

CANADA – BRITISH COLUMBIA

WATER QUALITY MONITORING AGREEMENT

WATER QUALITY ASSESSMENT OF KOOTENAY RIVER AT FENWICK STATION (1971 – 2000)

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Environment
Canada

Environnement
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Ministry of
Environment

Executive Summary

The Kootenay River watershed is located in the southeast corner of British Columbia. At Fenwick Station, the river flows in the Rocky Mountain Trench, southeast of Kimberley, draining 12,000 km² of the Rocky Mountains to the east and the Purcell Mountains to the west. It is a transboundary river, which joins the Elk River and then flows into Kooacanusa Lake (the reservoir of Libby Dam in Montana), which straddles the Canada – U.S. border. The water quality sampling station on the Kootenay River at Fenwick Station is located 12 km downstream from the St. Mary River, 50 km upstream from the Elk River and about 70 km upstream from the border. This assessment is based on up to 30 years of water quality data during 1971-2000. The main human activities in the Kootenay River watershed were the Sullivan lead-zinc mine, concentrator and former fertilizer plant at Kimberley in the St. Mary River watershed, a kraft pulp mill at Skookumchuck, forestry, agriculture, and residential and commercial development. The water quality trends identified below have not yet been confirmed by statistical analysis.

CONCLUSIONS

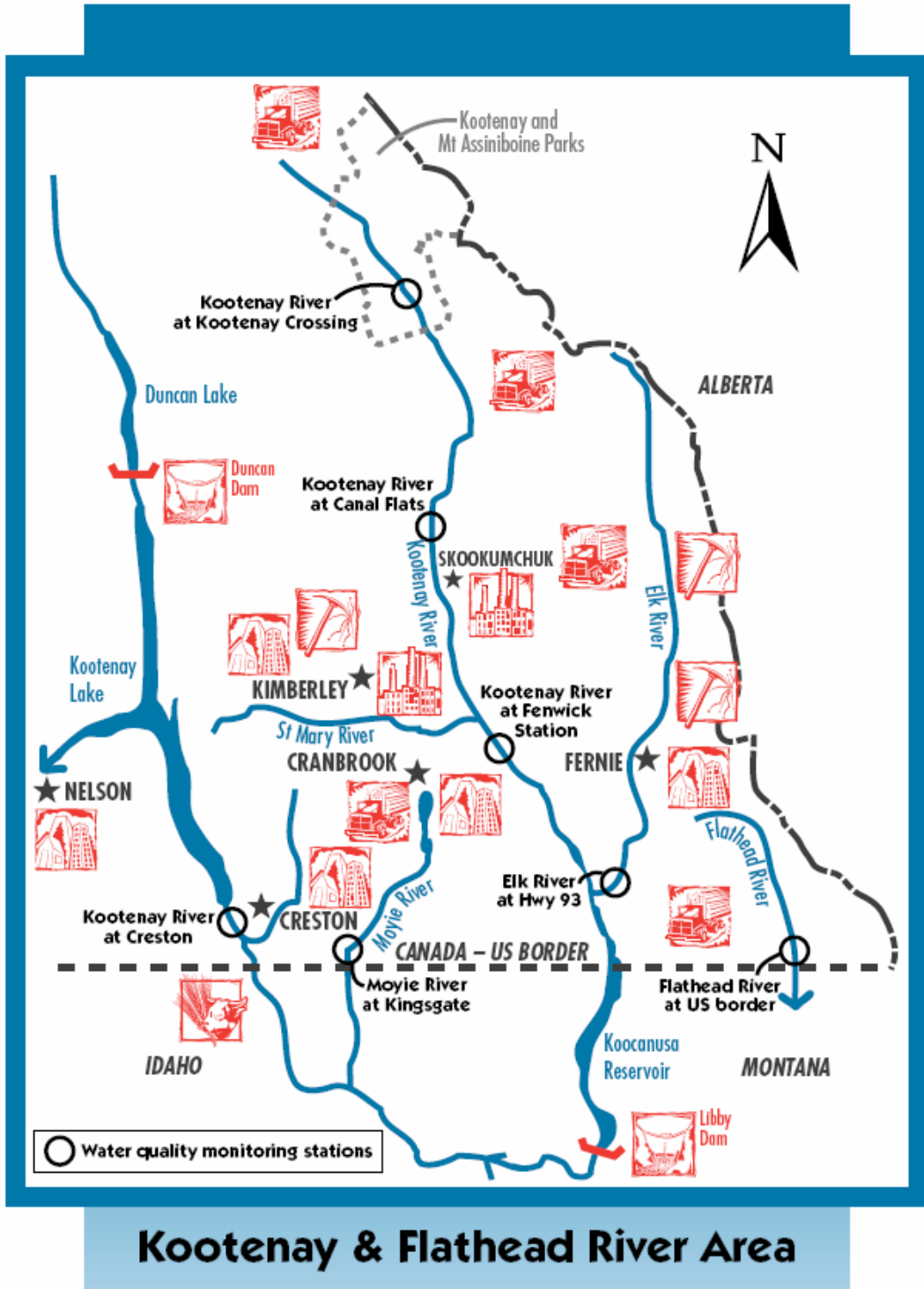
- Iron, lead, manganese, phosphorus and zinc had dramatic decreasing trends during the 1970's and early 1980's due to waste abatement at the Cominco complex on the St. Mary River at Kimberley. Since then, there has been little or no change of environmental significance in these indicators with the exception of zinc.
- Zinc had another decreasing trend during the 1990's due to renewed waste abatement at the Cominco Sullivan Mine, but aquatic life guidelines were still exceeded in 1997 and 2000.
- Cadmium data were not adequate for trend assessment, but aquatic life guidelines were exceeded in 1997 and 2000.
- Colour had decreasing trends during the 1980's and 1990's due to waste abatement at the pulp mill at Skookumchuck in 1981 (ground infiltration) and 1994 (tertiary treatment).
- Fecal contamination was greatly reduced between the 1970's and 2000, probably due to improved sewage and pulp mill effluent treatment and disposal. In 2000, the water was suitable for swimming, livestock, irrigation, and drinking water that receives partial treatment and disinfection.
- Turbidity had elevated levels during the spring snowmelt freshet, indicating that turbidity removal (e.g., filtration) would be needed before drinking water use. The turbidity peaks also caused metals such as cadmium, chromium, cobalt, copper, iron, lead and manganese to peak and exceed guidelines for aquatic life and drinking water. However, being associated with turbidity, the metals were not likely bio-available and would be removed by the water treatment needed prior to drinking water use.
- Calcium, magnesium, sodium, conductivity and hardness all had minor increasing trends for unknown reasons. The only effect of these trends was that the water became less aesthetically pleasing for drinking water due to increasing water hardness.

- pH occasionally exceeded the aesthetic objective for drinking water.

RECOMMENDATIONS

- Monitoring for the current suite of water quality indicators should continue because the Kootenay River at Fenwick Station and the Elk River at Highway 93 are the major inflows to Koocanusa Lake (the reservoir of the Libby Dam in Montana), which is a transboundary waterbody. Abatement of acid rock drainage at the Sullivan Mine is continuing (the mine is expected to be permanently closed in 2002) and there is a need to continue to track pollutants such as cadmium and zinc.

FIGURE 1 MAP OF THE KOOTENAY RIVER BASIN



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1. INTRODUCTION

The Kootenay River at Fenwick Station (also known as Picture Valley) water quality monitoring station is located east of Cranbrook, B.C., just before the river enters Koocanusa Lake, the reservoir of the Libby Dam in Montana (Figure 1). The drainage area of the river is 12,000 km² and its major tributary is the St. Mary River 12 km upstream. This reach of the river supports significant fisheries (e.g., westslope cutthroat trout, bull trout and whitefish) and the water is used for recreation and irrigation. The Cominco Ltd. Sullivan lead-zinc mine (expected to close in 2002), concentrator and former fertilizer plant (1953- 1987) are located in the St. Mary River watershed at Kimberley. The Crestbrook Forest Industries kraft pulp mill, which began operation in 1968, is located on the Kootenay River at Skookumchuck, about 45 km upstream from Fenwick Station. Forestry and agriculture are other potential influences on water quality.

Environment Canada has monitored flow on the Kootenay River at Fort Steele, about 10 km upstream from Fenwick Station since 1963. The flow data are stored on the Water Survey of Canada database under station number BC08NG065. Thirty years (1971-2000) of flow data are plotted in Figure 2. The Province began collecting water quality data at Fenwick Station in 1971 and the data are stored on the Environmental Monitoring System (EMS) under site number 0200038. Environment Canada began monitoring water quality at Fenwick Station in 1984, and since 1986 Canada and B.C. have jointly operated the station as a federal-provincial station. Water quality data have been collected every two weeks since 1985 and are stored on the ENVIRODAT database under station number BC08NH0009 and on EMS under site number 0200038. Up to thirty years (1971-2000) of water quality data were used in this report. The data for the current suite of water quality indicators are plotted in Figures 3 to 49. These are the water quality indicators that were recommended by a previous assessment (Ministry of Environment, Lands and Parks and Environment Canada, 1996) and that have been monitored up to the present.

2. WATER QUALITY ASSESSMENT

The status and trends of water quality were assessed by plotting the water quality indicators over time and comparing the values to the Province's approved and working water quality guidelines (Ministry of Environment, Lands and Parks, 2001a & 2001b). Any levels or changes of the indicators over time that may have been harmful to sensitive water uses, such as drinking water, aquatic life, wildlife, recreation, irrigation and livestock, are described below in alphabetical order.

Water quality indicators that were plotted but not discussed because they easily met all water quality guidelines and showed no harmful trends were: aluminum, total, barium, total and extractable, beryllium, total and extractable, boron, extractable, gallium, extractable, lanthanum, extractable, lithium, total and extractable, molybdenum, total, nickel, total and extractable, nitrogen, total dissolved, selenium, total and extractable, strontium, total and extractable, thallium, extractable, uranium, extractable, and vanadium, total and extractable.

Trace elements at this station were measured by total and extractable methods. Total and extractable samples are both acidified in the field with nitric acid to about pH 2. Extractable zinc samples are then analysed in the laboratory without further treatment, while total zinc samples have additional nitric and hydrochloric acid added and are boiled to dryness before analysis. The additional extraction step has the potential to extract trace elements that are strongly bound to particulate matter and unlikely to be bio-available.

Arsenic, total was monitored during 1971-78 and 1984-2000, but the data prior to 1984 were excluded due to high detection limits (0.005 mg/L). Figure 4 shows that there was an apparent decline in arsenic levels between 1984-2000. This was due at least in part to a change in detection limit in 1994 (0.0002 to 0.0001 mg/L), but a decline is also evident during 1984-93, possibly due to waste abatement at Cominco's Kimberley operations. The aquatic life guideline was always met during 1984-2000.

Cadmium, total (Figure 8) was monitored during 1973-2000, but most of the data prior to 1986 were excluded owing to high detection limits (0.01, 0.001 and 0.0005 mg/L). Only data with a detection limit of 0.0001 mg/L, which is still above the aquatic life guidelines (0.00003-0.00006 mg/L), were included. Nevertheless, there were many detectable values above the guideline during 1973-2000, mostly occurring in freshet due to elevated turbidity, suggesting that the cadmium was particulate-bound and not likely to have been bio-available. Some of the detectable values may also be false positives since the values were all close to the detection limit. The maximum value of 0.0018 mg/L was still below the drinking water guideline of 0.005 mg/L. There may have been a slight decrease over time.

Cadmium, extractable (Figure 9) was monitored during 1997-2000 with a detection limit of 0.000005 mg/L. Figure 9 shows that extractable cadmium values were significantly lower than total cadmium values. For total cadmium values >0.0001 mg/L, extractable cadmium represented 8-47% of the total cadmium, indicating that 53-92% of the total cadmium was strongly bound to particulate matter and not bio-available. Six extractable cadmium values exceeded the aquatic life guidelines in April-May 1997 and May 2000. St. Mary River monitoring during 1999-2000 shows that extractable cadmium often exceeded aquatic life guidelines, and thus the St. Mary River may be the cause of the elevated levels in the Kootenay River. Waste discharges from the Sullivan Mine are the probable cause of the elevated levels in the St. Mary River. The extractable cadmium record is too short to discern trends.

Calcium (Figure 10) was monitored during 1971-2000. Dissolved, total and extractable calcium data were combined in Figure 10, since there was little difference in paired values. There has been a slight increasing trend in calcium values over time. Calcium and magnesium are the two main components of water hardness, and increasing levels make the water less aesthetically desirable for drinking water, as discussed under hardness below.

Carbon, dissolved organic (Figure 11) was monitored during 1997-2000. All but one of the measurements was below the 4 mg/L guideline for drinking water that will be disinfected with chlorine. The value of 24.7 mg/L on October 5, 2000 appears to be an error because true colour (6 units) and single-wavelength colour (<5 units) were low that day.

Chromium, total (Figure 12) was monitored during 1973-2000, but the data prior to 1990 were excluded due to high detection limits (0.01 and 0.005 mg/L) and contamination from preservative vials in 1986-90. During 1990-2000, two values (0.013 and 0.02 mg/L) exceeded the 0.009 mg/L aquatic life guideline for trivalent chromium. One of the peaks occurred during freshet when turbidity was high, and one happened in winter when turbidity was low. The aquatic life guideline of 0.001 mg/L for hexavalent chromium was exceeded often. However, during 1997-2000 seven of the eight exceedances were during freshet when turbidity was high. This indicates that the chromium was particulate-bound and probably not bio-available. There was an apparent slight decrease over time.

Chromium, extractable (Figure 13) was monitored during 1997-2000, and the values were similar to total chromium values, except during freshet, when extractable levels were 3-57% of the total. This indicates that much of the chromium was strongly bound to particulate matter during freshet, and thus not bio-available. Three extractable values slightly exceeded the 0.001 mg/L aquatic life guideline for hexavalent chromium. (Four extractable chromium values significantly exceeded the corresponding total chromium values and were excluded as probable errors.) The extractable chromium record is too short to discern trends.

Cobalt, total (Figure 14) was monitored during 1982-2000, but data prior to 1990 were excluded due to a high detection limit (0.1 mg/L). During 1990-2000, a detection limit of 0.0001 mg/L was used and 11 values exceeded the 0.0009 mg/L aquatic life guideline. These peaks occurred during spring freshet due to elevated turbidity and thus were probably not bioavailable. There were no apparent changes over time. **Cobalt, extractable** (Figure 14) was monitored during 1997-2000 with a detection limit of 0.000002 mg/L. Levels were somewhat lower than for total cobalt, confirming that some of the cobalt was strongly bound to particulate matter and not bio-available. The aquatic life guideline was slightly exceeded twice during spring freshet. The extractable cobalt record is too short to discern trends.

Coliforms, fecal (Figure 15) were monitored in 1973-77 and 2000. The levels in 2000 (maximum of 12/100 mL) were much lower than in 1973-77 (maximum of <20,000/100 mL), probably due to improved sewage and pulp mill effluent treatment. The 2000 levels suggest that the water met the guidelines for swimming, livestock and irrigation (200/100 mL) and raw drinking water that receives partial treatment and disinfection (10-100/100 mL), but there were relatively few data (n=12).

Colour, true (Figure 16) was monitored in 1971-77 and 1997-2000, and there was an apparent decline between the two time periods. During 1971-77, the aesthetic guideline

for drinking water (15 true colour units) was exceeded five times, all during winter low flows due to waste discharges from the pulp mill at Skookumchuck (Ministry of Environment, 1981). Since then, ground infiltration for the pulp mill effluent was initiated in 1981 and tertiary treatment for effluent colour removal was initiated in 1994 (Kaukinen & Burns, 1996). The effect of the trend in true colour was to make the river more aesthetically desirable for drinking water and recreation. The 1997-2000 true colour values exceeded the 15-unit guideline once during spring freshet.

Colour, single-wavelength (Figure 17) was monitored during 1982-2000. There was no apparent change in mean level during 1982-March 1994, during which time the pulp mill effluent was discharged to ground adjacent to the Kootenay River at Skookumchuck. There was an apparent decreasing trend after March 1994, when tertiary treatment of the pulp mill effluent was initiated. The effect of the trend in colour was to make the river more aesthetically desirable for drinking water and recreation.

Conductivity, specific (Figure 18) was monitored during 1971-2000. There was an apparent increasing trend over time, although the maximum (440 microSiemens/cm) was well below the lowest guidelines for drinking water and irrigation (700 microSiemens/cm). Conductivity is a measure of the dissolved ions in water and thus the increasing trend is a reflection of the increasing levels of calcium, magnesium and sodium ions.

Copper, total (Figure 19) was monitored during 1973-2000, but data prior to 1991 were excluded due to high detection limits (0.01-0.001 mg/L) and contamination from preservative vials in 1986-90. During 1991-2000 a detection limit of 0.0002 mg/L was used, and nine values exceeded the 0.002-0.007 mg/L average guidelines for aquatic life with a maximum of 0.0078 mg/L. Most of these peaks (7 of 9) occurred during spring freshet when turbidity was high, and thus the copper was likely particulate-bound and not bio-available. There appeared to be a very slight decline over time.

Copper, extractable (Figure 20) was monitored during 1997-2000 with a detection limit of 0.00004 mg/L. The values were similar to those for total copper, with one notable exception. When the peak total copper value of 0.0078 mg/L occurred, the extractable copper level was 0.000273 mg/L, suggesting that the total copper value was either an error or that most of the copper was strongly particulate-bound, and thus not bio-available. Extractable copper values exceeded the aquatic life guidelines once during the 2000 freshet when turbidity was high (57 NTU). The record is too short to comment on trends.

Hardness (Figure 22) was monitored during 1971-2000 and exhibited a slight increasing trend over time. Increasing trends in calcium and magnesium caused this trend, since they are the main components of water hardness. The environmental significance of this trend is that drinking water becomes less desirable aesthetically as hardness increases above 80-100 mg/L. However, levels have remained at or below 200 mg/L, which is the poor, but tolerable level.

Iron, total (Figure 23) was monitored during 1973-2000. There was a marked decreasing trend during 1973-81 due to abatement of the Cominco waste discharges to the St. Mary River (Ministry of Environment, 1981). There was also a more gradual decreasing trend during 1984-2000. These trends made the water more suitable for irrigation, aquatic life and drinking water. Prior to 1992, eight values exceeded the 5 mg/L guideline for irrigation (maximum of 10 mg/L), but the guideline was not exceeded since then. These peak values occurred during spring freshet when turbidity was high (the turbidity-total iron regression has a $R^2=0.837$). Iron is the fourth most abundant element in the Earth's crust and the large amount of suspended sediment present during freshet accounts for the high total iron levels. The 0.3 mg/L guideline for drinking water and aquatic life was exceeded on numerous occasions whenever turbidity was elevated due to the particulate-bound iron in the suspended sediment. Particulate-bound iron is unlikely to be bio-available and would be removed by the water treatment needed to remove turbidity prior to use as drinking water.

Lead, total (Figure 25) was monitored during 1973-2000 and data with a detection limit of 0.001 mg/L or lower were included. There was a downward trend due to the decline in detection limits from 0.001 to 0.0007 to 0.0002 mg/L over this time, as well as due to abatement of the Cominco waste discharges to the St. Mary River. This trend made the water safer for aquatic life and drinking water, since guidelines for these water uses were often exceeded during 1973-90. (Note that artificially elevated levels during 1986-90 are evident due to contamination from preservative vials.) During 1991-2000, there was no apparent change and only three values (0.0064 to 0.0085 mg/L) exceeded the average aquatic life guideline of 0.006 mg/L. These values occurred during spring freshet when turbidity was high, and thus the lead was probably particulate-bound and not bio-available.

Lead, extractable (Figure 26) was monitored during 1997-2000 with a detection limit of 0.00001 mg/L. Levels were similar to those for total lead, and exceeded the aquatic life guideline once during freshet in 2000 when turbidity was high. The record is too short to comment on trends.

Magnesium (Figure 28) was monitored during 1972-2000. Dissolved, total and extractable magnesium data were combined in Figure 24, since there was little difference in paired values. There was a slight increasing trend in magnesium values over time. Calcium and magnesium are the two main components of water hardness, and increasing levels make the water less aesthetically desirable for drinking water, as discussed under hardness above.

Manganese, total (Figure 29) was monitored during 1973-2000 and **extractable manganese** was monitored in 1984 and 1997-2000. The data were similar in paired samples and have been combined in Figure 29. There was a declining trend during 1973-84, followed by little or no change during 1985-2000. The downward trend was caused by abatement of the Cominco waste discharges to the St. Mary River (Ministry of Environment, 1981) and by declining detection limits (0.02, 0.01, 0.0001 mg/L). The effect of the declining trend was to make the water more aesthetically desirable for

drinking water. Many values exceeded the aesthetic guideline for drinking water of 0.05 mg/L, especially during 1973-79. The guideline was exceeded less often in recent years and the elevated levels were due to elevated turbidity during spring freshet. The manganese was associated with particulate matter (turbidity-total manganese correlation $R^2=0.8316$) and would be removed by the water treatment needed prior to use as drinking water. The maximum of 0.35 mg/L was below the average aquatic life guideline of 0.9 mg/L at 75 mg/L of hardness.

Nitrogen, total dissolved (Figure 32) was monitored during 1984-2000. There was a slight increasing trend over this time period. The source of the increased nitrogen is not known. The nitrogen levels were well below guidelines for drinking water and aquatic life. The increasing trend has reduced any nitrogen limitation for algal growth, but algal growth in the Kootenay River is limited by the availability of phosphorus, which has shown little change during 1987-2000 (see phosphorus, dissolved ortho and total).

pH (Figure 33) was monitored during 1971-2000 and ranged from 6.8 to 9.1 pH units. Two values exceeded the aquatic life guideline of 9.0 units and 28 values exceeded the aesthetic drinking water guideline of 8.5 units. All of the values >8.5 were field measurements. In 28 pairs of field and laboratory pH measurements where at least one of the pair was >8.5 , the laboratory value never exceeded 8.3 units. Field values are expected to be higher than laboratory values because of lower temperatures and lower carbon dioxide concentrations during measurement. Because of pH instability due to CO_2 diffusion enroute to the laboratory, field measurement of pH is desirable, but high quality field pH measurements are difficult to obtain due to increased operator error and poor equipment performance (McKean and Huggins, 1989). There was an apparent slight increasing trend over time, but it does not appear to be environmentally significant with respect to guidelines. The preponderance of higher field values during 1991-94 may have contributed to the trend.

Phosphorus, dissolved ortho was monitored during 1971-2000. Figure 34 shows a dramatic downward trend during 1971-76 due to abatement of Cominco's fertilizer plant discharge to the St. Mary River. Figure 35 shows that the downward trend continued until the fertilizer plant was closed in 1987. Figure 36 shows that there may have been a slight increasing trend during 1987-2000, but all of the data were below the limit of quantitation (e.g., 3-20 times the detection limit), and thus must be used with caution (Clark and Whitfield 1994). The effect of the downward trend was to prevent nuisance algal growths and blooms as far downstream as Kootenay Lake.

Phosphorus, total was monitored during 1971-2000. Like dissolved orthophosphorus, Figure 37 shows a dramatic downward trend during 1971-76 due to abatement at the Cominco fertilizer plant, followed by a more gradual downward trend until about 1985 (Figure 38). There was no change in total phosphorus levels during 1985-2000 (Figure 39). The effect of the downward trend was to prevent nuisance algal growths and blooms as far downstream as Kootenay Lake.

Silver, total was monitored during 1996-2000 with a detection limit of 0.0001 mg/L and **extractable silver** was monitored during 1997-2000 with a detection limit of 0.000005 mg/L (Figure 41). All of the values were at their respective detection limits, with the exception of one total silver value of 0.003 mg/L on May 13, 1997 during spring freshet when turbidity was high (39 NTU). The extractable silver value on this day was <0.000005 mg/L, indicating that either the total silver value was an error or that all of the silver was strongly bound to particulate matter. The high total silver value was excluded from Figure 42. There was no change in silver over time.

Sodium, dissolved (1971-89) and **extractable sodium** (1989-2000) have been combined in Figure 42, showing a slight increasing trend over time for both sodium forms. The maximum value of 18 mg/L was below the 20 mg/L alert level for persons on a sodium-restricted diet and well below the 200 mg/L aesthetic objective for drinking water. The cause of the trend is not known.

Temperature, water (Figure 44) was monitored during 1971-2000. There was no change over time, and water temperatures met the guidelines for freshwater aquatic life (maximum of 19 degrees C) on all but one occasion. Water temperatures often exceeded 15 degrees C during summer, which is the aesthetic guideline for drinking water, but the lower limit for swimming.

Turbidity (Figure 46) was monitored during 1971-2000 and is an optical measure of the amount of suspended sediment in water. All but one of the peak values (e.g., >50 NTU) occurred during the spring snowmelt freshet. The recreation guideline of 50 NTU was exceeded almost every year during the freshet, and the drinking water guidelines of 1-5 NTU were often exceeded, indicating that water treatment to remove turbidity (e.g., filtration) would be needed before using the river for drinking water. There may have been a slight decreasing trend over time.

Zinc, total (Figure 49) was monitored during 1973-2000, and **extractable zinc** (Figure 50) was monitored during 1997-2000. There was a dramatic downward trend during 1973-80 due to abatement of Cominco's discharges to the St. Mary River. There was no apparent change during 1981-90 (Figures 49 & 50), and then another decreasing trend during 1991-2000 due to renewed zinc abatement at the Sullivan Mine, beginning in the summer of 1990. The effect of the downward trends has been to make the water safer for aquatic life. The guidelines for aquatic life were often exceeded substantially during 1973-80, but the frequency and amount of the exceedances declined over time since then. The guidelines were exceeded during the spring freshets of 1997 and 2000, when both total and extractable values were elevated along with turbidity (10-102 NTU) on six occasions.

Figure 51 shows that total and extractable zinc values were similar on most occasions, with extractable zinc accounting for 66-118% (mean=96%) of the total zinc, indicating that the zinc was not strongly bound to the particulate matter.

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Figure 2 Flow at the Kootenay River at Fort Steele, 1971-2000

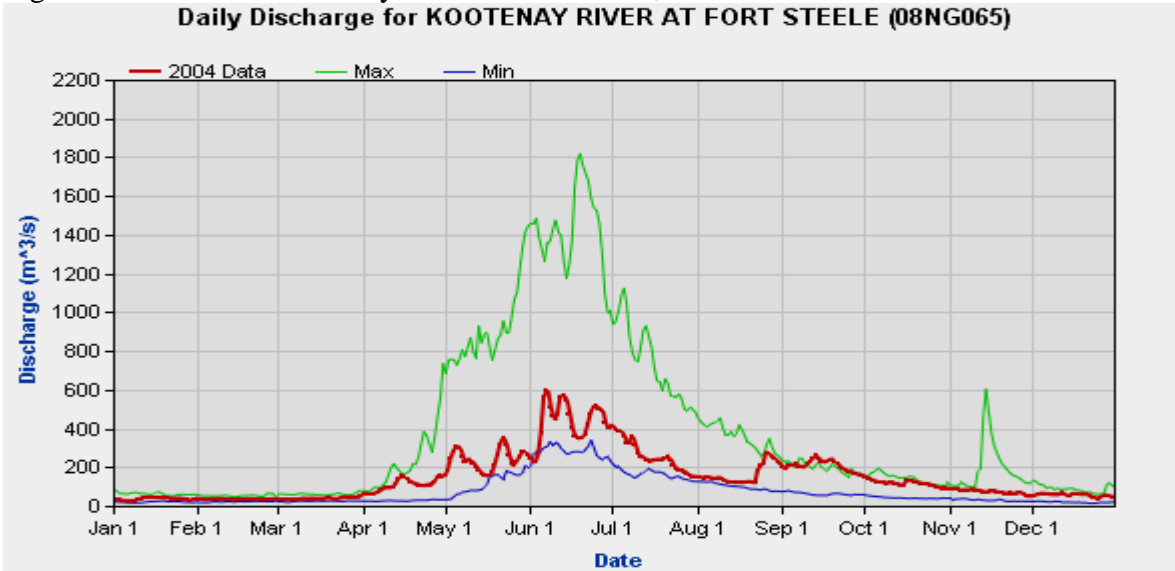
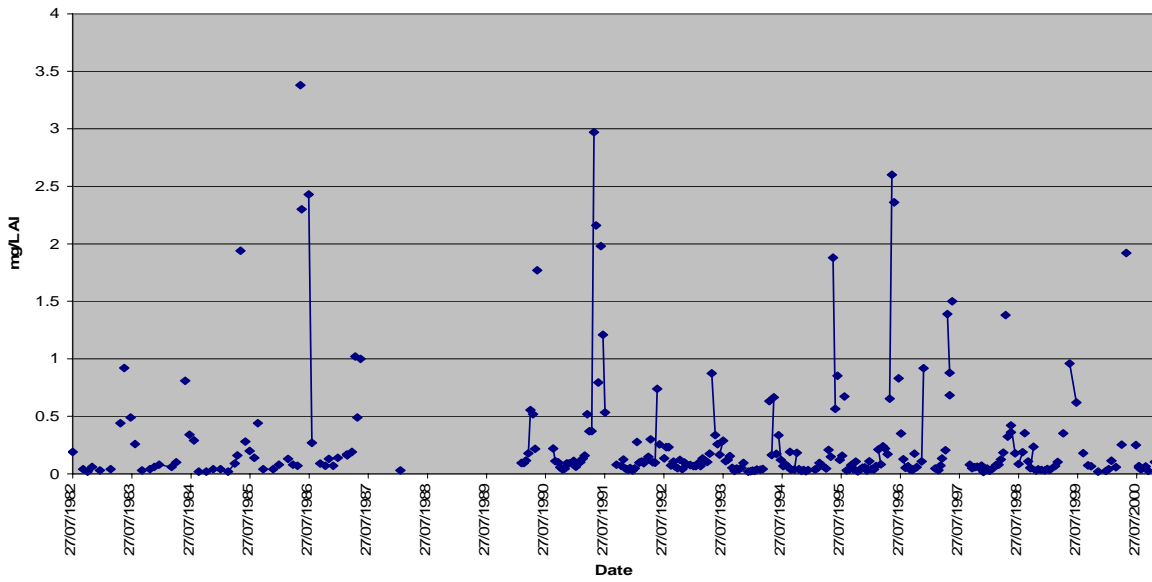


Figure 3 Kootenay River at Fenwick - Aluminum, Total



Water Quality Assessment of the Kootenay River at Fenwick Station, 1971-2000

Figure 4 Kootenay River at Fenwick Station - Arsenic, Total

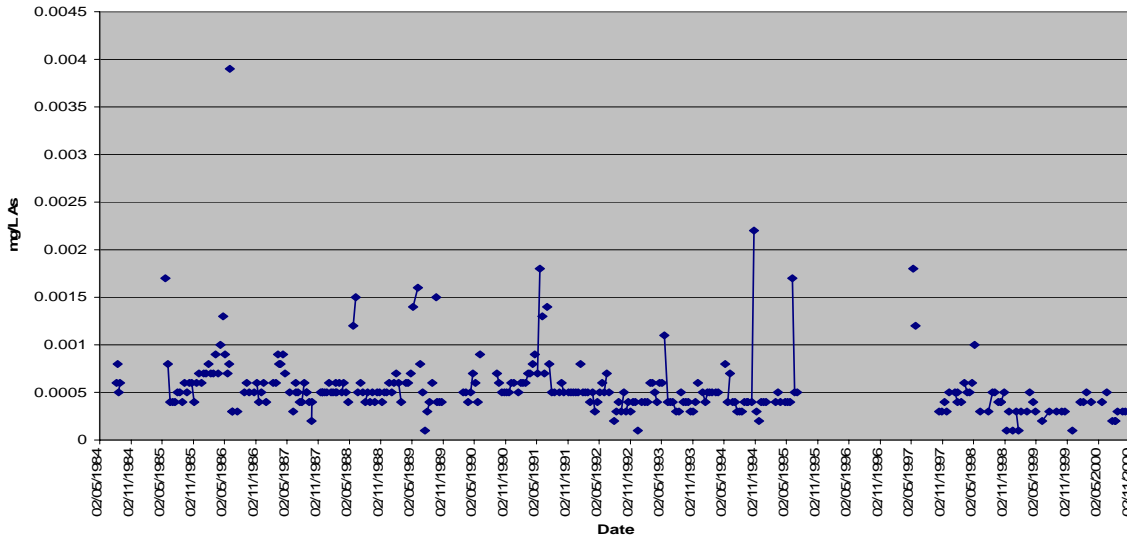
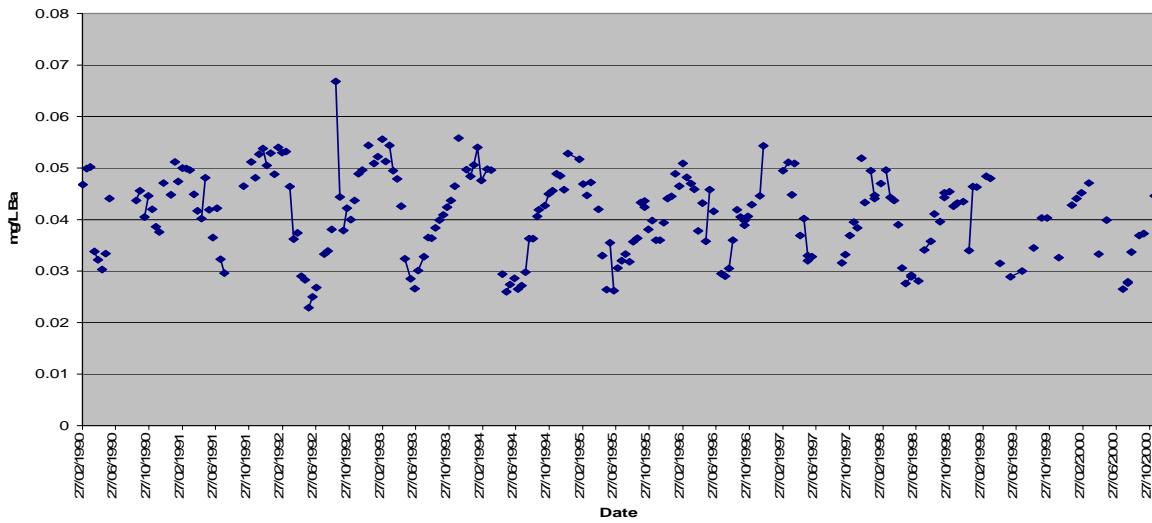


Figure 5 Kootenay River at Fenwick Station - Barium, Total



Water Quality Assessment of the Kootenay River at Fenwick Station, 1971-2000

Figure 6 Kootenay River at Fenwick Station - Beryllium, Total and Extractable

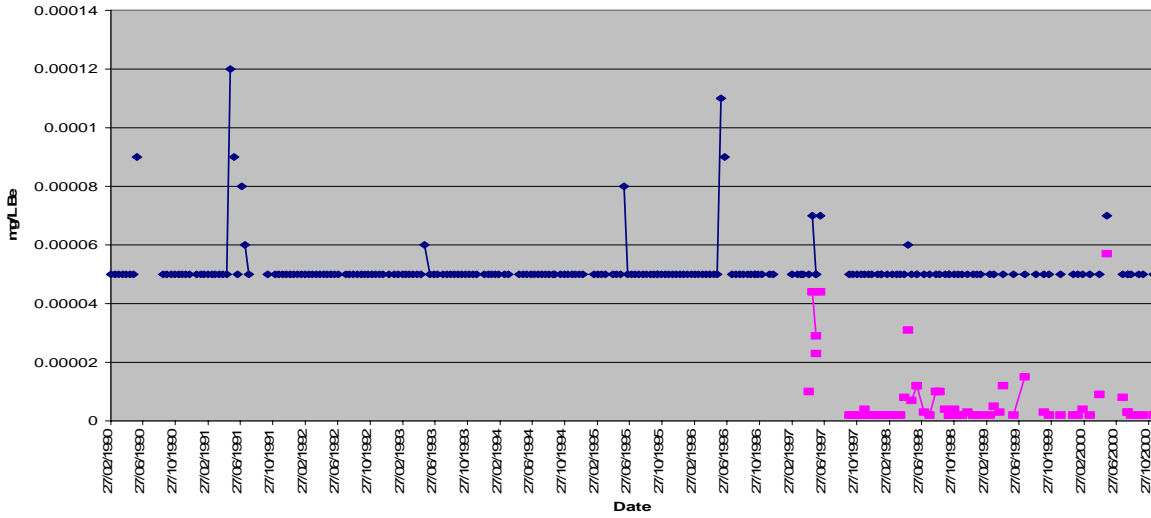


Figure 7 Kootenay River at Fenwick Station - Boron, Extractable

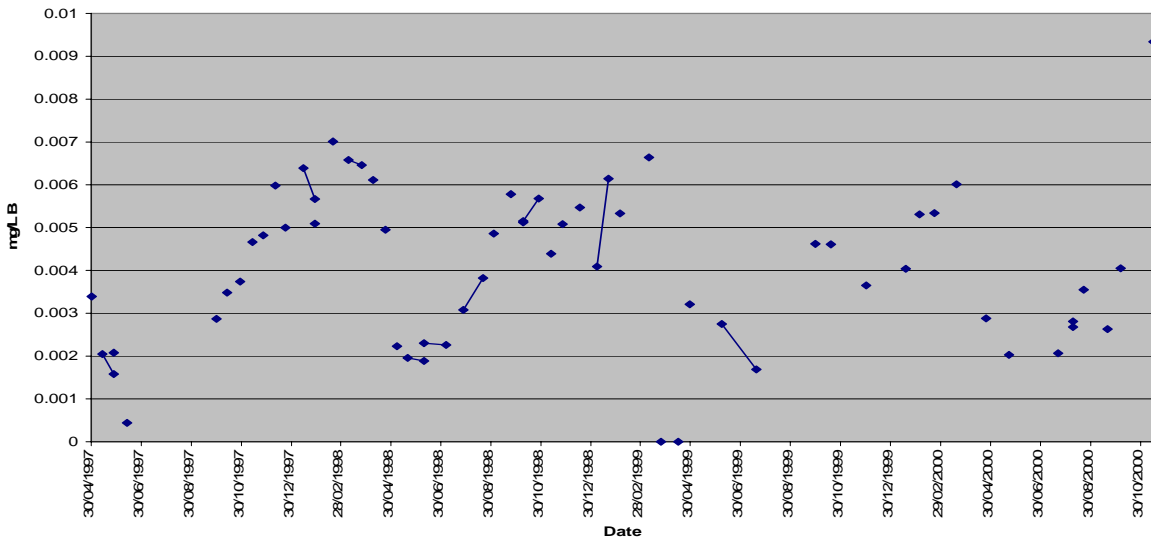


Figure 8 Kootenay River at Fenwick Station - Cadmium, Total

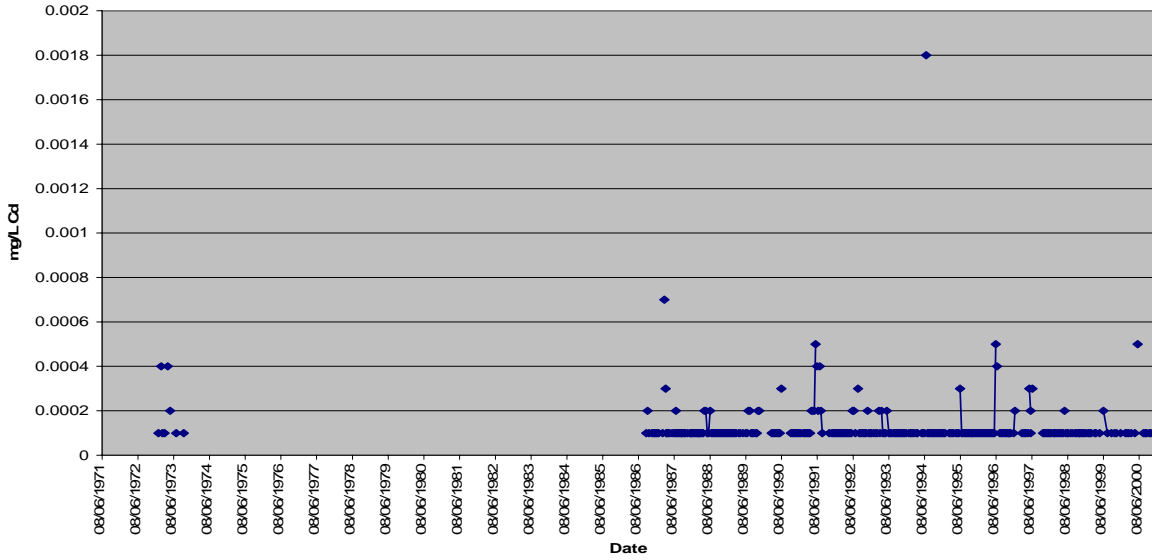


Figure 9 Kootenay River at Fenwick Station - Cadmium, Total and Extractable

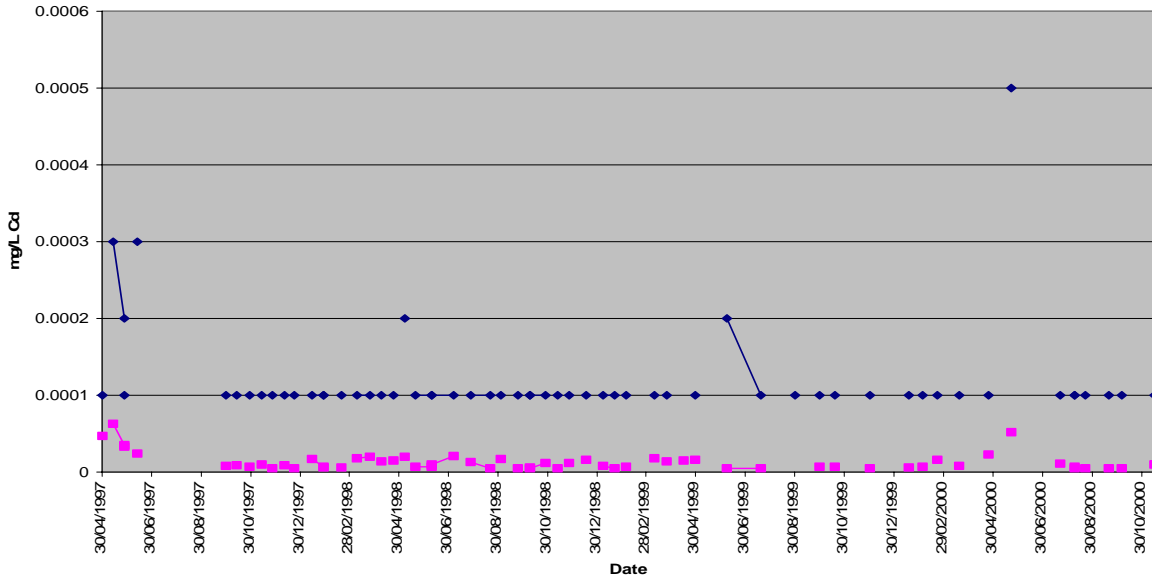


Figure 10 Kootenay River at Fenwick Station - Calcium

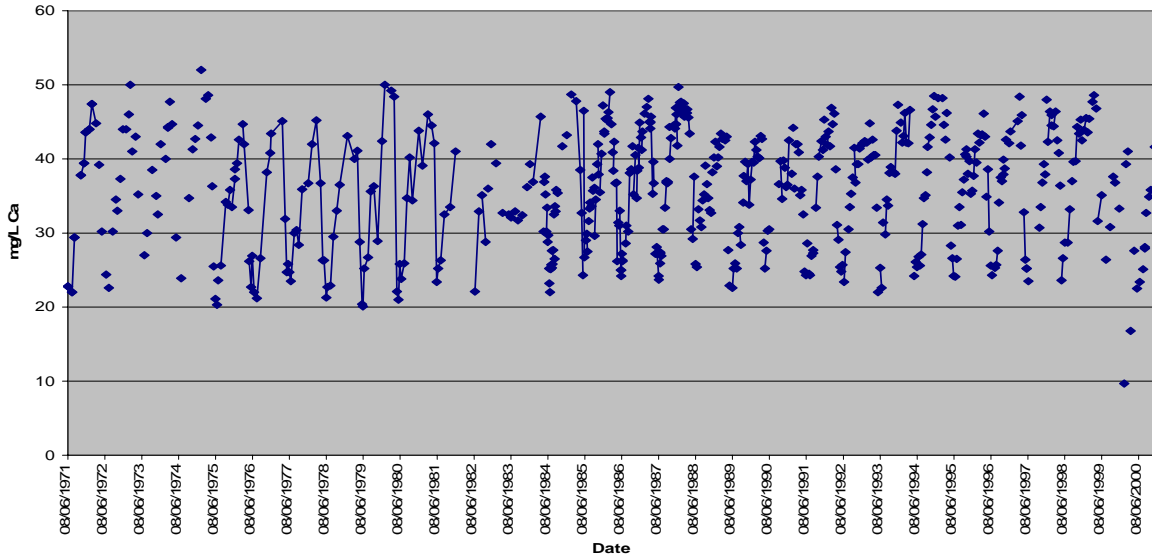
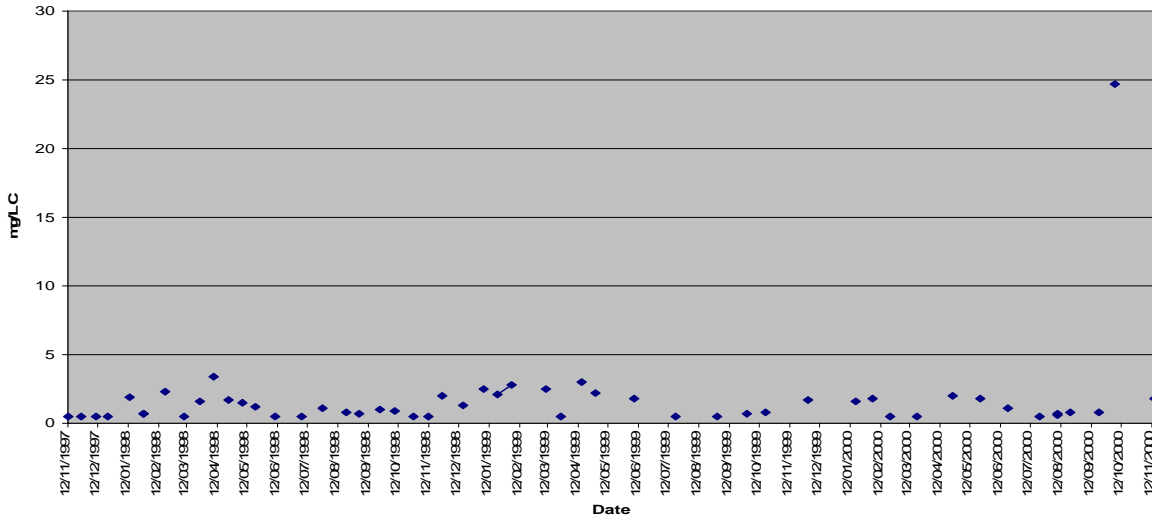


Figure 11 Kootenay River at Fenwick Station - Dissolved Organic Carbon



Water Quality Assessment of the Kootenay River at Fenwick Station, 1971-2000

Figure 12 Kootenay River at Fenwick Station - Chromium, Total

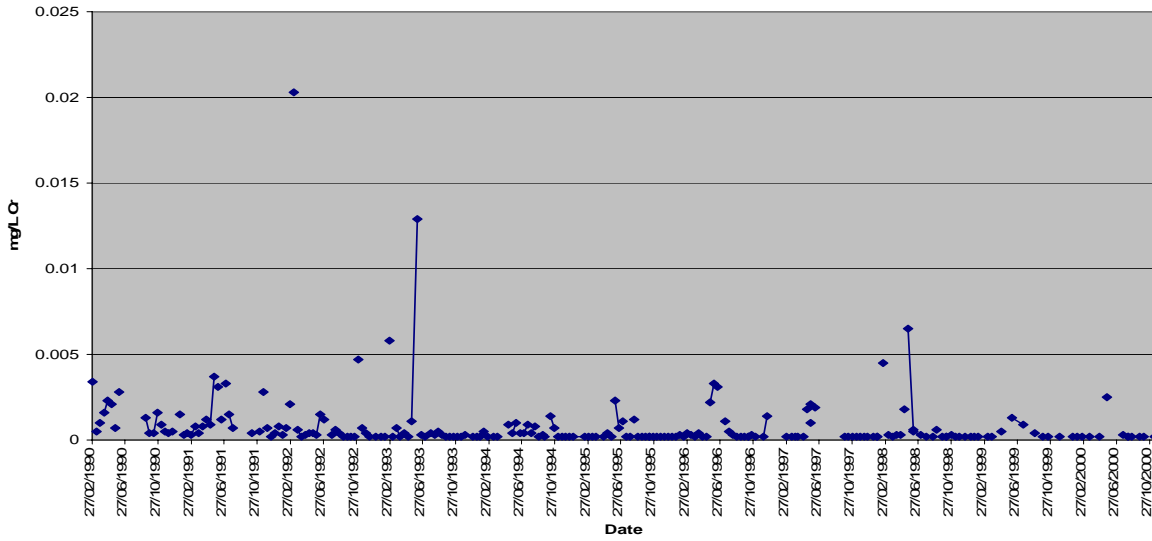
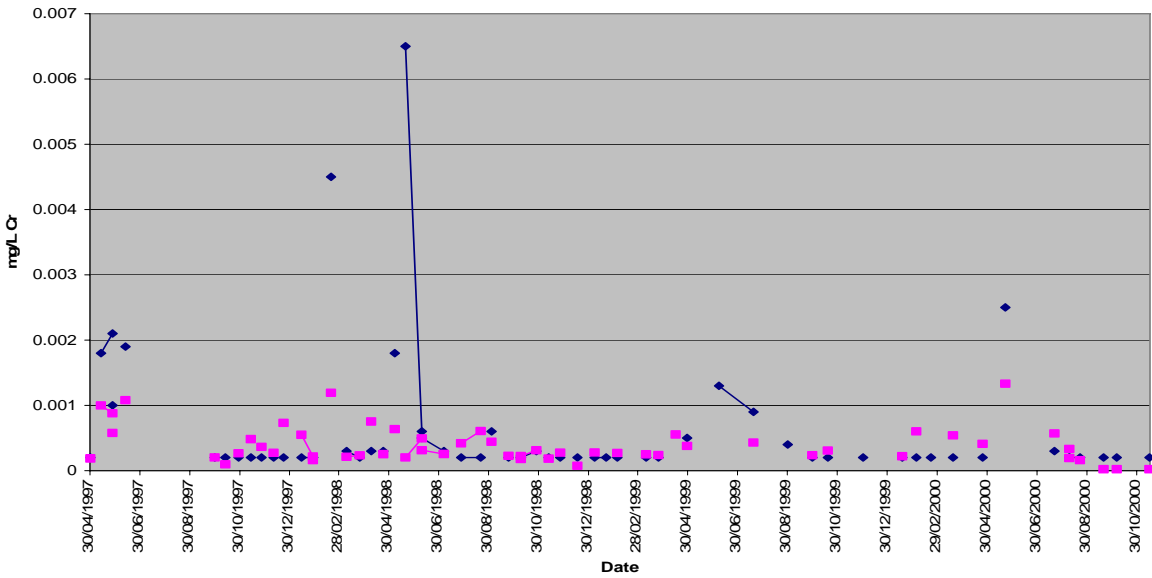


Figure 13 Kootenay River at Fenwick Station - Chromium, Total and Extractable



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Figure 14 Kootenay River at Fenwick Station - Cobalt, Total and Extractable

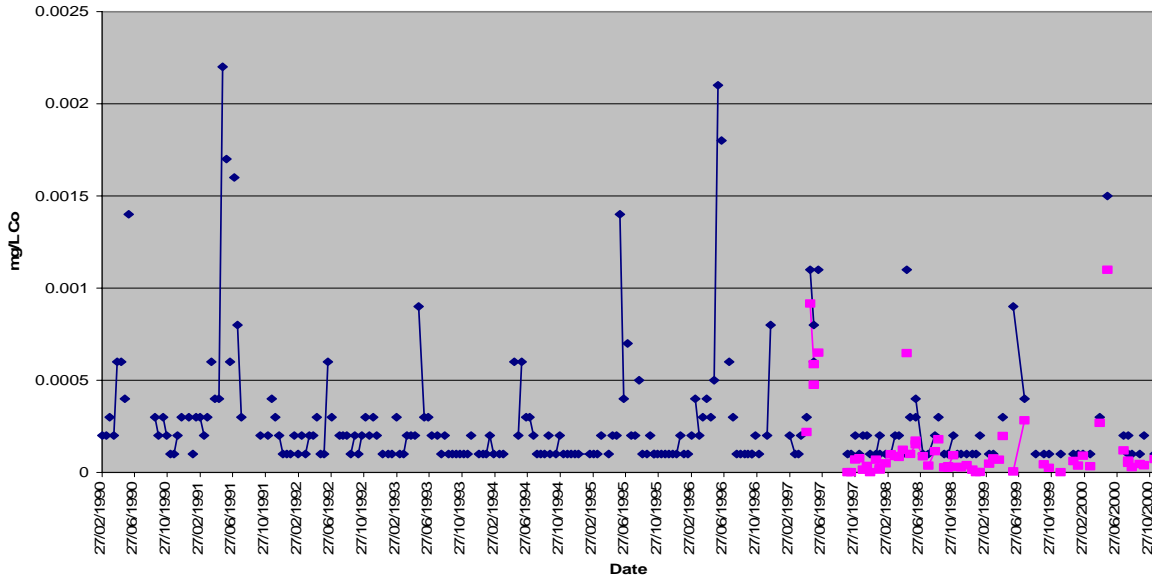


Figure 15 Kootenay River at Fenwick Station - Fecal Coliforms

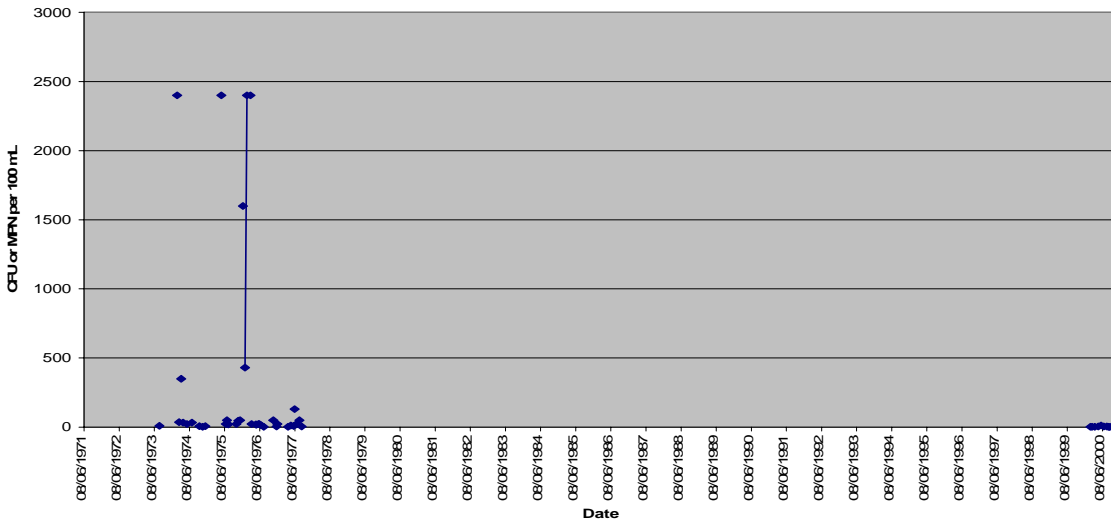


Figure 16 Kootenay River at Fenwick Station - Colour, True

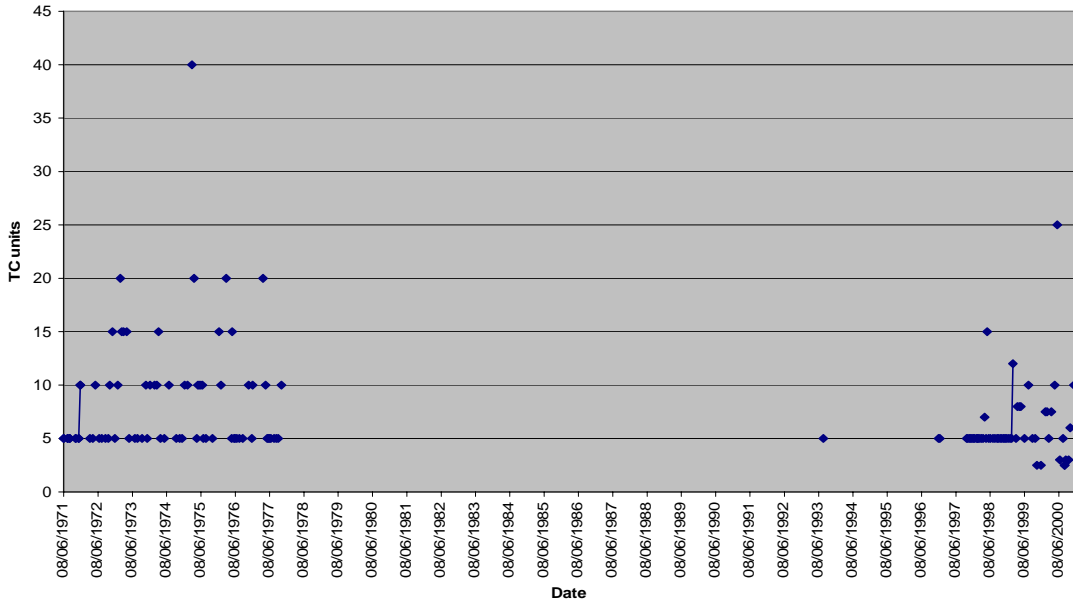


Figure 17 Kootenay River at Fenwick Station - Colour, Single Wavelength

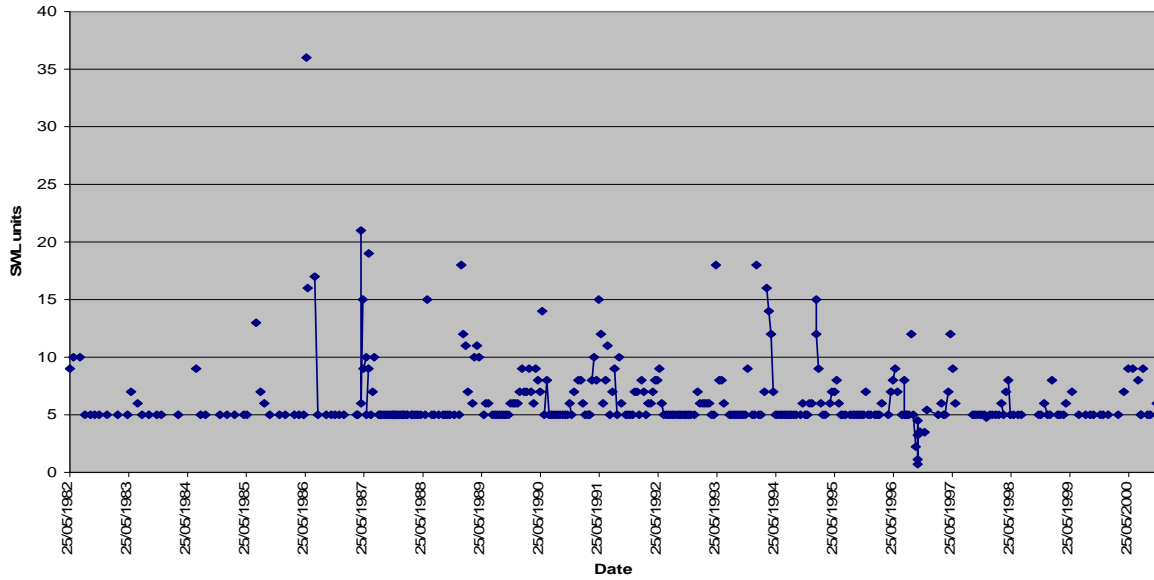


Figure 18 Kootenay River at Fenwick Station - Specific Conductance

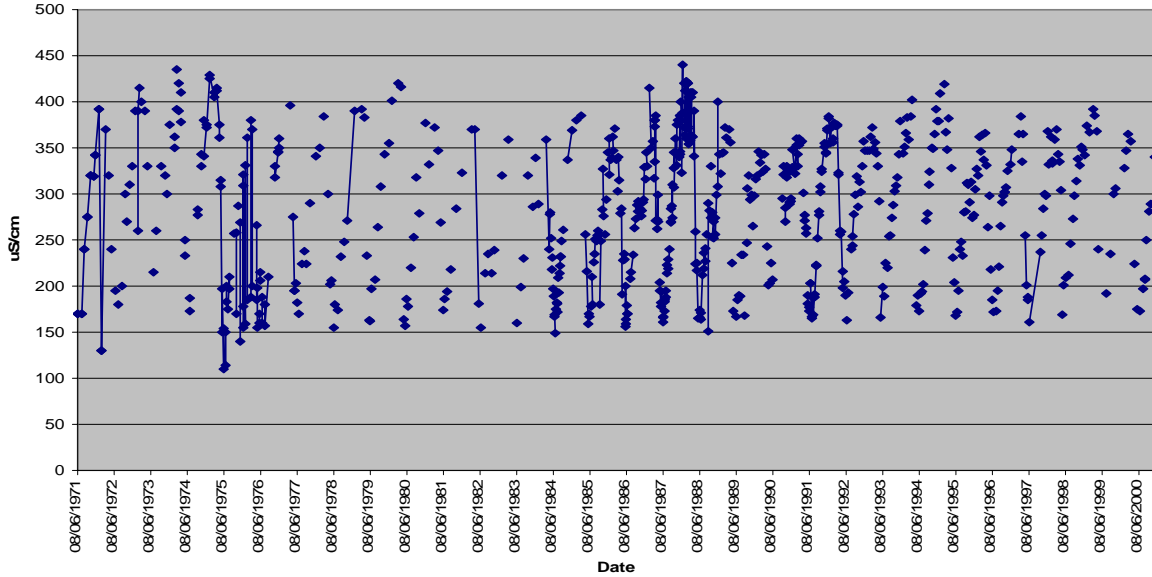
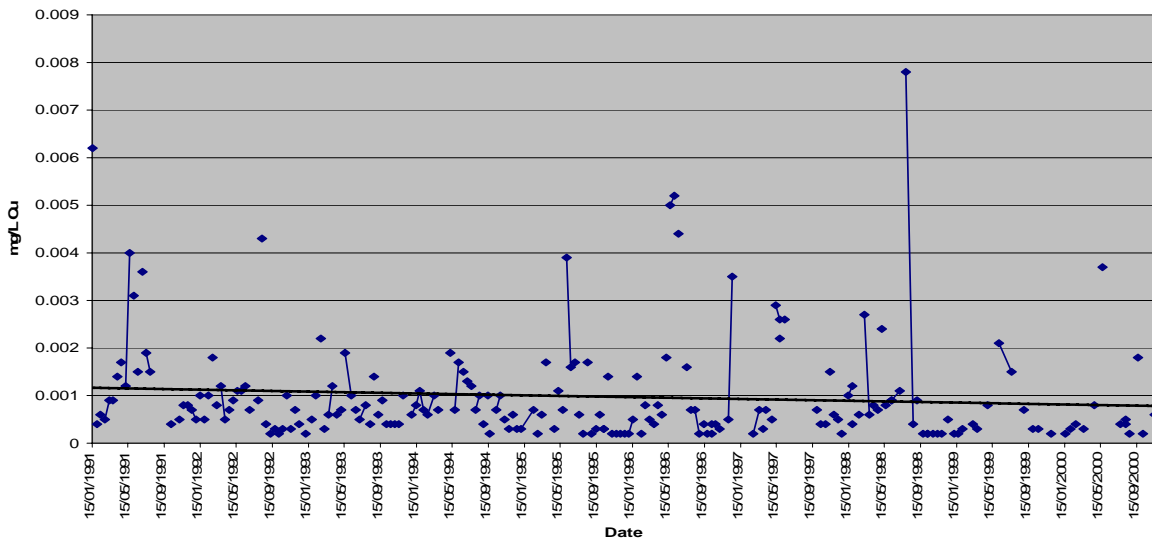


Figure 19 Kootenay River at Fenwick Station - Copper, Total



Water Quality Assessment of the Kootenay River at Fenwick Station, 1971-2000

Figure 20 Kootenay River at Fenwick Station - Copper, Total and Extractable

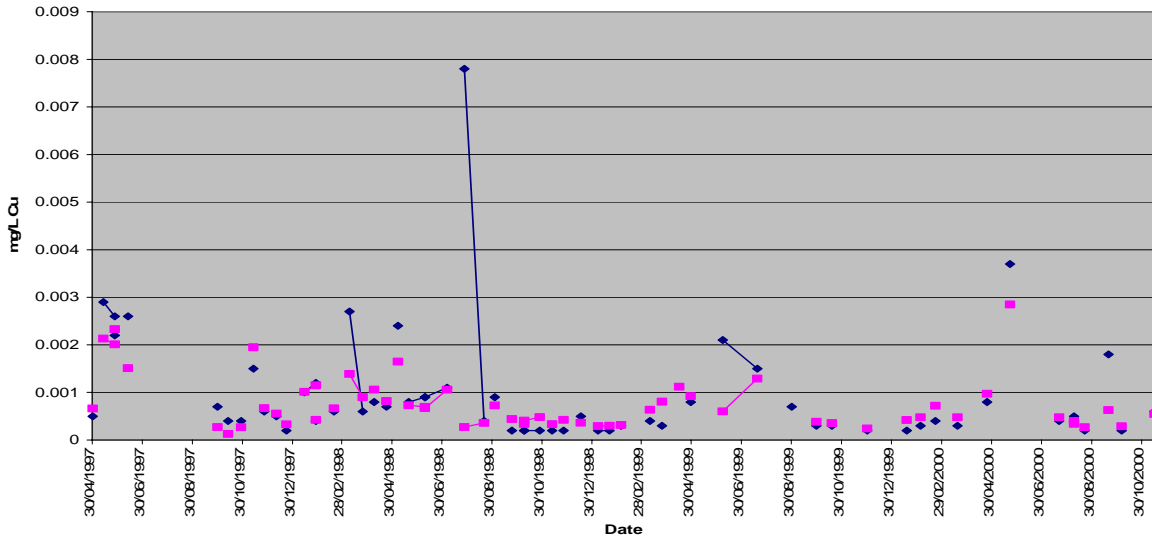
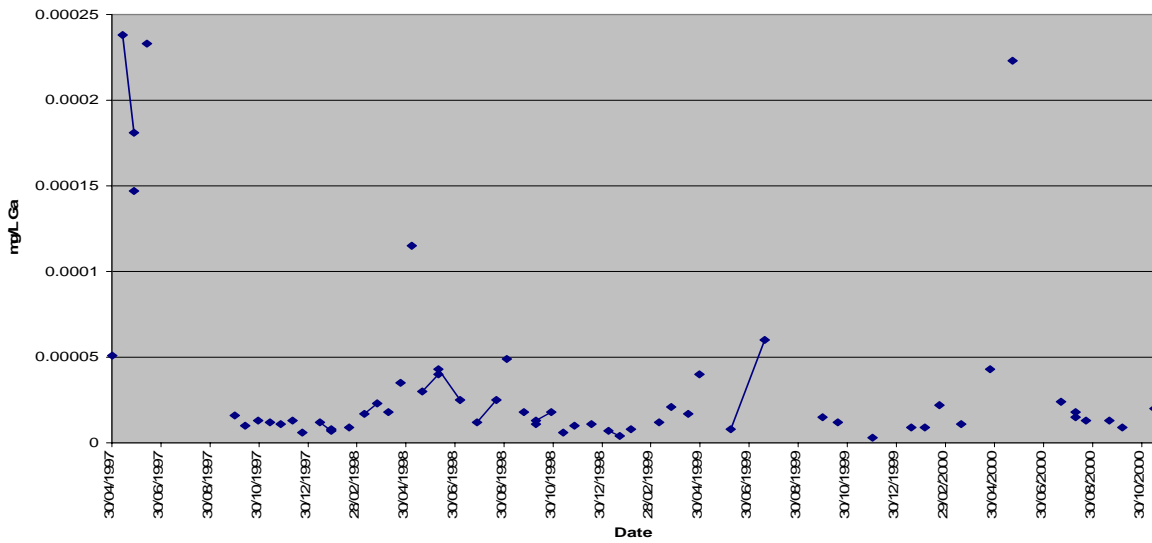


Figure 21 Kootenay River at Fenwick Station - Gallium, Extractable



Water Quality Assessment of the Kootenay River at Fenwick Station, 1971-2000

Figure 22 Kootenay River at Fenwick Station - Hardness

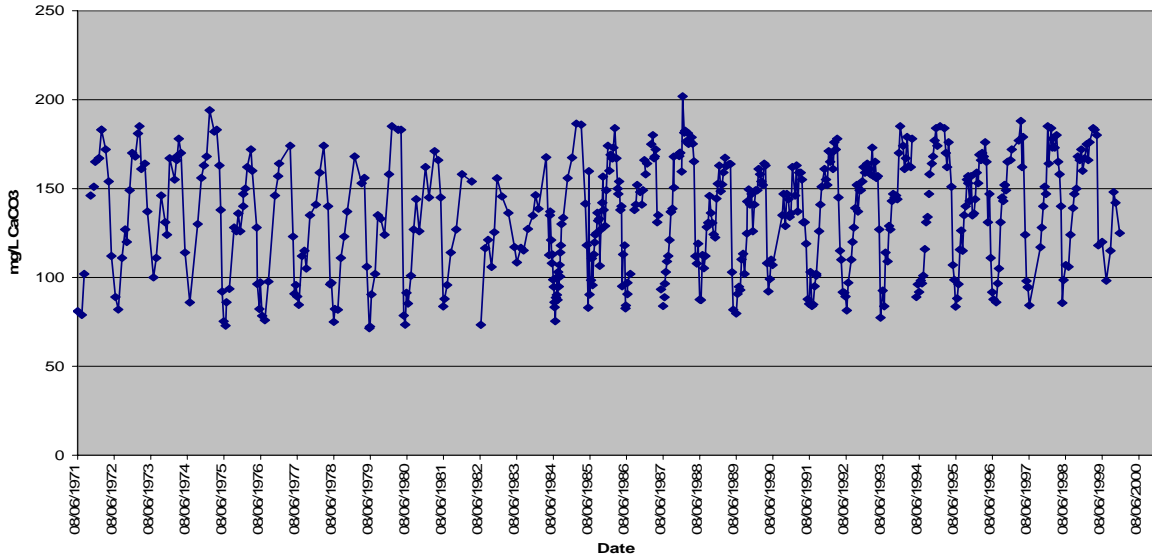
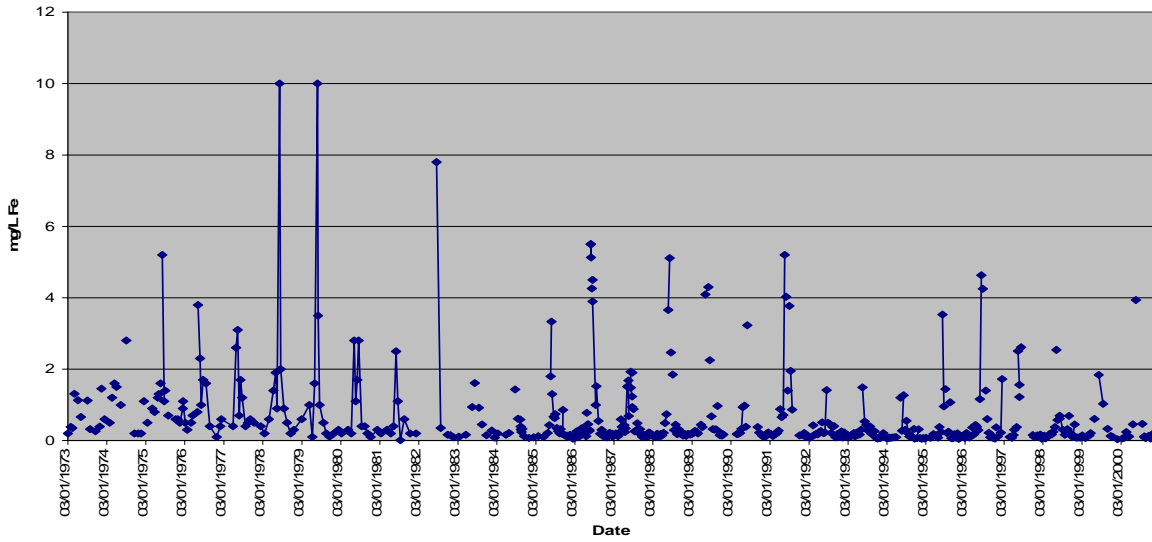


Figure 23 Kootenay River at Fenwick Station - Iron, Total



Water Quality Assessment of the Kootenay River at Fenwick Station, 1971-2000

Figure 24 Kootenay River at Fenwick Station - Lanthanum, Extractable

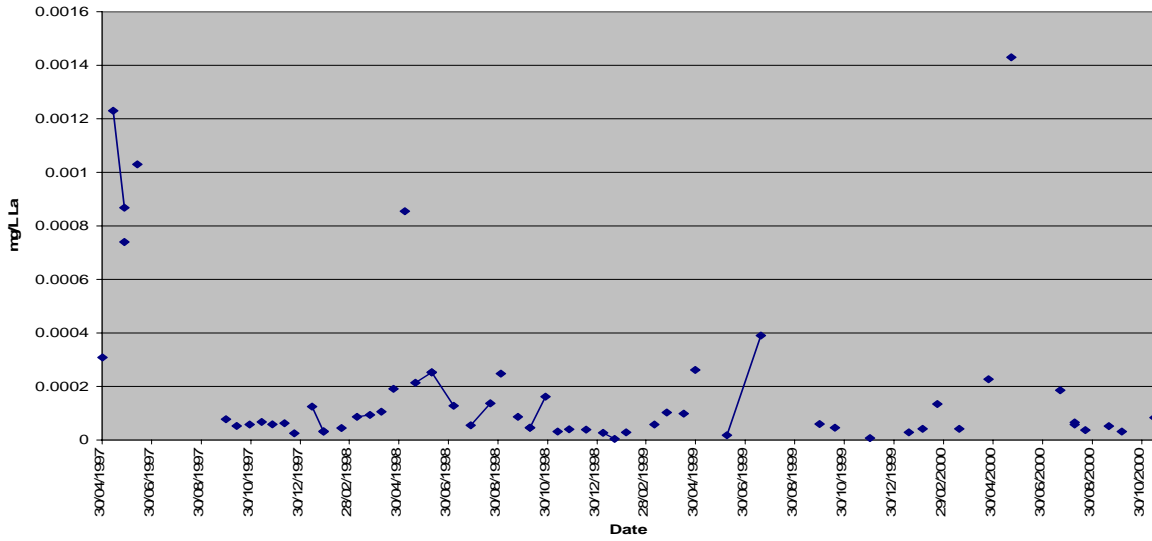


Figure 25 Kootenay River at Fenwick Station - Lead, Total

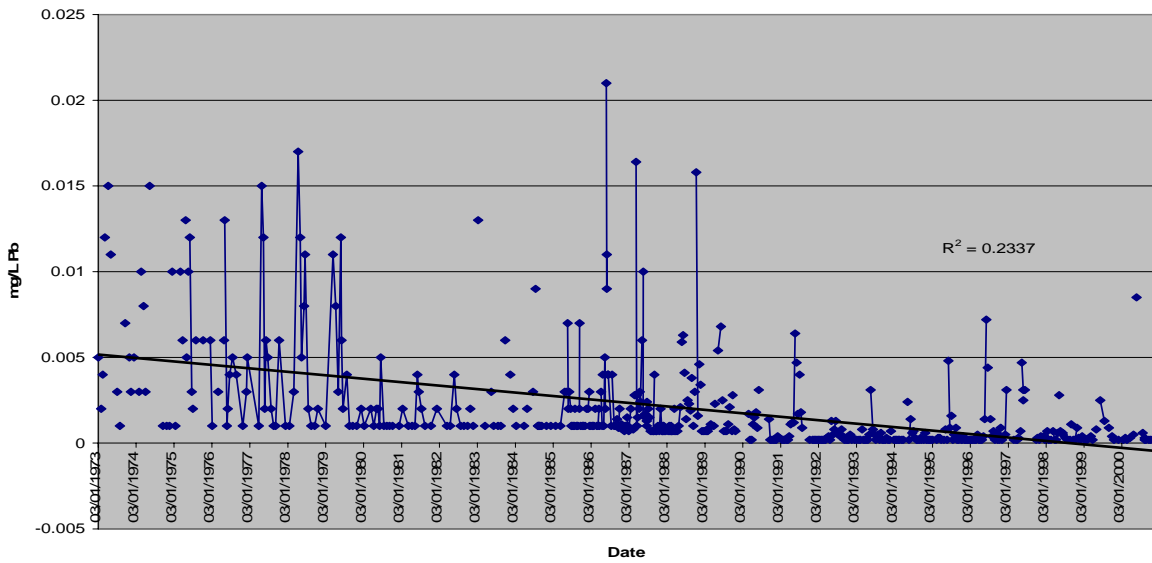


Figure 26 Kootenay River at Fenwick Station - Lead, Total and Extractable

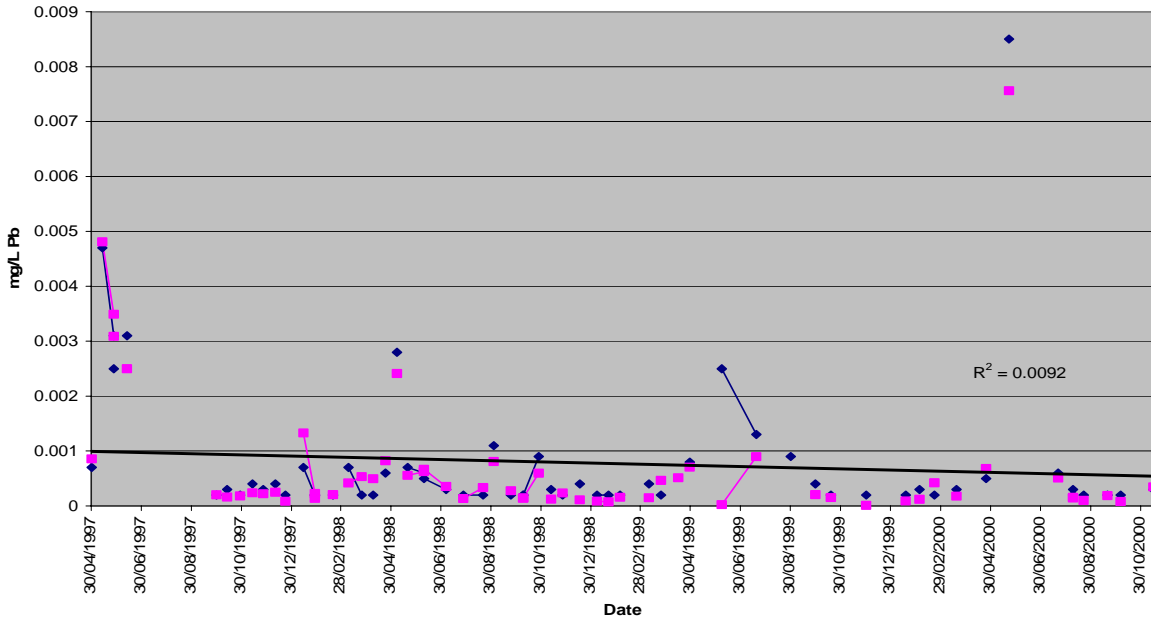


Figure 27 Kootenay River at Fenwick Station - Lithium, Total and Extractable

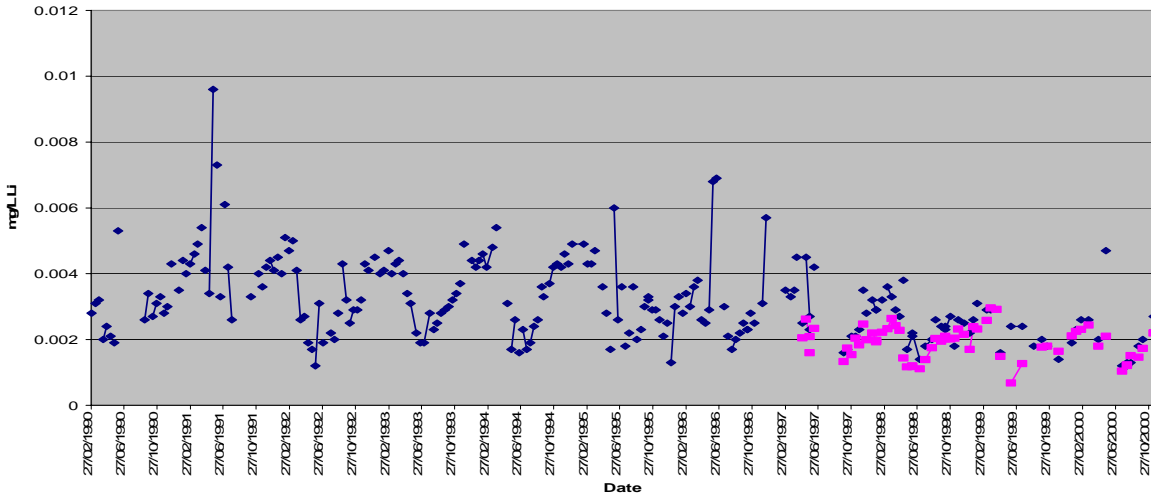


Figure 28 Kootenay River at Fenwick Station - Magnesium

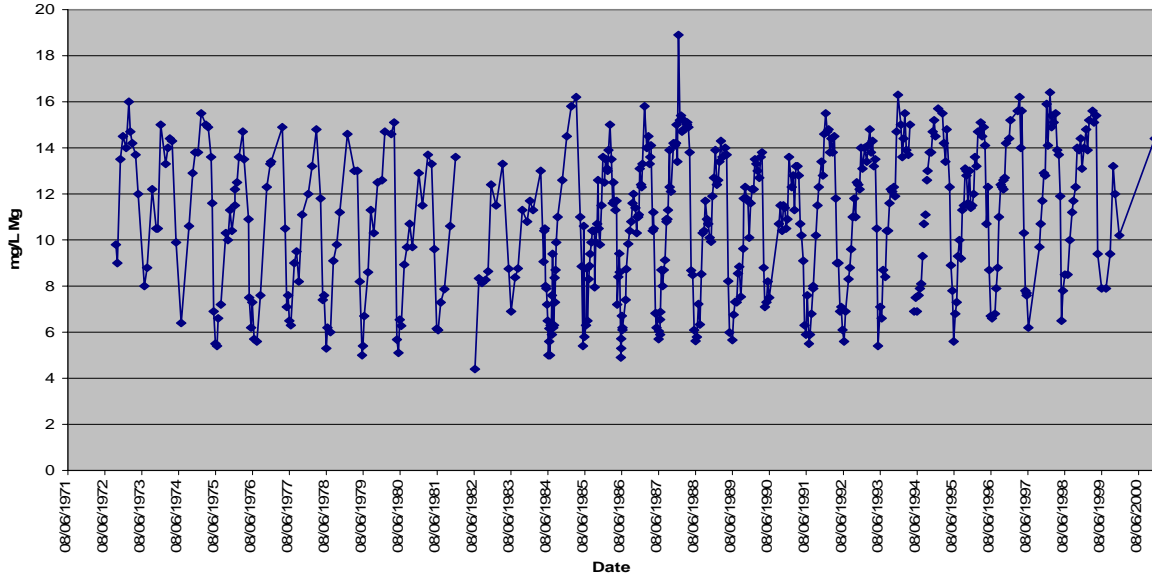
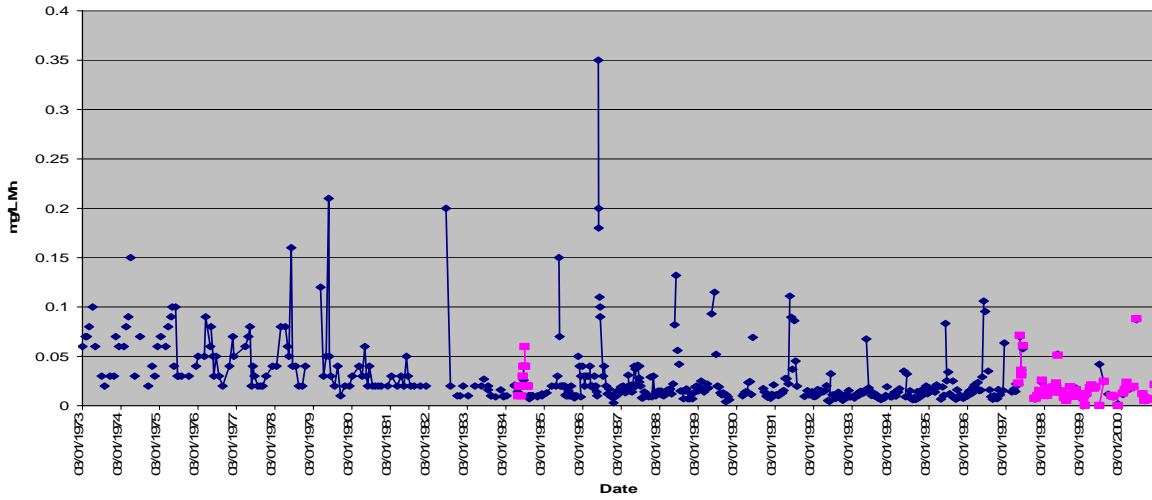


Figure 29 Kootenay River at Fenwick Station - Manganese, Total and Extractable



Water Quality Assessment of the Kootenay River at Fenwick Station, 1971-2000

Figure 30 Kootenay River at Fenwick Station - Molybdenum, Total

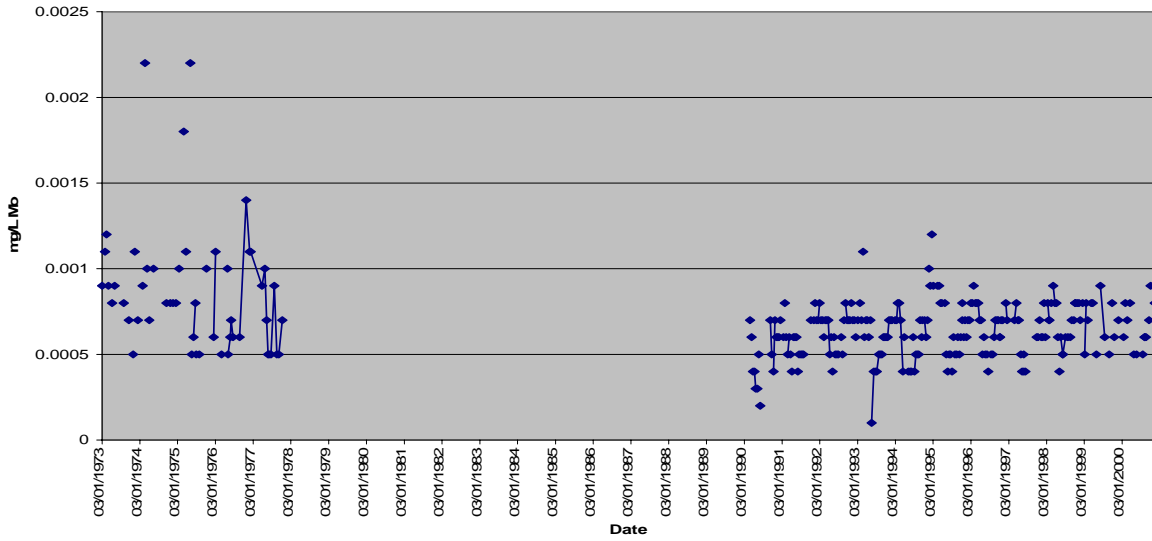
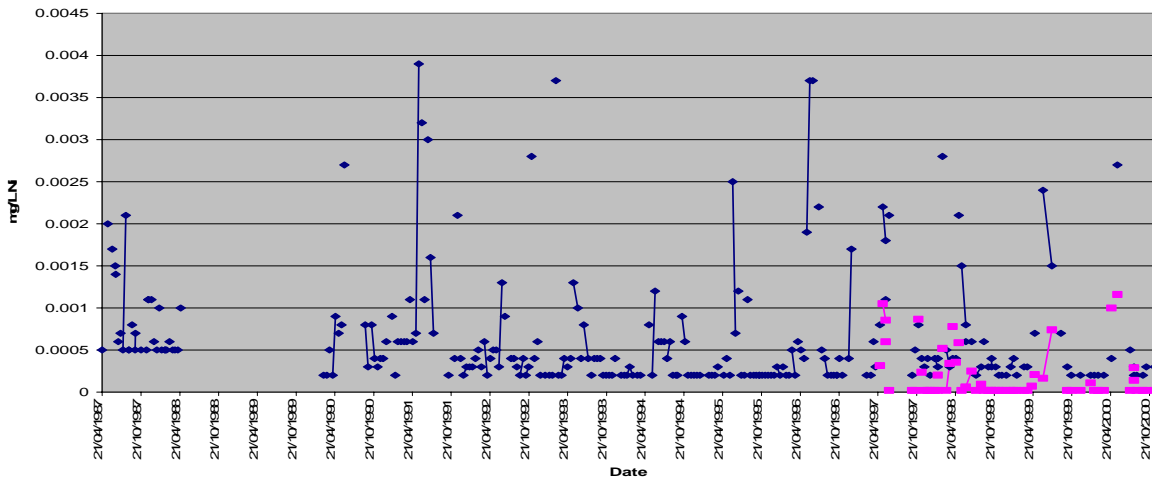


Figure 31 Kootenay River at Fenwick Station - Nickel, Total and Extractable



Water Quality Assessment of the Kootenay River at Fenwick Station, 1971-2000

Figure 32 Kootenay River at Fenwick Station - Nitrogen, Total Dissolved

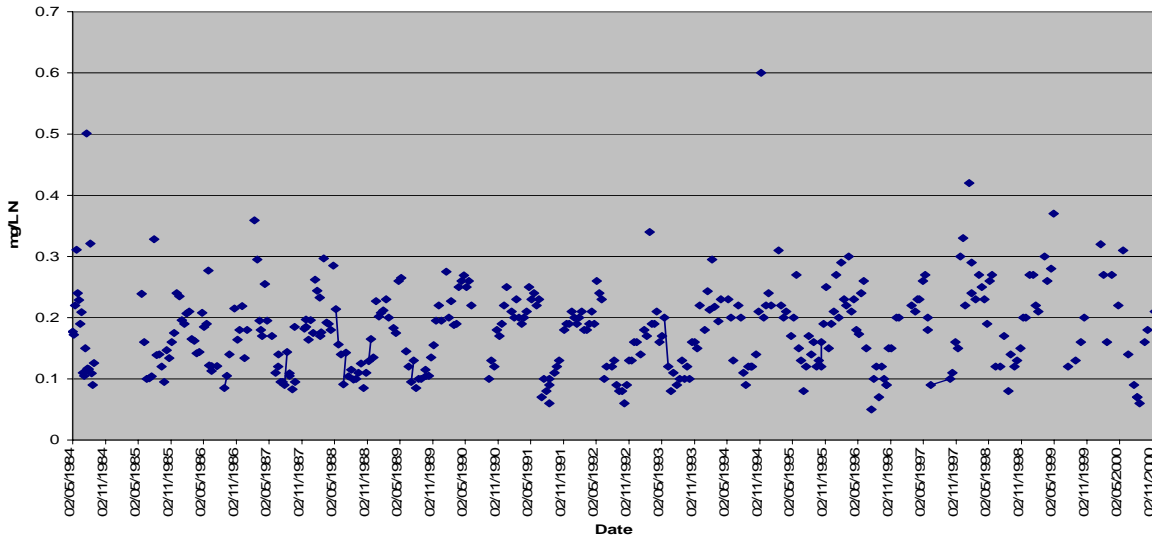


Figure 33 Kootenay River at Fenwick Station - pH

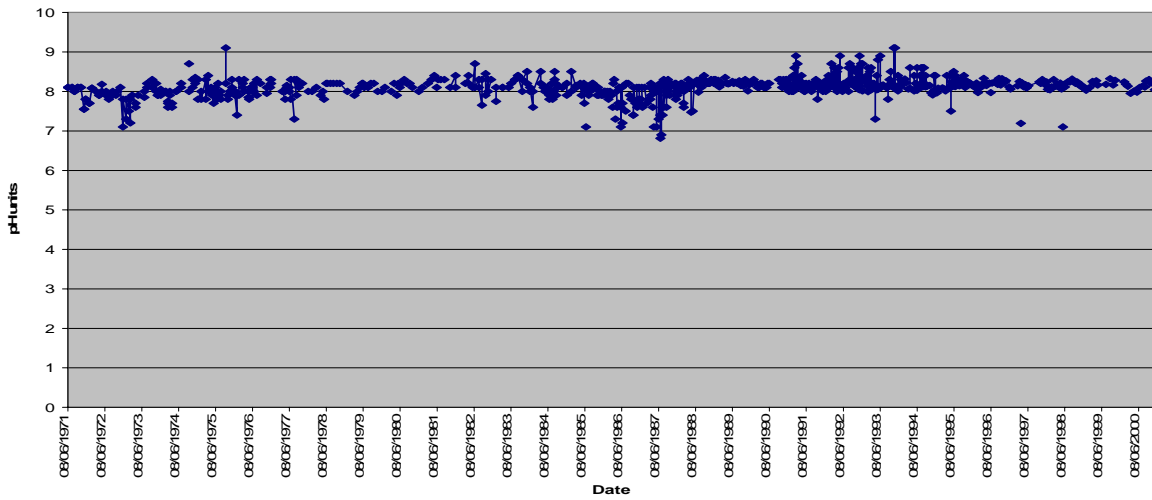


Figure 34 Kootenay River at Fenwick Station - Phosphorus, Dissolved Ortho, 1971-2000

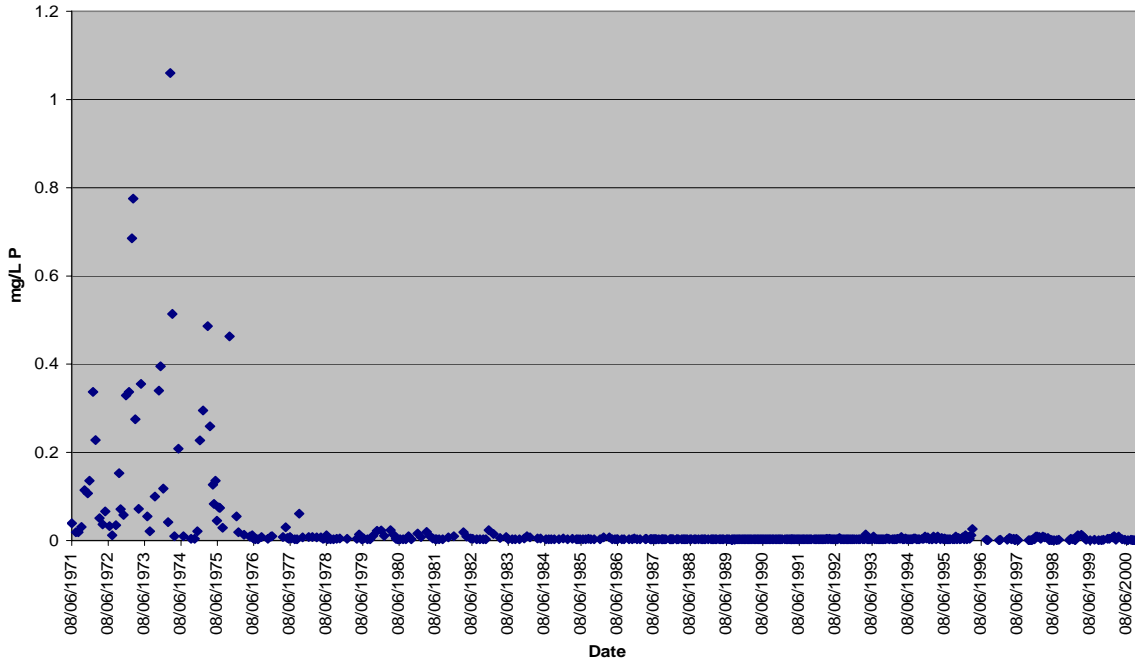


Figure 35 Kootenay River at Fenwick Station - Phosphorus, Dissolved Ortho, 1976-2000

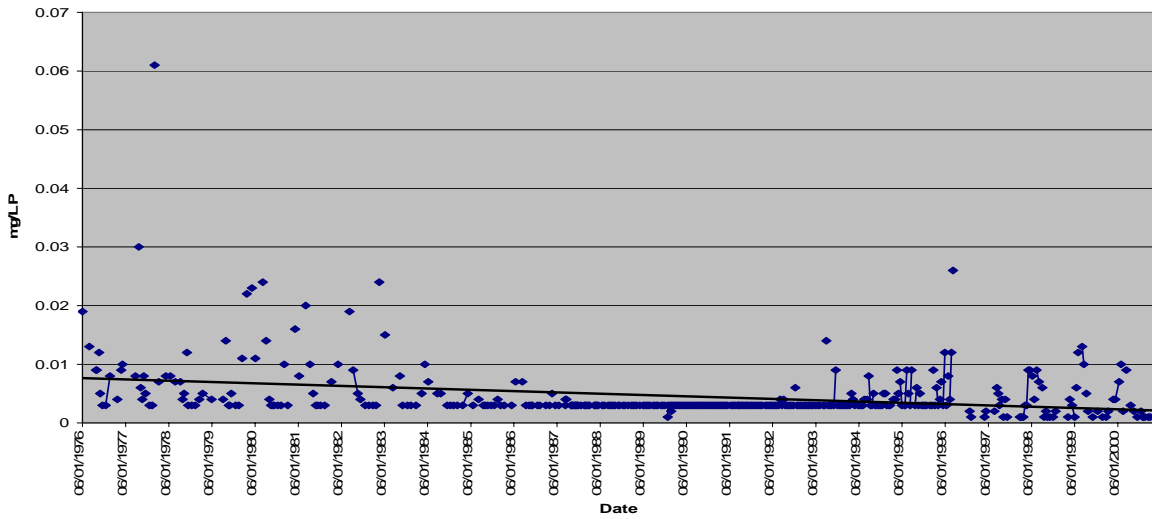


Figure 36 Kootenay River at Fenwick Station - Phosphorus, Dissolved Ortho, 1987-2000

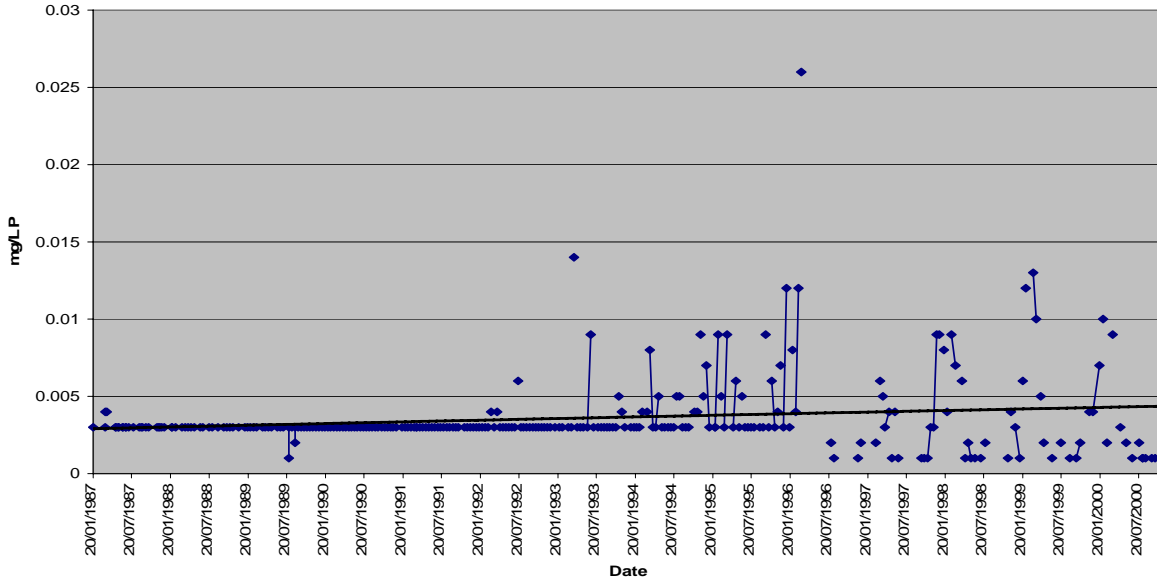


Figure 37 Kootenay River at Fenwick Station - Phosphorus, Total, 1971-2000

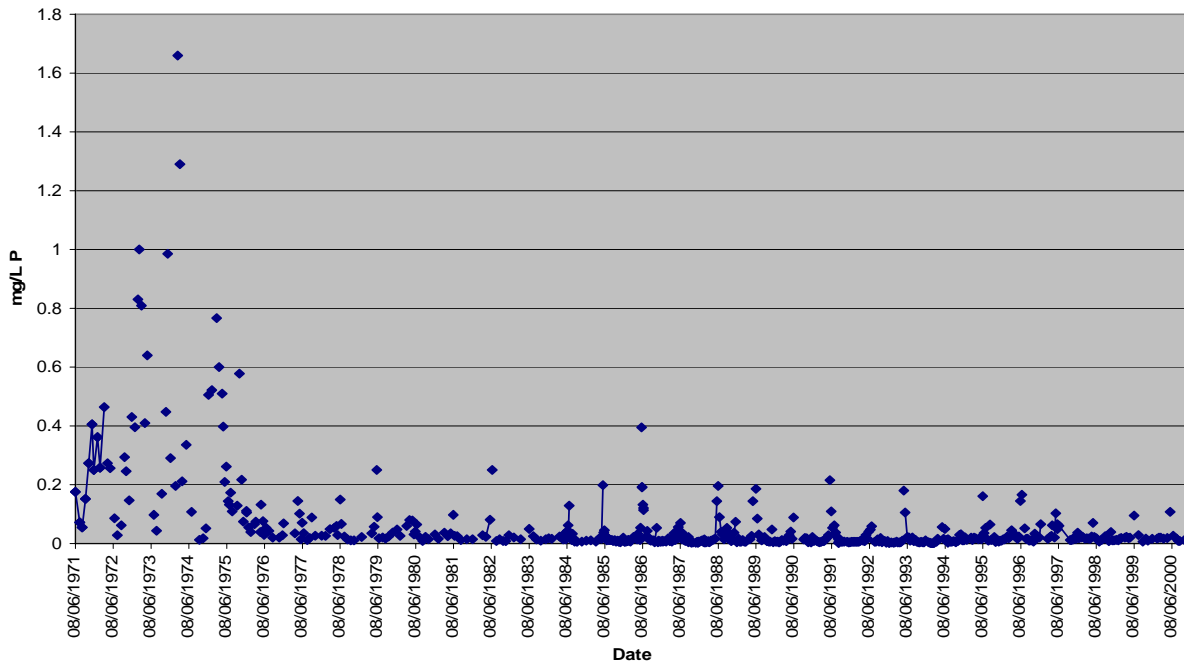


Figure 38 Kootenay River at Fenwick Station - Phosphorus, Total, 1976-2000

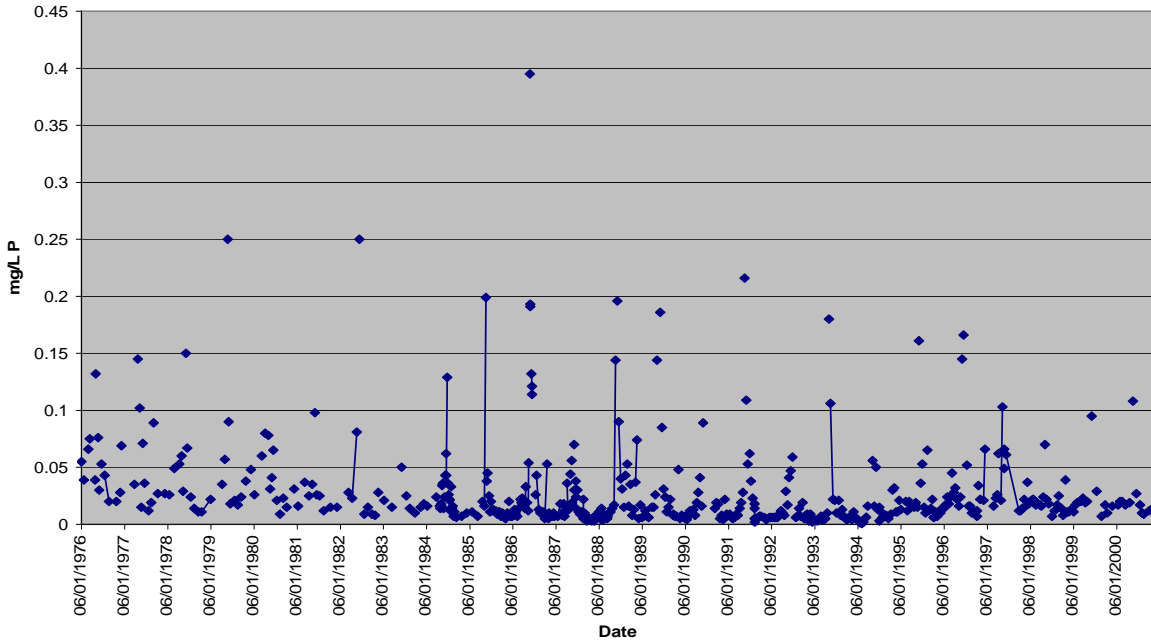


Figure 39 Kootenay River at Fenwick Station - Phosphorus, Total, 1985-2000

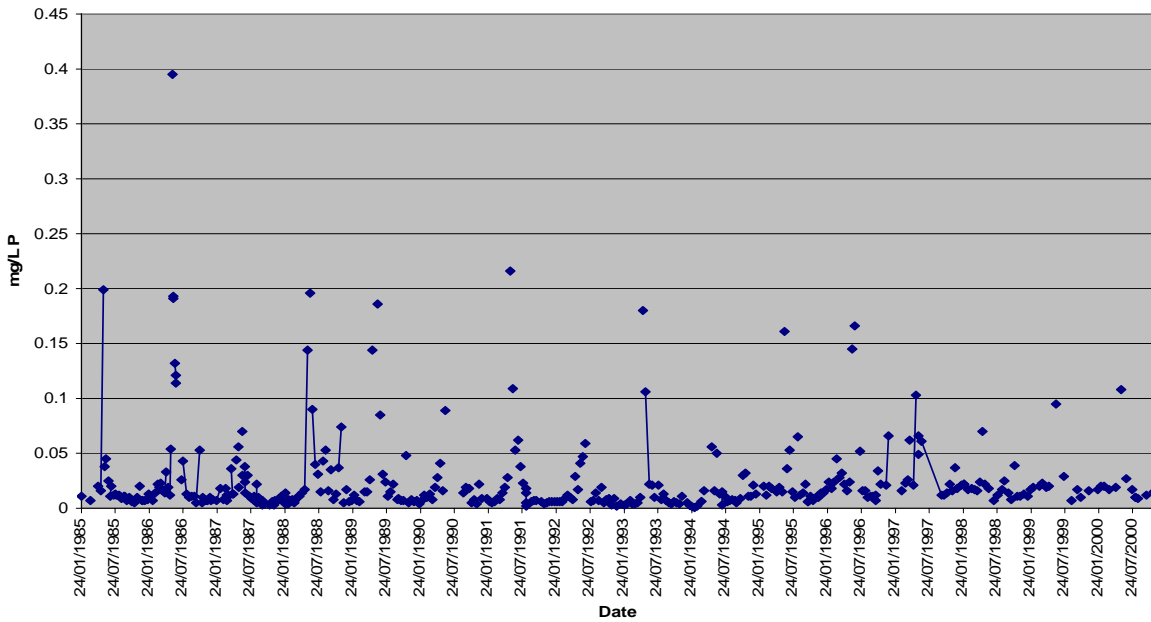


Figure 40 Kootenay River at Fenwick Station - Selenium, Total

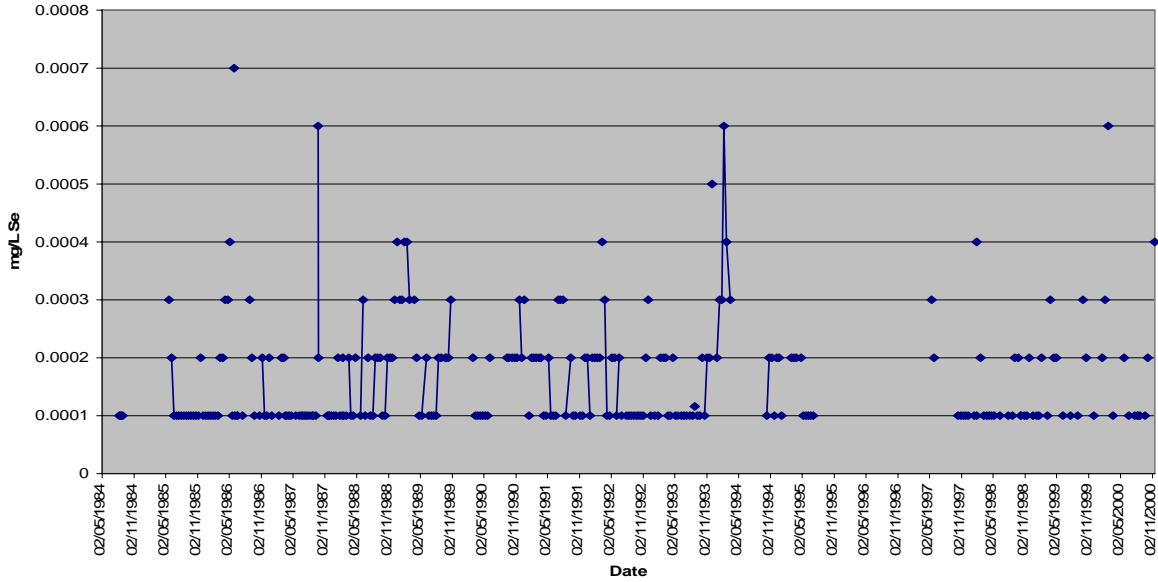
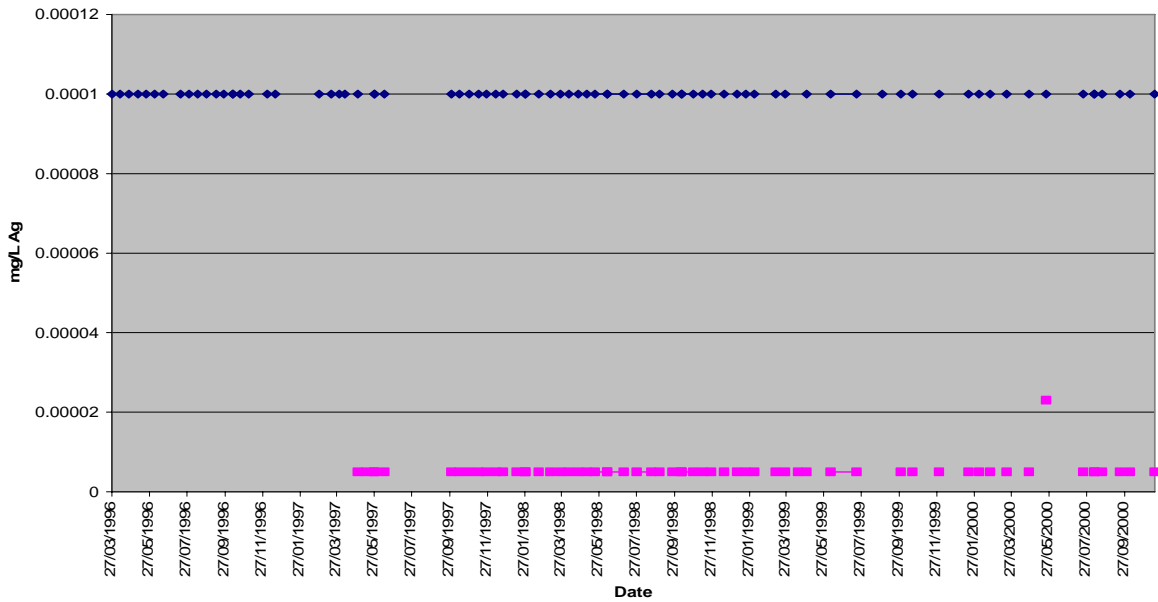


Figure 41 Kootenay River at Fenwick Station - Silver, Total and Extractable



Water Quality Assessment of the Kootenay River at Fenwick Station, 1971-2000

Figure 42 Kootenay River at Fenwick Station - Sodium, Dissolved and Extractable

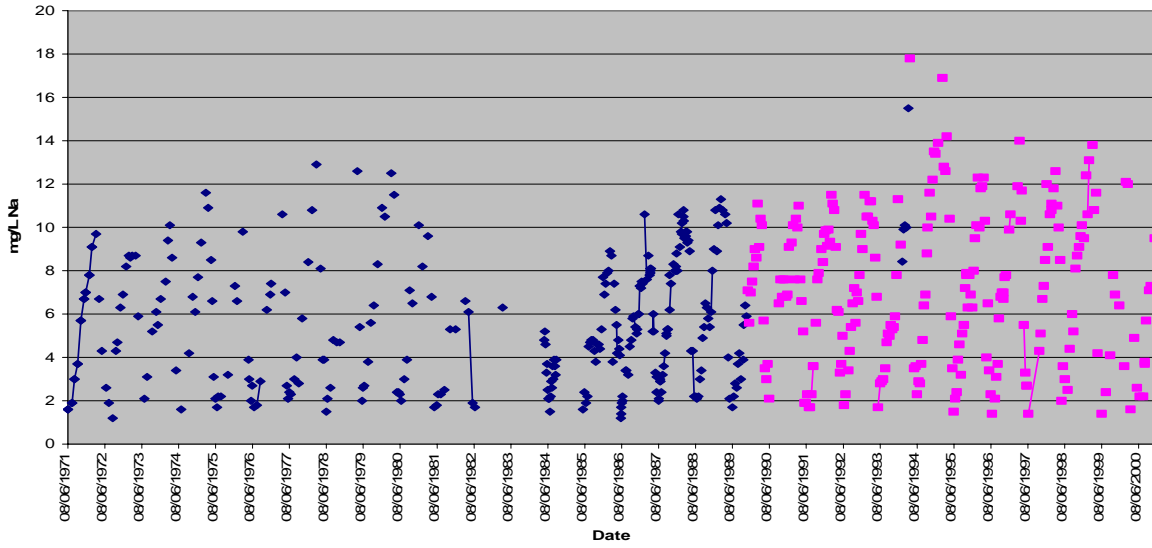


Figure 43 Kootenay River at Fenwick Station - Strontium, Total and Extractable

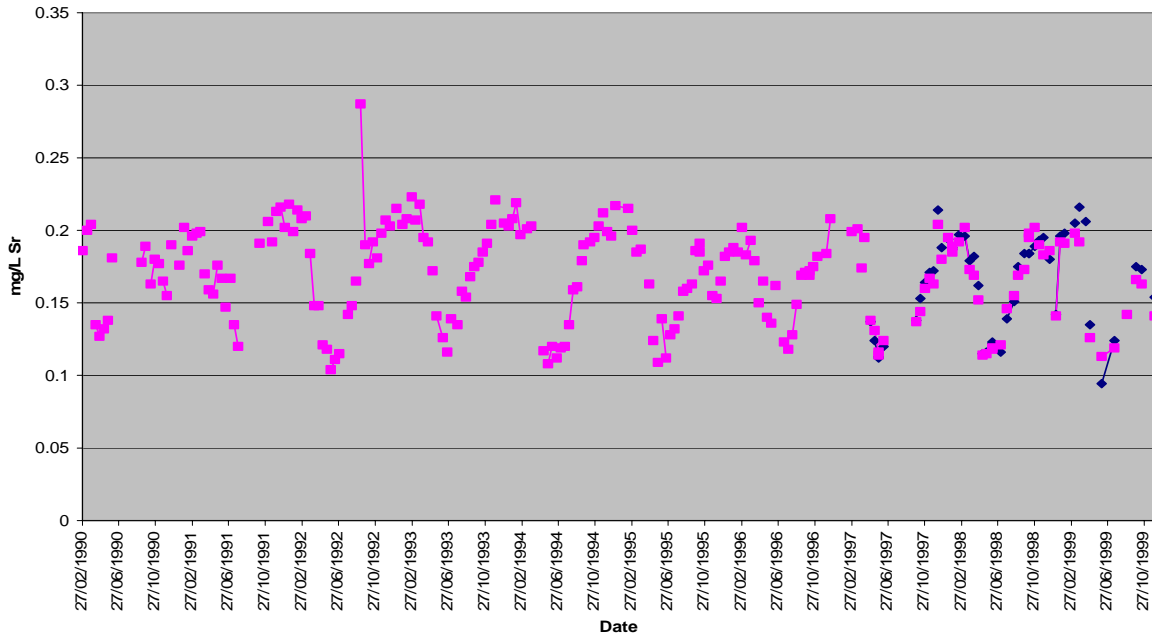


Figure 44 Kootenay River at Fenwick Station - Water Temperature

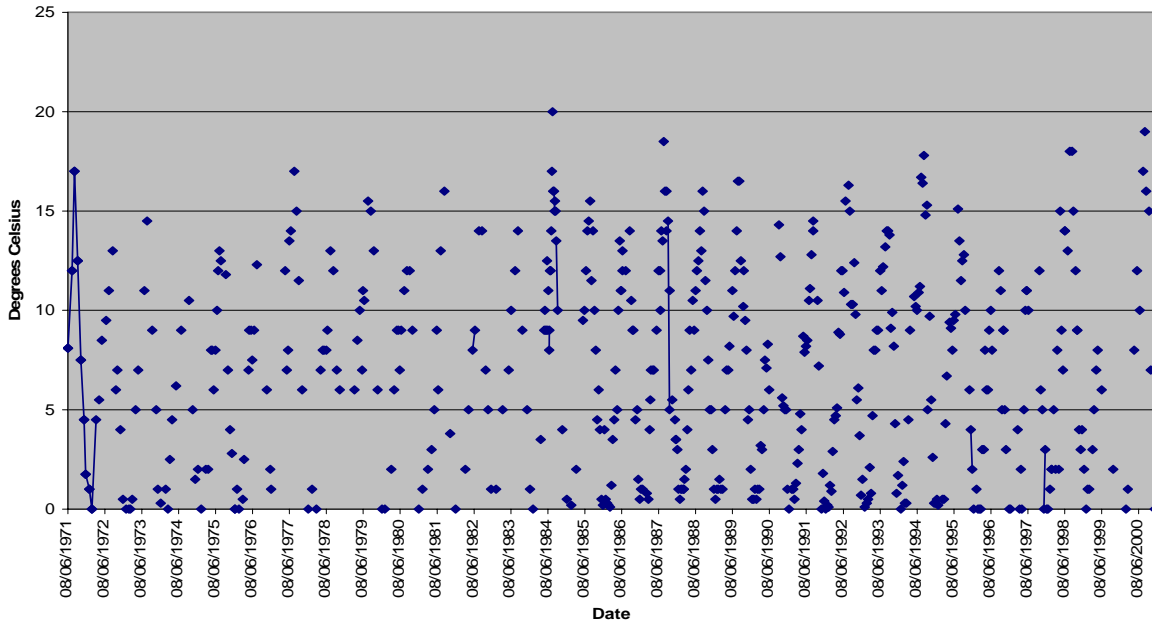
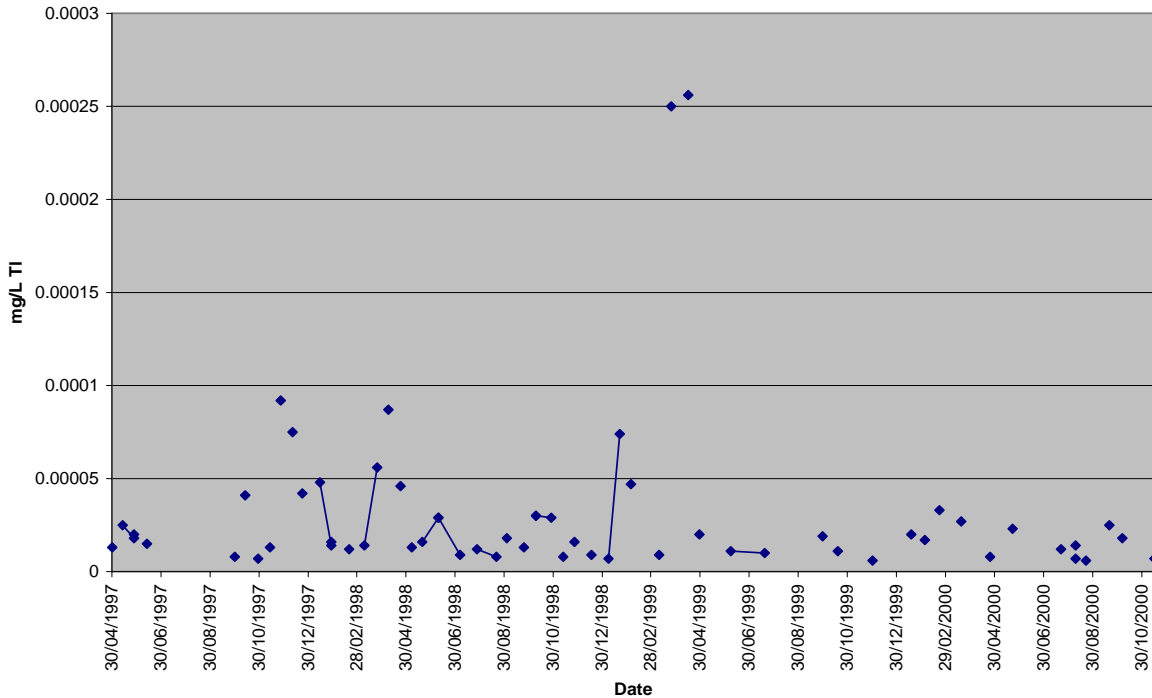


Figure 45 Kootenay River at Fenwick Station - Thallium, Extractable



Water Quality Assessment of the Kootenay River at Fenwick Station, 1971-2000

Figure 46 Kootenay River at Fenwick Station - Turbidity

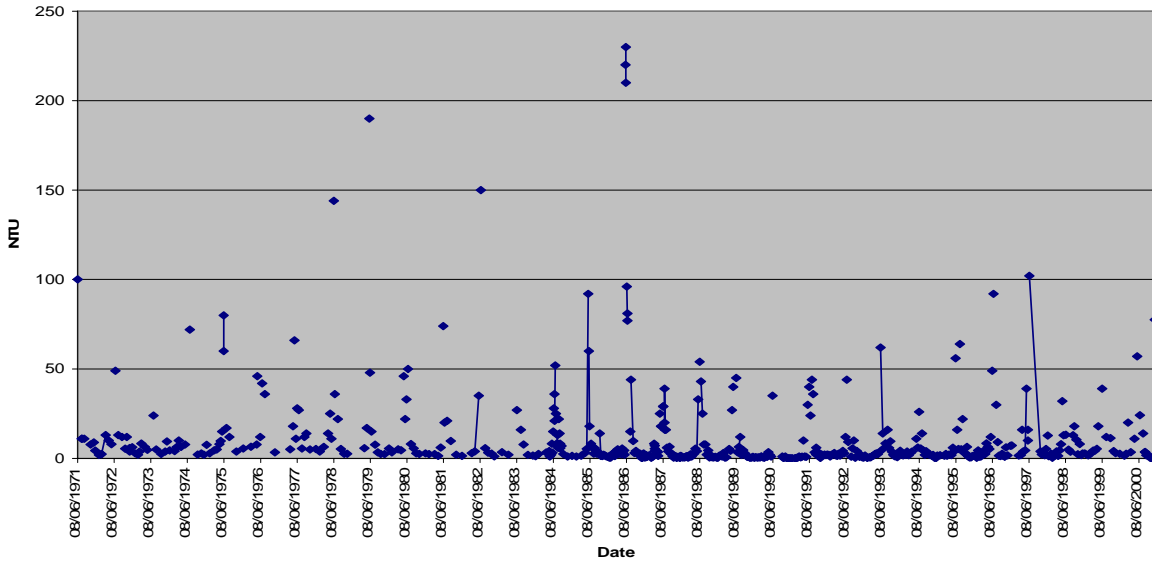


Figure 47 Kootenay River at Fenwick Station - Uranium, Extractable

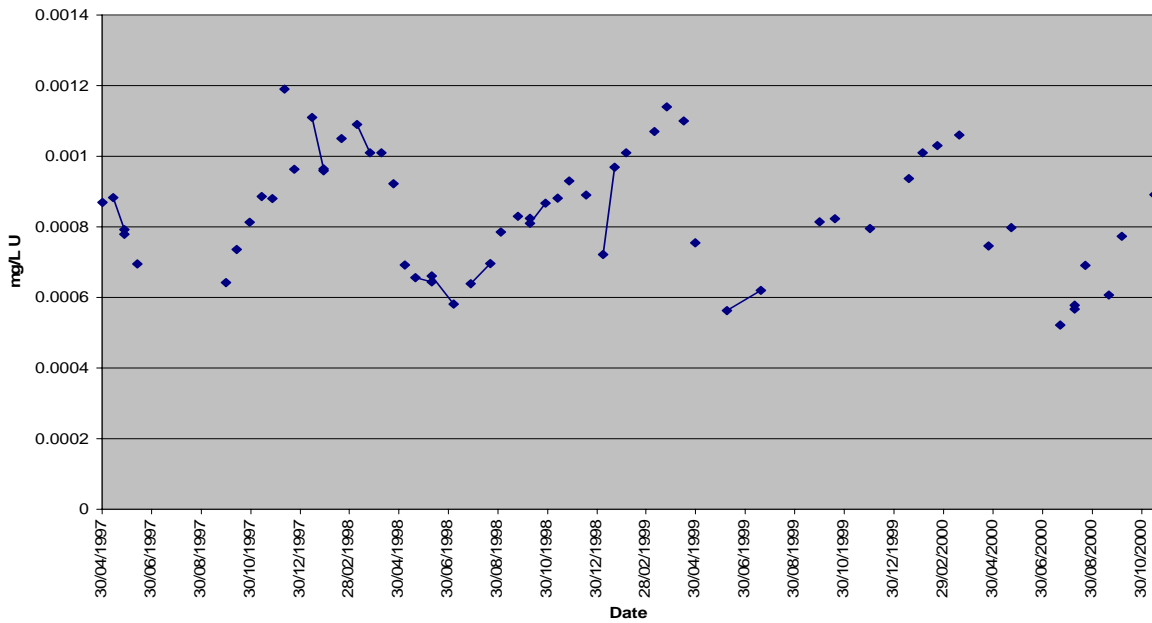


Figure 48 Kootenay River at Fenwick Station - Vanadium, Total and Extractable

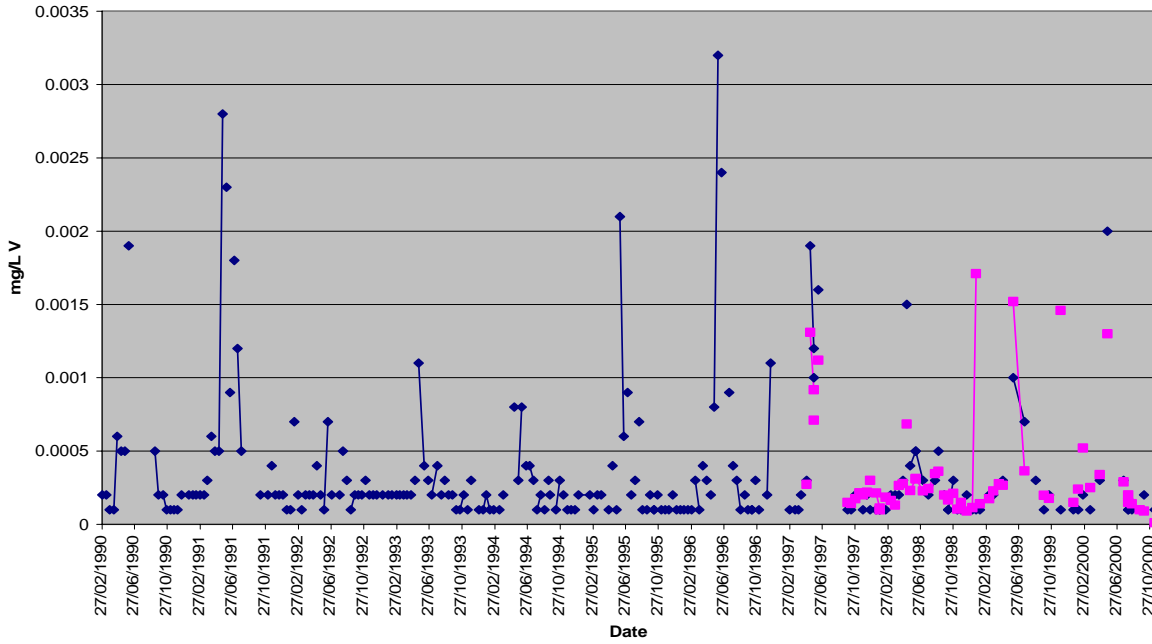


Figure 49 Kootenay River at Fenwick Station - Zinc, Total

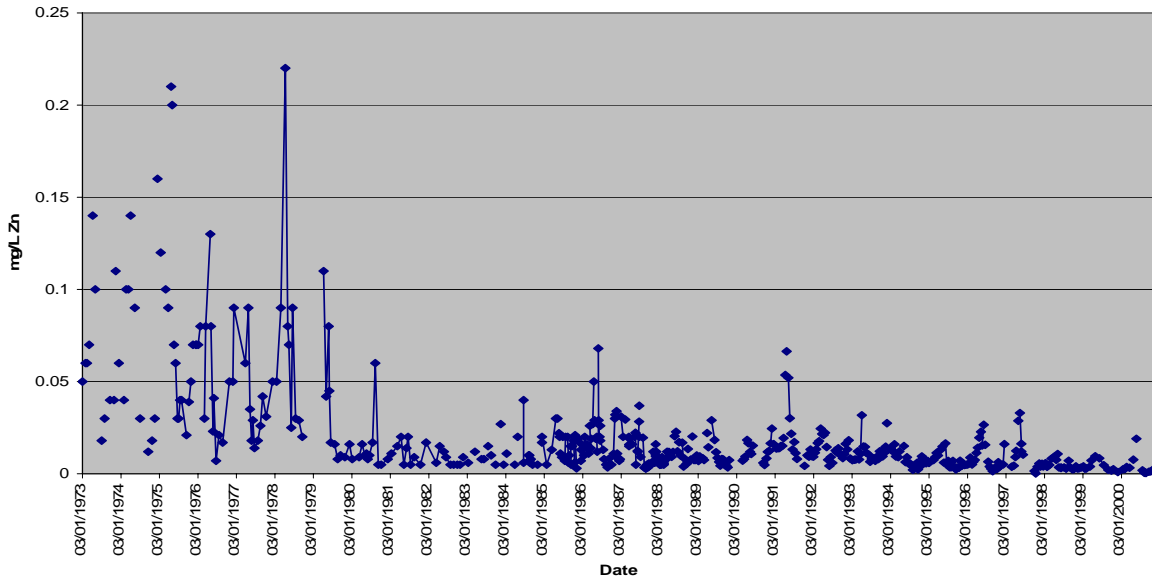


Figure 50 Kootenay River at Fenwick Station - Zinc, Total, 1991-2000

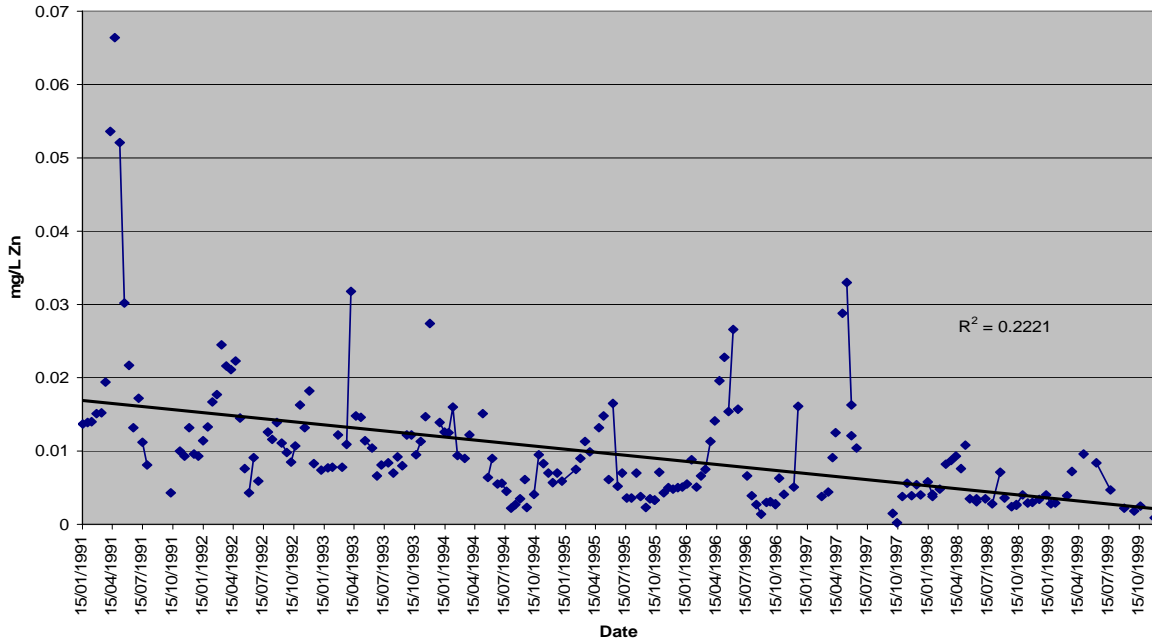


Figure 51 Kootenay River at Fenwick Station - Zinc, Total & Extractable, 1997-2000

