PRAIRIE PROVINCES WATER BOARD

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NORTH SASKATCHEWAN RIVER WATER QUALITY SAMPLING SITE RE-LOCATION: EFFECTS ON SELECTED WATER QUALITY PARAMETERS

PREPARED FOR THE PPWB COMMITTEE ON WATER QUALITY

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North Saskatchewan River
Water Quality Sampling Site Re-location:
Effects on Selected Water Quality Parameters

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Background

Environment Canada has conducted monthly and quarterly monitoring for the Prairie Provinces Water Board since 1974. Currently monitoring is conducted at 12 sites on major rivers along the borders of Alberta, Saskatchewan and Manitoba. The results of the this long term monitoring program are used to determine if the PPWB Water Quality Objectives are met within a given year but also to determine long-term trends in water quality for parameters of concern. The results are further used to address potential interprovincial water quality concerns and to provide information required in establishing baseline water quality characteristics. The number of samples and parameters collected in a given year depend on the site location, local water quality conditions and potential concerns. Although sampling and data evaluation at these sites has been on going for the last 30 years several modification to the program have been implemented that have periodically required review.

The water quality results from the sampling site on the North Saskatchewan River at the Alberta/Saskatchewan border, (Figure 1), are currently under review as the site has been relocated twice over the last 30 years. As with all PPWB monitoring locations, the sampling site is to be located on the main stem of the North Saskatchewan River at or near the border in order to capture conditions exiting the province of Alberta. The site is near the Alberta – Saskatchewan border adjacent to the city of Lloydminster. The initial sampling site established in 1974 was located within Saskatchewan at Highway #3 (Figure 2). In October 1982, the site was moved across the Alberta border to Lea Park and was sampled for 5.5 years. The current site close to the border at Highway 17 was initiated in April 1988. There are no reports on record to indicate if any special studies were conducted to examine the effect of station relocations on the water quality characteristics being recorded from this site.

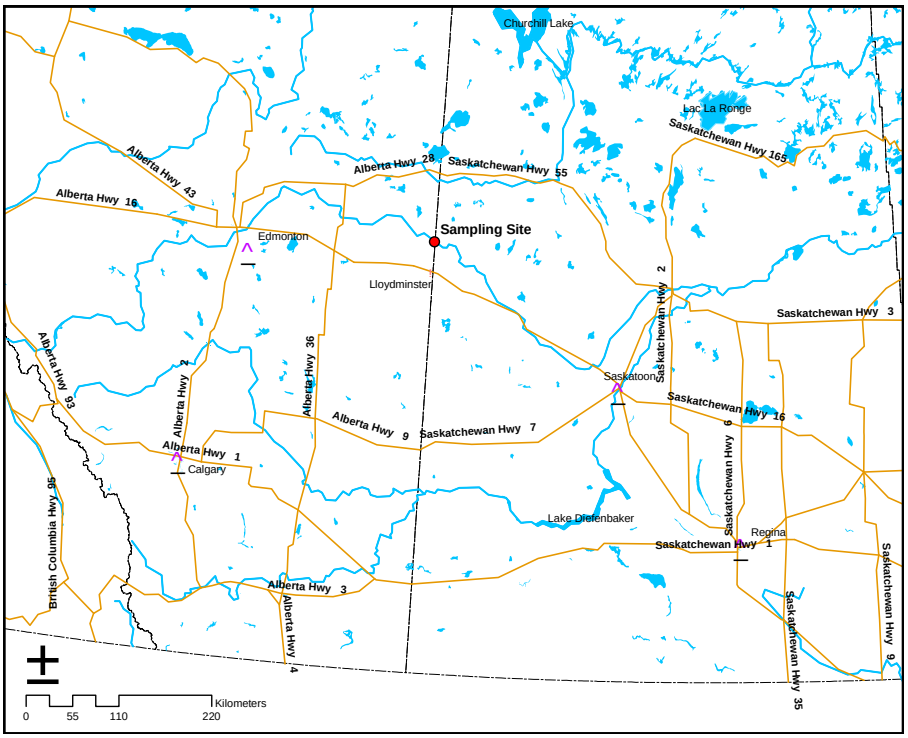


Figure 1: Image of the present day site along the North Saskatchewan River

Figure 2: Image of the three North Saskatchewan River Sampling locations between 1974 and present day.

Objectives/Methods

The purpose of this note was to examine water quality data collected from the three different sites to assess if changes observed through the period of record may have been associated with the changes in sampling location. As concurrent sampling was not conducted at the sites at the time of relocation, direct comparisons of water quality at the sites is not possible. Therefore, seven water quality parameters were investigated to examine if major step changes in basic water chemistry may have occurred coincident with the site re-locations. These parameters were selected as indicators of changes in longitudinal-geochemical conditions in river chemistry. In addition, several nutrients and fecal coliforms were included in the event that point or non-point sources may change with longitudinal distance. The set of parameters examined in this report included; pH, total phosphorus (TP), total dissolved solids (TDS) and nitrogen dissolved (NO_3 & NO_2), non filterable residue (NFR), dissolved oxygen (O_2), total hardness and fecal coliforms.

First, to examine these data, each parameter was plotted over time and the time series plots were examined for obvious stepwise changes or increased frequency of outliers between time periods with different sampling locations. Such a change could indicate a difference in water quality associated with the change of location. Second, to determine if there was a significant shift in the median values for the selected parameters between the three time frames, a Kruskal-Wallis non-parametric test for differences between medians was run on the eight parameters.

Results

No obvious step changes associated with the change in location over the period of record are evident for any of the parameters examined (Figures 3-10). Although some parameters show outliers throughout the 30 year time frame, changes in frequency or occurrence are not associated with changes in station location. In addition, the box plots do not indicated major changes in median or percentile values associated with the time frames of the site re-locations.

PPWB objectives and excursion rates, where applicable, are also indicated on the box plots. Although some dissolved oxygen values were lower than the objective, there were no true excursions given that the objective is for open water and all excursions occurred under ice. A single excursion occurred for pH over the entire period of record and was not considered significant relevant to site relocation. Fecal coliforms show the highest percent excursion rate, however there is no large discrepancy between excursion rates at the three site locations; 14, 11 and 11 % for the three consecutive time periods respectively. Over all excursion rates are low in this analysis and do not imply impacts from changes in station location.

The Kruskal-Wallis test showed no significant changes in median values for six of the parameters tested (Table 1). However, significant differences for pH and total

phosphorus, with p values of 0.018 and 0.037, respectively, were detected. The median pH values changed, respectively, from 7.9 to 8.0 to 8.1 over the three consecutive time periods. Although pH has units on a logarithmic scale and thus these single decimal place changes represent larger changes, pH in the river has not changed significantly to warrant any concern regarding the PPWB water quality objective (pH = 6.5-9.0). The maximum values during each time period have been within a decimal point of the upper objective with only a single excursion during the entire period of record. Thus, the significant difference in pH values between sampling periods is not likely a concern to water quality along the North Saskatchewan River.

For total phosphorous, the significant difference in median values (0.08, 0.11, 0.08 mg/L for consecutive time periods) likely resulted from more frequent (n= 9) total phosphorous concentrations greater than 0.3 mg/L occurring during the middle time period at the Lea Park site. As there are currently no total phosphorous objectives at this site we cannot evaluate the effect of these apparent changes on excursion rates. Minimum values were similar and the maximum value during the period of record occurred in the later time period. As the Lea Park site is the most upstream of the three sampling locations, future investigations should examine if this site location differs in proximity to point or non point source nutrient inputs and the influence of the 5.5 years of sampling at this site on trend analyses should be examined carefully.

Table 1. Results of Kruskal Wallis non parametric rank test. * significant difference $p<0.05$

Parameter	df	Kruskal-Wallis Test Statistic	p value
NO3 & NO2	2	2.747	0.253
pH	2	7.989	**0.018***
TP	2	6.595	**0.037***
TDS	2	3.285	0.194
NFR	2	3.578	0.143
DO	2	1.133	0.751
Hardness	2	0.279	0.219
Fecal Coliforms	2	3.48	0.176

Unfortunately, the main conclusion of this short investigation is that there is a confounding effect in this analysis due to the non-overlapping time frames/site relocations. Samples from the three locations were never taken during the same years thus making it more difficult to interpret the significance of these results. Ideally, data should have been collected at the two sites simultaneously over a number of years to determine any significant differences in water quality due to site location. Due to this confounding effect, it is difficult to assess if there has been a significant change in water quality between locations or through time.

Recommendations:

Three recommendations are forward:

1) Reports, and reasoning for changes in site location, should be well documented for future work and reference.
2) Future changes in station locations should be met with considerable care. Should a change of location be necessary, specific steps should be followed. The primary recommendation is that water quality monitoring should be conducted at stations simultaneously, to determine if the proposed new location is suitable and will not contribute to confounded temporal trend analyses in the future. As long term temporal trend analysis is a major objective of the PPWB water quality monitoring program, this is an important consideration for the future. A time period of at least one year to capture the seasonal nature of water chemistry and more likely a two year period to also capture a minimal amount of inter-annual variation is recommended for duplicate site sampling. When the new location has been determined to be suitable, monitoring can then be terminated at the old site.
3) Finally, and more specifically to the North Saskatchewan sampling site, although no large changes in water quality related to changes in site location were confirmed for the parameters examined, it is recommended that any data distribution for this site be accompanied by the information on site relocation. For future temporal trend analyses at this site, scrutiny for step changes associated with the time periods provided in this report should be a routine screening/ quality control step.

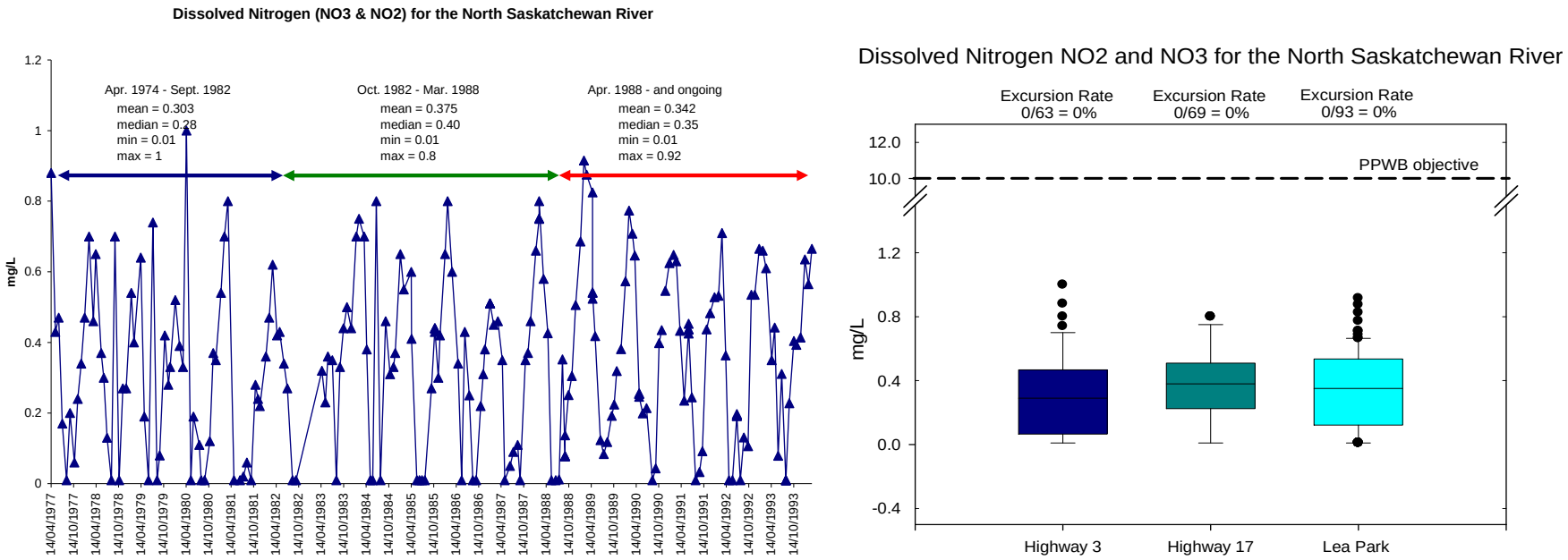
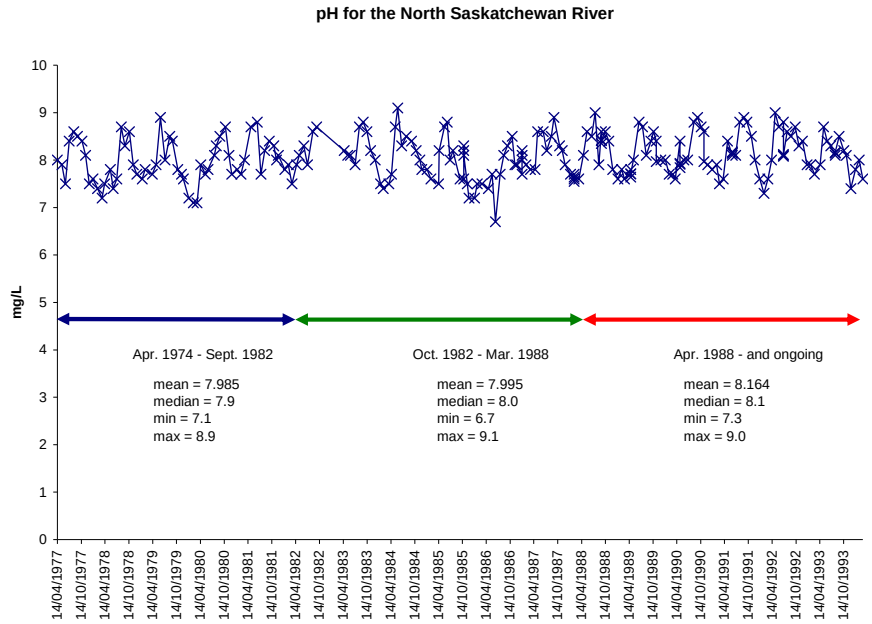


Figure 3: Dissolved nitrogen (NO_3&NO_2) concentrations through time in the North Saskatchewan River.



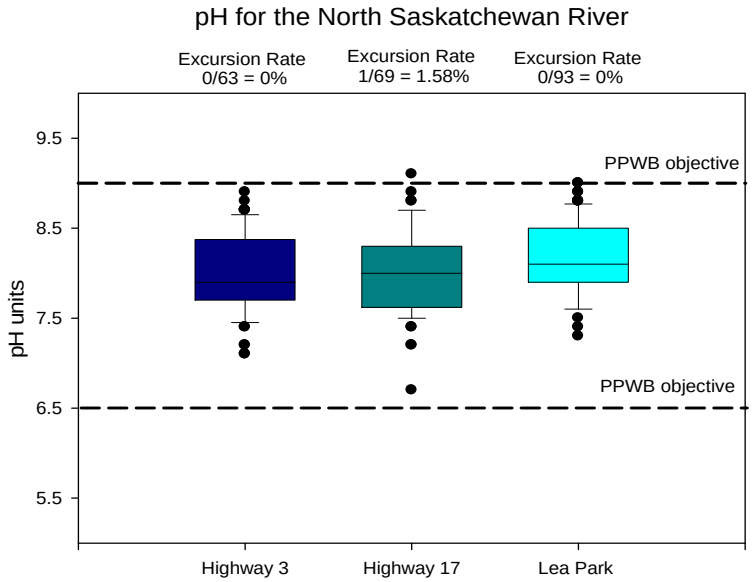


Figure 4: pH values through time in the North Saskatchewan River.

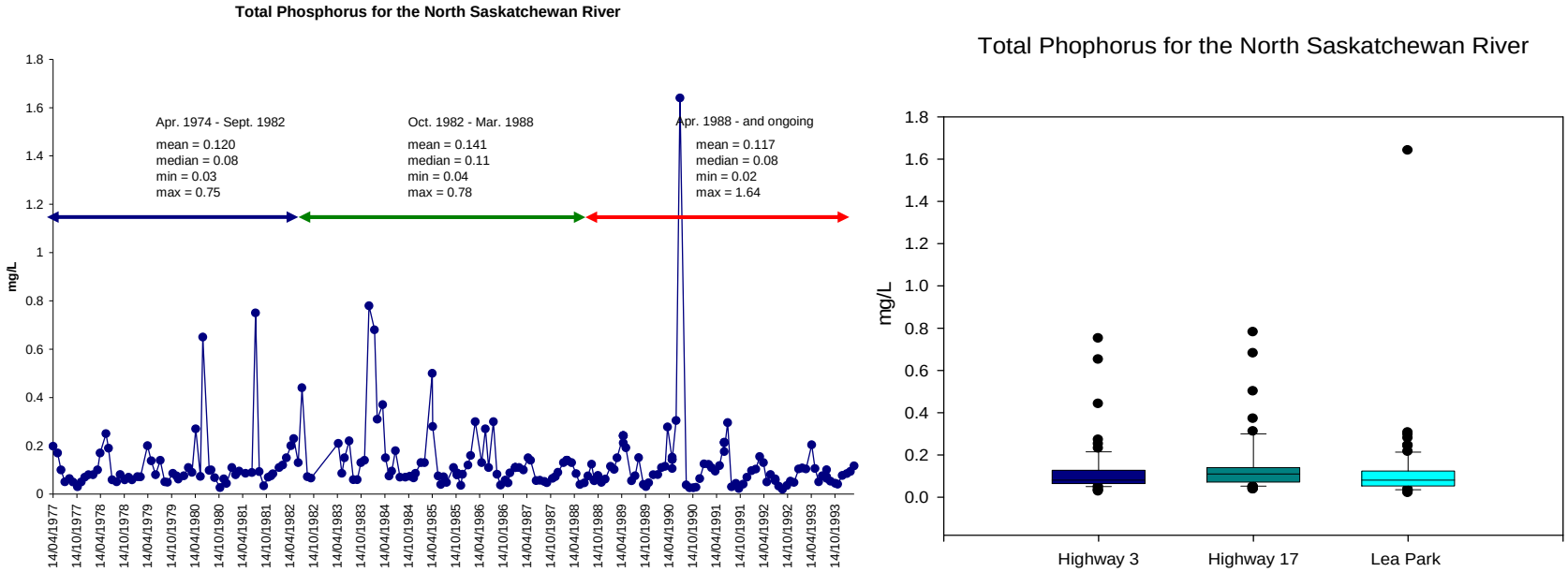


Figure 5: Total phosphorous concentrations through time in the North Saskatchewan River.

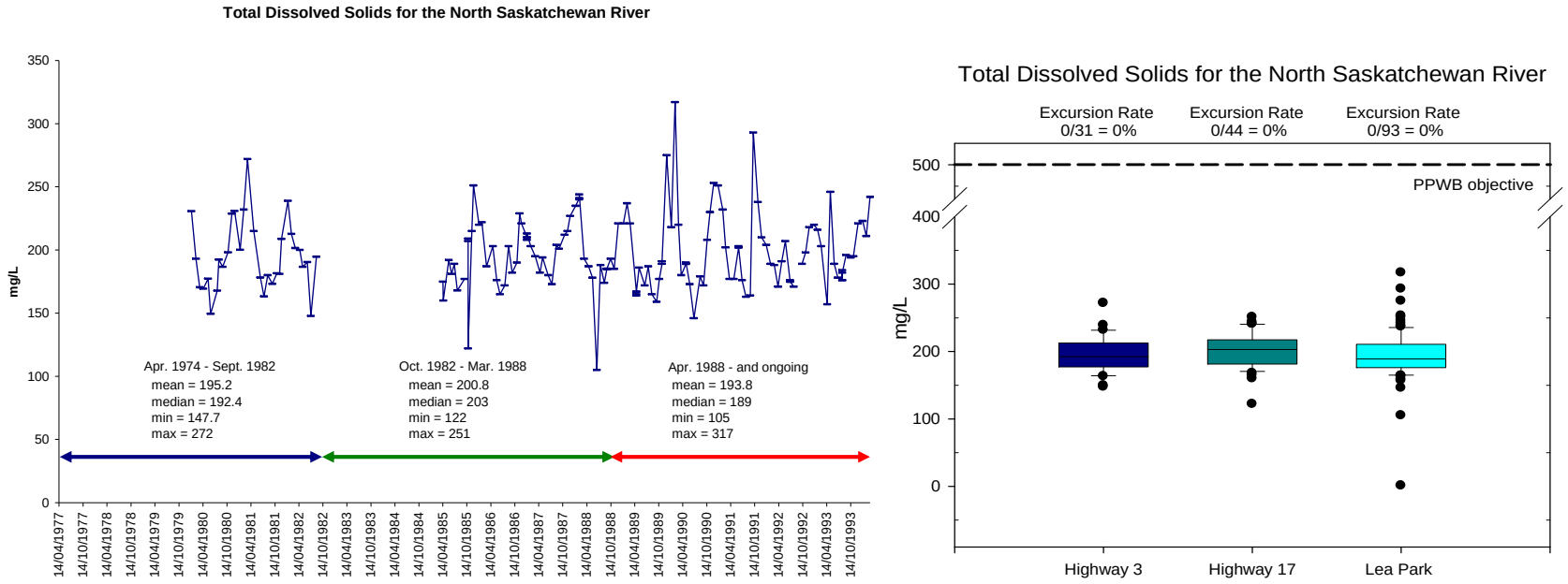


Figure 6: Total dissolved solid concentrations through time in the North Saskatchewan River.

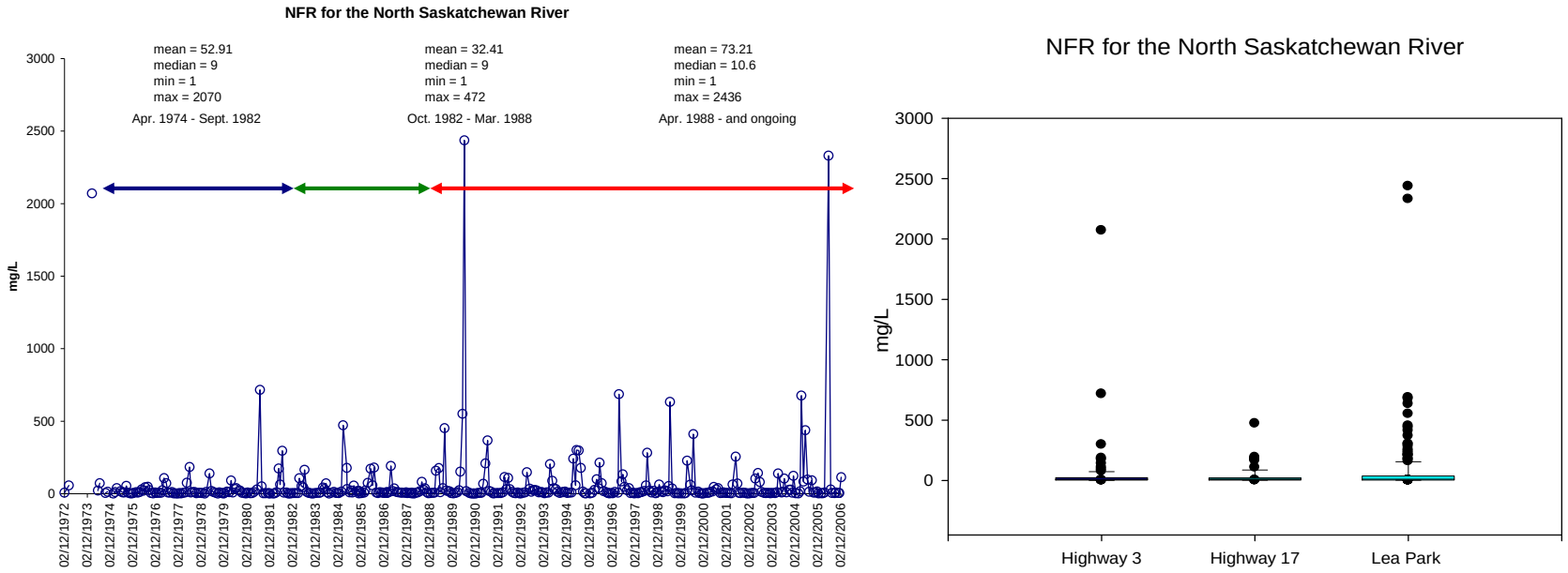


Figure 7: Non-filterable residue concentrations through time in the North Saskatchewan River.

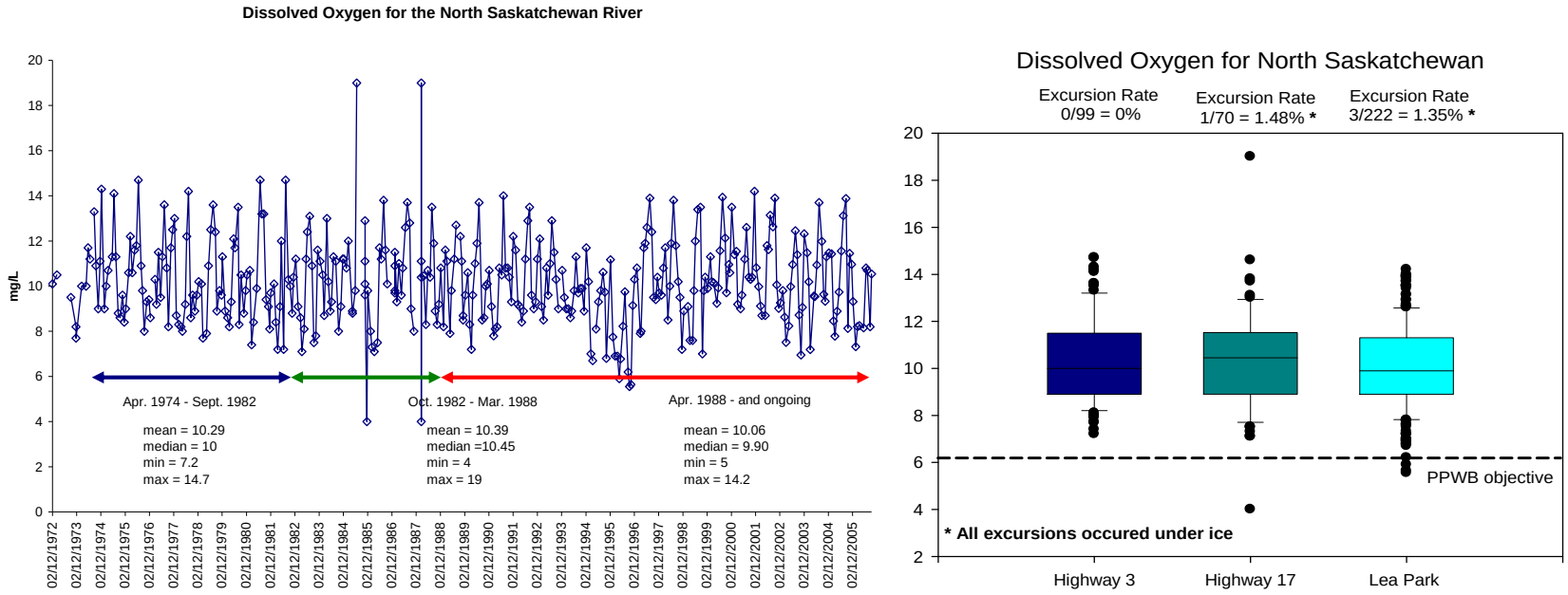


Figure 8: Dissolved oxygen concentrations through time in the North Saskatchewan River.

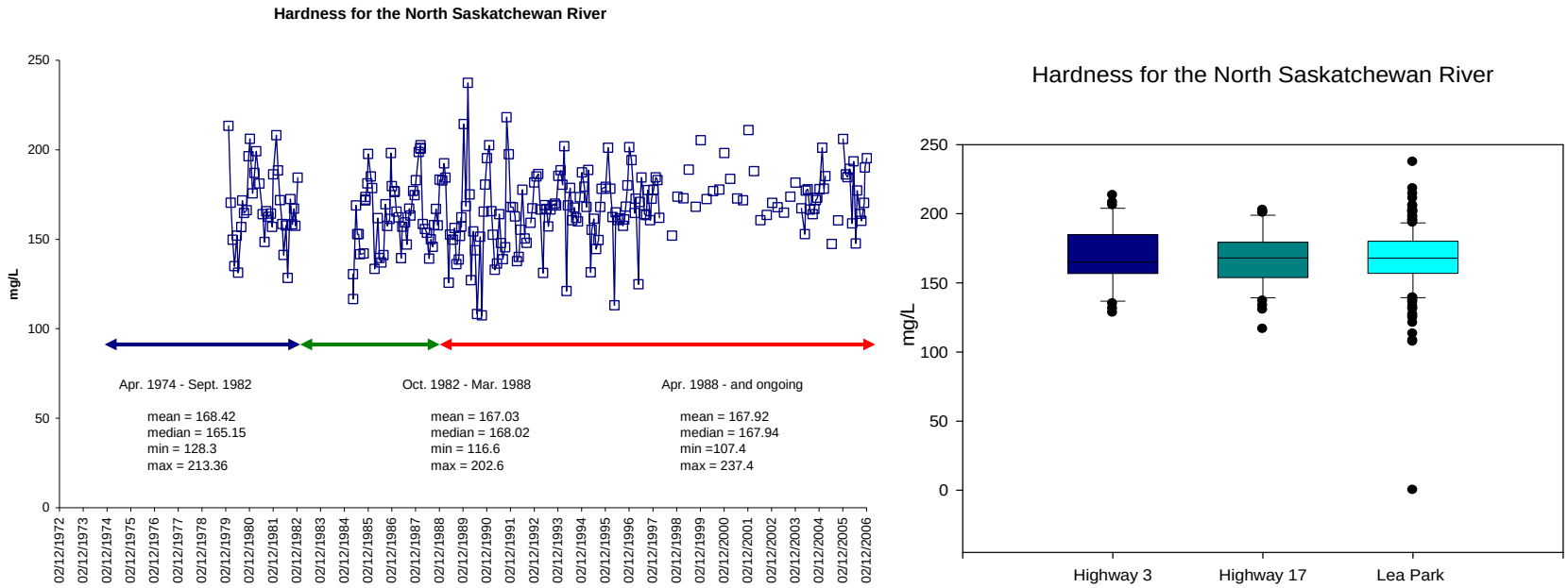


Figure 9: Total hardness through time in the North Saskatchewan River.

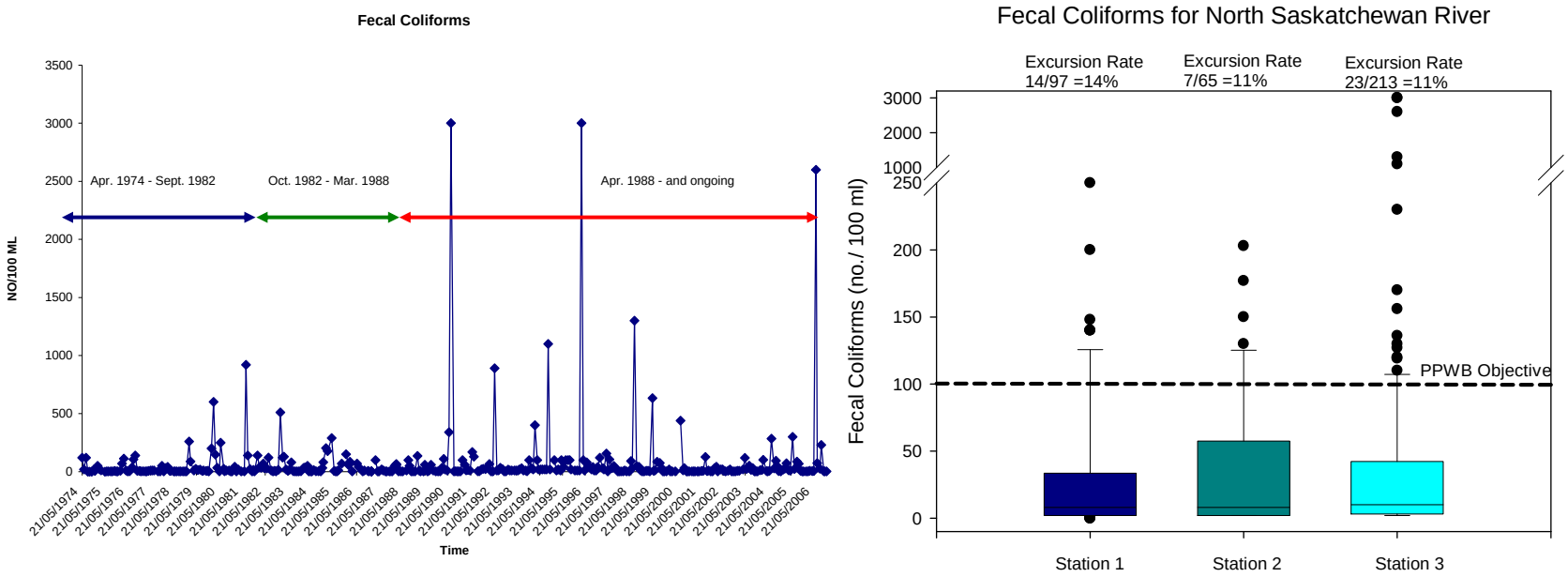


Figure 10: Fecal coliforms through time in the North Saskatchewan River.

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http://www.pnr-rpn.ec.gc.ca/water/fa01/index.en.html