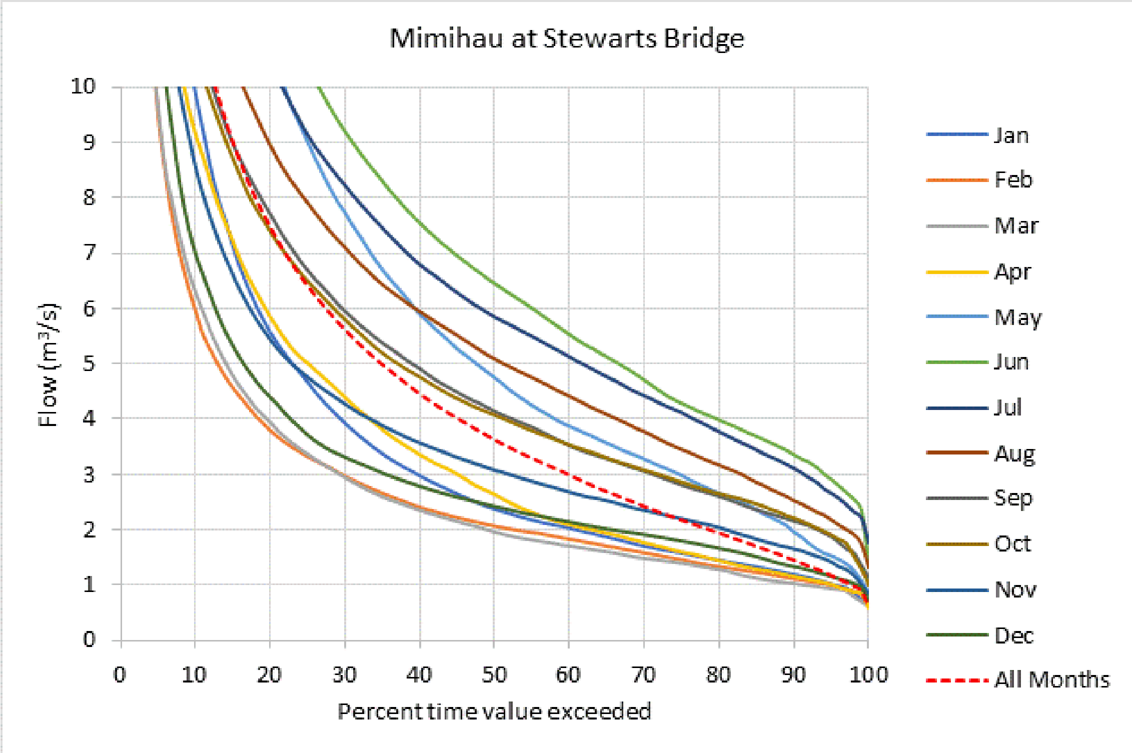


Figure C-5: Cumulative flow distribution by month for the Mimihau Stream at Stewarts Bridge simulated data. Hourly data for the period 1 January 1975 to 31 December 2022.

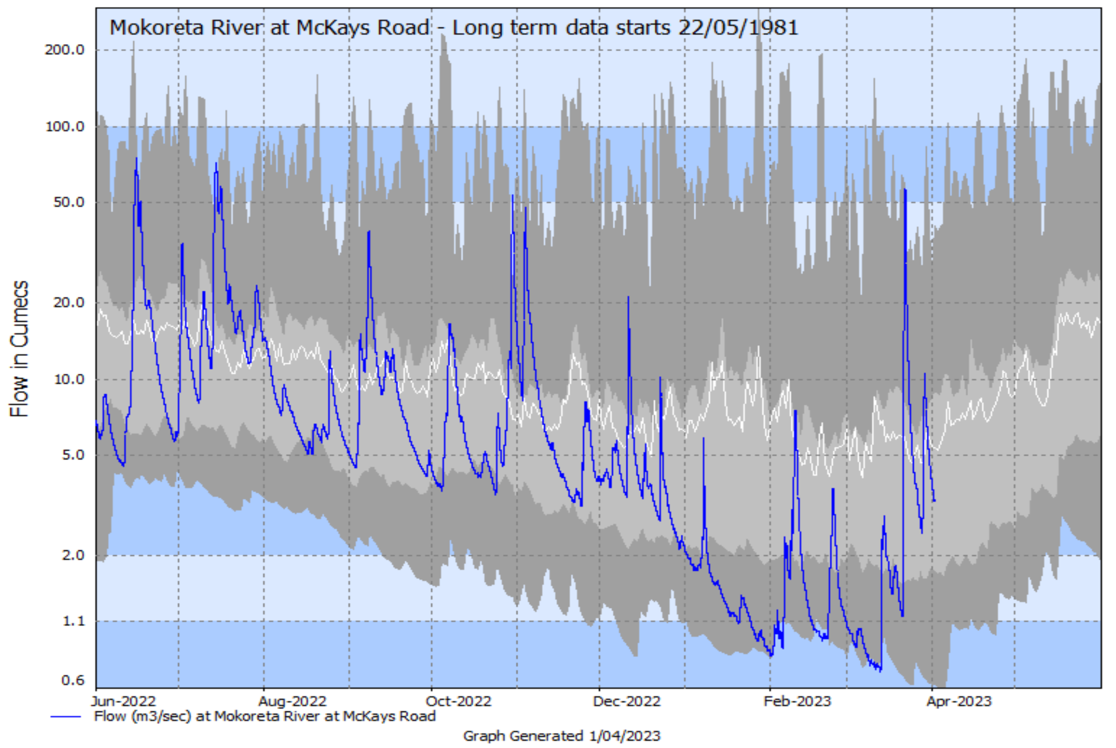


Figure C-6: Mokoreta at McKays Road flow since 1 June 2022 and long-term statistics (minimum, maximum, mean, and quartile flows).

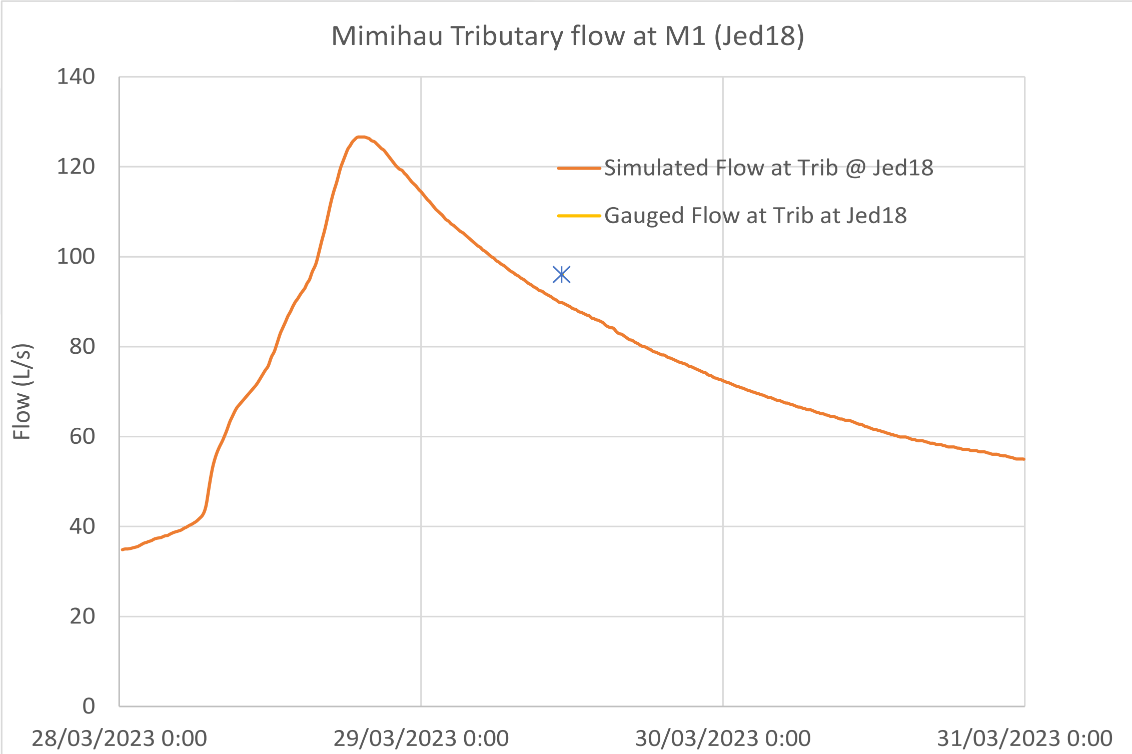


Figure C-7: Mimihau Stream flow at M1 ford simulated from Mokoreta at McKays flow and as gauged on 29 March 2023.

Appendix D

Mitchell Daysh Memo (30 January 2023)

MITCHELL DAYSH

Memorandum

To: Lennie Palmer and Riley

From: Mitchell Daysh Limited

Date: 30 January 2023

Re: Mimihau Wind Farm Water Take Permitted Activity Rules

Introduction

Contact Energy are proposing to establish a wind farm near Gore, described as the "Mimihau Wind Farm". As part of the proposal, Contact Energy need to obtain resource consent for a water take, potentially from the Mimihau Stream. The water take will primarily provide for water required during the construction phase, including road construction, dust control and concrete batching.

This memorandum outlines the consenting requirements for a water take, as outlined in the Southland Regional Water Plan (**"Operative Regional Plan"**) and the Proposed Southland Water and Land Plan (**"Proposed Regional Plan"**).

Mataura River Water Conservation Order

The Mimihau Stream is part of the Mataura River catchment, and as such, the Mimihau stream and its tributaries are subject to the Conservation Order for the Mataura River 1997 (**"the Mataura River Water Conservation Order"**). The Water Conservation Order includes the Mimihau Stream as being "protected water" and seeks to protect its outstanding fisheries and angling amenity features. The Mataura River Water Conservation Order sets restrictions relating to flow effects within the Mataura River, damming activities, and discharges. It requires that 95% of the flow remains in the "protected waters" above the Mataura Island Road bridge (and 90% below the Mataura Island Road bridge).

Information from the Southland Regional Council indicates that the Mataura catchment upstream of Gore (both its surface and groundwater resources) is overallocated under the Mataura River Water Conservation Order and the Proposed Southland Water and Land Plan. However, the site is situated below this area, and it seems that there is allocation available in the southern portion of the catchment.

Operative Regional Water Plan

The majority of the Operative Regional Plan was made operative in January 2010. The rules of relevance to the proposed Mimihau water take are outlined below. The limit on permitted takes from surface water bodies are set out in Rule 18 below. Any exceedance of these would trigger a consenting obligation.

Taking and Using Water

Rule 18 – Abstraction, diversion and use of surface water

a) In addition to the takes authorised by Section 14(3) of the Act and the abstraction, diversion and use of surface water permitted under Rules 18(b) and (c), the abstraction and use of up to 10,000 litres of surface water per landholding or per facility on public conservation land managed as such under the National Parks Act 1980, Conservation Act 1987, or the Reserves Act 1977 per day is a ***permitted activity*** *provided the following conditions are met:*

i. the rate of abstraction does not exceed 5 litres per second; and

ii. the abstraction and use does not result in adverse effects on existing water users, aquatic ecosystems or water quality; and

iii. fish are prevented from entering the reticulation system.

...

Proposed Southland Regional Water and Land Plan

Environment Southland are currently in the process of combining provisions from the Transitional Regional Plan, Regional Effluent Land Application Plan and Regional Water Plan into one document. This will form the Southland Regional Water and Land Plan.

The Proposed Regional Plan was made partially operative in January 2021. The Proposed Regional Plan is subject to appeals to the Environment Court, some of which are yet to be resolved and these provisions include those related to taking and using water. As a result of this outstanding appeal compliance with both the operative and proposed plan rules would be required to retain a permitted activity status for the proposed take. The permitted activity rules of the Proposed Regional Plan relevant to the proposed Mimihau water take are however outlined below.

Taking and Using Water

Rule 49[1] – Abstraction, diversion and use of surface water

[1] Appeal to Environment Court by (i) Meridian Energy Limited ENV-2018-CHC-000038; (ii) Alliance Group Limited ENV-2018-CHC-000039; (iii) Federated Farmers of New Zealand ENV-2018-CHC-000040.

Appendix E

Mitchell Daysh Emails (18 April 2023 and 28 April 2023)

Appendix E: Mitchell Daysh Emails
18 April 2023

Subject: RE: SFA variation - Mimihau hydrology - Permitted Take and storage

- There are no rules in the regional or district plans relating to the storage of water or limits to the volume of water storage.

- The Regional Water Plan defines a landholding as follows:

  (a) For land subject to the Land Transfer Act 1952, land in:

  (i) A single certificate of title; or

  (ii) Two or more adjoining certificates of title, with a common occupier.

  (b) For land not subject to the Land Transfer Act 1952, all contiguous land last acquired under one instrument of conveyance and occupied by a common occupier.

  The Rule states the permitted volume may be abstracted per landholding. Therefore, two water takes of up to 10,000 litres per day would be permitted if the water takes were within two separate landholdings, with a different landowner (i.e. Matariki Forests' property and Jedburgh Station's property). It would have to be confirmed that the abstraction and use will not result in adverse effects on existing water users, aquatic ecosystems or water quality, in accordance with the conditions of the Rule.
- If you were to construct a storage pond, for example, this may trigger rules in the District Plan relating to earthworks. The permitted earthwork volumes must not exceed $1000m^3$ per property or alter the ground level by more than 5m in depth, provided the earthworks are greater than 20m away from a waterbody. Therefore, if the storage pond requires earthworks greater than this volume, or will be deeper than 5m, resource consent will be required for a restricted discretionary activity.
- A water storage container (or facility) would meet the definition of a building, as defined in the Building Act, as a temporary or permanent movable or immovable structure. This is permitted in the District Plan provided that:
  - The maximum height of the building is 12m above natural ground level;
  - The height of the building in relation to the external property boundaries complies with the height in relation to boundary and height recession requirements of the District Plan;
  - The building does not exceed 1,500m2 in area;
  - The building is setback 4.5m from the boundary of a road.
  - If any of these standards are not met, resource consent is required for a restricted discretionary activity.

28 April 2023

Subject: RE: SFA variation - Mimihau hydrology - Permitted Take and storage

That is essentially what the rule says! Which I agree is very difficult for a permitted activity standard and a check box type approach. The rule is copied below for reference:

Rule 18 – Abstraction, diversion and use of surface water

a. In addition to the takes authorised by Section 14(3) of the Act and the abstraction, diversion and use of surface water permitted under Rules 18(b) and (c), the abstraction and use of up to 10,000 litres of surface water per landholding or per facility on public conservation land managed as such under the National Parks Act 1980, Conservation Act 1987, or the Reserves Act 1977 per day is a permitted activity provided the following conditions are met:

    i. the rate of abstraction does not exceed 5 litres per second; and

    ii. the abstraction and use does not result in adverse effects on existing water users, aquatic ecosystems or water quality; and

    iii. fish are prevented from entering the reticulation system.

I think provided you comply with the limits set out in this rule then that would be sufficient. Another guide to use here would be to refer to the proposed plan rule, which is a lot more certain, as follows – however that rule is still subject to an appeal so can't be relied upon on its entirety, but we can say that by complying with these obligations we should also be achieving the "no adverse effects" test in the operative permitted activity rule.

Rule 491 – Abstraction, diversion and use of surface water

ab) Despite Rule 49(a), the take and use of surface water for infrastructure construction, maintenance and repair is a permitted activity provided the following conditions are met:

    i. the rate of take does not exceed 15 litres per second;

    ii. the volume of take does not exceed 100,000 litres per day;

    iii. the bed of the watercourse from where the take occurs is at least 1 metre wide and the depth of flow in the watercourse at that location exceeds 0.5 metres at the time of the take;

    iv. the take does not occur for more than 45 consecutive minutes and multiple takes from the same site on a single day are at least 30 minutes apart;

    v. the point of abstraction is not located within 50 metres of any existing lawfully established surface water take;

    vi. the Southland Regional Council is notified at least three working days prior to the take commencing;

    vii. the take occurs between 1 September and 31 March inclusive; and

    viii. fish are prevented from entering the water intake in accordance with Appendix R.

Appendix F

Hydrological Monitoring Memo

Roaring40s
steve@roaring40s.co.nz

13 September 2023

Our Ref: 220372-A

Attention: Mr Steve Harding

Dear Mr Harding

Mimihau Hydrological Monitoring Site Visit (29-30 March 2023)

1.0 Introduction

Riley Consultants Ltd (Riley) has been engaged by Roaring40s to undertake flow measurements and install stream water level monitoring in the Mimihau Stream. This monitoring is associated with; water take assessment (for construction activities) and stream flood levels (for bridge and culvert design). The following memo summarises details associated with installed monitoring locations and the flow gaugings.

Riley was accompanied and assisted at site with personnel from either Roaring40s or Contact Energy Ltd.

2.0 Site Visit Summary

The Mimihau Stream site visit was completed on 29-30 March 2023.

Three Mimihau Stream level monitoring locations were established at;

- M1 – tributary of the Mimihau South Branch. Purpose to assist with the water take assessment.
- M2 – upper Mimihau South Branch. Purpose to assist with flood assessment.
- M3 - upper Mimihau North Branch. Purpose to assist with flood assessment.

One barometric logger (M-Baro) is located in the Venlaw station ATV shed.

Figure 1, Figure A-1 and Figure A-2 provides the site locations. Table A-1 provides site photographs and Table A-2 site description and GPS locations.

The Mimihau Stream was waded gauged using a Flow Tracker[1] at all three Stream locations, with an additional gauging on the Mimihau Stream at Waiarikiki Road Bridge. The Flow Tracker gaugings had 24+ vertical measurements with no vertical measurement representing more than 10% of the flow. The Flow Tracker NEMS[2] flow measurement quality would be assessed as good. However, a qualitative assessment is also provided to assess the relative quality between the gaugings based on site conditions, i.e. cross-section, velocity angle, turbulence, upstream conditions etc. The quality of Flow Tracker gaugings based on site conditions were good.

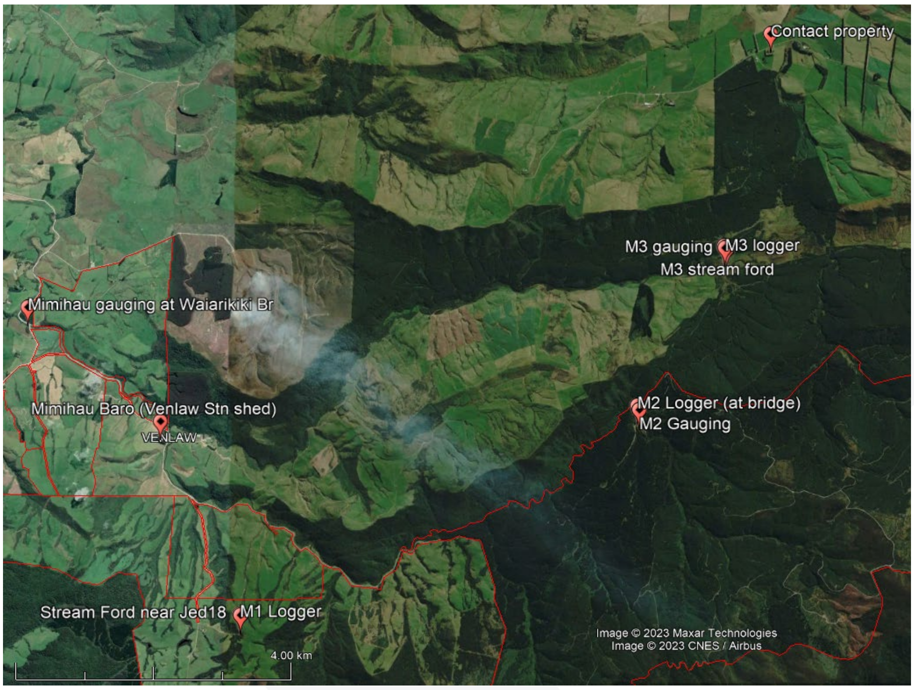


Figure 1: Mimihau Stream Gauging and Tributary Locations

Table 1 summarises the Mimihau Stream flow and level measurements undertaken this visit, and Table A-2 provides photographs taken at the gauging and logger locations.

Mean water temperature for the Mimihau Stream flow gauging were between 6.1°C and 6.7°C for the upper catchment sites, and 7.8°C for the Waiarikiki Bridge location. All loggers are set on 15-minute timesteps.

Flows across the catchment were receding from a small fresh that peaked late on the 27 March 2023. Figure 2 illustrates the flow in the adjacent Mokoreta catchment at the Southland Regional Council (SRC) site at McKays Road. The flow and gauging information presented here will be incorporated into the hydrological assessment for the Mimihau catchment.

Further information can be provided to that presented here. If you have any queries, please do not hesitate to contact the undersigned.

[1] Acoustic Doppler Velocity (ADV) measurement instrument
[2] As required by National Environmental Monitoring Standards (NEMS) Open Channel Flow Measurement v1.1 (2013) for "Good Quality" flow measurements

Table 1: Mimihau Stream Gauging Summary (29 and 30 March 2023)

General	Weather conditions cloudy, cold, some breeze. Both days. All sites except M3 visited on 29 March 2023. Flow Tracker P2850; Software 2.3 and Firmware 3.9.				
Location	**Start Time (NZST)**	**End Time (NZST)**	**Flow (L/s)**	**Stage Readings**	**Comments**
M1 (Mimihau Logger 1. Venlaw Station Property) 29 March	1034	1117	**96**	10:25 -323mm	Distance from top of lateral waratah to water surface (Table A-1, Photo 2 and 4). A stage of 1.0m for this point. Thus, stage will be 1.0m -0.323m and is 0.677m. Gauged 4m upstream logger location. Water Temperature 6.5°C.
M2 (Mimihau Logger 2. Forestry Property) 29 March	1325	1403	**209**	14:15 Short waratah -235 Long waratah -1025mm	Distance from top of short waratah to water surface (Table A-1, Photo 6). A stage of 1.0m for this point. Thus, stage will be 1.0m -0.235m and is 0.765m. Gauged approx 80m upstream Bridge, 20m upstream ford. Small left bank trib between gauging and bridge flowing at 2L/s Water Temperature 6.7°C.
M3 Mimihau Logger 3. Forestry Property 30 March	0938	1010	**167**	09:15 Short waratah -288 Long waratah -458mm	Distance from top of short waratah to water surface (Table A-1, Photo 6). A stage of 1.0m for this point. Thus, stage will be 1.0m -0.288m and is 0.712m. Stream gauged approx 30m upstream logger Water temperature 6.1°C.
M-Baro (Mimihau Barometric Logger) 29 March	-	-	**-**	-	Installed in shed approx 11:00 NZST
Mimihau Stream at Waiarikiki Road Bridge 29 March	1514	1553	**1247**	-	Gauged 20m downstream bridge Water slightly discoloured – flows up a bit. Water Temperature 7.8°C.

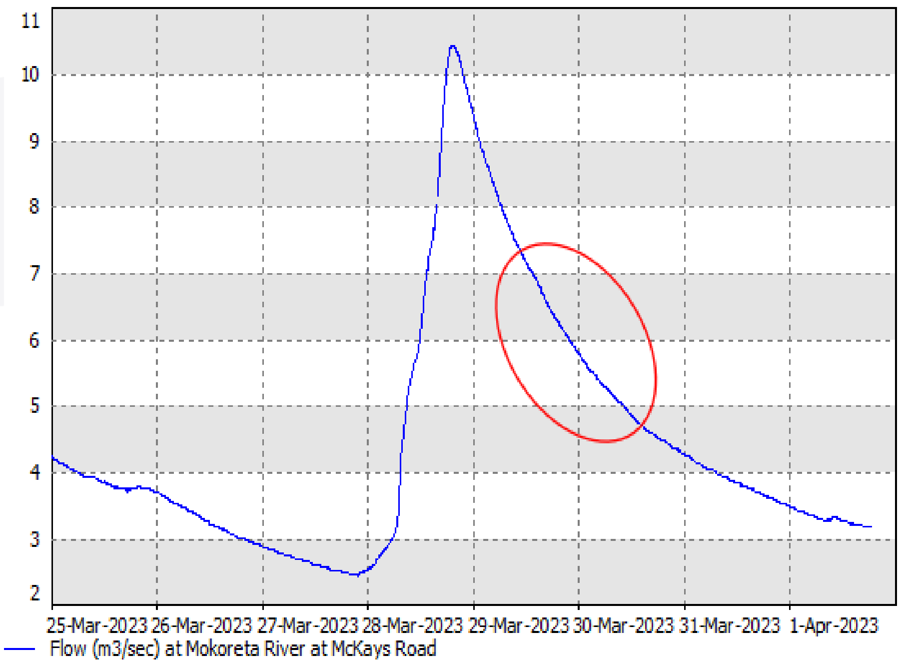


Figure 2: Mokoreta River at McKays Road flow over the period of gaugings (circled). Source SRC website.

3.0 Limitation

This letter report has been prepared solely for the benefit of Roaring40s as our client, with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

The analyses and recommendations contained in this letter report are based on our understanding and interpretation of the available information. The recommendations are therefore subject to the accuracy and completeness of the information available at the time of the study. Should any further information become available, the analyses and findings of this assessment should be reviewed accordingly.

Yours faithfully
Riley Consultants Ltd

Prepared by:	Reviewed by:	Approved for issue by:
Lennie Palmer	Thomas Fritz	Paul Rivett
Principal Hydrologist	**Principal Water Resource Engineer**	**Project Director, CPEng**

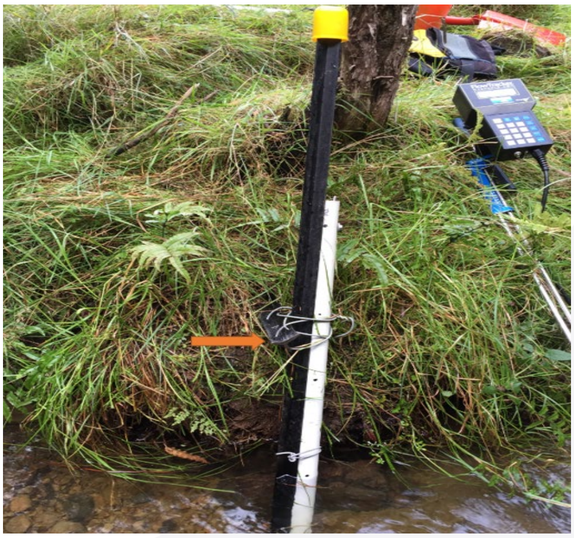
Enc: Additional Information

Additional Information

Figure A-1: M1 (left figure) and M2 (right figure) logger location

Figure A-2: M3 (left figure) and M-Baro (right figure) logger location

Table A-1: Photographs – Mimihau Stream Logger and Gauging Locations

Mimihau 1 - Logger Location	
 Photo 1: Upstream view from logger location and gauged section.	 Photo 2: Logger housed in plastic pipe attached to waratah. Reference level to the water surface taken from lateral waratah (as indicated).
 Photo 3: Downstream view of gauged section and logger location.	 Photo 4: Level taken from lateral waratah (as indicated) as distance to water surface.

Mimihau 2 - Logger Location

Photo 5: View downstream from logger location.

Photo 6: Logger housed in plastic pipe attached to waratah. Level taken from top of short waratah (as indicated) as distance to water surface.

Photo 7: View upstream across section where gauged.

Photo 8: View downstream where gauged.

Photo 9: View upstream from logger location.

Mimihau 3 - Logger Location

Photo 10: View upstream towards logger.

Photo 11: Logger housed in plastic pipe attached to waratah. Level taken from top of logger waratah and top of lateral waratah (as indicated) as distance to water surface.

 Photo 12: View downstream from logger location.	 Photo 13: Flood debris in fence 1m above water level. Location above gauging section (Photo 14)
 Photo 14: View upstream where gauged	 Photo 15: View downstream where gauged.

Mimihau Baro - Logger Location	
 Photo 16: Baro logger hanging on nail inside locked shed (that houses the ATV).	

Mimihau at Waiarikiki Road Bridge Gauging	
 Photo 17: View upstream where gauged towards Bridge.	 Photo 18: View upstream where gauged.

Photo 19: View downstream where gauged.

Table A-2: Mimihau Catchment Logger Location Details

ID	Location	Latitude	Longitude	Comment
Mimihau Stream Locations				
M1	Mimihau Logger 1. Venlaw Station Property	-46.320348°	169.035455°	Left bank, ≈20m downstream ford. Located on Venlaw Farm property. Access of Thornhill Road. At location near proposed JED18.
M2	Mimihau Logger 2. Forestry Property	-46.292807°	169.109434°	Right Bank, immediately upstream bridge. Forestry property/Road. Access via Venlaw Road Logger waratah attached to upmost gabion.
M3	Mimihau Logger 3. Forestry Property	-46.271530°	169.126020°	Left bank, ≈30m upstream ford. Forestry property/Road off Davison Road East.
M-Baro	Mimihau Barometric Logger	-46.294906°	169.018741°	Located in Venlaw Station lock-up shed. Same shed AVR stored. Inside near access door.
	Other - Gauging			
	Mimihau Stream at Waiarikiki Road Bridge	-46.279434°	168.992769°	Gauged 20m downstream Wairikiki Road bridge

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