State Of Water Quality Of South Thompson River At Kamloops 1973 – 1997

Canada - British Columbia
Water Quality Monitoring Agreement

Environment Environnement
Canada Canada

Ministry Of
Environment,
Lands And Parks

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Water Quality Section
Water Management Branch
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EXECUTIVE SUMMARY

This report assesses the long-term water quality trends of the South Thompson River at Kamloops. The South Thompson River, in the Southern Interior of British Columbia, begins at the outlet of Little Shuswap Lake, and flows southwest and west for 60 km before it converges with the North Thompson River at the City of Kamloops. Water quality has been monitored on the South Thompson River at Kamloops, with a flow station near Chase. BC Environment began water quality monitoring at Kamloops in 1973. Five other related water quality monitoring stations within the Thompson River watershed are:

the North Thompson River at North Kamloops, the Bonaparte River near mouth, the Thompson River at Spences Bridge, the Salmon River at Highway #1, and the Nicola River at Spences Bridge.

The plotted data were compared to the water quality objectives for the South Thompson River and to British Columbia's approved and working guidelines for water quality to see if any of the measurements had exceeded objectives or guidelines. Of special interest were water quality levels and trends that were deemed deleterious to sensitive water uses, including drinking water, aquatic life, wildlife, recreation, irrigation, and livestock watering.

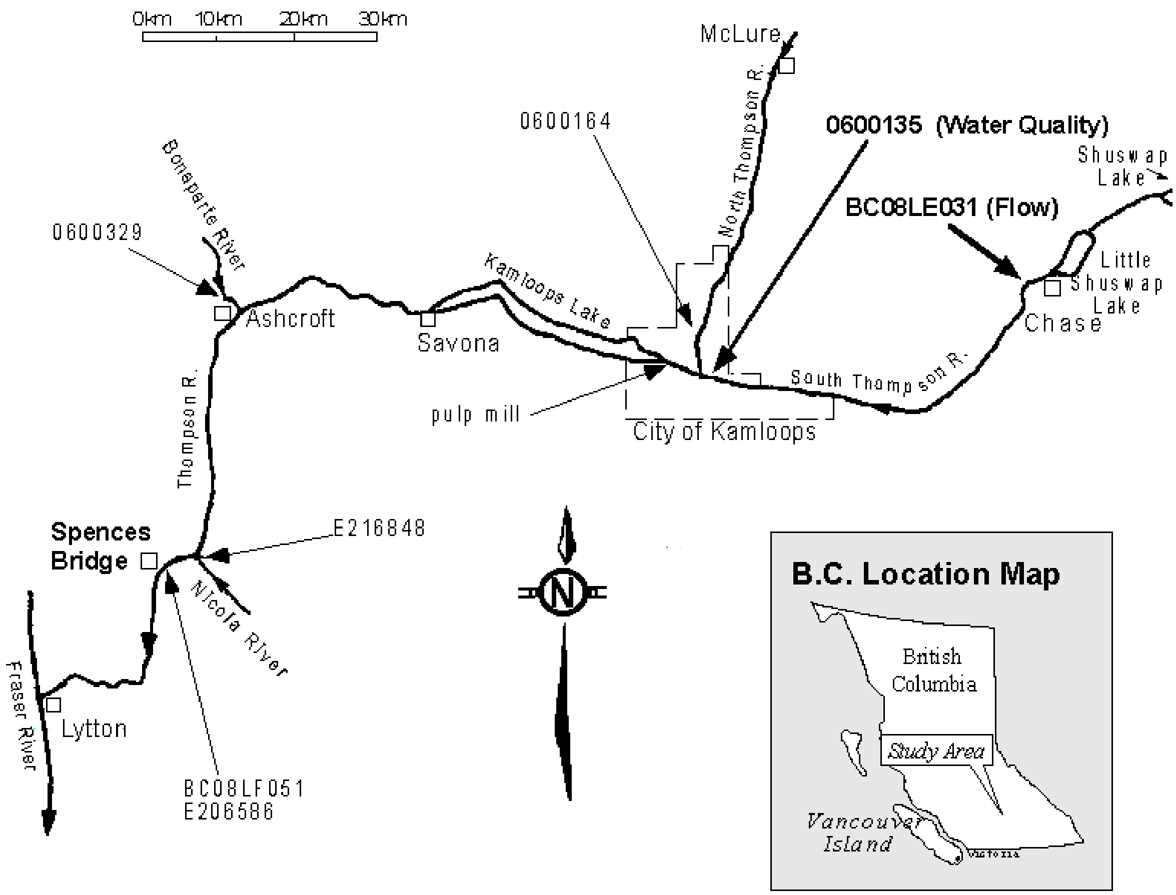
The main conclusions of this assessment are:

· No environmentally significant trends in water quality were detected by visual appraisal of the data with the exception of suspended solids which is thought to be largely non-point source related such as from agriculture, forestry and residential development.
· The water was well buffered against acid inputs throughout the year, but yet quite soft for drinking water.
· The water was cool or cold enough throughout most of the year to be aesthetically pleasing for drinking, and usually warm enough during the summer months to permit water-contact recreation such as swimming.
· Turbidity and non-filterable residue levels were elevated during freshet when higher flows resulted in increased runoff and erosion, particularly from tributary streams. Remediation of non-filterable residue and turbidity sources and levels is needed.
· Fecal coliforms probably did not meet the water quality objective for the South Thompson River designed to protect raw drinking water for use after only disinfection, and the remediation of the sources of fecal contamination is probably needed.
· During freshet, elevated levels of aluminum and iron occurred. These levels may not have been of concern however, since they were due to the increased suspended sediment in the water, and thus were probably mostly biologically unavailable.
· During freshet, elevated levels of phosphorus occurred, but the phosphorus was largely in particulate form, and not readily available for algal growth.

Our main recommendations:

· Reduce sources and levels of fecal coliforms, non-filterable residue, and turbidity in the watershed. Continue monitoring at this site as the South Thompson River is important both as a water resource and as an aquatic habitat.

Figure 1. Map of the Thompson River Basin.



1. Introduction

The South Thompson River, in the Southern Interior of British Columbia, begins at the outlet of Little Shuswap Lake, and flows southwest and west for 60 km before it converges with the North Thompson River at the City of Kamloops (Figure 1). It has a drainage area of approximately 16,200 km^2 and a mean flow of 300 m^3/s. The South Thompson River comprises about 40% of the flow of the Thompson River after the convergence with the North Thompson River (Nordin & Holmes, 1992), and ultimately drains into the Fraser River at Lytton. Water quality data for the South Thompson River were acquired at a monitoring station at Kamloops; stream flow data were acquired at a monitoring station near Chase.

The South Thompson River is an extremely important habitat for many fish species, with the well-known Adams River salmon run each summer and fall, and native species such as rainbow trout and Rocky Mountain Whitefish year-round (Nordin & Holmes, 1992). Besides the use as a habitat for many aquatic species, the designated water uses of the South Thompson River include agricultural irrigation, livestock and wildlife watering, domestic water supply, industrial use, and a significant amount of outdoor recreation such as swimming, fishing, camping, and boating. Non-point discharges provide the largest human contribution to water quality contamination in the South Thompson River, with land use activities, particularly cattle operations and forest activities in Chase Creek, probably having the greatest influence (Nordin & Holmes, 1992; Holmes, pc 1997).

The flow of the South Thompson River (Figure 2) was measured at Environment Canada site BC08LE031 near Chase (latitude 50° 45' 54" N by longitude 119° 44' 25"), and is plotted in Figure 2. The provincial water quality sampling station is located downstream from this site, at Kamloops, just before the confluence with the North Thompson River (latitude 50° 40' 46" by longitude 121° 19' 24"). Water quality monitoring began in 1973 and has been about monthly, with some gaps during the 1980's. The data are stored on the province's Environmental Monitoring System (EMS) database under site number 0600135. This report assesses the data between 1973 and 1997. The water quality data are plotted in alphabetical order in Figures 3 to 38. Other water quality stations within the Thompson River watershed include: the North Thompson at North Kamloops (Brewer & Webber, 1997b), the Bonaparte River near mouth (Brewer & Webber, 1997a), the Nicola River at Spences Bridge, the Salmon River at Highway #1 (Lilley & Webber, 2001), and the Thompson River at Spences Bridge (Webber *et al*., 2000).

2. Quality Assurance

The water quality data were reviewed, and values that were known outliers or erroneous were removed. Certain peak values were plotted off-scale using an asterisk, the value, and the sample date to facilitate better viewing and interpretation of the other values around guidelines and minimum detectable limits (MDLs). There was a known quality assurance problem for zinc during 1993-96.

3. State of the Water Quality

The state of the water quality was assessed by comparing the values to the water quality objectives for the South Thompson River (Nordin & Holmes, 1992) and to B.C.'s Approved Guidelines and 1998 Compendium of Working Guidelines for water quality (Nagpal *et al.*, 1998), and by looking for any obvious trends in the data. Any levels or trends that were found to be deleterious or potentially deleterious to sensitive water uses, including drinking water, aquatic life and wildlife, recreation, irrigation, and livestock watering were noted in the following discussion. The following water quality indicators were not discussed as they easily met all water quality objectives or guidelines and showed no clearly visible trends: total barium, total inorganic carbon, total absorbance colour, specific conductivity, magnesium, total manganese, nitrogen (ammonia, Kjeldahl, nitrate, nitrate/nitrite, total, and total organic), potassium, dissolved silica, and dissolved silicon.

Flow (Figure 2) values showed consistent seasonal patterns, with the highest flows occurring during freshet in spring and early summer and the lowest flows occurring in late fall and winter. Flow monitoring should continue because of its importance in interpreting many water quality indicators.

Total alkalinity (Figure 3) and **calcium** (Figure 6) values showed that the river at this location was well buffered and had a low sensitivity to acid inputs at all times of the year.

Total aluminum (Figure 4) values showed fairly consistent peaks that exceeded the dissolved aluminum guidelines for aquatic life (0.05 - 0.1 mg/L) and for drinking water and recreation (0.2 mg/L), but remained well below the 5 mg/L total aluminum guideline for wildlife, livestock, and irrigation. However, total aluminum cannot be directly compared to the dissolved aluminum guidelines. The aluminum peaks were largely correlated with high flows and elevated non-filterable residue (Figure 33) during spring freshets. Therefore, most of the aluminum was likely in particulate form, and probably not biologically available. The dissolved aluminum fraction was suspected to be much lower. here appears to be a declining trend in peak total aluminum levels between 1993 and 1996, a trend partly explained by declining peak non-filterable residue values in 1994-96 (Figure 33). Both dissolved and total aluminum should be monitored in the future to allow for appropriate comparison to the guidelines.

Total organic carbon (Figure 8) values exceeded the 4 mg/L proposed guideline for drinking water between 1973 and 1975, but decreased to below the guideline since then, although the data are very sparse. Dissolved carbon should be measured in the future due to its role in the toxicity of metals and to evaluate the suitability of the water for drinking.

Dissolved chloride (Figure 9) values appear to have shown an increasing trend between 1991 and 1996. Levels have remained well below guidelines however, and are not of any current environmental concern, although a trend towards increasing concentration may signal some problem or contaminant in the environment, possibly road salt.

Total copper (Figure 12) measurements may have exceeded the 0.002 mg/L guideline for aquatic life, but the minimum detectable limits were too high to compare the total copper values to the guideline. The MDL will have to be lowered to at least one-tenth of the guideline to assess any environmental significance, and future monitoring should include total and dissolved copper to assess its biological availability.

Fecal coliforms (Figures 14 and 15) were measured by the multiple-tube fermentation method from 1975 to 1989 (Figure 14) and by the membrane filtration method from 1988 to 1997 (Figure 15). *E. coli*, a more specific indicator of fecal contamination from warm-blooded animals than fecal coliforms, was also measured during 1993-96 (Figure 13). The *E. coli* and fecal coliform levels were quite similar during 1993-96. Fecal coliforms and *E. coli* were not measured frequently enough (e.g., 5 or more times in 30 days) to permit rigorous comparison to the objectives and guidelines. However, the data suggest that:

· the objective for raw drinking water receiving disinfection only (90th percentile of 10/100 mL) was probably not met.

· the guideline for raw drinking water receiving partial treatment and disinfection (90th percentile of 100/100 mL) was probably met.

· the objective for recreation and irrigation (geometric mean of 200/100 mL) was met.

Continued and more frequent monitoring (e.g., 5 or more times in 30 days) of fecal coliforms and/or *E. coli* should be done to evaluate the attainment of the objectives more rigorously, but it appears that reduction of the sources of fecal contamination is needed to meet the objective.

Hardness (Figure 16) values showed that the water was soft and always below the optimum range for drinking water (80 - 100 mg/L), but still quite acceptable for drinking. Hardness should continue to be monitored due to its influence on metal toxicity.

About 25% of the **total iron** (Figure 17) values were above the 0.3 mg/L drinking water (aesthetics) and aquatic life guideline. However, since most of the iron peaks coincided with turbidity or non-filterable residue peaks, the high iron content in the water was probably due to the iron content of the suspended sediment. Therefore, much of the iron was probably not in a bio-available form. Both dissolved and total iron should be monitored in the future.

Total molybdenum (Figure 20) met the lowest guideline for irrigation (0.01 mg/L) with the exception of one value of 0.02 mg/L in 1988, which may have been a false positive value close to the 0.01 mg/L detection limit.

Dissolved oxygen (Figure 27) values met the instantaneous minimum for all aquatic life stages with the exception of one value in 1974, but the instantaneous minimum for buried embryo/alevin life stages was often not met in 1974-76. It is not known if there were buried embryos or alevins in this reach of the South Thompson River at these times. No data have been collected since 1982.

pH (Figure 28) values remained within the upper and lower guidelines for drinking water and aquatic life between 1975 and 1996. We recommend that pH continue to be monitored due to its effect on organism physiology and its influence on other variables.

Total dissolved and **total phosphorus** (Figures 29 and 30) did not show any obvious trends and there are no guidelines for phosphorus in rivers. There was a statistically significant linear decreasing trend in total phosphorus between 1987 and 1995 (Regnier & Ryan, 1997), but the higher levels in 1996-97 appear to have nullified this trend. Peak total phosphorus values were well correlated with peak non-filterable residue values, indicating that much of the phosphorus was in a particulate form. This is confirmed by the total dissolved phosphorus values (Figure 29), which were significantly lower than total phosphorus values. Phosphorus is generally accepted as the limiting nutrient for algal growth in the Thompson River system (Nordin & Holmes, 1992), and, therefore it remains an important environmental indicator. Total and total dissolved phosphorus should continue to be monitored.

Filterable residue (FR) (i.e., dissolved solids) (Figure 32) levels were well below the upper limit for drinking water (aesthetics) and the irrigation guideline (500 mg/L), and did not show any obvious trend. **Specific conductivity** (Figure 11) is a more precise and cheaper variable to monitor and has a reasonably constant relationship to filterable residue. We recommend that conductivity be used as a surrogate for FR in future monitoring.

Non-filterable residue (NFR) (i.e., suspended solids or sediment) levels and **Turbidity** levels are shown in Figures 33 and 37, respectively. NFR levels were usually below the general fisheries guideline of 25 mg/L (Newcombe, 1986) during the non-freshet periods, but often exceeded it during the spring freshet between 1991 and 1998. The 50 NTU turbidity guideline for recreation was never exceeded, but the 1 NTU guideline for disinfected drinking water (health) was often exceeded and the 5 NTU guideline for disinfected drinking water (aesthetics) was occasionally exceeded. As the turbidity levels appear to be the result of human activities, such as forestry on Chase Creek and agriculture on other tributaries (Holmes, pc 1997), remediation in decreasing the sources and levels of non-filterable residues and turbidity is recommended. Because of the increasing trend in suspended solids during the 1987-98 period, mainly due to non-point sources of pollution such as agriculture, forestry and residential development, NFR and turbidity should continue to be monitored. Major erosion in tributary streams is another main cause of this increasing trend.

Water temperature (Figure 36) values usually remained below the 15 ^{0}C drinking water guideline (aesthetics) throughout the sampling period between 1974 and 1977, except during the summers. During the summers, the water temperature usually met or exceeded the lower limit for recreation (also 15 ^{0}C), indicating that the water was warm enough for swimming. Water temperature should again be monitored due to the impact it has on recreational activities, on drinking water aesthetics, on fisheries, on organism physiology, and on other water quality variables. Air temperature values should also be recorded.

Total zinc (Figure 38) values regularly exceeded the chronic effects guideline at 0.0075 mg/L and also the acute effects guideline at 0.033 mg/L during 1993-96. Many of these values were the product of suspected contamination due to preservative vial cap liner failures between 1993 and 1996. Unusually high zinc was found at three unrelated sites (S. Thompson, N. Thompson and Bonaparte rivers) during this time period, leading to the conclusion that it must have been due to artificial contamination (Brewer & Webber, 1997a and 1997b). Total and dissolved zinc should be measured in the future and the detection limit should be at least one tenth of the average guideline. It should be noted that current zinc guidelines are based on 30-day average results but there is insufficient reliable data here to meet the sample frequency criterion for both aquatic life guidelines.

Conclusions - State of Water Quality

· There was an increasing trend in suspended solids observed through visual appraisal of the data during 198-1997. Turbidity and non-filterable residue levels were elevated during freshet when higher flows resulted in increased runoff and erosion. Remediation of turbidity sources and levels is needed.
· The water was well buffered against acid inputs throughout the year, but yet quite soft for drinking water.
· The water was cool or cold enough throughout most of the year to be aesthetically pleasing for drinking, and usually warm enough during the summer months to permit water-contact recreation such as swimming.
· Fecal coliforms probably did not meet the water quality objective for the South Thompson River designed to protect raw drinking water for use after only disinfection, and the remediation of the sources of fecal contamination is probably needed.
· During freshet, elevated levels of aluminum and iron occurred. These levels may not have been of concern however, since they were due to the increased suspended sediment in the water, and thus were probably mostly biologically unavailable.
· During freshet, elevated levels of phosphorus occurred, but the phosphorus was largely in particulate form, and not readily available for algal growth.

4. Recommendations for Water Quality Management

4.1 Remediation

· Reduce sources and levels of fecal coliforms, non-filterable residue, and turbidity in the watershed.

4.2 Monitoring

We recommend that monitoring be continued at this station as the South Thompson River is important both as a water resource and as an aquatic habitat. Key variables to monitor in the future are:
· flow, hardness, pH, non-filterable residue, turbidity, air and water temperature, dissolved organic carbon, specific conductivity;
· total and dissolved aluminum, copper, iron and zinc, fecal coliforms and *E. coli*, total dissolved nitrogen, and total and total dissolved phosphorus. Minimum detectable limits should be at least 10 times below water quality guidelines for all variables; and
· adsorbable organo-halides (AOX) to document background levels upstream from the pulp mill at Kamloops.

Figure 2 Flow

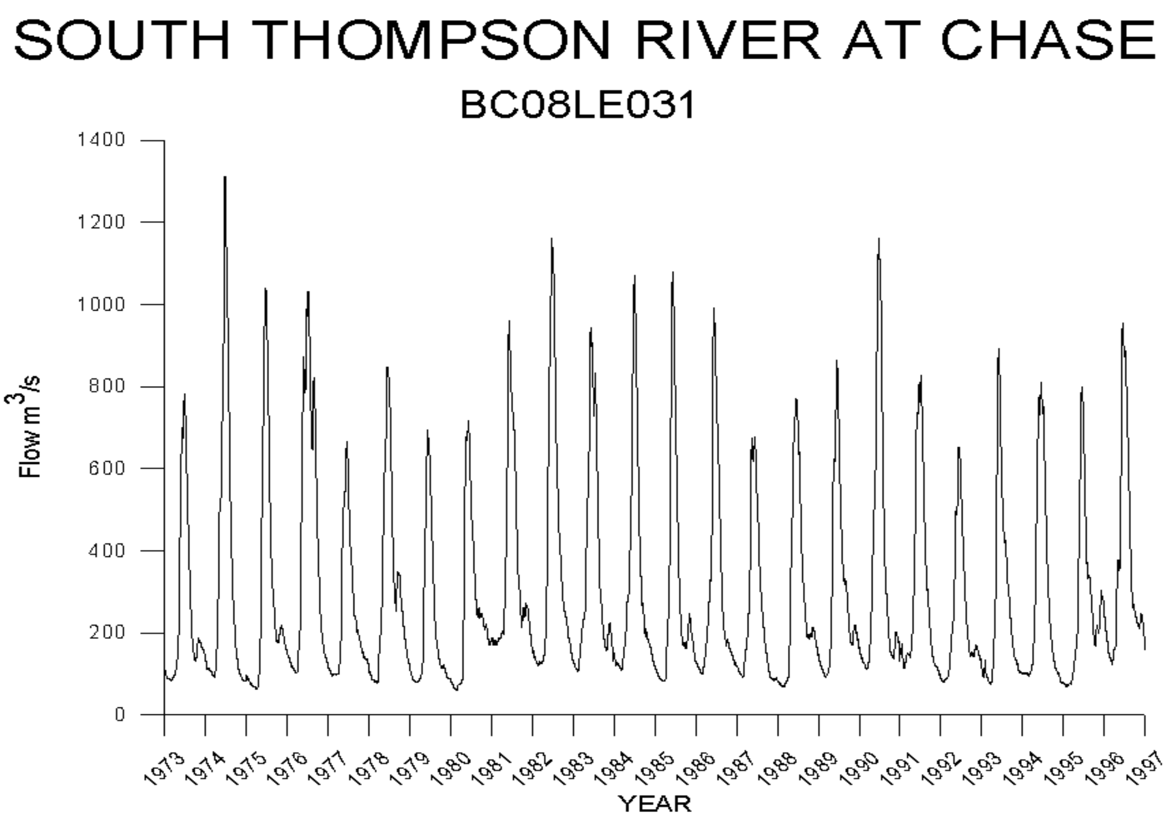


Figure 3 Total Alkalinity

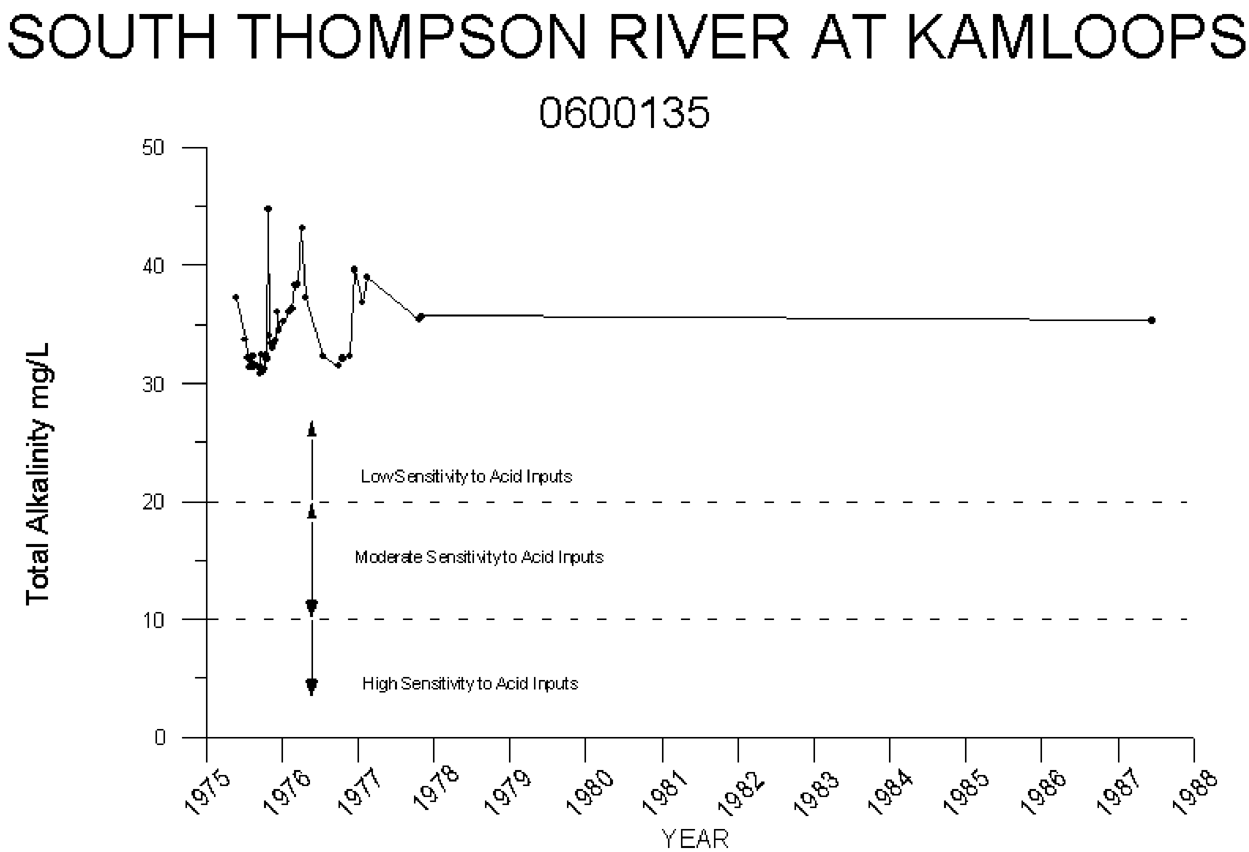


Figure 4 Total Aluminum

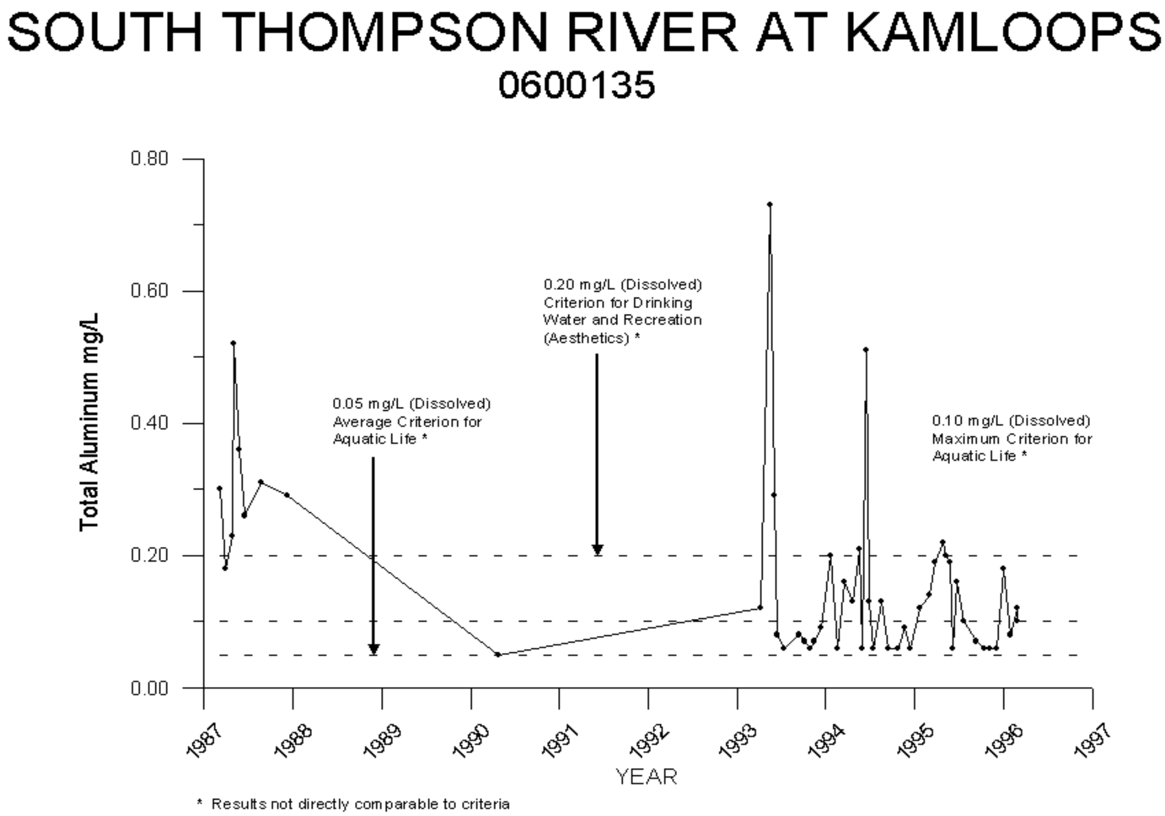


Figure 5 Total Barium

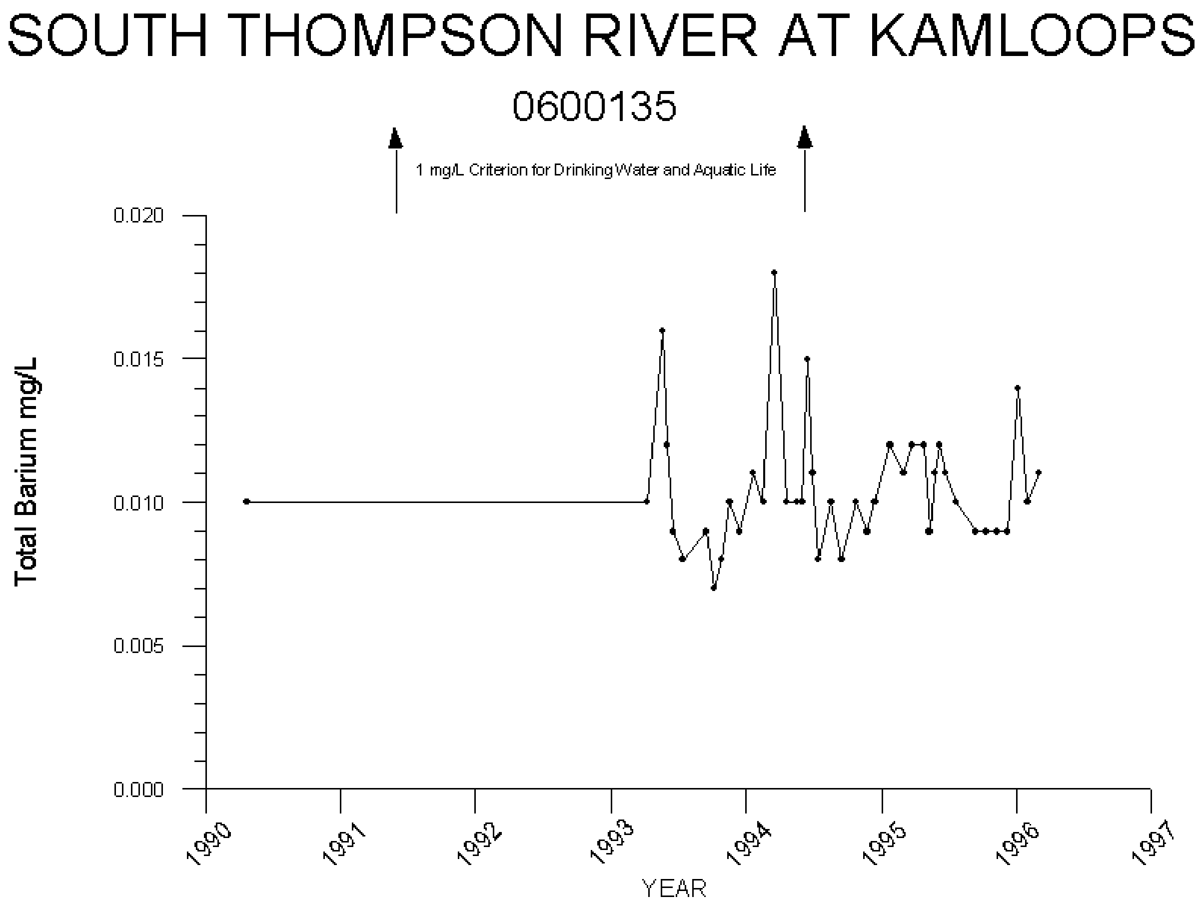


Figure 6 Calcium

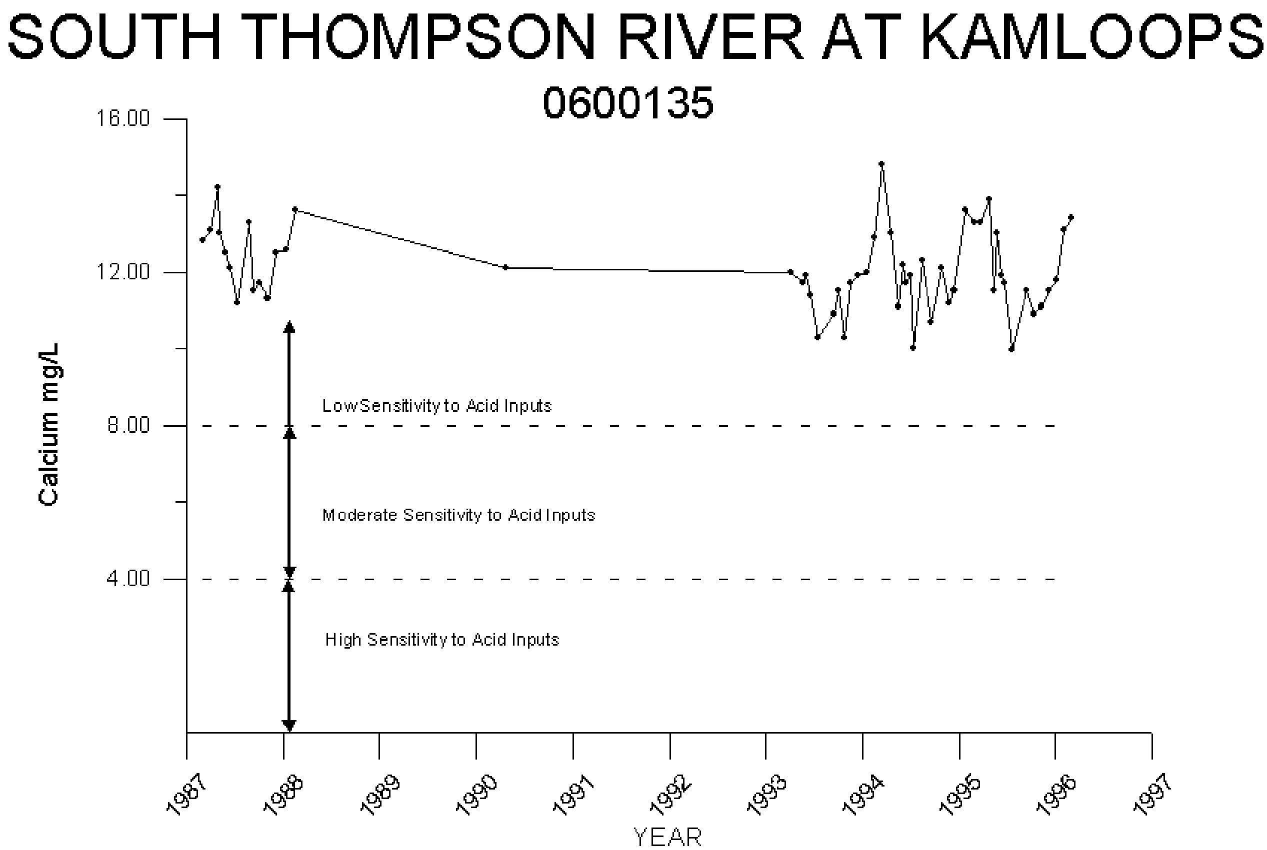


Figure 7 Total Inorganic Carbon

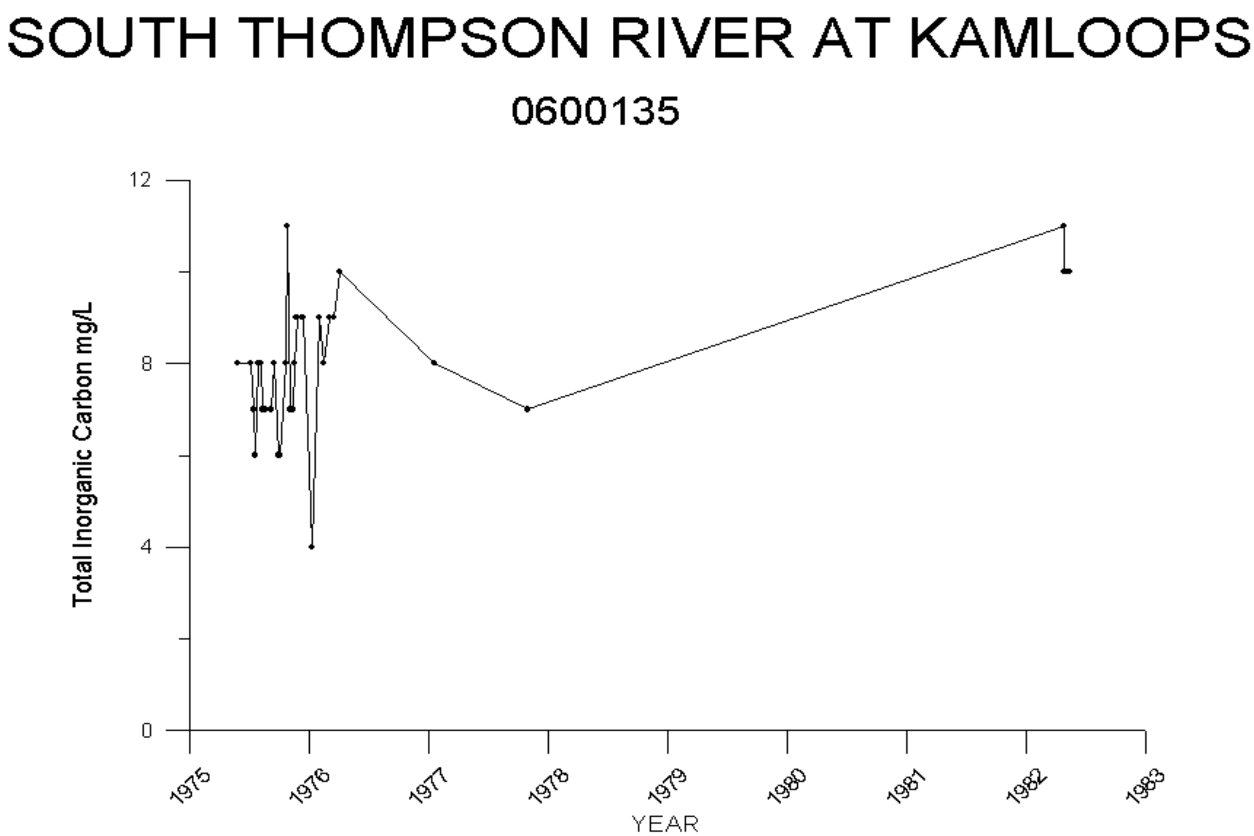


Figure 8 Total Organic Carbon

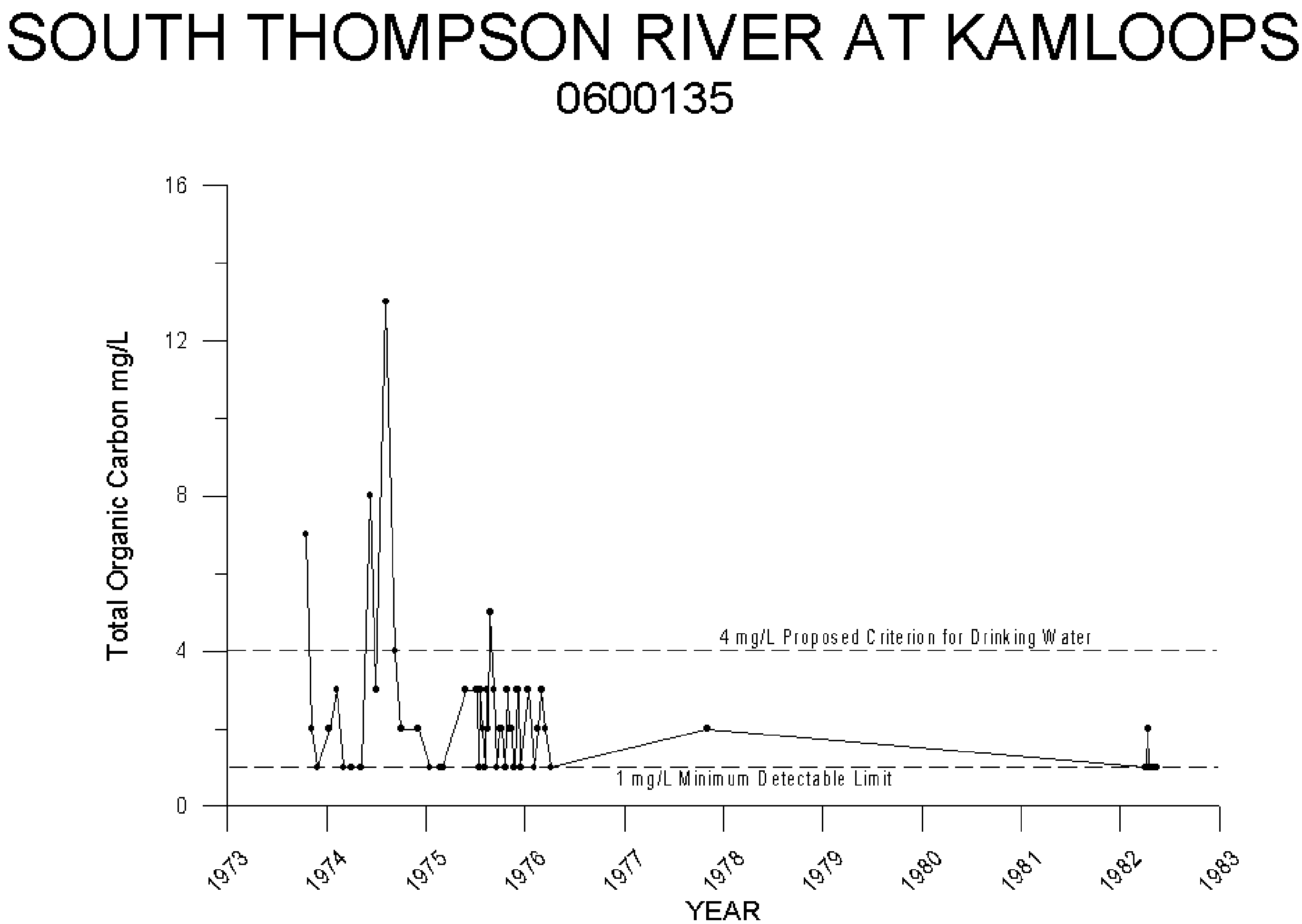


Figure 9 Dissolved Chloride

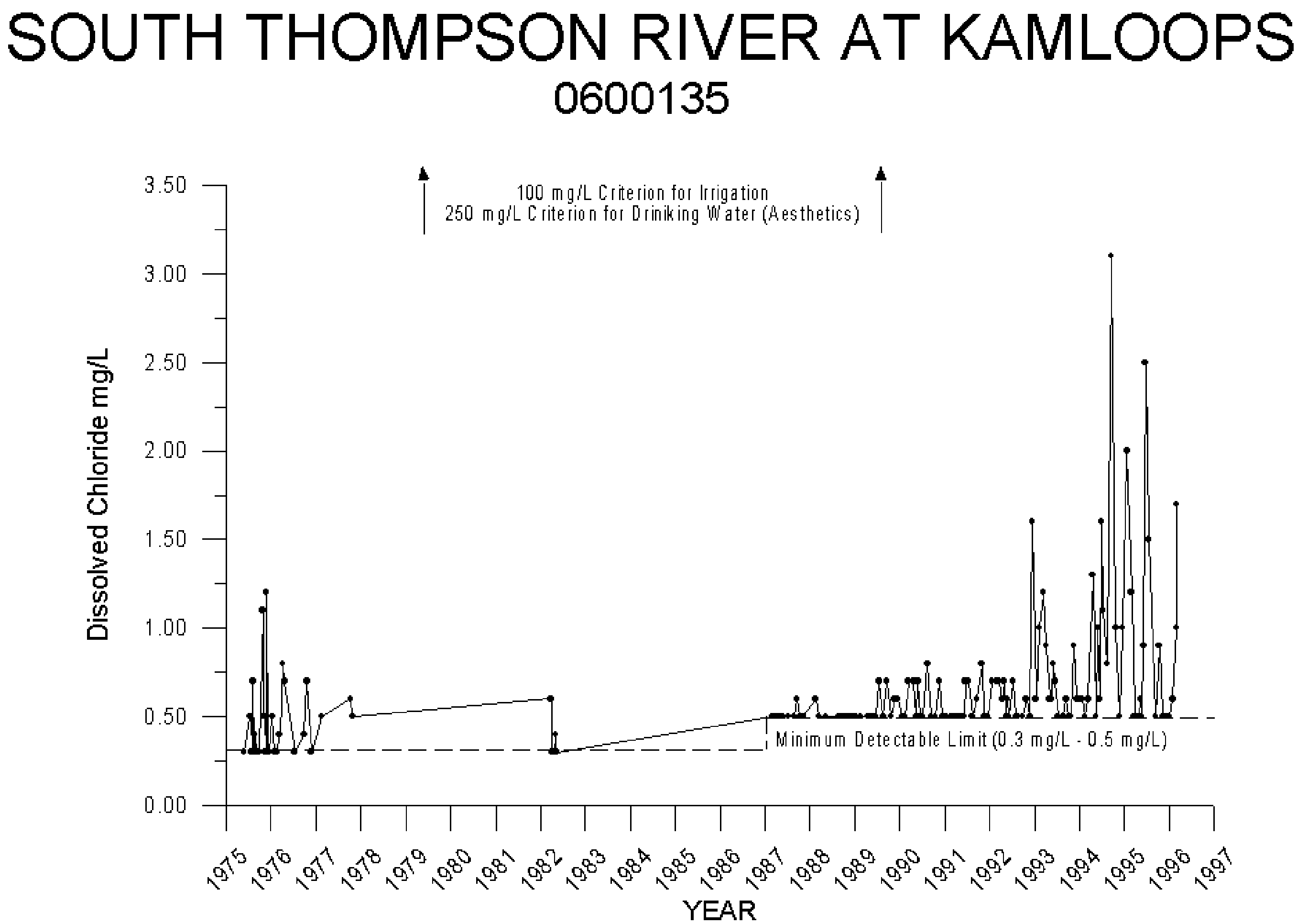


Figure 10 Total Absorbance Colour

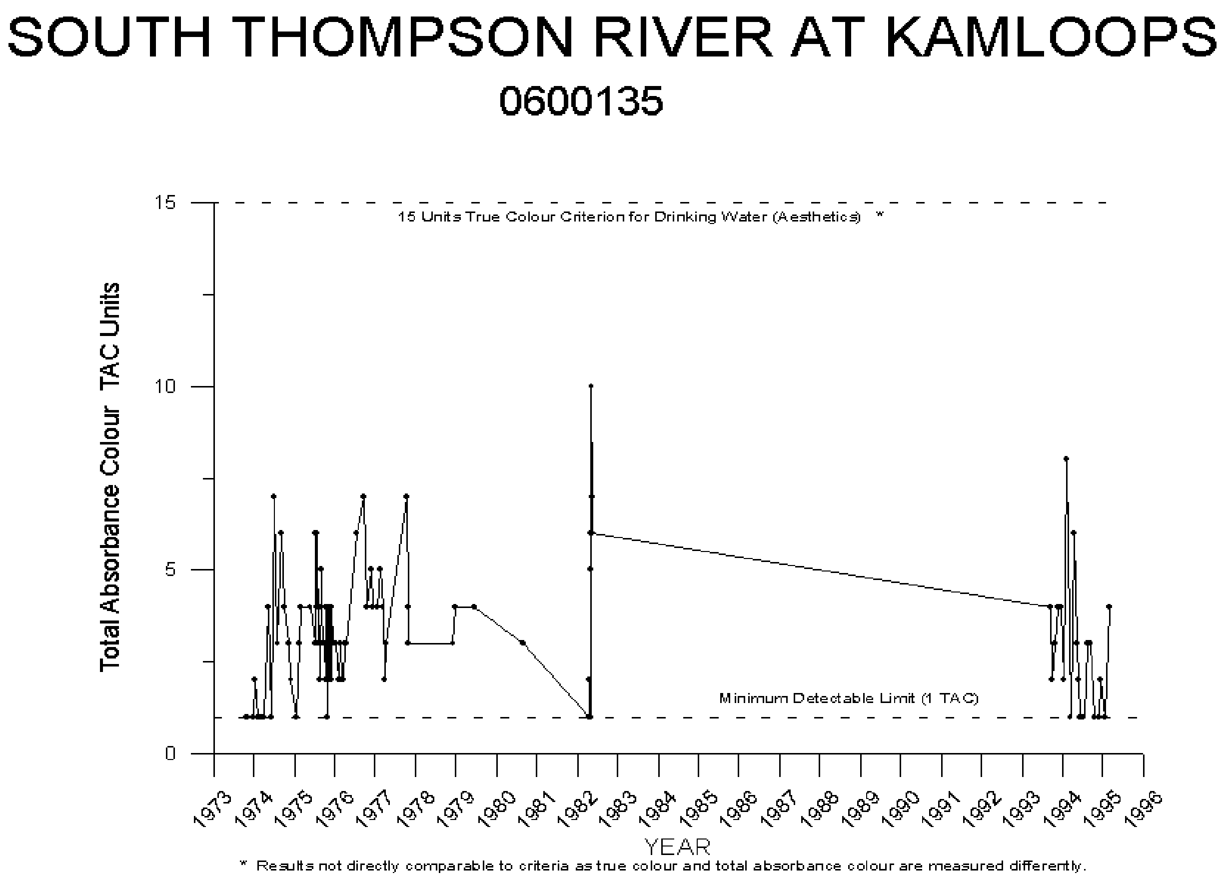


Figure 11 Specific Conductivity

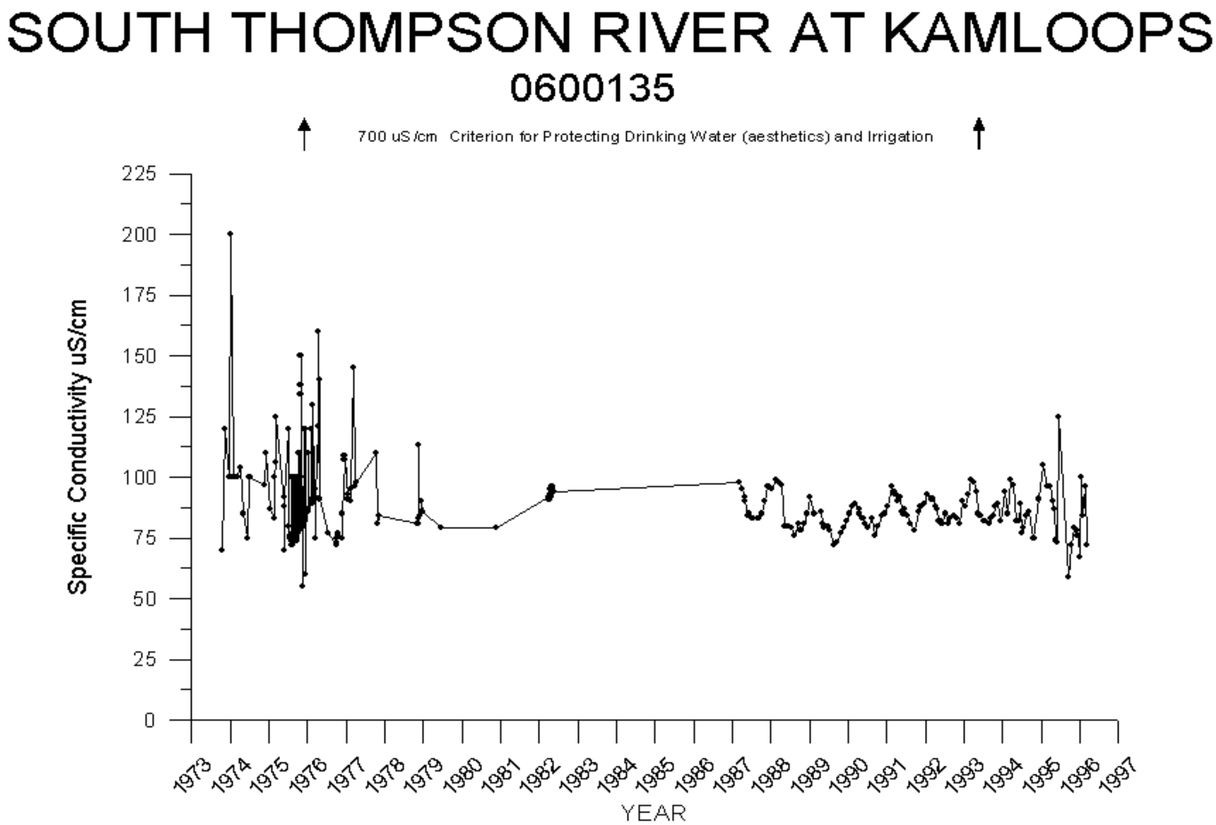


Figure 12 Total Copper

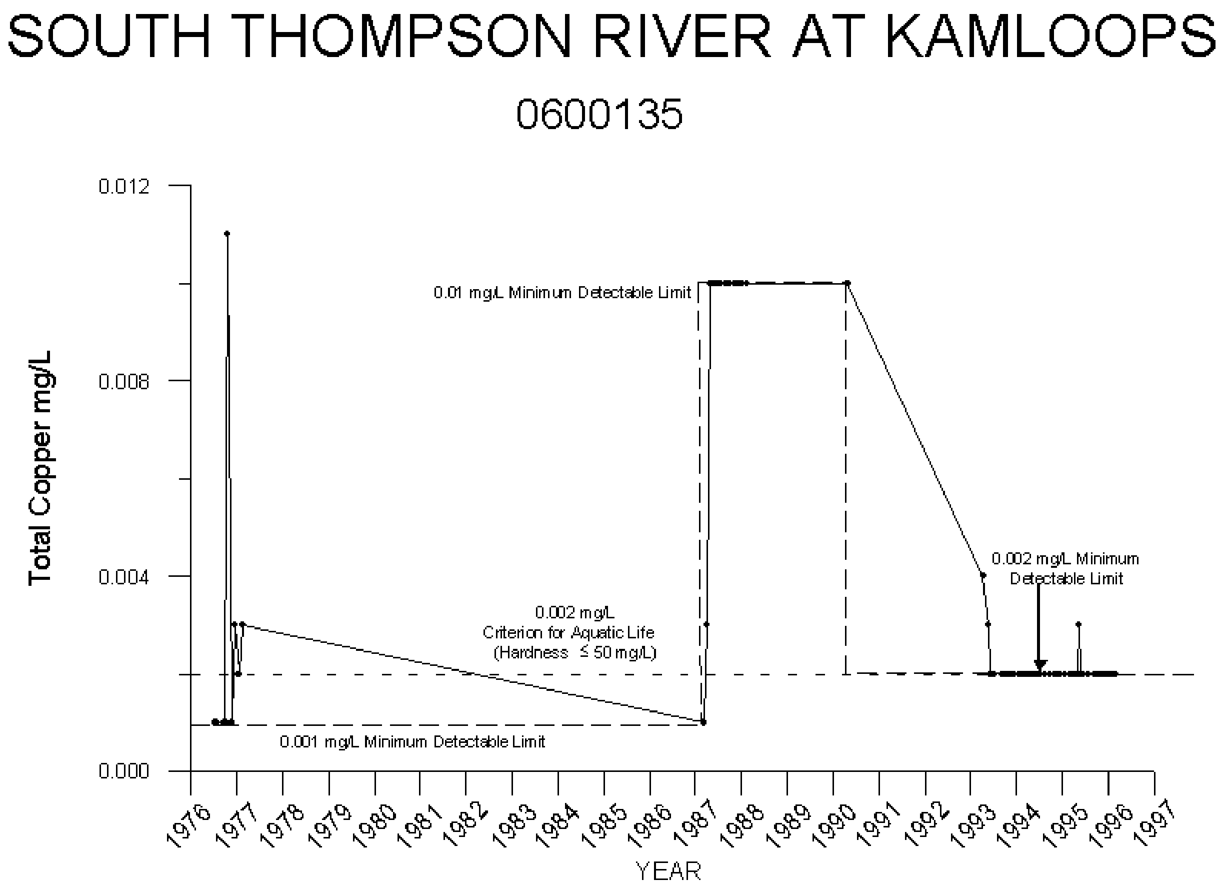


Figure 13 *E. coli*

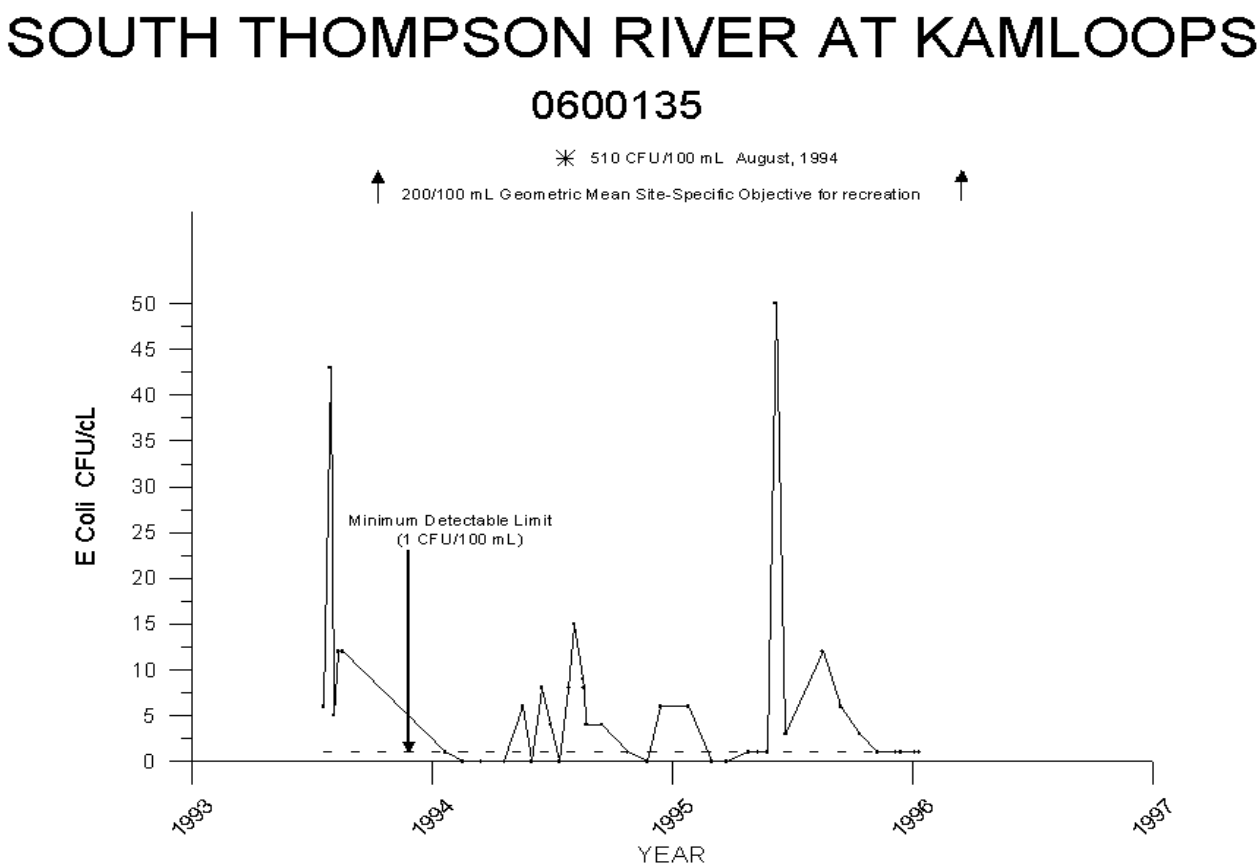


Figure 14 Fecal Coliforms (MPN/100 mL)

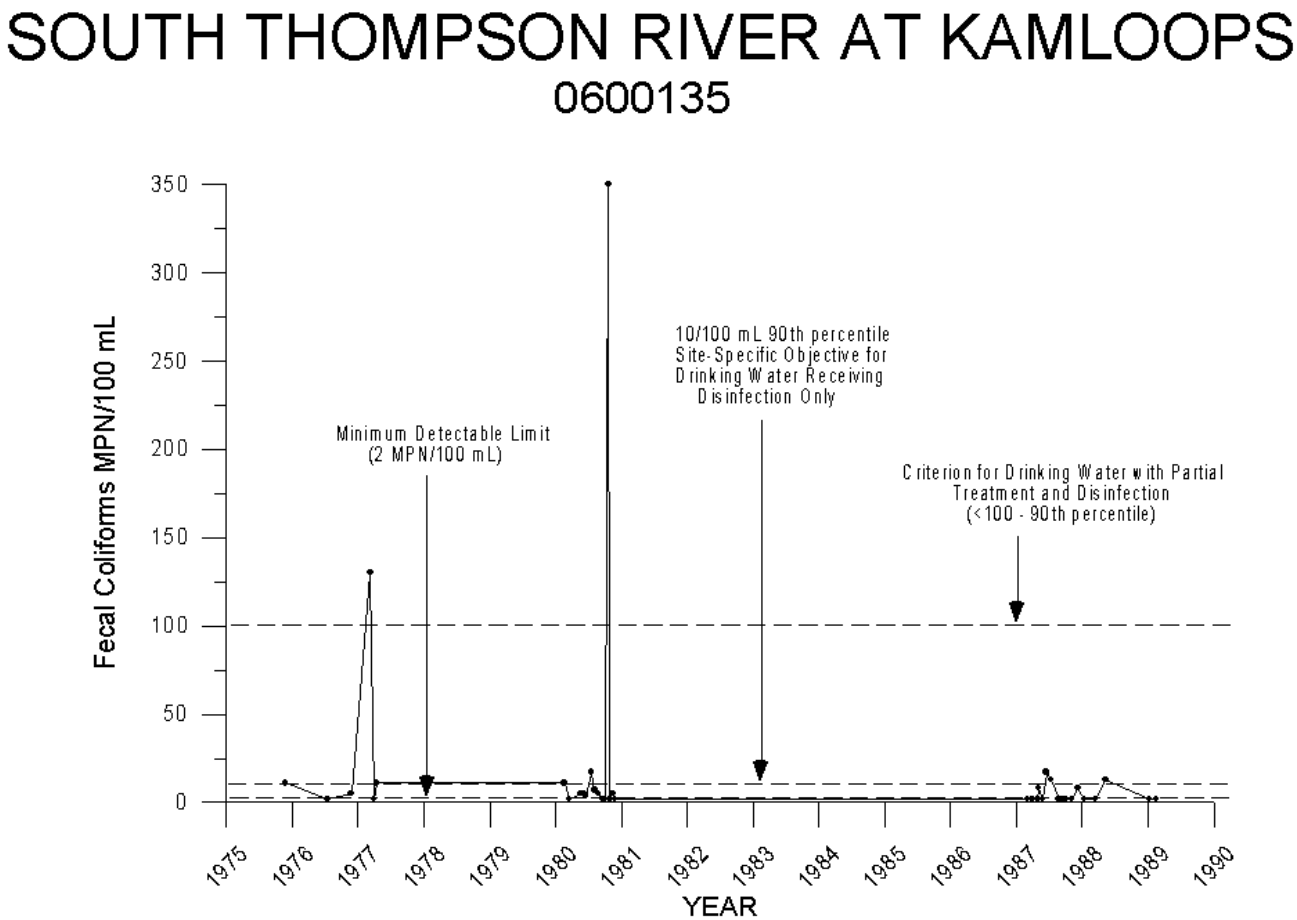


Figure 15 Fecal Coliforms (CFU/100 mL)

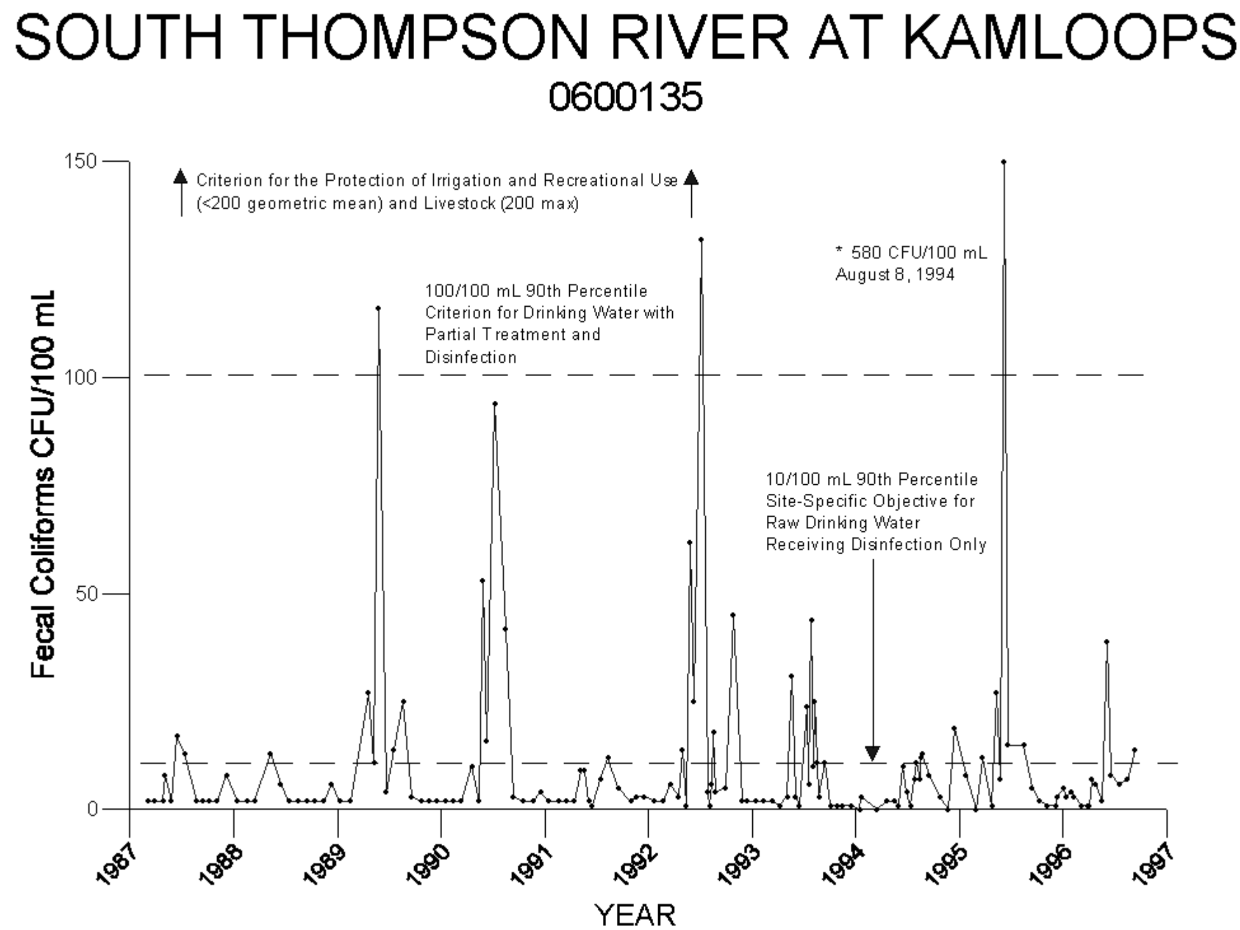


Figure 16 Hardness

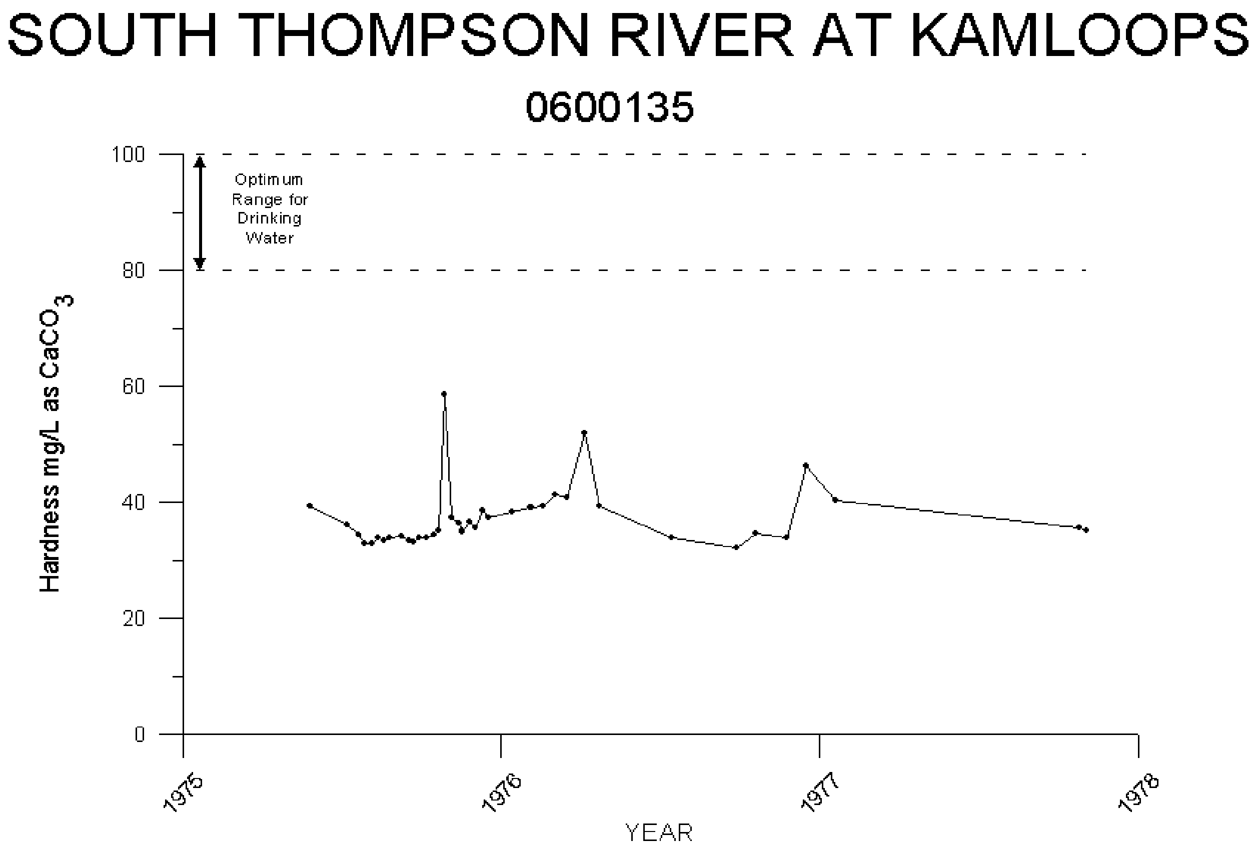


Figure 17 Total Iron

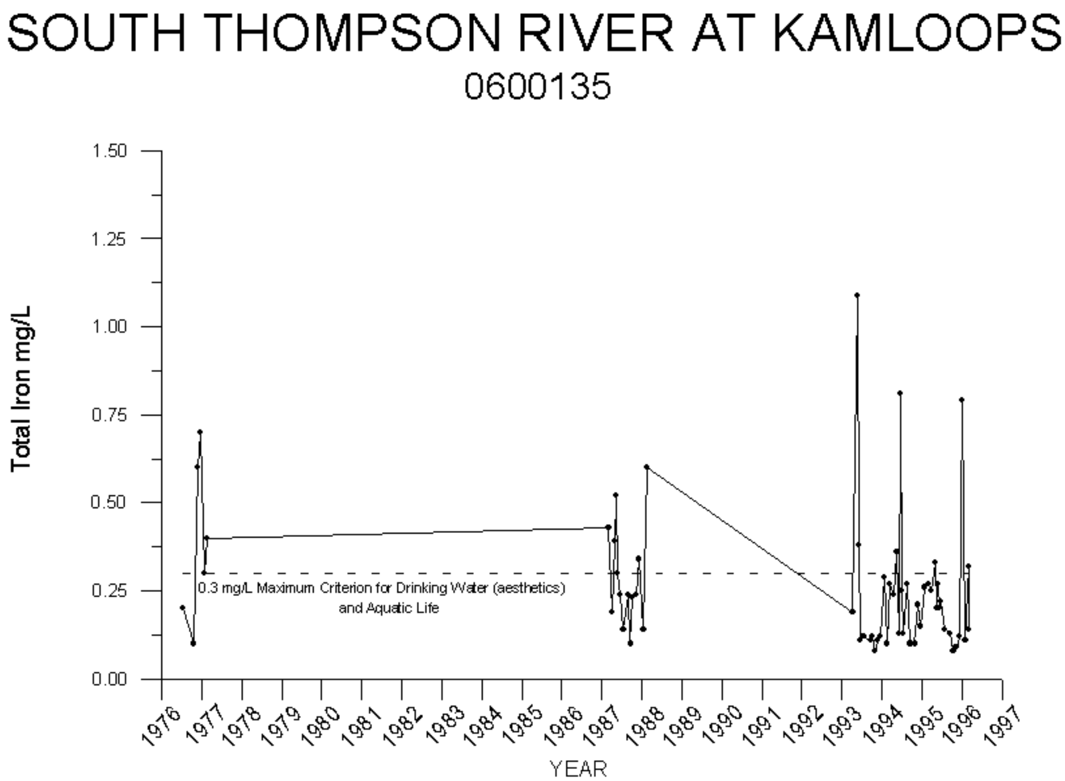


Figure 18 Magnesium

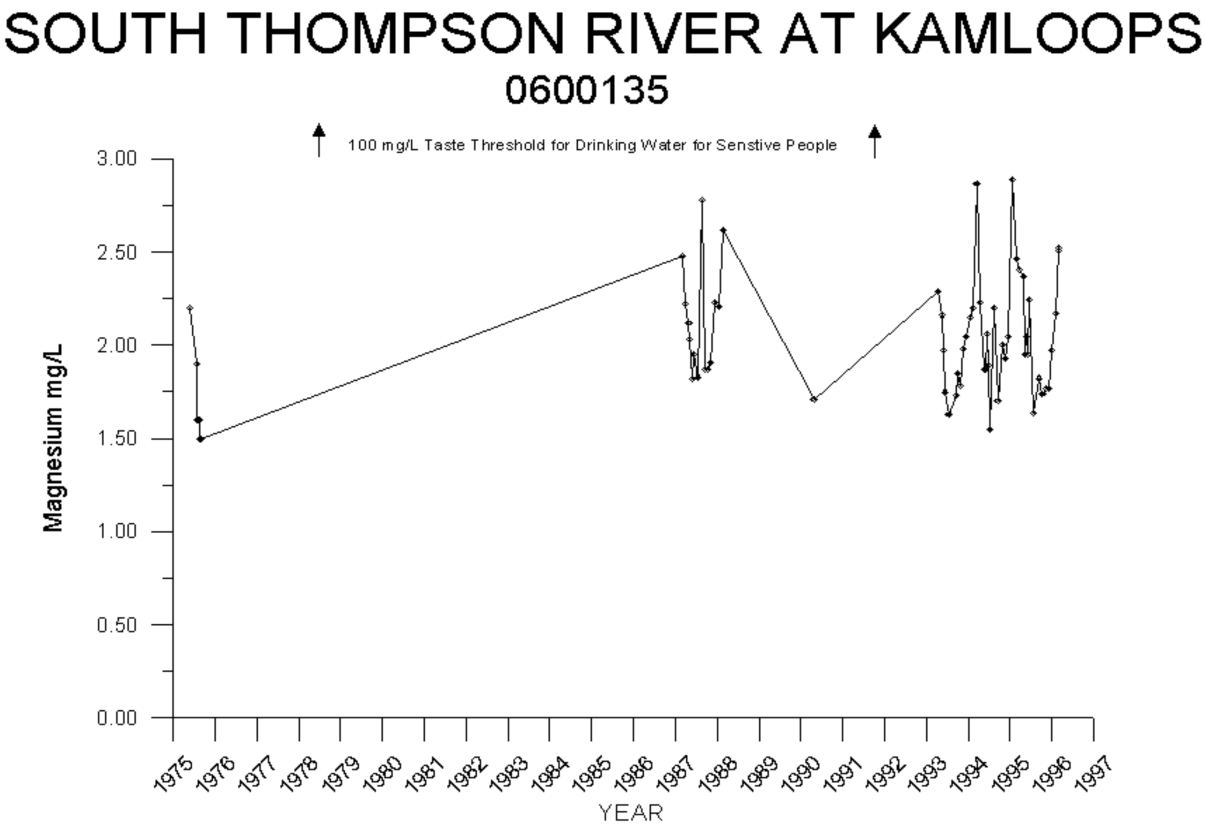


Figure 19 Total Manganese

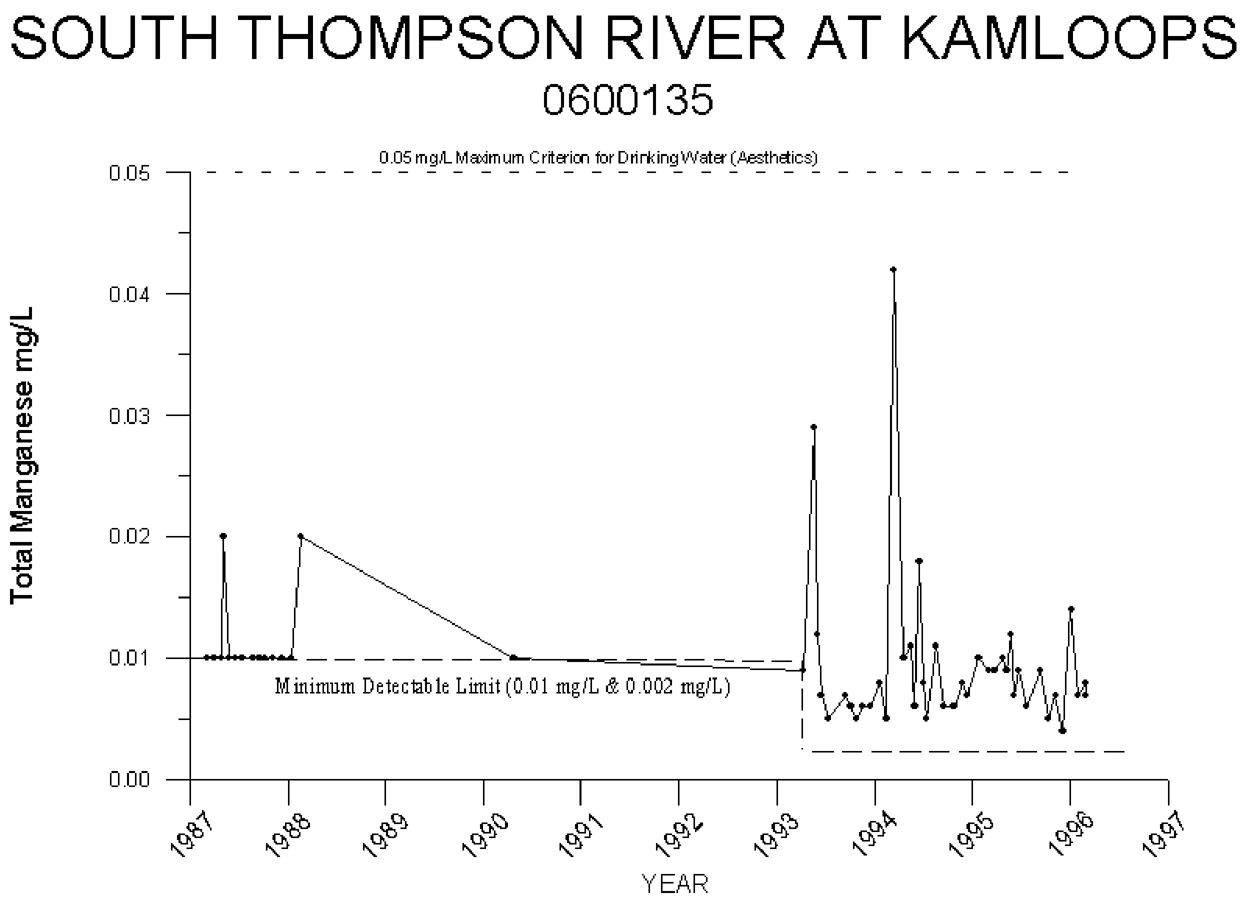


Figure 20 Total Molybdenum

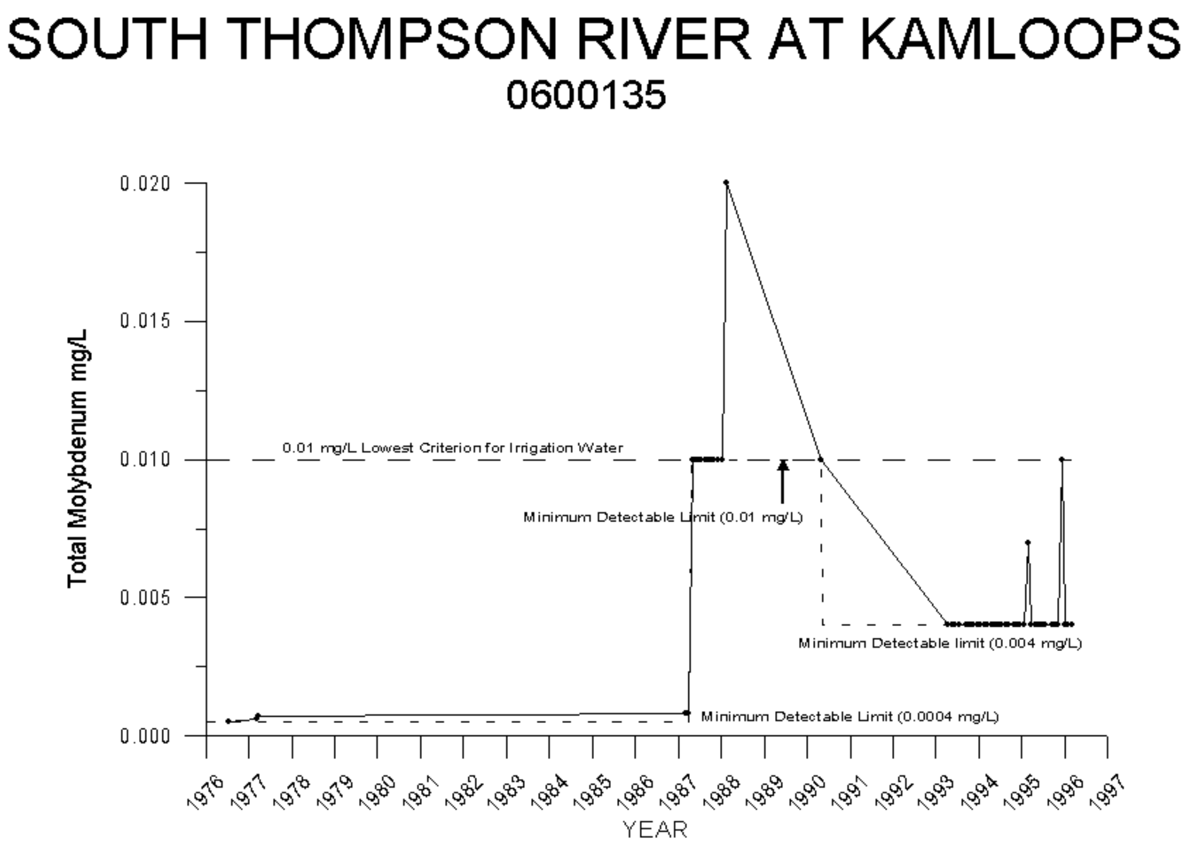


Figure 21 Nitrogen - Ammonia

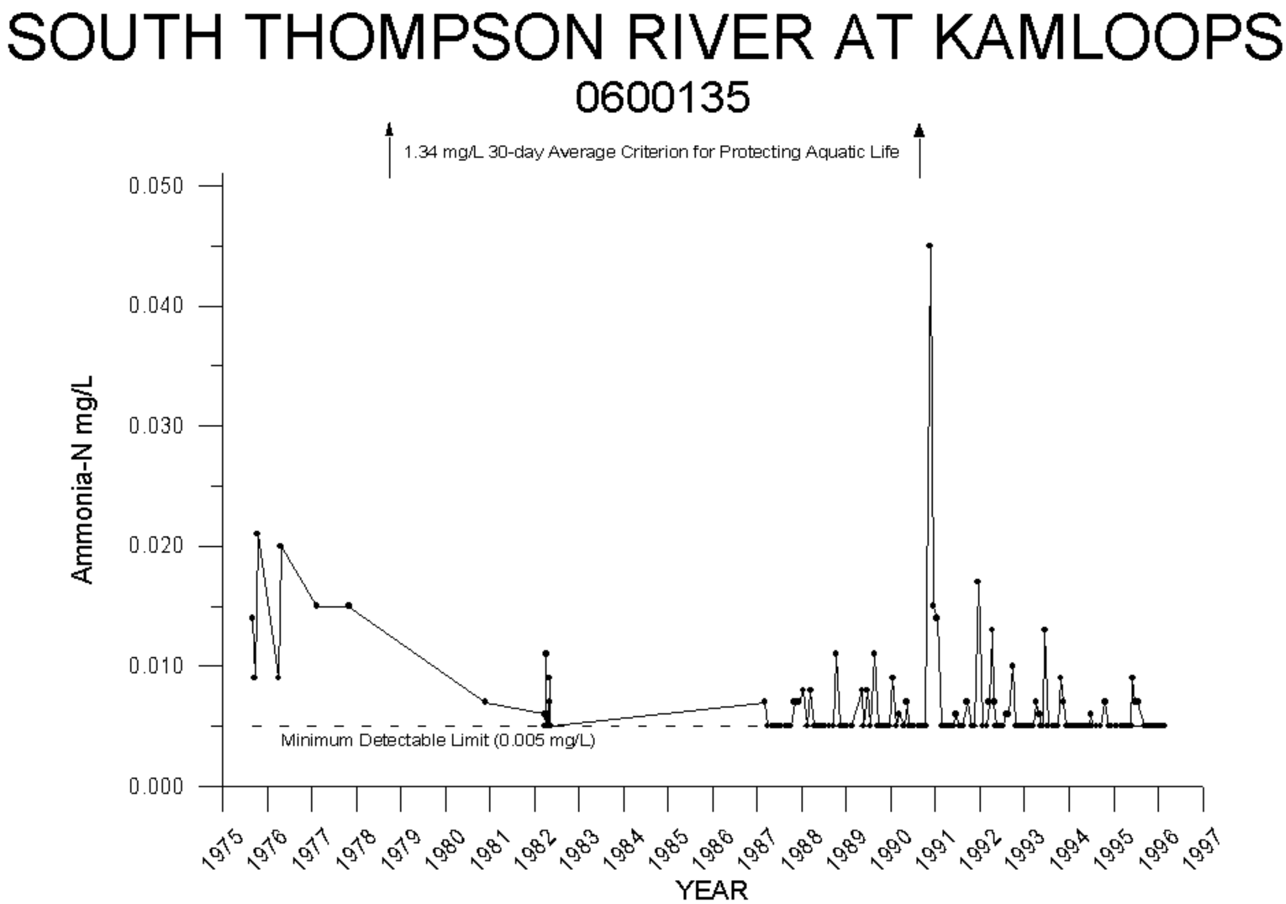


Figure 22 Nitrogen - Kjeldahl

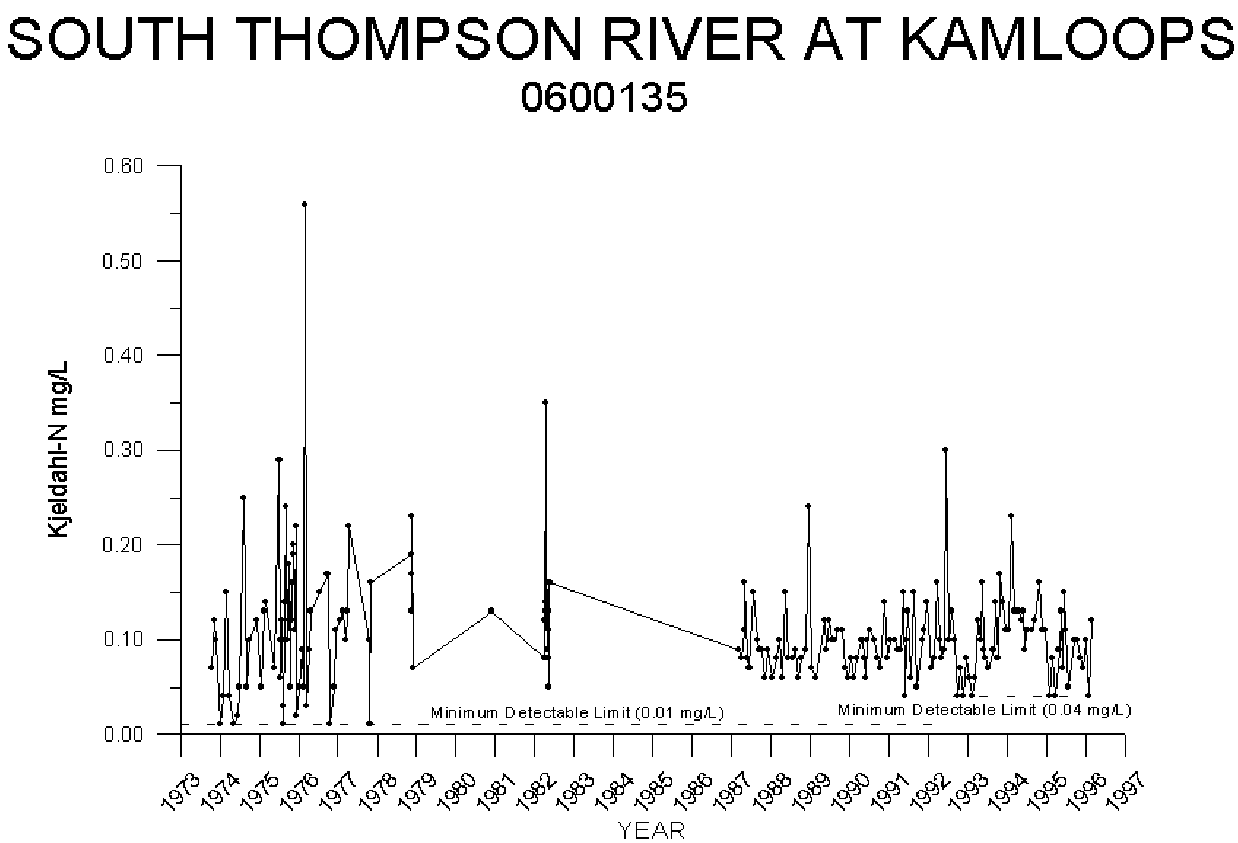


Figure 23 Nitrogen - Nitrate

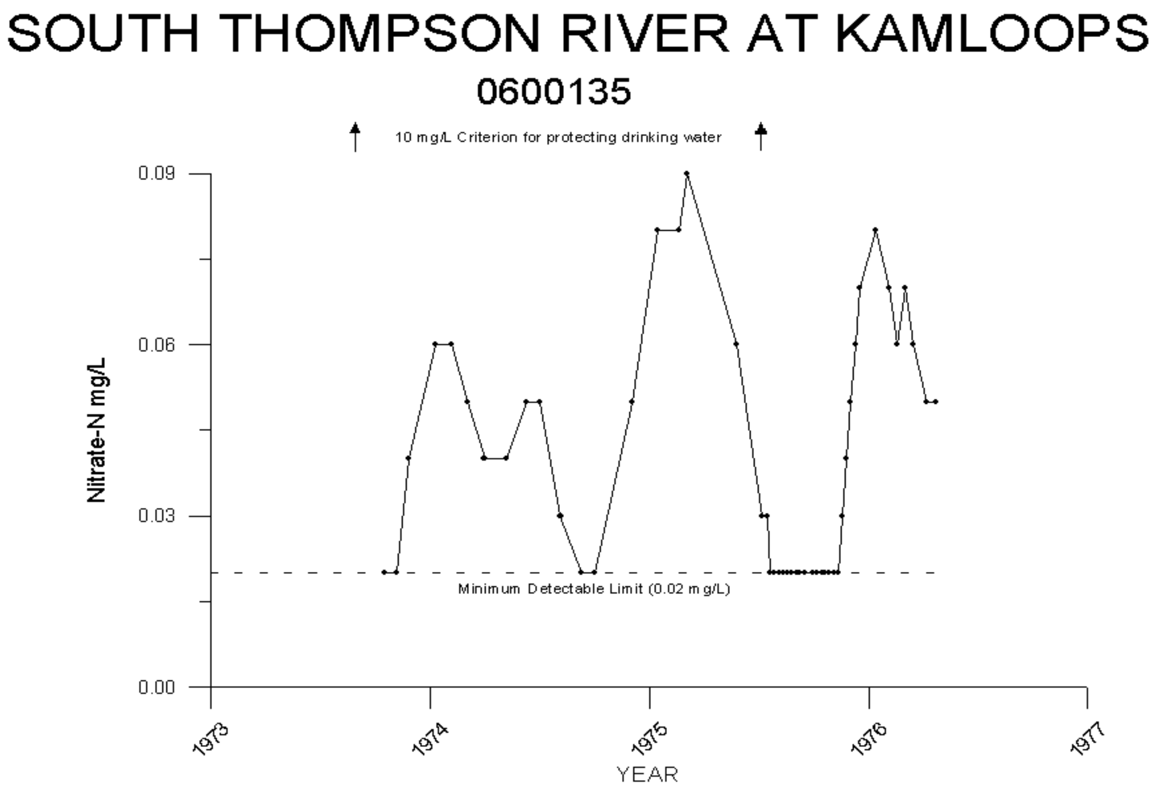


Figure 24 Nitrogen - Nitrate/Nitrite

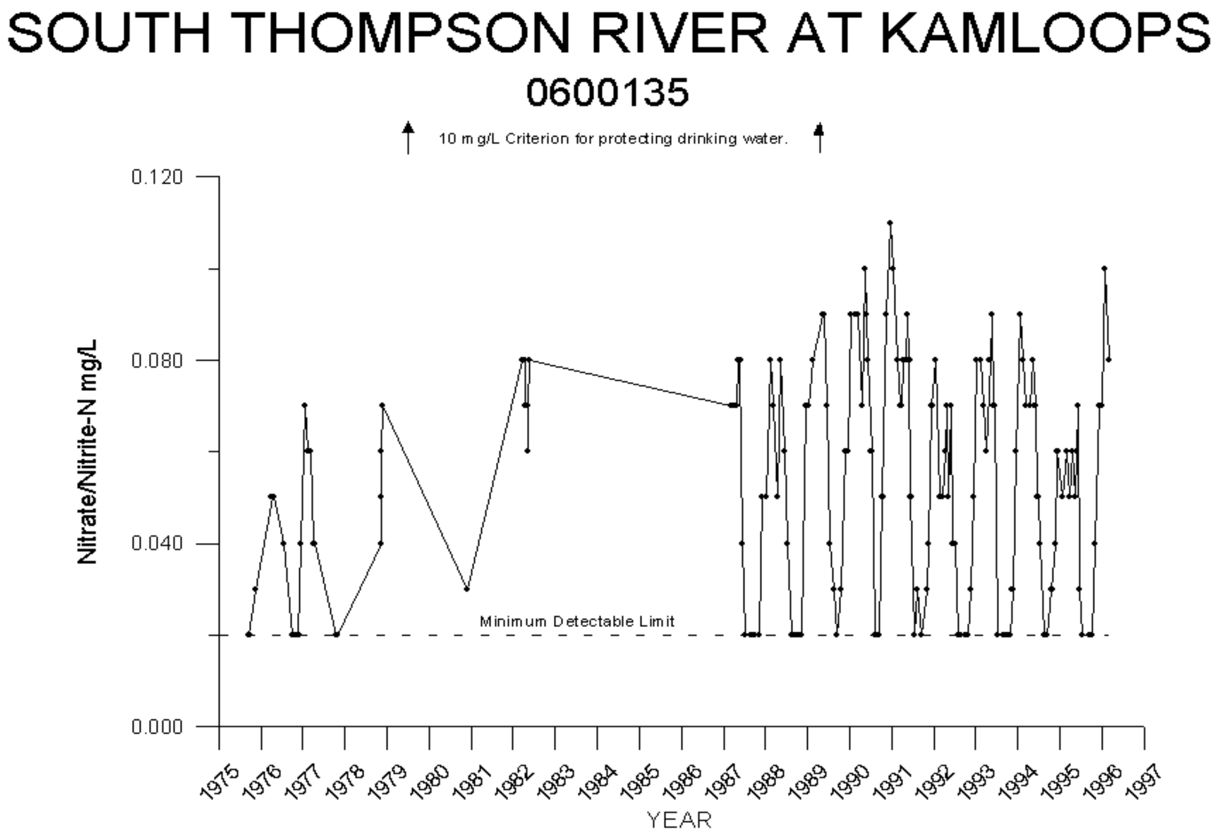


Figure 25 Total Nitrogen

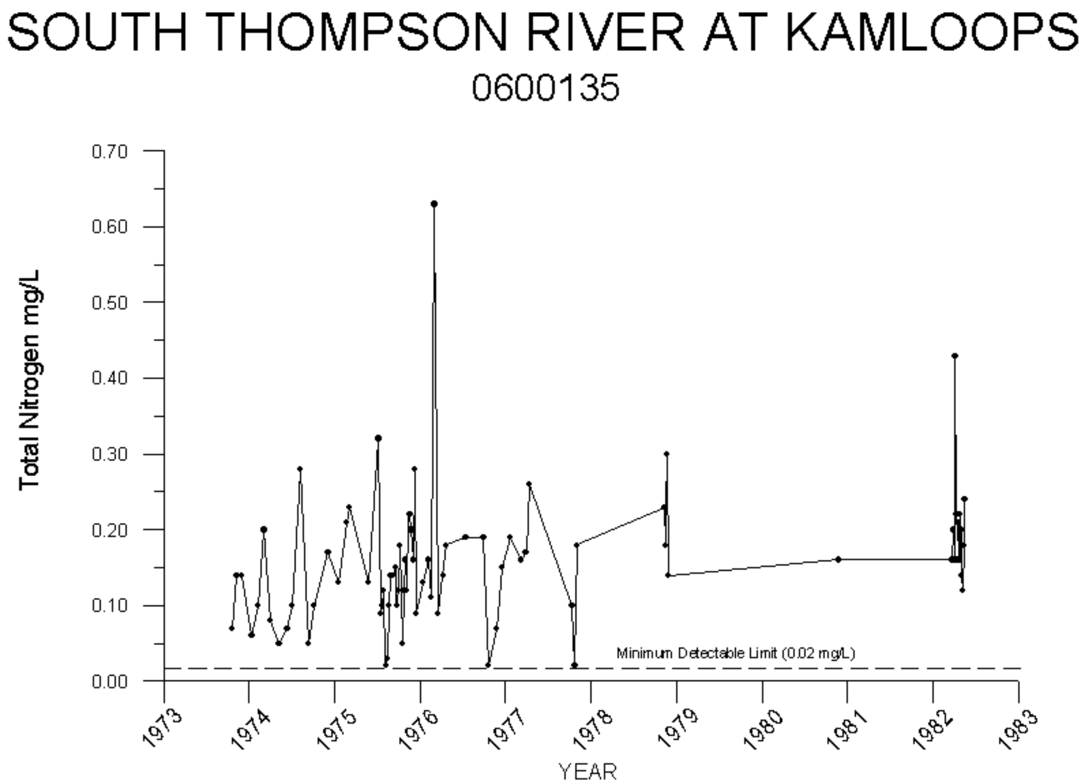


Figure 26 Nitrogen - Total Organic

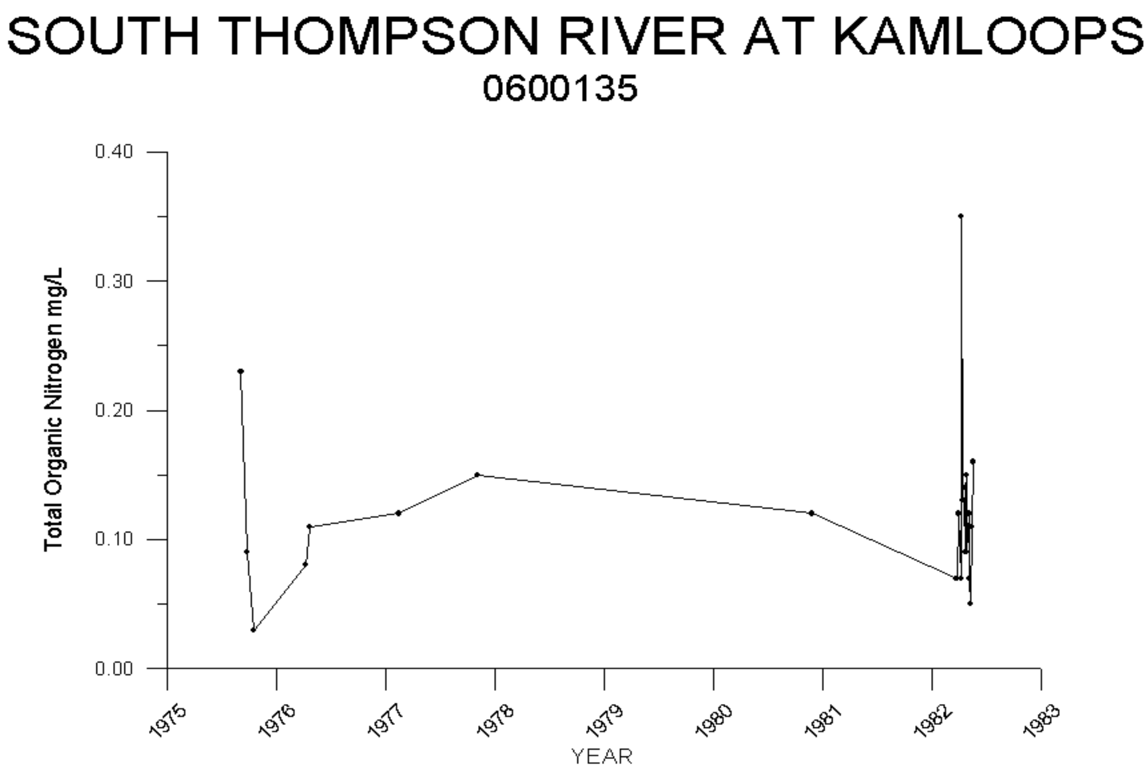


Figure 27 Dissolved Oxygen

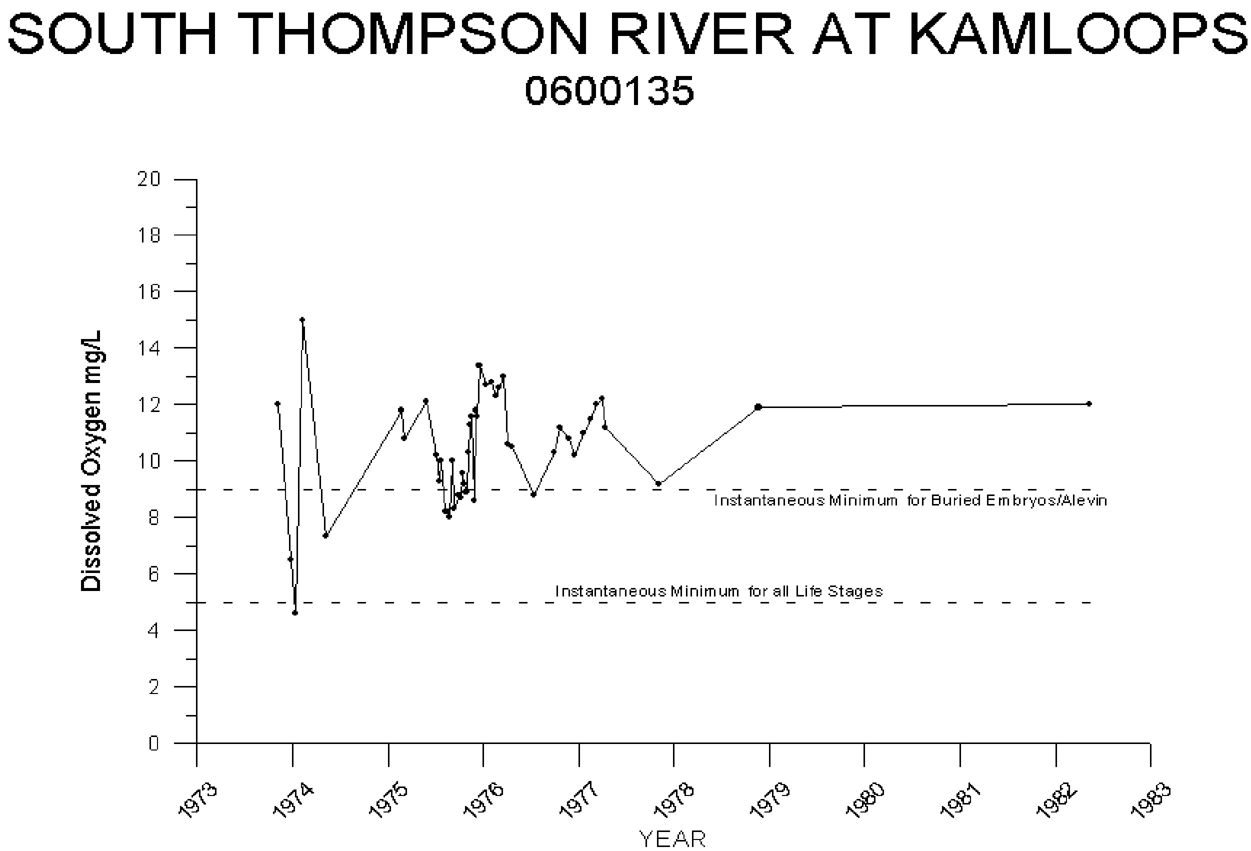
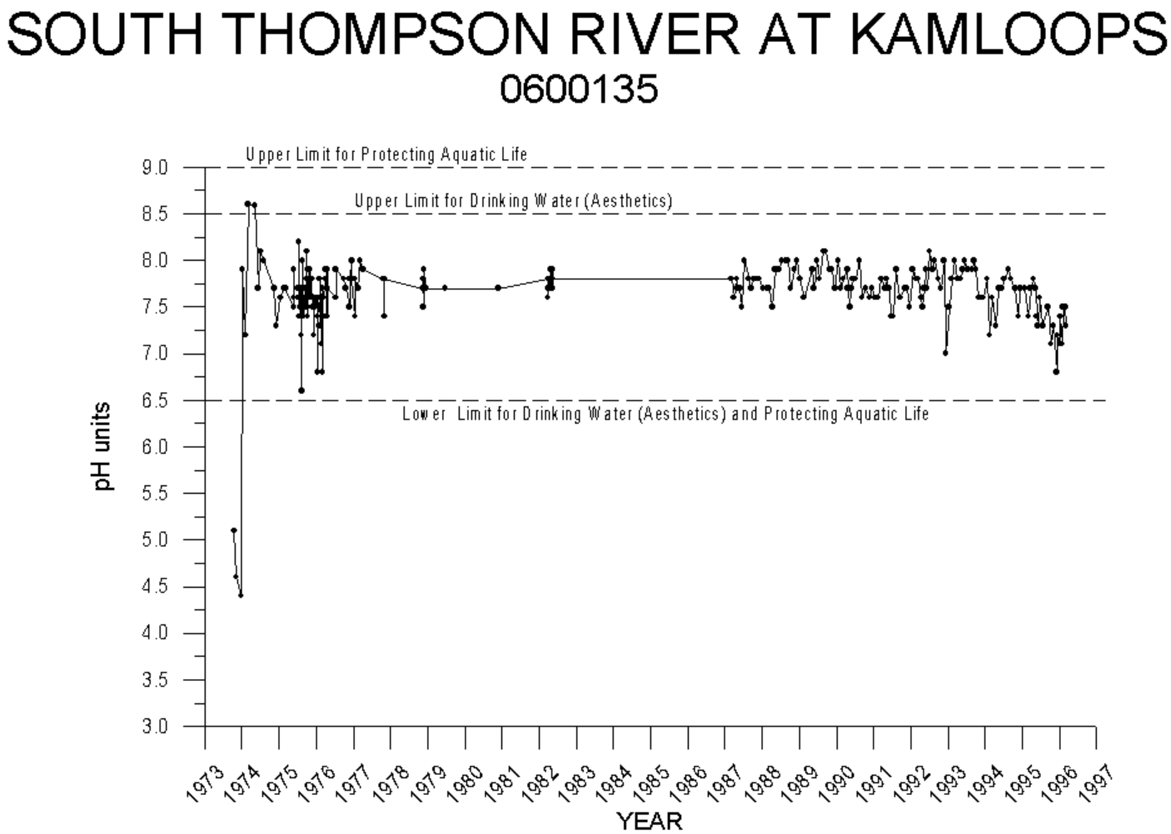


Figure 28 pH



SOUTH THOMPSON RIVER AT KAMLOOPS
0600135
Upper Limit for Protecting Aquatic Life
Upper Limit for Drinking Water (Aesthetics)
Lower Limit for Drinking Water (Aesthetics) and Protecting Aquatic Life
pH units
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
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1997
YEAR

Figure 29 Total Dissolved Phosphorus

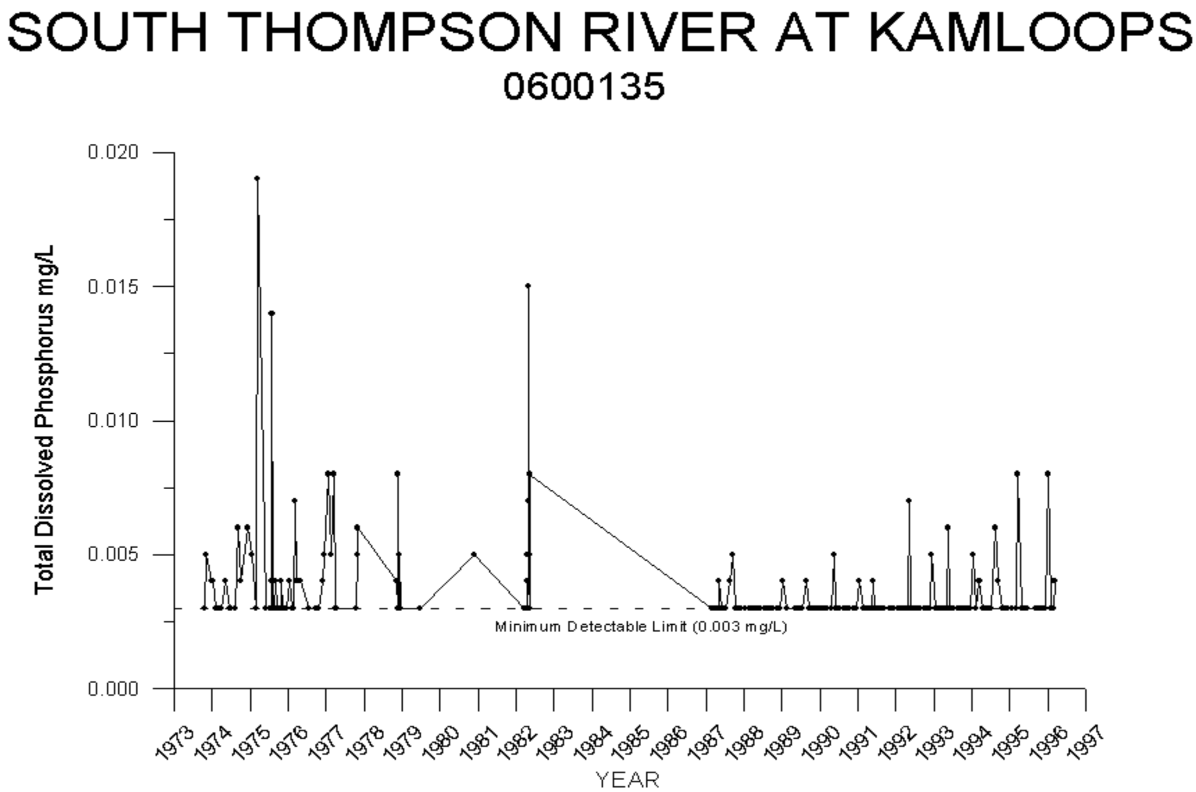


Figure 30 Total Phosphorus

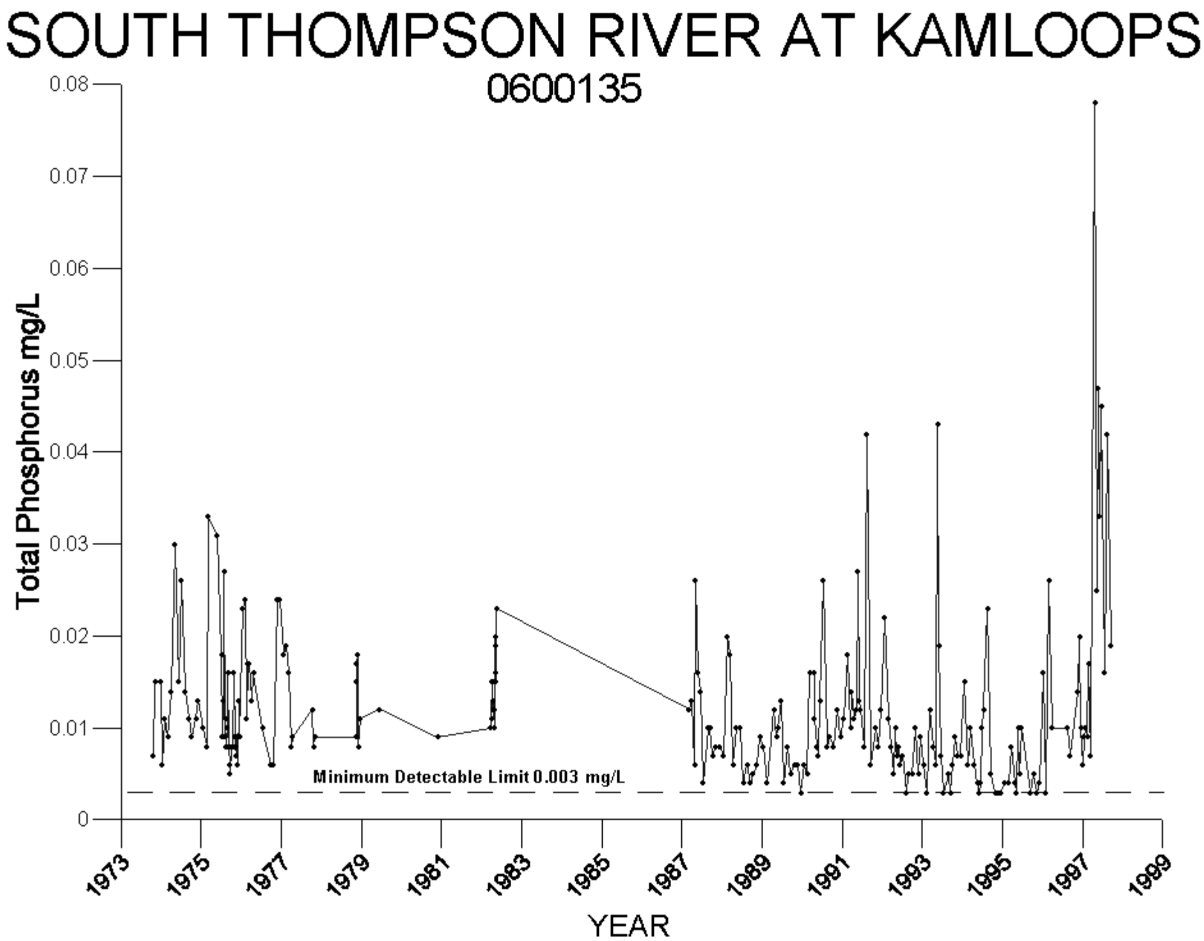


Figure 31 Potassium

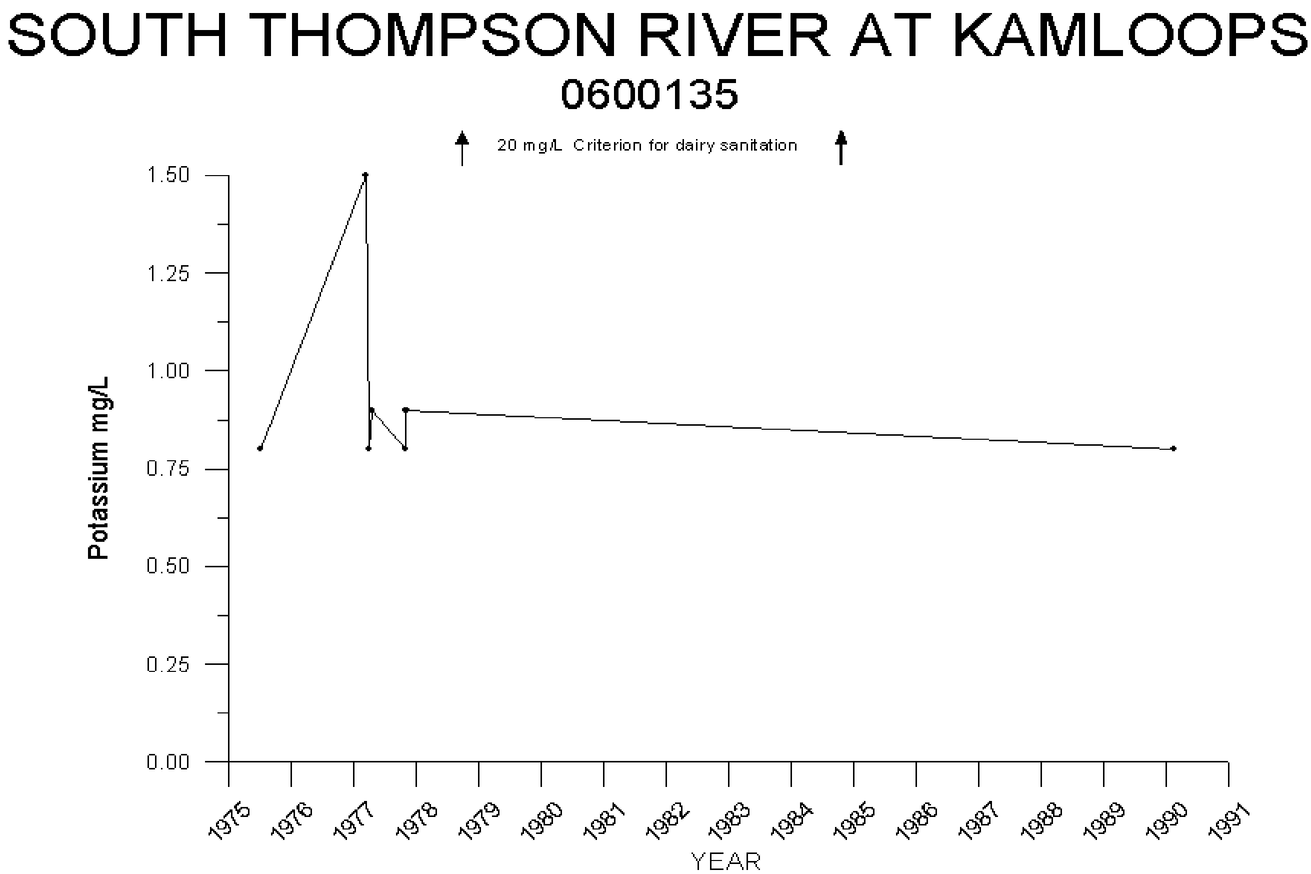


Figure 32 Filterable Residue

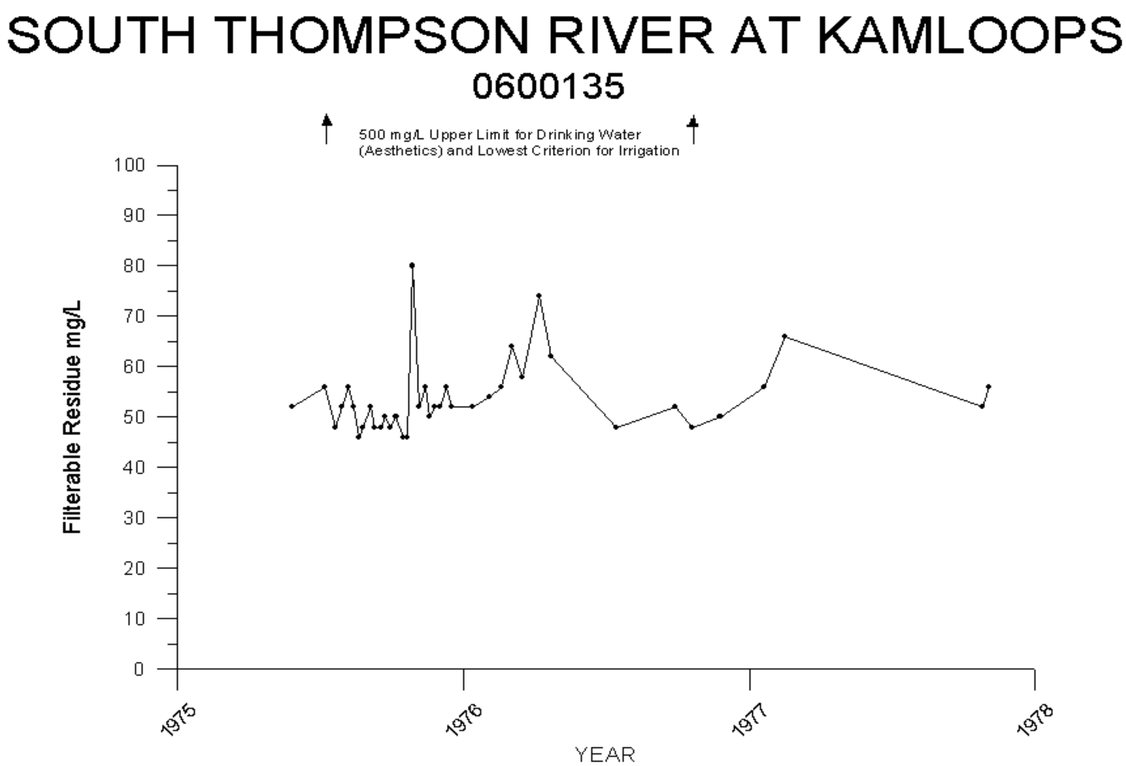


Figure 33 Non-filterable Residue

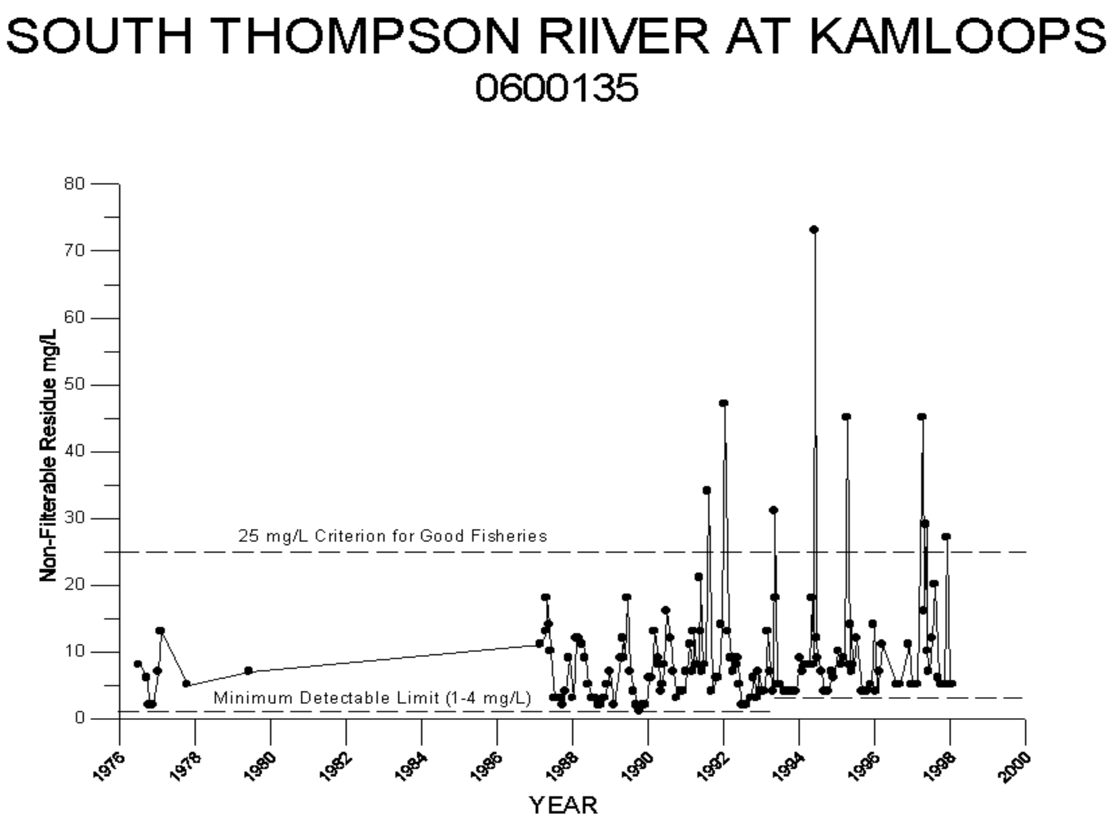


Figure 34 Dissolved Silica

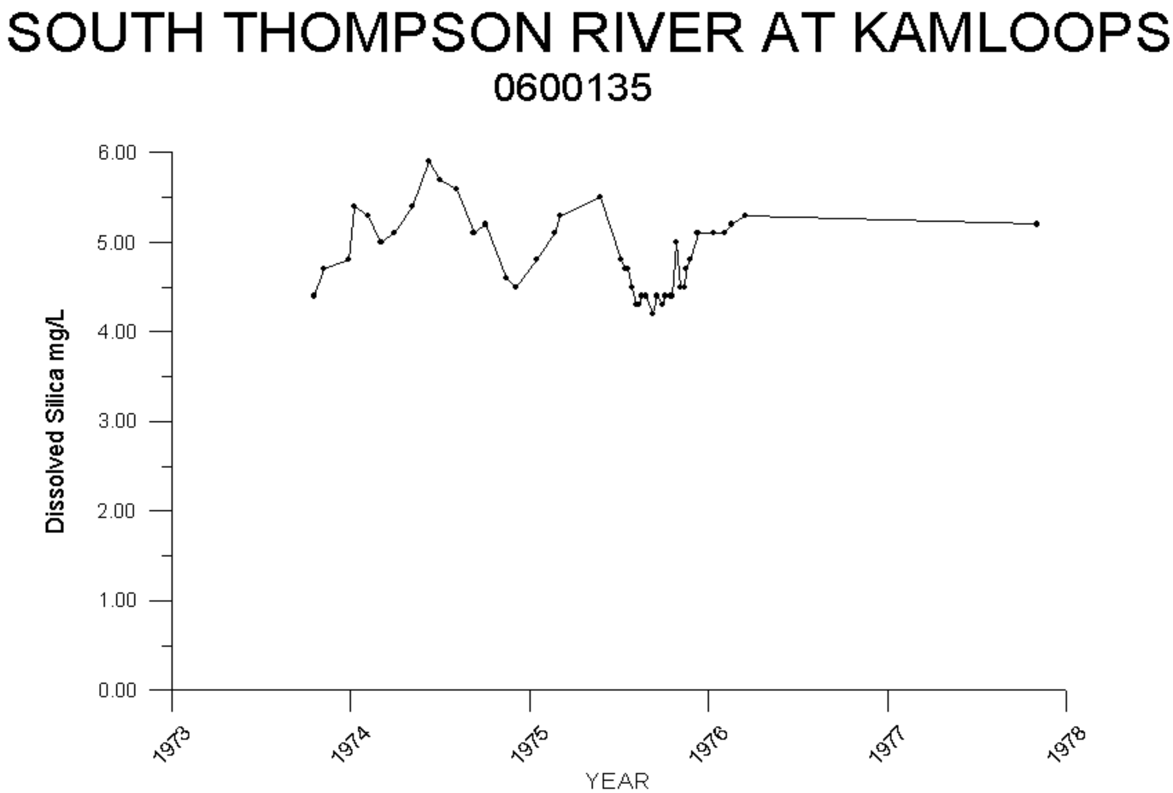


Figure 35 Dissolved Silicon

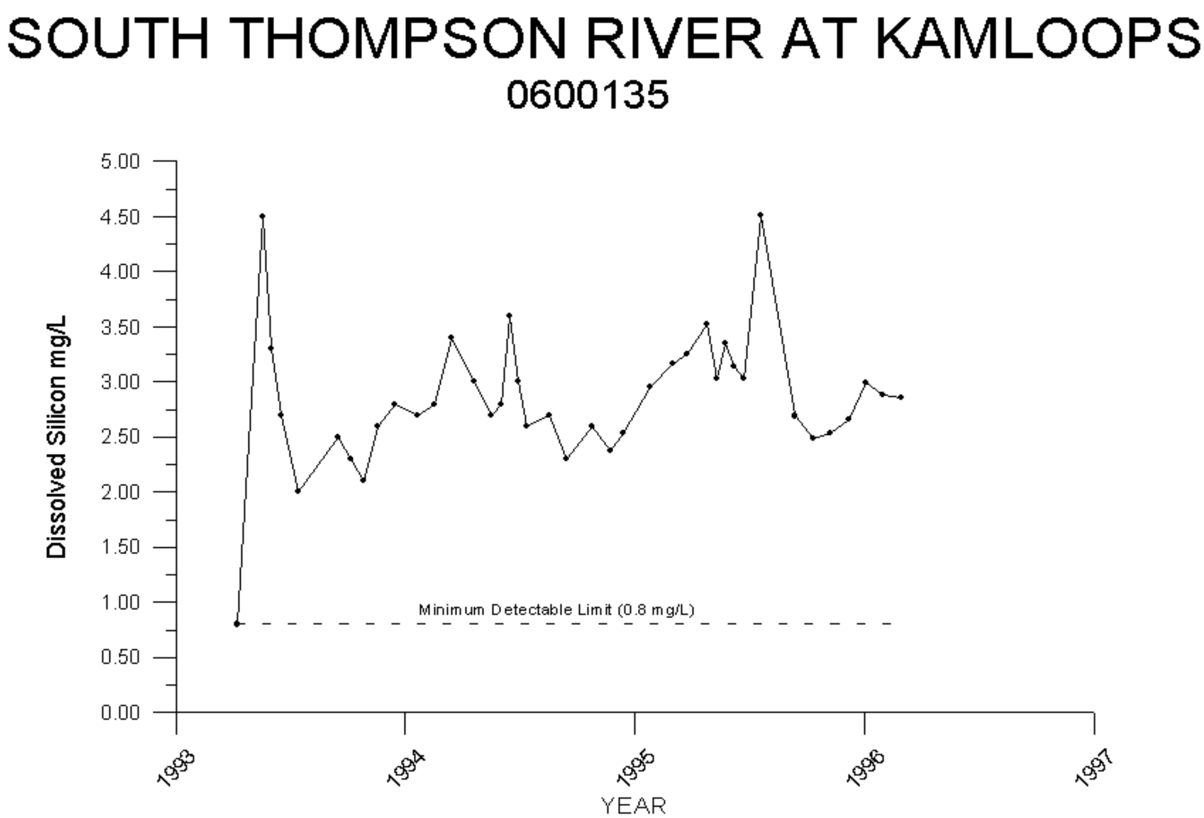


Figure 36 Water Temperature

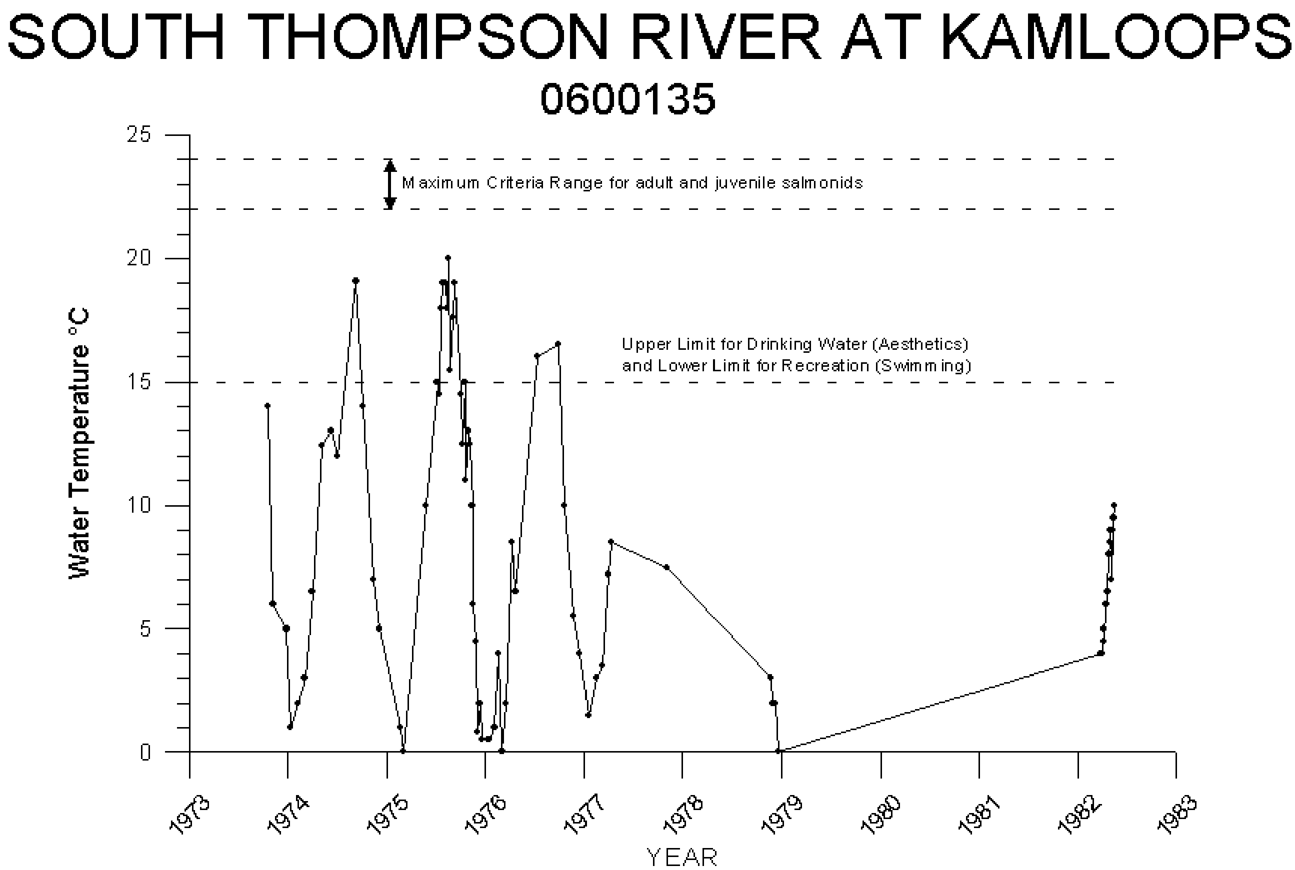


Figure 37 Turbidity

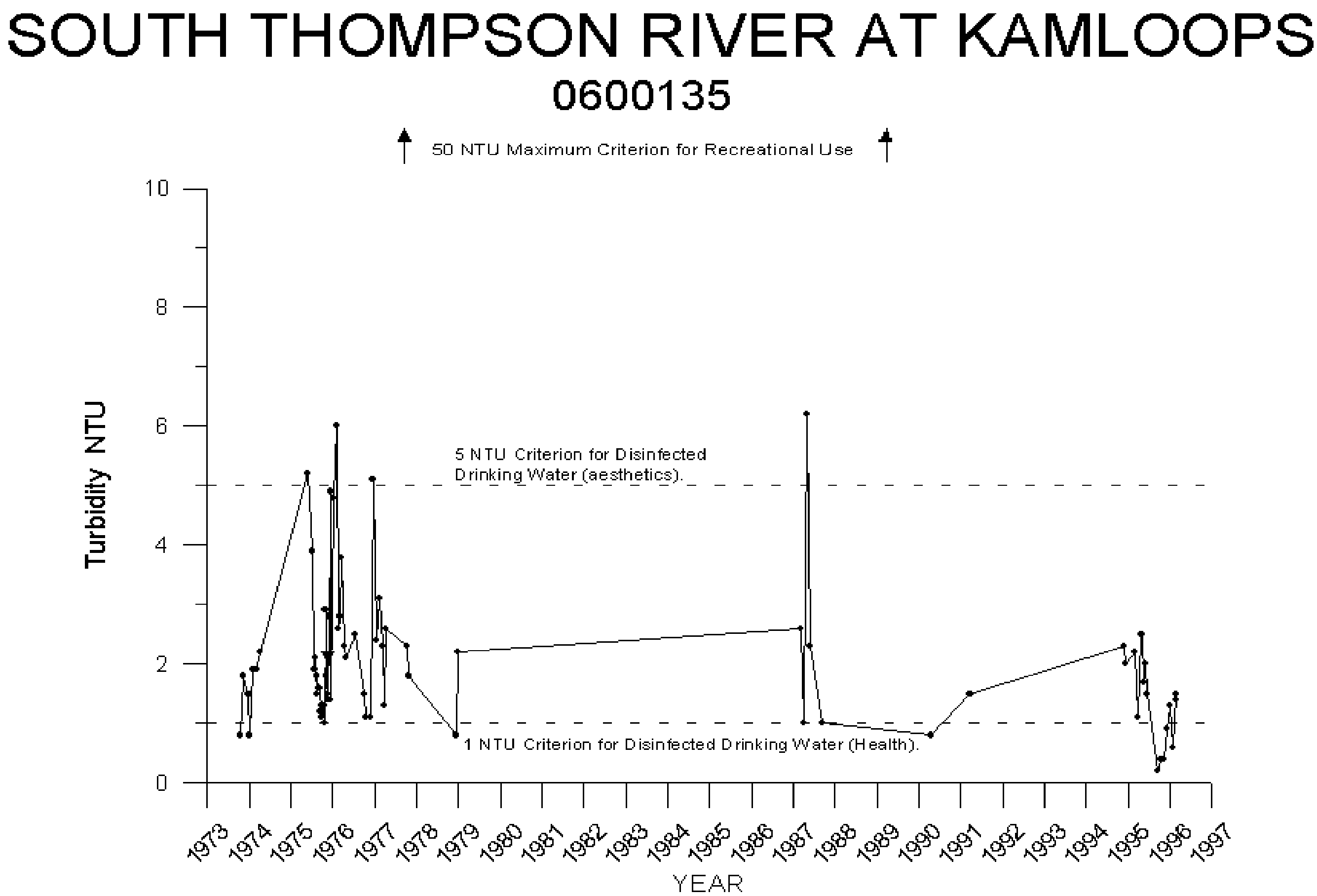
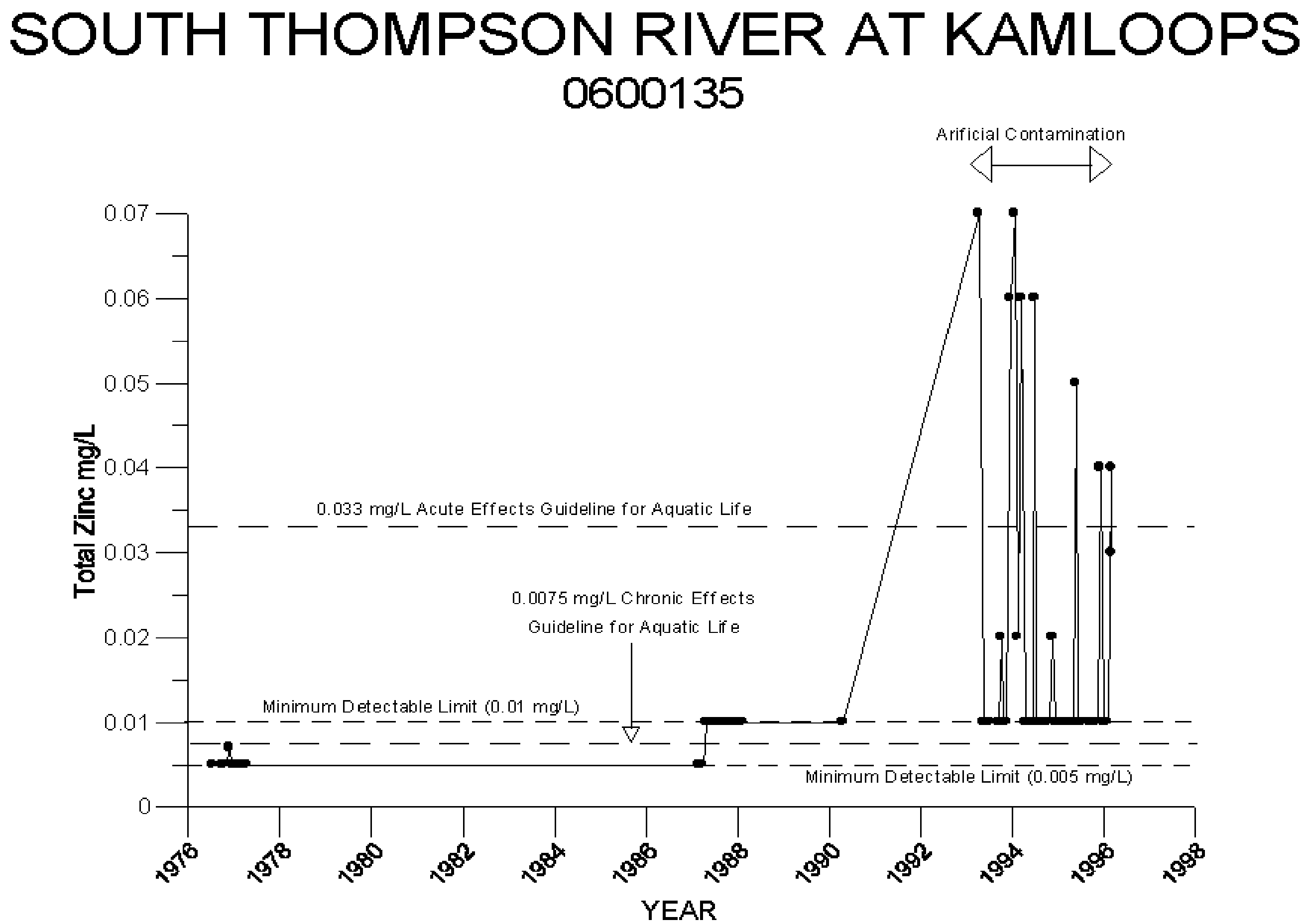


Figure 38 Total Zinc



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