

Reference Hydrosite Catchments Report for the Low-Flow Gauging Programme for Northland



Compiled by

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Abbreviations

7d-MALF	7 day Mean Annual Low Flow
LCDB6	Land Cover Database version 6
MALF	Mean Annual Low Flow
NIWA	National Institute of Water and Atmospheric Research
NPS-FM	National Policy Statement for Freshwater Management
NRC	Northland Regional Council
RWQN	Regional Water Quality Network
SOE	State of the Environment
VCSN	Virtual Climate Station Network
WAT	Water Allocation Tool

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Executive summary

Northland Region is characterised by a dense network of small and short rivers and streams and approximately 1,700 individual source-to-sea catchments. Due to the high number of catchments, it is not feasible to monitor flow in all rivers and streams. As such, the estimation of minimum flow and allocation limits of water resources in the region has been mainly based on modelling data. The flow recorder site network has been improving the understanding of the hydrology of the gauged catchments in the region. To augment this, the region's flow gauging programme has been used to meet various objectives, including improving the understanding of flows in ungauged catchments, estimating stream flows during drought conditions, and supporting consent compliance monitoring.

The objectives of this desktop assessment were to identify gauged catchments in Northland that can serve as reference sites in low-flow investigations and to describe their catchment characteristics using a predefined set of hydrological, climatic, geological, land-use, and water resource attributes. Once confirmed, these sites can be used in future low-flow investigations, including donor–receiver correlation analysis, rainfall–runoff modelling, and the development of regional relationships for estimating flows in physiographically similar, ungauged catchments.

Six potential reference hydrosite catchments were identified based on minimal anthropogenic influences, few or no water take consents, predominantly vegetated land cover, and the availability of long-term continuous streamflow records. All six catchments satisfy the selection criteria and have telemetered flow sites suitable for future low-flow analyses. These include

- Ngunguru at Dugmores Rock – 56 years of continuous flow data, no consented water takes, and a mix of indigenous forest, exotic forest, and grassland.
- Kaihu at Gorge – a large reference catchment with 56 years of flow data and minimal consented water allocation relative to low flows.
- Waipoua at SH12 – 19 years of continuous flow data, no consented water takes, and extensive indigenous forest cover, making it one of the most natural catchments assessed.
- Maungaparerua at Tyrees Ford – 58 years of continuous flow data and a catchment underlain by the Puketotara basalt aquifer, providing a groundwater fed reference system.
- Waipapa at Forest Ranger – the largest reference catchment assessed (121.8 km²), with 48 years of flow data and predominantly indigenous forest cover.
- Mangahahuru at County Weir – 56 years of continuous flow data, no consented water takes, and predominantly exotic plantation forest cover.

Overall, the assessment concluded that all six catchments are suitable potential reference hydrosites for future low-flow investigations in Northland. Collectively, they represent a broad range of climatic, geological, hydrological, and land-use settings and provide a strong foundation for donor–receiver correlation analyses, validation of geology-based low-flow estimation methods, refinement of modelled low-flow statistics, and rainfall–runoff modelling. To support these future applications, field verification of key catchment attributes is recommended, together with the identification and characterisation of physiographically similar receiver catchments for subsequent low-flow analysis.

1. Introduction

Background

Northland Region is characterised by a dense network of small and short rivers and streams comprising approximately 1,700 source-to-sea catchments. Owing to the region's seasonal rainfall patterns, most of these rivers and streams exhibit highly variable flows, with particularly low discharges in summer months. Given the large number of catchments in the region, many of which are relatively small, it is not practical to continuously monitor stream flows in all of them. Consequently, some catchments in Northland are not continuously monitored.

The flow statistics used to estimate minimum flow and water allocation limits in Northland are primarily based on modelling undertaken by the National Institute of Water and Atmospheric Research (NIWA) at the river-reach scale in 2012 (Booker et al., 2012). Calibration of these modelled flows was undertaken using data from Northland's continuous flow monitoring network, highlighting the importance of observed flow data, particularly at low flows, for validating and refining model outputs.

To improve the understanding of low-flow behaviour and refine existing modelled low-flow estimates in ungauged catchments across Northland, targeted low-flow gauging is being undertaken in selected catchments. In support of the overall objectives of the low-flow gauging programme, including refinement of modelled low-flow estimates in ungauged catchments, validation of the Waugh geology method, and support of water allocation low-flow statistics, a number of analytical techniques have been identified for potential application.

These techniques include the correlation of low-flow measurements from ungauged (receiver) catchments with flows observed from gauged (donor) catchments that exhibit similar physiographic characteristics. The approach involves undertaking targeted low-flow gauging in ungauged catchments of interest and pairing these measurements with concurrent flows from reference (donor) catchments that possess long-term, continuous flow records. Where strong statistical relationships are identified between gauged and ungauged catchments, these correlations can be used to refine low-flow estimates for the ungauged systems with improved confidence. In addition, rainfall-runoff modelling can also be undertaken to estimate and refine low-flow statistics in ungauged catchments.

Scope of the report

This report documents a desktop-based assessment undertaken to identify and evaluate potential hydrosite catchments that are suitable for use as donor or reference sites in detailed low-flow investigations. It outlines the selection criteria applied to identify six reference hydrosite catchments and describes the physical, hydrological, and monitoring attributes used to characterise each of them.

Objectives

The primary objectives of the low-flow gauging programme are as follows:

- To improve the understanding of low-flow behaviour in ungauged catchments.
- To reduce uncertainty in modelled low-flow estimates to improve confidence in water allocation estimates
- To validate yield estimates derived using the Waugh geology-based method.
- To support extrapolation of correlated low-flow relationships to physiographically similar ungauged catchments across the region.

In achieving the primary objectives of the low-flow gauging programme, the specific objectives of this desktop assessment are as follows:

- Select potential hydrosite catchments in Northland that can be used as reference (donor) catchments in low-flow gauging investigations.
- Assess the suitability of the identified hydrosite catchments for use in low-flow studies based on hydrological and physiographic criteria.
- Describe and report the catchment characteristics of the selected reference (donor) hydrosite catchments to support subsequent low-flow analysis and interpretation.

2. Methodology

Reference hydrosite catchments were selected according to their alignment with the attribute criteria outlined in Table 1. Only catchments that satisfied these criteria and were considered suitable were included in this report.

Table 1: Attributes and criteria used in the identification of reference catchments

Attributes	Criteria for identification of reference hydrosite catchment
Hydrology and water resources situation	• The catchment should have a telemetered flow recorder site with a minimum of 10 years of continuous flow data. • The flow records should show stable rating relationships, particularly at low flows, with adequate low-flow gauging coverage. • Data gaps during critical low-flow periods should be minimal, ensuring sufficient representation of low-flow conditions for the record period. • The catchment should have minimal or no active flow regulation, diversion structures, inter catchment transfers or river control works affecting low flows behaviour. • Surface water abstraction should be minimal or absent, and there should be no known groundwater abstractions that materially affect baseflow contributions to the stream. Where there are water takes, they should be accounted for through naturalisation.
Climate	• Catchment climate should be representative of the broader region under consideration. • A minimum of 10 years of data should be available for contextual analysis.

Attributes	Criteria for identification of reference hydrosite catchment
	Rainfall and potential evapotranspiration (PET) data may be sourced from measured datasets (e.g. rainfall stations or full climate stations) and derived datasets (e.g. Augmented VCSN and rainfall radar data).
Landuse and land cover	There should be no evidence of recent, large-scale land-use change during the period of record particularly where changes are associated with plantation forestry (e.g. pine forestry establishment or harvesting) may influence hydrological response.

In addition to the attributes and criteria used to select suitable reference catchments, the following additional attributes were considered in characterising and describing the selected reference sites.

Table 2: Attributes used in the description of selected reference hydrosite catchments

Catchment attribute	Description of attribute
Locality	- Location of the hydrosite catchment, including its geographic context within Northland. - The estimated catchment area contributing flow to the recorder site.
Hydrology and water resources situation	- Description of rivers and streams draining the catchment. - An assessment of the water allocation status of the catchment, including known surface water takes and any groundwater use where there is hydraulic connectivity.
Catchment flow data	- Key flow statistics for the catchment should be estimated and documented - The statistics should include the 7d-MALF, 1 in 5 year 7-day low flow, mean and median flow.
Geology and hydrogeology	- Description of the main geology of the catchment. - Identification of any mapped aquifers, where applicable. - Notable groundwater–surface water interaction that may influence baseflow in the catchment. - Identification of physiographic or hydrological units to support comparison with similar catchments and potential application to ungauged sites.
Soils	- Description of the dominant soil texture classes within the catchment. - Identification of soil attributes relevant to comparison with physiographically similar catchments.
Land cover	- The prevailing landuse and land cover types should be identified from the Maanaki Whenua Land Cover Database v6.0 (Manaaki Whenua – Landcare Research, 2025) and landuse datasets. - Recent satellite imagery should be reviewed to identify and avoid areas that have experienced significant land use change, particularly plantation forestry which may influence hydrological regimes.

3. Characteristics of selected reference hydrosite catchments

This section covers a description of catchment characteristics of six selected reference hydrosite catchments. Some of the key catchment attributes include hydrology, (including flow statistics), landuse and land cover, soils, geology, hydrogeology and water use.

Ngunguru at Dugmores Rock hydrosite catchment

LOCALITY

The Ngunguru at Dugmores Rock hydrosite catchment is relatively small, covering approximately 12.2 km². The catchment is located to the west of both Matapouri and the Tutukaka Coast in Whangārei District. The locality of the hydrosite catchment and locations of the flow and rainfall stations are shown in Figure 1.

CLIMATE

The Ngunguru at Dugmores Rock rainfall station is located near the outlet of the catchment at the flow site. The mean monthly rainfall distribution and the mean annual rainfall for the rainfall station are shown in Table 4. The mean annual rainfall for the catchment is about 1,772 mm. The Whangārei Aero AWS is the closest full climate station to the catchment. Additionally, the Augmented VCSN dataset can be used.

Table 3: Summary of key active climate stations around the Ngunguru at Dugmores Rock catchment

Station name	IRIS ID	Type of station	Date station opened	Status	Duration of rainfall monitoring
Ngunguru at Dugmores Rock	LOC.546416	Rainfall	28-10-1987	Active	38 years
Whangārei Aero AWS	LOC.547307	Full Climate	03-12-1991	Active	34 years

Table 4: Mean monthly and annual rainfall for the Ngunguru at Dugmores Rock rainfall station (1987-2024)

Rainfall Station	Mean monthly rainfall (mm)												Mean Annual Rainfall (mm)
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Ngunguru at Dugmores Rock	220	177	142	113	111	139	121	118	140	146	155	190	1,772

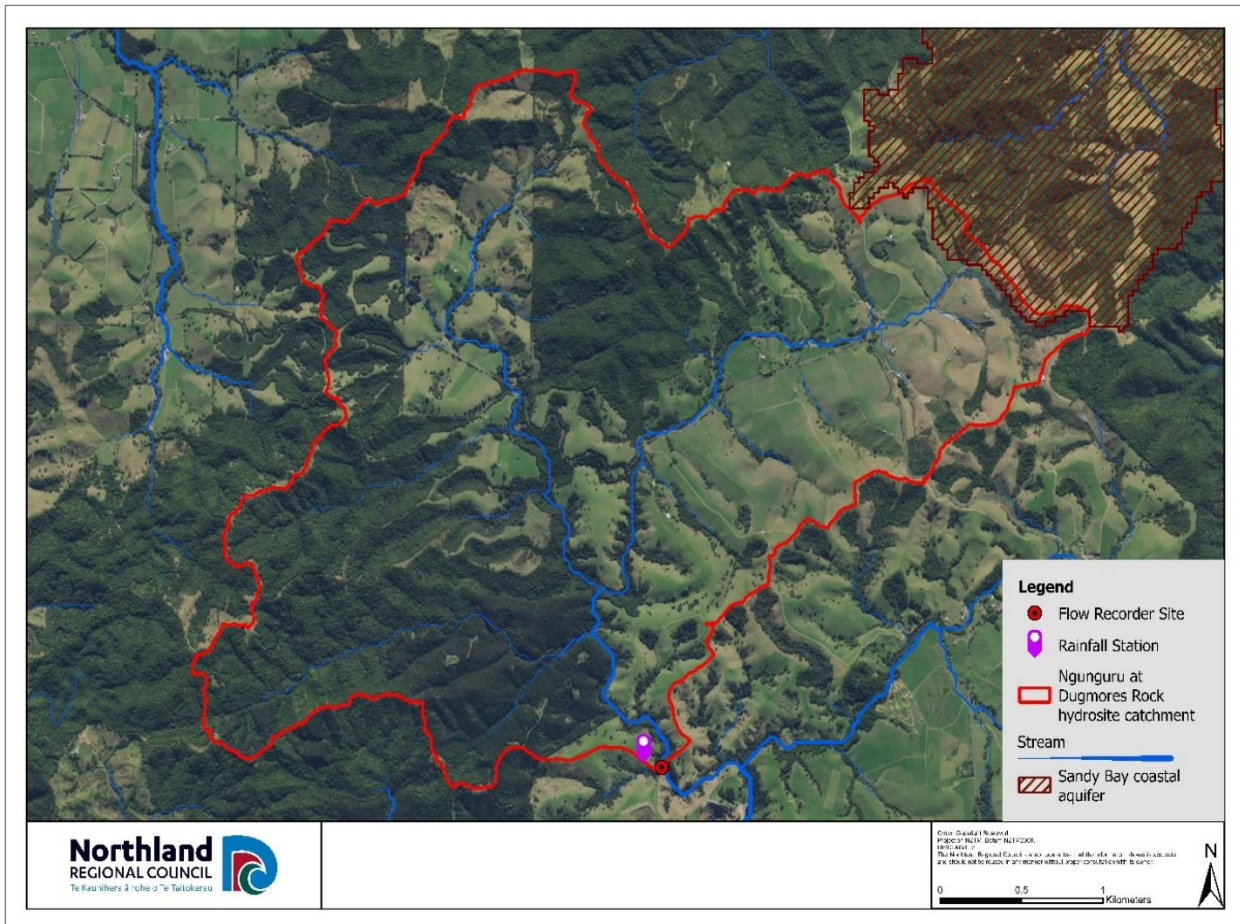


Figure 1: Ngunguru at Dugmores Hydrosite catchment and flow site

HYDROLOGY AND WATER RESOURCES SITUATION

The hydrosite catchment is drained by the Ngunguru River and its tributaries. The source of the Ngunguru River is in this catchment. There are no consented surface water or groundwater takes from the catchment. There may be permitted activity (PA) water takes for stock watering based on the proportion of pasture land. The hydrology of the catchment is outlined in Table 5.

Table 5: Hydrological and water allocation of the Ngunguru at Dugmores Rock hydrosite catchment

Hydrosite catchment parameter	Value
Catchment area	12.2 km ²
Date flow station was opened	22 August 1969
Number of years of flow records	56
7d – MALF	88 L/s
1 in 5 year 7-day flow	55 L/s
Mean flow	422 L/s
Median flow	216 L/s
Number of water take consents	0
Current consented allocation	0 L/s
Consented allocation as percentage of 7d-MALF	0 %

LANDCOVER AND LANDUSE

An analysis conducted using the New Zealand Land Cover Database version 6.0 (LCDB6) showed that the catchment is characterised by a mix of pasture land, indigenous and exotic forests. The dominant landcover type in the catchment is exotic grassland (approximately 46%) that is associated with pasture land. Other land uses practised in the catchment include indigenous forestry (approximately 37%) and exotic forestry (9.3%).

Table 6: Landcover types practised in the Ngunguru at Dugmores Rock hydrosite catchment (LCDB6)

Land cover type	Area (km ²)	Percentage of catchment area
Exotic Forest	1.14	9.3%
Exotic Grassland	5.65	46.1%
Exotic Scrub	0.06	0.5%
Indigenous Forest	4.54	37.0%
Indigenous Scrub	0.50	4.1%
Other Grassland	0.38	3.1%
TOTAL	12.28	100%

GEOLOGY, SOILS AND HYDROGEOLOGY

The catchment is underlain predominantly by Waipapa Group basement rocks comprising greywacke, with local occurrences of chert, argillite and basalt. Parts of the catchment are also characterised by mud, sand and gravel deposits of the Tauranga Group. Soil types are largely controlled by the underlying geology, with clay loam and clay being the dominant soil texture classes. A small section in the north-eastern part of the catchment is underlain by the Sandy Bay Coastal Aquifer

Kaihu at Gorge hydrosite catchment

LOCALITY

The Kaihu at Gorge is one of the largest reference hydrosite catchments considered in this assessment, covering an area of 114 km². The catchment is situated in the Kaipara District, northwest of Dargaville, and between the Waipoua and Kaihu Forests. Figure 2 shows a map of the catchment and the locations of the flow and rainfall stations.

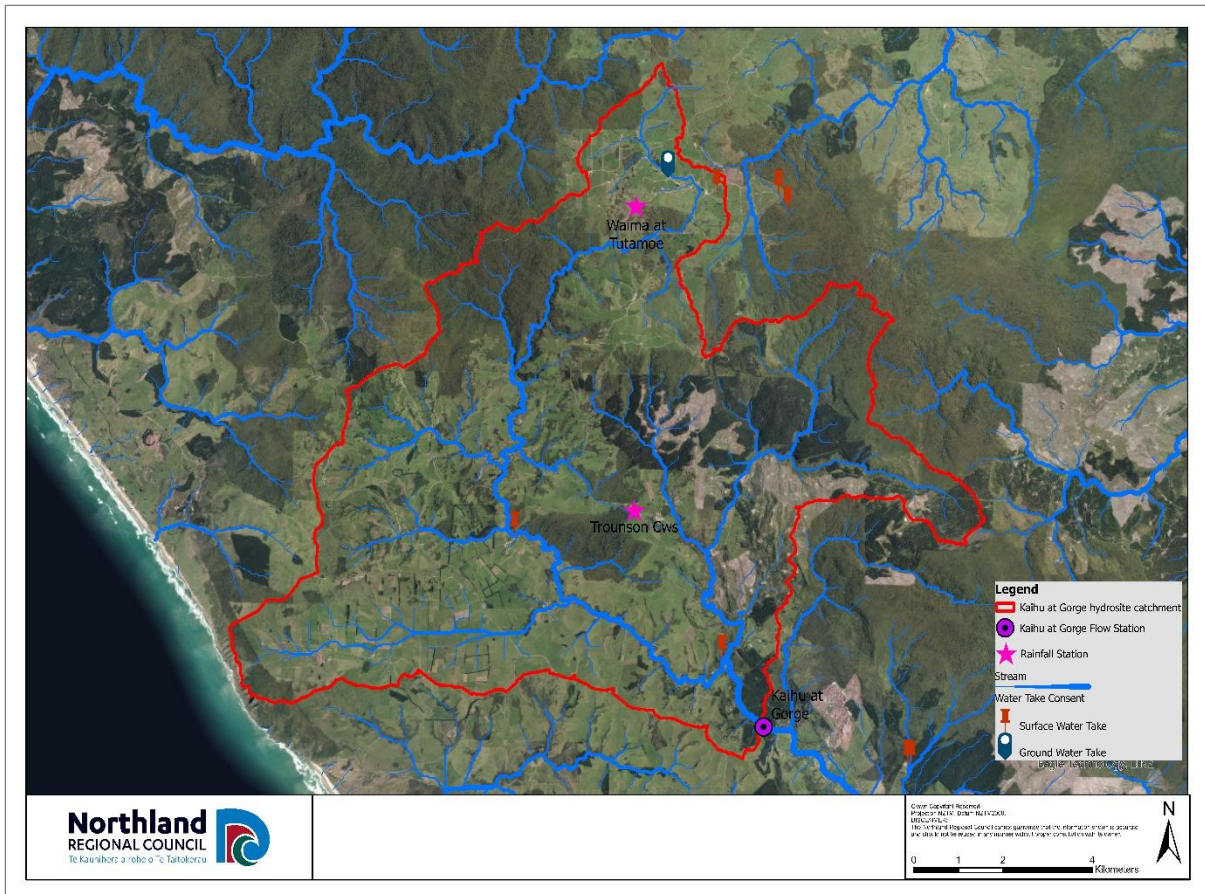


Figure 2: Kaihu at Gorge Hydrosite catchment and flow site

CLIMATE

There are two active rainfall stations in the catchment as shown in Figure 2 and Table 7. The mean monthly rainfall distribution and mean annual rainfall for the station are shown in Table 8. The mean annual rainfall for the catchment is about 1,824 mm. The Augmented VCSN and rainfall radar datasets can also be used.

Table 7: Rainfall stations within the Kaihu at Gorge catchment

Station name	IRIS ID	Type of station	Date station opened	Status	Duration of rainfall monitoring
Waima at Tutamoe	LOC.536613	Rainfall	23-10-2003	Active	22 years
Trounson CWS	LOC.537602	Rainfall	04-06-2009	Active	17 years

Table 8: Mean monthly and annual rainfall for the Kaihu at Gorge catchment

Rainfall Station	Mean monthly rainfall (mm)												Mean Annual Rainfall (mm)
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Waima at Tutamoe	271	221	196	159	112	128	134	124	122	150	212	243	2,072
Trounson CWS	244	167	140	108	77	83	102	90	82	102	182	200	1,576

HYDROLOGY AND WATER RESOURCES SITUATION

The catchment forms part of the headwaters of the broader Kaihu river catchment. The catchment is drained by the Kaihu and Waima Rivers, and their tributaries that include the Mangatu and Ngaioire streams. The Waima River flows from the northern boundary of the catchment. From its confluence with the Mangatu Stream in the Whatoro area, the river is known as Kaihu which flows southeast until its confluence with the Wairoa River in Dargaville. The hydrology of the catchment is outlined in Table 9.

Table 9: Hydrological and water allocation of the Kaihu at Gorge hydrosite catchment

Hydrosite catchment parameter	Value
Catchment area	114 km ²
Date flow station was opened	2 March 1970
Number of years of flow records	56
7d – MALF	736 L/s
1 in 5 year 7-day flow	614 L/s
Mean flow	3,964 L/s
Median flow	2,373 L/s
Number of water take consents	3
Current consented allocation	26.45 L/s
Consented allocation as percentage of 7d-MALF	3.6 %

Appendix 1 outlines the water take consents from within the catchment. These need to be accounted for through naturalisation whenever the flow site is used for correlation or in rainfall-runoff modelling.

LANDCOVER AND LANDUSE

The catchment is characterised by a mix of exotic grassland associated with stock rearing, indigenous and exotic forests. Exotic grassland that is associated with pasture land accounts for 53% of the catchment area whilst indigenous forests cover about 29% of the catchment. Exotic forests account for about 17% of the catchment as shown in table 10.

Table 10: Landcover types of the Kaihu at Gorge hydrosite catchment (LCDB6)

Land cover type	Area (km ²)	Percentage of catchment area
Exotic Forest	19.6	17.2%
Exotic Grassland	60.7	53.3%
Exotic Scrub	0.1	0.1%
Indigenous Forest	32.9	28.9%
Indigenous Scrub	0.5	0.4%
Other Grassland	0.1	0.1%
TOTAL	114.0	100%

GEOLOGY, SOILS AND HYDROGEOLOGY

The main geology of the catchment is characterised by the Waipoua basalts of the Waitakere Group. To the south of the catchment are sections that are distinguished by sand, peat and mud deposits of the Karioitahi Group. There are parts of the catchment that are characterised by mudstone and sandstone of the Mangakahia Complex. The main soils in the catchment comprise clay loam and clay. Although aquifer mapping has not been undertaken for the Kaihu catchment, the Waipoua Basalts are likely to exhibit similar hydrogeological characteristics to other basalt aquifers in Northland. Streams draining basalt-influenced headwaters in the region are commonly sustained by groundwater contribution, including baseflow and spring discharge, particularly near the edges of basalt formations.

Waipoua at SH12 hydrosite catchment

LOCALITY

The Waipoua at SH12 is a hydrosite catchment located in both the Far North and Kaipara Districts of Northland. The rivers in the catchment primarily flow through the native Waipoua Kauri Forest. The catchment covers an area of 65.8 km².

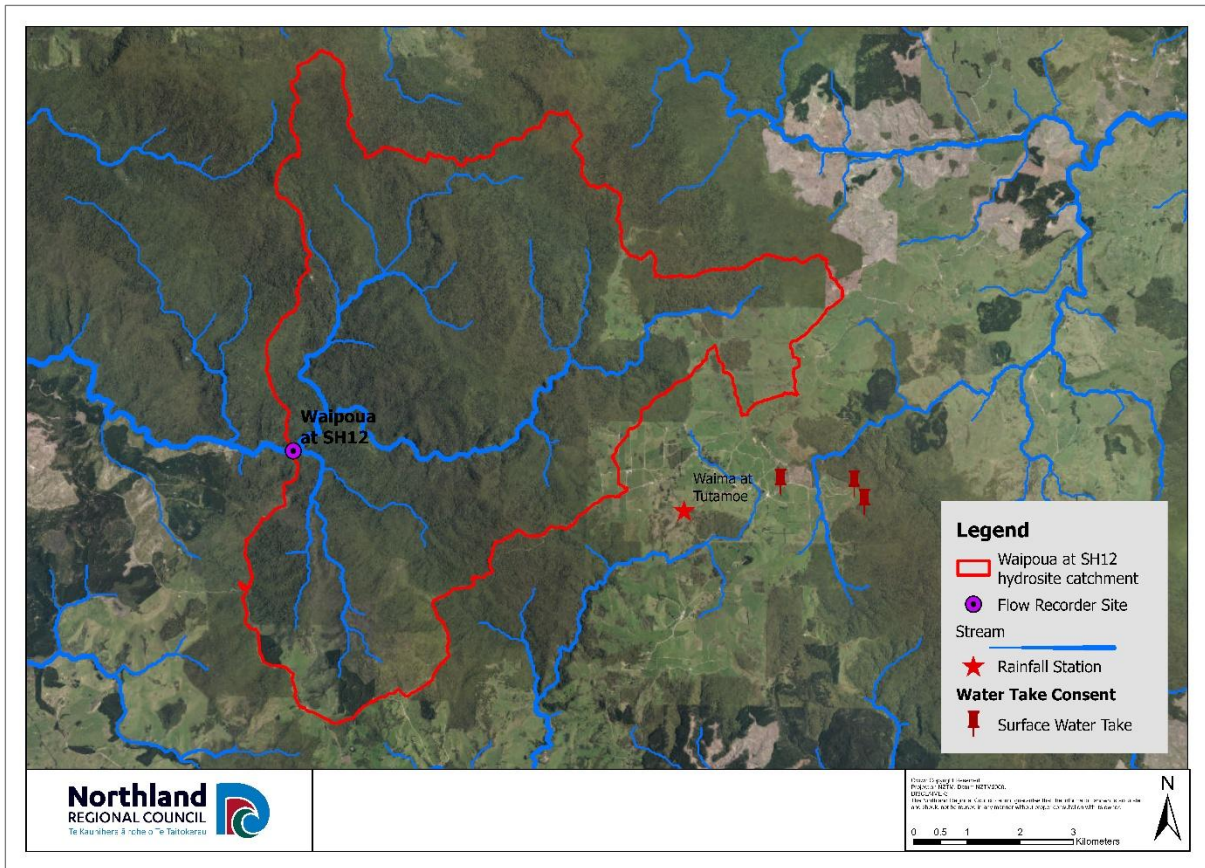


Figure 3: Waipoua at SH12 Hydrosite catchment and flow site

CLIMATE

The Waima at Tutamoe rainfall station located in the adjacent Kaihu catchment is the closest and most suitable rainfall station for extrapolating rainfall statistics for the Waipoua catchment. The mean monthly rainfall distribution and mean annual for the rainfall station are shown in Table 12. The extrapolated mean annual rainfall for the catchment is about 2,072 mm. The Augmented VCSN and rainfall radar datasets can also be used.

Table 11: Waima at Tutamoe rainfall station details

Station name	IRIS ID	Type of station	Date station opened	Status	Duration of rainfall monitoring
Waima at Tutamoe	LOC.536613	Rainfall	23-10-2003	Active	22 years

Table 12: Mean monthly and annual rainfall for the Waima at Tutamoe rainfall station (2003-2024)

Rainfall Station	Mean monthly rainfall (mm)												Mean Annual Rainfall (mm)
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Waima at Tutamoe	271	221	196	159	112	128	134	124	122	150	212	243	2,072

HYDROLOGY AND WATER RESOURCES SITUATION

The catchment is drained by the Waipoua River, and the Kopai, Okawawa and Toronui streams. The headwaters of the catchment are in the Parataiko Range. The Waipoua River flows westwards from the hydrosite catchment outlet towards its mouth on the Tasman Sea. The hydrology of the catchment is as follows:

Table 13: Hydrological and water allocation of the Waipoua at SH12 hydrosite catchment

Hydrosite catchment parameter	Value
Catchment area	65.8 km ²
Date flow station was opened	30 May 2007
Number of years of flow records	19
7d – MALF	454 L/s
1 in 5 year 7-day flow	368 L/s
Mean flow	2,952 L/s
Median flow	1,462 L/s
Number of water take consents	0
Current consented allocation	0 L/s
Consented allocation as percentage of 7d-MALF	0 %

LANDCOVER AND LANDUSE

The Waipoua at SH12 hydrosite catchment is one of the most pristine in Northland. The catchment is largely under the native kauri forest. Approximately 87% of the catchment is under indigenous forest and about 7.8% is covered by exotic grassland. About 1.4% of the catchment is under exotic forest. It is for this reason and considering the absence of any water take consents that the catchment has been selected as almost pristine and as a potential reference hydrosite catchment.

Table 14: Landcover types of the Waipoua at SH12 hydrosite catchment (LCDB6)

Land cover type	Area (km ²)	Percentage of catchment area
Exotic Forest	0.94	1.4%
Exotic Grassland	5.16	7.8%
Indigenous Forest	57.50	87.4%
Indigenous Scrub	2.12	3.2%
Other Grassland	0.05	0.1%
TOTAL	65.8	100%

GEOLOGY, SOILS AND HYDROGEOLOGY

The catchment is primarily characterised by the Waipoua basalts of the Waitakere Group. In the northern part of the catchment, small sections are underlain by mudstone and sandstone of the Otaua Group. While clay is the dominant soil texture class, the middle of the catchment contains small sections of reddish clay loam.

Maungaparerua at Tyrees Ford hydrosite catchment

LOCALITY

The Maungaparerua at Tyrees Ford hydrosite catchment is located to the west of Kerikeri in the Far North District. The hydrosite has a small catchment area of 11 km². Figure 4 shows the locality of the catchment and the flow recorder site.

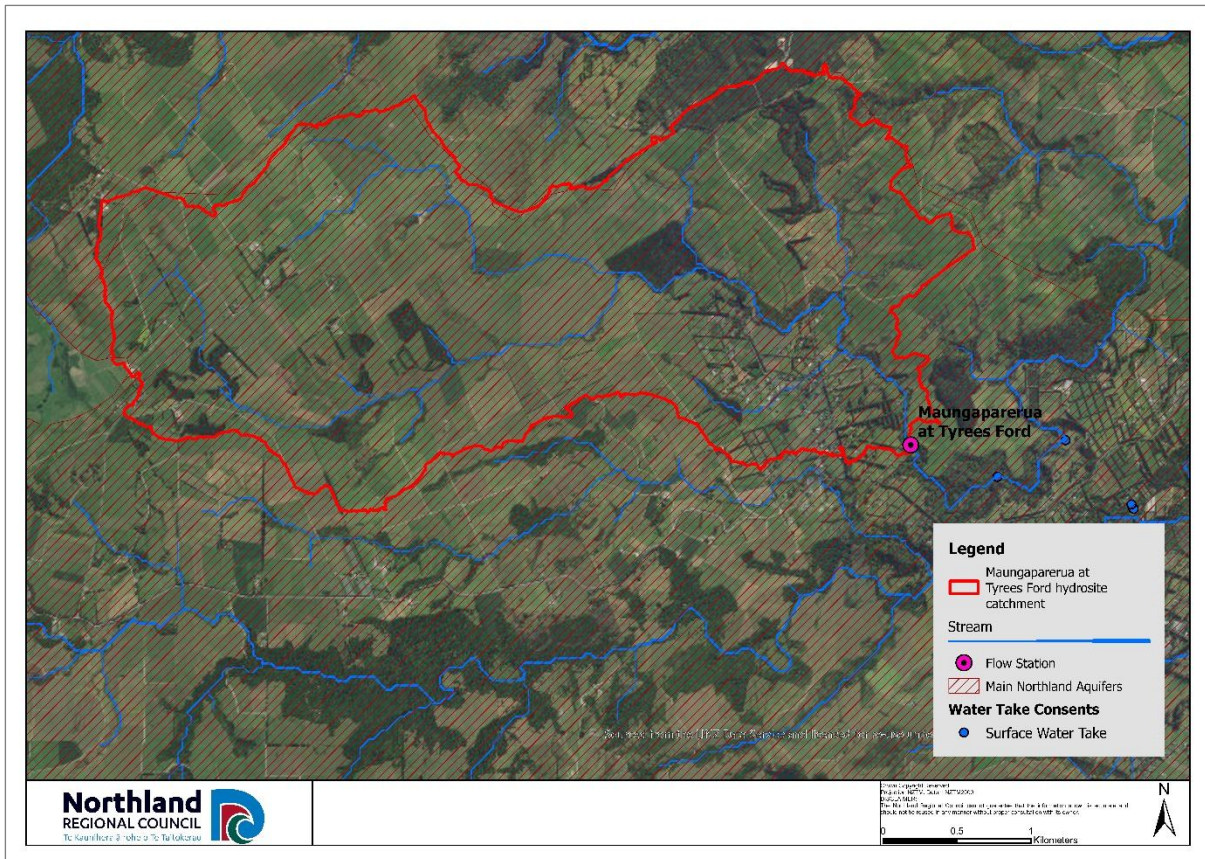


Figure 4: Maungaparerua at Tyrees Ford Hydrosite catchment and flow site

CLIMATE

The Kerikeri EWS rainfall station located in the nearby Rangitane river catchment is the rainfall station with a long monitoring data set and can be used for extrapolation for the Maungaparerua catchment. The mean monthly rainfall distribution and the mean annual rainfall for the rainfall station are shown in Table 16. The mean annual rainfall for the catchment is about 1,674 mm. The Augmented VCSN and rainfall radar datasets can also be used.

Table 15: Kerikeri EWS rainfall station details

Station name	IRIS ID	Type of station	Date station opened	Status	Duration of rainfall monitoring
Kerikeri EWS	LOC.531901	Rainfall	01-08-1981	Active	44 years

Table 16: Mean monthly and annual rainfall for the Kerikeri EWS rainfall station (2003-2024)

Rainfall Station	Mean monthly rainfall (mm)												Mean Annual Rainfall (mm)
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Kerikeri EWS	201	183	148	123	104	105	110	111	128	137	156	179	1,674

HYDROLOGY AND WATER RESOURCES SITUATION

The catchment is drained by the Maungaparerua and Waipetakoura streams. The streams flow eastwards and discharge into the Kerikeri River downstream of the hydrosite catchment. Although there are no consented water takes, there are several small farm dams that may be associated with PA water takes. The hydrology of the catchment is as follows:

Table 17: Hydrological and water allocation of the Maungaparerua at Tyrees Ford hydrosite catchment

Hydrosite catchment parameter	Value
Catchment area	11 km ²
Date flow station was opened	22 November 1967
Number of years of flow records	58
7d – MALF	36 L/s
1 in 5 year 7-day flow	21 L/s
Mean flow	460 L/s
Median flow	202 L/s
Number of water take consents	0
Current consented allocation	0 L/s
Consented allocation as percentage of 7d-MALF	0 %

LANDCOVER AND LANDUSE

The catchment is largely under the pasture. Approximately 87.8% of the catchment is under exotic grassland and about 4.7% is covered by exotic forest. About 3.1% of the catchment is under indigenous scrub. Other landcover types occupy negligible portions of the catchment.

Table 18: Landcover types of the Maungaparerua at Tyrees Ford hydrosite catchment (LCDB6)

Land cover type	Area (km ²)	Percentage of catchment area
Cropland	0.06	0.6%
Exotic Forest	0.51	4.7%
Exotic Grassland	9.67	87.8%
Exotic Scrub	0.22	2.0%
Indigenous Forest	0.10	0.9%
Indigenous Scrub	0.34	3.1%
Water	0.04	0.4%
Wetland	0.05	0.5%
TOTAL	11.00	100%

GEOLOGY, SOILS AND HYDROGEOLOGY

The catchment is primarily underlain by volcanic rocks of the Kerikeri Volcanic Group. The greater part of the catchment is characterised by basalt and basanite and the eastern portion is underlain by rhyolite. A small portion of the catchment is distinguished by sand, mud and gravel deposits of the Tauranga Group.

The main soil texture class in the catchment is clay. However, there are small pockets of silt loam and fine sandy loam to the eastern part of the catchment. The whole hydrosite catchment is totally underlain by the Puketotara basaltic aquifer.

Waipapa at Forest Ranger hydrosite catchment

LOCALITY

The Waipapa at Forest Ranger is the biggest hydrosite catchment considered in this report with an area of approximately 121.8 km². The catchment is located between Waipapa and Mangamuka in the Far North District.

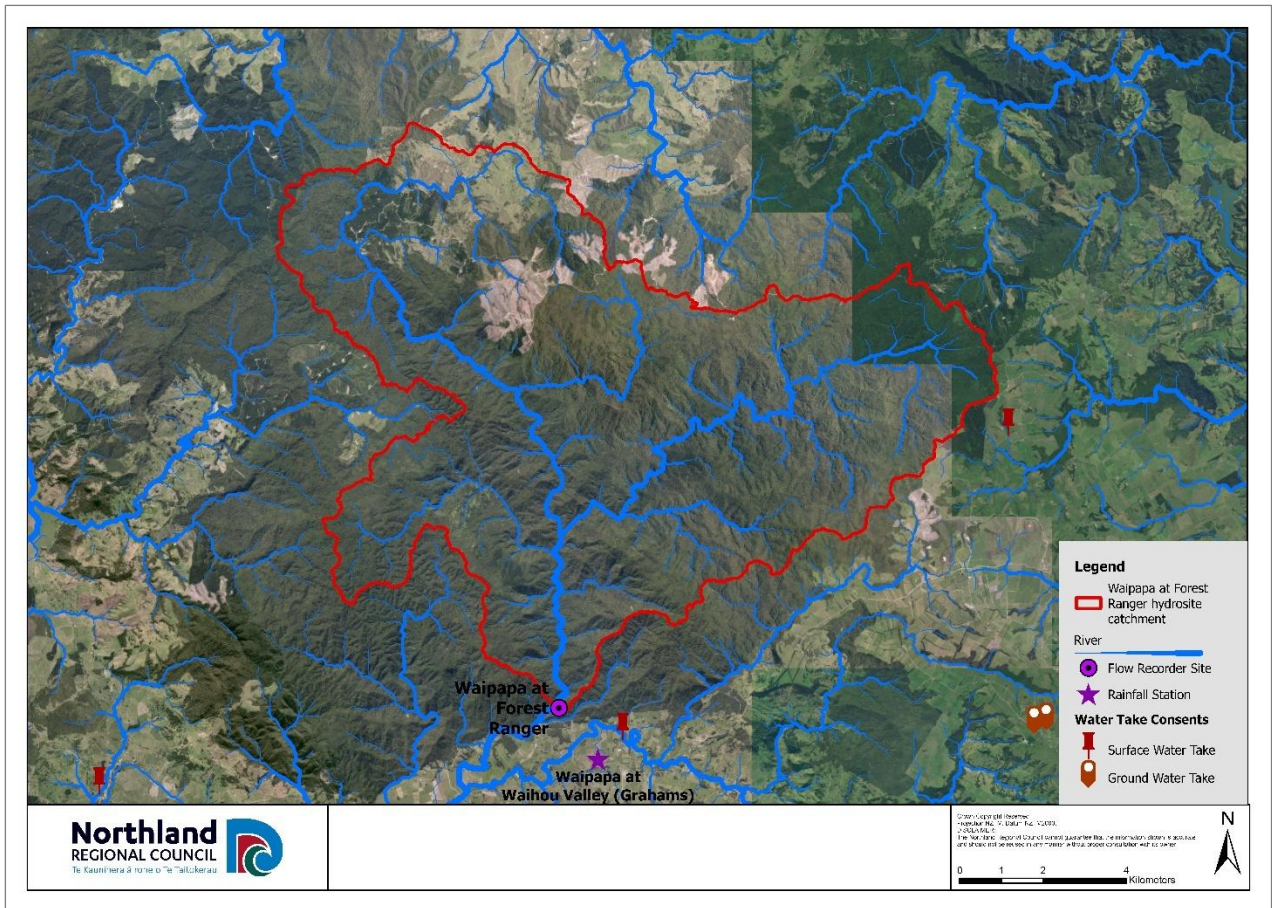


Figure 5: Waipapa at Forest Ranger Hydrosite catchment and flow site

CLIMATE

The Waipapa at Waihou Valley (Grahams) rainfall station was used for extrapolating rainfall estimates for the catchment. The rainfall station is located in the adjacent Whakanekeneke river catchment and is near the Waipapa at Forest Ranger flow site. The mean monthly rainfall distribution and mean annual rainfall for the station are shown in Table 20. The mean annual rainfall for the catchment is about 1,681 mm. The Augmented VCSN and rainfall radar datasets can also be used for this catchment.

Table 19: Waipapa at Waihou Valley (Grahams) rainfall station details

Station name	IRIS ID	Type of station	Date station opened	Status	Duration of rainfall monitoring
Waipapa at Waihou Valley (Grahams)	LOC.532611	Rainfall	01-01-1979	Active	47 years

Table 20: Mean monthly and annual rainfall for the Waipapa at Waihou Valley (Grahams) rainfall station (1979-2023)

Rainfall Station	Mean monthly rainfall (mm)												Mean Annual Rainfall (mm)
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Waipapa at Waihou Valley (Grahams)	214	180	153	126	105	111	107	107	121	119	157	180	1,681

HYDROLOGY AND WATER RESOURCES SITUATION

The catchment is drained by the Waipapa and Mangapa Rivers and their numerous tributaries that include the Whakateterekia, Nikauponuonu, Pairirengarenga, Mangakino and Merumeru streams. The rivers and streams in the catchment flow southwards into the Hokianga Harbour. As the rivers and streams primarily flow through native and undisturbed forests, the catchment is identified as pristine and the stream flows are anticipated to be almost natural. The hydrology of the catchment is as follows:

Table 21: Hydrological and water allocation of the Waipapa at Forest Ranger hydrosite catchment

Hydrosite catchment parameter	Value
Catchment area	121.8 km ²
Date flow station was opened	31 March 1978
Number of years of flow records	48
7d – MALF	743 L/s
1 in 5 year 7-day flow	539 L/s
Mean flow	4,969 L/s
Median flow	2,150 L/s
Number of water take consents	0
Current consented allocation	0 L/s
Consented allocation as percentage of 7d-MALF	0 %

LANDCOVER AND LANDUSE

This catchment drains a predominantly native forested area with small areas of pine forests in its headwaters hence its selection as a reference hydrosite catchment. Native forest covers approximately 86.8% of the catchment, while exotic forest accounts for 8.6%, and exotic grassland makes up around 3.1%. Due to its near pristine state and the absence of water take consents, the catchment was selected as a reference site for this study. There has been some changes in landcover related to the harvesting and replanting of the part of the catchment that is under exotic forestry plantations.

Table 22: Landcover types practised in the Waipapa at Forest Ranger hydrosite catchment (LCDB6)

Land cover type	Area (km ²)	Percentage of catchment area
Exotic Forest	10.42	8.6%
Exotic Grassland	3.81	3.1%
Indigenous Forest	105.73	86.8%
Indigenous Scrub	1.75	1.4%
Other Grassland	0.06	0.1%
TOTAL	121.81	100%

GEOLOGY, SOILS AND HYDROGEOLOGY

The catchment is partly characterised by basalts of the Puketi Unit and also tuff, and chert. The catchment is also underlain by sedimentary rocks comprising sandstone and argillite. The main soils of the catchment are clay loams with smaller portions being under clays. A small section of the eastern part of the catchment area is underlain by the Kerikeri basalt aquifer that has high recharge rates of between 15 and 20% of the mean annual rainfall (NRC, 2008).

Mangahuru at County Weir hydrosite catchment

LOCALITY

The Mangahuru at County Weir is a small hydrosite catchment (approximately 21.1 km²) that is located in the Kauri area, to the north of the city of Whangārei.

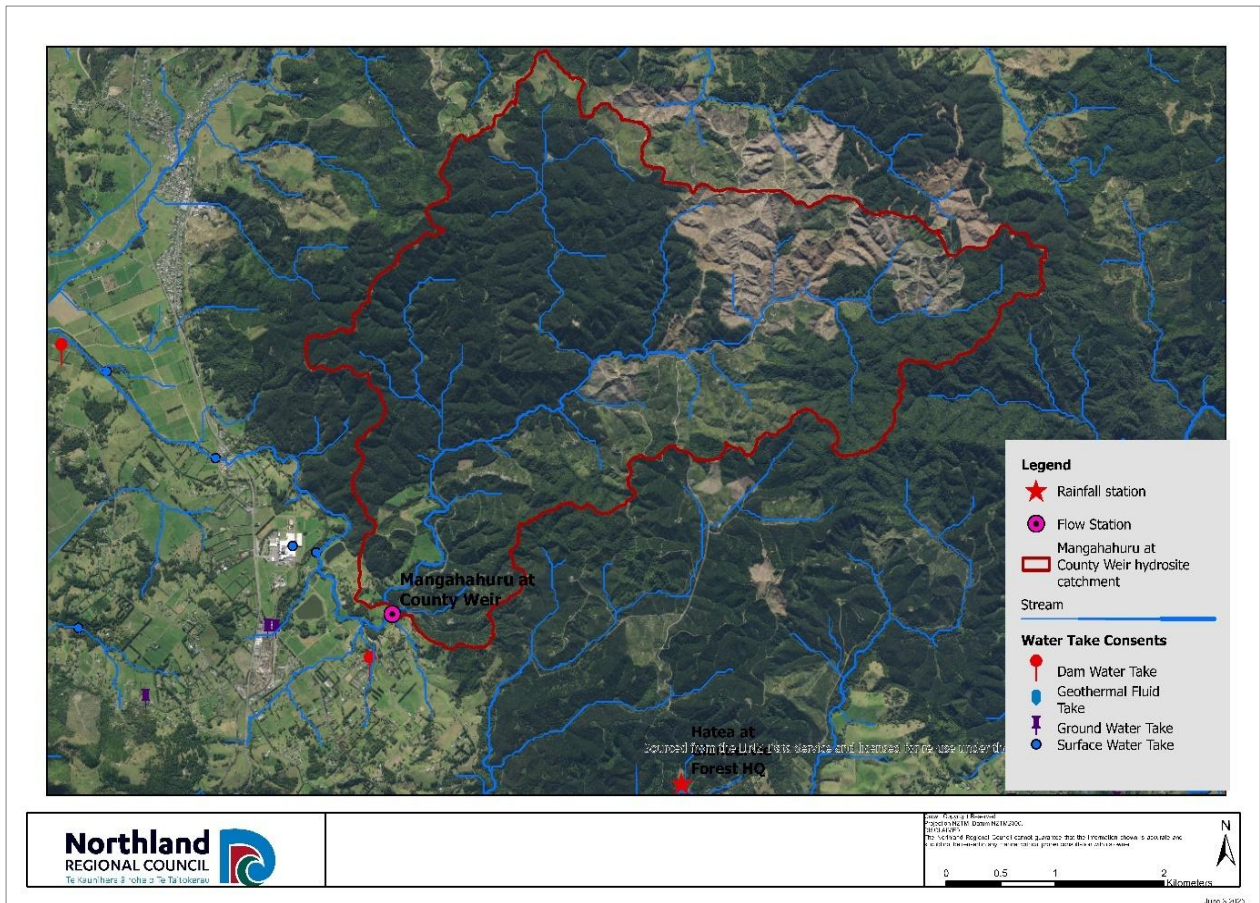


Figure 6: Mangahahuru at Country Weir hydrosite catchment and flow site

CLIMATE

The Hatea at Glenbervie Forest HQ rainfall station and the Whangārei Airport climate station are closest to the catchment. The mean monthly rainfall distribution and the mean annual rainfall for the station are shown in Table 24. The mean annual rainfall for the catchment is approximately 1,815 mm. The Whangārei Aero AWS is the closest full climate station to the catchment. Additionally, the Augmented VCSN dataset can be used.

Table 23: Summary of key active climate stations around the catchment

Station name	IRIS ID	Type of station	Date station opened	Status	Duration of rainfall monitoring
Hatea at Glenbervie Forest HQ	LOC.546301	Rainfall	01-09-1947	Active	78 years
Whangārei Aero AWS	LOC.547307	Full Climate	03-12-1991	Active	34 years

Table 24: Mean monthly and annual rainfall for the Hatea at Glenbervie Forest HQ rainfall station (1948-2024)

Rainfall Station	Mean monthly rainfall (mm)												Mean Annual Rainfall (mm)
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Hatea at Glenbervie Forest HQ	210	187	151	129	110	118	113	140	156	147	160	196	1,815

HYDROLOGY AND WATER RESOURCES SITUATION

The hydrosite catchment is drained by the Mangahahuru stream and its tributaries. The Mangahahuru stream is a tributary of the Wairua River, and their confluence is in the Matarau area to the west of Hikurangi. The catchment does not have any consented water takes. This was one of the main criteria that was considered in identifying this as a reference catchment. However, there are both surface water and groundwater consented water takes downstream of the catchment. The hydrology of the catchment is outlined in Table 25.

Table 25: Hydrological and water allocation of the Mangahahuru at County Weir hydrosite catchment

Hydrosite catchment parameter	Value
Catchment area	21.1 km ²
Date flow station was opened	15 December 1968
Number of years of flow records	57 years
7d - MALF	127 L/s
1 in 5 year 7-day flow	78 L/s
Mean flow	593 L/s
Median flow	323 L/s
Number of water take consents	0
Current consented allocation	0 L/s
Consented allocation as percentage of 7d-MALF	0 %

LANDCOVER AND LANDUSE

The catchment is predominantly under exotic plantation forestry, which occupies approximately 79% of the catchment area, with indigenous forest accounting for a further 15.9%. Plantation forestry in the catchment is subject to harvesting and replanting cycles, that have the potential to influence catchment hydrology over time. An investigation by Mourot et al. (2021) identified a substantial increase in forest cover within the catchment and observed declining streamflow trends during the 2008–2020 period. While the study suggested that increased tree water use may have contributed to reduced streamflows, it also noted the difficulty in separating the effects of land-use change from climatic variability. Consequently, forestry influences should be considered when interpreting long-term flow statistics from this catchment. Nevertheless, the catchment remains a valuable reference hydrosite for understanding low-flow behaviour in forestry-dominated catchments and for supporting future low-flow investigations in similar settings.

Table 26: Landcover types in the Mangahahuru at County Weir hydrosite catchment (LCDB6)

Land cover type	Area (km ²)	Percentage of catchment area
Exotic Forest	16.75	79.4%
Exotic Grassland	0.59	2.8%
Exotic Scrub	0.19	0.9%
Indigenous Forest	3.36	15.9%
Indigenous Scrub	0.20	0.9%
TOTAL	21.10	100%

GEOLOGY, SOILS AND HYDROGEOLOGY

The catchment is underlain predominantly by rocks of the Waipapa Composite Terrane comprising mainly greywacke, with local occurrences of chert, argillite and basalt. Parts of the catchment are also characterised by mud, sand and gravel deposits of the Tauranga Group. The main soils of the catchment are dictated by the geology. The dominant soil texture class is clay loam of the Marua suite. The catchment is not underlain by any of the main mapped aquifers of Northland.

Comparison of candidate reference hydrosite catchments

To support a comparative assessment of the selected reference hydrosite catchments, a summary is presented in Table 27. The table summarises the key catchment characteristics, hydrological metrics, water allocation status, and factors that informed the suitability of the catchments as potential reference hydrosites for future low-flow investigations.

Table 27: Summary comparison of selected reference hydrosite catchments

Hydrosite catchment	Area (km ²)	Flow record (years)	Water allocation status	Land cover	Key geological and hydrogeological settings	Key reference catchment attributes
Ngunguru at Dugmores Rock	12.2	56	No consented water takes (0% of 7d-MALF)	Mainly exotic grassland (46%) and indigenous forest (37%) with minor exotic forest cover	Basement sedimentary rocks (Waipapa Group); Small section of Sandy Bay coastal aquifer.	Long flow record, no consented water takes, representative mixed land-cover catchment
Kaihu at Gorge	114.0	56	26.45 L/s consented allocation (3.6% of 7d-MALF)	Predominantly exotic grassland (53%). Contains also indigenous forest cover (29%) and exotic forest	Predominantly Waipoua basalts	Long flow record, low allocation relative to stream flows, suitable following flow naturalisation
Waipoua at SH12	65.8	19	No consented water takes (0% of 7d-MALF)	Predominantly indigenous forest (87%) with minor exotic grassland and indigenous scrub	Predominantly Waipoua basalts	Near-natural catchment conditions, no consented allocation, extensive indigenous vegetation cover
Maungaparerua at Tyrees Ford	11.0	58	No consented water takes (0% of 7d-MALF)	Predominantly exotic grassland (88%), with minor exotic forest and scrub cover	Kerikeri Volcanic basalts; Puketotara basalt aquifer	Long flow record, useful for representing basalt-influenced hydrology
Waipapa at Forest Ranger	121.8	48	No consented water takes (0% of 7d-MALF)	Predominantly indigenous forest (87%), with minor exotic forest and grassland cover	Mix of Puketi Unit basalt and Caples Group and Te Kuiti group sedimentary rocks. Small section of Kerikeri basalt aquifer.	Near-natural catchment conditions, no consented water takes, long flow record, extensive indigenous forest cover
Mangahahuru at County Weir	21.1	57	No consented water takes (0% of 7d-MALF)	Predominantly exotic plantation forest (79%), with minor indigenous forest cover (16%)	Waipapa Group sedimentary rocks.	Long flow record, no consented water takes, representative of exotic forestry dominated catchments

4. Assumptions and limitations

The following assumptions and limitations have been acknowledged in this study.

Assumptions

- The selected hydrosite catchments are assumed to be representative of reference (donor) catchments in future low-flow investigations.
- Long-term flow records from the selected hydrosites are assumed to provide a reliable representation of catchment hydrological behaviour, including low-flow conditions.
- The selected catchments are assumed to remain broadly stable over time, such that future low-flow analyses can utilise the existing flow records as representative of current hydrological behaviour.
- Hydrological and physiographic similarities between selected donor catchments and future receiver catchments can be reasonably identified using available catchment attributes, including geology, land cover, climate, soils, and flow regime characteristics.

Limitations

- This assessment was undertaken primarily as a desktop study and did not include detailed field verification of catchment characteristics. Ground-truthing may be required to confirm catchment conditions and potential hydrological influences.
- While consented water takes were assessed, PA takes may not be fully represented because they are based on estimates. Consequently, actual abstraction pressures may be underestimated in some catchments.
- Land cover datasets represent a point in time and may not fully capture historical changes in forestry harvesting, replanting, agricultural development, or other land-use changes that may have influenced flow records.

5. Conclusions and Recommendations

Conclusions

The following conclusions have been drawn from the study

1. Six hydrosite catchments were identified as suitable potential reference catchments for future low-flow investigations based on the availability of long-term flow records, minimal abstraction pressures, and broadly representative physiographic characteristics.
2. All selected hydrosites have long-term continuous flow records (19–58 years), providing a strong foundation for future low-flow correlation studies, rainfall–runoff modelling, and validation of regional low-flow estimation approaches.
3. The selected catchments encompass a range of climatic, geological, hydrological, and land-use settings across Northland, providing a diverse set of candidate reference catchments for future low flow investigations, regionalisation studies and transferability assessments.
4. Most selected catchments have no active consented water takes, while water takes in the Kaihu at Gorge catchment are small relative to the catchment 7d-MALF and can potentially be accounted for through naturalisation.
5. Several catchments are associated with high-yielding basalt aquifer systems, suggesting strong groundwater contributions and sustained baseflow conditions that are valuable for understanding low-flow behaviour in groundwater-supported systems.
6. The selected hydrosites provide an appropriate foundation for future donor–receiver correlation analyses, refinement of modelled low-flow statistics, validation of geology-based approaches including the Waugh method, and future rainfall–runoff modelling applications.

Recommendations

Based on the desktop assessment, the following recommendations may be considered by NRC:

1. Given that the report was based on a desktop assessment, it may be advisable to undertake field verification of the selected reference catchments to confirm desktop assessment findings, including catchment characteristics and potential anthropogenic influences before use for correlation or in rainfall-runoff modelling.
2. It is recommended to adopt the six hydrosite catchments as candidate donor catchments for future low-flow investigations and regionalisation studies.
3. Identify and characterise physiographically similar receiver catchments that could be paired with the selected donor catchments for future targeted low-flow analysis.
4. Periodically review catchment conditions, land-use changes, abstraction pressures, and monitoring data to ensure the selected catchments remain suitable as reference sites over time.
5. Continue to maintain and operate the selected flow recorder sites to preserve their long-term flow records and strengthen their value as reference catchments for future low-flow investigations, model calibration, and regional hydrological assessments.
6. Consider identifying additional reference catchments in future where required to improve representation of physiographic conditions not currently captured by the selected catchments.

References

Booker, D., Woods, R. and Franklin, P. (2012) Hydrological estimates for Northland. Northland Regional Council. NIWA Client Report No. CHC2012-096

Cameron, S., Osbaldiston, S., Skuse, G. and Revfem, C. (2001): Northland. *In* Groundwaters of New Zealand, M.R. Rosen and P.A. White (eds) New Zealand Hydrological Society Inc., Wellington. P291 – 302

Landscape DNA, (2024) *Physiographics Environments*. Available on <https://landscapedna.org/maps/physiographic-environments/family/>

Manaaki Whenua – Landcare Research (2025) *LCDB v6.0 - Land Cover Database version 6.0, Mainland, New Zealand*. Available from [LCDB v6.0 - Land Cover Database version 6.0, Mainland, New Zealand | LRIS Portal](#)

Ministry for the Environment (2023) National Policy Statement for Freshwater Management 2020

Mourot, F., Westerhoff, R.S., Cameron, S.G. (2020) Effects of afforestation on groundwater recharge: Perspectives for New Zealand in relation to the One Billion Trees Programme. Lower Hutt (NZ): GNS Science. 84 p. (GNS Science report; 2020/21). doi:10.21420/5ZCK-DJ09.

Mourot, F., Westerhoff, R.S., Taves, M.W., Macdonald, N. and Moreau, M. (2021) Investigation of the effects of afforestation on catchment water balance: case studies in Northland and Waikato. Wairakei (NZ): GNS Science. 62 p. Consultancy Report 2021/57

NRC (2018) *IRIS site datasets* Available on <https://nrcmaps.nrc.govt.nz/portal/home/item.html?id=491a629abdf749a1aa973aaac506c1a6>

NRC (2021a) *Fundamental Soils* Available on <https://nrcmaps.nrc.govt.nz/portal/home/item.html?id=ab48514c48f9497b9c25d2ba019614b4>

NRC (2021b) *Physiographics reference Layer* Available on <https://nrcmaps.nrc.govt.nz/portal/home/item.html?id=727f5add98c04e3e8ccce1712b4c2b04>

NRC (2022a) *Main Northland Aquifers* Available on <https://nrcmaps.nrc.govt.nz/portal/home/item.html?id=9280e03f91f64dd19ae54160a172ea34>

NRC (2024a) *IRIS Authorisations – Resource Consents* Available on <https://nrcmaps.nrc.govt.nz/portal/home/item.html?id=b2f4d0784f914c89a82208ae36651307>

NRC (2008) Annual Monitoring Report 2007 – 2008. Available on <https://www.nrc.govt.nz/media/33tfjrlu/groundwaterpdffinal.pdf>

Appendix 1: Water take consents from the Kaihu at Gorge catchment

IRIS ID	Type	Status	Source	Purpose	Net take (L/s)	Continuation flow (L/s)	Allocation Amount (m ³ /year)	Allocation Comment
AUT.007642.01.03	Surface Water Take	Current	River	Irrigation - Pasture	25.46	640	150,000	
AUT.004318.03.02	Surface Water Take	Current	River	Drinking - Private Domestic Water Supply	0.42	88	6,500	
AUT.043558.01.01	Surface Water Take	Current	River	Stock - Dairy Shed	0.57	1158.4	17,885	Double accounting with GWT AUT.043558.02.01
AUT.043558.02.01	Ground Water Take	Current	Bore	Stock - Dairy Shed	0.57	N/A	17,885	Double accounting with SWT AUT.043558.01.01

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