



Otago
Regional
Council

Flow Naturalisation of Waiareka Creek at Taipo Road in North Otago

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ISBN

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Completed: June 2023

Published: November 2023

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This document describes how naturalised flow statistics were derived at the flow recorder on Waiareka Creek at Taipo Road (**Figure 1**) in North Otago.



Figure 1. The current consents and flow recorders in the upstream area above Waiareka Creek at Taipo Road.

Data

Flow data

Table 1 lists all the available flow data in the upstream area of Waiareka Creek at the Taipo Road flow site. The data was retrieved on 14 Jun 2023.

Table 1. The flow data available in the upstream area above Waiareka Creek at the Taipo Road flow site.

Site	Start	End	Length_yr
Waiareka Creek at Springhill Road	2/11/2005	15/03/2006	0.4
Waiareka Creek at Taipo Road	20/02/2007	8/06/2023	16.3
Farm Drain at Windsor Park Dairy	7/09/2011	8/06/2012	0.8

The observed flow time series data from Waiareka Creek at Taipo Road flow site (**Table 1**) is used in this study.

Discharge and water use (WU) data

The HTML file listed in the **Appendix** includes the complete consent list for the area above Waiareka Creek at Taipo Road. All the identified surface water uses are currently managed by North Otago Irrigation Company (NOIC). NOIC has a resource consent to take a large amount of water (up to 8000 L/s) from the Waitaki River (authorised by Environment Canterbury) and several other consents (from Otago Regional Council) to use it in North Otago. Dave Stewart managed to obtain the daily discharge and offtake time series from NOIC on 13 Jun 2023. **Figure 2** shows the hydrographs of the data. The original data is included in the **Appendix**.

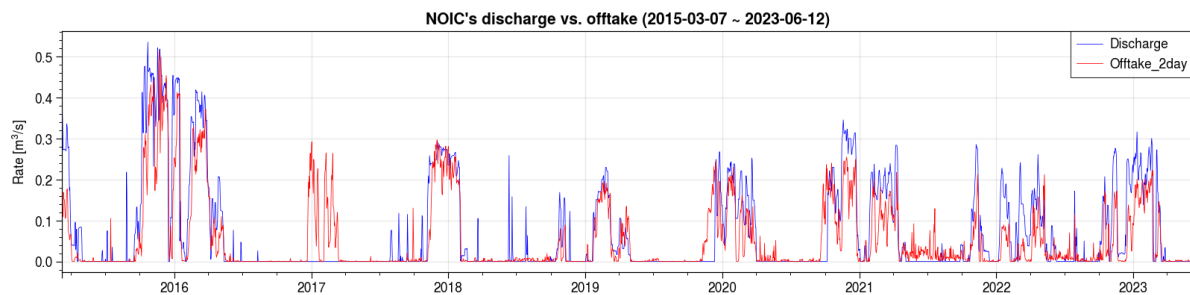


Figure 2. NOIC discharge and offtake hydrographs.

Method

Waiareka Creek does not have significant headwaters. Before the North Otago Irrigation Scheme (NOIC) came to the area, flows in the creek were often very low and intermittent, especially over the dry summer period. The NOIC use Waiareka Creek to transport water for irrigation (sourced from the Waitaki River) to individual farmers who abstract it directly out of Waiareka Creek. These discharges and offtakes by NOIC (and/or any others) need to be removed from the Taipo Road flow records to get estimated natural flows in Waiareka Creek at Taipo Road.

The water balance method is used to simplify the effects of multiple offtakes and discharges on the flows in Waiareka Creek (see **Equation 1**):

$$\text{Natural} = \text{Observed} - \text{Discharge} + \text{Offtake} \quad (1)$$

When applying this equation to remove the NOIC effects, the estimated natural flows at Taipo Road can be negative when the observed flows are less than the difference between NOIC's

discharges and offtakes by considering the water balance. When this happens, the baseflow¹ needs to be used instead as it is more representative of natural conditions during low-flows. A baseflow time series reflects the lowest observed natural low flows when there is no rainfall and can be derived using the observed low flow data.

There are periods in the records where NOIC was not operating. At those times, NOIC does not need to maintain a minimum flow at the Taipo site (e.g. winter), and the flows in Waiareka Creek at the Taipo Road flow site are natural.

Figure 3 illustrates the workflow to derive the natural flows at Waiareka at Taipo Road:

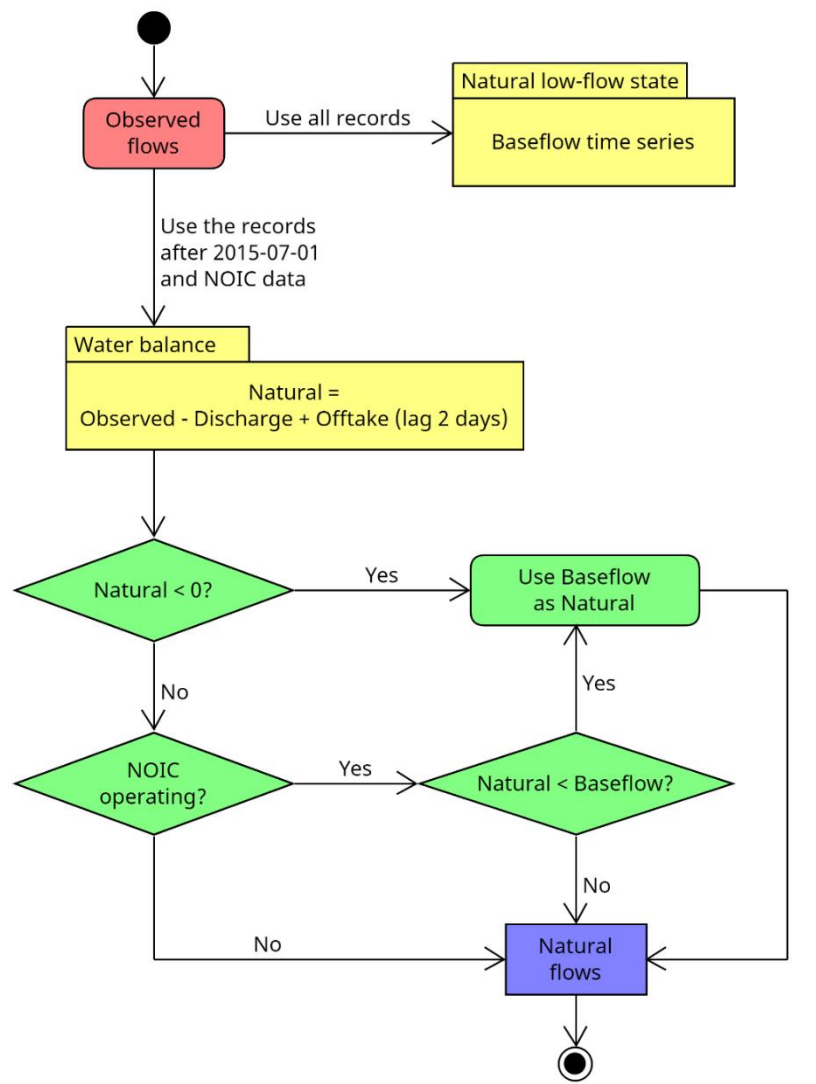


Figure 3. Workflow for natural flow estimation at Taipo Road flow recorder (negative values fixed).

¹ **Baseflow** is a portion of the stream flow that is not runoff; it is water from the ground, flowing into the channel over a long time and with a certain delay [source].

As illustrated in **Figure 3**, the daily baseflow time series is derived from all the daily flow time series measured at Taipo Road. The method used to derive the baseflow time series is presented in Chapter 5 in the Operational Hydrology Report No. 50 (WMO, 2008) on pages 43-44.

Due to the NOIC's data availability, only the records after the water year 2015/16 are used to estimate the natural flows at Taipo Road (by **Equation 1**). Note that the 2016/2017 season is not included since no NOIC discharge data were available. The derived baseflow time series represents the natural flow baseline/limit during low-flow spells, and this baseflow data is used in the derived natural flow data when **Equation 1** results in negative flows.

Results

Table 2 summarises the flow statistics at Waiareka at Taipo Road.

Table 2. Flow statistics [m^3/s], and FRE3 [$year^{-1}$] of the observed and estimated natural flows (from 1/7/2015 onwards)

Site	Start	End	Mean	Min	50%	Max	7dMALF	FRE3
Waiareka at Taipo Road (observed)	1/07/2015	8/06/2023	0.503	0.061	0.265	66.060	0.126	4.8
Waiareka at Taipo Road (natural)	1/07/2015	8/06/2023	0.493	0.062	0.255	66.060	0.114	5.0

Figure 4 illustrates the observed and estimated natural flow hydrographs during the water year 2021/22. This figure shows that the estimated natural flows are not always above the observed flows, depending on the combined effect of NOIC's discharges and offtakes on the flows in Waiareka Creek.

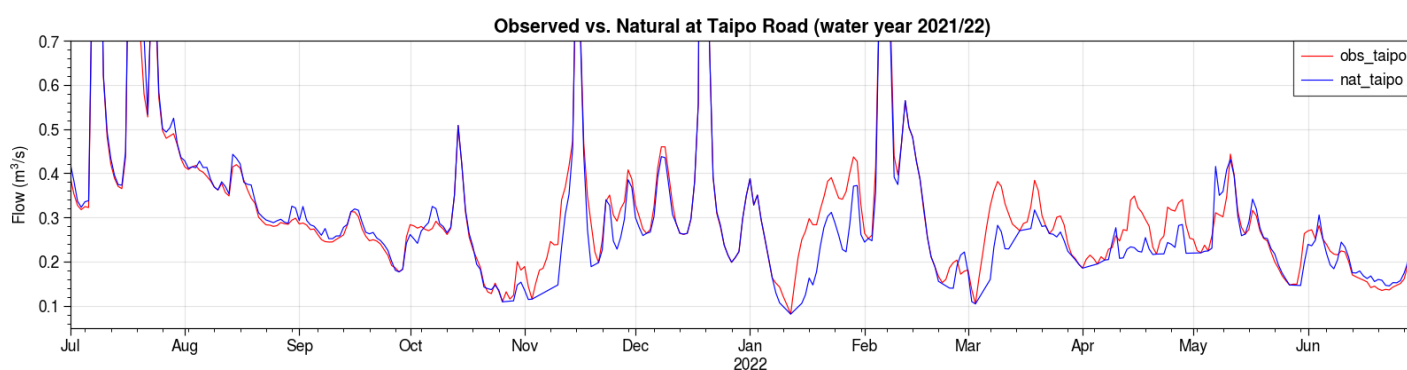


Figure 4. The comparison of the observed and natural flow at Taipo Road during the water year 2021/22

Appendix

1. The detailed consent list and the estimation of the total water use in the Waiareka Creek catchment can be found in [here](#).

2. The NOIC's daily discharge and offtake time series -



References

Manual on low-flow estimation and prediction (2008). Geneva: WMO.