# CANADA – BRITISH COLUMBIA
## WATER QUALITY MONITORING AGREEMENT

# WATER QUALITY ASSESSMENT OF Thompson River AT SPENCES BRIDGE (1984 – 2004)

Prepared by:
L. G. Swain, P. Eng.
B.C. Ministry of Environment

Prepared for:
B.C. Ministry of Environment
and
Environment Canada

March 2007

Environment Canada Environnement Canada

BRITISH COLUMBIA The Best Place on Earth | Ministry of Environment

## EXECUTIVE SUMMARY

The Thompson River drains over 55,000 $km^2$ of the Interior Plateau, Shuswap Highlands, and Columbia Mountains to the Fraser River at Lytton. The river is important for fish spawning and rearing, for migrating salmon, and for irrigation, livestock watering, drinking water, and recreation such as rafting and steelhead fishing.

Main influences on water quality include treated effluent from a bleached kraft pulp mill and the City of Kamloops wastewater treatment plant discharge upstream from Kamloops Lake. Other small point sources include the Merritt, Clinton, Cache Creek and Ashcroft wastewater treatment plant discharges. There are several large mines in the watershed, but only small amounts of seepage are discharged. There are also non-point source discharges from agriculture, urban development, forestry, transportation and stream bank erosion. No long-term water quality trends were identified.

## CONCLUSIONS

- Water quality guidelines to protect aquatic life were exceeded on occasion for cadmium, copper, iron, lead, dissolved oxygen, silver, water temperature, and zinc. Metals values that exceeded guidelines were usually related to high turbidity concentrations, and thus were not likely to be a concern because the metals would be in a particulate form and not biologically available.
- We could not assess whether guidelines to protect aquatic life were exceeded for chromium or aluminum since the correct forms ($Cr^{+6}$ and $Cr^{+3}$, and dissolved aluminum) have not been measured. We do not believe that suitable test methods exist at present for the different forms of chromium.
- Detection limits for cadmium and silver were reduced significantly in 2003, thereby making interpretation of data relative to guideline values more meaningful than was possible in the past. Occasional values for both variables exceeded guidelines by a slight margin.

- Some variables that exceeded aquatic life guidelines may also exceed less sensitive guidelines to protect other water uses. Water quality guidelines were exceeded on occasion by aluminum, true colour, and turbidity.
- We did not see evidence of any long-term trends in concentrations for any variables.

## RECOMMENDATIONS

We recommend monitoring be continued for the Thompson River at Spences Bridge since it is last downstream site measuring the contribution from this significant tributary to the Fraser River.

Further, we recommend that efforts be made to measure the dissolved form of metals (particularly for aluminum) and for the trivalent and hexavalent forms of chromium. For chromium, we recommend that a better test method be developed.

Water quality indicators that are important for future monitoring are:

- flow, water temperature, specific conductivity, pH, turbidity, nutrients, and dissolved oxygen,
- appropriate forms of metals for comparison to their respective guidelines, and
- other variables related to drinking water such as colour.

## ACKNOWLEDGEMENTS

The graphs in this report were prepared by Sacha Wassick of Environment Canada. The draft report was reviewed by Carrie Morita and Bob Grace of BC Environment. We thank these individuals for their contributions to improving this document. Any errors or omissions are the responsibility of the author.

## TABLE OF CONTENTS

Page



## LIST OF FIGURES

Page

## LIST OF FIGURES

## (CONTINUED)

Page

## LIST OF FIGURES

## (CONTINUED)

Page

## INTRODUCTION

Since 1985, B.C. Ministry of Environment and Environment Canada have been cooperatively measuring water quality at a number of locations in British Columbia. The express purposes of this joint monitoring program have been to define the quality of the water and to determine whether there are any trends in water quality.

Water quality measurements for the Thompson River at Spences Bridge were plotted on a graph over time, along with the relevant water quality objectives or guidelines. The graphs were inspected for "environmentally significant" trends - where the measurements are increasing or decreasing over time and the levels are close to the objectives or guidelines, or are otherwise judged to represent an important change in water quality. These trends are further evaluated to ensure that they were not caused by measurement errors, to identify their causes, and to determine whether they are statistically significant. A confidence level of 95% or better is used to define statistical significance, unless noted otherwise.

The Thompson River drains over 55,000 $km^2$ of the Interior Plateau, Shuswap Highlands, and Columbia Mountains to the Fraser River at Lytton. The river is important for fish spawning and rearing, for migrating salmon, and for irrigation, livestock watering, drinking water, and recreation such as rafting and steelhead fishing.

Main influences on water quality include treated effluent from a bleached kraft pulp mill and the City of Kamloops wastewater treatment plant discharge upstream from Kamloops Lake. Other small point sources include the Merritt, Clinton, Cache Creek, Chase and Ashcroft wastewater treatment plant discharges. There are several large mines in the watershed, but only small amounts of un-recoverable seepage are discharged. There are also non-point source discharges from agriculture, urban development, forestry, transportation and stream bank erosion.

The sample is collected from the downstream side of the Highway 8 bridge crossing, just east from Spences Bridge.

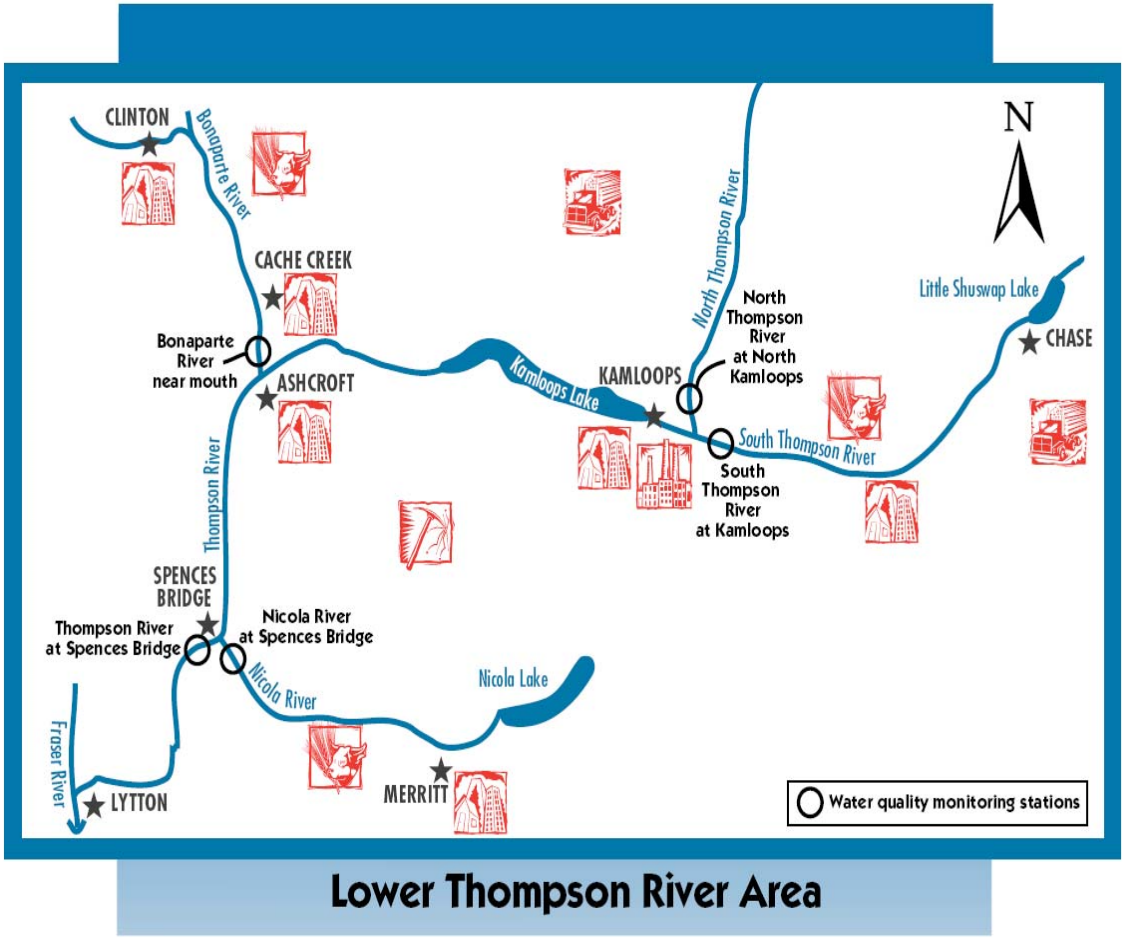



**FIGURE 1: THOMPSON RIVER AT SPENCES BRIDGE**

## WATER QUALITY ASSESSMENT

The state of the water quality was assessed by comparing the values to the site-specific water quality objectives for the Thompson River (Nordin and Holmes, 1992) and to B.C.'s approved and working guidelines (if guidelines or objectives exist for the variable) for water quality (B.C. Ministry of Environment, 2006a and b), and by looking for any obvious trends in the data. Any levels or apparent trends that were found to be deleterious or potentially deleterious to sensitive water uses, including drinking water, aquatic life,

wildlife, recreation, irrigation, and livestock watering were noted in the following variable-by-variable discussion described below in alphabetical order.

When concentrations of a substance cannot be detected, we have plotted the concentration at the level of detection. We believe this to be a conservative approach to assessing possible trends. As well, there are times when measurements were not taken for some reason. In these cases, straight lines will join the two consecutive points and may give the illusion on the graph of a trend that does not exist.

In cases where we have used statistical techniques such as linear regression analysis to estimate if a trend is possibly present, a more thorough statistical analysis of the trend is necessary for verification of the trend.

In some cases, testing for the presence of a variable has been terminated after a certain period. In general, this has been because a previous data assessment and review has indicated that collections of these data are not warranted for this station. For other variables, concerns about concentrations may have only arisen in recent years.

Data for the Thompson River at Spences Bridge have been collected on a frequency of about once every two weeks. As well, twice per year, two additional samples are collected in order to ensure that there are two periods when weekly samples are collected during five consecutive weeks. In addition, quality assurance samples (blanks and replicates) are collected six times per year. These results for each variable were used in this assessment to identify potential outliers that should be removed form consideration of trends, and to “flag” questionable data in the database (www.waterquality.ec.gc.ca) as to possible or likely errors.

The following water quality indicators were not discussed as they met all water quality guidelines (if guidelines exist) and showed no clearly visible trends: adsorbable organic halides (AOX), ammonia, boron, bismuth, bromide, dissolved organic carbon, fluoride, lithium, mercury, specific conductivity, molybdenum, nitrate, nitrite, total nitrogen, fixed

filterable residue, fixed non-filterable residue, non-filterable residue, filterable residue, selenium, silicon, tin and thallium.

The following water quality indicators seemed to fluctuate through the year according to turbidity concentrations, but were below guideline values (if guidelines exist) and had no other trends: alkalinity, antimony, arsenic, barium, beryllium, cobalt, gallium, lanthanum, nickel, phosphorus, rubidium, silica, and vanadium.

Other water quality indicators seemed to fluctuate through the year according to the specific conductivity of the water. For dissolved forms of many of these indicators, they would be a part of the measured conductivity, and this is to be expected. These types of indicators that were not measured above guideline values (if guidelines exist) included: dissolved inorganic carbon, dissolved calcium, dissolved chloride, total hardness, dissolved potassium, dissolved magnesium, total dissolved nitrogen, dissolved sodium, total strontium, dissolved sulphate, and total uranium.

**Flow** (Figure 2) values showed fairly typical patterns characteristic of an interior river with an alpine drainage with highest flows during freshet in spring and early summer, and with lowest flows in late fall and winter. Flow monitoring should continue because of its importance in interpreting many water quality indicators.

**Total aluminum** values (Figure 4) showed annual peaks that exceeded the dissolved aluminum guidelines for aquatic life (50 to 100 µg/L) and for drinking water and recreation (200 µg/L), but remained below the 5,000 µg/L total aluminum guideline for wildlife, livestock, and irrigation. These annual peaks were largely correlated with high flows and turbidity during spring freshets, suggesting that most aluminum was in particulate form, and thus was probably not biologically available and would be reduced by the treatment needed to remove turbidity prior to drinking. The dissolved aluminum fraction was suspected to be quite low and below all guidelines because of the low total aluminum concentrations when turbidity was low. Both dissolved and total aluminum should be monitored in the future to allow for appropriate comparison to the guidelines.

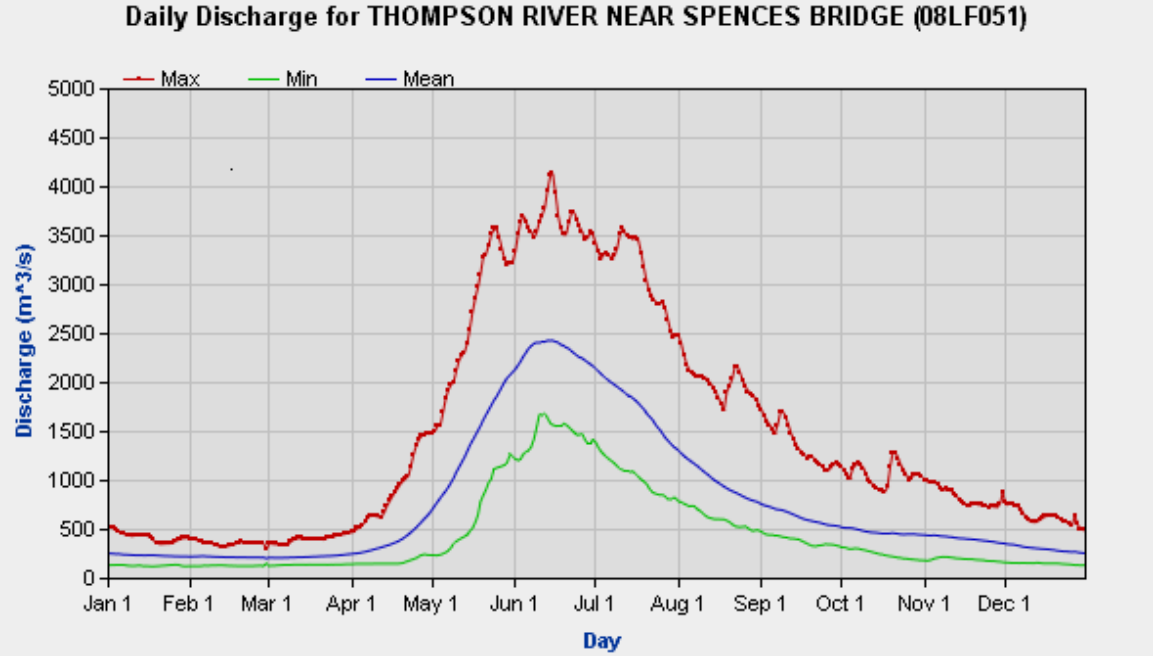



**Figure 2: Water Survey of Canada Flow Data for Thompson River at Spences Bridge**

**Total cadmium** had minimum detection limits that were three to ten times above the aquatic life guidelines (Figure 17), and above levels that are typical in pristine waters until about 2003. These MDLs were lowered in 2003 (Figure 18) to allow for better interpretation of the data relative to guideline levels to protect aquatic life, but the guideline levels (that are related to water hardness) are quite low (typically 0.015 µg/L. In 2003 and 2004, aquatic life guidelines were exceeded in about 30% of samples. There do not appear to be any trends in the data although the data record with low detection levels is quite limited. Higher values may be related to higher turbidity concentrations which would mean that the cadmium may not be biologically available.

**Apparent colour** values (Figure 21) occasionally exceeded the 15-unit true colour guidelines for drinking water and recreation. These values higher than the guideline usually occurred during high flows, and thus are the result of the higher turbidity found at these times. **True colour** measurements (Figure 22) gave lower results (only three values in excess of the guideline) since turbidity is removed prior to analysis. True colour should be monitored in the future to allow for appropriate comparison to the guidelines.

**Total chromium** (Figure 23) values often surpassed the 1 µg/L guideline value for hexavalent chromium for aquatic life (phyto- and zoo-plankton). The guidelines for trivalent chromium for the protection of aquatic life only were exceeded once, in 1987, when vial contamination was suspected. The total chromium value of 343 µg/L that was taken in September 1992 was excluded as an outlier. High chromium concentrations seem to be related to higher flows and turbidity; therefore, these are likely not biologically available. There does not appear to be a trend to higher or lower concentrations in the data. Both total and dissolved chromium should be monitored in the future, and speciation of chromium into Cr-III and Cr-VI should always be done when suitable methods become available for comparison to the updated CCME guidelines for Cr-III and Cr-VI.

**Total copper** measurements had widespread contamination due to the failure of preservative vial cap liners between 1986 and 1991 (Figure 24). After early 1991, when the vials were changed, 34 values exceeded the CCME aquatic life guideline (2 µg/L), and three values exceeded the maximum BC guideline calculated for the hardness that occurred at the same sampling time (1991, 1997, 2003). Two of these three values occurred during a time of high turbidity. There are no apparent trends in copper concentrations although higher total values do seem to be related to higher turbidity values. Total and dissolved copper should be monitored in the future.

**Total iron** values (Figure 27) were often well above the 300 µg/L drinking water (aesthetics) and aquatic life guideline, and, on one occasion exceeded the 5 mg/L continuous irrigation guideline. Since most of the iron peaks coincided with high turbidity peaks, the high iron content in the water was probably due to the iron content of the suspended sediment and was probably not biologically available. There did not appear to be any trends of increasing or decreasing iron values. Drinking water use during freshet would need turbidity (particulate) removal, which would probably reduce the iron levels to below the drinking water guideline. Both dissolved and total iron should be monitored in the future.

**Fecal coliform** levels (Figure 28) in the ambient water occasionally exceeded the guideline of 10 CFU/100 mL level for drinking water with disinfection only. These values in excess of the guideline often coincided with high turbidity values, when sediment removal for drinking waters should be taking place. Values in the 2002-2004 periods appear to be lower than recorded during the 2000-2001 periods; however, this likely is a reflection of a different analytical laboratory performing the analyses rather than a real trend in the data.

**Total lead** values (Figure 33) exceeded various guidelines at various times between 1985 and 2004, although the frequency with which guidelines have been exceeded seems to have declined after 1991 when vial contamination was discovered. In fact, the lowest guideline level (CCME for the protection of aquatic life which is hardness-dependent) was only exceeded eight times in that 14-year period. High lead concentrations appear to be related to higher turbidity values. The peak value in June of 1994 was eliminated from the dataset as it was identified as an error. Total lead does not appear to be of any current environmental concern.

**Total manganese** values (Figure 37) exceeded the drinking water guideline (aesthetics) of 50 µg/L on eight occasions. As most of the manganese and turbidity peaks coincided, the high manganese levels were probably due to the manganese content of the suspended sediment and thus of little concern. Drinking water use during freshet would require turbidity (particulate) removal, which would probably reduce the manganese levels below the drinking water guideline. There does not appear to be any trends of increasing or decreasing manganese concentrations through time. Dissolved and total manganese should be measured in the future should any concerns regarding manganese arise.

**Oxygen, dissolved** levels (Figure 45) have been measured infrequently but have usually been greater than the 8 mg/L minimum guideline level for the protection of aquatic life. One value in early 2001 was less than this guideline. It is a concern that such a basic measurement of water quality condition is not being measured regularly. We recommend that dissolved oxygen should be measured when any samples are collected.

**pH** (Figure 48) values prior to 1988 were significantly lower than have been measured since that time. Lower pH (federal) values during the 1986-89 period were considered suspect due to a loss of control in pH measurement in the laboratory. Larger fluctuations in pH values after 2000 are likely related to a change in analytical laboratory and the use of more sensitive analytical techniques at that time. Higher pH values seem to be correlated to the higher turbidity values at the same time. We recommend that pH continue to be monitored due to its effect on organism physiology and its influence on other variables.

**Silver** (Figures 57 and 58) had detection limits lowered significantly in 2003, but high values through time seem to be related to higher turbidity values. During the 2003-2004 periods, only one value exceeded the aquatic life guideline as a mean concentration, but did not exceed the maximum value for the guideline. Other than the lower values due to improved detection limits, there were no trends of increasing or decreasing silver values. Silver should continue to be measured at the Thompson River using these improved detection limits.

**Water temperature** values (Figure 63) often exceeded the 15 $^{0}$C drinking water guideline (aesthetics) and the 18 $^{0}$C aquatic life guideline for streams with unknown fish species present. Water temperature should continue to be monitored due to the impact it has on recreational activities, drinking water aesthetics, fisheries, organism physiology, and on other water quality variables.

**Turbidity** (Figure 66) values frequently exceeded the drinking water guideline of 1 NTU, likely during periods of high flows. Therefore, advanced treatment of drinking water supplies employing turbidity removal should occur during periods of high turbidity.

**Total zinc** values (Figure 69) occasionally exceeded the chronic effects aquatic life guideline at 7.5 µg/L after 1991 when vial contamination was eliminated. High zinc concentrations seem to be related to high turbidity values. Since 1991, there does not appear to be increasing or decreasing zinc concentrations. Total and dissolved zinc should be measured in the future.

## References

Ministry of Environment. 2006a. British Columbia Approved Water Quality Guidelines (Criteria). Ministry of Environment, Victoria, B.C.

Ministry of Environment. 2006b. A Compendium of Working Water Quality Guidelines for British Columbia. Ministry of Environment, Victoria, B.C.

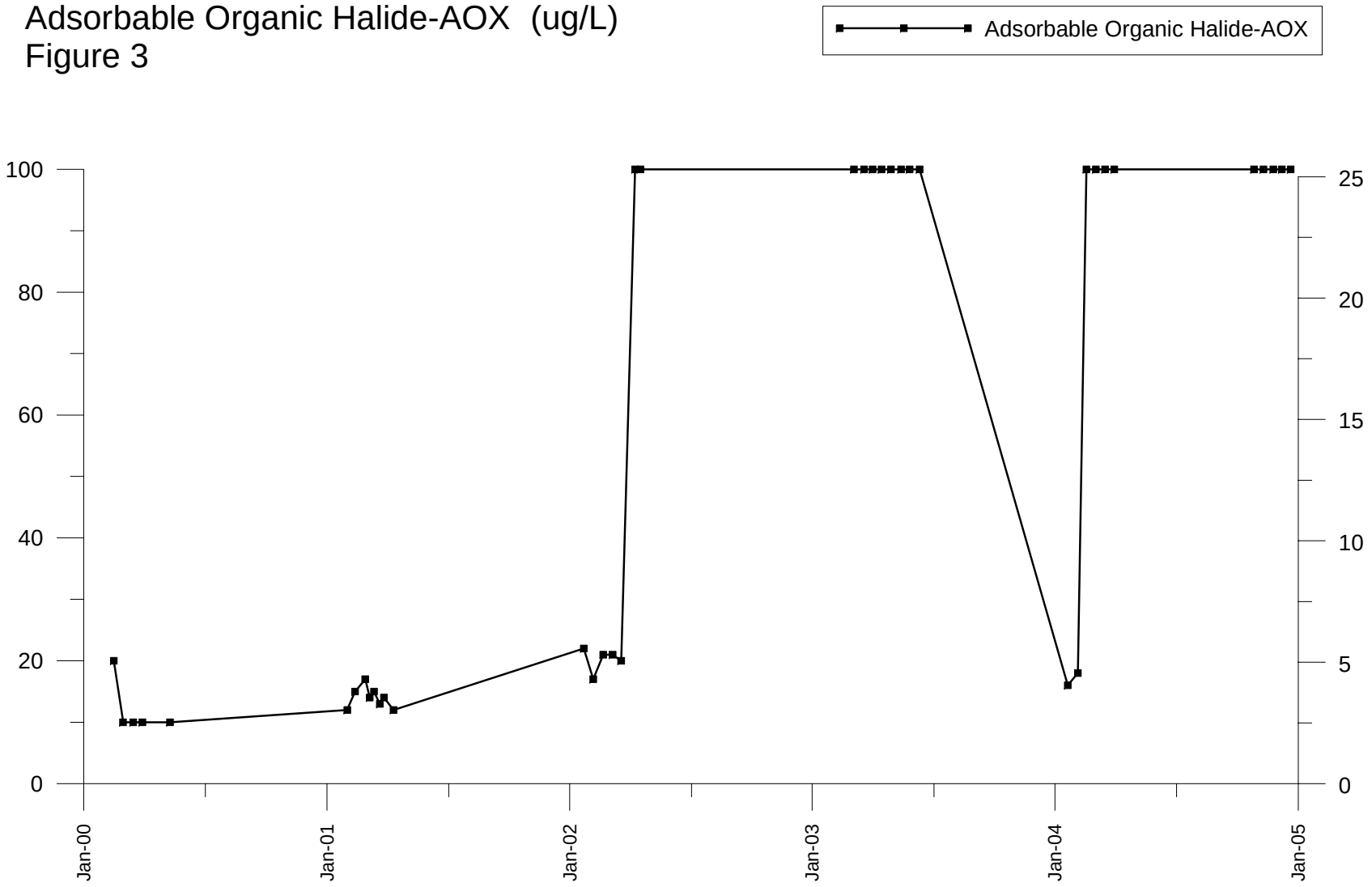
Nordin, R.N., Holmes, D.W. 1992. Thompson River Water Quality Assessment and Objectives Technical Appendix. Water Management Branch, Ministry of Environment, Lands and Parks. Victoria, B.C.

Pommen, L.W. 1994. Mercury Monitoring Issues (Mark II). Water Quality Branch, Environmental Protection Department, Ministry of Environment, Lands and Parks. Victoria, B.C.

# Thompson River at Spences Bridge

Adsorbable Organic Halide-AOX (ug/L)

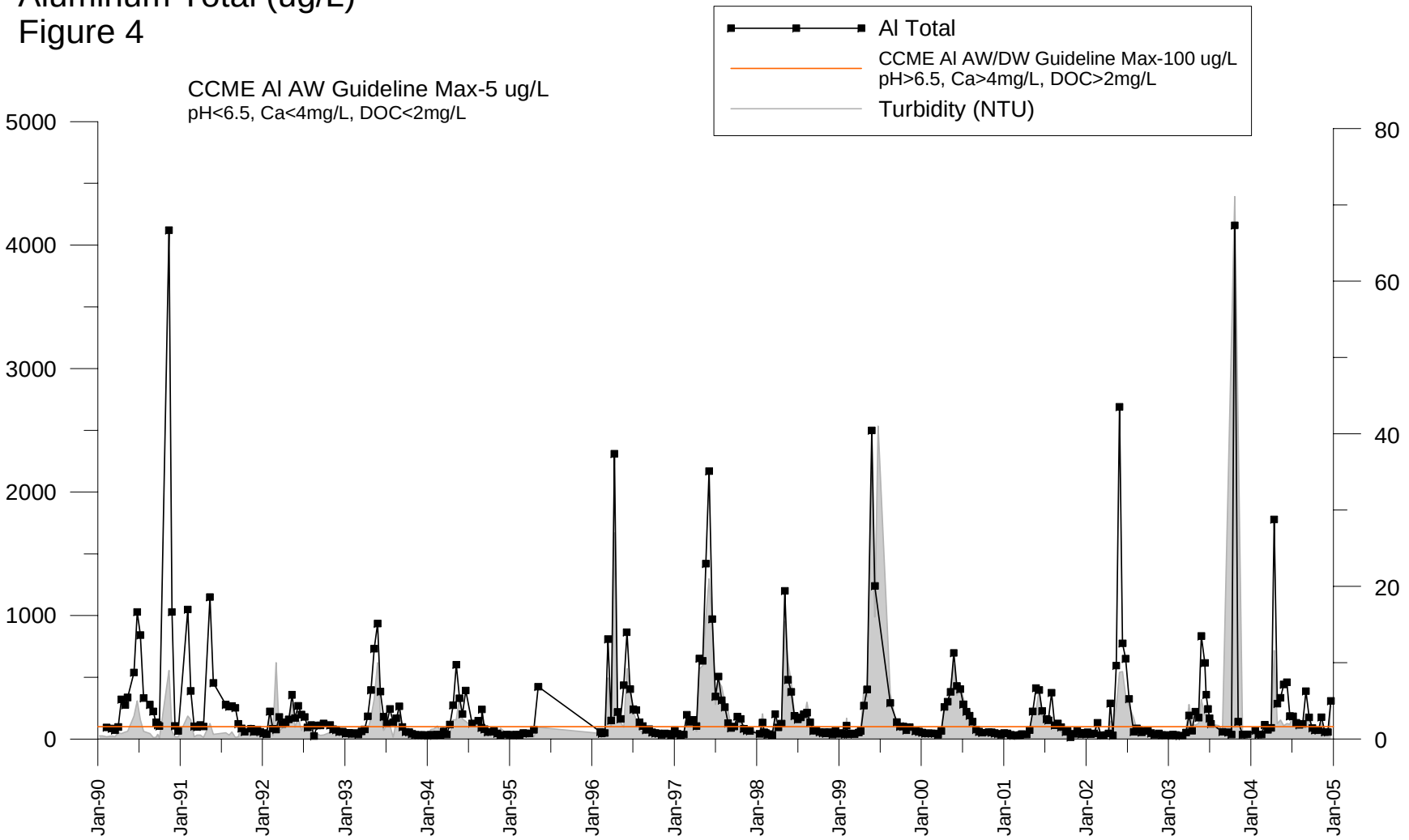
Figure 3



# Thompson River at Spences Bridge

## Aluminum Total (ug/L)

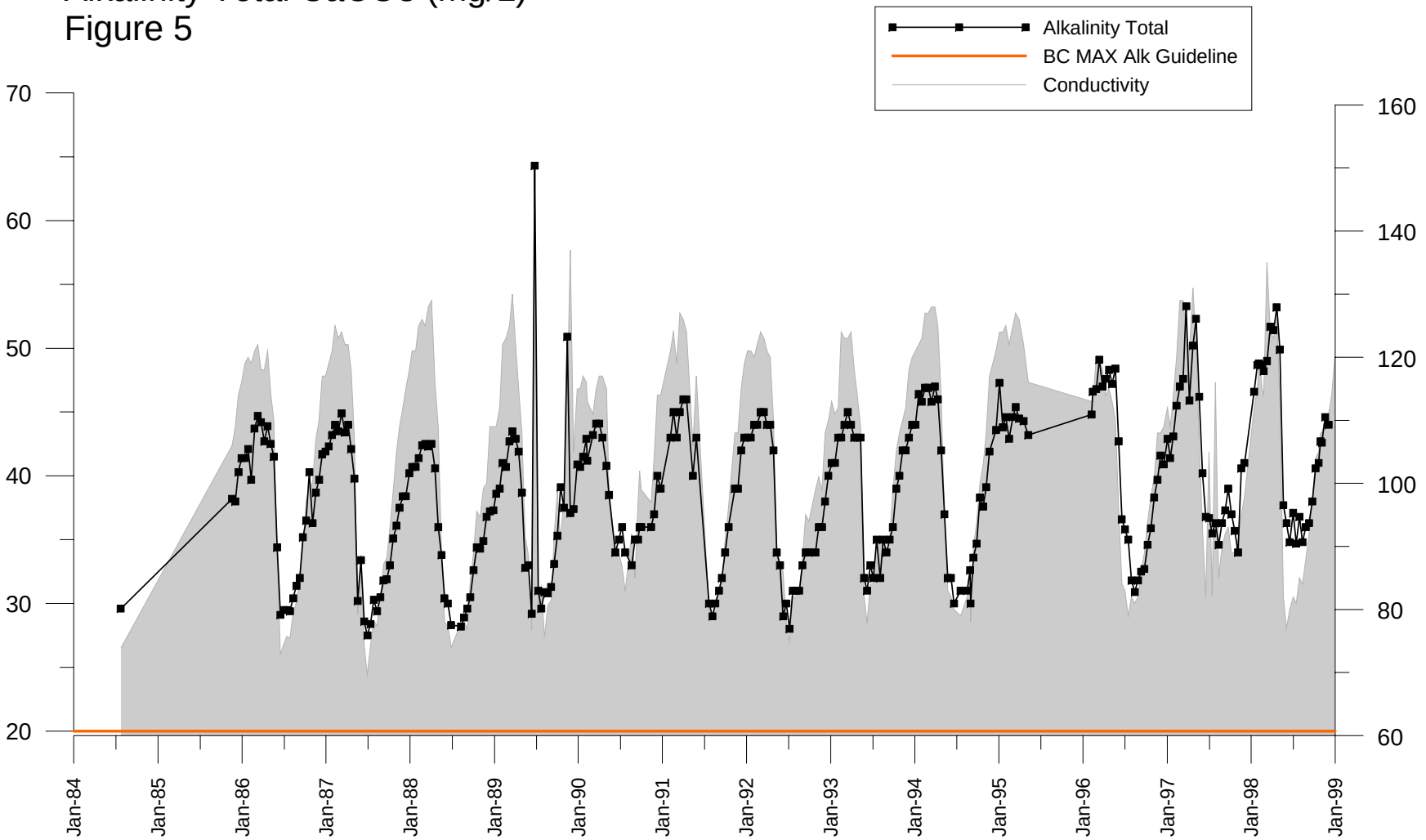
## Figure 4



# Thompson River at Spences Bridge

## Alkalinity Total CaCO3 (mg/L)

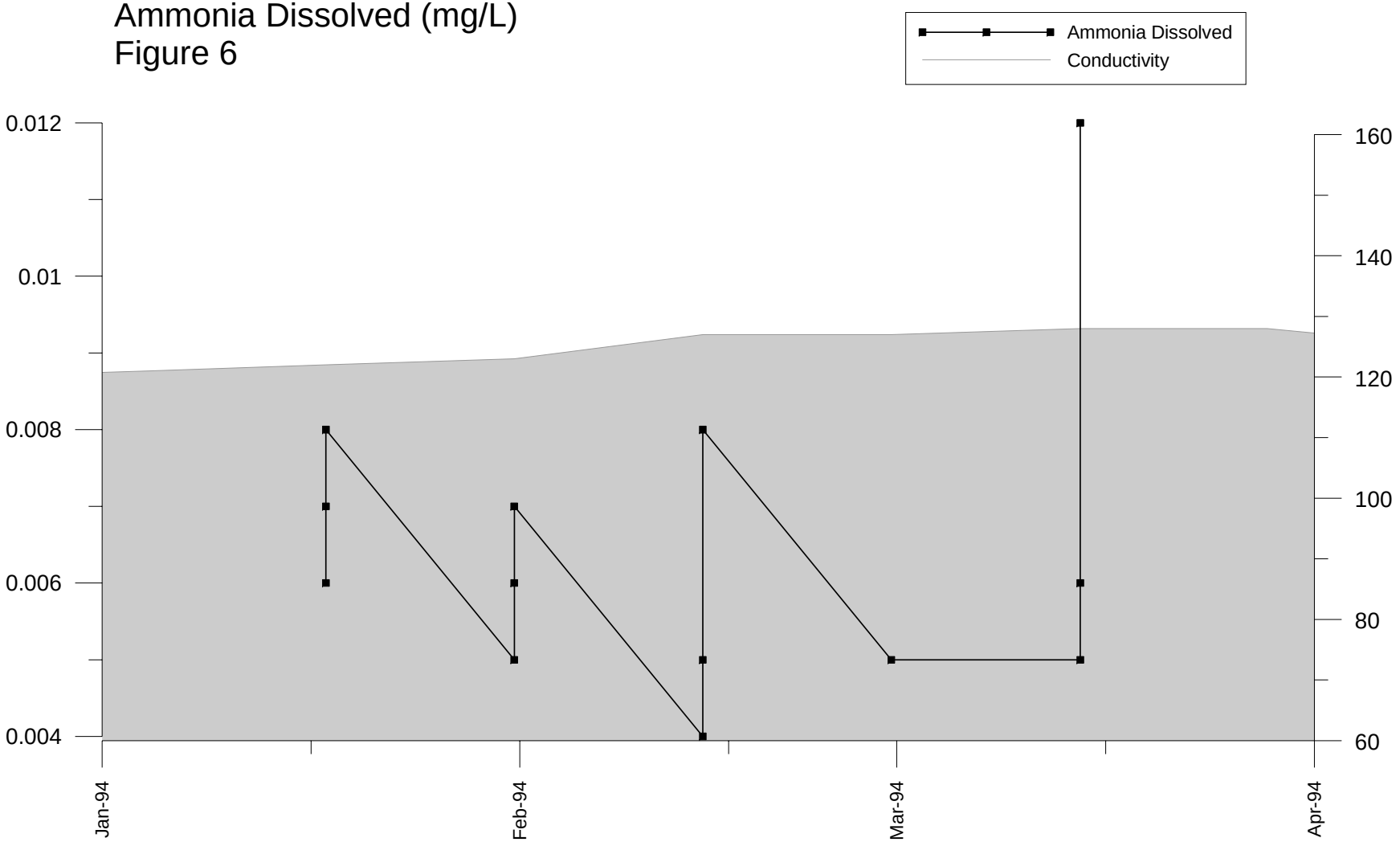
Figure 5



# Thompson River at Spences Bridge

Ammonia Dissolved (mg/L)

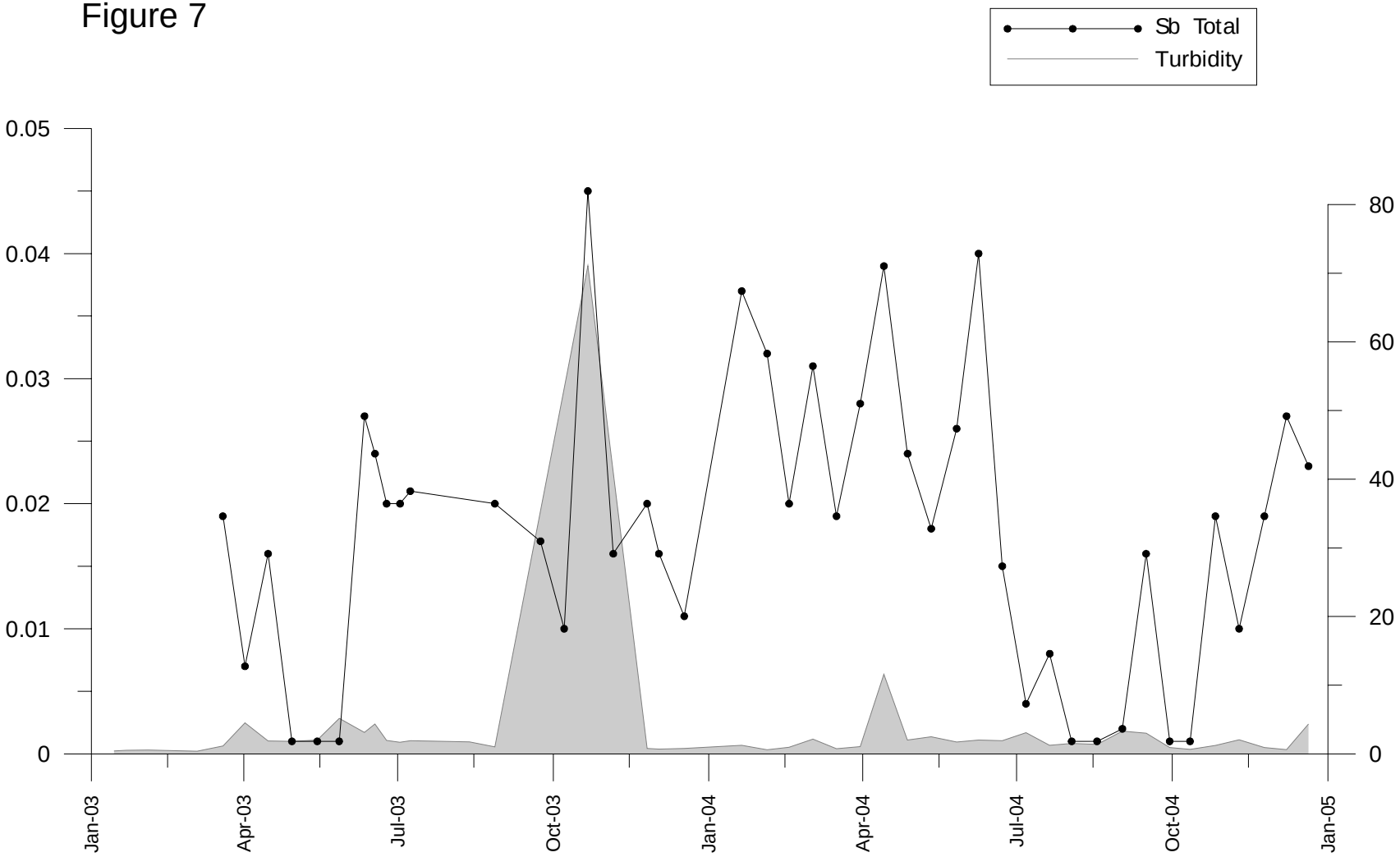
Figure 6



# Thompson River at Spences Bridge

Total Antimony (ug/L)

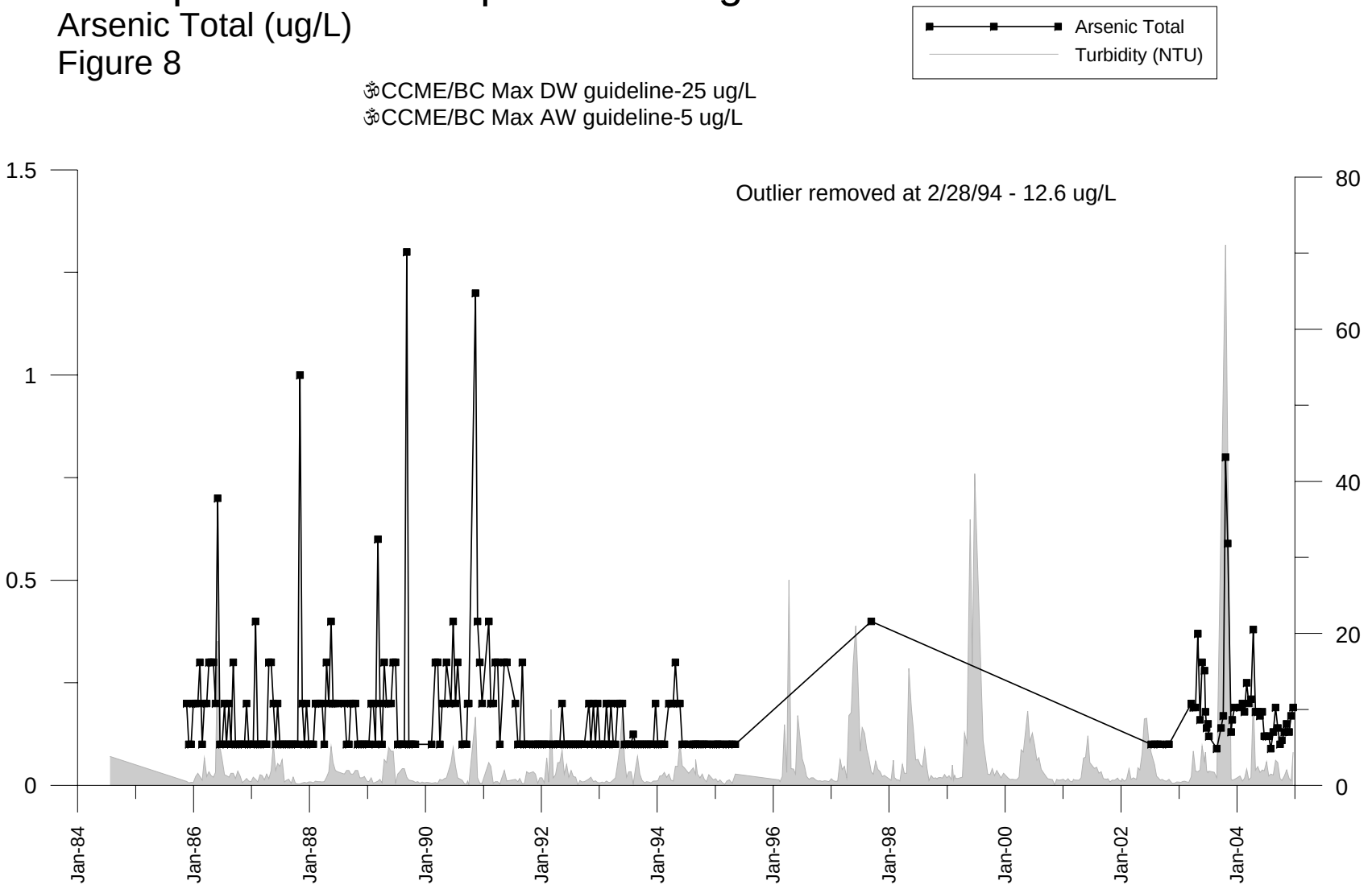
Figure 7



# Thompson River at Spences Bridge

## Arsenic Total (ug/L)

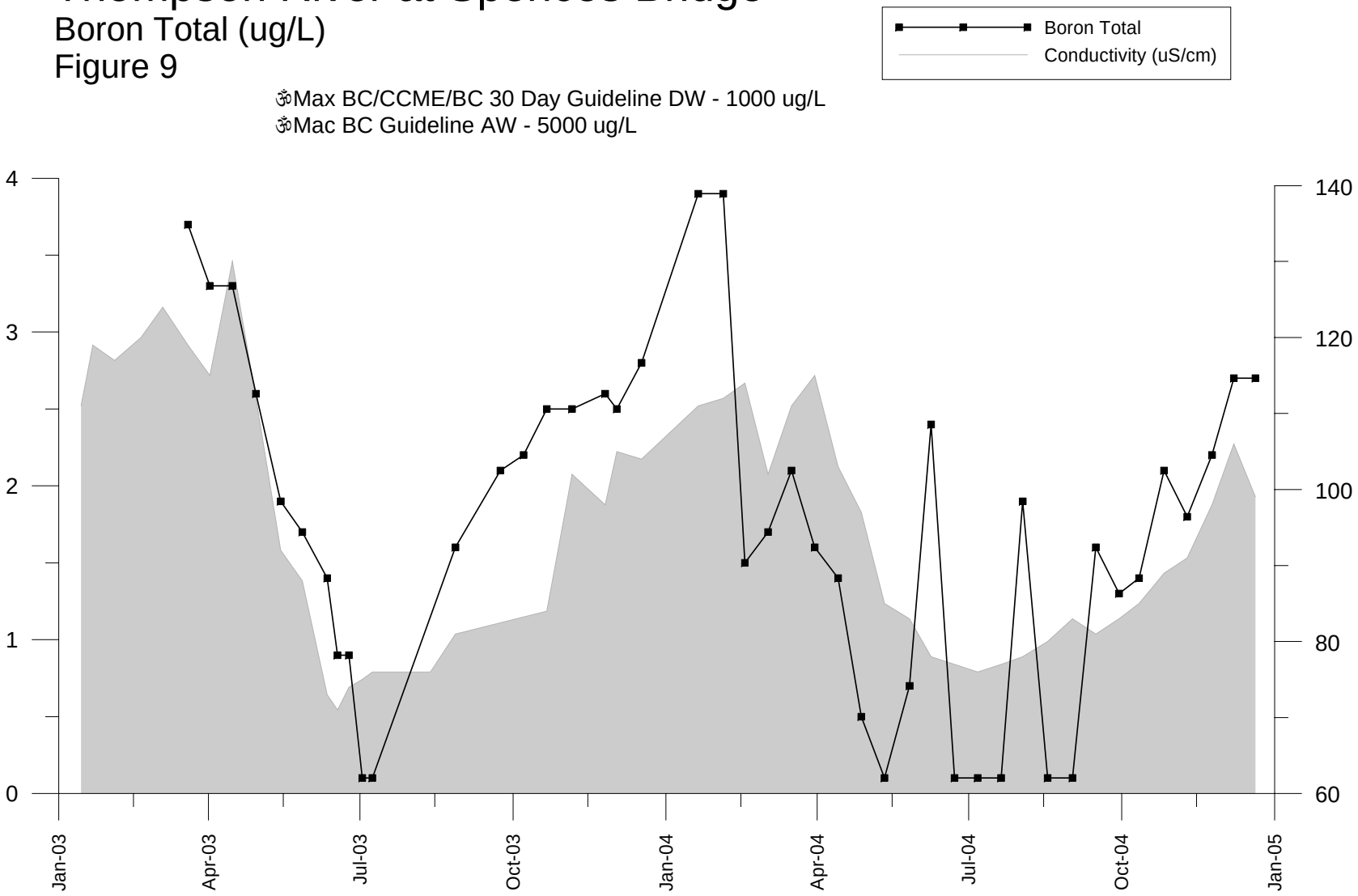
## Figure 8



# Thompson River at Spences Bridge

## Boron Total (ug/L)

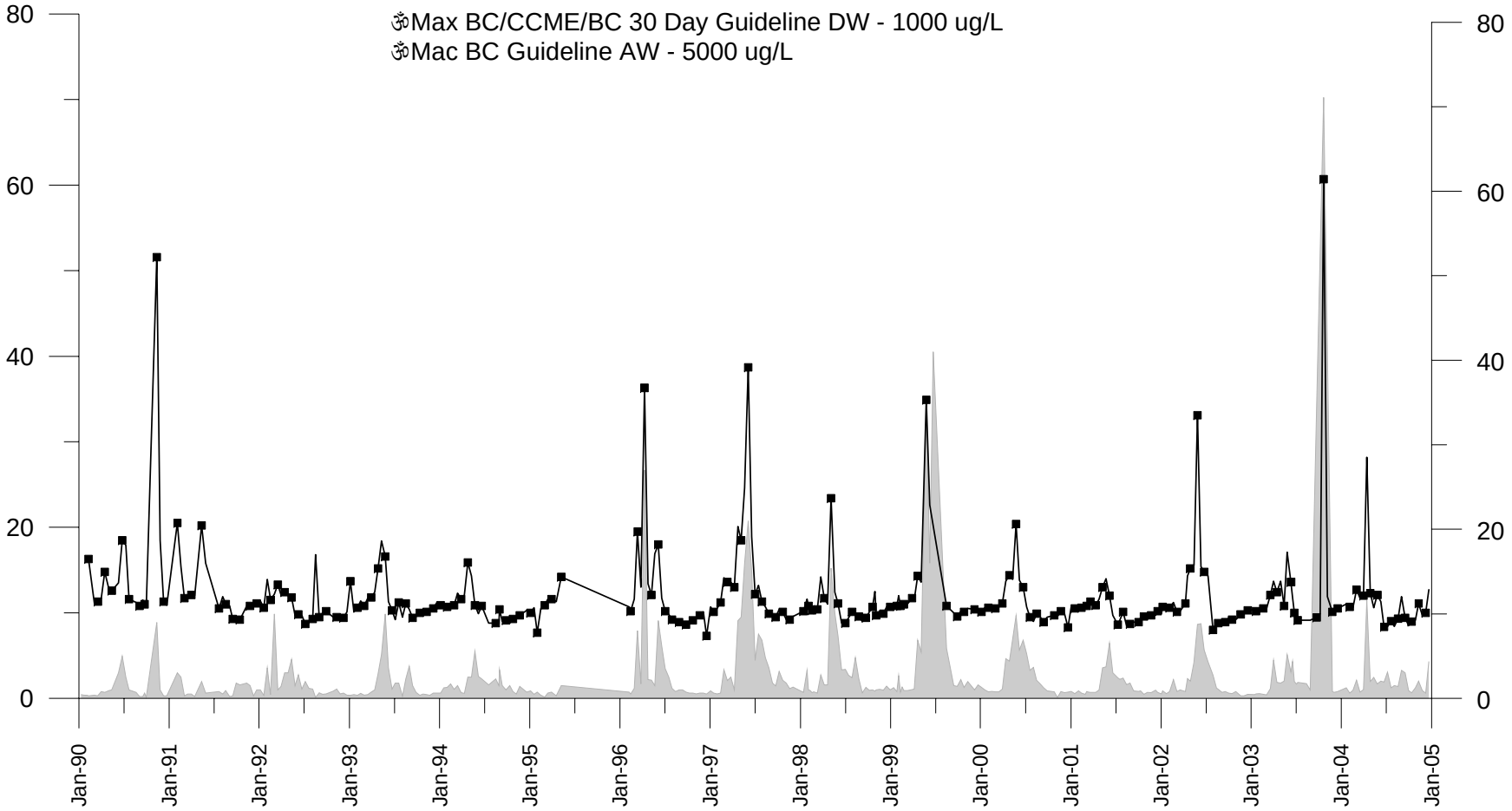
Figure 9



# Thompson River at Spences Bridge

## Barium Total (ug/L)

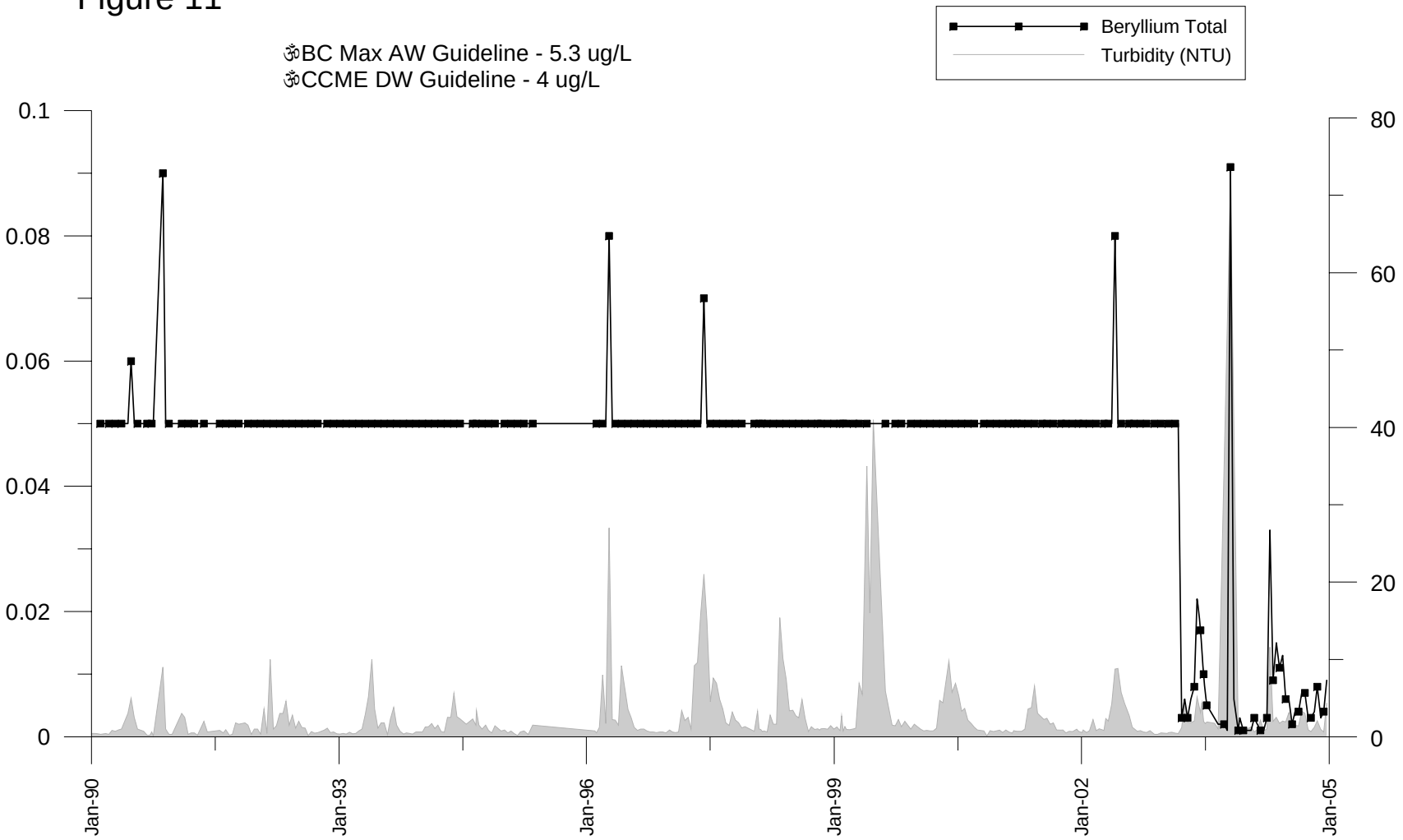
## Figure 10



# Thompson River at Spences Bridge

## Beryllium Total (ug/L)

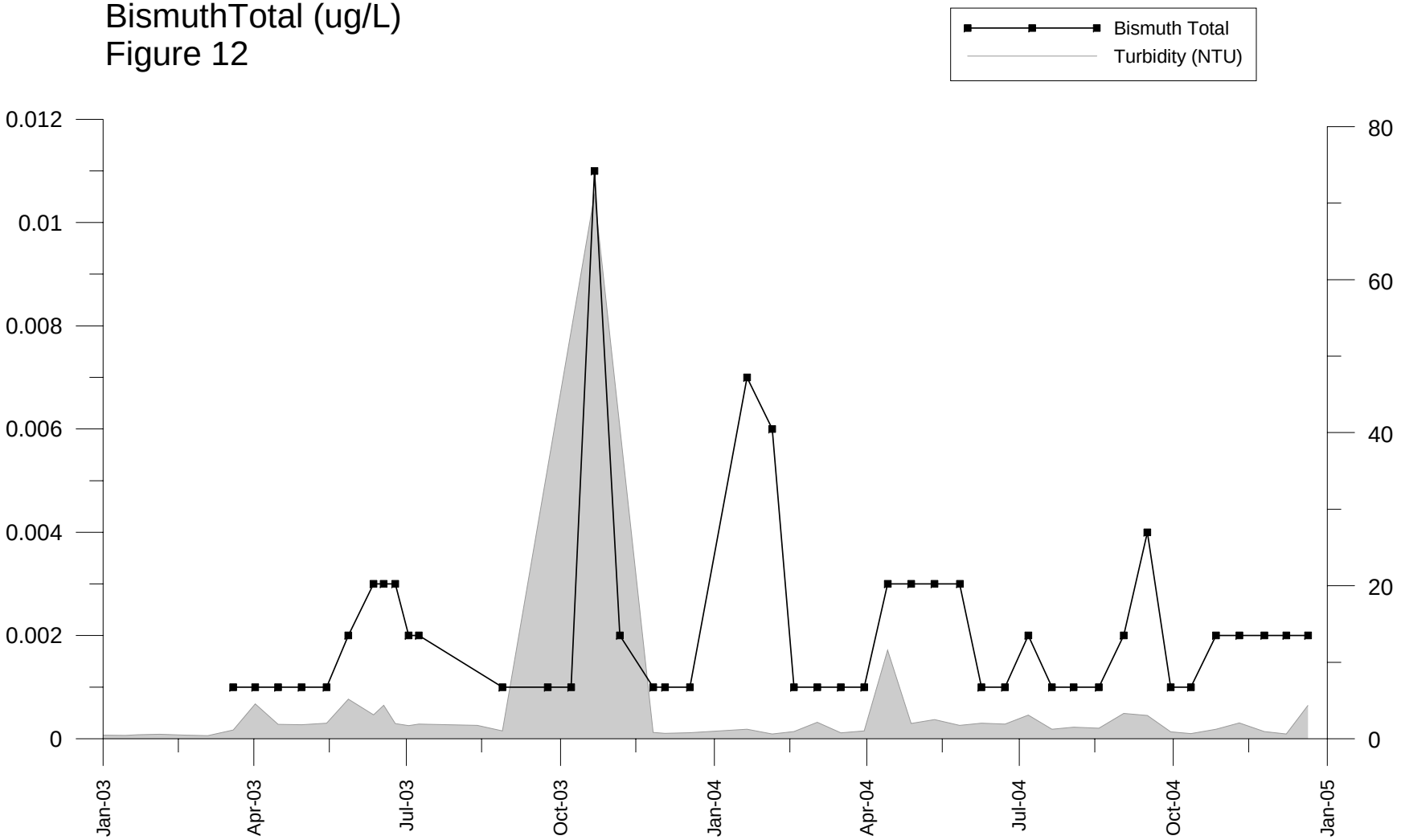
## Figure 11



# Thompson River at Spences Bridge

BismuthTotal (ug/L)

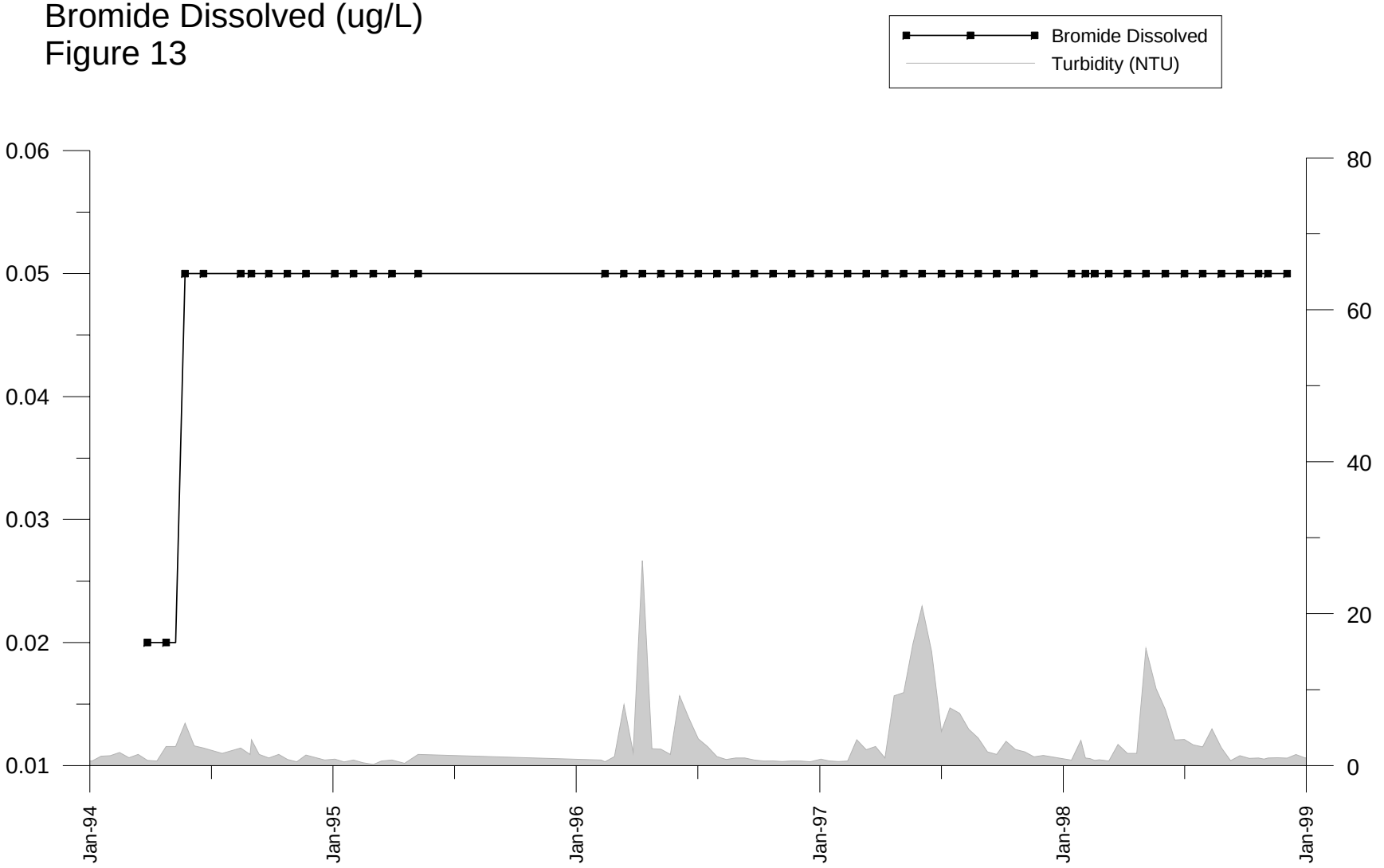
Figure 12



# Thompson River at Spences Bridge

Bromide Dissolved (ug/L)

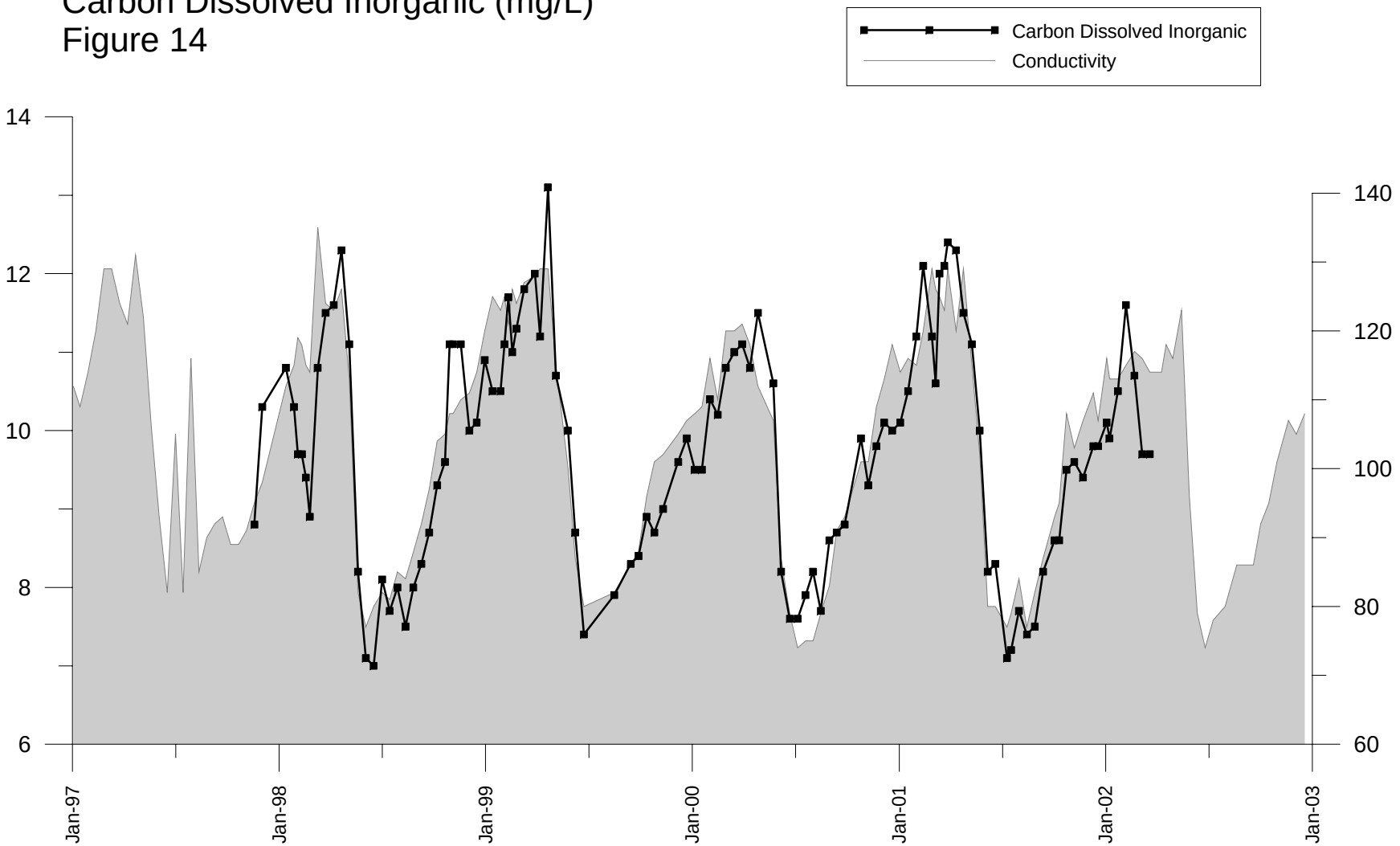
Figure 13



# Thompson River at Spences Bridge

## Carbon Dissolved Inorganic (mg/L)

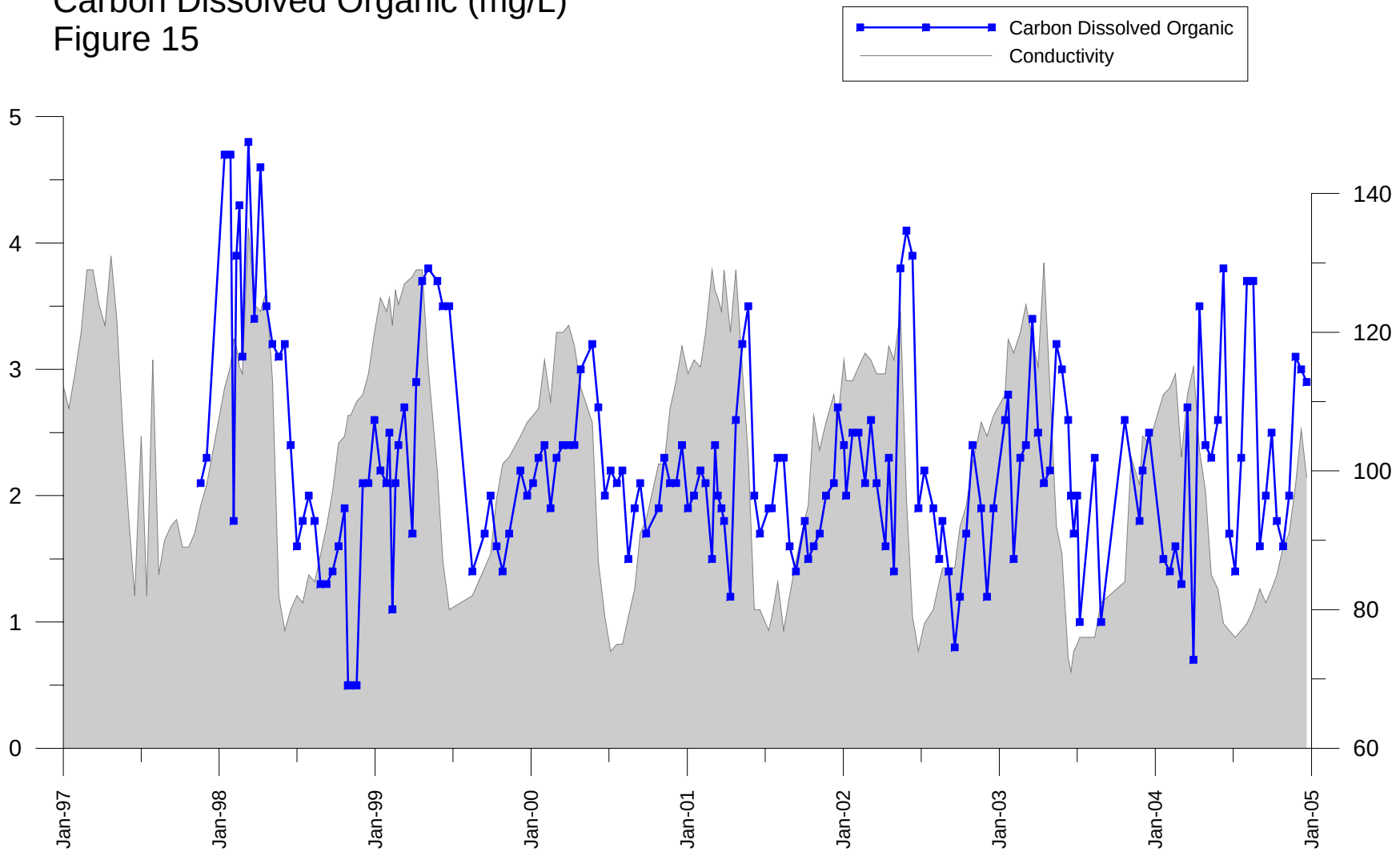
Figure 14



# Thompson River at Spences Bridge

## Carbon Dissolved Organic (mg/L)

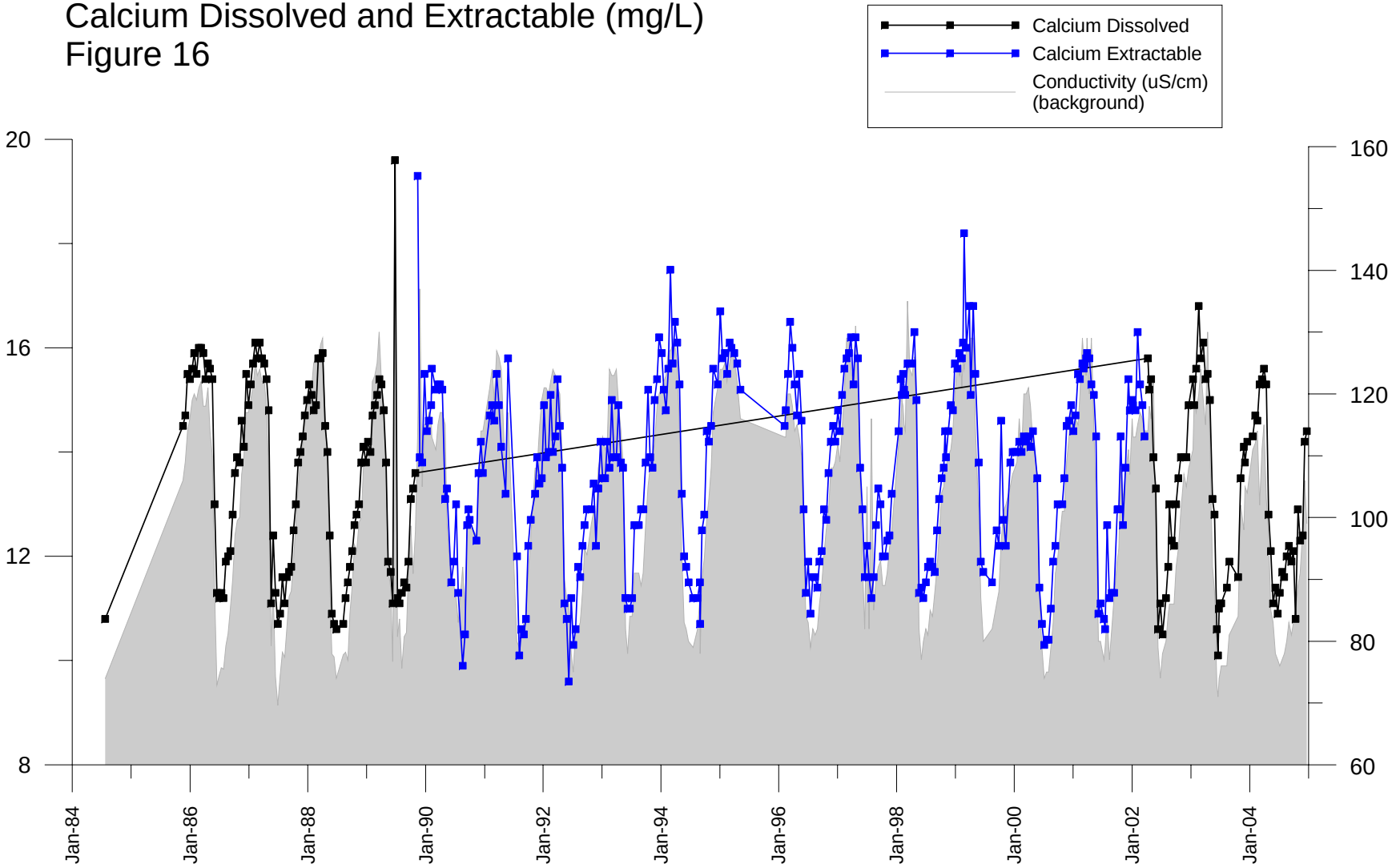
Figure 15



# Thompson River at Spences Bridge

## Calcium Dissolved and Extractable (mg/L)

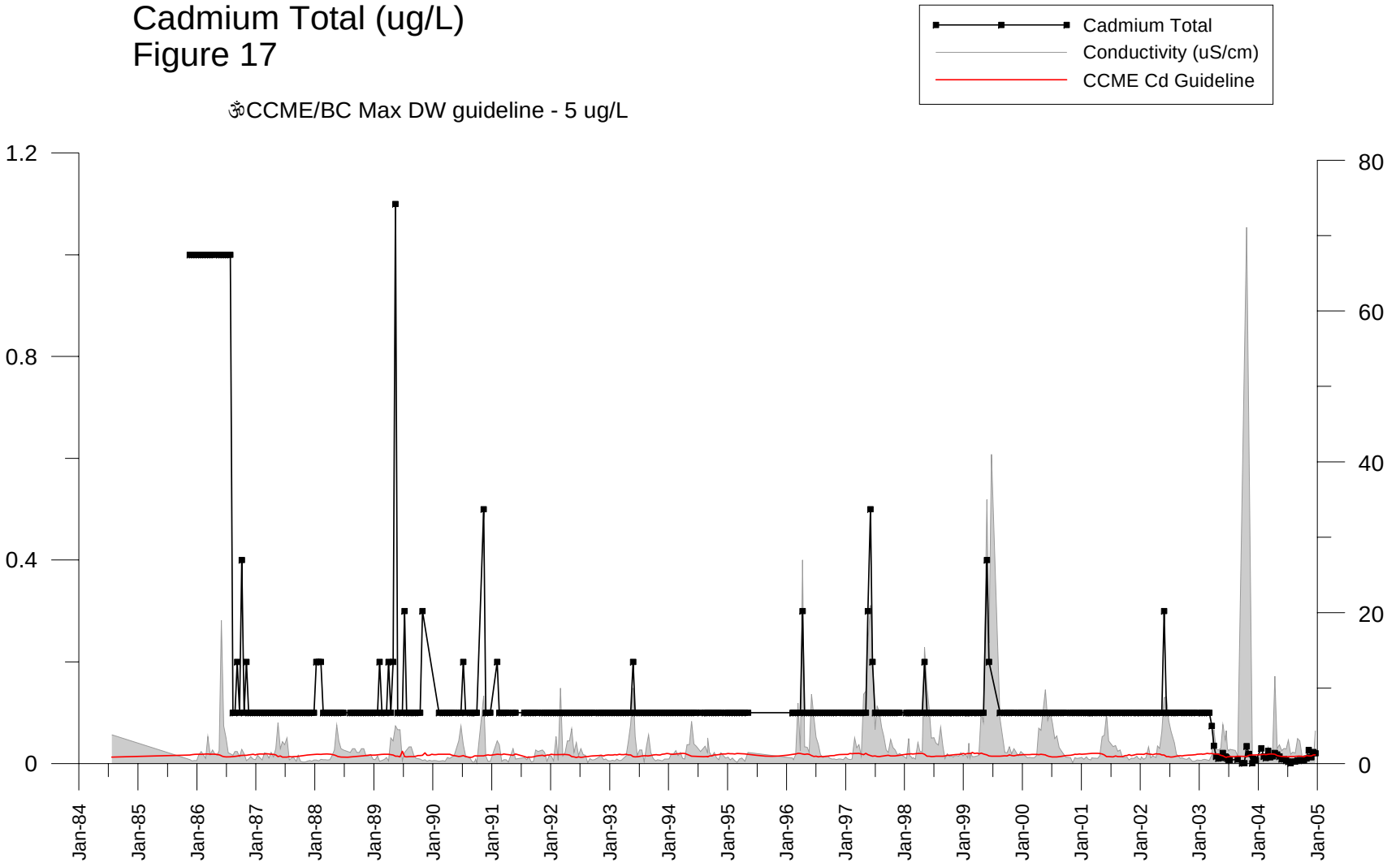
Figure 16



# Thompson River at Spences Bridge

## Cadmium Total (ug/L)

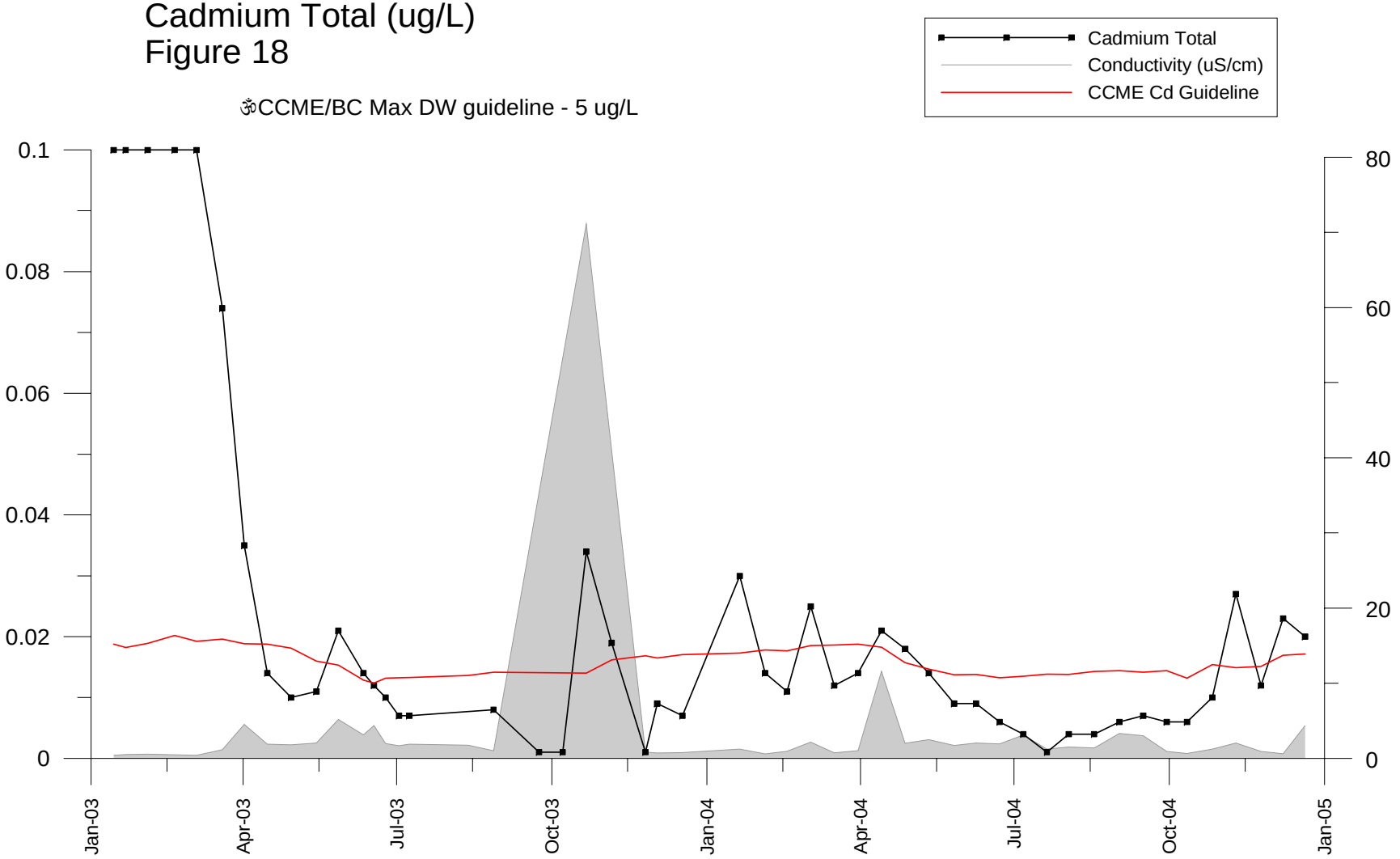
## Figure 17



# Thompson River at Spences Bridge

## Cadmium Total (ug/L)

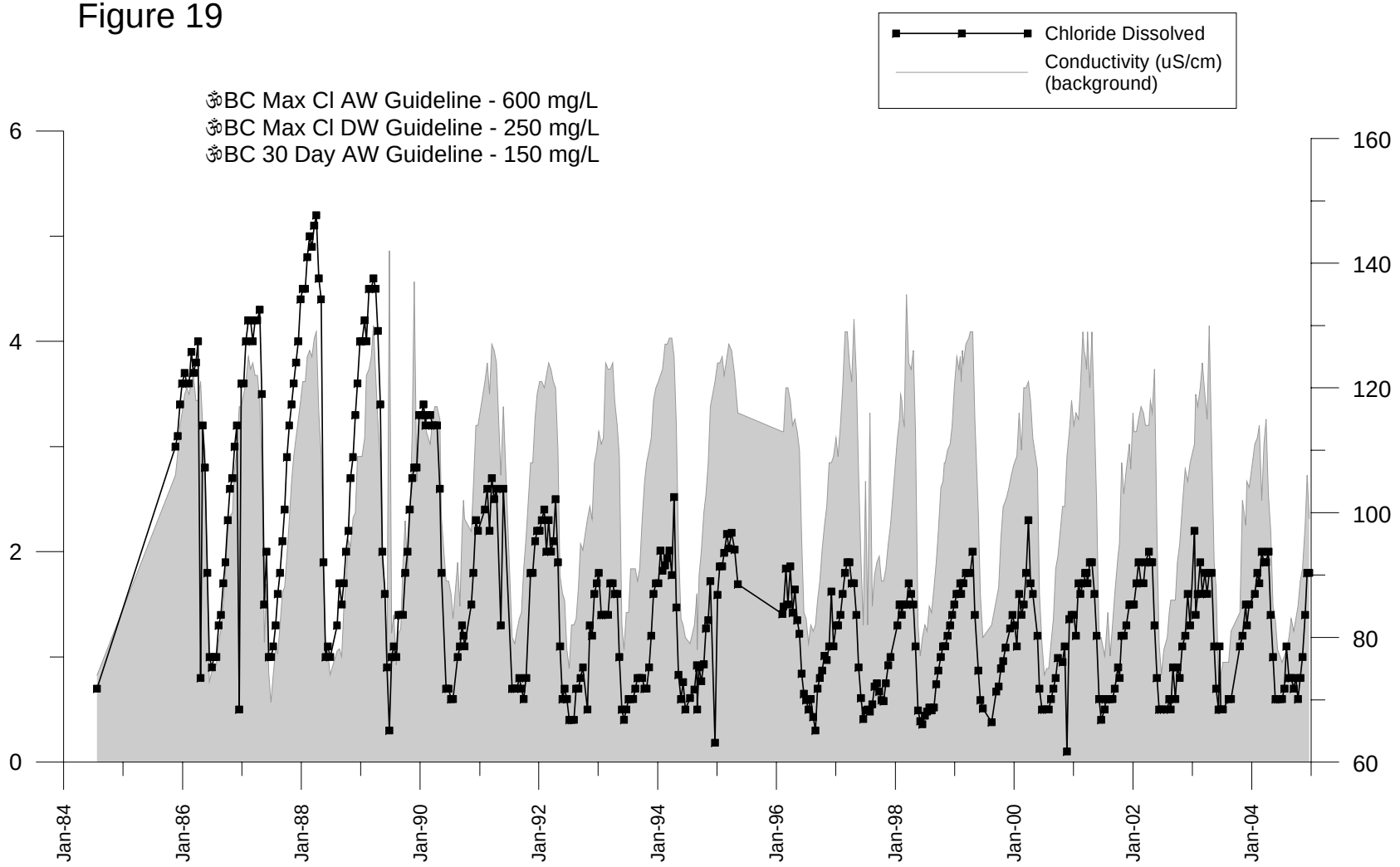
## Figure 18



# Thompson River at Spences Bridge

## Chloride Dissolved (mg/L)

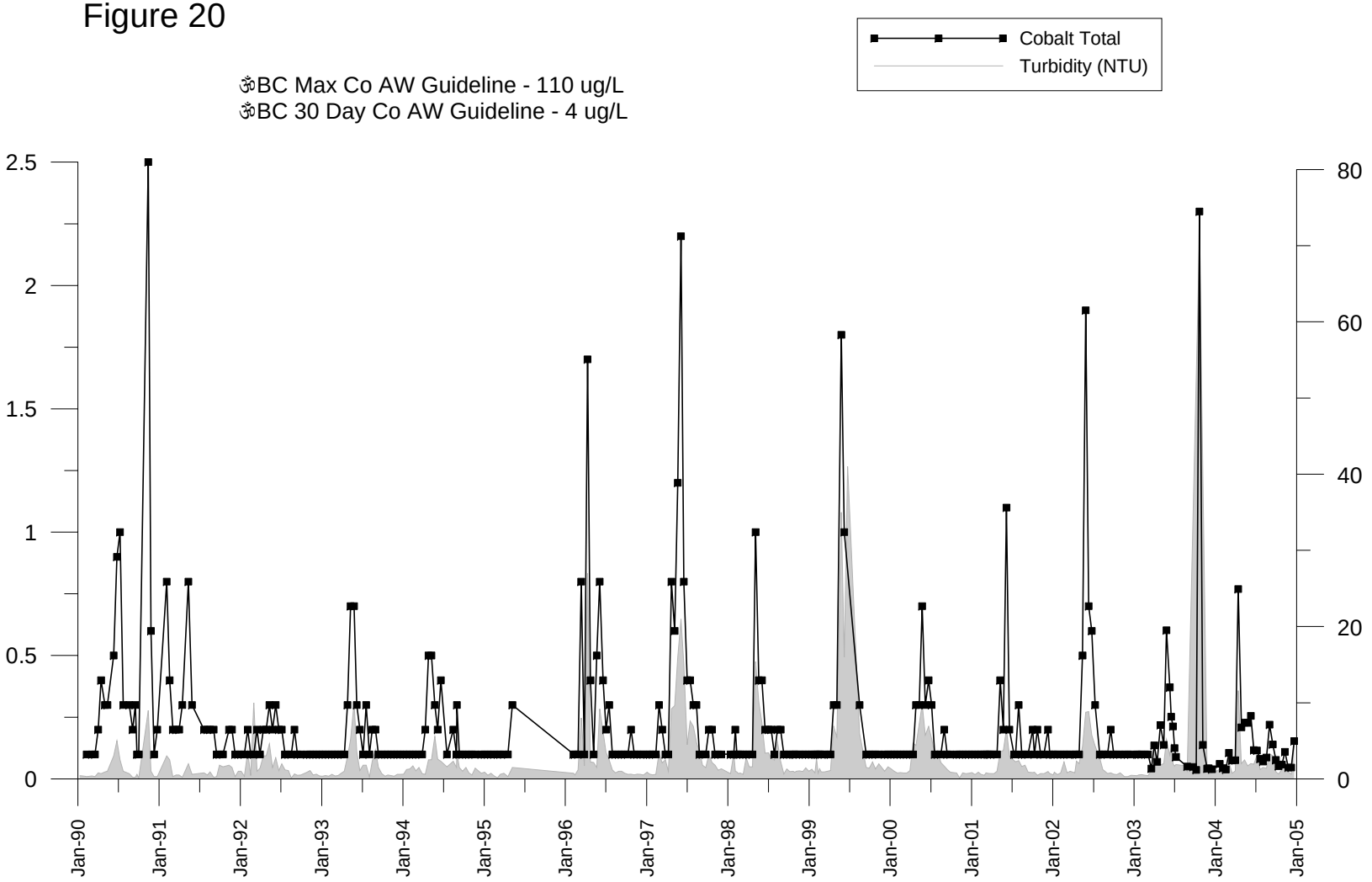
Figure 19



# Thompson River at Spences Bridge

Cobalt Total (ug/L)

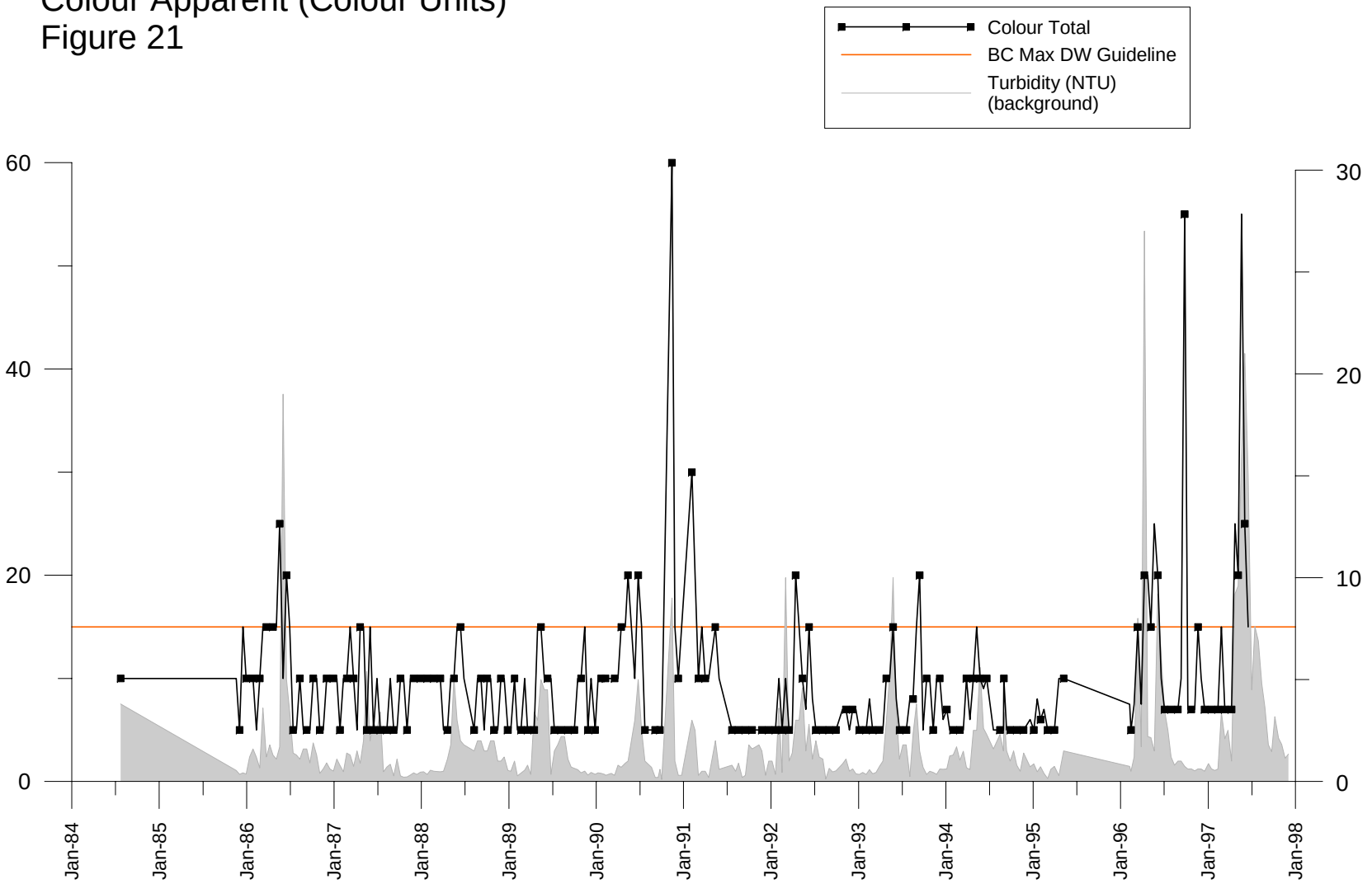
Figure 20



# Thompson River at Spences Bridge

Colour Apparent (Colour Units)

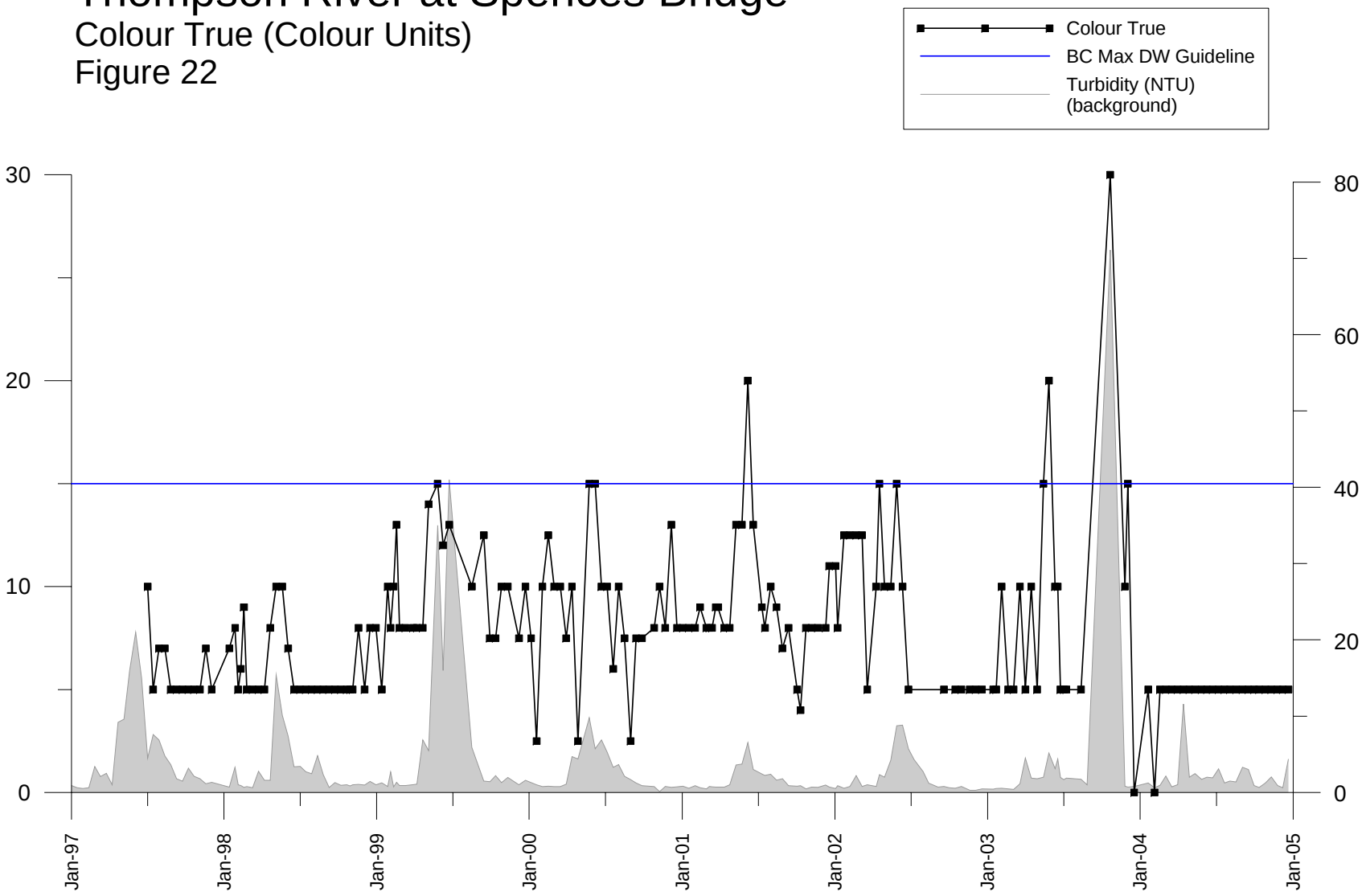
Figure 21



# Thompson River at Spences Bridge

Colour True (Colour Units)

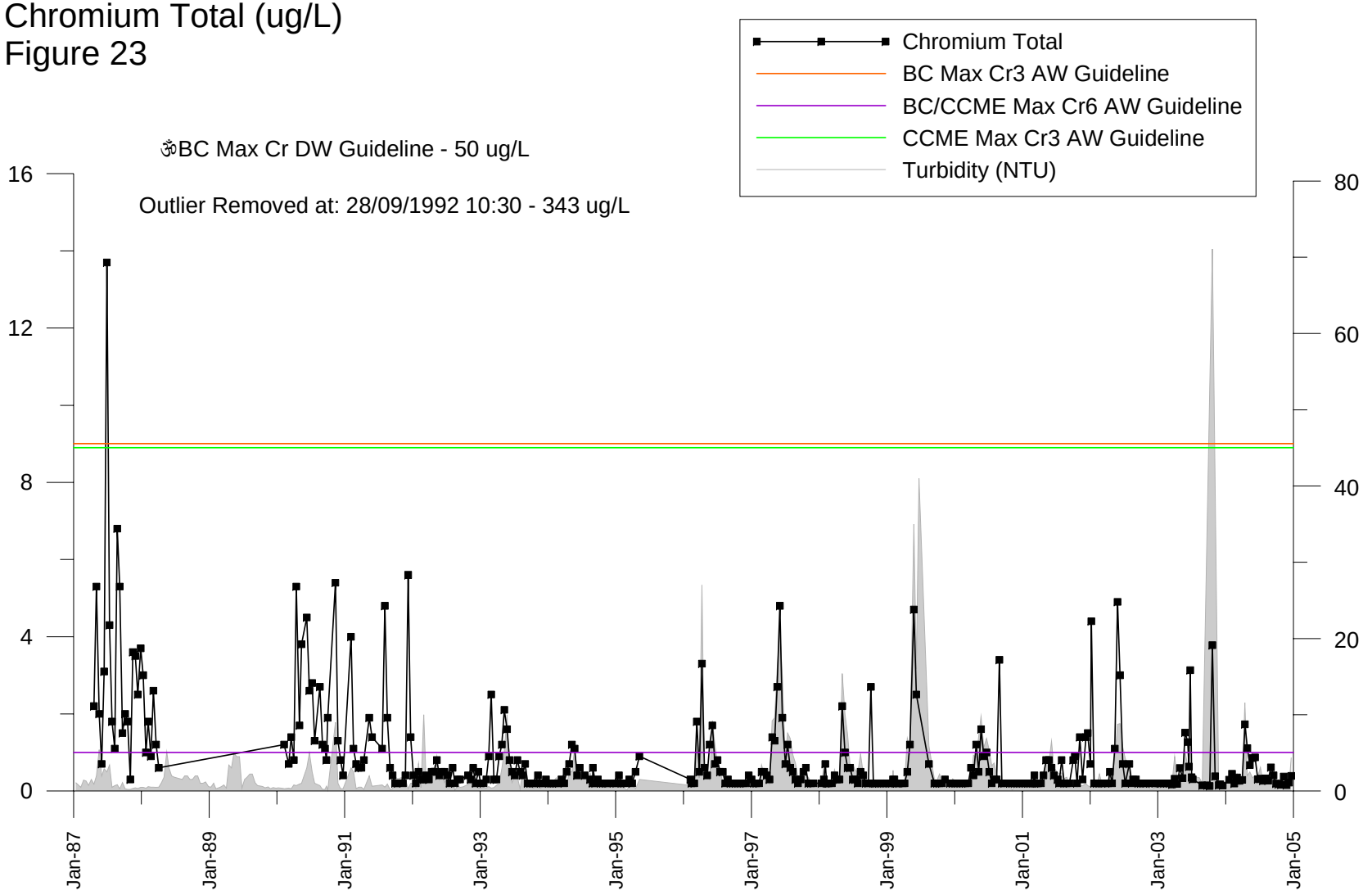
Figure 22



# Thompson River at Spences Bridge

## Chromium Total (ug/L)

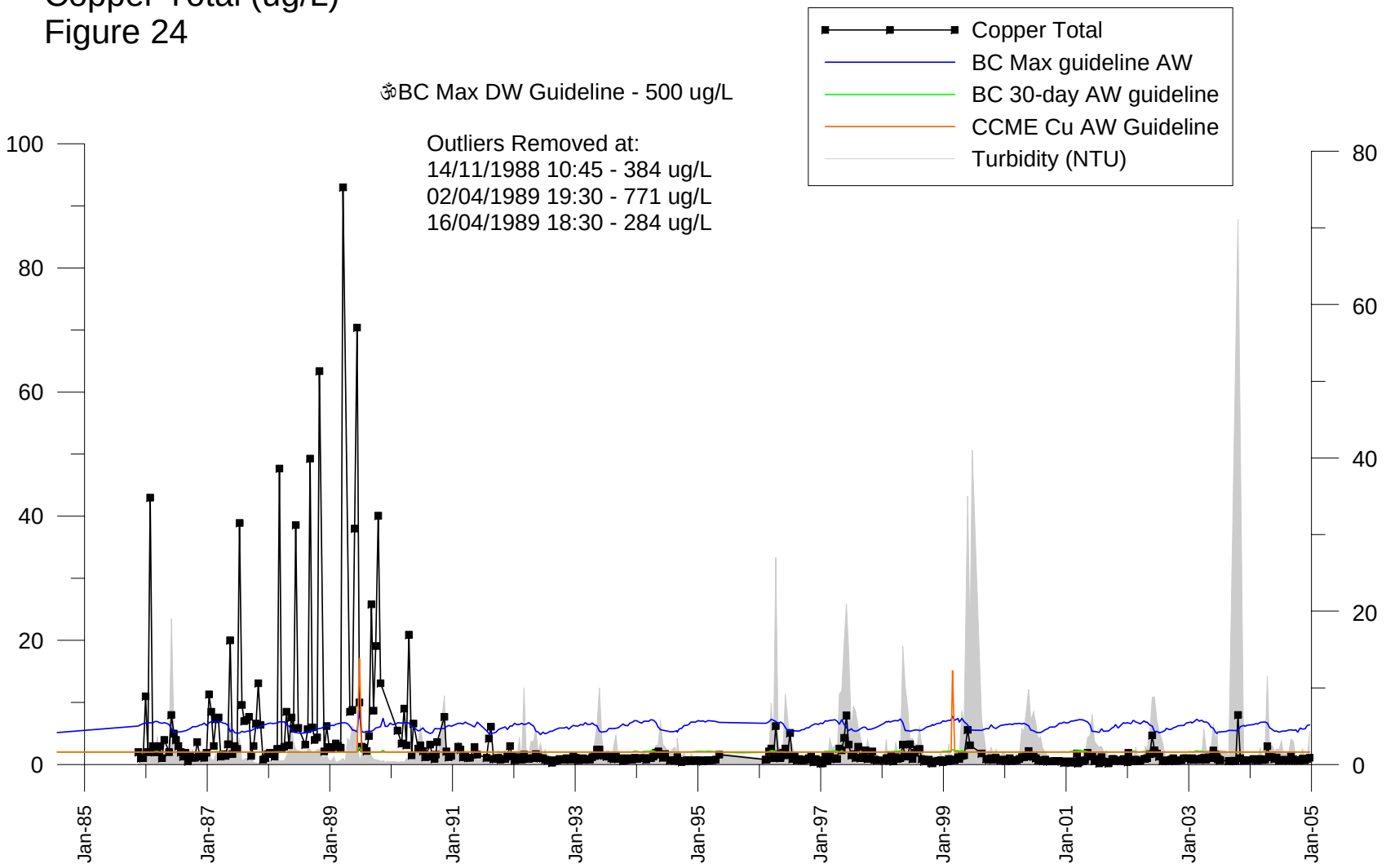
## Figure 23



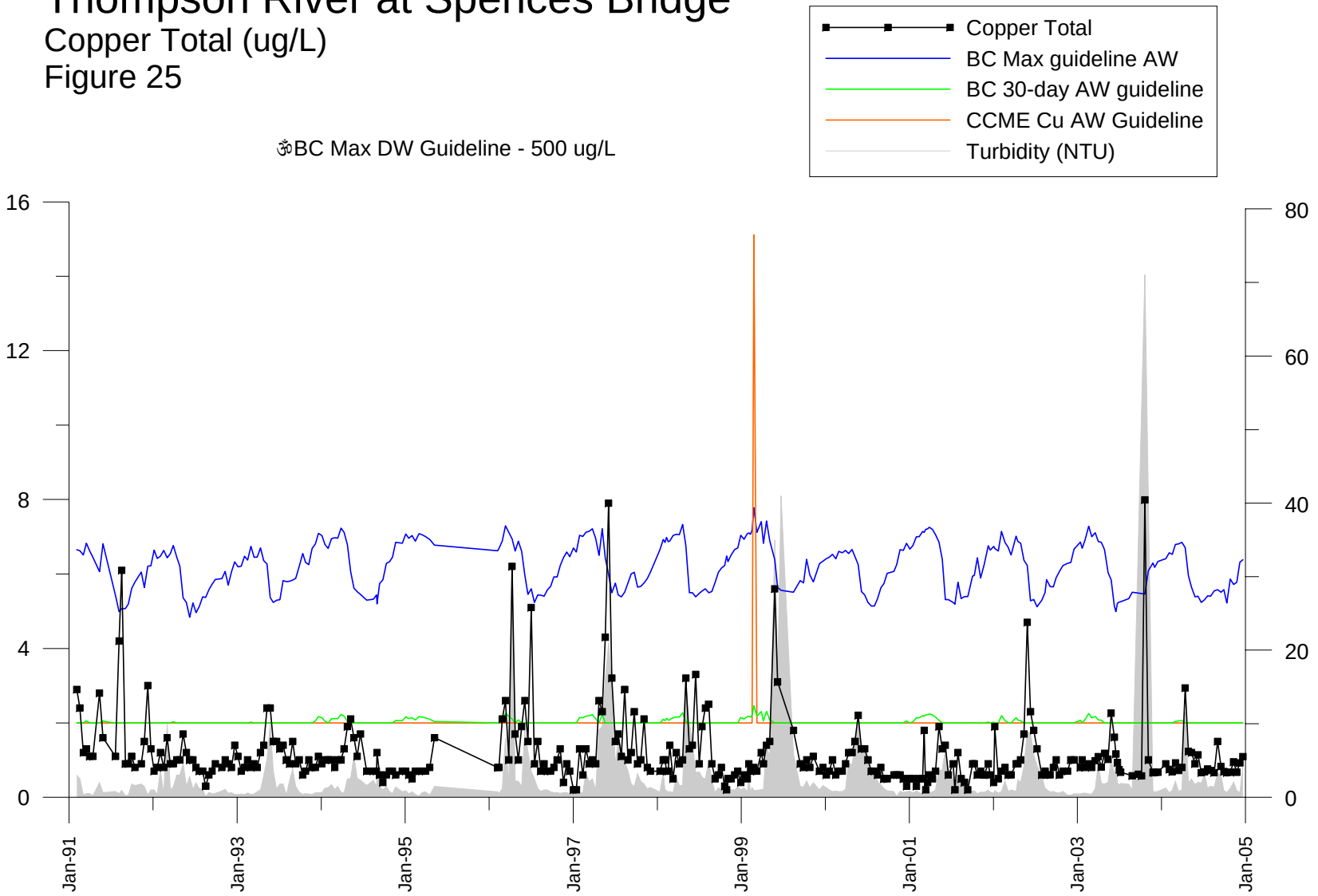
# Thompson River at Spences Bridge

## Copper Total (ug/L)

## Figure 24



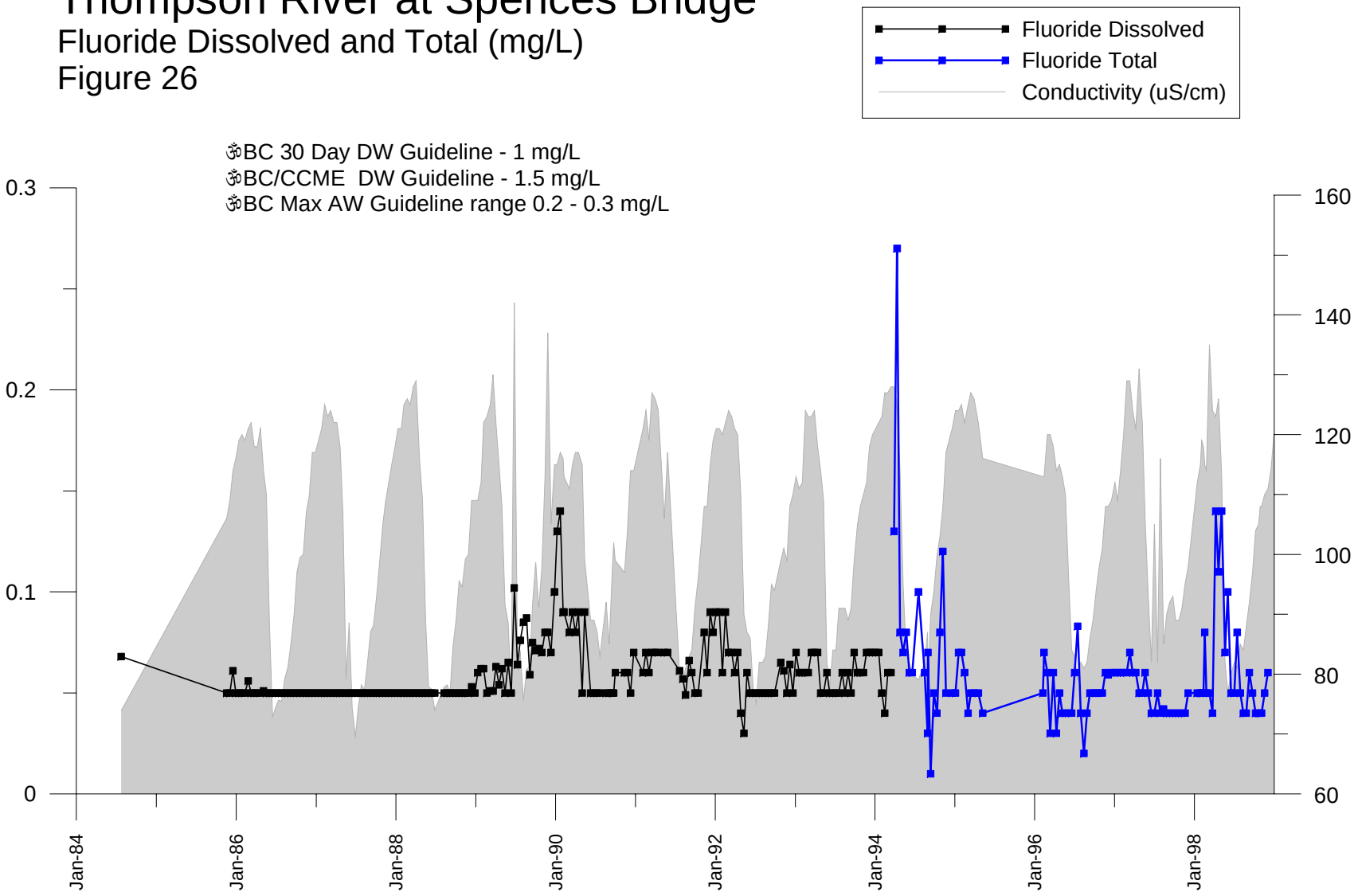
# Thompson River at Spences Bridge
## Copper Total (ug/L)
## Figure 25



# Thompson River at Spences Bridge

## Fluoride Dissolved and Total (mg/L)

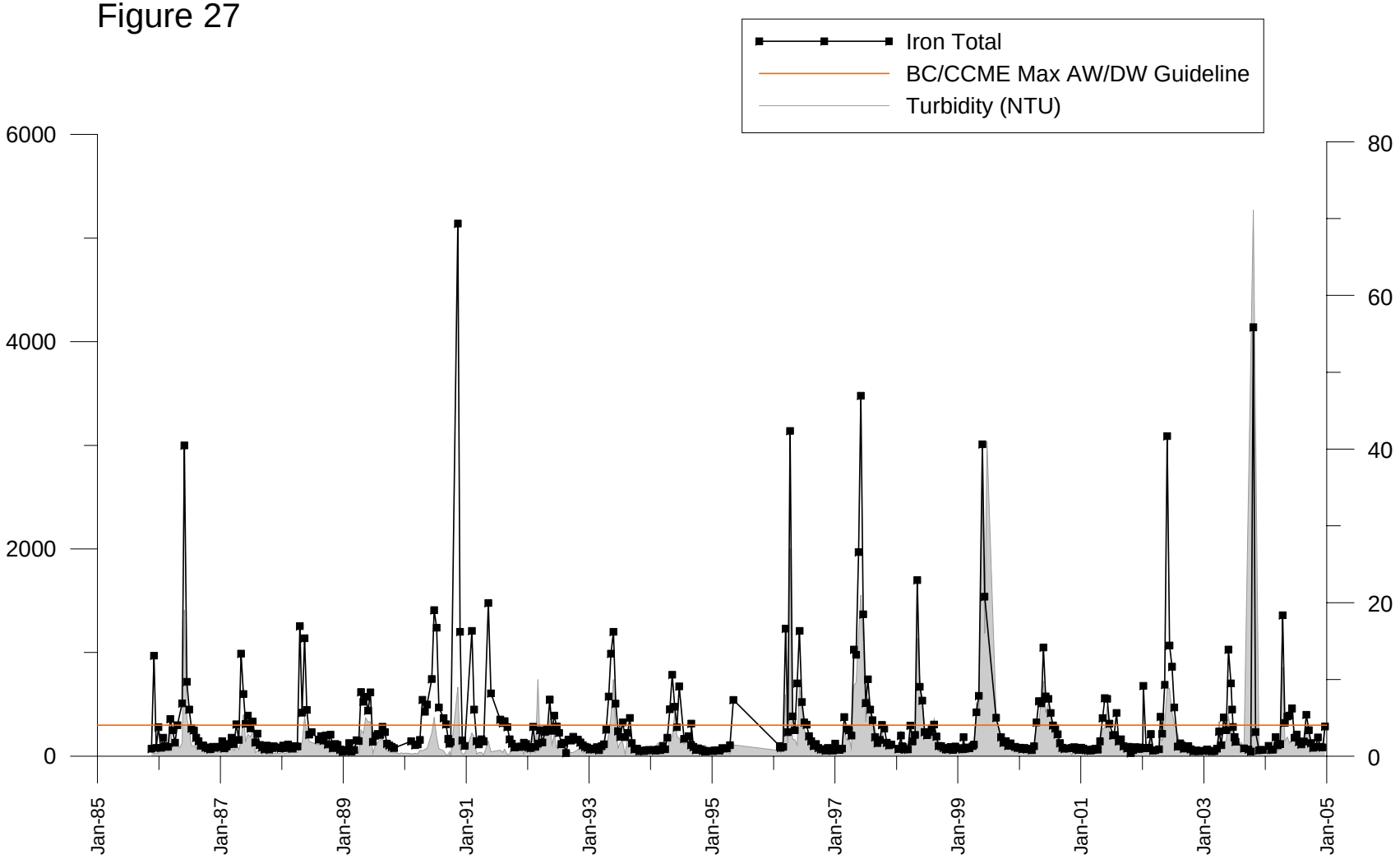
## Figure 26



# Thompson River at Spences Bridge

Iron Total (ug/L)

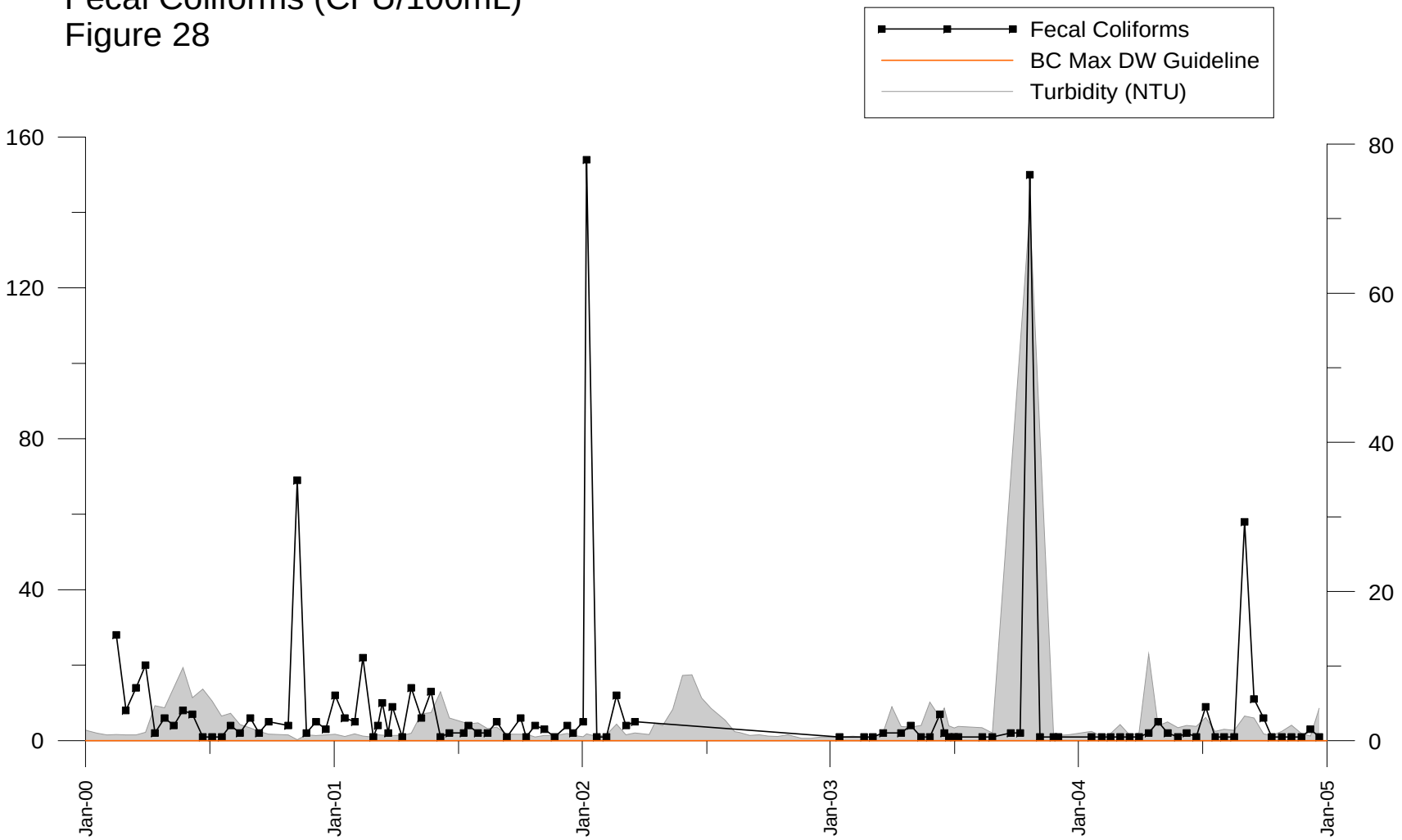
Figure 27



# Thompson River at Spences Bridge

Fecal Coliforms (CFU/100mL)

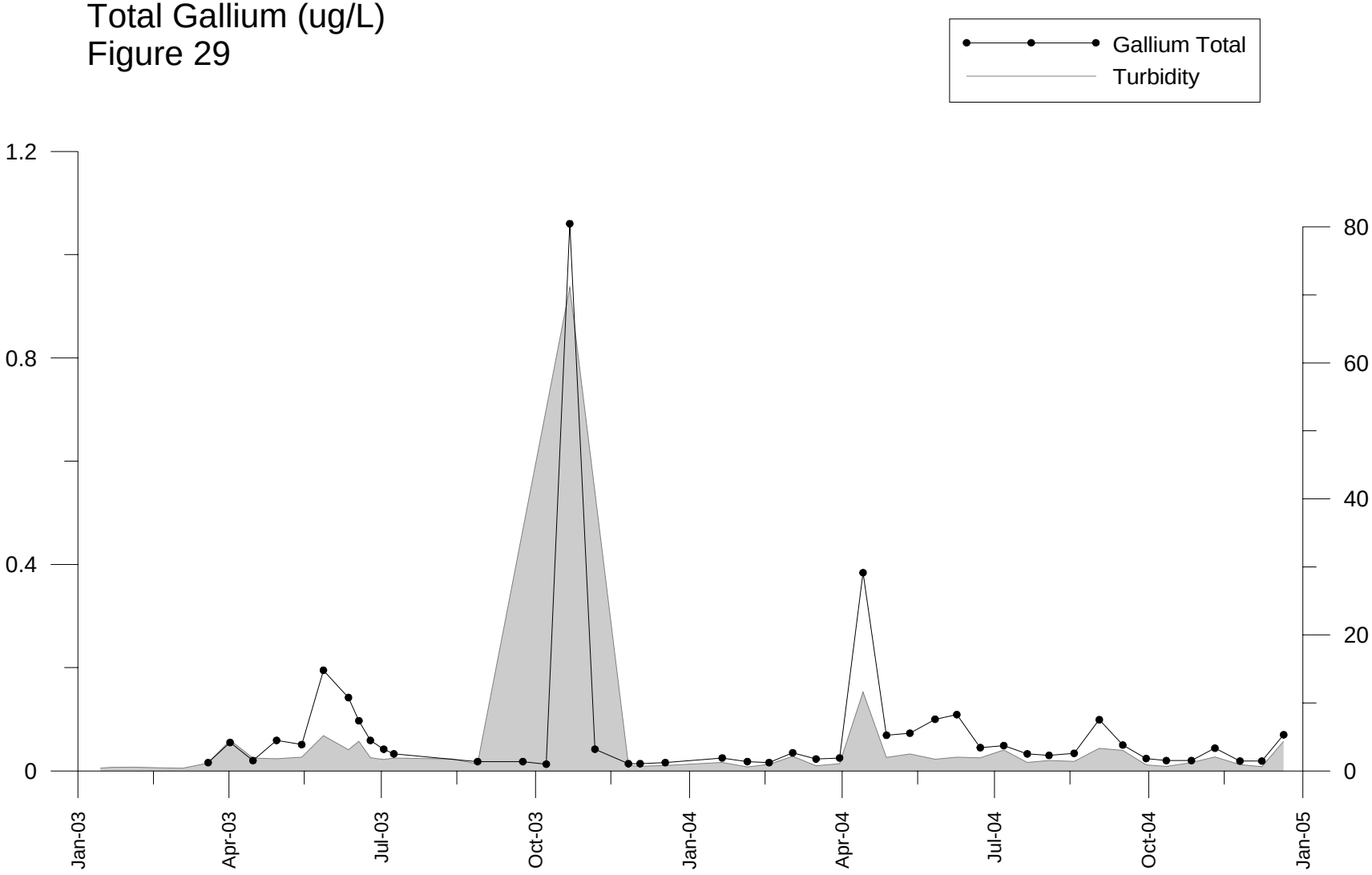
Figure 28



# Thompson River at Spences Bridge

Total Gallium (ug/L)

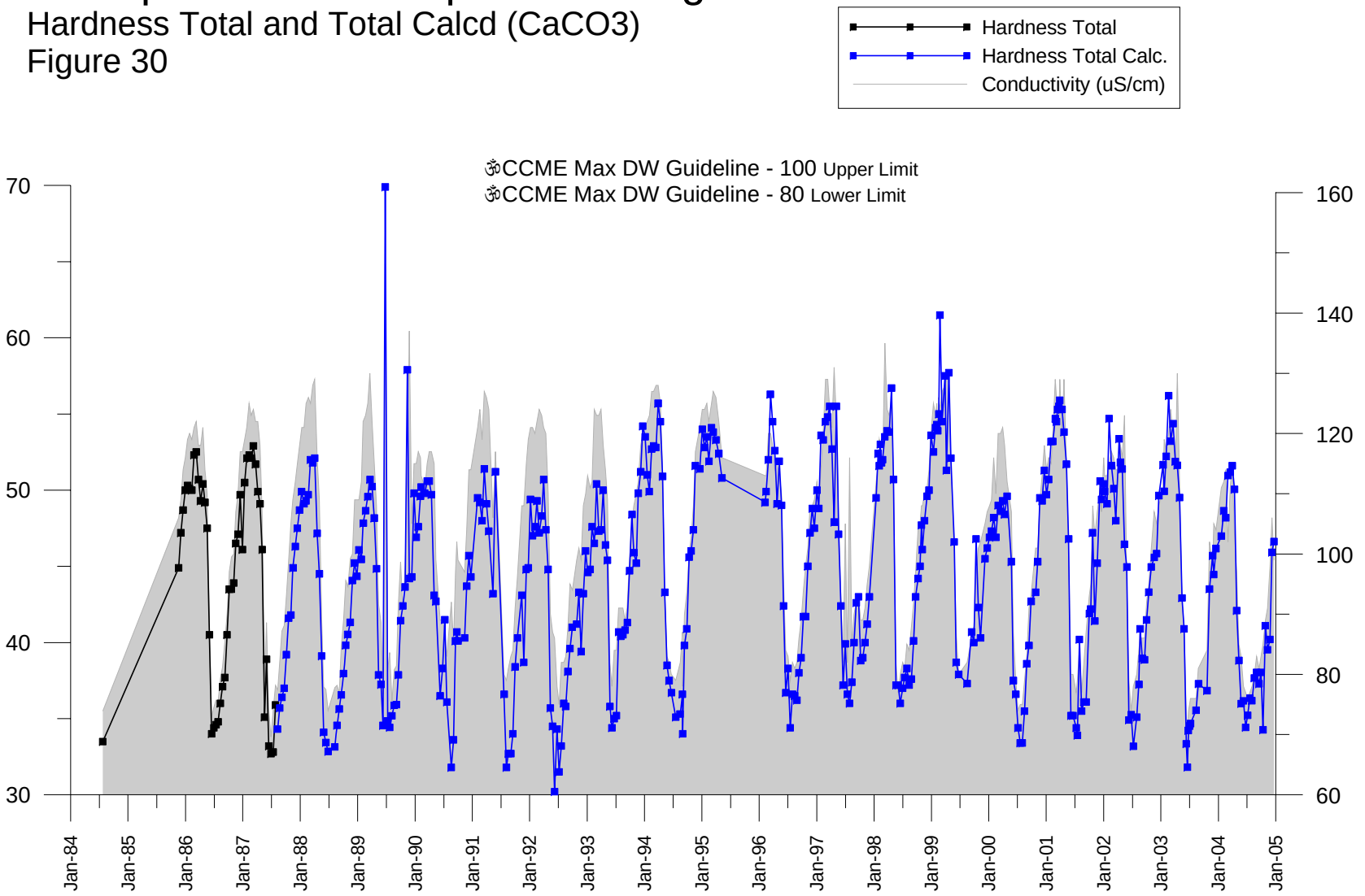
Figure 29



# Thompson River at Spences Bridge

## Hardness Total and Total Calcd (CaCO3)

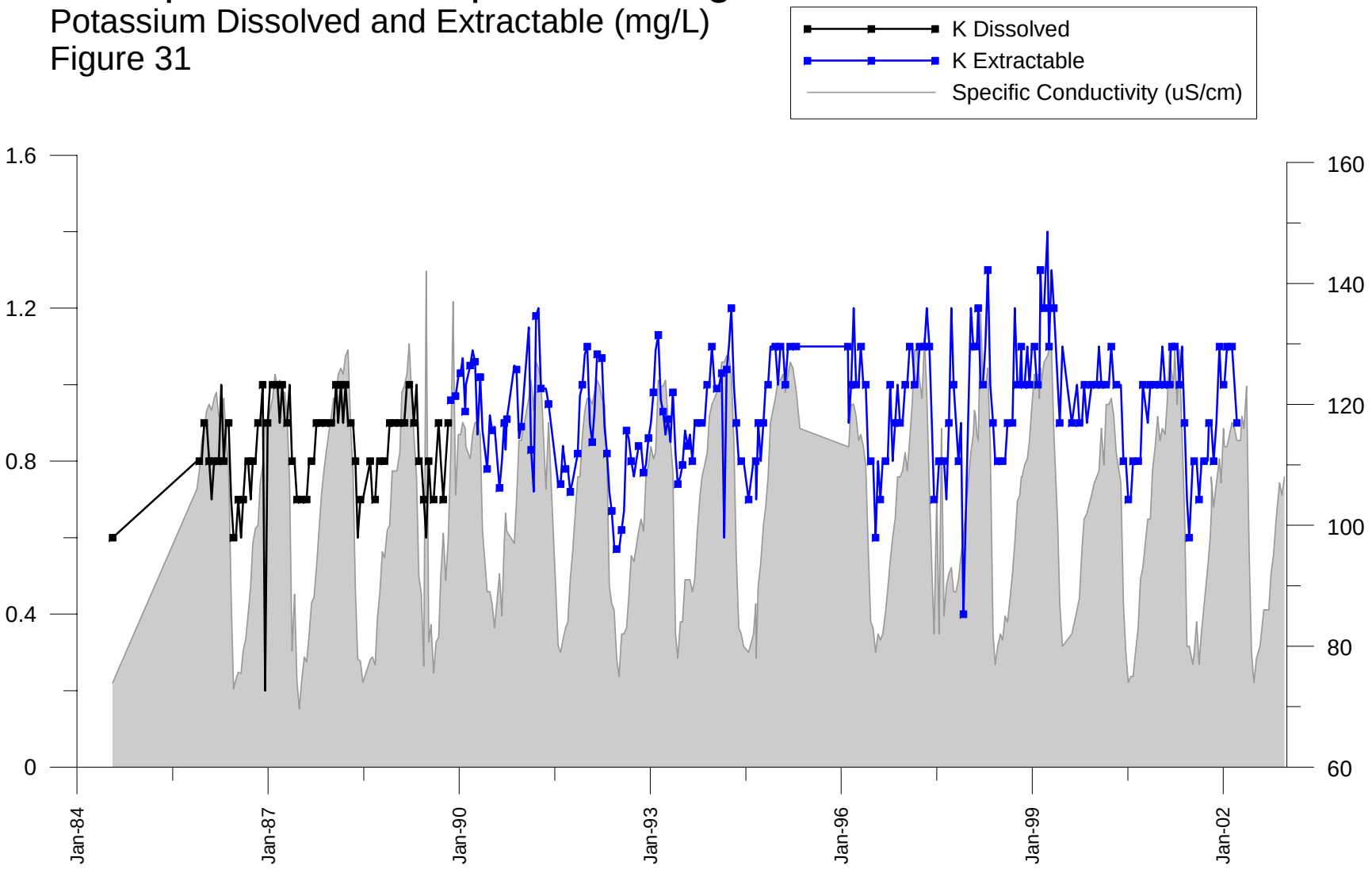
Figure 30



# Thompson River at Spences Bridge

## Potassium Dissolved and Extractable (mg/L)

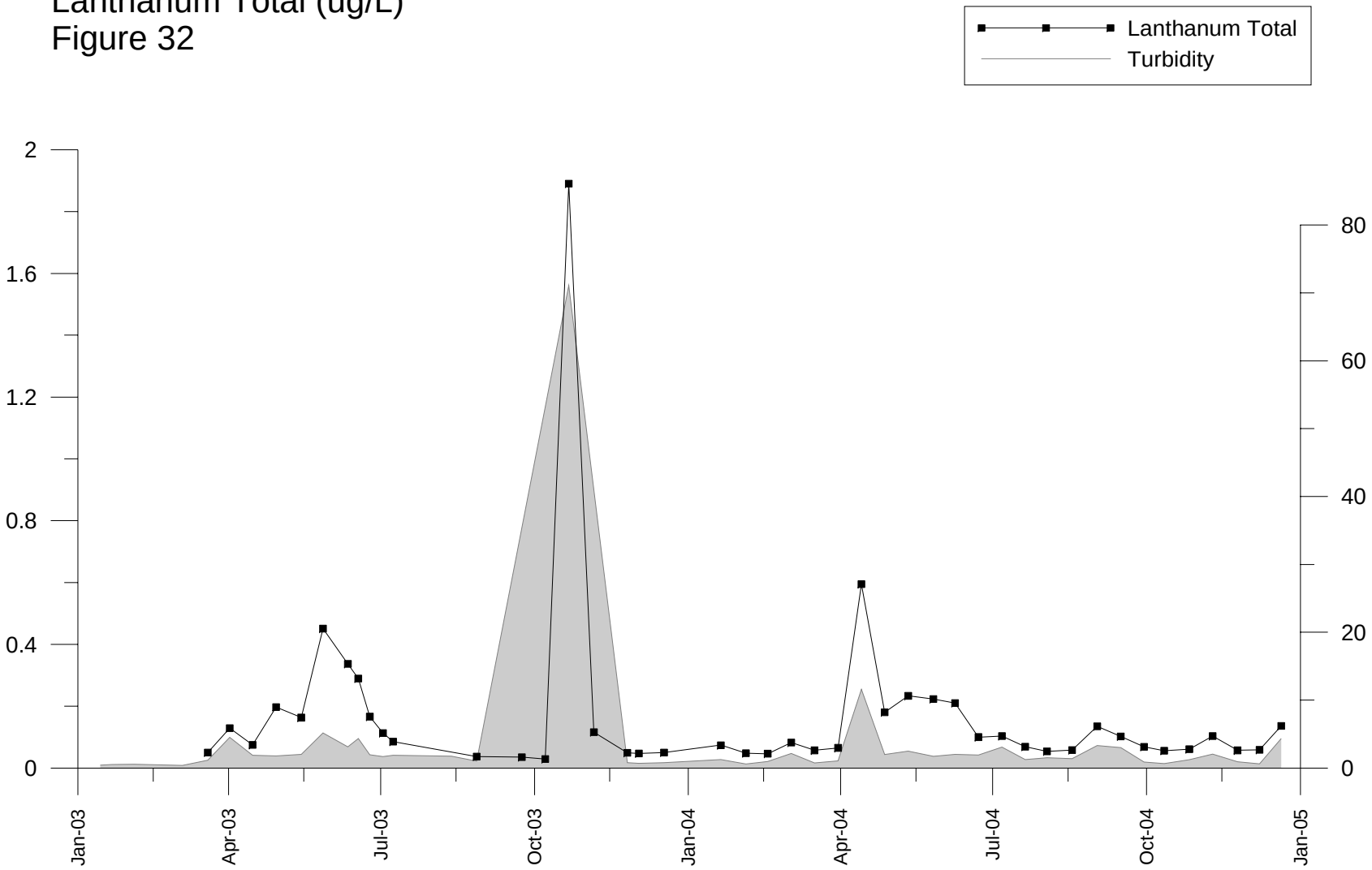
## Figure 31



# Thompson River at Spences Bridge

Lanthanum Total (ug/L)

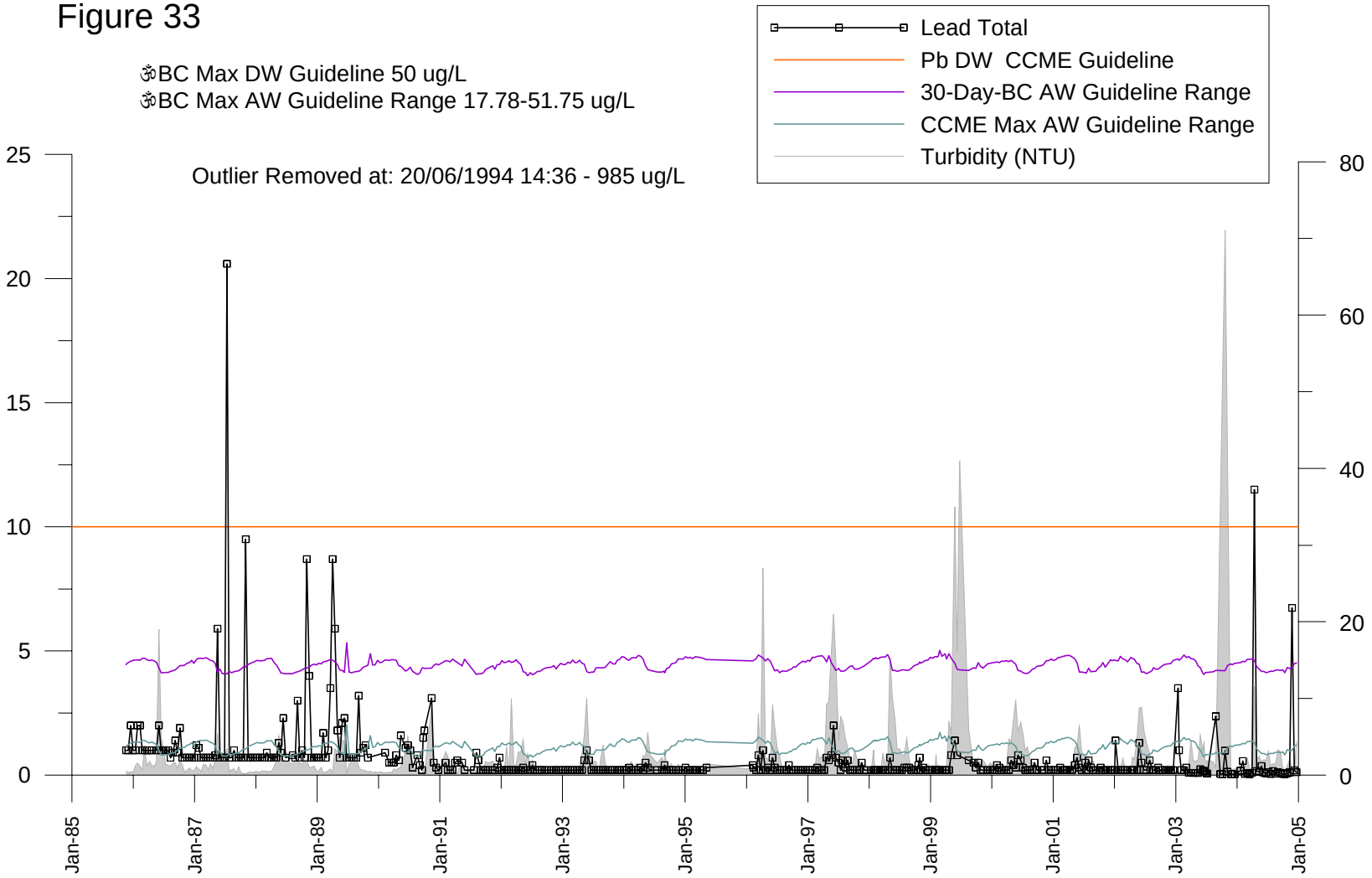
Figure 32



# Thompson River at Spences Bridge

## Lead Total (ug/L)

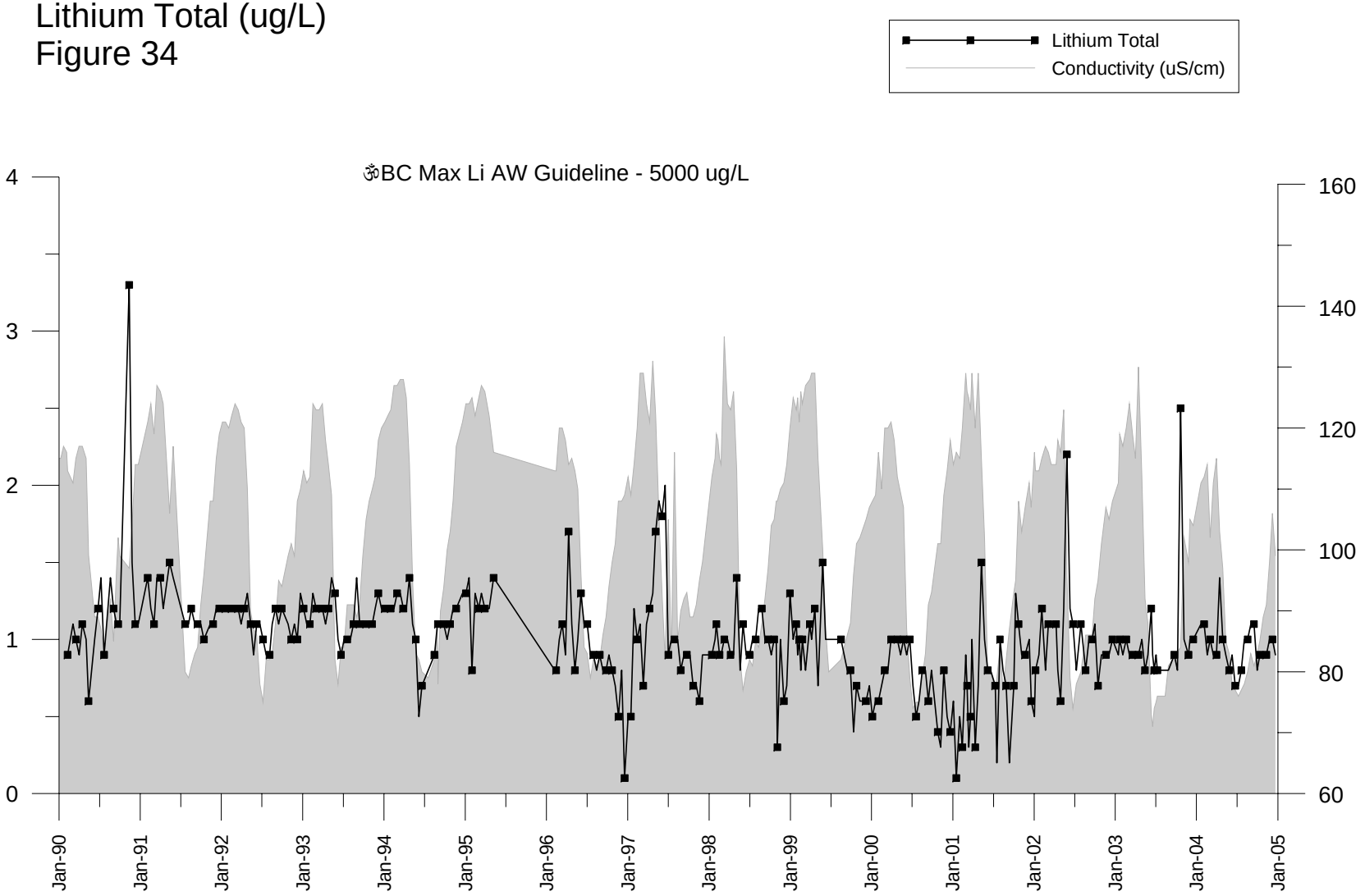
## Figure 33



# Thompson River at Spences Bridge

Lithium Total (ug/L)

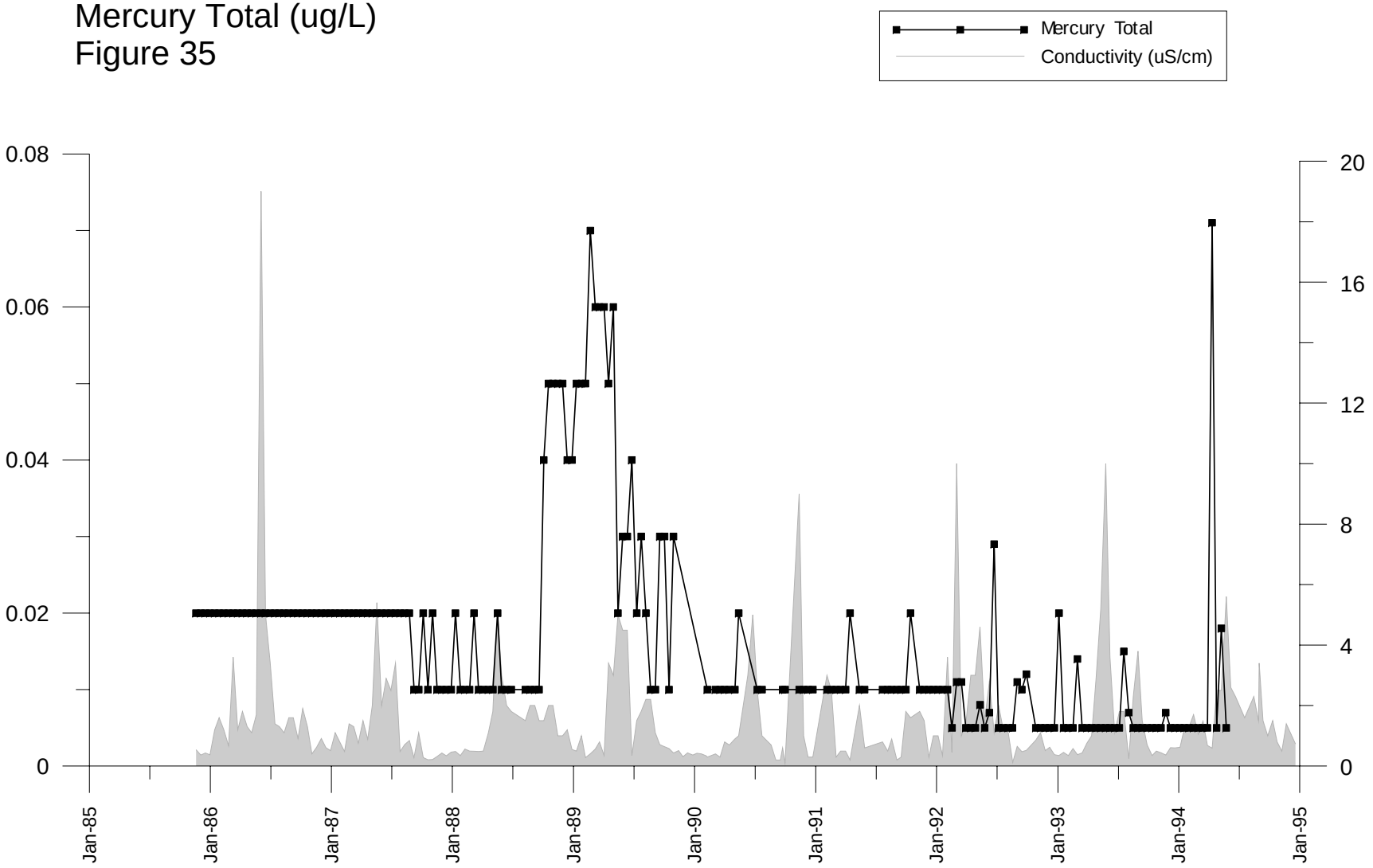
Figure 34



# Thompson River at Spences Bridge

Mercury Total (ug/L)

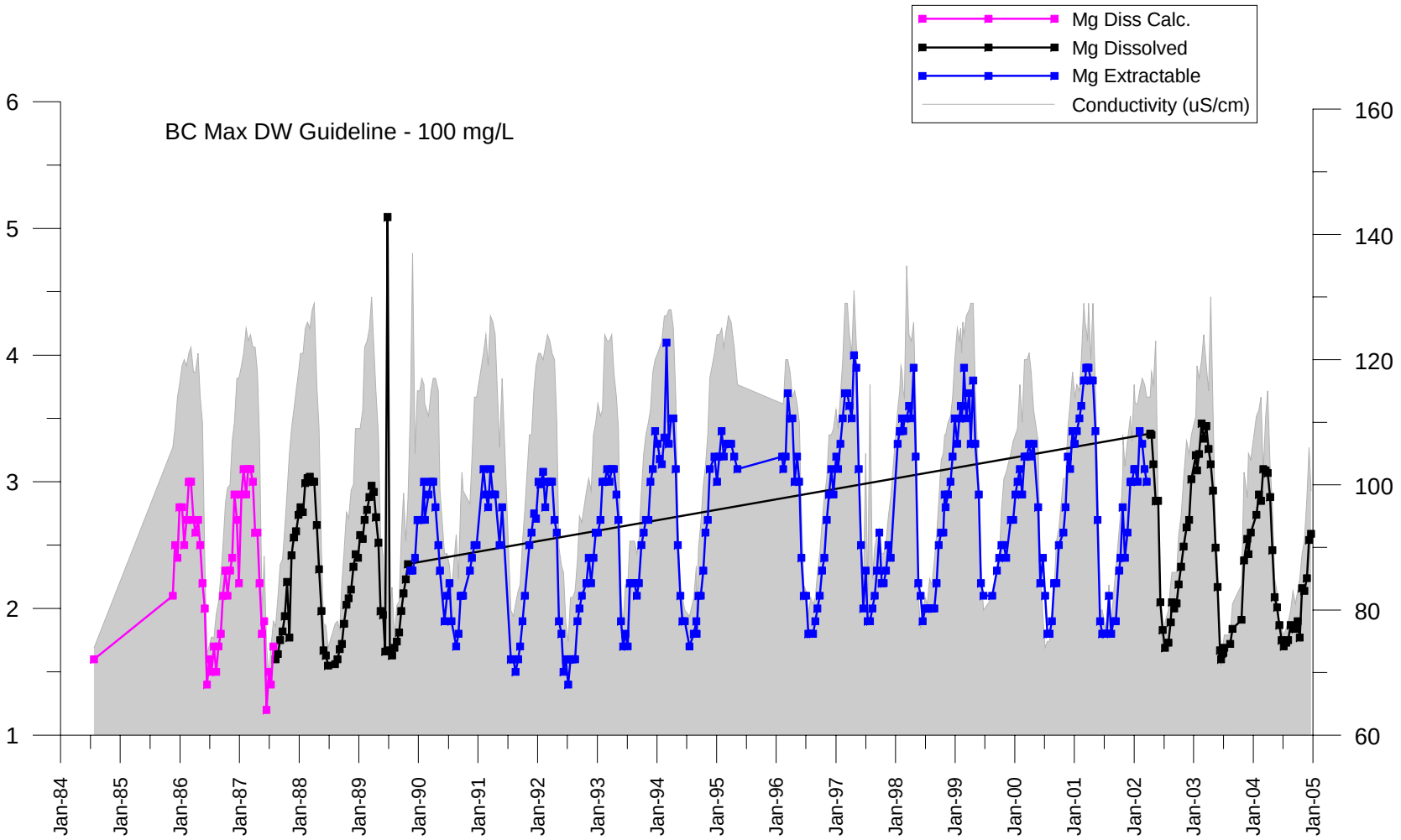
Figure 35



# Thompson River at Spences Bridge

## Magnesium Dissolved, Dissolved Calculated and Extractable(mg/L)

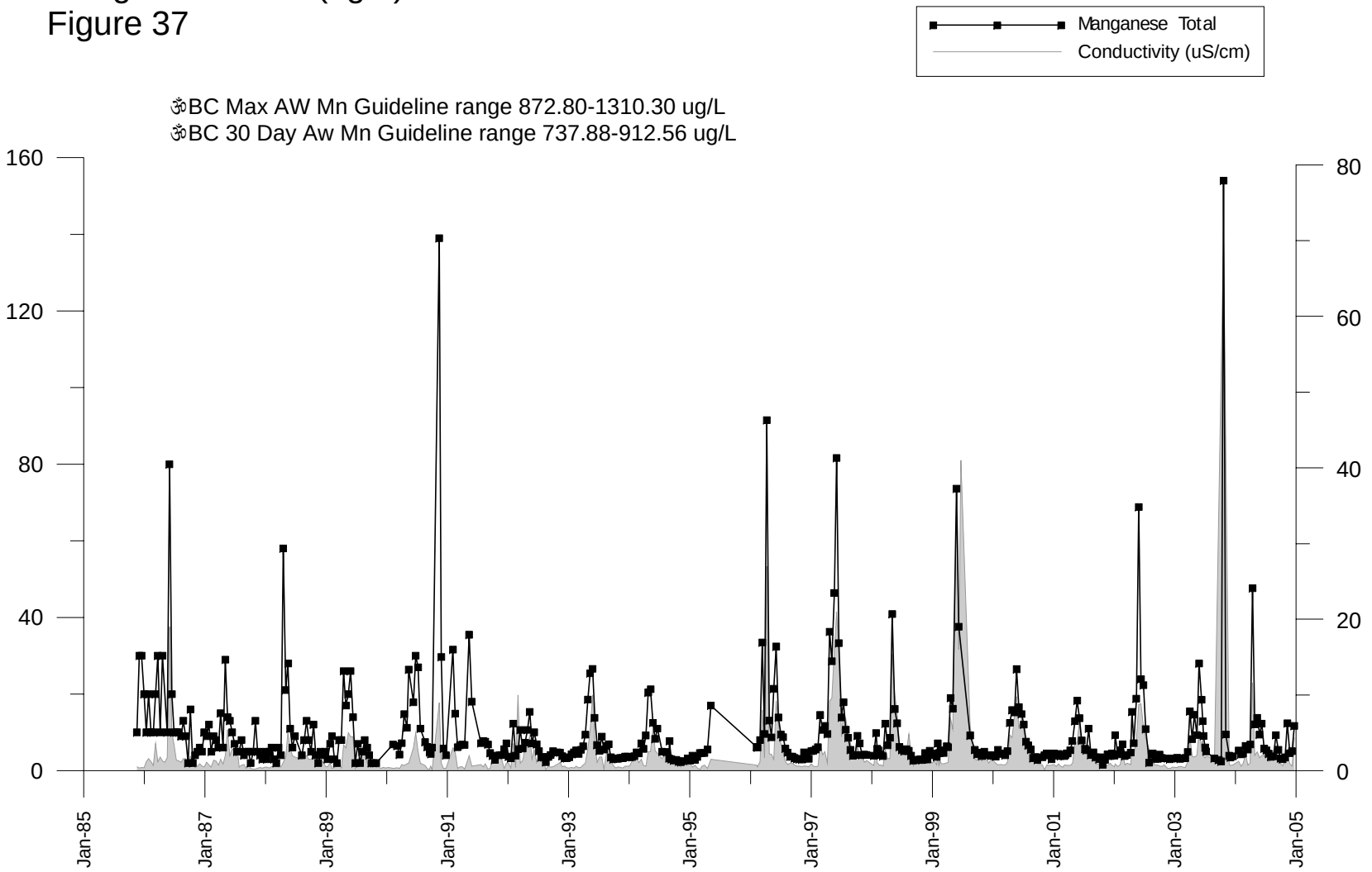
Figure 36



# Thompson River at Spences Bridge

Manganese Total (ug/L)

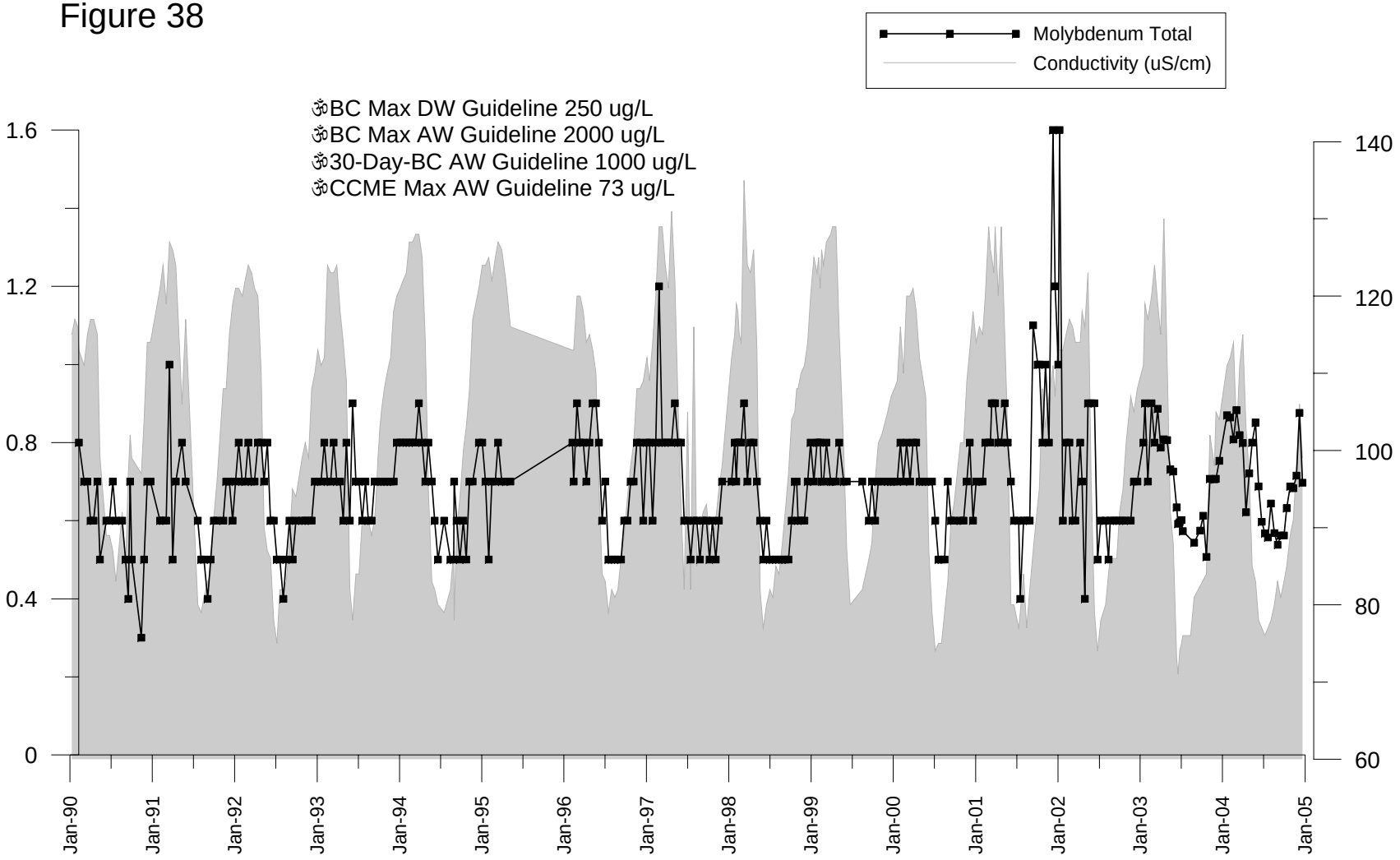
Figure 37



# Thompson River at Spences Bridge

Molybdenum Total (ug/L)

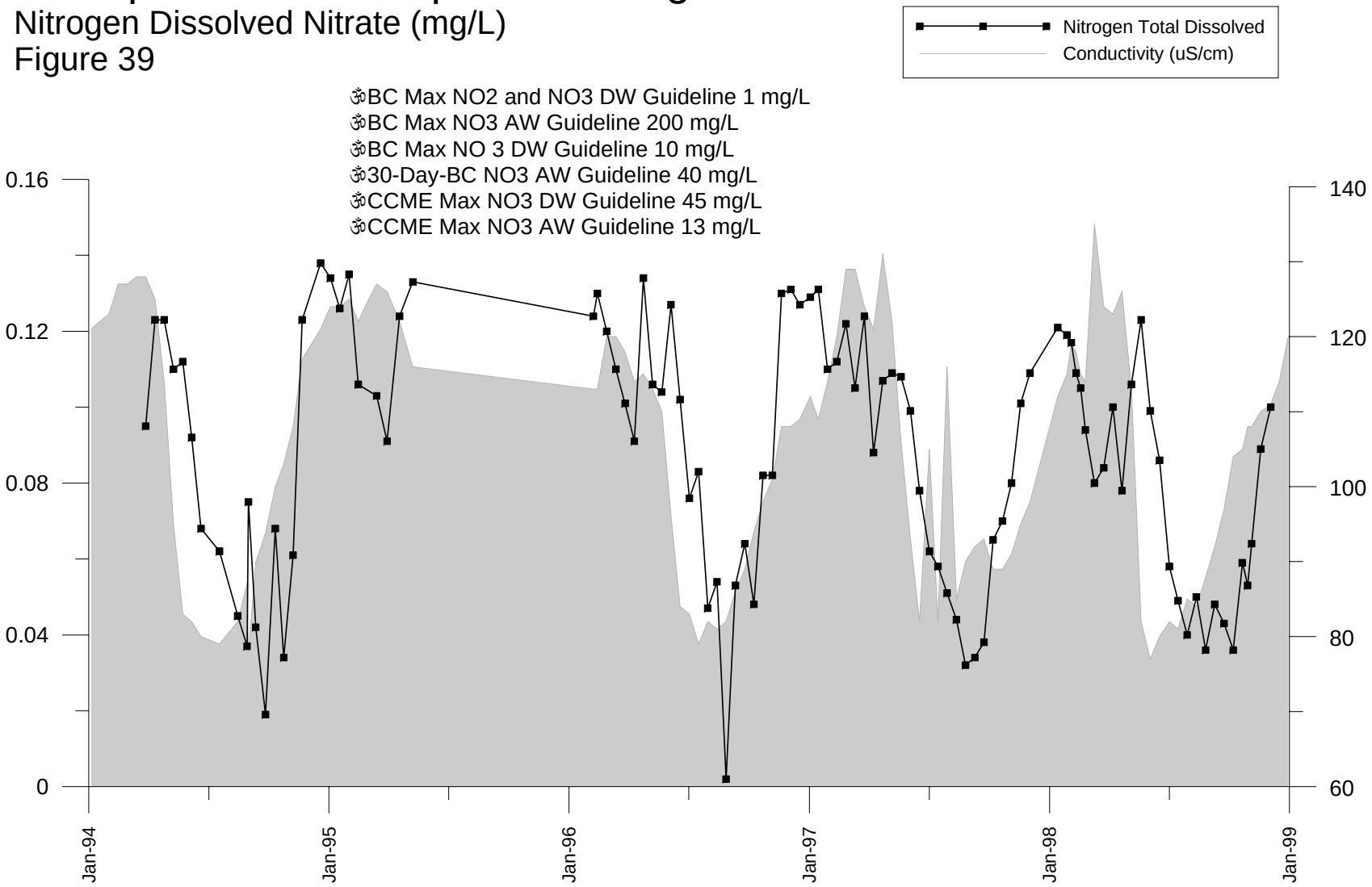
Figure 38



# Thompson River at Spences Bridge

## Nitrogen Dissolved Nitrate (mg/L)

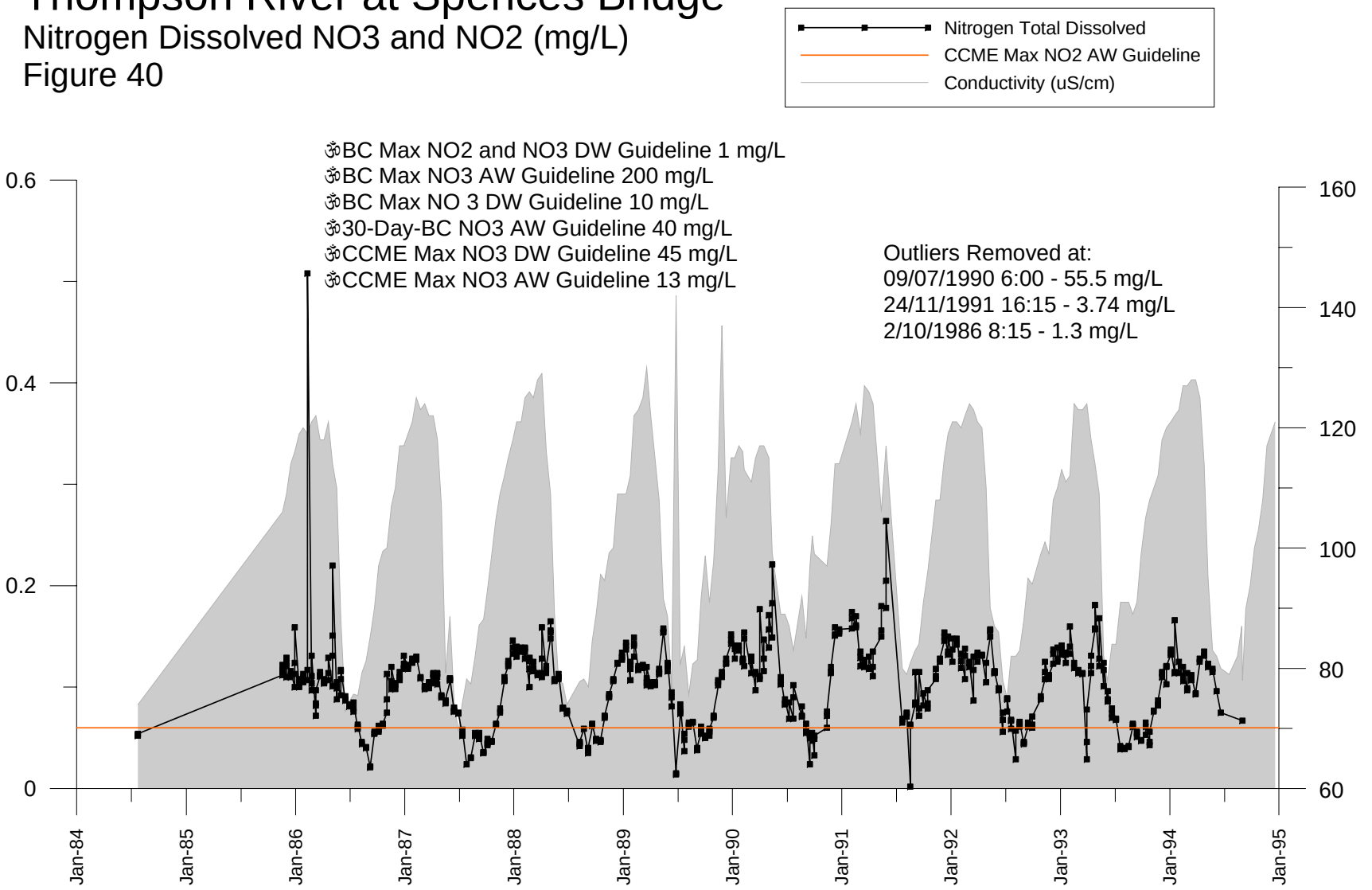
Figure 39



# Thompson River at Spences Bridge

## Nitrogen Dissolved NO3 and NO2 (mg/L)

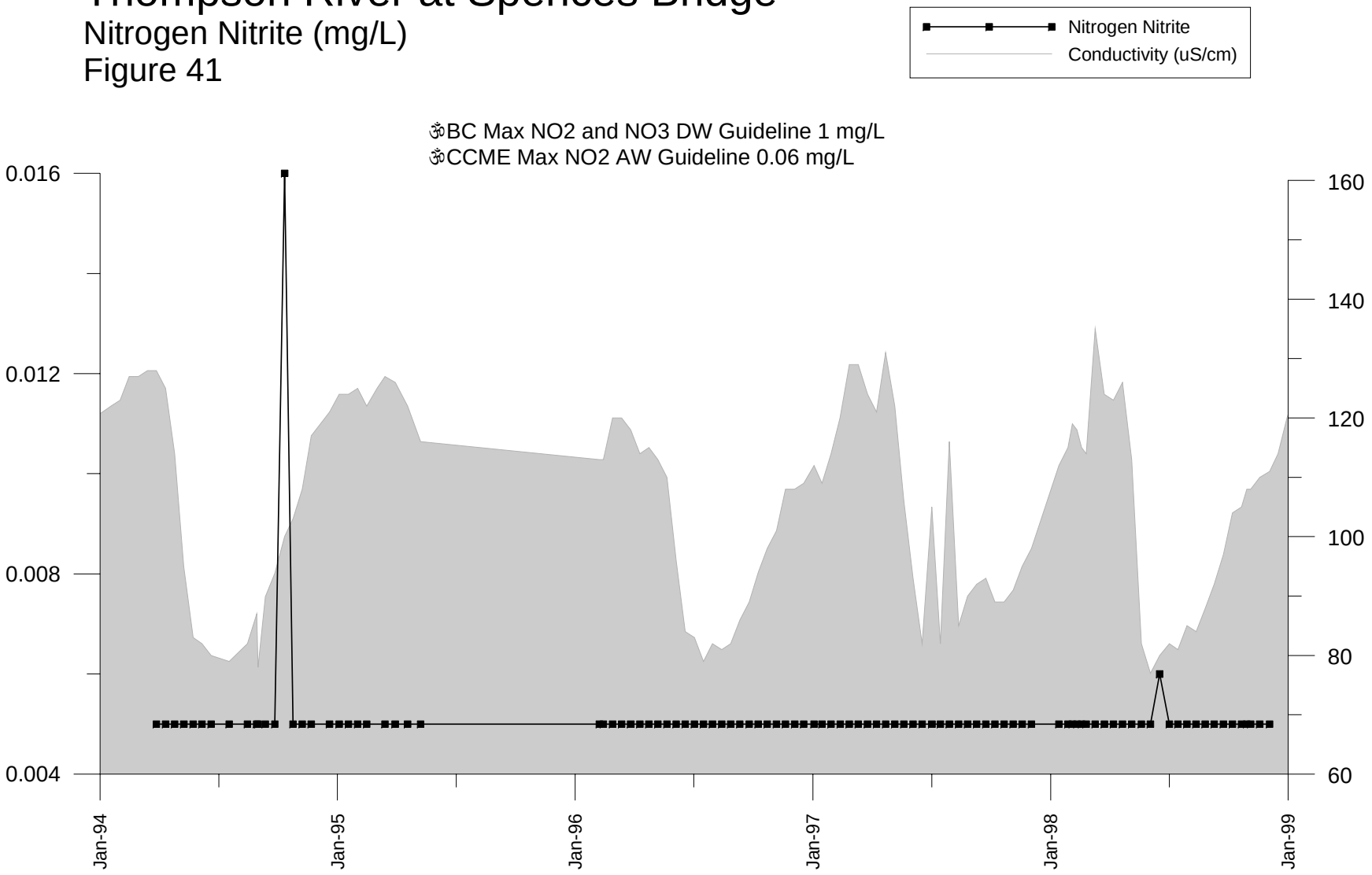
## Figure 40



# Thompson River at Spences Bridge

Nitrogen Nitrite (mg/L)

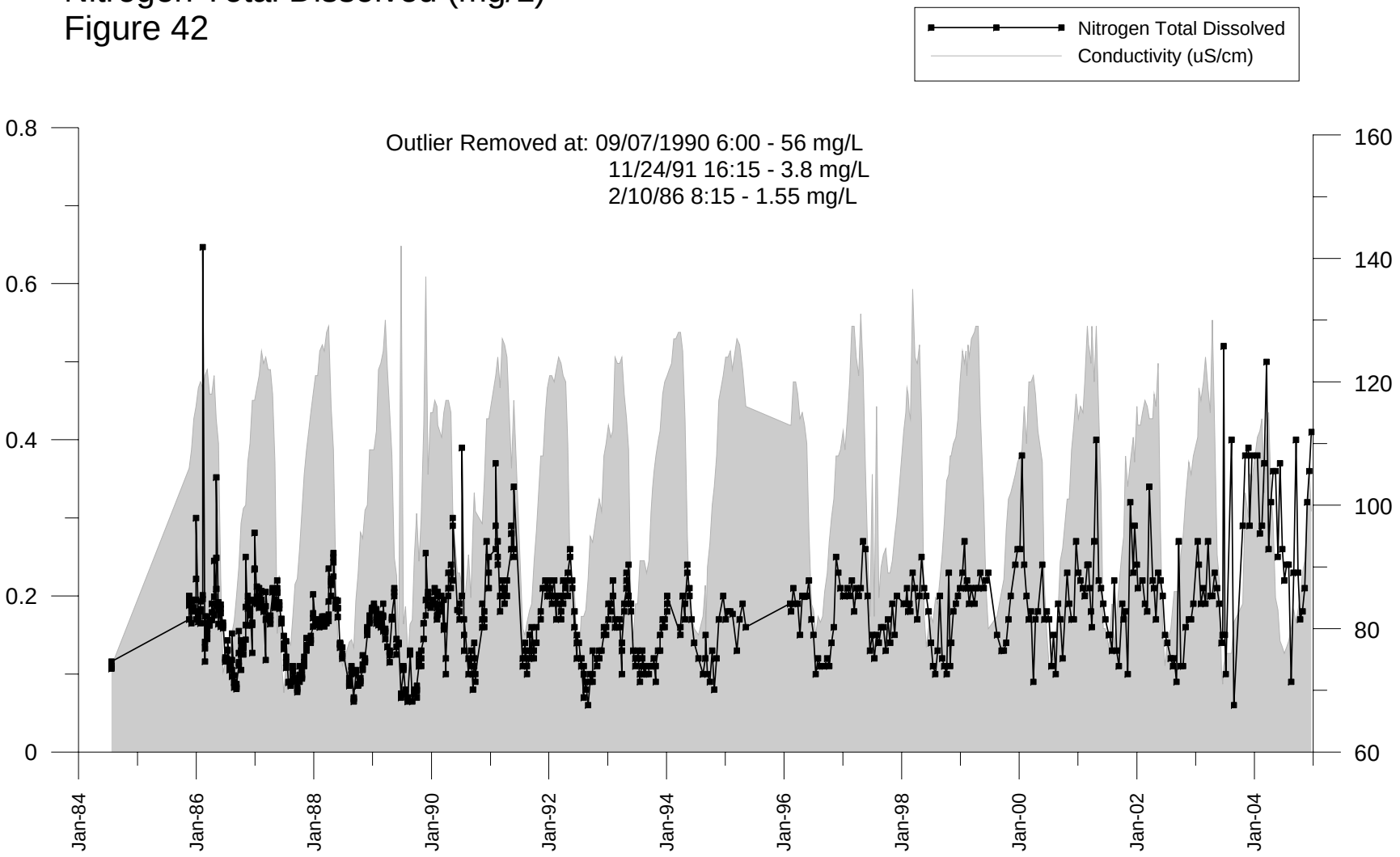
Figure 41



# Thompson River at Spences Bridge

## Nitrogen Total Dissolved (mg/L)

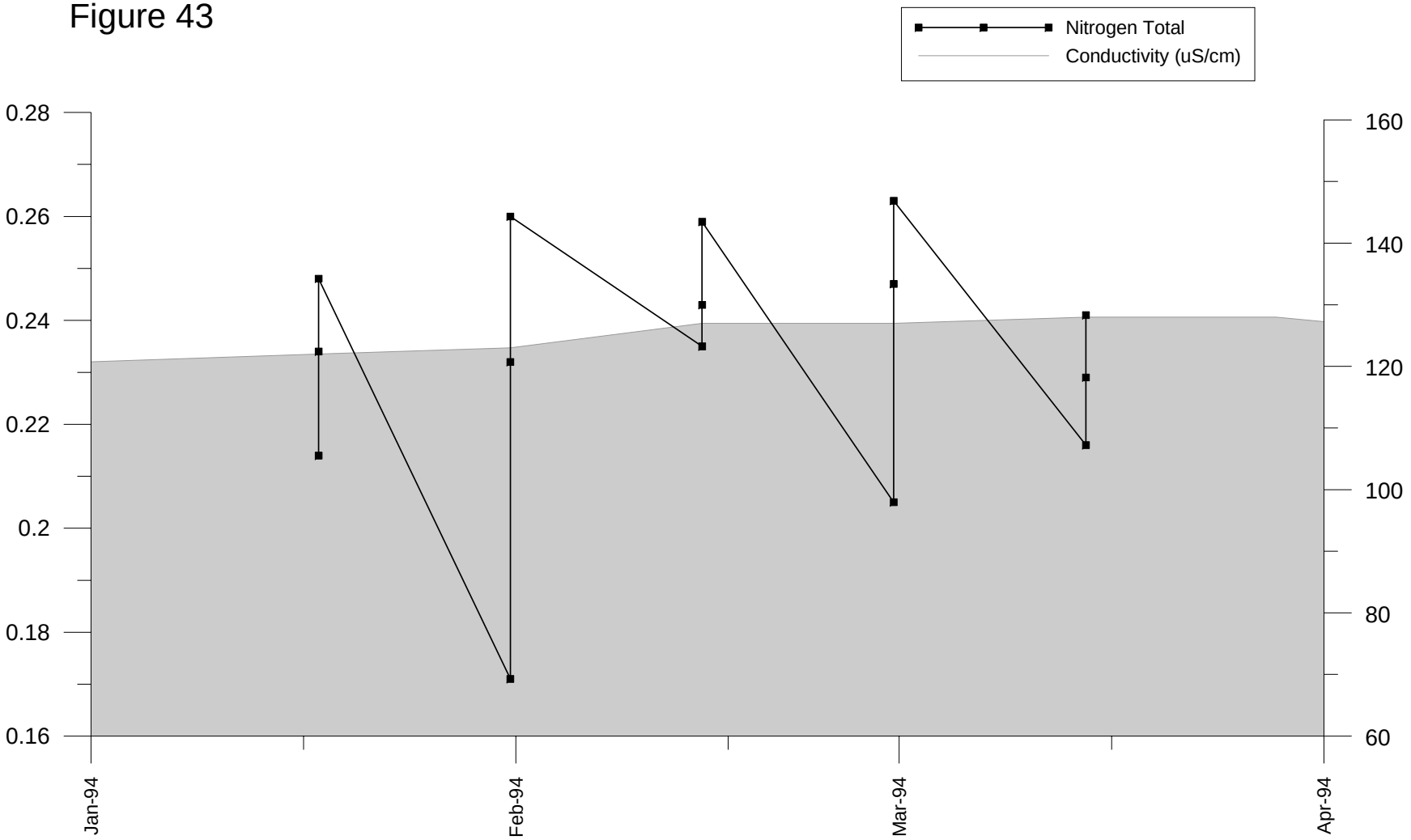
## Figure 42



# Thompson River at Spences Bridge

Nitrogen Total (mg/L)

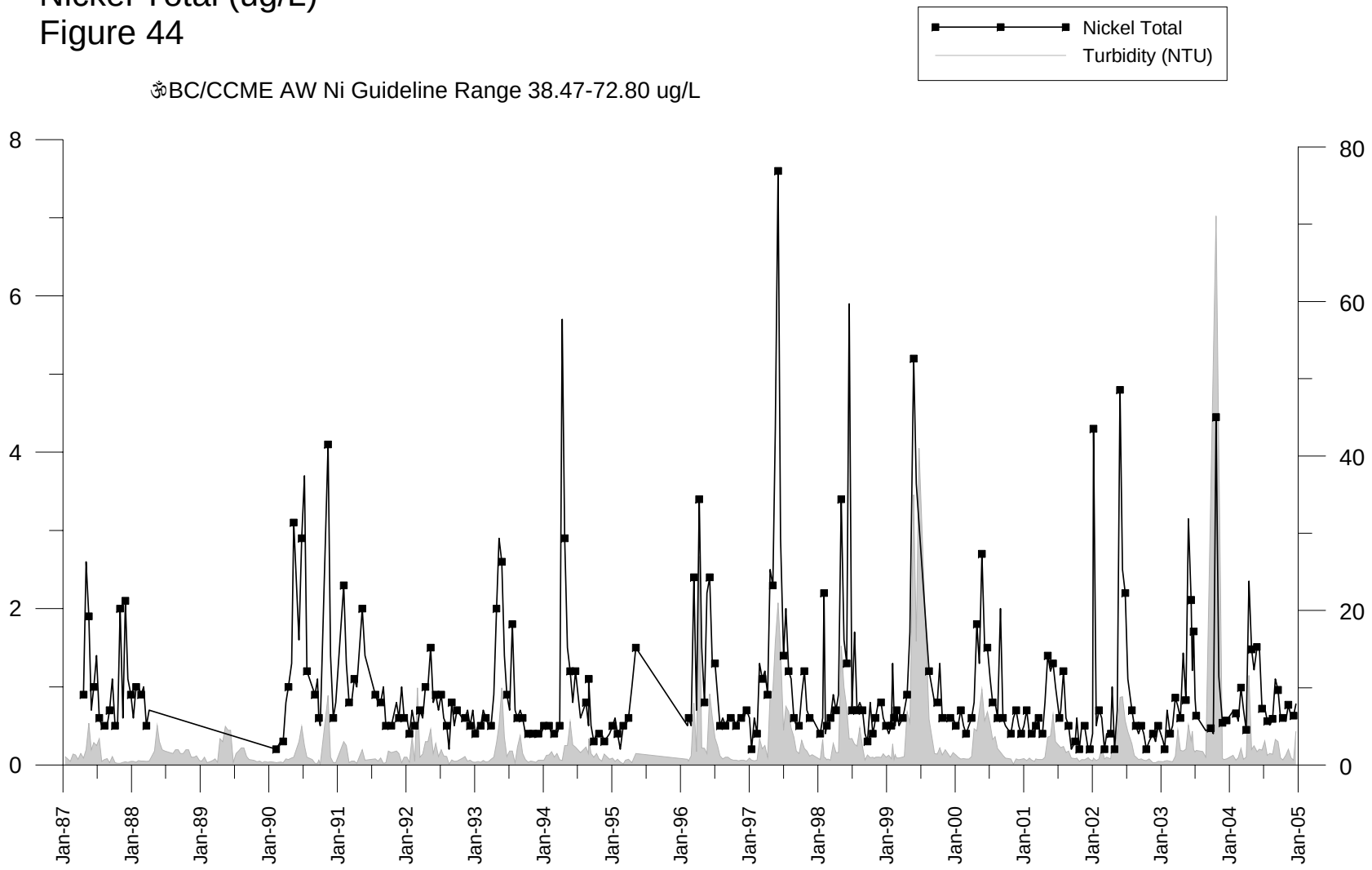
Figure 43



# Thompson River at Spences Bridge

## Nickel Total (ug/L)

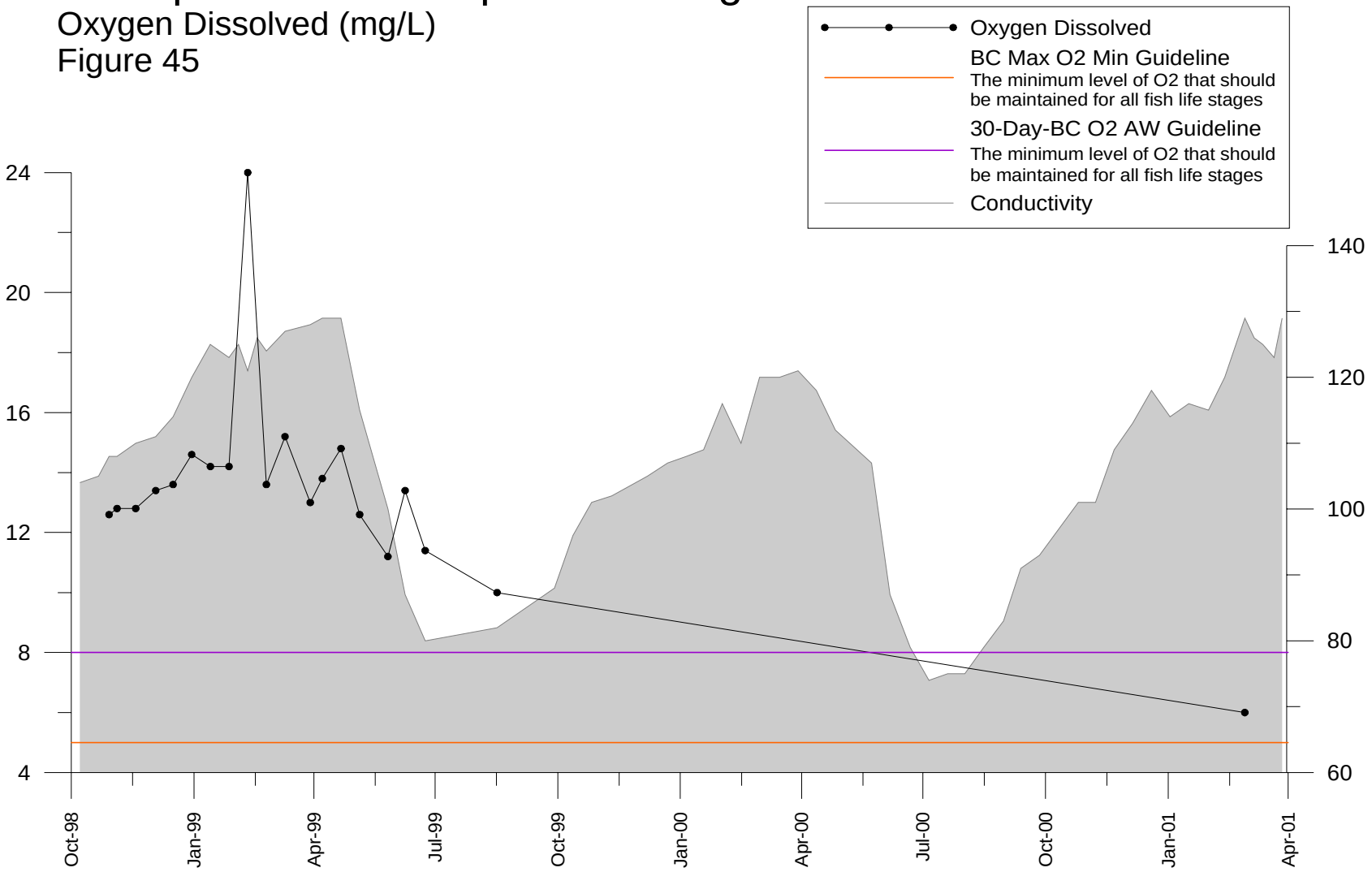
## Figure 44



# Thompson River at Spences Bridge

## Oxygen Dissolved (mg/L)

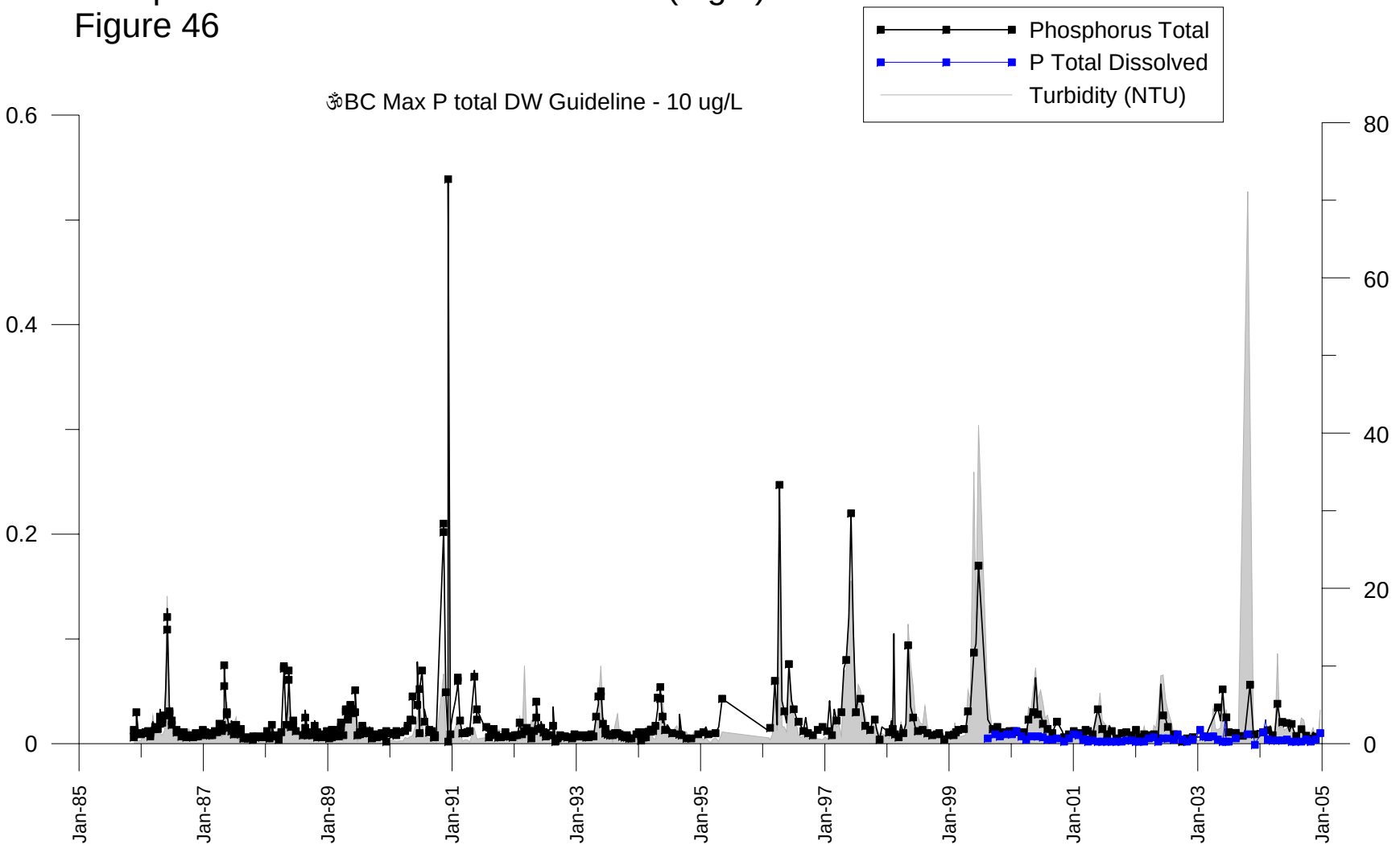
Figure 45



# Thompson River at Spences Bridge

## Phosphorus Total and Total Dissolved (mg/L)

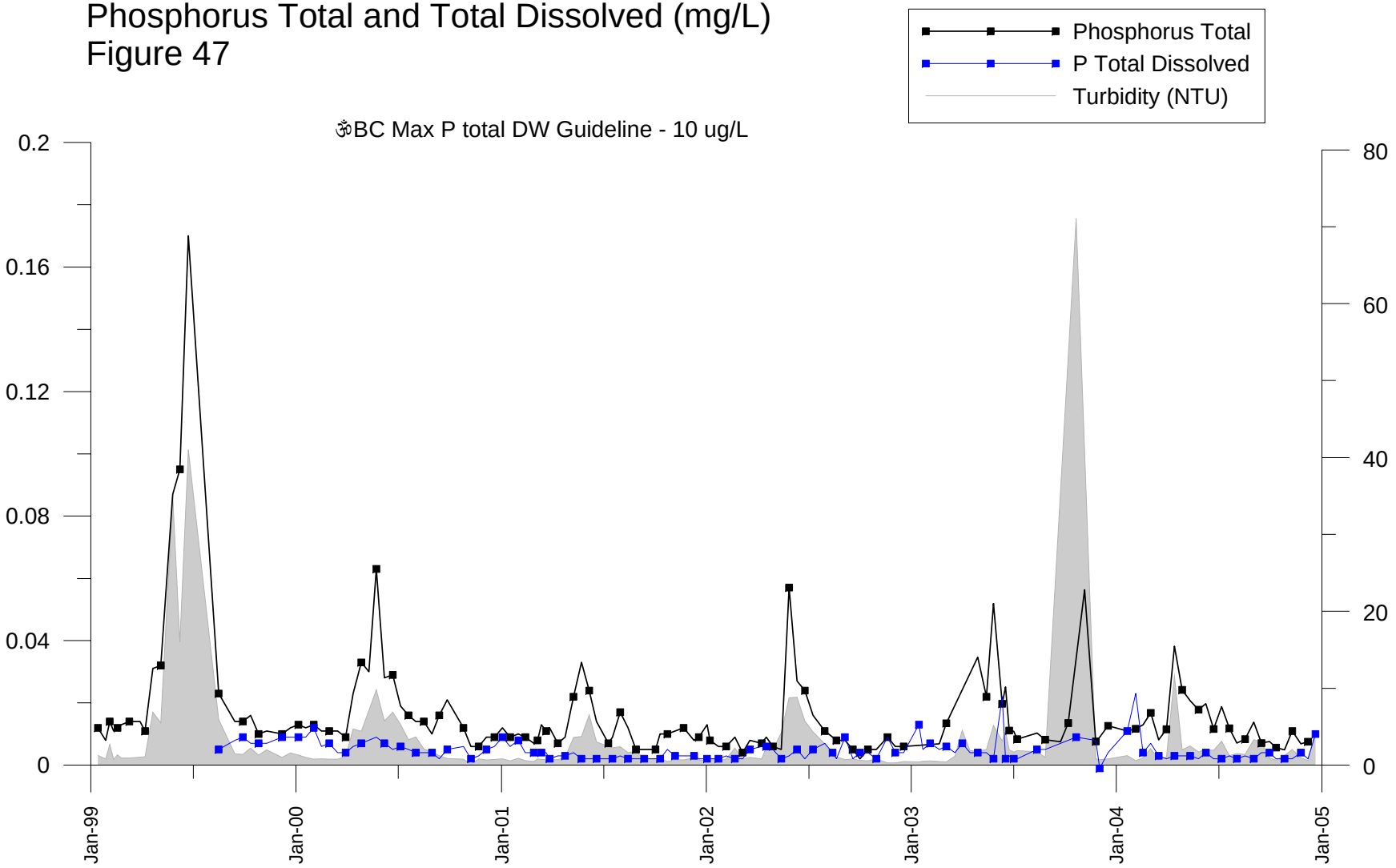
Figure 46



# Thompson River at Spences Bridge

## Phosphorus Total and Total Dissolved (mg/L)

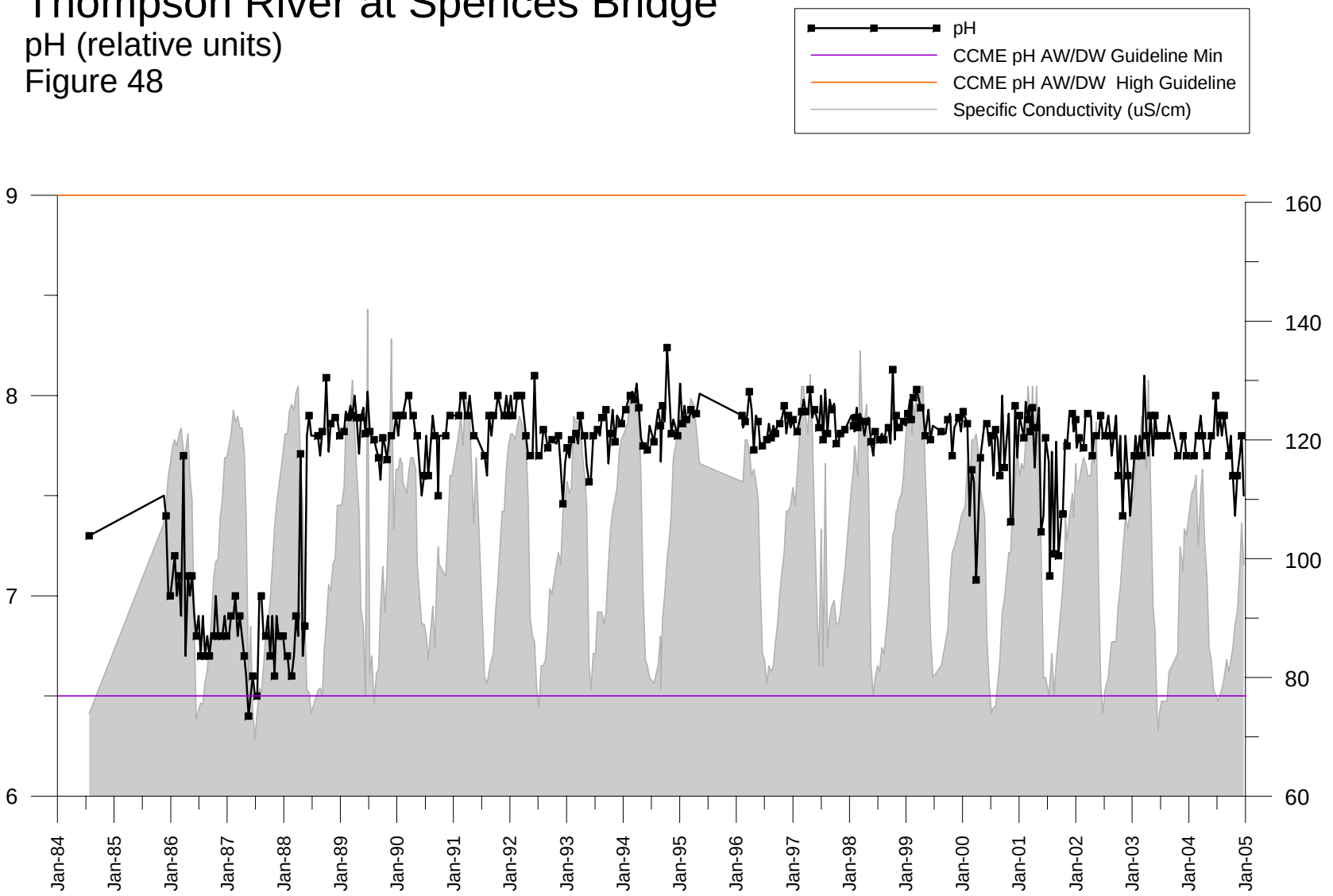
Figure 47



# Thompson River at Spences Bridge

pH (relative units)

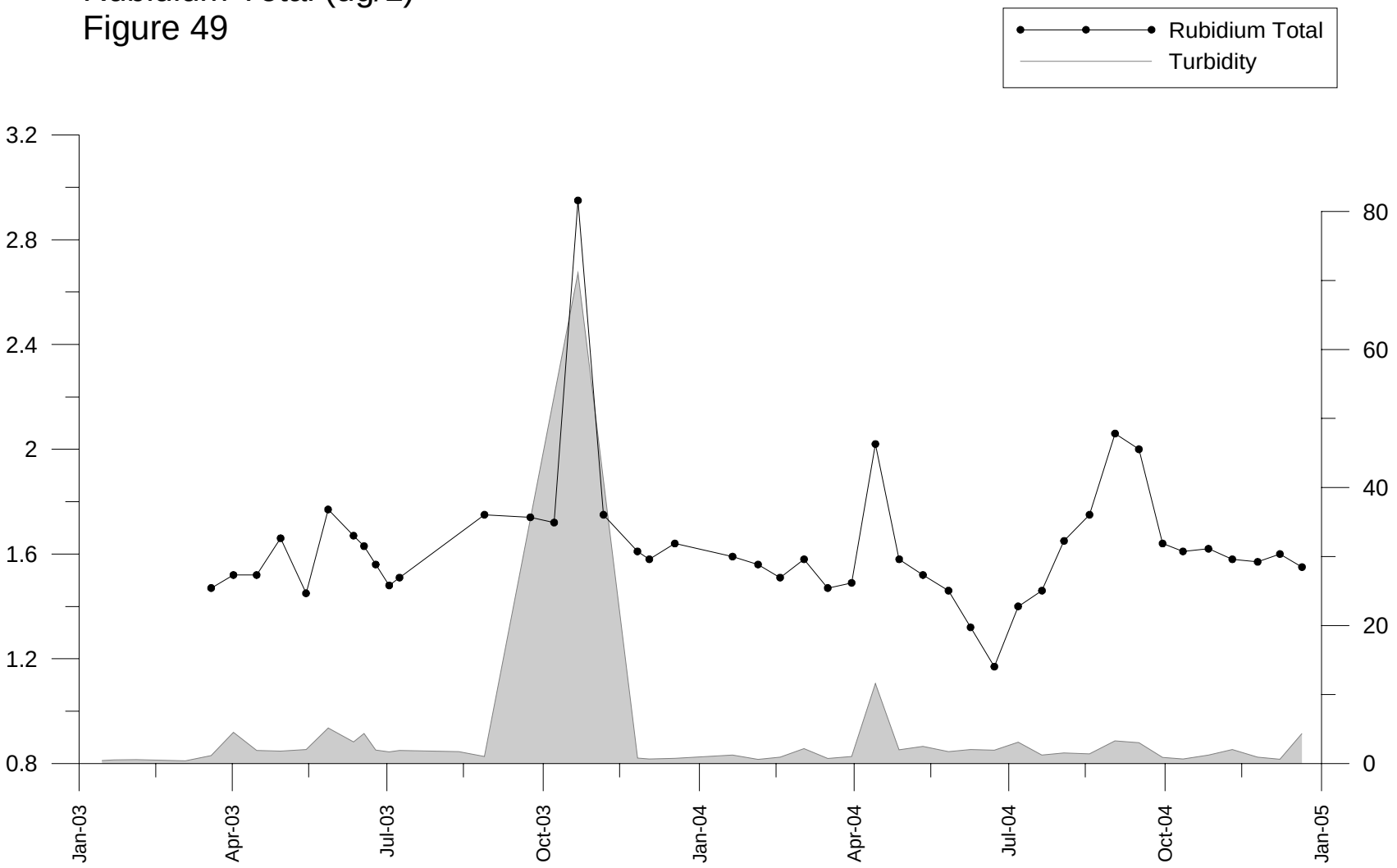
Figure 48



# Thompson River at Spences Bridge

Rubidium Total (ug/L)

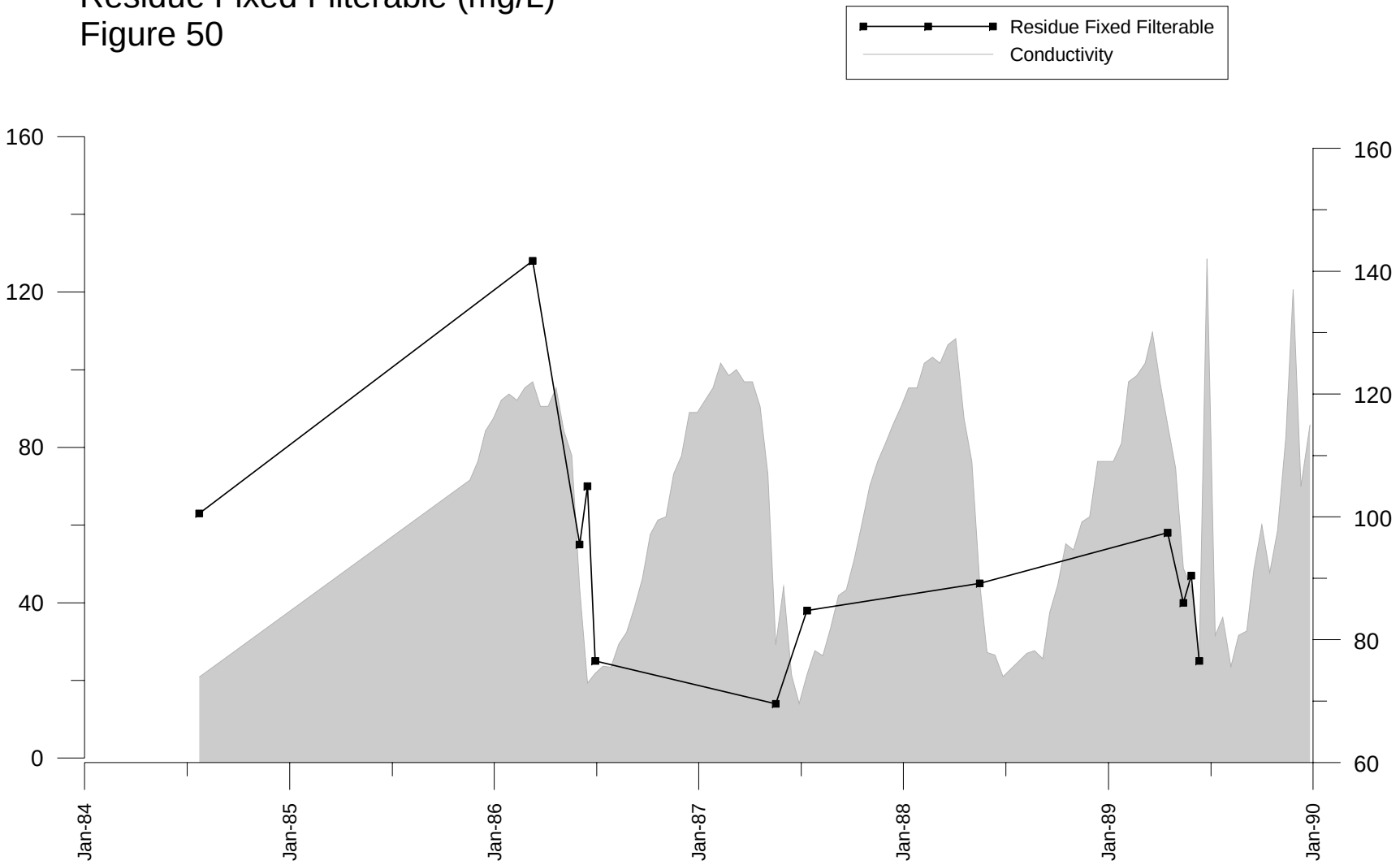
Figure 49



# Thompson River at Spences Bridge

Residue Fixed Filterable (mg/L)

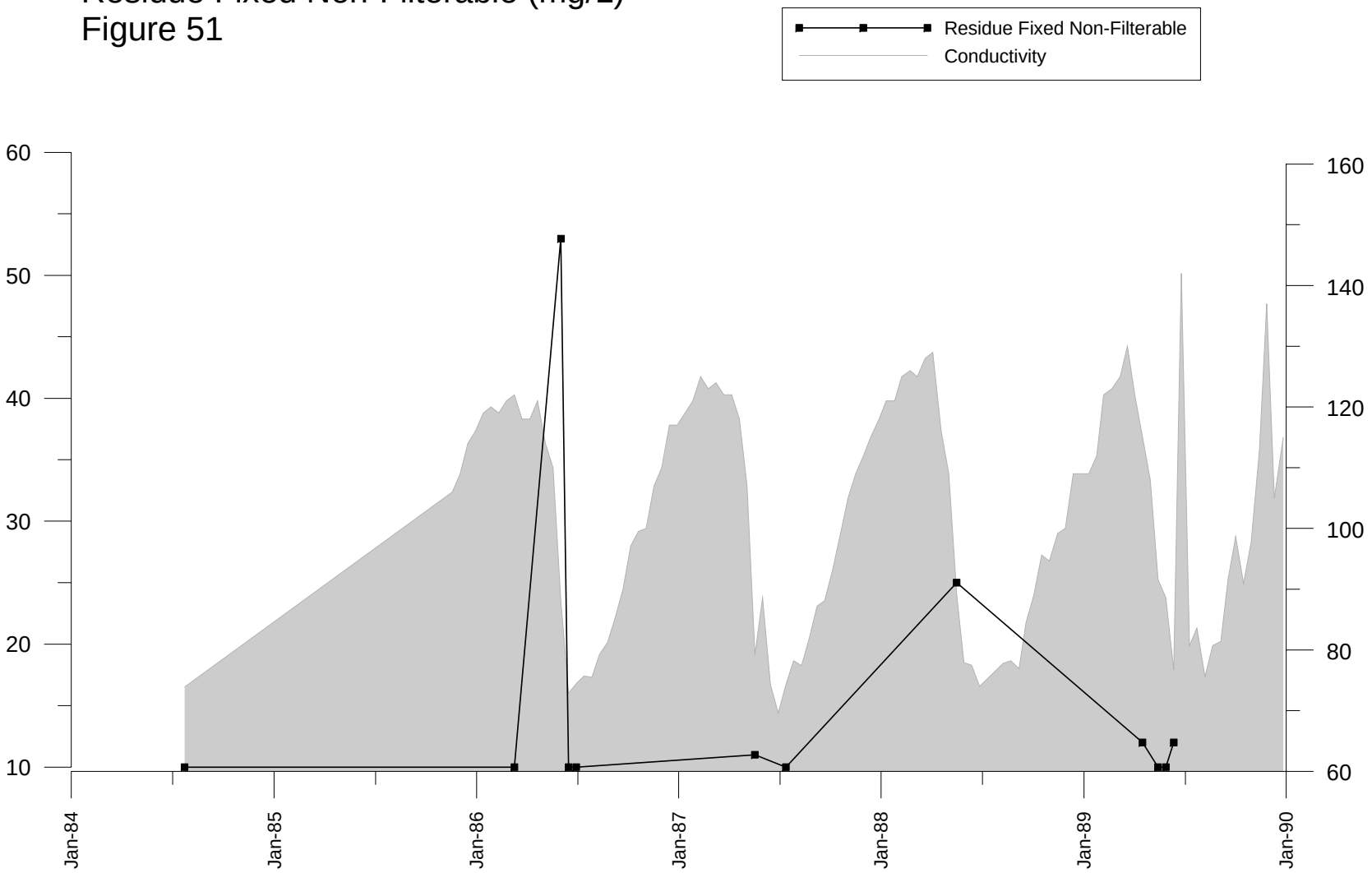
Figure 50



# Thompson River at Spences Bridge

## Residue Fixed Non-Filterable (mg/L)

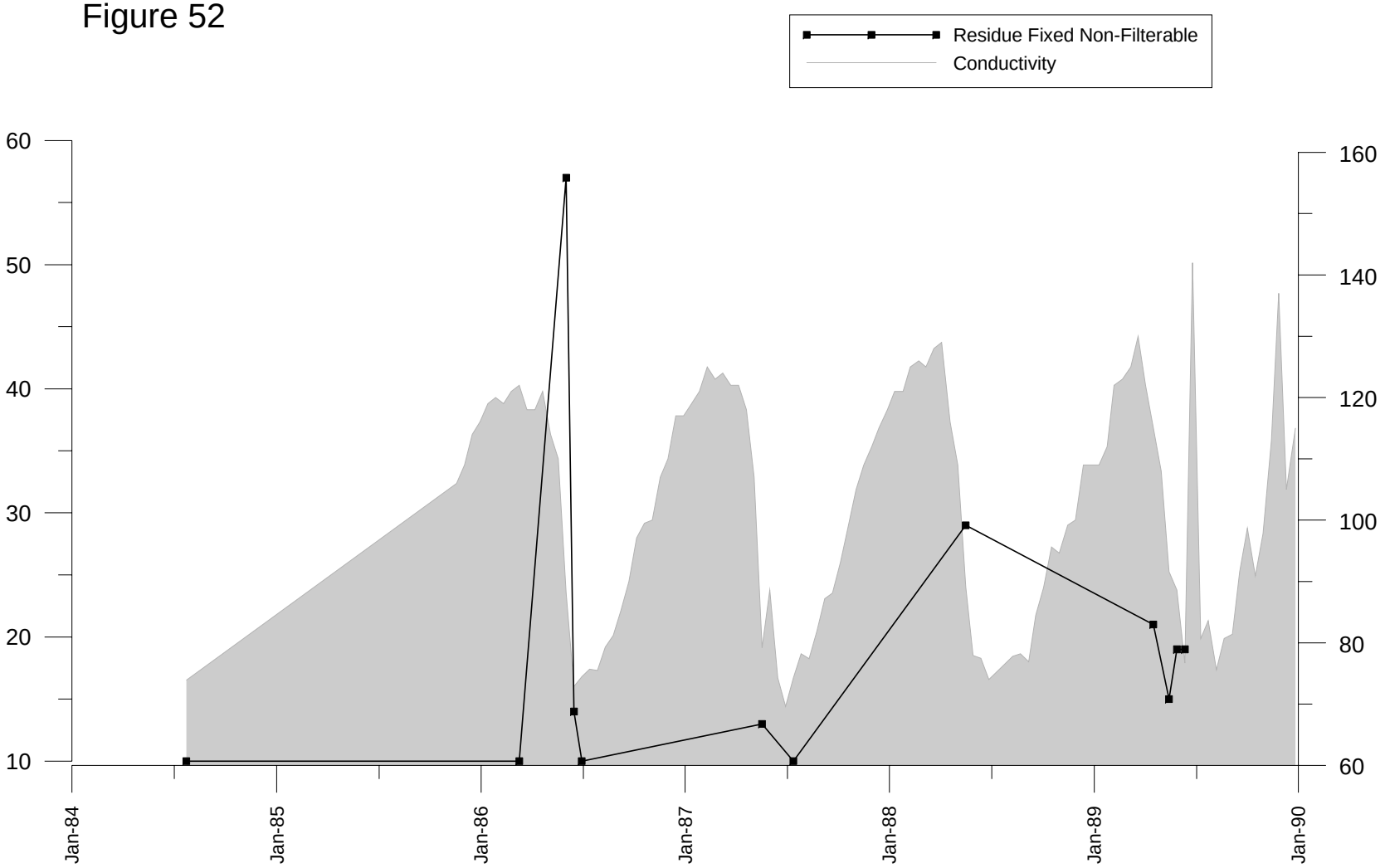
Figure 51



# Thompson River at Spences Bridge

Residue Non-Filterable (mg/L)

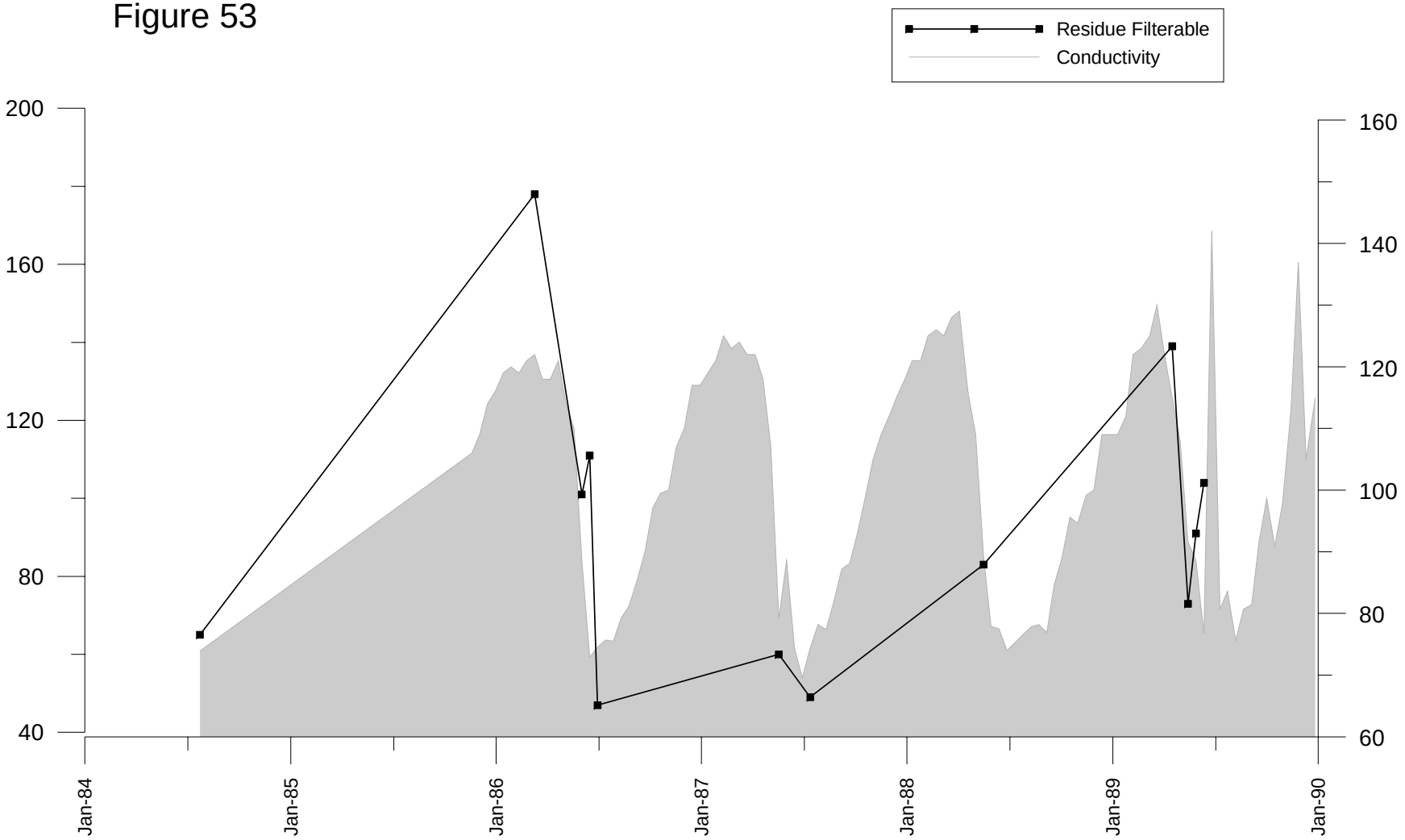
Figure 52



# Thompson River at Spences Bridge

Residue Filterable (mg/L)

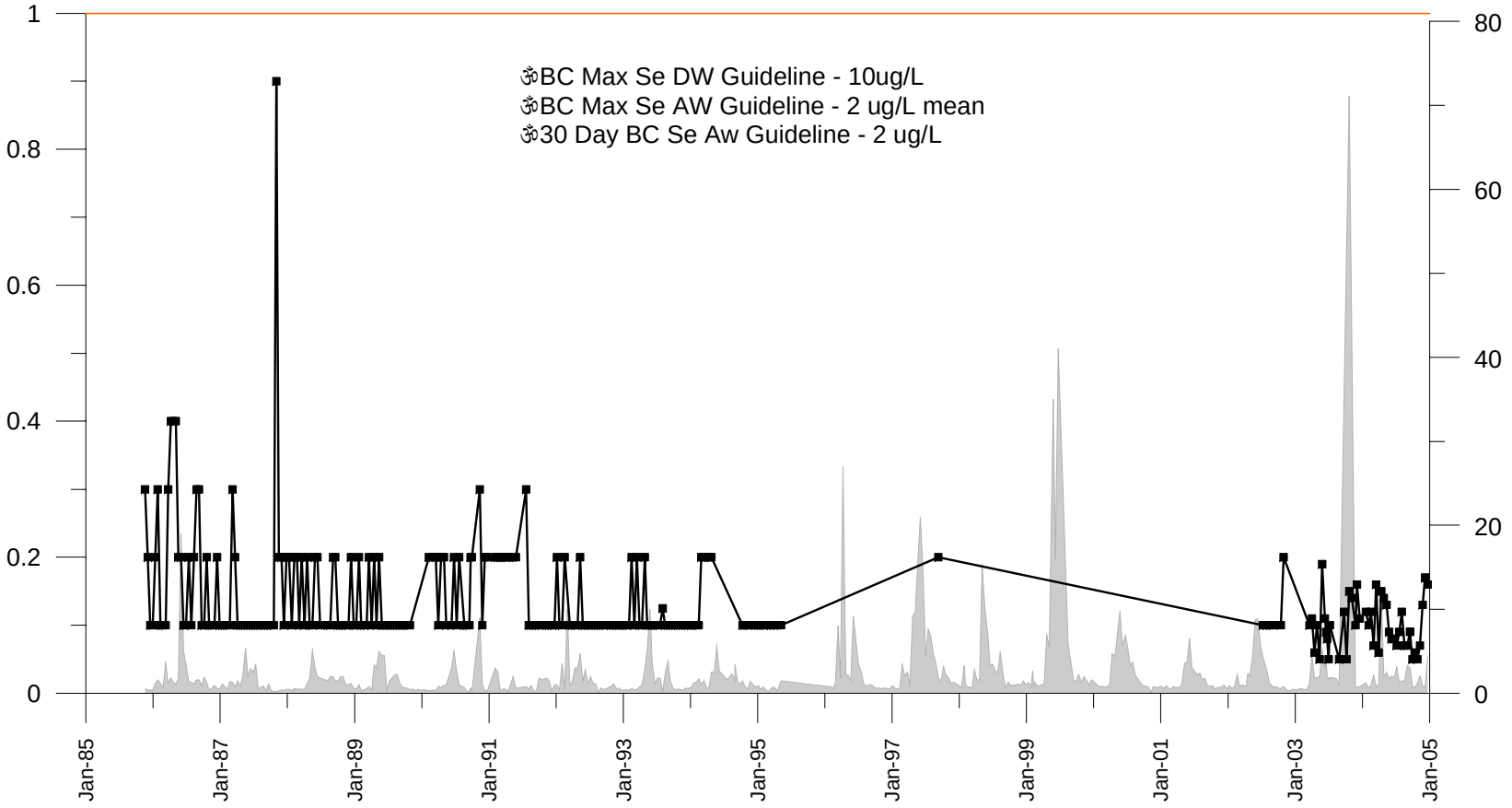
Figure 53



# Thompson River at Spences Bridge

Selenium Total (ug/L)

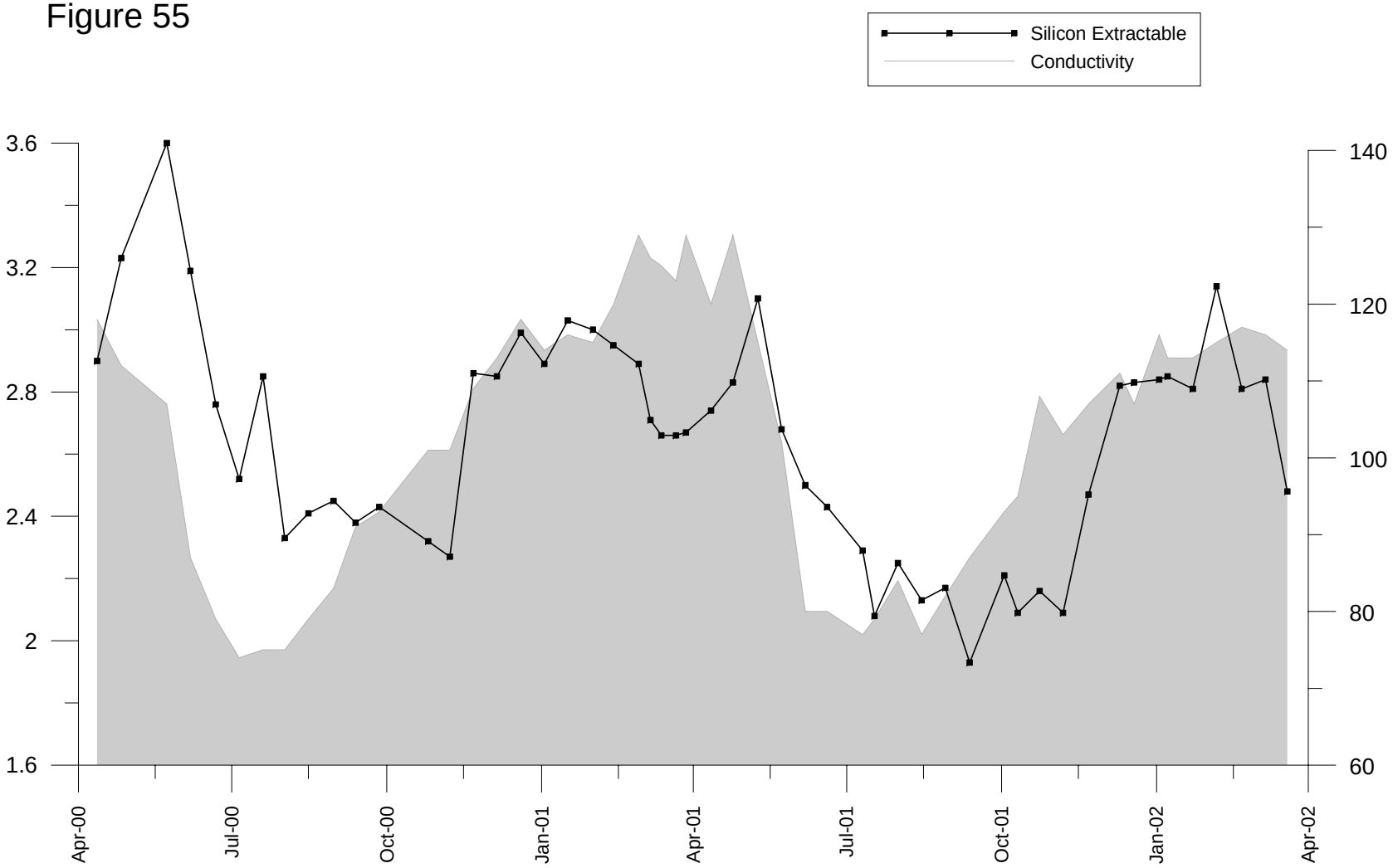
Figure 54



# Thompson River at Spences Bridge

Silicon Extractable (mg/L)

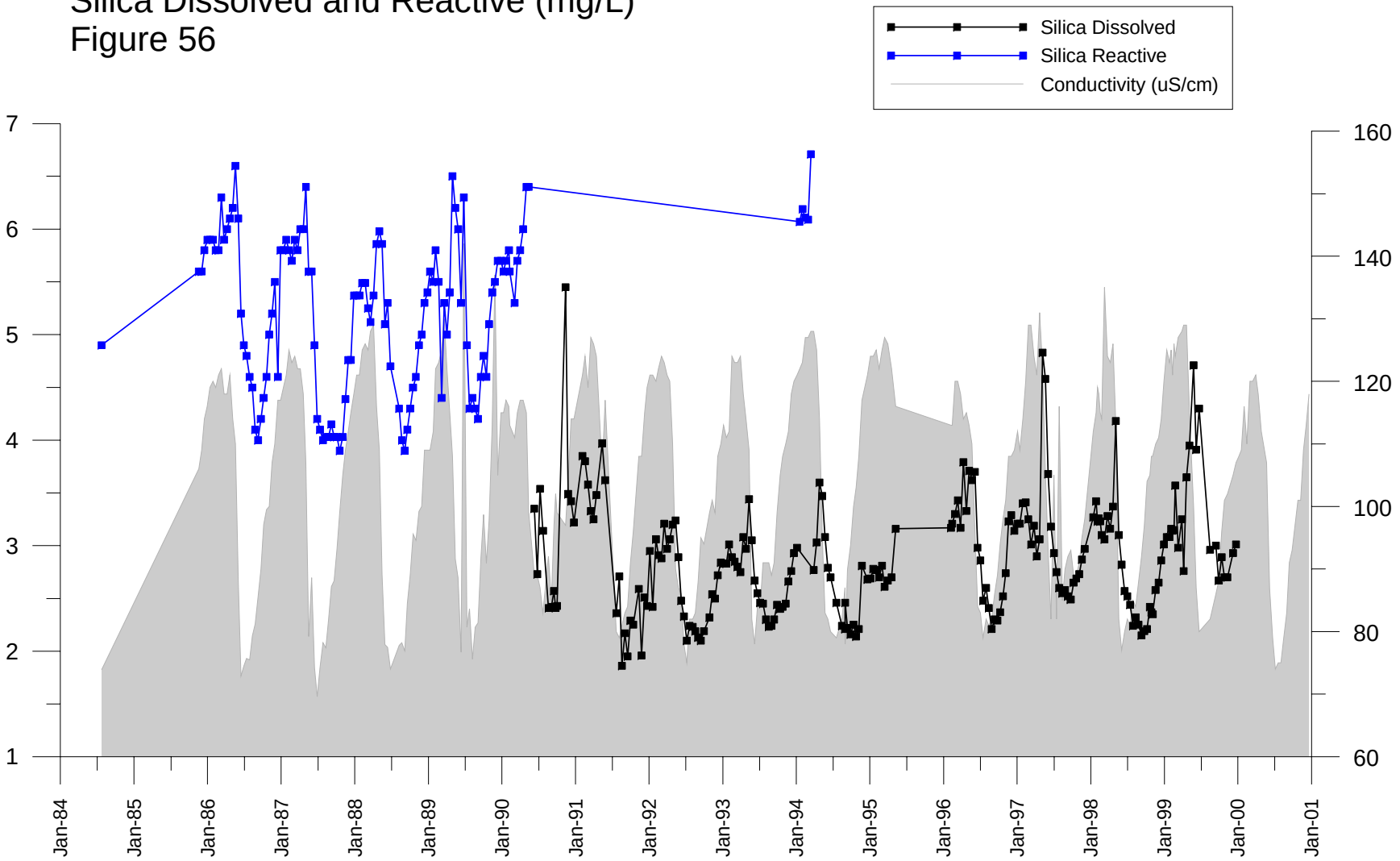
Figure 55



# Thompson River at Spences Bridge

## Silica Dissolved and Reactive (mg/L)

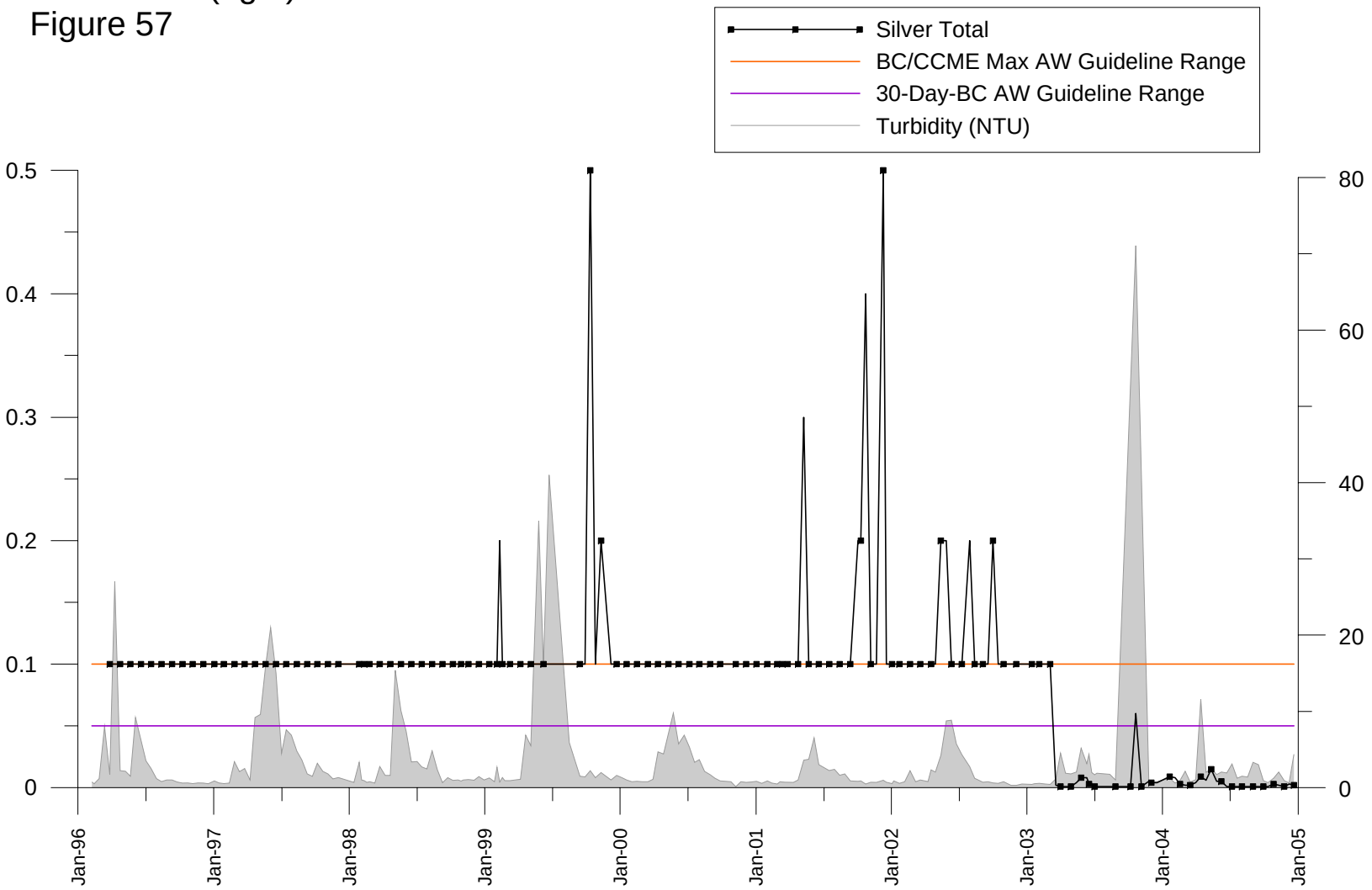
Figure 56



# Thompson River at Spences Bridge

Silver Total (ug/L)

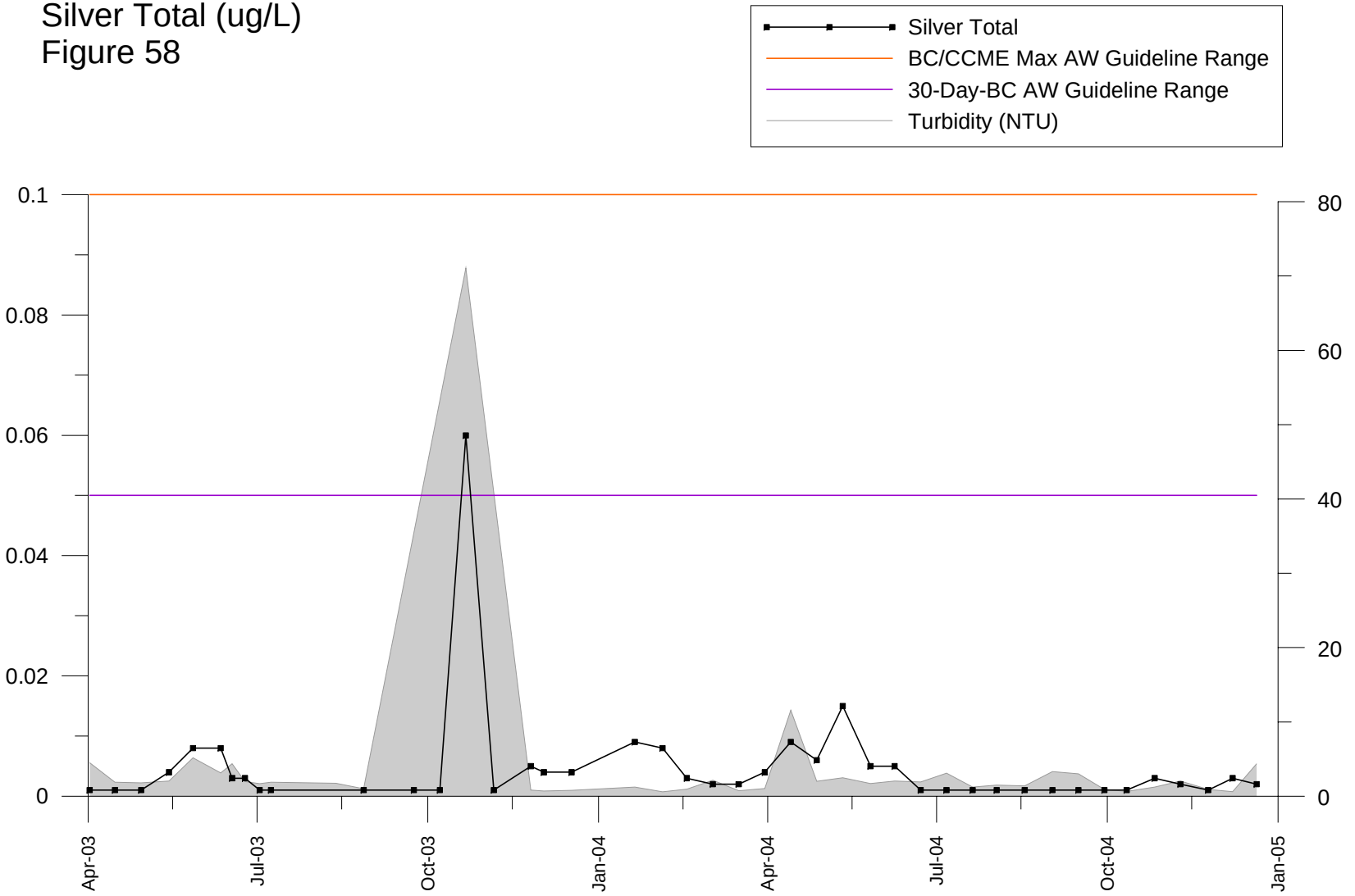
Figure 57



# Thompson River at Spences Bridge

Silver Total (ug/L)

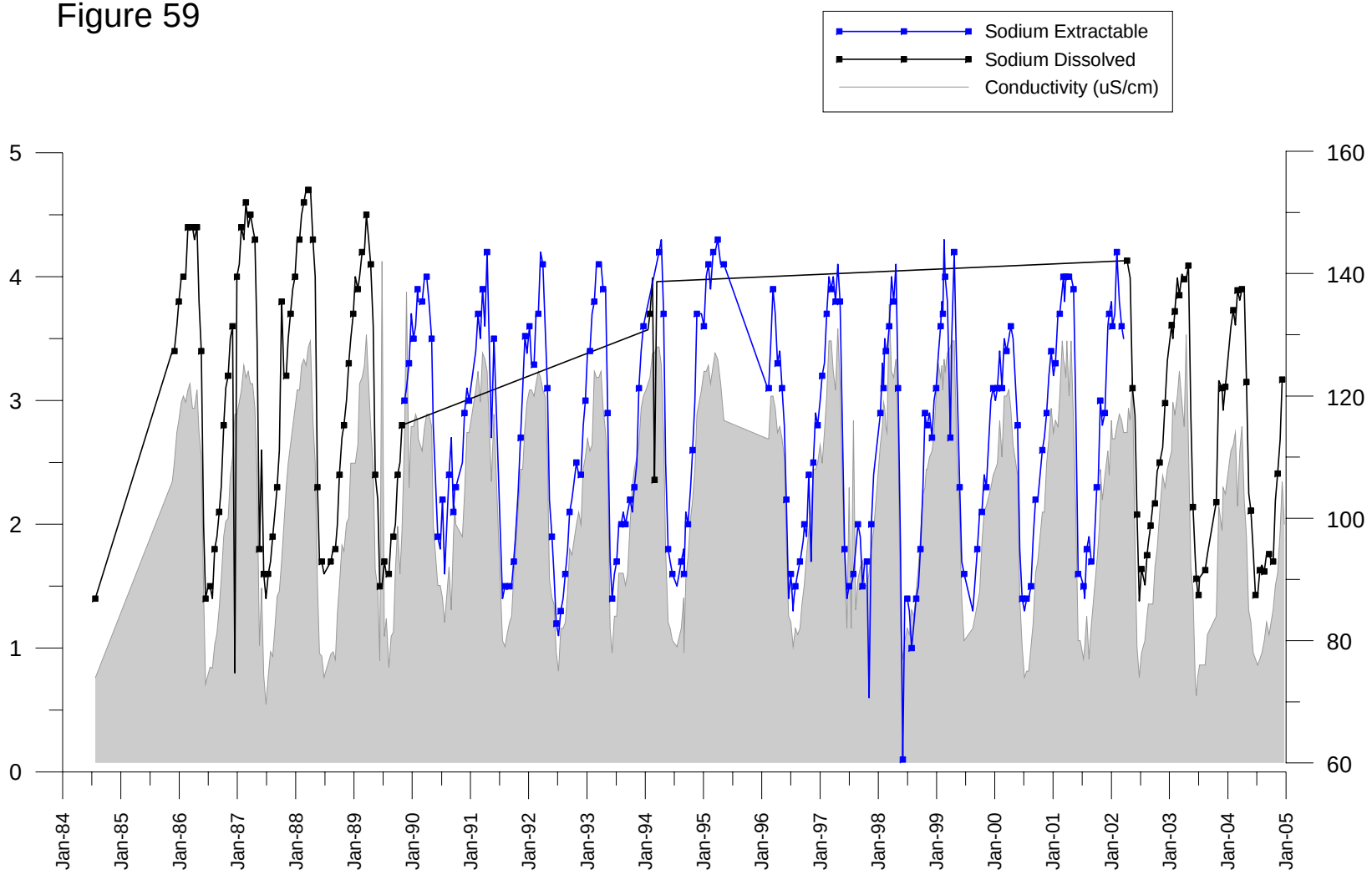
Figure 58



# Thompson River at Spences Bridge

## Sodium Dissolved and Extractable (mg/L)

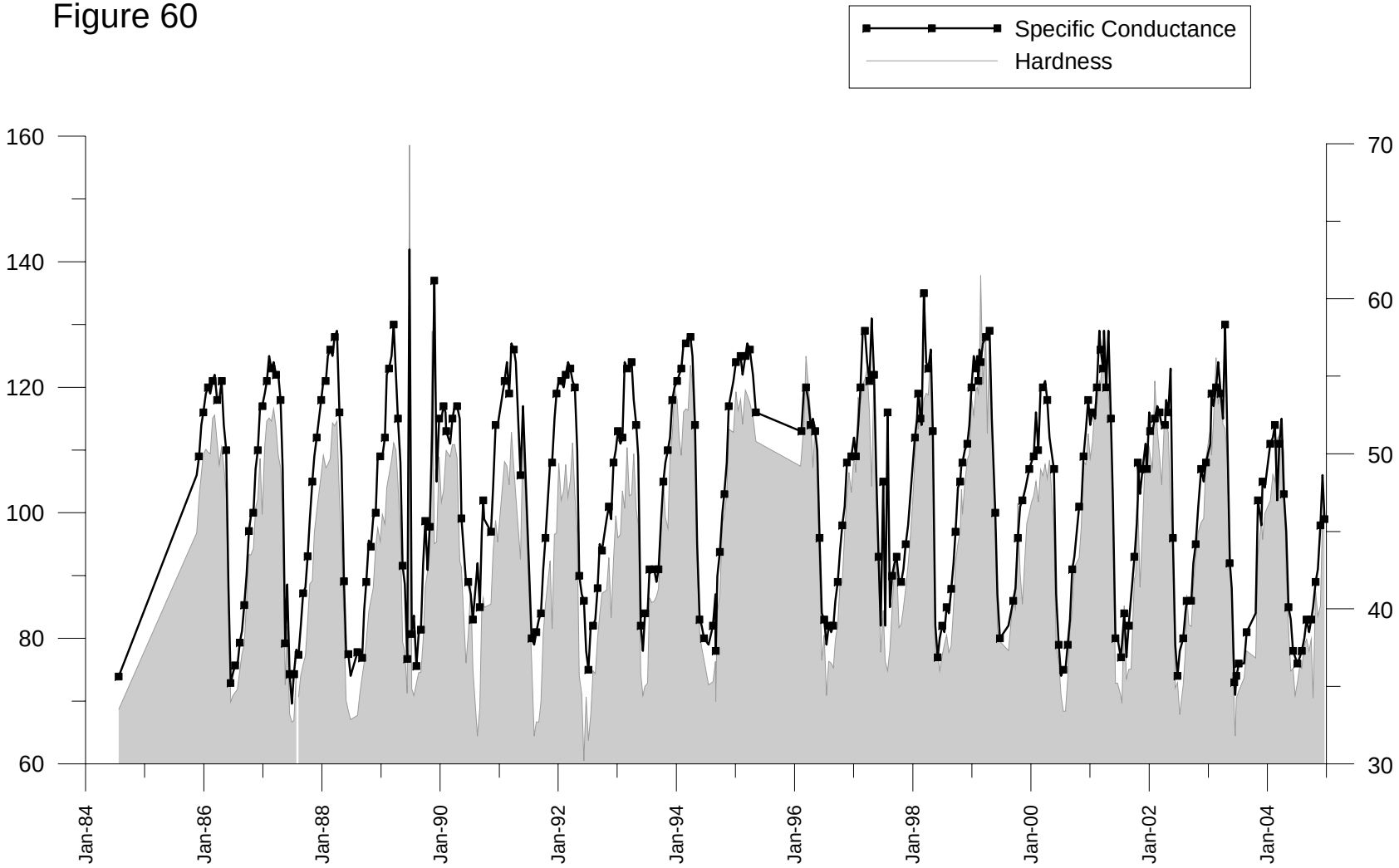
Figure 59



# Thompson River at Spences Bridge

Specific Conductance (uS/cm)

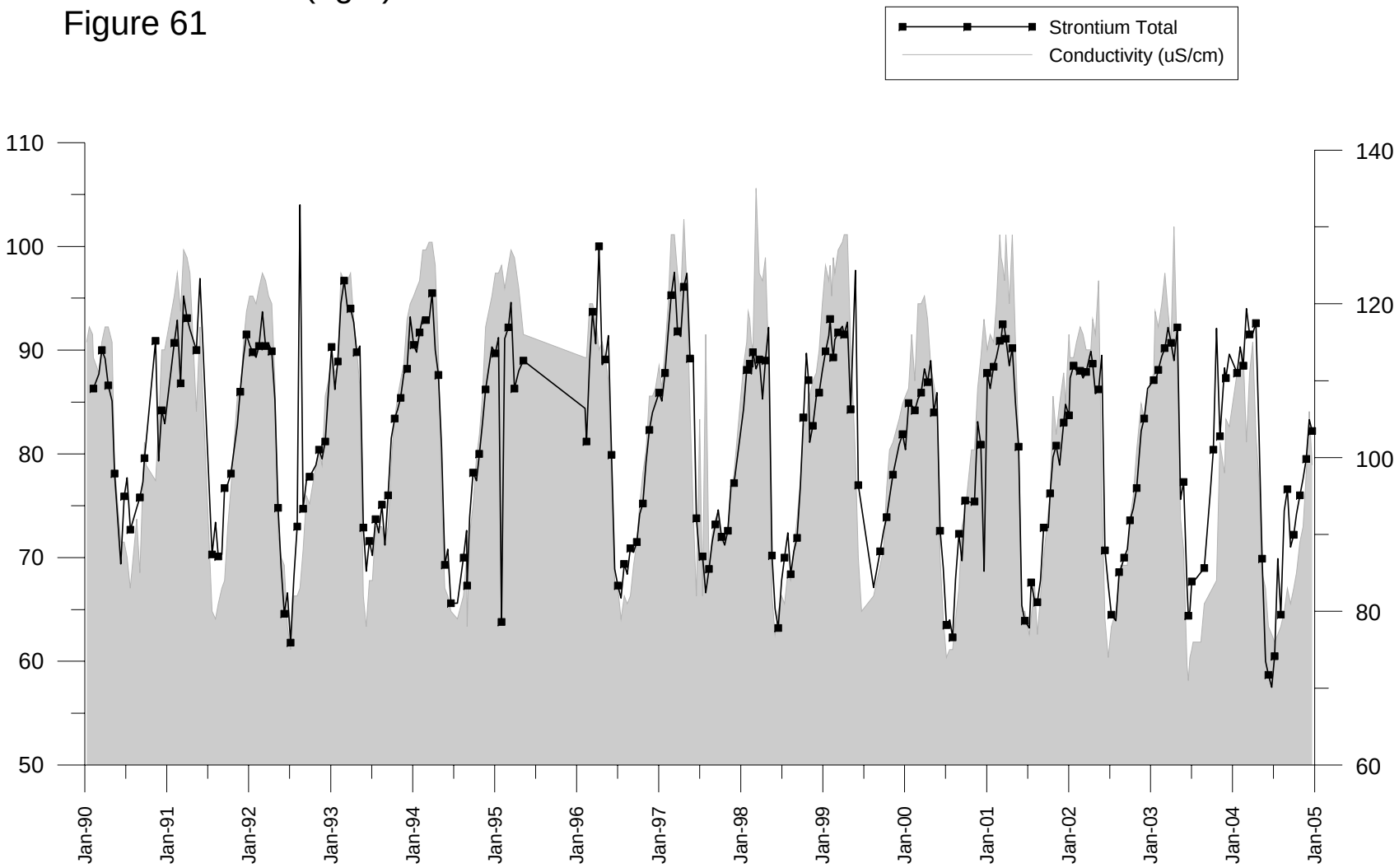
Figure 60



# Thompson River at Spences Bridge

Strontium Total (ug/L)

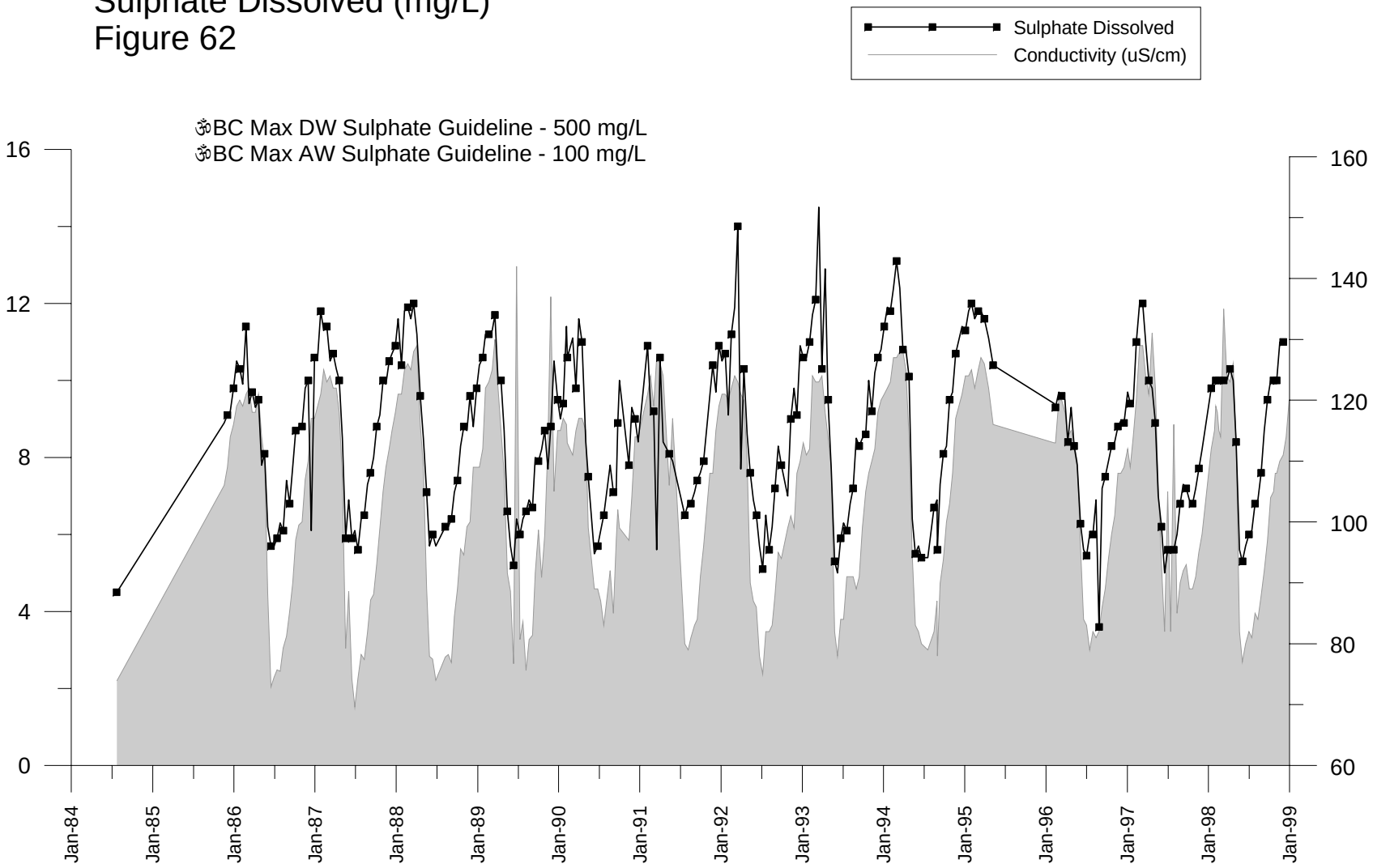
Figure 61



# Thompson River at Spences Bridge

## Sulphate Dissolved (mg/L)

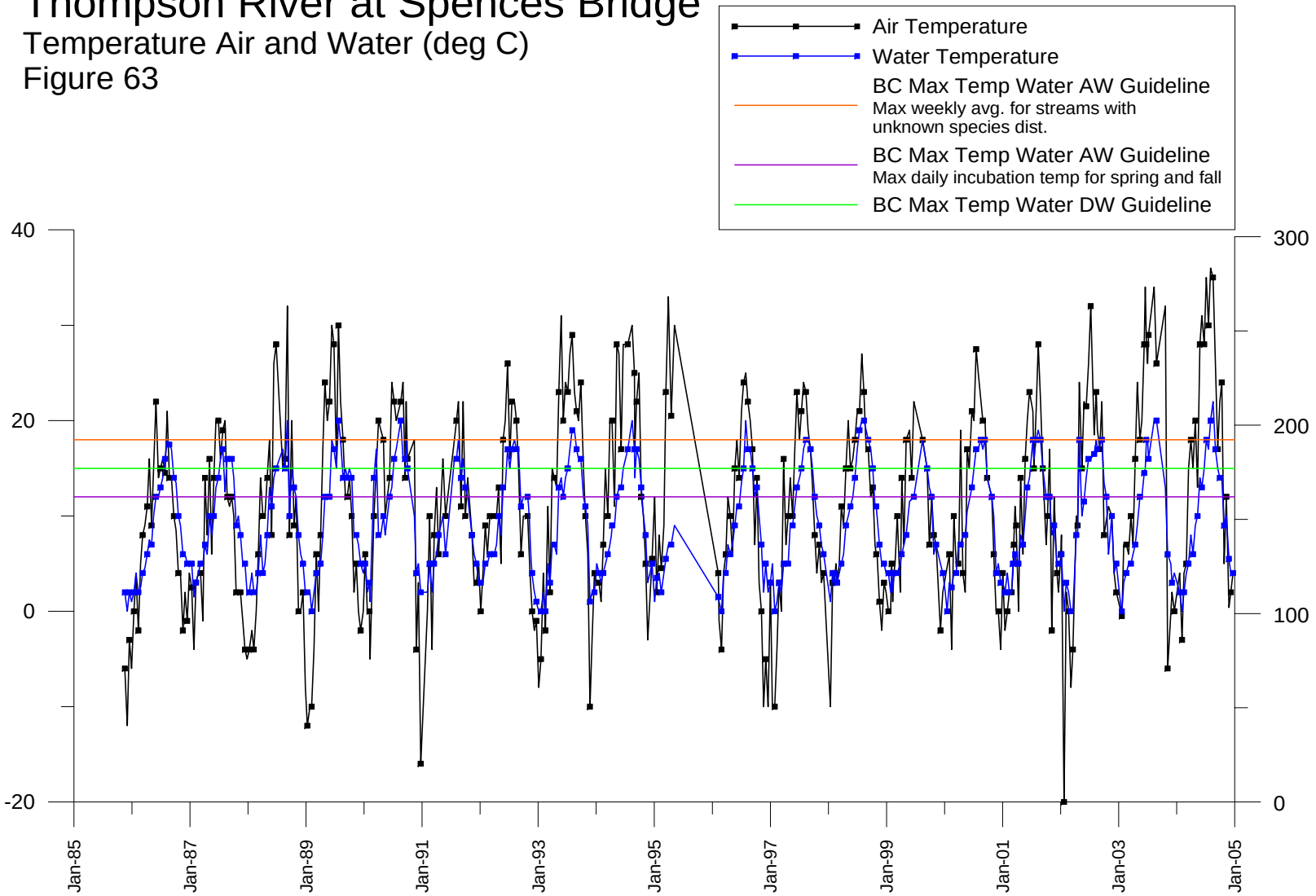
Figure 62



# Thompson River at Spences Bridge

Temperature Air and Water (deg C)

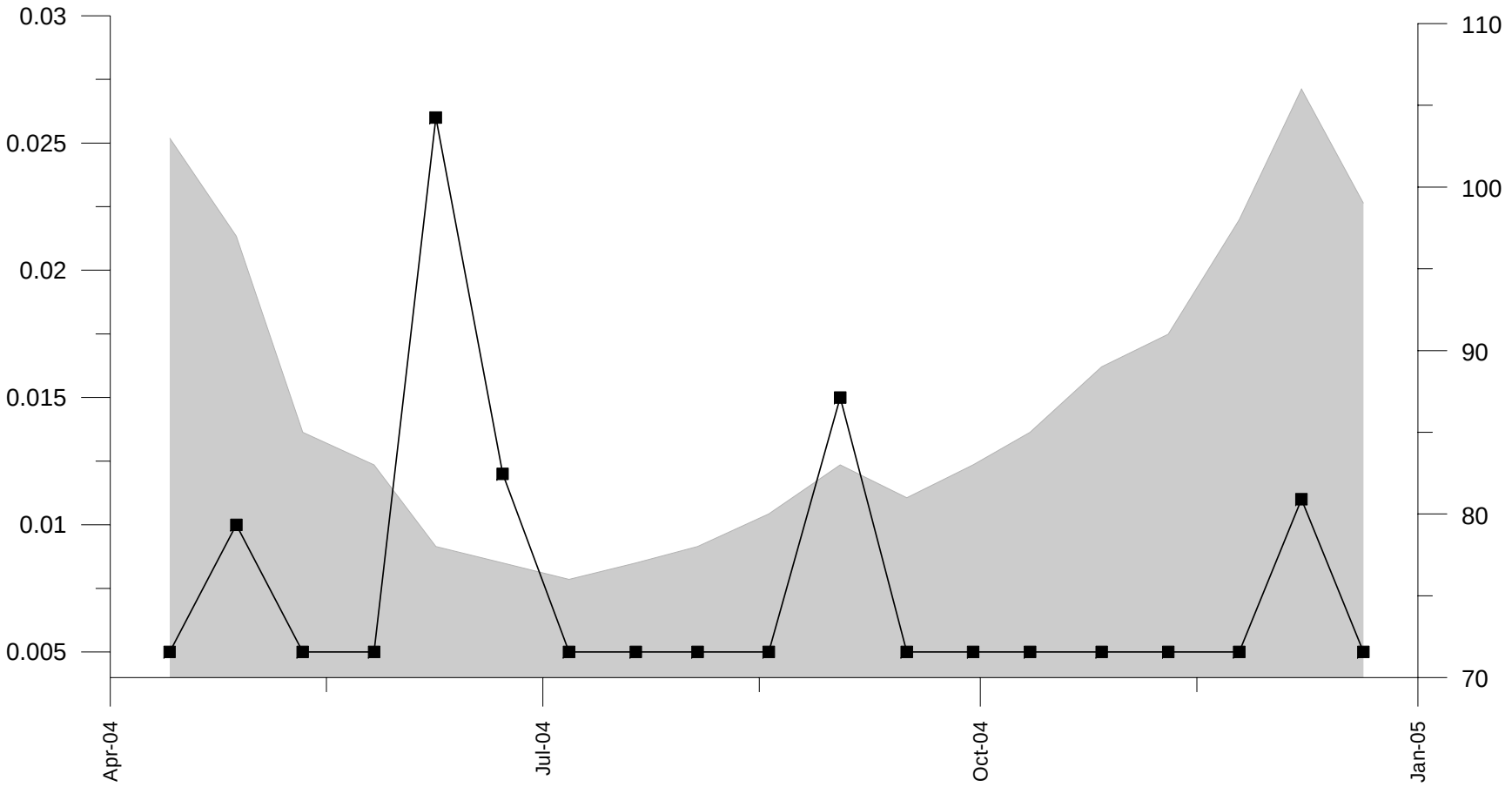
Figure 63



# Thompson River at Spences Bridge

Tin Total (ug/L)

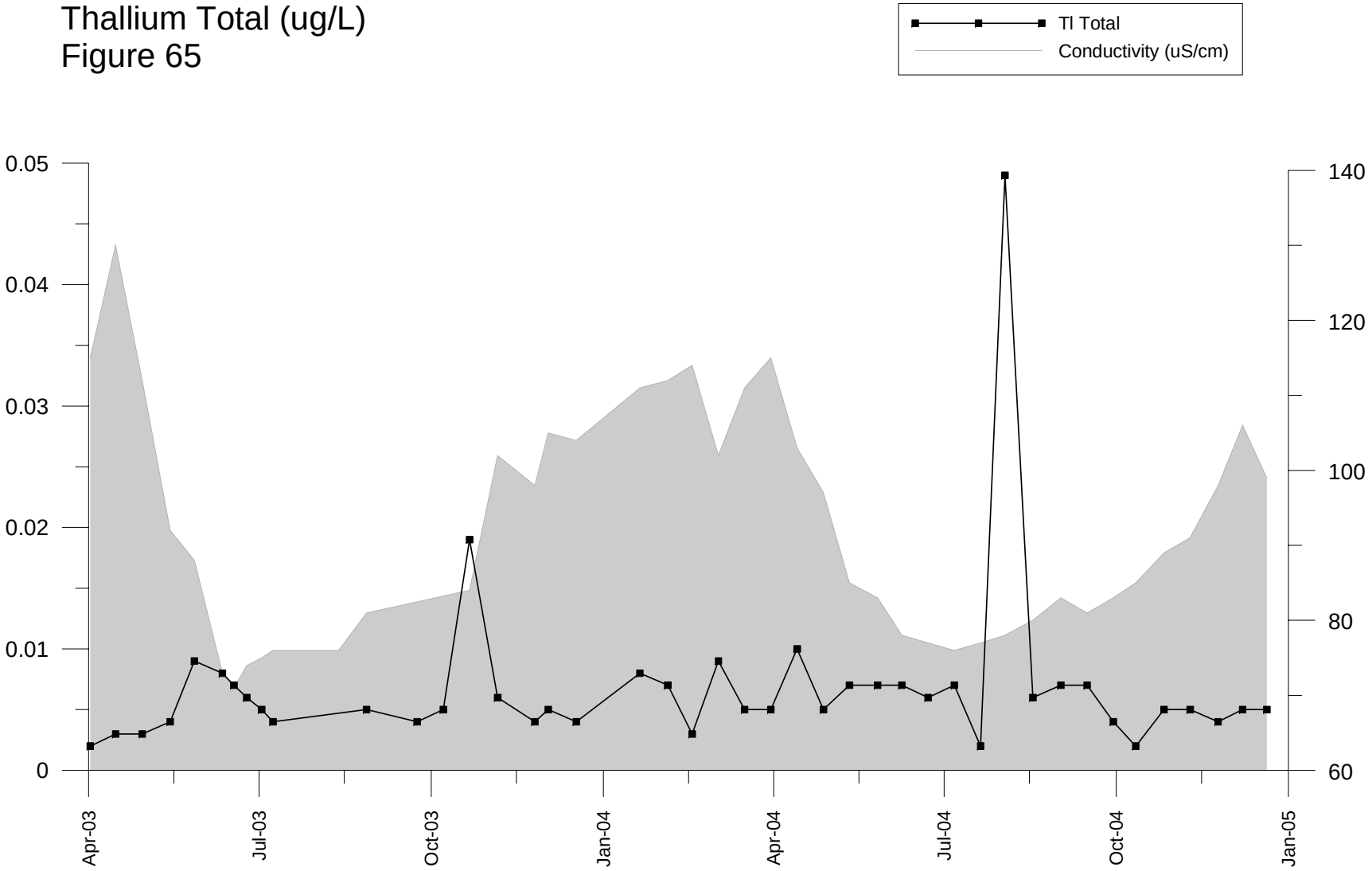
Figure 64



# Thompson River at Spences Bridge

## Thallium Total (ug/L)

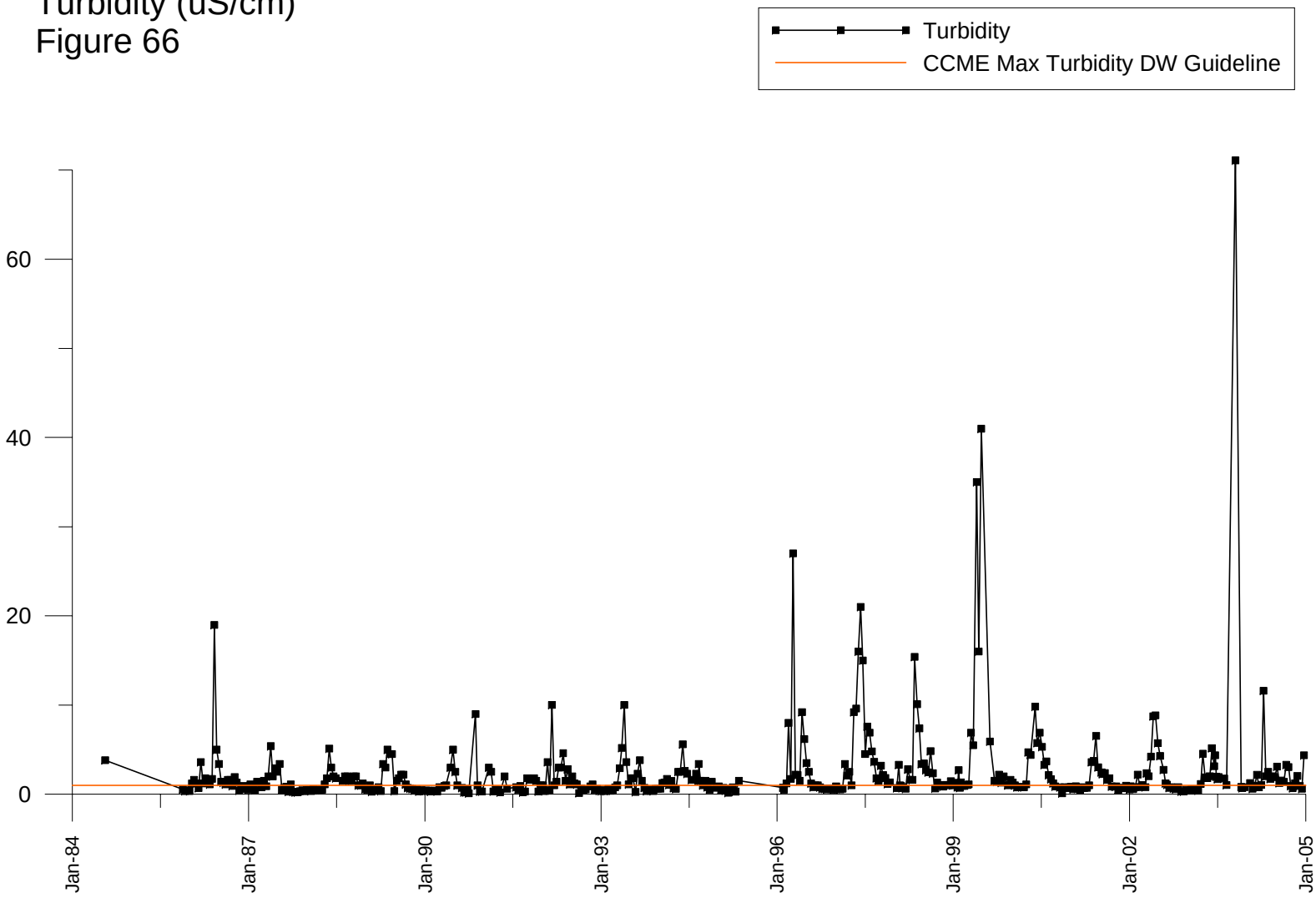
Figure 65



# Thompson River at Spences Bridge

Turbidity (uS/cm)

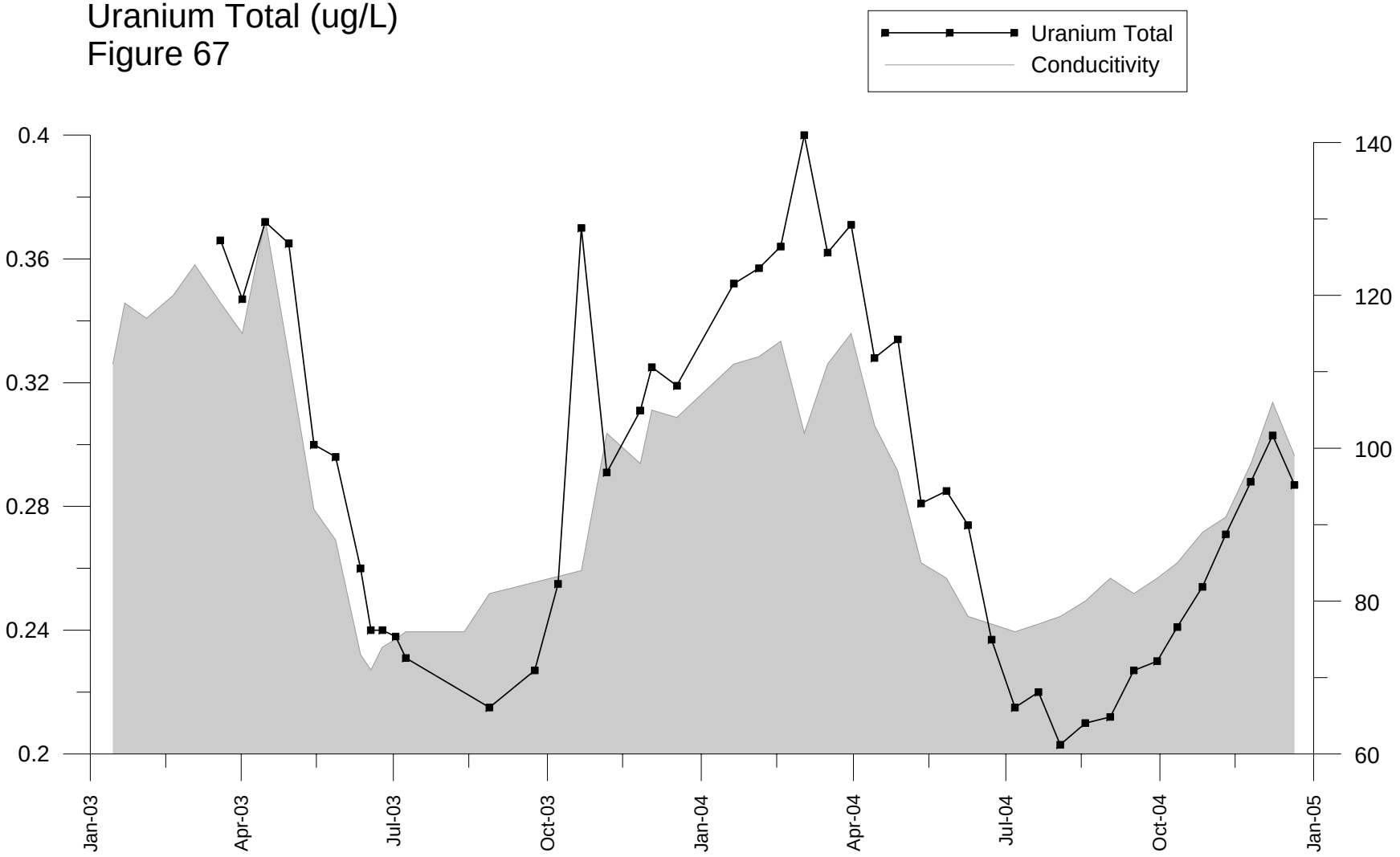
Figure 66



# Thompson River at Spences Bridge

Uranium Total (ug/L)

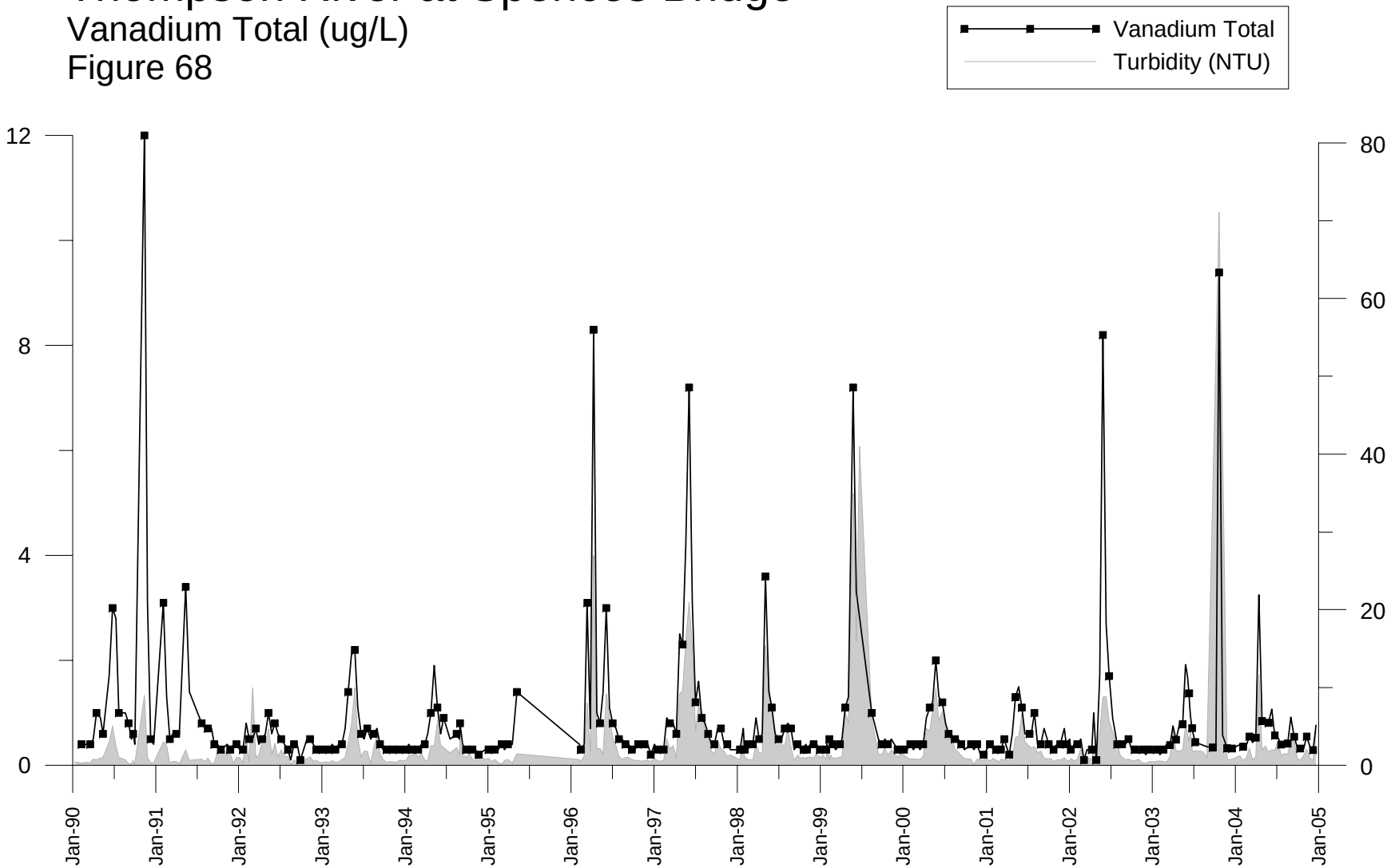
Figure 67



# Thompson River at Spences Bridge

Vanadium Total (ug/L)

Figure 68



# Thompson River at Spences Bridge

## Zinc Total (ug/L)

## Figure 69