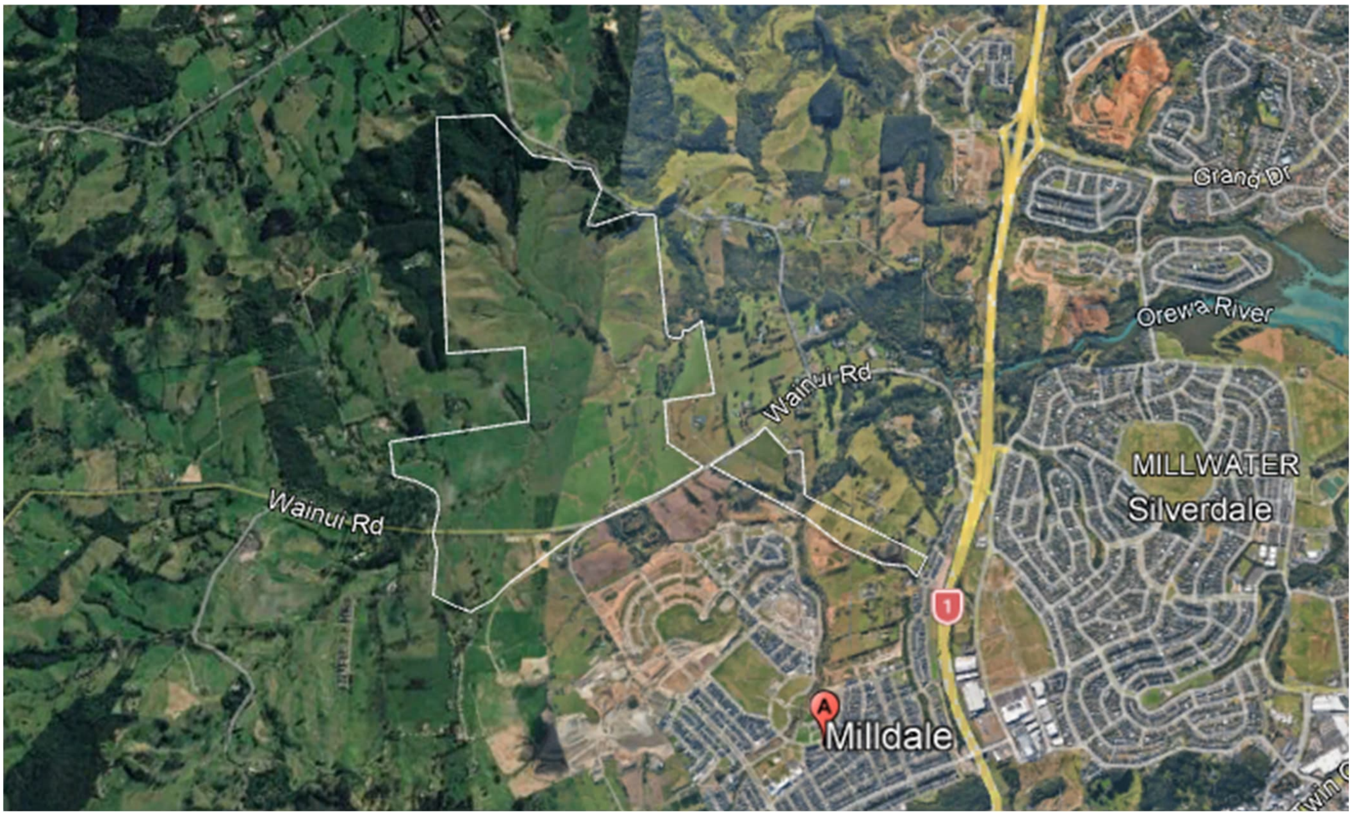
Surface Water Take Reliability Assessment

Milldale Stages 14-17 Fast-Track

FULTON HOGAN LAND DEVELOPMENT LTD

WWLA1603 | Rev. 3

11 August 2026



Milldale Stages 14-17 Fast-Track

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Williamson Water & Land Advisory

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Document history and status

Rev	Date	Description	By	Review	Approved
1	23 July 2026	Final Report	Barbara Tasca	Jon Williamson	Jon Williamson
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1	23 July 2026	Client	For review
2	3 August 2026	Client	Updated following client feedback
3	11 August 2026	Client	Minor edits following planning review

Statement of Qualifications and Experience

Author

My full name is Barbara F da Cunha Tasca.

I am an Experienced Graduate Hydrologist at Williamson Water & Land Advisory. I hold a bachelor's degree in environmental engineering, a postgraduate in urban development, and a master's in environmental physics, and have 8 years of professional experience in environmental impact assessments, monitoring, and compliance. My experience lies in hydrological assessments for urban development, water resource management, numerical modelling, and geospatial analysis applied to water resources.

Reviewer

My full name is Jonathan Lindsay Williamson.

I am the Managing Director at Williamson Water & Land Advisory. I hold the qualifications of Bachelor of Science, and Master of Science and Technology (Earth Science) from the University of Waikato and have over 30 years' professional experience in the field of hydrology and hydrogeology. My experience includes professional consultancy with experience in research and assessment of environmental impacts for a wide range of projects. My experience includes appearances at Council, Environment Court, Board of Enquiry, and EPA Fast-track Legislation Hearings, along with involvement in joint witness processes.

Ethical Declaration

We have been engaged by Fulton Hogan Land Development Limited (FHLD) (the Applicant) to undertake an assessment of environmental effects associated with the Milldale Stages 14-17 project and to prepare this report in support of the substantive application under the Fast-track Approvals Act 2024 (FTAA).

While this is not an Environment Court proceeding, we confirm that I have prepared this assessment in accordance with the applicable professional and ethical obligations of our profession and that the opinions expressed are within our area of expertise.

Contents

1. Introduction

This report has been prepared in support of the substantive application for the Milldale Stages 14-17 (Milldale North) Project under the Fast-track Approvals Act 2024 (FTAA).

The Project relates to approximately 231 ha of land centred around Wainui Road in Wainui, Auckland. The proposal provides for a comprehensively planned urban development including residential neighbourhoods, a supporting commercial node, transport and servicing infrastructure, open space, wetland and ecological restoration, and associated enabling works.

The application seeks approvals necessary to facilitate the staged development of the Project, including a suite of resource consents required under the FTAA framework.

The substantive application is supported by a comprehensive set of technical assessments and plans addressing the environmental, servicing and infrastructure matters associated with the proposal. This report should be read alongside the Planning Report and the appended technical reports and drawings lodged in support of the substantive application.

1.1 Purpose and Scope of this Report

This report addresses matters relating to the surface water potential for community water supply associated with the Project proposal. It seeks to assess if a high-flow stream take is a viable option to meet the potable water demand, and to determine and demonstrate supply reliability as a function of potential abstraction rate and reservoir storage volume.

This report has been prepared having regard to the relevant statutory and technical framework applicable to the proposal, including the Auckland Unitary Plan (AUP).

1.2 Site Description

The site comprises approximately 231 ha of land located to the north of the existing Milldale development. The site comprises two distinct areas:

- Residential subdivision area to the south of the Ōrewa river (shown in red in **Figure 1**); and
- Te Korowai o Maraeariki to the north of the Ōrewa river (shown in orange in **Figure 1**).

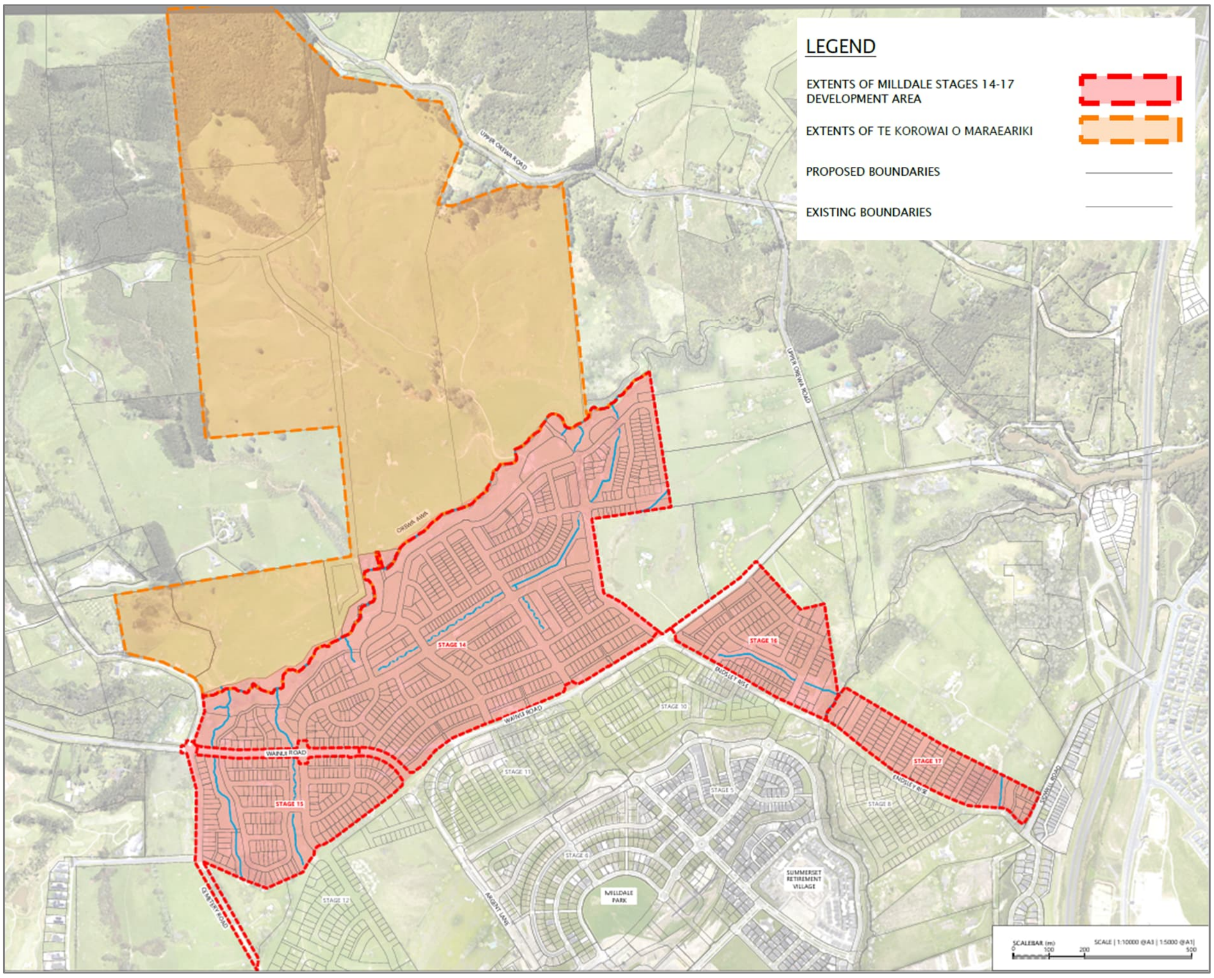


Figure 1. Site Location Plan.

The proposed residential subdivision area is located within the Future Urban Zone under the AUP. This part of the site is characterised by gently undulating to rolling pasture, with several streams, natural wetlands, constructed ponds and artificial drains traversing the area.

Te Korowai o Maraeariki is located to the north of the Ōrewa River and is zoned Rural Production under the AUP. This area is characterised by more undulating to steep terrain, with a series of ridgelines separated by incised gullies extending from the Ōrewa River. The land is predominantly managed pasture interspersed with streams and natural wetlands, together with pine plantations, exotic vegetation and gorse scrub. Relatively large areas of indigenous vegetation are also present, including a Significant Ecological Area – Terrestrial Overlay in the north-western portion of the site.

There is existing water, stormwater and wastewater infrastructure surrounding the site as a result of the extensive development within previous Milldale Stages. However, the site itself is not currently serviced in terms of supply and infrastructure. The surrounding roading network has been progressively developed in accordance with the staging of the Milldale development.

The surrounding area is now substantially developed. Milldale Stages 1 to 6 are complete, while Stage 7 is well advanced, with subdivision completed for Stages 7A–7C and construction of Stage 7D anticipated to commence in early 2027. Separate consents for the Stage 8 and 9 enabling works and subdivision were granted in 2024, with the associated offset and construction works now complete. The Milldale Local Centre has also been constructed, together with associated roads, accessways and drainage reserves. Community infrastructure within the surrounding area includes Ahutoetoe Primary School, two early childhood education centres and the

Summerset retirement village. Beyond the urban extent of Milldale, the site adjoins a number of rural residential properties.

Further detail regarding the site, surrounding environment and planning framework is provided within the Planning Report and technical reports appended to the application.

1.3 Description of the Proposal

The Milldale Stages 14-17 project seeks approvals for an urban development on the site. The proposal provides for up to 1,425 dwellings across a range of housing typologies and densities. In addition, the proposal includes provision for a small commercial area, transport infrastructure, servicing and stormwater infrastructure, subdivision, earthworks, stream works, and neighbourhood parks.

To the north of the Ōrewa River within Te Korowai o Maraeariki, the project includes private water and wastewater infrastructure, ecological restoration, as well as walking and cycling trails to enhance recreation and amenity.

Development of the Project will require a suite of approvals under the FTAA, including resource consents associated with subdivision, land use activities, bulk earthworks, infrastructure works, stream works, water take, diversion and discharge; along with NES for contamination and freshwater.

The aspects of the proposal relevant to this report include a surface water take.

A full description of the proposal is provided in the Planning Report and technical reports and drawings appended to the substantive application and should be read in conjunction with this report.

2. Potable Water Demand

The municipal water requirements have been calculated by Woods using Watercare's code of practice and a derivative assuming a conservation scenario using dual flush low flow toilets based on 1,425 dwellings, which produces a demand of 836 m^3/day. However, the water treatment plant is only 95% efficient, which means the supply requirements are 5% greater than demand, as summarised in **Table 1**.

A groundwater supply will provide a constant yield of 454.5 m^3/day, with the remainder coming from surface water 425.5 m^3/day).

Table 1. Summary of potable water average daily demand requirements and supply provisions.

Description	Demand (m^3/day)	Supply (m^3/day)	
		Groundwater	Surface Water
Demand + 5% in efficiency	880	454.5	425.5

2.1 Water Supply Strategy

The AUP provides for the taking and use of water under Chapters E2 and E7. The take and use of surface water require consent as a Discretionary Activity (DA) under Rule E7.4.1(A9) of the AUP.

The abstraction of water during "normal" conditions is referred to as a core allocation take. Core allocation takes consist of a defined available allocation, and a minimum flow requirement. Under the AUP, the available core allocation for catchments not specifically listed in the plan is defined as 30% of its Mean Annual Low Flow (MALF), and the minimum flow is equivalent to 85% of its MALF.

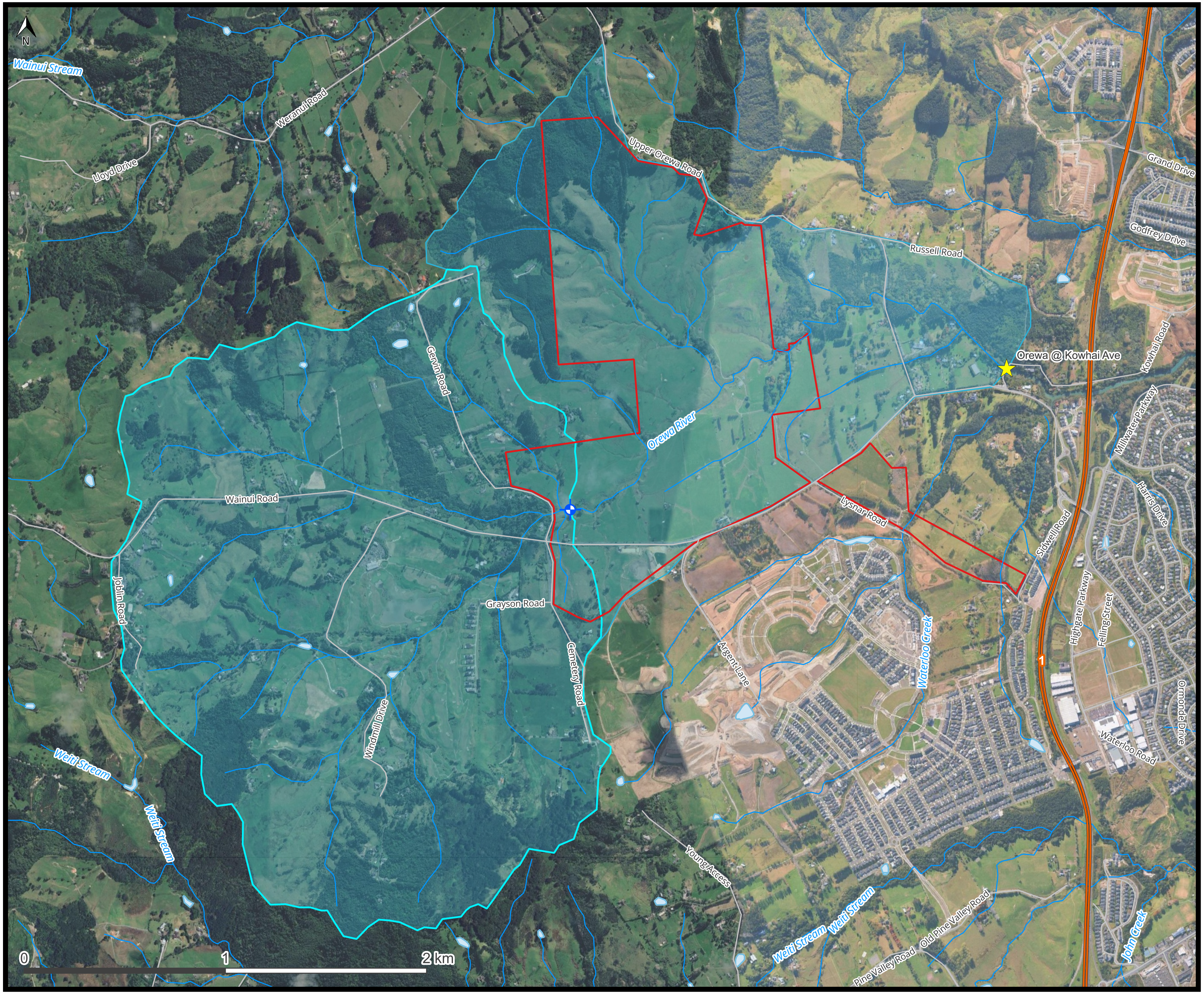
A take from a river or stream during flood conditions is referred to as a high-flow take. Significantly greater volumes of water are available for harvesting during high-flow. However, given their occurrence is limited to periods of flood or during freshes (i.e. periods of high flow in response to rainfall), high-flow takes require the water to be stored in a reservoir in order to provide a reliable water source outside of flood periods. The AUP states high-flow takes can occur when the river or stream flow is greater than the median flow, provided the total take does not exceed 10% of the flow in the river or stream at the time of abstraction.

On this basis, this report aims to assess the potential for a high-flow take in combination with a storage reservoir as an option for municipal supply.

3. Hydrological Assessment

The long-term historic streamflow regime (1972-2025) of the proposed take site was simulated using a catchment rainfall runoff model (known as the Soil Moisture Water Balance Model – SMWBM). The model was calibrated to measured flows further downstream at Auckland Council's Orewa River at Kowhai Avenue monitoring site. Details of the model configuration and calibration are provided in **Appendix A**.

The model catchment area was adjusted to simulate flows at the western edge (i.e., upstream) extent of the proposed Milldale Stages 14-17 development (**Figure 2**). The resulting simulated flow hydrograph and flow duration curves are presented in **Figure 3** and **Figure 4**, respectively.



Map Title:

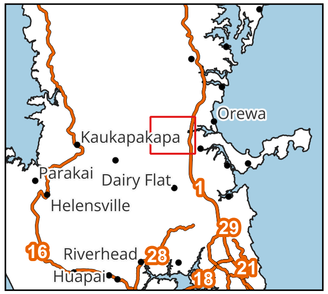
Proposed Surface Water Take - Model Catchment

Project:

WWLA1603 Milldale North Stgs 14-17

Client:

Fulton Hogan Land Development Ltd



Legend

- Proposed Water Take
- Flow Monitoring Site
- State Highways
- Roads
- Rivers/Streams
- Lakes
- Property Boundaries
- Model Catchment
- Orewa River Catchment

Data Provenance
Aerial imagery and land parcels from Land Information New Zealand

Drawn by: Barbara Tasca
03/08/2026

Layout Name
A4 Stream catchment G:\Shared drives\Projects\Fulton Hogan Land Development Ltd\WWLA1603_Milldale North Stgs 14-17\Technical\GIS\QGIS Project Files\Stream Flow.qgz

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Figure 2.

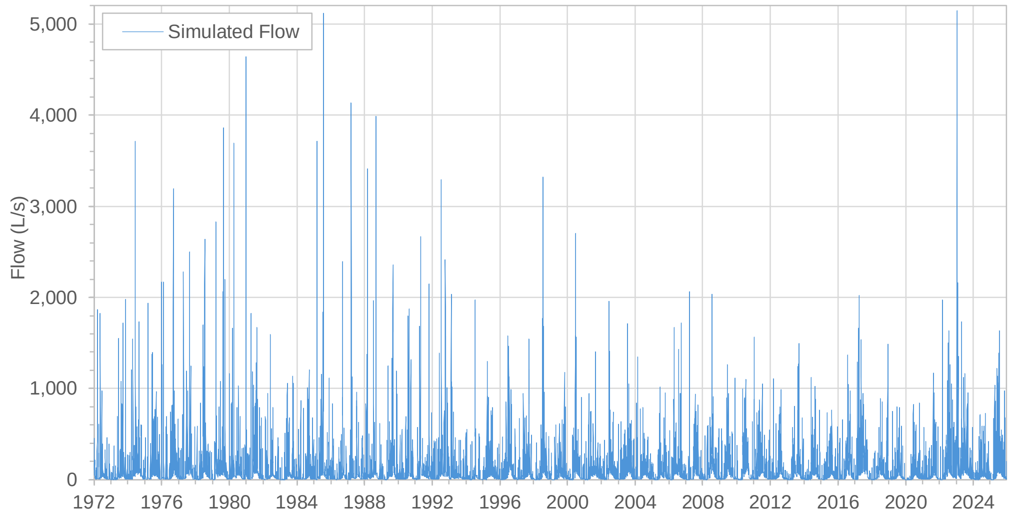

Figure 3. Simulated flow hydrograph at the proposed take site.

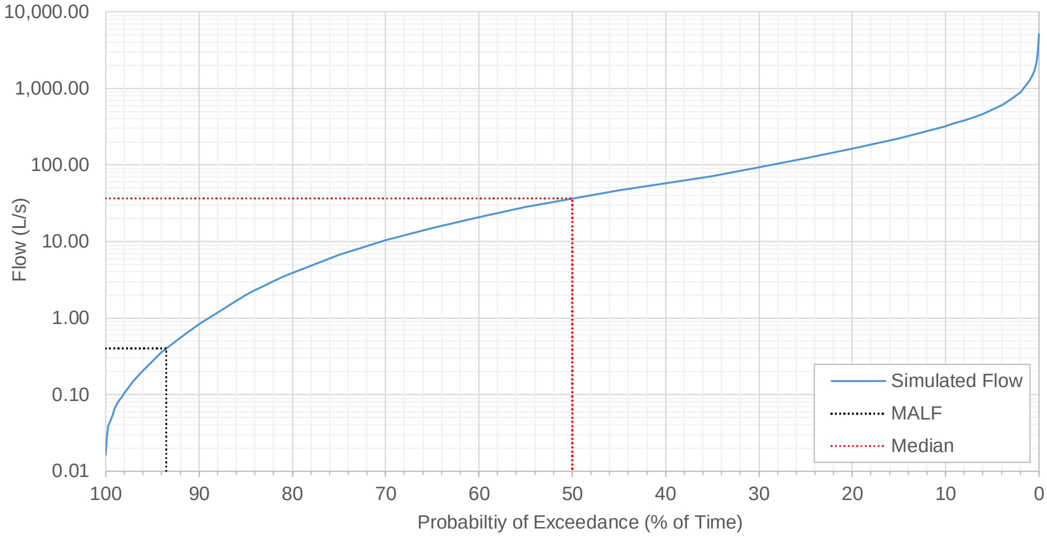

Figure 4. Simulated flow duration curve at the proposed take site.

The daily average runoff statistics for the stream are summarised in **Table 2**.

Table 2. Summary flow statistics.

Statistic	Flow (L/s)
Minimum	0.02
7 Day MALF	0.36
25th Percentile	6.68
Median	36.61
Mean	123.23
75th Percentile	123.19
Maximum	5,146

Statistic	Flow (L/s)
Avg. FRE3	22

The simulated streamflow regime illustrates a highly variable flow regime, characterised by frequent low flows and high flow events.

The minimum simulated flow was 0.02 L/s, indicating flows get very low during drought periods. However, relatively frequent high flows do occur, and flows exceed 120 L/s approximately 25% of the time – indicating a high-flow take would be a viable supply, subject to provision of adequate storage.

4. Reliability Assessment Modelling

WWLA's Reservoir Storage Model (RSM) was used to assess the reliability of various combinations of reservoir volume and maximum abstraction rates. The RSM balances reservoir storage inflows (river abstractions and direct rainfall on the storage), against storage outflows (daily water use and direct evaporation).

4.1 Demand

For the purposes of this assessment, the daily water use demand was fixed at 425 m^3/day.

4.2 High Flow Take

The assessment was undertaken at the proposed take site (shown in **Figure 2**) considering an abstraction of up to a maximum of 30% of the flow above the median.

By limiting harvestable flow abstractions to above the median flow, this approach maintains the median discharge as a minimum threshold, ensuring that river flows are not reduced below the median flow condition.

As noted in **Section 2.1**, the AUP allows high-flow takes when river or stream discharge is greater than the median flow - provided that the total take does not exceed 10% of the flow at the time of abstraction.

The combination of reservoir volumes and maximum abstraction rates was optimised to achieve the smallest reservoir volume whilst providing 100% reliability.

4.3 Reliability Assessment Results

Reliability is based on the number of years where the municipal demand is not met. Municipal demand was considered not met if storage was exhausted for one or more days for any given water year.

The reliability assessment assessed the storage volume on a daily basis for each year from 1972 to 2025 (54 years). The timeseries of the storage volume is presented in **Figure 5** and the probability of exceedance plot is illustrated in **Figure 6**.

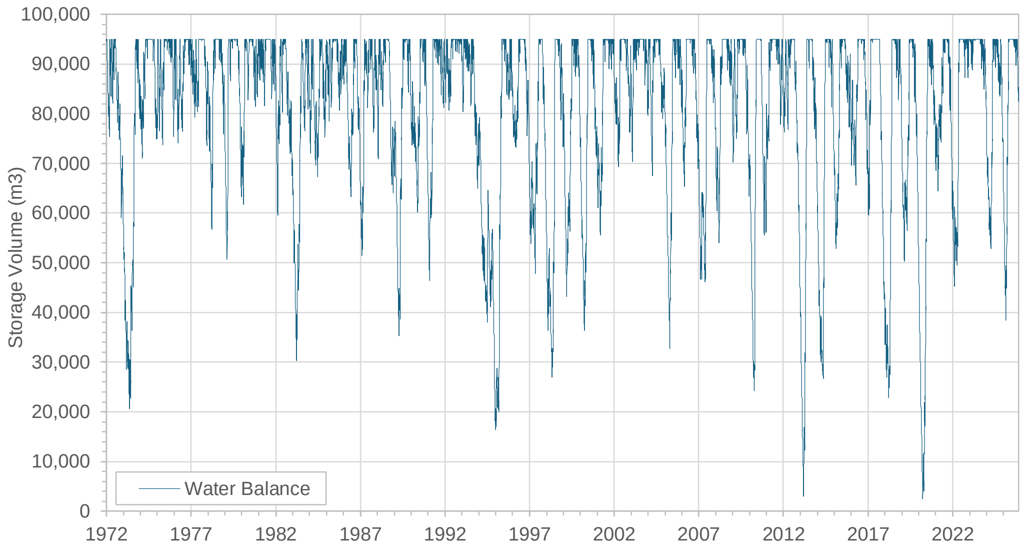

Figure 5. Timeseries of storage volume.

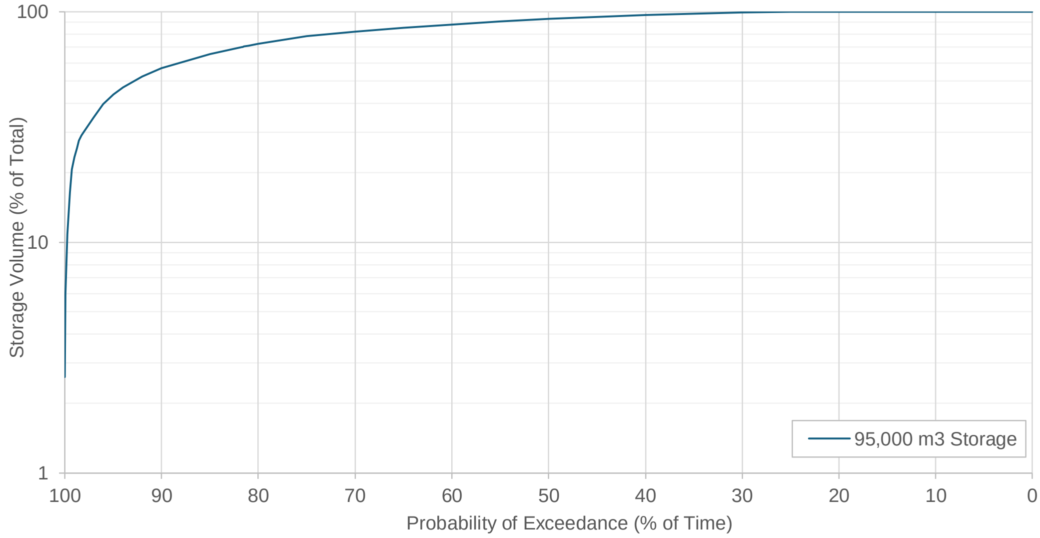

Figure 6. Probability of exceedance of percent of storage volume.

The historical reliability assessment for a 425 m^3/day demand indicates that a reservoir of 95,000 m^3 and abstractions up to 25 L/s when above the median flow would be required to achieve full reliability.

4.4 Assessment of Effects on Hydrology

Please refer to the Milldale Stages 14-17 Fast-Track – Catchment Hydrology Assessment[1] for a description of the potential and actual effects of the proposed high-flow surface water take on downstream flows and water users (i.e., consented water takes and permitted activity takes).

[1] WWLA. 2026. Catchment Hydrology Assessment. Milldale Stages 14-17 Fast Track. Consultancy report prepared for Fulton Hogan Land Development Ltd. WWLA1603. Rev 2.

5. Recommendations

Based on the assessment undertaken in this report, the following recommendations are made to avoid, remedy or mitigate potential adverse effects associated with the proposal and to support the appropriate implementation of the development.

Abstraction and Flow Recommendations

- Maximum Abstraction Rate: Stream abstraction should be limited to a maximum instantaneous rate of 25 L/s.
- Flow Condition Threshold: Abstractions should be restricted to periods when streamflow is above the median flow and limited to a maximum of 30% of stream flows above the median flow.
- Reservoir Storage: Storage reservoir capacity of 95,000 m^3 is recommended to support the required daily surface water demand to provide 100% supply reliability.

Abstraction and Flow Monitoring Recommendations

- Take Monitoring: Install a telemetry-enabled water meter on the intake line to continuously log abstraction volumes and instantaneous rates.
- Streamflow Monitoring: Establish continuous flow monitoring site near the proposed abstraction site to ensure the intake operates strictly when streamflow exceeds the median flow threshold.
- Proportional Abstraction Control: Integrate automated intake controls (PLC) linked to the streamflow monitoring site to restrict abstraction to no more than 30% of instantaneous flow above the median.

6. Conclusions

The hydrological assessment indicates that the flow in the proposed site take is highly variable and driven by high flow events, with large periods of very low flow and occasional high-flow events. This behaviour supports a high flow take approach, maintaining protection of low-flow conditions while taking water when it is hydrologically available.

To meet the potable water requirements of 425.5 m^3/day, an abstraction of 25 L/s would be required, taking up to 30% of the flows above the median. A reservoir storage of 95,000 m^3 is recommended.

The consenting of such a high flow take will be a Discretionary Activity because it does not meet the default abstraction provision of up to 10% of the high-low.

Appendix A. Rainfall Runoff Model Development and Calibration

The Soil Moisture Water Balance Model (SMWBM) is a semi-deterministic rainfall-runoff model. Model functionality includes an infiltration function, surface ponding function, evaporation functions for differing land cover.

The SMWBM was developed into a plugin specific for use as the rainfall runoff model within the SOURCE framework. Within SOURCE, the SMWBM plugin allows catchment parameters to be set for each of the model sub-catchments, transforming the SMWBM from a semi-deterministic lumped parameter model into a powerful conceptual distributed model.

The model utilises daily rainfall and monthly evaporation input data to calculate the soil moisture conditions under natural rainfall conditions. The model operates on a daily time step during dry days, however when rain days occur, a finer hourly calculation step is implemented to enable peak flows to be assessed more accurately than a daily time step model.

Table 3. SMWBM parameters.

Parameter	Name	Description
ST (mm)	Maximum soil water content	ST defines the size of the soil moisture store in terms of a depth of water
SL (mm)	Soil moisture content where drainage ceases.	Soil moisture storage capacity below which sub-soil drainage ceases due to soil moisture retention.
FT (mm/day)	Sub-soil drainage rate from soil moisture storage at full capacity	Together with POW, FT (mm/day) controls the rate of percolation to the underlying aquifer system from the soil moisture storage zone. FT is the maximum rate of percolation through the soil zone.
ZMAX (mm/hr)	Maximum infiltration rate	ZMAX and ZMIN are nominal maximum and minimum infiltration rates in mm/hr used by the model to calculate the actual infiltration rate ZACT. ZMAX and ZMIN regulate the volume of water entering soil moisture storage and the resulting surface runoff. ZACT may be greater than ZMAX at the start of a rainfall event. ZACT is usually nearest to ZMAX when soil moisture is nearing maximum capacity.
ZMIN (mm/hr)	Minimum infiltration rate	
POW (>0)	Power of the soil moisture-percolation equation	POW determines the rate at which sub-soil drainage diminishes as the soil moisture content is decreased. POW therefore has significant effect on the seasonal distribution and reliability of drainage and hence baseflow, as well as the total yield from a catchment.
PI (mm)	Interception storage capacity	PI defines the storage capacity of rainfall that that is intercepted by the overhead canopy or vegetation and does not reach the soil zone.
AI (-)	Impervious portion of catchment	AI represents the proportion of the catchment that is impervious and directly linked to drainage pathways.
R (0,1)	Evaporation – soil moisture relationship	Together with the soil moisture storage parameters ST and SL, R governs the evaporative process within the model. Two different relationships are available. The rate of evapotranspiration is estimated using either a linear (0) or power-curve (1) relationship relating evaporation to the soil moisture status of the soil. As the soil moisture capacity approaches, full, evaporation occurs at a near maximum rate based on the mean monthly pan evaporation rate, and as the soil moisture capacity decreases, evaporation decreases according to the predefined function.
DIV (-)	Fraction of excess rainfall allocated directly to pond storage	DIV has values between 0 and 1 and defines the proportion of excess rainfall ponded at the surface due to saturation of the soil zone or rainfall exceeding the soils infiltration capacity to eventually infiltrate the soil, with the remainder (and typically majority) as direct runoff.
TL (days)	Routing coefficient for surface runoff	TL defines the lag of surface water runoff.

GL (days)	Groundwater recession parameter	GL governs the lag in groundwater discharge or baseflow from a catchment.
QOBS (m^3/s)	Initial observed streamflow	QOBS defines the initial volume of water in the stream at the model start period and is used to precondition the soil moisture status.
AA, BB	Coefficients for rainfall disaggregation.	Used to determine the rainfall event duration and pattern. Default values usually suffice.

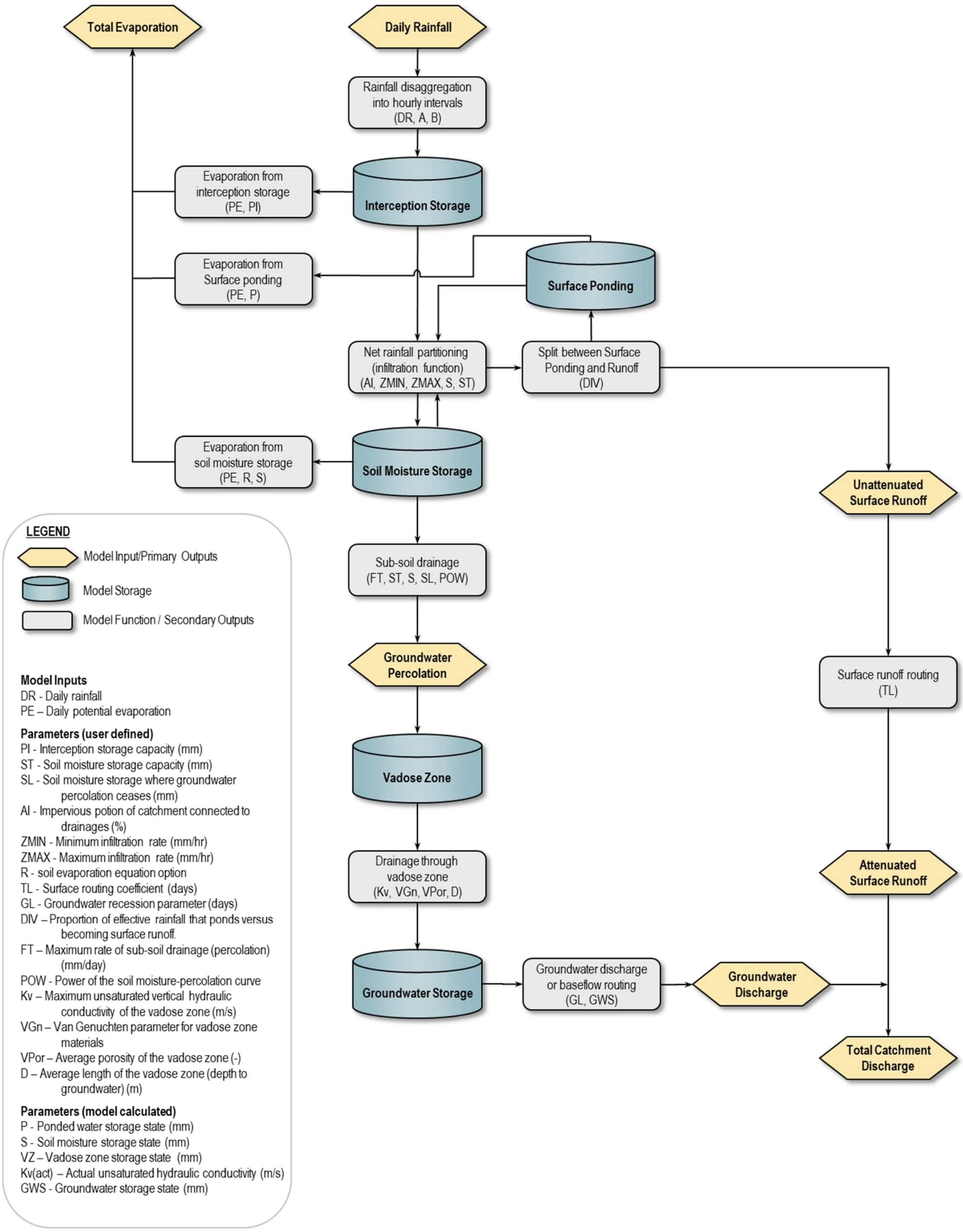

Figure 7. Flow diagram of the SMWBM structure and parameters.

The SMWBM was calibrated to Auckland Council's flow monitoring site Orewa River at Kowhai Ave, located approximately 2.9 km downstream of the proposed abstraction site. A comparison of the measured and modelled flow hydrographs is presented in **Figure 8** and **Figure 9**, and of the flow duration curves in **Figure 10**.

In general, the model showed good agreement to low and median flow conditions, and slightly over-predicted moderate sized events), and under-predicted the larger events (i.e., those exceeded >5% of the time). Overall, the level of calibration achieved is considered appropriate for the purposes of assessing the potential effects of the proposed high-flow abstraction.

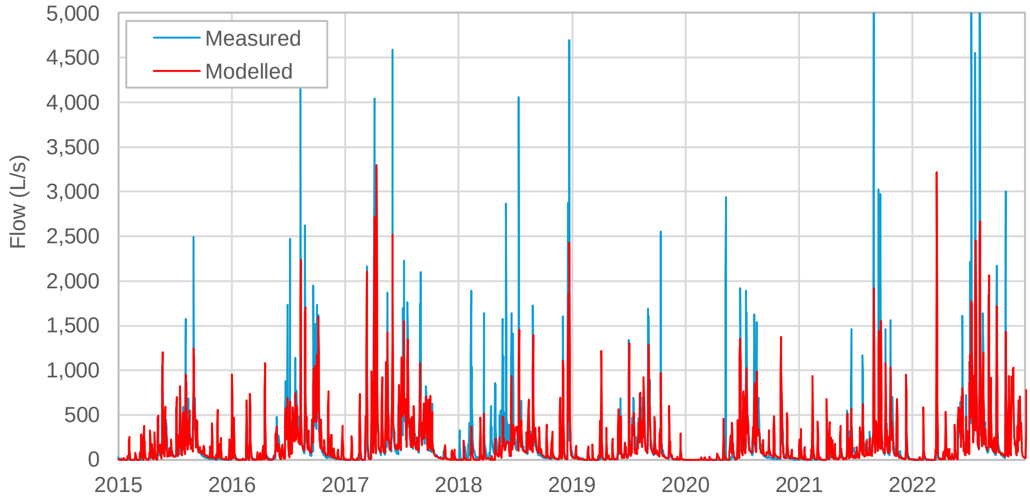

Figure 8. Comparison of flow hydrographs.

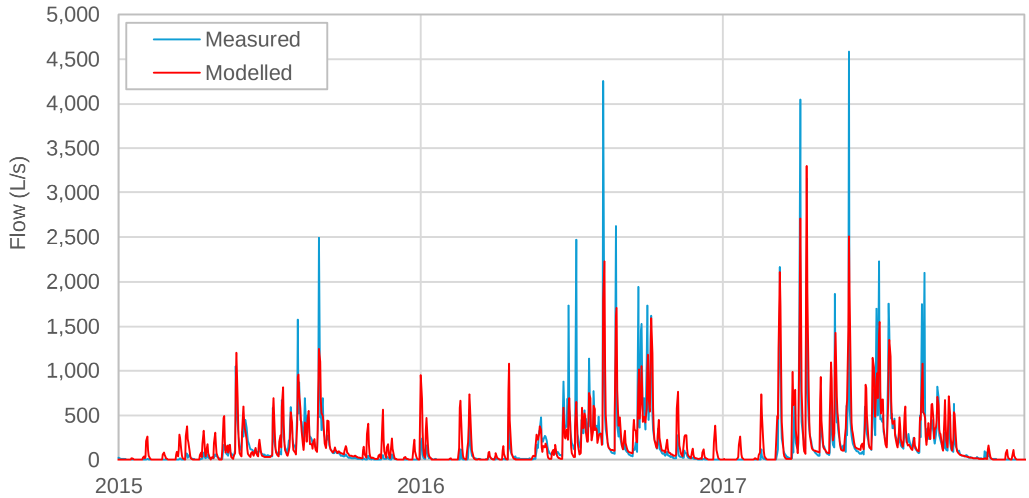

Figure 9. Comparison of flow hydrographs – shorter time period for clarity.

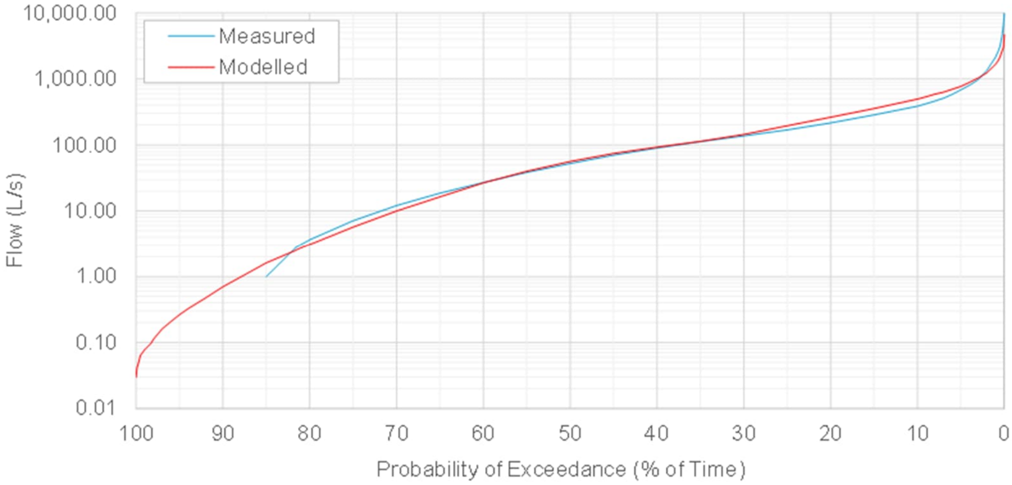

Figure 10. Comparison of flow duration curves.