CANADA – BRITISH COLUMBIA
WATER QUALITY MONITORING AGREEMENT

WATER QUALITY ASSESSMENT OF Fraser River AT HANSARD (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 Fraser River flows through a vast portion of the southern half of British Columbia, from the Rocky Mountains to the Pacific Ocean. The water quality monitoring site at Hansard, located on a sparsely populated stretch of the Fraser River northeast from Prince George, is the second of five long-term monitoring stations on the Fraser River. Of the remaining four sites, one is upstream, at Red Pass, and the other three are located downstream, at Stoner, Marguerite, and Hope. Water quality indicators measured at this site are compared with those at the nearest upstream site, located at Red Pass.

The water in this reach of the river is used for drinking, irrigation, recreation and industry, and sustains significant fish and wildlife resources. The Fraser River from Tete Jaune Cache to Greater Vancouver has been designated a B.C. and Canadian Heritage River. Human activities occurring upstream from this site that could impact water quality include the Yellowhead Highway and the Canadian National Railway, which run alongside the river most of the way from the headwaters to Hansard, forestry, mining, and agricultural activities, as well as the discharge of treated municipal effluent from McBride. The water quality trends identified below have not yet been confirmed by statistical analysis.

CONCLUSIONS

- Flows are typical of water bodies in the plateau area of British Columbia, with peaks occurring during the Spring through Summer periods and low flows taking place during the winter.
- Several metals had occasional values that exceeded the guidelines for the protection of aquatic life, but also appeared to be correlated with turbidity and were likely not of biological concern. These included aluminum, arsenic, cadmium, chromium, cobalt, copper, iron, silver and zinc.
- Total alkalinity has on one occasion been below the guideline that indicates that there is low sensitivity to acidic inputs.

- Increasing trends through time were not noted for any variables.

- Apparent colour values seem to fluctuate with turbidity and regularly exceeded the drinking water guideline for true colour; however, this is to be expected since true colour is measured on a filtered sample (i.e., turbidity removed). True colour values were lower than apparent colour values, as expected; however, values seem to fluctuate with turbidity and regularly exceeded the drinking water guideline.

- Turbidity levels and fecal coliform concentrations would require that drinking water supplies should as a minimum perform partial treatment of the supply. If this level of treatment is applied, Trihalomethane formation should be minimized in thee finished water.

- Dissolved oxygen levels were generally acceptable; however, some extremes in temperature above guidelines have been recorded. These generally last for only short periods of time.

RECOMMENDATIONS

Monitoring should be continued for the Fraser River at Hansard. It is the control station upstream from the first major population centre (Prince George) and industrial waste discharges (pulp mills) on the Fraser River. Water quality indicators that are important for future monitoring are:

- flow, water temperature, specific conductivity, pH,
- total dissolved phosphorus, total dissolved nitrogen, periphyton chlorophyll-*a*,
- dissolved oxygen, fecal coliforms, adsorbable organic halides (AOX), chloride,
- colour (true and total absorbance), turbidity, hardness, dissolved aluminum, total and dissolved or extractable cobalt, copper, lead, nickel, and zinc.
- Low-level cadmium, hexavalent and trivalent chromium, and silver.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF FIGURES
(CONTINUED)

Page

List of Figures
(Continued)

Page

LIST OF FIGURES
(CONTINUED)

INTRODUCTION

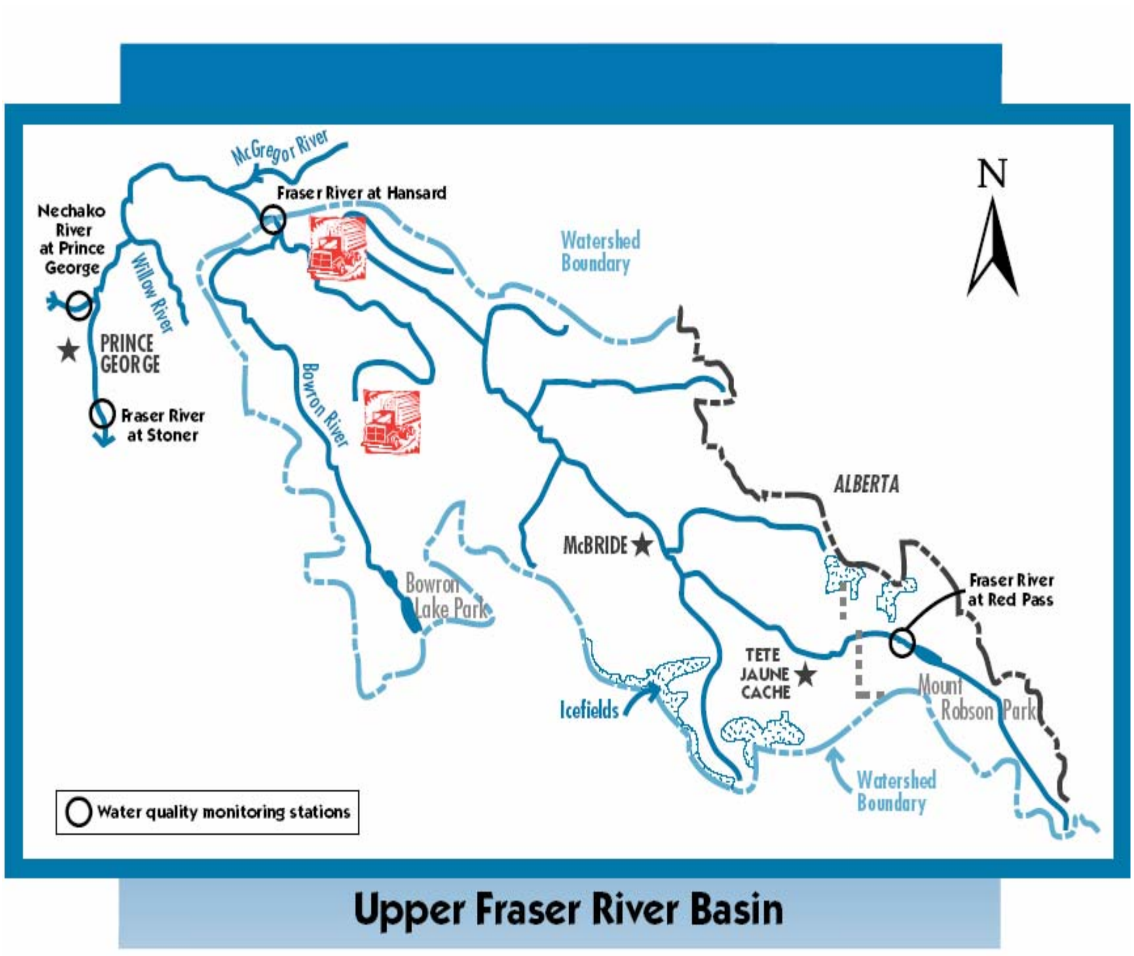
The Fraser River basin is one of British Columbia's most valued ecosystems, draining fully one quarter of the province. Its headwaters are located in the Mount Robson Provincial Park near Moose Lake in the Rocky Mountains. The northern part of the river follows a northwest path before heading south, starting just north from Prince George. The Fraser River then flows 1,200 km before turning to the west, near Hope, and continues for about 150 km before entering the Pacific Ocean at Vancouver. The river has two very important tributaries which affect both flow and water quality. They are the Nechako River, which merges with the Fraser River at Prince George, and the Thompson River, which flows into the Fraser River at Lytton.

There are four long-term federal-provincial water quality monitoring sites on the Fraser River (Fraser River at Red Pass, Hansard, Marguerite, and Hope). Also, there are long-term sites on both the Nechako and Thompson rivers. This report deals with the site on the Fraser River at Hansard (see below). The water quality monitoring site at Hansard, located on a sparsely populated stretch of the Fraser River northeast from Prince George, is the second of four long-term monitoring stations on the Fraser River.

The Fraser River supports commercial and recreational fisheries of all five salmon species, and salmon runs on the Fraser River are among the largest in the world. Forestry, agriculture, and mining activities occur upstream of this water quality monitoring site (Wipperman and Holms, 1996). Also, treated municipal sewage from McBride is discharged into the Fraser River upstream from this site (Swain *et al*., 1997). The drainage area above the site is approximately 18,000 km^2, and there are seven active water licenses between Moose Lake and Hansard. Water uses for this reach include irrigation, domestic consumption, secondary-contact recreation (e.g., boating) and industrial uses, as well as aquatic life and wildlife.

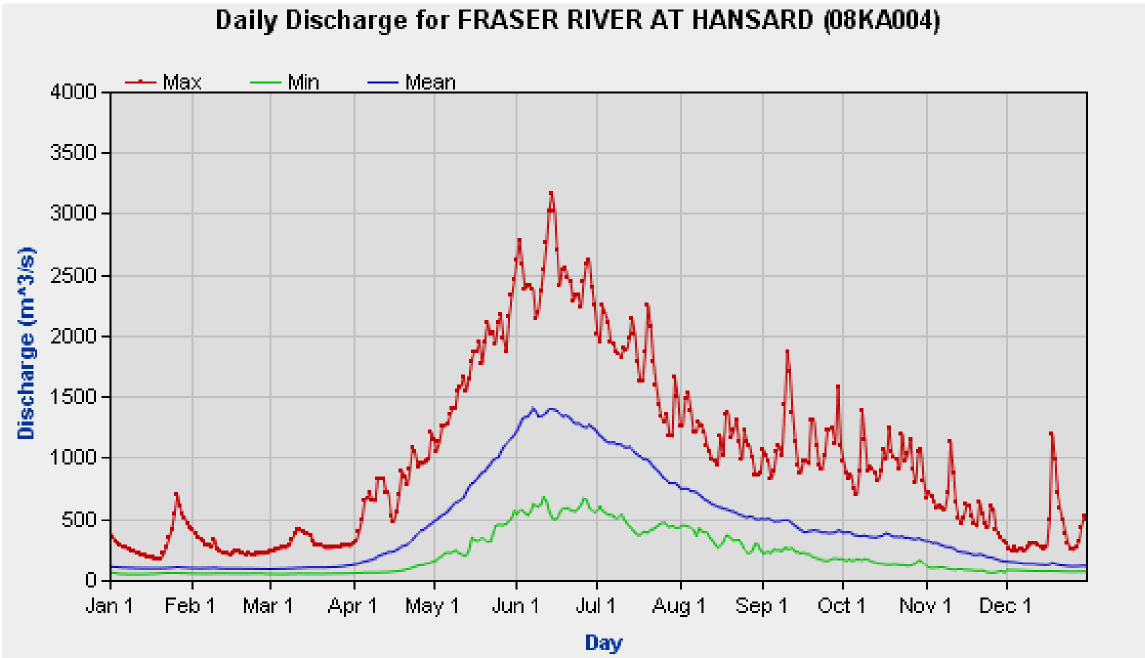
Data for the Fraser River at Hansard have been collected on a frequency of about once every two weeks. As well, twice per year, two additional samples are collected in order to ensure that there are two periods when weekly samples are collected during five consecutive weeks to assess attainment of water quality objectives. In addition, quality assurance samples (blanks and replicates) are collected three times per year.

Upper Fraser River – Fraser River at Hansard



This report assesses twenty-one years (1984 – 2004) of water quality data collected by Environment Canada and B.C Environment. The data are stored in the Environment Canada ENVIRODAT database (station BC08KA0001) and the B.C. Environment EMS database (site E206580), and are available at www.waterquality.ec.gc.ca. Water quality data are plotted in Figures 1 to 69.

Flow data for the Fraser River at Hansard (station no. BC08KA004), collected by the Water Survey of Canada, are plotted below for 1984-2004.



WATER QUALITY ASSESSMENT

The status and trends of various water quality indictors were assessed by plotting the indicators over time and comparing the values to the water quality objectives for this reach of the Fraser River (Swain *et al.* 1997) or 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 watering, are described below in alphabetical order.

Water quality indicators were not discussed if they were in no danger of exceeding water quality objectives or guidelines, had no guidelines or objectives, or showed no harmful trends. These include: AOX, ammonia, antimony, boron, tin, and uranium.

The following water quality indicators seemed to fluctuate through the year according to turbidity concentrations, but were below guideline values and had no other trends: barium, beryllium, bismuth, organic carbon, gallium, lanthanum, lead, lithium, manganese, molybdenum, nickel, total phosphorus, rubidium, fixed non-filterable and non-filterable residue, selenium, silicon, thallium, vanadium, and zinc.

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 included: bromide, dissolved inorganic carbon, calcium, chloride, fluoride, hardness, potassium, magnesium, nitrate/nitrite, dissolved nitrogen, fixed filterable and filterable residue, silica, sodium, strontium, and sulphate.

Aluminum (Figure 2): values (total) exceeded the dissolved aluminum guideline for drinking water. High aluminum concentrations coincided with high turbidity, which means that the aluminum is in particulate form and not likely biologically available.

Alkalinity(Figure 3): values fluctuated with specific conductivity and were generally above the guideline indicating low sensitivity to acidic inputs. Exceptions occurred during 1998 at times of low conductivity in the river. There do not appear to be any trends in the data through time.

Arsenic (Figure 6): values were generally below guidelines and fluctuated with turbidity, meaning that at higher concentrations, arsenic would be in particulate form and not biologically available. Only one value in 1991 exceeded the guideline, likely due to acid vial contamination at that. There do not appear to be any trends in the data.

Carbon (Figures 12 and 13): values on occasion exceeded the guideline to protect drinking water supplies from the formation of trihalomethanes. Values seem to be related to turbidity. There do not appear to be any trends in the data through time.

Cadmium (Figures 15 and 15 (a)): values have exceeded guidelines on occasion, usually when turbidity was high and the cadmium would be in particulate form and not biologically available. Although values appear to be decreasing in recent years, this is an anomaly related to the use of lower detection limits.

Cobalt (Figure 17): values often exceed the guideline for drinking water supplies when turbidity is high. The cobalt would be removed from the water with partial or complete treatment since it is related to particulate matter. There do not appear to be any trends in the data through time.

Colour (Figures 18 - 20): apparent colour (Figure 18) values seem to fluctuate with turbidity and regularly exceeded the drinking water guideline for true colour; however, this is to be expected since true colour is measured on a filtered sample (i.e., turbidity removed). True colour values (Figure 20) were lower than apparent colour values, as expected; however, values seem to fluctuate with turbidity and regularly exceeded the drinking water guideline.

Chromium (Figure 21): values fluctuate with turbidity values, and as a result the guidelines for hexavalent and on occasion trivalent chromium are exceeded during periods of high flow and turbidity. We recommend that either trivalent and hexavalent forms of chromium be measured in the future, or guidelines be developed for total chromium values.

Copper (Figures 22 and 23): values regularly exceed the BC guidelines for 30-d mean concentrations but only on occasion exceed the guideline for maximum concentrations.

As well, values varied in relation to turbidity values, meaning that the higher copper values are likely in particulate form and not biologically available.

Iron (Figure 25): values exceeded the drinking water and aquatic life guideline of 300 μg/L frequently. Iron concentrations vary in relation to turbidity, so that the iron is likely in particulate form and not biologically available.

Fecal coliform (Figure 26): values often exceed the guideline of 10 CFU/100 mL for waters that are disinfected only but have met the level of 100 CFU/100 mL where at least partial treatment is used. Solids concentrations in the river would require a minimum of partial treatment for solids removal prior to use for drinking.

Hardness (Figure 28): values are regularly above or below the range of 80 to 120 mg/L that is ideal for water supplies. Hardness fluctuates with conductivity, which fluctuates with river flow. There does not appear to be a trend in values through time.

Nitrate/Nitrite (Figure 38): Values for the combined form often exceeded the guideline for nitrite alone; however, due to the good oxidation available, the nitrogen would be converted quickly from nitrite to nitrate and would not be a concern in the river (if ever present as nitrite).

Dissolved Oxygen (Figure 43): values are above the guideline for a minimum concentration, except for one value in 1999. Values cycle annually, and appear to be lowest during periods of peak flows and lowest specific conductivity values.

pH (Figure 47): values were below the minimum guideline once in 1995. All other values were within the acceptable ranges for aquatic life and drinking water sources. There was no apparent relationship between specific conductivity values and pH. There was no trend through time for pH.

Silver (Figure 56): values prior to 2003 on occasion exceeded the guideline that is at the former detection level. Since 2003 when detection levels were lowered, no values have exceeded the guideline. Values that were higher seemed to be correlated to higher turbidity values.

Water Temperature (Figure 61): values exceed guidelines regularly, likely during hotter periods of the year. There do not seem to be any adverse effects to aquatic life taking place due to these extremes that are relatively short in duration.

Turbidity (Figure 64): values regularly exceed the guideline for drinking water supplies. Partial treatment as a minimum would be required for solids removal if this water is to be used for a drinking water supply.

Zinc (Figure 68): values on occasion exceed guidelines at times of high turbidity. This means that the zinc is likely in particulate form and not biologically available. There does not appear to be a trend in values through the period of record.

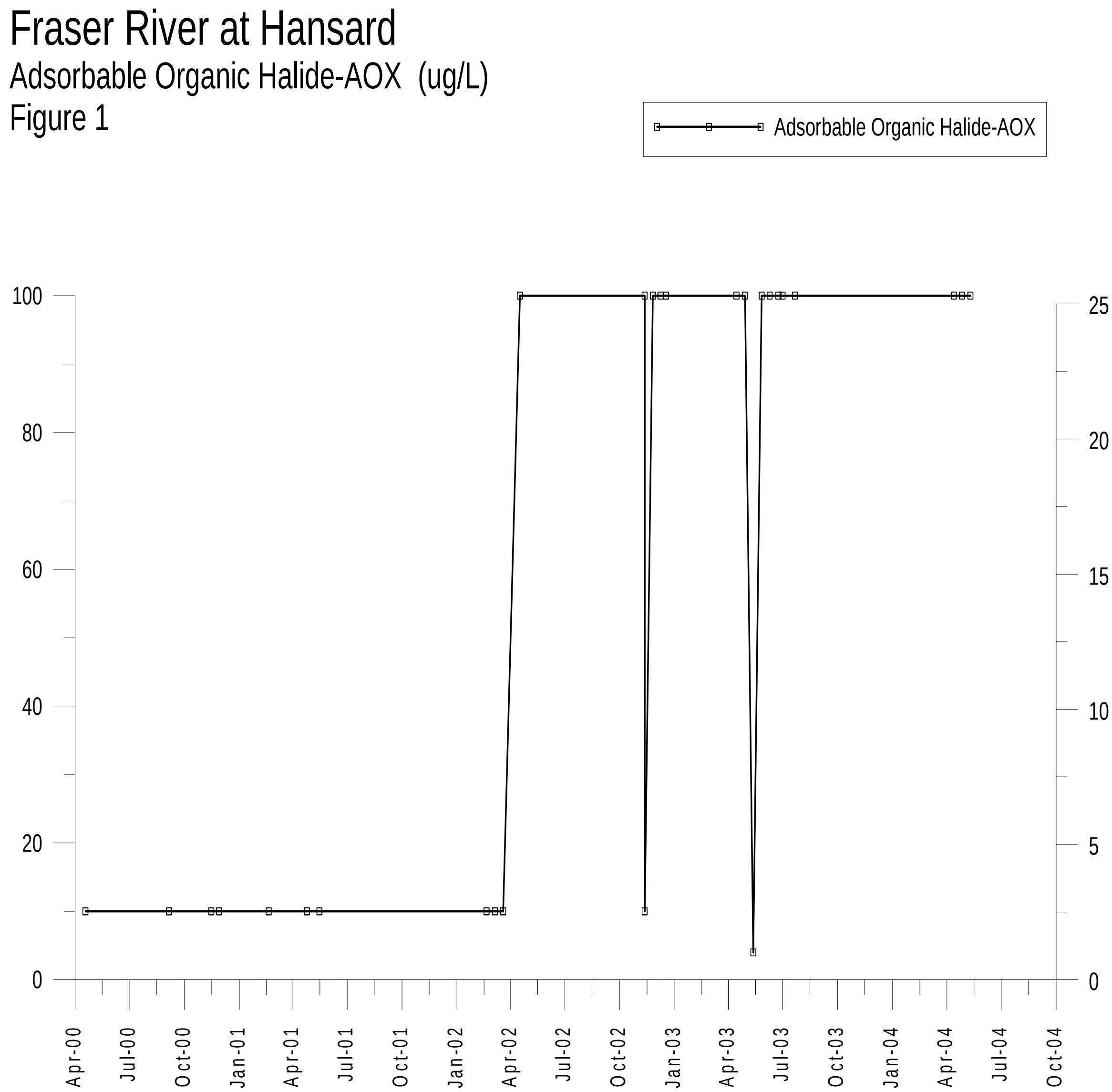
REFERENCES

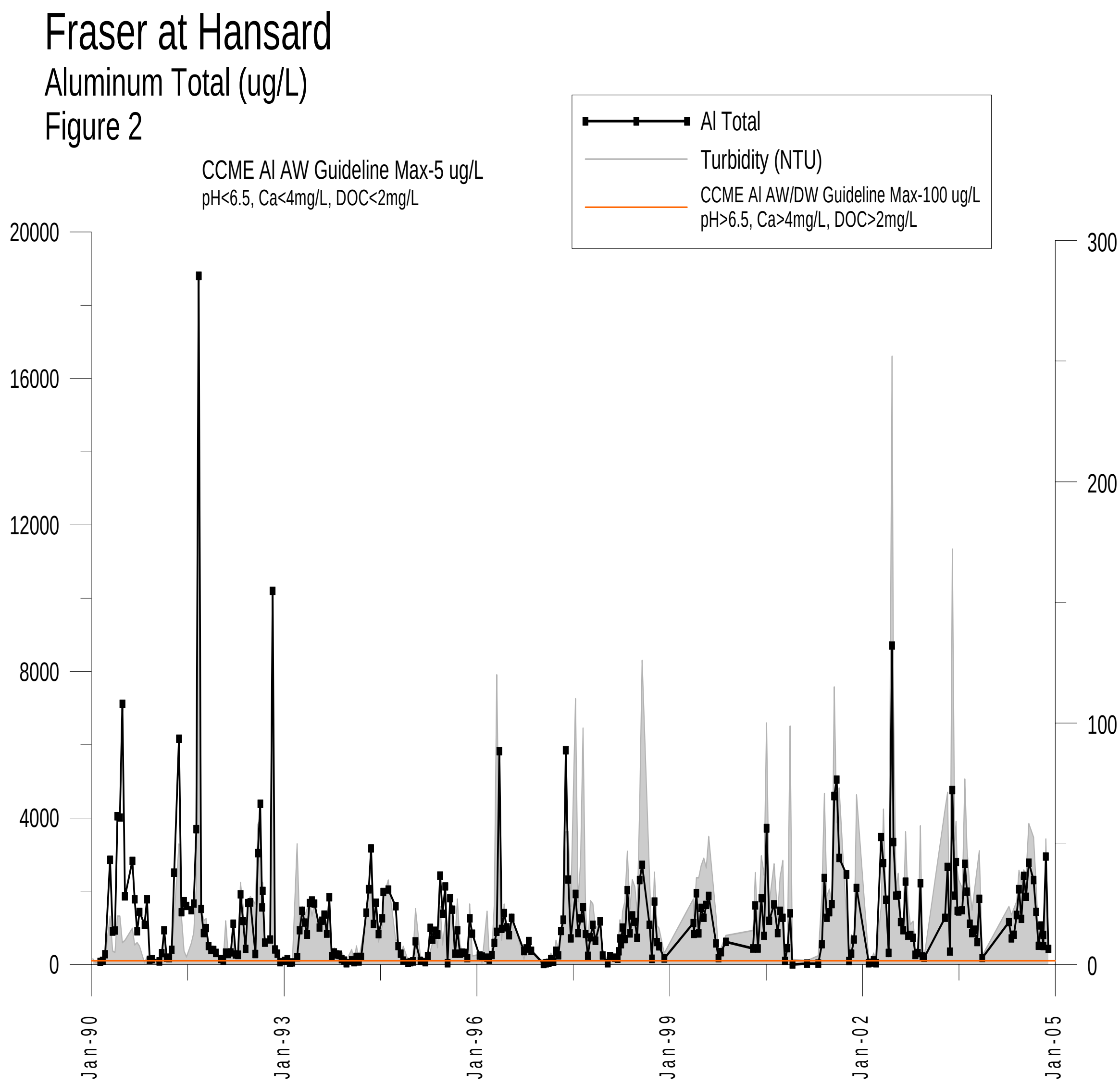
Ministry of Environment, Lands and Parks. 2001a. British Columbia Approved Water Quality Guidelines (Criteria). Water Quality Branch, Environmental Protection Department, Ministry of Environment, Lands and Parks, Victoria, B.C.

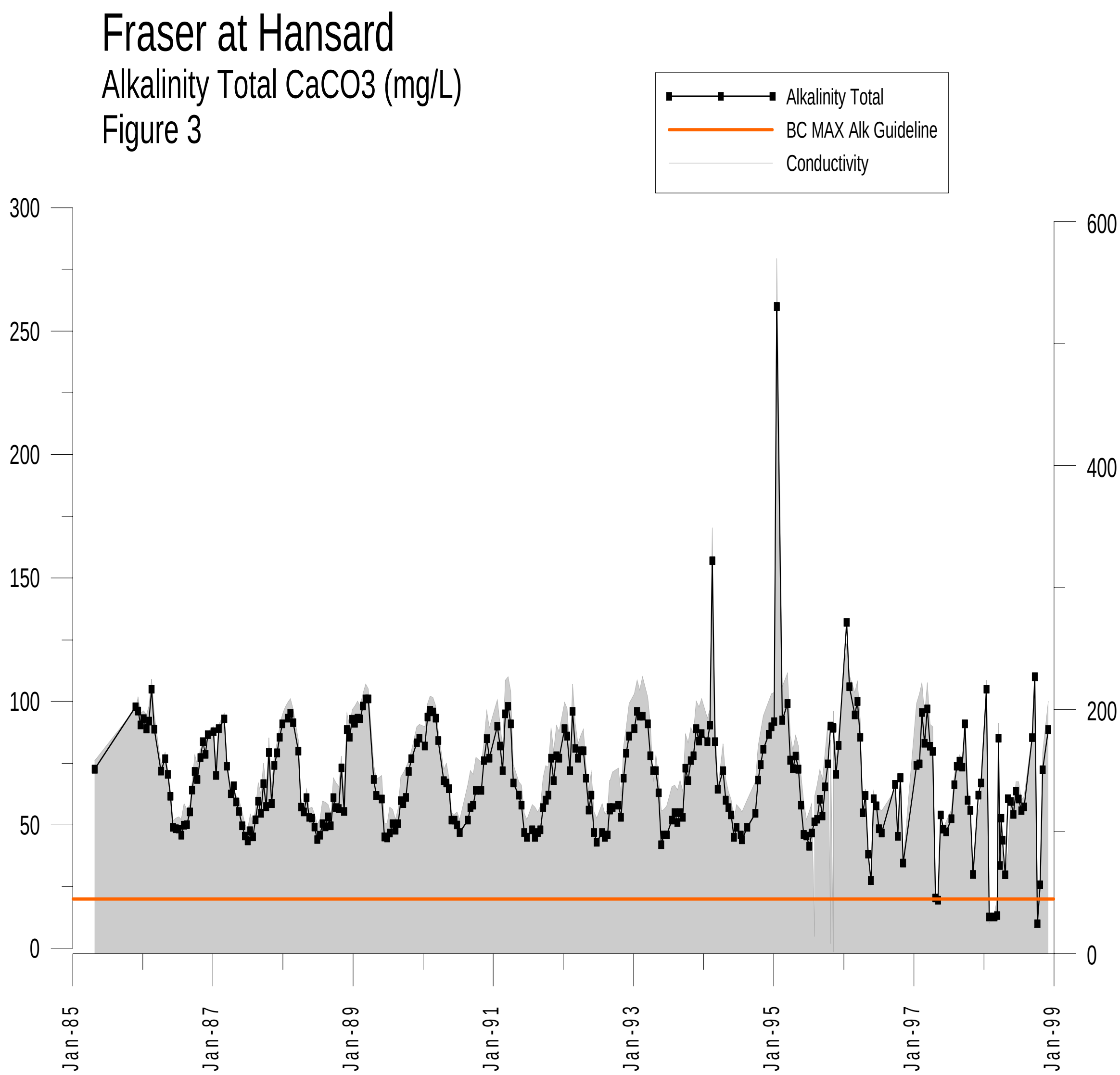
Ministry of Environment, Lands and Parks. 2001b. A Compendium of Working Water Quality Guidelines for British Columbia. Water Quality Branch, Environmental Protection Department, Ministry of Environment, Lands and Parks, Victoria, B.C.

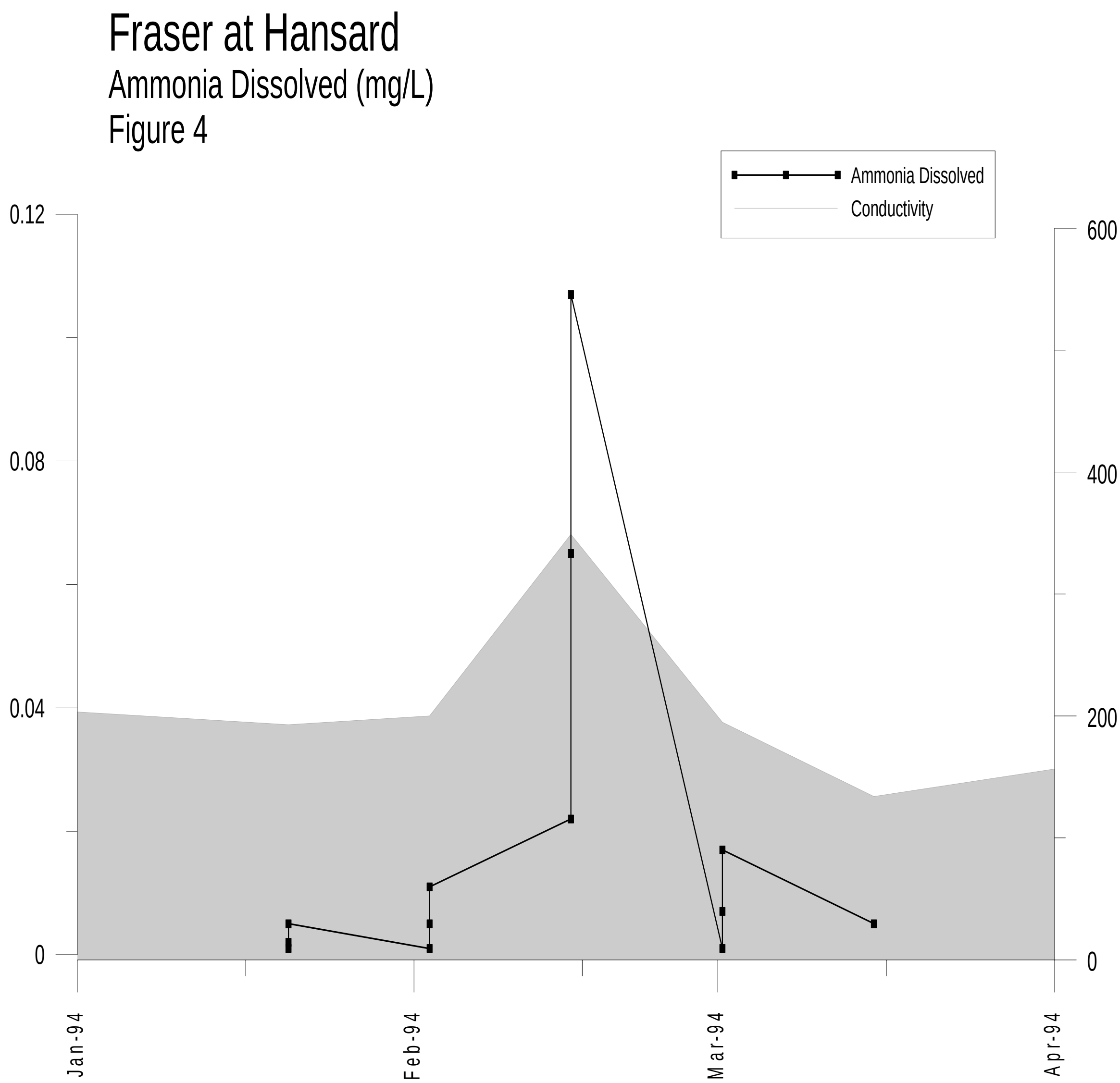
Swain, L.G., D. Walton and W. Obedkof. 1997. Water Quality Assessment and Objectives for the Fraser River from Moose Lake to Hope. Water Quality Branch, Environmental Protection Department, Ministry of Environment, Lands and Parks, Victoria, B.C.

Wipperman, B. and G.B. Holms. 1996. State of Water Quality of Fraser River at Hansard (1984-1995). *Canada - British Columbia Water Quality Monitoring Agreement*. Water Quality Section, Water Management Branch, Ministry of Environment, Lands and Parks, Victoria, B.C.

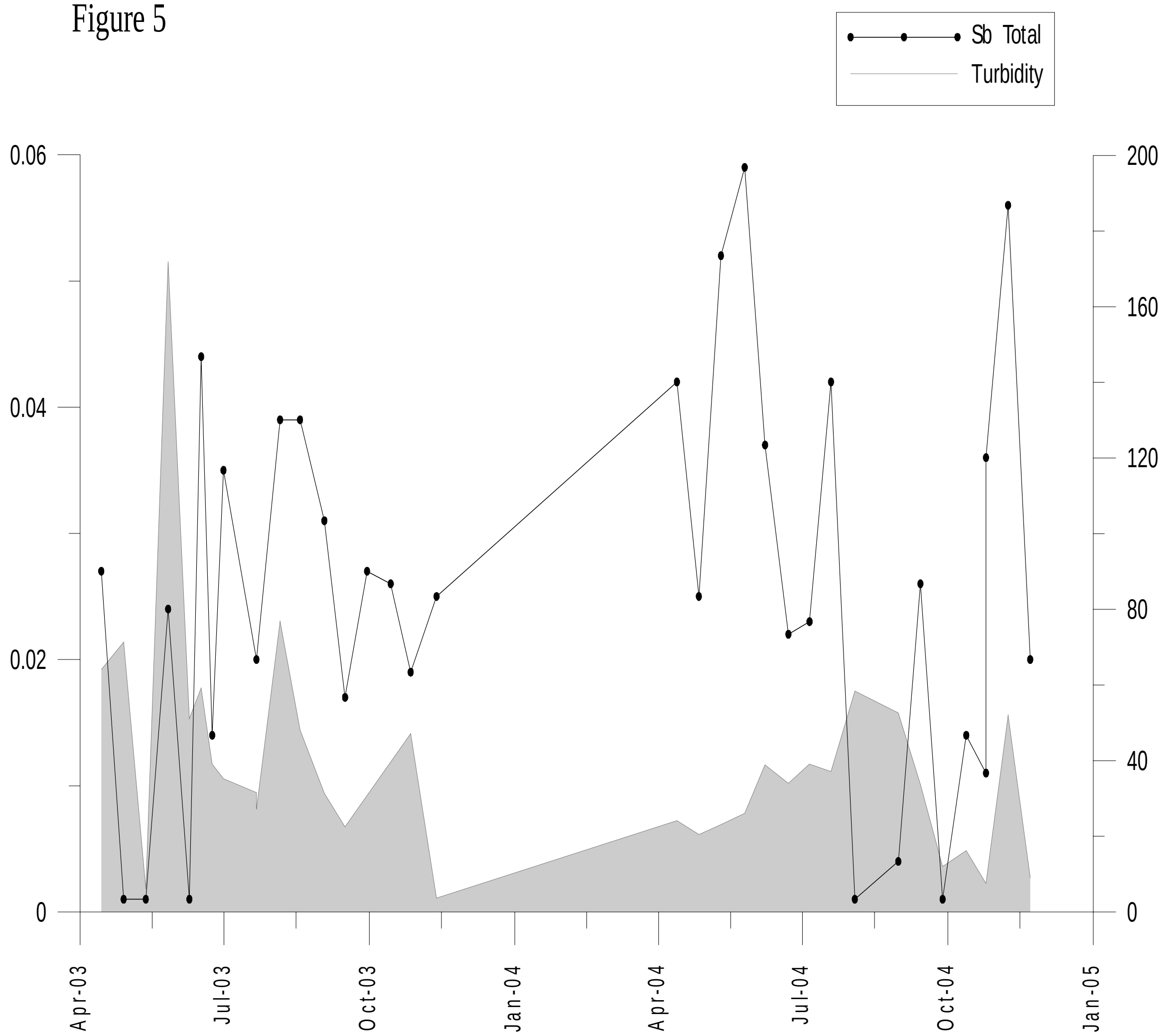

Fraser River at Hansard
Adsorbable Organic Halide-AOX (ug/L)
Figure 1
Adsorbable Organic Halide-AOX
100
80
60
40
20
0
25
20
15
10
5
0
Apr-00
Jul-00
Oct-00
Jan-01
Apr-01
Jul-01
Oct-01
Jan-02
Apr-02
Jul-02
Oct-02
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04

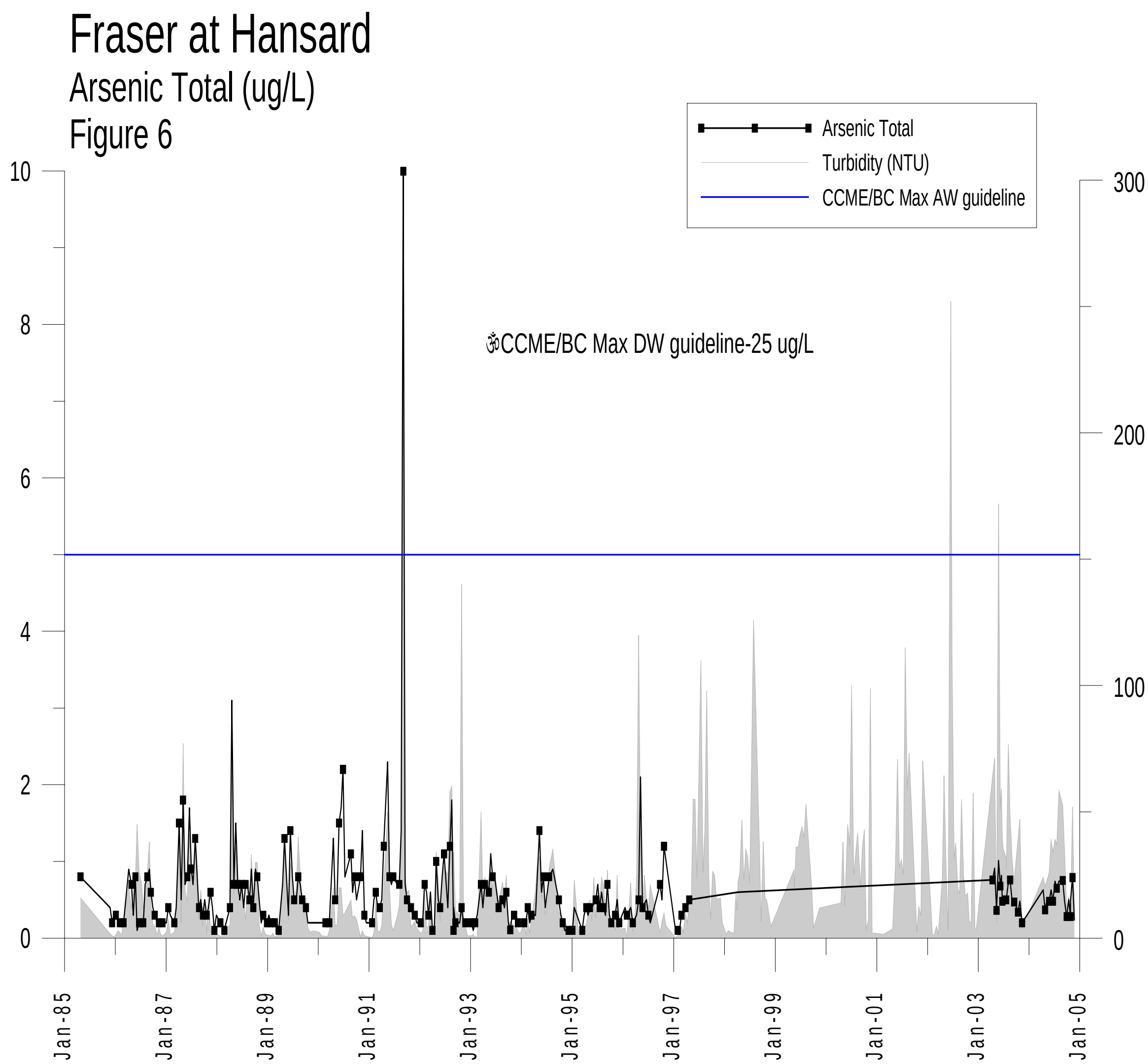

Fraser at Hansard
Aluminum Total (ug/L)
Figure 2
CCME Al AW Guideline Max-5 ug/L
pH<6.5, Ca<4mg/L, DOC<2mg/L
Al Total
Turbidity (NTU)
CCME Al AW/DW Guideline Max-100 ug/L
pH>6.5, Ca>4mg/L, DOC>2mg/L
20000
16000
12000
8000
4000
0
300
200
100
0
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05


Fraser at Hansard
Alkalinity Total CaCO3 (mg/L)
Figure 3
Alkalinity Total
BC MAX Alk Guideline
Conductivity
300
250
200
150
100
50
0
600
400
200
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99


Fraser at Hansard
Ammonia Dissolved (mg/L)
Figure 4
Ammonia Dissolved
Conductivity
0.12
0.08
0.04
0
600
400
200
0
Jan-94
Feb-94
Mar-94
Apr-94

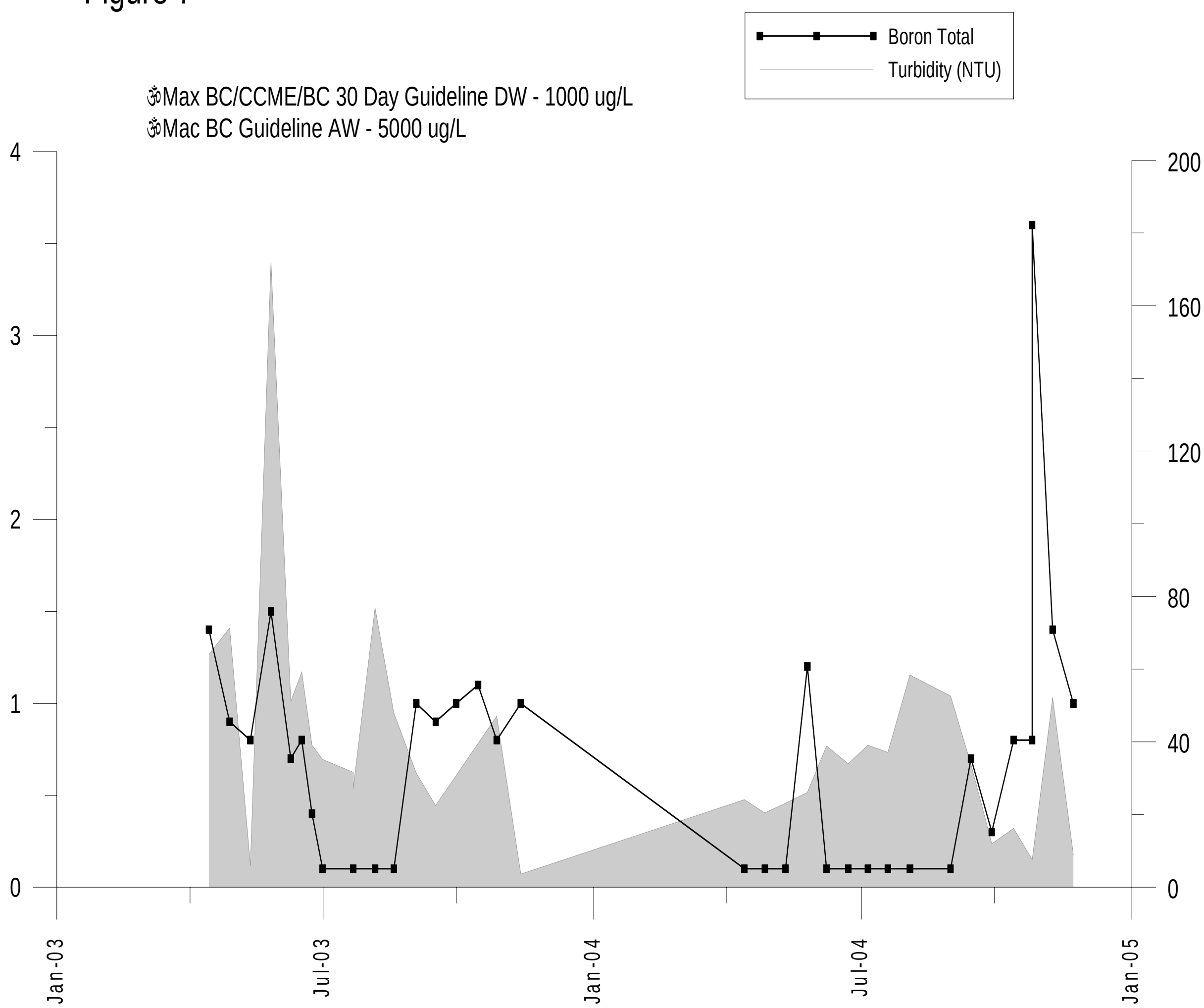
Fraser River at Hansard
Total Antimony (ug/L)
Figure 5

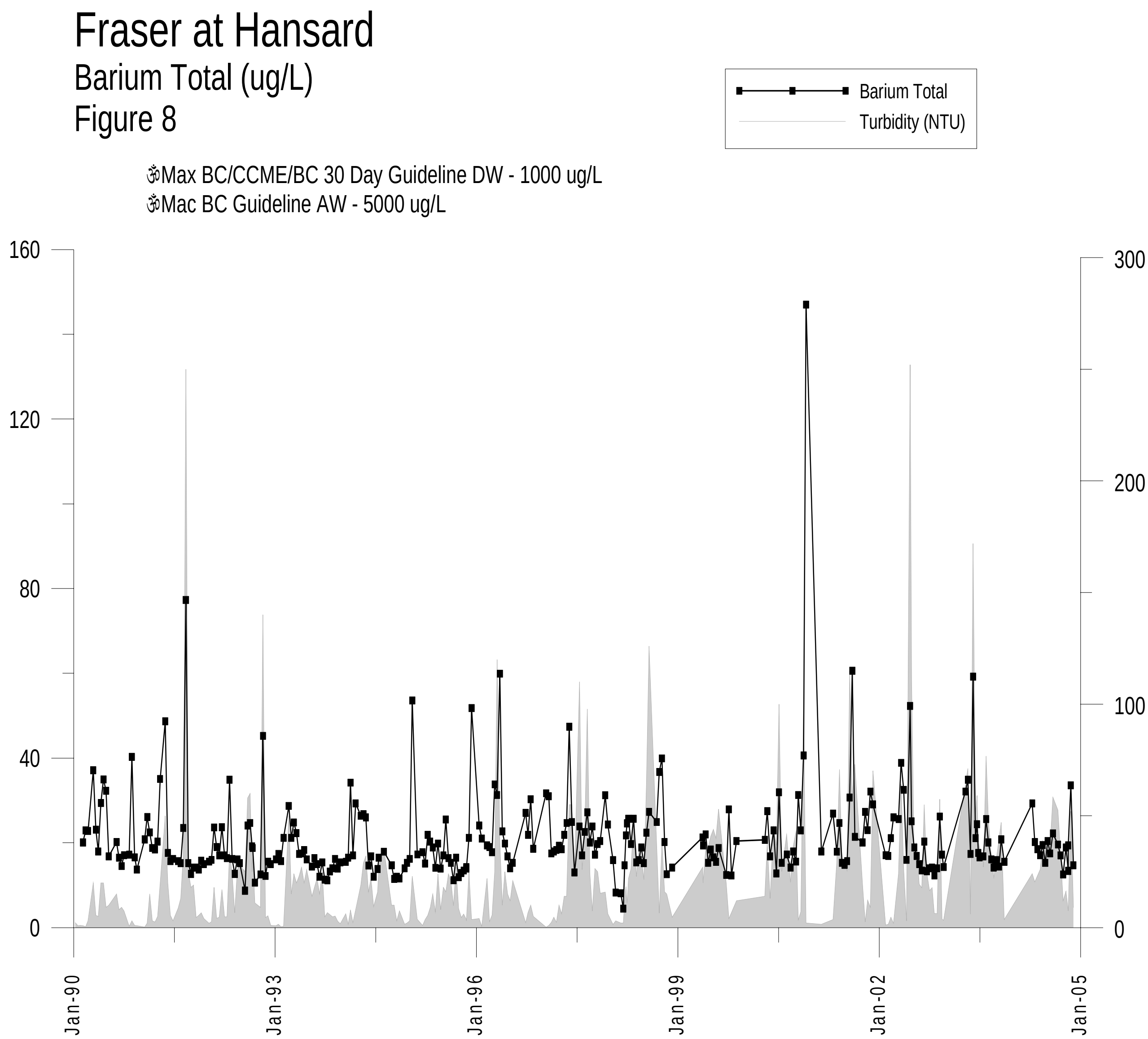


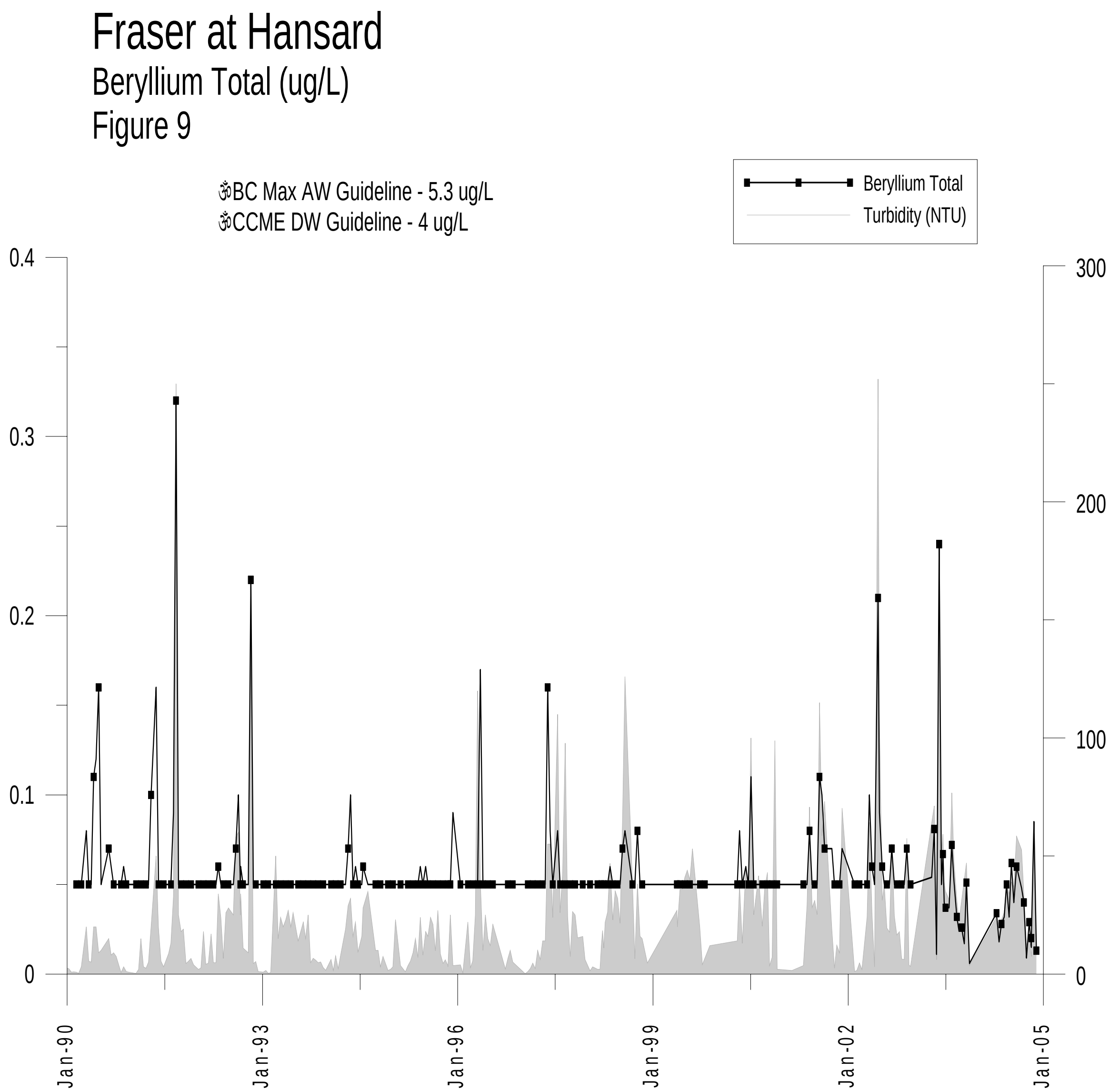


Fraser at Hansard
Arsenic Total (ug/L)
Figure 6
Arsenic Total
Turbidity (NTU)
CCME/BC Max AW guideline
CCME/BC Max DW guideline-25 ug/L
0
2
4
6
8
10
0
100
200
300
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

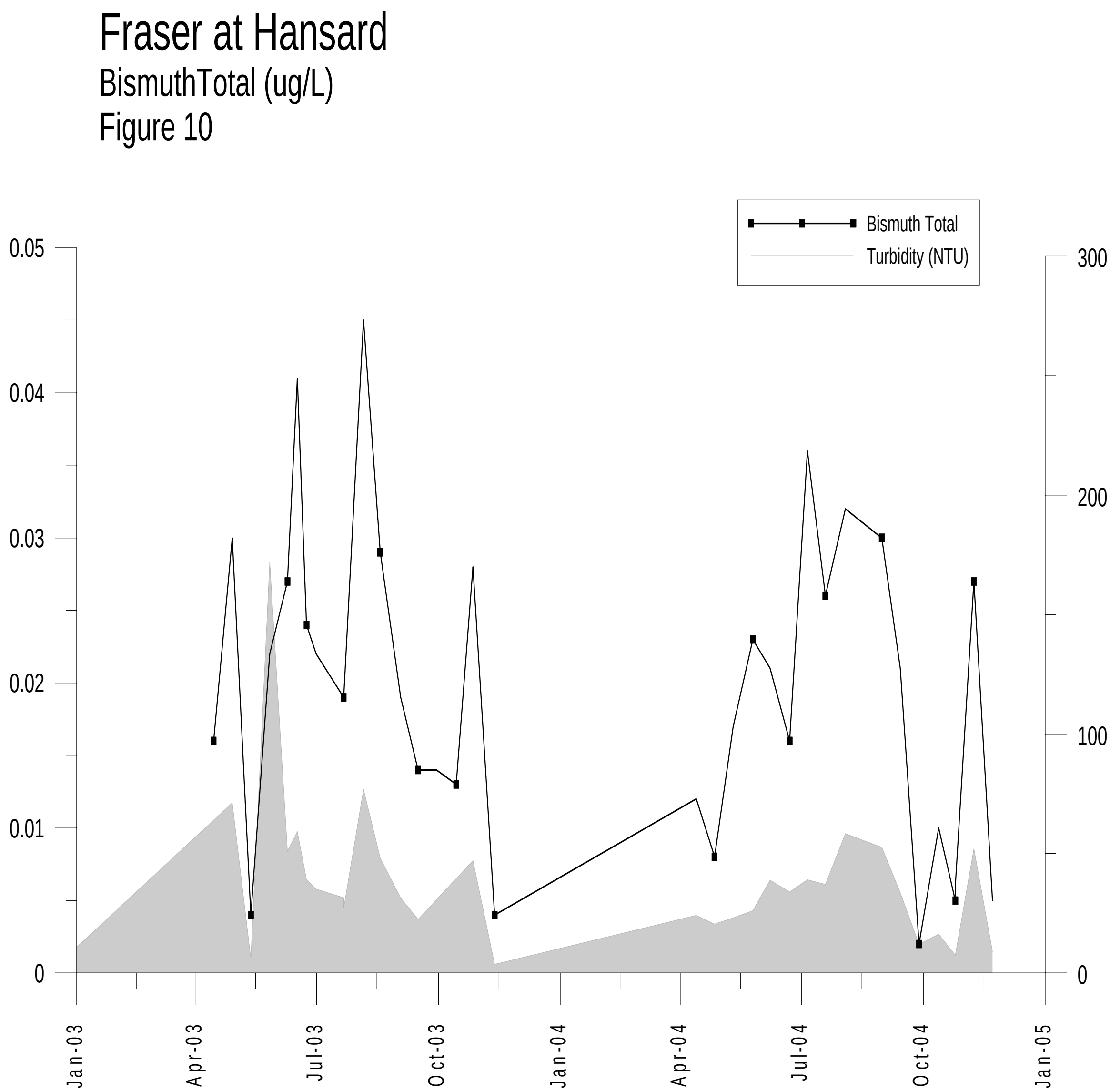
Fraser at Hansard
Boron Total (ug/L)
Figure 7

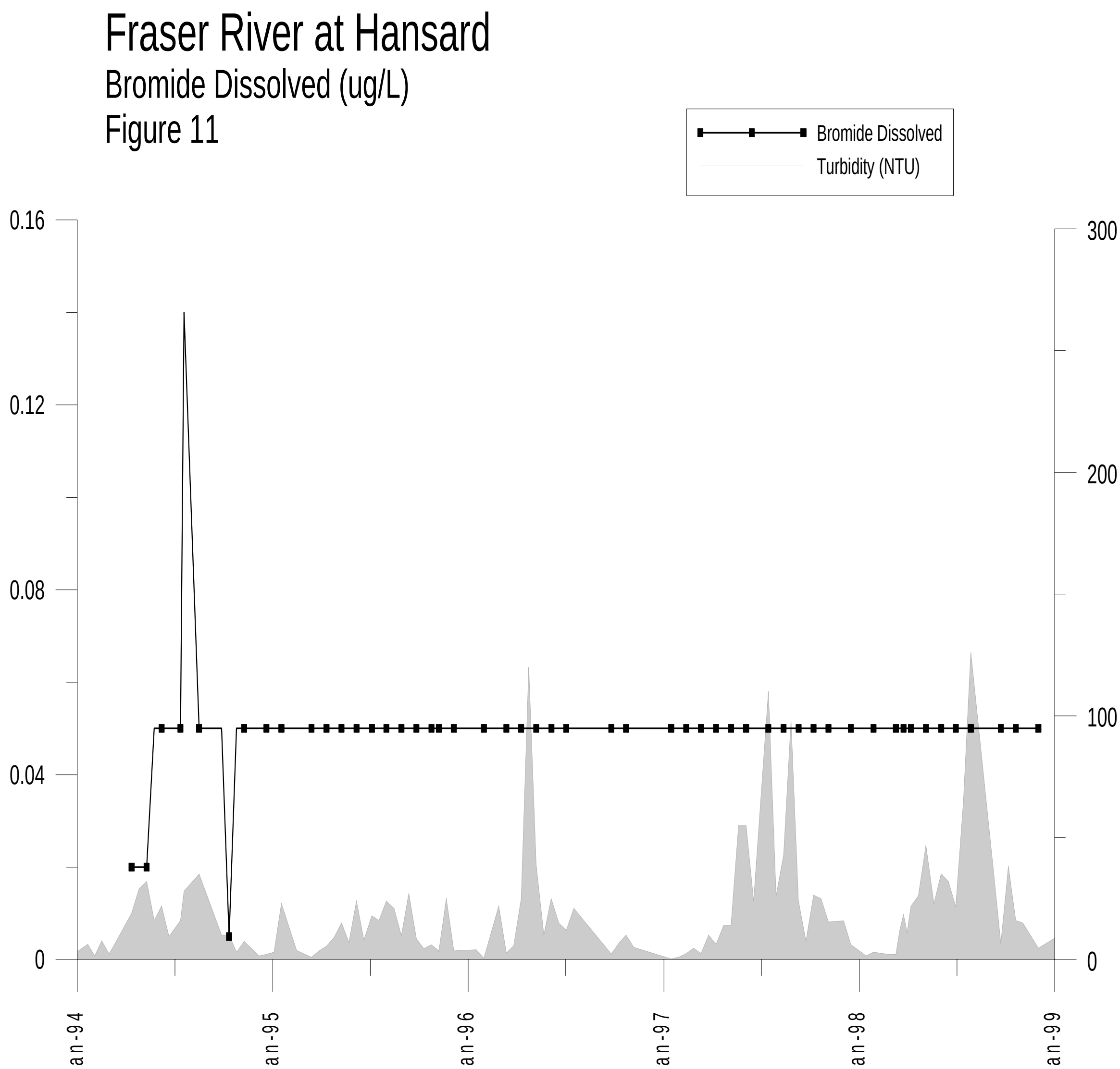


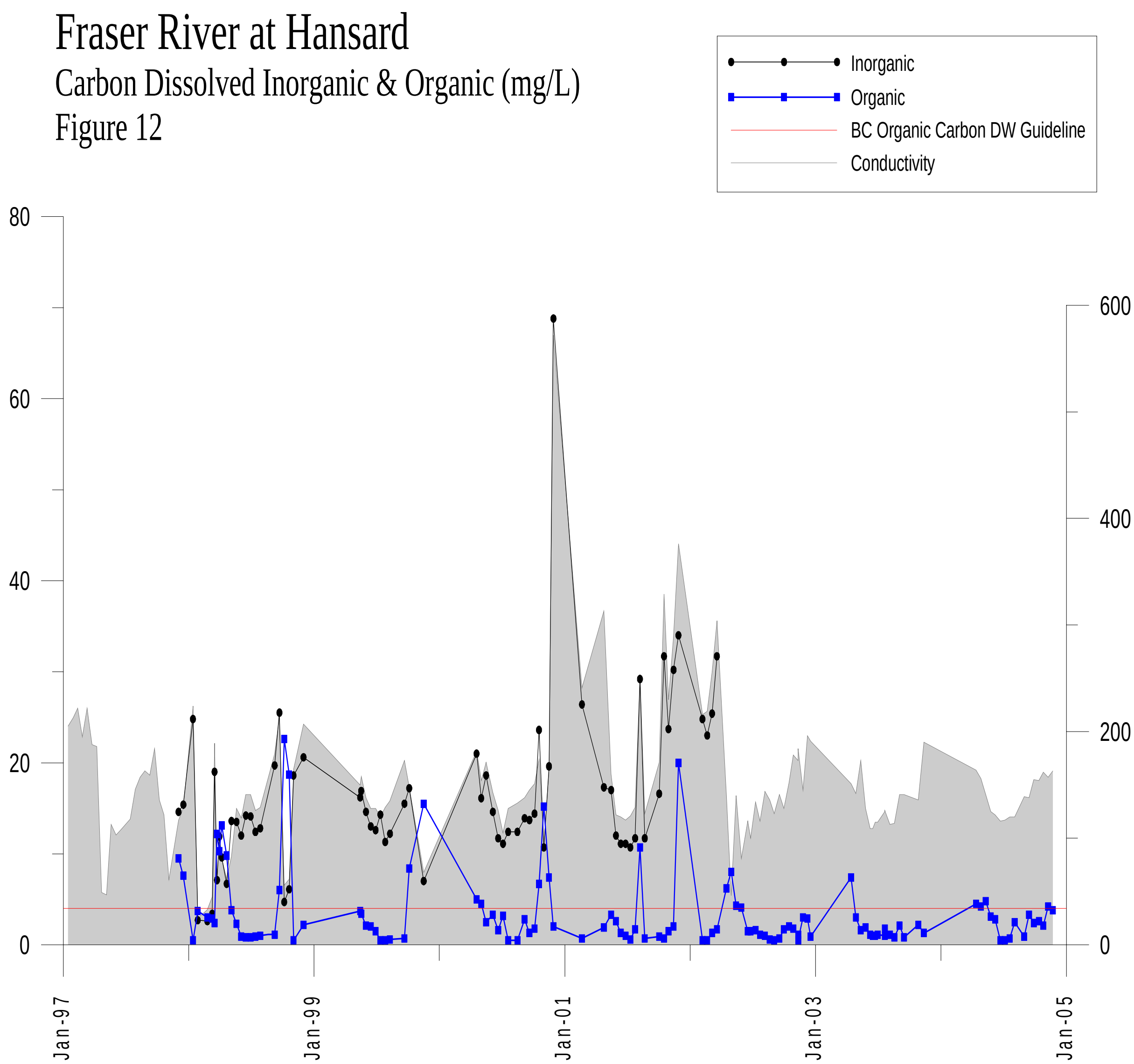

Fraser at Hansard
Barium Total (ug/L)
Figure 8
Barium Total
Turbidity (NTU)
ॐMax BC/CCME/BC 30 Day Guideline DW - 1000 ug/L
ॐMac BC Guideline AW - 5000 ug/L
160
120
80
40
0
300
200
100
0
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05

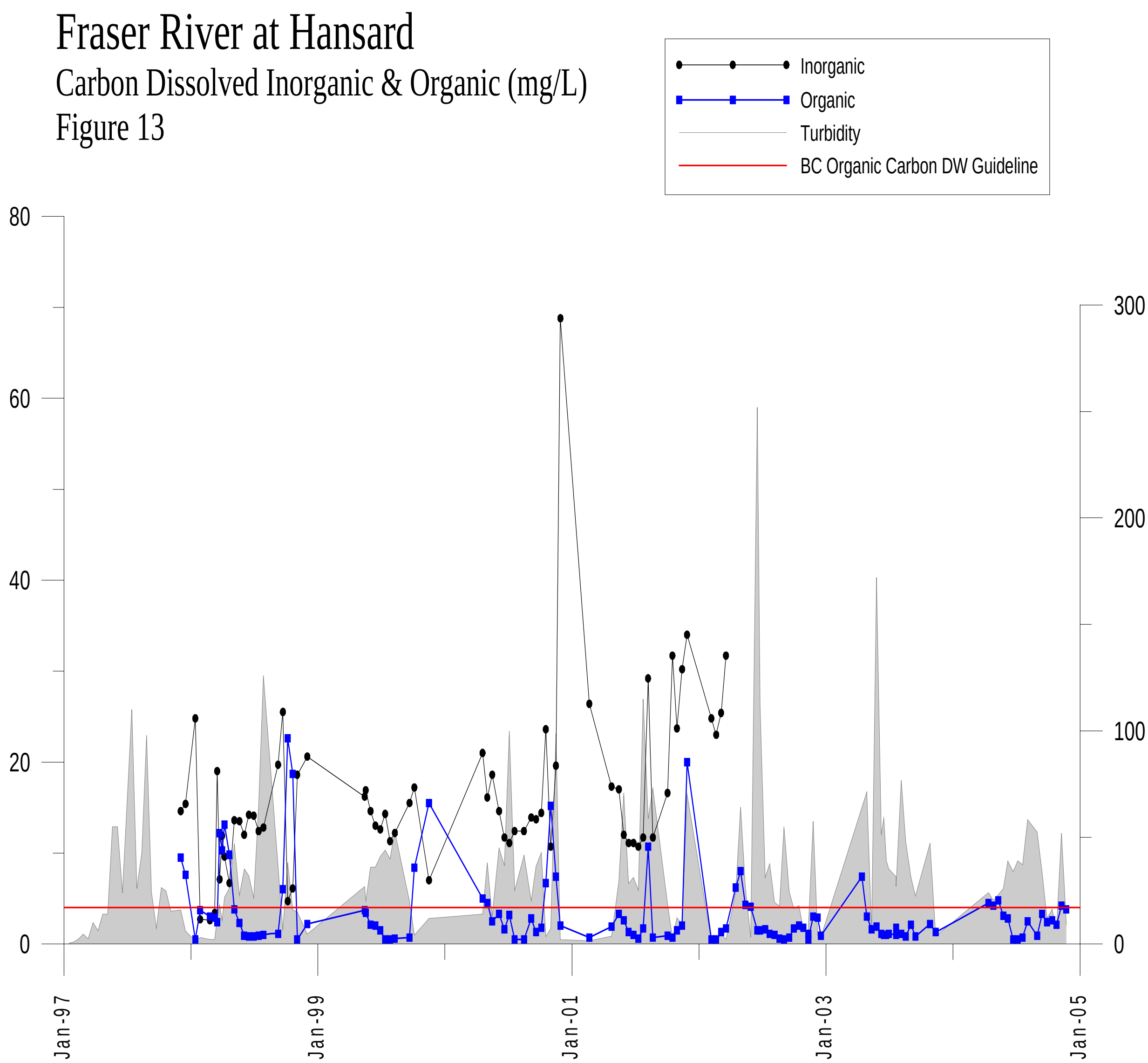


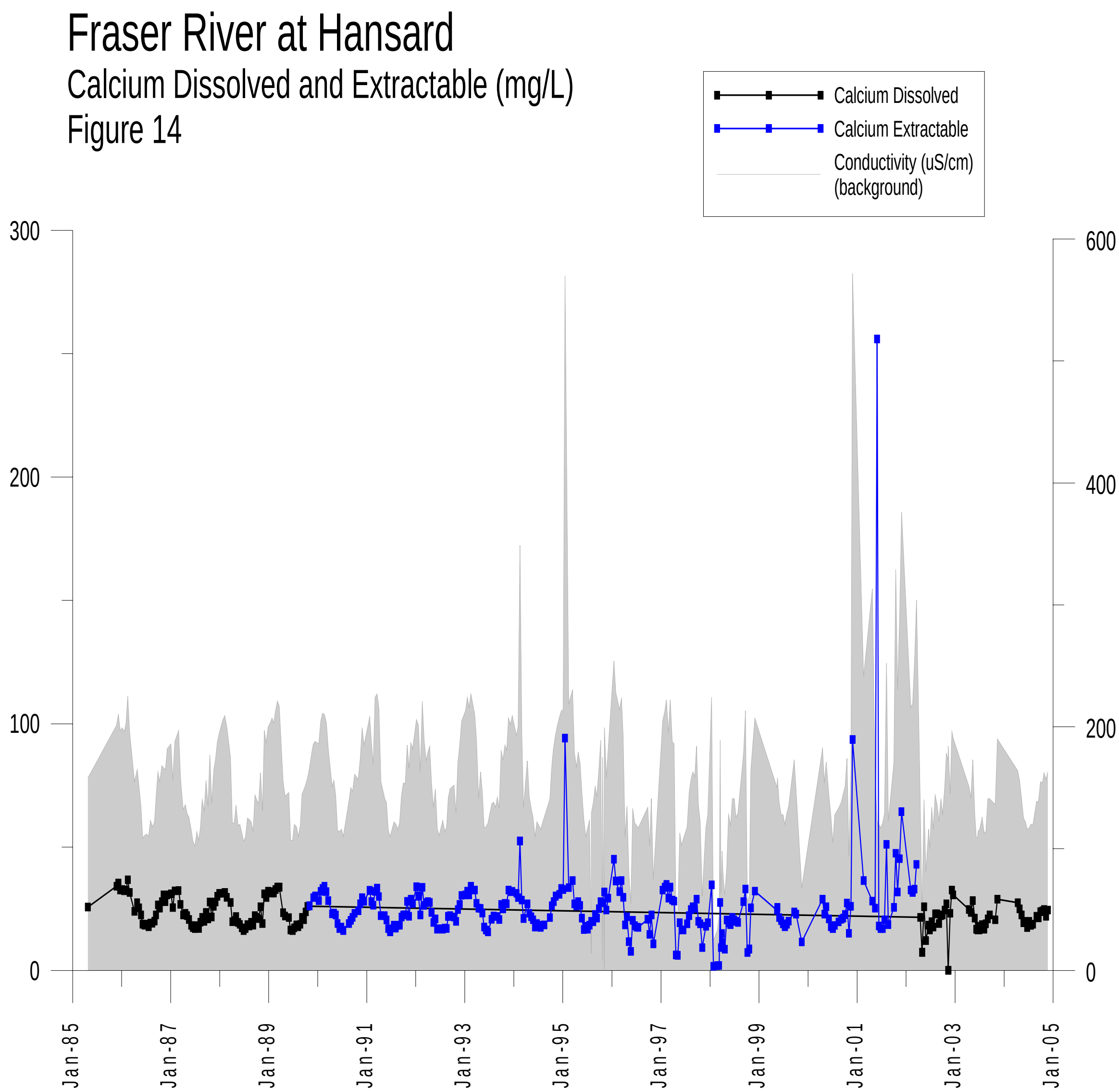
Fraser at Hansard
Beryllium Total (ug/L)
Figure 9
ૐBC Max AW Guideline - 5.3 ug/L
ૐCCME DW Guideline - 4 ug/L
Beryllium Total
Turbidity (NTU)
0.4
0.3
0.2
0.1
0
300
200
100
0
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05

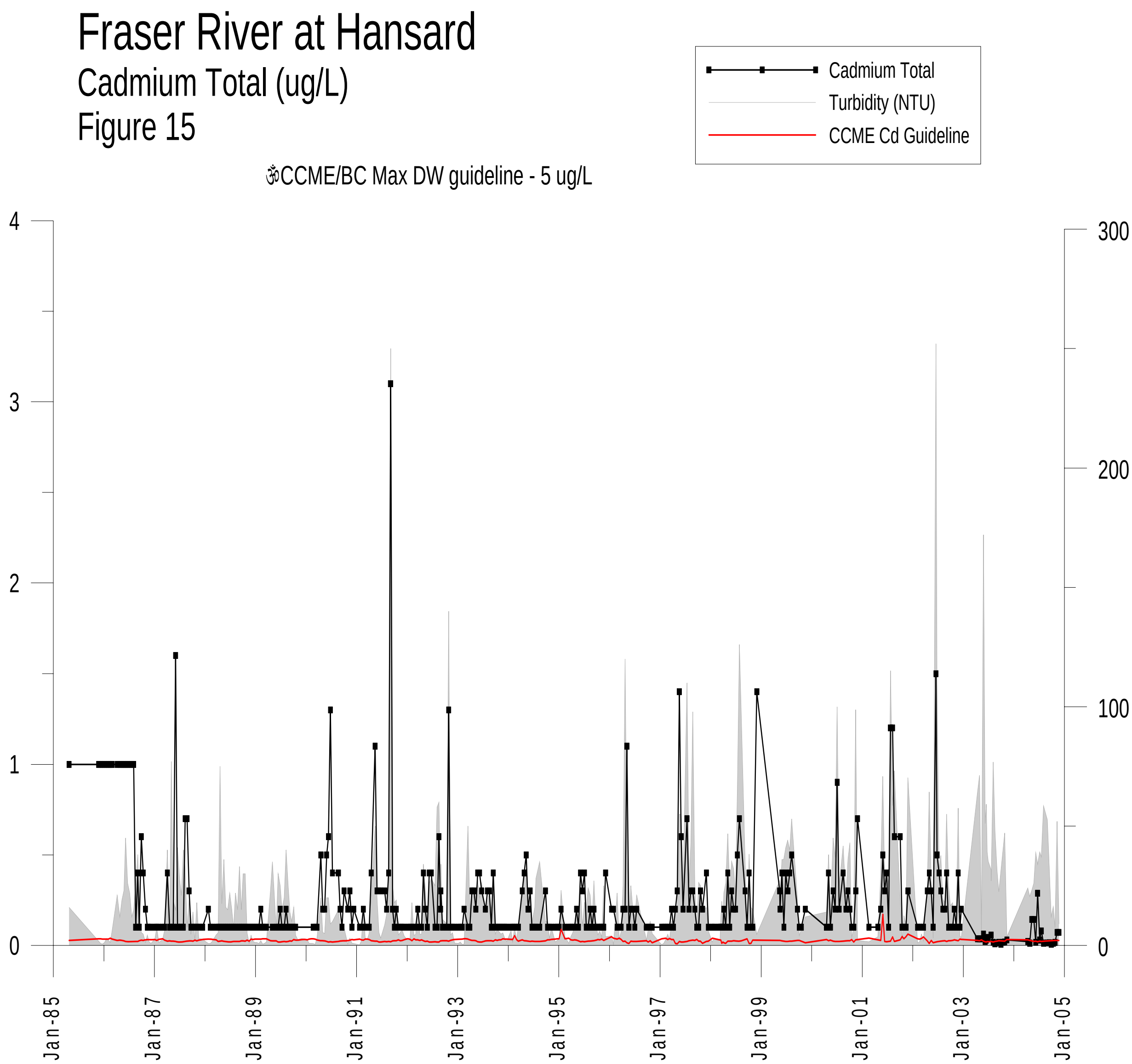

Fraser at Hansard
BismuthTotal (ug/L)
Figure 10
Bismuth Total
Turbidity (NTU)
0.05
0.04
0.03
0.02
0.01
0
300
200
100
0
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05

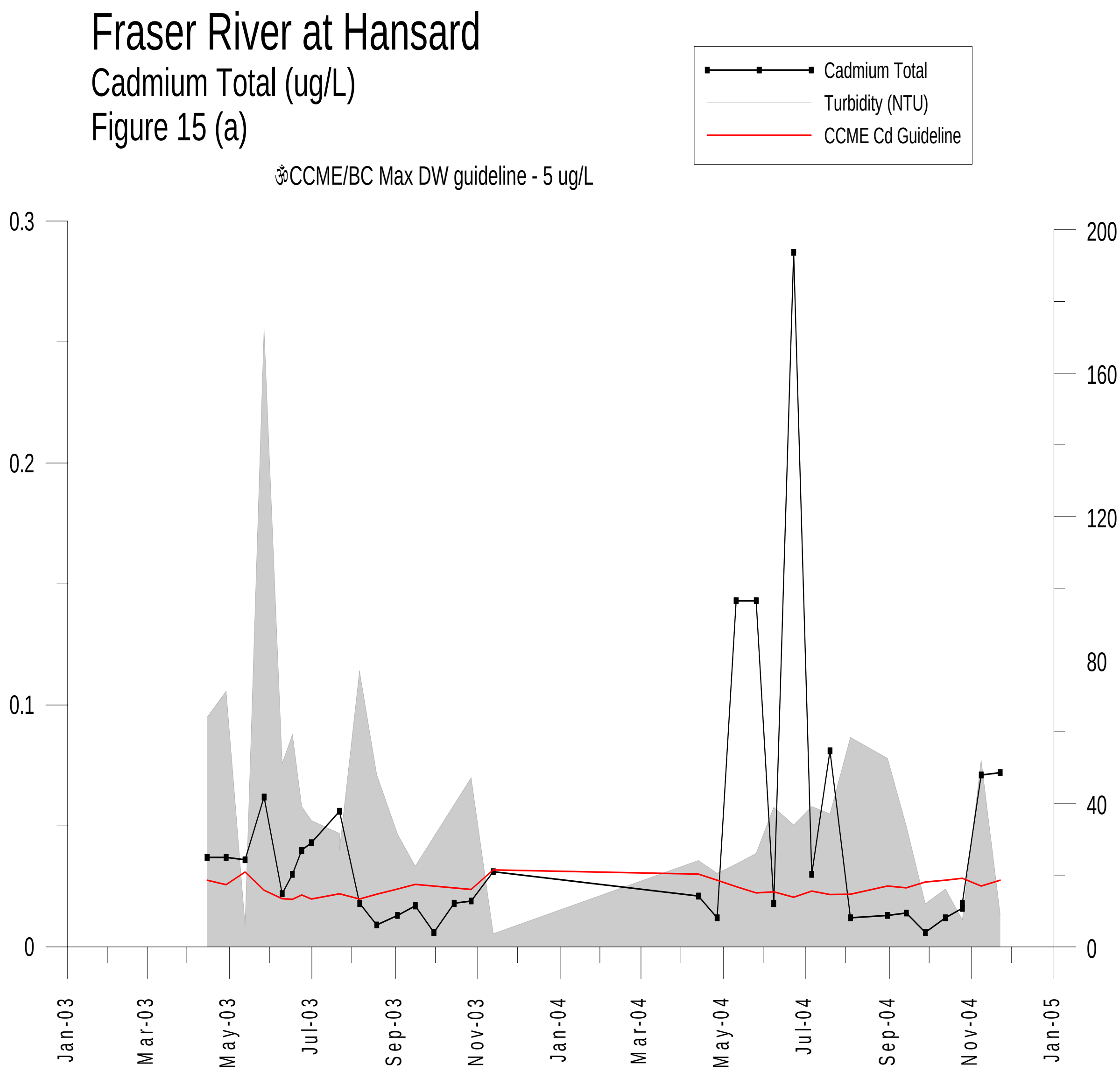

Fraser River at Hansard
Bromide Dissolved (ug/L)
Figure 11
Bromide Dissolved
Turbidity (NTU)
0.16
0.12
0.08
0.04
0
300
200
100
0
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99

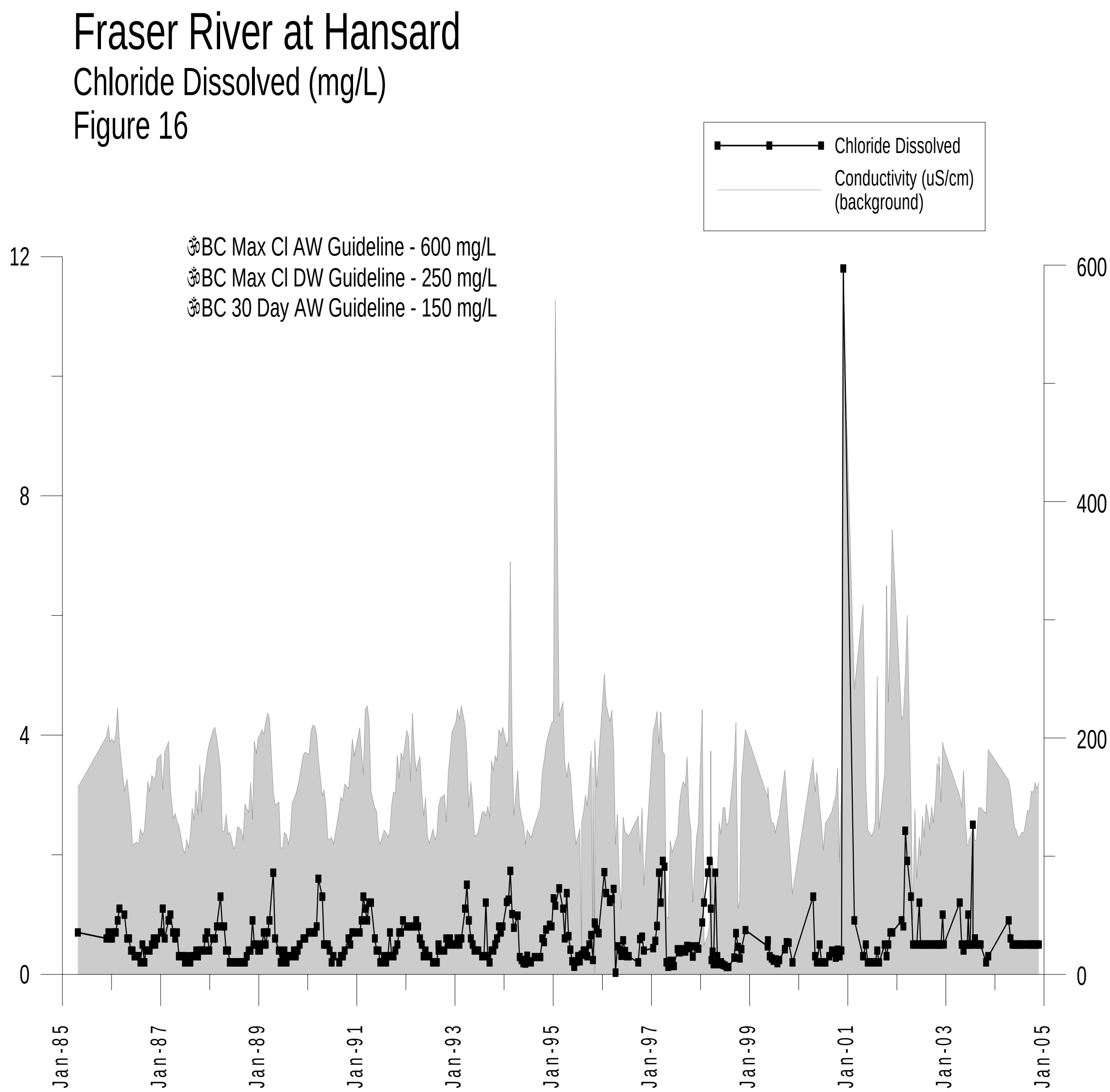

Fraser River at Hansard
Carbon Dissolved Inorganic & Organic (mg/L)
Figure 12
Inorganic
Organic
BC Organic Carbon DW Guideline
Conductivity
80
60
40
20
0
600
400
200
0
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

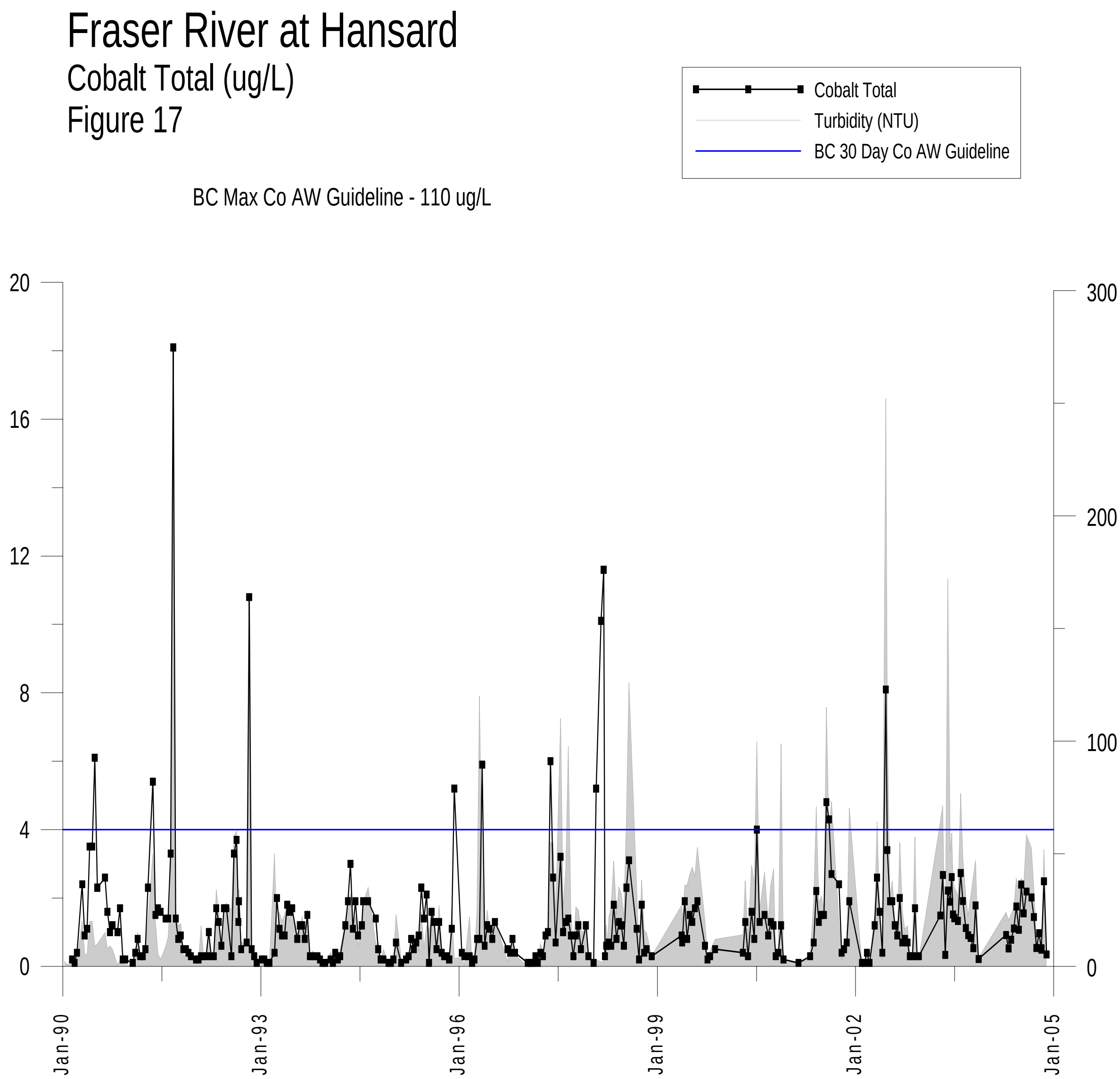

Fraser River at Hansard
Carbon Dissolved Inorganic & Organic (mg/L)
Figure 13
Inorganic
Organic
Turbidity
BC Organic Carbon DW Guideline
80
60
40
20
0
300
200
100
0
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

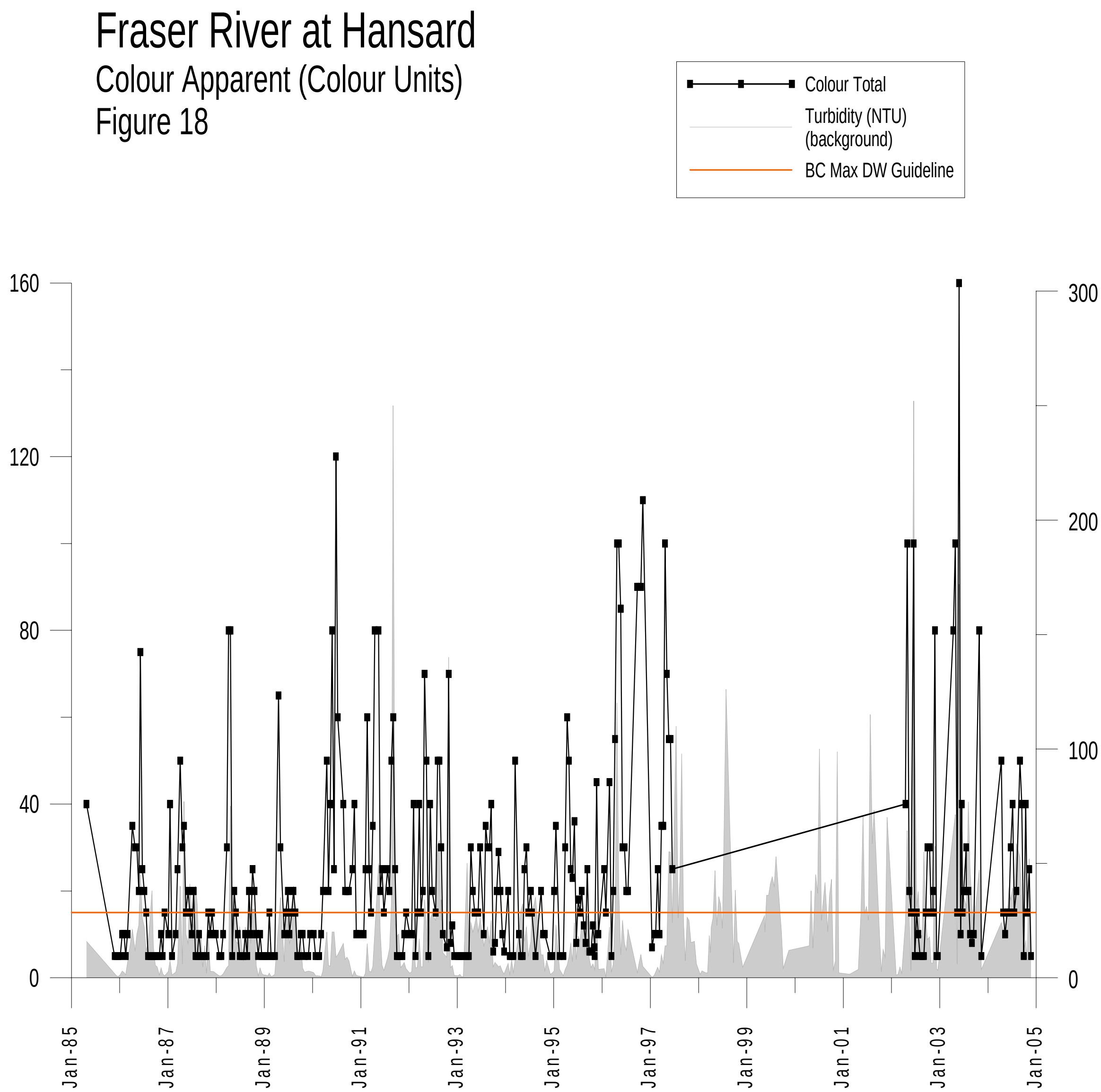

Fraser River at Hansard
Calcium Dissolved and Extractable (mg/L)
Figure 14
Calcium Dissolved
Calcium Extractable
Conductivity (uS/cm)
(background)
300
200
100
0
600
400
200
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

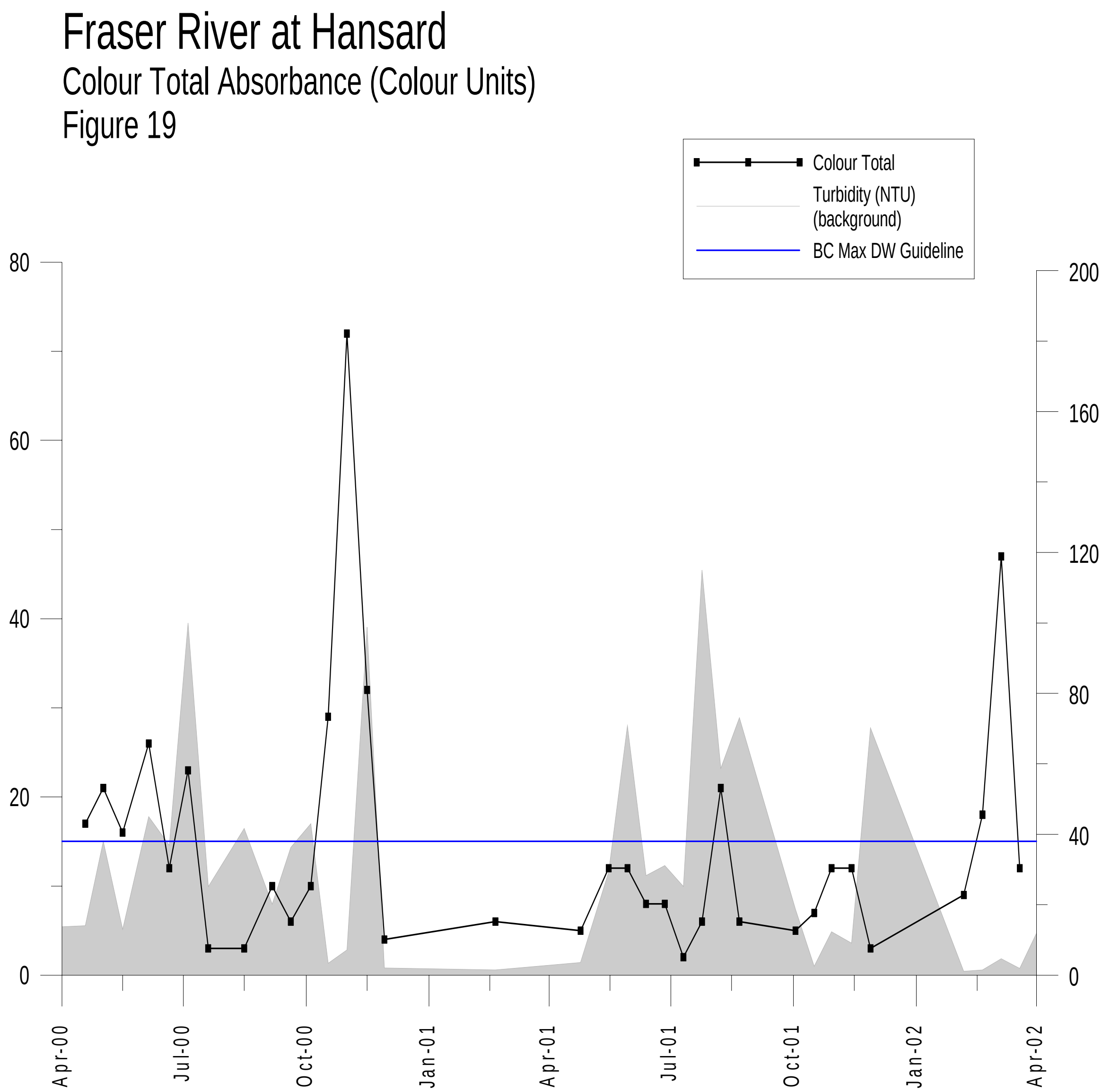

Fraser River at Hansard
Cadmium Total (ug/L)
Figure 15
ॐCCME/BC Max DW guideline - 5 ug/L
Cadmium Total
Turbidity (NTU)
CCME Cd Guideline
4
3
2
1
0
300
200
100
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

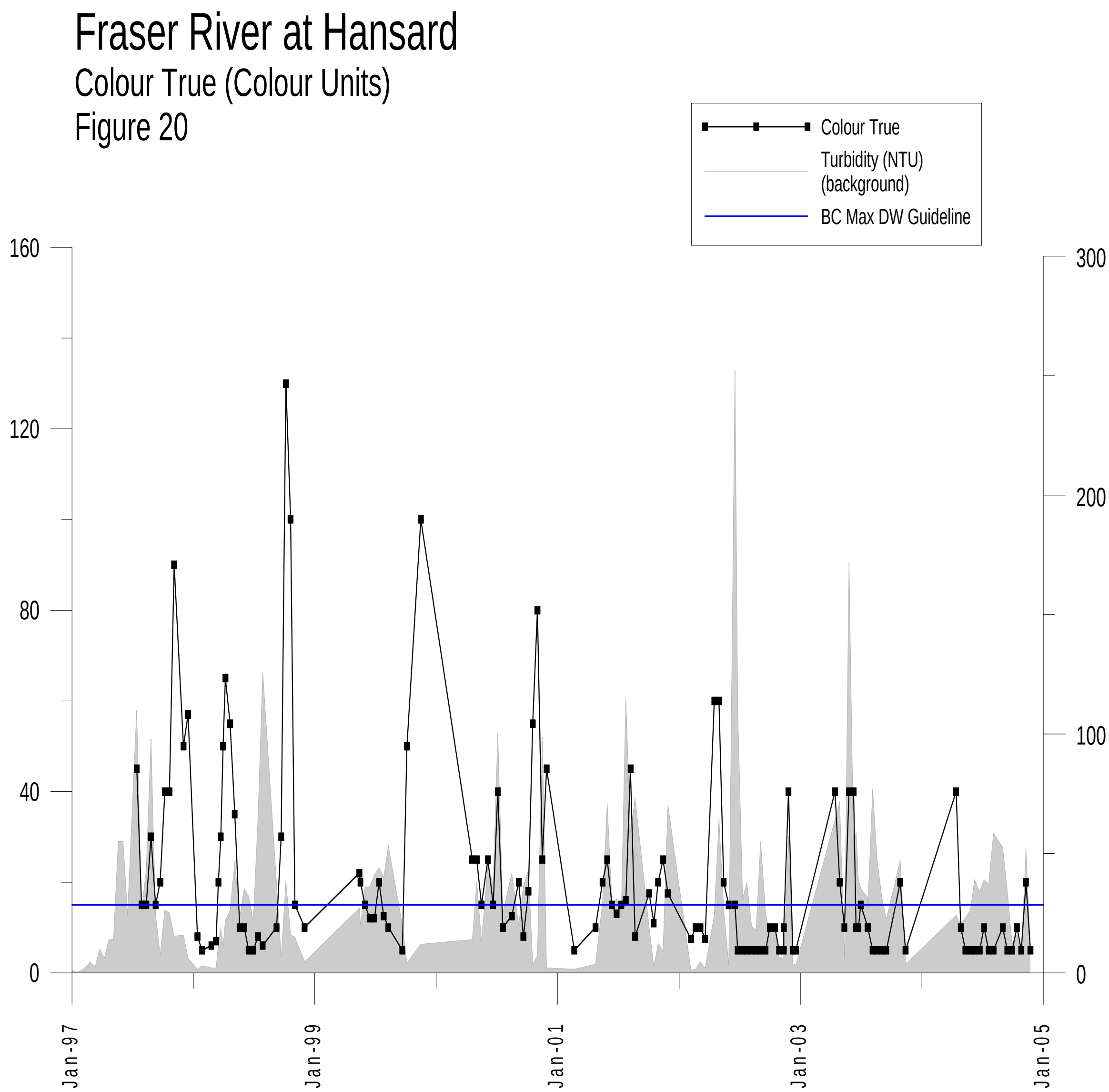

Fraser River at Hansard
Cadmium Total (ug/L)
Figure 15 (a)
CCME/BC Max DW guideline - 5 ug/L
Cadmium Total
Turbidity (NTU)
CCME Cd Guideline
0.3
0.2
0.1
0
200
160
120
80
40
0
Jan-03
Mar-03
May-03
Jul-03
Sep-03
Nov-03
Jan-04
Mar-04
May-04
Jul-04
Sep-04
Nov-04
Jan-05

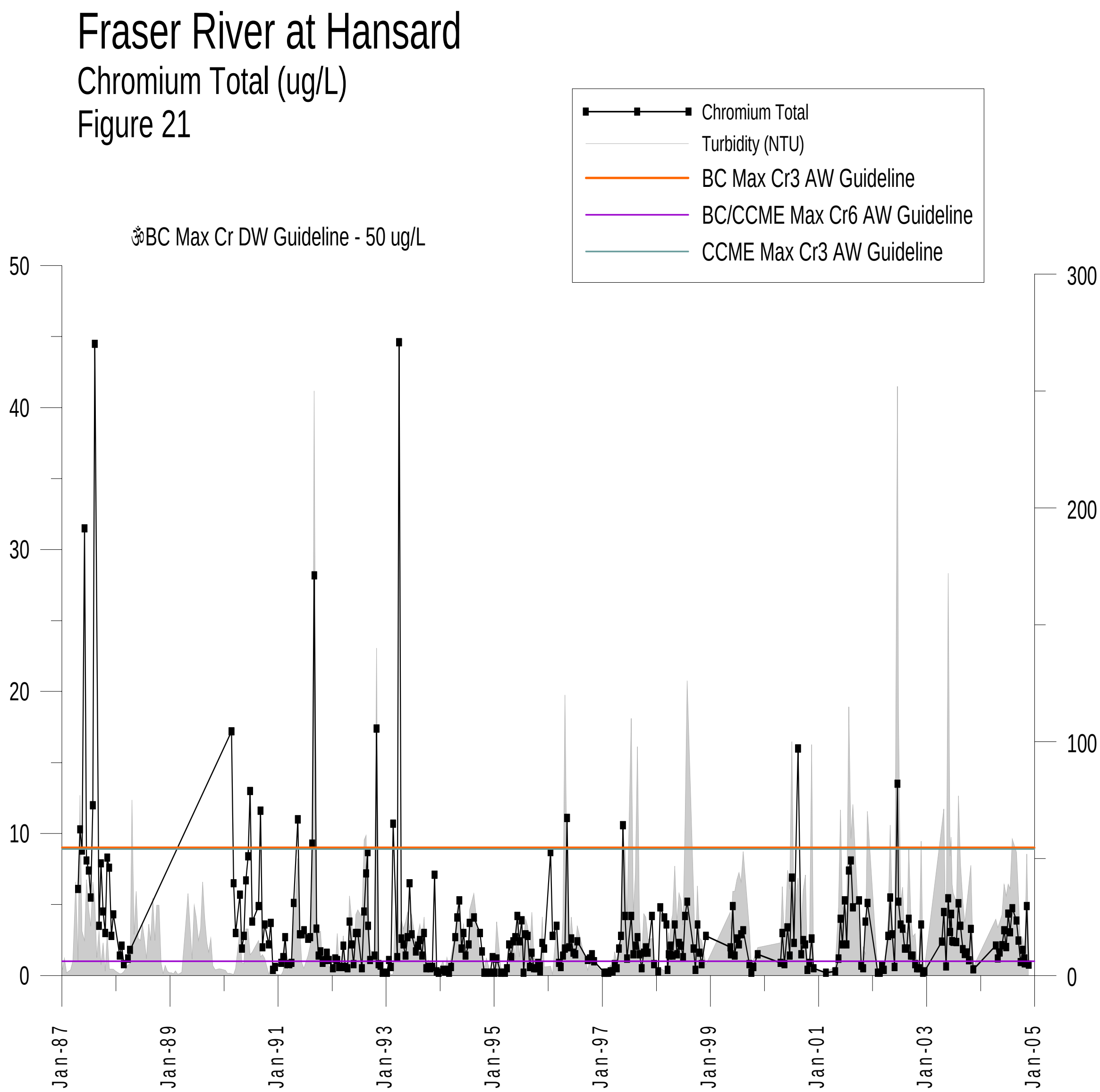

Fraser River at Hansard
Chloride Dissolved (mg/L)
Figure 16
Chloride Dissolved
Conductivity (uS/cm)
(background)
ॐBC Max Cl AW Guideline - 600 mg/L
ॐBC Max Cl DW Guideline - 250 mg/L
ॐBC 30 Day AW Guideline - 150 mg/L
12
8
4
0
600
400
200
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

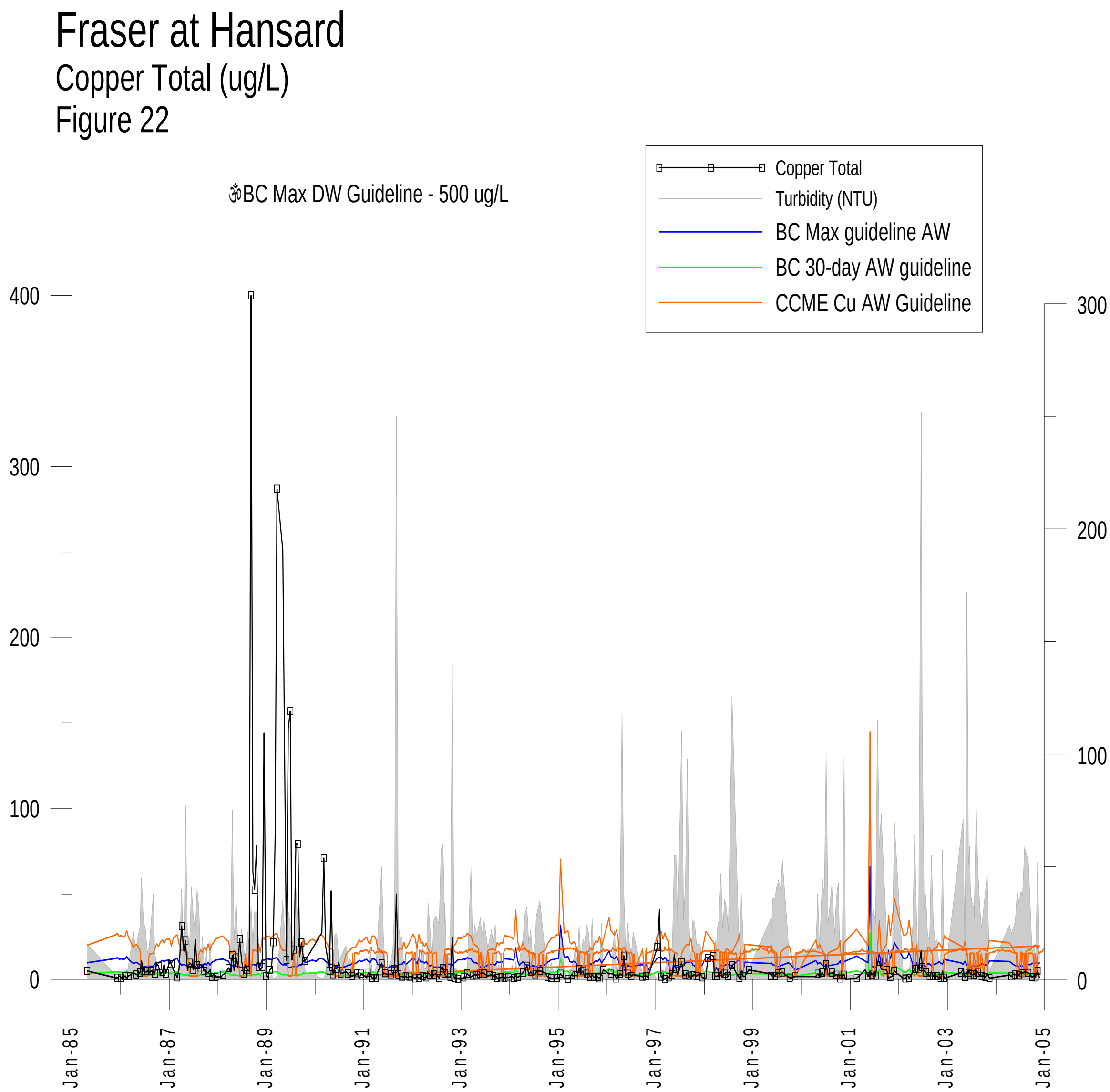

Fraser River at Hansard
Cobalt Total (ug/L)
Figure 17
Cobalt Total
Turbidity (NTU)
BC 30 Day Co AW Guideline
BC Max Co AW Guideline - 110 ug/L
20
16
12
8
4
0
300
200
100
0
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05

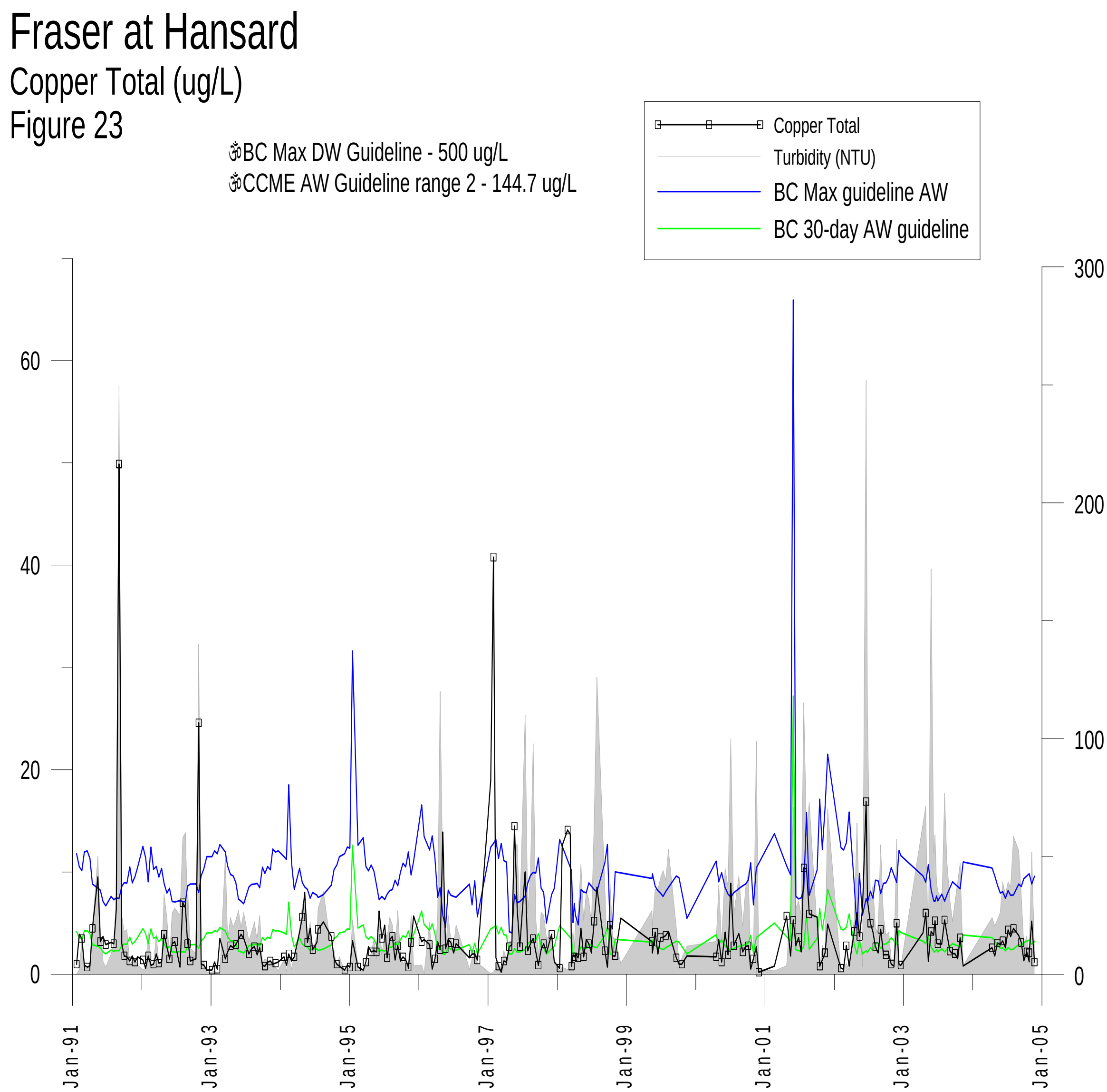

Fraser River at Hansard
Colour Apparent (Colour Units)
Figure 18
Colour Total
Turbidity (NTU) (background)
BC Max DW Guideline
160
120
80
40
0
300
200
100
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

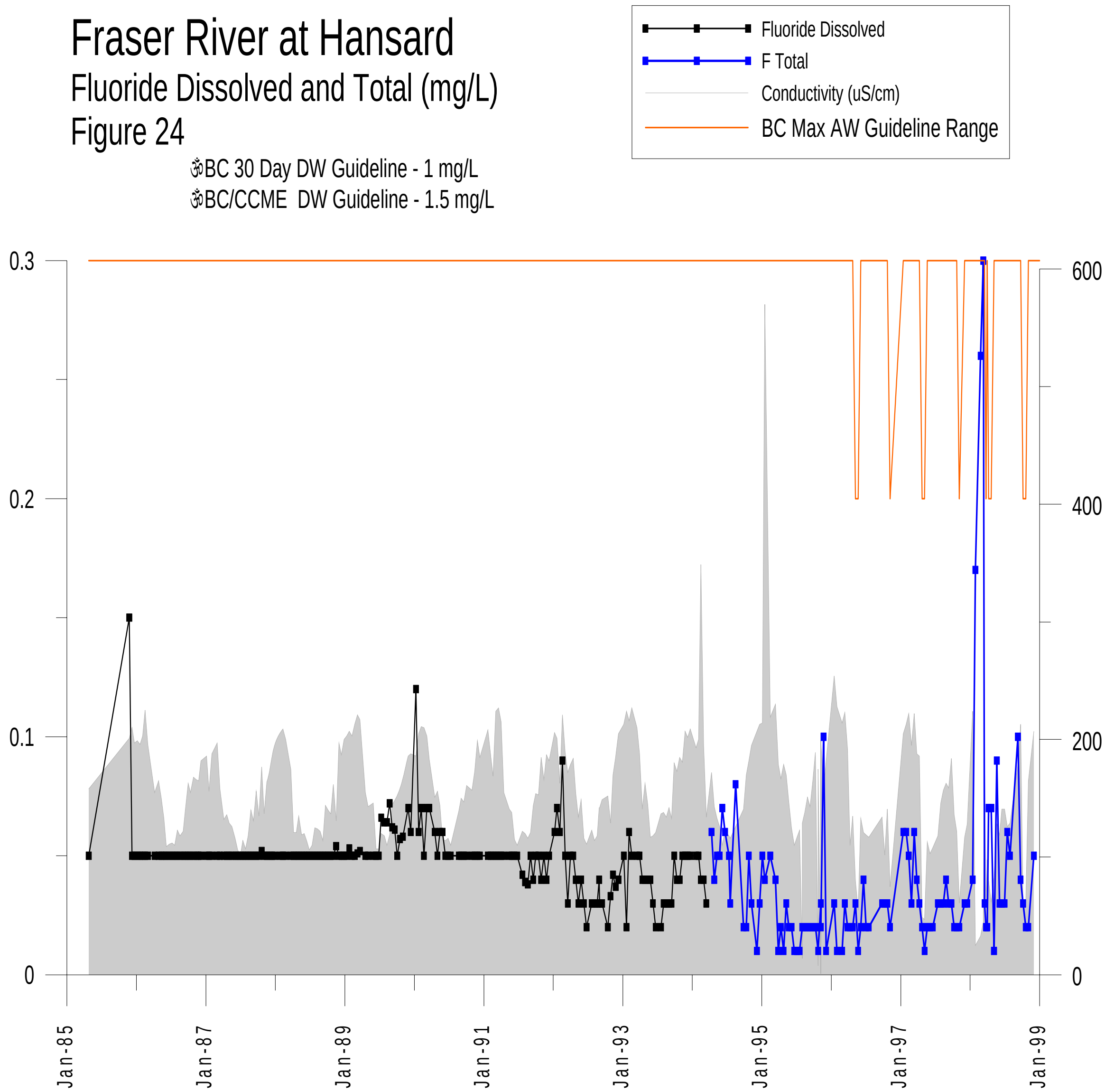

Fraser River at Hansard
Colour Total Absorbance (Colour Units)
Figure 19
Colour Total
Turbidity (NTU)
(background)
BC Max DW Guideline
0
20
40
60
80
0
40
80
120
160
200
Apr-00
Jul-00
Oct-00
Jan-01
Apr-01
Jul-01
Oct-01
Jan-02
Apr-02

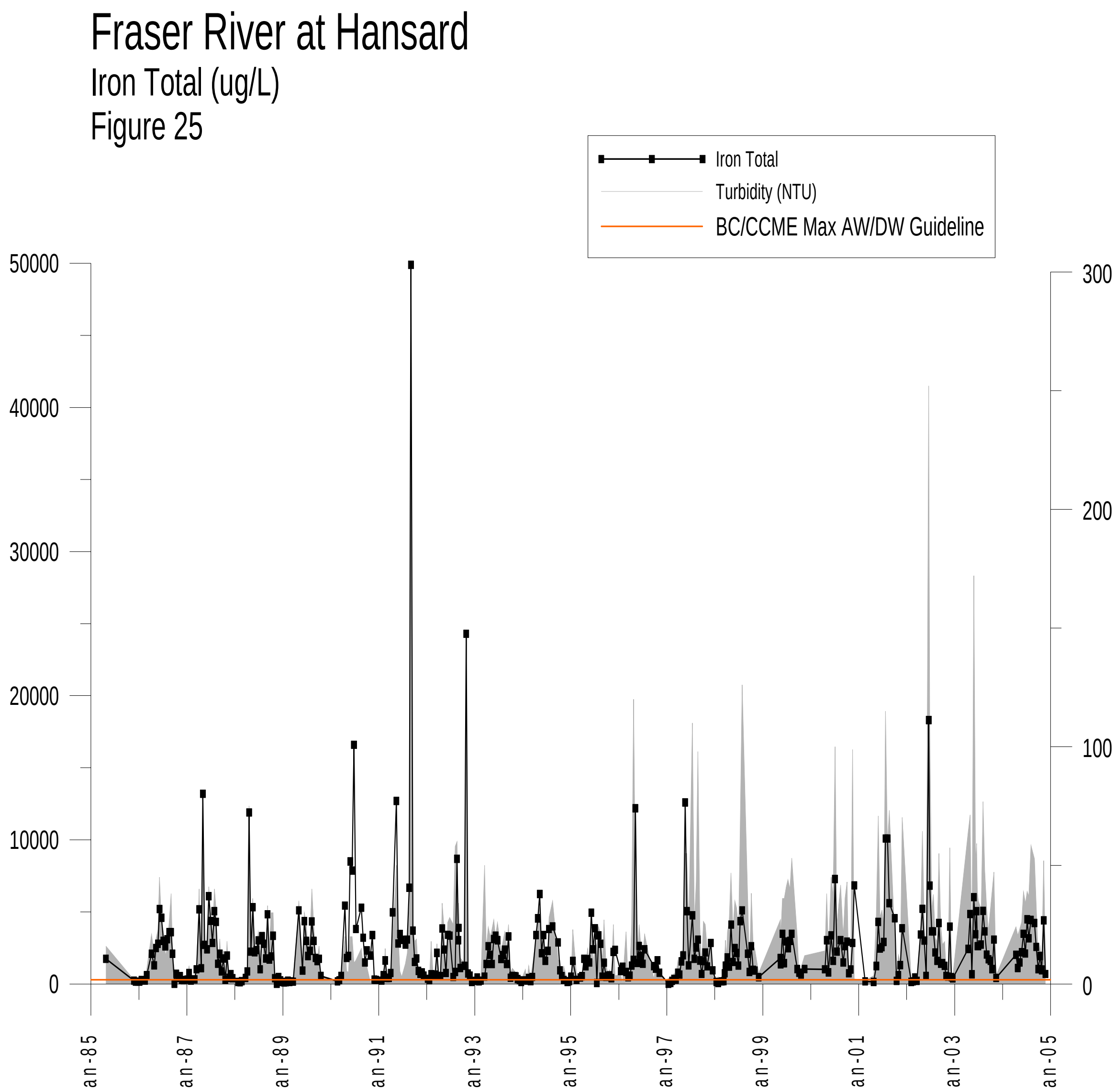

Fraser River at Hansard
Colour True (Colour Units)
Figure 20
Colour True
Turbidity (NTU) (background)
BC Max DW Guideline
160
120
80
40
0
300
200
100
0
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

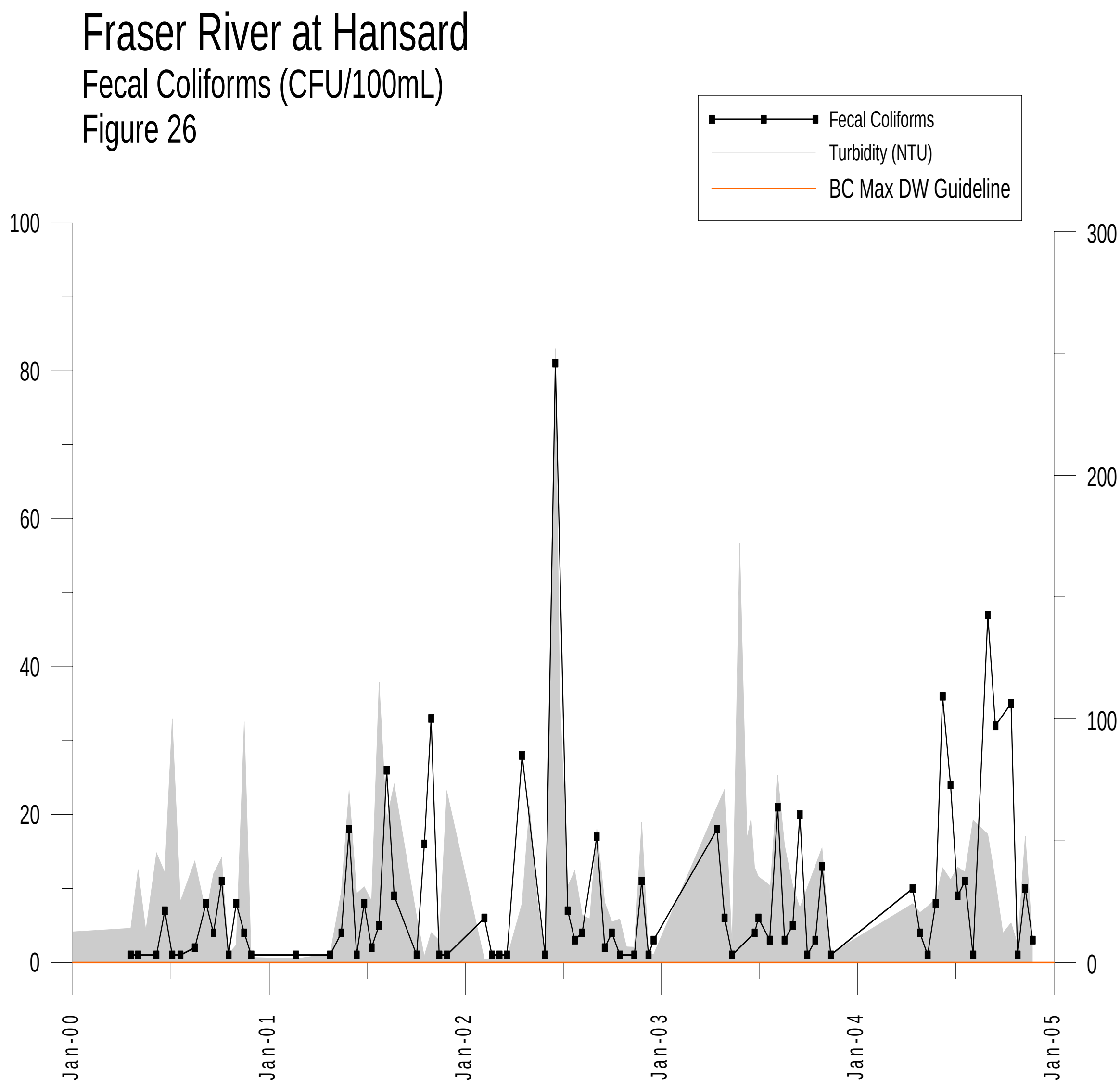

Fraser River at Hansard
Chromium Total (ug/L)
Figure 21
Chromium Total
Turbidity (NTU)
BC Max Cr3 AW Guideline
BC/CCME Max Cr6 AW Guideline
CCME Max Cr3 AW Guideline
BC Max Cr DW Guideline - 50 ug/L
50
40
30
20
10
0
300
200
100
0
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

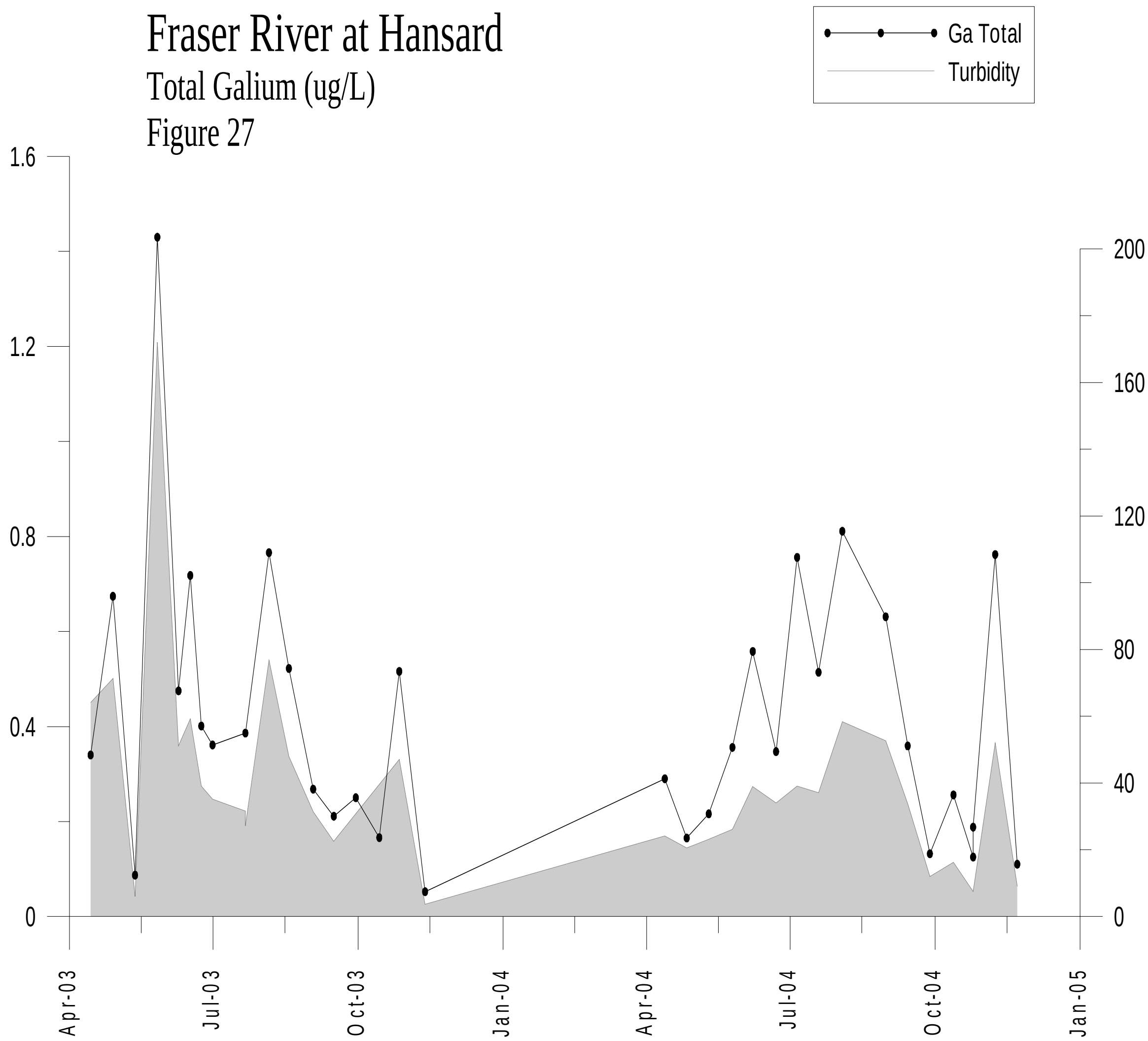

Fraser at Hansard
Copper Total (ug/L)
Figure 22
BC Max DW Guideline - 500 ug/L
Copper Total
Turbidity (NTU)
BC Max guideline AW
BC 30-day AW guideline
CCME Cu AW Guideline
400
300
200
100
0
300
200
100
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

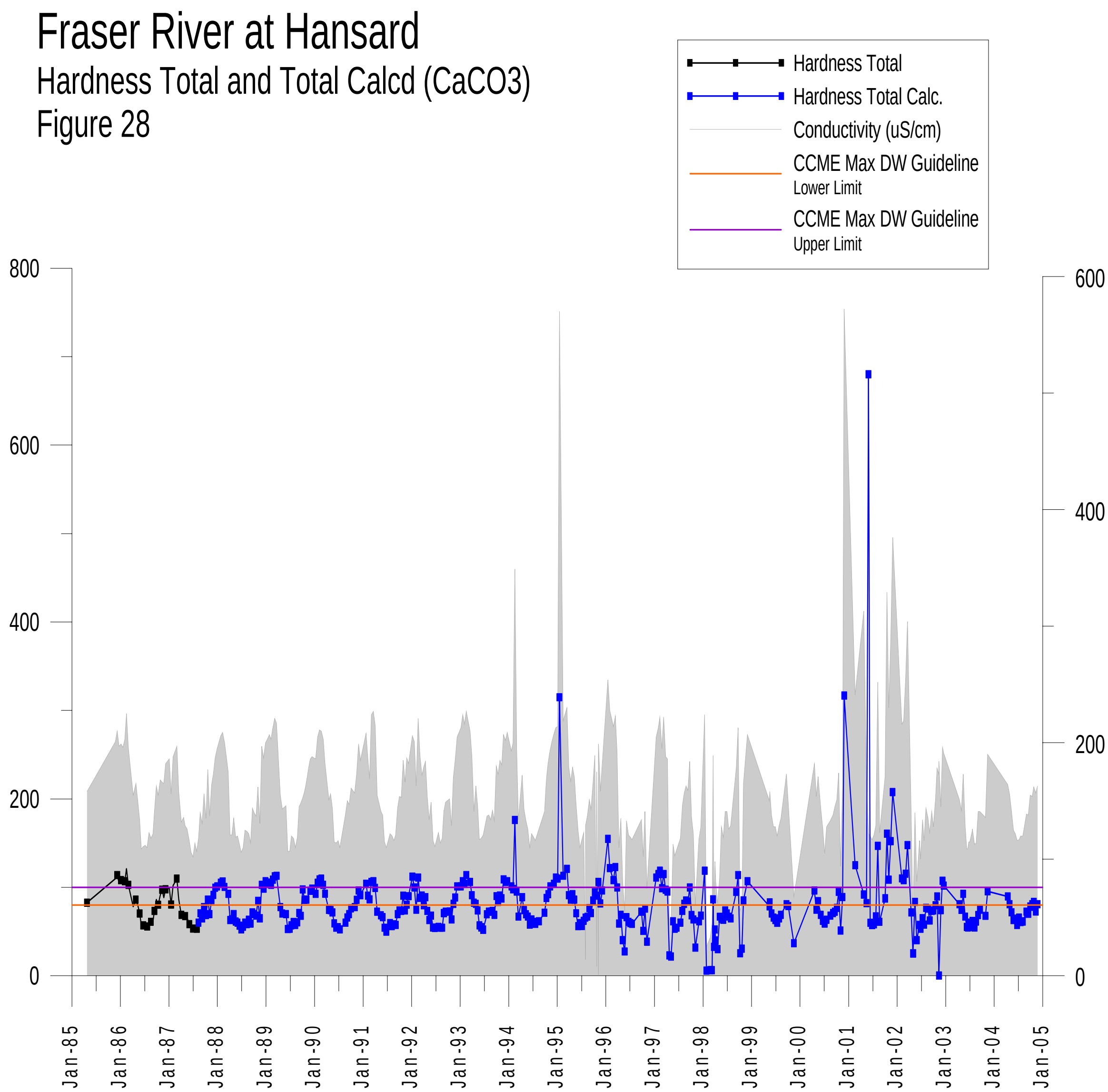

Fraser at Hansard
Copper Total (ug/L)
Figure 23
BC Max DW Guideline - 500 ug/L
CCME AW Guideline range 2 - 144.7 ug/L
Copper Total
Turbidity (NTU)
BC Max guideline AW
BC 30-day AW guideline
0
20
40
60
0
100
200
300
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

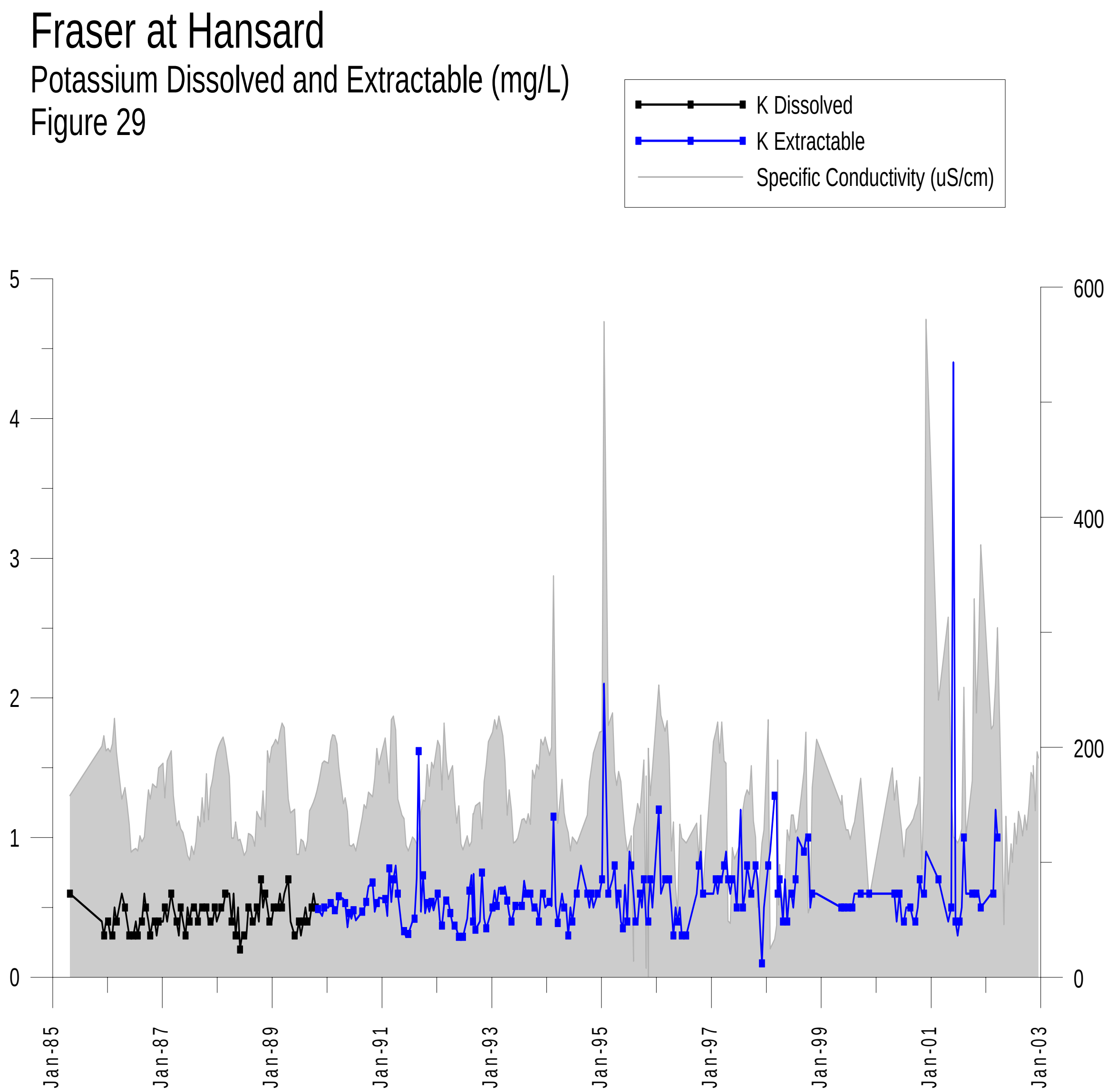

Fraser River at Hansard
Fluoride Dissolved and Total (mg/L)
Figure 24
BC 30 Day DW Guideline - 1 mg/L
BC/CCME DW Guideline - 1.5 mg/L
Fluoride Dissolved
F Total
Conductivity (uS/cm)
BC Max AW Guideline Range
0.3
0.2
0.1
0
600
400
200
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99

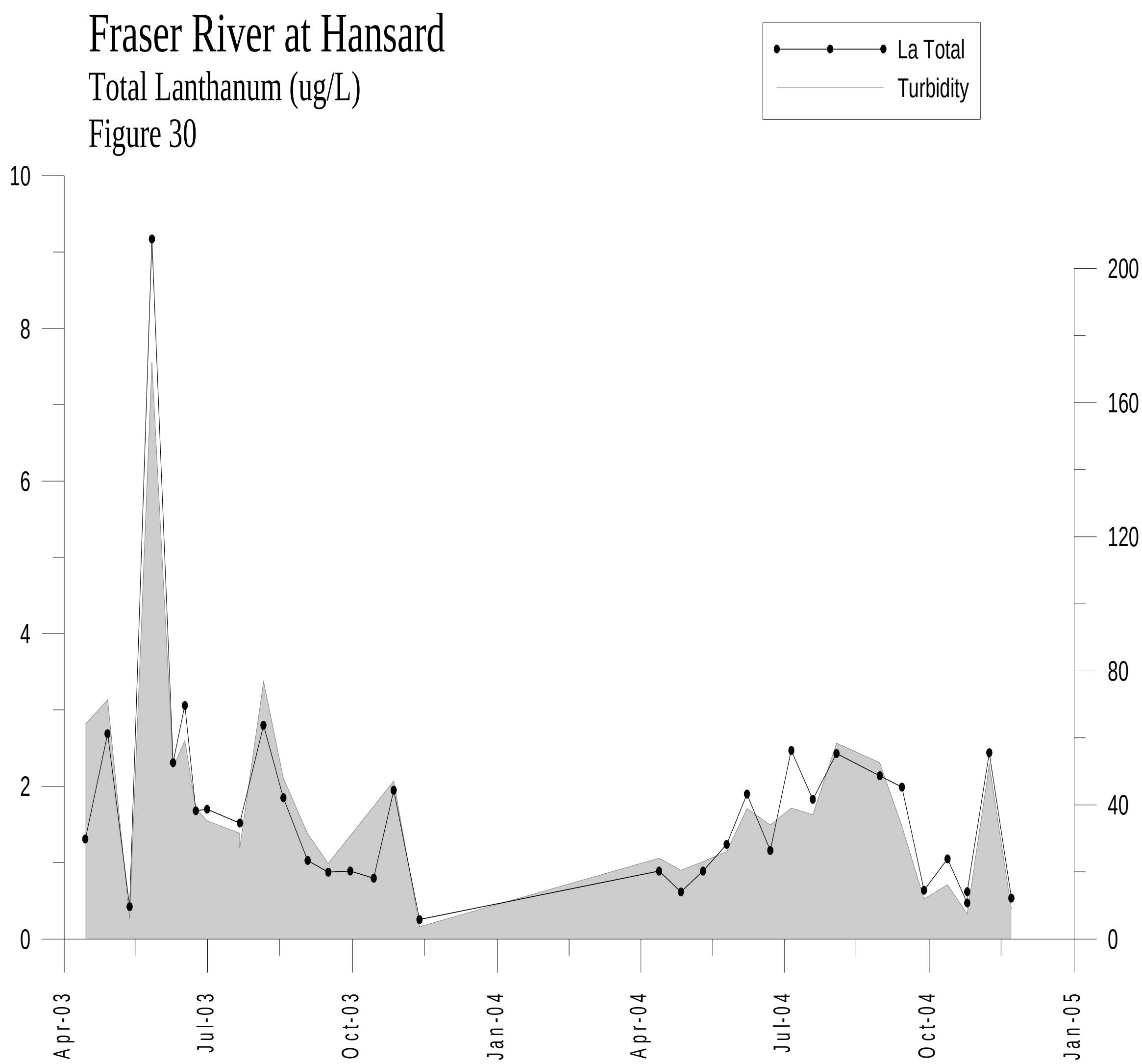

Fraser River at Hansard
Iron Total (ug/L)
Figure 25
Iron Total
Turbidity (NTU)
BC/CCME Max AW/DW Guideline
50000
40000
30000
20000
10000
0
300
200
100
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

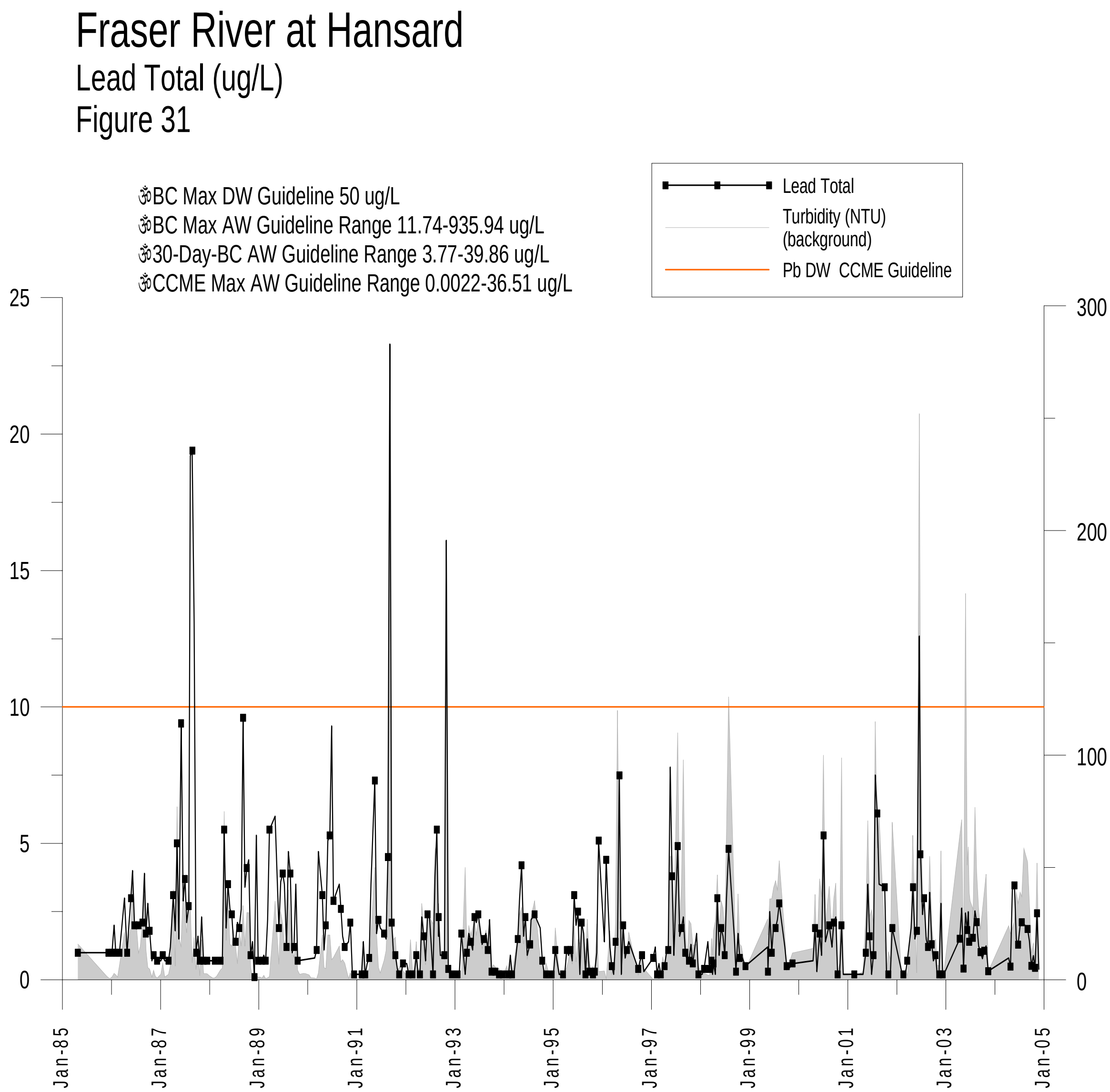

Fraser River at Hansard
Fecal Coliforms (CFU/100mL)
Figure 26
Fecal Coliforms
Turbidity (NTU)
BC Max DW Guideline
100
80
60
40
20
0
300
200
100
0
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05


Fraser River at Hansard
Total Galium (ug/L)
Figure 27
Ga Total
Turbidity
1.6
1.2
0.8
0.4
0
200
160
120
80
40
0
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05


Fraser River at Hansard
Hardness Total and Total Calcd (CaCO3)
Figure 28
Hardness Total
Hardness Total Calc.
Conductivity (uS/cm)
CCME Max DW Guideline Lower Limit
CCME Max DW Guideline Upper Limit
800
600
400
200
0
600
400
200
0
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05


Fraser at Hansard
Potassium Dissolved and Extractable (mg/L)
Figure 29
K Dissolved
K Extractable
Specific Conductivity (uS/cm)
0
1
2
3
4
5
0
200
400
600
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03

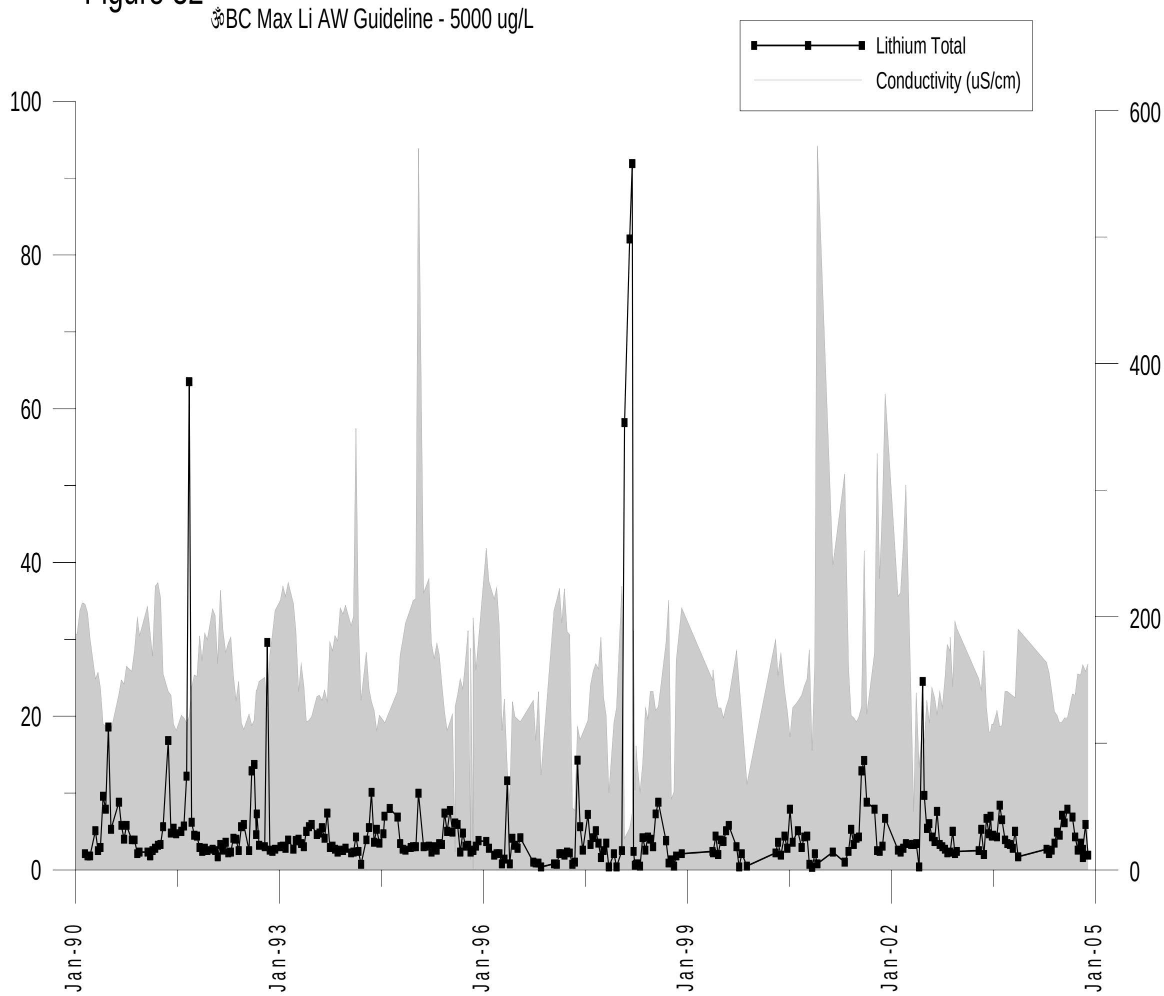

Fraser River at Hansard
Total Lanthanum (ug/L)
Figure 30
La Total
Turbidity
10
8
6
4
2
0
200
160
120
80
40
0
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05

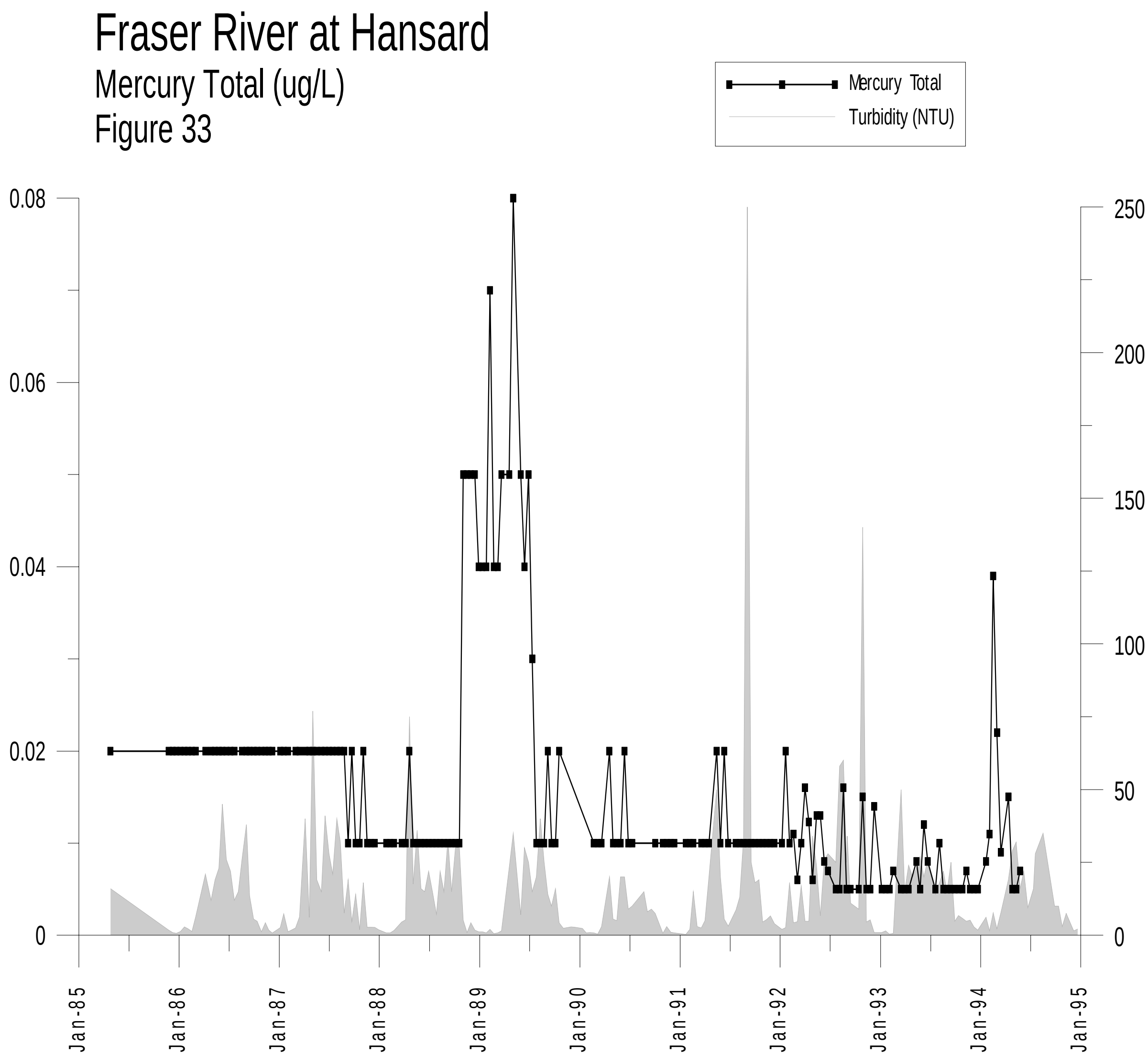

Fraser River at Hansard
Lead Total (ug/L)
Figure 31
ॐBC Max DW Guideline 50 ug/L
ॐBC Max AW Guideline Range 11.74-935.94 ug/L
ॐ30-Day-BC AW Guideline Range 3.77-39.86 ug/L
ॐCCME Max AW Guideline Range 0.0022-36.51 ug/L
Lead Total
Turbidity (NTU) (background)
Pb DW CCME Guideline
25
20
15
10
5
0
300
200
100
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

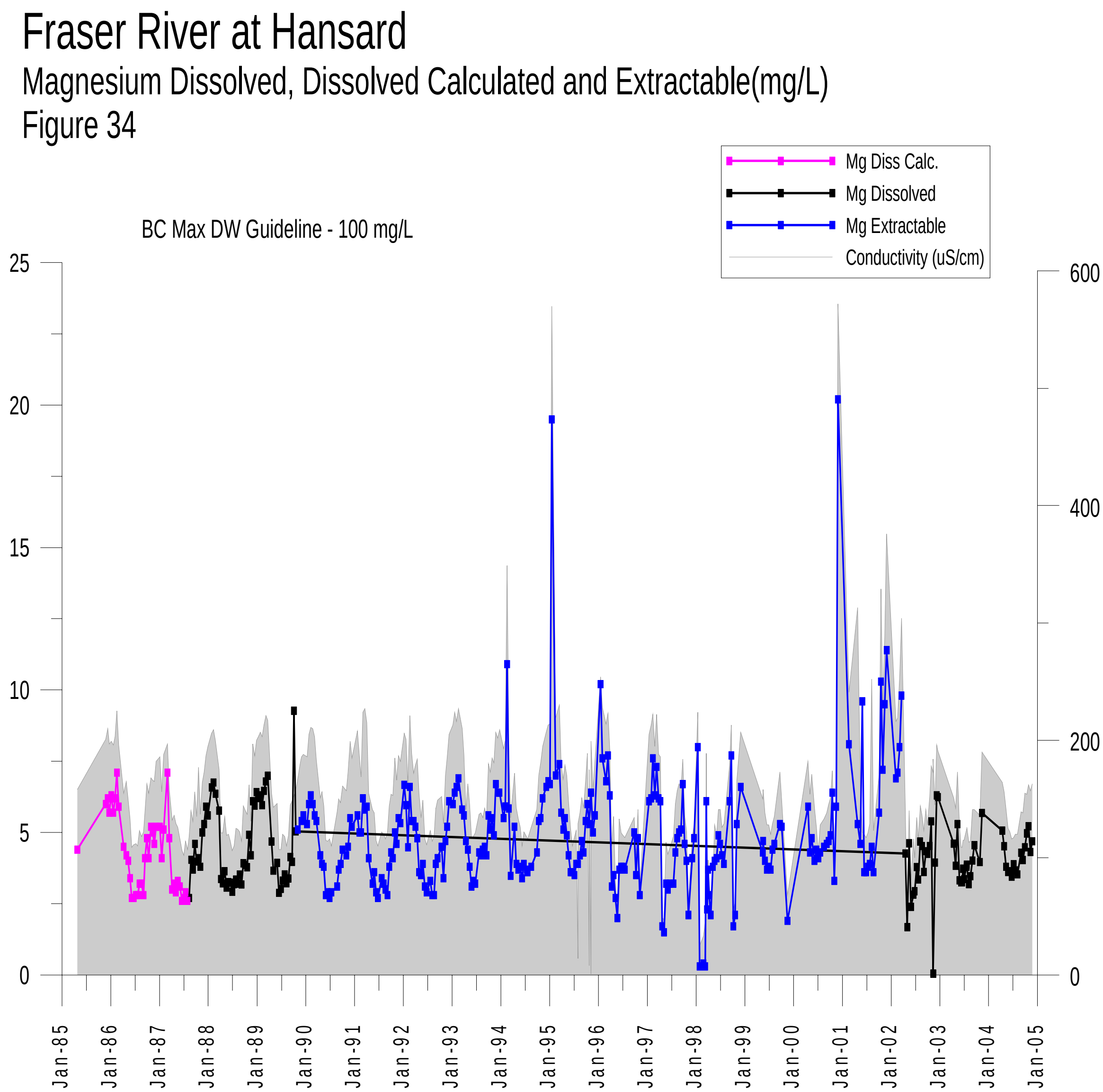
Fraser River at Hansard

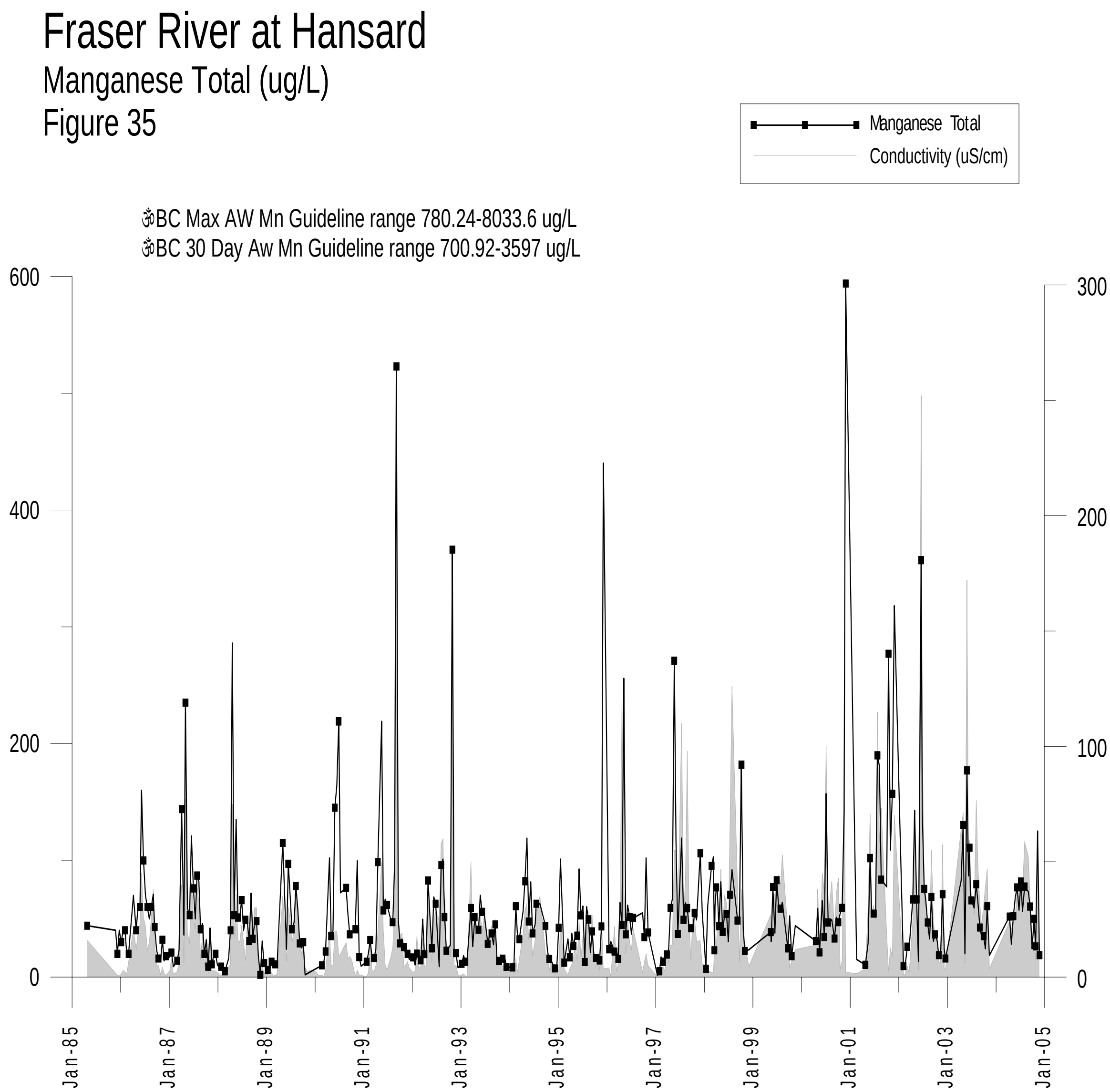
Lithium Total (ug/L)

Figure 32




Fraser River at Hansard
Mercury Total (ug/L)
Figure 33
Mercury Total
Turbidity (NTU)
0.08
0.06
0.04
0.02
0
250
200
150
100
50
0
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95

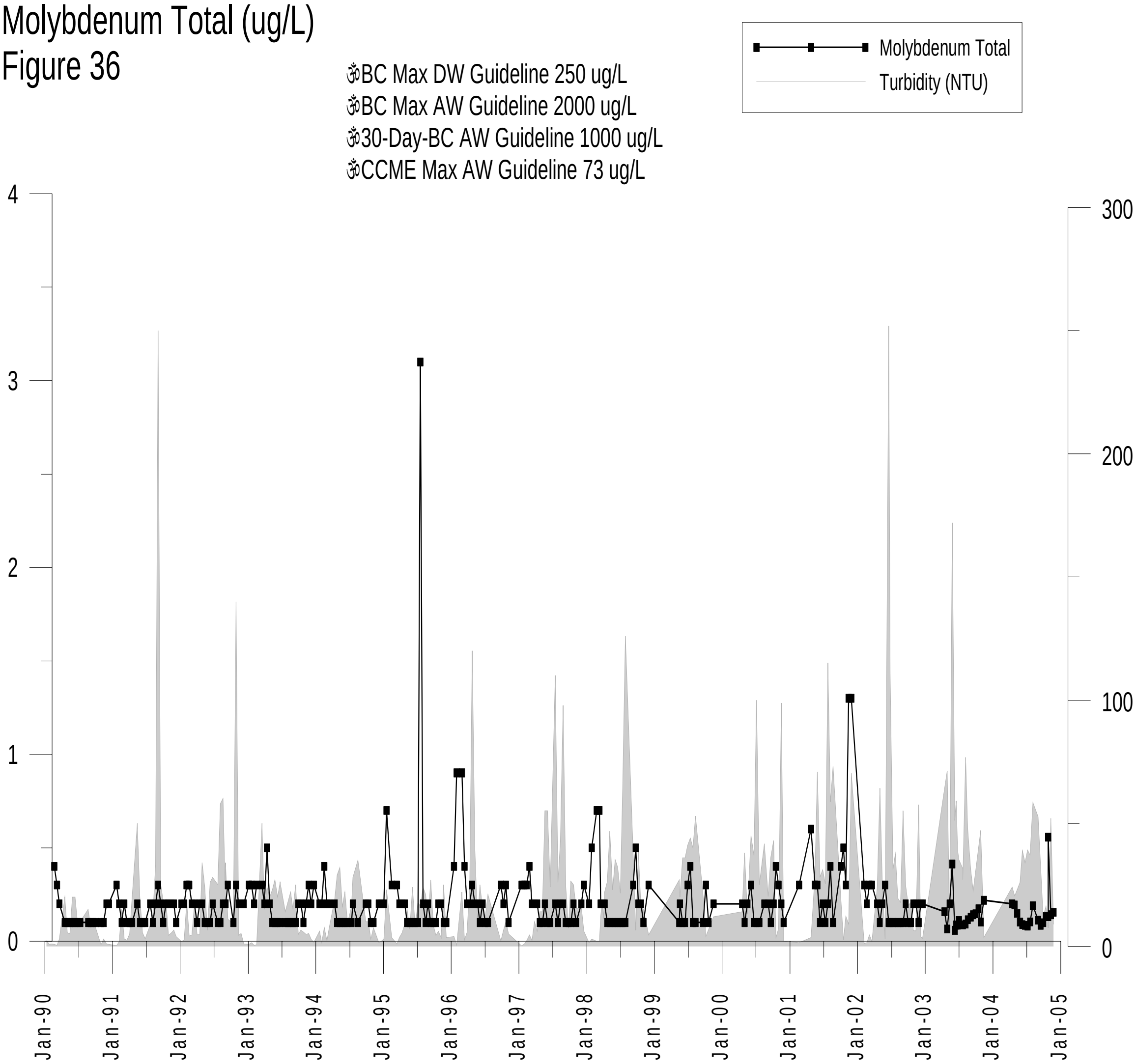

Fraser River at Hansard
Magnesium Dissolved, Dissolved Calculated and Extractable(mg/L)
Figure 34
Mg Diss Calc.
Mg Dissolved
Mg Extractable
Conductivity (uS/cm)
BC Max DW Guideline - 100 mg/L
25
20
15
10
5
0
600
400
200
0
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

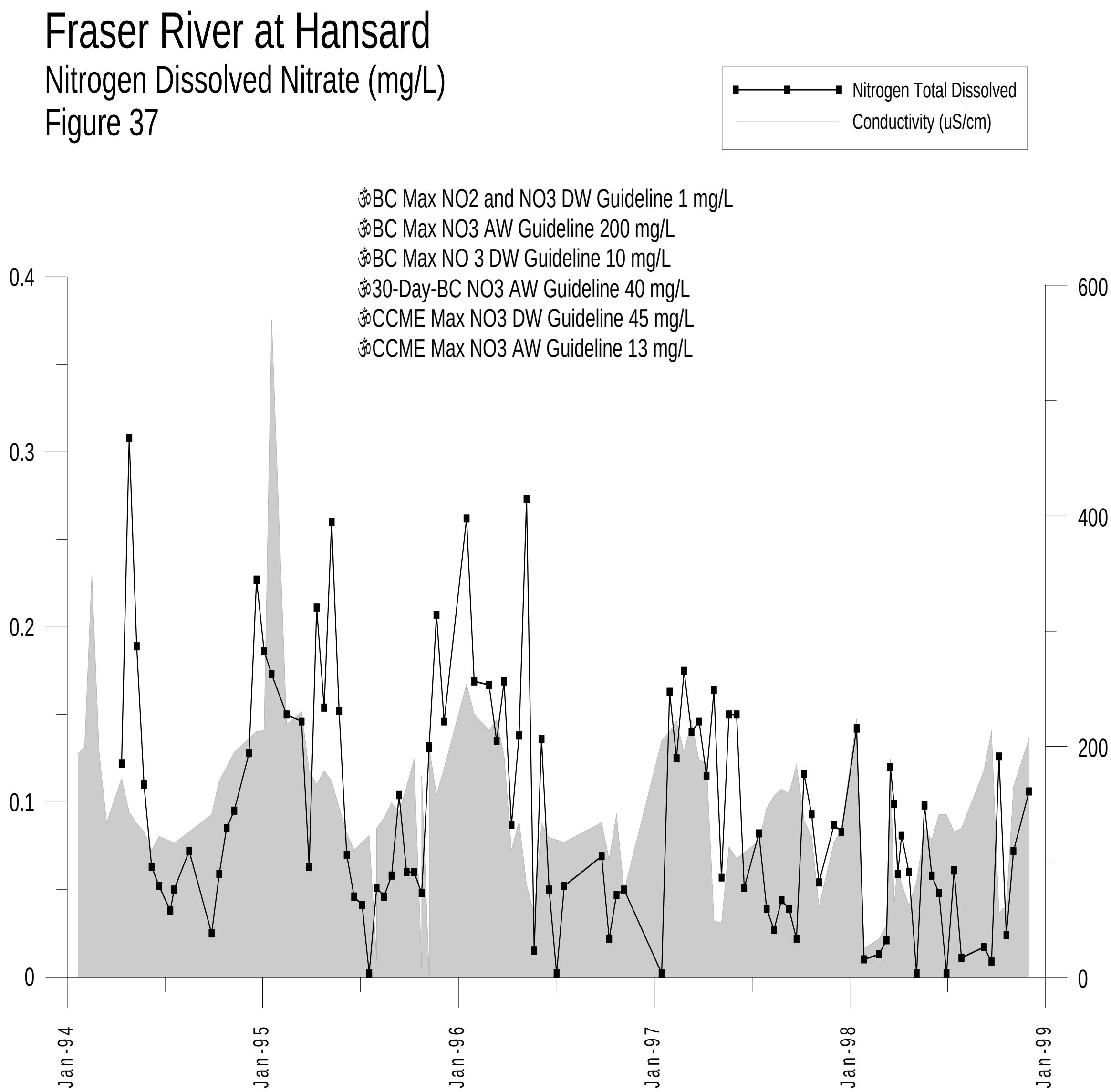

Fraser River at Hansard
Manganese Total (ug/L)
Figure 35
Manganese Total
Conductivity (uS/cm)
BC Max AW Mn Guideline range 780.24-8033.6 ug/L
BC 30 Day Aw Mn Guideline range 700.92-3597 ug/L
600
400
200
0
300
200
100
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

Fraser River at Hansard

Molybdenum Total (ug/L)

Figure 36

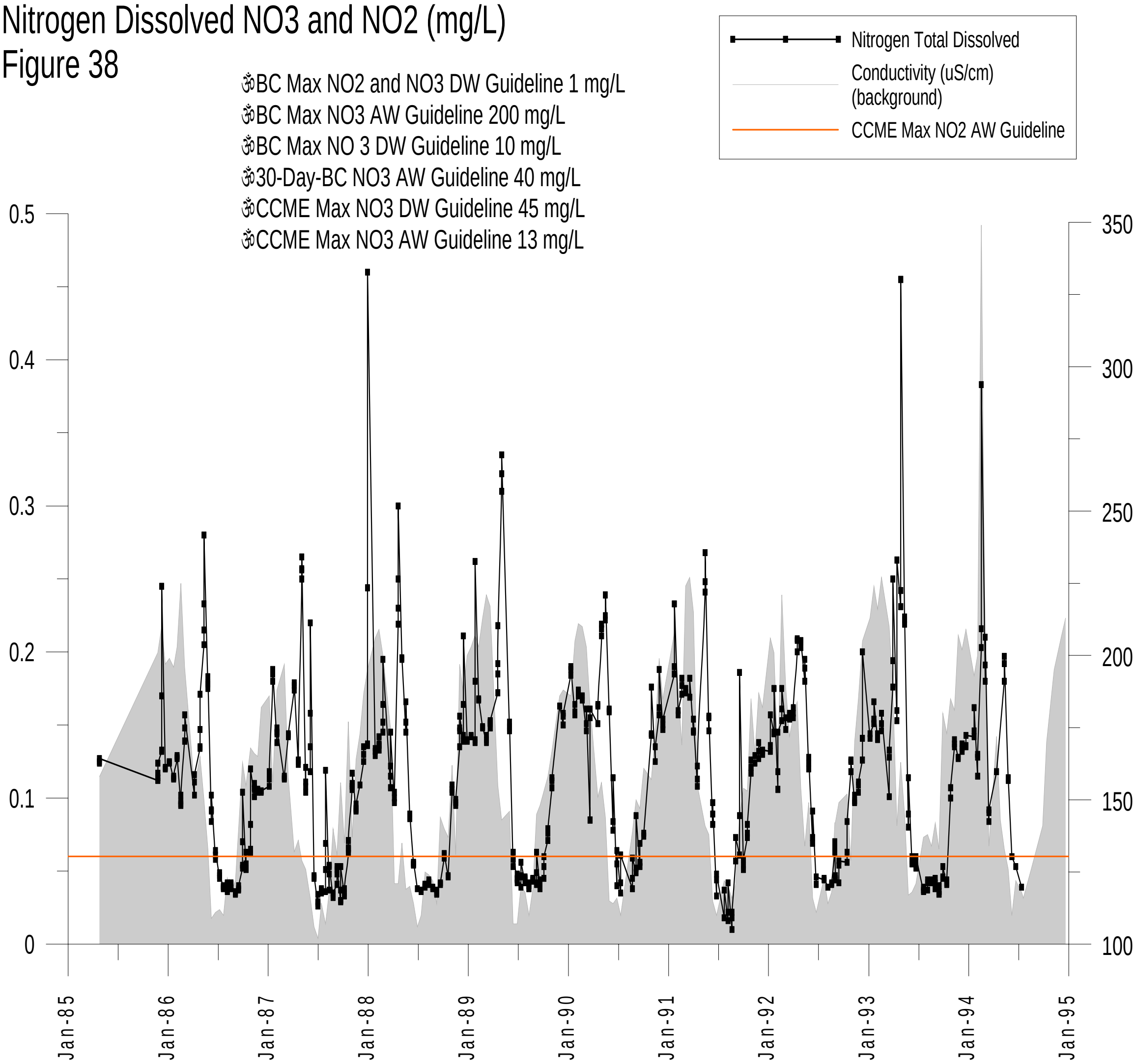


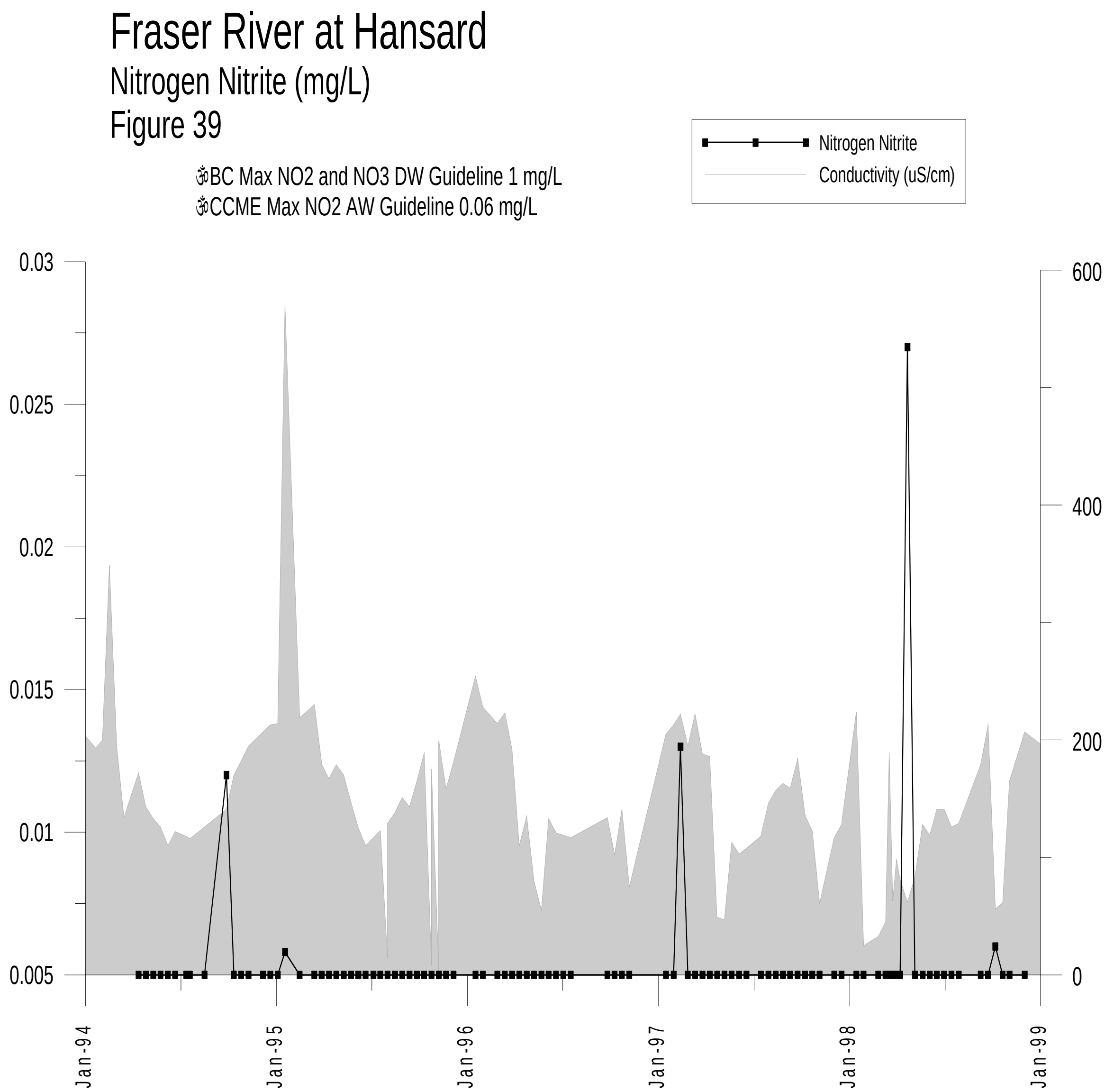

Fraser River at Hansard
Nitrogen Dissolved Nitrate (mg/L)
Figure 37
Nitrogen Total Dissolved
Conductivity (uS/cm)
BC Max NO2 and NO3 DW Guideline 1 mg/L
BC Max NO3 AW Guideline 200 mg/L
BC Max NO 3 DW Guideline 10 mg/L
30-Day-BC NO3 AW Guideline 40 mg/L
CCME Max NO3 DW Guideline 45 mg/L
CCME Max NO3 AW Guideline 13 mg/L
0.4
0.3
0.2
0.1
0
600
400
200
0
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99

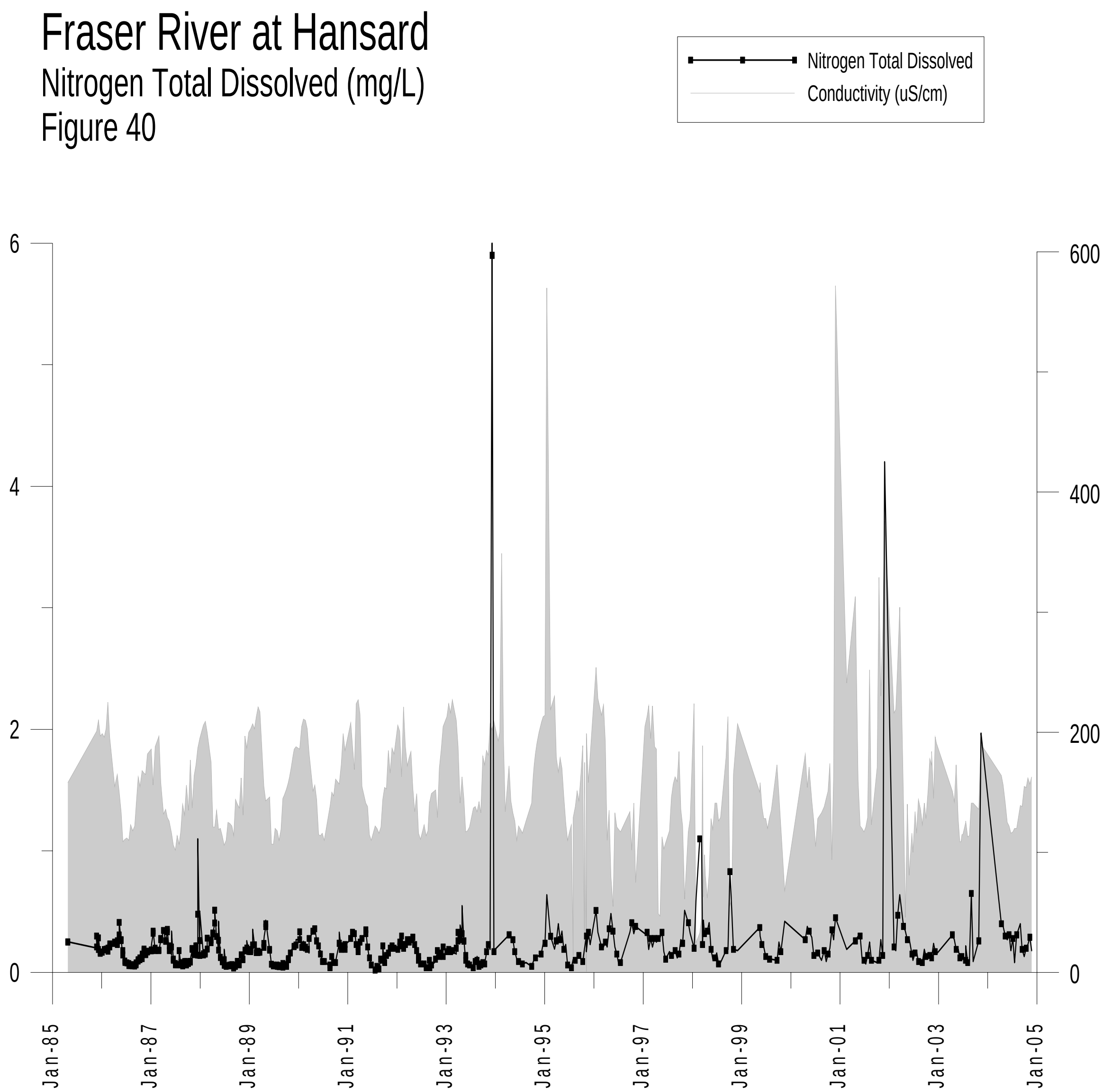
Fraser at River Hansard

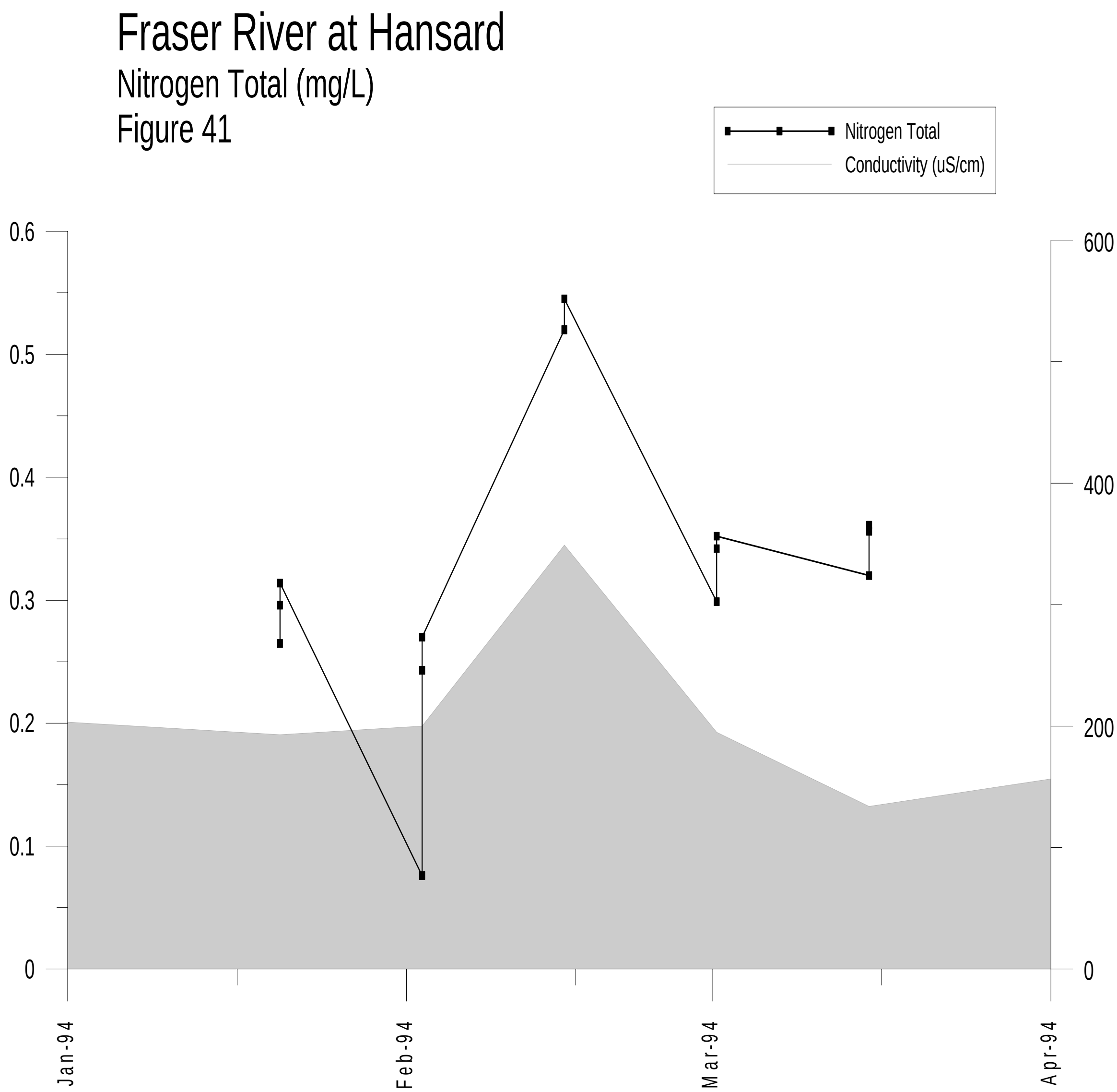
Nitrogen Dissolved NO3 and NO2 (mg/L)

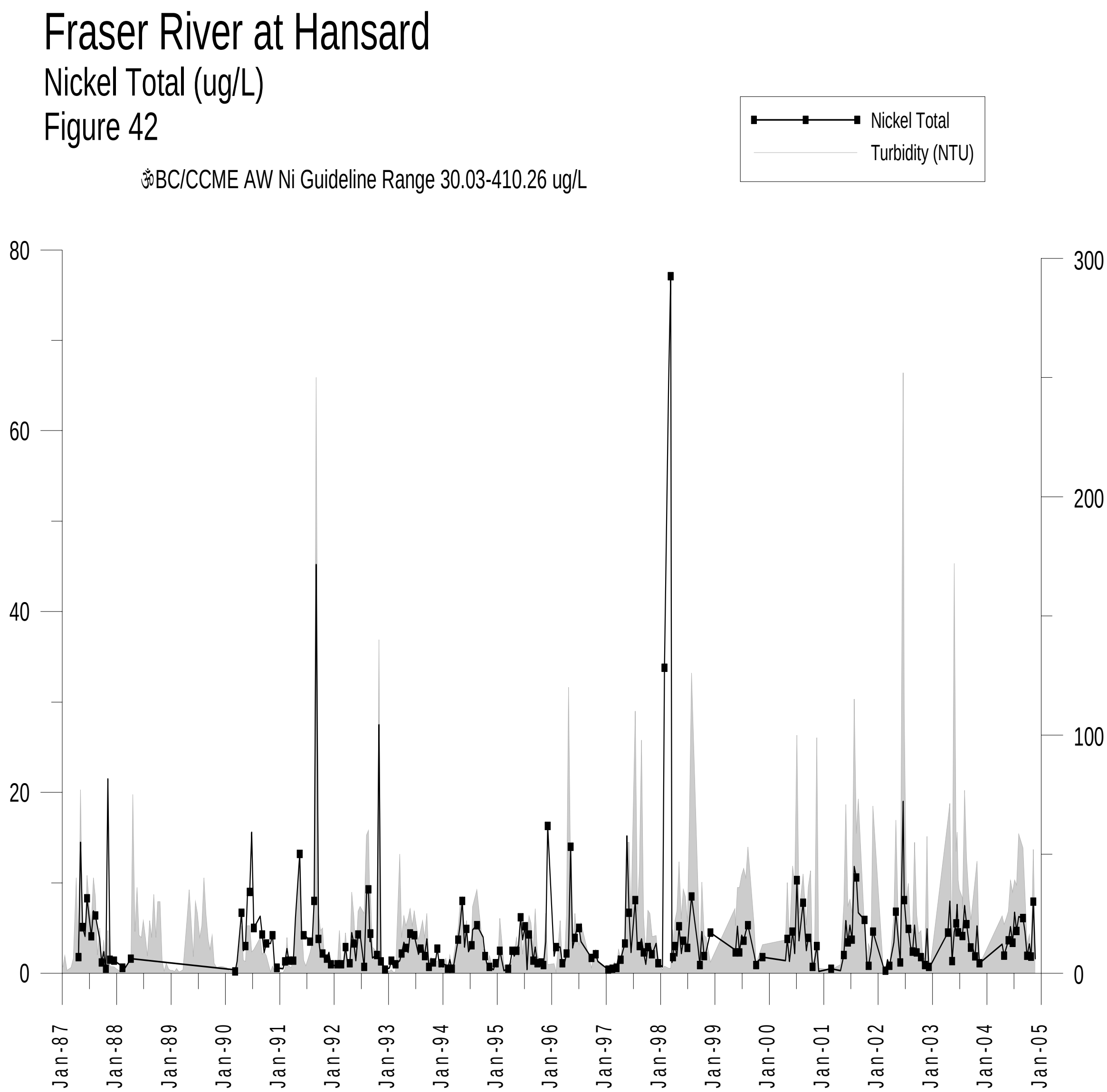
Figure 38

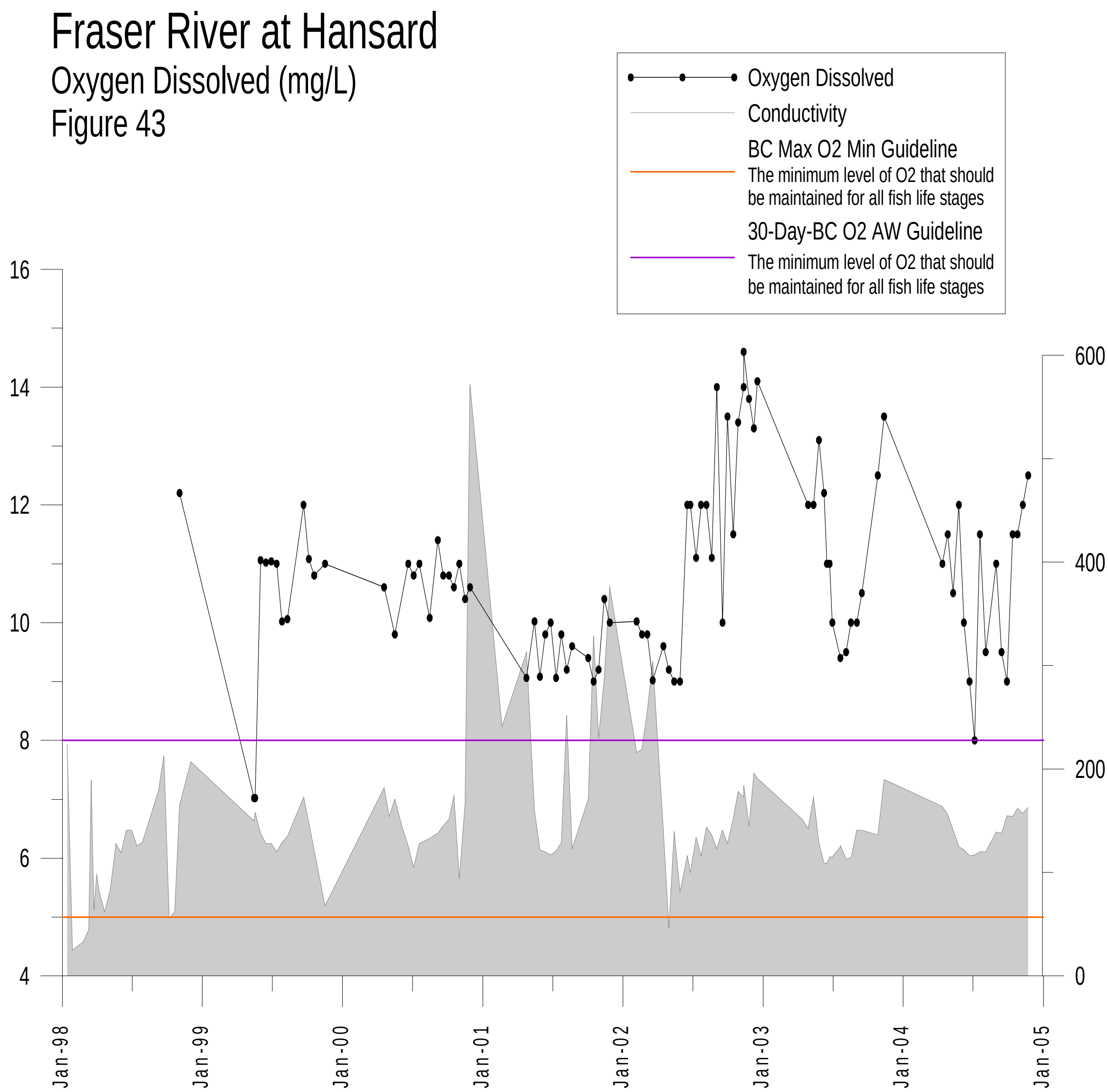


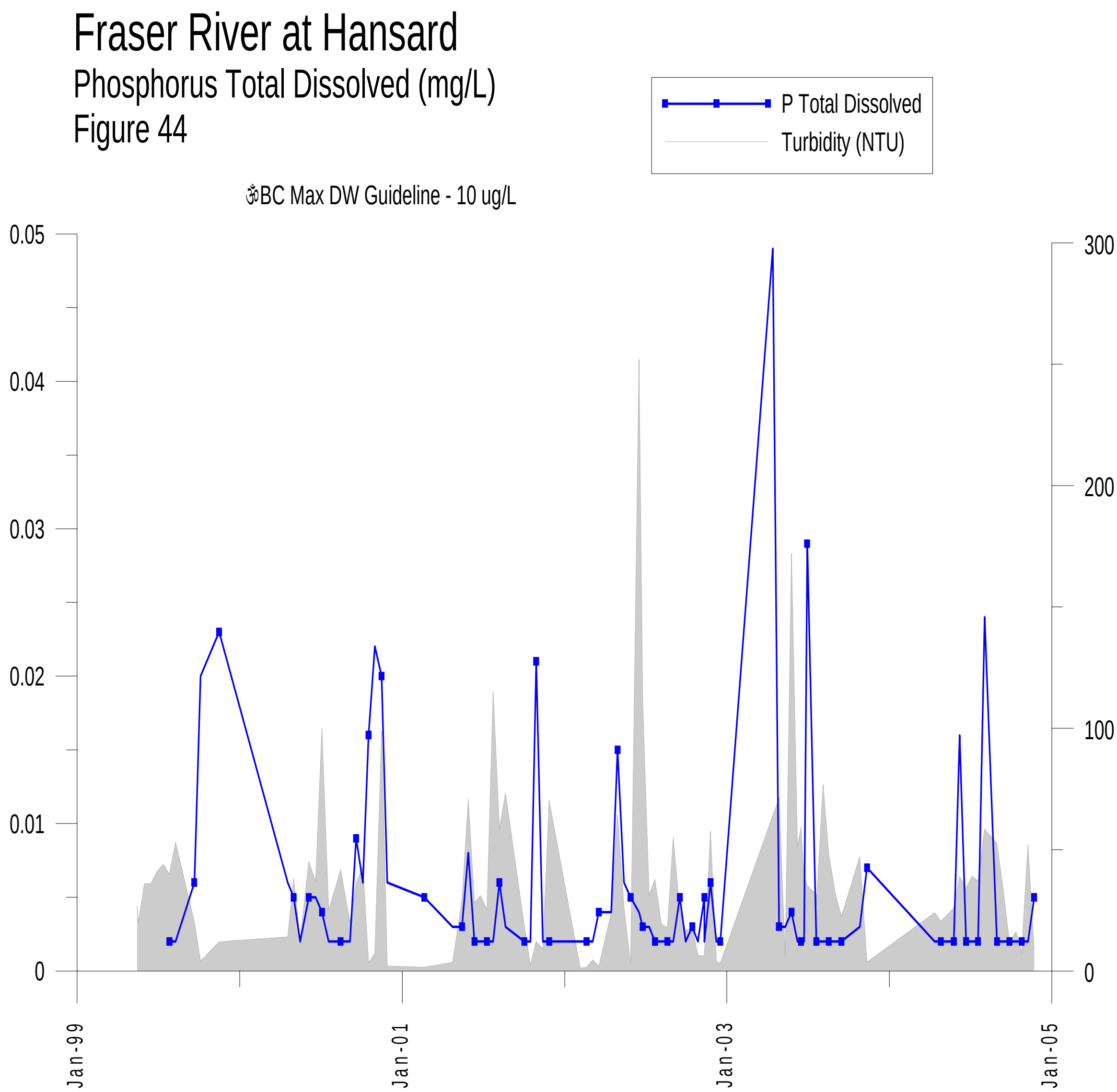

Fraser River at Hansard
Nitrogen Nitrite (mg/L)
Figure 39
ॐBC Max NO2 and NO3 DW Guideline 1 mg/L
ॐCCME Max NO2 AW Guideline 0.06 mg/L
Nitrogen Nitrite
Conductivity (uS/cm)
0.03
0.025
0.02
0.015
0.01
0.005
600
400
200
0
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99


Fraser River at Hansard
Nitrogen Total Dissolved (mg/L)
Figure 40
Nitrogen Total Dissolved
Conductivity (uS/cm)
0
2
4
6
0
200
400
600
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

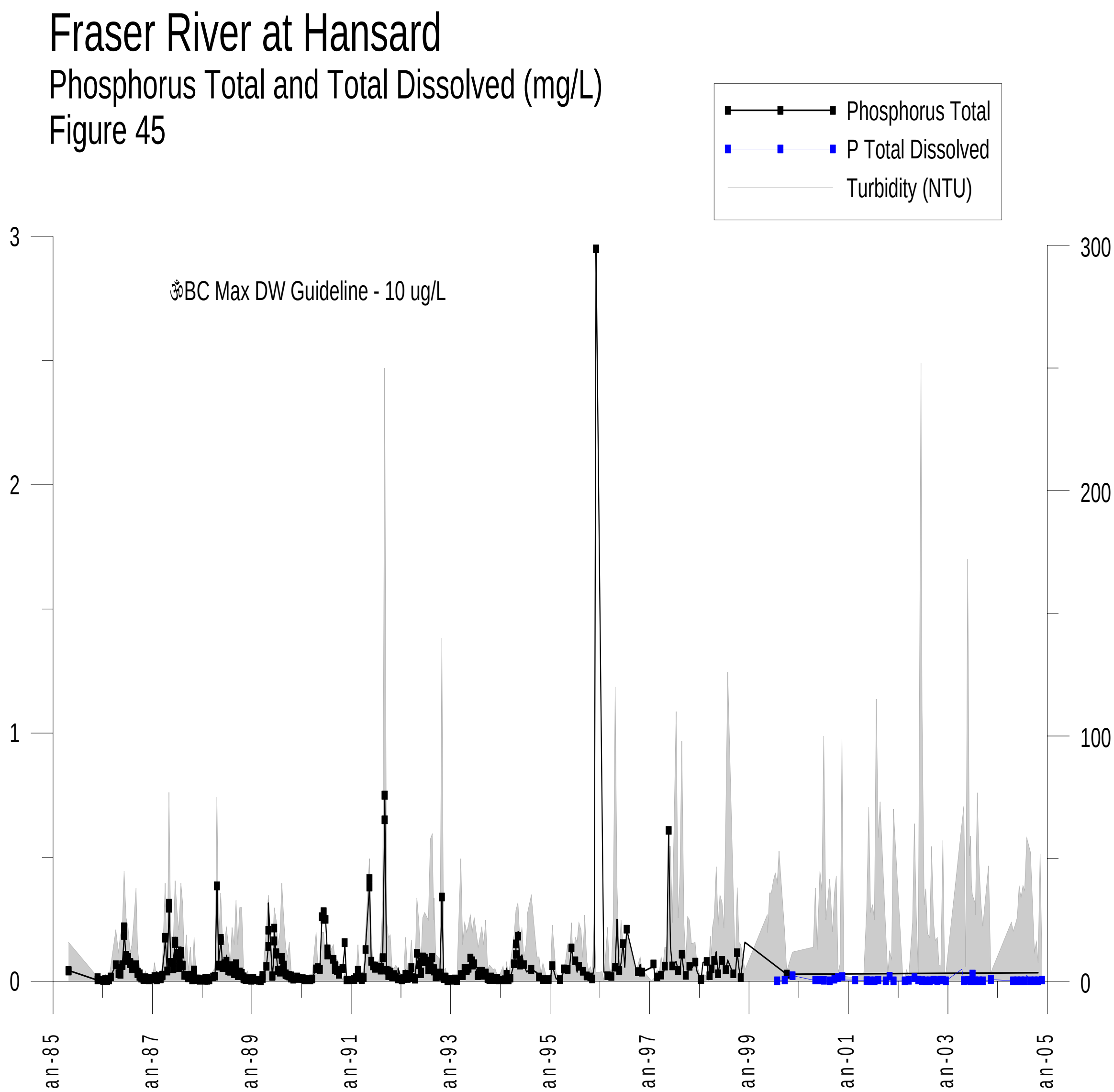

Fraser River at Hansard
Nitrogen Total (mg/L)
Figure 41
Nitrogen Total
Conductivity (uS/cm)
0.6
0.5
0.4
0.3
0.2
0.1
0
600
400
200
0
Jan-94
Feb-94
Mar-94
Apr-94

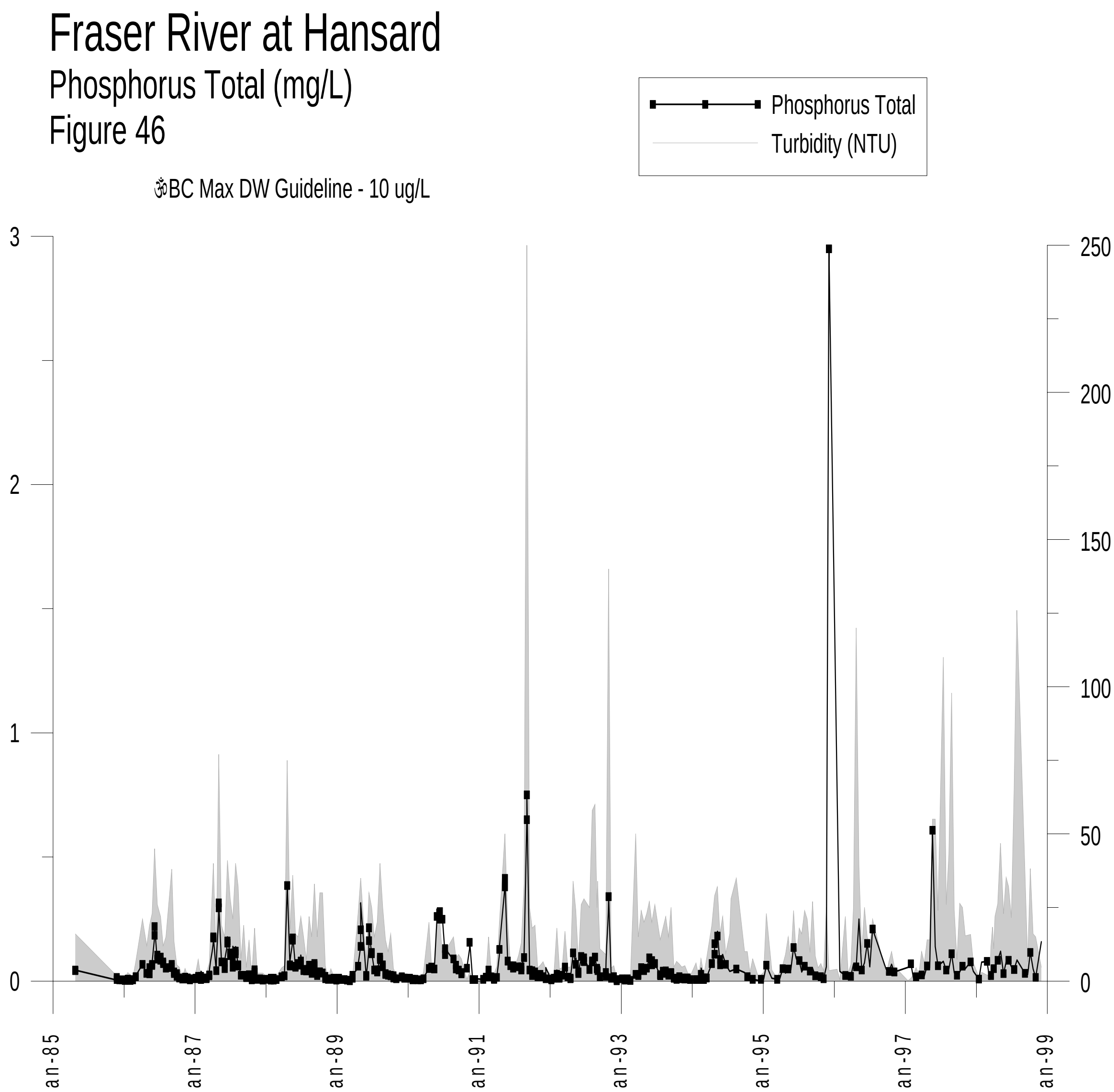

Fraser River at Hansard
Nickel Total (ug/L)
Figure 42
BC/CCME AW Ni Guideline Range 30.03-410.26 ug/L
Nickel Total
Turbidity (NTU)
80
60
40
20
0
300
200
100
0
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

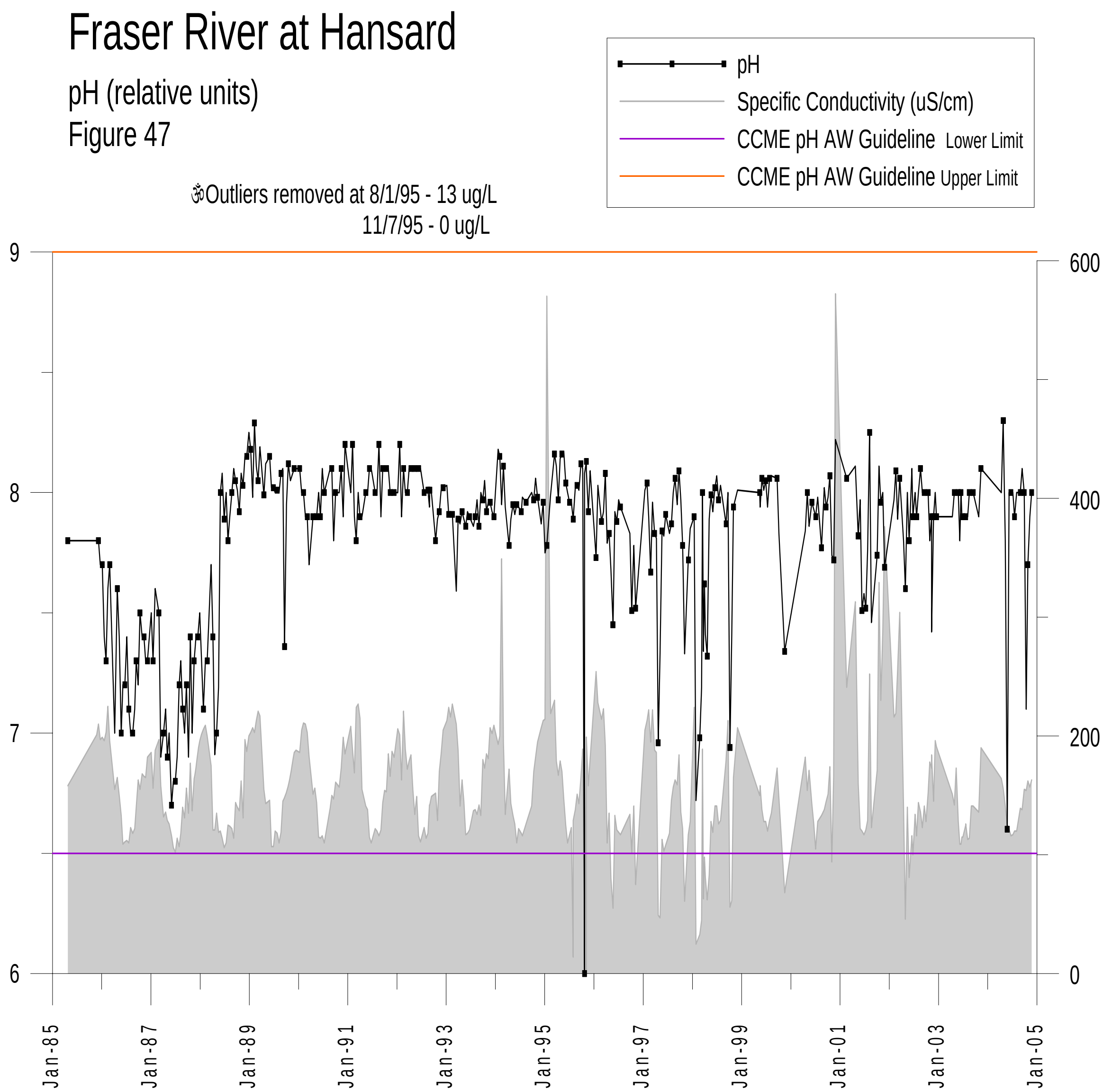

Fraser River at Hansard
Oxygen Dissolved (mg/L)
Figure 43
Oxygen Dissolved
Conductivity
BC Max O2 Min Guideline
The minimum level of O2 that should be maintained for all fish life stages
30-Day-BC O2 AW Guideline
The minimum level of O2 that should be maintained for all fish life stages
16
14
12
10
8
6
4
600
400
200
0
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

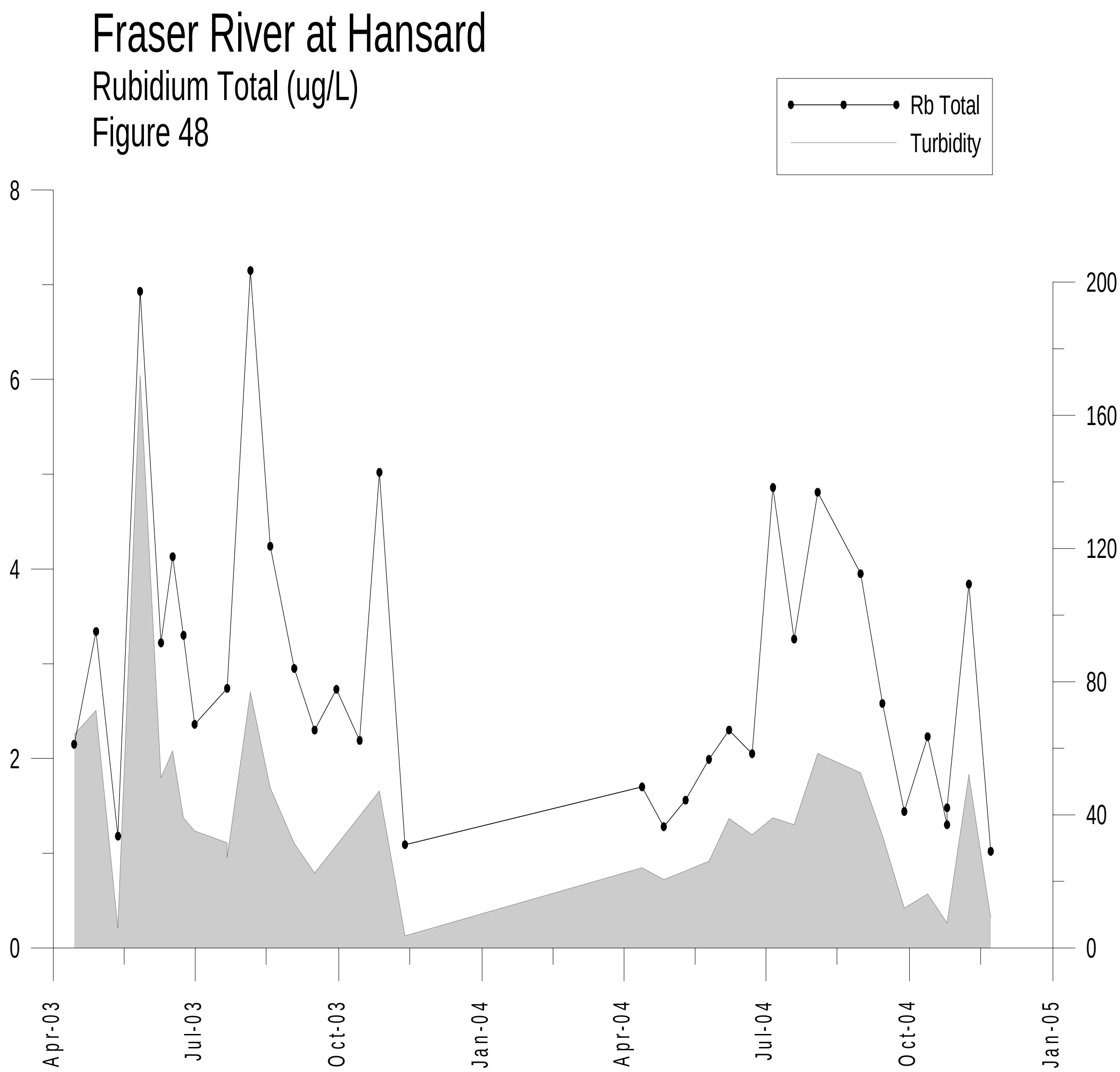


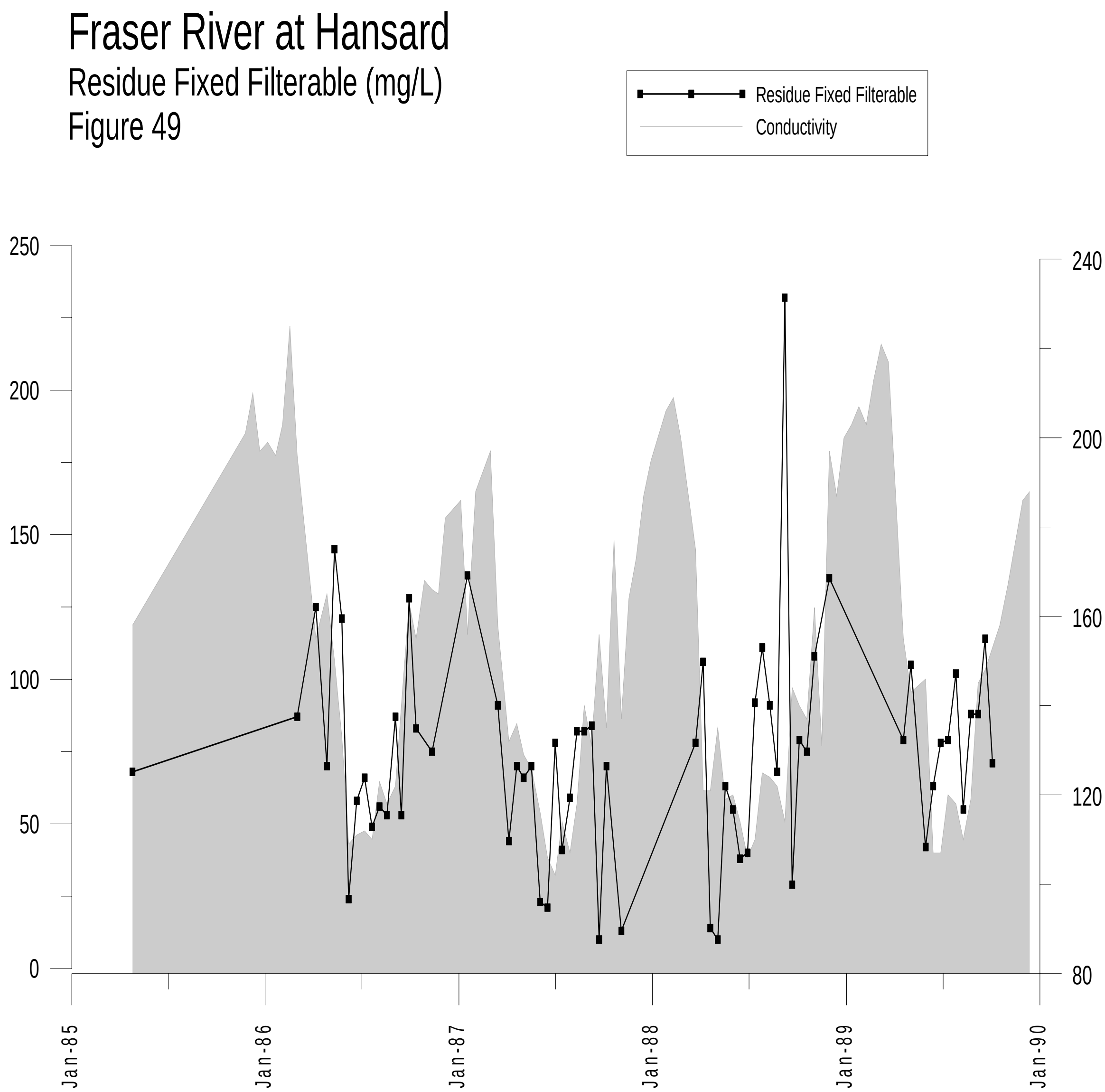
Fraser River at Hansard
Phosphorus Total Dissolved (mg/L)
Figure 44
P Total Dissolved
Turbidity (NTU)
BC Max DW Guideline - 10 ug/L
0.05
0.04
0.03
0.02
0.01
0
300
200
100
0
Jan-99
Jan-01
Jan-03
Jan-05

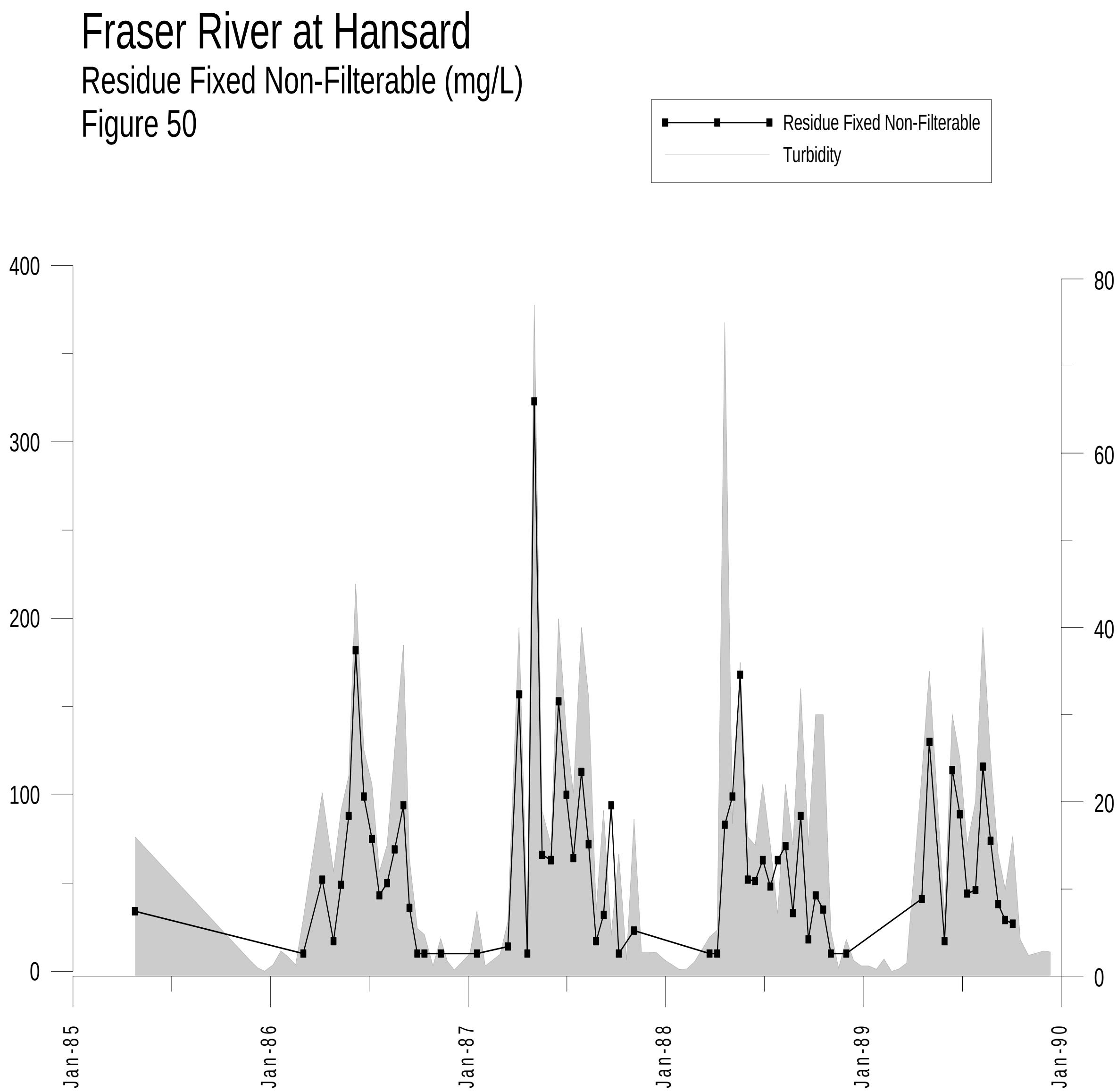

Fraser River at Hansard
Phosphorus Total and Total Dissolved (mg/L)
Figure 45
Phosphorus Total
P Total Dissolved
Turbidity (NTU)
BC Max DW Guideline - 10 ug/L
3
2
1
0
300
200
100
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

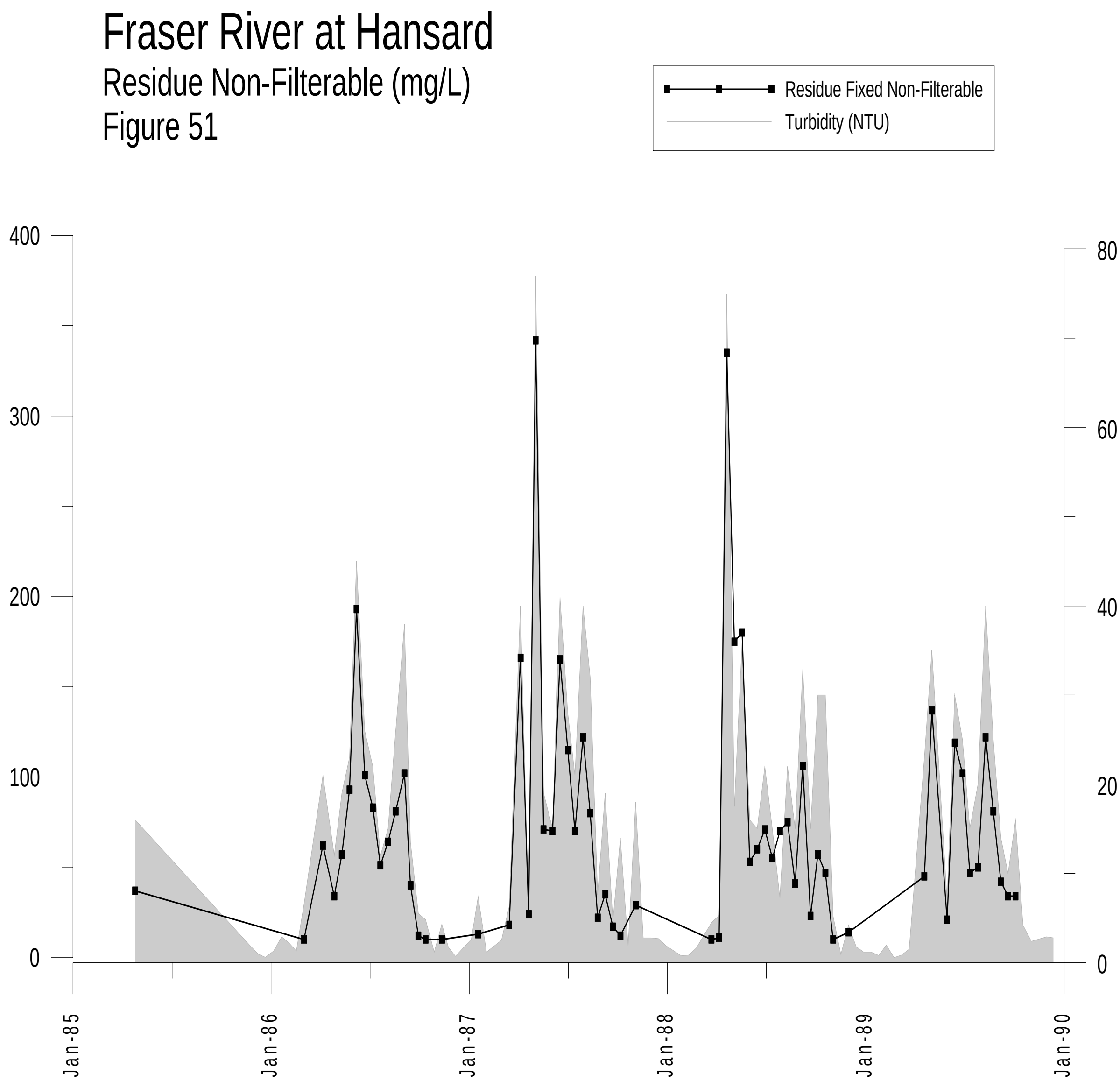

Fraser River at Hansard
Phosphorus Total (mg/L)
Figure 46
BC Max DW Guideline - 10 ug/L
Phosphorus Total
Turbidity (NTU)
3
2
1
0
250
200
150
100
50
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99

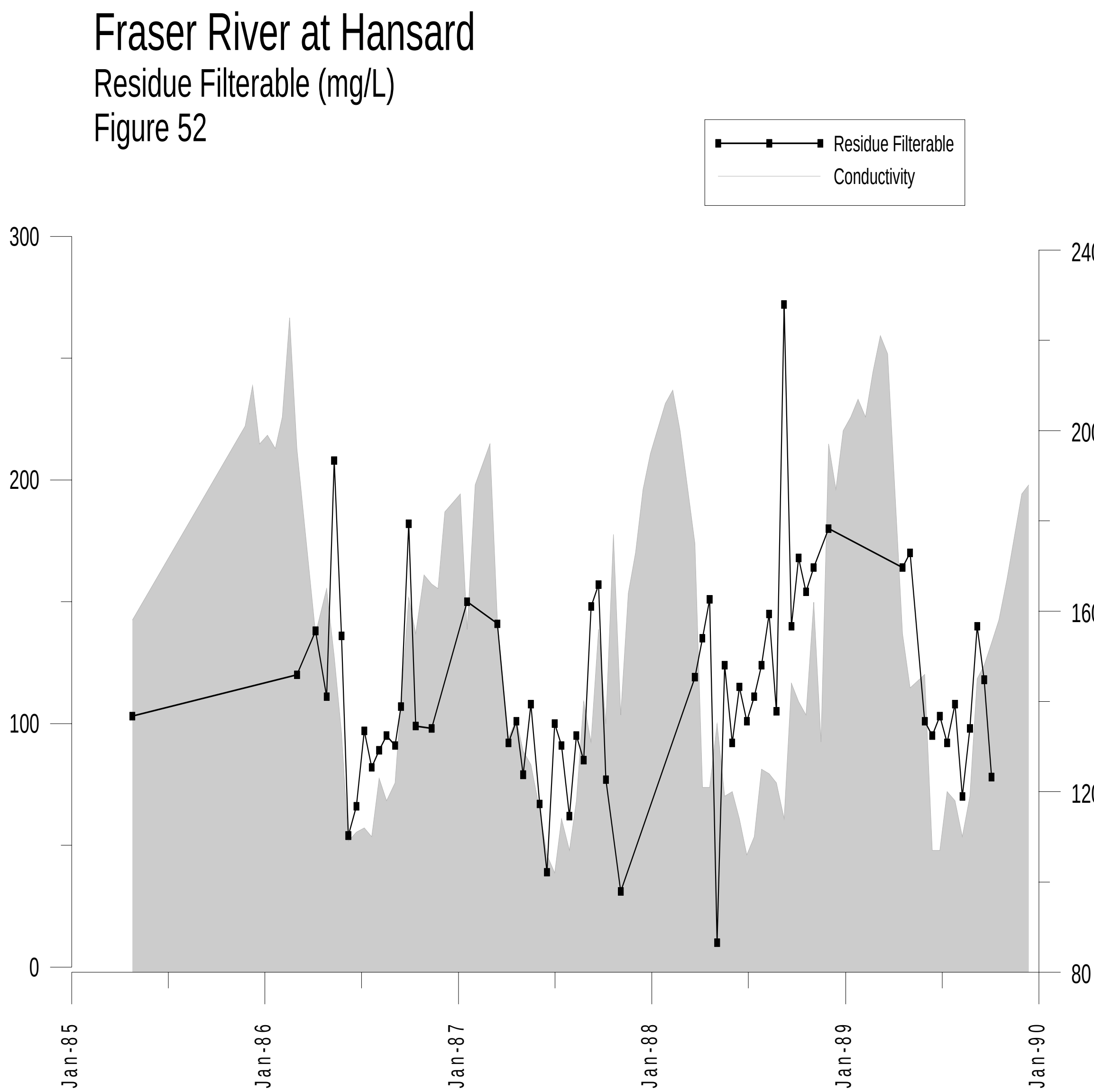

Fraser River at Hansard
pH (relative units)
Figure 47
Outliers removed at 8/1/95 - 13 ug/L
11/7/95 - 0 ug/L
pH
Specific Conductivity (uS/cm)
CCME pH AW Guideline Lower Limit
CCME pH AW Guideline Upper Limit
9
8
7
6
600
400
200
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

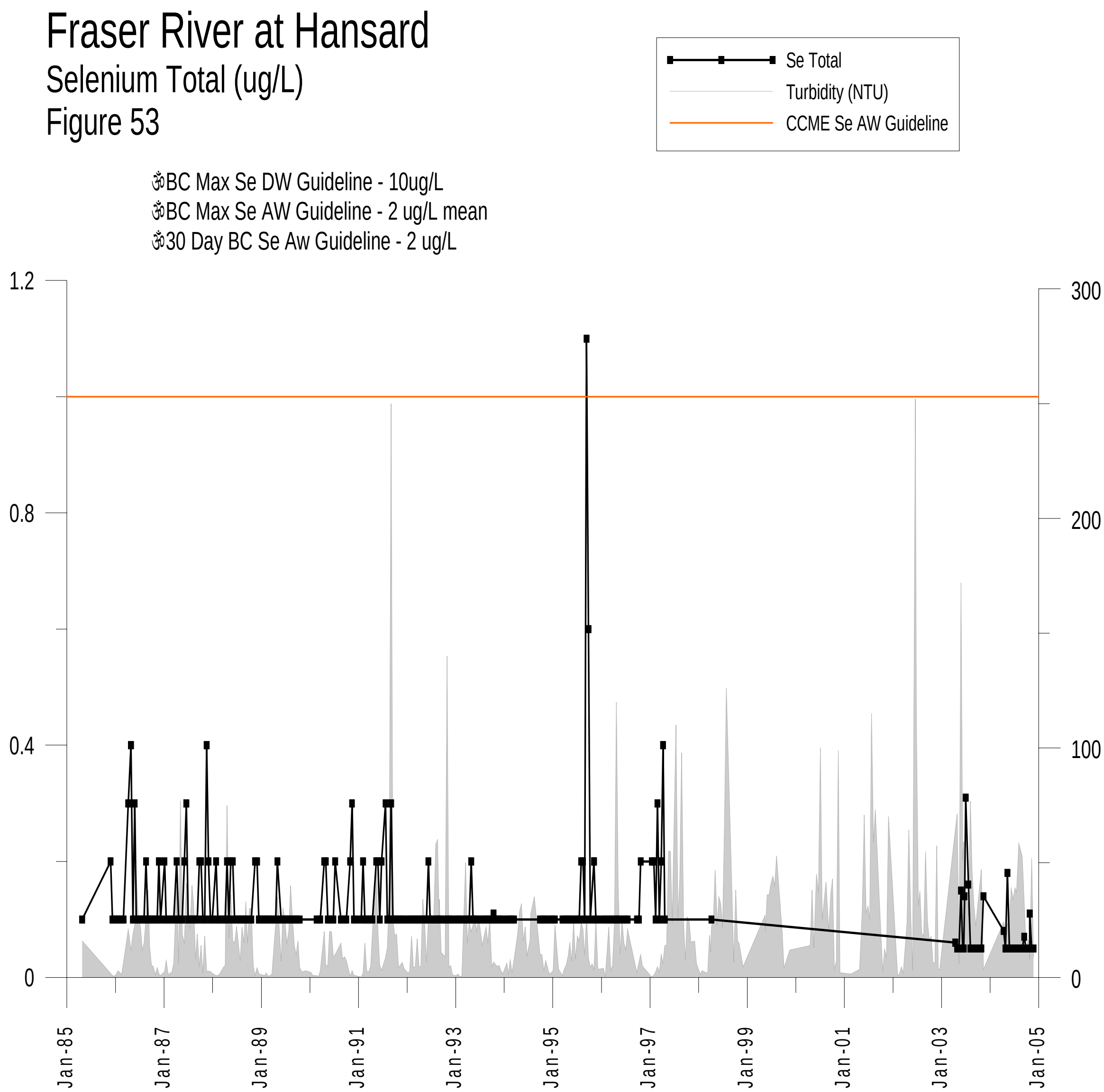

Fraser River at Hansard
Rubidium Total (ug/L)
Figure 48
Rb Total
Turbidity
0
2
4
6
8
0
40
80
120
160
200
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05

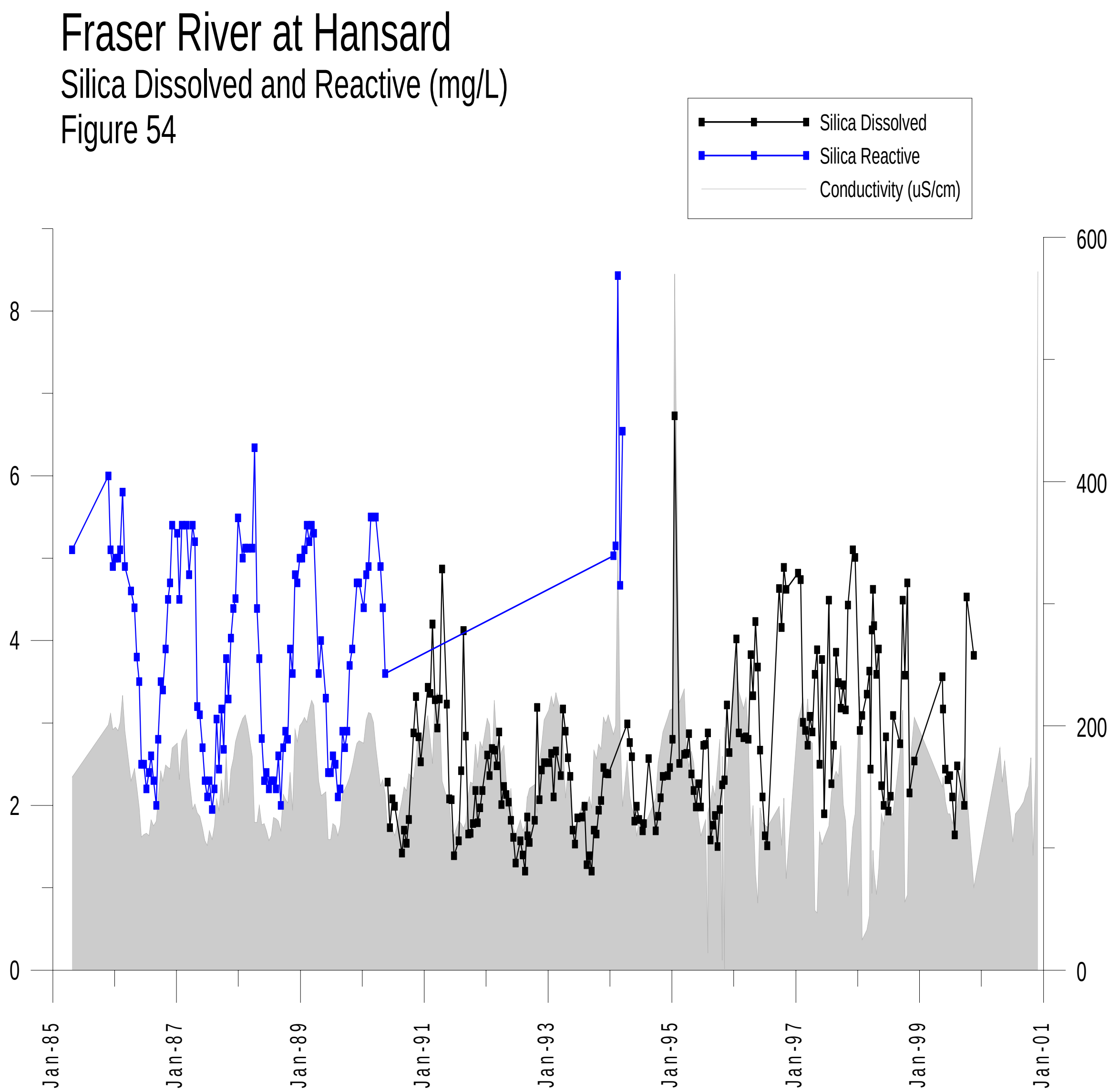

Fraser River at Hansard
Residue Fixed Filterable (mg/L)
Figure 49
Residue Fixed Filterable
Conductivity
250
200
150
100
50
0
240
200
160
120
80
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90

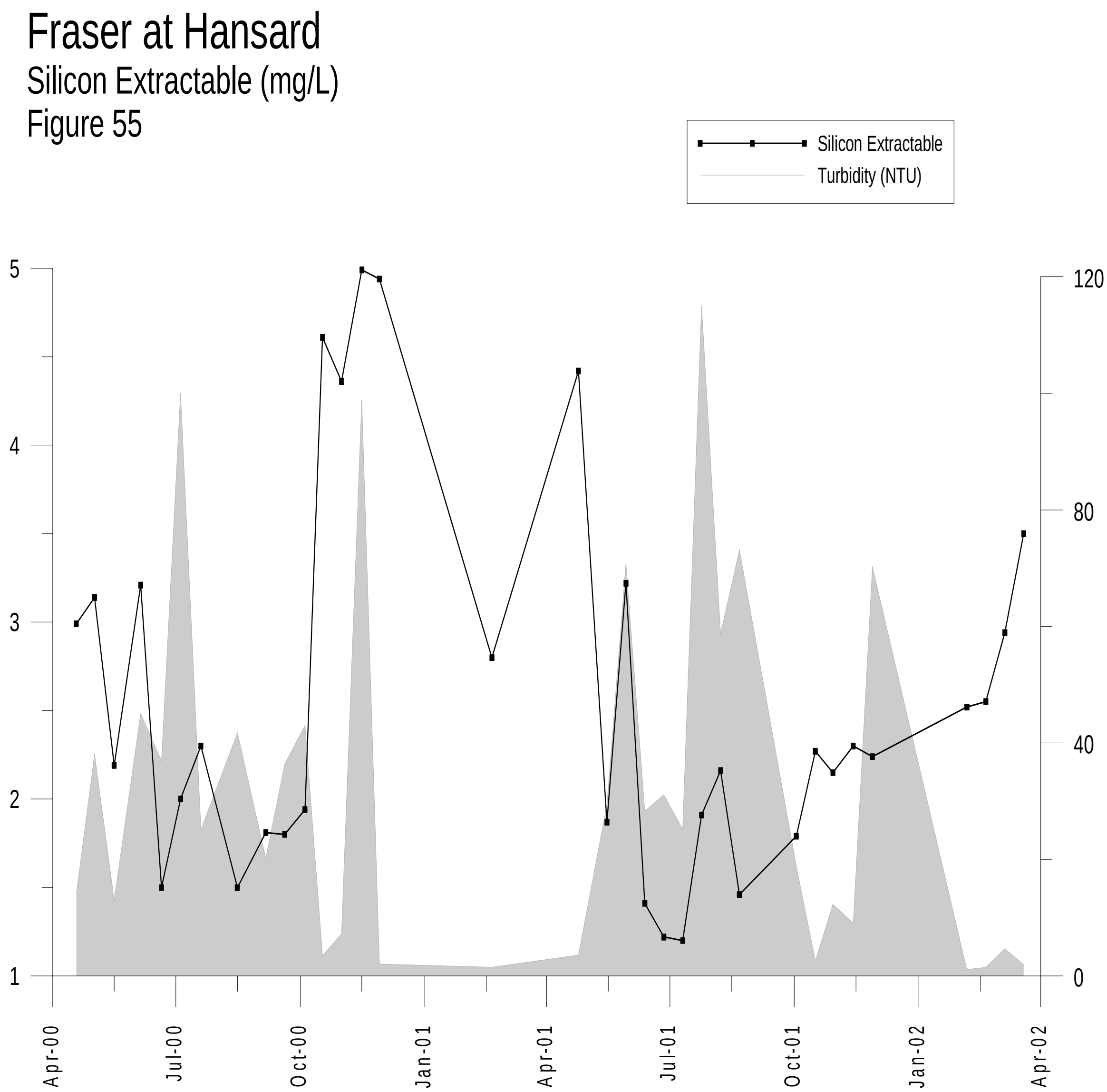

Fraser River at Hansard
Residue Fixed Non-Filterable (mg/L)
Figure 50
Residue Fixed Non-Filterable
Turbidity
400
300
200
100
0
80
60
40
20
0
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90

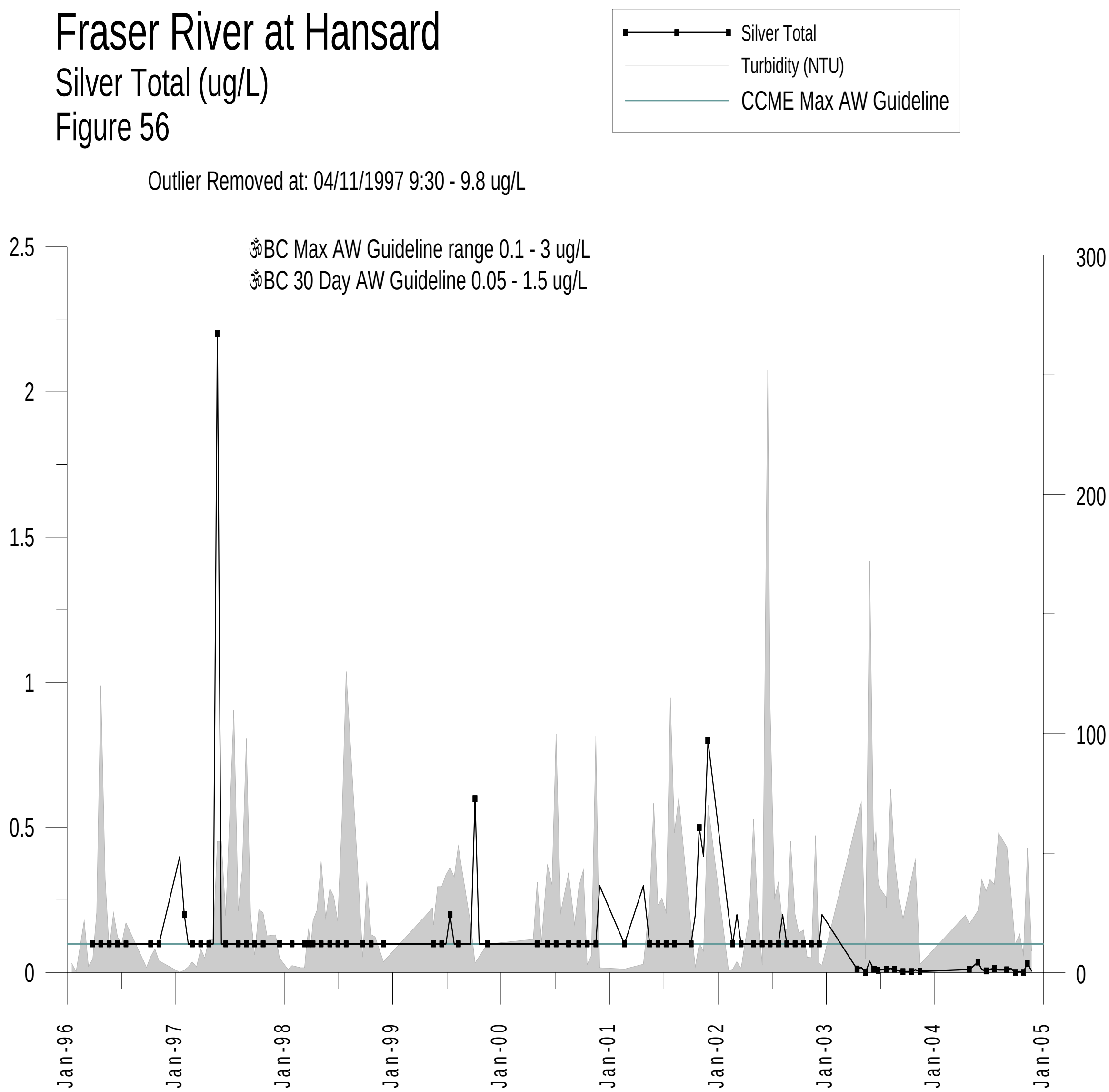

Fraser River at Hansard
Residue Non-Filterable (mg/L)
Figure 51
Residue Fixed Non-Filterable
Turbidity (NTU)
400
300
200
100
0
80
60
40
20
0
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90

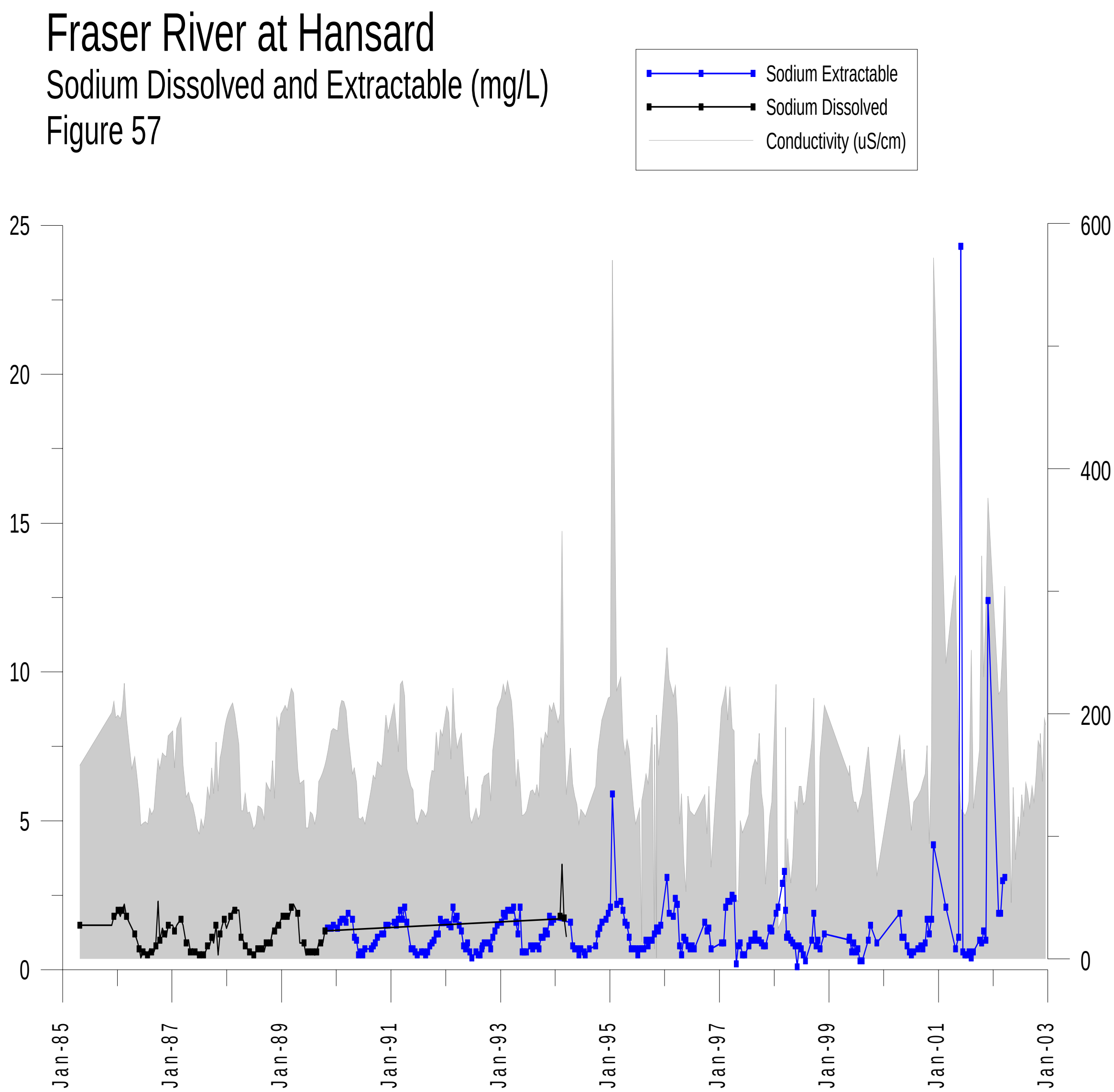

Fraser River at Hansard
Residue Filterable (mg/L)
Figure 52
Residue Filterable
Conductivity
300
200
100
0
240
200
160
120
80
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90

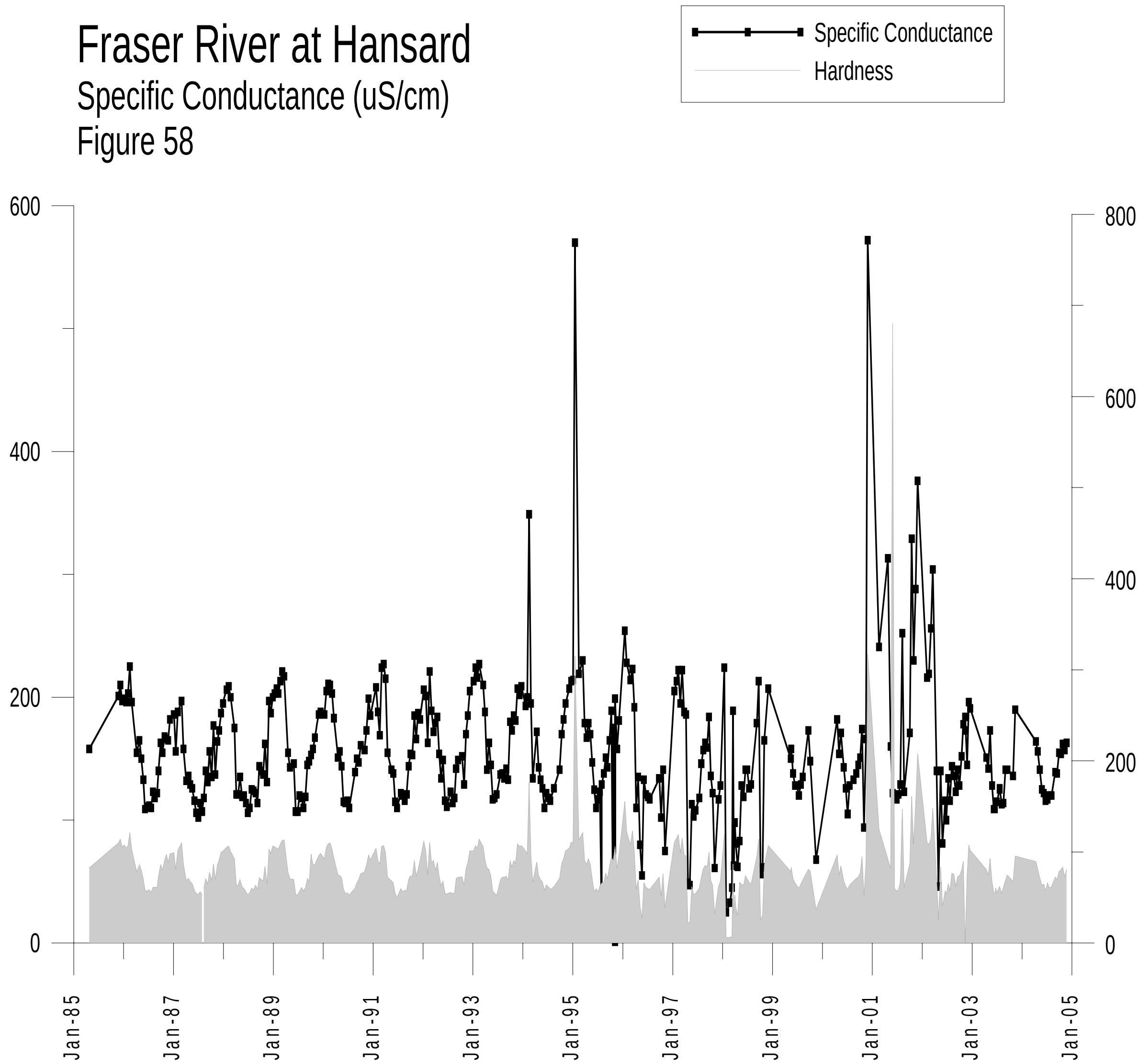

Fraser River at Hansard
Selenium Total (ug/L)
Figure 53
Se Total
Turbidity (NTU)
CCME Se AW Guideline
BC Max Se DW Guideline - 10ug/L
BC Max Se AW Guideline - 2 ug/L mean
30 Day BC Se Aw Guideline - 2 ug/L
1.2
0.8
0.4
0
300
200
100
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

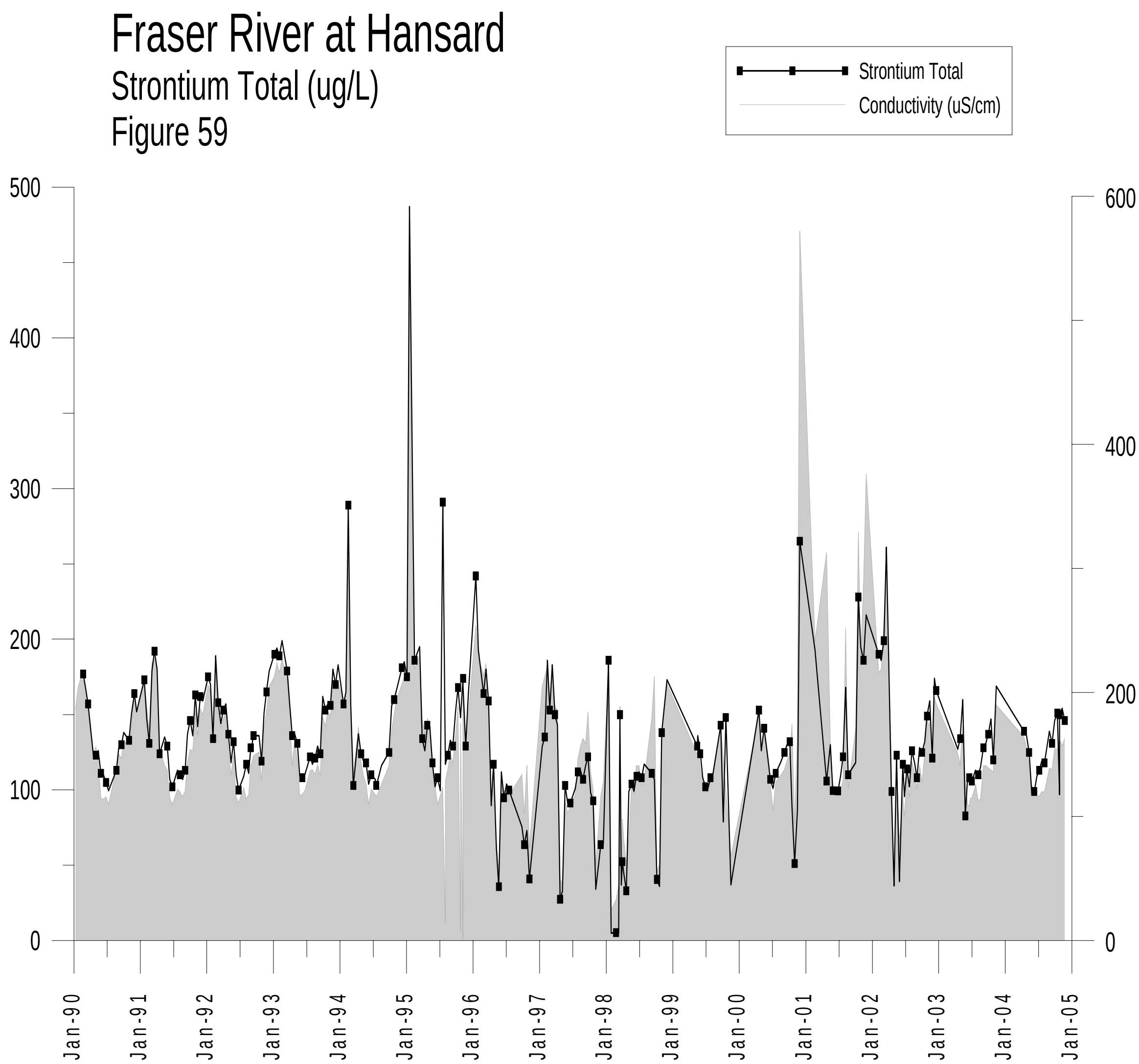

Fraser River at Hansard
Silica Dissolved and Reactive (mg/L)
Figure 54
Silica Dissolved
Silica Reactive
Conductivity (uS/cm)
0
2
4
6
8
0
200
400
600
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01

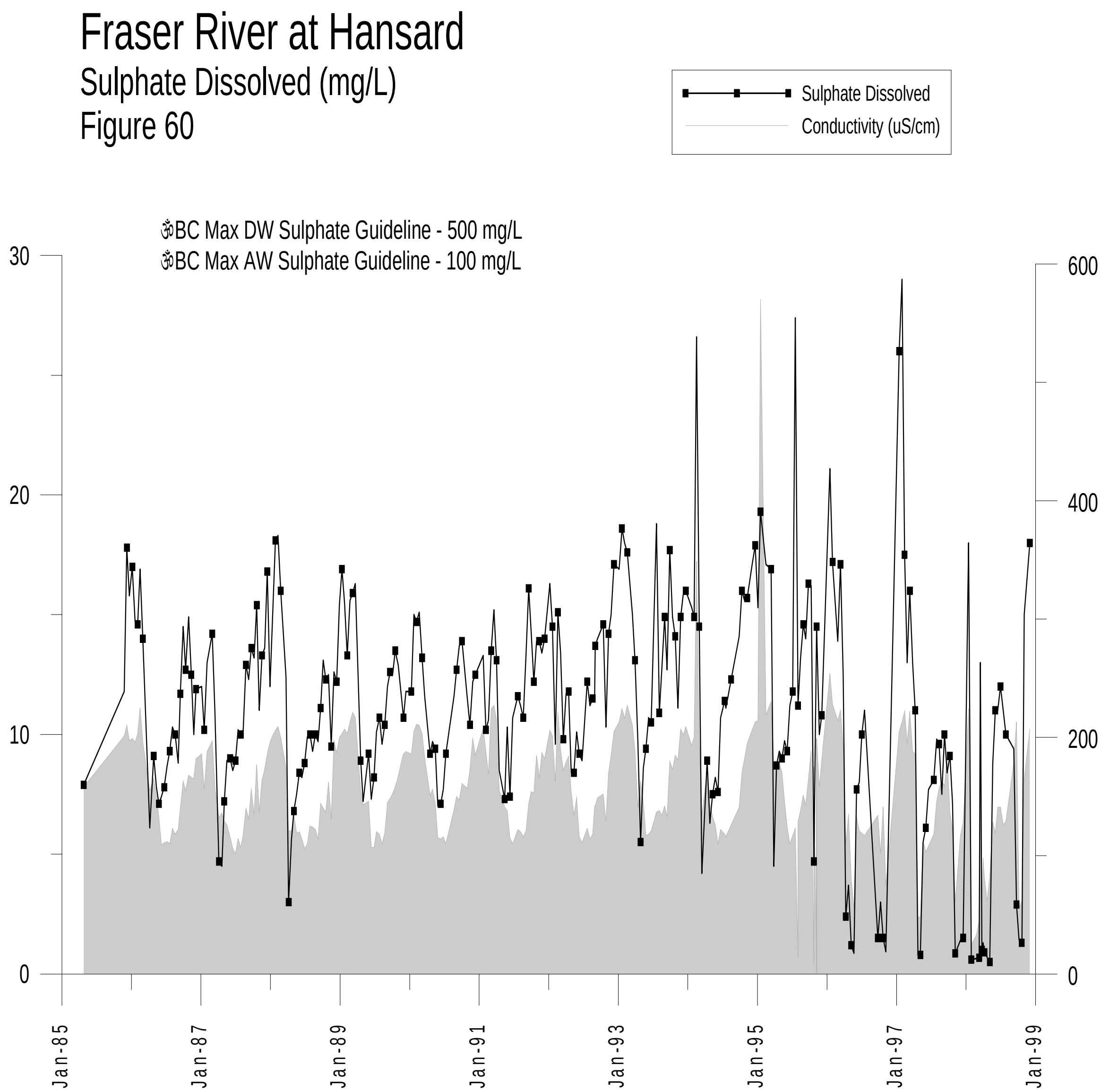

Fraser at Hansard
Silicon Extractable (mg/L)
Figure 55
Silicon Extractable
Turbidity (NTU)
5
4
3
2
1
120
80
40
0
Apr-00
Jul-00
Oct-00
Jan-01
Apr-01
Jul-01
Oct-01
Jan-02
Apr-02

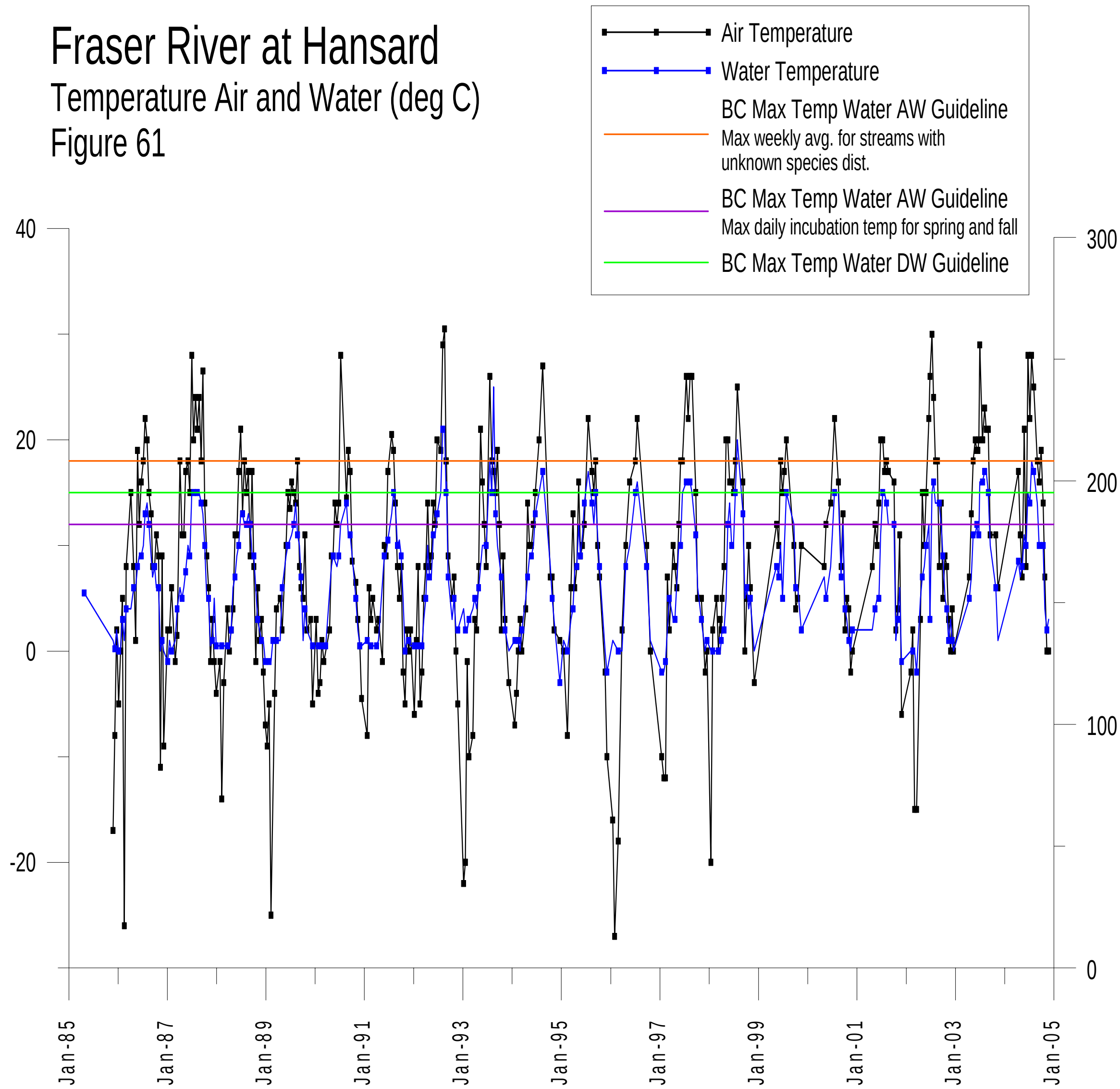

Fraser River at Hansard
Silver Total (ug/L)
Figure 56
Silver Total
Turbidity (NTU)
CCME Max AW Guideline
Outlier Removed at: 04/11/1997 9:30 - 9.8 ug/L
BC Max AW Guideline range 0.1 - 3 ug/L
BC 30 Day AW Guideline 0.05 - 1.5 ug/L
2.5
2
1.5
1
0.5
0
300
200
100
0
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05


Fraser River at Hansard
Sodium Dissolved and Extractable (mg/L)
Figure 57
Sodium Extractable
Sodium Dissolved
Conductivity (uS/cm)
25
20
15
10
5
0
600
400
200
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03

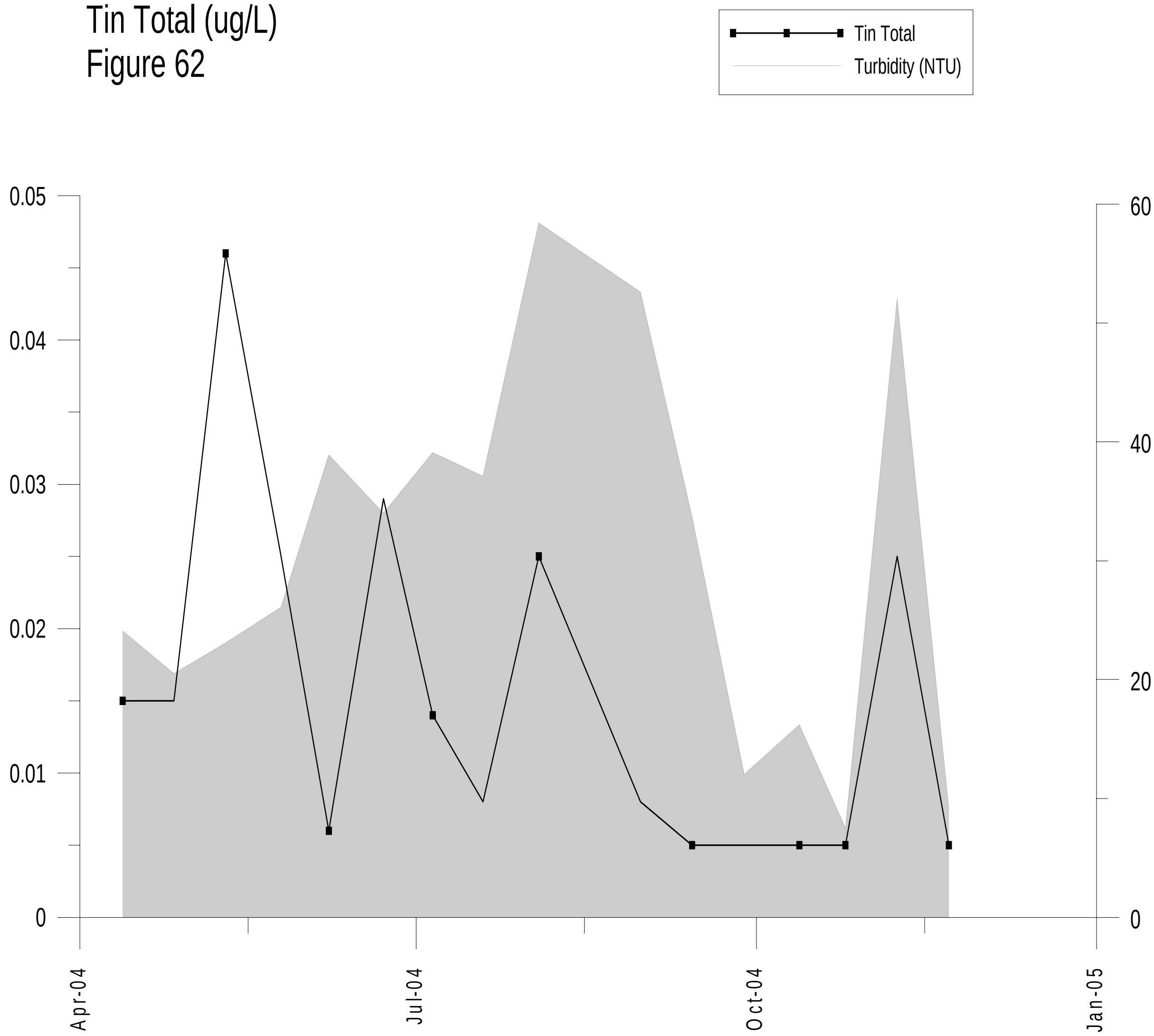

Fraser River at Hansard
Specific Conductance (uS/cm)
Figure 58
Specific Conductance
Hardness
600
400
200
0
800
600
400
200
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

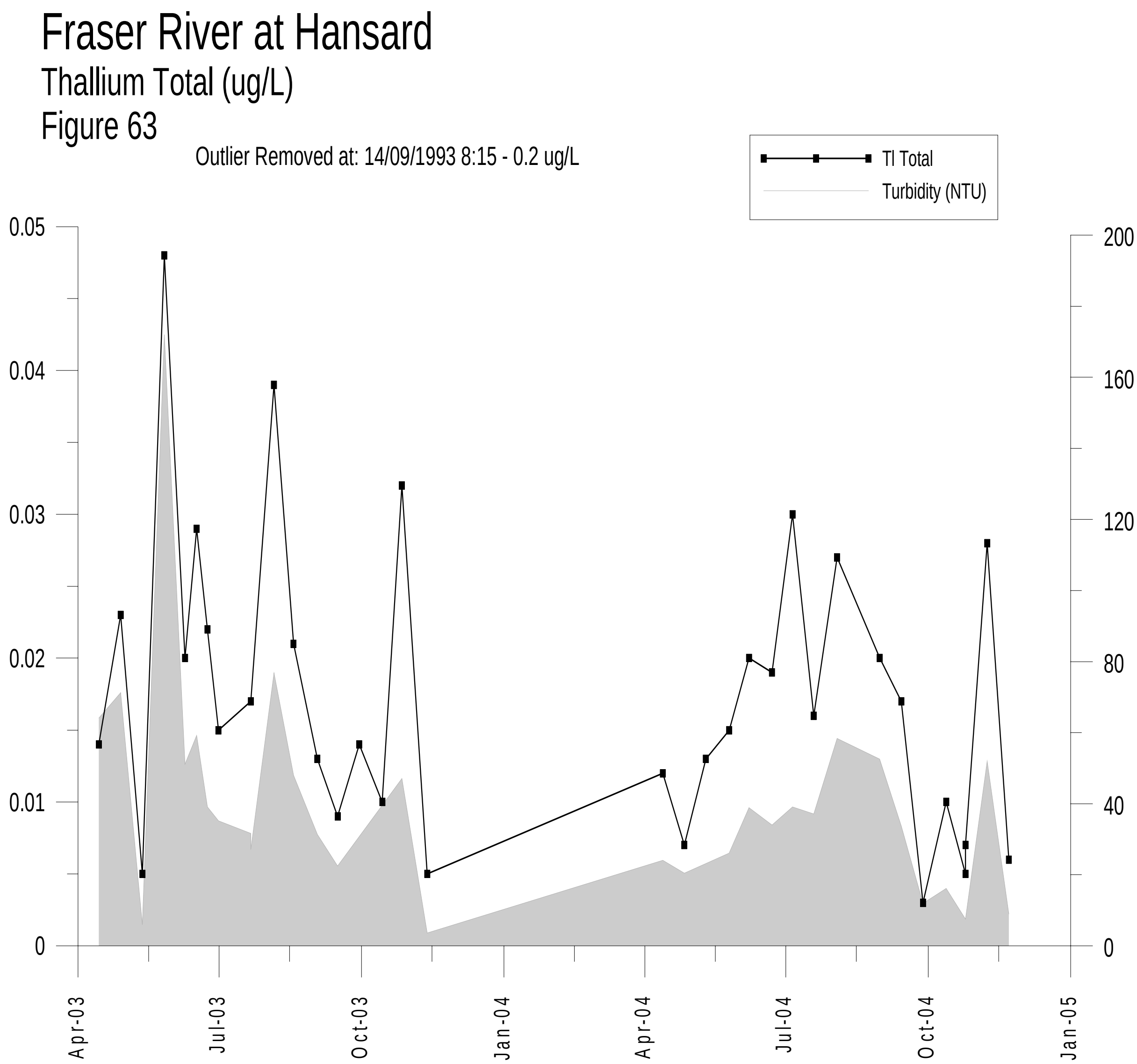

Fraser River at Hansard
Strontium Total (ug/L)
Figure 59
Strontium Total
Conductivity (uS/cm)
500
400
300
200
100
0
600
400
200
0
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

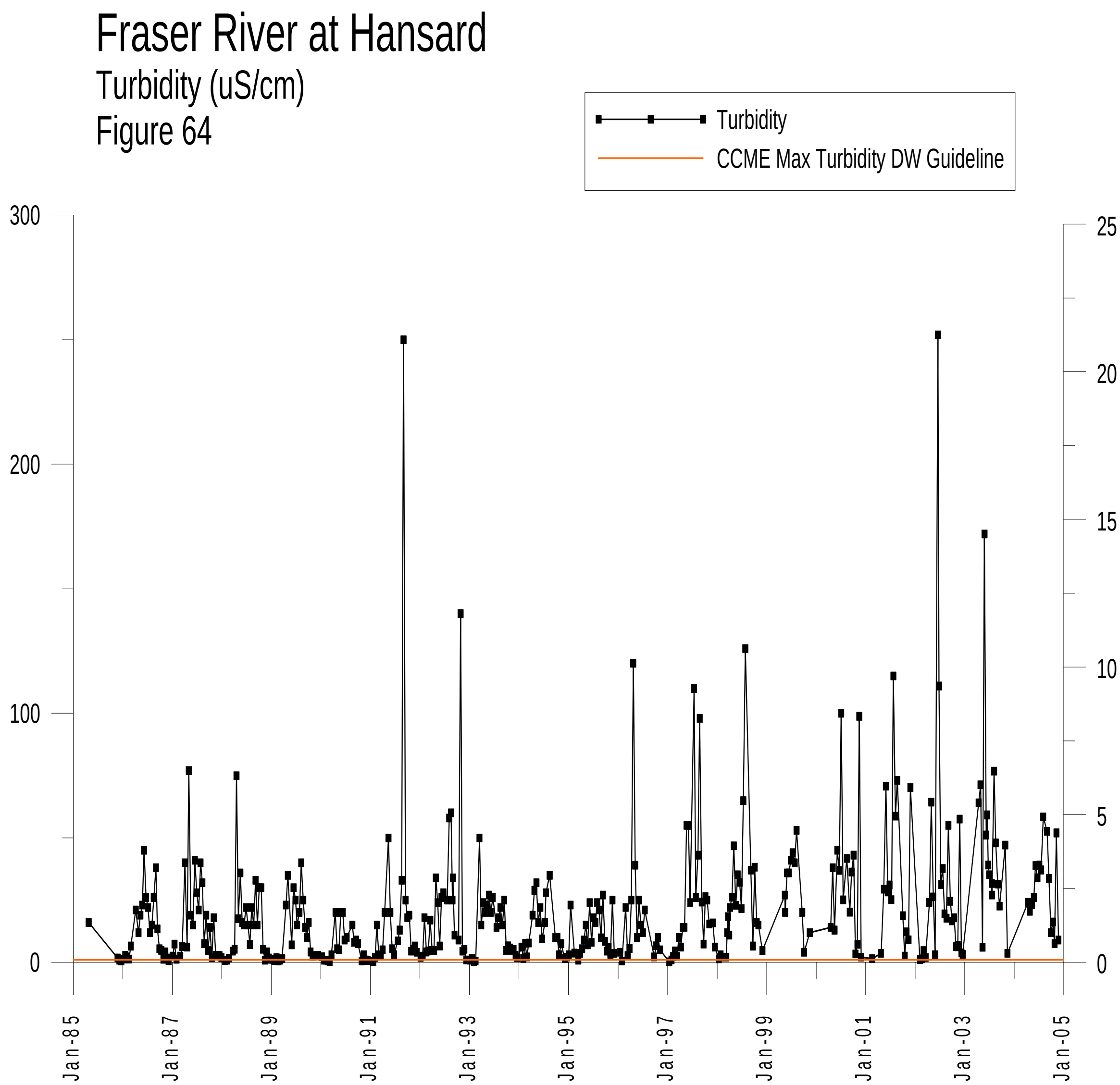

Fraser River at Hansard
Sulphate Dissolved (mg/L)
Figure 60
Sulphate Dissolved
Conductivity (uS/cm)
ॐBC Max DW Sulphate Guideline - 500 mg/L
ॐBC Max AW Sulphate Guideline - 100 mg/L
30
20
10
0
600
400
200
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99

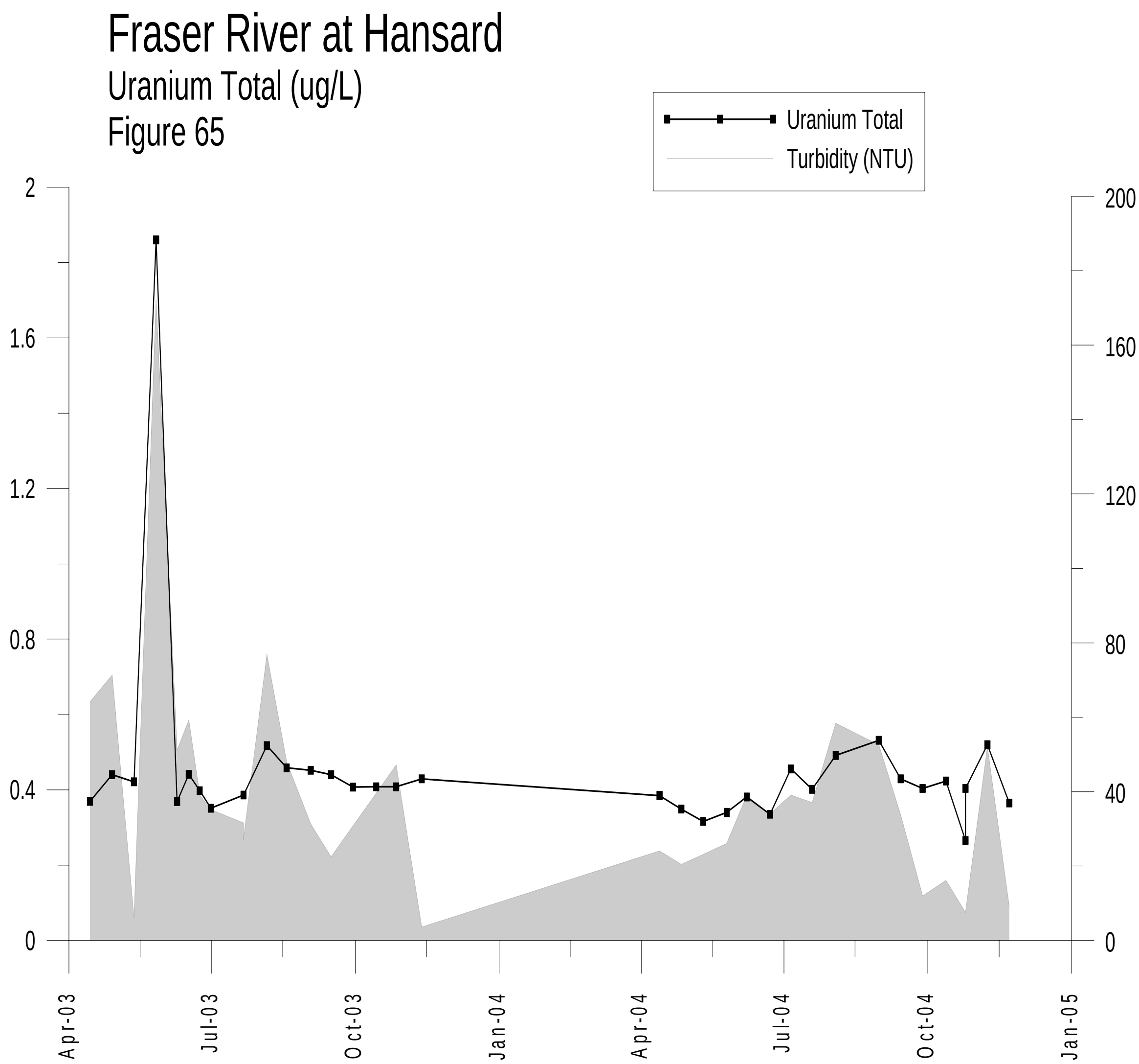

Fraser River at Hansard
Temperature Air and Water (deg C)
Figure 61
Air Temperature
Water Temperature
BC Max Temp Water AW Guideline
Max weekly avg. for streams with unknown species dist.
BC Max Temp Water AW Guideline
Max daily incubation temp for spring and fall
BC Max Temp Water DW Guideline
40
20
0
-20
300
200
100
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

Fraser River at Hansard
Tin Total (ug/L)
Figure 62

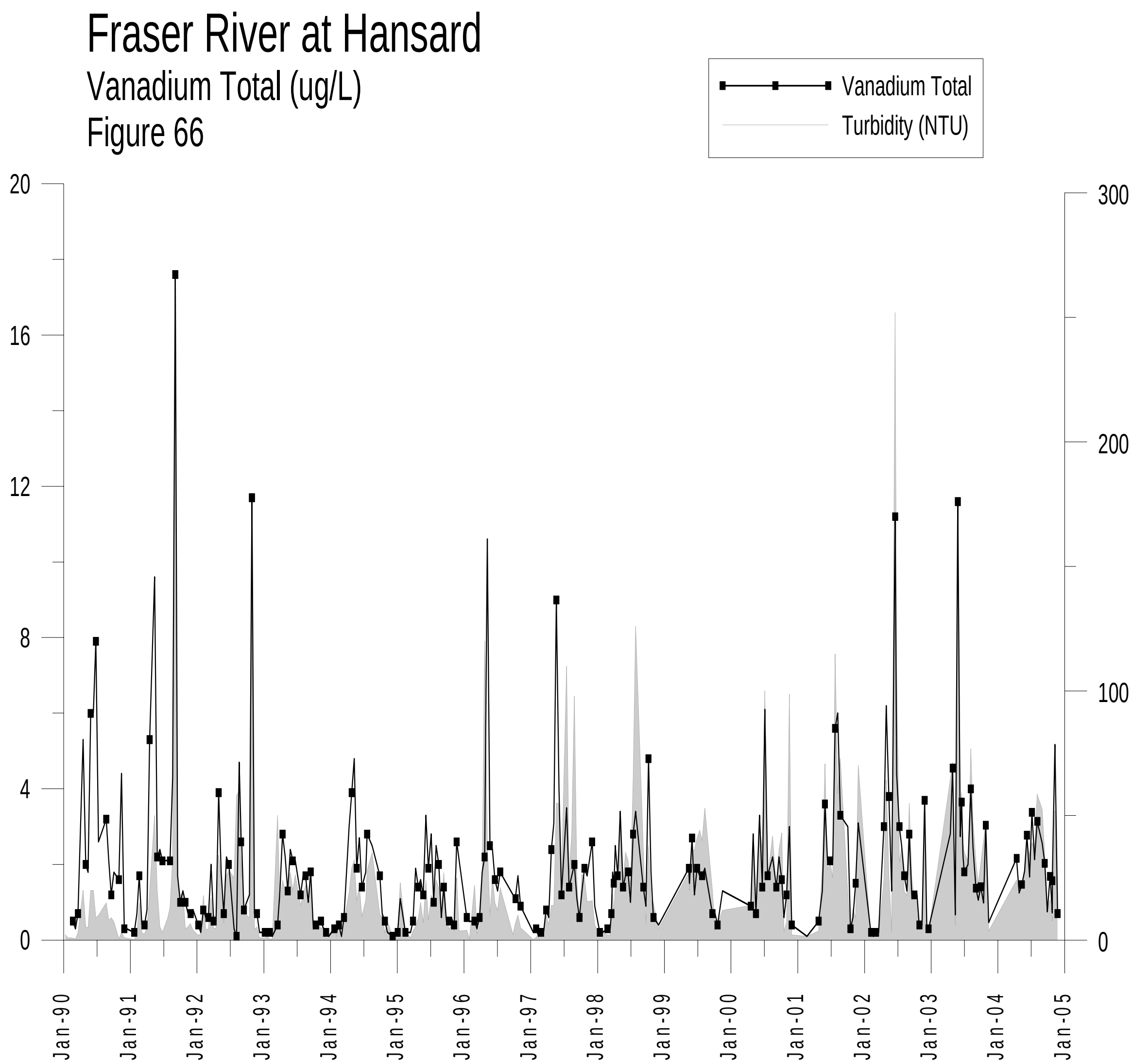


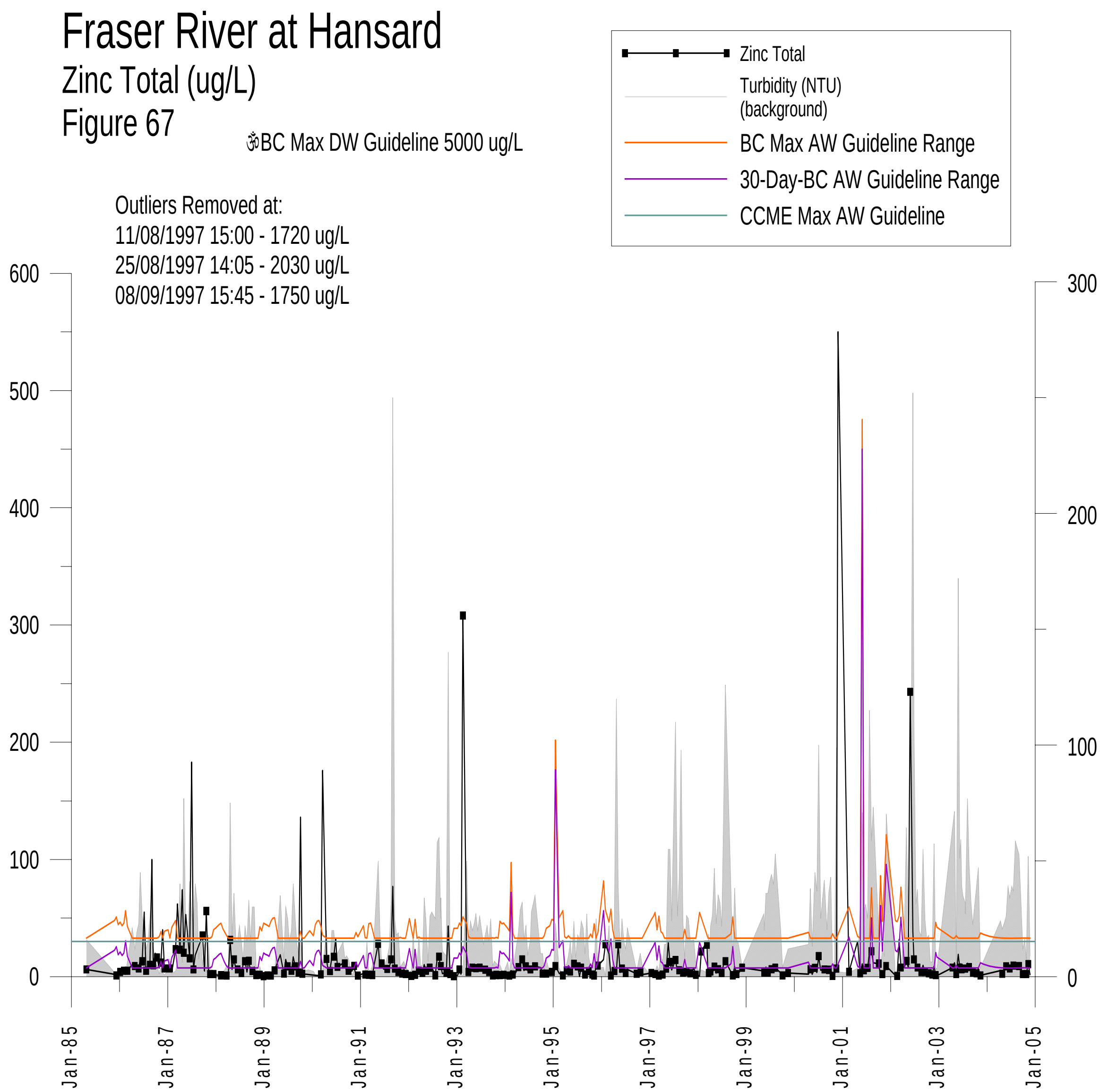

Fraser River at Hansard
Thallium Total (ug/L)
Figure 63
Outlier Removed at: 14/09/1993 8:15 - 0.2 ug/L
Tl Total
Turbidity (NTU)
0.05
0.04
0.03
0.02
0.01
0
200
160
120
80
40
0
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05


Fraser River at Hansard
Turbidity (uS/cm)
Figure 64
Turbidity
CCME Max Turbidity DW Guideline
300
200
100
0
25
20
15
10
5
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

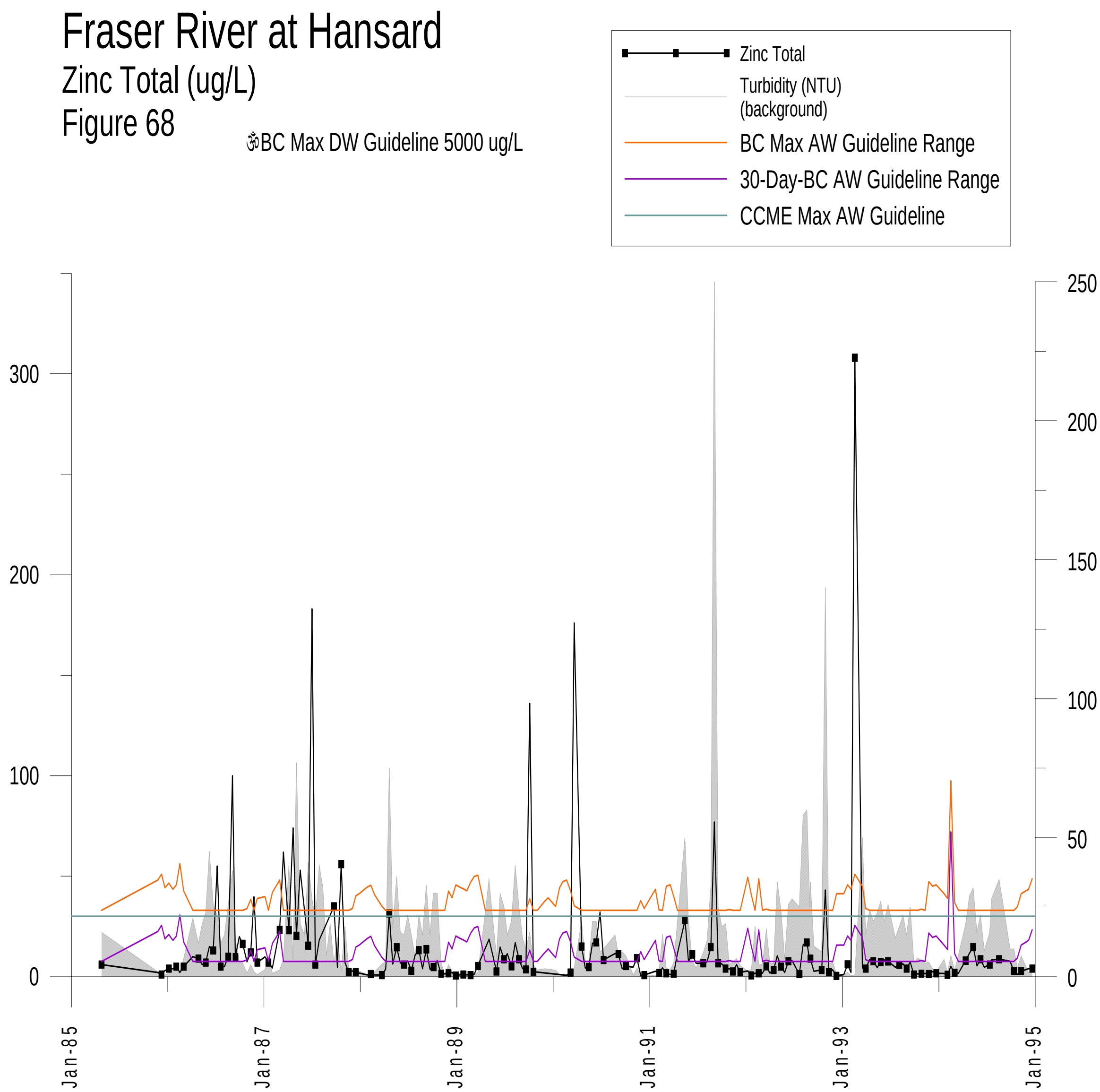


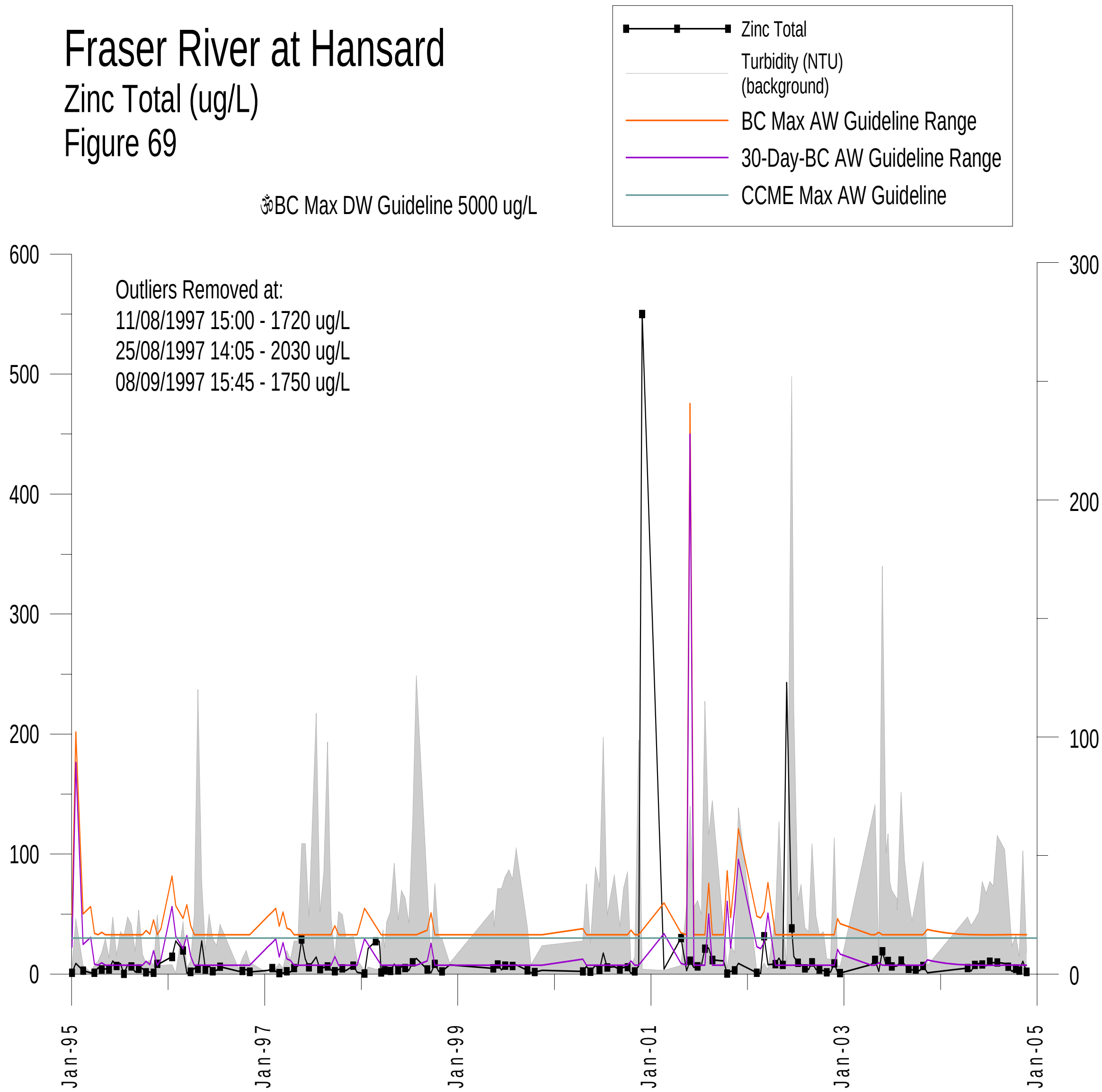
Fraser River at Hansard
Uranium Total (ug/L)
Figure 65
Uranium Total
Turbidity (NTU)
2
1.6
1.2
0.8
0.4
0
200
160
120
80
40
0
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05


Fraser River at Hansard
Vanadium Total (ug/L)
Figure 66
Vanadium Total
Turbidity (NTU)
20
16
12
8
4
0
300
200
100
0
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05



Fraser River at Hansard
Zinc Total (ug/L)
Figure 67
BC Max DW Guideline 5000 ug/L
Outliers Removed at:
11/08/1997 15:00 - 1720 ug/L
25/08/1997 14:05 - 2030 ug/L
08/09/1997 15:45 - 1750 ug/L
Zinc Total
Turbidity (NTU) (background)
BC Max AW Guideline Range
30-Day-BC AW Guideline Range
CCME Max AW Guideline
0
100
200
300
400
500
600
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05


Fraser River at Hansard
Zinc Total (ug/L)
Figure 68
BC Max DW Guideline 5000 ug/L
Zinc Total
Turbidity (NTU)
(background)
BC Max AW Guideline Range
30-Day-BC AW Guideline Range
CCME Max AW Guideline
300
200
100
0
250
200
150
100
50
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95


Fraser River at Hansard
Zinc Total (ug/L)
Figure 69
BC Max DW Guideline 5000 ug/L
Zinc Total
Turbidity (NTU) (background)
BC Max AW Guideline Range
30-Day-BC AW Guideline Range
CCME Max AW Guideline
Outliers Removed at:
11/08/1997 15:00 - 1720 ug/L
25/08/1997 14:05 - 2030 ug/L
08/09/1997 15:45 - 1750 ug/L
0
100
200
300
400
500
600
0
100
200
300
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05