Upper Hawkesbury River Water Quality Monitoring Program 2020 - 2021

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 2020-2021 financial year. This document continues the 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 2020–2021 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) which is normally applied to upper reaches of rivers 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 and therefore a trigger value for chlorophyll-a of 7µg/l was deemed more appropriate. This is based on recommendations made in the '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

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 within the lower Macdonald River which also falls within the Hawkesbury City Council LGA (Figure 1).

Water quality data were collected at 3-4 week intervals, 12 times throughout the year, between July 2020 and June 2021. Sampling at this frequency allows both monthly and seasonal variability in water quality to be assessed

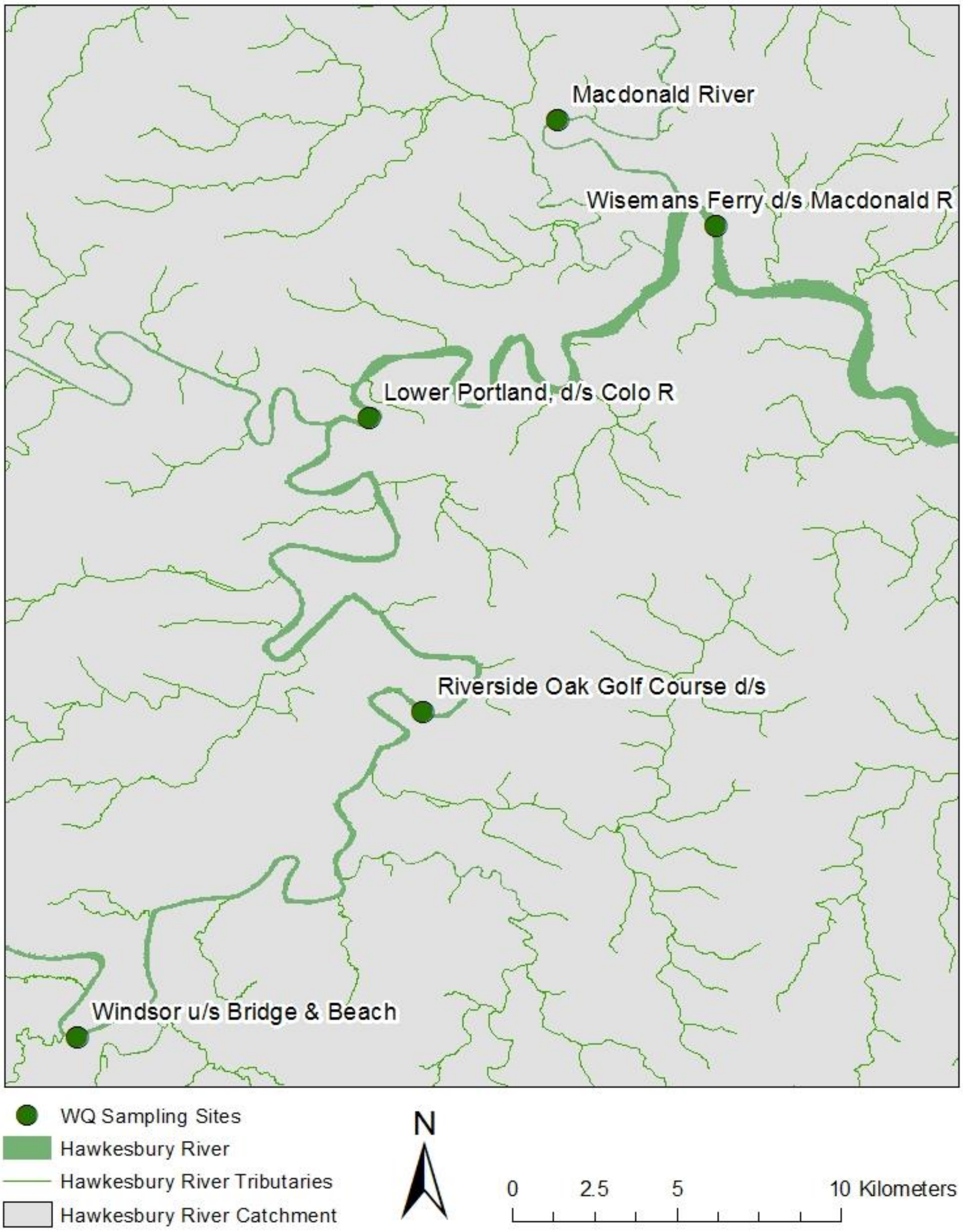


Figure 1: Locations of sampling zones in the Upper Hawkesbury River for the 2020 – 2021 monitoring program

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

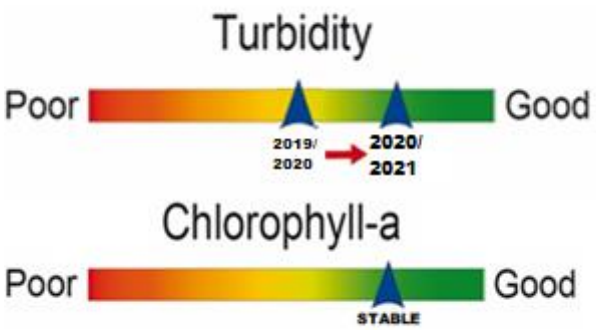
Report Card Grades

Wisemans Ferry (downstream of Macdonald River)

Overall water quality at Wisemans Ferry remained good in 2020-2021. The 80th percentile trigger value for chlorophyll-a was exceeded on two of the six sampling trips used to calculate the grades and remained good. The improvement in turbidity grade was driven by a decrease in the frequency of the 80th percentile trigger value being exceeded. The mean salinity recorded at Wisemans Ferry was 0.63ppt, which was much lower than that recorded in 2019-2020 (6.53ppt). A minimum salinity of 0.10ppt was recorded in April 2021 after a major flood event in March, with the maximum recorded salinity of 8.53ppt recorded in October 2020.

Table 2: Calculated grades at Wisemans Ferry during the 2020-2021 monitoring period.

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

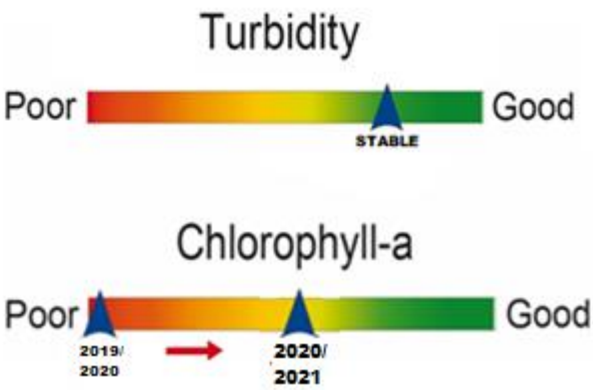


Lower Portland (downstream of Colo River)

Overall water quality observed at the Lower Portland zone improved from fair in 2019-2020 to good during 2020-2021. This was mainly driven by an improvement in the chlorophyll-a grade. While the 80th percentile trigger values for chlorophyll-a was exceeded on four of the six sampling occasion over the summer/autumn, it was only grossly exceeded on one occasion. The turbidity grade remained stable at good, with the trigger value only exceeded on one sampling occasion after a major flood event in March 2021. Salinity recorded at Lower Portland was generally below 0.2ppt, with a mean salinity of 0.10ppt.

Table 3: Calculated grades at Lower Portland during the 2020-2021 monitoring period.

Sampling Period	Turbidity	Chlorophyll-a	Overall Water Quality
2018 – 2019	C	F	D
2019 – 2020	B	F	C
2020-2021	**B**	**C**	**B**

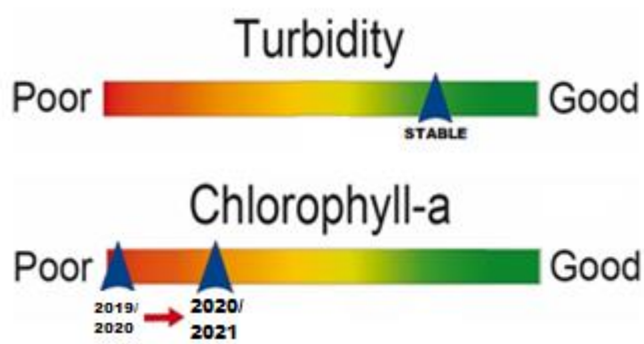


Riverside Oaks (downstream of golf course)

Overall water quality at Riverside Oaks improved from poor in 2019-2020 to fair in the 2020-2021 sampling period. This improvement was driven by a slight improvement in chlorophyll-a grade, however the 80th percentile trigger value for chlorophyll-a was exceeded on four occasions over summer/autumn (grossly exceeding the trigger value on two of these occasions). The turbidity grade remained as good with the trigger for turbidity only exceeded on two occasion over summer/autumn. Salinity recorded at Riverside Oaks was generally below 0.2ppt, with a mean salinity of 0.12ppt.

Table 4: Calculated grades at Riverside Oaks during the 2020-2021 monitoring period.

Sampling Period	Turbidity	Chlorophyll-a	Overall Water Quality
2018 - 2019	C	D	C
2019 - 2020	B	F	D
2020 - 2021	**B**	**D**	**C**

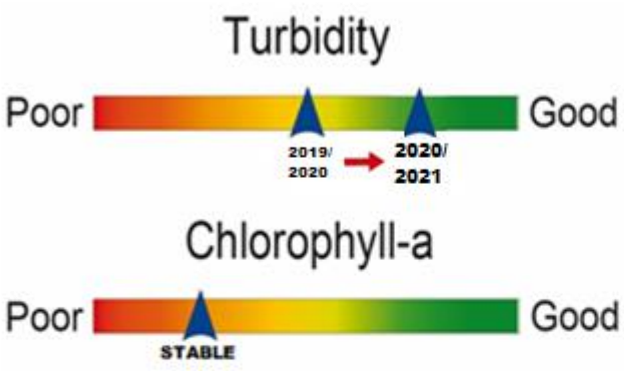


Windsor (upstream of Windsor Bridge)

Overall water quality at Windsor improved from poor in 2019-2020 to fair in the 2020-2021 sampling period. This improvement was driven by a slight improvement in turbidity grade, with the chlorophyll grade remaining unchanged for the third year running. The 80th percentile trigger value for turbidity was exceeded on three sampling trips, 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 0.2ppt, with a mean salinity of 0.11ppt.

Table 5: Calculated grades at Windsor during the 2020-2021 monitoring period.

Sampling Period	Turbidity	Chlorophyll-a	Overall Water Quality
2018 - 2019	C	D	D
2019 - 2020	C	D	D
2020 - 2021	**B**	**D**	**C**

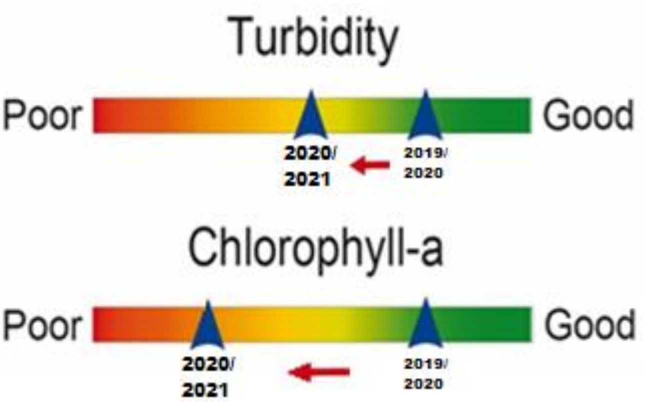


Macdonald River

Overall water quality in the Macdonald River decreased from good in 2019-2020 to fair in 2020-2021. This was a result of a decline in both the turbidity and chlorophyll-a grades, with the 80th percentile trigger value exceeded on all occasions for turbidity and all but one occasion for and chlorophyll-a over the summer/autumn. The mean salinity recorded at the Macdonald River site was 2.54ppt, with a minimum salinity 0.08 ppt and a maximum recorded salinity of 8.53ppt recorded in October 2020.

Table 6: Calculated grades in the Macdonald River during the 2020-2021 monitoring period.

Sampling Period	Turbidity	Chlorophyll-a	Overall Water Quality
2018 - 2019	B	B	B
2019 - 2020	B	B	B
2020 - 2021	**C**	**D**	**C**



Summary

Overall, we saw a slight improvement in the overall water quality grade at the upper three sites within the main river stem (Lower Portland, Riverside Oaks and Windsor) during 2020-2021, with the Wisemans Ferry site remaining stable at fair. The chlorophyll-a grades progressively decreased as we moved upstream with Windsor and Riverside Oaks receiving a poor grade, Lower Portland receiving a fair grade and Wisemans Ferry classed as good. The turbidity grade was classed as good at all sites within the main river stem, with an improvement in grade from fair to good recorded for both Wisemans Ferry and Windsor.

We saw a decline in the overall water quality at the Macdonald River zone, with a decline recorded for both turbidity and chlorophyll-a. This increase in turbidity and chlorophyll-a was visually observed when sampling on most sampling trips. It is likely that the increased turbidity has resulted in an increase in available nutrients at this site, resulting increase in algae/chlorophyll-a concentration recorded. This is surprising for this site as generally this site has performed better than those in the main river stem due to its catchment being much less disturbed than that of the main river stem and many of the tributaries feeding into it.

Flow Conditions

Chlorophyll-a concentrations within the Hawkesbury have been shown to be flow dependent, with high concentrations often linked to low flow conditions (Figure 3). The sampling conducted during 2020-2021 in the Upper Hawkesbury Water Quality monitoring program was dominated by moderate to high flows (<50 percentile) as a result of increased rainfall, combine with numerous water releases from Warragamba Dam (Figure 2). Three post high flow events samples (02/09/2020, 7/04/2021 and 13/05/2021) were collected where flows were in the top 10 percentile range (Tables 7 & Figure 2). Flow conditions leading up to 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).

Sampling Trip no.	Sampling Date	instantaneous	7 day mean	14 day mean
Trip 1	23/07/2020	183	212	212
Trip 2	2/09/2020	6477	7495	7824
Trip 3	30/09/2020	271	353	885
Trip 4	16/10/2020	293	181	177
Trip 5	30/11/2020	137	210	1548
Trip 6	17/12/2020	1242	392	304
Trip 7	3/01/2021	752	753	694
Trip 8	22/02/2021	884	812	668
Trip 9	16/04/2021	546	4477	7482
Trip 10	13/05/2021	11718	17747	9423
Trip 11	1/06/2021	408	493	2513
2 weeks post flood- data not used for grades	7/04/2021	10719	10862	24382

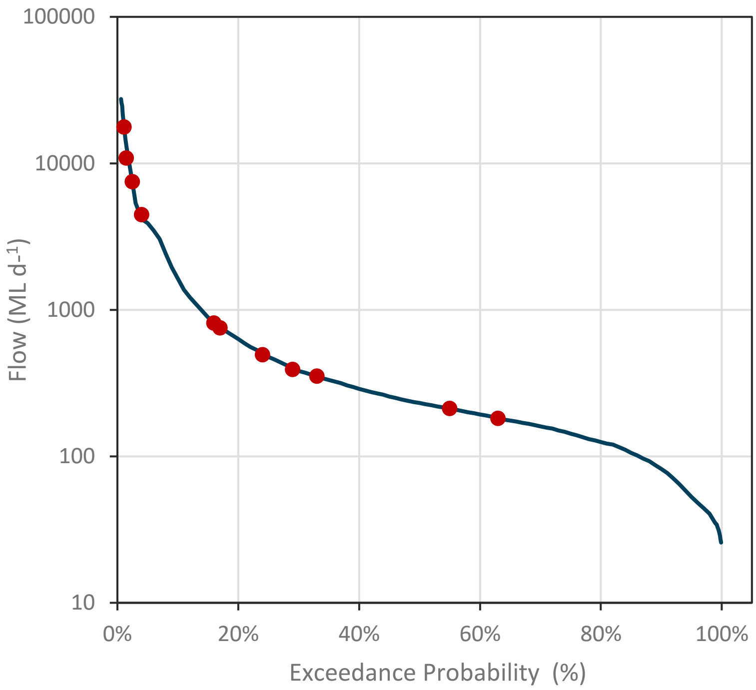


Figure 2: Flow exceedance curve for Nepean River at Penrith Weir (blue line), showing flows during sample times (orange dots).

System State

During the study period (July 2020 to June 2021) the Hawkesbury River was flow dominated. Data from Hornsby Council's Laughtondale in situ logger provided a more integrated indication of the relative influence of cumulative freshwater inflows during each sample time than the instantaneous flows (Figure 5). During this sampling season we saw increase in flows for much of the year, with brackish estuarine conditions rarely extending upstream of our Wisemans Ferry site.

The first sample event occurred during winter under low flow conditions, with brackish estuarine conditions extending upstream of Wisemans Ferry. The second sampling trip occurred at the beginning of September, following a period of moderate flows from a combination of rain in late July and early August and dam releases from Warragamba, which resulted in the brackish/freshwater interface being displaced downstream of Wisemans Ferry. The following three sample occasions occurred during lower or diminishing flows over spring, with estuarine conditions recovering in the lower reach of the study area and the brackish/freshwater interface returning to Wisemans Ferry. Trips 6, 7 and 8 occurred during moderate flow, which saw the brackish/freshwater interface remain around Wisemans Ferry. The sample effort on 7/4/2021 occurred 2.5 weeks after a major flood, which combine with dam releases caused freshwater conditions to extend downstream of Laughtondale for one month. Sampling on the 16/4/2021 was still within this period of freshwater extending beyond Laughtondale, with sampling in mid May 2021 occurred following on from another rain event, a week prior, which resulting in the system returning to freshwater conditions after beginning to return to estuarine conditions in late April 2021. The final sample time (1/6/2021) occurred just as the Wisemans Ferry site was beginning to return to estuarine conditions once again.

Chlorophyll

The general trends in chlorophyll-*a* over the study period follow our conceptual understanding in tidal pool processes; decreased flow = increased chlorophyll-a (figure 3). Phytoplankton biomass increased throughout the upper to mid tidal pool following two months of lower flows in August and September 2020 (Figure 6) as residence times increased and water clarity improved. We saw an increase in biomass at Lower Portland, Wisemans Ferry and River Side Oaks in December 2020 sample, following 3 weeks of lower flows (Figure 6). With numerous rain events and dam releases over much of the sampling period, an increase in chlorophyll-a associated with periods of low flow was not as pronounced as we have seen previously, however the general trend of decreased flow resulting in increased chlorophyll-a concentrations was still present (Figure 3). Phytoplankton biomass at most sites was greatly reduced during the post-flood sample time (April 2021) (Figure 6) 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 begun showing signs of recovery by the June 2021 sample time (Figure 6), most likely due to reduced freshwater inputs leading to increased residence times, as well as a decrease in turbidity.

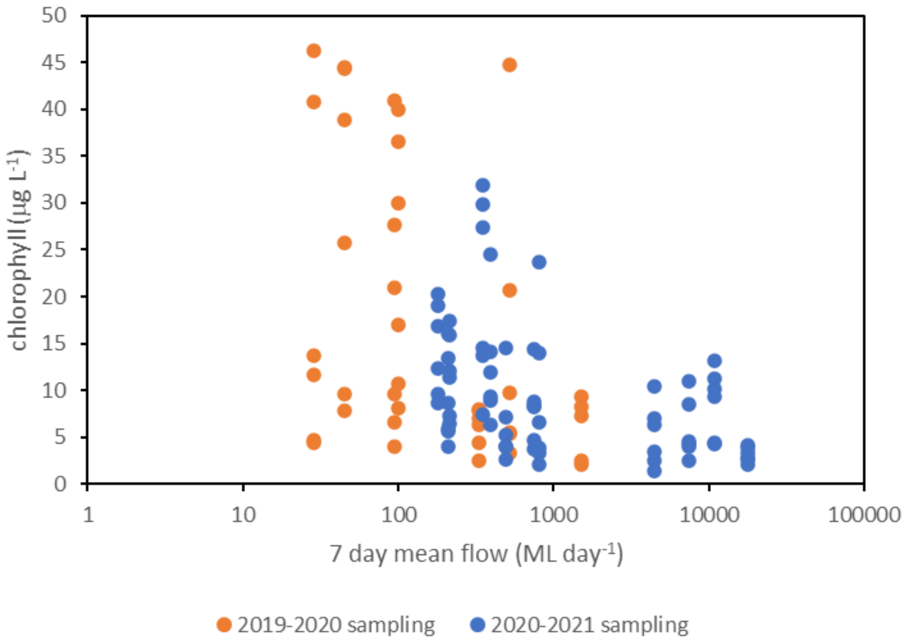


Figure 2: Flow vs chlorophyll-a for all site sampled as part of the 2019-2020 (represented by orange dots) and 2020-2021 (represented by blue dots) Upper Hawkesbury water quality monitoring program.

Turbidity

Trends in turbidity are driven by spatial factors throughout the bulk of time, with episodic large spikes due to high-flow inputs of diffuse material. In the past we have seen turbidity in the Windsor reach during low flows to be 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 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 5), which shows data from Wisemans Ferry superimposed. This indicates 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 4 and Figure 5).

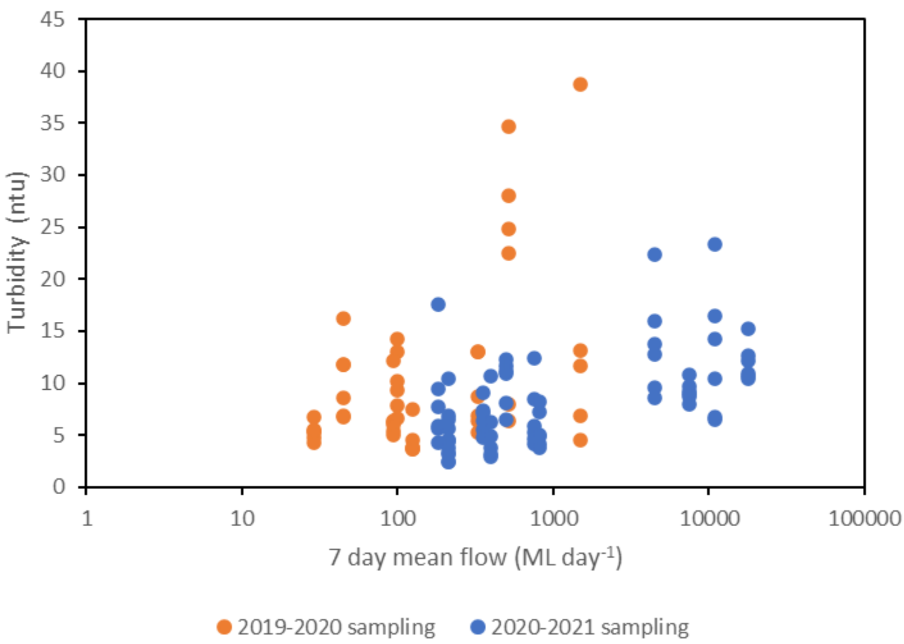


Figure 4: Flow vs turbidity for all site sampled as part of the 2019-2020 (represented by orange dots) and 2020-2021 (represented by blue dots) Upper Hawkesbury water quality monitoring program.

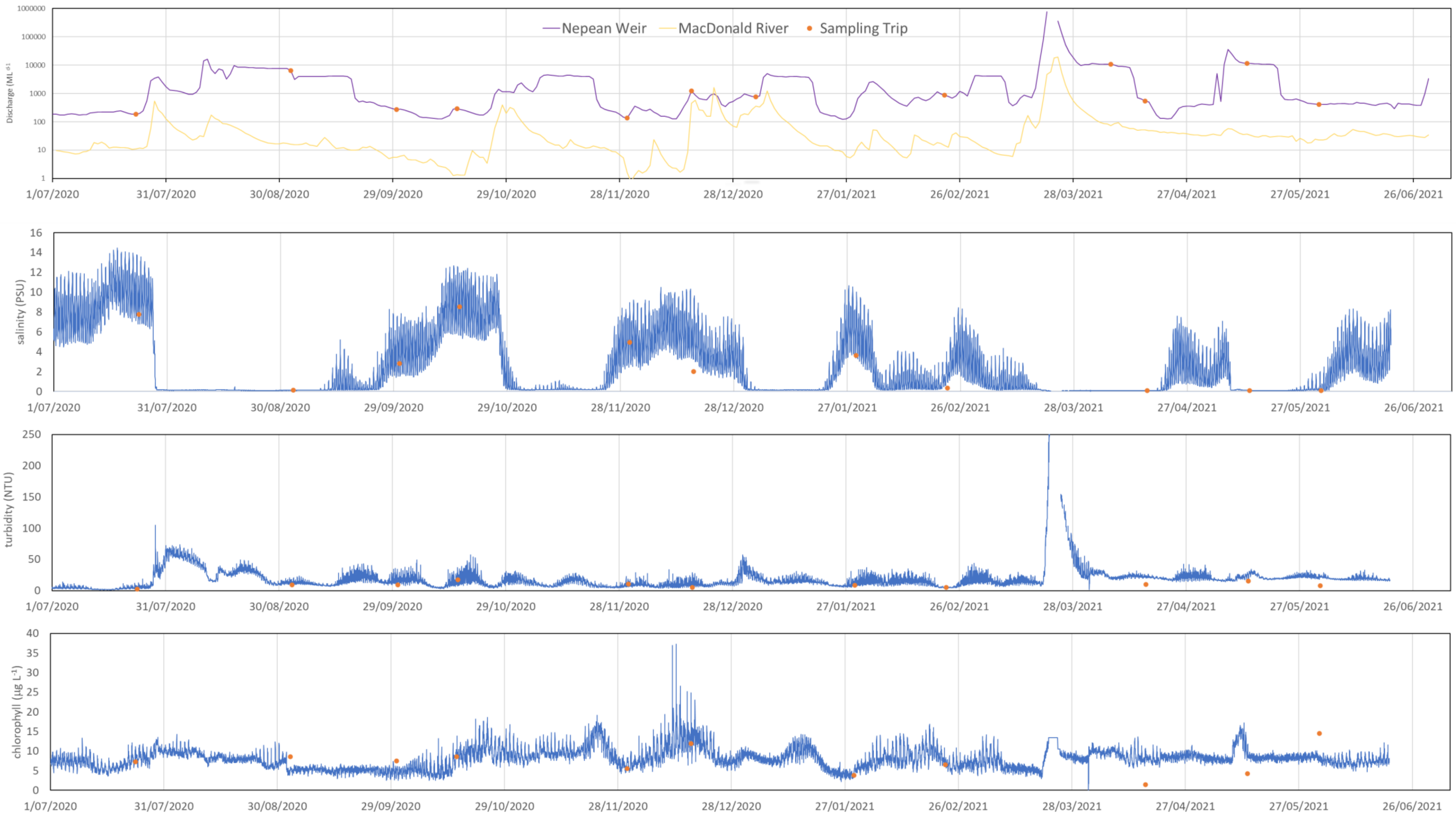


Figure 5: Timeseries of discharge (Penrith Weir & Macdonald River), and salinity, turbidity and chlorophyll from Hornby Council's Laughtondale logger. Orange dots indicate data collected at the Wisemans Ferry site as part of the 2020-2021 Upper Hawkesbury water quality monitoring program.

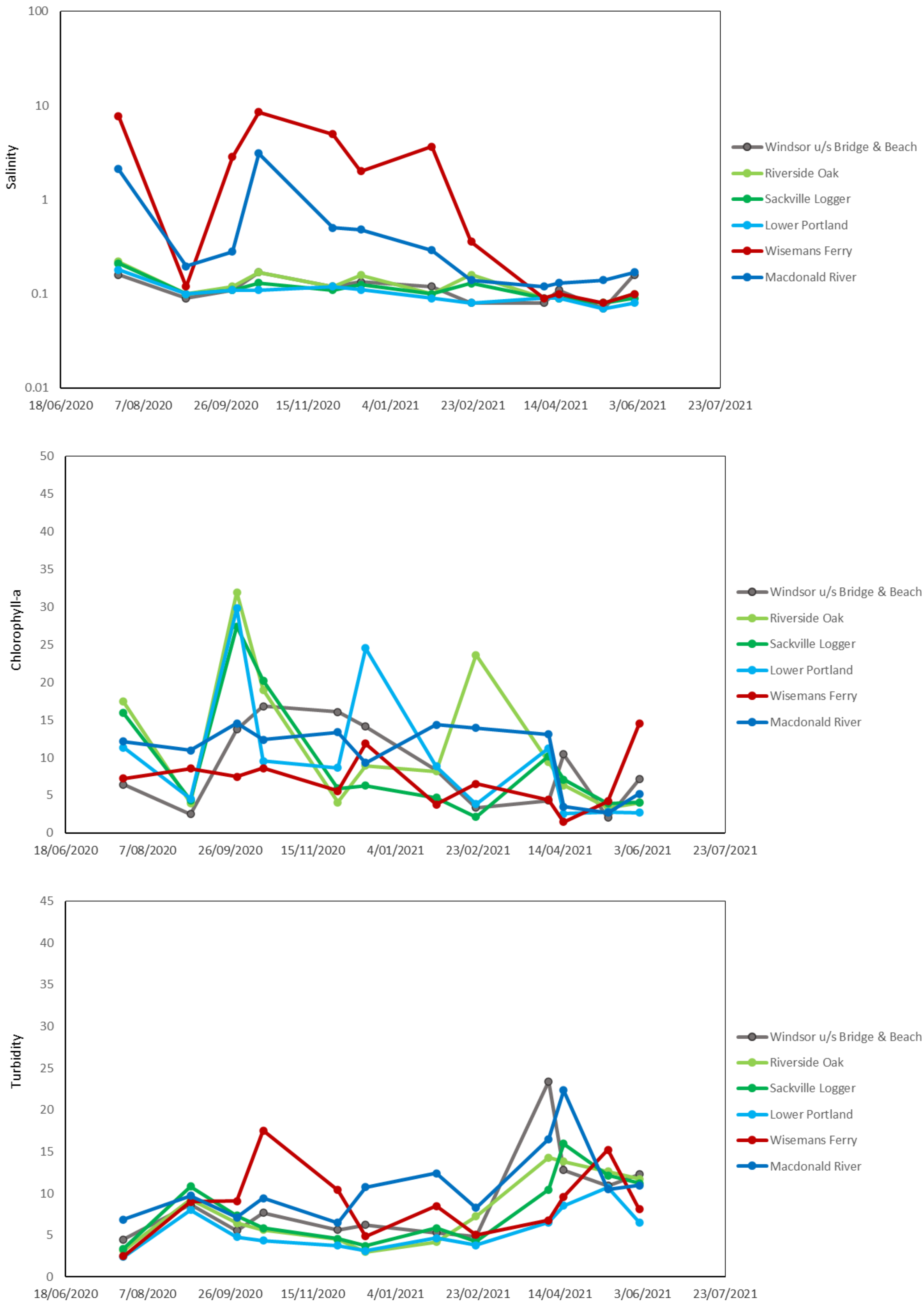


Figure 6: **Temporal trends in water quality across monitoring sites during the 2020-2021.**

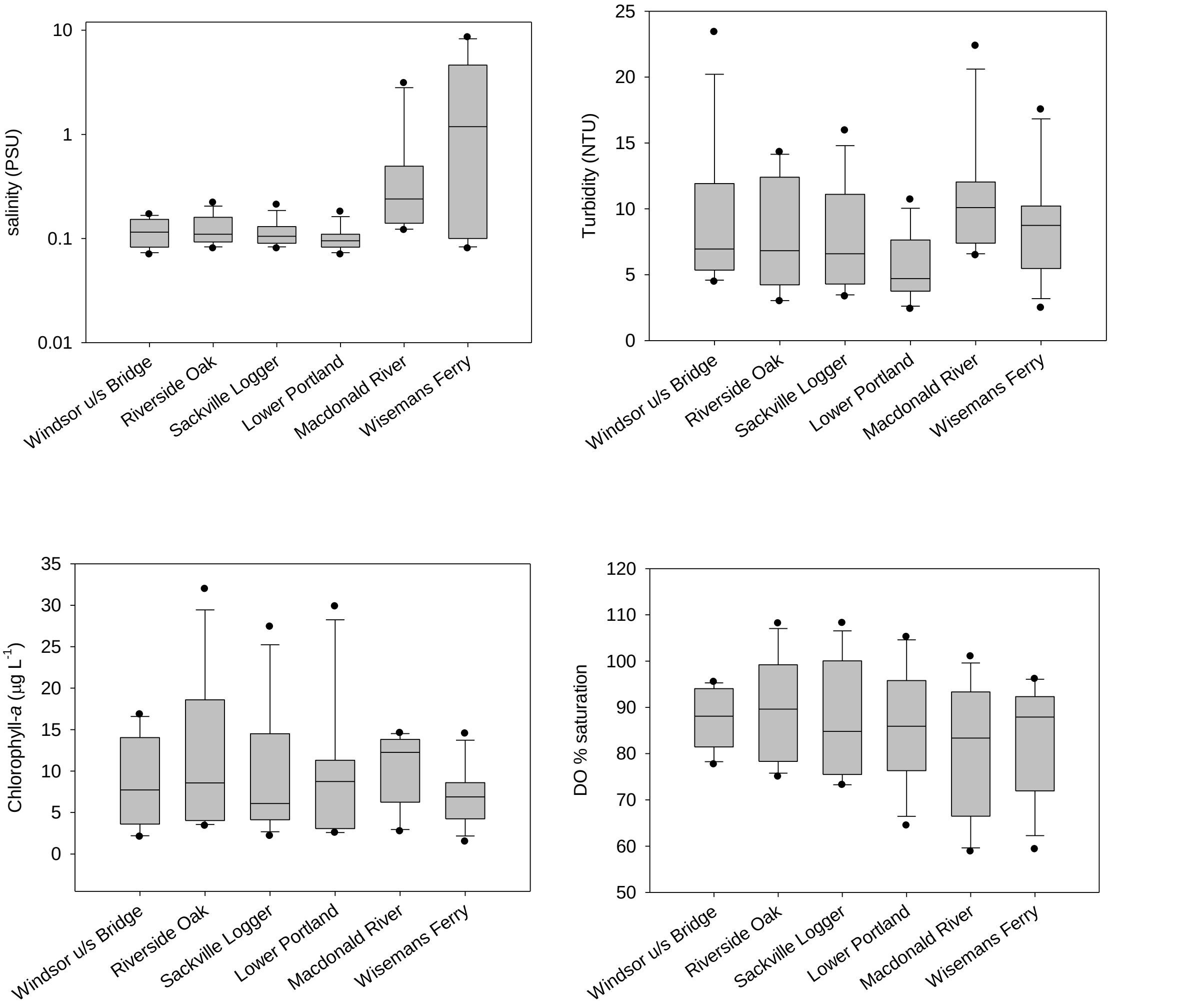


Figure 7: Spatial trends in water quality across monitoring sites during the 2020-2021.

References

APHA 2012, *Standard methods for the examination of water and wastewater*, 22nd edition, American Public Health Association, Washington DC.

Ferguson 2018, *Interim nutrient load cap assessment for the Hawkesbury Nepean River*, Office of Environment and Heritage, Sydney.

OEH 2016, *Assessing Estuary Ecosystem Health: Sampling, data analysis and reporting protocols*, NSW Natural Resources Monitoring, Evaluation and Reporting Program, Office of Environment and Heritage, Sydney.

OEH 2018, *NSW Estuary Water Quality Trigger Values*, How new water quality Trigger Values for estuaries in NSW were derived, Office of Environment and Heritage, Sydney.