State of Water Quality of Liard River at Upper Crossing 1983-1994

Canada - British Columbia
Water Quality Monitoring Agreement

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

Monitoring and Systems Branch
Pacific and Yukon Region
Environment Canada

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Executive Summary

The Liard River is a major tributary of the Mackenzie River, flowing southeast from the Yukon into British Columbia, looping through northern B.C., and then flowing northeast into the Northwest Territories to the Mackenzie (Figure 1). Water quality is affected by mining and forestry.

There are three water quality stations on the Liard River: Upper Crossing near the Yukon-B.C. border, Lower Crossing at Liard River, B.C., and at Fort Liard in the Northwest Territories (Figure 1). This report assesses water quality data collected at the Upper Crossing monitoring station located at the Alaska Highway bridge near the Yukon-B.C. border. Water quality samples were collected between 1983 and

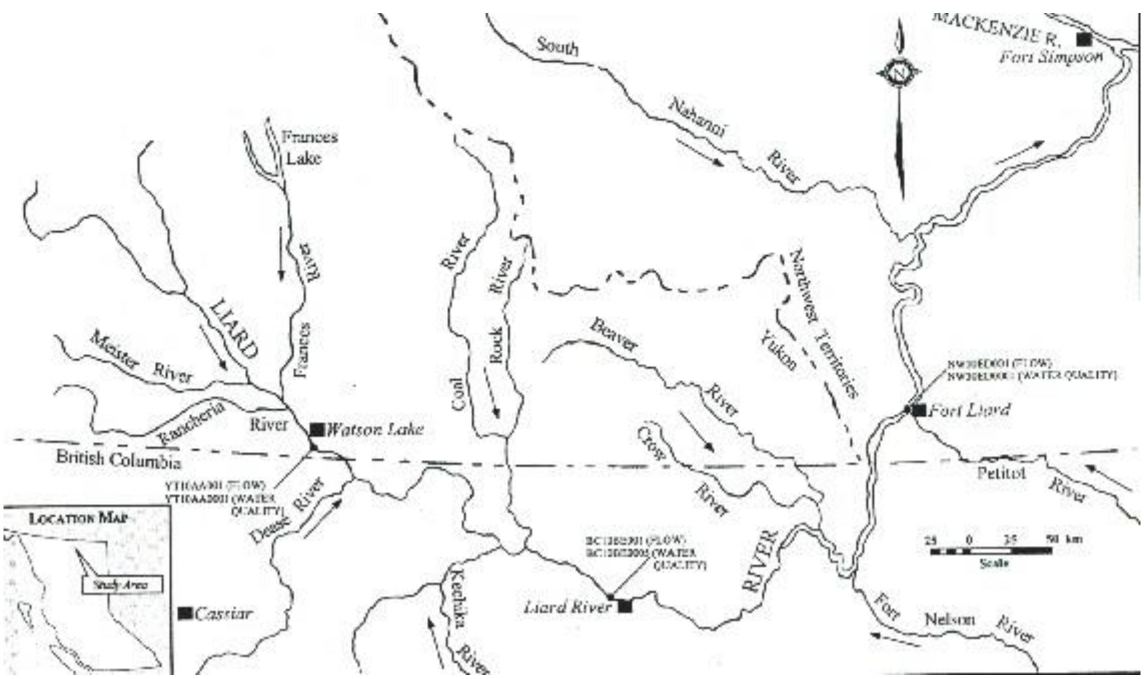
1994 by Environment Canada. Flow was measured at a Water Survey of Canada flow gauge at the water quality monitoring station.

We concluded that:

· There were no environmentally significant trends in water quality that could be identified through visual examination of the data.
· Total aluminum, cadmium, iron, manganese and zinc at times exceeded water quality criteria for drinking water or aquatic life due to high levels of suspended sediment during high river flow. These metals were probably not bio-available and would be removed by drinking water treatment needed to remove turbidity.
· Turbidity and disinfection are needed prior to drinking water use.
· The river had a low sensitivity to acid inputs.
· Hardness levels were at or below the optimum range for drinking water in the summer, but above the optimum range in the winter months, reaching the poor range for short periods.
· The water was cool enough to be aesthetically pleasing for drinking, but too cold for water-contact recreation.

We recommend that monitoring be terminated for the Liard River at Upper Crossing because there are no apparent water quality trends or concerns at this time.

Figure 1 Map of Liard River (Scale 1:3,300,000)



Authors

Jang, L. Water Quality Section, Water Management Branch, Ministry of Environment, Lands and Parks, Victoria, B.C.

Pommen, L.W. Water Quality Section, Water Management Branch, Ministry of Environment, Lands and Parks, Victoria, B.C.

Contributors

Boettger, B. Water Quality Consultant, Environmental Health Program, Public Health Protection Branch, Ministry of Health, Victoria, B.C.

Carmichael, B. Environmental Protection, Ministry of Environment, Lands and Parks, Omineca-Peace Region, Prince George, B.C.

Holms, G.B. Water Quality Section, Water Management Branch, Ministry of Environment, Lands and Parks, Victoria, B.C.

Regnier, R. Monitoring Strategies Division, Monitoring and Systems Branch, Pacific and Yukon Region, Environment Canada, Vancouver,B.C.

Ryan, A. Monitoring Strategies Division, Monitoring and Systems Branch, Pacific and Yukon Region, Environment Canada, Vancouver, B.C.

Introduction

The Liard River originates in the southern portion of the Yukon Territory (Figure 1). The river flows southeast across the British Columbia border, past the town of Liard River. Then, the Liard flows north across the Northwest Territories border to the confluence with the South Nahanni River and continues northeast, where it joins the Mackenzie River. The Frances River comes from the north and meets the Liard 20 km upstream from Watson Lake. Other major tributaries which are further downstream include the Kechika, Fort Nelson, Petitot and South Nahanni Rivers. The Liard River is under ice from November to April.

There are three water quality monitoring stations on the Liard River (Upper Crossing in the Yukon, Lower Crossing in British Columbia, and Fort Liard in the Northwest Territories - see Figure 1). The Upper Crossing monitoring station is located at the Alaska Highway Bridge near the Yukon/British Columbia border and 11 km west of Watson Lake. The water quality of the other two stations is discussed in two separate reports (Jang & Pommen, 1996a & 1996b). Some mining activities are located within the Liard River headwaters. Forestry occurs around the Meister, Rancheria and Liard Rivers. Plans for a hydroelectric project near the town of Liard River, British Columbia exist, but are not expected to proceed within the next twenty years (MacDonald, 1993).

Data for this report are from sampling by Environment Canada, between 1983 and 1994, and are stored under ENVIRODAT station number YT10AA0001. The water quality indicators are plotted in Figures 3 to

45. Water Survey of Canada operated a flow gauge at the water quality monitoring station (site number YT10AA001). The drainage area at the flow station is 33 400 km^2. Flow data are graphed in Figure 2.

Quality Assurance

The water quality graphs were inspected and erroneous values were removed. There were questionable values for total aluminum, total dissolved nitrogen and pH. Total chromium, copper, lead, and zinc had high values between 1986 and 1991 due to the failure of preservative vial lid liners which resulted in sample contamination. Mercury data were not plotted because all detectable values were likely due to contamination (Pommen, 1994). Values for pH between 1986 and 1988 were much lower than the rest of the pH data due to laboratory control problems at that time. Quality assurance issues are discussed in further detail in the next section.

State of the Water Quality

The state of the water quality is judged by comparing values to the Ministry of Environment, Lands and Parks' Approved and Working Criteria for Water Quality (Nagpal *et al.*, 1995). Indicators not discussed below met the criteria and did not display any noticeable trends. These include: barium, beryllium, total inorganic carbon, chloride, cobalt, lithium, magnesium, molybdenum, nickel, nitrate/nitrite, total dissolved nitrogen, total phosphorus, potassium, filterable residue, fixed filterable residue, fixed non-filterable residue, selenium, silica, sodium, conductivity, strontium, sulphate and vanadium.

Flow (Figure 2) values were highest during spring freshet (May-July). Peak flow values were similar most years except for lower peak values in 1989 and 1991.

Total alkalinity (Figure 3) and **calcium** (Figure 9) concentrations indicate a low sensitivity to acid inputs.

Total aluminum (Figure 4) values met the 0.2 mg/L criterion for drinking water at least 77% of the time. Also, at least 58% of the values met the 0.1 mg/L maximum criterion for aquatic life, and at least 40% of the values met the 0.05 mg/L average criterion for aquatic life. However, all these criteria are for dissolved aluminum. Total aluminum values are not directly comparable to dissolved criteria because dissolved aluminum values in the water column are much lower than total aluminum. For direct comparison to these criteria, dissolved aluminum should be measured. Peak aluminum values corresponded to peak non-filterable residue and turbidity values. This suggests that the aluminum was in a particulate form and was probably not biologically available and would be removed by the turbidity removal needed before drinking.

Total arsenic (Figure 5) had one value (July 20, 1988) that slightly exceeded the 0.005 mg/L proposed aquatic life criterion.

Total cadmium (Figure 8) values were high between 1986 and 1991 due to suspected preservative vial contamination. Minimum detectable limits (0.0001 mg/L, 0.0005 mg/L, and 0.001 mg/L) were 2 to 33 times above the aquatic life criteria (0.00003 mg/L to 0.00006 mg/L). Since 1991, cadmium was detected 13 times at levels above the aquatic life criteria. Some of the detectable values corresponded to elevated turbidity and thus the cadmium may have been in a particulate form and not bio-available. Other detectable values may have been false positives close to the detection limit. To evaluate the criteria for aquatic life accurately, the minimum detectable limit should be lowered to at least one-tenth of the lowest criterion, and dissolved cadmium should also be measured.

Total organic carbon (Figure 11) exceeded the 4 mg/L criterion for drinking water twice (August 20, 1987 and December 27, 1994).

Total chromium (Figure 13) values in 1990 may have been high due to preservative vial contamination. Since then, 9% of the values exceeded the 0.002 mg/L criterion for phyto- and zoo-plankton. The chromium values above the criterion did not normally correspond to high turbidity or non-filterable residue, and thus may have been in a bio-available form. Total chromium levels above the 0.002 mg/L criterion were found at many of the federal-provincial water quality stations in B.C., and thus they may be a natural occurrence or due to network-wide artificial contamination (Pommen, 1996). Total and dissolved chromium should be measured.

Apparent colour (Figure 15) was highest during the summer months and near the minimum detectable limit (5 units) during the winter months. The 15-unit true colour drinking water and recreation criterion was met at least 88% of the time. The high apparent colour values occurred in samples with high turbidity, and true colour would have been much lower because turbidity is removed before measurement. True colour should be measured to compare the data to the criteria effectively.

Total copper (Figure 16) values were high between 1986 and 1991 due to preservative vial contamination. Since early 1991, the aquatic life criteria have been met.

Dissolved fluoride (Figure 17) exceeded the lower (0.2 mg/L) criterion for aquatic life once (February 4, 1993, with a hardness of 48.1 mg/L).

Hardness (Figure 18) values were within the optimum range for drinking water (80-100 mg/L as $CaCO_3$) 32% of the time. Fifty-four percent of the values were above this range and 14% were below. During most winters, hardness exceeded 200 mg/L for short periods. Levels of more than 200 mg/L are rated as poor for drinking, but still tolerable. Lowest hardness occurred in the summer and highest values occurred in the winter. Higher flow leads to increased dilution of dissolved constituents such as hardness, while lower flow results in less dilution and higher hardness values.

Total iron (Figure 19) values exceeded the 5 mg/L criterion for irrigation once (May 5, 1989). Also, 35% of the values were above the 0.3 mg/L drinking water and aquatic life criteria. High values of iron and turbidity occurred together. Thus, the iron was probably in a particulate form and not biologically available and would be removed by treatment needed to remove turbidity prior to drinking.

Total lead values (Figure 20) were high between 1986 and 1991 due to preservative vial contamination. Since 1991, all criteria have been met.

Total manganese (Figure 23) values exceeded the 0.1 mg/L aquatic life criterion three times (February 25, 1988, May 5, 1989 and May 30, 1990) and the 0.05 mg/L drinking water criterion 8% of the time. High manganese and turbidity usually occurred together between 1987 and 1992. Thus, the manganese was probably in a particulate form and not biologically available. Also, the manganese would probably be removed by the treatment needed to remove turbidity prior to drinking.

pH (Figure 28) was low between 1986 and 1988 because of laboratory control problems. One value (April 21, 1989) exceeded the 8.5-unit upper aesthetic limit for drinking water. All other values met criteria.

Non-filterable residue (Figure 32) values exceeded the 25 mg/L criterion for good fisheries 19% of the time during peak flows.

Air temperature (Figure 41) had no freezing temperatures prior to about 1990, indicating a systematic error in measuring or recording air temperature.

Water temperature (Figure 42) exceeded the 15°C upper aesthetic limit for drinking water and the lower limit for recreation 4% of the time. This means that the water is cool enough to be aesthetically pleasing for drinking, but too cold for water-contact recreation such as swimming.

Turbidity (Figure 43) values exceeded the 5 NTU aesthetics criterion for drinking water 13% of the time and the 1 NTU health criterion for drinking water 46% of the time during peak flows. Turbidity removal and disinfection are needed prior to use for drinking water.

Total zinc (Figure 45) had high values between 1986 and 1991 due to preservative vial contamination. Outside of that period, the 0.015 mg/L algae criterion was exceeded three times (November 11, 1991, April 18, 1992 and June 15, 1992), but the criterion for fish and invertebrates was met. Two of the three higher values corresponded to elevated turbidity, indicating that the zinc was in a particulate form and probably not bio-available.

Conclusions - State of Water Quality

· There were no environmentally significant trends in water quality that could be identified through visual examination of the data.
· Total aluminum, cadmium, iron, manganese and zinc at times exceeded water quality criteria for drinking water or aquatic life due to high levels of suspended sediment during high river flow. These metals were probably not bio-available and would be removed by drinking water treatment needed to remove turbidity.
· Turbidity removal and disinfection are needed prior to drinking water use.
· The river had a low sensitivity to acid inputs.
· Hardness levels were at or below the optimum range for drinking water in the summer, but above the optimum range in the winter months, reaching the poor range for short periods.
· The water was cool enough to be aesthetically pleasing for drinking, but too cold for water-contact recreation.

Recommendations for Water Quality Management

Remediation

No remedial activities appear to be necessary at this time.

Monitoring

· We recommend that monitoring be terminated for the Liard River at Upper Crossing because there are no apparent water quality trends or concerns at this time.

Figure 2 Flow

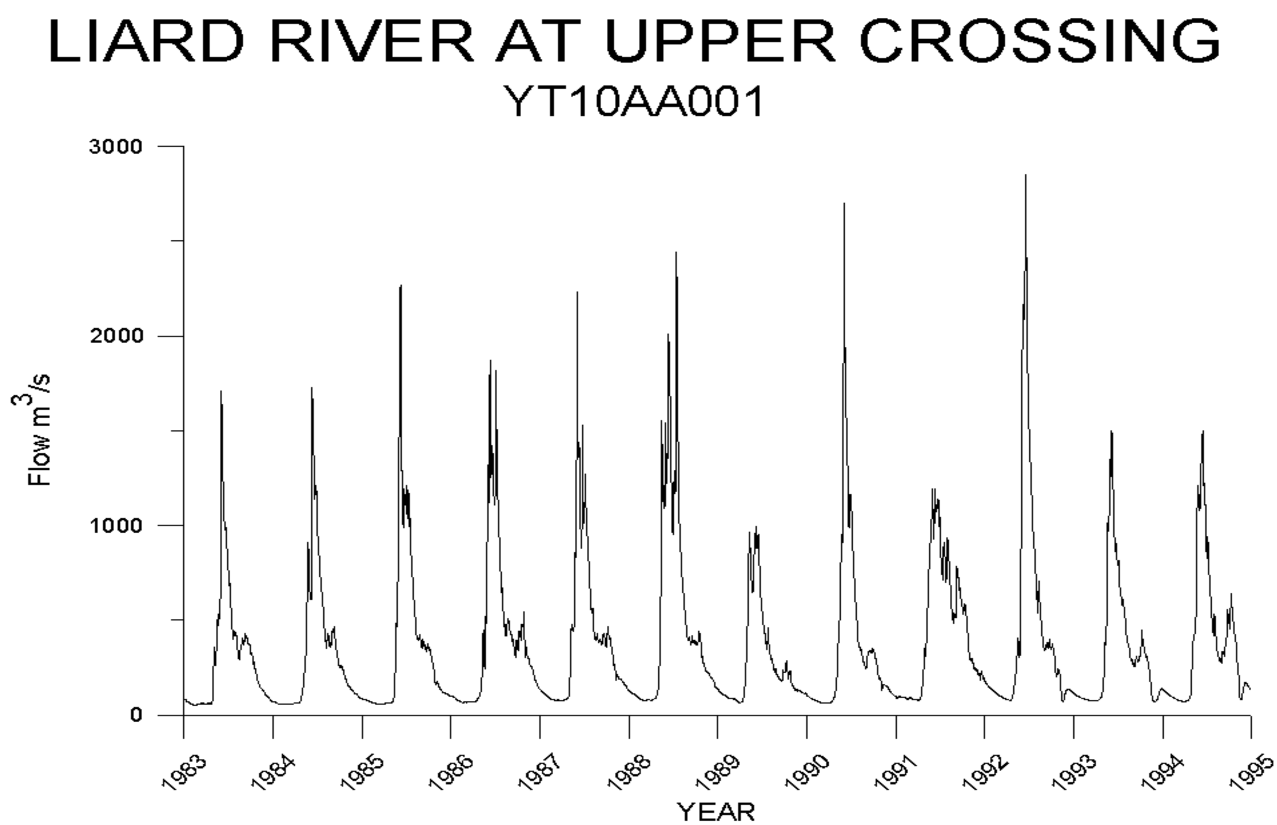


Figure 3 Total Alkalinity

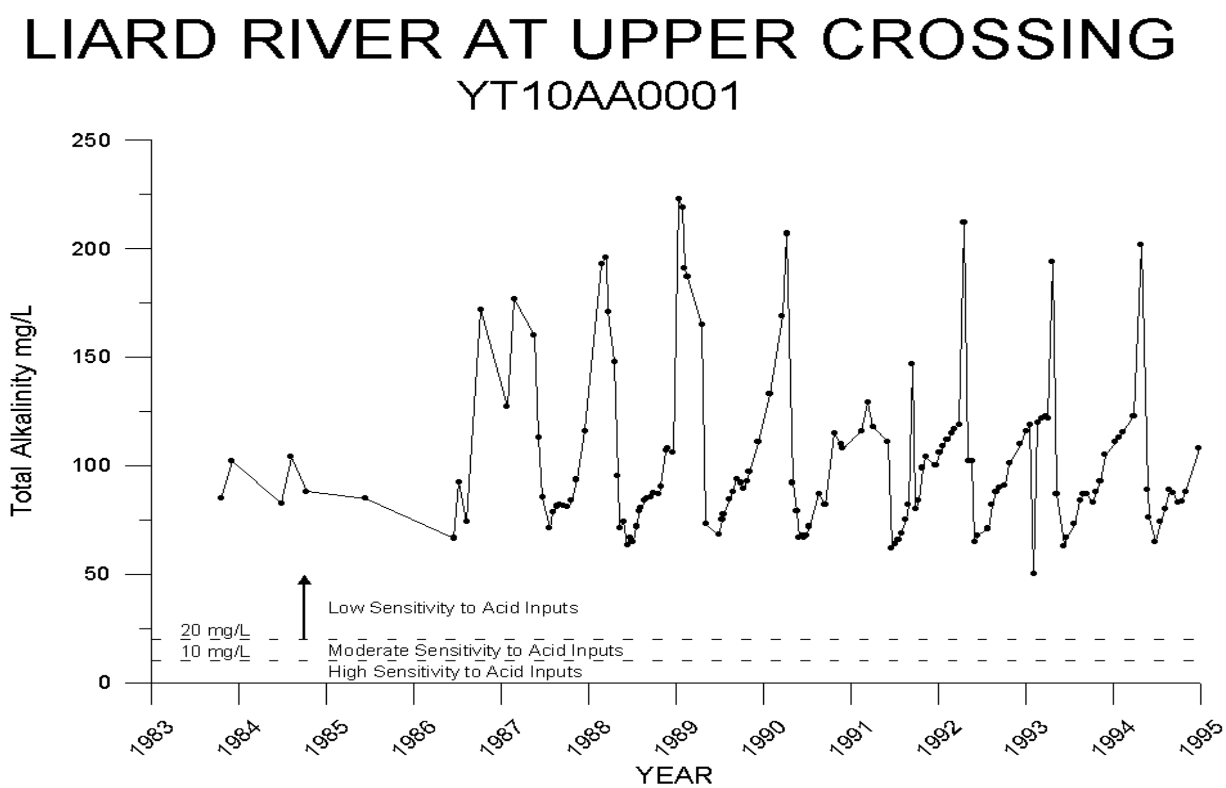


Figure 4 Total Aluminum

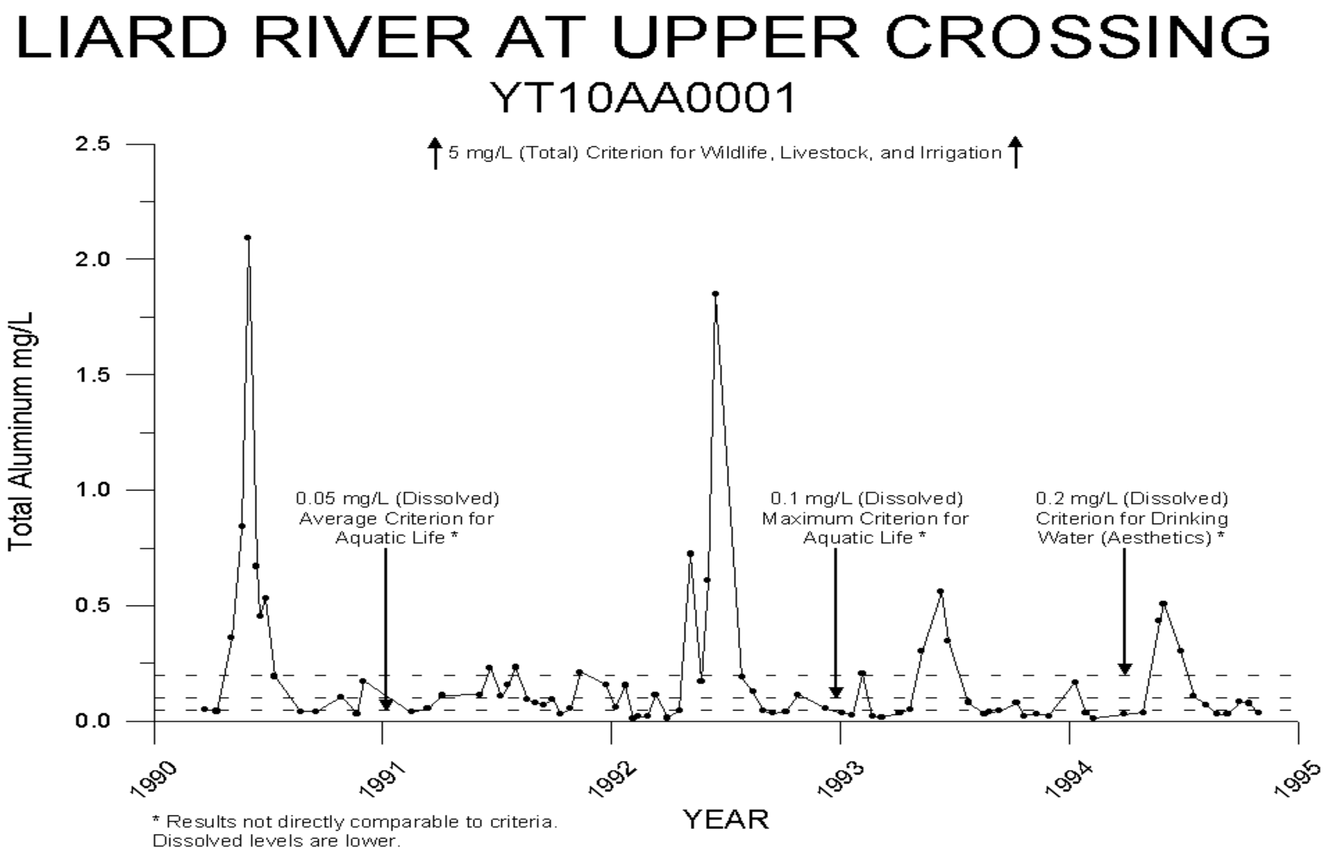


Figure 5 Total Arsenic

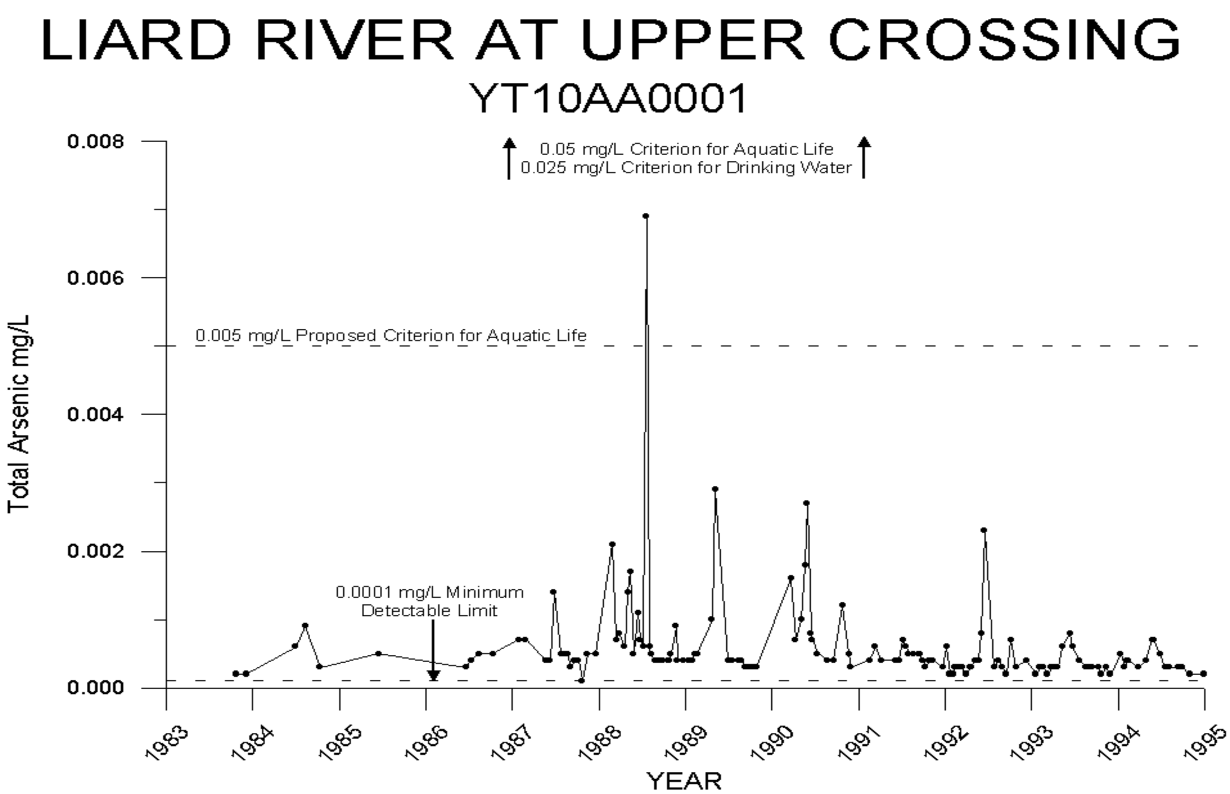


Figure 6 Total Barium

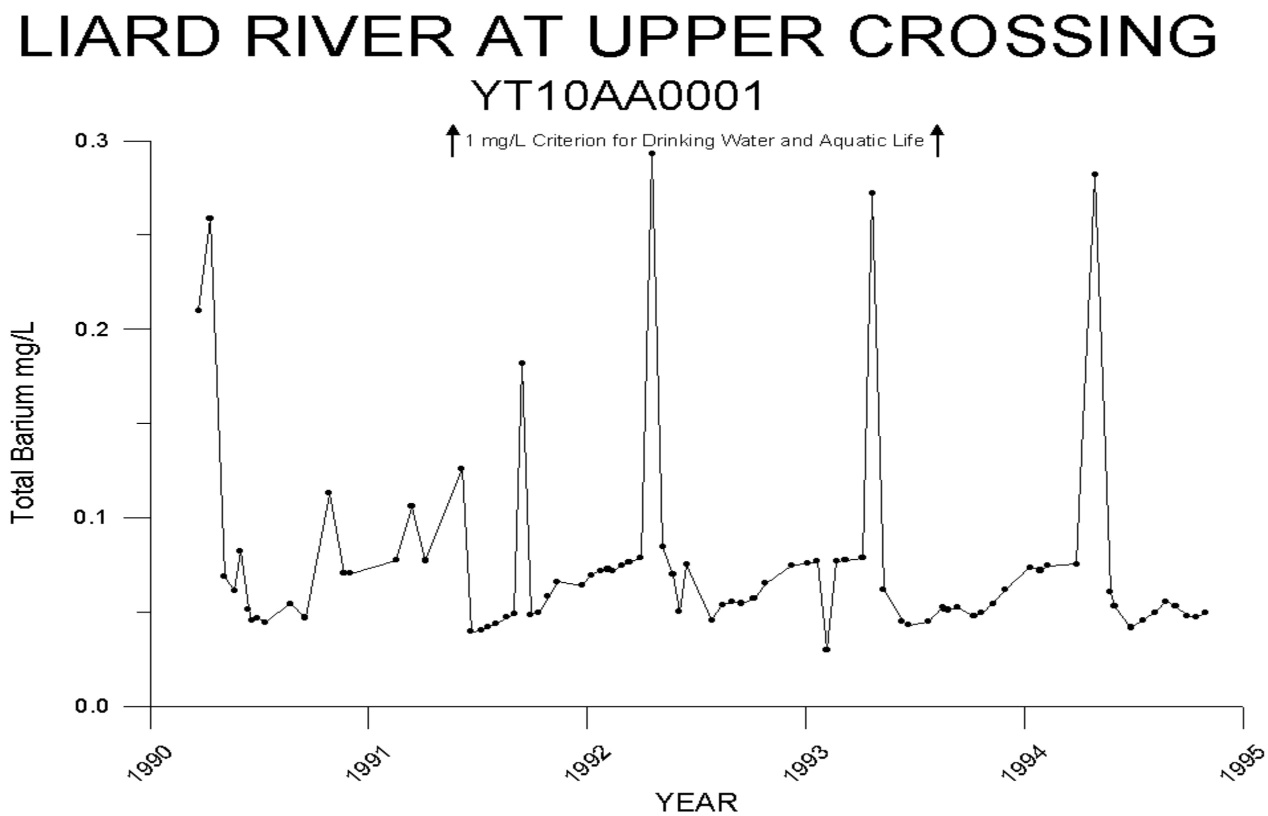


Figure 7 Total Beryllium

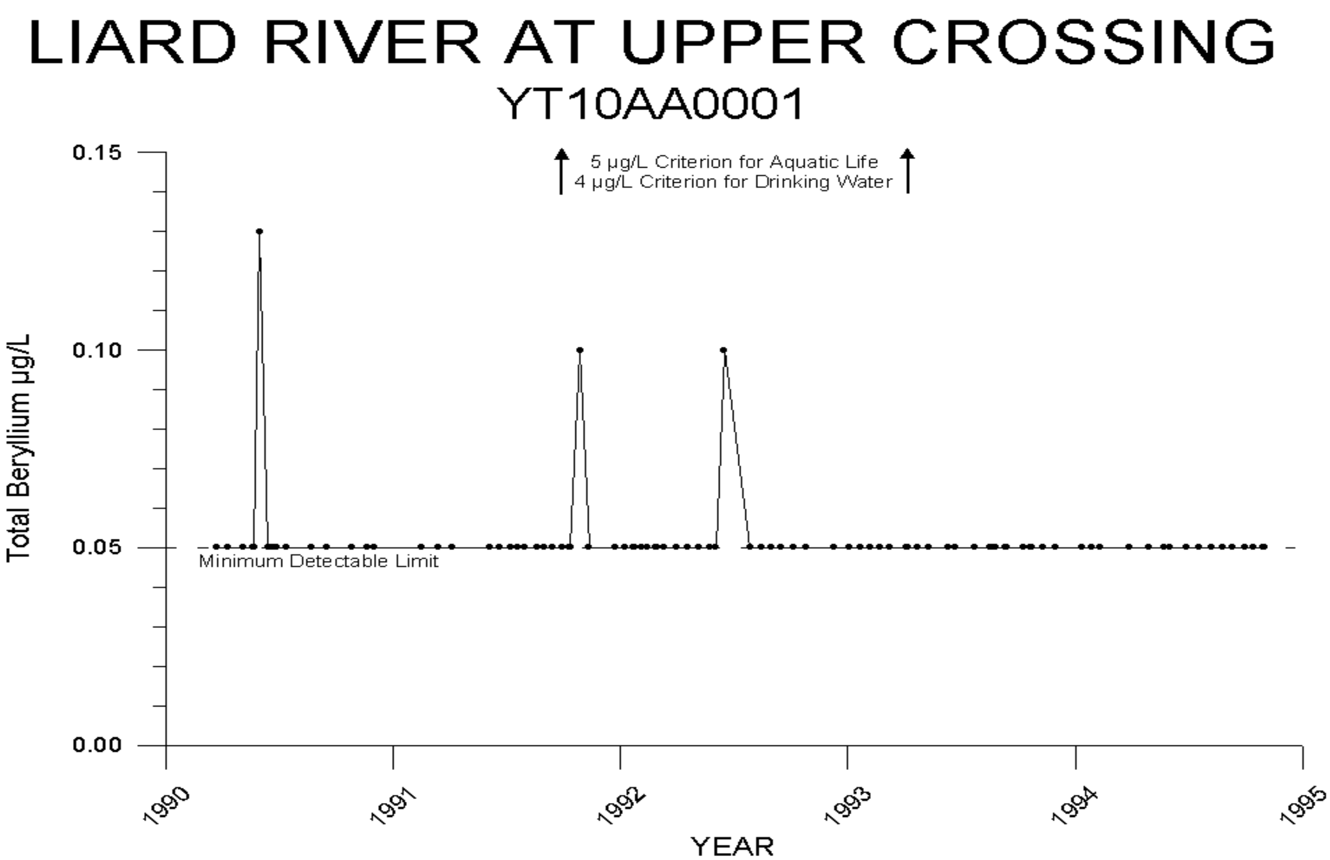


Figure 8 Total Cadmium

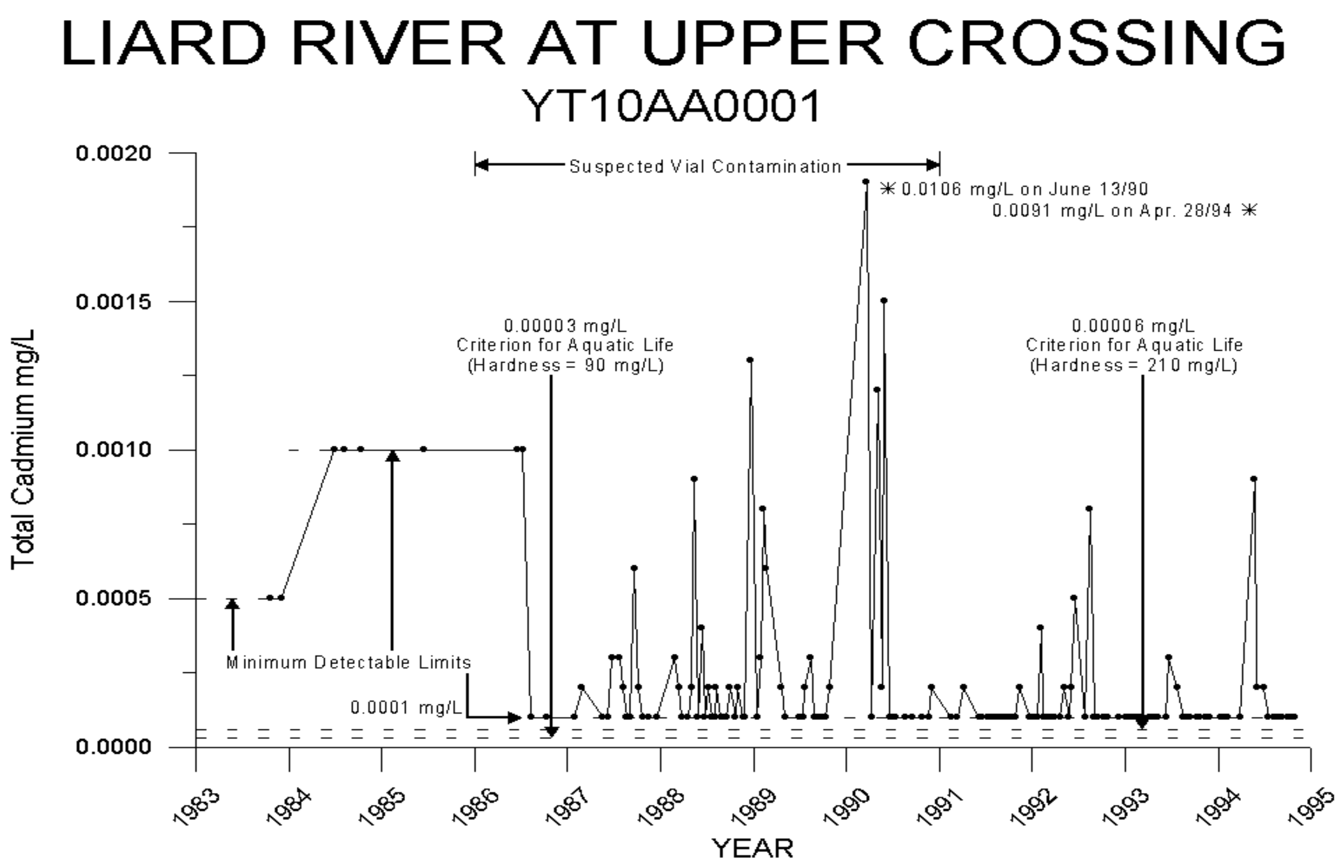


Figure 9 Calcium

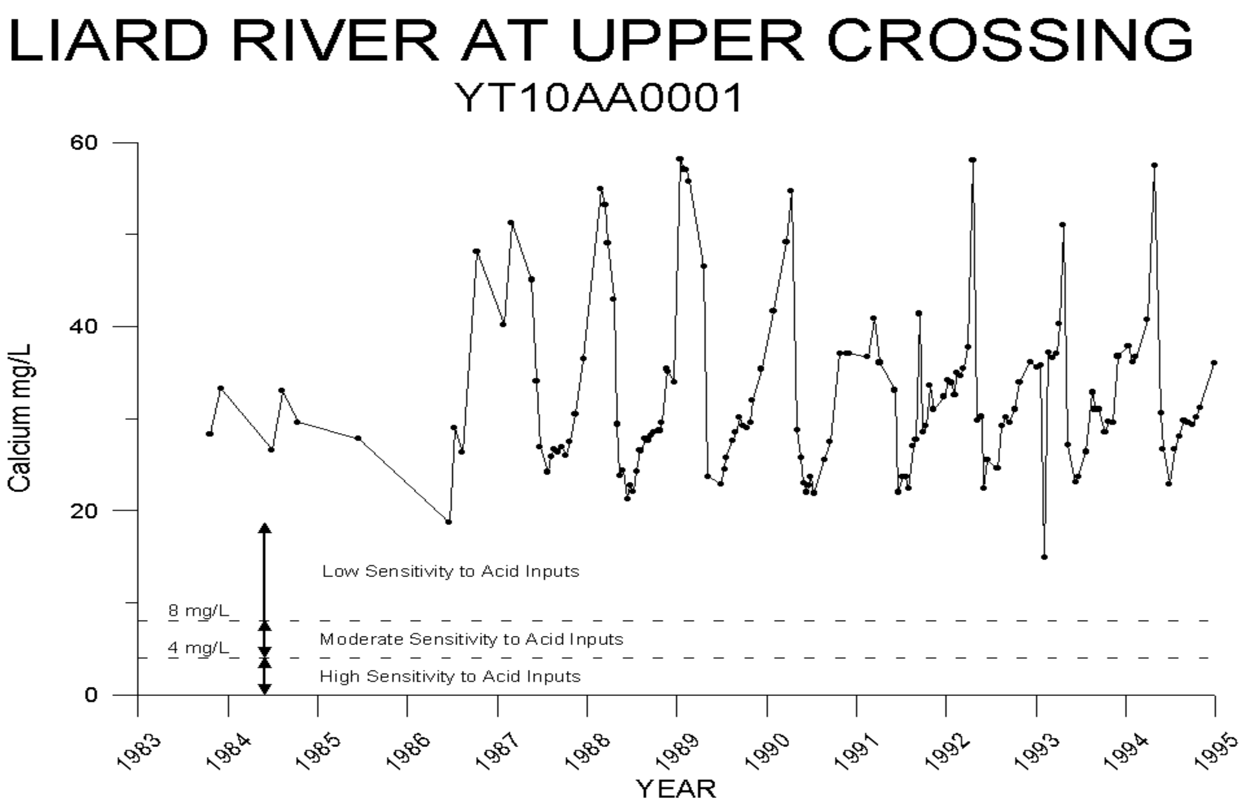


Figure 10 Total Inorganic Carbon

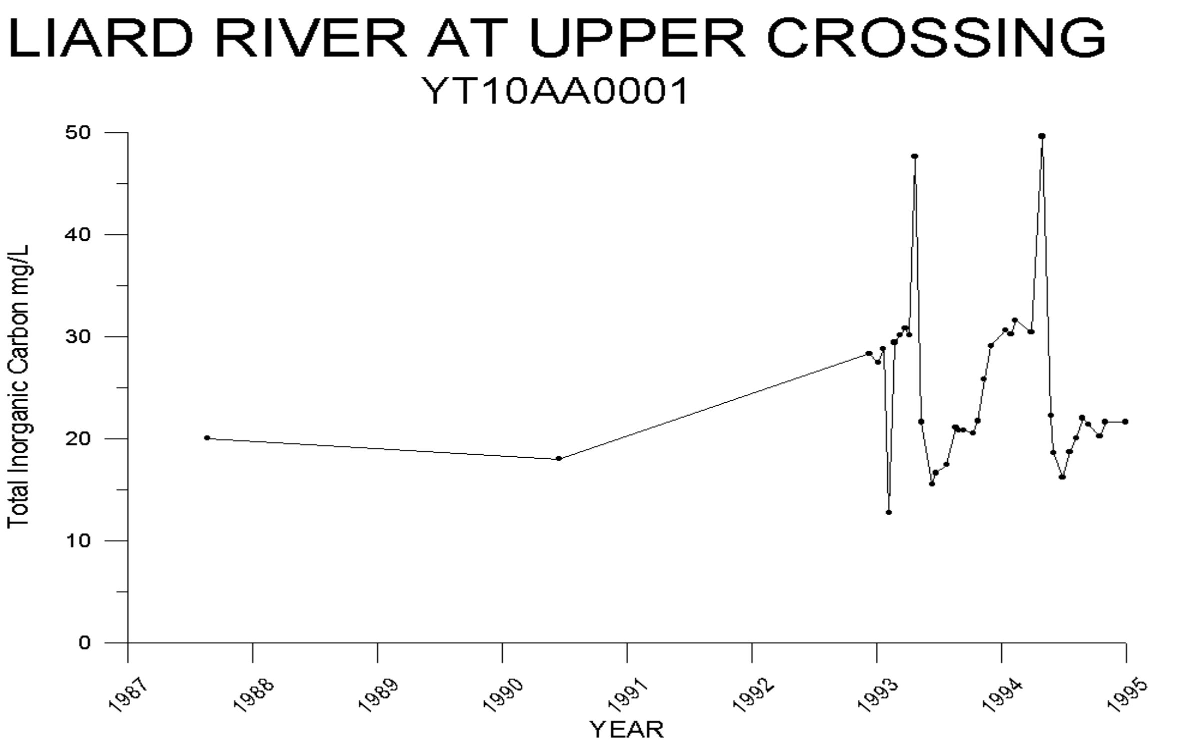


Figure 11 Total Organic Carbon

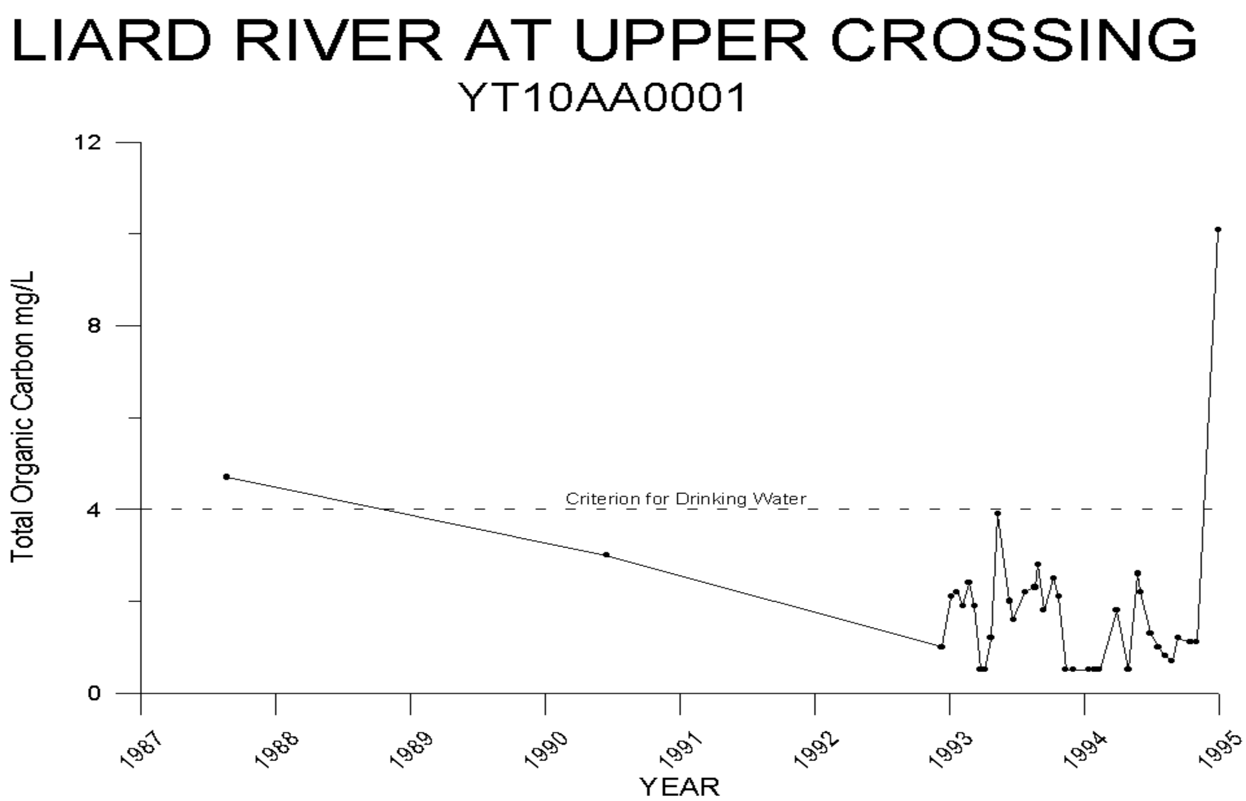


Figure 12 Dissolved Chloride

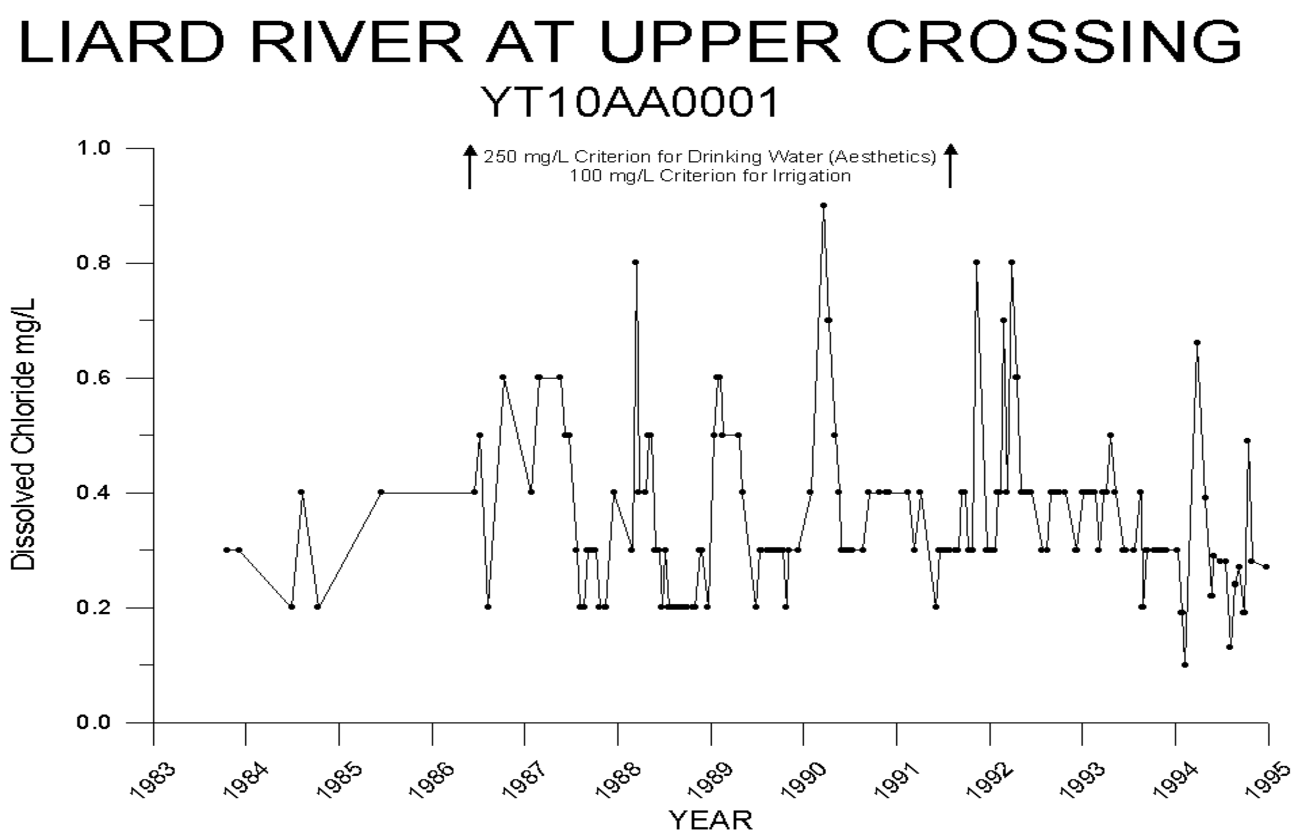


Figure 13 Total Chromium

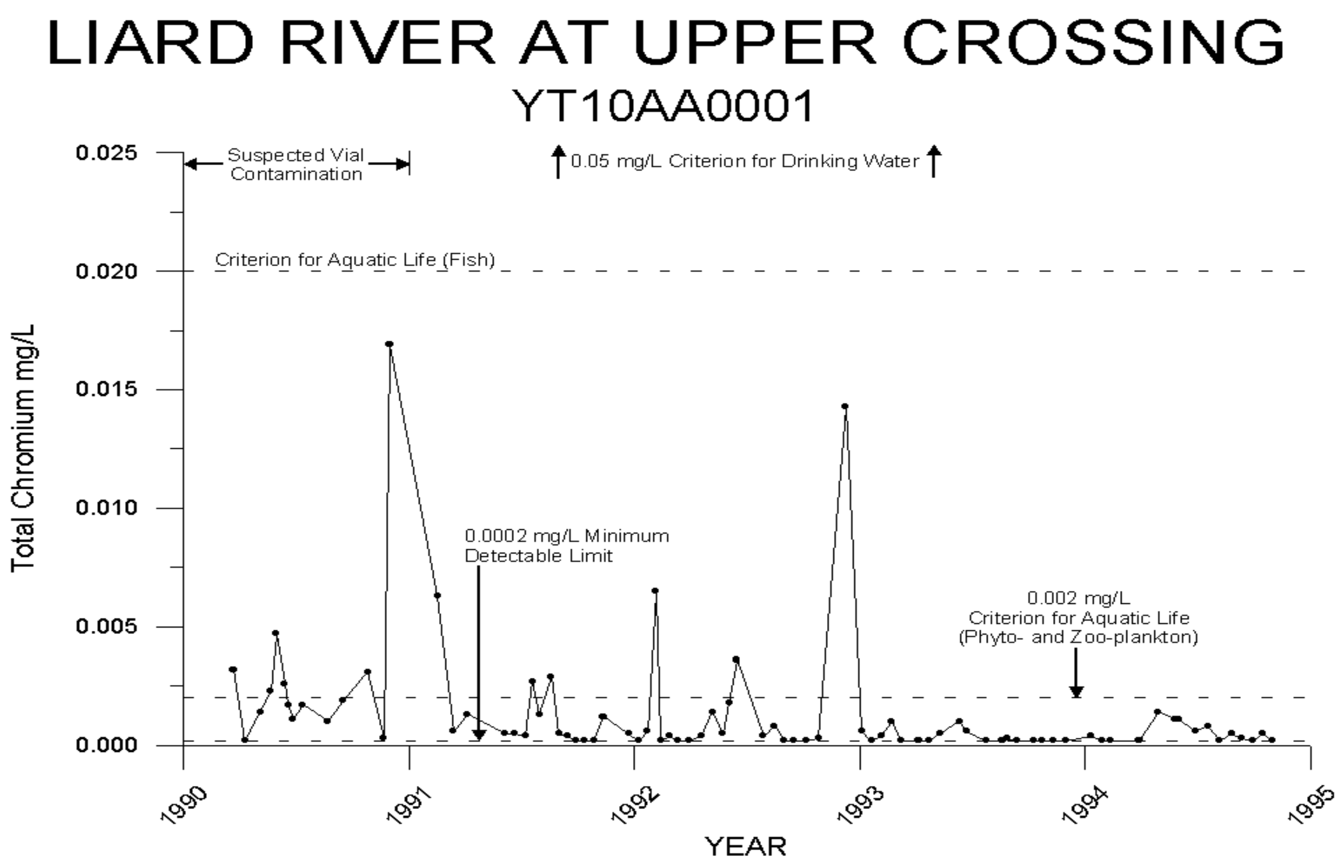


Figure 14 Total Cobalt

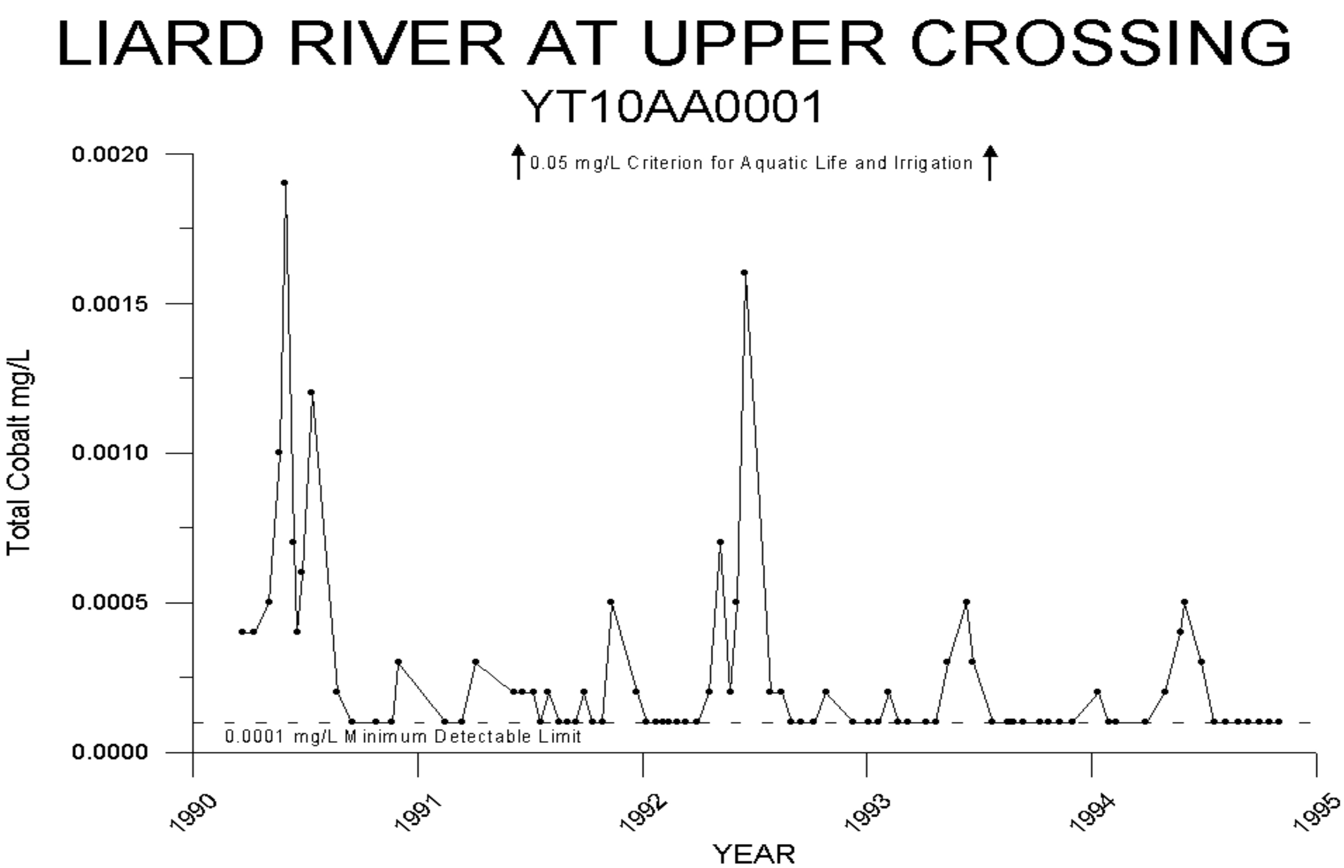


Figure 15 Apparent Colour

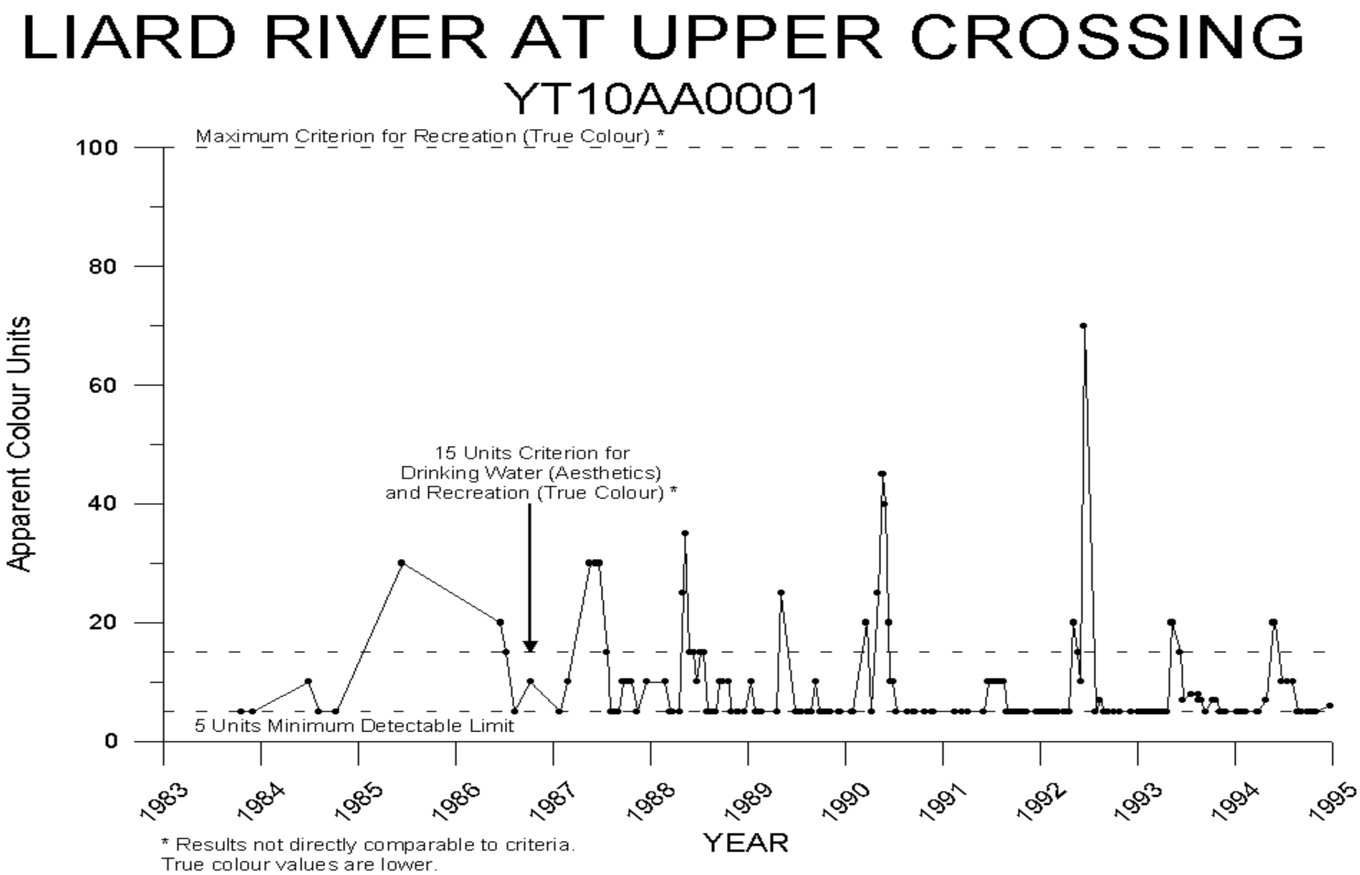


Figure 16 Total Copper

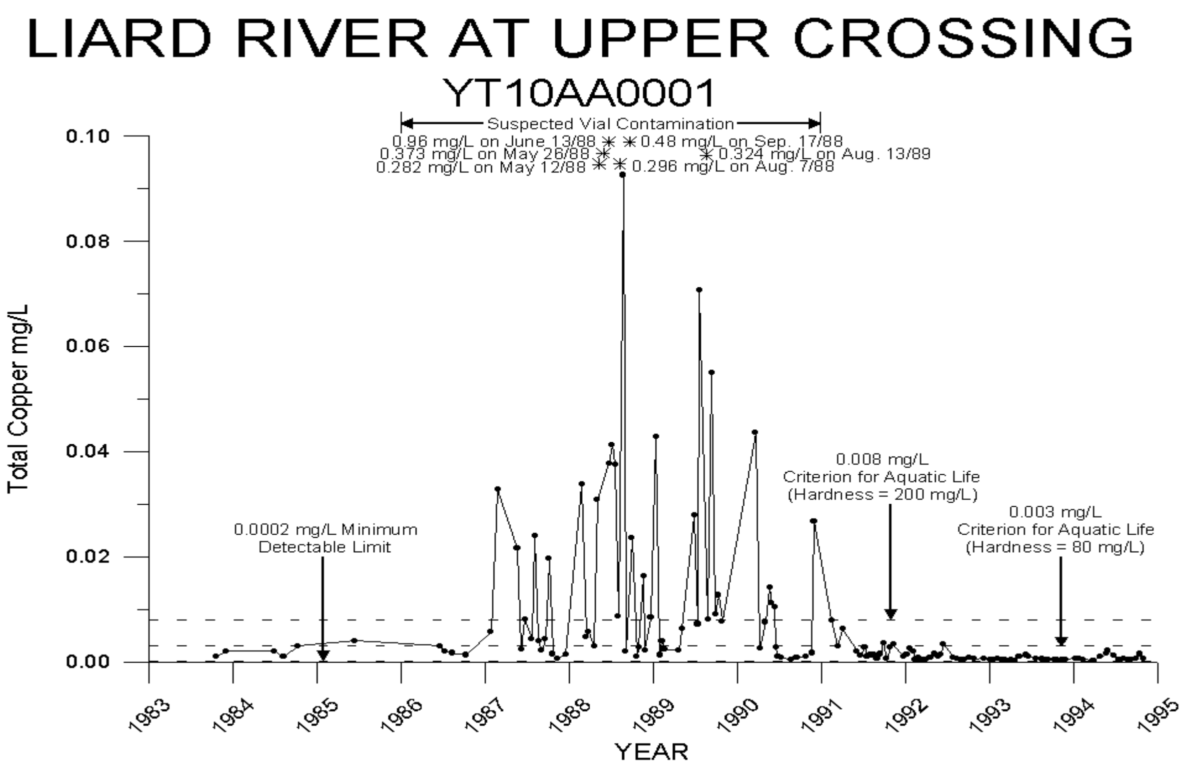


Figure 17 Dissolved Fluoride

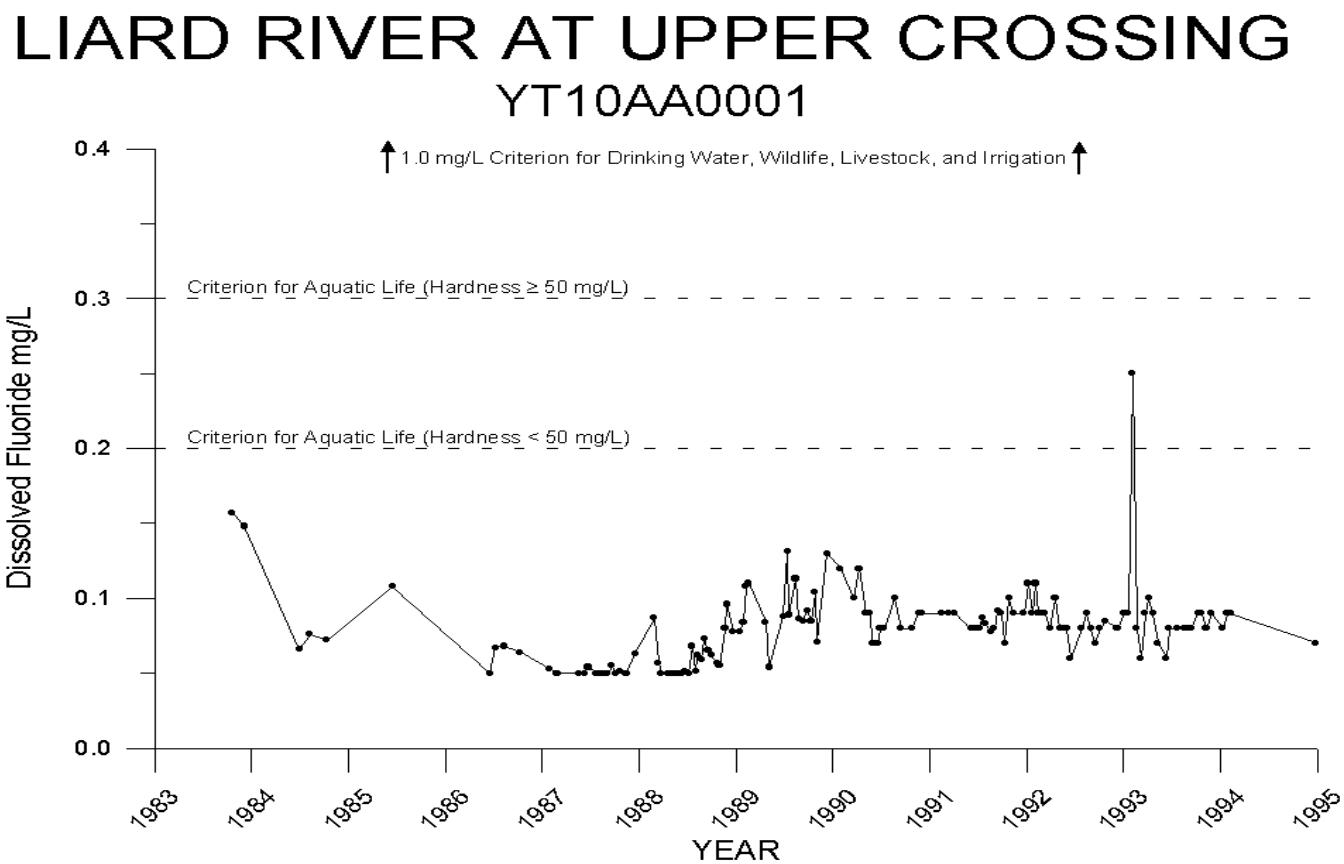


Figure 18 Hardness

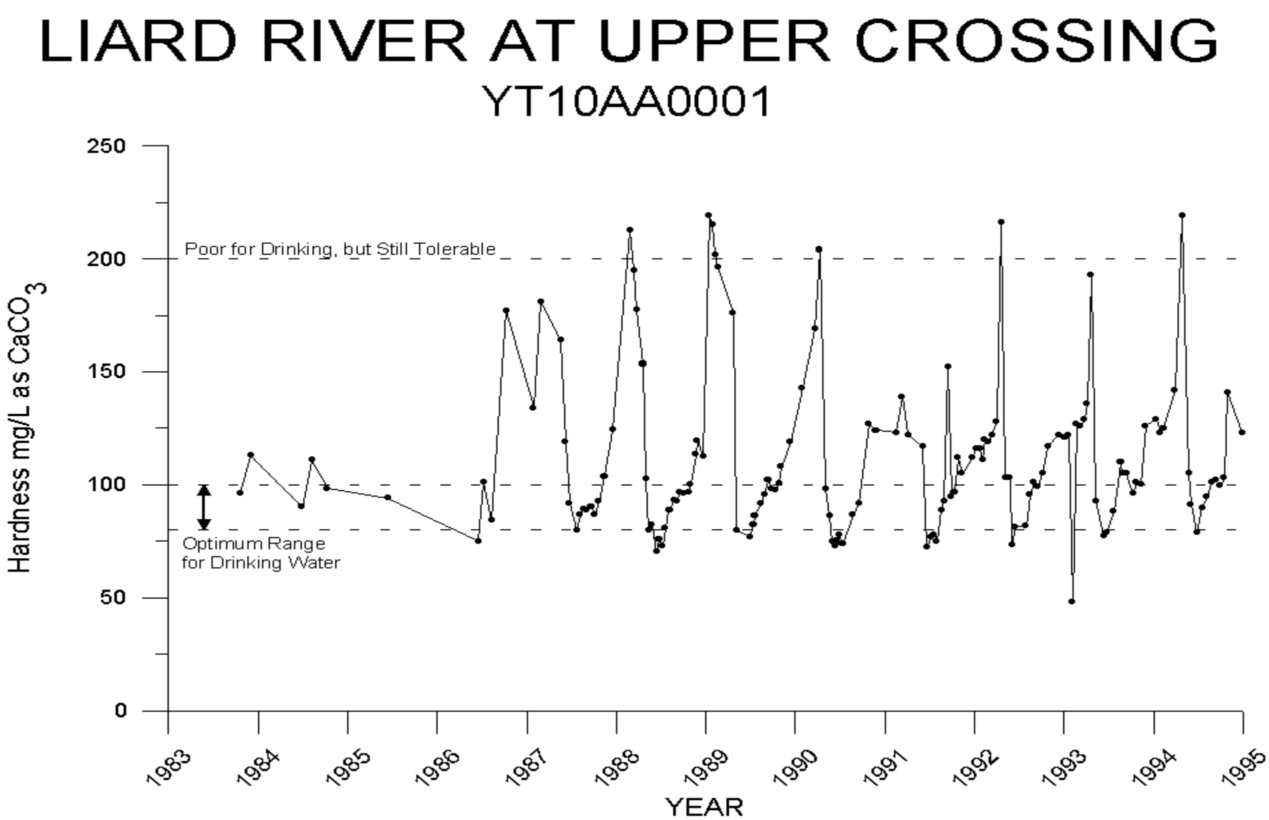


Figure 19 Total Iron

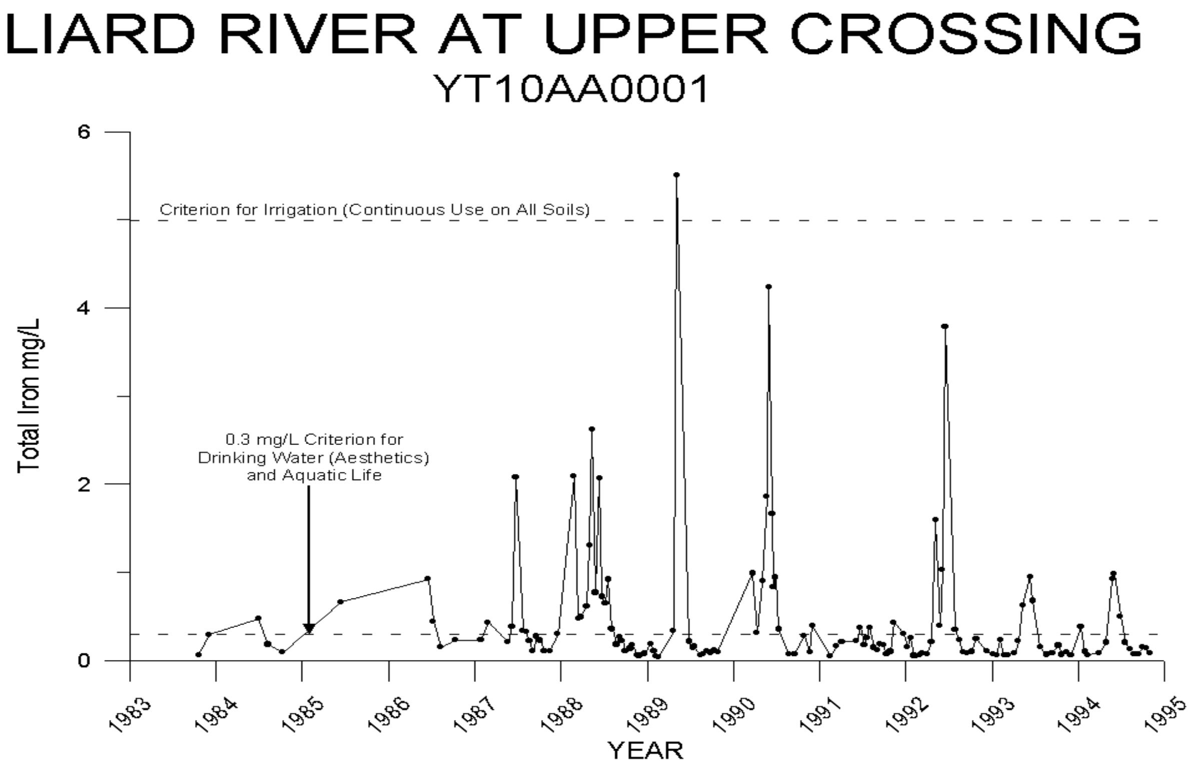


Figure 20 Total Lead

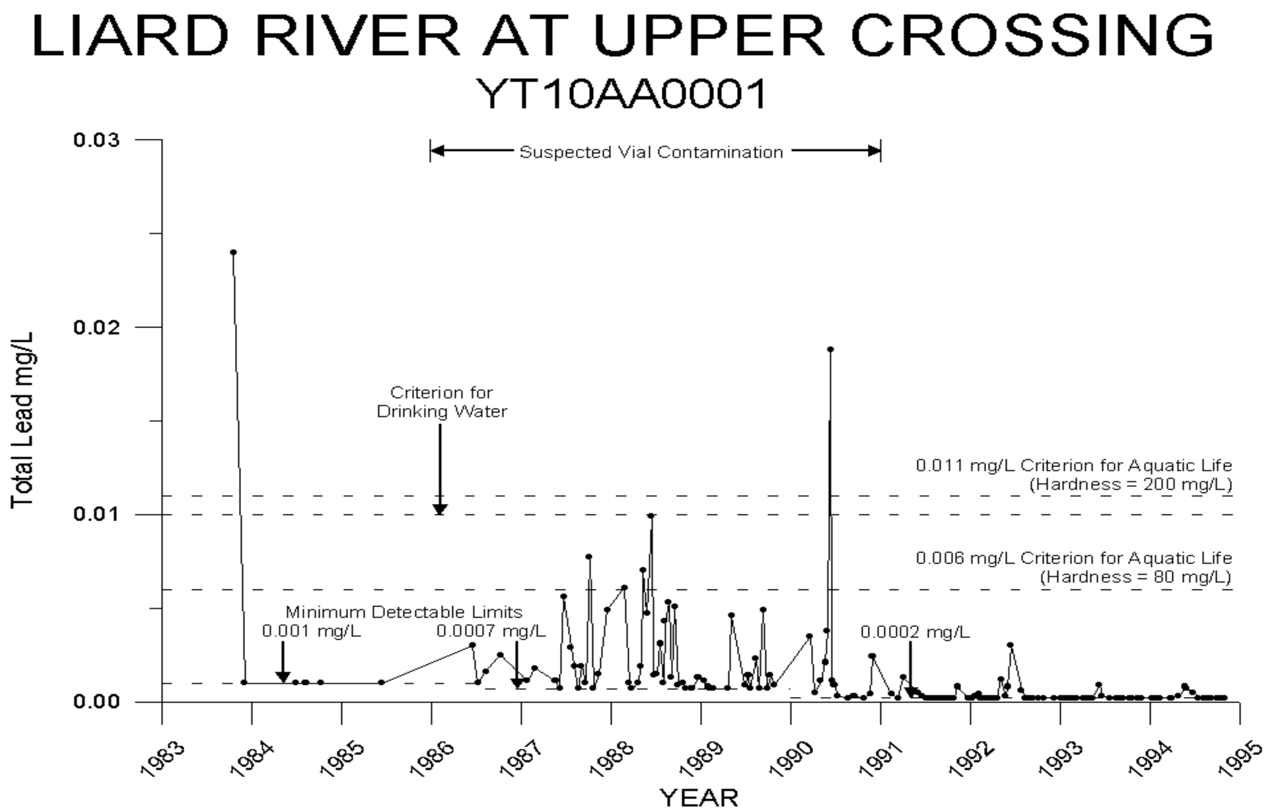


Figure 21 Total Lithium

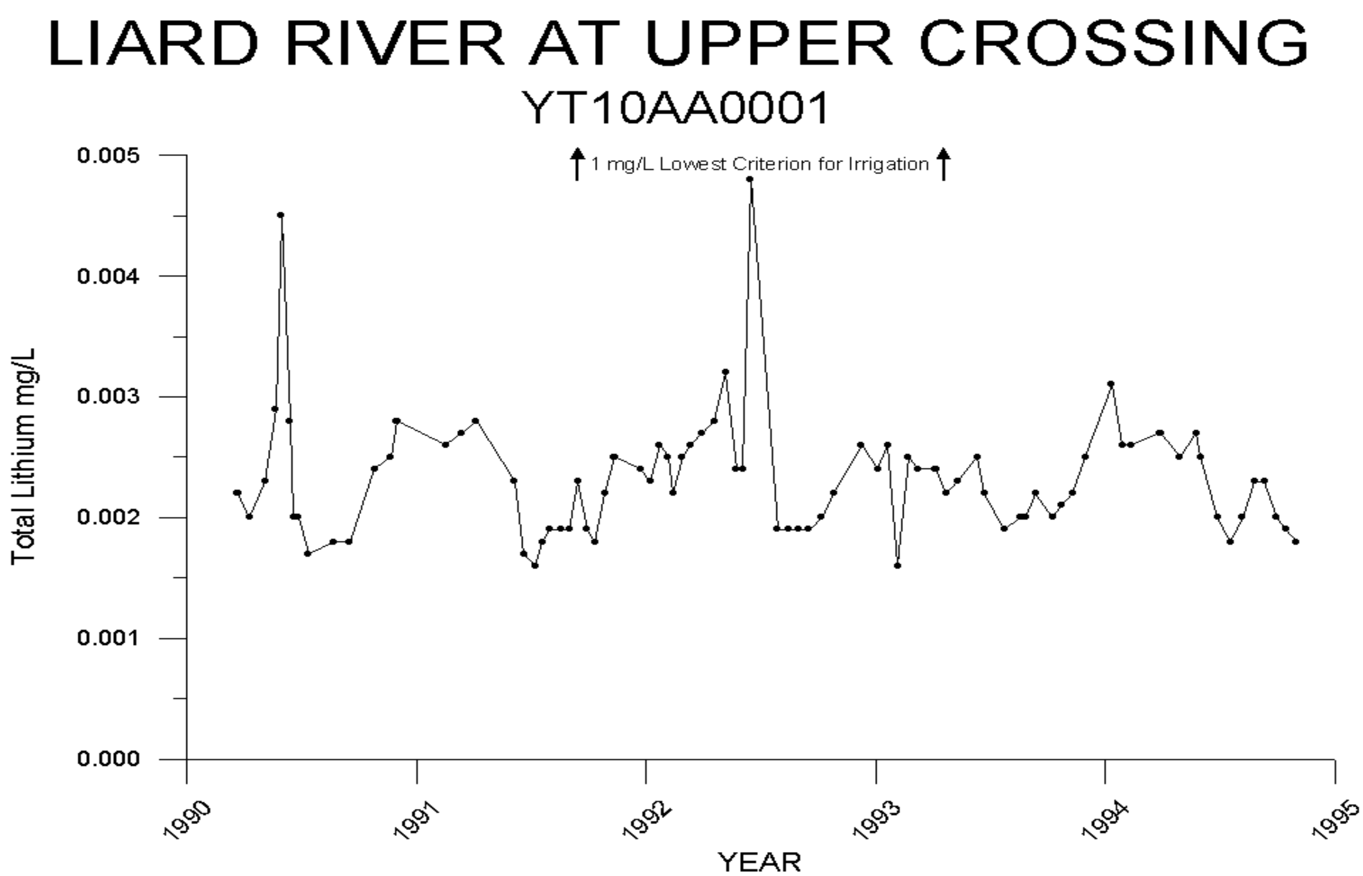


Figure 22 Magnesium

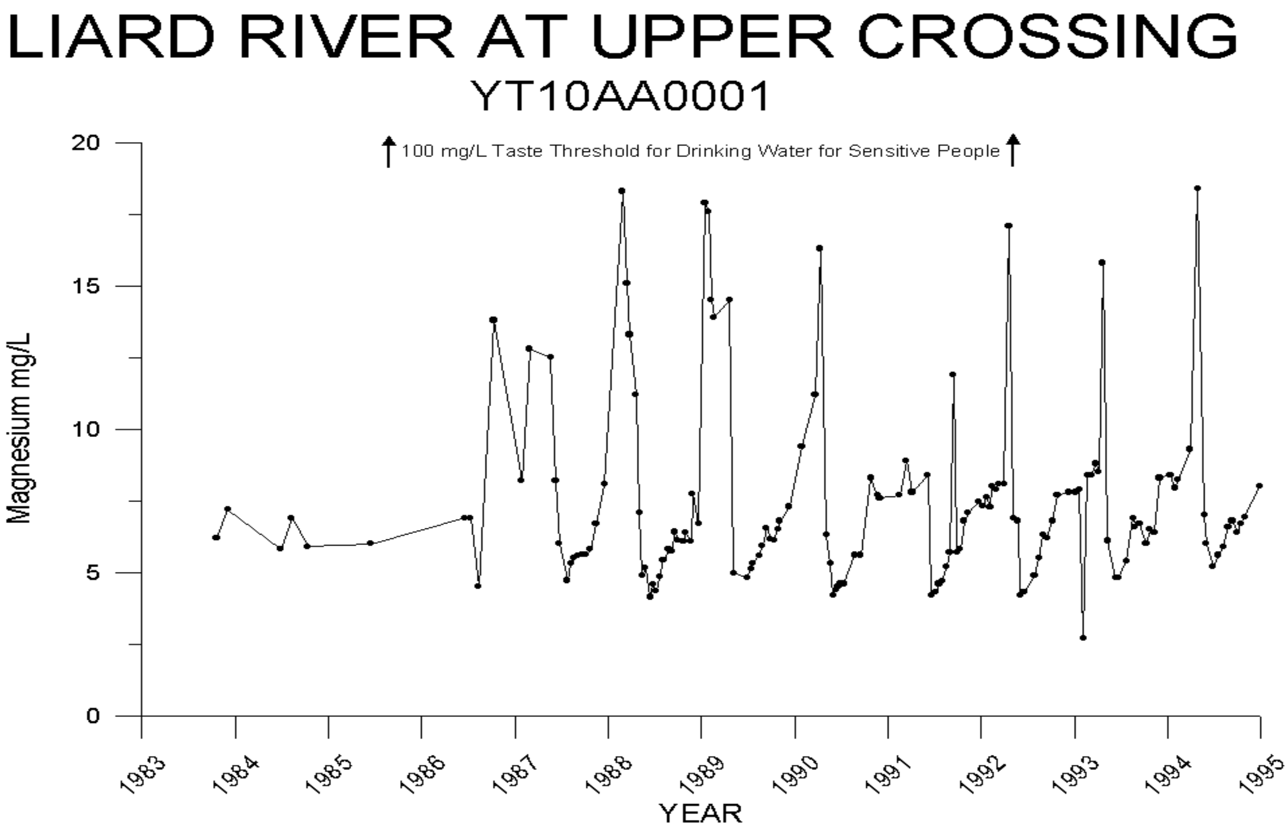


Figure 23 Total Manganese

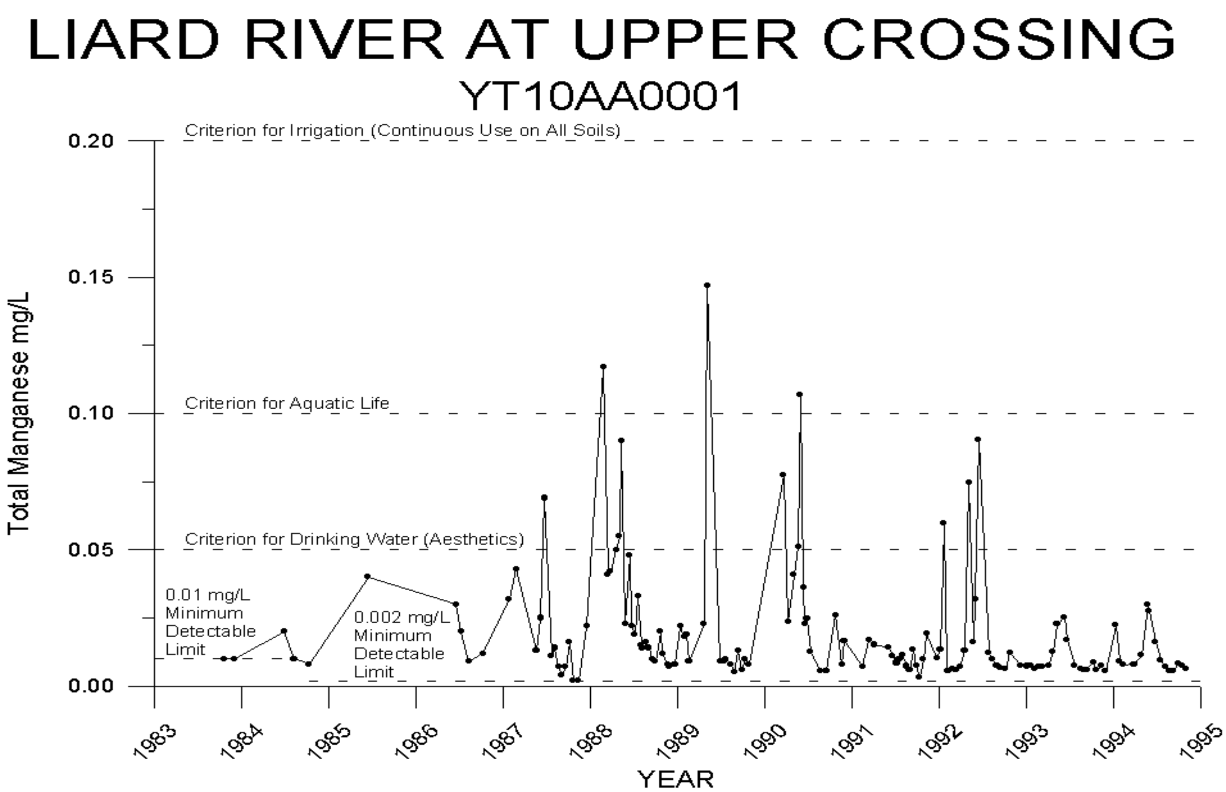


Figure 24 Total Molybdenum

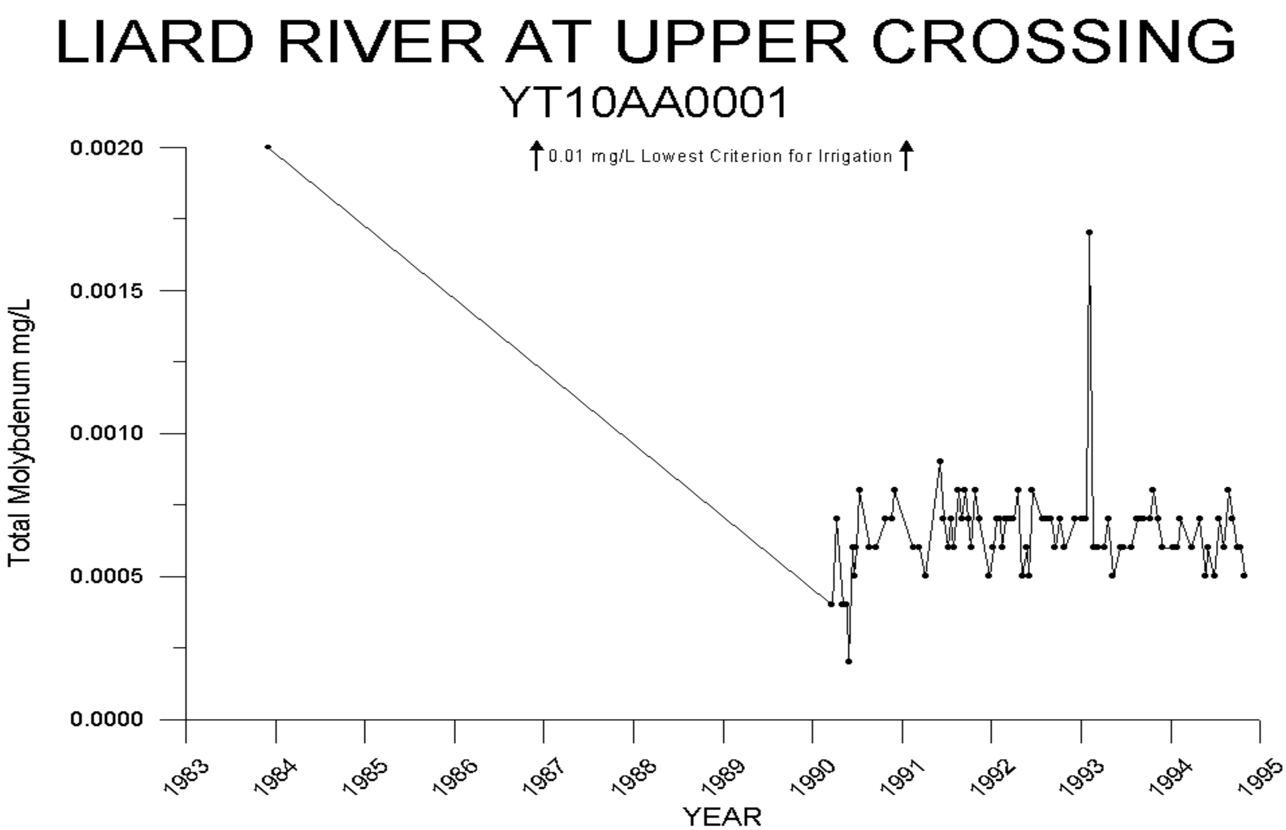


Figure 25 Total Nickel

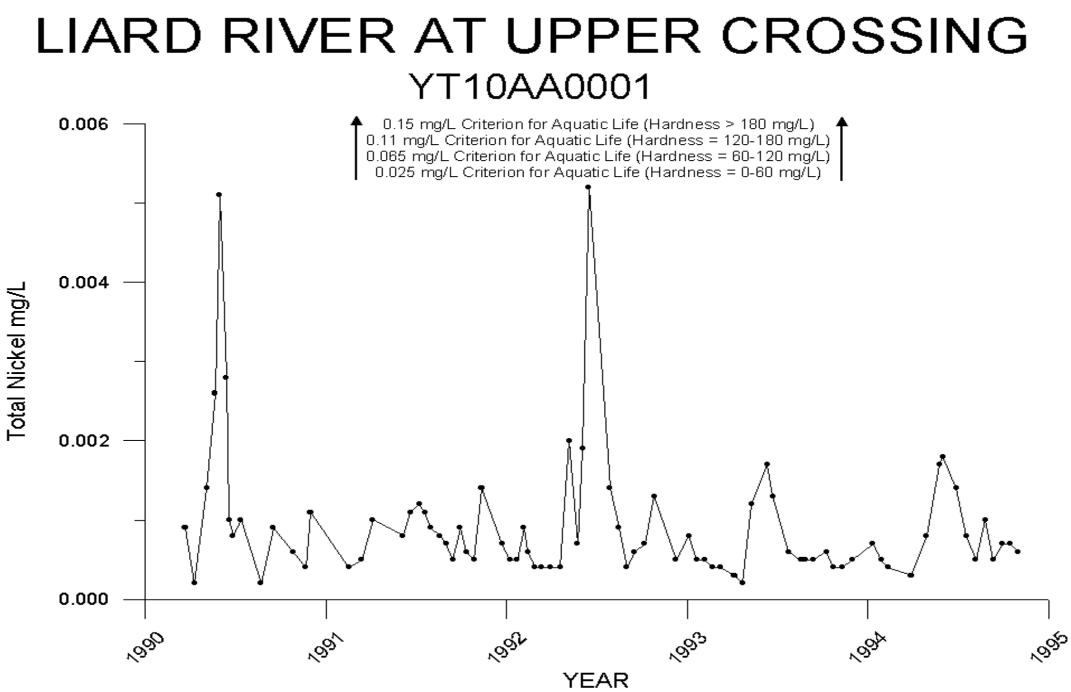


Figure 26 Nitrogen (Nitrate/Nitrite)

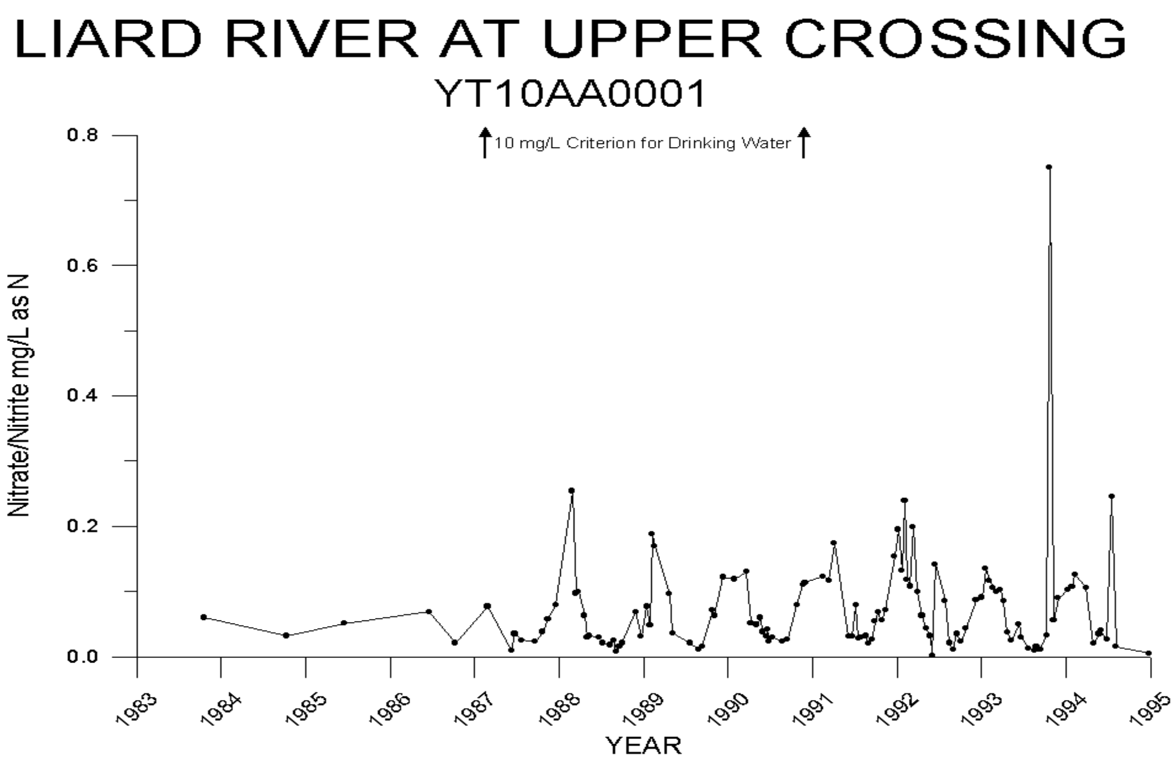


Figure 27 Total Dissolved Nitrogen

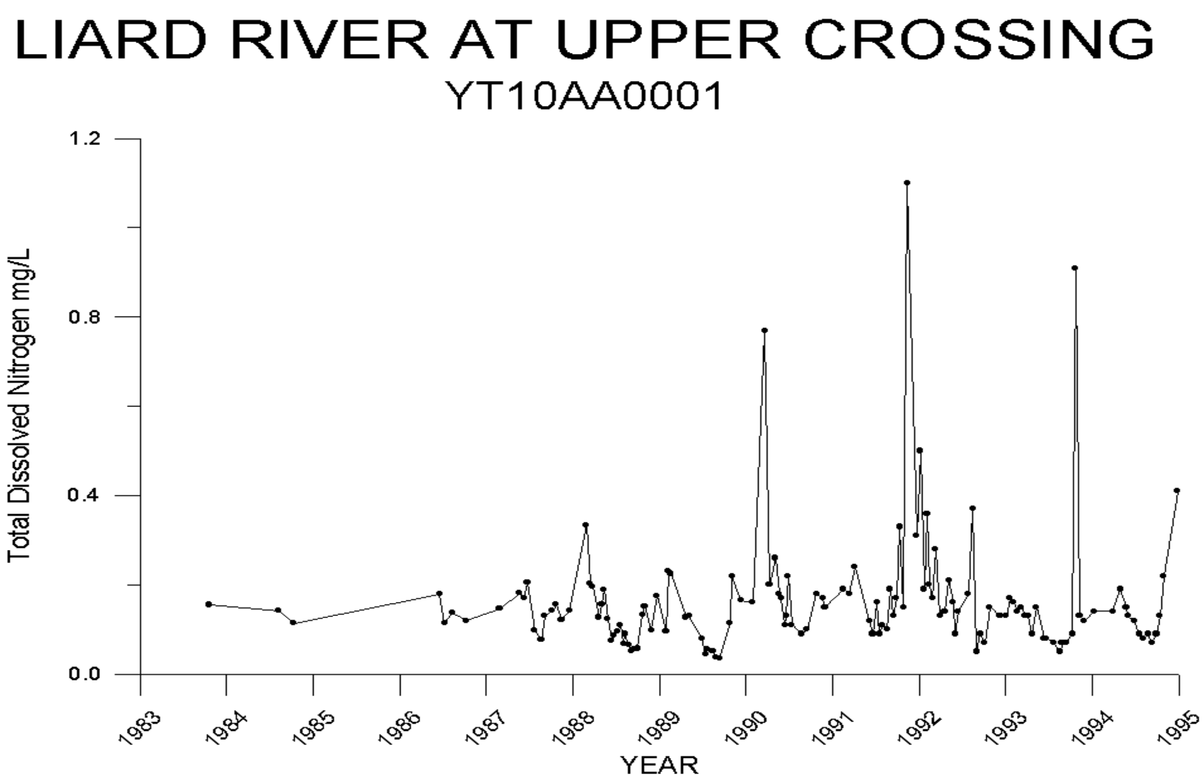


Figure 28 pH

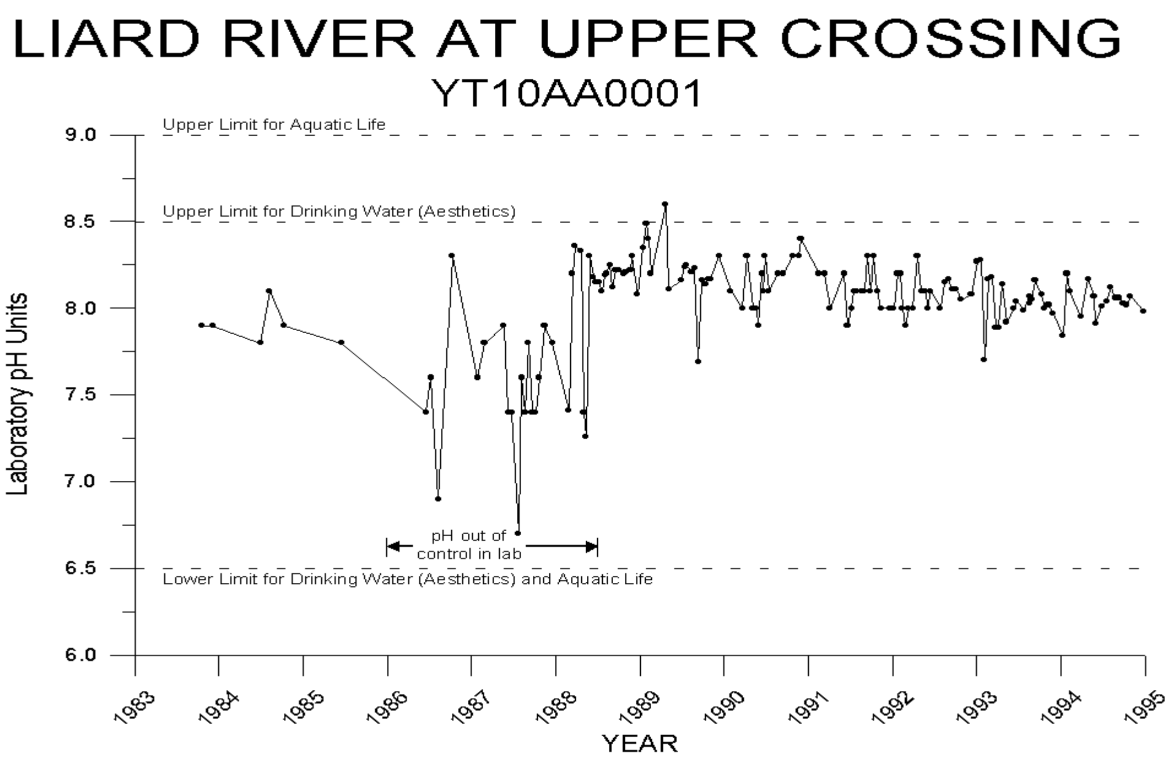

LIARD RIVER AT UPPER CROSSING
YT10AA0001
Upper Limit for Aquatic Life
Upper Limit for Drinking Water (Aesthetics)
pH out of control in lab
Lower Limit for Drinking Water (Aesthetics) and Aquatic Life
Laboratory pH Units
9.0
8.5
8.0
7.5
7.0
6.5
6.0
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
YEAR

Figure 29 Total Phosphorus

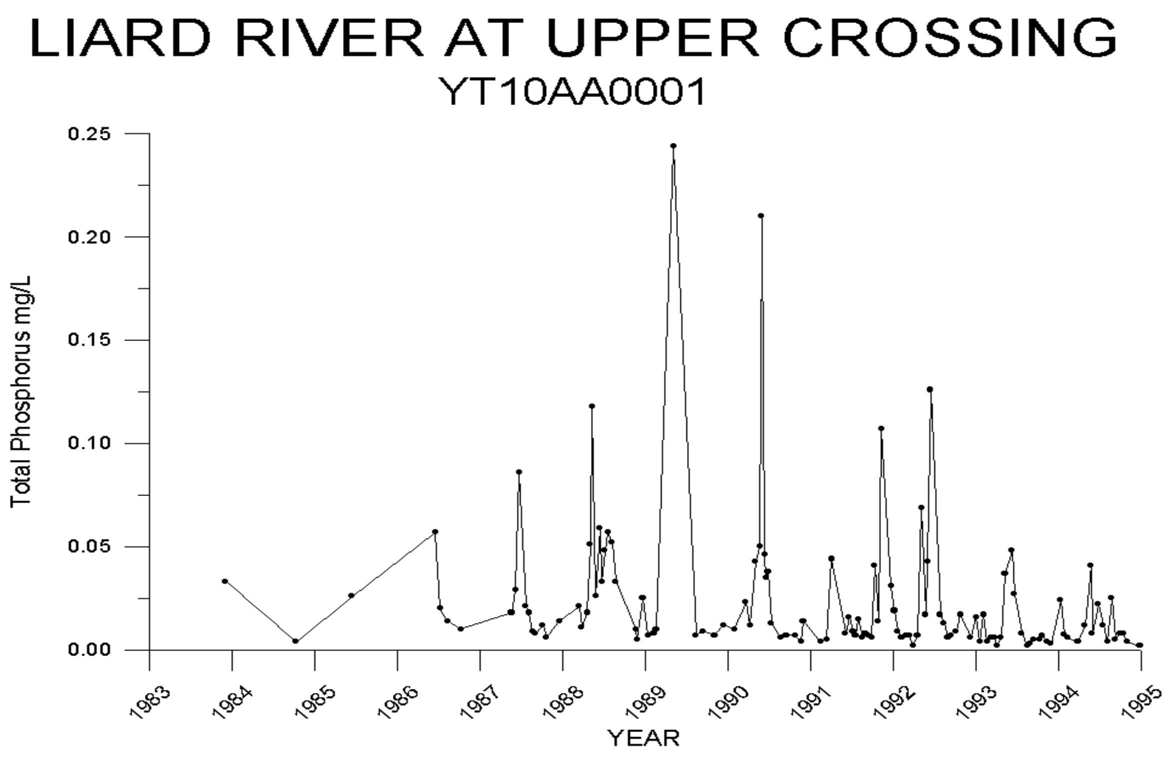


Figure 30 Potassium

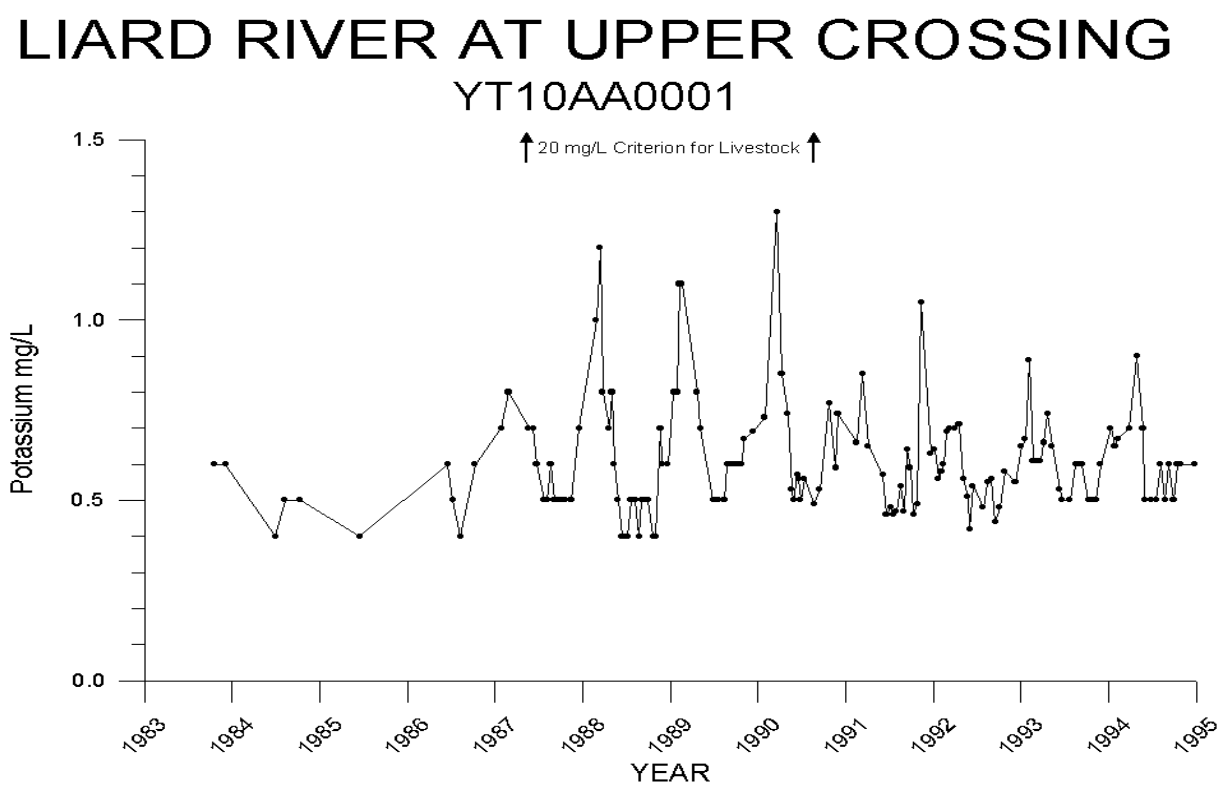


Figure 31 Filterable Residue

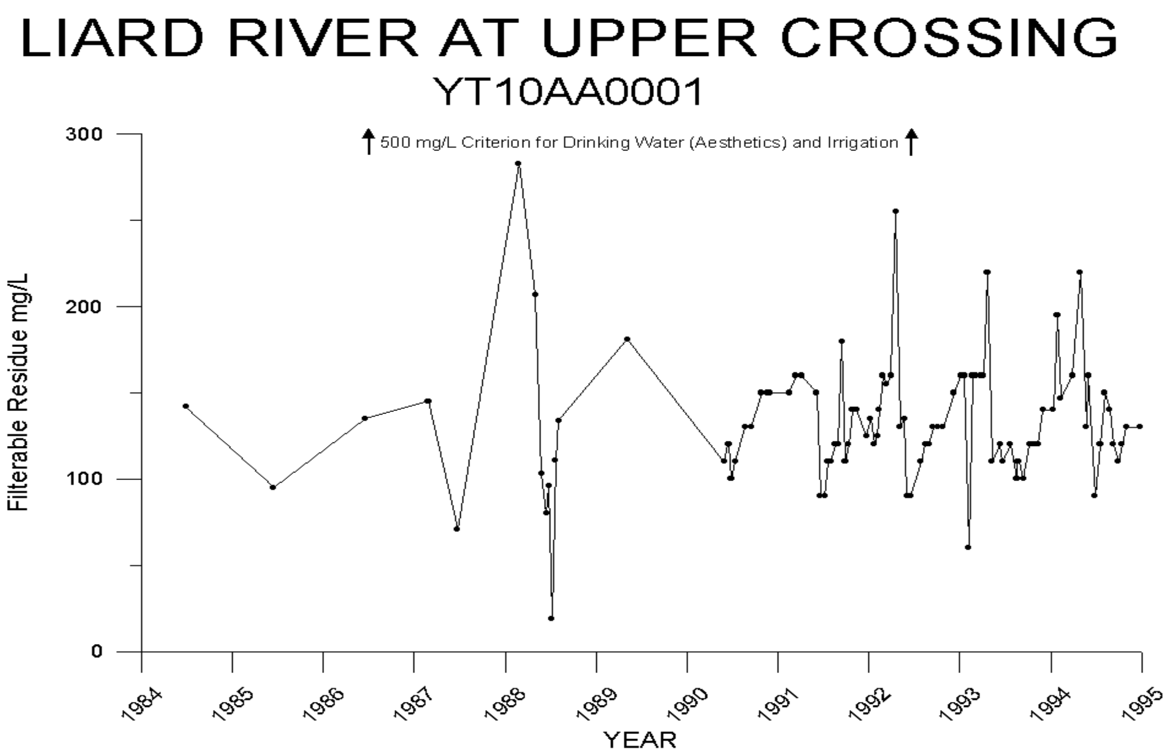


Figure 32 Non-Filterable Residue

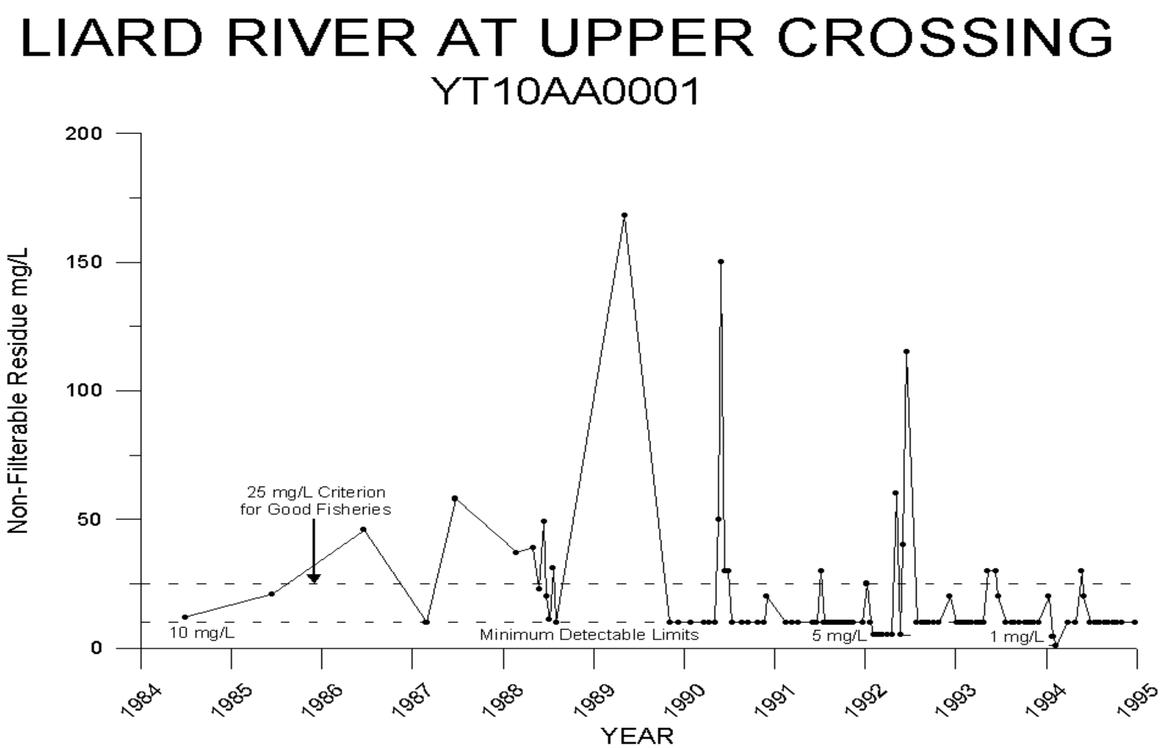


Figure 33 Fixed Filterable Residue

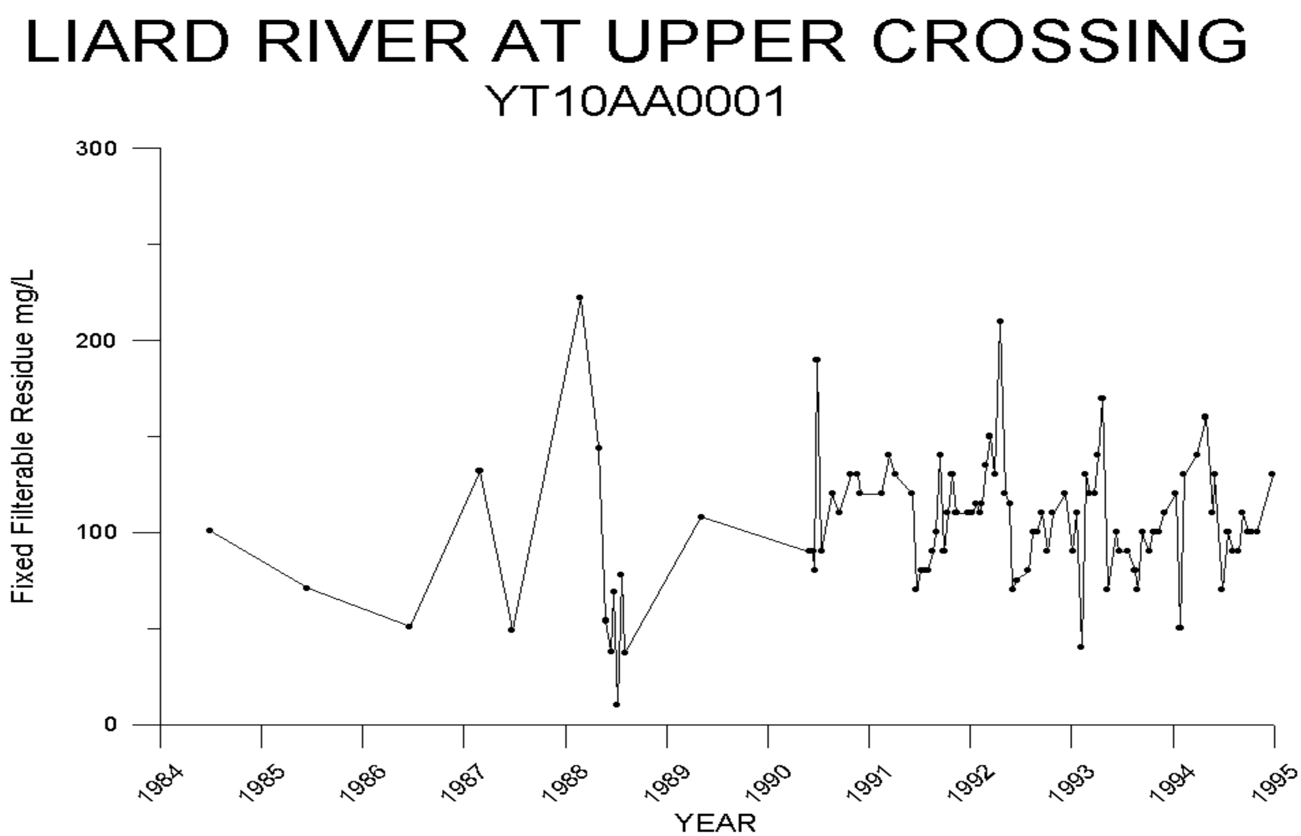


Figure 34 Fixed Non-Filterable Residue

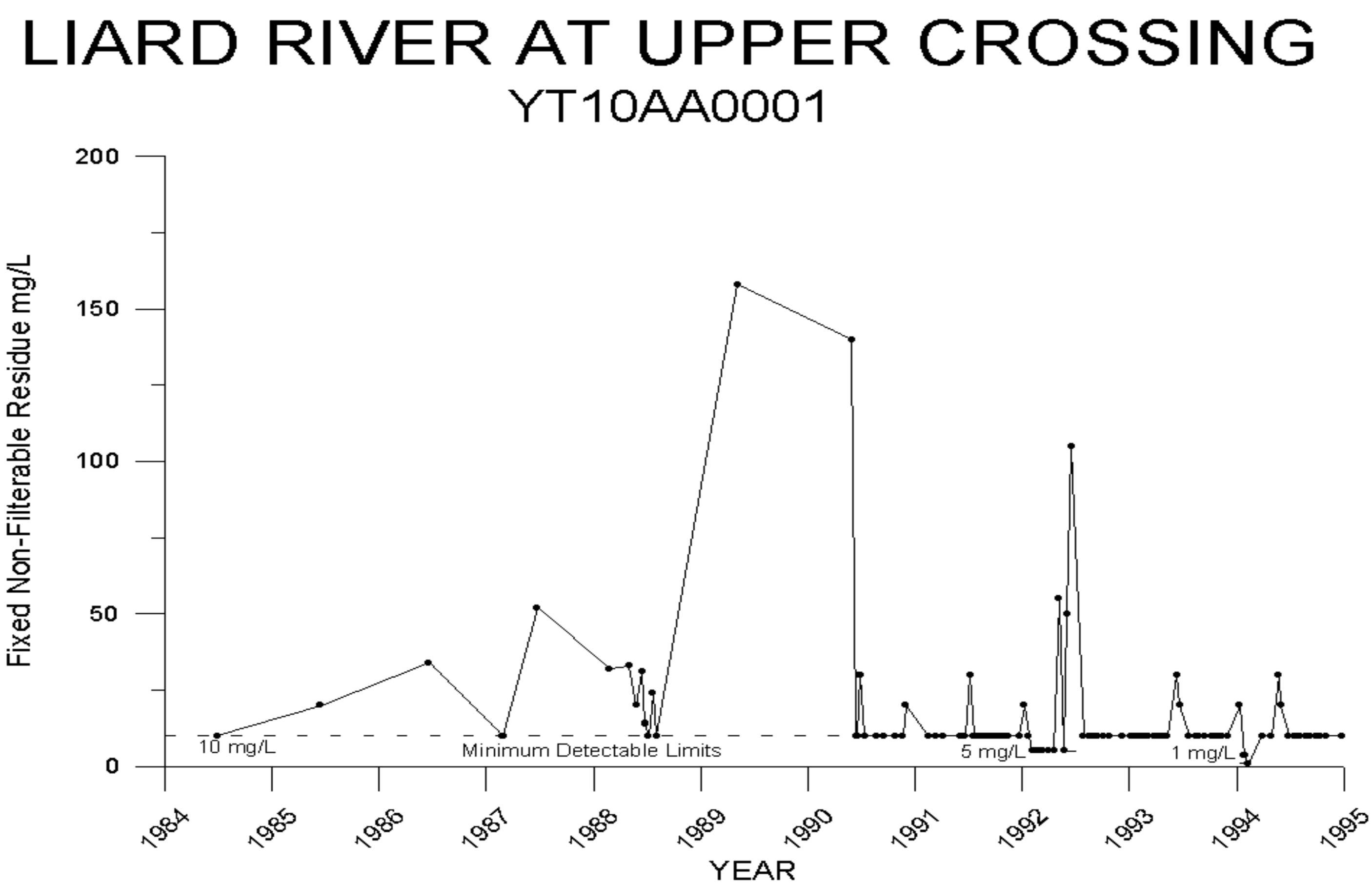


Figure 35 Total Selenium

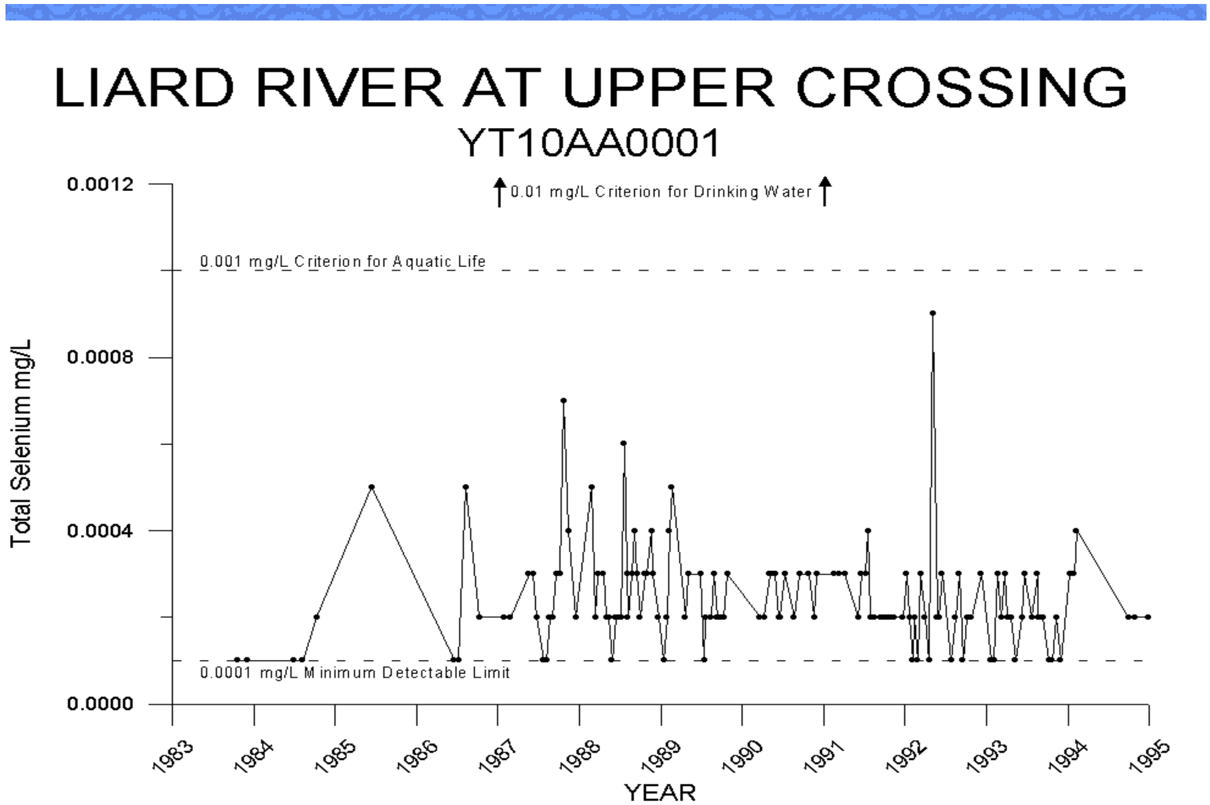


Figure 36 Silica

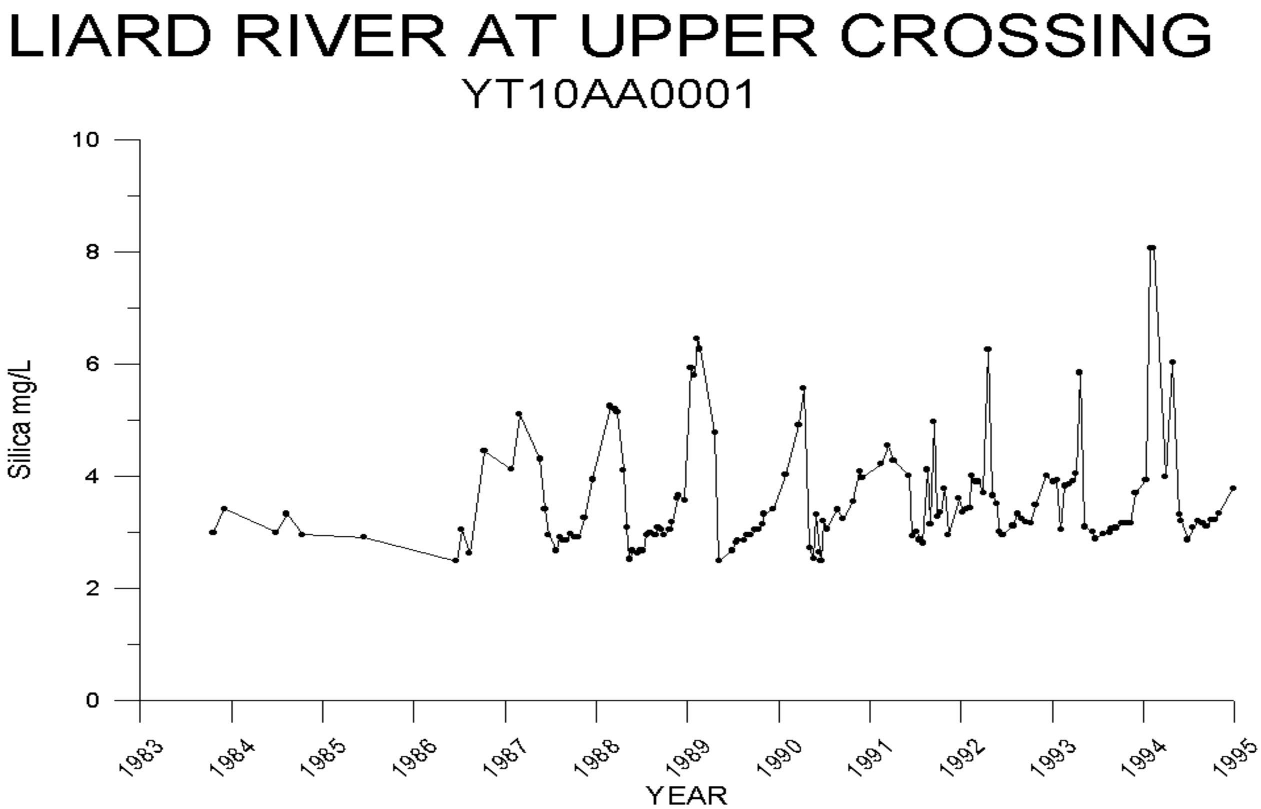


Figure 37 Sodium

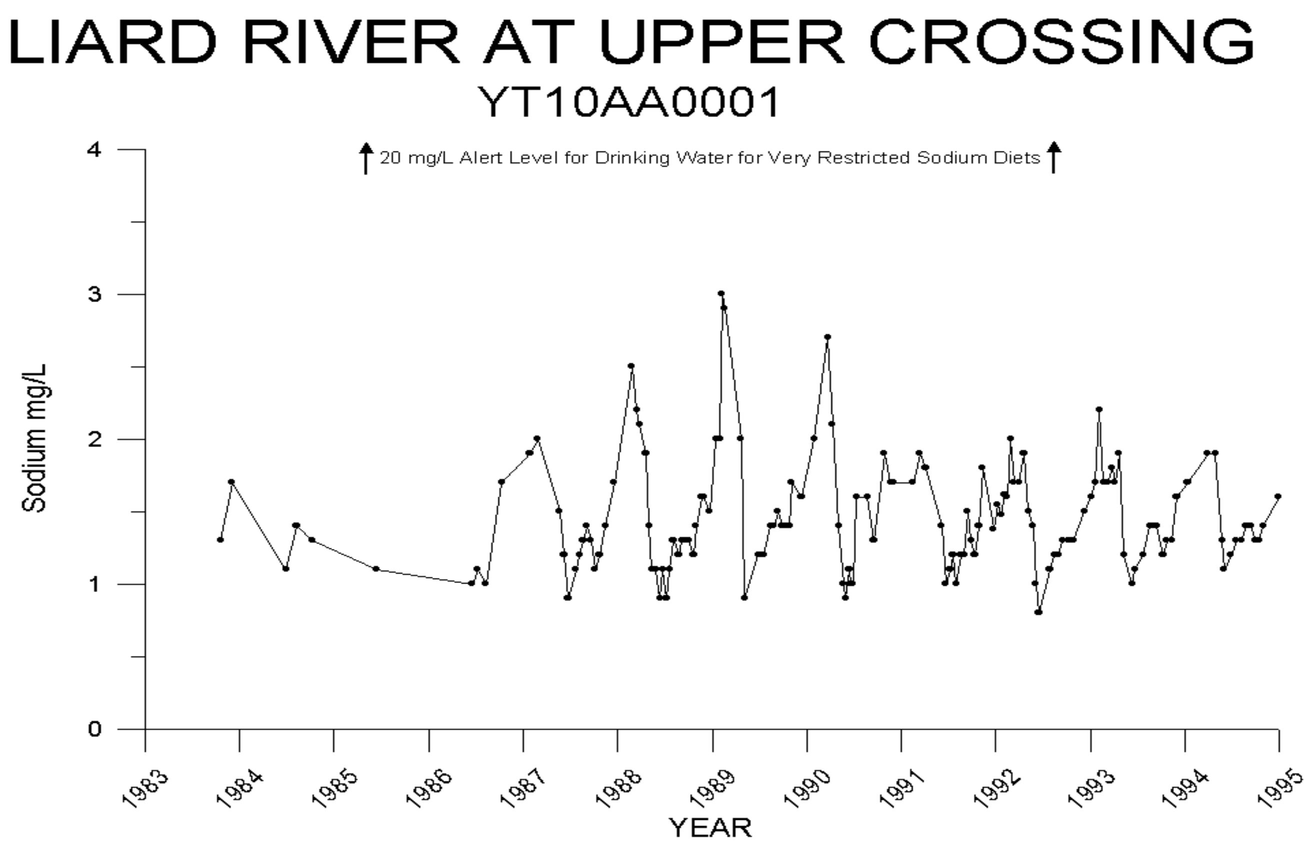


Figure 38 Specific Conductivity

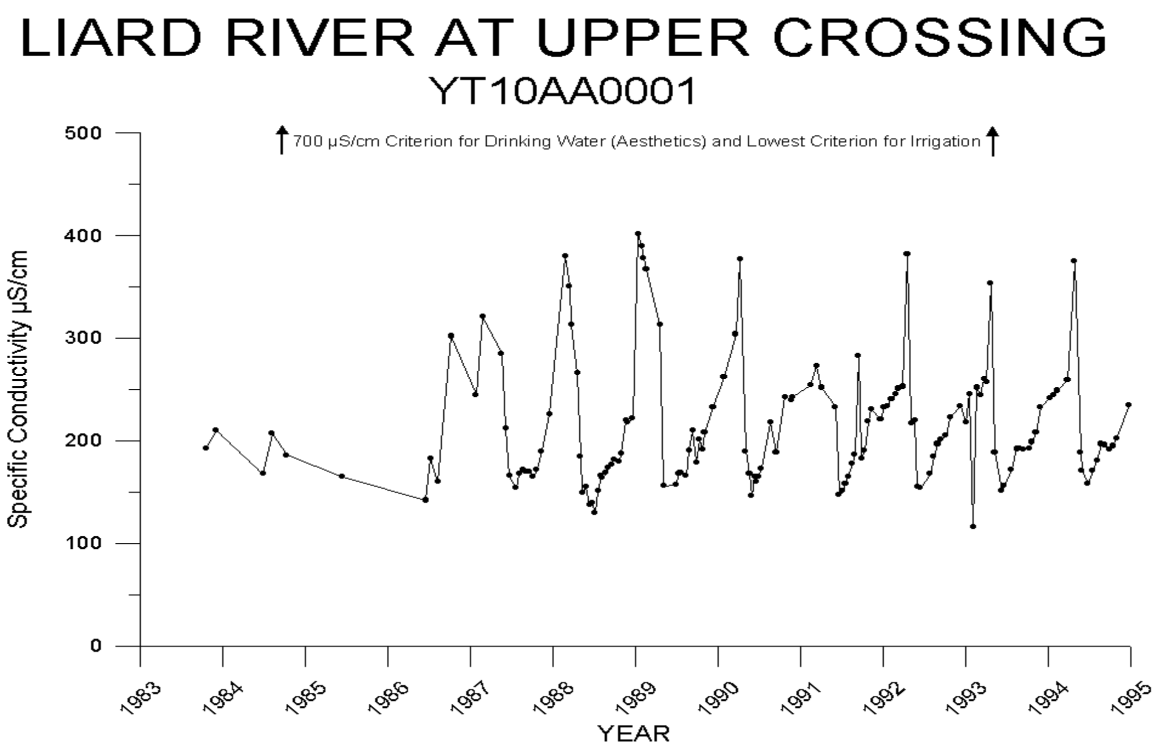


Figure 39 Total Strontium

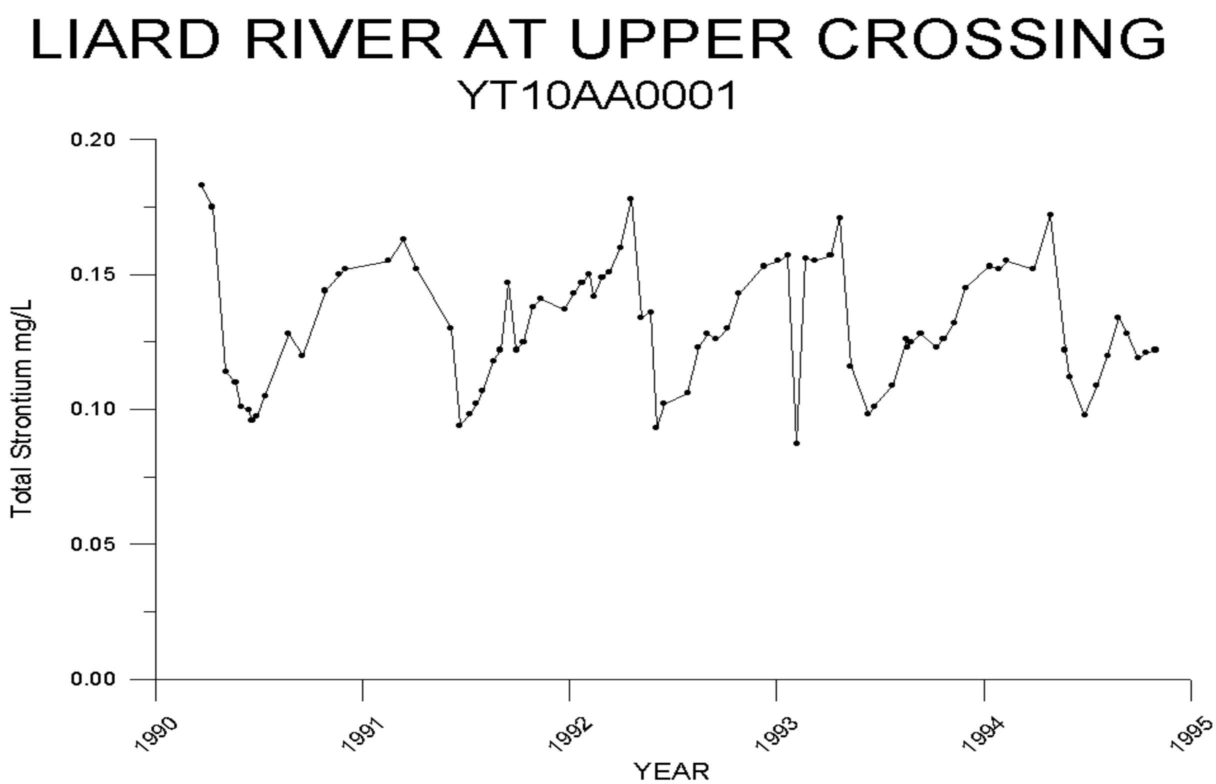


Figure 40 Dissolved Sulphate

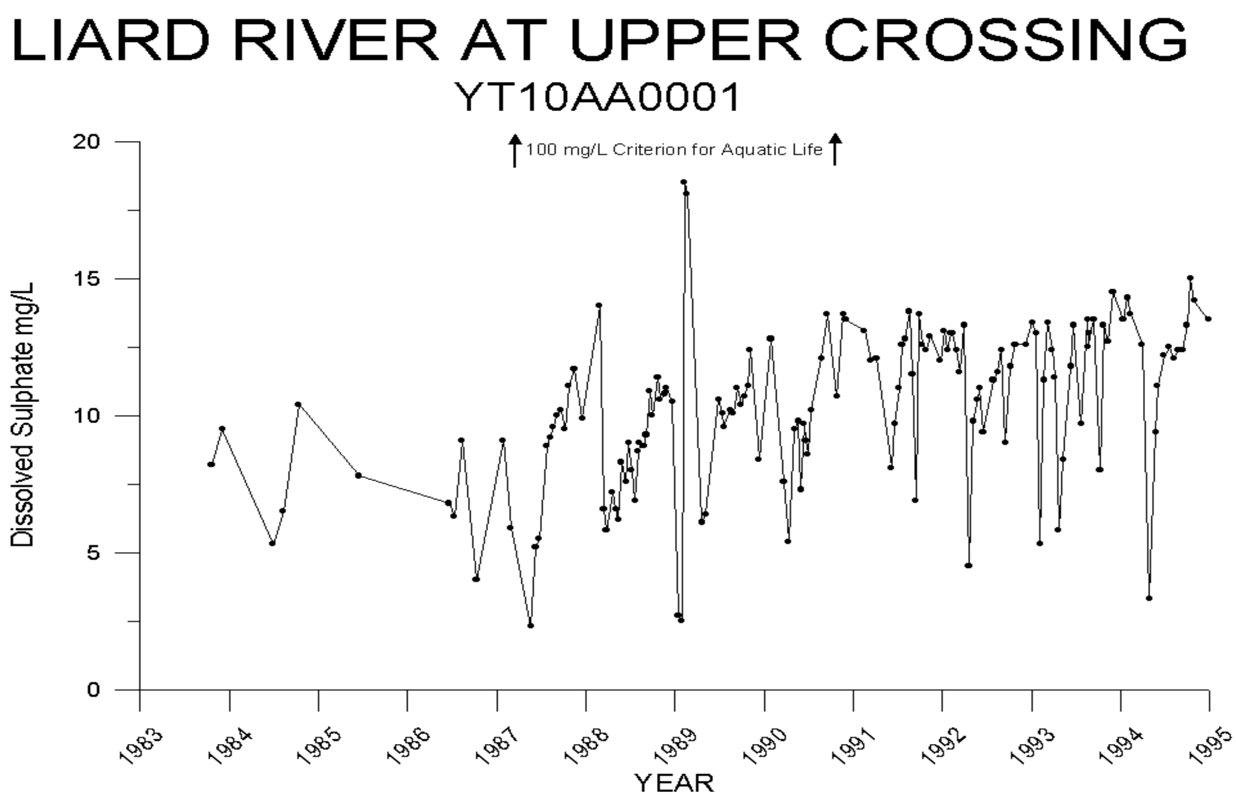


Figure 41 Air Temperature

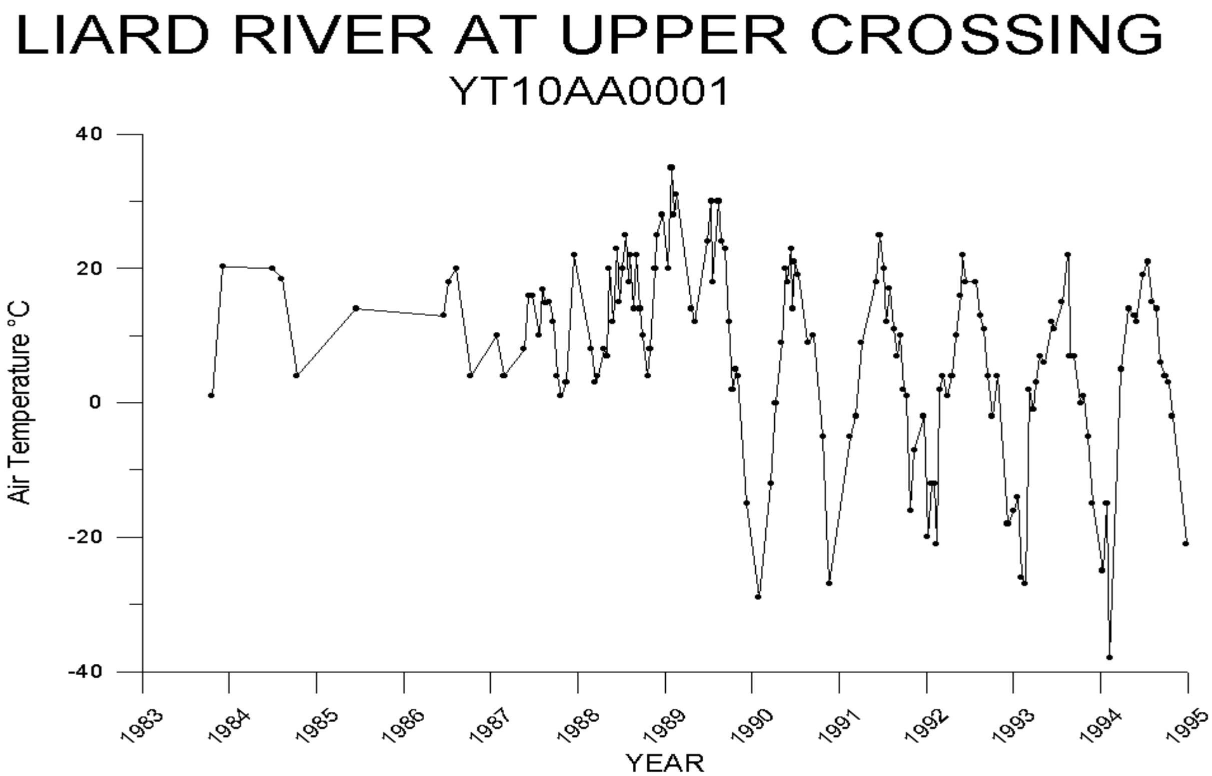


Figure 42 Water Temperature

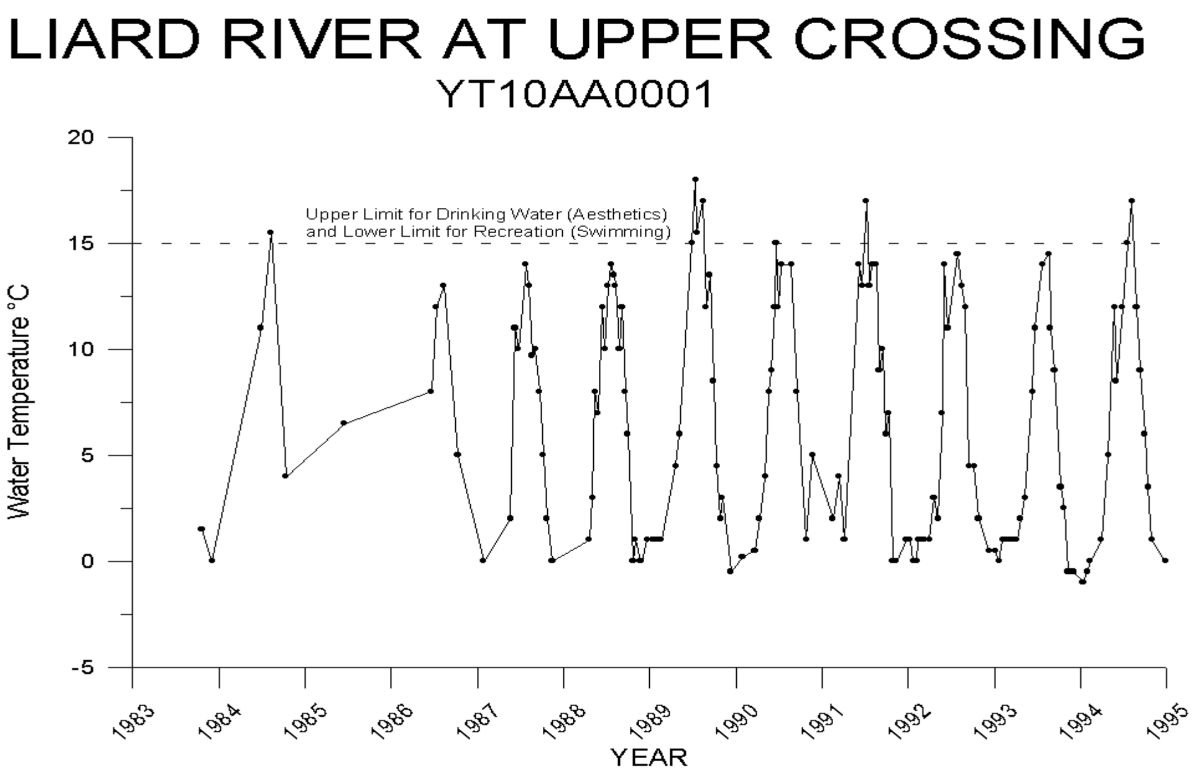


Figure 43 Turbidity

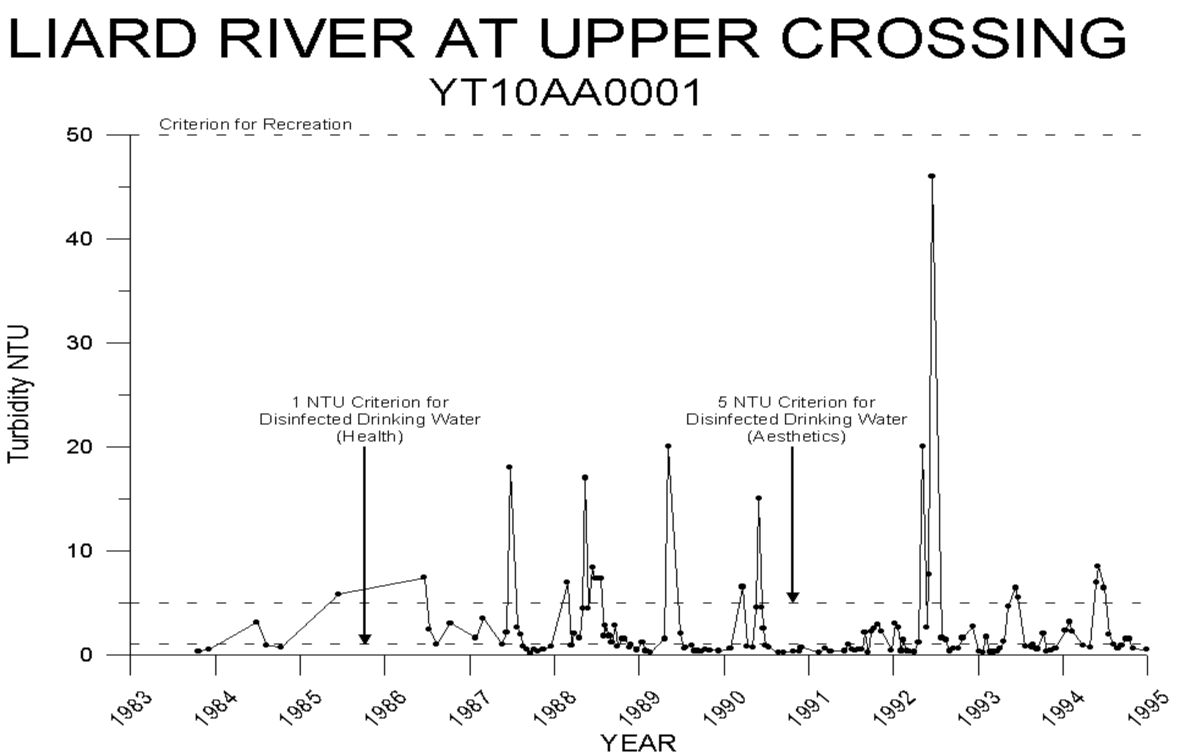


Figure 44 Total Vanadium

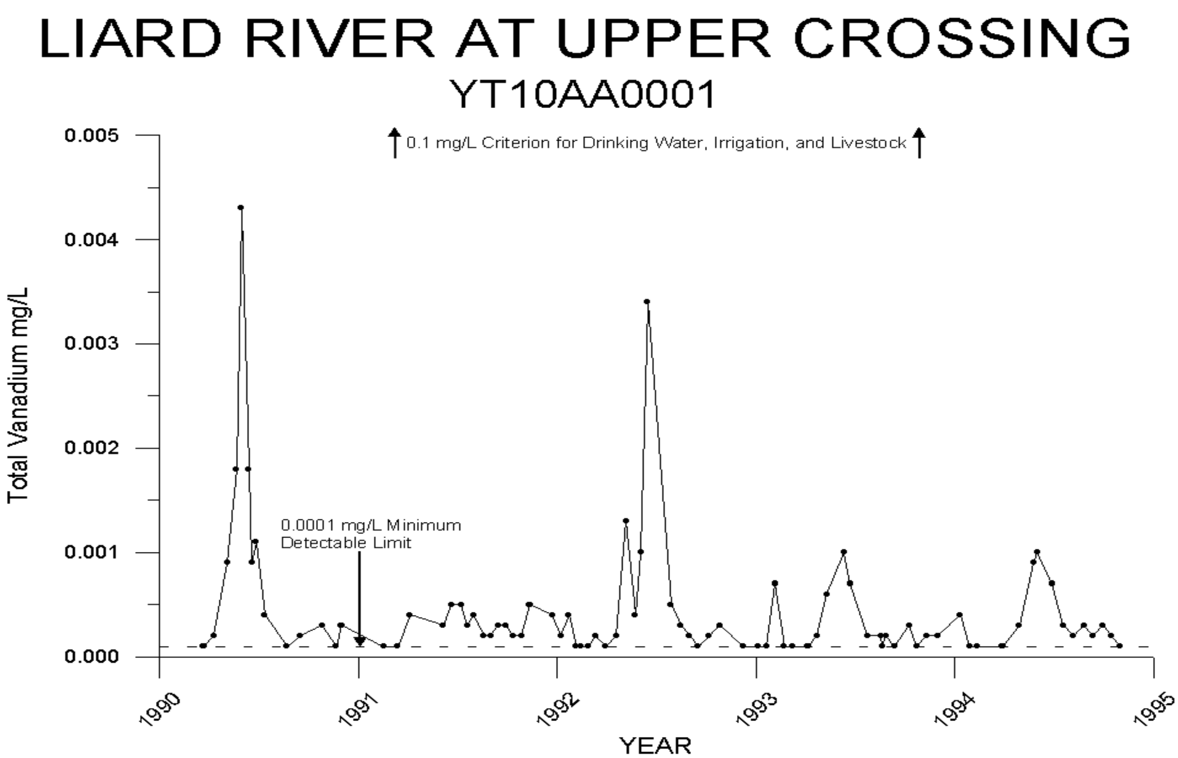
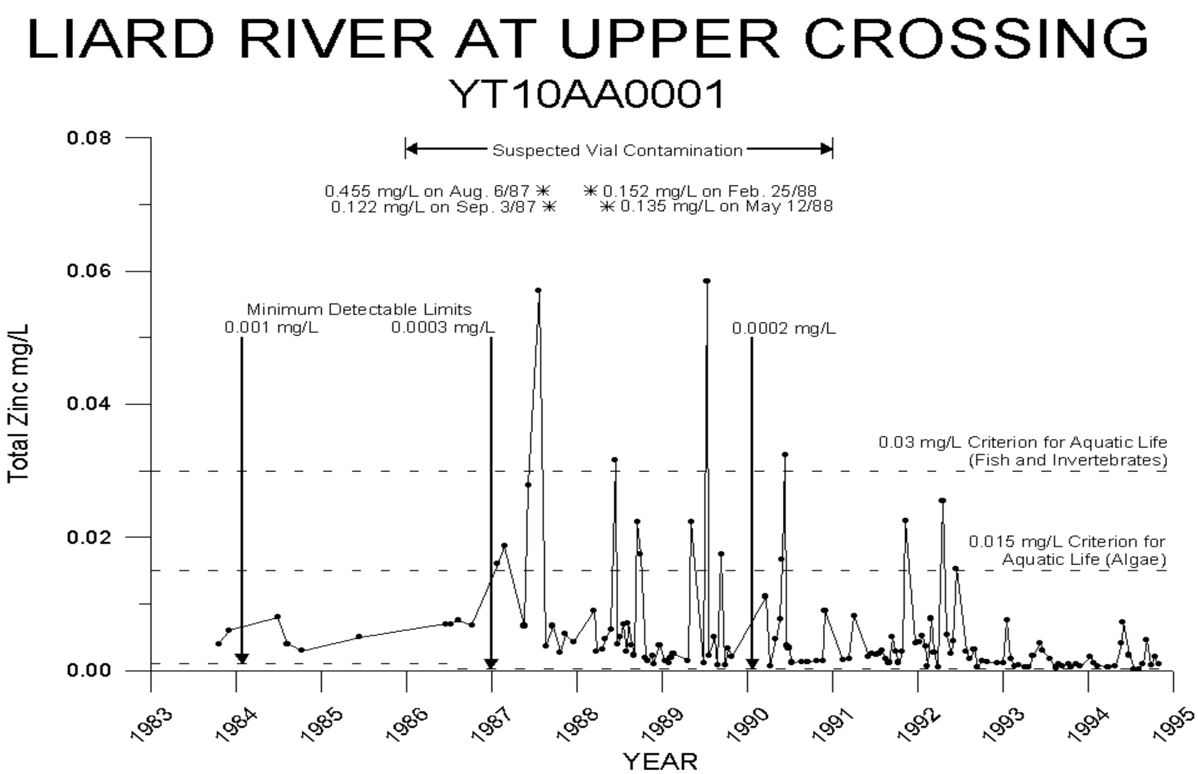


Figure 45 Total Zinc



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