State Of Water Quality Of North Thompson River At North Kamloops
1985 - 1995

Canada - British Columbia
Water Quality Monitoring Agreement

Water Quality Section
Water Management Branch
Ministry of Environment, Lands and Parks

Aquatic Sciences Section
Environmental Conservation Branch
Environment Canada
Pacific and Yukon Region

May, 1997

Canadian Cataloguing in Publication Data

Brewer, L. (Lori)
State of water quality of North Thompson River at North Kamloops, 1987-1995.

At head of title: Canada-British Columbia Water Quality Monitoring Agreement.
Authors: Brewer, L., Webber, T. Cf. P.
Co-published by British Columbia, Ministry of Environment, Lands and Parks.
Includes bibliographical references: p.
ISBN 0-7726-3217-0

1. Water quality - British Columbia - North Thompson River. 2. Water quality - British Columbia - Kamloops Region. 3. Water - Pollution - British Columbia - North Thompson River. 4. Water - Pollution - British Columbia - Kamloops Region. I. Webber, T. N.
II. Canada. Environment Canada. III. British Columbia. Ministry of Environment, Lands and Parks. IV. Canada-British Columbia Water Quality Monitoring Agreement. V. Title.

TD227.B7B732 1997 363.739'42'0971172 C97-960098-7

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EXECUTIVE SUMMARY

The North Thompson River originates in British Columbia's Rocky Mountain interior southwest from Valemount, flows south to Clearwater and McLure, and joins the South Thompson River at Kamloops to become the Thompson River (Figure 1). Approximately 300 km in length, the river is important for uses such as drinking water, recreation, aquatic life, wildlife, irrigation and livestock watering. Water quality is affected by agriculture, urbanization, and forestry, particularly in the southern section of the river downstream from McLure. There are no significant industrial or municipal discharges into the river. Other long-term monitoring stations on the Thompson River are South Thompson River at Kamloops and Thompson River at Spences Bridge.

In this report, nine years of data (1987-1995) obtained under the Canada - B.C. Water Quality Monitoring Agreement were assessed for trends and concerns in water quality. The 47 variables were graphed, and compared to water quality guidelines and to site-specific water quality objectives set by BC Environment.

The main conclusions of this study are:

· No environmentally significant trends were found.
· The site-specific fecal coliform objective to protect drinking water receiving only disinfection appeared to have been exceeded at times. Partial treatment and disinfection of drinking water are needed due to frequent high fecal coliform, *E. coli* and turbidity levels.
· Occasionally, levels of aluminum, copper, iron and zinc exceeding guidelines for aquatic life or drinking water have been observed in winter and fall, in association with low levels of non-filterable residue.

Levels appeared to be naturally high in the river, since higher values during low flows have occasionally occurred since monitoring began in 1987, and since there were no significant industrial discharges into the river.

· Variables exceeding guidelines at times during spring freshet were aluminum, chromium, copper, iron, manganese and titanium. High levels occurred in conjunction with high levels of non-filterable residue and turbidity, suggesting that the metals were in particulate form, not biologically available, and would be removed by drinking water treatment needed to remove turbidity.

· Guidelines were consistently met for most of the sampled variables, including: barium, beryllium, boron, dissolved chloride, magnesium, nickel, molybdenum, ammonia, nitrate/nitrite, pH, specific conductivity, dissolved sulphate, and vanadium.

· The water was well buffered against acid inputs.

Recommendations

1. Re-evaluating the Site-specific Objectives

· The site-specific objective for fecal coliforms to protect raw drinking water that will receive only disinfection was not always met. However, the turbidity of the river was such that partial treatment (e.g., filtration) to remove the turbidity prior to drinking was needed most of the time. We recommend that the fecal coliform objective be re-evaluated to consider the need for partial treatment plus disinfection. The guideline to protect water receiving partial treatment plus disinfection (i.e., 90^{th} percentile of 100/100 mL) was met.

2. Monitoring

· Monitoring should include: flow, dissolved organic carbon, fecal coliforms, true colour, hardness, total dissolved nitrogen, total phosphorus, low-level dissolved ortho-phosphorus, non-filterable residue, turbidity and total and dissolved metals (aluminum, chromium, copper, iron, manganese, titanium, and zinc).

· Lower minimum detectable limits (MDLs) are needed for antimony, arsenic, cadmium, lead, selenium, silver, and thallium should these metals be monitored in future. MDLs should be at least 10 times below the water quality guidelines or objectives for all variables.

· Increased sampling (five samples in 30 days), should be employed for fecal coliforms and copper to compare results to objectives and guidelines more accurately.

· Field blanks and replicates should be collected to assess artificial contamination and precision.

Figure 1 Map of the North Thompson River Basin

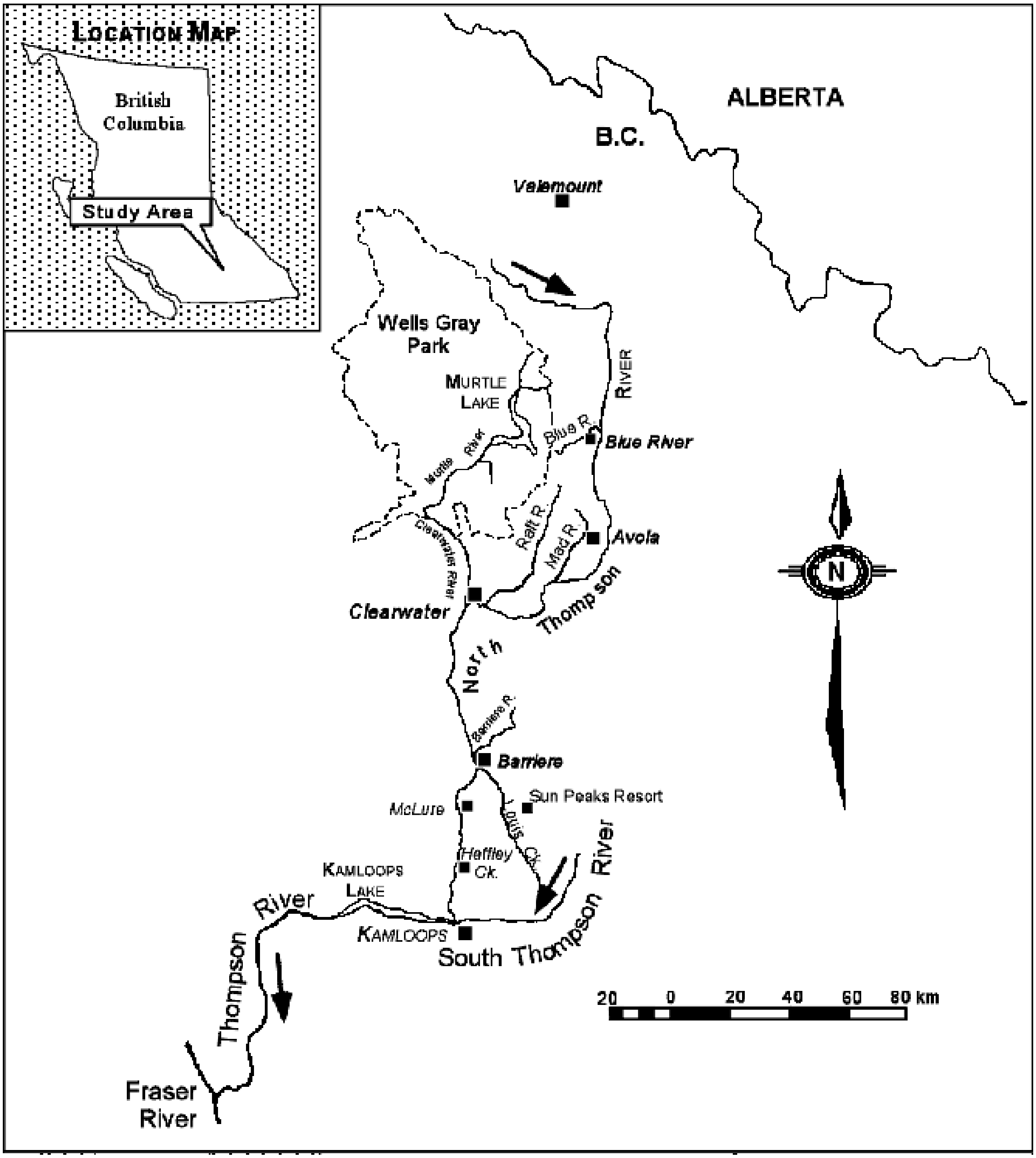
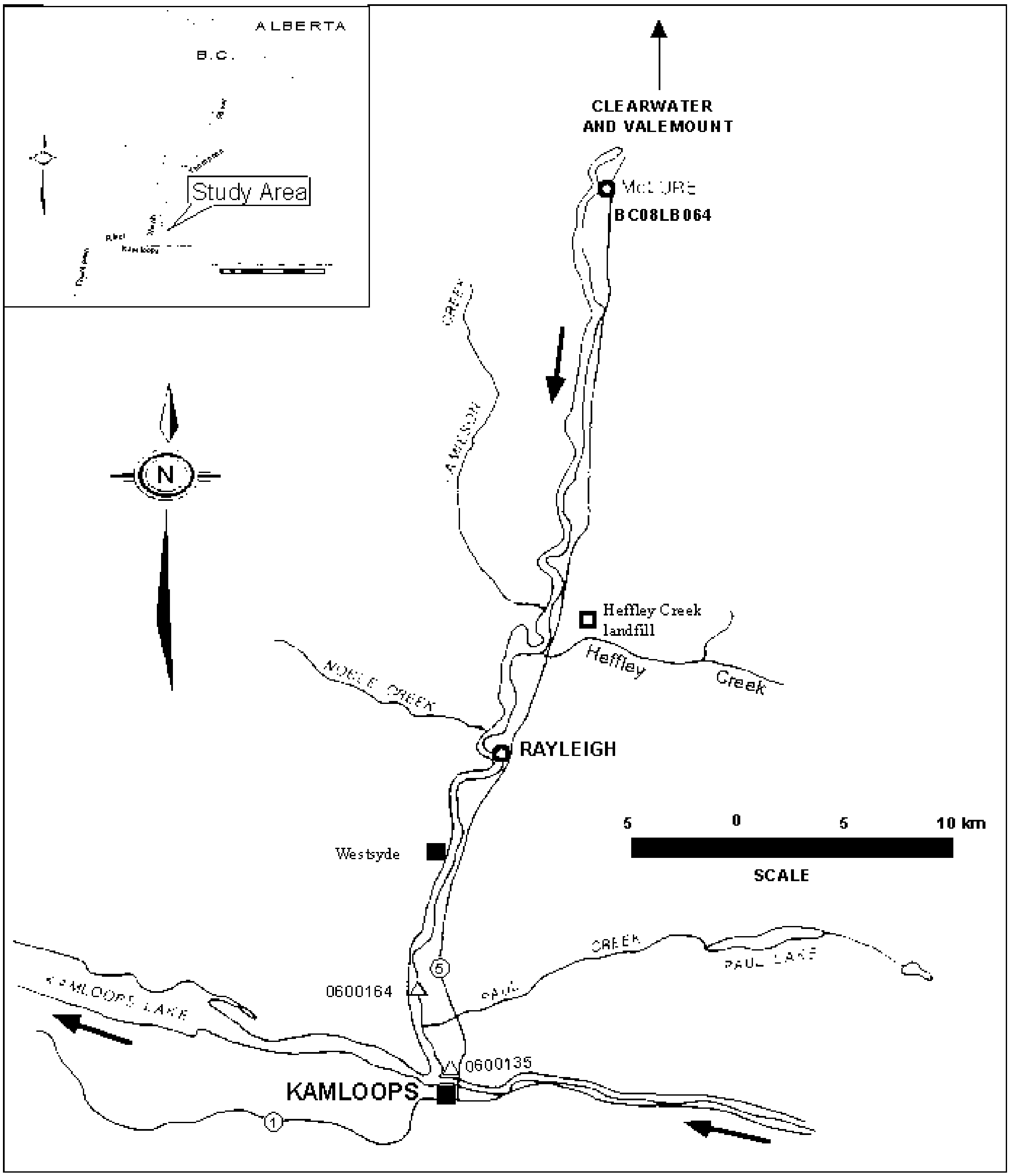


Figure 2 Map of the North Thompson River Basin south from McLure



1. Introduction

The North Thompson River originates in British Columbia's Rocky Mountains approximately 30 km southwest from Valemount, and flows mostly south through Clearwater and McLure (Figures 1 and 2). Approximately 300 km in length, the North Thompson River joins the South Thompson River at Kamloops, becoming the Thompson River, a main tributary to the Fraser River. Important tributaries are Noble, Heffley and Jamieson creeks, as well as Barriere, Clearwater, Raft, Mad, and Blue rivers, located successively upstream from the sampling site on the North Thompson River at North Kamloops. The drainage area at this site is about 20,000 km^2 (Environment Canada, 1991).

There were no significant industrial discharges (Mardon, 1996) or municipal discharges (Wong, 1996) to the North Thompson River. The Clearwater Sewage Treatment Plant (STP) discharges to the ground near the river. There are no known sources of metals and no active mines in this watershed. However, agriculture, urbanization and forestry impacted the watershed. These effects were more pronounced in the lower part of the river, downstream from McLure, due to the higher population. In terms of agriculture, one problem feedlot near Jamieson Creek closed and is now being used to grow ginseng. This eliminated the manure problem, but added a potential problem with fungicides (Grace, 1996). The Clearwater fish hatchery has temporarily closed, eliminating it as a source of nutrients and organics (Grace, 1996), but was purchased by the provincial fisheries and will be reopened for trout production to replace the Loon Lake hatchery.

Expansions as a result of urbanization, such as the Sun Peaks Resort (formerly Tod Mountain), also impacted water quality. The ski hill increased its operations, and developed several large subdivisions and a village core of condominiums and about a dozen hotels. Expansion is expected to continue for another 30-40 years, ultimately resulting in 20,000 beds in the alpine watershed of Louis Creek (Grace, 1996). As well, the Heffley Creek landfill was expanded, since the landfill at Paul Lake was closed down and replaced with a transfer station due to problem bears. Water quality impacts of the landfills were likely minimal due to the small amount of leachate produced in the arid climate (Grace, 1996). A segment of Kamloops called Westsyde, which was served by on-site septic tanks and tile fields, was sewered in 1993-94. Since then, a large subdivision and golf course complex was built on the banks near Westsyde, likely increasing erosion into the North Thompson (Grace, 1996).

Forestry also influenced water quality, and monitoring of these impacts commenced in the summer of 1996 on some North Thompson River tributaries (Laviolette, 1996). Analyses of these data were not yet available. A plywood mill at Heffley Creek discharged a small amount of condensate from the veneer dryers to a wetland that drains into the river. Sampling of the wetland discharge showed no detectable effect (Mardon, 1996).

Water quality was monitored at the North Thompson River at North Kamloops by BC Environment from 1987 to 1995 at site number 0600164 (Figure 2). Flow was monitored at McLure by Environment Canada at station number BC08LB064, and is plotted in Figure 3. The water quality variables are plotted in alphabetical order in Figures 4 to 49. Other long-term monitoring stations in the Thompson River watershed are: South Thompson River at Kamloops (Webber, 2000a), and Thompson River at Spences Bridge (Webber, 2000b).

2. Quality Assurance

Quality assurance samples, consisting of field blanks and sequential replicates, were taken since 1993, and all water quality data were scanned for accuracy and errors. Artificial zinc contamination since 1992 has been confirmed, and values since then were ignored in the assessment.

3. State of Water Quality

The state of water quality was assessed by comparing values obtained for each variable to BC Environment's approved and working guidelines for water quality (Nagpal *et al.*, 1998a,b), as well as to site-specific objectives set by the BC Environment. (Guidelines were formerly called criteria, and the older term has been used in many of the figures in this report.) Assessment of the data was based entirely on visual interpretation of the graphed variables. The following variables easily met guidelines or objectives and showed no environmentally significant trends: barium, beryllium, boron, dissolved chloride, hardness, magnesium, molybdenum, nickel, ammonia, nitrate/nitrite, pH, specific conductivity, dissolved sulphate, and vanadium. Guidelines or objectives were not available for the following variables, nor were potentially significant trends apparent: bismuth, dissolved ortho-phosphorus, silica, strontium, tellurium, tin, and zirconium. Minimum detectable limits were too high to permit comparison to all or some of the guidelines for: antimony, arsenic, cadmium, chromium, cobalt, copper, lead, selenium, silver, thallium, and zinc. Variables discussed below displayed levels that were potentially detrimental to such uses as drinking water, recreation, irrigation, agriculture, aquatic life and wildlife, or merited some explanation.

Flow (Figure 3) values showed consistent seasonal variations, with highest annual flow in the spring freshet and early summer, and lowest in the winter. The river was free flowing, with no intervening lakes, and thus was noticeably affected by snowmelt and rainfall. Flow monitoring should continue because of its importance in interpreting water quality indicators.

Total aluminum (Figure 4) met the 0.2 mg/L dissolved guideline for drinking water, and the 0.1 mg/L dissolved guideline for aquatic life at least 47% and 27% of the time, respectively. The 0.05 mg/L average dissolved guideline for aquatic life was not met at all. Nordin and Holmes (1993) noted some unexpectedly high values for aluminum in this river. High aluminum and high non-filterable residue values (Figure 35) usually occurred together, suggesting that the aluminum was in a particulate form and not likely biologically available, and would be removed by the treatment needed to remove turbidity before drinking. Since the guidelines used are for dissolved aluminum, which would likely be much lower than the total aluminum values collected, the attainment of guidelines was probably much greater than indicated above. Dissolved aluminum should be measured in future for appropriate comparison to the guidelines.

Calcium (Figure 12) values showed that the North Thompson River was quite well buffered against acid inputs. Lower values in spring and early summer occurred as a result of dilution during freshet from snowmelt, which has a low calcium content.

Total chromium (Figure 14) values remained well below the guideline for drinking water, and the aquatic life guideline for trivalent chromium, but exceeded aquatic life guideline for hexavalent chromium once, on May 19, 1993. Flow (Figure 3) and non-filterable residue (NFR) (Figure 35) were also high on this date during spring freshet, indicating that the chromium was probably in a particulate form, and not biologically available. This value could also have been a false positive, close to the 0.002 mg/L minimum detectable limit. Dissolved chromium should also be measured and a lower minimum detectable limit (_0.0001 mg/L) should be used. Measurements of trivalent and hexavalent chromium may be needed if dissolved or total chromium values exceed the aquatic life guidelines.

Fecal coliforms (Figure 16) met all guidelines, except the 10/100 mL site-specific objective and guideline for raw drinking water receiving disinfection only, which was exceeded 27% of the time. *E. coli* (Figure 19) also exceeded the raw drinking water objective for water receiving disinfection only (<10 - 90th percentile), most notably at times of high flow during the early summer freshet of 1993 and 1994. This indicates that the water should be partially treated and disinfected prior to consumption. Higher levels of these indicator organisms generally occurred during periods of high flows and non-filterable residue in spring and early summer (Figures 3 and 35), suggesting that fecal coliform levels may have been related to agricultural runoff during high flows. When Westsyde was sewered in 1993-94, a substantial amount of contaminated ground water was removed from the foreshore of the North Thompson (Grace, 1996). At the Sun Peaks Resort, sewage treatment will likely not become a major water quality issue until about half way through the projected development (Grace, 1996). Both fecal coliforms and *E. coli* should continue to be monitored as a measure of fecal contamination in the river, and the frequency of monitoring should be increased to at least five times in 30 days for better comparison to the objective.

Total absorbance colour (Figure 17) consistently met the 100-unit maximum true colour recreation guideline, but exceeded the 15-unit true colour drinking water and desirable recreation guideline once, on April 19, 1994 during spring freshet when non-filterable residue levels were high. The values cannot be directly compared to the true colour guidelines since total absorbance colour is measured differently than true colour. True colour should be measured to permit direct comparison to the guidelines, and to provide the background levels for the true colour objective for the Thompson River (Nordin and Holmes, 1993).

Total copper (Figure 18) values exceeded the 0.002 mg/L guideline for aquatic life three times. One of these dates, May 19, 1993, had a high non-filterable residue level (Figure 35), suggesting that the copper was in a particulate form and was probably not biologically available. The copper levels on October 26, 1993 and March 23, 1995 occurred during lower flows and non-filterable residue levels, suggesting that the copper may have been bioavailable. These data compare favourably with Nordin and Holmes (1993), who found some unexpectedly high copper values. Samples were collected less often than the required five samples in 30 days for proper comparison to guidelines, and thus increased frequency of measurements is recommended for total and dissolved copper. The minimum detectable limit should be lowered to at least one- tenth of the guideline. Field blanks and replicates should also be collected to assess the potential for artificial contamination.

Hardness (Figure 20) values indicate that the water was relatively soft (30-60 mg/L) and below the optimum level for drinking water, but still quite acceptable. Hardness should continue to be monitored due to its influence on metal toxicity, and dissolved organic carbon should be added for the same reason.

Total iron (Figure 21) consistently met the 5 mg/L guideline for irrigation, but exceeded the guideline for drinking water (aesthetics) and aquatic life (0.3 mg/L) 63% of the time. Usually, higher levels of iron and non-filterable residue (Figure 35) occurred together, indicating that the metal was in particulate form, was probably not biologically available, and would be removed by treatment needed to remove turbidity before drinking. Given that the average concentration of iron in the Earth's crust is 56,300 mg/kg (Demayo, 1992), as little as 5.5 mg/L of non-filterable residue could cause the 0.3 mg/L guideline to be exceeded. However, the guideline was also exceeded at times when non-filterable residue was low. Given the lack of anthropogenic sources of iron, and since levels have been high since monitoring began in 1987, we speculate that iron levels were probably naturally high in this river. Total and dissolved iron should be monitored.

Total manganese (Figure 24) levels were generally well below most guidelines, but slightly exceeded the drinking water (aesthetics) guideline twice, during spring freshet. Since non-filterable residues (Figure 35) were also elevated at these times, the manganese was probably in particulate form and would be removed by the treatment needed to remove turbidity before drinking.

Molybdenum (Figure 25) exceeded the irrigation guideline on August 24, 1987, but this value may well have been a false positive, being close to the minimum detectable limit. Since 1988, levels have remained below the guideline.

Total Kjeldahl Nitrogen (Figure 28) values were highest during spring freshet, when flow (Figure 3) and fecal coliform (Figure 16) levels were highest, implying a link to agricultural runoff. Higher levels could also have been due to increased instream periphyton biological production in the spring to summer months. Nordin and Holmes (1993) noticed slightly increasing values, but there are no trends apparent in our data
(Figure 28).

Total phosphorus (Figure 31) peak values occurred when suspended sediments (non-filterable residue) were elevated (Figure 35) during freshet due to increased erosion and agricultural runoff. The dissolved phosphorus measurements discussed below indicate that most of the total phosphorus was in a particulate form and probably not readily bioavailable. This variable should continue to be monitored as an indicator of nutrient loadings to Kamloops Lake.

Low-level dissolved ortho-phosphorus (Figure 32) concentrations showed no consistent patterns or trends. There was little similarity to other measures of dissolved phosphorus [**total dissolved phosphorus** and **dissolved ortho-phosphorus** (Figures 33 and 34)], possibly since all the values were close to the minimum detectable limits (MDL). Uncertainty in the values is high close to the MDL (levels were less than nine, three and two times above the MDL's for each variable, respectively). Low-level dissolved ortho-phosphorus has the lowest MDL, and thus it should continue to be monitored as the measure of bioavailable phosphorus.

The non-filterable residue (NFR) (i.e., suspended solids or sediment) (Figure 35) fisheries guideline was exceeded 26% of the time. The **turbidity** (Figure 46) values were always below the guideline for recreation, but exceeded the 5 and 1 NTU guidelines for drinking water 35% and 89% of the time, respectively. Higher levels of both variables occurred most often during times of highest flows, in spring freshet, and during early glacial melts, due to enhanced erosion. Turbidity removal (e.g., filtration) plus disinfection are needed prior to drinking water use. When Westsyde was sewered, in 1993-94, major residential infilling occurred, potentially causing increased erosion and sediment production. In addition to this, the large subdivision and golf course complex built near Westsyde on the banks of the North

Thompson could have impacted water quality in terms of increased erosion and urban run-off entering the river (Grace, 1996). Similar impacts could be expected for the Sun Peaks Resort expansion. Since 1993, however, turbidity and NFR results have been stable, although the data were rather sparse. There were no apparent trends in NFR or turbidity during 1987-95. These variables should continue to be monitored to assess potential impacts on water quality as a result of erosion.

Total titanium (Figure 45) exceeded the drinking water and aquatic life guideline once, on May 19, 1993, a time of high flows (Figure 3) and non-filterable residue levels (Figure 35) during spring freshet. Thus, the metal was probably not biologically available, and would be removed by the treatment needed to remove turbidity prior to drinking. Levels have remained below guidelines since then.

Artificial contamination of samples of **total zinc** (Figure 48) occurred during 1993-1995. Prior to 1993, levels were below the maximum aquatic life guideline except on March 30, 1987, a time of low non-filterable residues (Figure 35). The MDL was too high to evaluate attainment of the average aquatic life guideline. Nordin and Holmes (1993) noted some unexpectedly high values for zinc in the river. Total and dissolved zinc with a lower minimum detectable limit (e.g., _0.001 mg/L) should be measured to establish the zinc levels in the river. Field blanks and replicates should also be collected to assess the potential for artificial contamination.

Conclusions - State of Water Quality

· No environmentally significant trends were found.
· The site-specific fecal coliform objective to protect drinking water receiving only disinfection appeared to have been exceeded at times. Partial treatment and disinfection of drinking water are needed due to frequent high fecal coliform, *E. coli* and turbidity levels.
· Occasionally, levels of aluminum, copper, iron and zinc exceeding guidelines for aquatic life or drinking water have been observed in winter and fall, in association with low levels of non-filterable residue. Levels appeared to be naturally high in the river, since higher values during low flows have occasionally occurred since monitoring began in 1987, and since there were no significant industrial discharges into the river.
· Variables exceeding guidelines at times during spring freshet were aluminum, chromium, copper, iron, manganese and titanium. High levels occurred in conjunction with high levels of non-filterable residue and turbidity, suggesting that the metals were in particulate form, not biologically available, and would be removed by drinking water treatment needed to remove turbidity.
· Guidelines were consistently met for most of the sampled variables, including: barium, beryllium, boron, dissolved chloride, magnesium, nickel, molybdenum, ammonia, nitrate/nitrite, pH, specific conductivity, dissolved sulphate, and vanadium.
· The water was well buffered against acid inputs.

4. Recommendations for Water Quality Management

4.1 Re-evaluating the Site-specific Objectives

· The site-specific objective for fecal coliforms to protect raw drinking water that will receive only disinfection was not always met. However, the turbidity of the river was such that partial treatment (e.g., filtration) to remove the turbidity prior to drinking was needed most of the time. We recommend that the fecal coliform objective be re-evaluated to consider the need for partial treatment plus disinfection. The guideline to protect water receiving partial treatment plus disinfection (i.e., 90^{th} percentile of 100/100 mL) was met.

4.2 Monitoring

· Monitoring should include: flow, dissolved organic carbon, fecal coliforms, true colour, hardness, total dissolved nitrogen, total phosphorus, low-level dissolved ortho-phosphorus, non-filterable residue, turbidity and total and dissolved metals (aluminum, chromium, copper, iron, manganese, titanium, and zinc).
· Lower minimum detectable limits (MDLs) are needed for antimony, arsenic, cadmium, lead, selenium, silver, and thallium should these metals be monitored in future. MDLs should be at least 10 times below the water quality guidelines or objectives for all variables.
· Increased sampling (five samples in 30 days), should be employed for fecal coliforms and copper to compare results to objectives and guidelines more accurately.
· Field blanks and replicates should be collected to assess artificial contamination and precision.

Figure 3 Flow

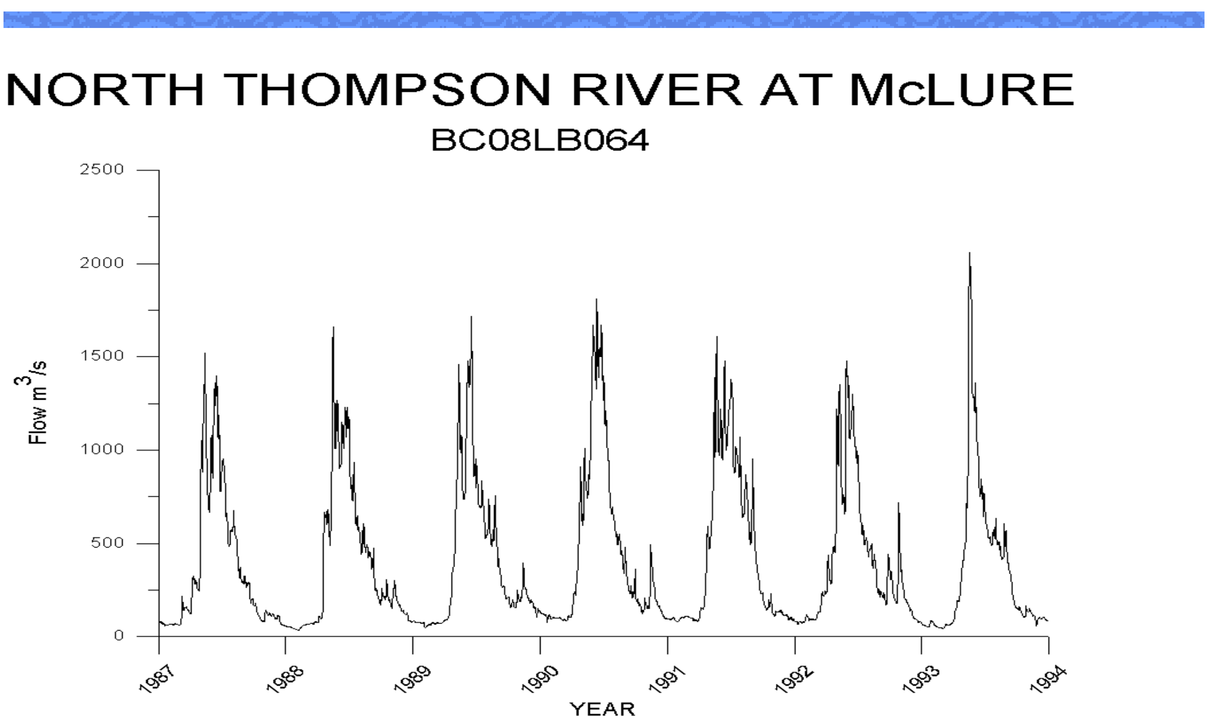


Figure 4 Total Aluminum

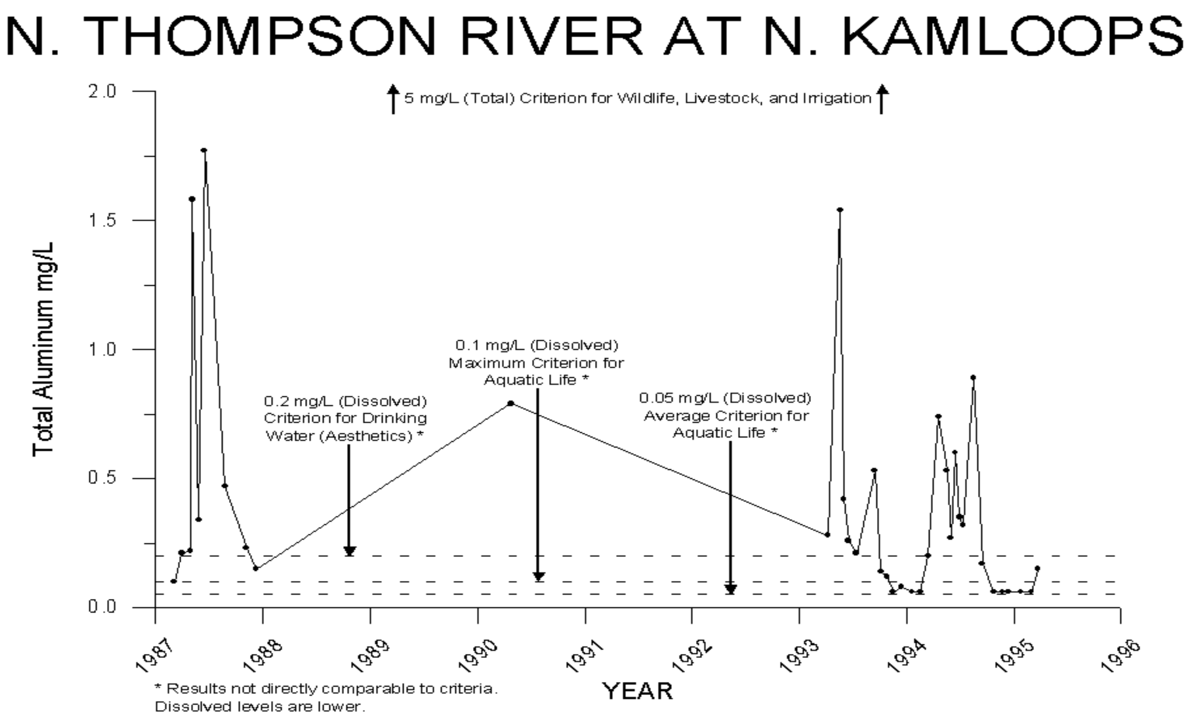


Figure 5 Total Antimony

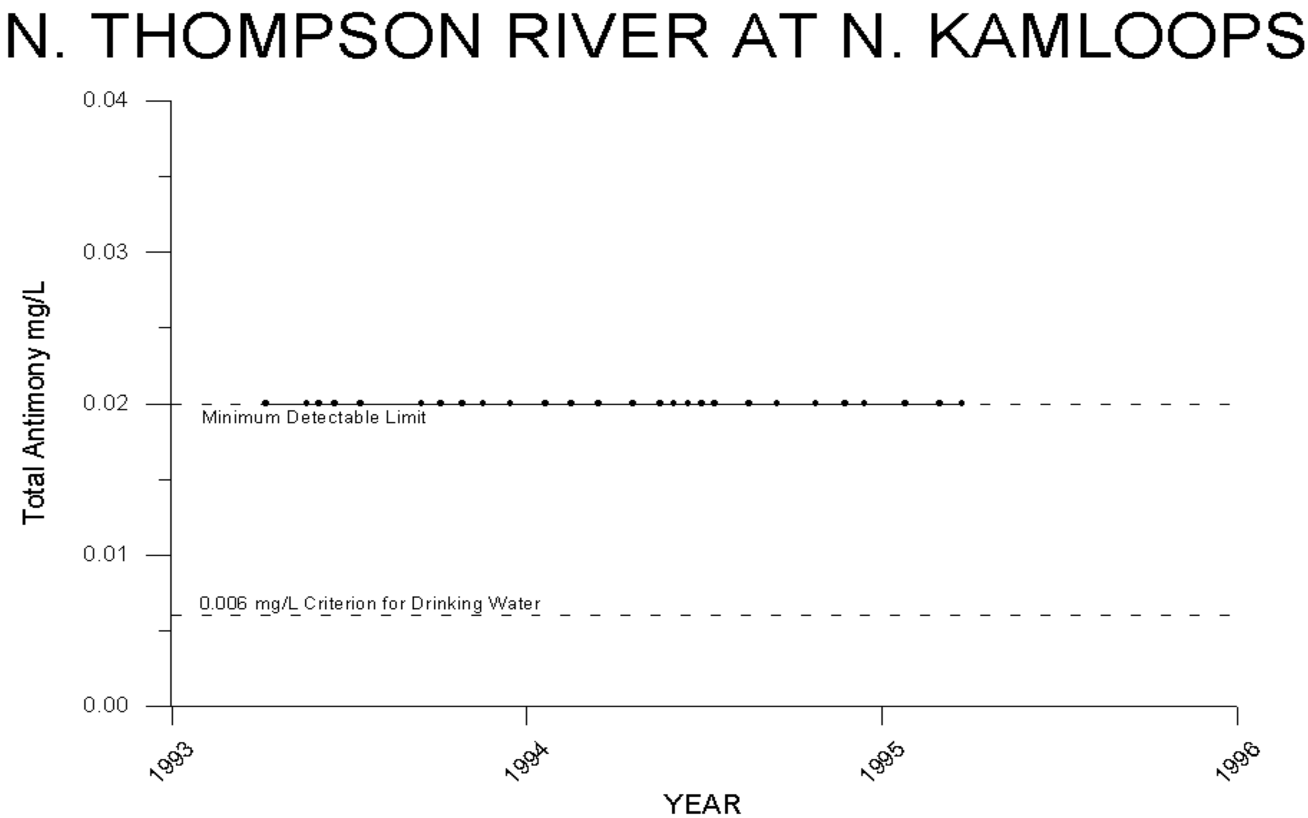


Figure 6 Total Arsenic

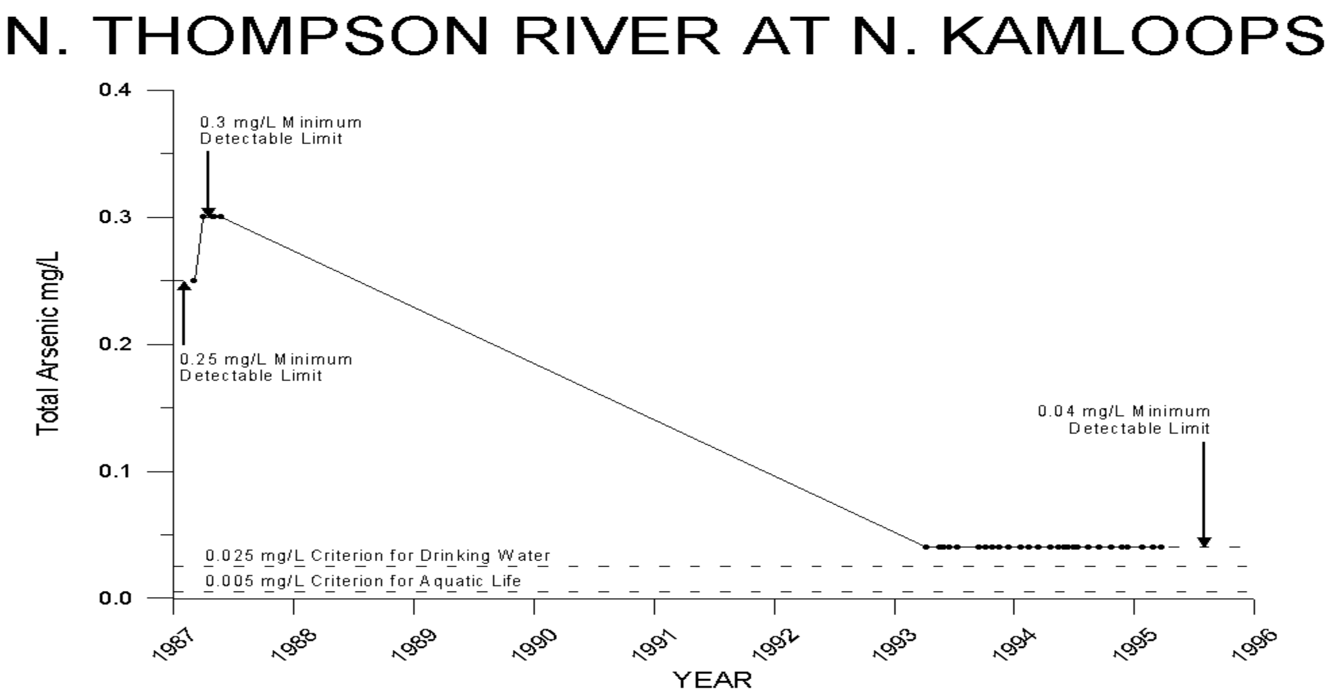


Figure 7 Total Barium

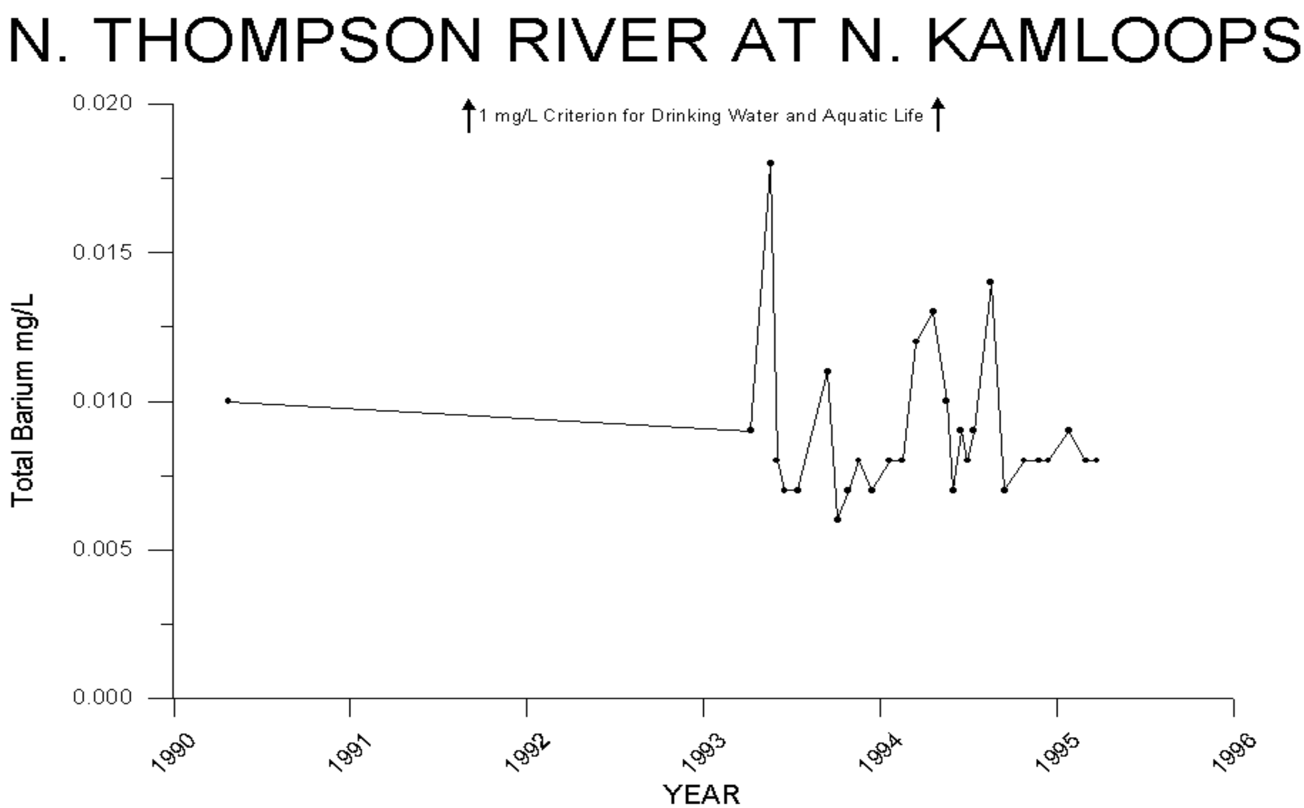


Figure 8 Total Beryllium

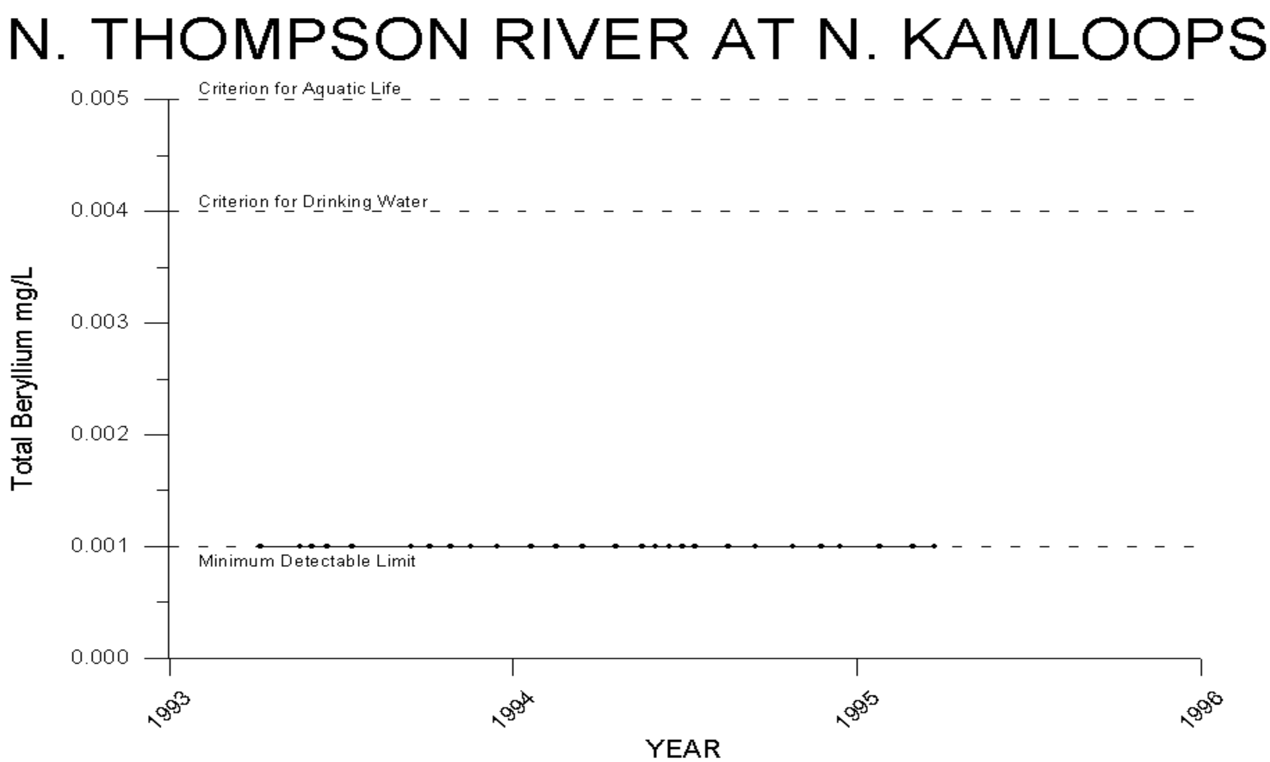


Figure 9 Total Bismuth

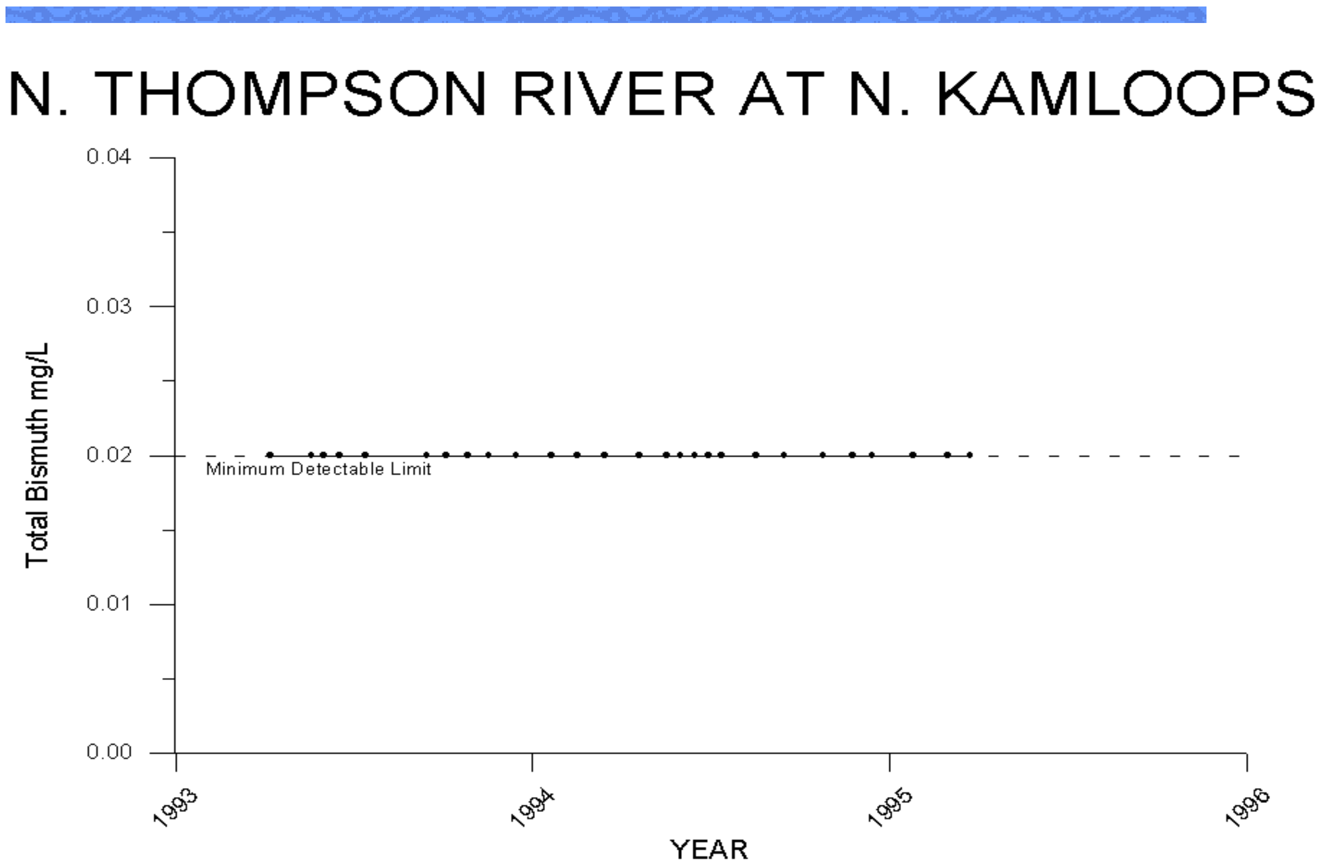


Figure 10 Total Boron

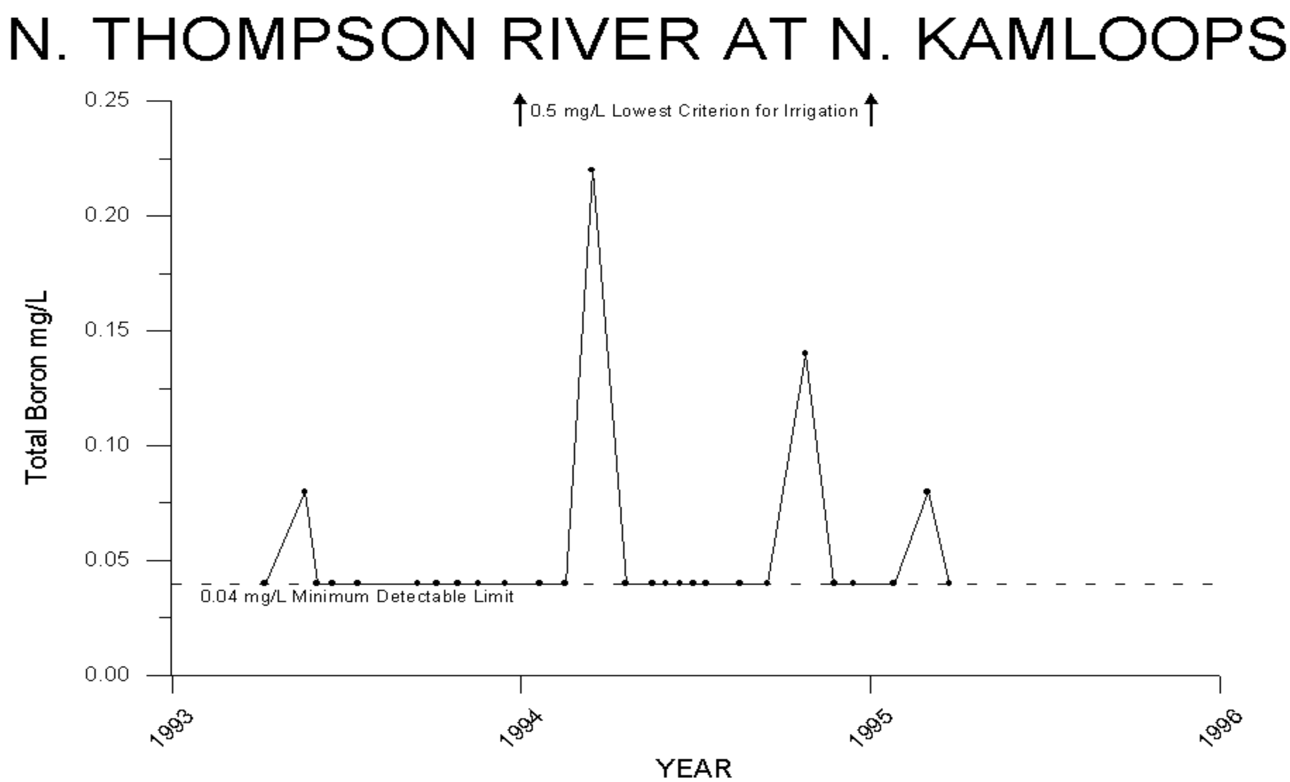


Figure 11 Total Cadmium

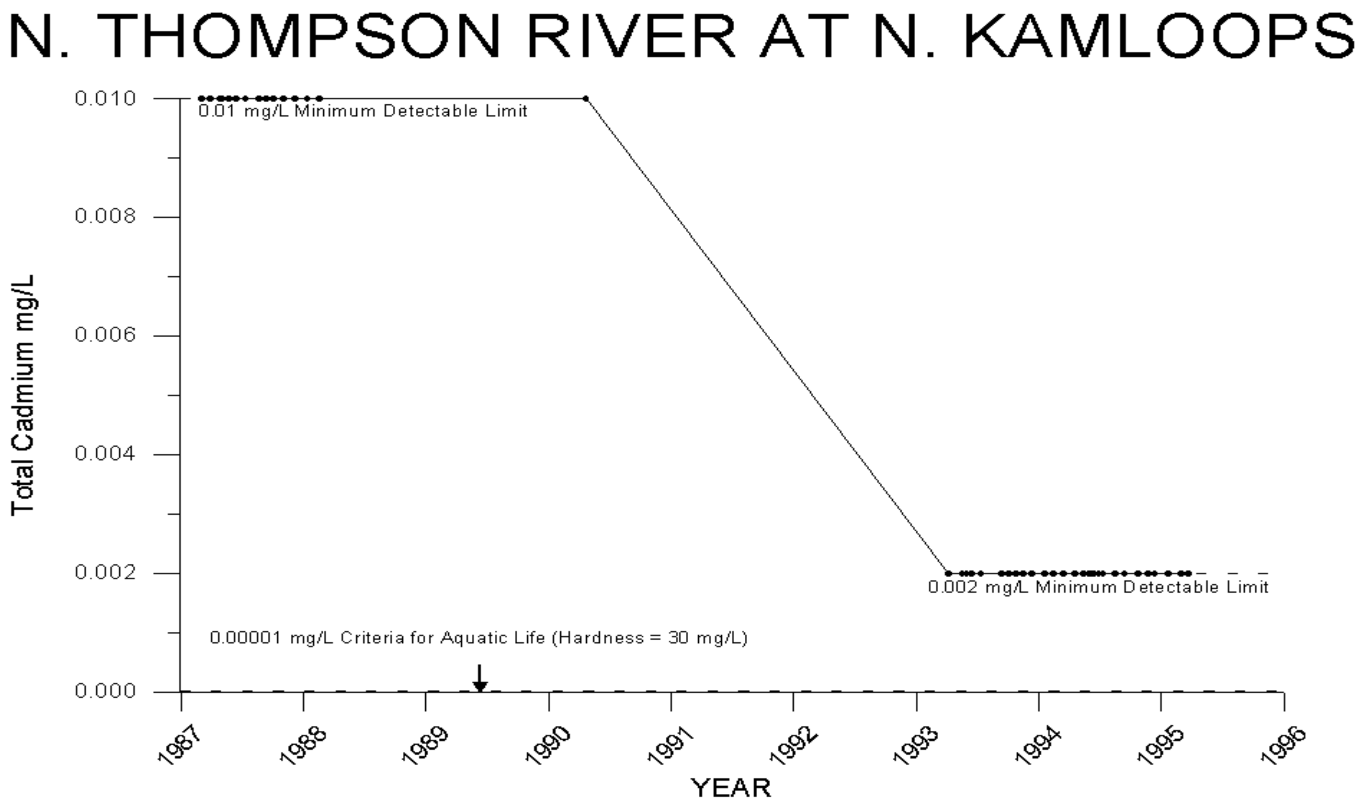


Figure 12 Calcium

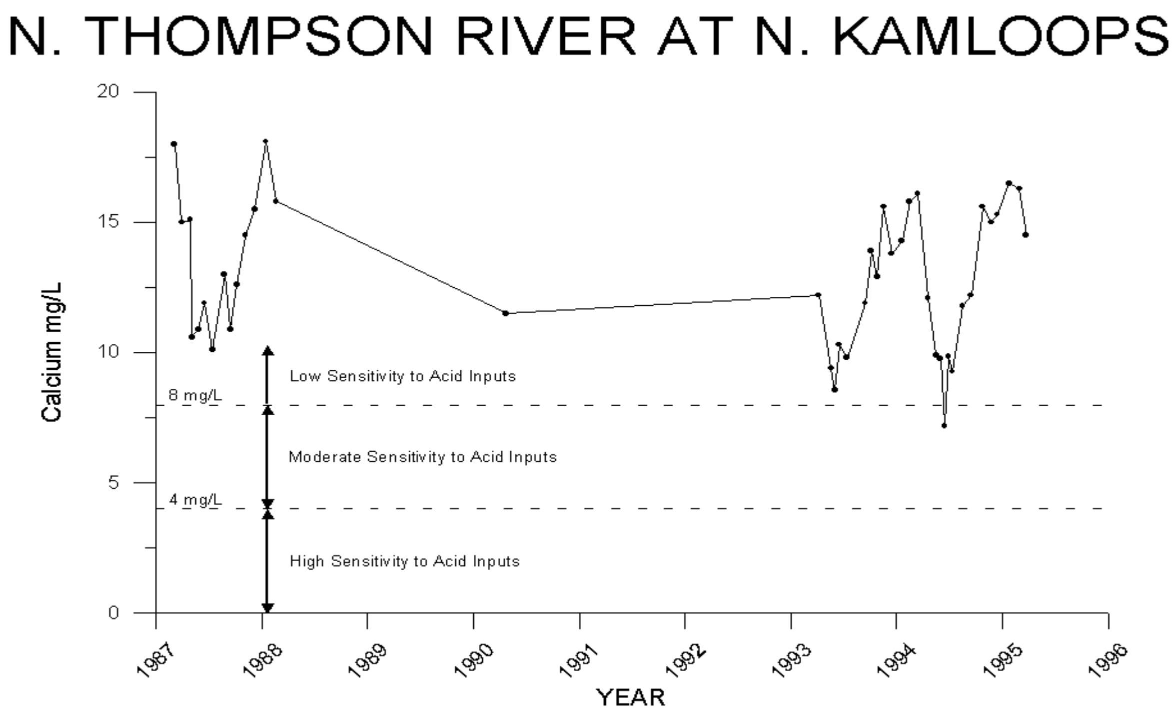


Figure 13 Dissolved Chloride

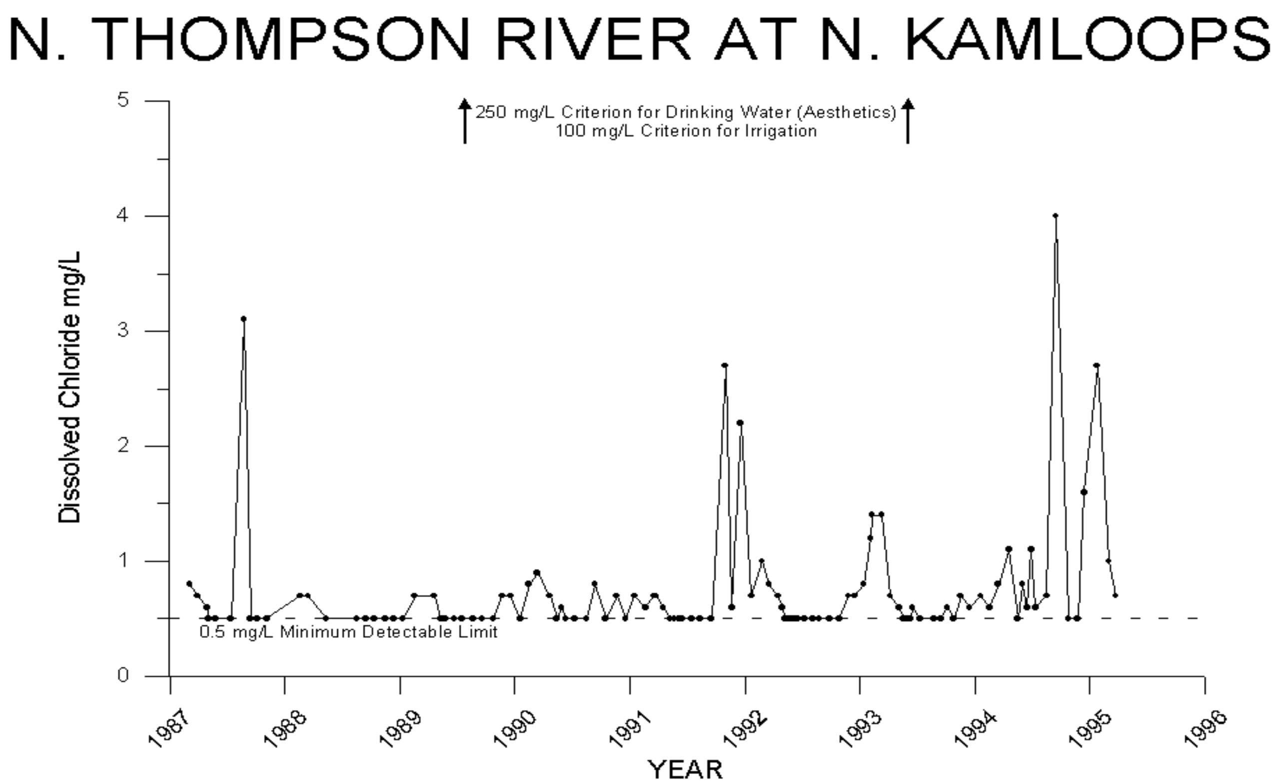


Figure 14 Total Chromium

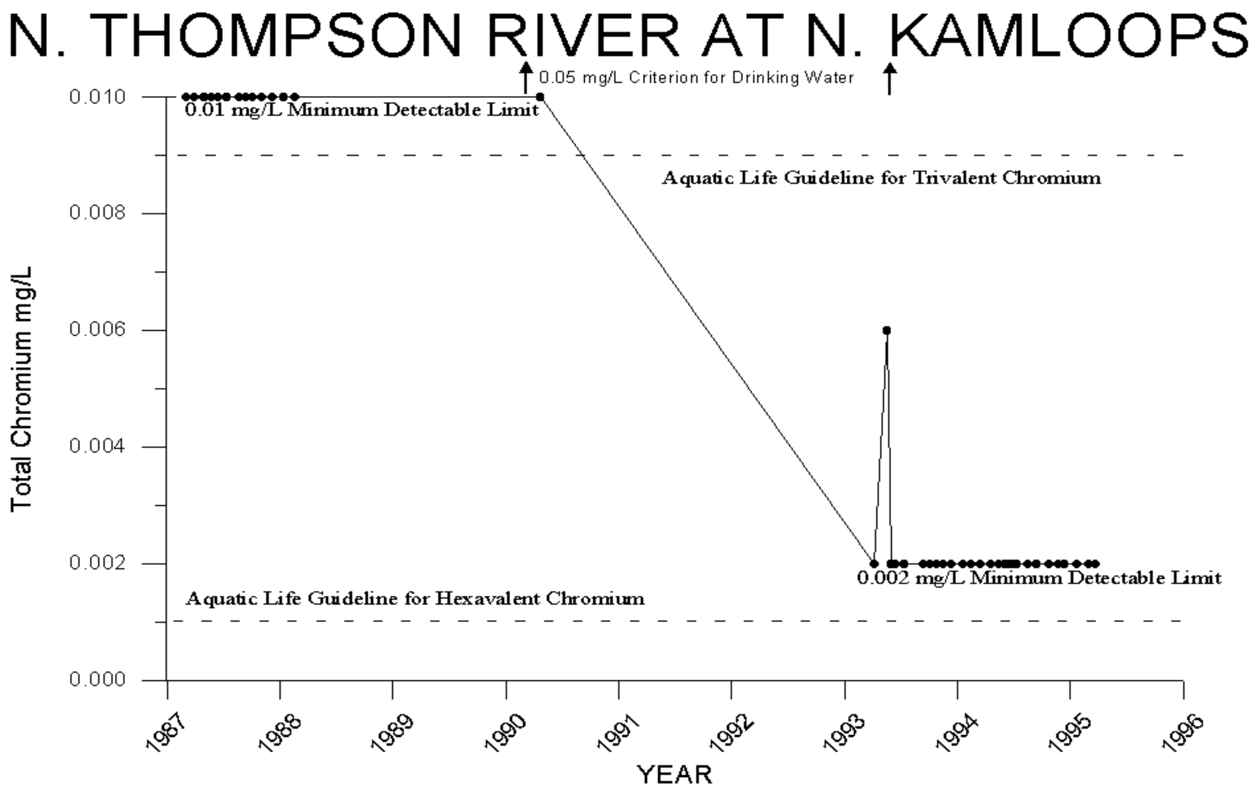


Figure 15 Total Cobalt

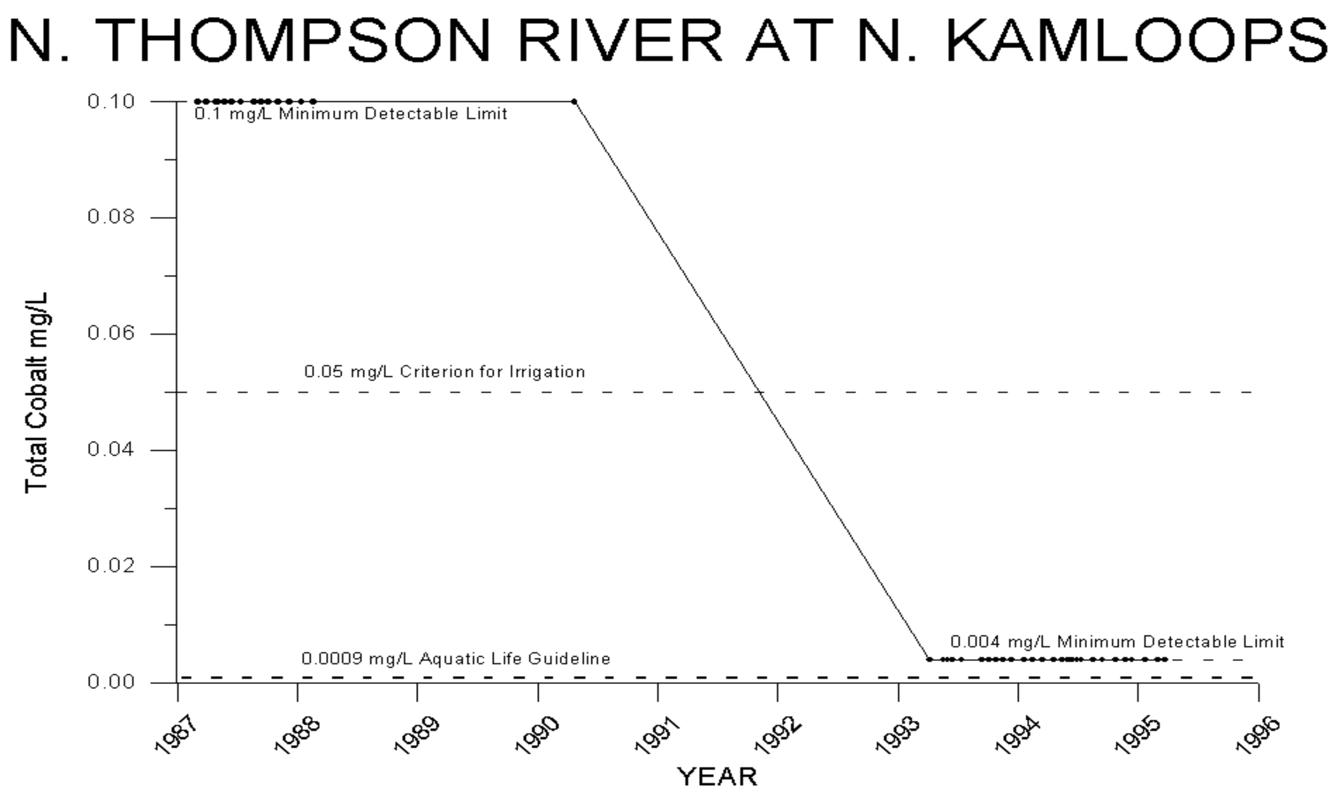


Figure 16 Fecal Colforms

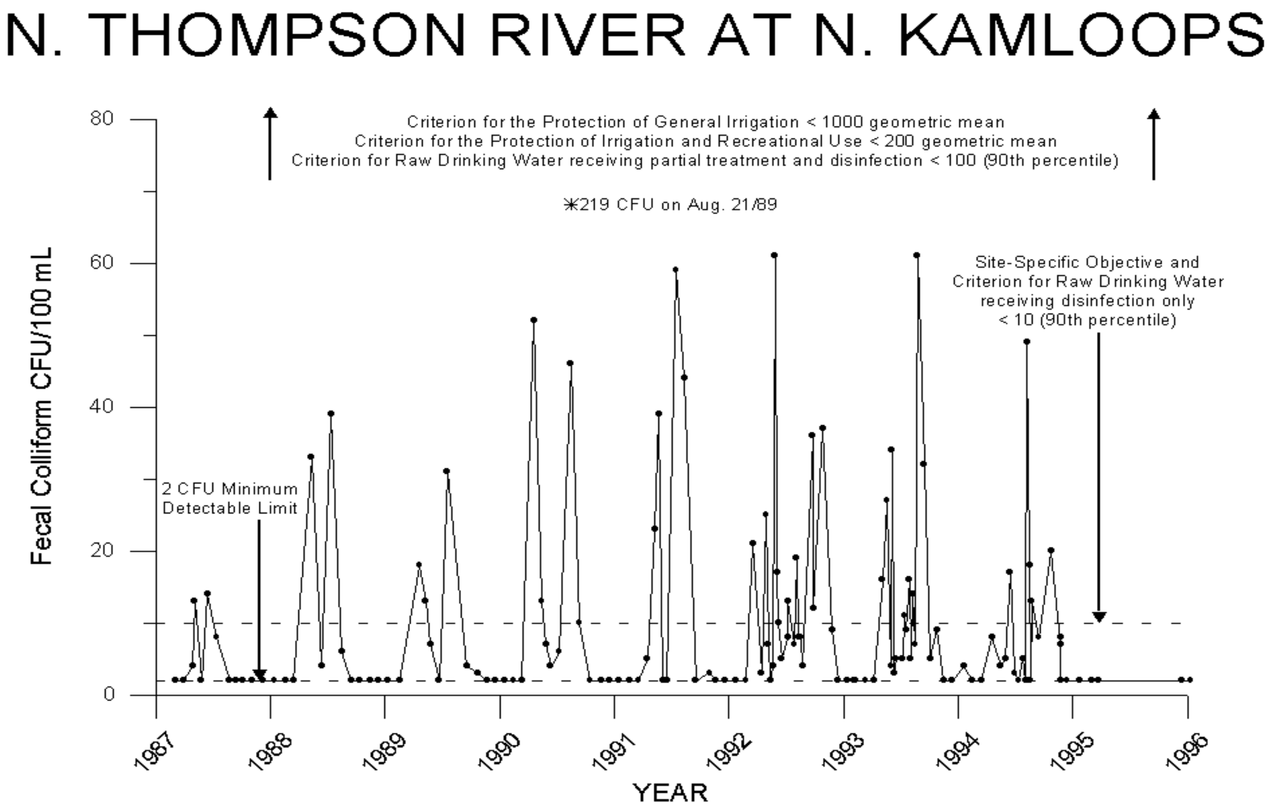


Figure 17 Colour (TAC)

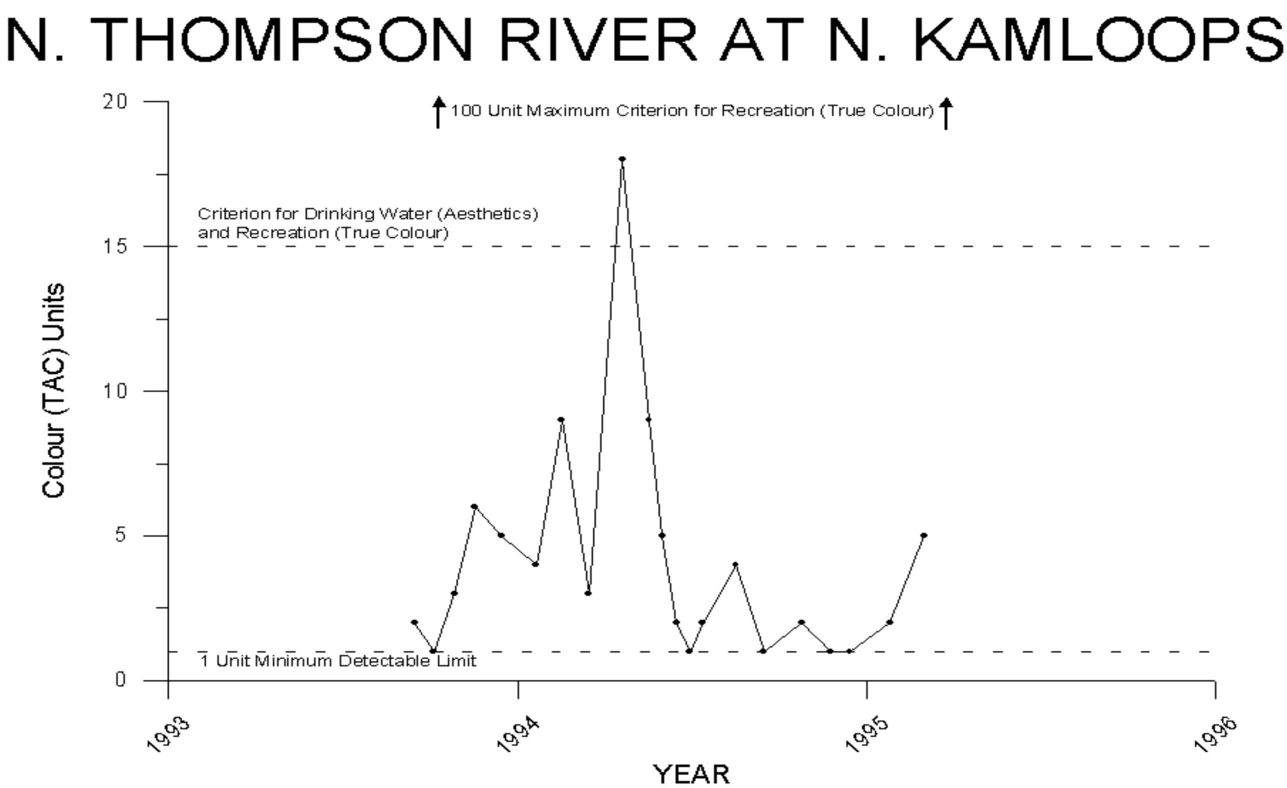


Figure 18 Total Copper

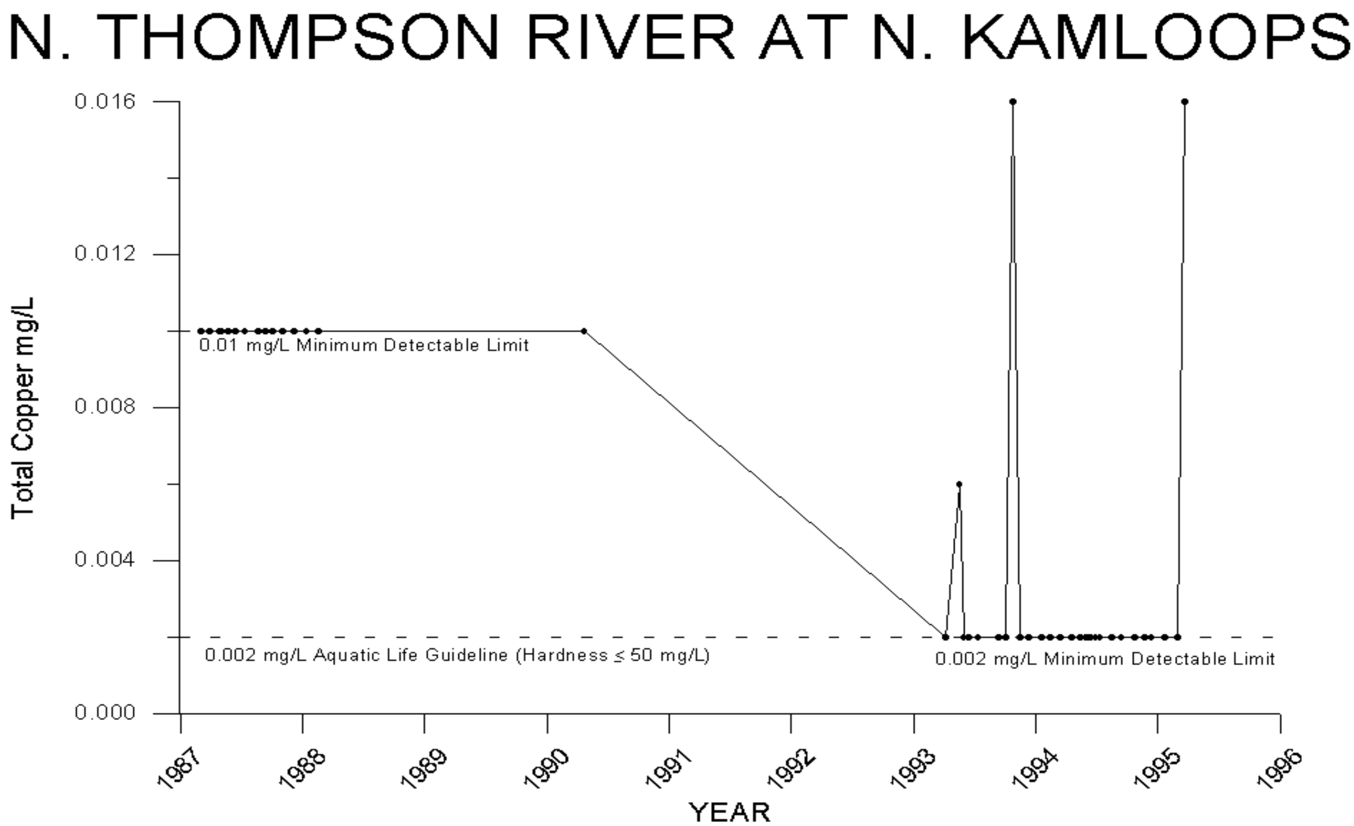


Figure 19 E. Coli

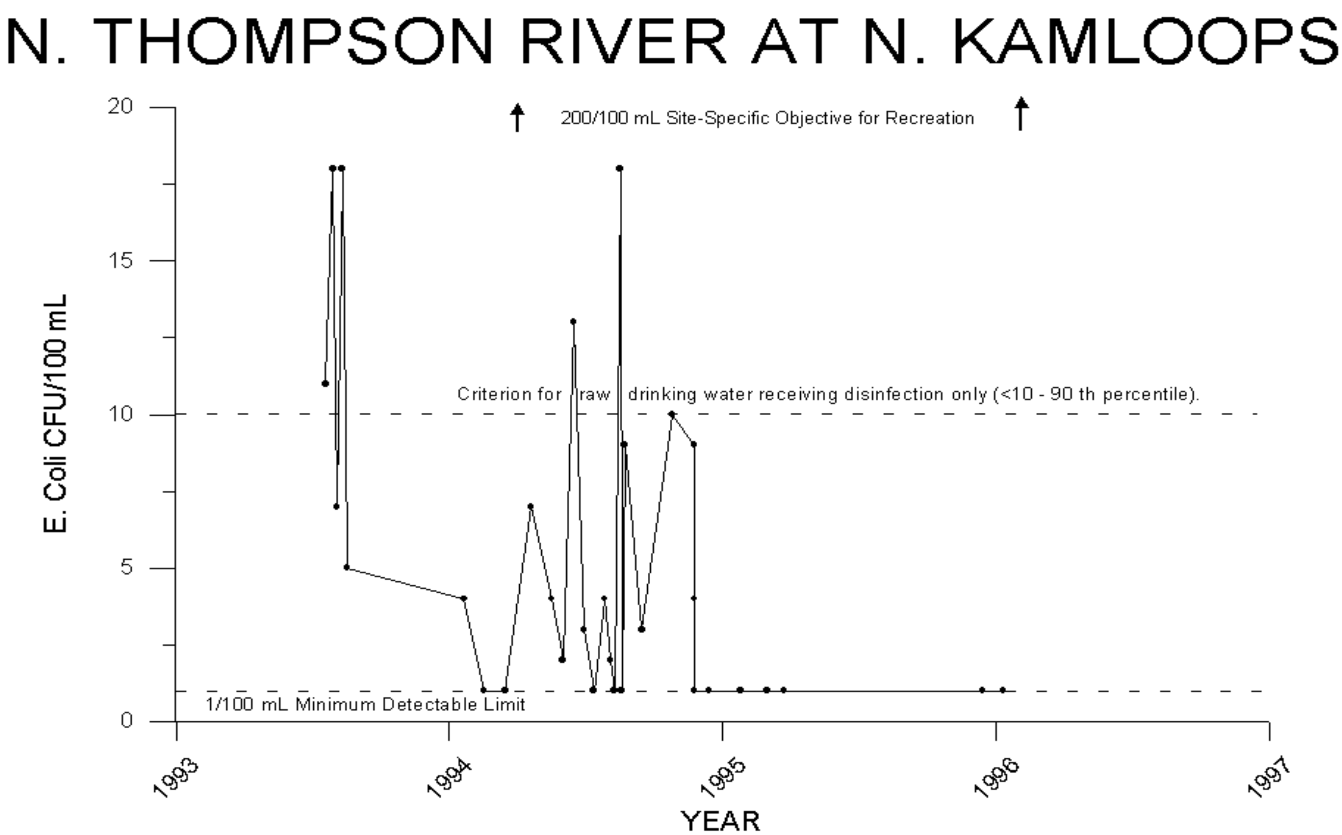


Figure 20 Hardness

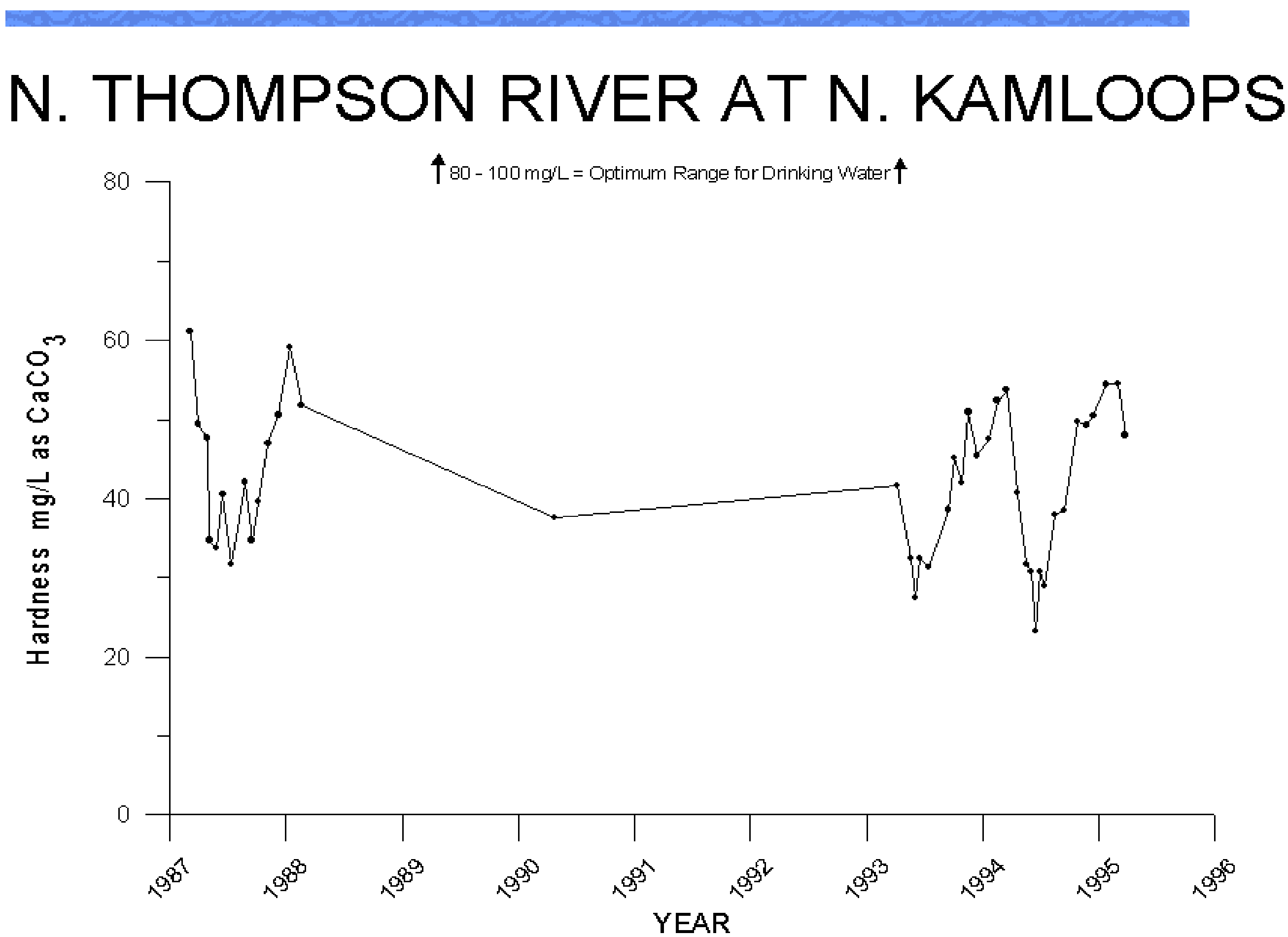


Figure 21 Total Iron

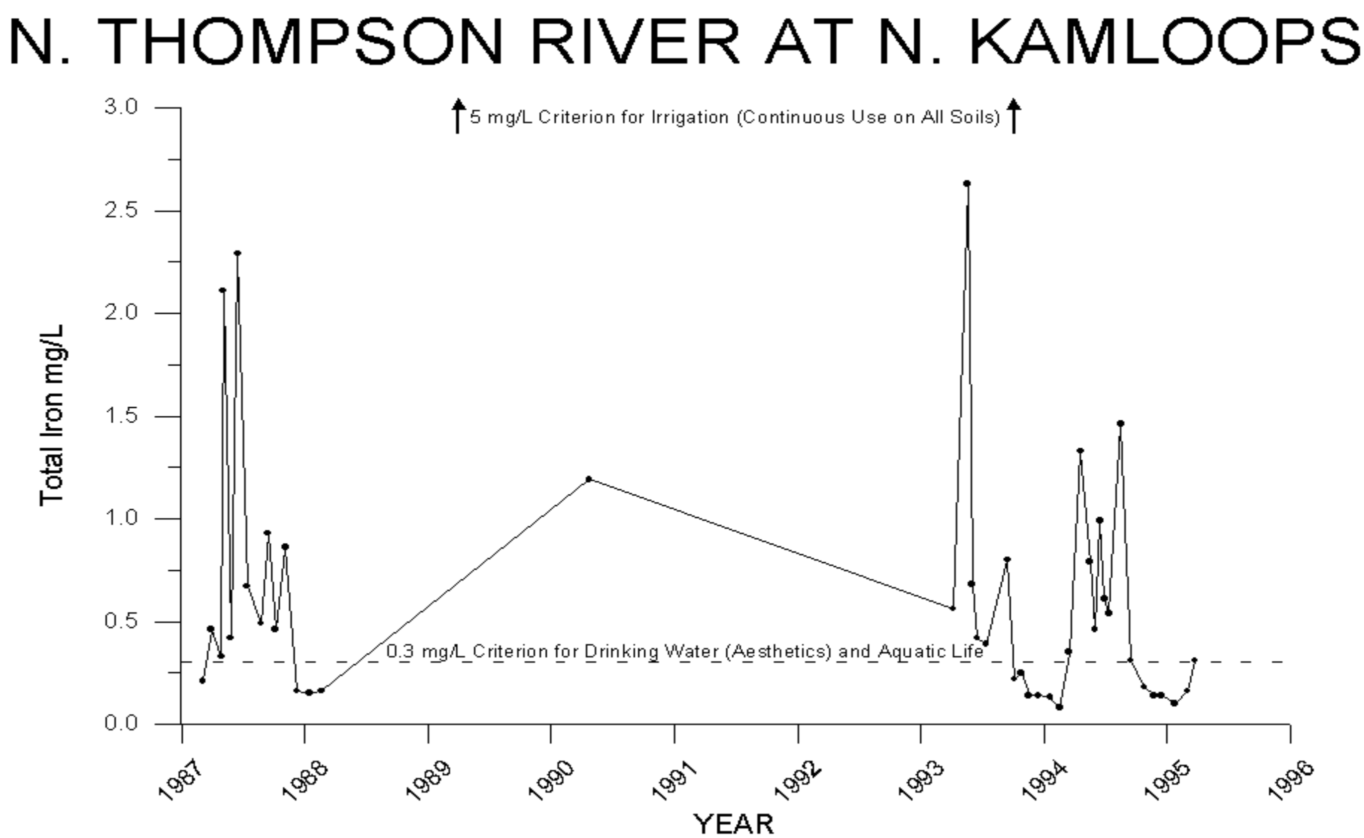


Figure 22 Total Lead

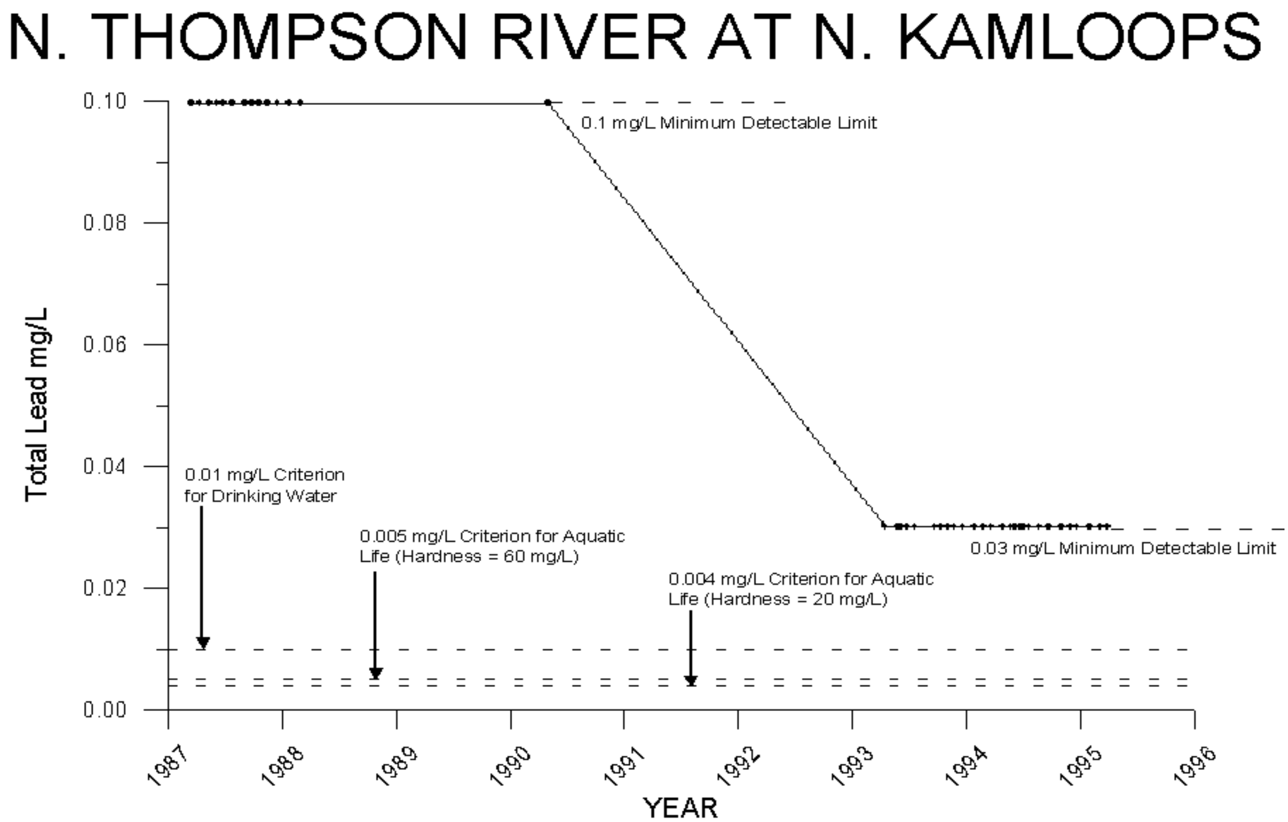


Figure 23 Magnesium

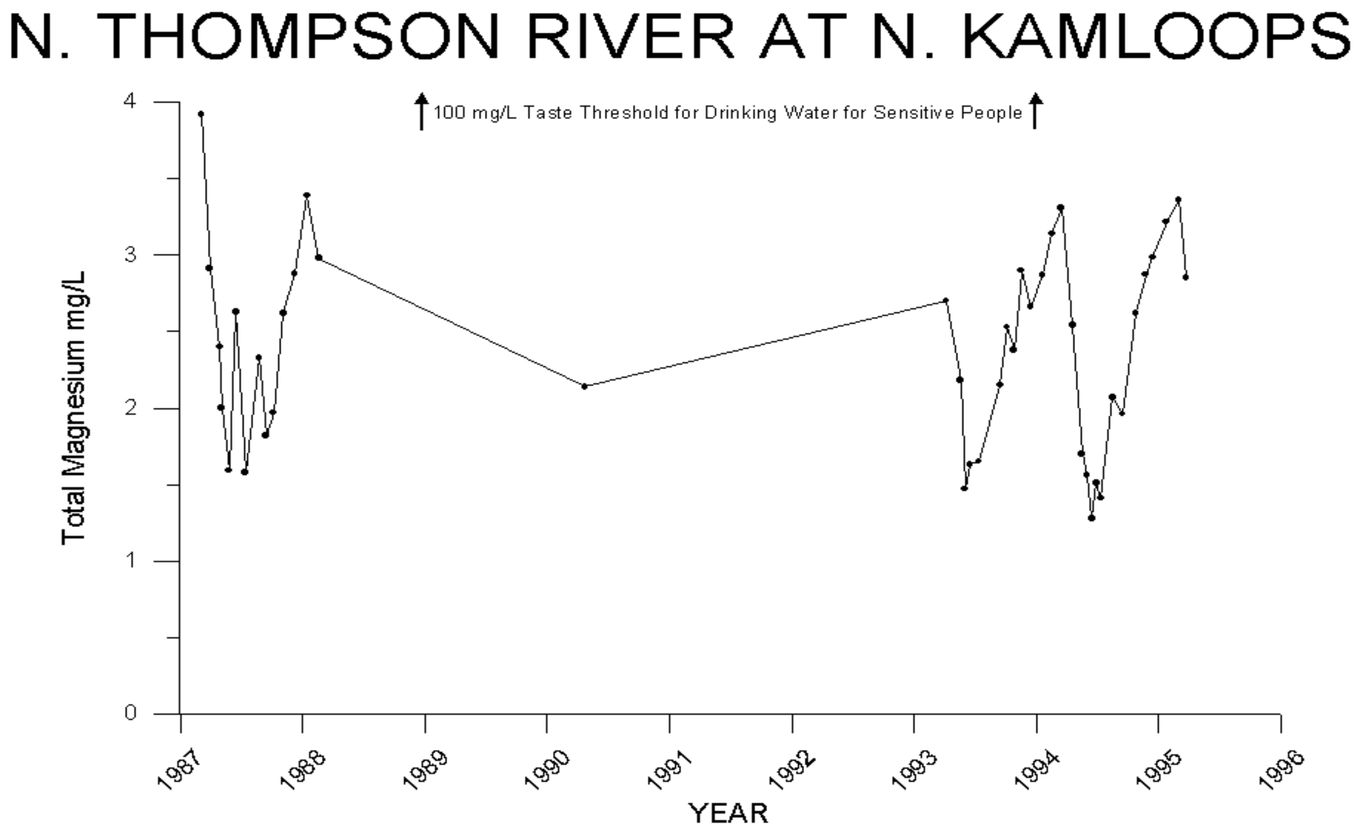


Figure 24 Total Manganese

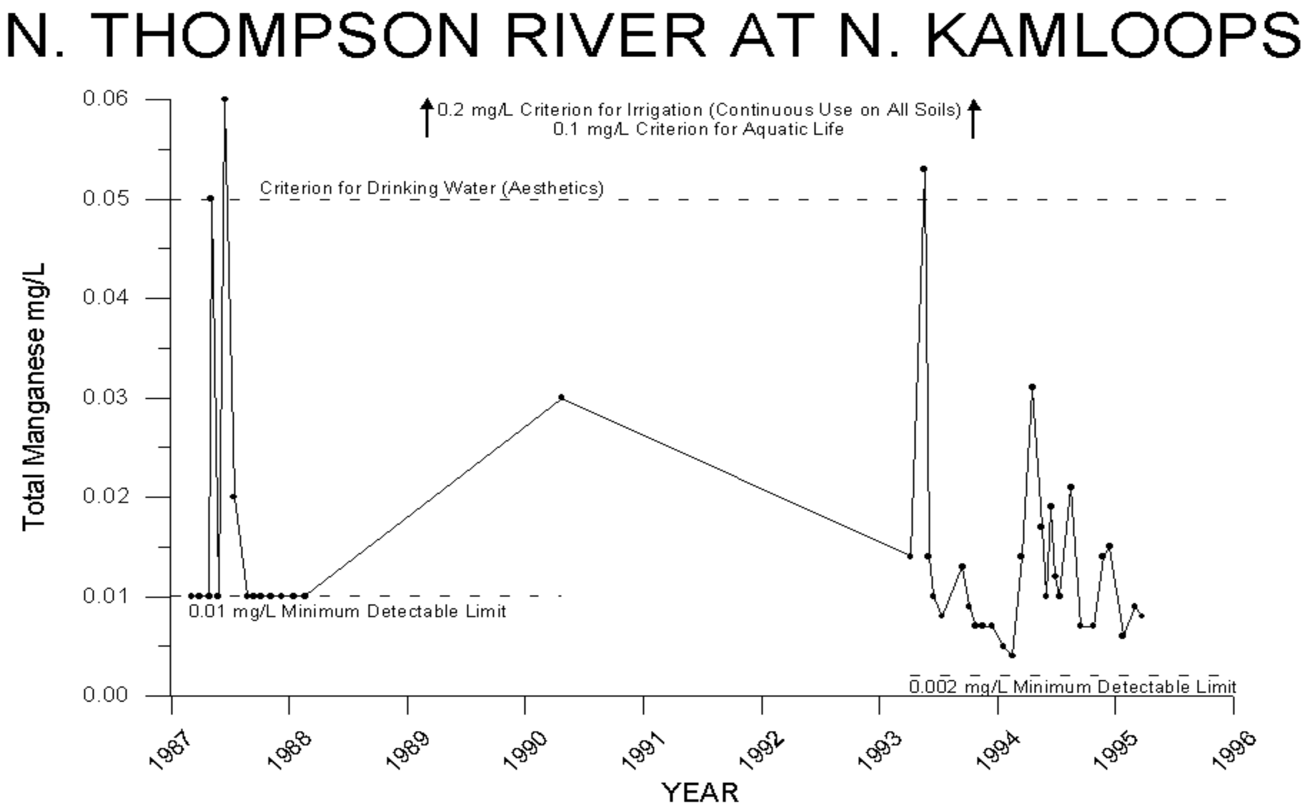


Figure 25 Total Molybdenum

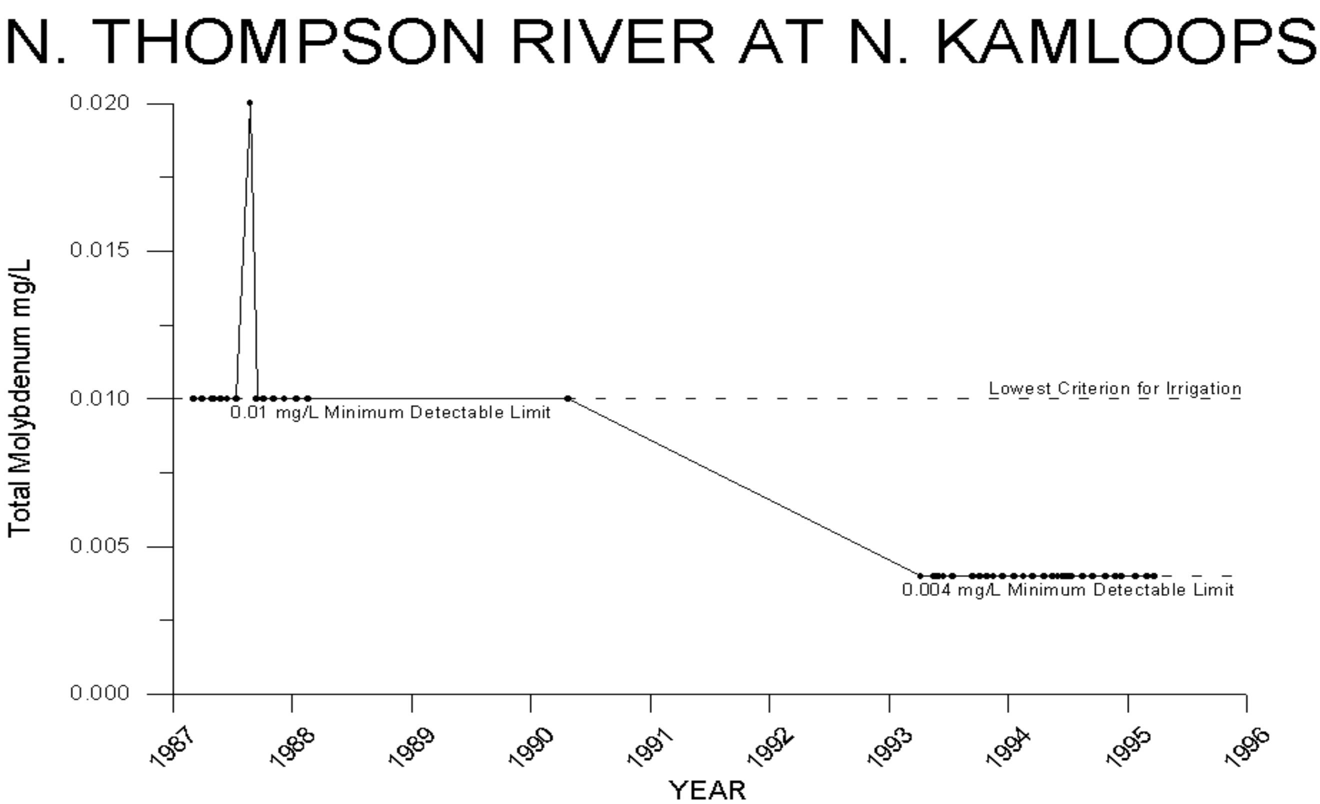


Figure 26 Total Nickel

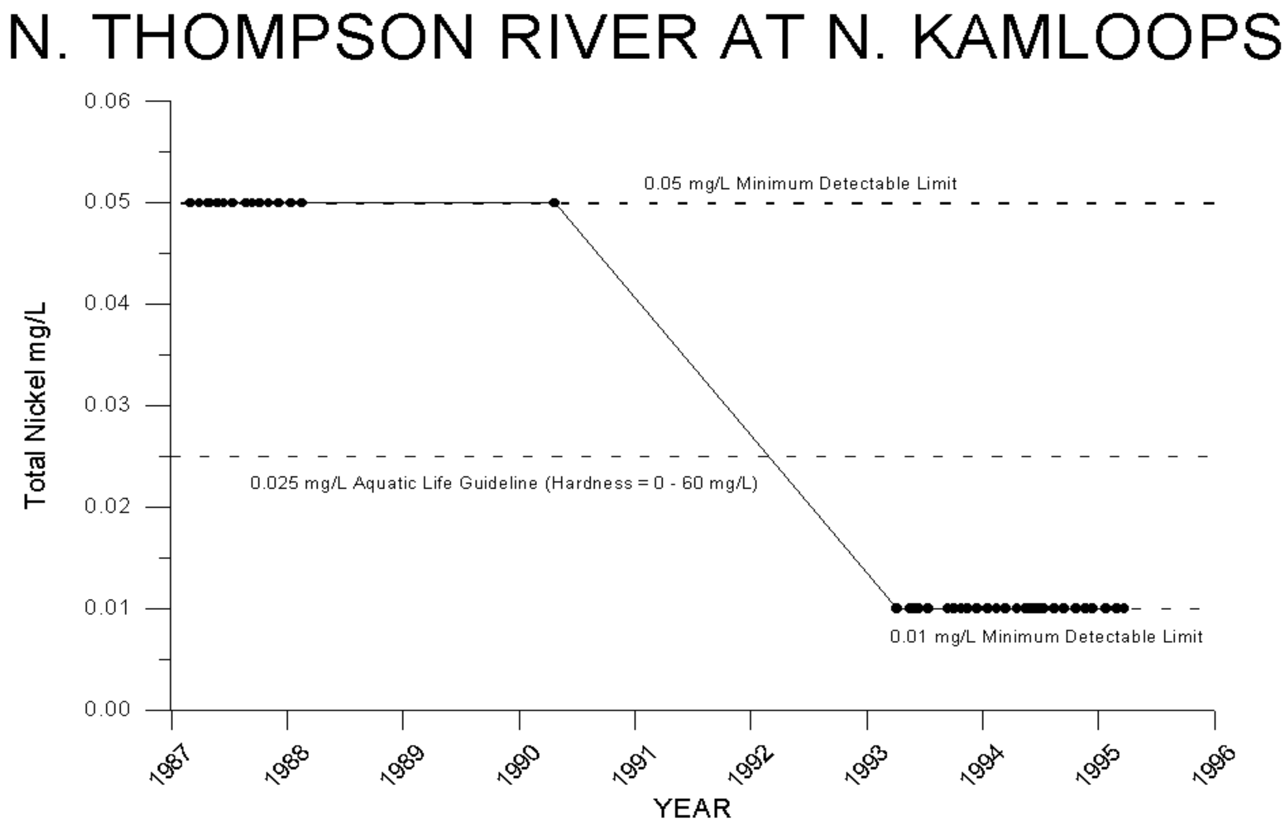


Figure 27 Nitrogen (Ammonia)

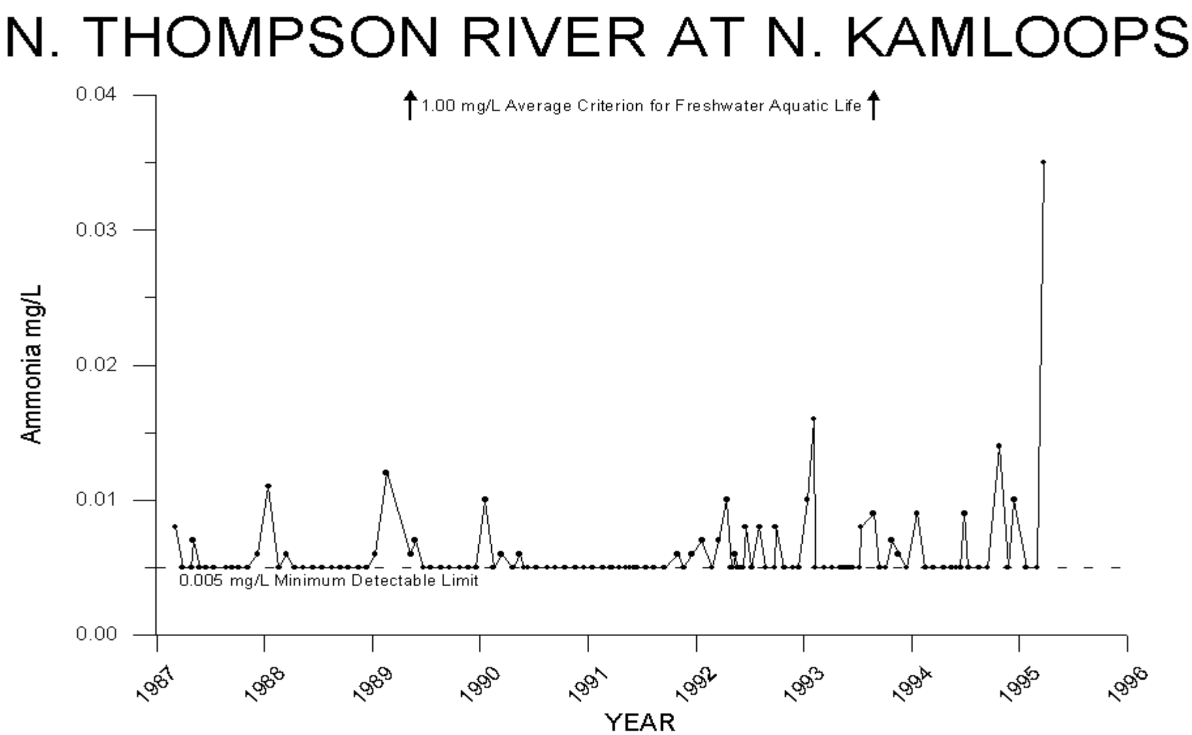


Figure 28 Nitrogen (Kjeldahl)

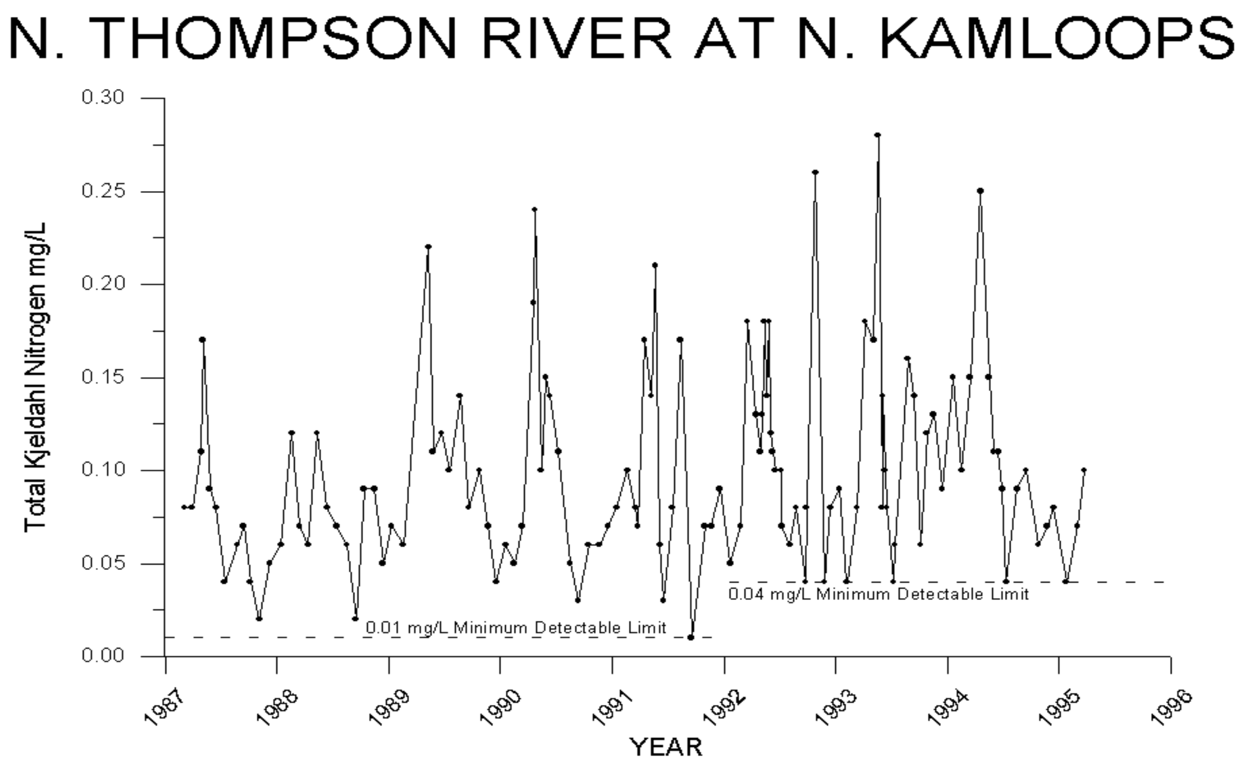


Figure 29 Nitrogen (Nitrate/Nitrite)

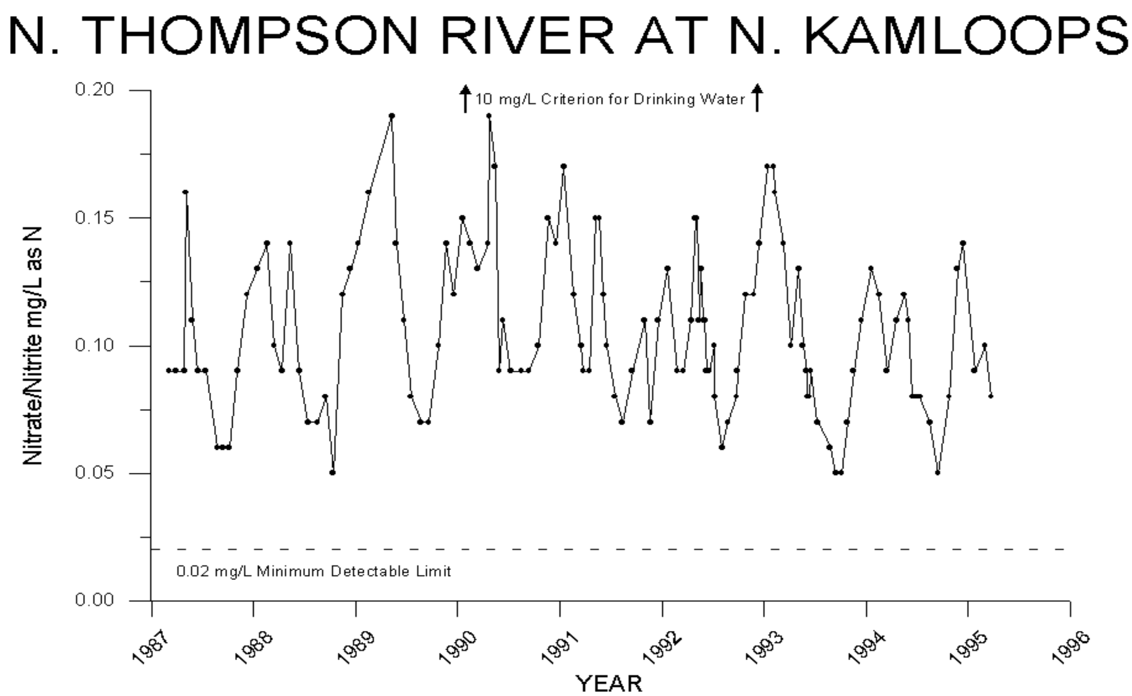
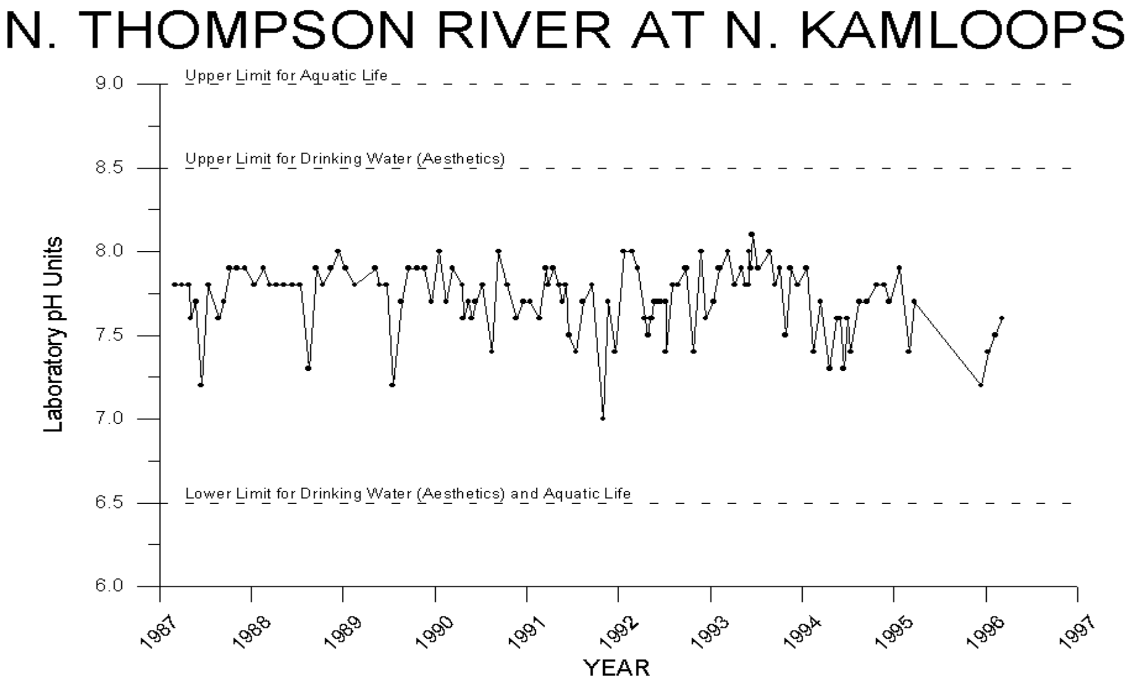


Figure 30 pH



N. THOMPSON RIVER AT N. KAMLOOPS
Upper Limit for Aquatic Life
Upper Limit for Drinking Water (Aesthetics)
Lower Limit for Drinking Water (Aesthetics) and Aquatic Life
Laboratory pH Units
9.0
8.5
8.0
7.5
7.0
6.5
6.0
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
YEAR

Figure 31 Total Phosphorus

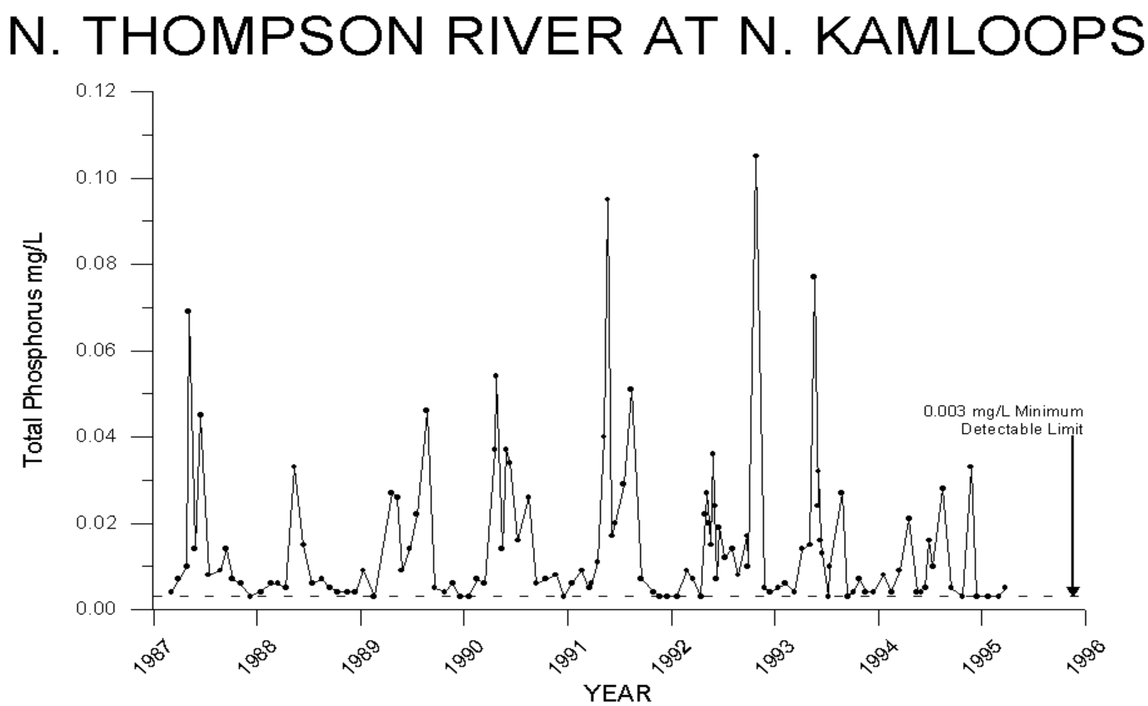


Figure 32 Dissolved Ortho-Phosphorus (Low Level)

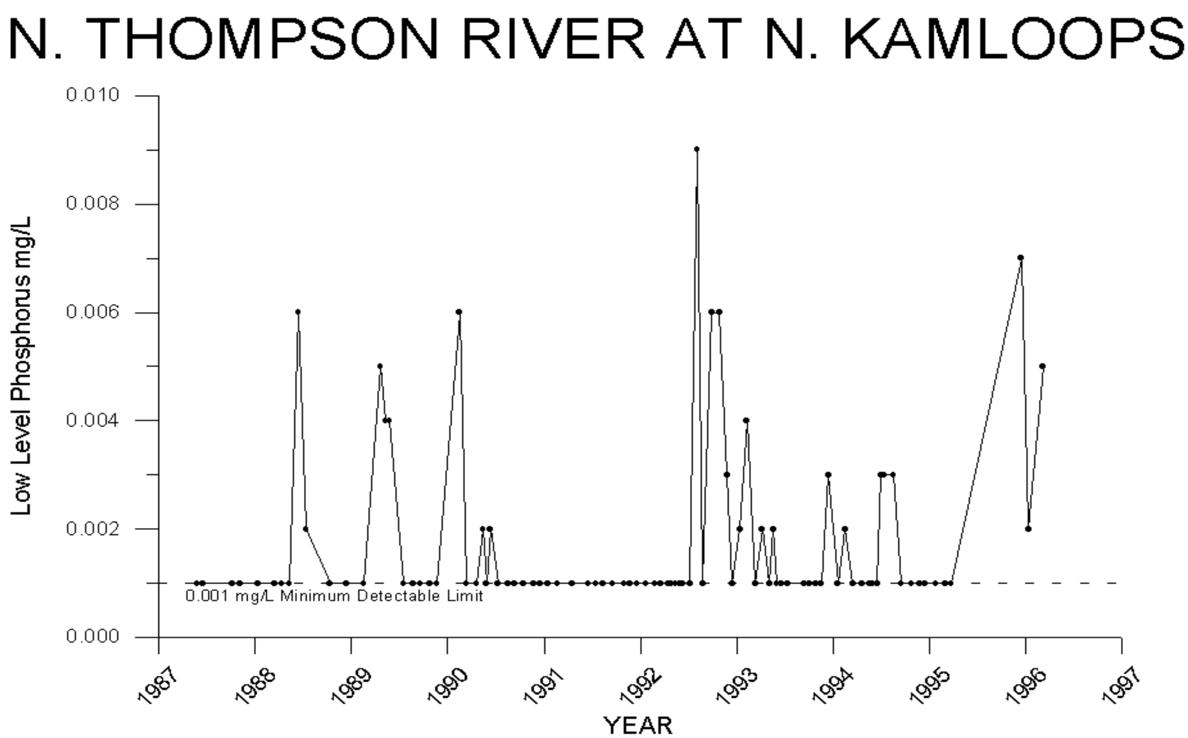


Figure 33 Total Dissolved Phosphorus

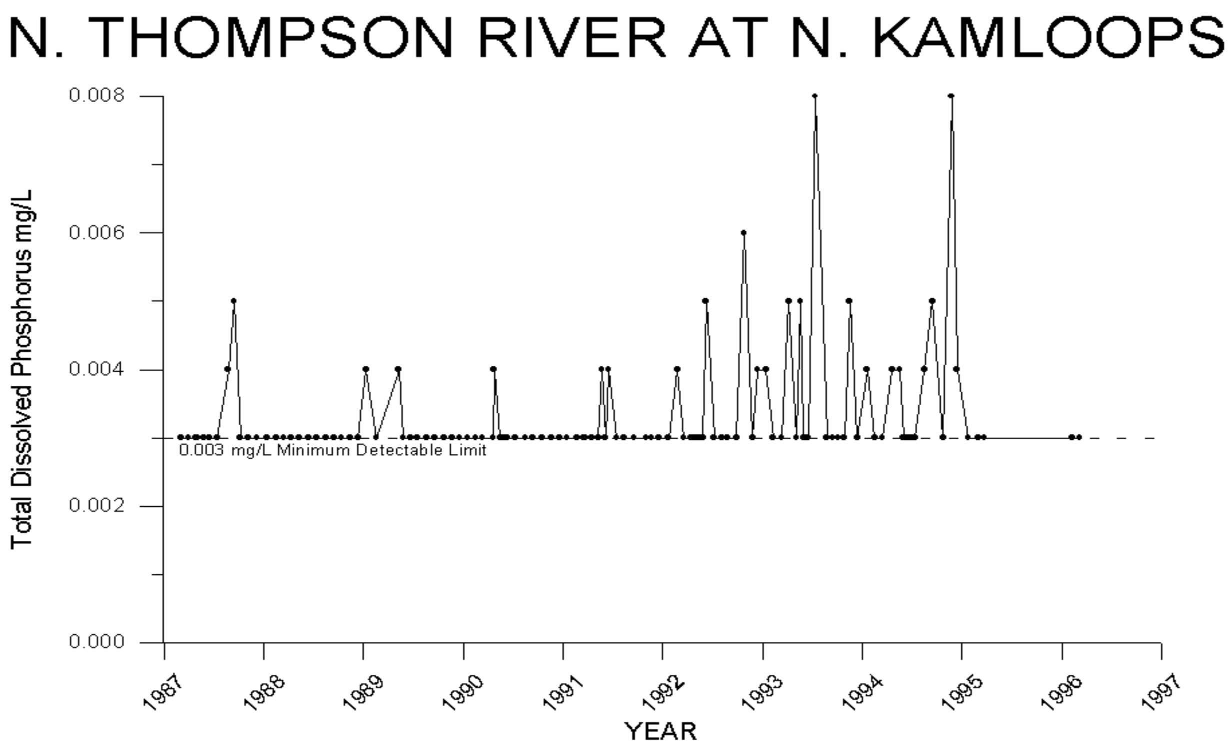


Figure 34 Dissolved Ortho-Phosphorus

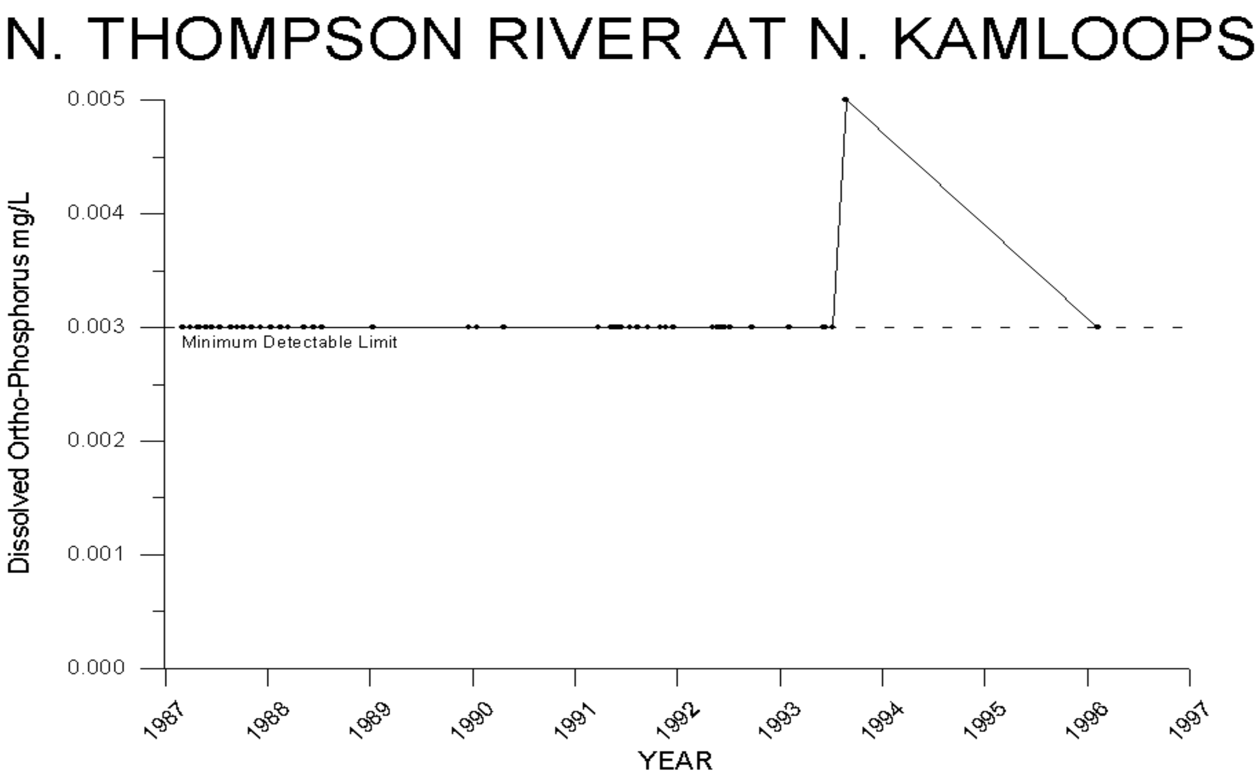


Figure 35 Non-Filterable Residue

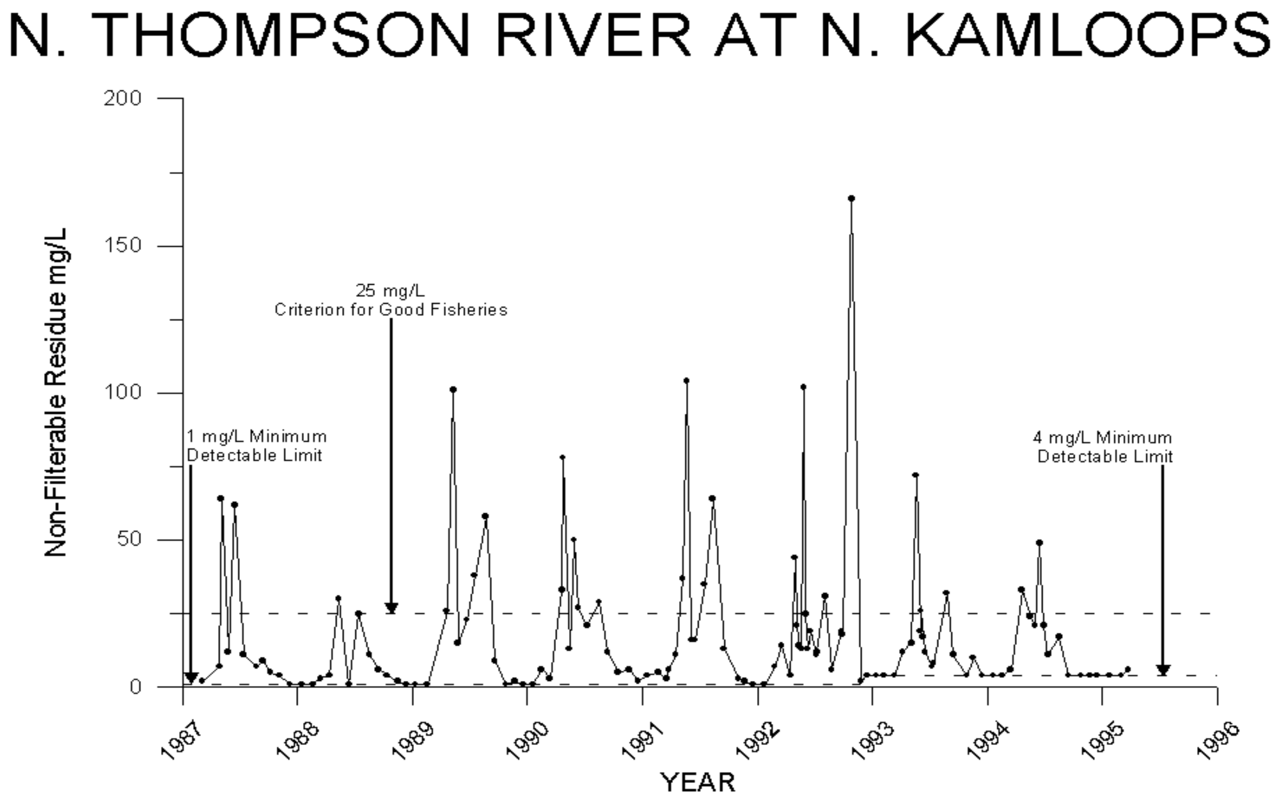


Figure 36 Total Selenium

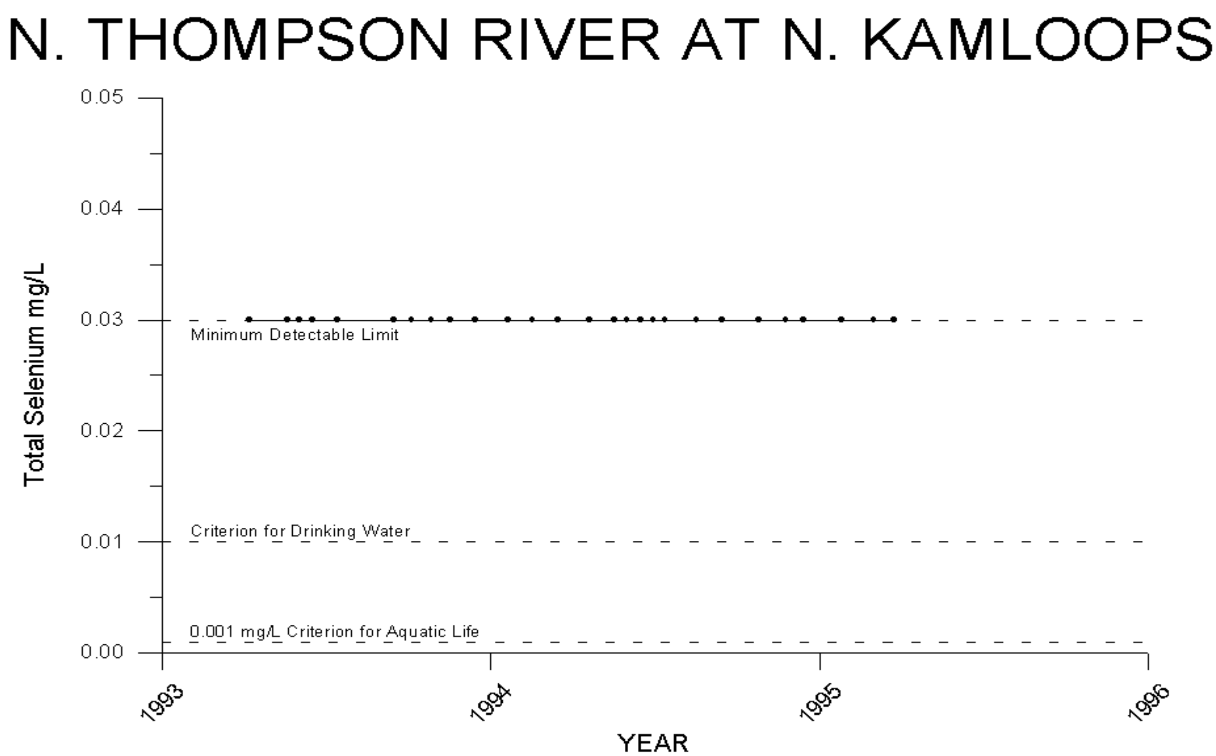


Figure 37 Silica

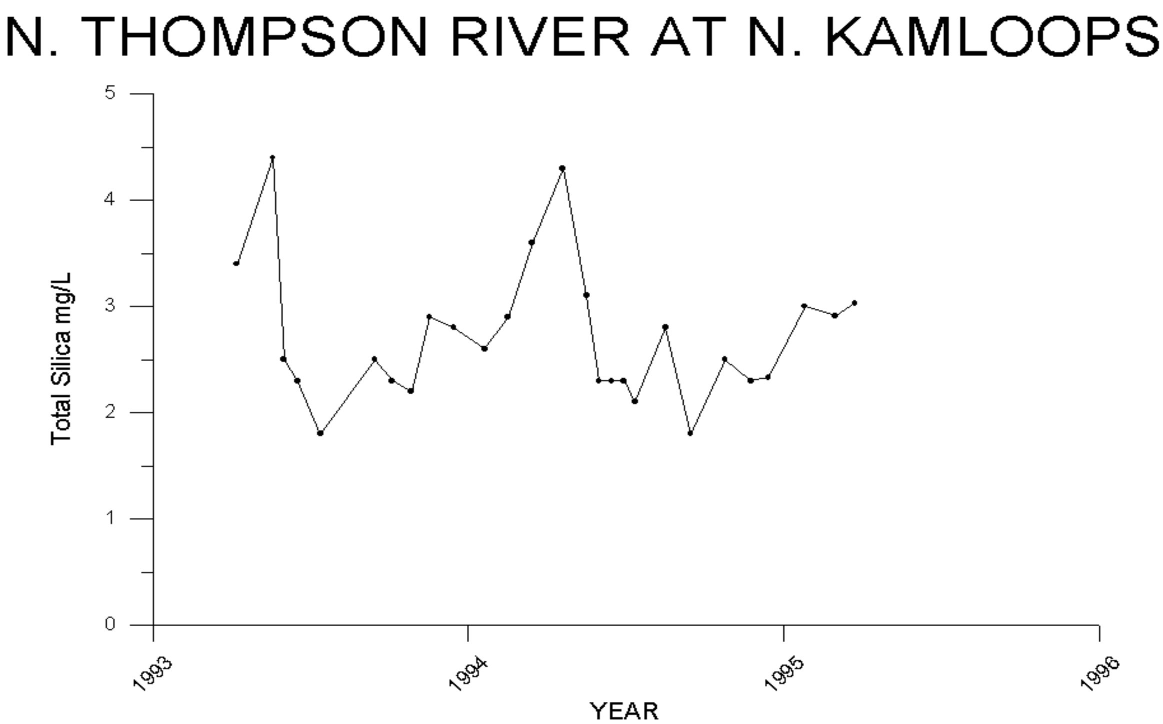


Figure 38 Total Silver

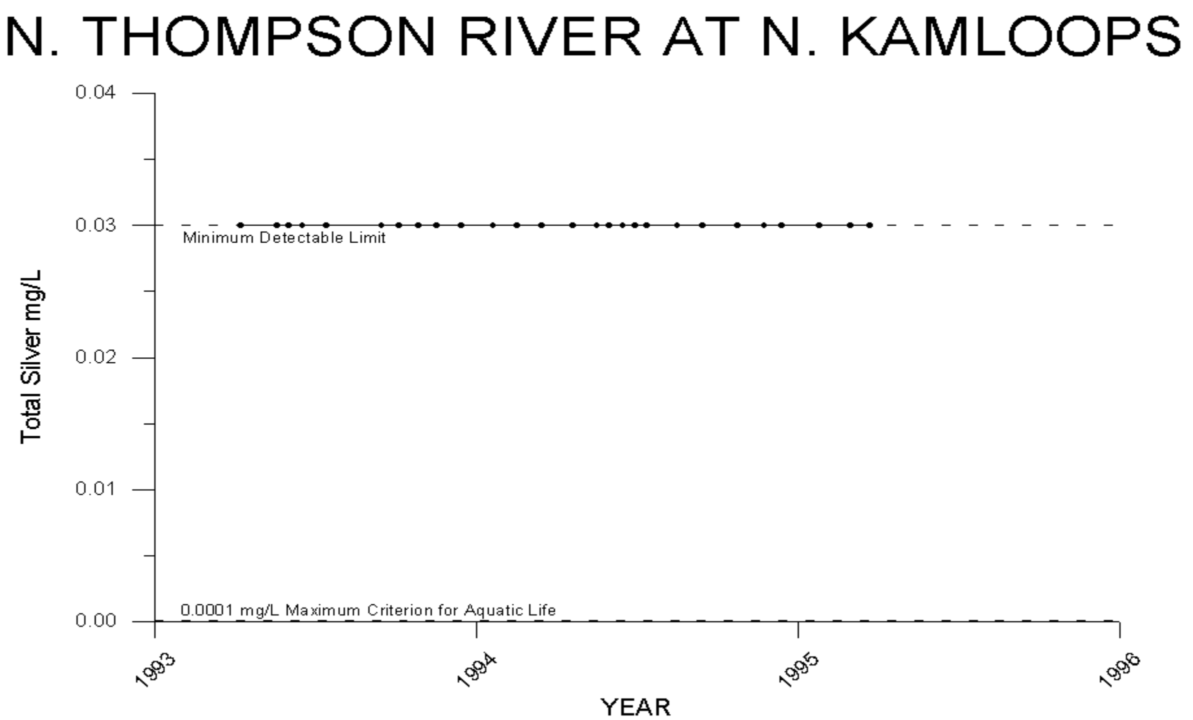


Figure 39 Specific Conductivity

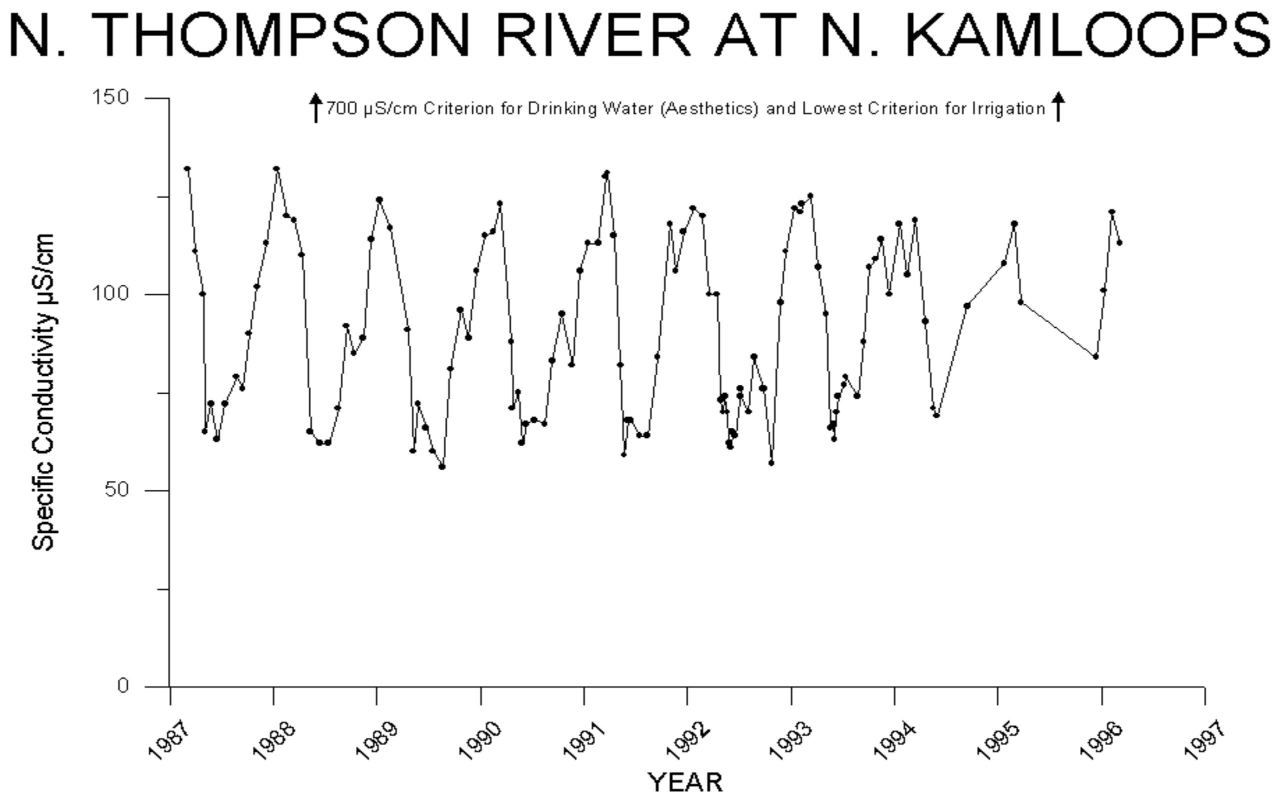


Figure 40 Total Strontium

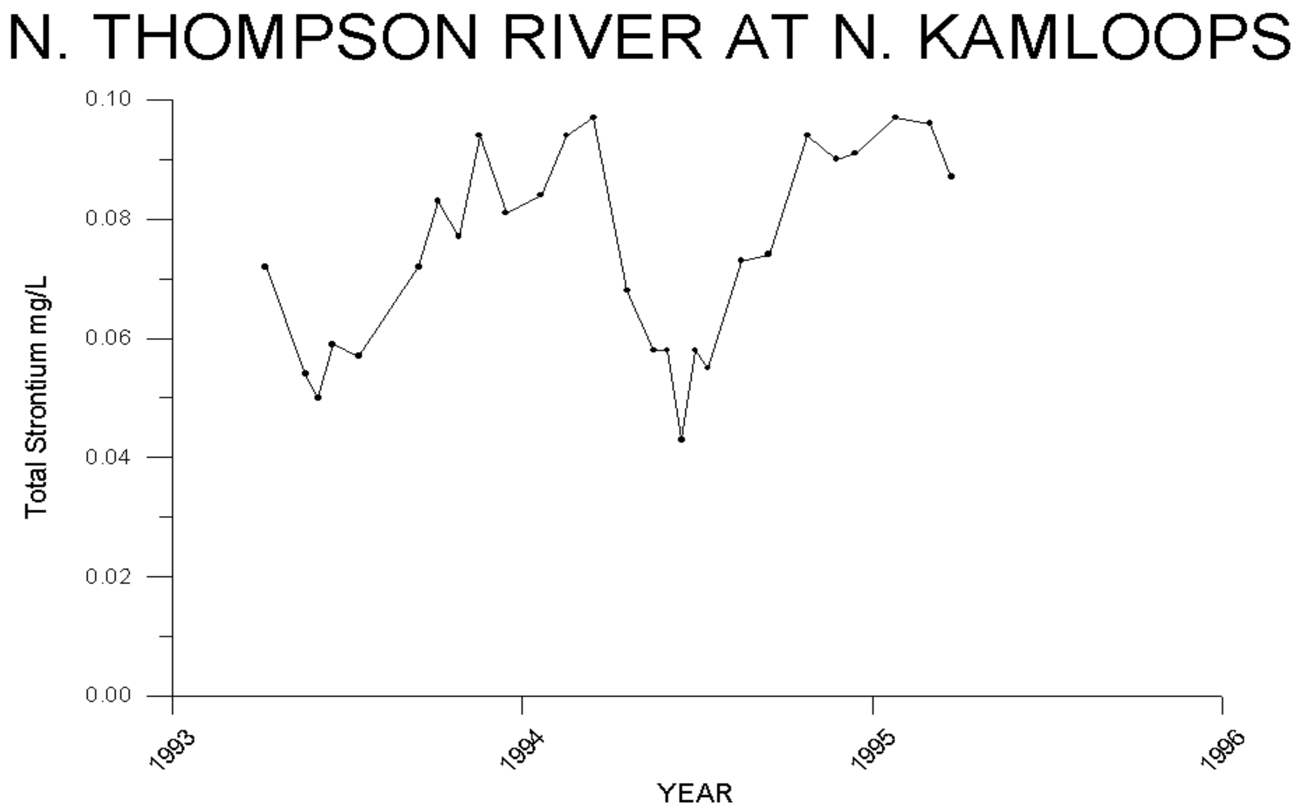


Figure 41 Dissolved Sulphate

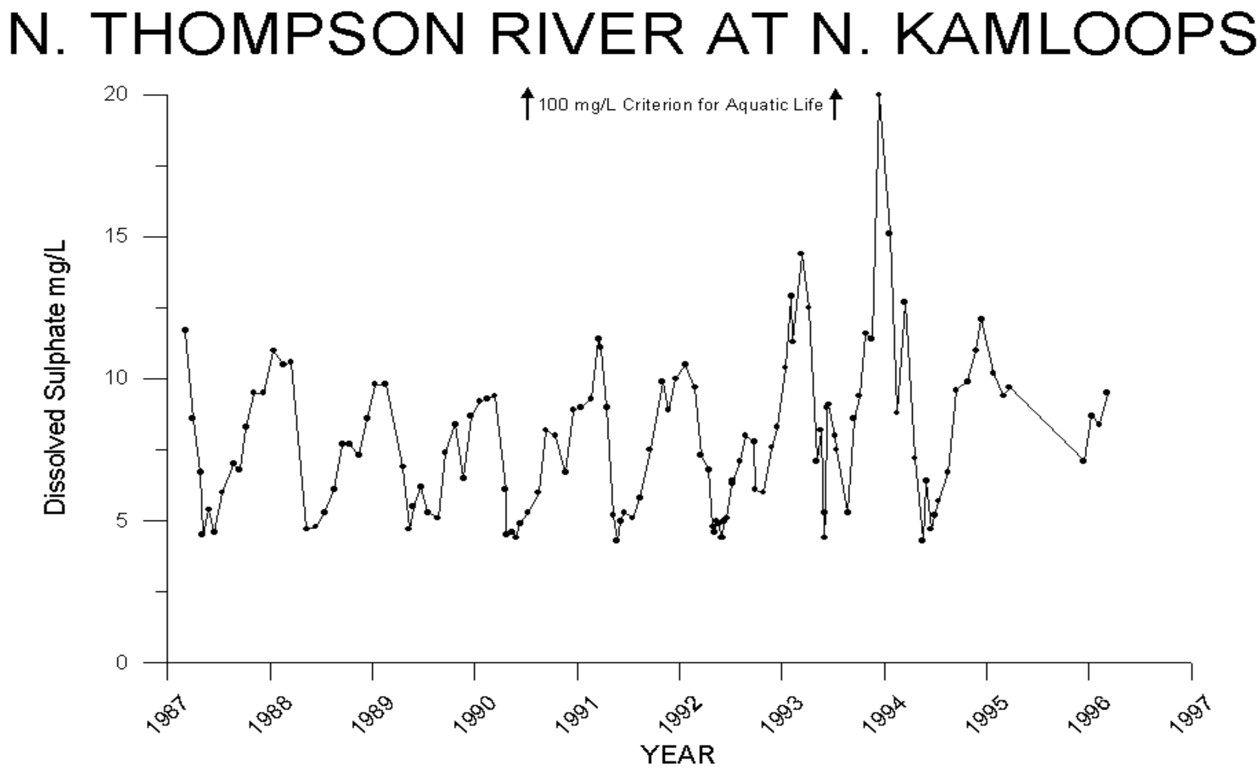


Figure 42 Total Tellurium

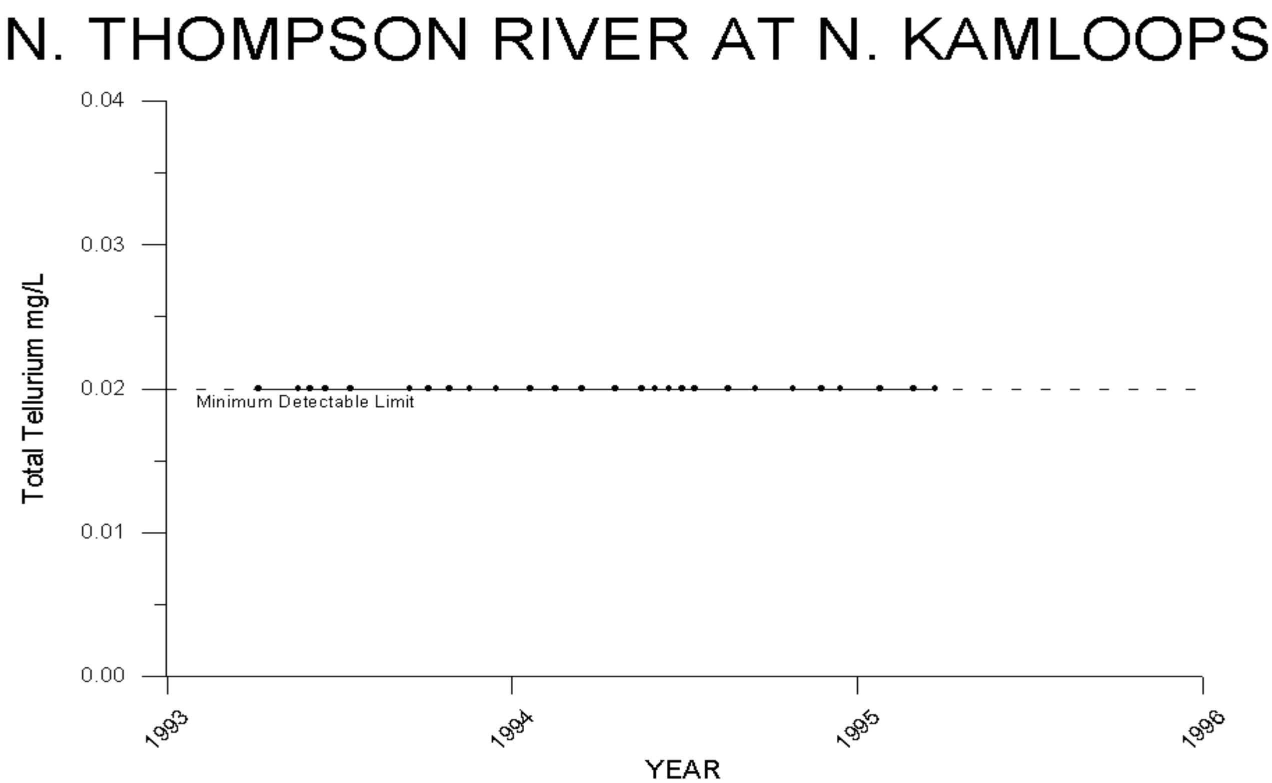


Figure 43 Total Thallium

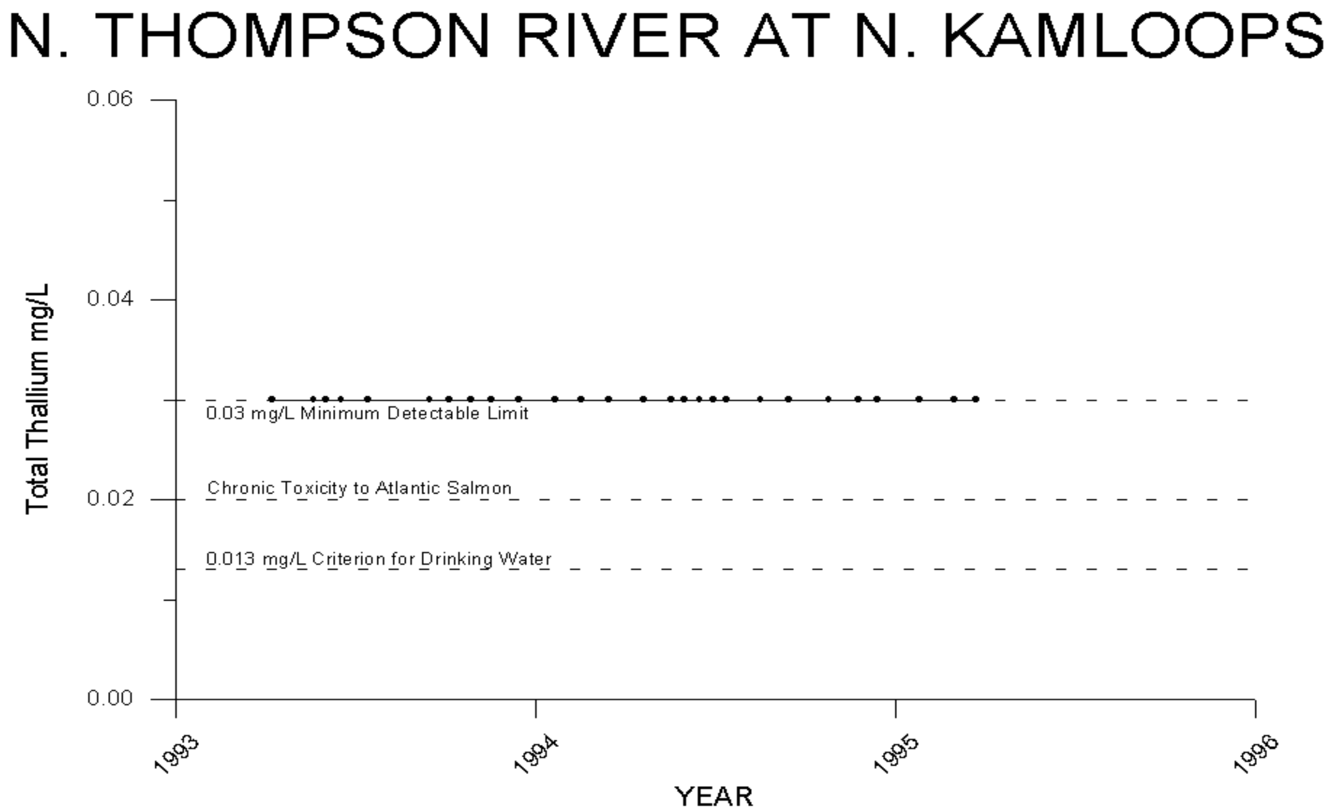


Figure 44 Total Tin

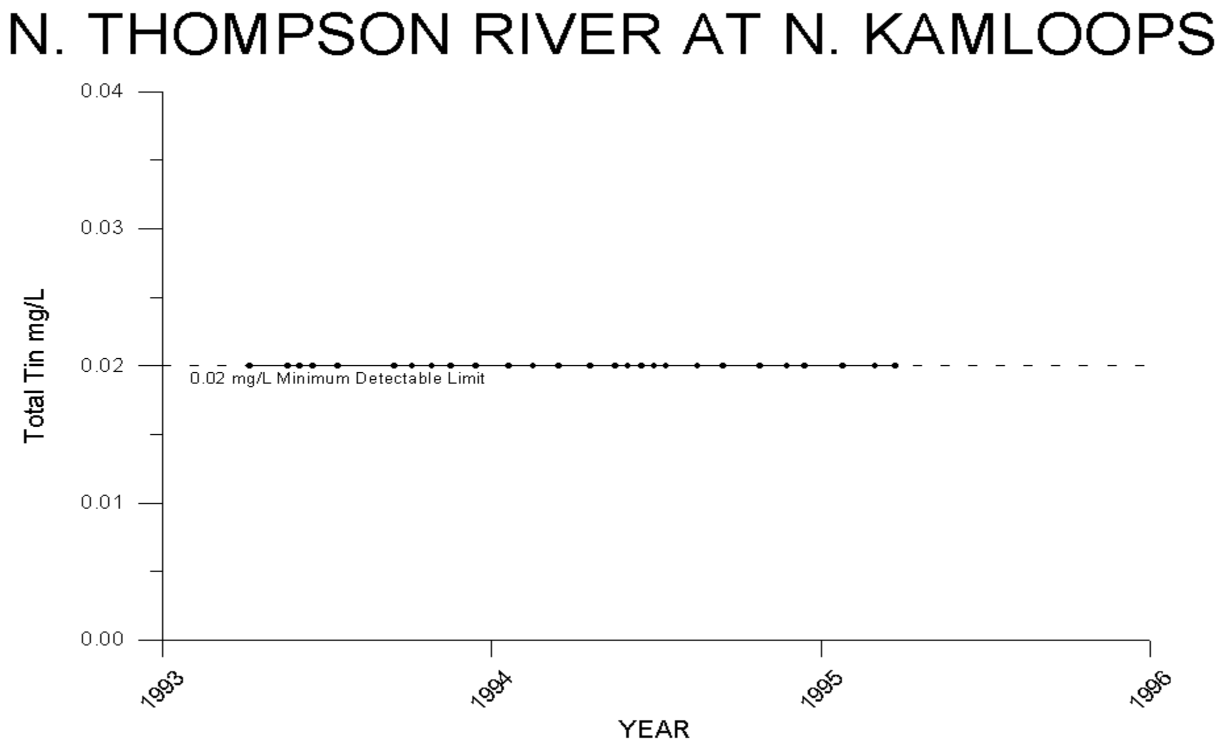


Figure 45 Total Titanium

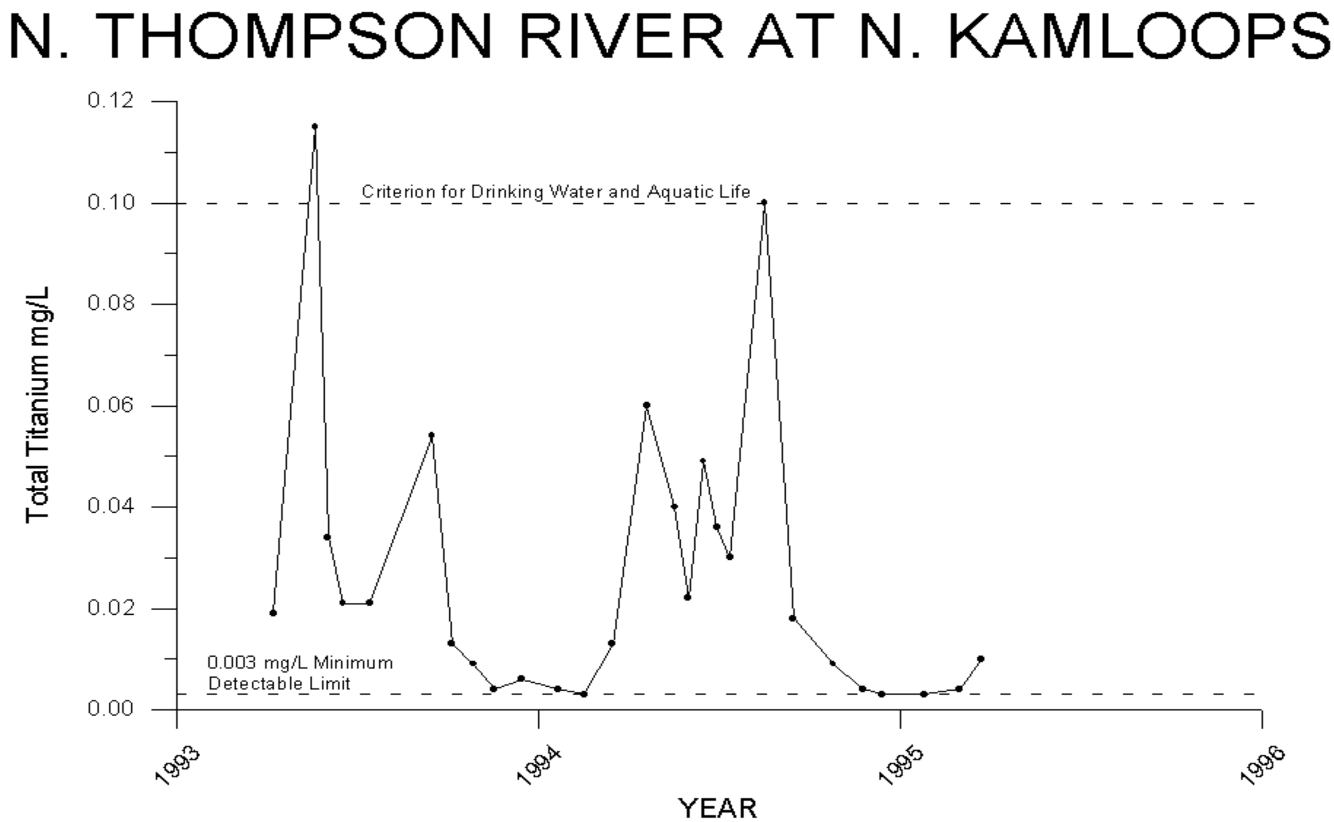


Figure 46 Turbidity

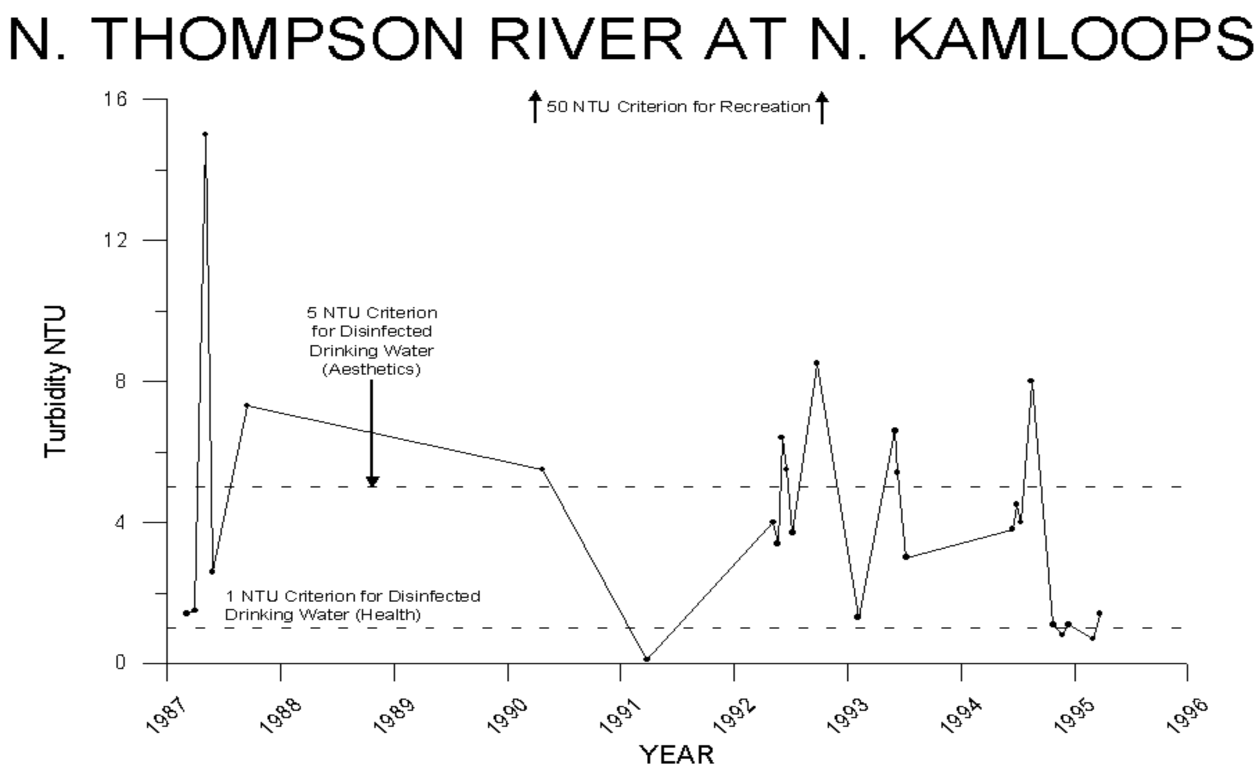


Figure 47 Total Vanadium

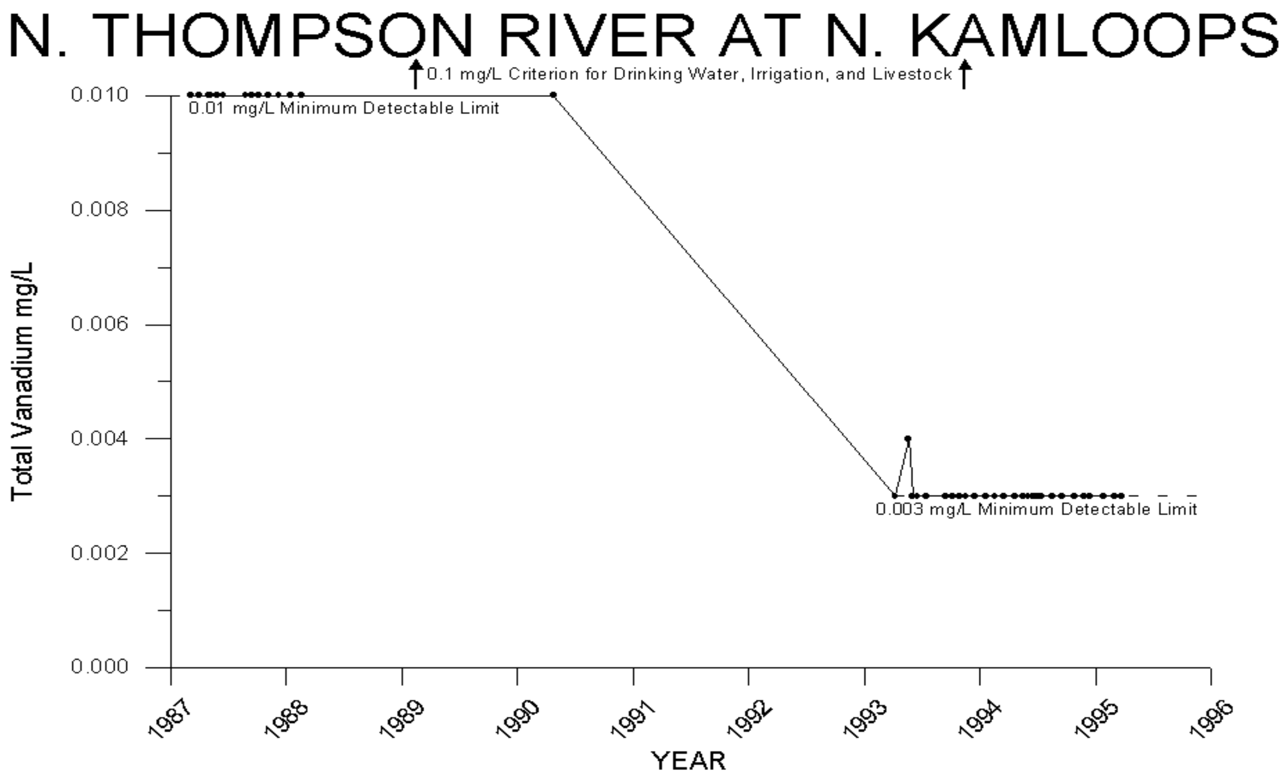


Figure 48 Total Zinc

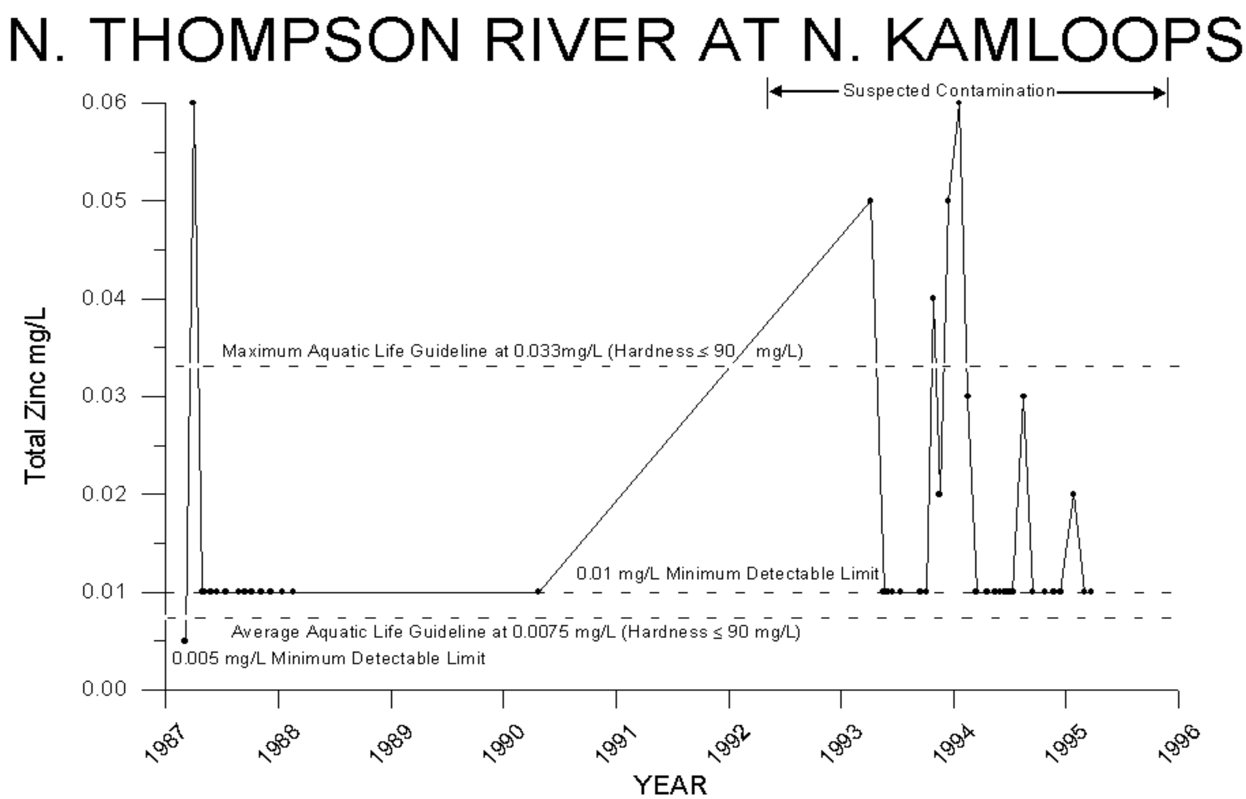
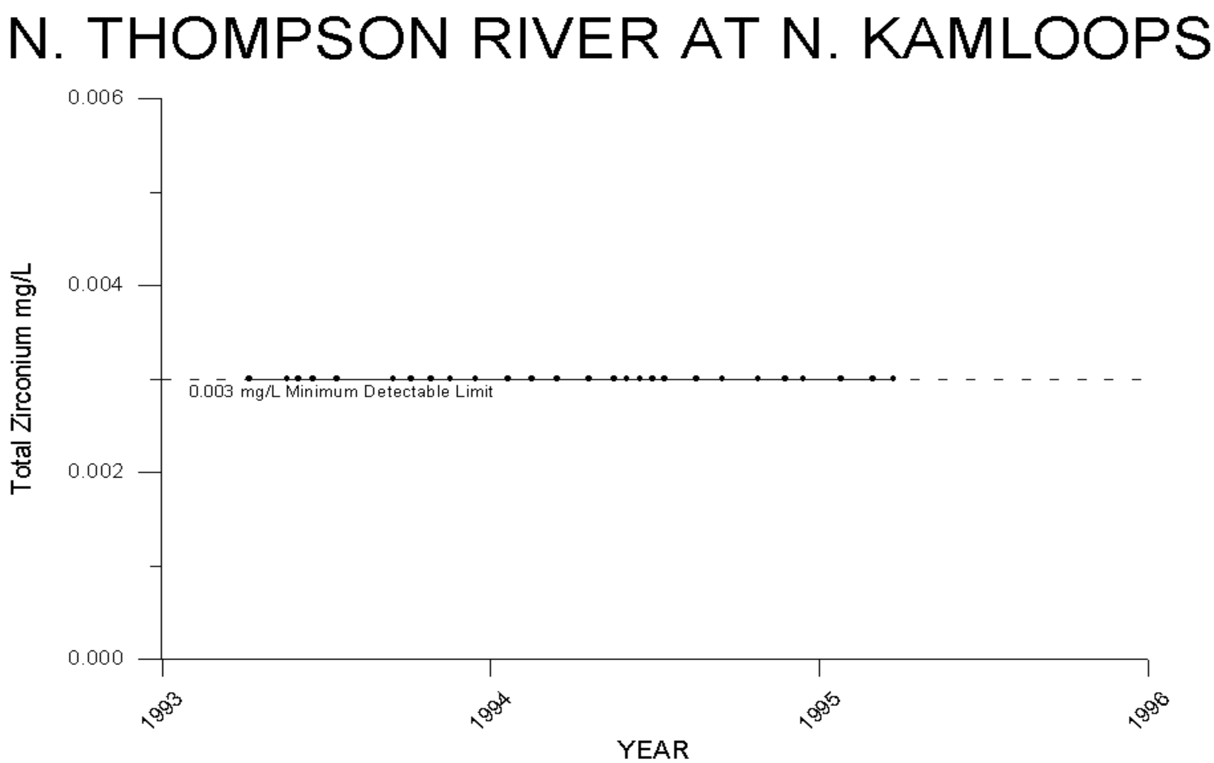


Figure 49 Total Zirconium



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