Approach used to determine freshwater allocation in Northland

Freshwater quantity accounting system

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Northland REGIONAL COUNCIL

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1. Introduction

1.1 Purpose of this report

The proposed new regional plan for Northland sets freshwater quantity limits (minimum flows, water levels and allocation limits) for the region's rivers, lakes and aquifers. The limits specify how much water is available for use while safeguarding the ecological health of water bodies.

The purpose of this report is to provide an overview of:

- The technical work that has been undertaken to support decisions on how Northland's river network and groundwater were grouped into freshwater management units[1]; and
- The approach used to determine how much water is estimated to be available for allocation from the rivers and groundwater in the freshwater management units and the amount that is already allocated to be taken. (Fresh water quantity accounting system.)

Note: lakes and wetlands are not covered in this report.

1.2 Background

In 2009 the council initiated the Sustainable Water Allocation Project. The purpose of the water allocation project was to establish minimum flows, levels and allocation limits for the region's freshwater bodies that protect the environment and provides users with reasonable reliability of supply.

Soon after the government issued the National Policy Statement for Fresh Water Management 2011 (NPS–FM). The NPS–FM sets out objectives and policies that direct regional councils to manage water in an integrated and sustainable way, while providing for economic growth with set water quantity and quantity limits. Regional councils are required to ensure that regional plans establish freshwater objectives and set environmental flows and levels for all freshwater management units in their regions. Environmental flows and levels include allocation limits and minimum flows for rivers and allocation limits and minimum water levels for lakes and aquifers. The NPS–FM also requires regional councils to avoid and phase out over-allocation, which is the situation where water:

(a) has been allocated to users beyond a limit; or

(b) is being used to a point where a freshwater objective is no longer being met.

The Regional Water and Soil Plan for Northland specifies minimum flows for rivers, although it provides for lesser flows to be justified under certain circumstances. The plan does not set allocation limits for water bodies.

In September 2017, the council released a proposed new regional plan for Northland (proposed regional plan). The proposed regional plan groups the region's rivers, lakes and aquifers into freshwater management units and sets water quantity limits for them.

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[1] A freshwater management unit is a water body, multiple water bodies or any part of a water body determined by the regional council as the appropriate spatial scale for setting freshwater objectives and limits and for freshwater accounting and management purposes (NPS-FM definition).

2. Freshwater Management Units – Water Quantity

2.1 River Management Units

Northland's geology, topography and climate varies significantly across the region. This has resulted in a dense network of streams in over 167,000 of individual streams (Niwa Digital Network 3), approximately 1,700 source-to-sea catchments, and variable groundwater resources.

It is not efficient or indeed necessary to set specific freshwater quantity limits for each water body and therefore the council has grouped the them into freshwater management units based on based on common values of the water bodies and the sensitivity of the values to changes in flows. The proposed river management units for water quantity are:

- Large River
- Small River
- Coastal River and
- Outstanding Value River

Large River

The large river grouping is based on the outcome of the Environmental Flow Strategic Assessment Platform (EFSAP) modelling as described in report by Franklin 2013. The report describes how different allocation limits and minimum flows can result in different outcomes in reliability of supply and impacts on instream habitat for specific fish species across the region. Where the modelling indicated that rivers resulted in similar outcomes these rivers were grouped into the one unit. The Large river unit was adopted from this work while the small river units was divided further as described below.

Small River and Coastal rivers units

The small rivers management unit identified in the ESAP modelling was split into two management units (coastal rivers unit and small rivers unit) to recognise the high fish diversity in coastal streams and rivers as reported in Franklin 2013 and Franklin 2015.

In 2011 the council commissioned Paul Franklin of NIWA to identify streams in Northland most at risk to changes in flows based on their hydrology and the probability of flow sensitive fish species being present. The work ranked each stream as low, medium or high risk to effects on fish from reduced flows. The council decided that if at least 30% or more of streams in a catchment are at high risk of hydrological alteration then all of the streams in the catchment should be included in the coastal rivers management unit. Thirty percent threshold was applied on the basis that this indicated a significant proportion of the catchment is important habitat for flow sensitive fish species and vulnerable to hydrological alteration. While this can be seen as conservative, precaution is warranted given the at risk status of many freshwater species and that many native fish migrate throughout the catchment in their life cycle. The output from the work resulted in source to sea catchment boundaries for the coastal and small river management units.

Outstanding value rivers

The current operative plan identifies and protects flow regimes in rivers with outstanding values. The councils considered that it is appropriate to continue to do so through the new regional plan.

The boundaries for the proposed river water quantity management units are shown in Figure 2 below.

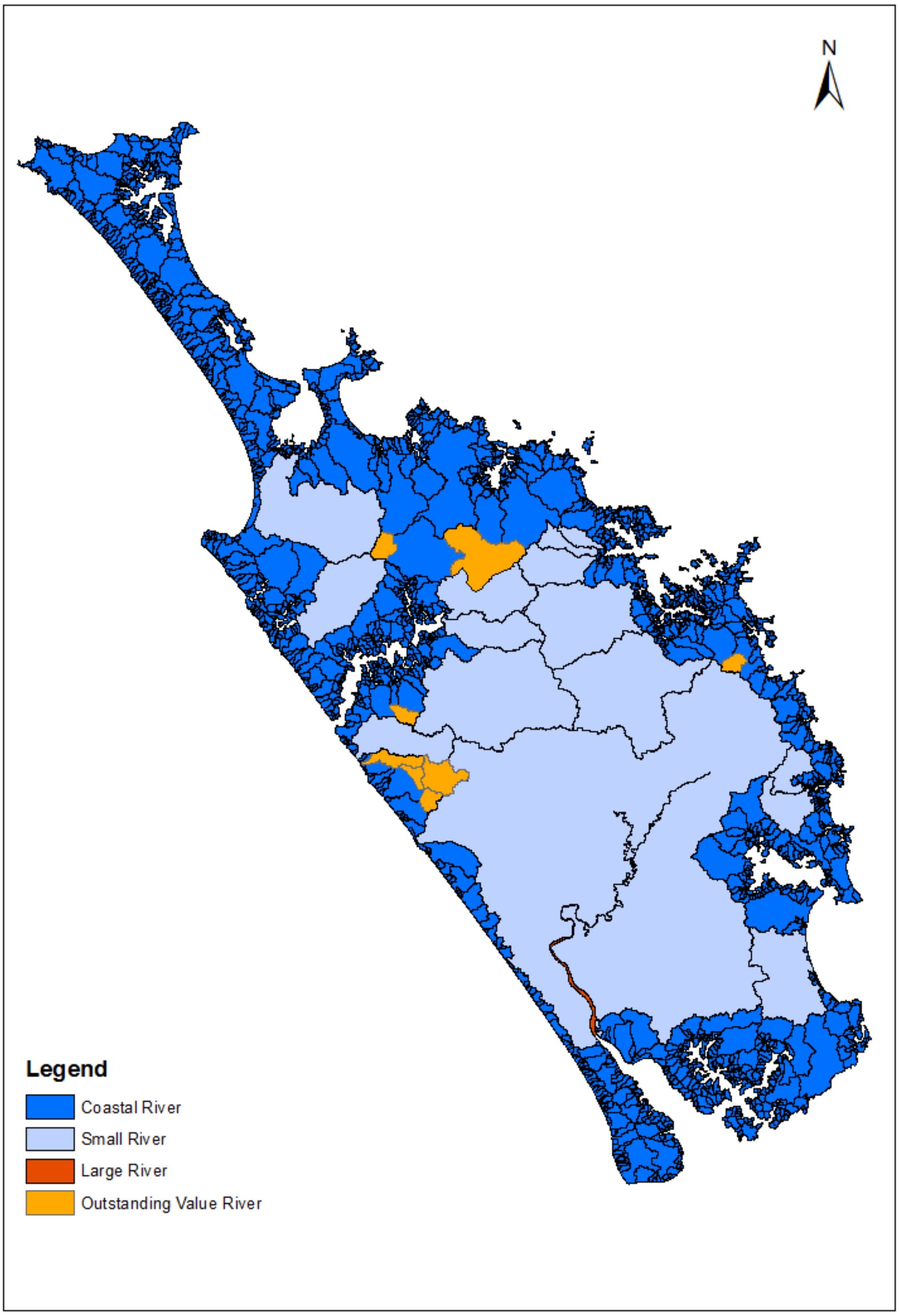

Figure 2: Amended River Water Quantity Management Units for Northland

2.2 Groundwater Management Units

A similar approach of considering the values and sensitivities of a water body was applied for groundwater in Northland.

Groundwater can be found in many areas throughout the region, however, it can vary significantly in quality and quantity. The council has mapped 63 aquifers and undertaken assessments of these aquifers ranging from preliminary to complex investigations depending on the information available. Approximately 80% of the consented groundwater takes occur within the mapped aquifers.

Groundwater systems near the coast are sensitive to saline intrusion. Due to this sensitivity, all mapped aquifers adjoining the coast and a 200 metre buffer strip along the coast have been grouped together as the Coastal Groundwater Management Unit, with the exception of the Aupōuri Aquifer. The council has sufficient information on the Aupōuri Aquifer to establish specific allocation limits for it. Information includes long term monitoring data. As such, the aquifer has been identified as a specific aquifer unit and the proposed regional plan set specific allocation limits based on a comprehensive assessment of the aquifer system. The remaining groundwater systems within Northland have been grouped as "Other" Groundwater Units.

Figure 3 shows the map of the Groundwater Management Units. The map also indicates the existing mapped aquifers. The boundaries for these aquifers are based on geological units as identified in the Aquifer Extent Report by Pride Mangeya, 2015.

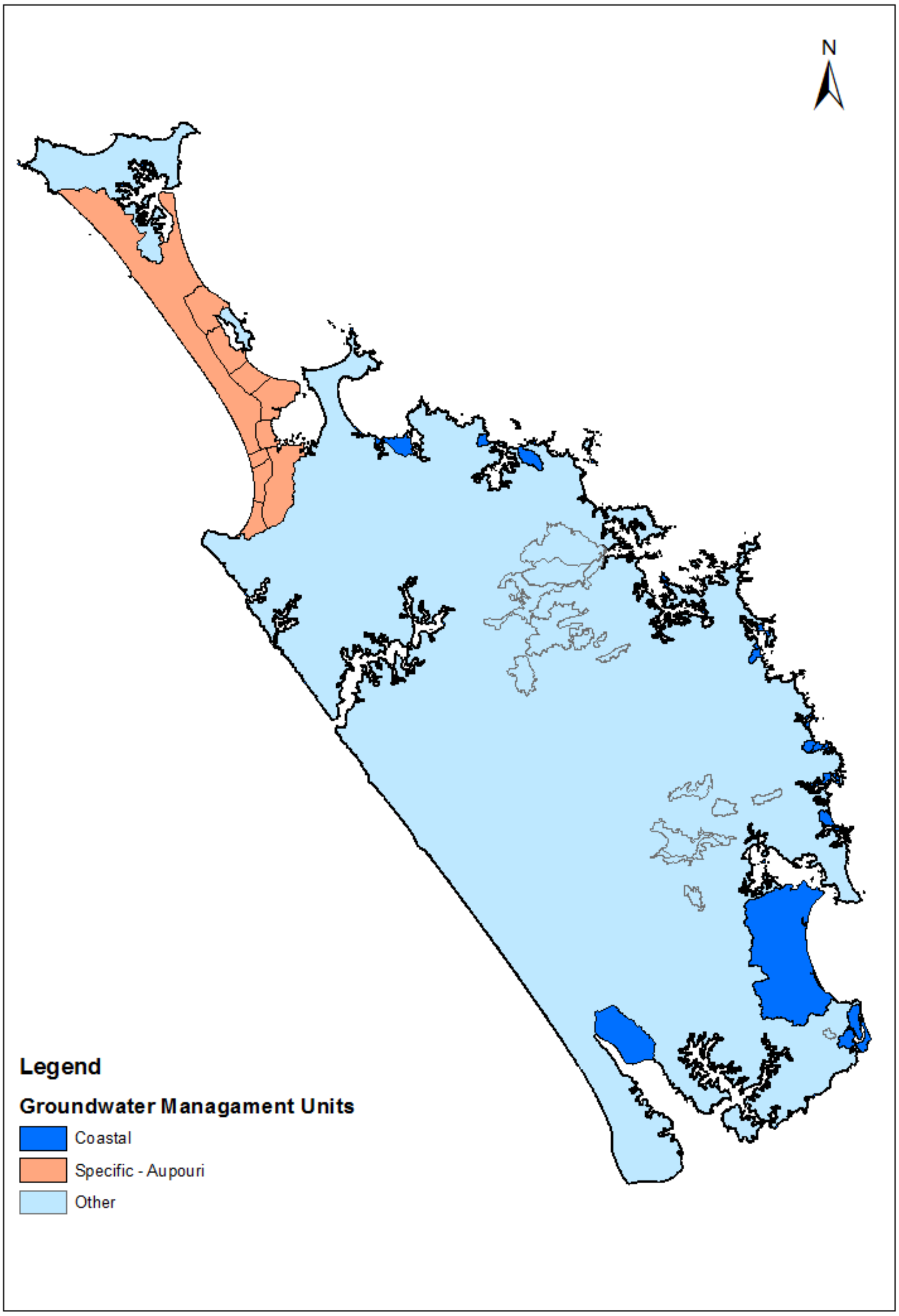

Figure 3: Groundwater Quantity Management Units for Northland

3. Water available for allocation – Freshwater quantity limits

3.1 Overview

Minimum flows are set to protect in-stream values, particularly the health of aquatic ecosystems. They are based on the premise that the less water there is in a water body, the less habitat there is available for aquatic species (for example, plants, invertebrates, and fish) and the increased likelihood of other adverse effects (for example, reduced levels of dissolved oxygen and higher water temperatures). Minimum flows also impact on water abstracters but with the opposite impact. That is, the lower the minimum flow the greater the reliability of supply (and vice versa). When a flow in a river reduces to the minimum flow, water takes are restricted so that the flow is not artificially reduced below the minimum flow.

However, minimum flows only maintain the quantity of water left in a water body. They do not regulate the natural flow variability above the minimum flows that are important for ecosystem health, for example by flushing fine sediment, periphyton and other aquatic vegetation, influencing fish migrations and community structure. The also do not solely regulate the security of supply. These factors are affected by allocation limits.

Allocation limits are set to cap the amount of water that can be taken from a water body above a minimum flow or level in the case of groundwater or lakes. They ensure that rivers have natural fluctuations in flows and they provide a degree of security of supply for water users. This is because reliability of supply reduces with increasing allocation and increases the length of time that a water body will be at a minimum flow, which is often referred to as "flat-lining". When a flow in a river drops below a management flow (the minimum flow plus the allocation limit) then partial restrictions on takes are meant to occur. Restrictions are imposed by the council by way of conditions on resource consents, in rules for water takes, or in water shortage directions.

Minimum flows and allocation limits are designed primarily to protect in-stream values and the quantity and reliability of water supply during normal to low flows (that is, typical high demand periods). Figure 1 below illustrates a simple minimum flow and allocation limit regime.

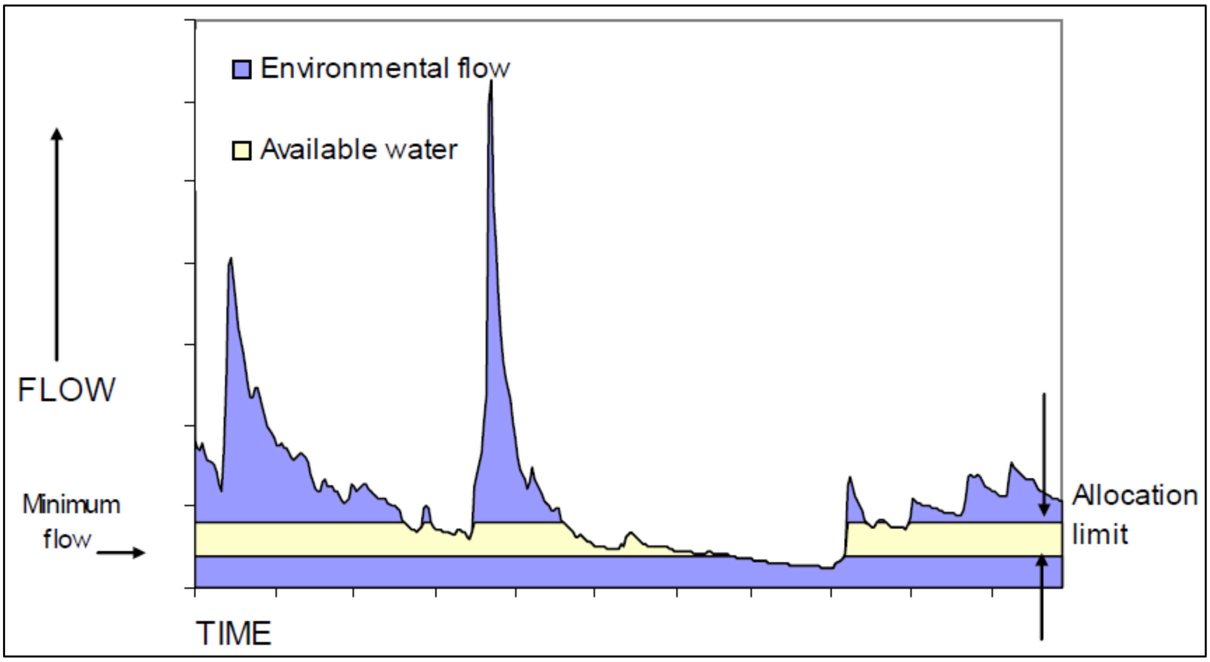

Figure 3: **Illustration of a simple minimum flow and allocation limit regime (reproduced from Figure 4 in MfE 2008. Proposed National Environmental Standard on Ecological Flows and Water Levels: Discussion Document.)**

Allocation limits and levels are also required for groundwater systems. These limits and levels need to consider the effects of abstraction on the groundwater system and any connected surface water bodies.

3.2 Proposed limits

The proposed new regional plan sets minimum flows and allocation limits for Northland's rivers and allocation limits for its aquifers. The limits are set out tables 1 and 2 below.

The minimum flow and allocation limits for rivers are based on a percentage of the 7-day Mean Annual Low Flow (7-day MALF) for each of the freshwater management units. The 7-day MALF is a very common measure used for setting water quantity limits because it defines water availability during periods of scarcity. Scaling river flows by the 7-day MALF standardises the allocation limit and minimum flow by the size of the river. This allows rivers to be grouped irrespective of the sizes of their river flows. Flows less than the 7-day MALF generally occur on average once in every two years.[2] The 7-day MALF is also used in the Proposed National Environmental Standard for Ecological Flows and Levels 2008.

Table 1: **Proposed minimum flows and allocation limits for Northland's rivers**

Management Unit	Minimum Flow (% of 7-day MALF)	Allocation Limit (% of 7-day MALF)
Outstanding rivers	100%	10%*
Coastal rivers	90%	30%*
Small rivers	80%	40%*
Large rivers	80%	50%*

*Note that if the amount of water authorised to be taken from a river exceeds an allocation limit at the public notification date of the plan (15 September 2017) then the allocation is capped at the current level. For further details on the limits see proposed policies D.4.14 and D.4.16 and Section 32 RMA evaluation report.

Table 2: Proposed allocation limits for Northland's aquifers

Management Unit	Allocation Limit (% of annual average recharge)
Aupōuri-Waihopo aquifer	15%
Aupōuri-Houhora aquifer	11%
Aupōuri-Motutangi aquifer	10%
Aupōuri-Waiparera aquifer	10%
Aupōuri-Paparore aquifer	35%
Aupōuri-Waipapakauri aquifer	20%
Aupōuri-Awanui aquifer	12%
Aupōuri-Sweetwater aquifer	35%
Aupōuri-Ahipara aquifer	12%
Coastal aquifers outside of Aupōuri Peninsula	10%
Other aquifers	35%

The groundwater allocation limits for the Aupōuri aquifer are based on numerical modelling undertaken by Scott Willson, 2015. This modelling predicted how much water could be abstracted from areas along the Aupōuri Peninsula while still maintaining groundwater levels and flows to the coast. Maintenance of appropriate levels and flows ensures that the allocations are sustainable and unlikely to result in saltwater intrusion.

The Proposed National Environmental Standard for Ecological Flows and Levels 2008 limit suggested an interim limit for Coastal aquifers of 15% of the annual average recharge. However, based on the modelling undertaken for the Aupōuri Aquifer a more conservative limit of 10% of annual average recharge has been adopted in the proposed Regional Plan.

The allocation for the other aquifers are based on the Proposed National Environmental Standard for Ecological Flows and Levels 2008.

Where aquifers are linked to surface water an integrated management approach needs to be taken in accordance with the NPS-FM. Aquifers can be an important source of the base flow for many streams and rivers in Northlands particularly during dry periods. Where groundwater systems are hydraulically linked to surface water flows restrictions on groundwater takes may be required to maintain surface water flows and the surface water limits maybe applied. The hydraulic connection is dependent on a range of attributes including location of the bore, geology and bore construction. The degree of hydraulic connection and subsequently the requirement for surface water limits to be imposed will be assessed on a case by case basis through the consenting process.

4. Method for assessing indicative allocation

4.1 Water Allocation Tool overview

The Water Allocation Tool is a series of ArcGIS models and Python scripts that provide a snap-shot of the indicative level of allocation in Northlands catchments and aquifers.

The tool has been designed to meet the freshwater quantity accounting requirements of the NPS-FM[3] and inform the council of areas where there are high levels of allocation. This enables the council to plan monitoring, investigations and management options in priority areas.

The tool provides the following key outputs.

Rivers – reach (individual stream) scale

- Total surface water accumulation down the river network
- Indication of water availability down the river network;
- Minimum flow accumulation

Rivers – catchment scale

- Water available for allocation at catchment scale
- Current level of allocation compared to water available at catchment scale

Groundwater – Mapped Aquifers

- Water available for Allocation
- Level of allocation compared to water available

The key output for the water allocation tool is available to the public via the NRC website : Indicative water quantity allocation maps . The allocation rules in the Proposed Plan currently apply at each individual stream. As such the public map shows how much water is estimated to be available in each stream, based on the allocation limit for the stream and how much water is already allocated within the catchment. The output map considers the cumulative effects of allocation throughout the catchment. For example, if the allocation is already at the limit then the streams that contribute to the flow at that site are also at their limit, as any further takes upstream will impact on the flow at that site.

The tool can also provide other outputs as describe above, to assist in informing Council staff on potential pressures and allocation issues throughout the region. More detail on the key inputs and outputs as well as associated uncertainties are provided in the following section.

4.2 Model inputs and uncertainties

4.2.1 Rivers – stream scale

The allocation calculator accumulates allocation down the river network at each individual stream, and can also show accumulated minimum flow rules. However, there is a high level

[3] Policy CC1, NPS-FM.

of uncertainty for the estimated flows at this level of resolution as many Northland streams have small low flows ie less than 5 L/s. Estimating flows for small streams can result in high levels of uncertainty ie an estimated flow of 3 L/s with a difference of +/- 2 L/s. Due to this high level of uncertainty a traffic light signal approach has been adopted rather than displaying absolute figures. This approach has been adopted to indicate areas where there may be potential restrictions.

A summary of the key inputs and uncertainties for rivers catchment scale model are provided in Table 5 and 6 below.

Table 3: Key inputs to reach scale model – Water available for allocation

Input	Description	Source
Digital River Network	Digital River Network 1	NIWA
7-day MALF for Digital Flow Network (L/s)	Estimated 7-day MALF calculated for each reach on the network and calibrated to NRC recorder sites. Measured 7-day MALF used where there is a recorder site on the reach with sufficient flow record.	NIWA, using random forest regression method. NRC, statistical calculation from long term flow recorder data
Water available for allocation at reach scale converted to %	Model identifies estimated 7-day MALF for the terminal reach of each catchment and multiplies by allocation limit in proposed plan	Proposed Regional Plan and inputs above

Table 4: Key inputs to reach scale model – Level of Allocation compared to water available catchment scale

Input	Description	Source
Consent take (L/s)	Average daily allocation for surface water takes converted to L/s, estimated run of stream takes from dams in the beds of rivers (Report Pride Mangeya, 2015) and estimated stream depletion from groundwater takes in hydraulically connected systems (Report SKM 2012).	Consent database (IRIS)
Total Allocation (L/s)	Consent take	Inputs above

Note this does not include dairy washdown at this stage as there is currently limited information on the location of these takes.

NRC is in the process of obtaining improved electronic use data. Historically most water use data was submitted on paper and the accuracy of this data was sometimes questionable. The now improved collection and processing of water use data will enable a better understanding of actual water use compared to allocation within catchments.

4.2.1 Rivers –catchment scale

A summary of the key inputs and uncertainties for rivers catchment scale model are provided in Table 3 and 4 below. The catchment scale tool provides an estimation of the dairy wash-down volumes.

Table 5: Key inputs to catchment scale model – Water available for allocation

Input	Description	Source
Digital River Network	Digital Network 1	NIWA
Catchment Boundary	Source to sea catchment boundaries are based on source to sea watershed catchments REC1 except for tributaries within the Northern Wairoa, and Waipū. Sub catchments have been divided in these areas based on long term flow recorder sites and the Large River Freshwater Management Unit	NIWA and NRC
7-day MALF for Digital Flow Network (L/s)	Measured 7-day MALF used where there is a recorder site on the reach with sufficient flow record. Estimated 7-day MALF calculated for each reach on the network and calibrated to NRC recorder sites as described in Booker 2012.	NRC, statistical calculation from long term flow recorder data NIWA, using random forest regression method.
Water available for allocation at catchment scale (L/s)	Model identifies value for terminal reach and multiplies by allocation limit in proposed plan	Proposed Regional Plan and inputs above

Table 6: Key Inputs to catchment scale model – Level of allocation compared to water available

Input	Description	Source
Consent takes within each catchment (L/s)	Average daily allocation for surface water takes, estimated run of stream takes from dams in the beds of rivers (Report Pride Mangeya, 2014) and estimated stream depletion from groundwater takes in hydraulically connected systems (Report SKM 2012).	Consent database (IRIS)
Estimated average dairyshed washdown/cooling within each catchment (L/s)	Unauthorised and permitted dairy takes within each catchment based on 70 L/cow/day using locations and stock numbers on the NRC IRIS database. Where there is no maximum stock number available the average herd size for the Northland region is applied.	IRIS
Estimated average dairy drinking during the summer months	Estimated dairy drinking has been calculated based on 120 L/cow/day using locations and stock numbers on the NRC IRIS database. Where there is no maximum stock number available the average herd size for the Northland region is applied.	
Total allocation for each catchment (L/s)	Consented daily Take + Estimated dairy shed/cooling use.	Inputs above

The dairy cow drinking (based on 120 L/cow/day using stock numbers on the FDE database); and other stock drinking (based on Census NZ data 2012) has been estimated by the council this is currently not included in the public allocation map as the proposed policy excludes stock drinking from allocation calculations. Domestic takes from surface water has also not been estimated at this stage due to uncertainties as to locations of these takes.

This output map is currently used internally and presents the allocation level at a source to sea catchment level or sub catchment level in the Wairoa/Wairua, Kaihū and Waipū rivers. The map highlighted key pressure areas and will be used to inform and prioritise future investigations and assessments.

The allocation calculator can also account at the Freshwater Management Unit level, however accounting at this large scale is not considered useful as it does not indicate the pressures within the individual catchments.

4.2.3 Groundwater – Mapped Aquifers

A summary of the key inputs for groundwater model are provided Table 7 and 8 below.

Table 7: Groundwater available for allocation – key inputs

Input	Description	Source
Aquifer area (m^2)	Aquifer area based on geological boundaries	Aquifer extents review Pride Mangeya 2016
Rainfall (mm/year)	Annual average rainfall for the location based on the NRC rainfall network	NRC rainfall network kriging is used to extrapolate the point data over the region
Annual Aquifer recharge (m^3/year)	Average recharge to the aquifer calculated by the following Rainfall x aquifer area x recharge rate Where more robust assessment of the aquifer recharge has been undertaken or a specific limit has been set then this is entered as the allocation limit.	Recharge Estimates Pride Mangeya 2015
Water available for allocation (m^3/year)	Annual aquifer recharge x allocation limit in proposed plan	Proposed Regional Plan and inputs above

Table 8: Level of Groundwater Allocation compared to water available – key inputs

Input	Description	Source
Consented Annual Volume (m^3/year)	Annual Consented takes from groundwater from the aquifer. Where no annual limit specified in the consent then annual limited calculated to from daily limit x 365 days	Consent database (IRIS).
Annual dairyshed washdown/cooling (m^3/year)	Unauthorised and permitted dairy takes within each aquifer is based on 70 L/cow/day using locations and stock numbers on the NRC IRIS database converted to an annual estimate then multiplied by percent estimated to be sourced from groundwater (pers.com D Wright). This differs for each aquifer and is currently based on estimates. Where there is no maximum stock number of the FDE database the average herd size for the Northland region is applied. Where	FDE database (IRIS)
Total Annual Allocation (m^3/year)	Consent Annual Volume + Annual dairy shed/cooling	Inputs above

Although domestic, dairy cow drinking and other stock drinking has been estimated by the council, at the time this report was written these estimates have not been included in the public allocation map in accordance with policy in the proposed regional plan which currently excludes domestic and stock drinking use from allocation calculations.

For coastal aquifers, cumulative domestic use is also important. Where the total allocation of all takes (including domestic) in an aquifer is estimated to be high this is also highlighted in the public maps.

In some areas, the current approach for accounting for diary shed use means a % of the take is allocated from groundwater and surface water. This approach is considered appropriate at this stage based on current policy and risk. However, when information on the actual source of these dairy takes becomes available the tool can be updated as appropriate. The percentage used for each mapped aquifer is provided in Appendix 1.

The tool does not currently calculate allocation outside mapped aquifers as both the level of allocation and the groundwater available is dependent on the aquifer boundaries which have not at this stage been mapped.

4.3 Integrated Surface Water and Groundwater Management

Where aquifers are linked to surface water an integrated management approach needs to be taken in accordance with the NPS-FM. Basalt aquifers are important sources of the base flow for many streams and rivers in Northlands particularly during dry periods.

In 2012 the council contracted Sinclair Knight Merz (SKM) to develop a 'Tool' to help assess how groundwater takes from basalt aquifers such as Kaikohe, Matarau, Three Mile Bush, Maunu, Whatitiri Maungakaramea and Glenbervie effect surrounding surface water flows.

The tool has been applied to consented groundwater takes in the main basalt aquifers listed above. The tool provides an indication of how much of the groundwater allocated by consents would be taken indirectly from the surface water streams. This helps the council understand the total surface allocation in the influenced rivers and stream, and assists in identifying when and integrated surface water and groundwater management approach is appropriate.

As some groundwater takes impact on surface water flows the public maps also show areas where groundwater takes may be restricted because of the impacts of the groundwater takes on surface water flows. As stream depletion effects are dependent on a range of site specific attributes such as bore construction and geology, the requirement to impose surface water limits on groundwater takes will be assessed on a case by case basis through the consenting process.

5. Summary of uncertainties and proposed work programmes

A summary of the uncertainties and assumptions for the accounting tool and associated modelling are detailed in Table 9 below.

Table 9: Summary of uncertainties and proposed work to improve tool

	Attribute	Data used	Level of uncertainty	Proposed work to reduce uncertainty
Water available	Medium to large catchments - with flow recorders	The council has undertaken statistical analysis of the flows measured at recorder sites to determine 7-day MALFs at the stream where the recorder site is located. The measured 7-day MALF at the recorder sites are currently unnaturalised meaning that takes influence the record at any given time. The recorder site data has been used to calibrate the estimates of 7-day MALF across the region.	Low	Ongoing flow data collection and data review Long term strategy to naturalise flows.
	Medium to Large catchments - no flow recorders	NIWA has modelled 7-day MALF estimates calibrated to Northlands hydrometric network. As stated above the council has undertaken statistical analysis of the flows at recorder sites to determine 7-day MALFs at the stream where the recorder site is located. Although the recorder sites information provides a good upstanding of the cumulative flows throughout the region, it only provides specific flow at the site of the recorder. NIWA was commissioned to undertake modelling to estimate 7-day MALFs at every stream in the region where we do not have measured flows. Refer to *"Hydrological Estimates for Northland."* Doug Booker, Ross Woods, Paul Franklin, 2012. NIWA's modelled 7-day MALF estimates consider a range of attributes including climate, rainfall,	Medium	Recorder sites have been installed where spatial gaps in the network have been identified. Compare various modelled data and local assessment using spot gaugings, and water balance modelling.

		catchment area, catchment geology and slope.		
	Small catchments	NIWA has modelled 7-day MALF estimates which consider a range of attributes including climate, rainfall, catchment area, catchment geology and slope. However, modelling flows for small streams can result in high levels of uncertainty ie for a moderate stream with an estimated flow of 30 L/s and error variation of +/-3 L/s the uncertainty is 10%. For a small stream with an estimated flow of 5 L/s and an error variation of +/- 3 L/s the uncertainty is 60%.	High	Low flow gaugings in small catchments to provide improved calibration of 7-day MALF estimates.
	Ground-water	Groundwater limits are based on a percentage of aquifer recharge. The aquifer recharge estimates for mapped aquifers are based on the aquifer geology and investigations undertaken in the region as detailed in the report "*Preliminary Assessment of Groundwater Recharge Rates. Northland Groundwater Recharge Zones." Pride Mangeya 2015.* Note specific recharge rates have been set in the tool for the Aupouri Aquifer as detailed "*Aupouri Aquifer Review."* Scott Wilson, Ali Shorkri, 2015.	Medium	Aquifer specific investigations in highly allocated aquifers to set aquifer specific recharge values.
Water Taken	Consented Takes	The model accounts for what is legally allowed to be abstracted in accordance with the conditions of consent with the following considerations. Average daily take rate has been used rather than instantaneous rate of take. The reason for this is the allocation of run of river takes at rates greater than the equivalent 24 hour rate is likely to over-estimate cumulative effects. The model accounts for average daily summer month allocation for surface water takes, this excludes takes for frost protection. The "Net" daily take has been applied where that take also has an associated freshwater discharge. This approach excludes non-consumptive takes such as takes for hydro-power generation.	Low	Ongoing data scrubbing and data checks are required.

		For groundwater, the allocation is based on the annual allocation. The model does not account for abstractions from storage and applies the Dam methodology to determine the run of stream takes from dams during the summer months. Refer to "Dam Low Flow Allocation – Catchment Specific Dam Take Assessment. Pride Mangeya, 2015." Currently this methodology has only applied in the highly allocated catchments. Stream depletion effects have been calculated as described in technical report "Groundwater Stream Depletion." SKM, 2013. Consented water use data was reviewed in 2010, and again in 2014 to ensure the NRC database is as accurate as possible.	Medium to High	Dam methodology to be applied in all catchments. Independent peer review of stream depletion report and methodology. Ongoing data quality checks
	Permitted / Unauthorised Takes	The dairy use has been estimated based on stocking rates provided to NRC by farmers. There is limited information on the potential source of the water. In some areas such as mapped groundwater a % of the estimated take is been included in groundwater and the surface water calculation. The % of groundwater is aquifer dependent as detailed in Appendix 1. NRC worked with MPI to obtain stock drinking water use at a mesh block area based on the Census NZ data 2012 — this was then proportioned to source to sea catchments. Permitted takes are currently not estimated for surface water takes.	Medium-High	Catchment specific water surveys in high allocation catchments Update details on actual volumes and source of permitted takes including dairy when this information becomes available.
Allocation Limits	Rivers	The default allocation limit % of 7-day MALF for each FMU was determined through the planning process and are supported by the technical documents such as "*Options for default minimum flow and allocation limits in Northland." Paul Franklin, Jani Diettrich and Doug Booker, 2013.*	Medium	Catchment specific investigations in highly allocated catchments on which to base specific limits

		However, they are averaged across the FMU and effects of changes in flows differ for individual streams.		
	Ground-water	The default limits are a % of aquifer recharge. Further work is proposed to consider setting aquifer specific limits.	Medium	Aquifer specific investigations to set aquifer specific limits

The proposed work in the table above will improve the accounting system and reduce uncertainties in the tool. The proposed work is subject to Council funding, resourcing and planning processes.

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Appendix A

The percentage of dairy use included in the allocation for each aquifer has been based on Council's experienced field staff recommendation. This will be updated as actual source data becomes available. The percentage of dairy use in each aquifer is detailed in table 9 below.

Table 9. Percentage of dairy use included in the allocation for aquifers.

Name	Freshwater Management Unit	% dairy takes sourced from groundwater
Matarau	Mapped - Non Coastal	50
Maungakaramea	Mapped - Non Coastal	30
Ruawai Deep	Mapped - Coastal	70
Aupouri-Houhora	Specific - Aupouri	80
Aupouri-Motutangi	Specific - Aupouri	80
Aupouri-Paparore	Specific - Aupouri	80
Aupouri-Waipapakauri	Specific - Aupouri	80
Aupouri-Sweetwater	Specific - Aupouri	80
Aupouri-Ahipara	Specific - Aupouri	80
Aupouri-Awanui	Specific - Aupouri	80
Aupouri-Waiparere	Specific - Aupouri	80
Pakaraka West	Mapped - Non Coastal	50
Waimate	Mapped - Non Coastal	50
Okaihau	Mapped - Non Coastal	50
Kaikohe	Mapped-Non Coastal	50
Kerikeri	Mapped - Non Coastal	50
Puketotara	Mapped - Non Coastal	50
Moerewa	Mapped - Non Coastal	50
Mangawhai West	Mapped - Coastal	50
Marsden-Ruakaka	Mapped - Coastal	50
Aupouri-Other	Specific - Aupouri	80
Whatitiri South	Mapped - Non Coastal	30
Maunu-Maungatapere South	Mapped - Non Coastal	30
Waipao	Mapped - Non Coastal	30

Northland
REGIONAL COUNCIL

WHANGĀREI 36 Water Street, Private Bag 9021, Whangārei Mail Centre, Whangārei 0148; P 09 470 1200 | F 09 470 1202
DARGAVILLE 42 Hokianga Road, Dargaville; P 439 3300 | F 09 439 3301
KAITĀIA 192 Commerce Street, Kaitāia; P 09 408 6600 | F 09 408 6601
ŌPUA Unit 10, Industrial Marine Park, Ōpua; P 09 402 7516 | F 09 402 7510
WAIPAPA Shop 9, 12 Klinac Lane, Waipapa 0295; P 09 470 1200 | F 09 470 1202

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