Upper Hawkesbury River Water Quality Monitoring Program 2019 - 2020

Summary Report

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Subtitle: Summary Report

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Background

Hawkesbury City Council contracted the Estuaries and Catchments Team (ECT) of the NSW Department of Planning, Industry and Environment (DPIE) to assist Council staff to assess the water quality in part of the upper Hawkesbury River that falls within the Hawkesbury City Council Local Government Area (LGA) over the 2019/2020 financial year. This document continues reporting of an annual monitoring program that commenced in 2018. Long term monitoring programs are essential for tracking estuary ecological health and to identify potential areas requiring management.

The NSW Natural Resources Monitoring, Evaluation and Reporting (MER) Program outlines standard sampling, data analysis and reporting protocols to assess estuary ecological health (OEH, 2016). The Upper Hawkesbury River monitoring program was designed by DPIE to adhere to these protocols and to also address locally relevant issues.

The aims of the monitoring program are to assess the ecological health of Upper Hawkesbury River using methods that are scientifically valid and standardised, and to report the information generated in an accessible way to a number of potential users in a report card style format. This summary report presents the report card grades for the 2018 – 2019 monitoring period.

With the Hawkesbury being such a large system that runs through several Council LGA's, this program also falls within a larger overall aim to establish a standarised report card and grades that other Council's can adopt.

Methods

Monitoring Parameters

Turbidity and chlorophyll-a are considered to be appropriate measures of estuary ecological health as they are indicators of ecosystem performance in response to catchment pressure. The concentration of chlorophyll-a in the water column is a biological indicator reflecting phytoplankton biomass, and typically reflects the nutrient load into the system. Turbidity is a proxy measure of water clarity, where high turbidity can result in a reduction of light available for photosynthesis, limiting algal and seagrass growth. These indicators are consistent with the NSW MER protocols.

Turbidity and chlorophyll-a data collected from NSW estuaries by ECT as part of the statewide estuarine MER program have been used to develop trigger values specific to NSW estuaries (OEH, 2016). Compliance against a guideline or trigger value is commonly used to assess the status of a condition indicator. Exceeding the trigger value frequently, or by a large extent, should 'trigger' further investigation or management action. Table 1 shows trigger values established for coastal rivers (<10 psu) that were generated from the statewide estuarine water quality dataset (OEH, 2018) that were used in this report.

It should be noted that a trigger value for Chlorophyll-a of 7µg/l has been adopted instead of the standard trigger value of 4.8 µg/l (OEH 2016) applied to upper reaches with a salinity of less than 10psu. The sites sampled in the Hawkesbury River as part of this monitoring program are within the tidal freshwater pool. Currently there is limited available data on tidal freshwater pools & as such a trigger value for Chlorophyll-a of 7µg/l was deemed more appropriate, based on recommendations made in 'Interim nutrient load cap assessment for the Hawkesbury Nepean River' report (Ferguson 2018), which identified that a knowledge gap exists and that a Chlorophyll-a value of 4.8µg/l was not appropriate for the tidal freshwater pool within the Hawkesbury River. It was also noted that guideline values for the system should be reviewed and revised as more knowledge is gained about the system in the future (Ferguson 2018). DPIE is working on developing revised trigger values for freshwater tidal pools as part of the Tidal Rivers Program.

Table 1: Trigger Values for water quality indicators in NSW rivers.

*A trigger value for Chlorophyll-a of 7 µg/l has been adopted instead of the standard OEH trigger value of 4.8 (see explanation above)

Indicators	Rivers Upper
Turbidity NTU	6
Chlorophyll-a µg/L	7*[4.8]
Ammonia µg/L	52
NOx µg/L	34
TDN µg/L	550
TN µg/L	670
Phosphate µg/L	5
TDP µg/L	6
TP µg/L	16

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Sampling and Analysis

Turbidity and other physico-chemical water quality parameters were measured using a Xylem EXO-2 multiparameter water quality sonde. The sonde logged data at approximately 0.5m depth at one second intervals for a total of 3 minutes at each site, while the vessel used for sampling freely drifted, following the method outlined in the MER protocols.

A bucket was filled using an integrated sampler which collects water from the top 1m of the water column. The bucket was subsampled for chlorophyll-a, total suspended solids and total nitrogen and total phosphorous including their respective dissolved and particulate fractions. A second bucket of water was then collected and subsampled for chlorophyll-a and total suspended solids to provide a replicate sample for each.

Chlorophyll-a samples were filtered through a 0.45 µm glass fibre filter paper under vacuum and the filter paper frozen until analysis. Concentrations were determined by fluorometry following extraction with 90% acetone solution, in accordance with standard methods (APHA 10200H) (APHA, 2012).

Sites and Timing

Water quality sampling was carried out at 5 zones along main river stem and lower Macdonald River which also falls within the Hawkesbury City Council LGA (Figure 1).

Water quality data were scheduled to be collected at 3-4 week intervals 12 times throughout the year, between July 2019 and June 2020. Sampling at this frequency allows both long and short term variability in water quality to be assessed. However, due to a significant flood in Febuary 2020 and social distancing restrictions as a result of COVID, only one sampling event was conducted between mid-January 2020 and May 2020 resulting in only 9 sampling runs occurring over the year.

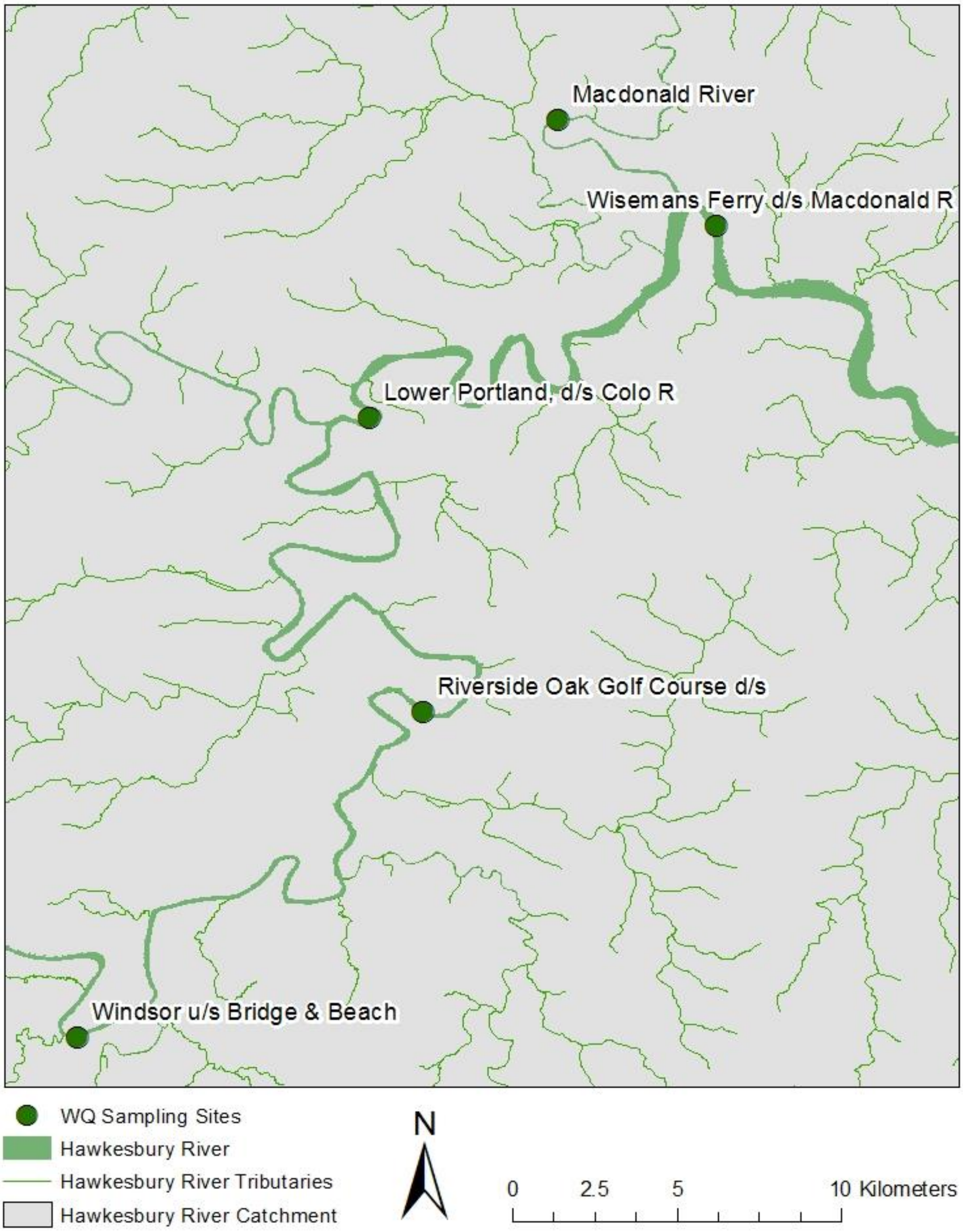


Figure 1: Locations of sampling zones in the Upper Hawkesbury River for the 2019 – 2020 monitoring program

Calculation of Report Card Grades

Water quality data collected in the monitoring program were used to calculate a report card grade for a number of sites in the Hawkesbury River. Grades for water quality are calculated by calculating how often and to what extent the values for turbidity and chlorophyll-a exceed the the statewide 80th percentile trigger value. A comprehensive description of how the grades are calculated is available in the NSW MER protocols (OEH, 2016). As explained earlier, it should be noted that for upper coastal river reaches, a trigger value for chlorophyll-a of 7µg/l has been adopted instead of the standard trigger value of 4.8 µg/l (OEH 2016).

Results

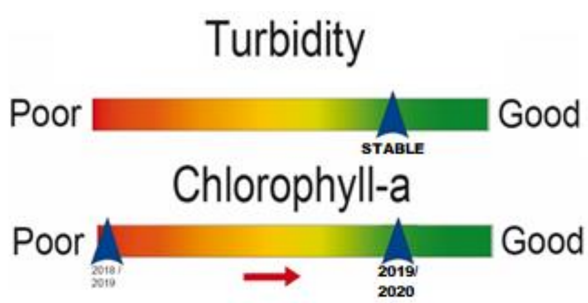
Report Card Grades

Wisemans Ferry (downstream of Macdonald River)

Overall water quality at Wisemans Ferry was good in 2019-2020. While the 80th percentile trigger value for chlorophyll-a was only exceeded on two of the five sampling trips used to calculate grades, the 80th percentile trigger value for turbidity was exceeded on all sampling trips. The mean salinity recorded at Wisemans Ferry was 6.53ppt, with a minimum salinity of 0.27ppt recorded in March after flooding in February. A maximum recorded salinity of 17.65ppt was recorded in January after months of below average rainfall.

Table 2: Calculated grades at Wisemans Ferry during the 2019-2020 monitoring period.

Sampling Period	Turbidity	Chlorophyll-a	Overall Water Quality
2018 - 2019	C	F	D
2019 - 2020	**C**	**B**	**B**

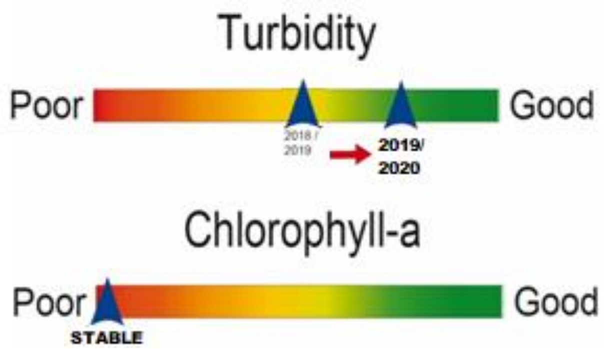


Lower Portland (downstream of Colo River)

Overall water quality observed at the Lower Portland zone was fair for 2019-2020. The main driver for this only fair grade was chlorophyll-a, which grossly exceeded the 80th percentile trigger values on two of the five sampling occasion over the summer/autumn. While a slight increase in turbidity grade was observed, the trigger value was still exceeded on three of the five sampling occasions used to calculate grades. Salinity recorded at Lower Portland was generally below 0.5ppt, with a maximum recorded salinity of 4.51ppt recorded in January and a mean salinity of 0.79ppt.

Table 3: Calculated grades at Lower Portland during the 2019-2020 monitoring period.

Sampling Period	Turbidity	Chlorophyll-a	Overall Water Quality
2018 - 2019	C	F	D
2019 - 2020	**B**	**F**	**C**

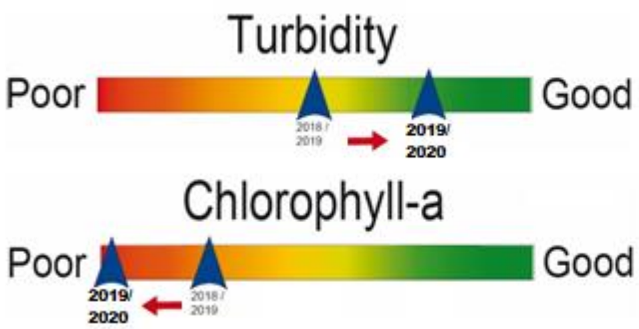


Riverside Oaks (downstream of golf course)

Overall water quality at Riverside Oaks was poor throughout the 2019 – 2020 sampling period. This grade is not surprising, given that the 80th percentile trigger value for chlorophyll-a was exceeded (most often grossly) on all occasions, with the trigger for turbidity exceeded on all but one occasion over summer/autumn. Salinity recorded at Riverside Oaks was below 0.3ppt, with a mean salinity of 0.19ppt.

Table 4: Calculated grades at Riverside Oaks during the 2019-2020 monitoring period.

Sampling Period	Turbidity	Chlorophyll-a	Overall Water Quality
2018 - 2019	C	D	C
2019 - 2020	**B**	**F**	**D**

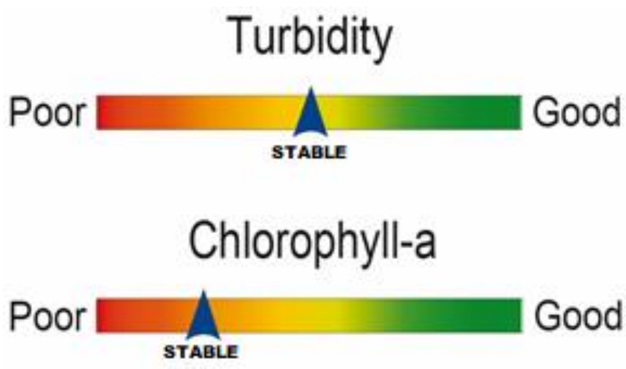


Windsor (upstream of Windsor Bridge)

Overall water quality at Windsor remained poor. The 80th percentile trigger value for turbidity was exceeded for all but one sampling trip, with chlorophyll-a close too or more than double the 80th percentile trigger value on all but two of the sampling occasions used to calculate grades. Salinity recorded at Windsor was below 0.3ppt, with a mean salinity of 0.18ppt.

Table 5: Calculated grades at Windsor during the 2019-2020 monitoring period.

Sampling Period	Turbidity	Chlorophyll-a	Overall Water Quality
2018 - 2019	C	D	D
2019 - 2020	**C**	**D**	**D**

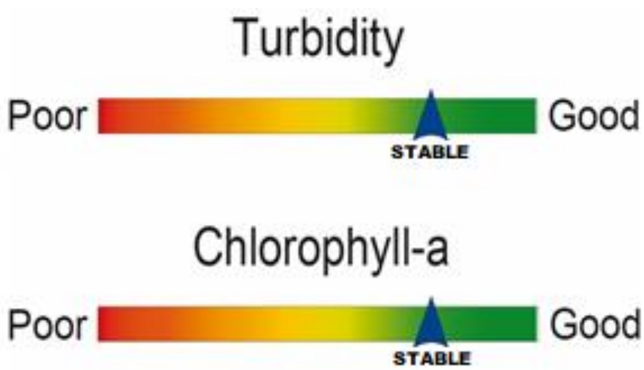


Macdonald River

Overall water quality in the Macdonald River continued to be good in 2019/20. While 80th percentile trigger value exceedances for both turbidity and chlorophyll a were common, these exceedances were for the most part only relatively minor. The mean salinity recorded at the Macdonald River site was 3.16ppt, with a minimum salinity 0.21 ppt and a maximum recorded salinity of 10.36ppt recorded in January after months of below average rainfall.

Table 6: Calculated grades in the Macdonald River during the 2019-2020 monitoring period.

Sampling Period	Turbidity	Chlorophyll-a	Overall Water Quality
2018 - 2019	B	B	B
2019 - 2020	**B**	**B**	**B**



Summary

The overall water quality grade at the two upper sites (Riverside Oaks and Windsor) was poor during 2019-2020, with Lower Portland receiving a fair grade and Sackville classified as good. The chlorophyll-a grades for all zones along the main river stem except Wisemans Ferry was poor. Despite the turbidity grade at Riverside Oaks and Lower Portland receiving a good grade, the 80th percentile trigger value for turbidity was exceeded frequently at all sites. Interestingly, the chlorophyll-a grade at Wisemans Ferry (most downstream site) was good. This could potentially be a result of the site becoming more estuarine, as a result of low rainfall, as indicated by higher salinity during spring and early summer.

The overall water quality at the Macdonald River zone was good with turbidity and chlorophyll-a generally lower than that observed in the main river stem. It is not surprising that Macdonald River scored better considering its catchment is much less disturbed when compared to the highly developed catchment of the main river stem and many of the tributaries feeding into it.

Flow Conditions

Chlorophyll-a concentrations within the Hawkesbury appear to be flow dependent, with high concentrations often linked to low flow conditions. The 2019-2020 Upper Hawkesbury monitoring program spanned a range of flow conditions, with most samples taken during low flows (<20th percentile) during 2019, one median flow sample (5/05/2020), and two post high flow events samples (25/09/2019 and 5/03/2020) (Tables 7 & Figure 2). Flow conditions leading up and at the time of sampling are important for determining primary drivers in the system (e.g. residence times, external vs internal nutrient supply, external TSS inputs etc.) that in turn impact on health indicators.

Table 7: Nepean River flows (ML d^{-1}) at Penrith Weir on the sample times (instantaneous) and for the preceding 7 and 14 days (means).

	instantaneous	7day mean	14 day mean
23/07/2019	110	124	136
28/08/2019	96	95	98
25/09/2019	361	519	315
23/10/2019	83	100	135
18/11/2019	37	45	60
8/01/2020	30	29	29
5/03/2020	732	1494	1768
5/05/2020	274	327	270

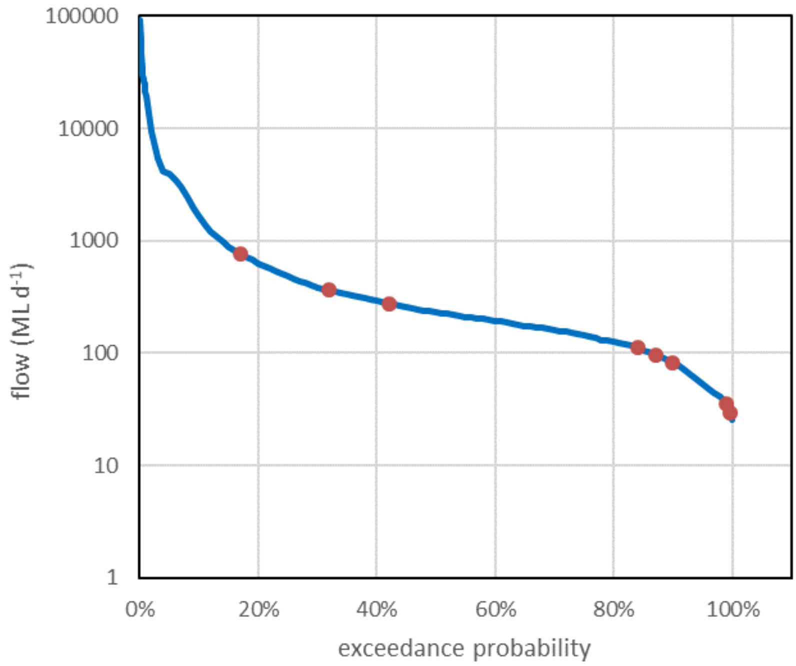


Figure 2: Flow exceedance curve for Nepean River at Penrith Weir (blue line), showing flows during sample times (orange dots).

System State

Data from Hornsby Council's Laughtondale *in situ* logger provide a more integrated indication of the relative influence of cumulative freshwater inflows during each sample time than the instantaneous flows (Figure 3). The first two samples times occurred during winter under low flow conditions, with brackish estuarine conditions extending upstream of Wisemans Ferry. The third sample time occurred immediately after a small fresh which caused the brackish/freshwater interface to be displaced downstream to Wisemans Ferry. The following three sample times occurred during diminishing flows over late spring-summer, with estuarine conditions recovering in the lower reach of the study area and the brackish/freshwater interface moving upstream of Portland. The sample effort on 5/3/2020 occurred 26 days after a major flood, which caused freshwater conditions to extend downstream of Laughtondale for over three weeks. The final sample time (5/5/2020) occurred during a period of estuarine recovery following an extended period of high flows after the February flood.

Chlorophyll

The general trends in chlorophyll-*a* over the study period follow our conceptual understanding of tidal pool processes. Phytoplankton blooms and biomass tend to be greatest in the Sackville reach and may extend further upstream during low flow conditions and be displaced downstream during higher flows (e.g. Portland 25/9/19 sample) (Figures 4 and 5). Phytoplankton biomass increased throughout the upper to mid tidal pool following the small fresh in September 2019 (Figure 4), as residence times increased, and water clarity improved. The decrease in biomass at Portland in the January 2020 sample time is consistent with an increase in salinity at this site (Figure 4), as estuarine conditions recovered into the dry season which would have resulted in a dieback of freshwater phytoplankton species. The post-fresh increase in phytoplankton biomass at the Windsor site is more modest due a combination of shorter residence times and competition for available nutrients by macrophytes. This reach is also upstream of the South Creek confluence, which represents a major input of both diffuse nutrients (phosphorus) and treated effluent (nitrogen). Nutrient (phosphorus) limitation in the Windsor reach is likely to increase as flows diminish which accounts for the drop-in biomass during the January 2020.

Phytoplankton biomass at all sites was greatly reduced during the post-flood sample time (March 2020) (Figure 4) due to the flushing effect of the flood, suppression of growth due to high turbidity, and limitation of biomass increase due to reduced residence times. Biomass had not recovered by the May 2020 sample time (Figure 5), most likely due to continued freshwater inputs and associated limitation due to turbidity and reduced residence times.

Turbidity

Trends in turbidity are driven by spatial factors throughout the bulk of the time, with episodic large spikes due to high-flow inputs of diffuse material. Turbidity in the Windsor reach during low flows is commonly low relative to other reaches due to a combination of lower phytoplankton biomass, lower tidal currents, and trapping of particulates by macrophytes. Turbidity in the Sackville reach during low flows is primarily comprised of organic suspended particulates associated with live and detrital phytoplankton biomass (Figure 5). Tidal currents in this reach are sufficient to keep particulate material in constant suspension. In contrast, turbidity in the Wisemans Ferry reach during low flow is primarily associated with the tidally driven resuspension of inorganic sediments (Figure 5), which greatly increases during spring tides. The effect of tide on turbidity is graphically illustrated at the Laughtondale logger (Figure 3), which shows data from Wisemans Ferry superimposed. This shows that state of tide at the time of sampling has a large bearing on the results.

Turbidity tends to increase throughout the system during floods and freshets, with relatively rapid recovery at the brackish/freshwater interface due to flocculation/sedimentation (Figure 3). Turbidity in the Sackville reach displays much longer recovery times (~2 months) due to a combination of tidal currents maintaining particulate suspension and freshwater conditions limiting flocculation.

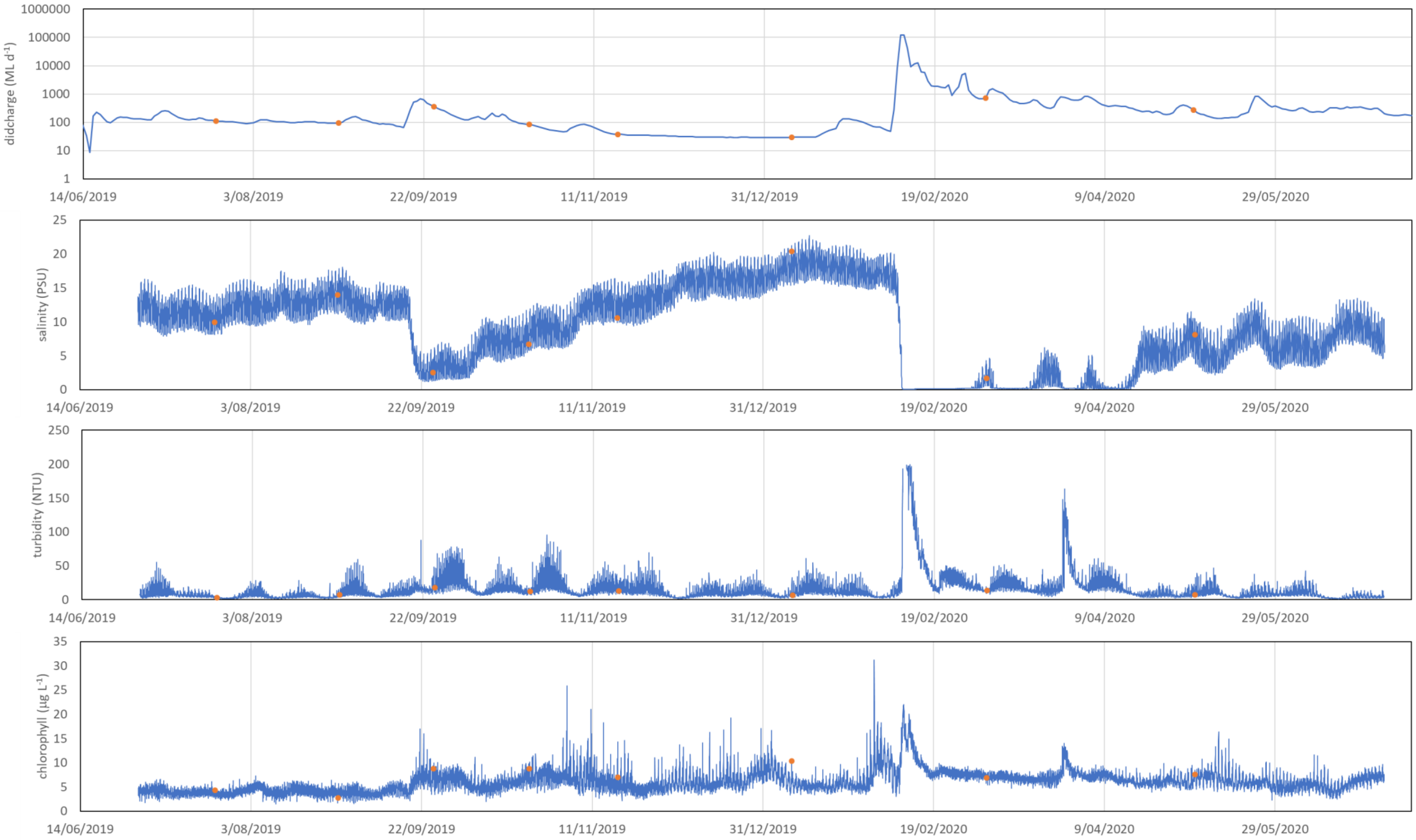


Figure 3: Timeseries of discharge (Penrith Weir), and salinity, turbidity and chlorophyll from Hornby Council's Laughtondale logger. Orange dots indicate data collected at the Wisemans Ferry site as part of the 2019-2020 Upper Hawkesbury water quality monitoring program.

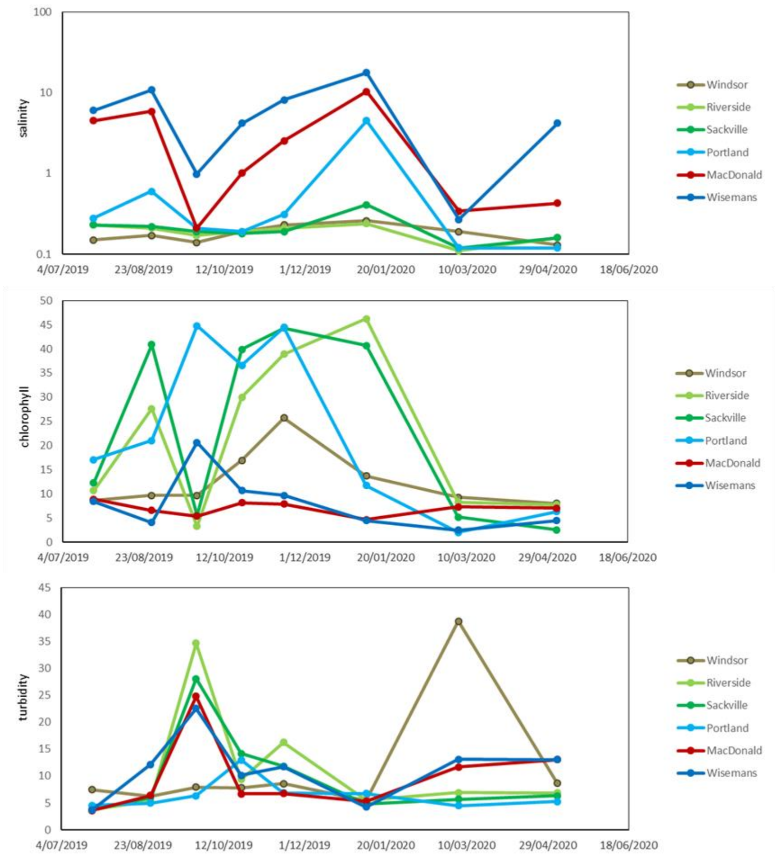


Figure 4: **Temporal trends in water quality across monitoring sites during the 2019-2020.**

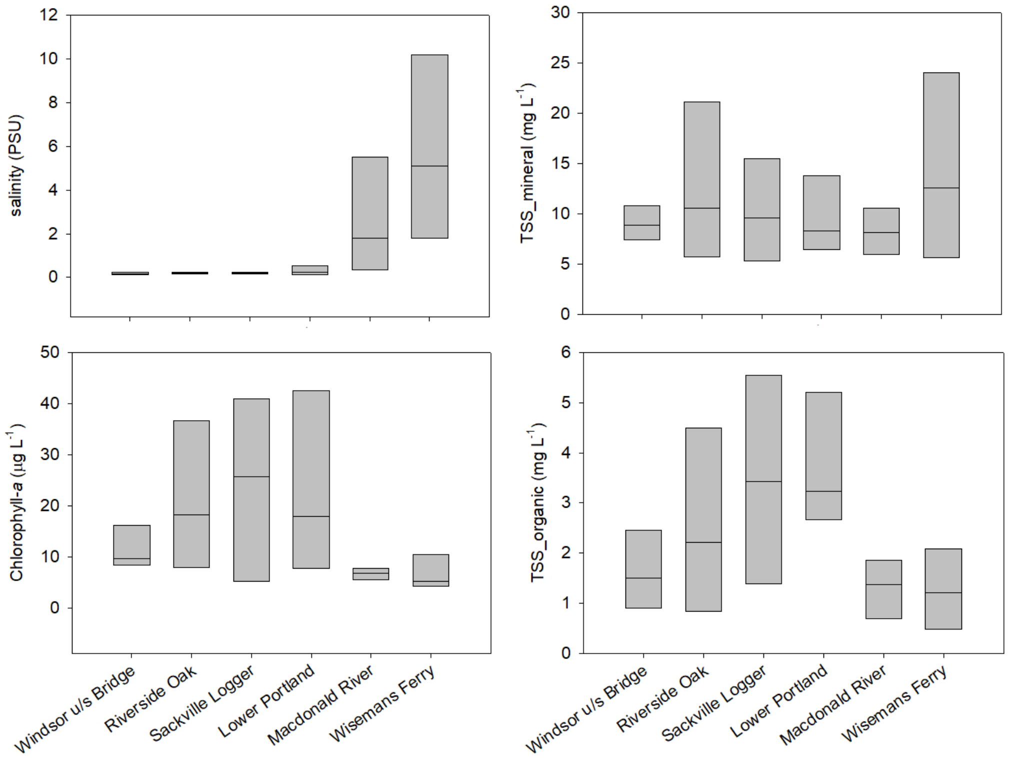


Figure 5: **Spatial trends in water quality across monitoring sites during the 2019-2020.**

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