



NEW ZEALAND
ALUMINIUM SMELTERS LIMITED

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**INTERDEPARTMENTAL
COMMITTEE
REPORT**

1992

**REPORT TO THE INTERDEPARTMENTAL COMMITTEE
ON ENVIRONMENTAL EFFECTS OF THE TIWAI ALUMINIUM SMELTER
FOR THE YEAR ENDED 31 DECEMBER 1992**

MEETING AT TIWAI
20th APRIL, 1993

**THE INFORMATION CONTAINED IN THIS REPORT IS CONFIDENTIAL TO
THE MEMBERS OF THE INTERDEPARTMENTAL COMMITTEE**

CONTENTS	PAGE
SUMMARY	1
1. INTRODUCTION	2
MAP OF NZAS MONITORING SITES	3
2. EMISSIONS TO AIR	4
2.1 MAIN STACK EMISSIONS	4
2.2 POTROOMS ROOF LOUVRE EMISSIONS	7
2.3 BAGHOUSE EMISSIONS	9
3. DISPERSION AND EFFECTS OF EMISSIONS TO AIR	9
3.1 Meteorological Conditions	9
3.2 Ambient Air Gaseous Fluoride	11
3.3 Ungrazed Grasses	15
3.4 Grazing Monitor Project	17
3.5 Tiwai Experimental Farm Project	29
4: DISCHARGES TO WATER AND THEIR EFFECTS	33
4.1 Coastal Permit No 90057 - North Drain	33
4.2 Coastal Permit No 90058 - West Drain	35
4.3 Coastal Permit No 90059 - South Drain	36
4.4 Coastal Permit No 90060 - Sewage Discharge	39
4.5 Coastal Permit No 90061 - Spent Cathode Leachate	41
5: GROUNDWATER	44

SUMMARY

Page 1

The paraclone replacement program completed at the end of 1992 reduced the total particulate concentration in the main stack emissions. Work continues to optimize all systems associated with the measurement and control of the main stack emissions.

During December the monthly mean concentrations of gaseous fluoride exceeded that permit condition for both the main stack and the pot rooms roof louvres. The annual mean values for these two discharges were within the annual mean permit conditions.

The overall effect of the smelter on the environment as measured by the ambient air gaseous fluoride, the ungrazed grass and the grazing monitor projects was relatively stable and at similar levels to the previous years. The exceptions being an increase in the vegetation fluoride in the area directly north of the smelter and a reduction in the ambient air gaseous fluoride concentration on the Tiwai Peninsula. None of the parameters measured exceeded their relevant permit condition.

The source of the elevated levels of fluoride in the north drain has been identified as the low level pot room roof louvre emissions. A study of remedial options is underway. A 29% reduction in the volume of effluent arriving at the sewage plant resulted in a reduction in the BOD5 and solids concentrations in this discharge.

It was recognized that leachate from the south spent cathode storage pad had entered the ground water beneath this pad. Works undertaken to mitigate any future production of this leachate include the capping of the south pad, the decommissioning of the north pad and the commissioning of a spent pot lining storage building. Work continues on identifying and developing processes that can be used to remediate the effected groundwater. The capping of the south spent cathode storage pad and the changes to the discharge procedures produced apparent rather than real shifts in the measured effects on the environment.

At NZAS each Manager is directly accountable for the effect of area operations on the environment. Work continues to be carried out by each Manager to continuously improve the systems to minimise these effects.

**REPORT TO THE INTERDEPARTMENTAL COMMITTEE ON
ENVIRONMENTAL EFFECTS OF THE TIWAI ALUMINIUM
SMELTER FOR THE YEAR ENDING 31 DECEMBER, 1992**

1. INTRODUCTION

For NZAS, 1992 was a year where continuous efforts were applied towards minimizing the present and improving the future environmental effects of the Tiwai Aluminium Smelter.

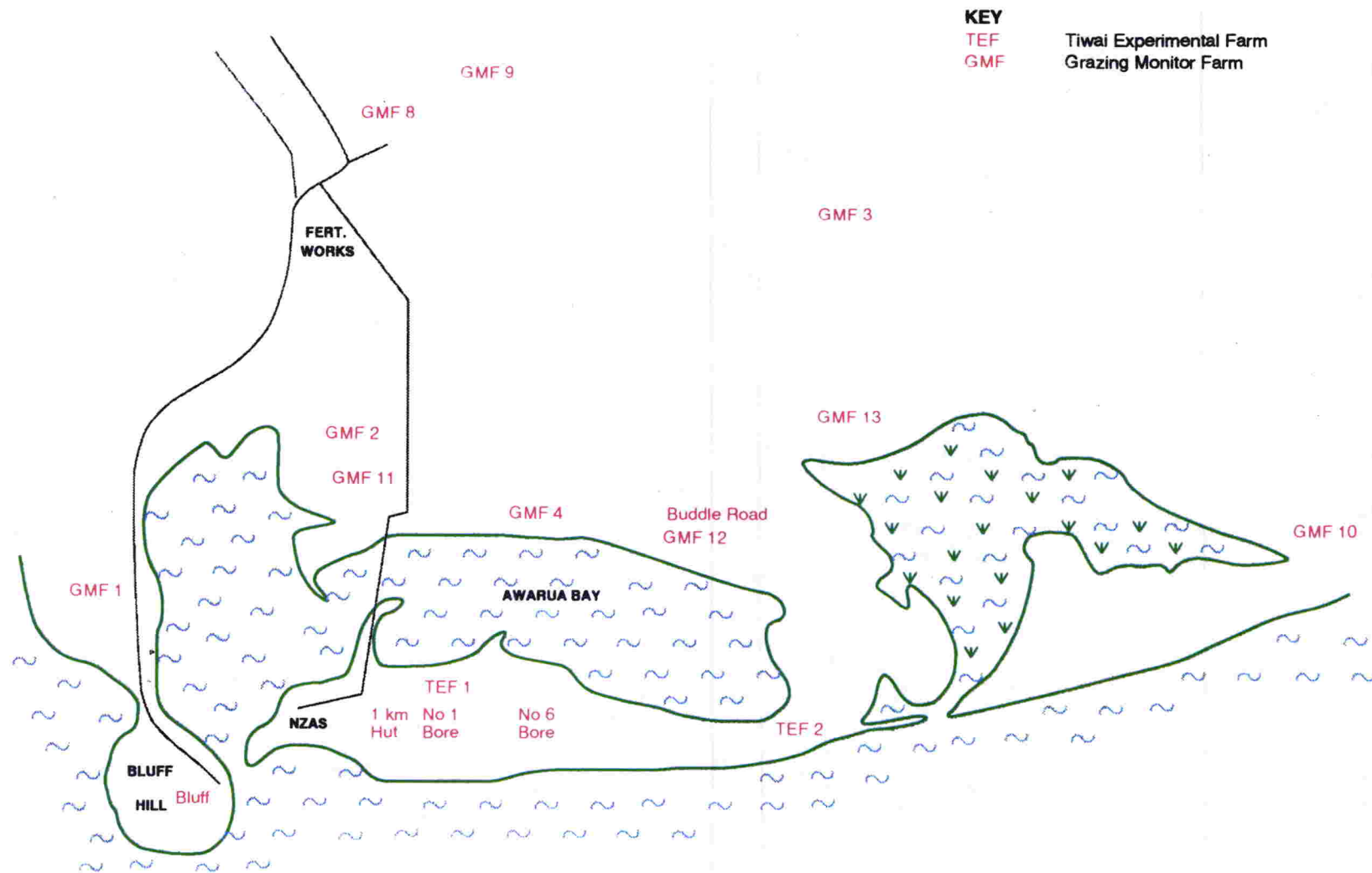
The extensive paraclone replacement programme initiated in 1991 was completed. The Atmospheric Emissions Control MRU, also established in 1991, continued its study into the general mechanisms of atmospheric emissions from the aluminium reduction process and the development of a pilot scale dry scrubbing reactor. Successful trials of this reactor have resulted in a further study of the performance of a scaled up reactor as a future option for control of the smelters potroom emissions.

The closure and subsequent restart of Line 2 put a considerable strain on the smelter's resources. The major effort expended by the smelter staff during this restart minimized any periods of abnormal operating conditions which were believed to have the potential to increase the environmental impact of the smelter.

The presence of contaminated groundwater in the vicinity of the spent cathode storage pads resulted in the immediate actions of capping the existing pad and constructing a building for the storage of future spent potlining material.

This report quantifies the resultant environmental effects of these actions as well as the ongoing routine smelter operations.

NZAS MONITORING SITES



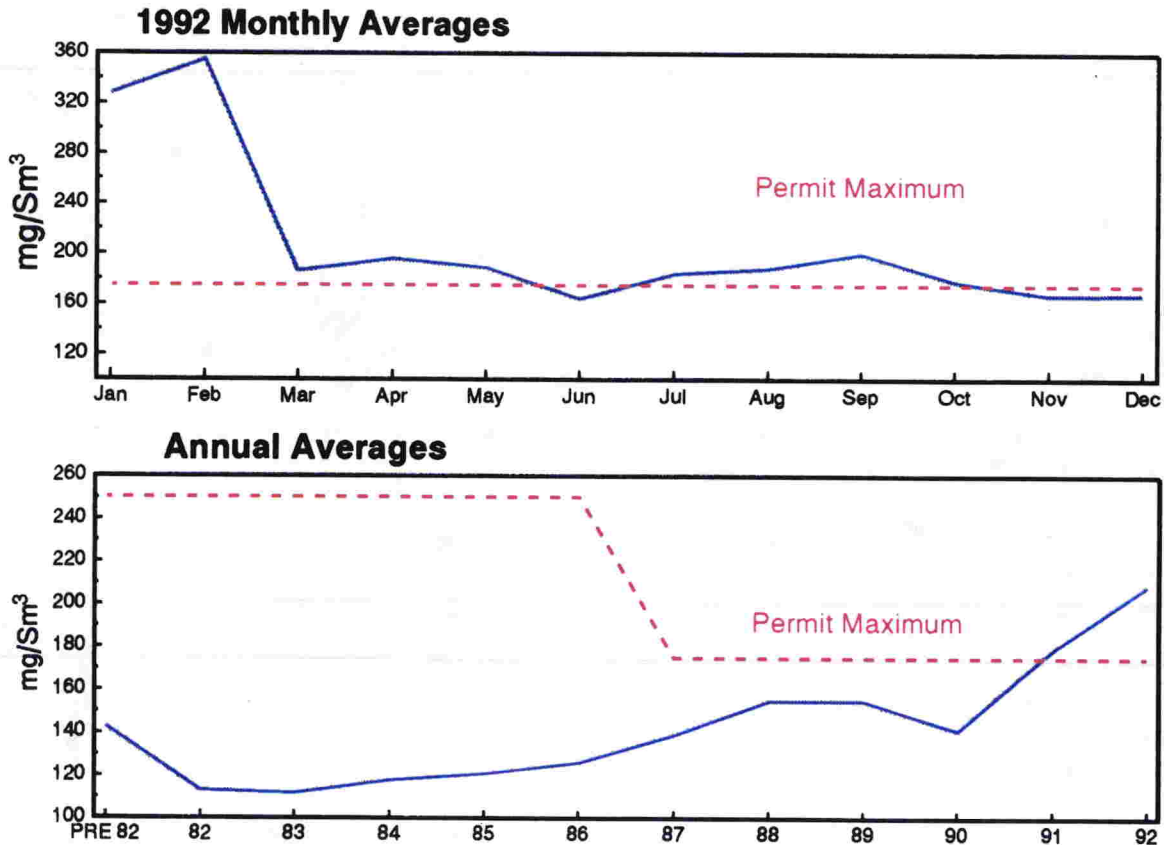
2: EMISSIONS TO AIR

Page 4

The emissions to air from the smelter were subject to Discharge Permit No HD/19/0006/88. The following sections give details of the emission trends.

2.1 MAIN STACK EMISSIONS

2.1.1 Total Particulate Concentrations



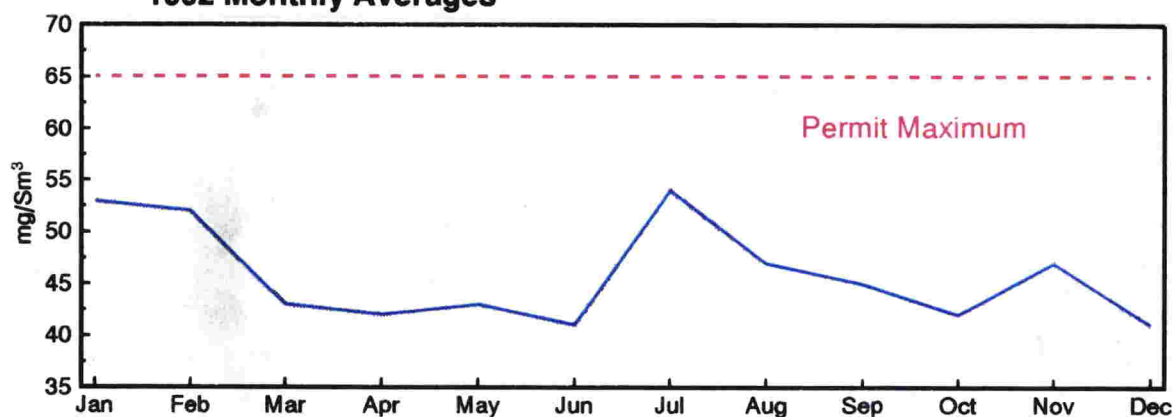
The 1992 average stack total particulate concentration was 206mg/Sm³ exceeding the permit condition maximum of 175mg/Sm³. However, as work progressed on the replacement of the multicyclone paraclones during the year from March 1992, the average total particulate concentration reduced. For the ten months from March 1992 the average particulate concentration was 182mg/Sm³.

It was recognised that to continue the use of alumina injection to control HF gaseous emission and reduce wear on the new paraclones, an additional pre-collection system was required. The first system was installed in Potroom 3A ducting during the third quarter 1992 and optimisation trials completed. While this pre-collector has achieved the expected recovery of injected alumina, the reversion to the original secondary air system to allow collection of the pre-collector material by the Bag House, has caused an increase in fines carry over.

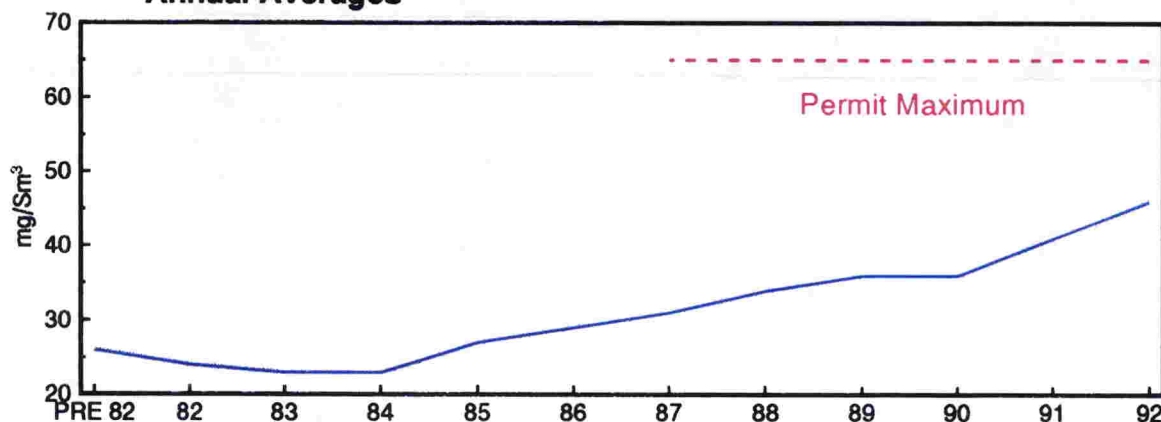
Work is now being done to balance the two systems, but results to date indicate that additional dust collection and unloading capacity may be necessary to handle the increased amount of alumina being injected.

2.1.2 Particulate Fluoride Concentration

1992 Monthly Averages



Annual Averages

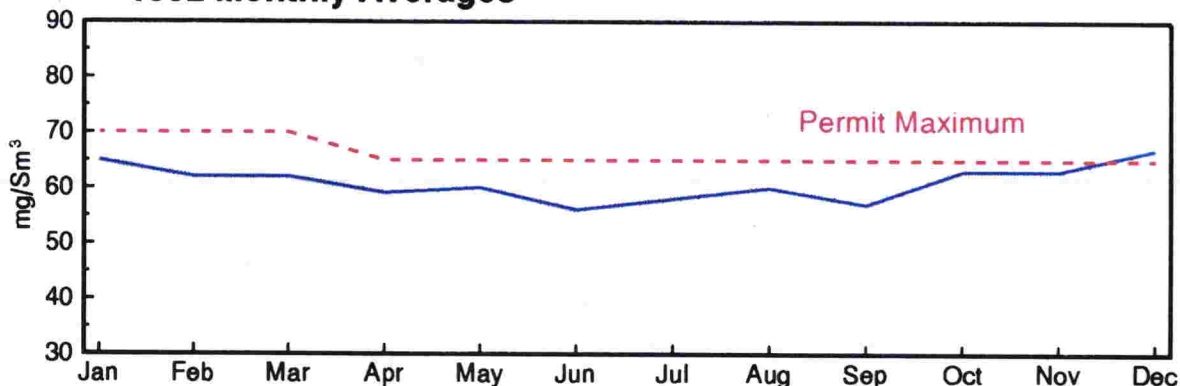


The 1992 average stack particulate fluoride concentration was 46mg/Sm.³

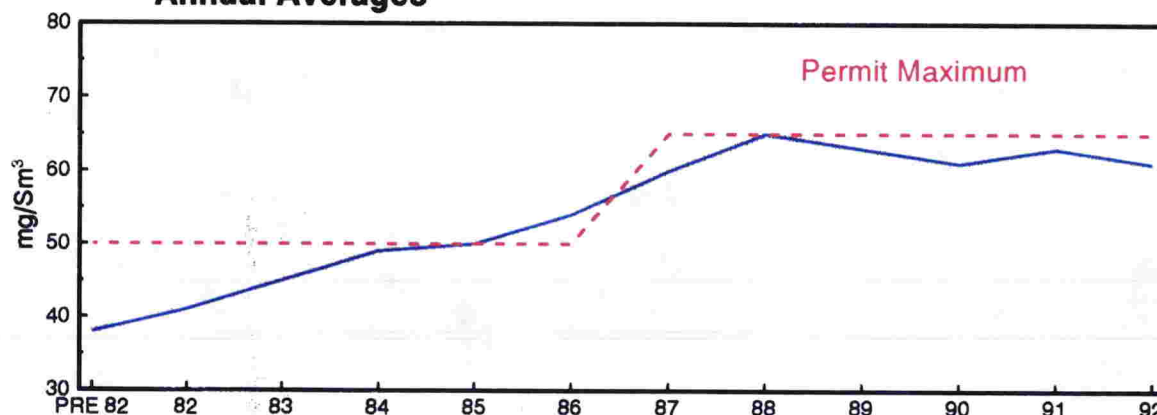
Additional comment is made in Section 2.1.1 relating to some fines carry over.

2.1.3 Gaseous Fluoride Concentrations

1992 Monthly Averages



Annual Averages



The 1992 average stack gaseous fluoride concentration of 61 mg/Sm³ was slightly lower than the 1991 average concentration of 63 mg/Sm³. The decrease reflecting improved control of the alumina injection system.

Process Improvement Team investigations into the fundamental mechanisms of fluoride generation are continuing and the "ideal" pot hooding system developed from modelling work is being translated for practical application.

2.1.4 Sulphur Dioxide Concentration

The 1992 average stack sulphur dioxide concentration was 165 mg/Sm³.

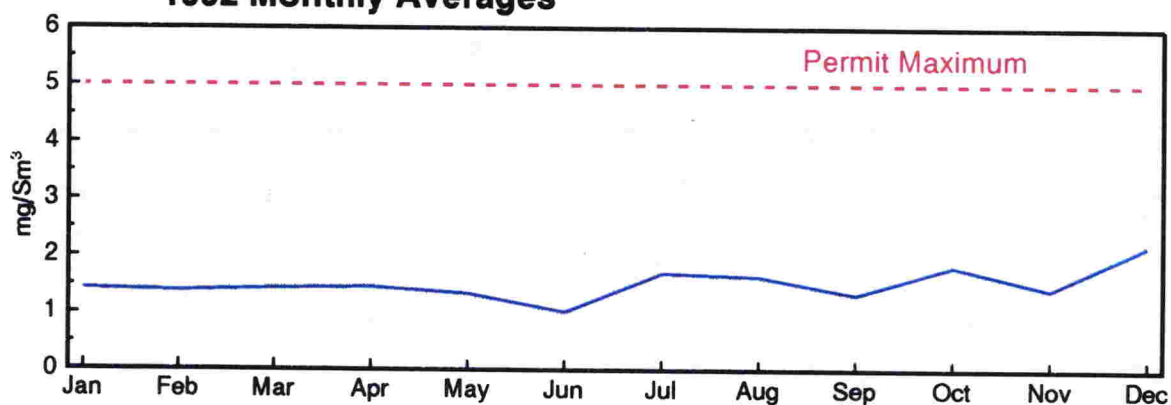
2.1.5 Ringelmann Smoke Density Number

The 1992 median stack Ringelmann smoke density number was 1.75 with a maximum observation of 2.25.

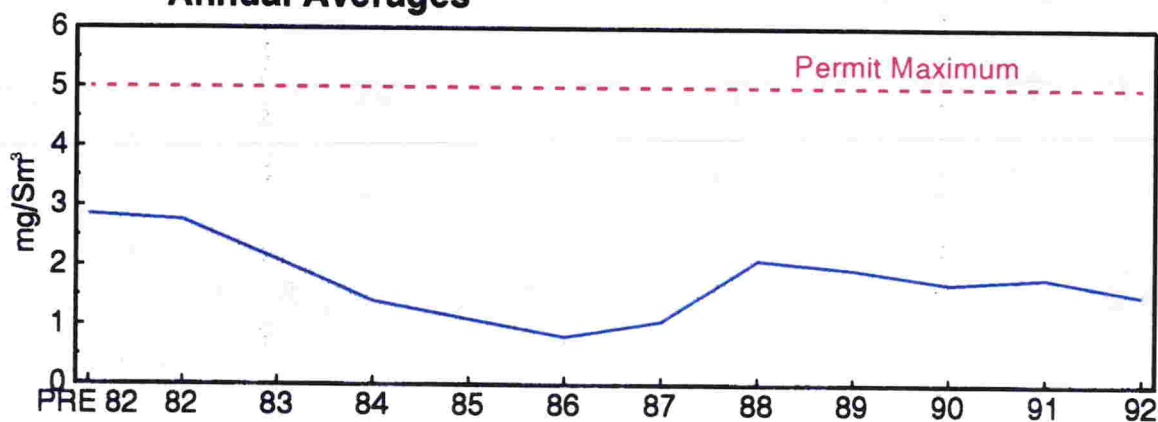
2.2 POTROOMS ROOF LOUVRE EMISSIONS

2.2.1 Total Particulate Concentrations

1992 Monthly Averages



Annual Averages



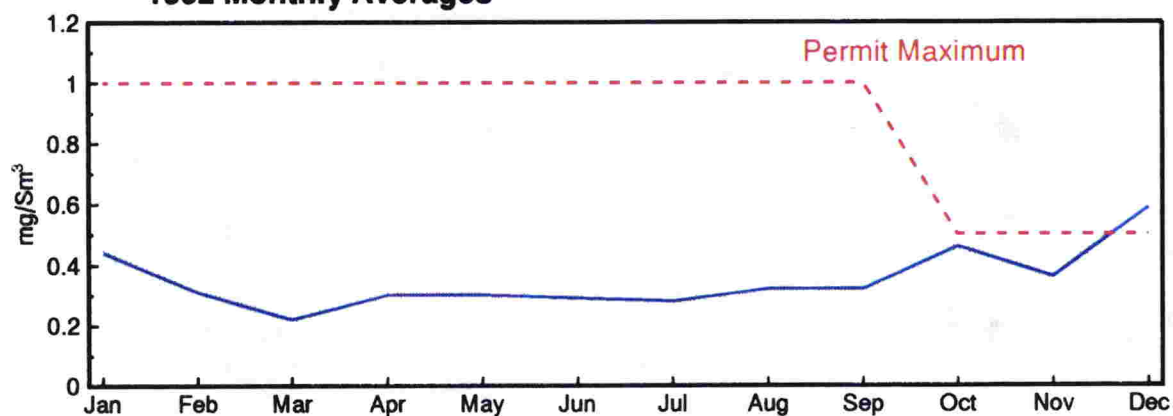
The 1992 average Potroom roof louvre total particulate concentration was 1.51mg/Sm³ . There is no trend evident.

2.2.2 Particulate Fluoride Concentration

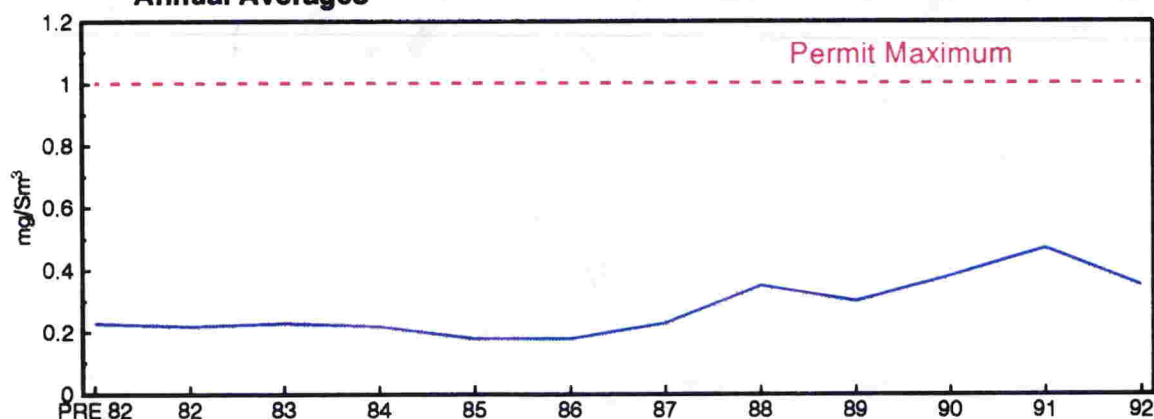
The 1992 average Potroom roof louvre particulate fluoride concentration was 0.36 mg/Sm^3 .

2.2.3 Gaseous Fluoride Concentrations

1992 Monthly Averages



Annual Averages



The 1992 average Potroom roof louvre gaseous fluoride concentration was 0.35 mg/Sm^3 .

The gaseous fluoride measurement exceeded the permit condition in December. The Line 2 start-up operation led to a higher than predicted level of roof emissions during this period.

2.2.4 Sulphur Dioxide Concentration

The 1992 average Potroom roof louvre sulphur dioxide concentration was 0.73 mg/Sm³. This is within the normal range of results.

2.3 BAGHOUSE EMISSIONS

The regular visual inspection of baghouse emissions was continued. These inspections supported the on-going operational surveillance of this equipment which ensured the required standards were maintained.

3: DISPERSION AND EFFECTS OF EMISSIONS TO AIR

3.1 METEOROLOGICAL CONDITIONS

The mean wind frequency diagram shown on the following page indicates the near typical Tiwai wind pattern which is dominated by westerly winds. Again, as in 1991, there was a reduction in south-westerly and a slight increase in north-westerly winds when compared to previous years.

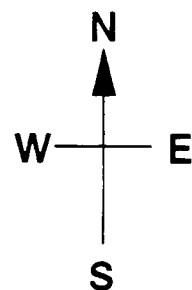
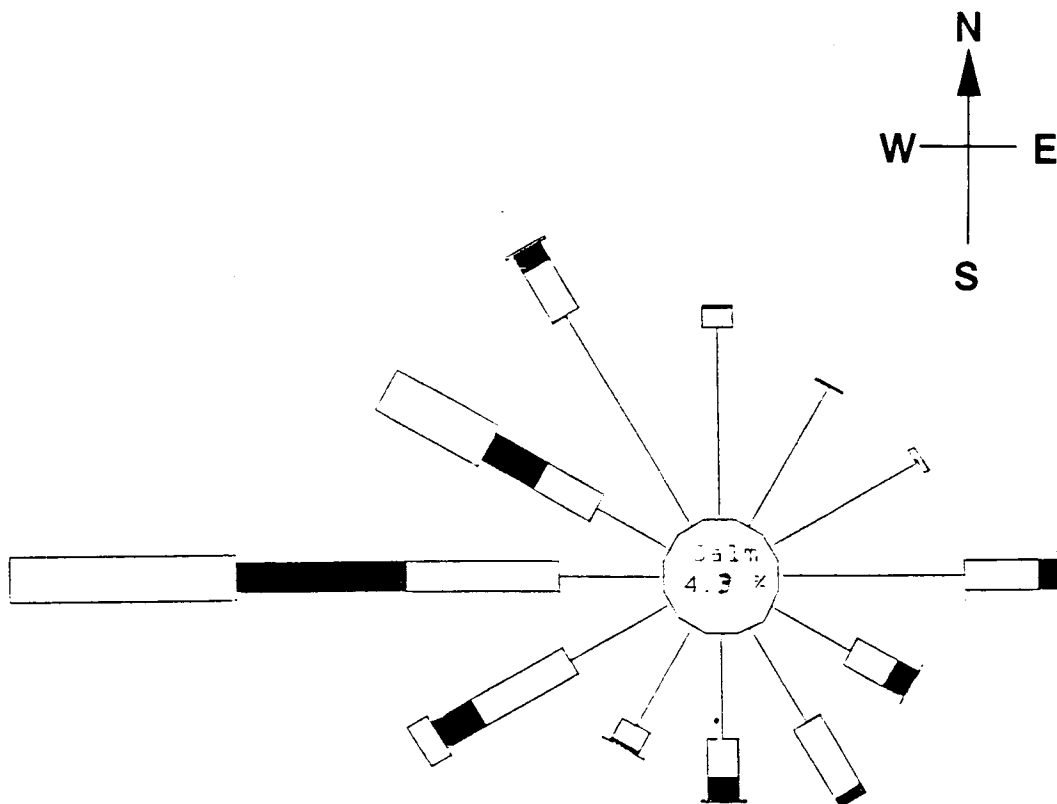
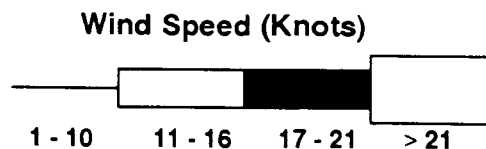
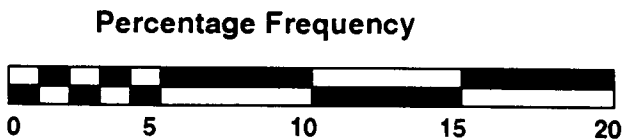
The Tiwai meteorological station was not operational during the last two months of the year due to equipment failure that required off-shore servicing. Data from the Invercargill meteorological station was used to complete the mean wind frequency diagram.

The first three months of 1992 were dominated by strong westerly winds. During April, May and June the site experienced an unusually high number of light winds from the northerly quarter. Easterlies characterized July but August saw a return to a more westerly dominated wind pattern. The winds in September and October were generally light from all quarters. There is no site data for November or December. During those months Invercargill's wind patterns were dominated by south-easterly then south-westerly winds respectively.

TIWAI POINT
MEAN WIND FREQUENCY (%) OF SURFACE WIND DIRECTIONS
FOR THE YEAR 1992

(Invercargill data used for Nov. & Dec.)

Scale:



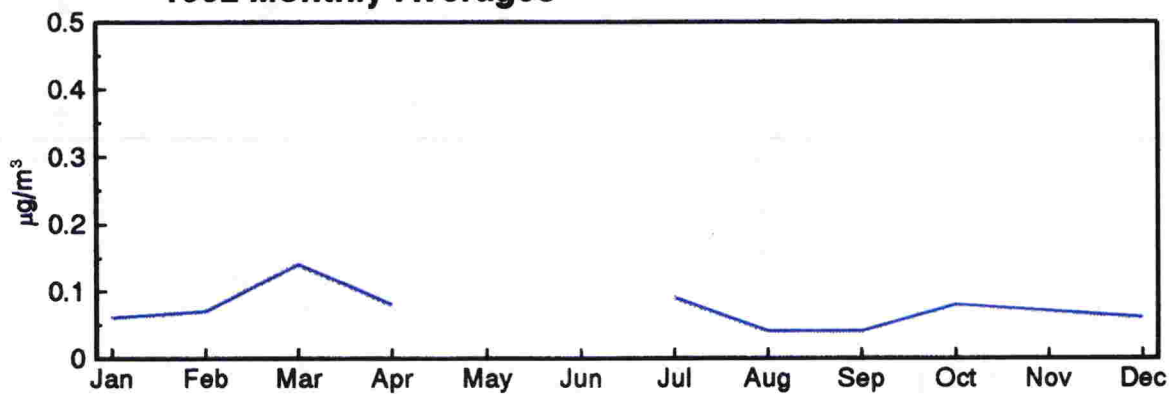
% Time at

Calm	4.3
1-10 Knots	52.0
11-16 Knots	20.8
17-21 Knots	11.6
>21 Knots	11.6

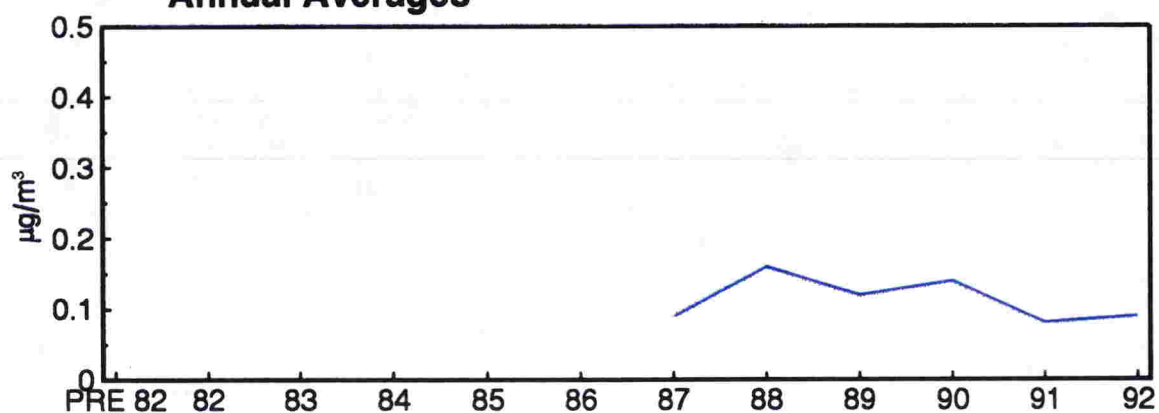
3.2 AMBIENT AIR GASEOUS FLUORIDE

3.2.1 1 km Hut

1992 Monthly Averages



Annual Averages

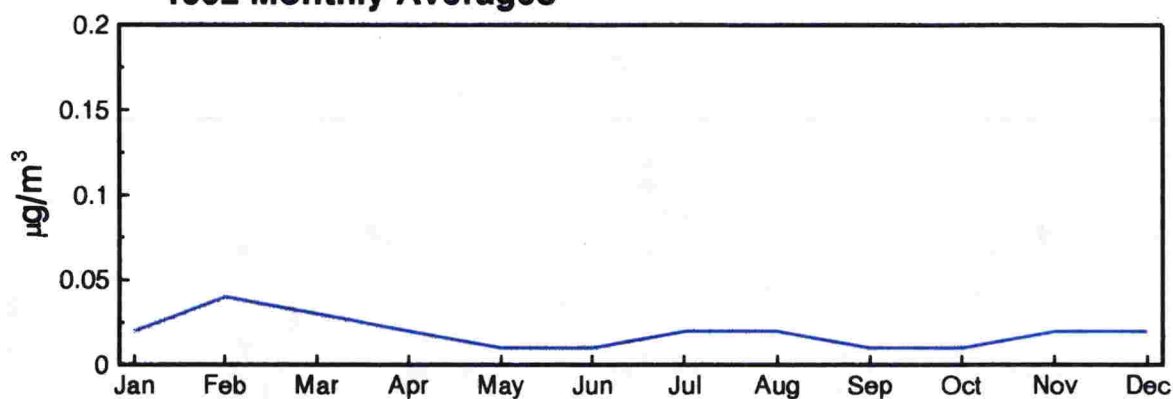


The 1992 mean gaseous fluoride concentration at the 1 km hut was $0.09 \mu\text{g}/\text{m}^3$.

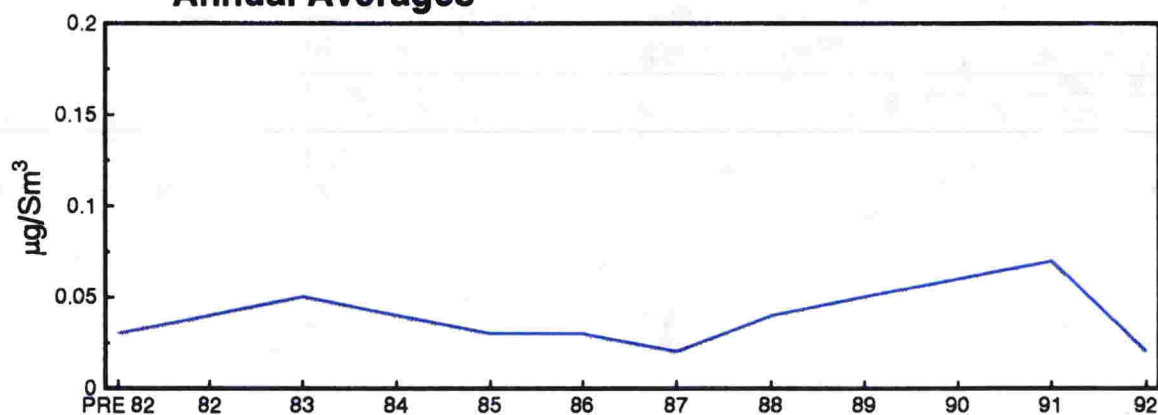
Malfunctions of the continuous analyser at the 1 km hut resulted in no data being available for May and June.

3.2.2 No 1 Bore

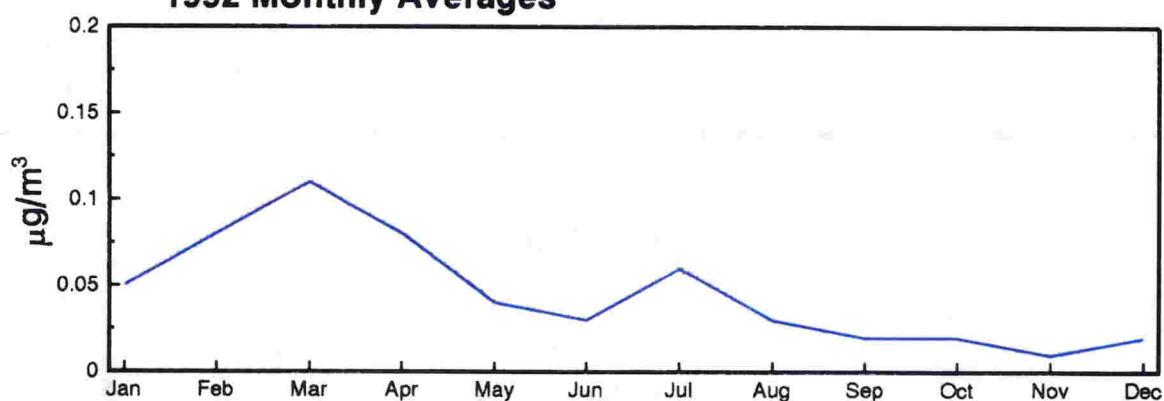
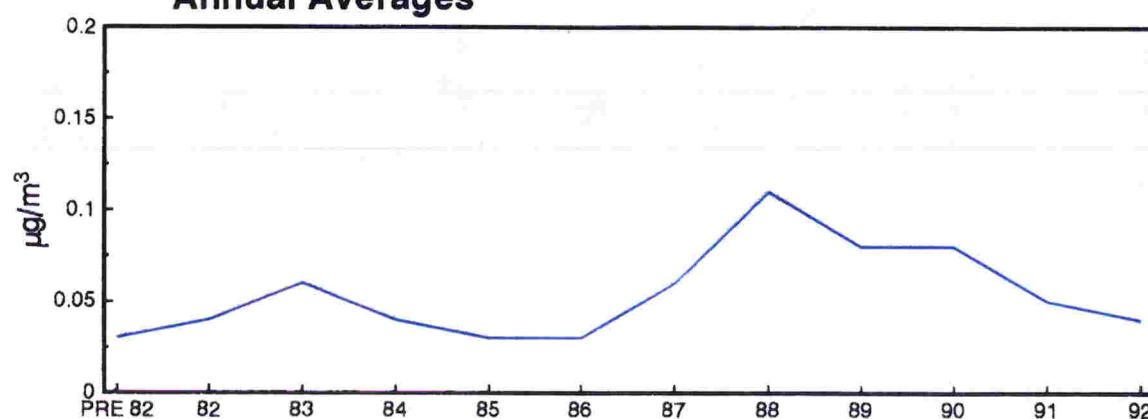
1992 Monthly Averages



Annual Averages



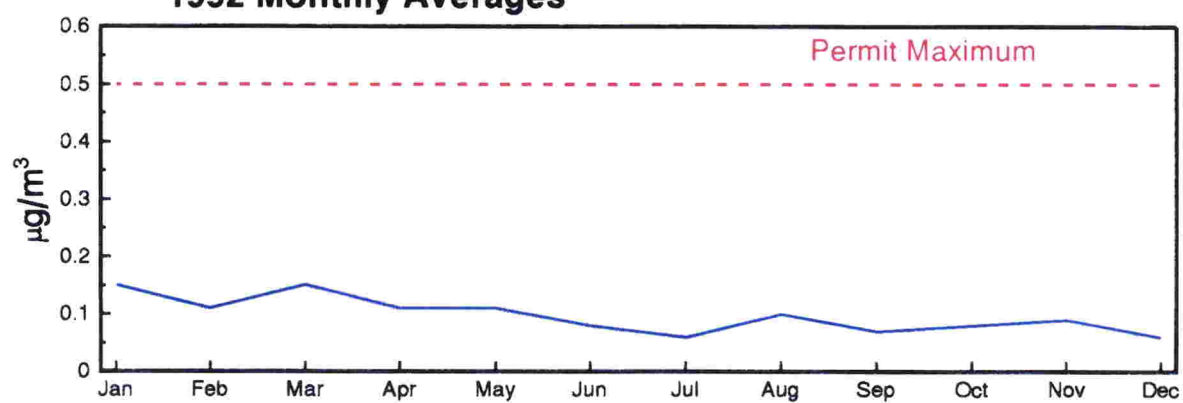
The lower gaseous fluoride concentrations that were evident at the end of 1991 were sustained through out 1992 resulting in a mean gaseous fluoride concentration of $0.02\mu\text{g}/\text{m}^3$. This is markedly lower than the 1991 mean of $0.07\mu\text{g}/\text{m}^3$.

3.2.3 No 6 Bore**1992 Monthly Averages****Annual Averages**

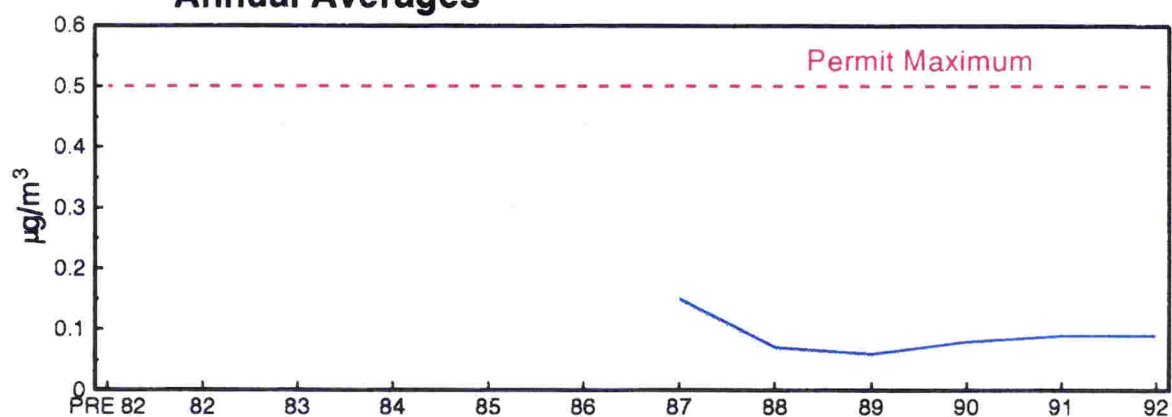
The 1992 mean gaseous fluoride concentration was $0.04\mu\text{g}/\text{m}^3$, a reduction from the 1991 figure of $0.05\mu\text{g}/\text{m}^3$. As with previous years, periods of elevated gaseous fluoride concentrations correspond to periods of strong westerly winds. The 1992 mean gaseous fluoride concentration continued the downward trend from the peak recorded in 1988.

3.2.4 Buddle Road

1992 Monthly Averages

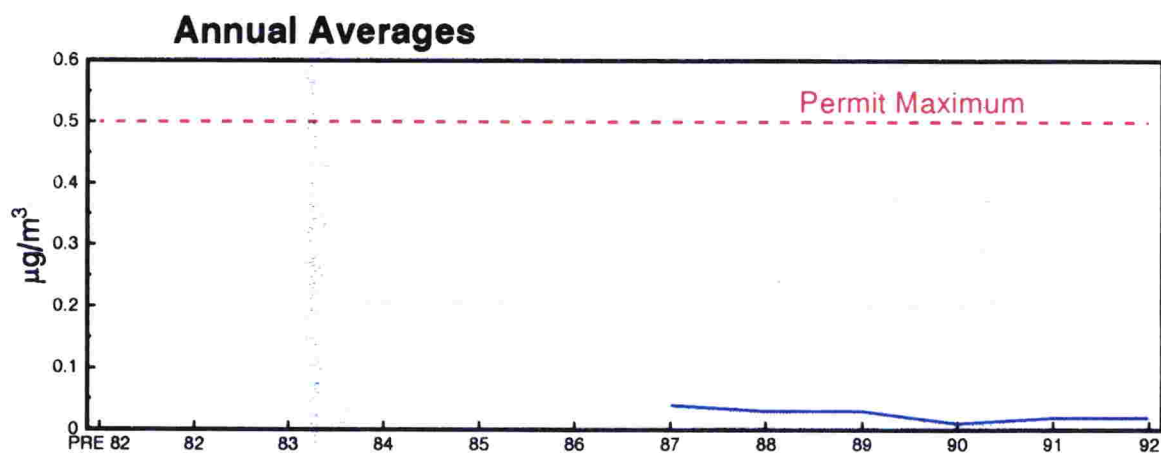
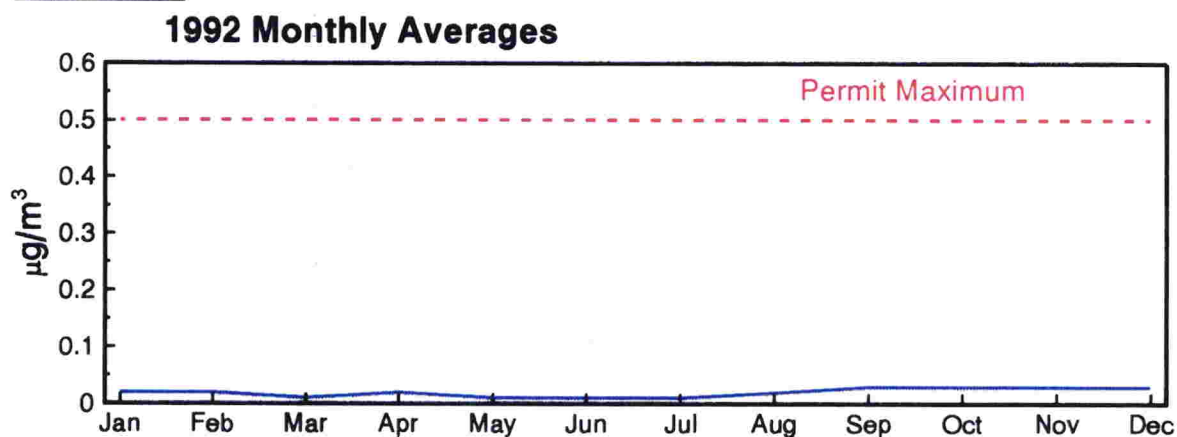


Annual Averages



The 1992 mean gaseous fluoride concentration of $0.09\mu\text{g}/\text{m}^3$ which is similar to previous years mean values.

3.2.5 Bluff



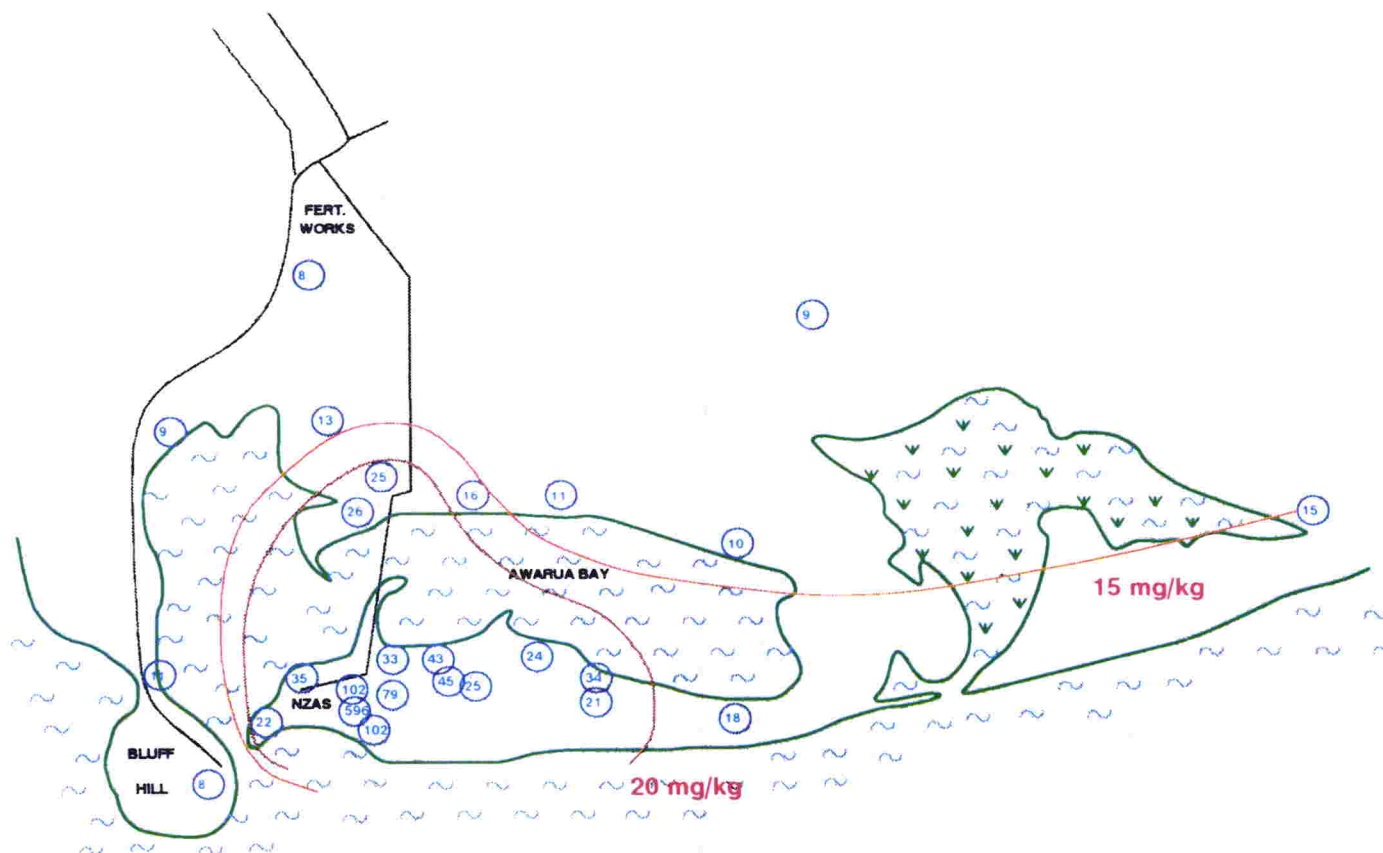
The 1992 mean gaseous fluoride concentration of $0.02\mu\text{g}/\text{m}^3$ indicates a continuation of the very low concentrations at Bluff. It is interesting to note that there was no noticeable variation during July, a month dominated by easterly winds.

3.3 Ungrazed Grasses

The ungrazed grasses 1992 mean concentrations are shown on the map on the following page. Comparison with the 1991 mean concentrations indicates similar results in most locations. The exceptions being the higher mean concentrations reported for the sites on the northern shore of Awarua Bay.

UNGRAZED GRASS FLUORIDE CONCENTRATIONS

1992 MEAN CONCENTRATIONS



Key: (10) mg/kg fluoride - unwashed dry weight basis

3.4 GRAZING MONITOR PROJECT

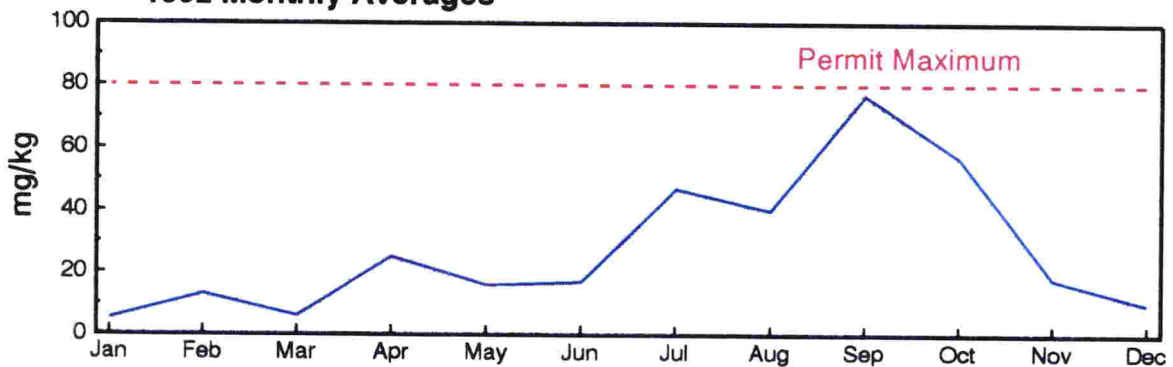
Page 17

The Grazing Monitor Project was established in 1969, prior to smelter commissioning, to provide a method of assessing the effects on the livestock on productive farms. The Project has continued, with minor modifications, as part of the NZAS environmental monitoring programme.

3.4.1 Farm No 1

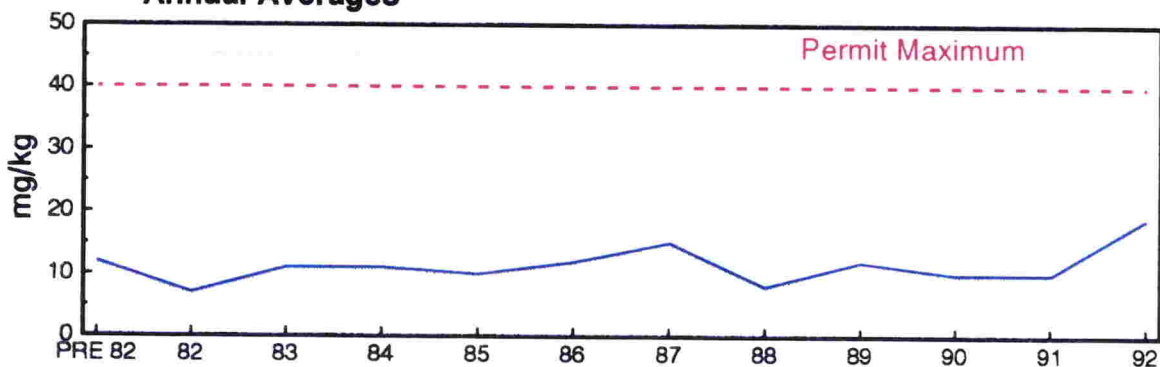
Pasture Fluoride Concentrations

1992 Monthly Averages



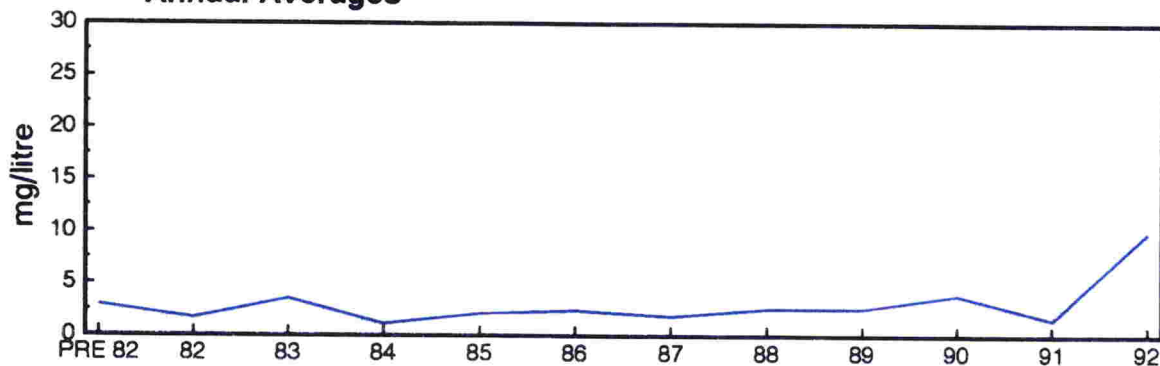
Pasture Fluoride Concentrations

Annual Averages



Cattle Urinary Fluoride Concentrations

Annual Averages



This farm is to the west of the smelter at Green Point.

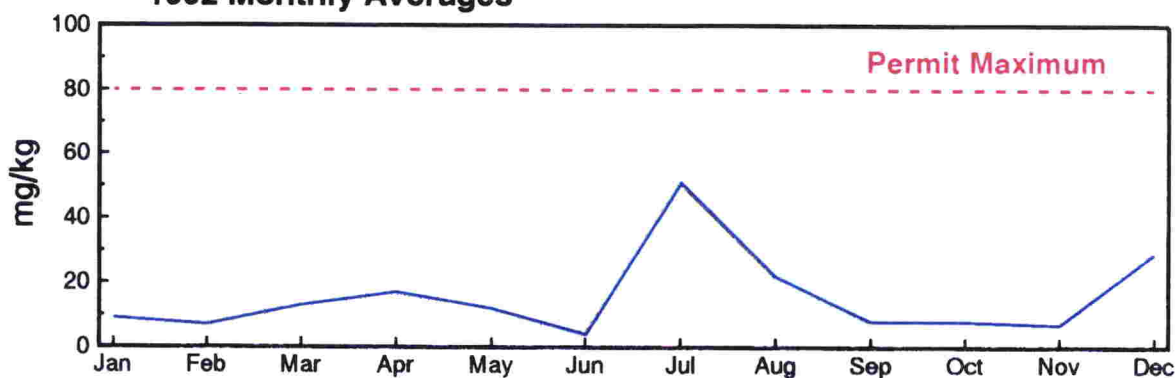
Of the 4 months that correspond to the period of elevated pasture fluoride concentrations only the results for July and October are supported by the nearby ungrazed grass monitoring. In both cases a period of easterly winds preceeded the sample collections. This would indicate that the pasture fluoride concentrations had been affected by smelter emissions. In comparison the September result is totally unsupported by both the ungrazed grass monitoring at nearby sites and the meteorological data collected prior to the sample date. The two nearest monitoring sites returned results of 11 mg/kg and 8 mg/kg and as there was an almost total absence of easterly wind leading up to the samples being collected the smelter is unlikely to be the source of the fluoride. With reportedly no top dressing on the farm this result remains unexplained.

The mean cattle urinary fluoride concentration for 1992 was 10.0 mg/litre. The samples were collected in May when the pasture fluoride concentrations were normal. This result should be considered to be demonstrating part of the natural variation of this parameter on this farm.

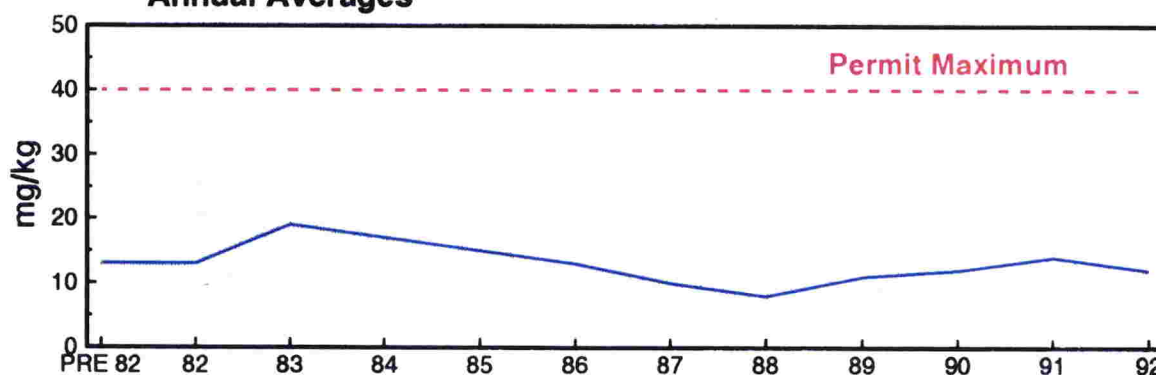
Due to the collapse of the head bale on this farm no bone biopsies were conducted. The dental condition was assessed by the NZAS veterinary consultant and no change was indicated.

3.4.2 Farm No 2

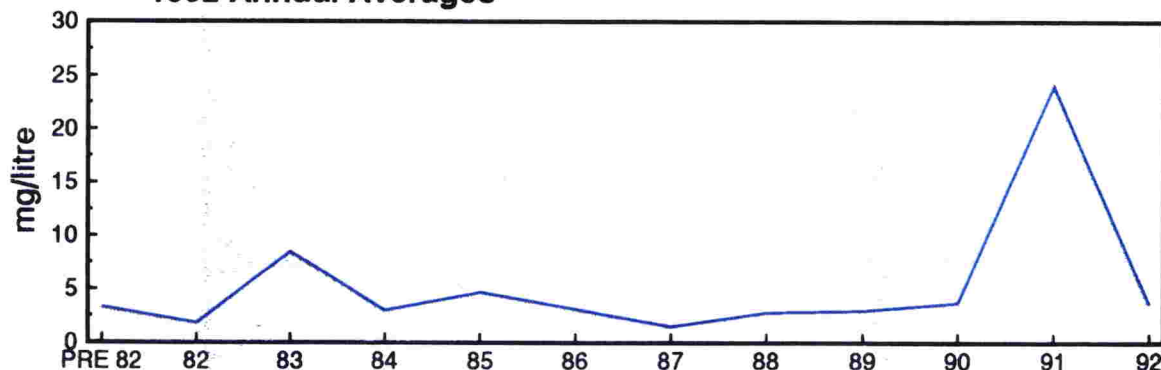
Pasture Fluoride Concentrations 1992 Monthly Averages



Pasture Fluoride Concentrations Annual Averages



Cattle Urinary Fluoride Concentrations 1992 Annual Averages



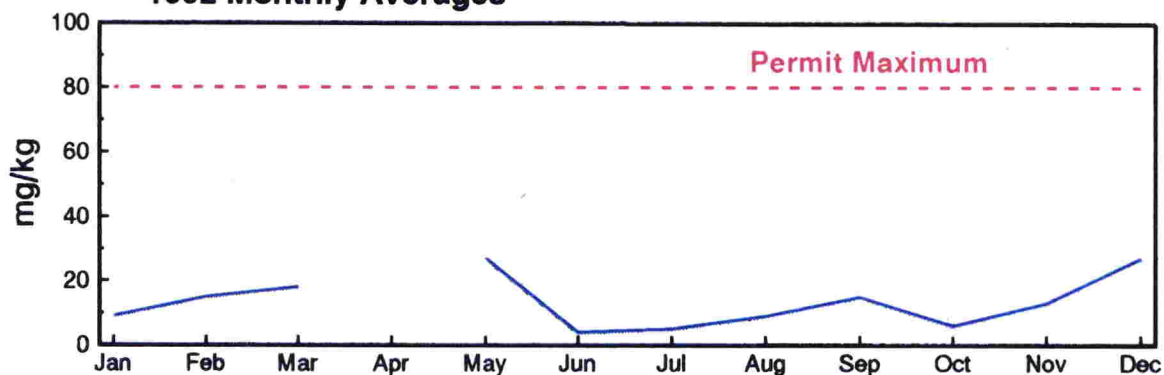
This farm is 6 km north of the smelter. The elevated pasture fluoride concentration in July is not reflected in either the nearby deposit gauge or the ungrazed grass monitoring. As there were effectively no southerly winds for the whole of July it is unlikely that this result is due to smelter emissions. No top dressing was reported.

The mean fluoride concentration in the cattle urine samples collected was 3.6 mg/litre. This is similar to the results recorded in all years other than 1991.

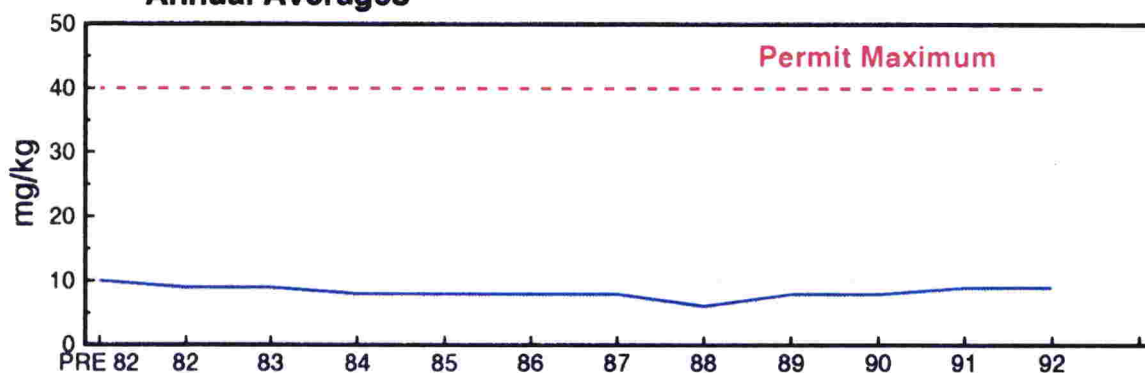
Cattle bone biopsies were conducted and the bone fluoride concentrations were in the normal range for this farm. The dental condition was inspected by the NZAS veterinary consultant and no change was indicated.

3.4.3 Farm No 3

Pasture Fluoride Concentrations 1992 Monthly Averages



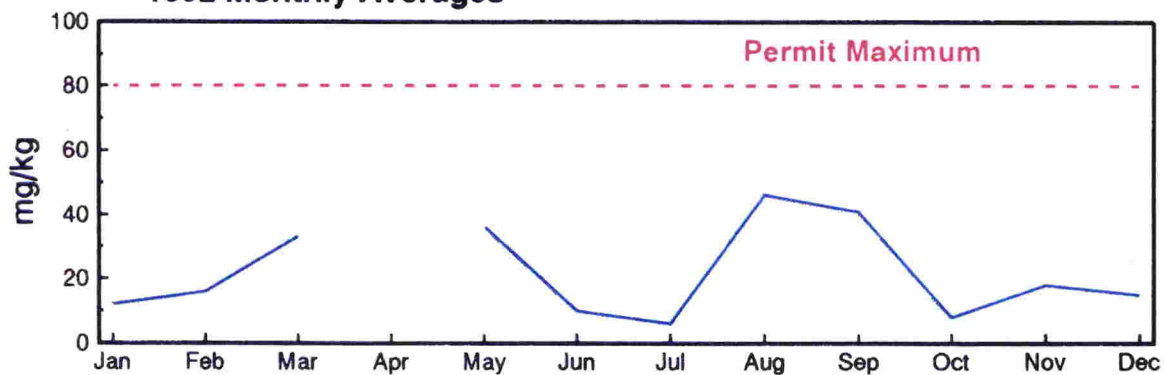
Pasture Fluoride Concentrations Annual Averages



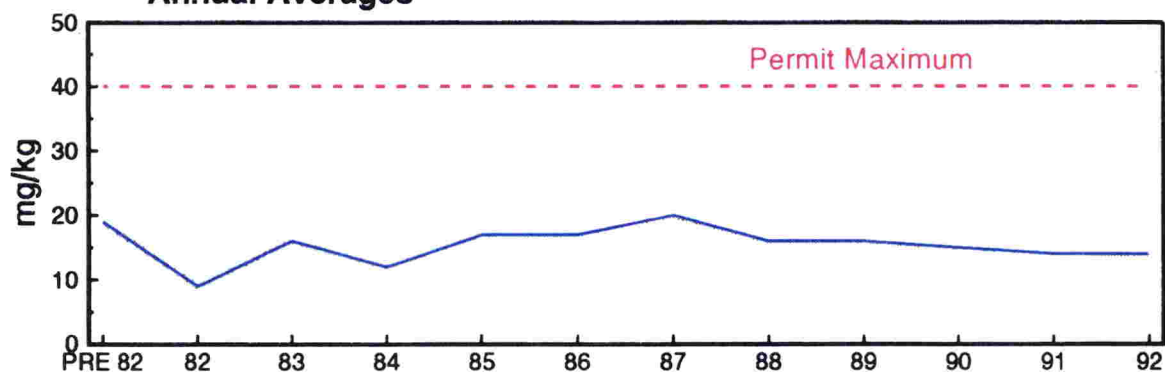
This farm is 18 km north east of the smelter . The pasture fluoride concentrations on this farm continue to be low. A sampling error in April resulted in the loss of that months data.

3.4.4 Farm No 4

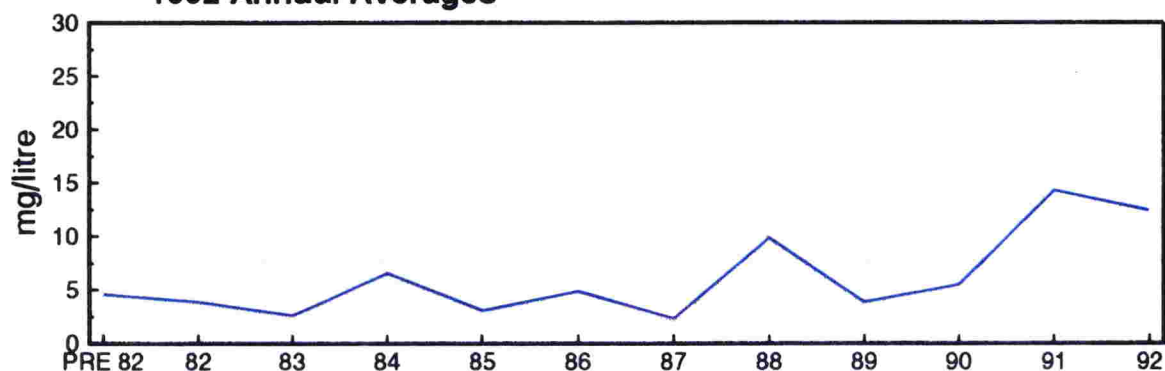
Pasture Fluoride Concentrations 1992 Monthly Averages



Pasture Fluoride Concentrations Annual Averages

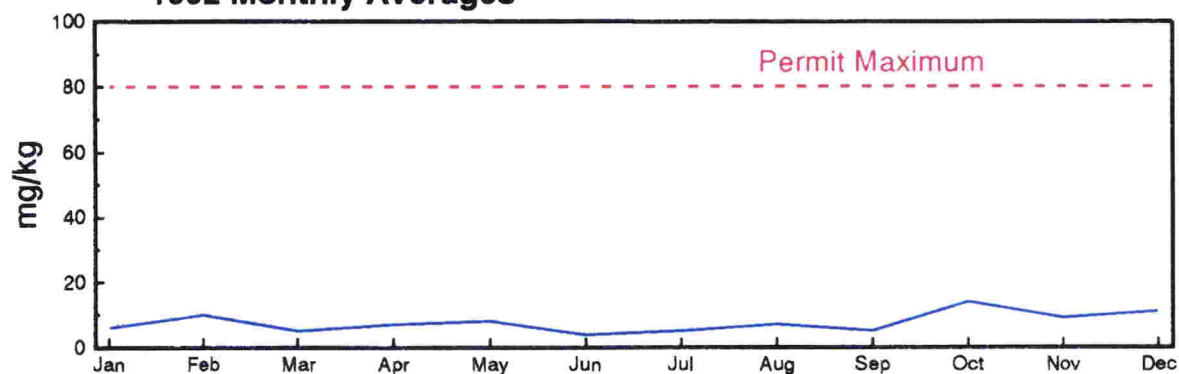
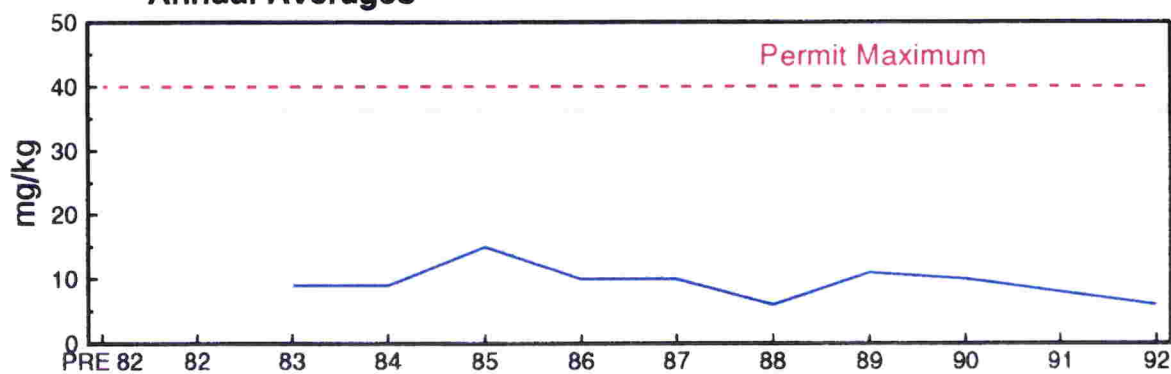


Cattle Urinary Fluoride Concentrations 1992 Annual Averages



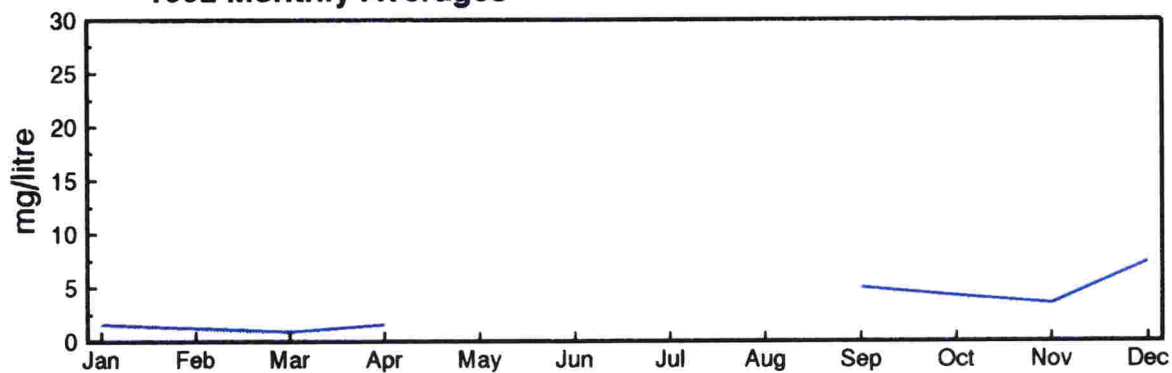
This farm is on the northern shore of Awarua Bay, north-east of the smelter. Because of its proximity to the smelter and its position relative to the prevailing winds this farm is periodically affected by the smelter's emissions. Although there was marked variation in the pasture fluoride concentration during the year the levels remained well below the permitted maximum. To some extent the nearby deposit gauge and ungrazed grass monitoring sites show the same variation in fluoride concentration. A sampling error in April resulted in the loss of that months data.

The cattle urine samples collected in March had higher than normal fluoride concentrations. This is likely to be linked to the high pasture fluoride concentration that was recorded at the same time. Bone biopsies were performed with the fluoride concentrations very similar to the 1991 results and in the normal range for this farm. The NZAS veterinary consultant noted some wear and tooth staining but the actual tooth scores were similar to those in 1991.

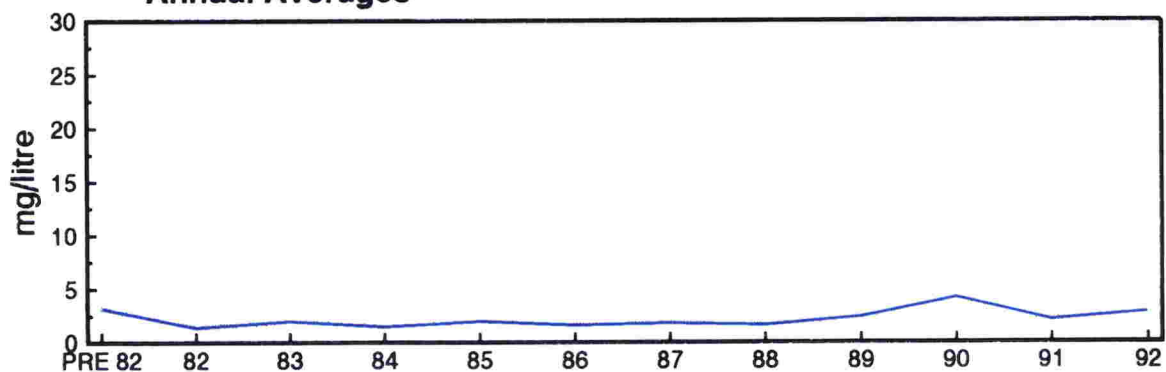
3.4.6 Farm No 8**Pasture Fluoride Concentrations****1992 Monthly Averages****Pasture Fluoride Concentrations****Annual Averages**

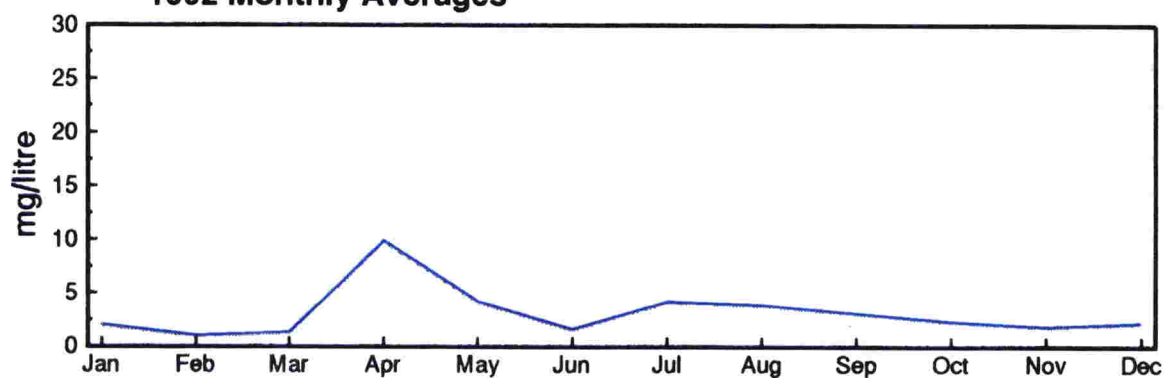
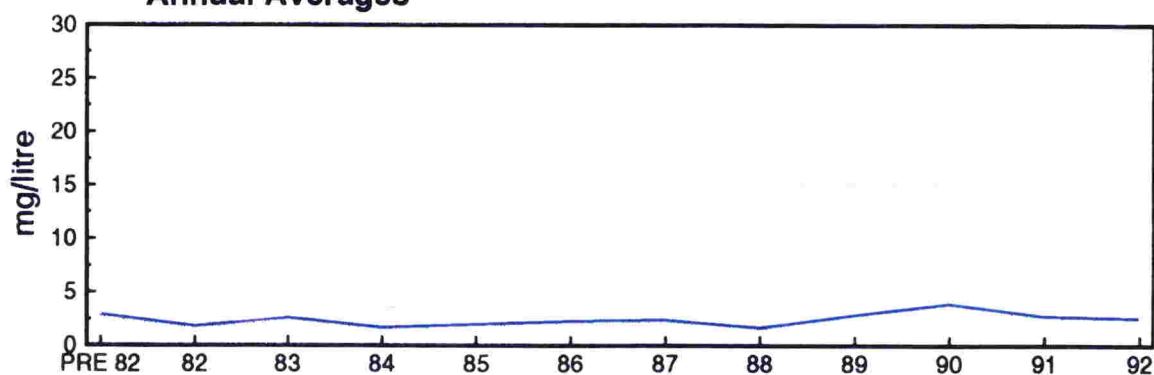
This farm is 13 km north of the smelter and is unlikely to be affected by the emissions. The pasture and cattle urinary fluoride concentrations continue to be low.

**Cattle Urinary Fluoride
1992 Monthly Averages**

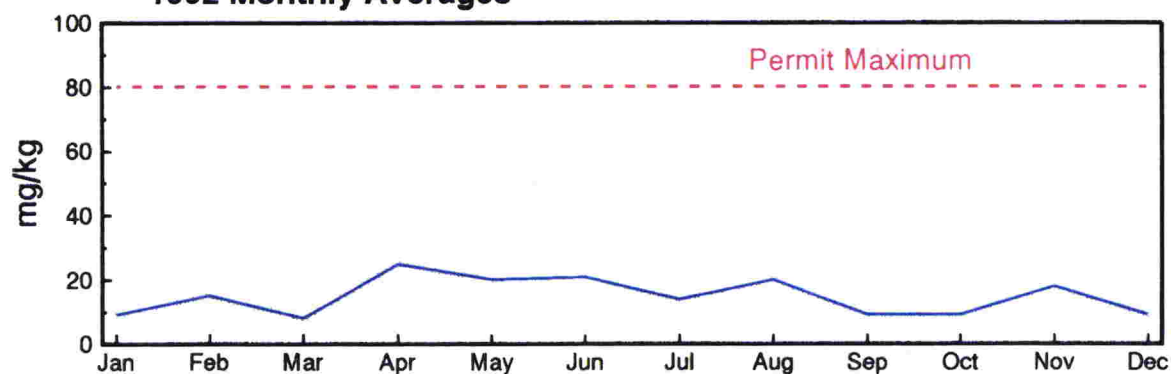
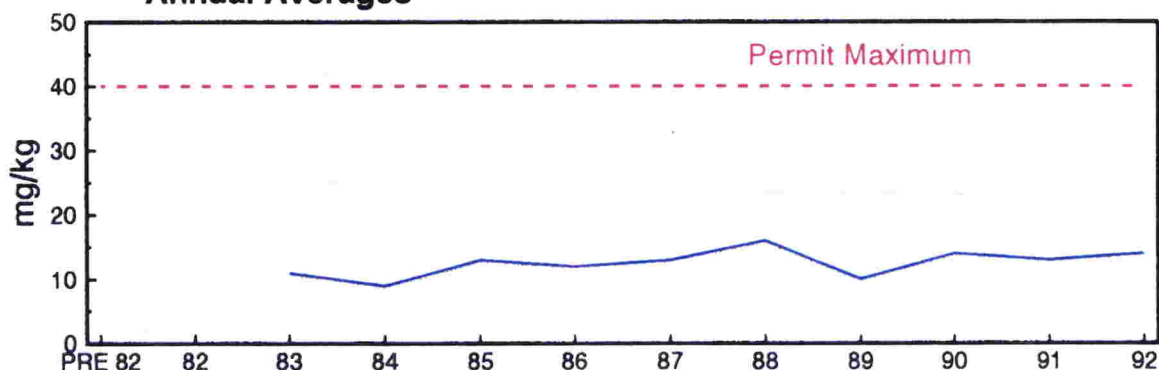


**Cattle Urinary Fluoride
Annual Averages**

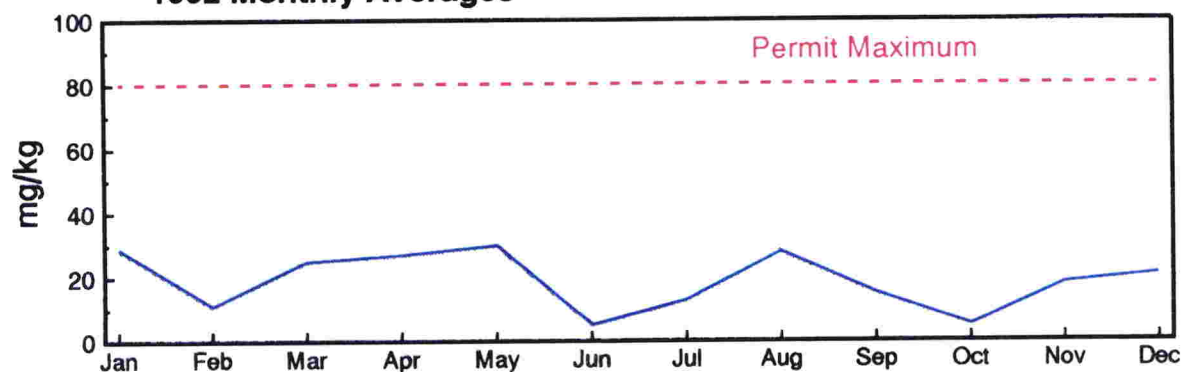
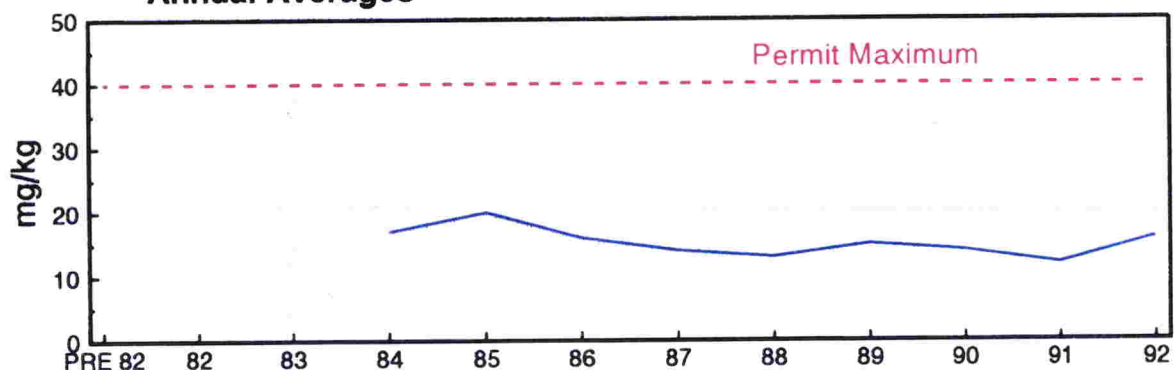


3.4.7 Farm No 9**Cattle Urinary Fluoride****1992 Monthly Averages****Cattle Urinary Fluoride****Annual Averages**

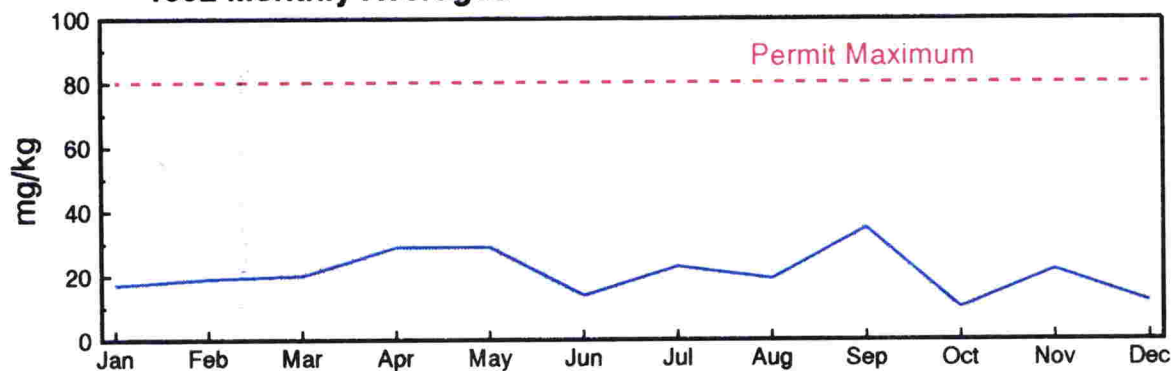
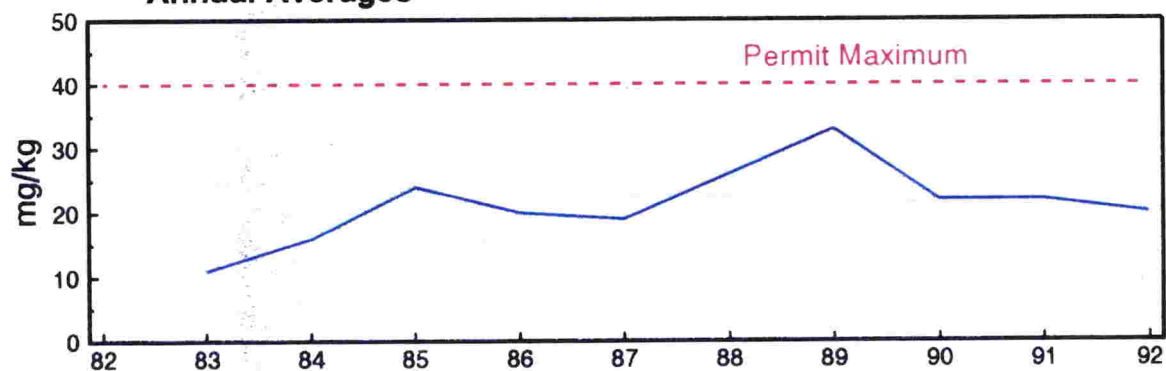
This farm is 15.5 km north-west of the smelter and is unlikely to be affected by the smelter's emissions. The cattle urinary fluoride concentrations remain low.

3.4.8 Farm No 10**Pasture Fluoride Concentrations
1992 Monthly Averages****Pasture Fluoride Concentrations
Annual Averages**

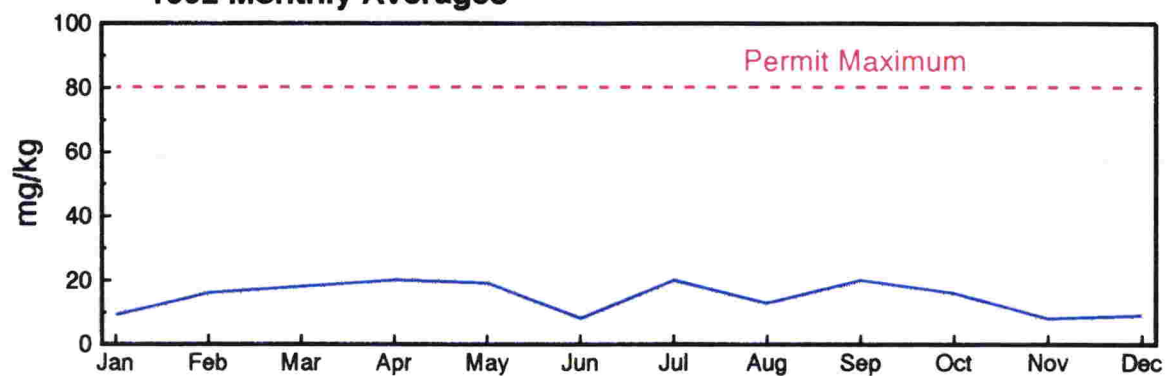
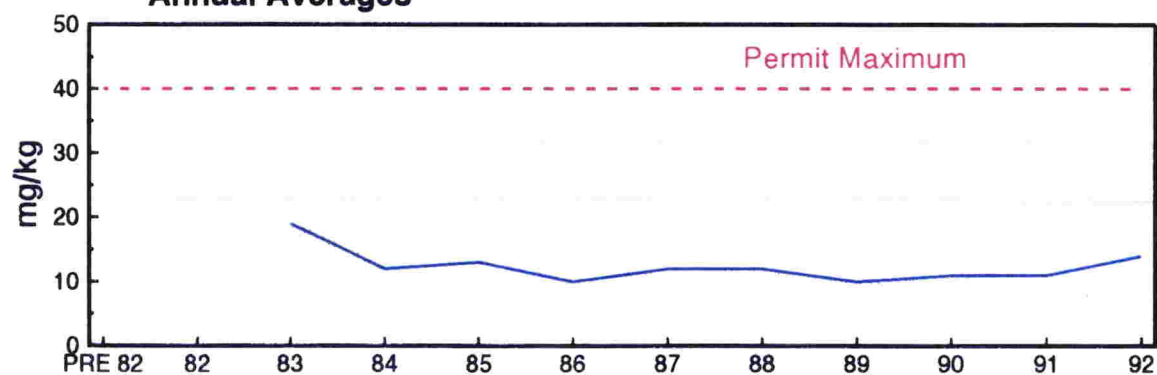
This farm is 25 km east-north-east of the smelter. The 1992 pasture fluoride concentrations were normal. The mean fluoride concentration of 14 mg/kg is very similar to the previous years results. The mean ungrazed grass fluoride concentration for samples collected in the same area was 15 mg/kg, again a very similar result to previous years as was the result from the nearby deposit gauge.

3.4.9 Farm No 11**Pasture Fluoride Concentrations
1992 Monthly Averages****Pasture Fluoride Concentrations
Annual Averages**

This farm is 5 km north-north-east of the smelter. The 1992 pasture fluoride concentrations demonstrated greater variation than previous years but the annual mean was unaffected with the 1992 result within the normal distribution of results for this farm.

3.4.10 Farm No 12**Pasture Fluoride Concentrations
1992 Monthly Averages****Pasture Fluoride Concentrations
Annual Averages**

This farm is on the northern shore of Awarua Bay, 9.5 km east-north-east of the smelter. The 1992 pasture fluoride concentrations were generally lower and were without the large variation which has characterized previous years monitoring results.

3.4.11 Farm No 13**Pasture Fluoride Concentrations
1992 Monthly Averages****Pasture Fluoride Concentrations
Annual Averages**

This farm is 15 km east-north-east of the smelter. No trends are apparent.

3.5 TIWAI EXPERIMENTAL FARMS

Page 29

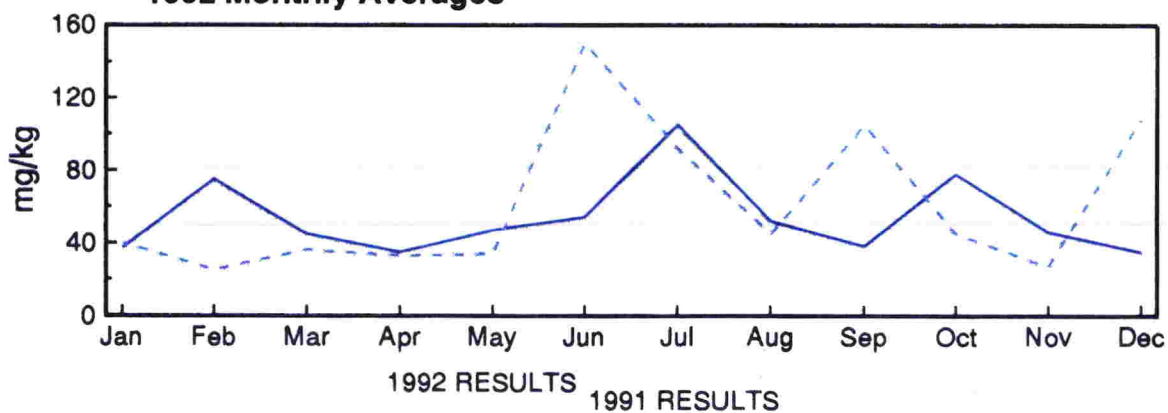
This project was established to support the Grazing Monitor Project. Its aim was to expose livestock to smelter emissions and to study the effects. It would also provide local veterinary officers with experience in diagnosing fluorosis.

The No 1 Farm is on the Tiwai Peninsula, 3.5 km downwind of the smelter. It was established in 1971. The No 2 Farm is at the eastern end of the the Tiwai Peninsula, 10km downwind of the smelter, and was established in 1973.

3.5.1 Farm No 1

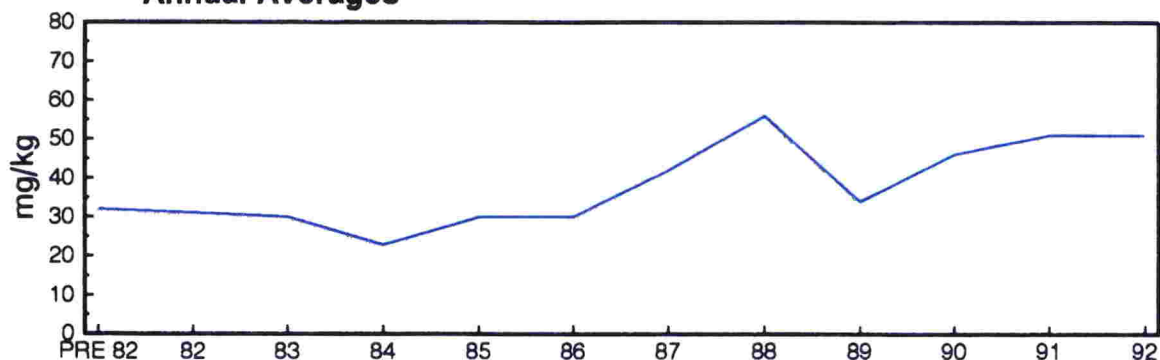
Pasture Fluoride Concentrations

1992 Monthly Averages

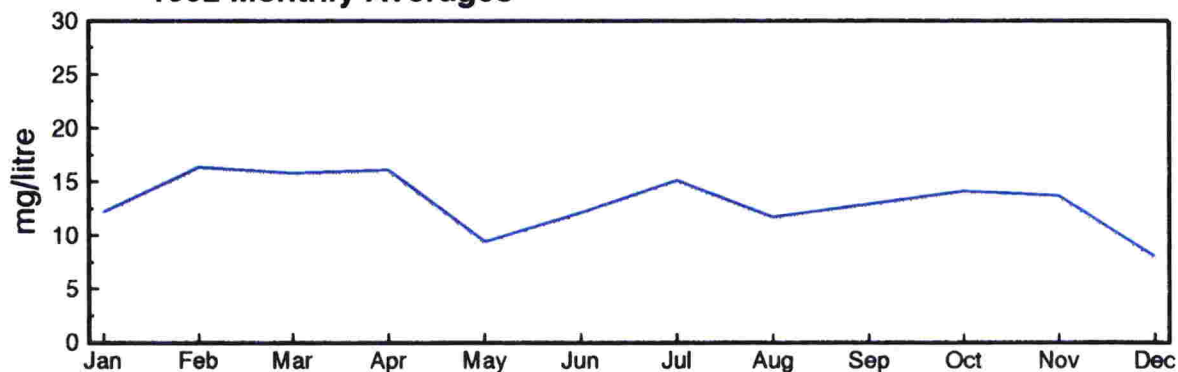


Pasture Fluoride Concentrations

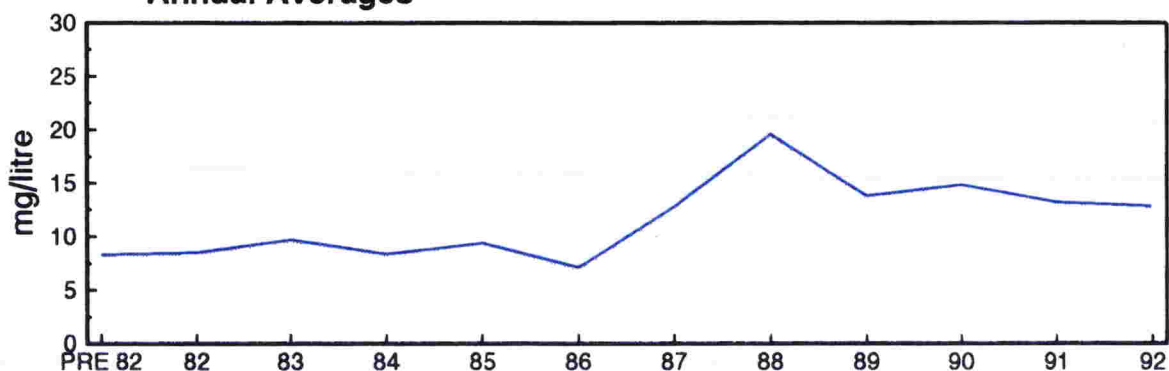
Annual Averages



Sheep Urinary Fluoride 1992 Monthly Averages

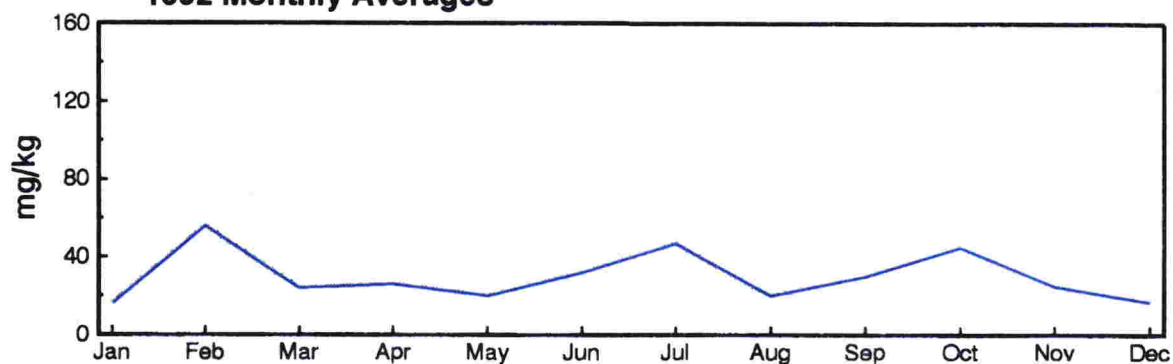
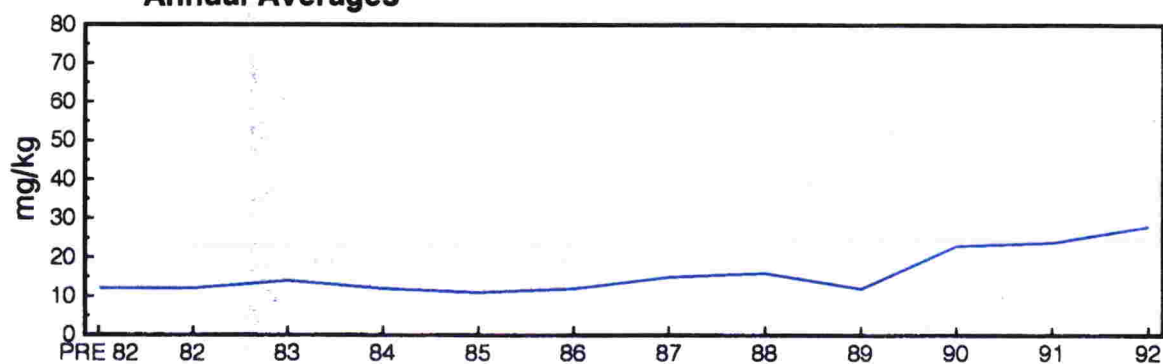
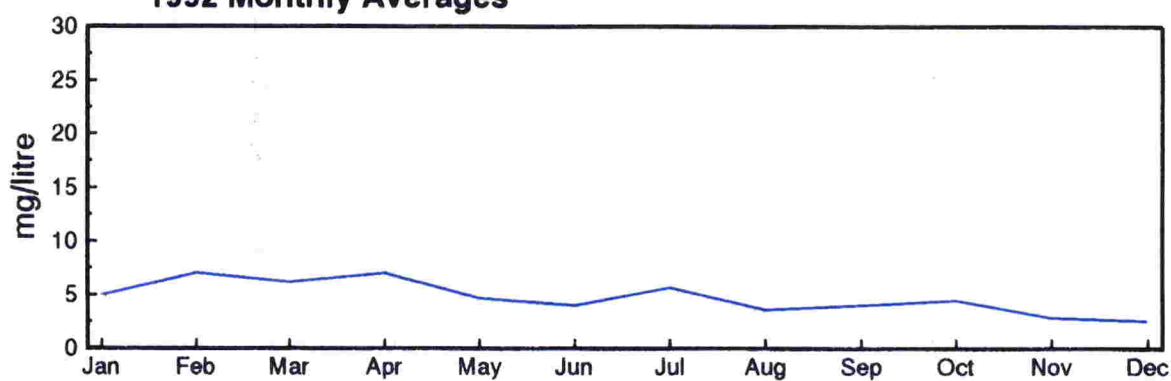


Sheep Urinary Fluoride Annual Averages

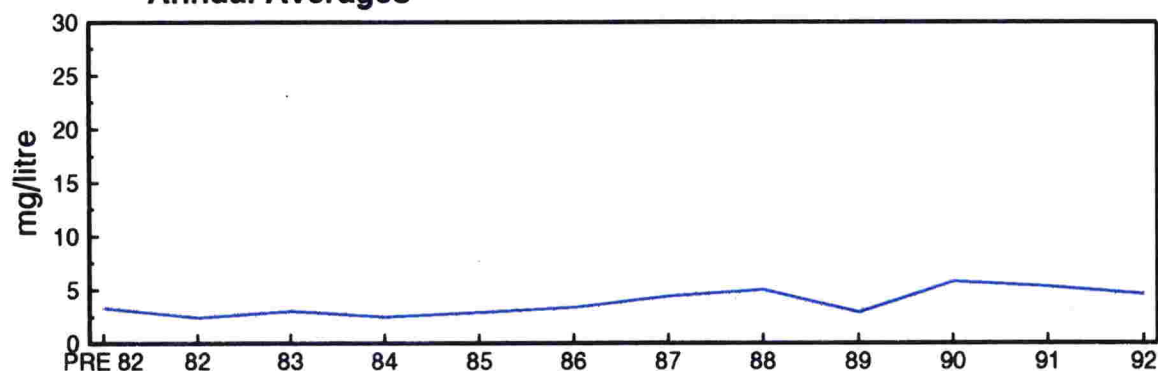


The amount of variation in the monthly pasture fluoride concentrations is similar to previous years. There has been no consistent trend in the annual mean values, with the 1992 results within the normal distribution of previous years values. The monthly pasture fluoride concentration data presented for this farm in the 1991 report was incorrect. This oversight has been corrected in this report.

Jaw bone samples were collected and the bone fluoride concentration measured. No trend was evident. The dental condition of the sheep was assessed by the NZAS veterinary consultant and there was no indication of any change in dental condition.

3.5.2 Farm No 2**Pasture Fluoride Concentrations
1992 Monthly Averages****Pasture Fluoride Concentrations
Annual Averages****Lamb Urinary Fluoride
1992 Monthly Averages**

Lamb Urinary Fluoride Annual Averages



The 1992 pasture fluoride concentrations follow the same pattern of monthly variation as Farm No. 1 although the magnitude of change is not as great. This, along with annual mean pasture fluoride concentrations, illustrates the scale of the reduction in the effects of the smelter's emissions with increasing distance from the smelter.

There was little variation in the lamb urinary fluoride and no trend is evident in the annual mean concentration which remains low.

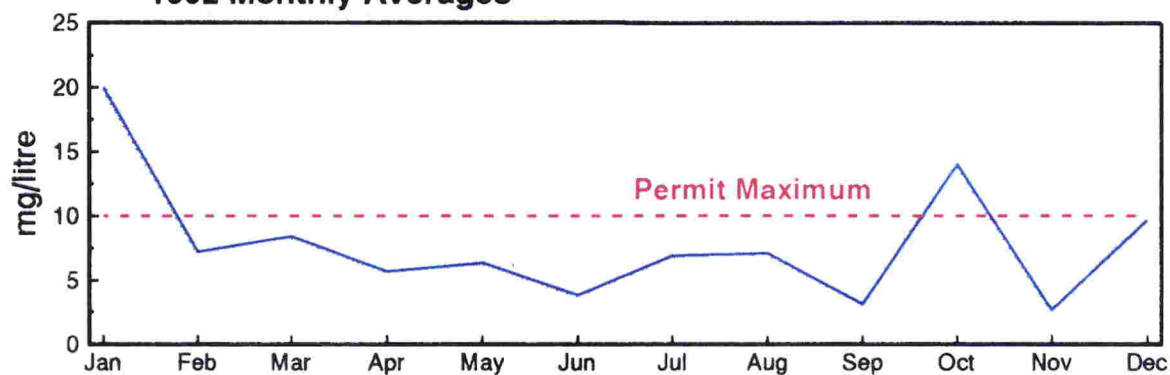
4: DISCHARGES TO WATER AND THEIR EFFECTS

The smelter's liquid discharges were subject to five Coastal Permits. The following sections give details of the trends for each Permit.

4.1 COASTAL PERMIT No 90057 - NORTH DRAIN

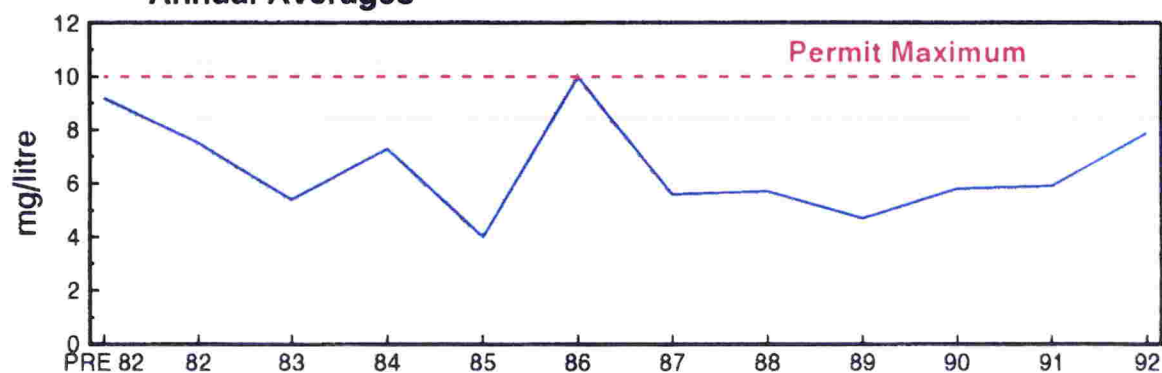
Discharge Fluoride Concentrations

1992 Monthly Averages



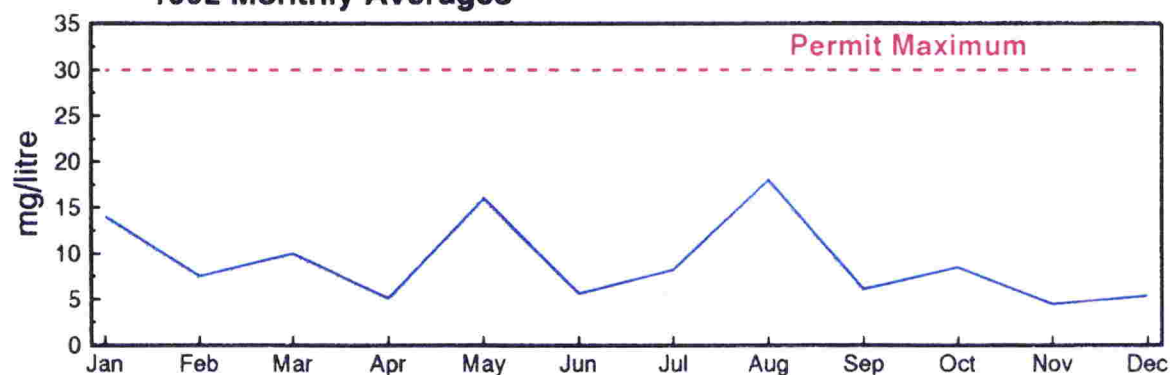
Discharge Fluoride Concentrations

Annual Averages

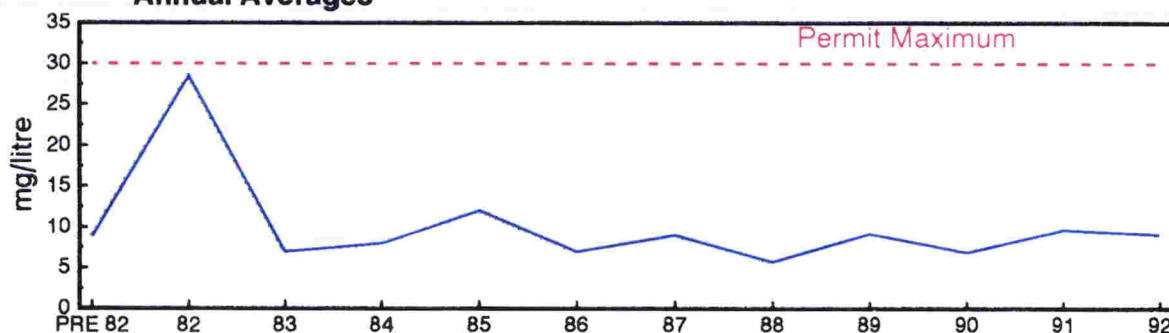


Discharge Suspended Solids Concentrations

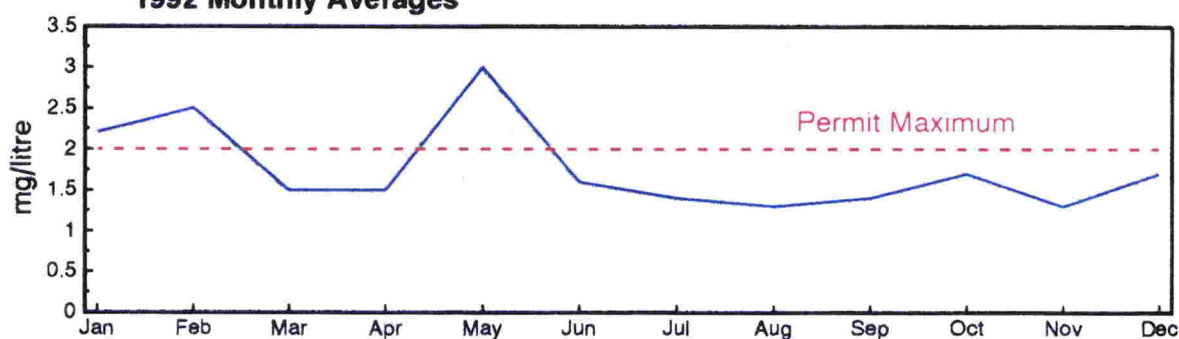
1992 Monthly Averages



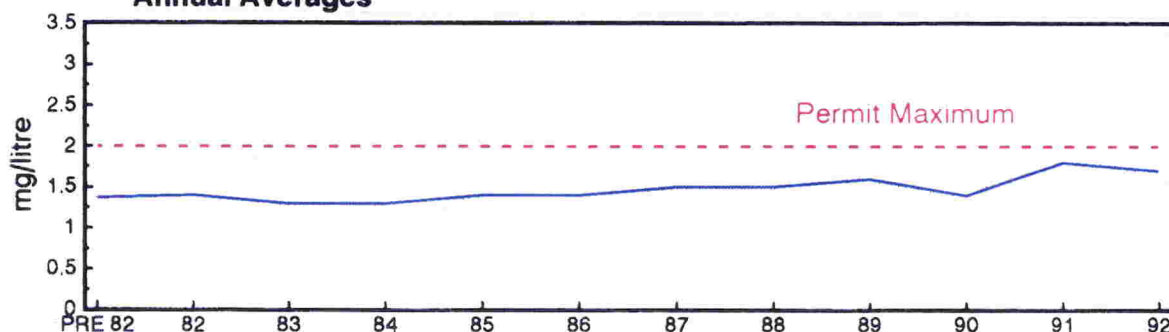
Discharge Suspended Solids Concentrations Annual Averages



Receiving Water Fluoride Concentrations 1992 Monthly Averages



Receiving Water Fluoride Concentrations Annual Averages



The 1992 north drain discharge fluoride concentrations demonstrated similar variation to previous years. An investigation has determined that the major source of this fluoride is the low level roof louvre emissions from Potrooms which have historically been within permit conditions. A number of remedial options are now under review.

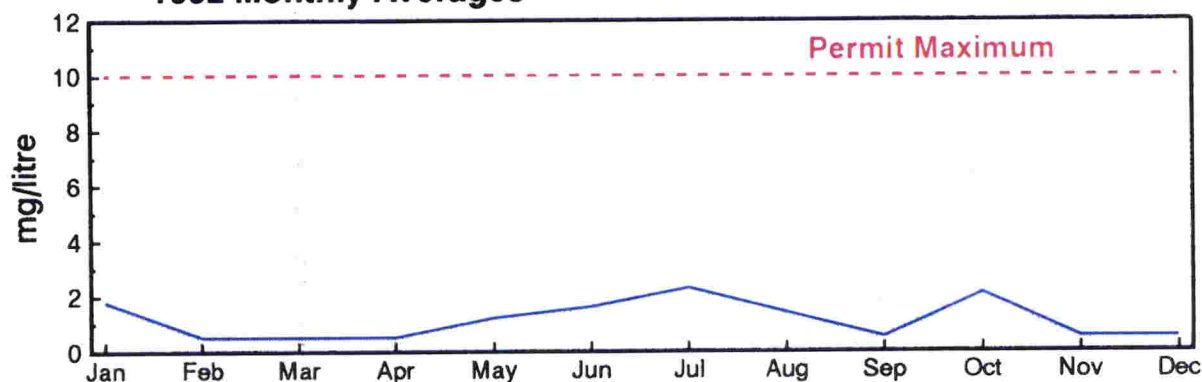
The 1992 annual mean drain discharge fluoride concentration of 7.9 mg/litre is an increase on the 1991 figure. This result is within the normal distribution of this data and does not indicate a trend.

The lack of effective dispersion in the receiving seawater resulted in elevated levels of fluoride outside the mixing zone. This has been highlighted in previous reports and is being taken into consideration in developing a final remedial solution for the north drain.

4.2 COASTAL PERMIT No 90058 - WEST DRAIN

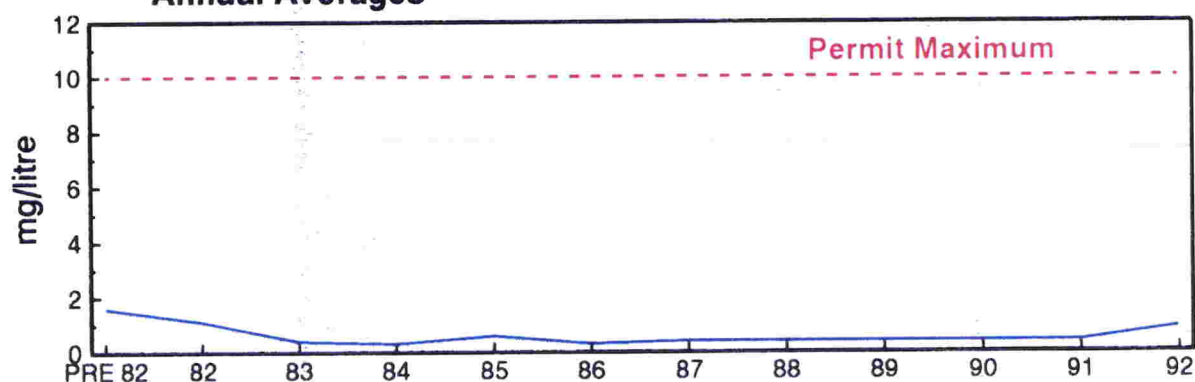
Discharge Fluoride Concentrations

1992 Monthly Averages



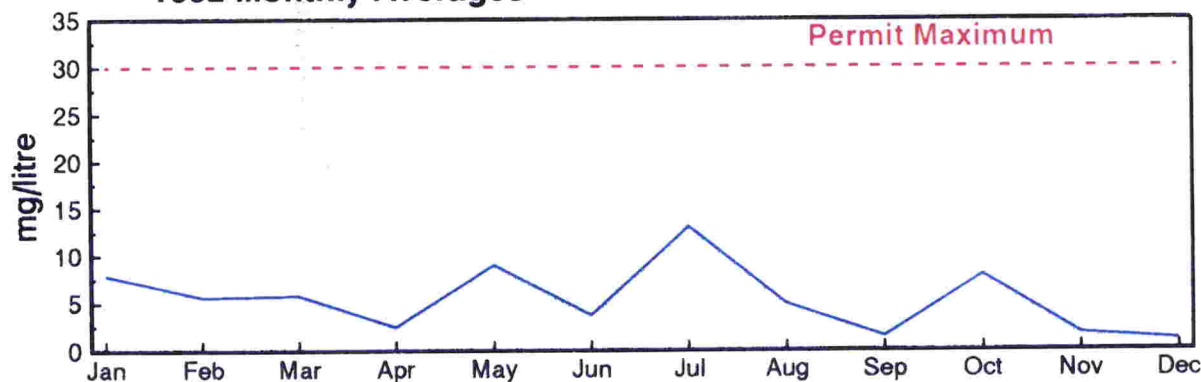
Discharge Fluoride Concentrations

Annual Averages

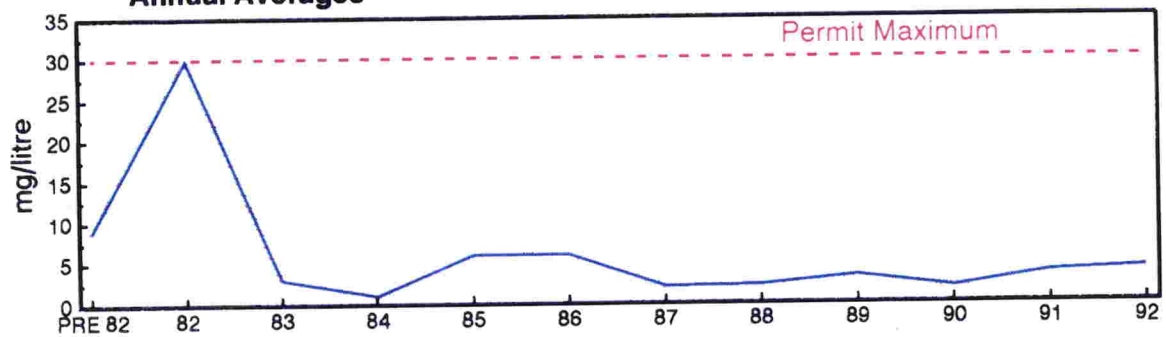


Discharge Suspended Solids Concentrations

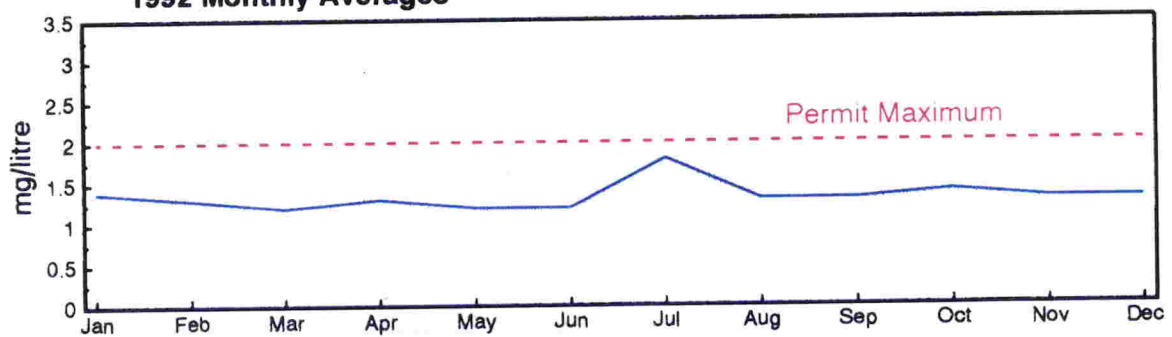
1992 Monthly Averages



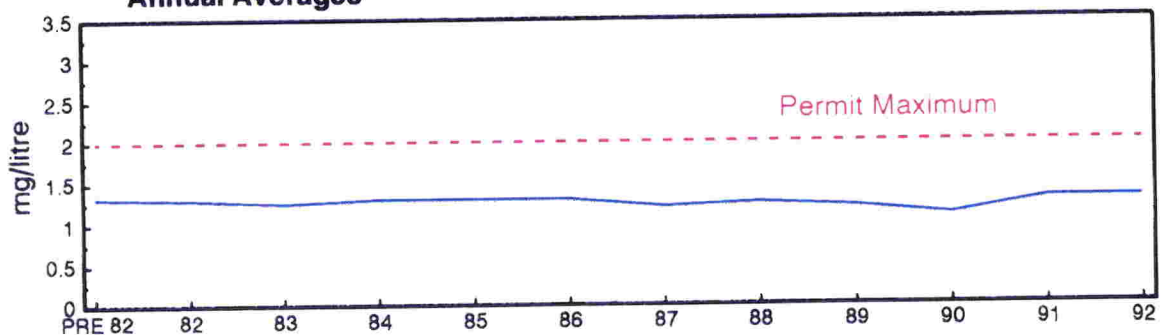
Discharge Suspended Solids Concentrations Annual Averages



Receiving Water Fluoride Concentrations 1992 Monthly Averages



Receiving Water Fluoride Concentrations Annual Averages

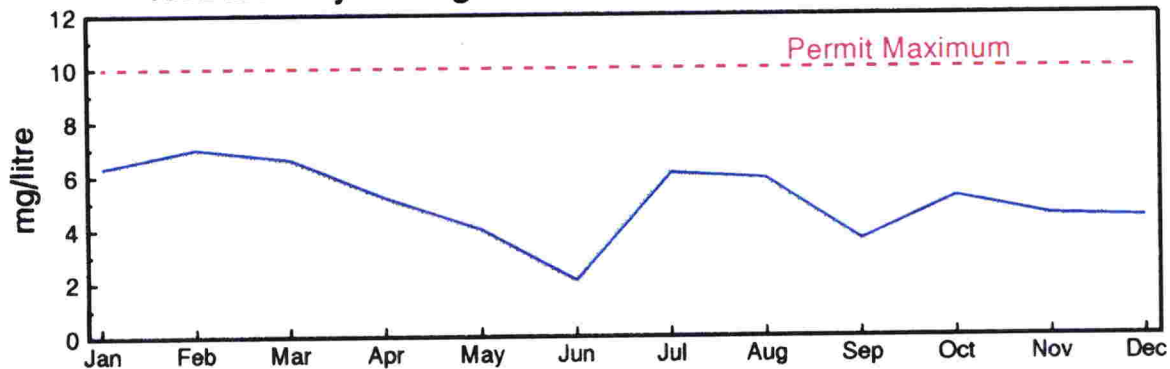


No trends are evident in the west drain discharge or receiving water data. All levels are well within permit conditions.

4.3 COASTAL PERMIT No 90059 - SOUTH DRAIN

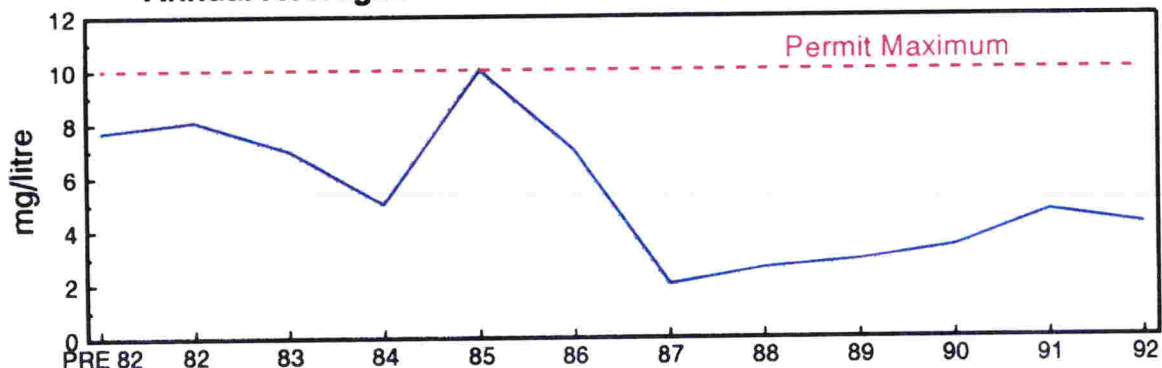
Discharge Fluoride Concentrations

1992 Monthly Averages



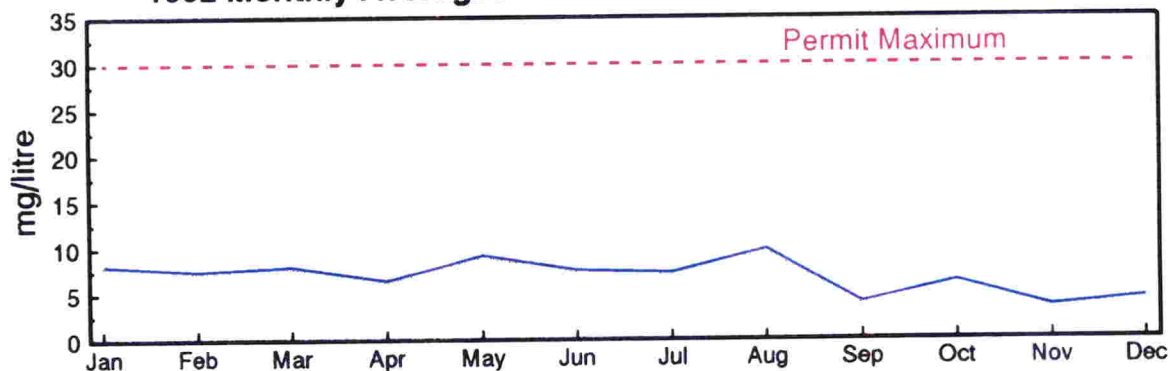
Discharge Fluoride Concentrations

Annual Averages

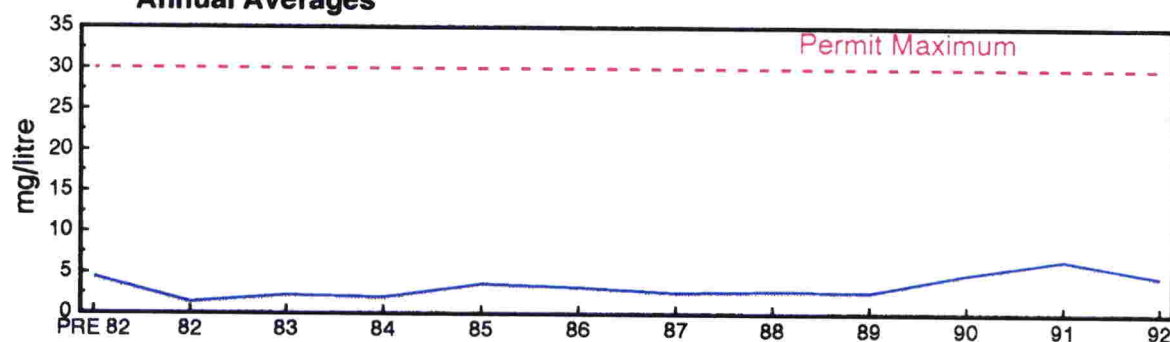


Discharge Suspended Solids Concentrations

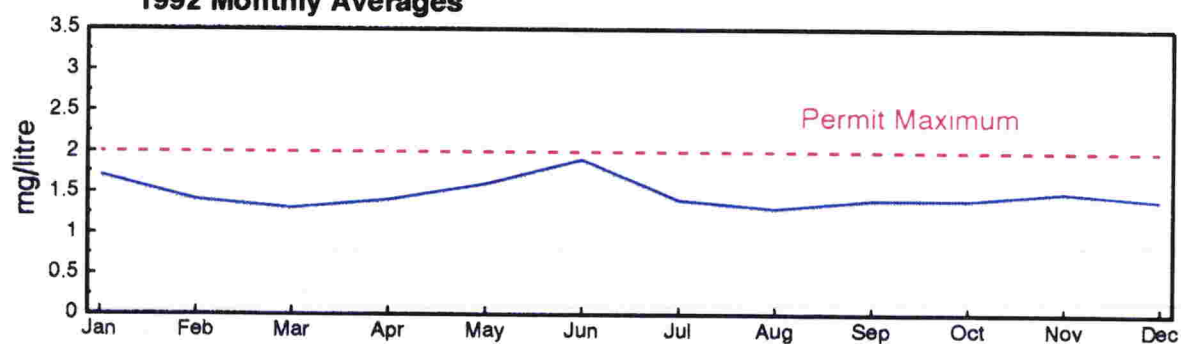
1992 Monthly Averages



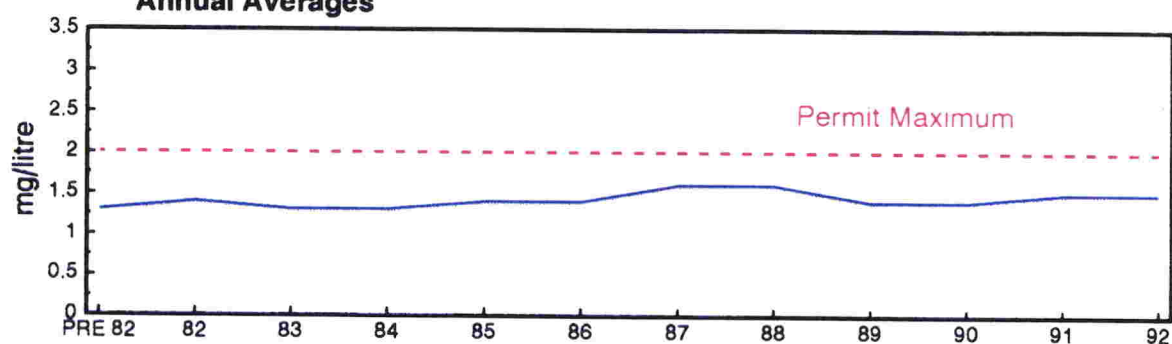
Discharge Suspended Solids Concentrations Annual Averages



Receiving Water Fluoride Concentrations 1992 Monthly Averages

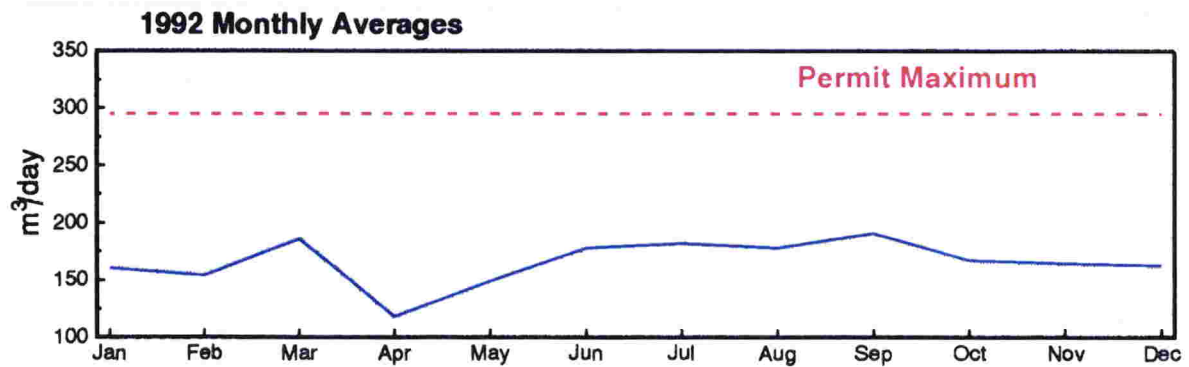


Receiving Water Fluoride Concentrations Annual Averages

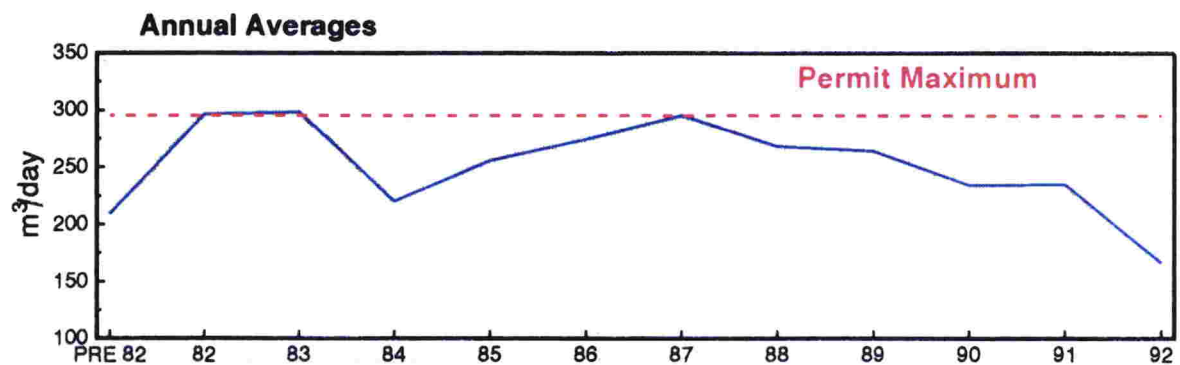


No trends are evident in the south drain discharge or receiving water data. All levels are well within permit conditions.

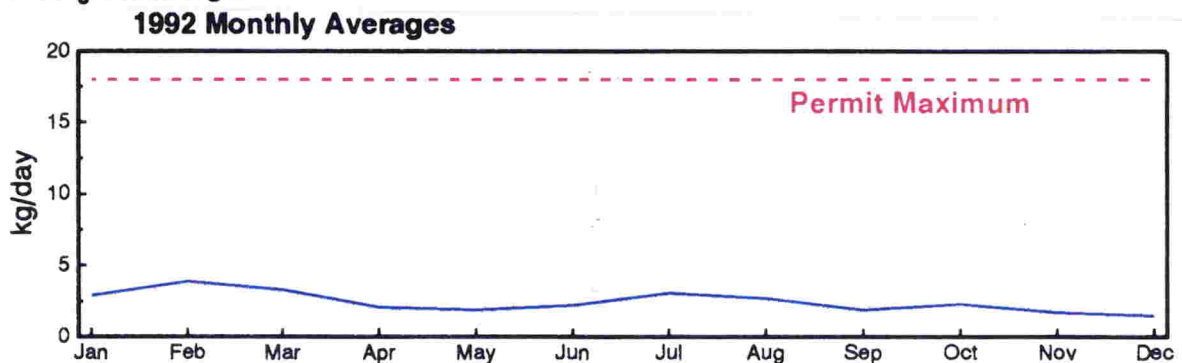
Flow Rates



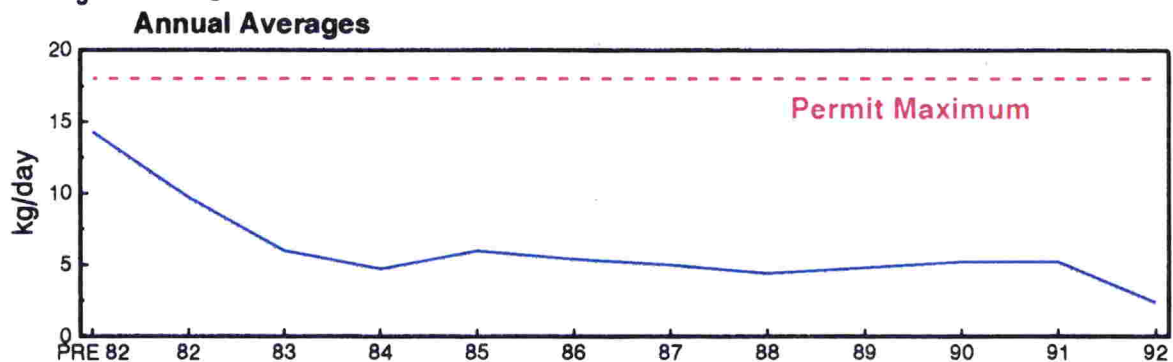
Flow Rates

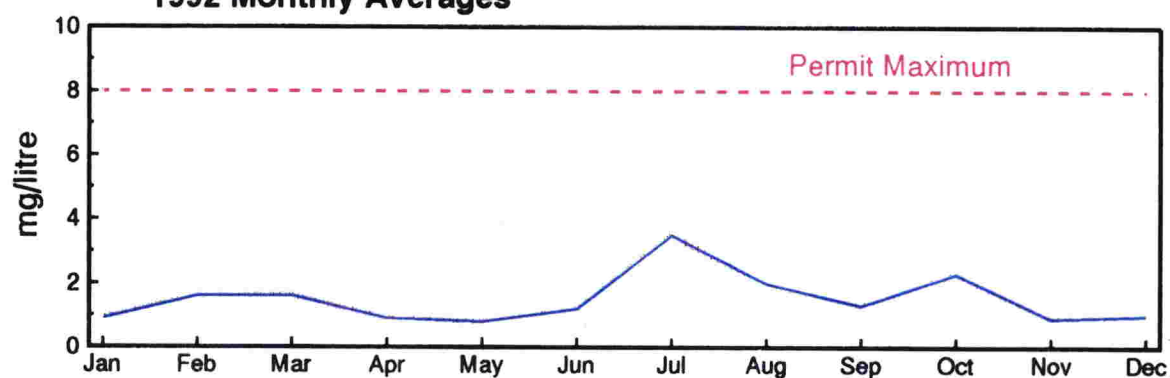
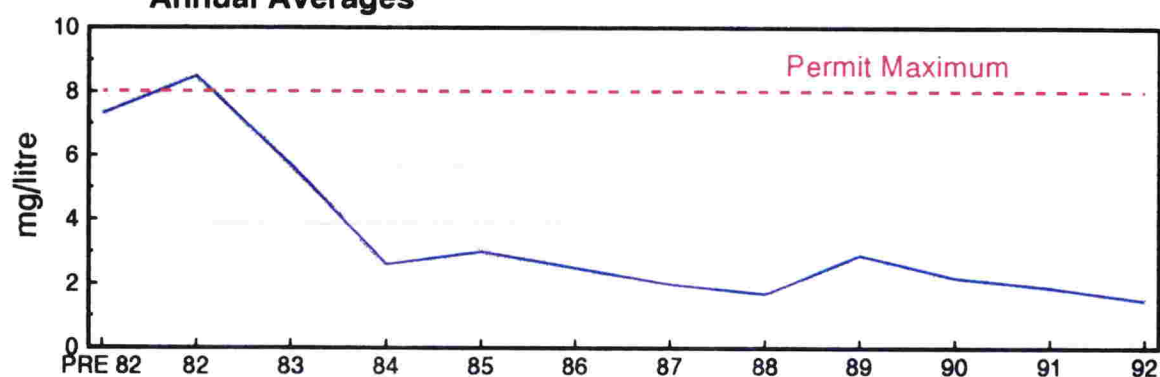


BOD₅ Discharges



BOD₅ Discharges



Suspended Solids**1992 Monthly Averages****Suspended Solids****Annual Averages**

As a result of improvement work to the sewage system and the elimination of storm water ingress into the system the mean flow was reduced from 235 m³/day in 1991 to 166 m³/day in 1992.

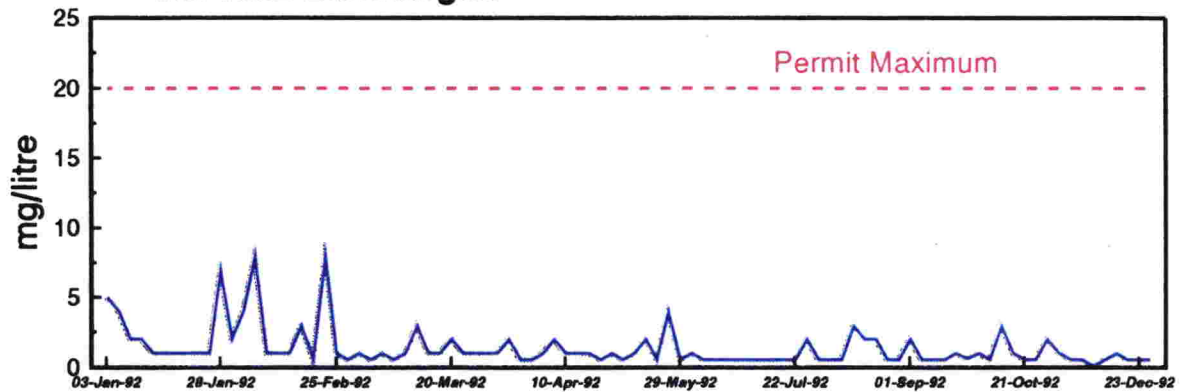
The resulting increased residence time in the contactor and clarifier reduced the BOD₅ count and the suspended solids concentration.

4.5 COASTAL PERMIT No 90061 - SPENT CATHODE LEACHATE

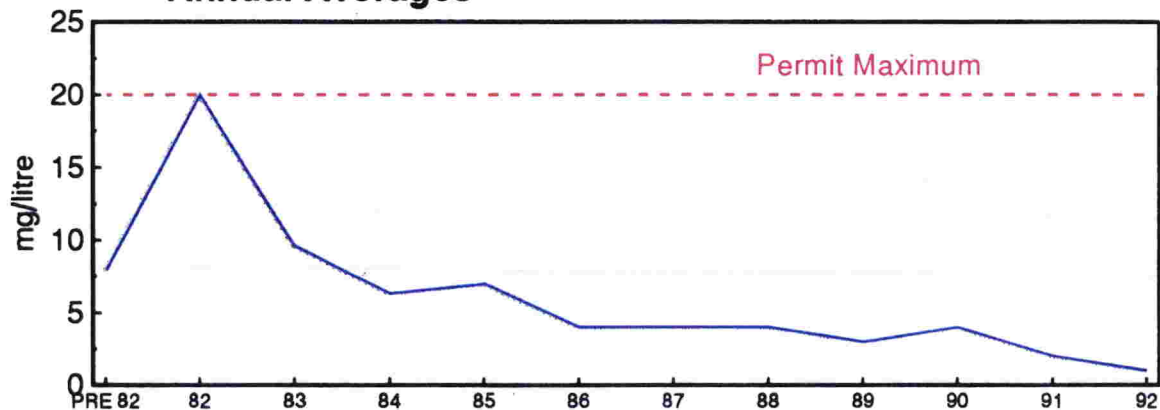
Page 41

4.5.1 Discharge Free Cyanide Concentrations

All 1992 Discharges



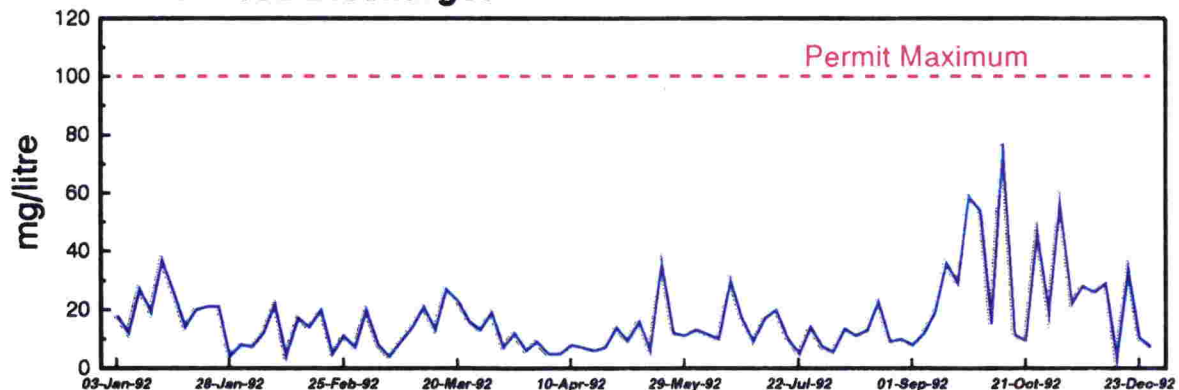
Annual Averages



The discharge free cyanide concentration remains low with the annual mean concentration for 1992 of 1mg/litre continuing the downward trend evident since 1982.

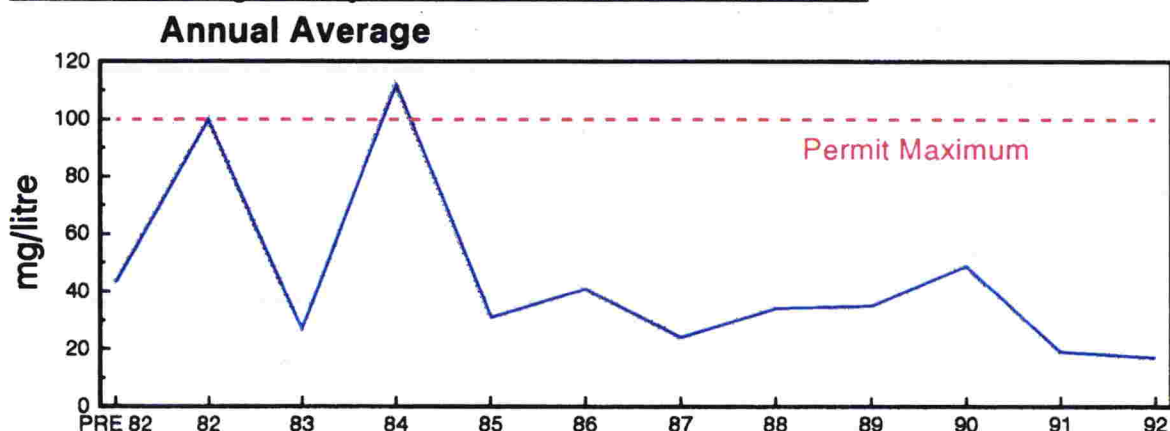
4.5.2 Discharge Suspended Solids Concentrations

All 1992 Discharges



4.5.2 Discharge Suspended Solids Concentrations

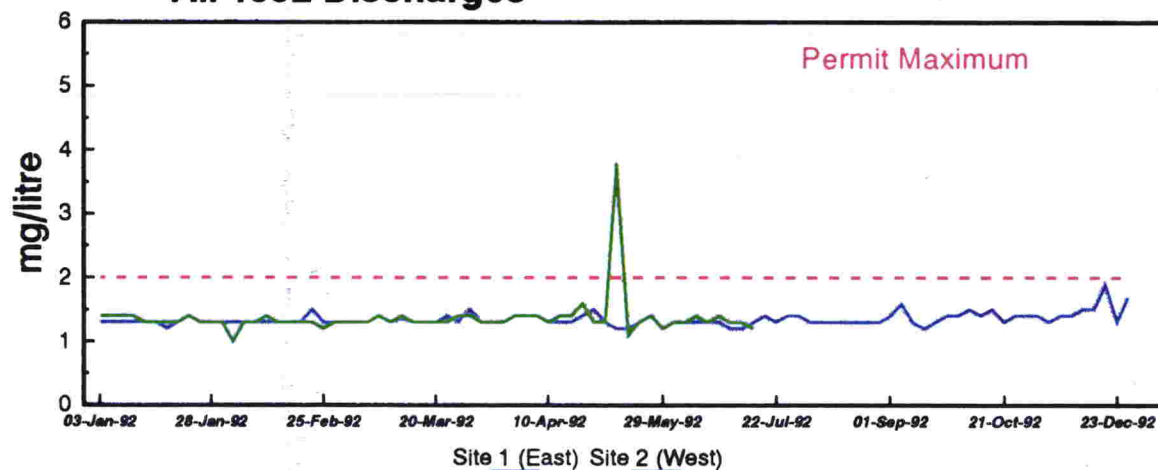
Page 42



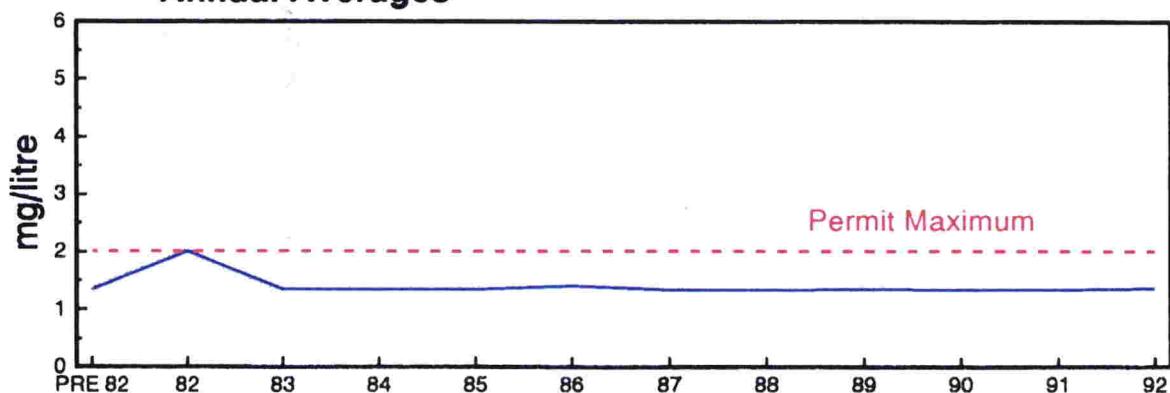
The period of large variation in the suspended solids concentration is related to the capping of the south cathode storage pad which resulted in a reduction in the total volume of effluent. The storm water run off from the north pad made up a greater percentage of this effluent and it was observed to have a high concentration of very fine solids. Compliance with the permit condition was maintained.

4.5.3 Receiving Water Fluoride Concentrations

All 1992 Discharges



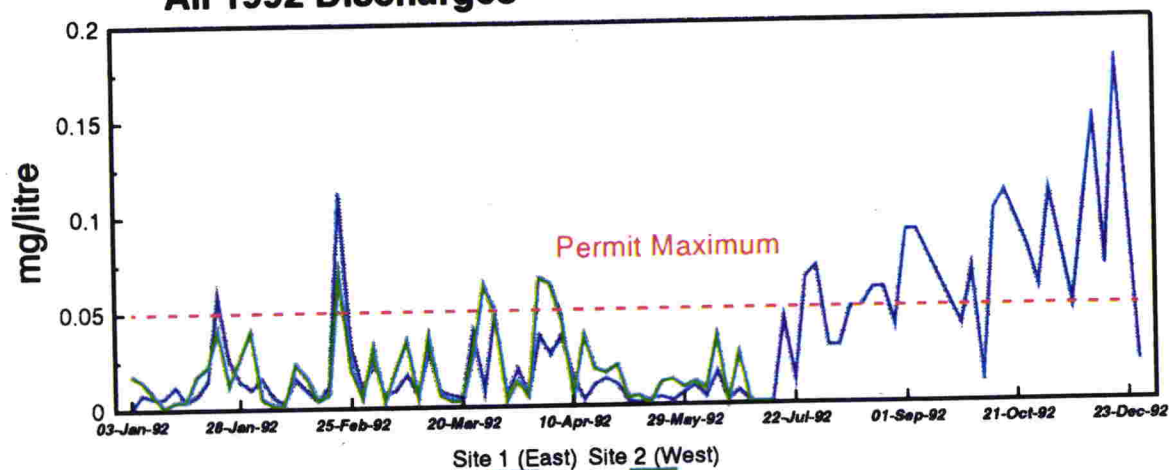
Annual Averages



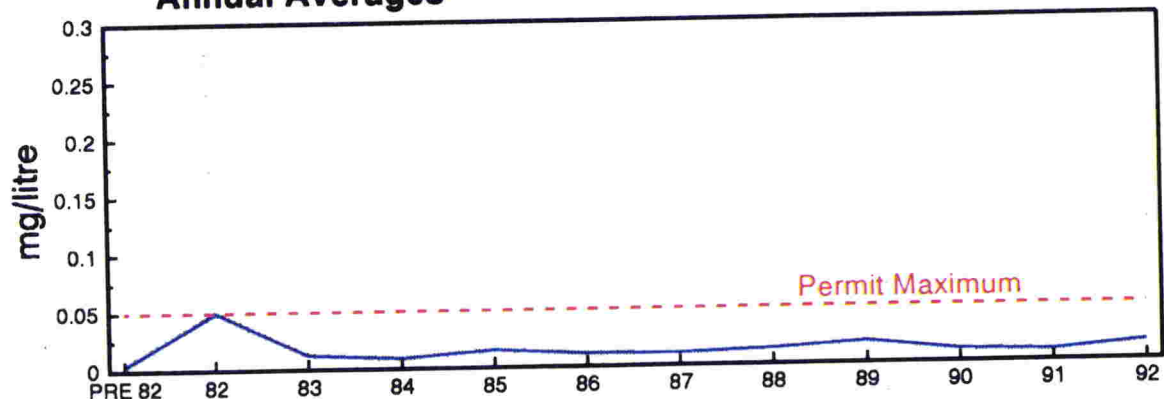
There are no trends evident in the receiving water fluoride concentrations. In mid-July the discharge procedure was changed, on the basis of consultants advice, so that treated cathode effluent was discharged to coincide with optimum dispersion characteristics in the receiving seawater. This occurs during the rising tide when there is a strong tidal flow west to east along the coast. The west sample point was discontinued when the change was made because it is now up current from the point of discharge.

4.5.4 Receiving Water Total Cyanide Concentrations

All 1992 Discharges



Annual Averages



As mentioned in section 4.5.3, mid-July saw a change in the discharge procedure. This was accompanied with a change in the time that the receiving seawater sample is taken. Previously this sample was taken at high tide, approximately the middle of the discharge. As of mid-July the sample is taken shortly after low tide when the receiving seawater effluent concentration is at its predicted maximum. Work completed during the year indicates that the most likely source of the detected total cyanide is contaminated groundwater. The concentrations measured are very dependent on the stage of the tide the sample is collected. The marked change in the reported receiving seawater total cyanide after July does not indicate a sudden change in the effect on the environment but a change in the way it is measured.

5.1 Diesel Leak

A leak of diesel fuel into the ground on NZAS property was detected on 15 July 1991. The leak originated from obsolete buried pipework supplying heating fuel to one of the smelter buildings.

The obsolete pipework was removed and a programme initiated to recover the leaked diesel. Woodward Clyde (NZ) Ltd were engaged and a network of recovery bores were installed. This programme is nearing completion with just over 520,000 litres of diesel being recovered. The next stage of the operation is the bioremediation of the remaining diesel residues. The system is being installed and the scheduled start up is the end of the first quarter 1993.

5.2 Spent Cathode Pad Leachate

During 1992 NZAS recognised the source of the spent cathode pad leachate in the groundwater as being the failure of the storage pad. In conjunction with works undertaken to mitigate the production of leachate by covering the south pad an investigation to define the nature and extent of the leachate movement was initiated. Woodward-Clyde (NZ) Ltd was retained to carry out this investigation.

The major conclusions drawn from the investigation were:

- Leachate from the spent cathode pad has entered the groundwater and has moved towards the coastline.
- It is likely that the leachate components are discharging into the sea from the pea gravels at or below the low tide level directly seaward of the pad. The width of the discharge zone is likely to be narrow, (200 - 300 metres).
- Groundwater movement is very slow with respect to the seawater movement and the mixing and diluting capacity of the sea is expected to be large given the assessed rate of release of the leachate into the marine environment.

A spent pot lining storage building has been commissioned and all the material stored on the north pad, including the pad itself, has been transferred to this building. Investigations are under way to determine (a) the actual effects on the environment and (b) a method of mitigating the effects of the contaminated groundwater. To date trial work has identified a naturally occurring micro-organism that will metabolize the total cyanide component of the leachate. Work is presently underway to determine if it is still viable in the concentrations found in the groundwater.