Hydrology Report

Reefton Power Scheme Restoration

23 NOVEMBER 2012

Prepared for

Inangahua Tourism Promotions Incorporated

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Introduction

1.1 Background

Reefton Power Station was initially completed 4 August 1888 and became the first public electricity supply in New Zealand and the southern hemisphere. This hydro scheme diverted water from Inangahua River between Blacks Point and Reefton. It was decommissioned in 1961 and has been registered by the New Zealand Historic Places Trust as a Category 2 historic place.

As part of the 125th anniversary of Reefton Power Station, it is proposed that this hydro scheme be reinstated as a community initiative to promote tourism in the area as well as generate revenue from hydroelectricity. As part of this, a new visitors and learning centre would be constructed to provide an on-site interactive educational experience, with the mains power sourced from Reefton Power Station. Power generated from this station may also supply the heritage lighting in Broadway in Reefton, when available.

1.2 Report Scope

This report provides a hydrological analysis to support the resource consent application to divert, use and discharge water from Inangahua River for the proposed Reefton Hydro Power Station restoration project. The report is structured as follows:

Section 2 provides an overview of the proposed scheme;

Section 3 defines the minimum river flows permitted under the regional plan as well as the existing hydrological conditions between the scheme intake and discharge points; and

Section 4 provides a brief analysis of the hydrological effects of the proposed scheme (between the scheme intake and discharge points) under different river flow scenarios.

2

Proposed Hydro Scheme

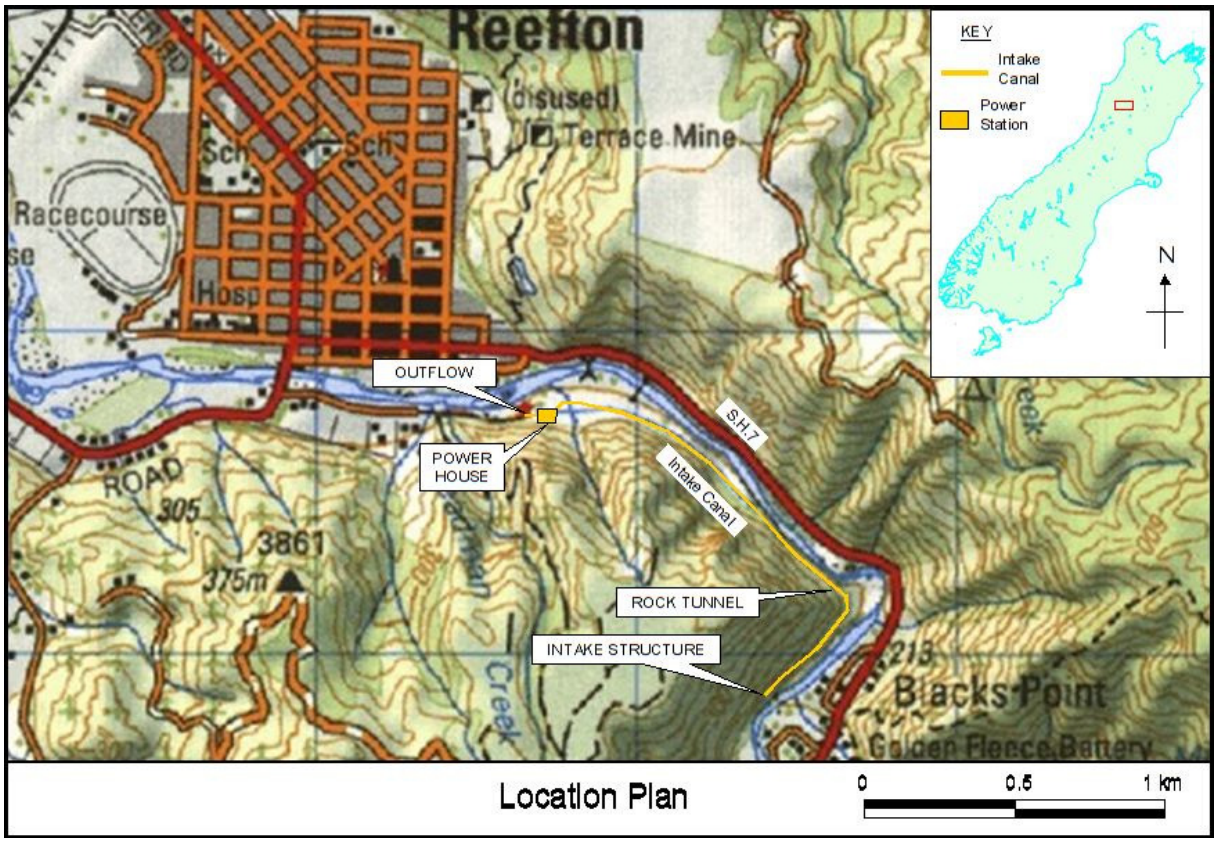
2.1 Scheme Description

The Reefton Power Scheme (Figure 2-1) is located on the south bank of the Inangahua River. It consists of a run-of -river hydropower scheme which diverts part of the river flow along a 2 km stretch between the intake at Blacks Point and the outflow point opposite Reefton township.

The Reefton Power Scheme is proposed to consist of the following key elements:

- A 3.5 m^3/s concrete intake structure founded in rock on the south bank of the Inangahua River, opposite the Blacks Point township;
- Approximately 2 km of canal, tunnel, and short length of wooden flume that conveys water from the intake to the power station;
- A power station containing the turbines and generating sets, switchboards and controls;
- A tailrace that discharges the water back to the Inangahua River; and
- A transmission line linking the power station with the town of Reefton.

Figure 2-1 Reefton Power Scheme Layout



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Current Site Conditions

3.1 Regulatory Considerations

Based on Policy 7.3 (specifically 7.3.2) of the West Coast Regional Council's Regional Land and Water Plan, 75 % 7-Day Mean Annual Low Flow (7MALF) is taken to be the minimum permitted river flow at the site. No rules around flow sharing above this value could be identified and it has been assumed that all water (up to the intake capacity) may be taken above the minimum value.

3.2 Hydrology

Flow data for the site was obtained from the Inangahua River at Blacks Point (Site 93207) flow gauge owned by the National Institute of Water and Atmospheric Research (NIWA). It is located approximately 2 km upstream of Reefton township, adjacent to the proposed scheme intake. (Figure 3-1) and has a total catchment area of 233 km^2 (as estimated from NIWA Water Resources Explorer). The available record runs for approximately 47 years, from 15 May 1965 to 13 November 2012, and has no gaps. As the flow gauge site is 1 km downstream of the proposed hydro intake at Inangahua River (with no significant flow addition between the intake and flow gauge sites), the historical flow gauge data is assumed to be representative of the expected flows at the intake site. No climate change analysis was undertaken for this report.

Figure 3-1 Flow Gauge Location

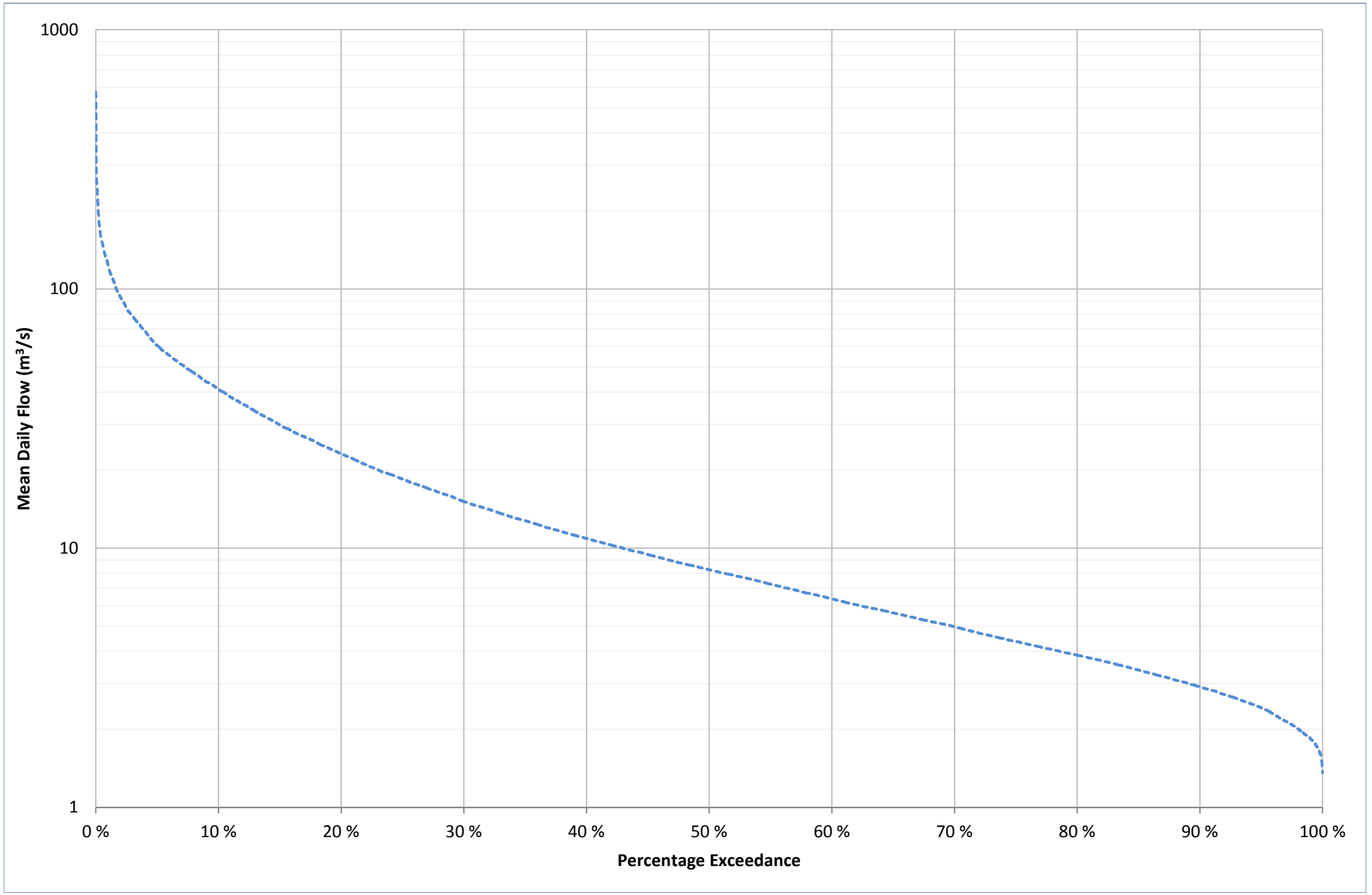
3 Current Site Conditions

Based on key statistics from historical daily mean flows (Table 3-1), the mean flow is estimated at 17 m^3/s, with a mean specific runoff of 0.073 $m^3/s/km^2$ for the contributing catchment. The median flow, at 8 m^3/s is approximately half of that of the mean flow. This is consistent with the general flow characteristics where the peak flow, at 575 m^3/s, is significantly higher than the 75th percentile flow of 18 m^3/s, indicating the susceptibility of the river to occasional flash floods up to an order of magnitude higher than its regular flows (Figure 3-2). The 7 Day Mean Annual Low Flow (7MALF), calculated at 2.3 m^3/s, is based on a hydrological year running from 1st September to 31st August each year.

The 7 Day Annual Low Flows for the length of the flow record do not display significant long term trends (Figure 3-3) and hence the 7MALF calculated from this record is considered a reasonable representation of the expected minimum flows.

Table 3-1 Summary Statistics for Daily Mean Flows at Inangahua River at Blacks Point (Site 93207)

Catchment Area (km^2)	Mean Specific Runoff ($m^3/s/ km^2$)	7-Day Mean Annual Low Flow (m^3/s)	25th Percentile Flow (m^3/s)	Median Flow (m^3/s)	Mean Flow (m^3/s)	75th Percentile Flow (m^3/s)	Peak Flow (m^3/s)
233.4	0.073	2.3	4.4	8.3	17.0	18.5	574.8



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NATURAL FLOW DURATION CURVE FOR INANGAHUA RIVER AT BLACKS POINT

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Figure: 3-2

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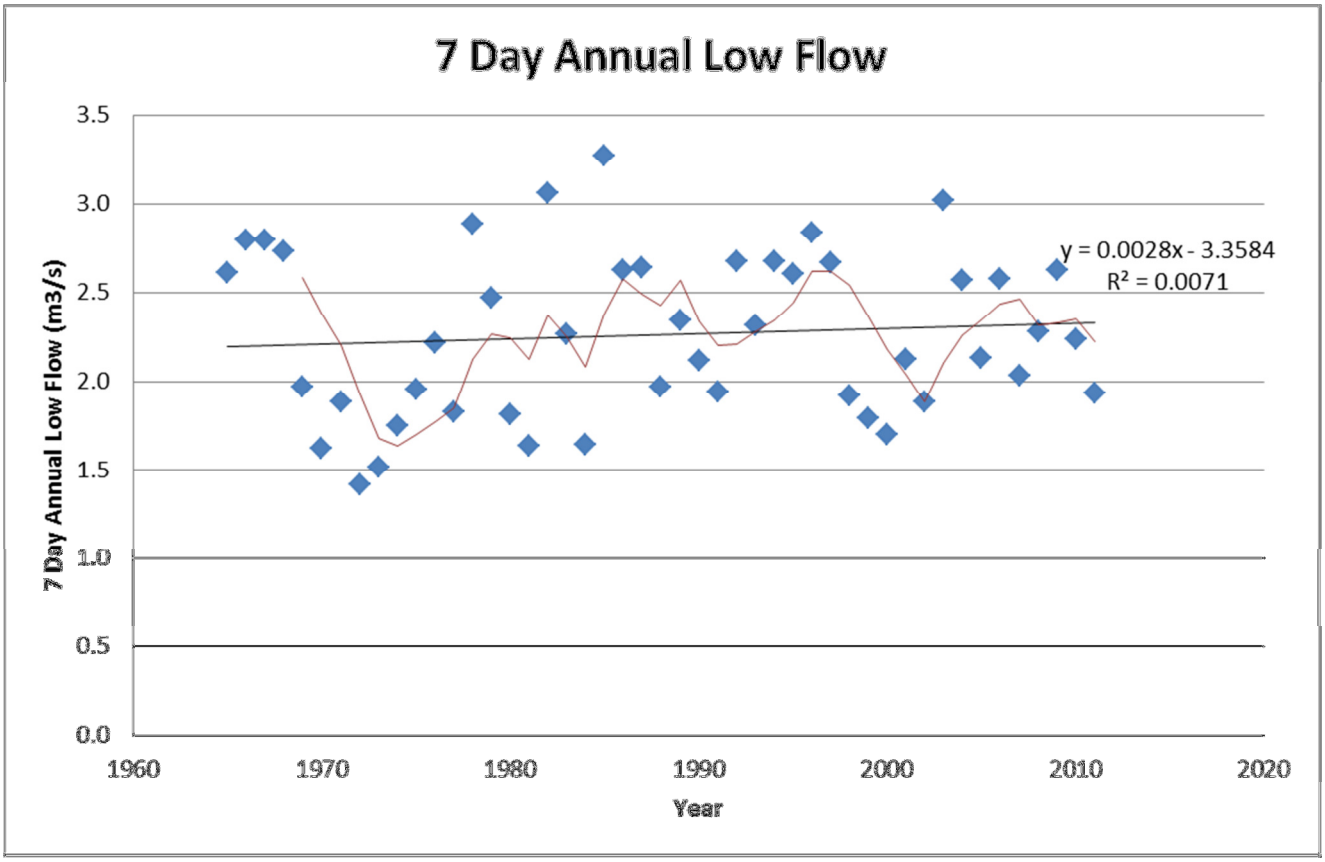
3 Current Site Conditions

Figure 3-3 7 Day Annual Low Flow for Inangahua River at Blacks Point (Site 93207)



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Hydrological Effects of Proposed Scheme

A base case scenario has been selected, based on a minimum flow set at 75 % of the 7MALF. A sensitivity analysis has then been undertaken with three different scenarios of increasing minimum flows to determine its effects on river hydrology and scheme available water. These scenarios and their respective outcomes are explained below in Section 4.1 and 4.2. For all scenarios, the maximum intake capacity at Blacks Point is assumed to be 3.5 m^3/s.

It is important to note that any effects described below occur only over the 2 km stretch of river between the intake at Blacks Point and discharge location opposite Reefton township. The proposed take is non-consumptive, therefore all water taken is returned to the river.

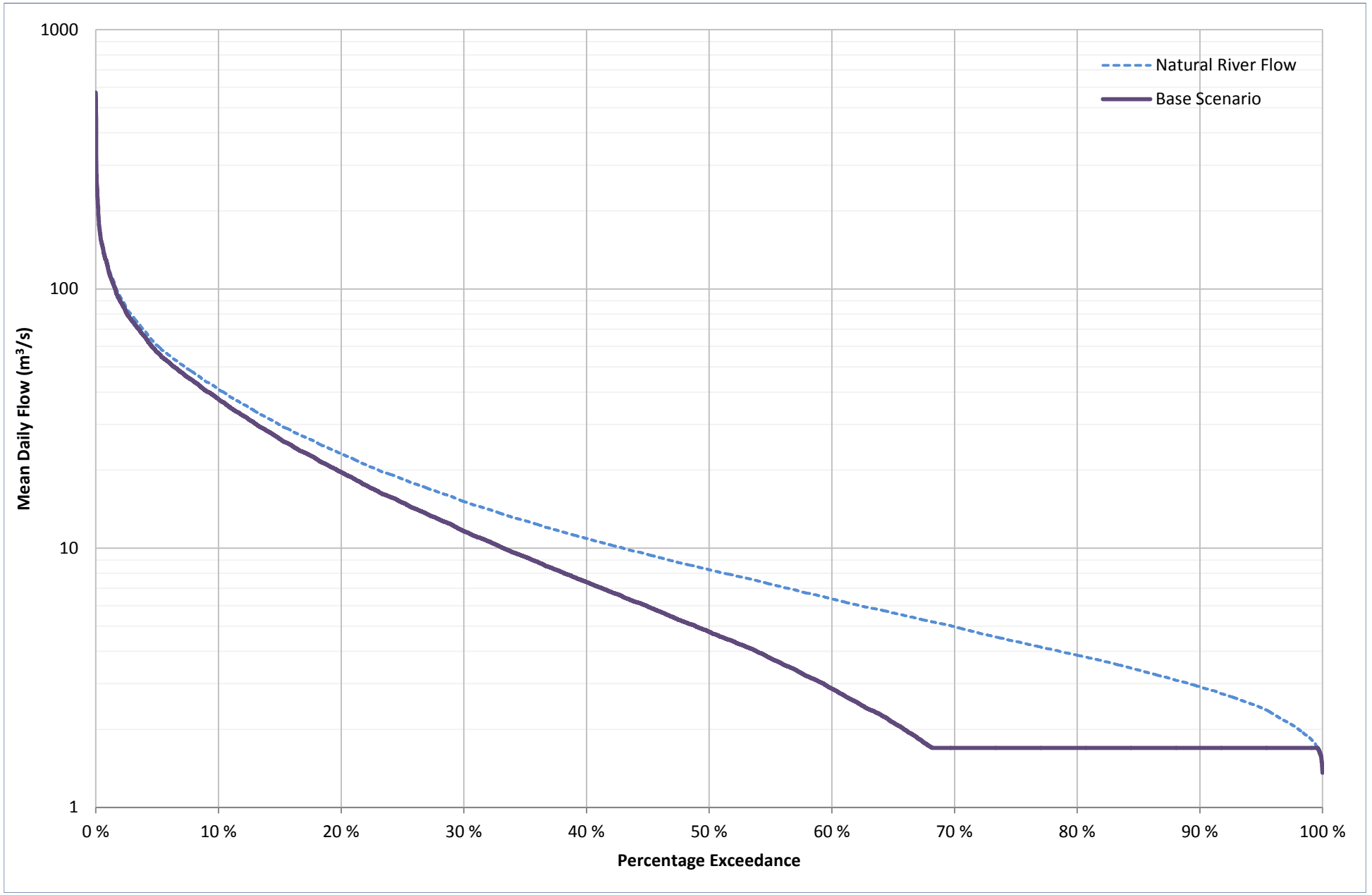
4.1 Base Scenario

Under the base scenario, no flow take will occur when the Inangahua River is at or below 75% of the 7MALF. Based on the Inangahua at Black Point (Site 93207) flow record, this 75% 7MALF value is 1.7 m^3/s. Any flow exceeding this minimum flow will be diverted, up to a maximum of 3.5 m^3/s (the proposed intake capacity). Hence, the base scenario represents the maximum flow that can be abstracted under current regulatory requirements.

Based on the model output for river flows (Table 4-1 and Figure 4-1), flood flows exceeding the 75th percentile flow will not be significantly impacted by the hydro scheme as the base scenario and natural river flows tend to converge at higher flows. There will be a 17 % reduction at mean flows and 26 % reduction at 7MALF low flows under the base scenario compared to the natural river flows. Under this base scenario, the hydro station is expected to be operating at full capacity 68 % of the time (Figure 4-2). On average, power generation at full capacity is expected to occur more than two thirds of the time between the months of May to December, and about half the time between the months of January to April (Figure 4-3). Any routine maintenance would therefore be best undertaken during the low flow months between January to March.

Table 4-1 Base Scenario Summary Statistics (Daily Mean Flows)

Flow Type	7MALF (m^3/s)	25th Percentile Flow (m^3/s)	Median Flow (m^3/s)	Mean Flow (m^3/s)	75th Percentile Flow (m^3/s)	Peak Flow (m^3/s)
Natural River Flow (Above intake)	2.3	4.4	8.3	17.0	18.5	574.8
Natural River Flow (Below intake)	1.7	1.7	4.8	14.0	15.0	571.3
Diverted Flow to Power Station	0.6	2.7	3.5	3.0	3.5	3.5



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INANGAHUA RIVER FLOW DURATION CURVE FOR BASE SCENARIO

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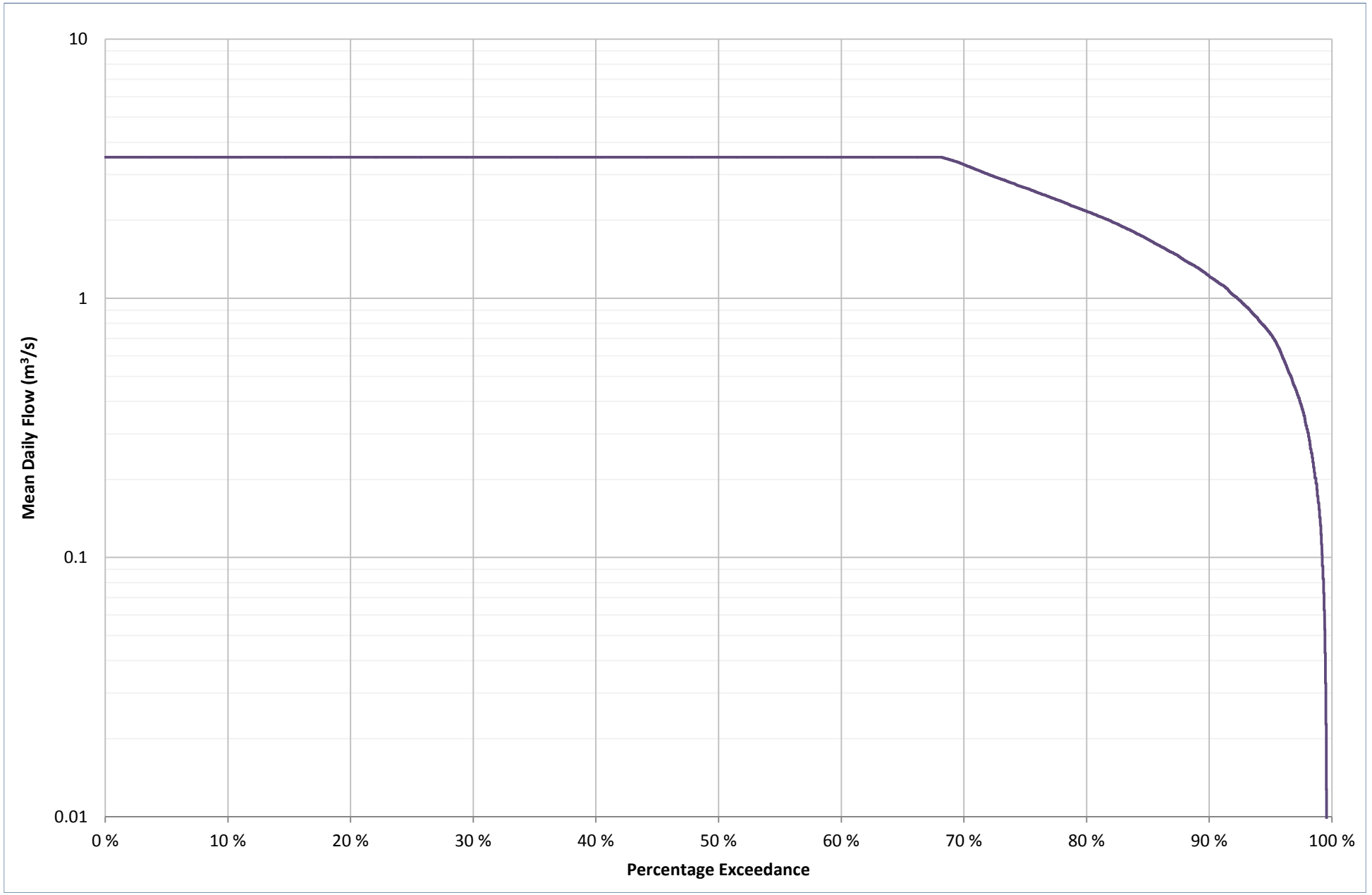

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HYDRO STATION FLOW DURATION CURVE FOR BASE SCENARIO

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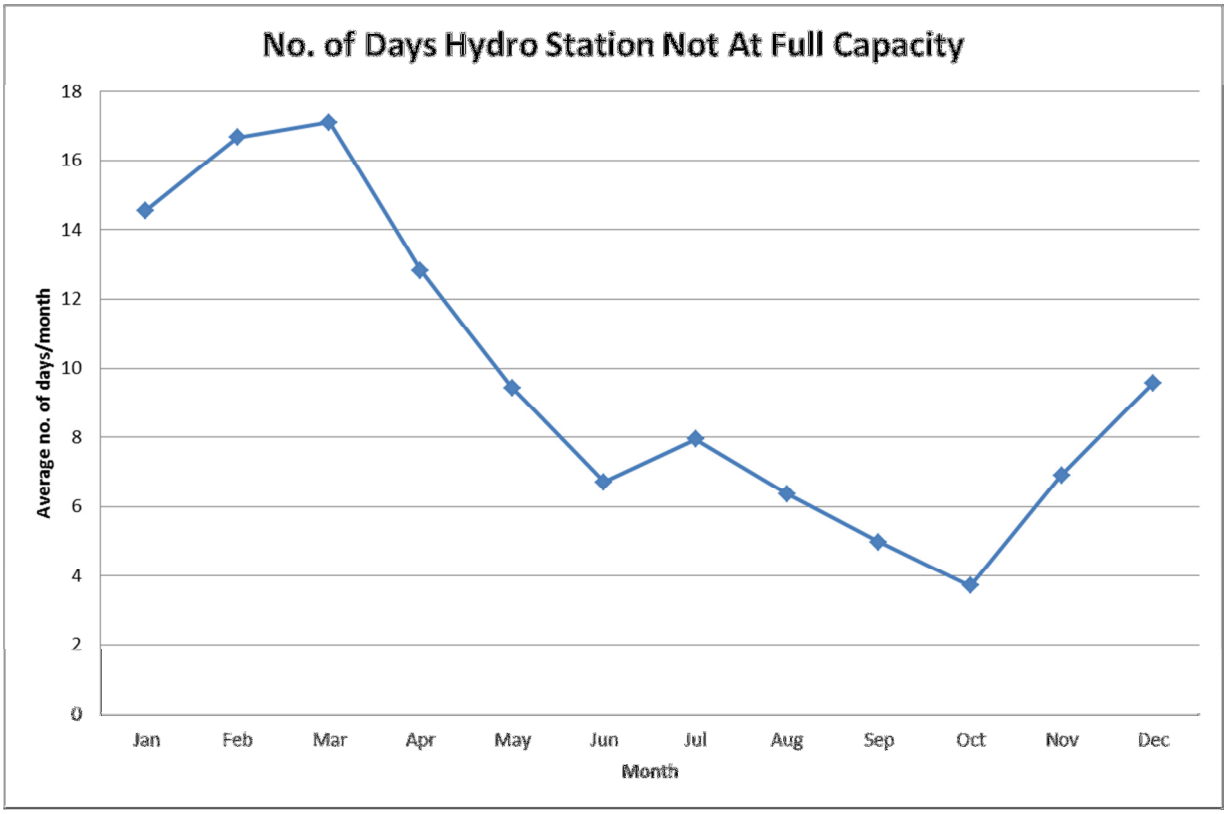
4 Hydrological Effects of Proposed Scheme

Figure 4-3 Number of Days per Month when the Hydro Station is not at Full Capacity (Base Scenario)



4.2 Sensitivity Analysis

Three additional minimum flow scenarios were tested to determine the potential effects of increasing the minimum flow threshold beyond the minimum required by the regional plan (Table 4-2). This work was to assess the extent to which scheme viability could be impacted by allowing a greater minimum flow in the river below the intake.

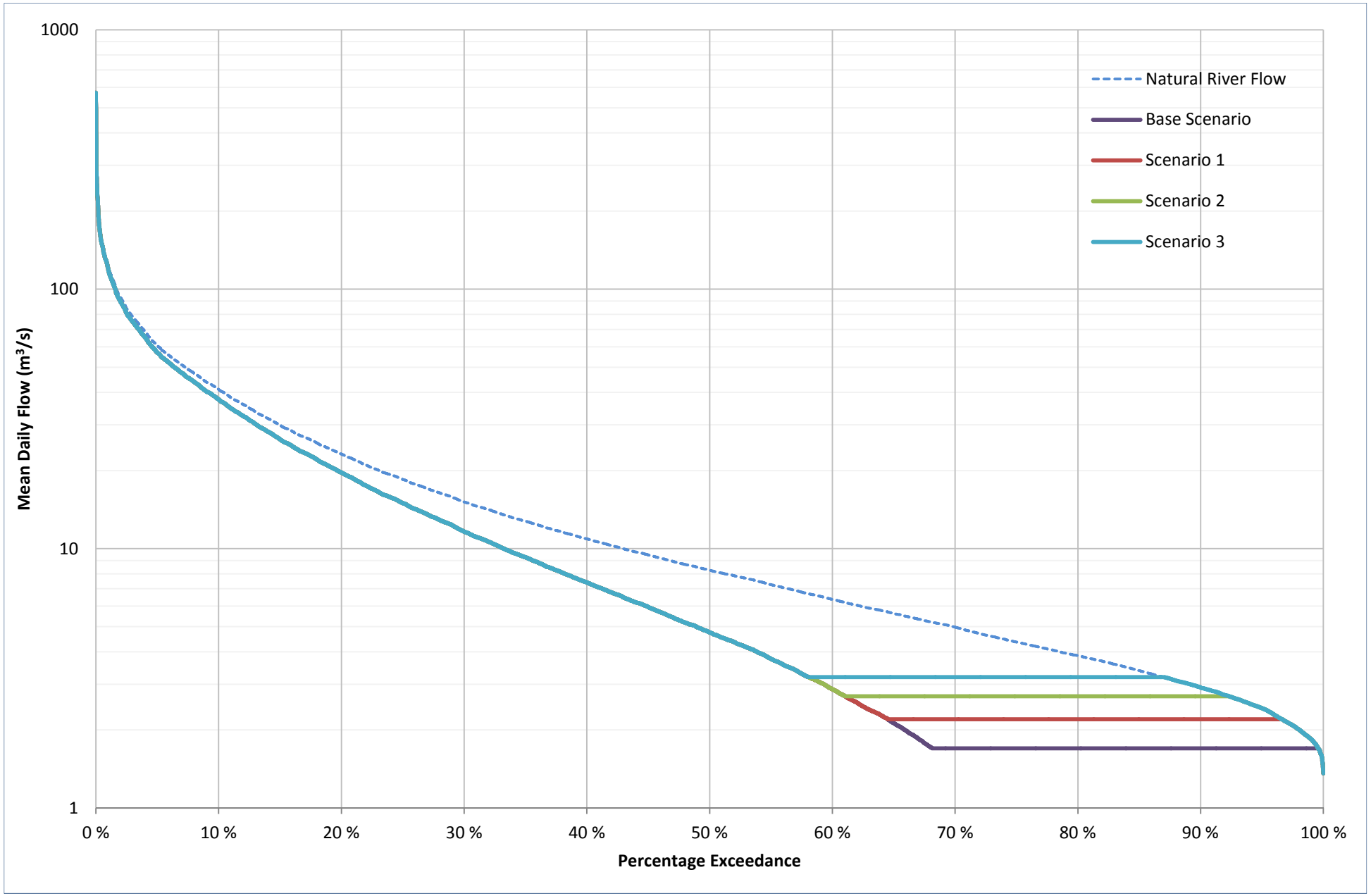
Table 4-2 Summary of Scenarios and the Corresponding Minimum Flow

Scenario no.	Description	Minimum Flow (m^3/s)
Base	Allow for 75% of 7MALF river flow	1.7
1	Allow for 75% of 7MALF river flow + 0.5 m^3/s	2.2
2	Allow for 75% of 7MALF river flow + 1.0 m3/s	2.7
3	Allow for 75% of 7MALF river flow + 1.5 m3/s	3.2

Based on predicted river flows for these scenarios (see Table 4-3 and Figure 4-4) no change in flow characteristics is observed above the median flow when compared to the base scenario. A slight increase (up to 3 %) of mean flows and an increase of up to 34 % of 7MALF flows can be expected when the minimum allowable river flow is increased by 1.5 m^3/s, compared to the base scenario. Flood flows do not vary between these scenarios and the base case.

Table 4-3 Summary Statistics (Daily Mean Flows) for Inangahua River for Current Flow and All Scenarios

Scenario no.	7MALF (m^3/s)	25th Percentile Flow (m^3/s)	Median Flow (m^3/s)	Mean Flow (m^3/s)	75th Percentile Flow (m^3/s)	Peak Flow (m^3/s)
Base	1.7	1.7	4.8	14.1	15.0	571.3
1	2.0	2.2	4.8	14.2	15.0	571.3
2	2.2	2.7	4.8	14.4	15.0	571.3
3	2.3	3.2	4.8	14.5	15.0	571.3



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INANGAHUA RIVER FLOW DURATION CURVE FOR ALL SCENARIOS

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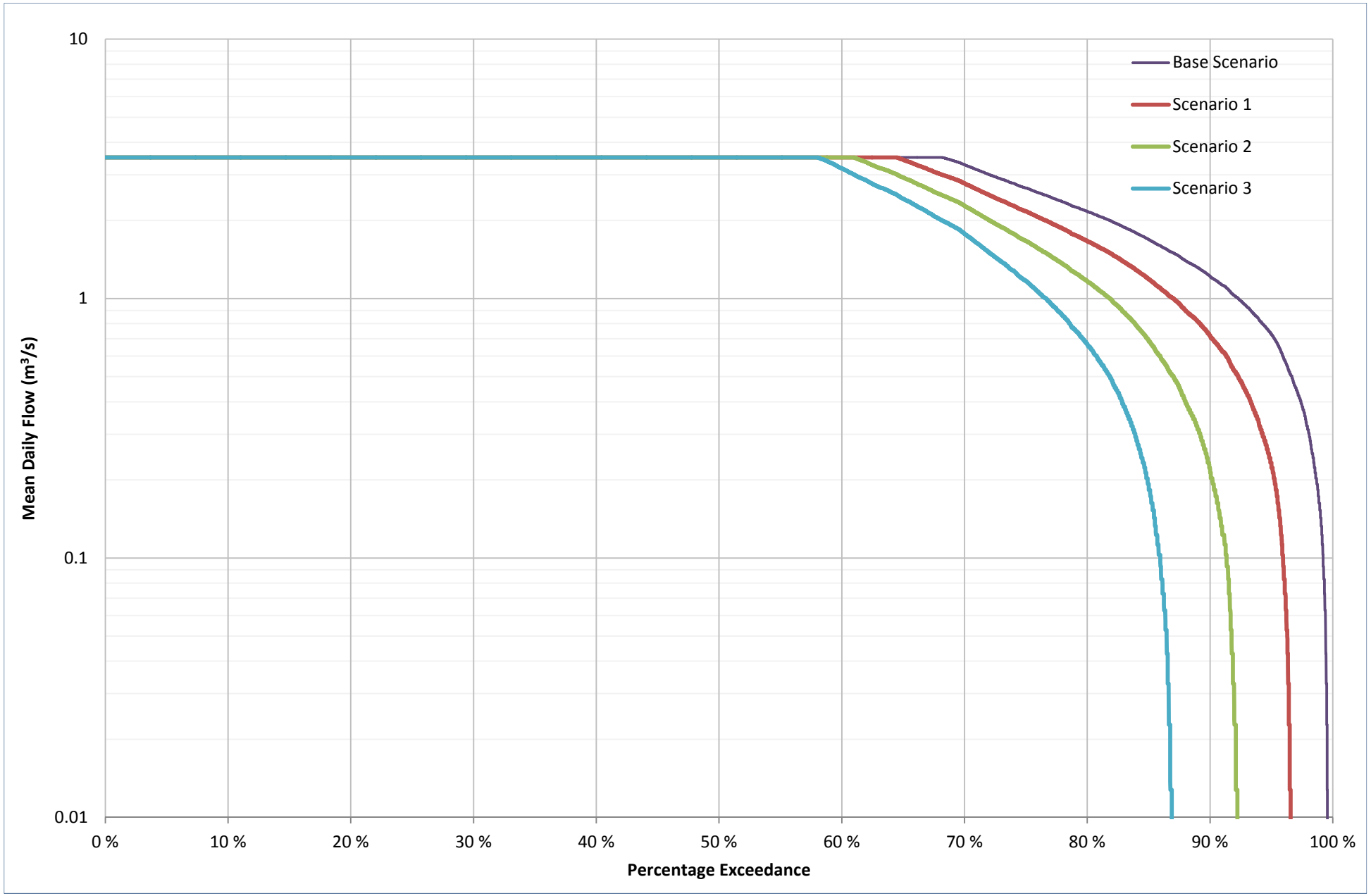
4 Hydrological Effects of Proposed Scheme

A reduction of mean hydro station flows (up to 16 %) is expected when the minimum allowable river flow is increased by 1.5 m^3/s compared to the base scenario (see Table 4-4). The hydro station flow is limited by the maximum intake capacity, which is 3.5 m^3/s.

The duration during which the hydro station is operating at full capacity is reduced by 10 %, to 58 %, when the minimum allowable river flow is increased by 1.5 m^3/s compared to the base scenario (Table 4-4).

Table 4-4 Summary Statistics (Daily Mean Flows) for Hydro Station for All Scenarios

Scenario no.	7MALF (m^3/s)	25th Percentile Flow (m^3/s)	Mean Flow (m^3/s)	Median Flow (m^3/s)	75th Percentile Flow (m^3/s)	Peak Flow (m^3/s)
Base	0.58	2.7	3.0	3.5	3.5	3.5
1	0.24	2.2	2.8	3.5	3.5	3.5
2	0.05	1.7	2.6	3.5	3.5	3.5
3	0.01	1.2	2.5	3.5	3.5	3.5



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HYDRO STATION FLOW DURATION CURVES FOR ALL SCENARIOS

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5

Conclusion

5.1 Conclusion

This report assesses the hydrological effects of the proposed hydro scheme on 2 km of the Inangahua River between the intake and discharge points. There will be a 17 % reduction at mean flow and 26 % reduction at the 7MALF under the base scenario compared to the pre-scheme conditions. When the minimum river flow for the abstraction is increased by 1.5 m^3/s compared to the base scenario, a slight increase (up to 3 %) of mean flows and an increase of 34 % of 7MALF flows is evident.

Flood flows exceeding the 75^{th} percentile flow are not significantly impacted by the hydro scheme as the removal of 3.5 m^3/s is inconsequential at river flows in the order of 100 m^3/s.

The hydro station is expected to operate at full capacity 68 % of the time under the base scenario (excluding any shut down periods). This is reduced by 10 %, to 58 %, when minimum allowable river flow is increased by 1.5 m^3/s compared to the base scenario.

This report provides a factual assessment of the scheme and its effects on river hydrology. The next step would be to undertake an effects based assessment to determine the actual effects of changes to hydrology on ecology and other in-stream values within the 2 km reach of river between the intake and discharge points.

6

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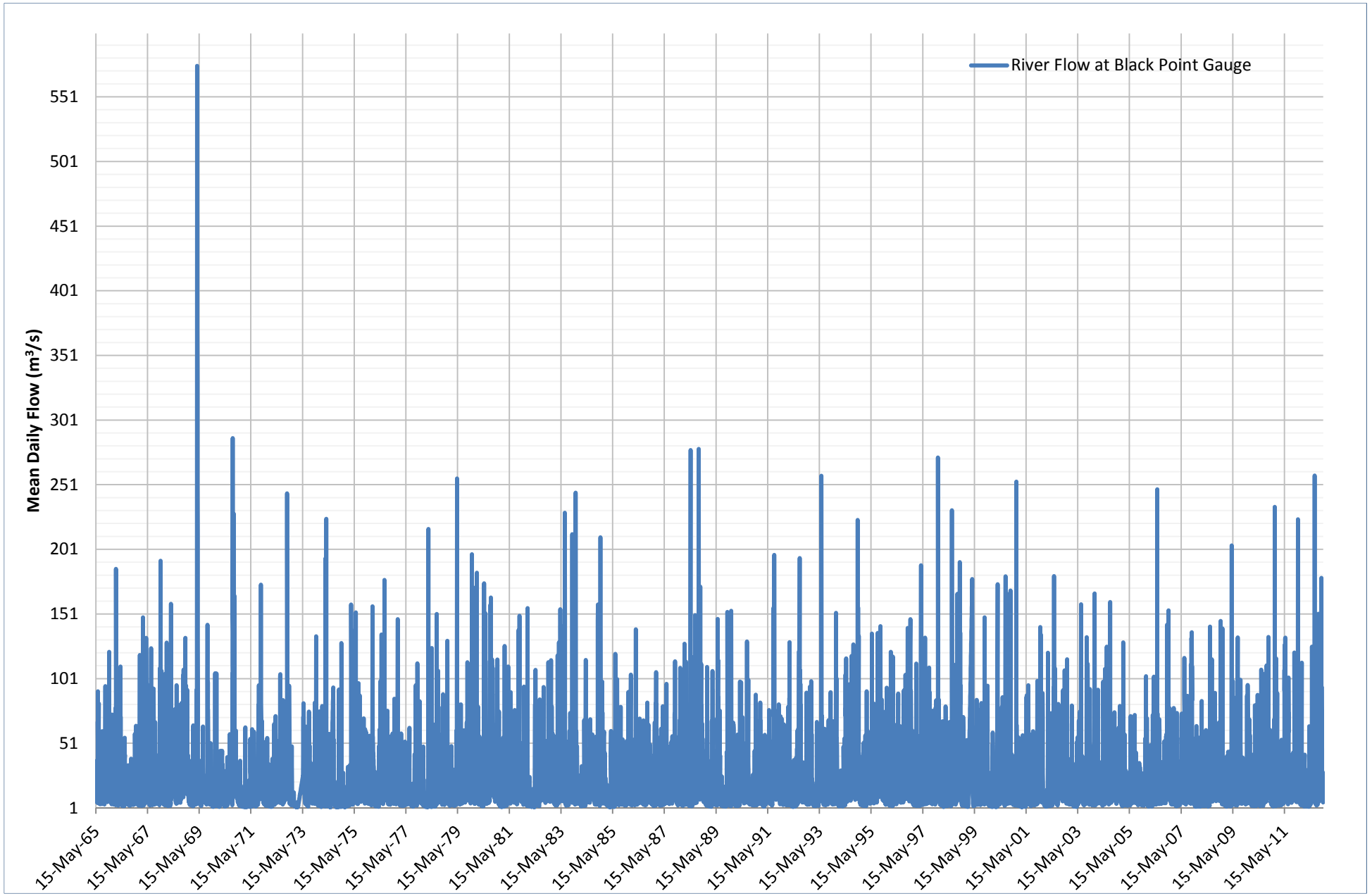
A

Appendix A Inangahua River Flow Series



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INANGAHUA RIVER TIME SERIES

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Figure: A-1

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