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CADMIUM IN THE ATLANTIC PROVINCES

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CADMIUM IN THE ATLANTIC PROVINCES

by

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ABSTRACT

Information on cadmium in the Atlantic Provinces is summarized in this report. Available data on levels in water, sediment, soil, biota, air and industrial effluents are included and, when the documented evidence warrants, potential sources and environmental effects are indicated. The data used originated primarily from federal and provincial government files and publications. Overall the regional data base is fairly extensive, although there are some areas in which additional information is urgently required.

RÉSUMÉ

L'information disponible sur le cadmium dans les provinces de l'Atlantique est résumée dams le présent rapport. Les données en réserve sur le niveau de cadmium présent dans l'eau, les sédiments, le sol, le milieu biotique et les effluents industriels y sont également inclues. Les sources possibles de cadmium ainsi que ses effets sur l'environnement sont aussi indiqués lorsque justifiés par les faits. Les présentes données proviennent principalement de dossiers et de publications fédérales et provinciales. En général, la banque de données régionales est relativement abondante, bien qu'il soit urgent d'obtenir des renseignements additionnels dans certains secteurs.

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1 INTRODUCTION

Cadmium is included on the DOE/NHW List of Priority Chemicals. This List focuses on those substances for which regulations are being developed under the Environmental Contaminants Act (ECA) and on those substances about which further information must be obtained to determine whether regulation is necessary. Materials on the List are evaluated on the basis of toxic effects, persistence and quantity and use criteria. Cadmium appears in Category II of the List, indicating that it is being investigated by the federal government to determine the nature and the extent of its danger to human health or the environment and the appropriate means to alleviate that danger.

An assessment of cadmium in the Canadian environment is presently being conducted by the Contaminants Control Branch (Environmental Impact Control Directorate) of the Environmental Protection Service (EPS). The conclusions and recommendations resulting from this review of national data will be instrumental in determining the nature of any future ECA regulatory action on cadmium. EPS Atlantic assisted in this evaluation process by supplying regional information relevant to the environmental assessment process.

During the course of assembling and compiling this data a number of federal and provincial government agencies in the region engaged in either cadmium monitoring or research were contacted and their assistance solicited. Several of these groups expressed an interest in examining the completed cadmium information package. Consequently, this document has been prepared to provide a comprehensive review of regional cadmium data. Information has been extracted from scientific publications and technical reports and, in some cases, permission has been obtained to include unpublished results. In view of the national assessment presently underway, no attempt has been made to prepare an independent regional evaluation. Opinions and inferences on cadmium sources, levels, and hazards are those of the original authors and are appropriately referenced. While a number of relevant cadmium related research projects have been or are presently being conducted in regional laboratories, the scope of this document has been restricted to an examination of environmental data. Unless otherwise noted cadmium in this document refers to divalent cadmium ion salts and complexes.

2 CADMIUM IN THE ENVIRONMENT

2.1 Natural Distribution

Cadmium is a rare, silvery white metal which occurs naturally in the earth's crust and waterways. The terrestrial abundance of cadmium is in the order of 0.3 μg/g (Boyle and Jonasson, 1979). Cadmium is found in ores in close association with other metals, particularly zinc, and is generally obtained as a by-product from the refining of zinc concentrates, which normally contain 0.1-0.3% cadmium (Gauvin, 1973). Ores, from which these concentrates are produced, contain 0.001-0.067% cadmium (Lymburner, 1974). Principal Canadian mineral deposits containing cadmium are shown in Figure 1 (Boyle and Jonasson, 1979).

2.2 Industrial Sources and Uses

Every industry involved in either the production or use of cadmium is a potential point source of input to

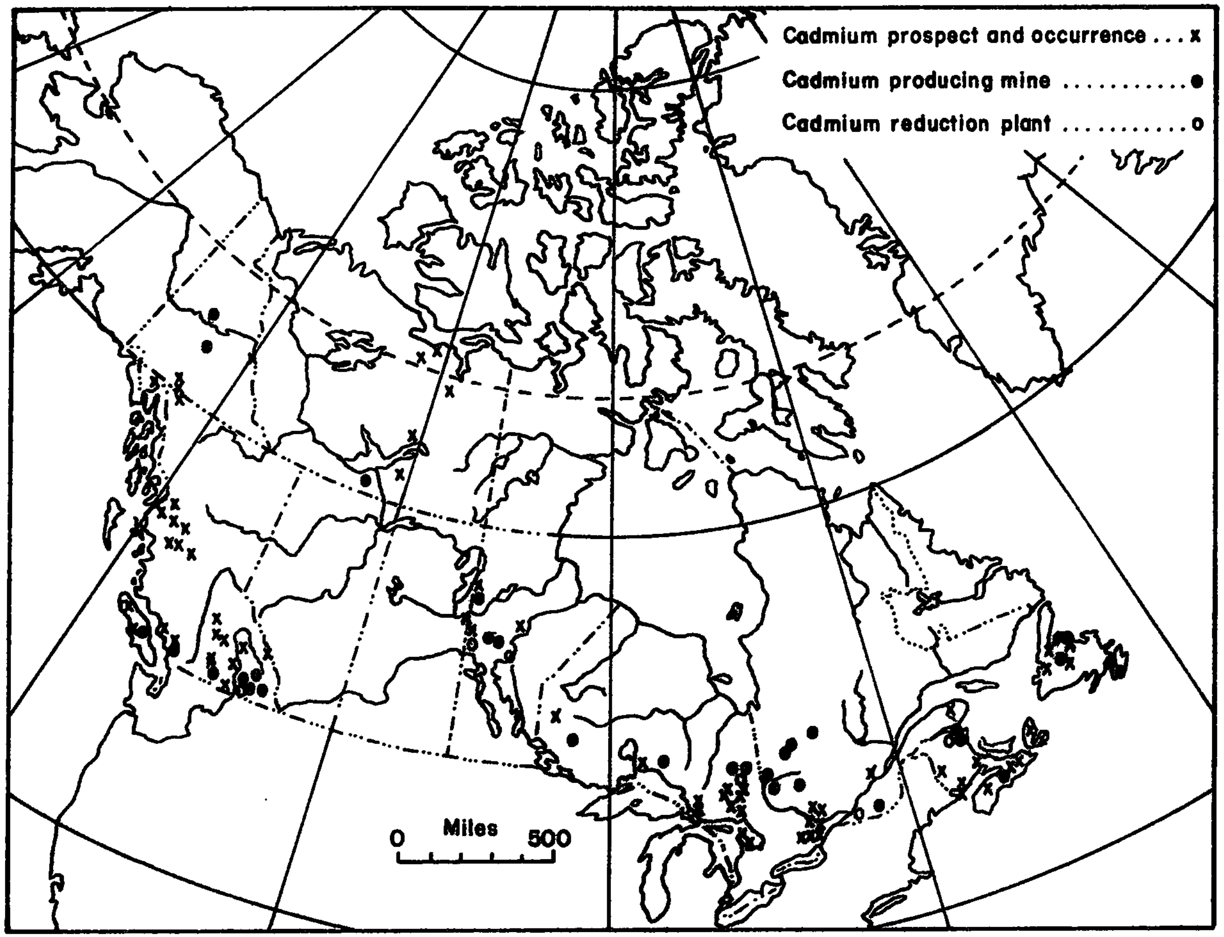


FIGURE 1 CADMIUM MINES, OCCURRENCES AND REDUCTION PLANTS
(Boyle and Jonasson, 1979)

the environment and, as industrial usage increases, so too does the potential pollution of water, soil and air.

Major cadmium emission sources in Canada are from mine drainage, smelter loss, electroplating operations and combustion of fossil fuels. It appears that cadmium pollution problems arise only near emission sources (Abdullah _et_. _al_., 1972; Preston, 1973; Kneep _et_. _al_., 1974; Holmes _et_. _al_., 1974 and Lund _et_. _al_., 1976).

Due to its anti-corrosive properties cadmium was first used extensively in the industrial field during World War II as a plating agent on metal parts of aircraft exposed to salt spray. The overall use of cadmium has expanded at the rate of 5-10% annually in recent years (Morrison, 1979). The manufacture of nickel-cadmium batteries represents the fastest growing application with an estimated consumption increase of 10% for each of the next four years. While electroplating is still its major industrial application (56 of the 75 tons used annually in Canada) (Lymburner, 1974; EPS, 1976), cadmium is now used in a variety of other commercial processes, particularly the manufacture of pigments, PVC stabilizers and metallic alloys. Minor quantities are used in the manufacture of television picture tubes, fungicides, ceramics and motor oil. An extensive list of the uses of elemental cadmium and its compounds has been published (Lymburner, 1974).

2.3 Cadmium in Air

In ambient air reported cadmium values are usually of the order 0.001-0.005 $\mu g/m^3$ in rural areas, 0.005- 0.05 $\mu g/m^3$ in urban areas, and up to 0.6 $\mu g/m^3$ near point sources (WHO, 1977). Friberg (1974) reported a normal background level of less than 0.001 $\mu g/m^3$. The concentration of cadmium in air in remote areas not affected by human activity is usually very low reflecting a lack of industrial and municipal wastes; concentrations measured in air over the Atlantic Ocean varied from 0.003-0.062 ng/m^3 (ibid).

Metal smelters, especially those utilizing zinc and lead ores, alloy production plants, metal recovery operations and waste incinerators are all major sources of cadmium input to the atmosphere. Cadmium is also a trace contaminant of fossil fuels and is released upon their combustion. Other sources of atmospheric cadmium are rubber manufacture, pigment and battery manufacture, mining operations, die-casting, vinyl plasticizers and stabilizers, brass and bronze foundries and cigarette smoking.

Most of the cadmium of thermal origin emitted to the air is probably in the oxide form (Morrison, 1979) and like most airborne contaminants ultimately reaches natural waterways.

Table 1 lists available quantitative data on airborne emissions of cadmium from various industries or production processes.

2.4 Cadmium in Aquatic Ecosystems

From available data it is estimated that 90% of annual emissions to the hydrosphere are from anthropogenic

TABLE 1 QUANTITATIVE ESTIMATES OF SOME CADMIUM AIRBORNE EMISSIONS IN CANADA (adapted from Lymburner, 1974)*

INDUSTRY OR PROCESS	ATMOSPHERIC EMISSION FACTOR[a]	ESTIMATED EMISSION[b]
plastics production	6	-[c]
pigment production	15	75 - 150
mining process (wind loss)	0.2	425
metallurgical works[d]	25 - 1300	-
cadmium alloy manufacture	10	135 - 250
nickel-cadmium battery manufacture	2	-
fertilizer usage	0.1%	60
motor vehicle emissions (from tires and oil)	-	1100

a Pounds per ton of cadmium processed.

b Pounds estimated for the year 1970.

c Estimate not available.

d 45% of cadmium losses to air occur during ore refining processes, e.g. roasting and sintering of zinc concentrates if not treated.

* Taken from Morrison, 1979.

sources (Fleisher et. al., 1974; Eaton, 1976) while natural weathering and erosion processes account for the remaining 10% of emissions (Bertine and Goldberg, 1971).

Once in the aquatic environment industrially discharged complexed cadmium adsorbs to both suspended particulate matter (Suzuki et. al., 1979) and bottom sediments, (Friberg et. al., 1979), especially in neutral or alkaline waters (Boyle and Jonasson, 1979) where hydrolysis to the highly insoluble cadmium hydroxide is facilitated. In waters with low pH hydrolysis is retarded and more of the cadmium remains dissolved in the water column. Natural background levels for marine waters and sediments are $\leq$0.1 μg/l (Anon, 1979) and 0.5 mg/kg (Swiss and Henderson, 1976) while levels in freshwater are reported as $\leq$1.0 μg/l (Anon, 1977).

Available information indicates that cadmium is not an essential trace element to aquatic organisms (McKee and Wolf, 1963; Eisler, 1971; Sharma and Shupe, 1977) but rather acts as a cumulative (Thorpe and Lake, 1974) and highly toxic poison.

2.4.1 Cadmium in Aquatic Animals

Dissolved cadmium in freshwater is absorbed primarily through the gills (Williams and Giesy, 1978; Jacobs, 1978) while cadmium uptake from seawater is primarily through the gastrointestinal tract (Eisler, 1974).

In both freshwater and marine species cadmium accumulates mainly in the kidneys, liver and internal organs (Topping, 1973; Freeman and Uthe, 1974;

Sangalang and Freeman, 1979) where it forms strong bonds with protein, especially metallothionein, displacing zinc and interrupting certain of its enzymatic functions. Documented effects on fish and invertebrates include gill damage (Doudoroff and Katz, 1953), behavorial changes (Eaton, 1974; Cearley and Coleman, 1974), altered respiration rate (Schweiger, 1957), vertebral and internal organ damage (Bengtsson et. al., 1975; Gardner and Yevich, 1969; 1970), reproductive impairment (Biesinger and Christensen, 1972; Sangalang and O'Hallaran, 1972; Freeman and Sangalang, 1976) and a variety of biochemical and hormonal responses (Christensen, 1975; Sangalang and O'Hallaran, 1972; 1973) as well as direct mortality.

In laboratory tests the lowest lethal level recorded for a fish is 8-10 μg Cd/l (7 day LC50) with Salmo gairdneri in hardwater (Tafenelli and Summerfelt, 1975) while the corresponding value for an invertebrate is 5 μg/l (21 day LC50) with Daphnia in soft water (Biesinger and Christensen, 1972). Concentrations of cadmium as low as 0.2 μg/l in water and 0.001 mg/kg in sediment have been observed to have detrimental effects on the common brook trout Salvelinus fontinalus (Freeman and Sangalang, 1976) and a level of 0.1 mg/l is potentially harmful to the mummichog, Fundulus heteroclitus and possibly other marine species (Swiss and Henderson, 1979).

The degree of concentration and associated toxic effects are species specific as well as dependent on life stage, the speciation of the metal and the presence of other compounds, metals and organisms. Other important environmental variables affecting uptake and toxicity are salinity, hardness, temperature, pH and dissolved oxygen content of the water.

Investigative studies indicate that species differences in sensitivity to cadmium are greater than for most other common pollutants (EIFAC, 1978). Juvenile life stages tend to be more sensitive than the adult (Eaton, 1974; Reish et. al., 1976). Generally cadmium levels are lower in vertebrate than invertebrate marine species with molluscs and crustaceans exhibiting the greatest accumulation potential (Pringle et. al., 1963). The state of the metal is important in that a complexed or chelated form may be less soluble and hence less toxic than the more readily soluble and available ionic forms (Ray and Coffin, 1977). The combined effect of cadmium and other chemicals may act synergistically to increase or decrease cadmium toxicity (Hutchinson and Czyrska, 1972; Hutchinson, 1973; Eisler and Gardner, 1973). Hardness is usually the single most important variable affecting cadmium toxicity in freshwater and an inverse relationship has been demonstrated (Pickering and Henderson, 1966; McCarty et. al., 1978). Similarly, in salt water systems toxicity decreases with increasing salinity since often uptake decreases (Eisler, 1971). Temperature (Eisler, 1974; Voyer et. al., 1977) and dissolved oxygen (Voyer, 1975; Voyer et. al., 1975) also influence toxicity but the exact relationship is unclear.

2.4.2 Cadmium in Aquatic Plants

Many aquatic plants selectively concentrate cadmium and other trace metals up to many thousands of times the ambient environmental levels. Accumulation factors ranging from 1,000 to 49,000 times ambient levels have been recorded for the pondweed, *Najis quadulapensis*, and the alga, *Cladophora glomerata*, respectively (Cearley and Coleman, 1973; Kenney et. al., 1976). Studies on the water hyacinth, Eichornia echlorina crossipes have reported an accumulation of 16.2 μg/g of cadmium at an aqueous level of 0.002 mg/l. Indeed, its accumulation potential is so great that it has been suggested as a means of clearing polluted waterways of heavy metals.

Cadmium inhibits the biosynthesis of chlorophyll (Fleisher et. al., 1974) leading to reduced growth and development (Hutchinson and Czyrska, 1972, 1975; Cearley and Coleman, 1973; Stanley, 1974). Table 2 summarizes the toxic effects observed in some studies.

Many of the environmental factors which affect uptake rate and toxicity in aquatic animals have a similar influence on plants.

2.5 Cadmium in Terrestrial Ecosystems

Anthropogenic input of cadmium to soils occurs in two general ways: through the deposition of aerosols produced by the combustion of fossil fuels (Berry and Wallace, 1974) or metal smelting (Whitley, 1974; Little and Martin, 1972) and by the application of phosphatic fertilizers (Reuss et. al., 1978; Schroeder and Balassa, 1963; Williams and David, 1973, 1976) or sewage sludge (Mahler et. al., 1978; Bingham et. al., 1975, 1976; Kirkham, 1975; Giordano et. al., 1975; Linnman et. al., 1973) for agricultural purposes.

Natural background levels in uncontaminated plants and soils are ~0.6 μg/g (Bowen, 1966) and ~0.2 μg/g (Anon, 1978) while soil values as high as 95 μg/g (John et. al., 1972) have been reported from heavily polluted areas.

TABLE 2 EFFECTS OF CADMIUM ON AQUATIC PLANTS (HUTCHINSON, 1979)

PLANT	LEVEL OF CADMIUM IN WATER ng/l	OBSERVED EFFECT(S)	REFERENCE(S)
Lemma valdiviana (duckweed)	0.01	Inhibition of frond development	Hutchinson and Czyrska, 1972 Hutchinson and Czyrska, 1975
Salvinia natans (fern)	0.01	Severe growth inhibition; chlorosis and necrosis	Hutchinson and Czyrska, 1972 Hutchinson and Czyrska, 1975
Najas guadalupensis (pond weed)	-	Chlorosis	Cearley and Coleman, 1973
Myriophyllum spicatum (milfoil)	7.4	50% decrease in root production	Stanley, 1974

2.5.1 Cadmium in Terrestrial Plants

Cadmium is considered by many scientists to be one of the most toxic heavy metals to plants (Rauser, 1978). Although they have no metabolic requirement for cadmium most plants readily accumulate it from their environment. The absorbed metal can disrupt the normal functioning of plant enzymes causing chlorosis of the leaves and reduced growth (Traynor and Knezek, 1973; Bingham et. al., 1975; McNaughton et. al., 1974; Hutchinson, 1977).

Some plants are more sensitive to cadmium accumulation than others. For instance, spinach, soybean and lettuce showed signs of poisoning when raised in soils with cadmium levels of 4-13 μg/g while cabbage and tomato tolerated soil levels of up to 170 μg/g (Bingham et. al., 1975).

While the extent of cadmium concentration depends on the plant species, other environmental variables such as soil pH, organic content and presence or absence of antagonistic chemicals are also important. A summary of observed effects on some land plants is given in Table 3.

Increasing soil pH (Linmann et. al., 1973; Williams and David, 1973; Bolton, 1975; Pinkerton and Simpson, 1977; Mahler et. al., 1978; Reuss et. al., 1978) and organic matter content (Haghiri, 1974; John et. al., 1972a; John, 1971; Williams and David, 1976) generally decreases cadmium availability. Increasing soil levels of metals antagonistic to cadmium such as copper, zinc and

TABLE 3 EFFECTS OF CADMIUM ON LAND PLANTS (HUTCHINSON, 1979)

PLANT	CADMIUM SOIL LEVEL $\mu g/m^3$	OBSERVED EFFECT(S)	REFERENCE(S)
All plants	112[a]	Reduced iron content of plant	Traynor and Knezek, 1973
Curleycress Spinach Soybean Lettuce	4-13[b]	Injury to foliage and decreased growth	Bingham *et.* *al*., 1975
Tomato, cabbage	170[b]	No signs of toxicity	Bingham *et.* *al*., 1975
Typha latifolia	73[c]	No signs of toxicity	McNaughton *et.* *al*., 1974
Most plants	13-350[d]	Reduced growth, some failure	Hutchinson, 1977
Tomato, raddish, Lettuce	13-350[d]	Death in 28 days	Hutchinson, 1977

a Cd added directly to soil.

b Cd added as contaminated sewage sludge.

c Cd from smelter fallout.

d Soil Cd levels corresponding to distances of 0.8 and 8.0 km respectively from a lead-zinc smelter in Flin-Flon, Manitoba.

selenium, reduce cadmium accumulation (John, 1972a, 1972b; Chaney, 1978); however, the levels required are often so high that these compounds themselves are toxic to the plants (Haghiri, 1974; Lagerwerff, 1971).

In studies undertaken to determine the ultimate fate of cadmium accumulated by plants it was found that, irrespective of soil or plant type, the greatest concentration was in the roots (John, 1972; John et. al., 1972a; Page et. al., 1972; Haghiri, 1973; John, 1973; Turner, 1973; Bingham et. al., 1975, 1976; Mahler et. al., 1978; Jarvis et. al., 1976). Accumulation was also observed in leaves and food storage tissue, but to a lesser extent. Other reports indicate that cadmium is highly mobile and is not excluded from edible portions such as fruits or seeds (Hutchinson, 1979).

Some edible plants can concentrate cadmium to levels considered dangerous to human health without obvious signs of damage and consequently they pose a threat to unsuspecting consumers.

2.5.2 Cadmium in Terrestrial Animals

The main sources of cadmium for animals are food and water since industrial exposure is exceptional. In addition, cadmium entry may occur by inhalation and adsorption of cadmium particulates in the air. Once in the body cadmium reacts with many nutrients which may cause altered absorption rates and responses. The main components of the diet that interact with cadmium include zinc (Powell et. al., 1967; Doyle et. al., 1974; Lee and Jones, 1976; Roberts et. al., 1976), copper (Underwood, 1971; Mills and Dagarno, 1972; Neanthery and Miller, 1975;

Lee and Jones, 1976), iron (Pond et. al., 1973), mercury and selenium (Parizek et. al., 1973; Lee and Jones, 1976) and calcium and protein (Neanthery and Miller, 1975).

The clinical symptoms of primary cadmium toxicity in animals are anemia, enlarged joints, scaly skin, liver and kidney damage, reduced growth and a mortality rate which relates directly to the concentration of cadmium fed (Pond and Walker, 1972; Cousins et. al., 1973; Neanthery and Miller, 1975; Pond, 1975; Lynch et. al., 1976). There is also evidence of gonadal, mostly testicular, degeneration following treatments with cadmium (Parizek and Zahor, 1956; Chiquoine and Suntzeff, 1965; Chatterjee and Kar, 1969; Baillargeon et. al., 1971a,b).

Cadmium ions absorbed from the intestine become bound to metallothionein or other transport proteins (Neathery and Miller, 1975) and stored in association with these proteins (Webb, 1975b). Cadmium tends to concentrate primarily in the kidney, liver and internal organs (Miller et. al., 1969; Neanthery and Miller, 1975; Find and Fischer, 1975). Very little cadmium reaches the milk (Mills and Dalgarno, 1972; Cornell and Pullansch, 1973; Doyle et. al., 1974; Neanthery et. al., 1974; Dorn, et. al., 1975) or muscle (Kirkpatrick and Coffin, 1973; Cousins et. al., 1973), the main animal proteins consumed by humans.

Defecation is the predominant route of cadmium excretion. After the occurrence of high cadmium concentrations in the kidney and associated renal damage with proteinuria, there will be elevated cadmium concentrations in urine (Friberg et. al., 1971; Underwood, 1971; Neanthery and Miller, 1975).

2.6 Cadmium in Man

Comprehensive reviews on the source, biological effects and human health aspects of cadmium are available (Friberg et. al., 1974, 1975; Fleisher et. al., 1974; Fulkerson and Goeller, 1974; Hiatt and Huff, 1975; Babich and Stotsky, 1976; Webb, 1979).

For man the major source of cadmium intake, excluding occupational exposure, is food and cigarette smoking with water and air providing only minor contributions. Foods containing the highest levels are organ meat, such as liver and kidney, seafood, especially shellfish, and certain cereal grains, such as rice. Cadmium levels of common foods and fish are listed in Tables 4 and 5, while average Canadian daily intake from each source is given in Table 6. Foodstuffs from contaminated areas contain 3-12 times as much cadmium as those from unpolluted areas (Nordberg, 1974).

The FAO/WHO Expert Committee recommends a provisional tolerable daily intake of 250-350 μg (Friberg, 1977). Cadmium injestion from foods in Canada, averages 305 - 686 μg/week (Friberg, 1977). In general, levels of cadmium in water are well below the Canadian drinking water standard of 5 μg/l and consequently this constitutes a minor source of human exposure (Goyer and Cherian,

TABLE 4 CADMIUM CONTENT OF CANADIAN FOODS (FMOI PROJECT, AUGUST 1971-MARCH 1976)[a], *

FOOD	NUMBER OF SAMPLES	CADMIUM CONCENTRATION (mg/kg fresh weight)	
		RANGE	AVERAGE
Milk	248	<0.01 - 0.19	0.02
Flour	183	<0.01 - 0.17	0.04
Eggs	129	<0.01 - 0.12	0.03
Meat, beef	178	<0.01 - 0.13	0.02
Meat, pork	175	<0.01 - 0.08	0.03
Meat, poultry	129	<0.01 - 0.10	0.02
Apples	141	<0.01 - 0.13	0.01
Carrots	130	<0.01 - 0.16	0.03
Tomatoes	205	<0.01 - 0.36	0.02
Cabbages	128	<0.01 - 0.12	0.02
Potatoes	201	<0.01 - 0.12	0.03
Beef kidney	63	0.13 - 2.78	0.60
Beef liver	85	0.04 - 0.82	0.15
Pork kidney	55	0.08 - 1.04	0.26
Pork liver	87	0.01 - 0.80	0.09
Chicken liver	58	0.02 - 0.76	0.06

a Data to be published, Health Protection Branch, Health and Welfare Canada.

* Taken from Sandi, 1979.

TABLE 5 CADMIUM CONTENT OF CANADIAN FISH (FISHERIES SERVICE, DOE, 1974)*

FISH	NUMBER OF SAMPLES	RANGE (mg/kg fresh weight)	AVERAGE (mg/kg fresh weight)
GROUNDFISH			
Cod	189	0.01 - 0.24	0.11
Salt cod	13	2.06 - 3.16	2.51
Others[a]	620	<0.01 - 0.50	0.09
PELAGIC AND ESTUARINE FISH	703	<0.01 - 0.38	0.13
MOLLUSCS AND CRUSTACEANS			
Lobster	94	0.01 - 2.45	0.33
Mussels and oysters	81	0.05 -11.30	0.56
Others[b]	230	0.02 - 1.32	0.23
MISCELLANEOUS			
Lobster paste	64	0.06 - 5.94	3.40
Lobster tomalley	12	1.35 - 2.47	1.83
Fish meals	32	<0.01 - 1.57	0.64
Others[c]	101	<0.01 - 2.55	0.19
FRESHWATER FISH			
Ontario	90	<0.01 - 0.10	0.01
St. Lawrence	113	<0.01 - 0.32	0.10
Quebec	217	<0.01 - 1.32	0.10
Others[d]	37	<0.01 - 0.32	0.01

a Flounder, halibut, sole, catfish, plaice, haddock, lingod pollock, tomcod, turbot, red fish, snapper, skate, sable fish and rock fish.

b Clam, shrimp, crab and scallop.

c Fish livers, fish liver oils and cod tongues.

d Alberta, Saskatchewan and Northwest Territories.

* Taken from Sandi, 1979.

TABLE 6 CADMIUM INTAKE FROM CANADIAN TOTAL DIET, 1969-1971[a], *

COMPOSITE	CONSUMPTION µg/day/man	Cd CONCENTRATION range (mg/kg)	Cd INTAKE (µg/day/man)
Milk and dairy products	495	0.01 - 0.03	5 - 15
Meat, fish and poultry	276	0.03 - 0.07	11 - 19
Cereals	190	0.04 - 0.07	8 - 13
Potatoes	191	0.06 - 0.10	12 - 19
Leafy vegetables	46	0.02 - 0.13	1 - 6
Legumes	32	0.04 - 0.05	1 - 2
Root vegetables	49	0.04 - 0.05	2 - 3
Garden fruits	82	0.02 - 0.04	2 - 3
Fruit	193	0.02 - 0.06	4 - 10
Oils and fats	27	0.05 - 0.10	1 - 2
Sugars and adjuncts	142	0.02 - 0.03	2 - 4
Drinks	59	0.02 - 0.03	1 - 2
Total			50 - 98

a Data from: Meranger and Smith (1972); Kirkpatrick and Coffin (1974, 1977).

* Taken from Sandi, 1979.

1979). About 6% of dietary cadmium is absorbed by humans (Friberg et. al., 1974). There is an extremely low excretion rate of the absorbed cadmium with only about 0.01% of the total body burden being excreted daily via urine and feces.

Cadmium content of air in unpolluted areas is approximately 0.001 - 0.01 $\mu g/m^3$ and may increase to 0.1 - 0.5 $\mu g/m^3$ around emitting factories (Friberg et. al., 1974). Even at the higher levels, inhaled cadmium would amount to only 2 - 10 μg/day (Goyer and Cherian, 1979). Cigarette smoking may add significantly to inhaled cadmium as each cigarette contains 1 - 2 μg (Lewis et. al., 1972). It is estimated that up to 50% of inhaled cadmium may be absorbed by humans (Friberg et. al., 1974).

Cadmium accumulates in the visceral organs, principally the kidneys (Schroader and Balasar, 1961), where once a level of 200 μg/g is reached, visible renal tubular dysfunction occurs (Friberg et. al., 1975). The average 50 year old United States male has a mean renal cadmium content of 10 - 50 μg/g (Goyer and Cherian, 1979).

Symptoms of chronic cadmium poisoning, mainly caused by occupational exposure, include kidney and liver damage as well as respiratory tract and musculoskeletal defects. Acute toxicity is accompanied by severe nausea, salivation, vomiting, diarrhea, abdominal pain and pneumonitis.

Both iron and calcium deficiency have been found to increase cadmium absorption (Flanagan et. al., 1978; Larsson and Piscatar, 1971). Cadmium has also been identified as a caustive factor of Itai-itai disease in Japan (Friberg et. al., 1971) and has been implicated as a mutagen (Shiraishi et. al., 1972; Deknudt et. al., 1975) and carcinogen (Potts, 1965; Kipling and Waterhouse, 1967; Lemen et. al., 1976; IARC, 1976). Several comprehensive reviews pertaining primarily to human health have been prepared (Nilsson, 1970; Flick et. al., 1971; Webb, 1975; Waldbott, 1978).

2.7 Standards and Guidelines for the Control of Cadmium in the Environment

2.7.1 Water Quality

2.7.1.1 Fresh Water Quality

Two types of guidelines apply to surface water quality in Canada. One type limits cadmium content of aqueous effluents being discharged directly to waterways (e.g. Canadian federal guidelines for the cadmium concentration of aqueous emissions from metal finishing industries suggest a maximum daily concentration of 1.5 mg/l). The second type of standard relates the cadmium concentration of a given water body to its suitability for a particular end use. Some typical surface water quality guidelines are given in Table 7.

2.7.1.2 Marine Water Quality

In Canada the ocean dumping of contaminated dredge spoils or other materials is regulated by the Ocean Dumping Control Act (1975) which prohibits the disposal of substances which contain in excess of 3 mg/l of cadmium in a liquid waste or of 0.6 μg/g dry weight in a solid waste.

TABLE 7 GUIDELINES FOR SURFACE WATER QUALITY FOR VARIOUS PURPOSES*

Year	Cadmium Concentration (ppb)[a]	Reference
	A. Protection of Freshwater Aquatic Life	
1968	0.002 of 96-hr TLM[b]	1094
1972	0.05 of 10-day LC50[b]	1095
1972	0.4[c] (<100)[d] 3[c] (>100)[d]	1096
1974	0.4[c] (<100)[d] 3[c] (>100)[d]	1097
1976	0.4[c] (<100)[d] 12[c] (<100)[d]	1093
1977	0.3[c] (<10)[d] 0.4[c] (<50)[d] 0.5[c] (<100)[d] 0.75[c] (>300)[d]	55,543
1977	0.2	643
1979	0.2	617
	B. Source Water for Public Water Supplies	
1968	10	1094a
1969	10	1098
1970	10	617a
1972	10	1095
1973	10	1096
1974	10	1097
1976	10	1099
	C. Livestock Watering	
1968	10	1094b
1972	50	1096a
	D. Irrigation	
1968	5[e] 50[f]	1094c
1972	5[e] 50[f]	1096b
1974	10	1097

a Except where otherwise indicated.
b For most sensitive test species.
c For salmonid species; other species studied tolerate higher concentrations.
d Numbers in parentheses indicate water hardness in ppm as calcium carbonate.
e For continuous use.
f For short-term use on fine textured neutral or alkaline soils.

* Taken from a report being prepared by Dr. Don MacGregor, title unavailable (in press)

2.7.1.3 Drinking Water Quality

The National Health and Welfare "Guidelines for Canadian Drinking Water Quality" (1978), recommend a maximum acceptable concentration of 5 μg/l for cadmium allowable in drinking water.

2.7.2 Air Quality

There are no North American guidelines or regulations controlling cadmium emissions to ambient air. However, Canadian guidelines pertaining to industrial exposure to cadmium dust and fumes have been promulgated. Jurisdiction for occupational health is divided between federal and provincial agencies. In general the responsible Canadian agencies follow the current Threshold Limit Value (TLV) concentrations specified by the American Conference of Governmental Industrial Hygienists (ACGIH). The current TLV for cadmium in fumes and dust is 0.05 mg/m^3 for industrially exposed workers.

2.7.3 Soil Quality

Regulations and/or guidelines for the maximum quantities of cadmium which can be added to soils in the form of sewage sludge are issued under provincial authority. The Ontario sewage sludge application guidelines recommend a maximum cadmium addition to soil of 1.6 kg/hectare over the 25 year period after 1978. Similar guidelines have yet to be issued by any of the Atlantic Provinces.

2.7.4 Miscellaneous Guidelines

2.7.4.1 Food Quality

The FAO/WHO Expert Committee recommends a provisional tolerable daily intake of 250 - 350 μg (Friberg, 1977). Although there are unofficial guidelines pertaining to cadmium content of various foods, regulatory action has yet to be taken. A guideline which prohibits an appreciable heavy metal content in food packaging material is, however, in effect. The Hazardous Products (Glazed Ceramics) Regulations issued under the Hazardous Products Act limits extractable cadmium from glazed ceramic dishes to 500 ppb.

2.7.4.2 Household Products

The Hazardous Products Act also bans the use of paints which contain in excess of 0.1% cadmium on toys for children three years of age or under.

3 ATLANTIC REGION CADMIUM DATA

3.1 Cadmium in Industrial Discharges

3.1.1 Potential Major Sources of Cadmium Discharge

Two industries in the Atlantic Region are suspected of discharging cadmium in quantities which may pose an environmental hazard. These industries are dealt with separately because of the abundance of survey and monitoring data.

3.1.1.1 Surrette Battery Company Limited - Springhill, N.S.

The plant is located on Lisgar Street in Springhill and produces batteries for automotive, marine and industrial usage. It consists of two buildings...the first containing the main battery manufacturing operation and the second housing the smelter and lead oxidizer. The smelter is operated three or four days every two weeks, as demand requires, with the production of approximately 50,000 pounds of lead each month. Lead plates used in the batteries are manufactured in the plant from lead recovered from old batteries brought to the plant from across Eastern Canada.

There are three significant sources of air emissions from the plant: blast furnace off-gases, blast furnace process area ventilation and other process area ventilation.

An initial study (de Koning, 1973) measured the cadmium content in air, soil and vegetation samples taken in the immediate vicinity of the operation (Figure 2). The air sampling network consisted of four monitoring stations while soil samples were taken on two concentric circles centered on the plant, the radius of the inner circle being 250 feet and that of the outer circle approximately 500 feet. Vegetation samples were taken simultaneously with the soil samples.

The maximum and average ambient cadmium levels, as well as the percentage frequency of occurrence, are listed in Table 8. In the United States, the average concentration of cadmium in air particulates is less than 0.011 $\mu g/m^3$. Compared with this figure the Springhill cadmium results indicate little that is unusual. The cadmium content of the soil samples is listed in Table 9. Normally cadmium is present in soils at concentrations of less than 1 $\mu g/g$ and the Springhill results appear somewhat high when compared to this. Natural variation among different soil types may account for differences up to 2 ppm but the levels in the area of the battery plant are too high to be explained by this means. Even though a consistent difference between the values for cadmium on

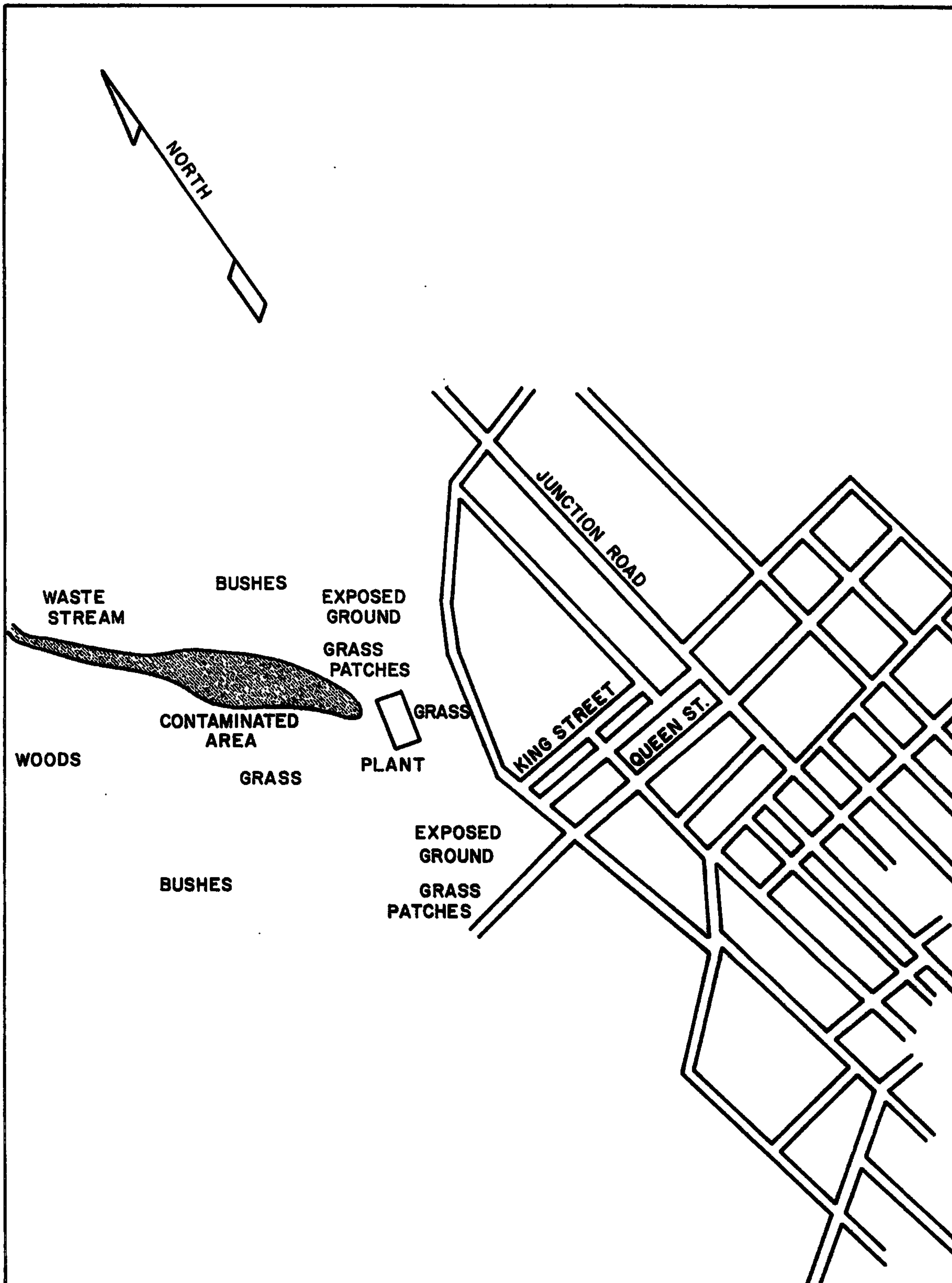


FIGURE 2 TOPOGRAPHY AROUND SURRETTE BATTERY PLANT
(Dewis and Lord, 1977)

TABLE 8 SUMMARY OF THE 24-HOUR CADMIUM CONCENTRATIONS ($\mu g/m^3$) IN THE AIR SURROUNDING THE SURRETTE BATTERY COMPANY PLANT (de Koning, 1973)

STATION NUMBER	NO. OF SAMPLES	MAXIMUM VALUE	AVERAGE VALUE	CUMULATIVE PERCENTAGE FREQUENCY OF OCCURRENCE[a]				
				90%	75%	50%	25%	10%
1	26	0.034	0.007	0.000	0.003	0.005	0.010	0.012
2	31	0.093	0.016	0.000	0.001	0.003	0.010	0.040
3	37	0.071	0.011	0.001	0.003	0.008	0.017	0.021
4	36	0.493	0.023	0.000	0.000	0.001	0.005	0.028

a The percentage of samples having cadmium concentrations greater than or equal to the values stated.

TABLE 9 CADMIUM CONCENTRATIONS IN SOIL AND VEGETATION, SURRETTE BATTERY COMPANY PLANT (de Koning, 1973)

BEARING[b]	CADMIUM IN SOIL (μg/g air-dry)		CADMIUM IN VEGETATION (μg/g oven-dry)	
	250 feet[a]	500 feet[a]	250 feet[a]	500 feet[a]
E	8.3	4.6	2.6	2.3
NE	19.3	5.6	4.0	3.0
N	7.0	5.3	3.8	1.0
NW	3.6	15.3	1.5	0.8
W	4.3	4.0	2.0	2.3
SW	5.0	10.6	2.3	1.5
S	3.6	13.6	1.8	1.3
SE	3.6	12.6	1.3	2.1
AVERAGE	6.8	8.9	2.4	1.8

a Distance from the Surrette Battery Company Plant.

b With respect to the Surrette Battery Company Plant.

the inner and outer ring could not be determined the plant cannot be excluded as a causative factor. The difference between the inner and outer rings is too small, i.e. rings are too close to draw any such conclusion. The vegetation data, listed in the same table, reveal a pattern similar to that observed with the soil but the values themselves are much lower than the corresponding soil concentrations on the same ring. A lower availability of cadmium compounds in the soil resulting in reduced uptake by the plants was postulated to account for this difference. De Koning concluded that the Surrette Battery Company plant was only a minor source of cadmium input to the environment.

In 1974 the Nova Scotia Department of the Environment initiated a study to assess any change in the value of particulate, lead and cadmium concentrations in the vicinity of this industrial operation (Ryan, 1974). Every effort was made to duplicate the air, soil and vegetation sampling procedures utilized in the de Koning study so that results from both surveys would be comparable. Air levels are reported in Table 10 while soil and vegetation results are detailed in Table 11. In addition, samples were taken from two major blueberry areas in the immediate vicinity of the plant and from other locations in the general area to assess any human health concerns. The levels of cadmium in the blueberry samples were below the analytical detection limit.

EPS, Atlantic (Dewis and Lord, 1977) conducted an environmental investigation of the area immediately surrounding the Surrette Battery Company Limited plant. In 1975 and 1977 soil samples were taken along three concentric circles with radii approximating 75 m, 150 m and 300 m. A soil sample was taken at eight points of the compass on each of the three circles. During all surveys

TABLE 10 CADMIUM CONCENTRATIONS IN AMBIENT AIR IN THE IMMEDIATE VICINITY OF THE SURRETTE BATTERY COMPANY PLANT (RYAN, 1974)

STATION NUMBER	NUMBER OF SAMPLES	MAXIMUM CADMIUM VALUE $\mu g/m^3$	AVERAGE CADMIUM VALUE $\mu g/m^3$
1	22	0.006	0.005
2	23	0.009	0.005
3	23	0.009	0.005
4	20	0.008	0.005

TABLE 11 CADMIUM CONCENTRATIONS IN SOIL AND VEGETATION IN THE VICINITY OF THE SURRETTE BATTERY COMPANY PLANT (RYAN, 1974)

BEARING[b]	CADMIUM IN SOIL (μg/g dry weight)		CADMIUM IN VEGETATION (μg/g dry weight)	
	250 ft.[a]	500 ft.[a]	250 ft.[a]	500 ft.[a]
N	1.0	N.D.[c]	1.7	1.6
NNE	1.6	N.D.	66.4	3.5
NE	1.4	2.9	10.6	7.7
ENE	7.6	2.1	11.3	3.7
E	2.4	3.0	4.8	1.4
ESE	3.2	2.7	2.3	1.2
SE	1.8	2.6	1.9	1.5
SSE	2.1	2.5	2.6	3.1
S	3.4	3.1	1.5	1.5
SSW	2.0	1.4	3.7	1.7
SW	6.6	3.0	2.2	1.7
WSW	4.1	2.4	9.2	2.8
W	6.6	6.9	4.8	3.8
WNW	1.0	3.4	1.5	1.5
NW	1.5	N.D.	1.0	1.6
NNW	1.6	1.0	2.0	1.3
MAXIMUM	7.6	6.9	66.4	7.7
AVERAGE	3.0	2.3	8.0	2.5

a Distance from Surrette Battery Company Plant.
b With respect to the Surrette Battery Company Plant.
c Not determined.

vegetation samples were taken at the same locations as the soil samples. These were usually Couch Grass (Agropyron repens), although in a few instances a second species, Timothy (Phleum pratense), was sampled instead. Duplicate samples of vegetation were collected and washed with water to simulate a rain storm. The wash water and washed grass were then analyzed separately. Results are reported in Tables 12A and 12B. The cadmium levels obtained from each of the vegetation samples collected in 1975 were all less than the detection limit of the analytical procedure (<2 µg/g). However, cadmium levels were considerably higher in the 1977 study (3.44 to 12.9 µg/g) with values decreasing as distance from the plant increased. Most of the soil concentrations in the 1975 survey were not exceptionally high compared to the normal level of <1 µg/g and these small elevations could be a result of natural variations occurring among different soils. Average 1975 soil values indicated a decrease away from the plant. Cadmium levels obtained in the 1977 survey are generally below the background level.

In 1977, samples of sphagnum moss suspended 2 m above the ground at distances of 75 m, 150 m and 300 m from the plant for a two week period were used to assess the degree of airborne contamination in the area. The cadmium levels were approximately three times higher than control values. The values obtained are listed in Table 13.

Both the 1975 and 1977 surveys showed cadmium levels in air and vegetation to be higher than normal but the values were too variable to pinpoint the Surrette Battery plant as the source. Cadmium levels in soil, reported in the 1977 survey, are generally an order of

TABLE 12A CADMIUM CONCENTRATIONS IN SOIL, GRASS, WASHED GRASS AND WASH WATER IN THE VICINITY OF THE SURRETTE BATTERY PLANT IN 1975 (DEWIS AND LORD, 1977)

BEARING	75 METRES				150 METERS		300 METRES	
	SOIL μg/g	GRASS μg/g	WASHED GRASS μg/g	WASH-WATER mg/1	SOIL μg/g	GRASS μg/g	SOIL μg/g	GRASS μg/g
N	3.6	<2.0	<2.0	<1.0	1.7	<2.0	<0.4	<2.0
NE	0.7	<2.0	<2.0	<1.0	1.1	<2.0	<0.4	<2.0
E	0.9	<2.0	<2.0	<1.0	0.8	<2.0	<0.4	<2.0
SE	1.4	<2.0	<2.0	<1.0	0.8	<2.0	<0.4	<2.0
S	1.7	<2.0	<2.0	<1.0	0.6	<2.0	<0.8	<2.0
SW	1.2	<2.0	<2.0	<1.0	0.6	<2.0	<0.4	<2.0
W	0.7	<2.0	<2.0	<1.0	0.8	<2.0	<0.4	<2.0
NW	1.7	<2.0	<2.0	<1.0	0.6	<2.0	<0.4	<2.0
AVERAGE	1.5	<2.0	<2.0	<1.0	0.9	<2.0	<0.5	<2.0

TABLE 12B CADMIUM CONCENTRATIONS IN SOIL, WASHED GRASS AND WASH WATER IN THE VICINITY OF THE SURRETTE BATTERY PLANT IN 1977 (DEWIS AND LORD, 1977)

BEARING	75 METRES			150 METERS			300 METRES		
	SOIL µg/g	WASHED GRASS µg/g	WASH-WATER mg/l	SOIL µg/g	WASHED GRASS µg/g	WASH-WATER mg/l	SOIL µg/g	WASHED GRASS µg/g	WASHED WATER mg/l
N	<0.010	6.70	0.002	0.080	7.79	0.001	0.200	3.44	0.001
NE	<0.010	4.21	<0.001	0.160	4.43	0.002	<0.010	4.70	0.001
E	<0.010	10.9	0.002	<0.010	4.57	<0.001	0.230	4.54	0.001
SE	0.370	9.27	0.009	0.150	9.56	0.008	<0.010	5.87	0.001
S	0.160	12.9	0.002	<0.010	8.91	0.005	<0.010	11.7	<0.001
SW	0.70	8.44	0.005	<0.010	8.95	0.005	<0.010	4.92	0.001
W	1.10	6.86	0.002	0.100	9.67	<0.001	0.520	10.2	0.002
NW	0.070	5.97	0.003	0.100	9.62	0.002	<0.010	5.46	0.001
AVERAGE	<0.275	8.16	0.003	<0.078	7.94	0.003	<0.125	6.36	0.001

TABLE 13 CADMIUM CONCENTRATIONS OF MOSS BAG SAMPLERS, SURRETTE BATTERY COMPANY PLANT (DEWIS AND LORD, 1977)

BEARING	75 METRES CADMIUM (μg/g)	150 METRES CADMIUM (μg/g)	300 METRES CADMIUM (μg/g)
N	5.44	2.51	2.75
E	3.68	-	6.83
S	0.25	4.02	1.42
S (duplicate)	-	-	8.25
W	8.97	9.26	4.17
AVERAGE	4.59	5.26	4.68

TABLE 14 CADMIUM CONCENTRATION IN THE LIQUID WASTE STREAM, SURRETTE BATTERY COMPANY PLANT, 1975

STATION	WATER (mg/l)	SEDIMENT (μg/g)
Outlet	<0.001	<0.050
30 meters below		<0.050
300 meters below	0.009	<0.050
East Brook bridge 24 route 233, Springhill to Athol	<0.001	

TABLE 15 FINAL EFFLUENT DATA FROM SURRETTE BATTERY COMPANY PLANT

SAMPLING DATE	CADMIUM (mg/l)
January 4, 1978	0.002
April 2, 1978	0.005
May 2, 1978	0.005
July 13, 1979	0.010

magnitude less than the 1975 survey, and up to two orders less than the de Koning study. For vegetation collected in both the de Koning and Dewis surveys, cadmium concentrations were of similar magnitude.

In 1975, the liquid waste stream and underlying sediment were analyzed for cadmium content and the results are reported in Table 14. The data indicates that the Surrette Battery Company is a minor source of cadmium emissions to the surrounding environment.

The effluent discharge of this industrial operation is monitored on a regular basis by EPS. Table 15 lists the data obtained from this monitoring program.

3.1.1.2 Brunswick Mining and Smelting Corporation Limited, Smelting Division, Belledune, N.B.

Brunswick Mining and Smelting operates a lead smelter, refinery and sulfuric acid plant at Belledune, New Brunswick bordering on the Baie des Chaleurs approximately 22 miles northwest of the city of Bathurst. In 1971 it was converted from a lead-zinc smelter to a facility treating lead concentrate only. The lead concentrate processed at the smelter comes from either Brunswick Mining and Smelting's No. 12 mine or Noranda's Horne mine in Quebec. The percentages of lead, zinc and cadmium are 38%, 10% and 0.14% respectively for Brunswick's No. 12 concentrates and 38%, 10% and 0.02% for Noranda's Horne concentrates.

The nominal annual capacity of the facility is 60,000 tons of refined lead, 120,000 tons of sulfuric acid, 2.5 million ounces of doré metal, 4,000 tons of copper metal and 600 tons of cadmium enriched smelter dust. Small amounts of bismuth, bismuth-lead alloys and lead-antimony alloys are also produced. The operations of the plant have been described by Dugdale and Young (1975) and Sergeant and Westlake (1980).

The main sources of cadmium emissions to the environment are air discharges (3,000 kg/year), process water effluent (1,000 kg/year) and surface water runoff (30 kg/year). Other possible sources of cadmium entering the environment are the rotary car dump facility where No. 12 mine concentrates are unloaded and the unloading, in the harbour, of Horne mine concentrates.

Monitoring surveys of plant operations are conducted regularly by EPS, Atlantic, Environment New Brunswick and Brunswick Mining and Smelting. Typical final effluent values obtained from these surveys are listed in Table 16 and range from 0.25-2.0 mg Cd/l. The estimated final effluent volume is 3500 IGPM. In some instances dissolved cadmium values exceed total concentrations; these discrepancies may be due to differing sampling and analytical techniques. Sampling sites and results of a 1979 spring runoff water sampling program conducted by Brunswick Mining and Smelting are given in Figure 3 and Table 17 respectively.

Ecological surveys have been conducted by the Noranda Research Centre for Brunswick Mining and Smelting on an annual basis since 1972. The surveys include biological, chemical and physical investigations pertinent to the assesment of the impact of the lead smelter operations on the marine ecosystem. Annual benthic

TABLE 16 CADMIUM CONTENT IN FINAL EFFLUENT, BRUNSWICK MINING AND SMELTING.

DATE	PARAMETER	CADMIUM CONCENTRATION (mg/l)
March 16, 1976	Total cadmium	0.86
August 25, 1977	" "	0.25
September 26, 1978	" "	1.6
September 28, 1978	" "	0.72
September 26, 1978	Dissolved cadmium	0.91
September 28, 1978	" "	2.0

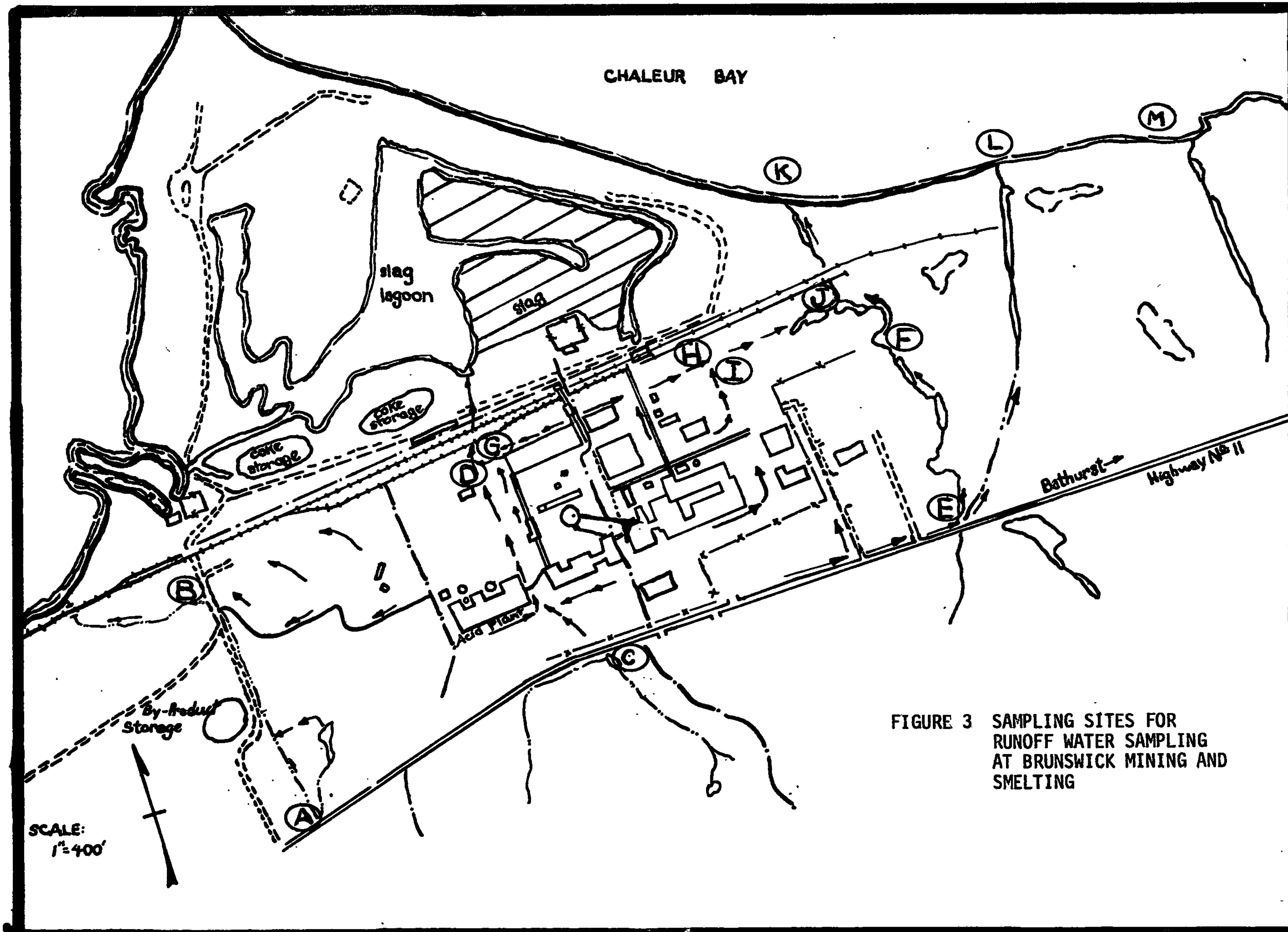


FIGURE 3 SAMPLING SITES FOR RUNOFF WATER SAMPLING AT BRUNSWICK MINING AND SMELTING

TABLE 17 CADMIUM CONTENT IN 1979 SPRING RUNOFF WATER, BRUNSWICK MINING AND SMELTING

DATE	WEATHER CONDITIONS	SAMPLING STATIONS	CADMIUM (mg/l)
April 23, 1979	Spring runoff	A	0.0029
		B	0.0062
		C	0.0089
		D	0.39
		E	0.0016
		F	0.0086
		G	16.
		H	4.5
		I	0.66
		J	0.50
		K	0.86
		L	0.0024
		M	-
May 3, 1979	During rain - one hour after rain began	A	0.0041
		B	0.35
		C	0.20
		D	1.9
		E	0.0031
		F	0.010
		G	23.
		H	3.5
		I	3.1
		J	1.7
		K	0.69
		L	0.0031
		M	0.0028
May 11, 1979	One hour after rain stopped	A	0.0025
		B	0.0030
		C	0.0095
		D	0.27
		E	0.0020
		F	0.0030
		G	0.86
		H	0.83
		I	0.48
		J	0.76
		K	0.28
		L	0.0043
		M	0.0039

surveys in the same area have been conducted by Beak Consultants Limited.

The latest Noranda study (Levaque Charron, 1979) utilizes native blue mussels, _Mytilus edulis_, winter flounder, _Pseudopleuronectes americanus_ and american lobster, _Homarus americanus_ as the main biological specimens. Samples of each species were collected at varying distances from the plant and analyzed for heavy metal content. The heavy metals analyzed included copper, lead, zinc, cadmium, arsenic and mercury.

BLUE MUSSEL STUDY

In addition to cadmium concentration in native blue mussel colonies located along the coast at varying distances from the smelter site, concentrations in surrounding sediment and seawater were also determined. Station locations are shown in Figure 4 and results detailed in Table 18. The data for the mussels indicate that cadmium levels were well above the Canadian Food and Drug Directorate (CFDD) limit of 1 ppm at all stations from the lagoon to station 8E (21 km downstream). Levels at all stations were similar to or higher than previous years. Levels are presented graphically along with 1977 and 1978 results in Figure 5. Cadmium levels in sediments were similar in pattern to those in mussels but there was less correlation between cadmium in water and mussels.

Additional studies on bioaccumulation and detoxification in blue mussels were also performed. The rate of heavy metal accumulation was determined from analysis of mussels relocated from an uncontaminated to a contaminated site. Conversely the rate of detoxification

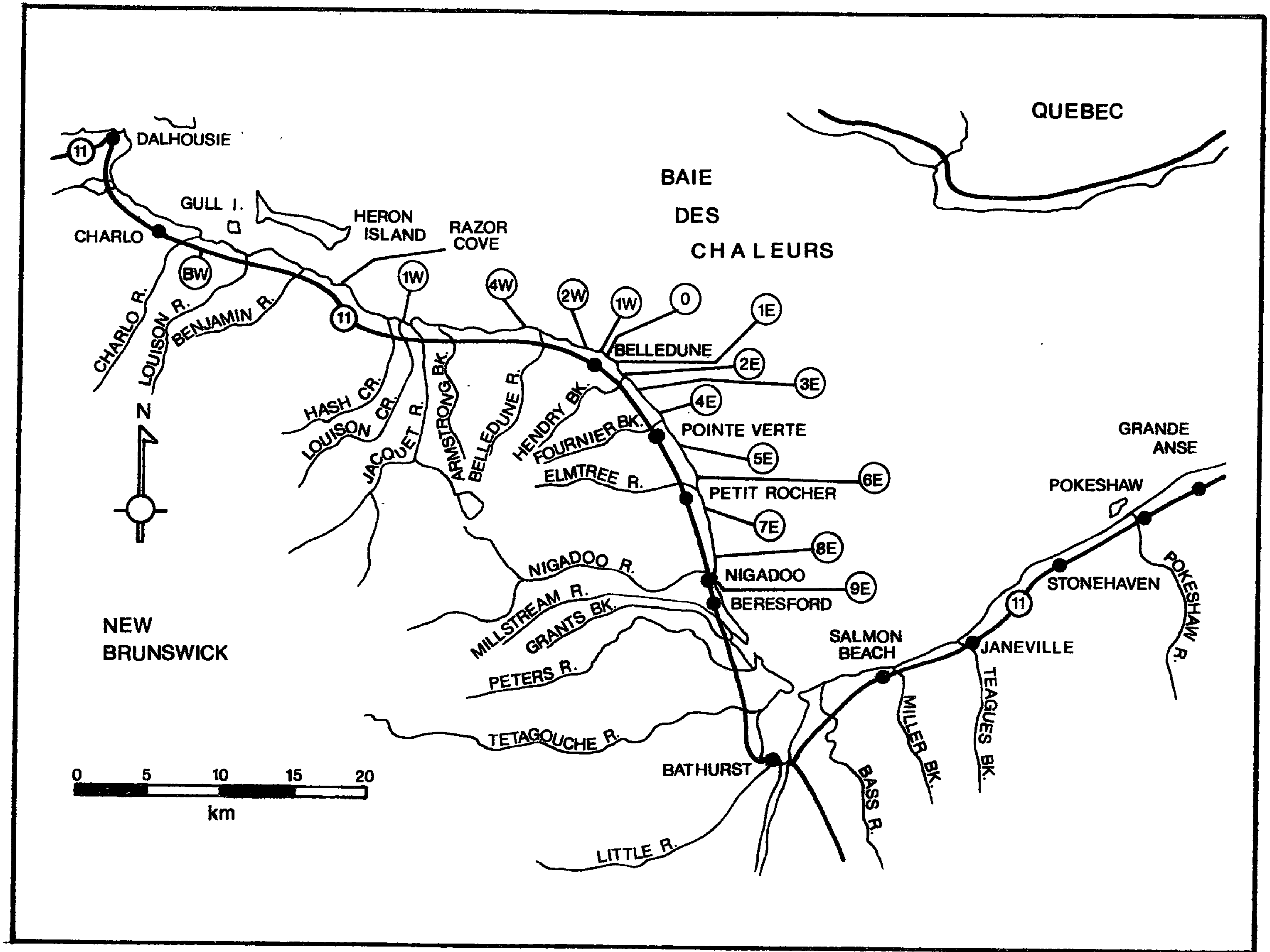


FIGURE 4 LOCATION OF NATIVE BLUE MUSSEL, *Mytilus edulis*, SAMPLING STATIONS ALONG THE NORTHEASTERN NEW BRUNSWICK COAST, JULY - AUGUST 1979

TABLE 18 CADMIUM LEVELS IN NATIVE BLUE MUSSELS, *Mytilus edulis* AND SURROUNDING SEDIMENT AND WATER SAMPLED ALONG THE NORTHEASTERN COAST OF NEW BRUNSWICK, JULY - AUGUST, 1979

SAMPLE LOCATION	DISTANCE FROM PLANT (km)	NO. OF SPECIMENS (MUSSELS ONLY)	CADMIUM PPM			
			MUSSELS	SEDIMENT	WATER	
					TOTAL	DISSOLVED
8W	30	197	0.6	0.9	0.001	<0.001
Razor Cove		459	0.5			
7W	19	170	0.8	<0.1	<0.001	<0.001
4W	6	211	1.0	<0.1	<0.001	<0.001
2W	1		2.2		<0.001	<0.001
1W[a]	0.3	80	26.8[a]		0.002	0.002
0	0	252	67	15	0.010	0.010
2E	3	263	21.3			
2E[a]		375	21.5	23	0.002	0.002
3E	4	199	11.3	40	<0.001	<0.001
3E[a]		305	16.2[a]	13		
4E	5	185	11.6			
4E[a]		100	17.0[a]	12	<0.001	<0.001
5E	8	294	4.3	3	0.002	0.001
6E	13	114	3.3	0.5	<0.001	<0.001
7E	16	219	2.4	1.7	<0.001	<0.001
8E[a]	21	264	2.0[a]	0.4	0.001	0.001
9E	27	30	1.6	0.1	<0.001	<0.001
9E[a]		207	1.5[a]			
Stonehaven	?	233	1.6	<0.1	0.001	<0.001

a Offshore samples and values.

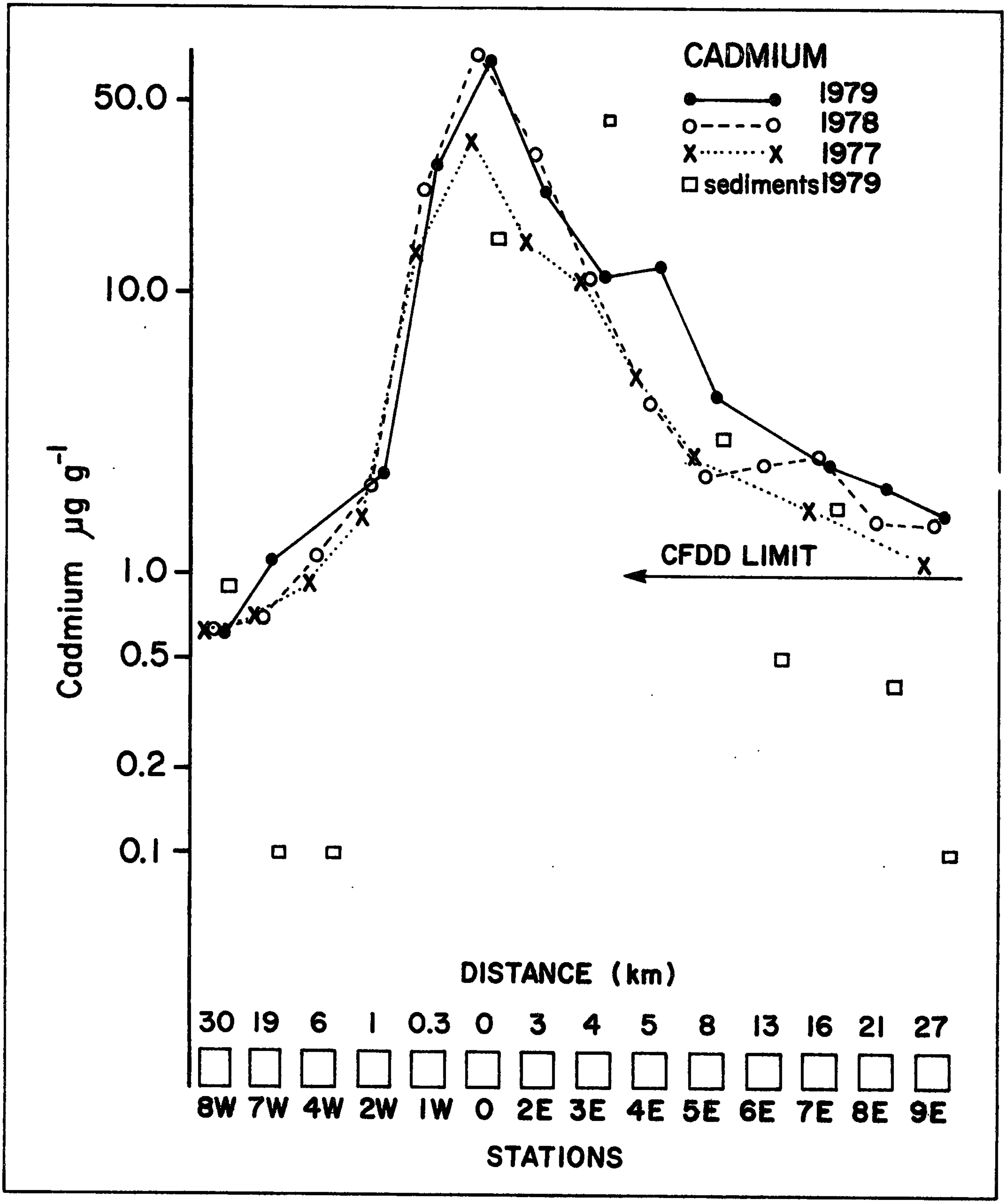


FIGURE 5 CADMIUM CONCENTRATION IN NATIVE BLUE MUSSELS, *Mytilus edulis*, COLLECTED ALONG THE NORTHEASTERN NEW BRUNSWICK COAST IN 1977, 1978 AND 1979

was determined by relocating mussels from a contaminated to an uncontaminated site. Results of the detoxification experiment reveal little change in cadmium levels since their relocation in 1978, indicating that little if any detoxification occurred. The results of the uptake study, by contrast, indicated an accumulation rate of 1-7 ppm in less than sixty days.

WINTER FLOUNDER STUDY

A study was initiated to assess the bioaccumulation of heavy metals in winter flounder, a bottom dwelling, fish eating invertebrate. Results given in Table 19 indicate that all metals were below the 1 ppm CFDD limit and that all levels are similar to previous years. In addition, levels in flounder at all three sites sampled (lagoon, harbour and distant site) were similar.

LOBSTER STUDY

A total of forty-three lobsters from the harbour, lagoon and a distant site were analyzed for cadmium. Telson flesh and tomalleys of all specimens were collected as well as the claw shells of the lagoon and distant site lobsters. Ranges and mean of cadmium levels are given in Table 20. Results show cadmium levels in the flesh of the harbour lobsters were lower than those in the lagoon. However, both harbour and lagoon values were higher than those for distant site lobsters. Some 58% of the levels in the harbour and 100% in the lagoon were higher than the CFDD limit. Results in 1979 were

TABLE 19 RANGES AND MEANS OF CADMIUM LEVELS (ppm WET WEIGHT) IN WINTER FLOUNDER, *Pseudopleuronectes americanus*, COLLECTED IN BELLEDUNE HARBOUR, LAGOON AND AT A DISTANT SITE, 1974-1979

LOCATION	NO. OF SAMPLES	YEAR	CADMIUM	
			RANGE	MEAN
HARBOUR	4	1974	0.03-<0.10	0.07
	11	1975	<0.10-<0.20	0.10
	12	1976	<0.10-<0.10	<0.10
	9	1977	<0.10- 0.10	<0.10
	20	1979	<0.10- 0.30	0.2
LAGOON	1	1974	<0.10	<0.1
	12	1975	0.11- 0.46	0.2
	9	1976	<0.10-<0.10	<0.1
	9	1977	<0.10-<0.10	<0.1
	20	1979	<0.10- 0.5	0.2
DISTANT SITE		1974		
	9	1975	<0.10-<0.10	<0.10
	9	1976	<0.10-<0.10	<0.10
	10	1977	<0.03-<0.04	<0.3
	12	1979	<0.01- 0.50	0.1

TABLE 20 RANGES AND MEANS OF CADMIUM LEVELS (ppm WET WEIGHT) IN AMERICAN LOBSTER, *Homarus americanus*, COLLECTED IN BELLEDUNE HARBOUR, LAGOON AND AT A DISTANT SITE, 1974-1979

LOCATION	NO. OF SAMPLES			YEAR	LOBSTER FLESH		TOMALLEY		CLAW SHELL	
					RANGE	MEAN	RANGE	MEAN	RANGE	MEAN
	F[a]	T[b]	S[c]							
HARBOUR	15			1974	0.06	0.06				
	8			1975	0.18-0.86	0.4				
	5			1976	0.22-1.11	0.6				
	30			1977	0.10-3.6	0.46				
	10			1978	0.26-4.08	1.46				
	28	28		1979	0.4 -11.0	2.7	5-342	88.4		
LAGOON	9			1974	0.06-0.23	0.19				
	6			1975	0.16-0.20	0.18				
	3			1976	0.79-1.24	0.96				
	11			1977	0.1 -4.49	1.15				
	-			1978	-	-				
	15	15	10	1979	3.0 -10.0	5.4	18-392	108.0	3-9	5.0
DISTANT SITE	2			1974	0.1 -0.5	0.3				
	8			1975	<0.1	<0.1				
	4			1976	0.08-0.10	0.09				
	8			1977	<0.02-0.13	0.07				
	7			1978	0.21-3.64	0.88				
	2	2	2	1979	0.2	0.2	2.0	2.0	2-3	2.5

a F = Flesh
b T = Tomalley
c S = Shell

TABLE 21 CADMIUM LEVELS (ppm DRY WEIGHT) IN SEDIMENTS COLLECTED IN BELLEDUNE HARBOUR DURING BEAK CONSULTANTS BENTHIC SURVEY

STATION	CADMIUM		% WATER		% L.O.I.	
	1977	1979	1977	1979	1977	1979
16	80	122	a	58	a	8.9
C-2	25	190		74		12.0
C-5	26	20		33		3.5
1	29	22		31		5.1
6	10	6		37		5.5
5	18	35		42		5.4
8	14	13		35		4.9
13	0.6	2		38		4.6
10	5	5		34		3.8
20		<0.1		21		2.2
23		<0.1		24		2.1
CONTROL		<0.2		35		4.3

a = Not determined in 1977.

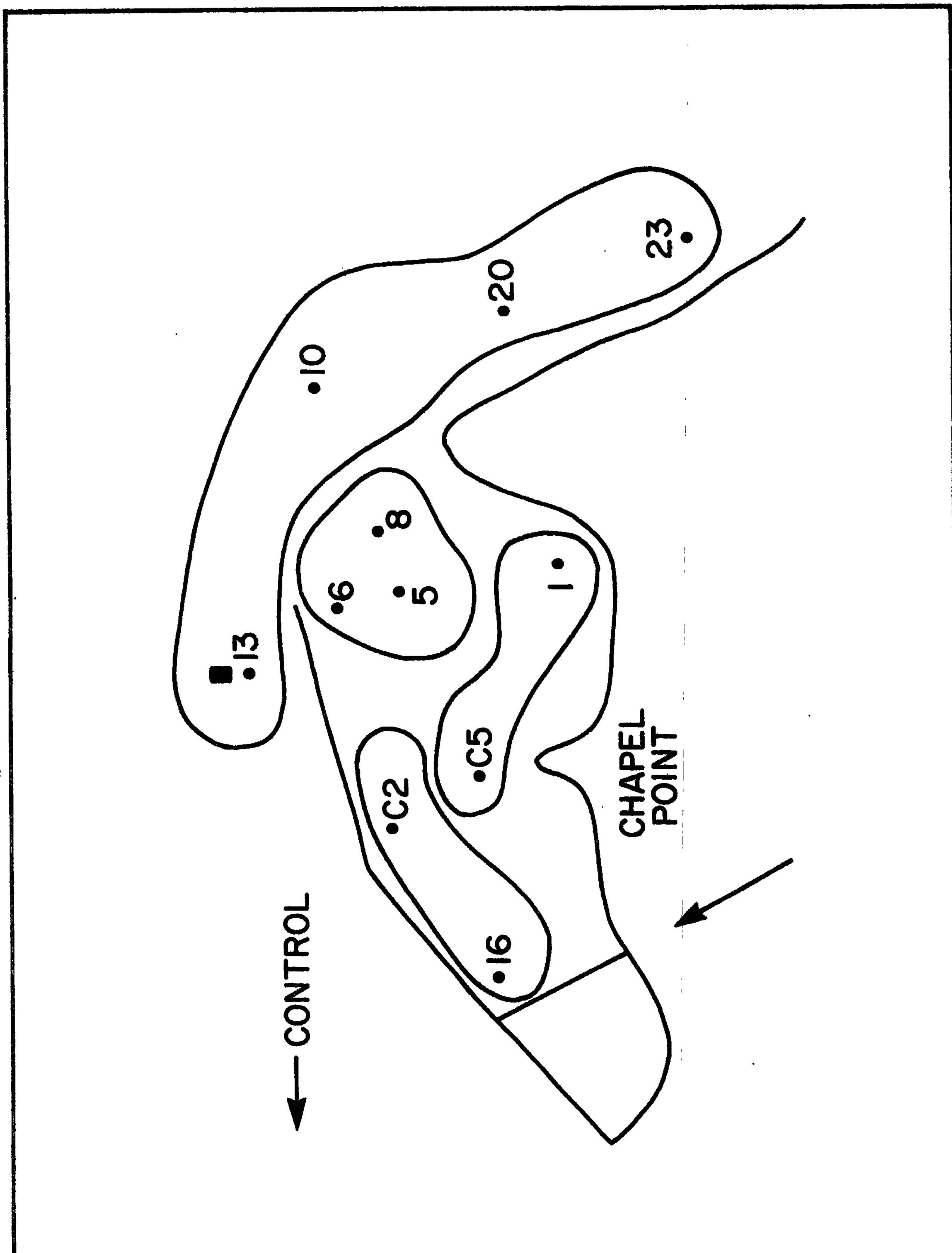


FIGURE 6 BEAK CONSULTANTS' SEDIMENT SAMPLING STATIONS NEAR BRUNSWICK MINING AND SMELTING, BELLEDUNE, NEW BRUNSWICK

higher than previous years in both the harbour and lagoon. Cadmium levels in tomalleys from all three sites were all above the CFDD limit; mean levels in the harbour and lagoon were 45 and 55 times higher than at a distant site. In the claw shell, cadmium was above the CFDD limit for both the lagoon and distant site.

SEDIMENT STUDY

Results of cadmium analysis of sediments collected during Beak Consultants benthic survey are given in Table 21. The two stations most contaminated by cadmium were 16 and C-2 (see Figure 6). Site C-2 in 1979 was considered to likely represent an area of concentrate spillage from the wharf.

3.1.2 Industrial Effluent Data

There is no regulation of cadmium in industrial effluents other than the 1.5 mg/l guideline for the metal finishing industry issued under Section 33.2 of the Fisheries Act. EPS, Atlantic monitors cadmium concentration in selected industrial effluents on a regular basis. Tables 22 and 23 list values obtained for final effluents of operations surveyed in Nova Scotia and New Brunswick respectively over the 1976-1979 sampling period. Also included in these two tables is information describing effluent volume and industry type.

TABLE 22 CADMIUM CONTENT IN FINAL EFFLUENTS OF NOVA SCOTIA INDUSTRIES

INDUSTRY NAME AND LOCATION	INDUSTRIAL CLASSIFICATION	EFFLUENT VOLUME (10^6 1/day)	SAMPLING DATE(S)	NO. OF SAMPLES	CADMIUM CONCENTRATION RANGE (mg/1)	AVERAGE CADMIUM CONCENTRATION (mg/1)
Atlantic Hardchrome and Crankshaft Rebuilders Limited Dartmouth	A	-	Feb./76-Aug./79	4	0.001-0.02	0.01
Atlantic Industries (N.B.) Limited, Galvanizing Division Amherst	A	.008	Aug.15, 1978	3	<0.01-0.04	0.03
Hermes Electronics Limited Dartmouth	A	.001-.003	June 15, 1978	1	N/A[a]	0.006
IMP-Aerospace (Electroplating Operation) Enfield	A	.0008-.002	June 18, 1979	1	N/A	0.85
Zenith Plating (Maritime) Limited Dartmouth	A	.017	Aug./76-June/79	4	<0.001-0.001	<0.001
Bowaters Mersey Paper Company Limited Liverpool	C	20.5	May 31, 1977	3	0.001-0.003	0.002

Cont'd

TABLE 22 (Cont'd)

INDUSTRY NAME AND LOCATION	INDUSTRIAL CLASSIFICATION	EFFLUENT VOLUME (10^6 l/day)	SAMPLING DATE(S)	NO. OF SAMPLES	CADMIUM CONCENTRATION RANGE (mg/l)	AVERAGE CADMIUM CONCENTRATION (mg/l)
Canadian Keyes Fibre Hantsport	C	0.75	Sept./76-Dec./77	6	0.001-0.003	0.002
Minas Basin Pulp and Paper Hantsport	C	9.09	Sept./76-Dec./77	7	0.001-0.003	0.002
Nova Scotia Forest Industries Point Tupper	C	22.7	Sept./76-July/77	3	0.001-0.004	0.002
Scott Maritimes Pulp Limited Abercrombie	C	21.8	July/76-Jan./78	7	0.001-0.003	0.002
Crossley Karastan Carpet Mills Limited Truro	D	1.6	March 14, 1978	1	N/A	0.001
Stanfield's Limited Truro	D	-	March 14, 1978	1	N/A	0.008
United Elastics Limited Bridgetown	D	-	Oct. 11, 1978	2	0.070-0.10	0.080

Cont'd

TABLE 22 (Cont'd)

INDUSTRY NAME AND LOCATION	INDUSTRIAL CLASSIFICATION	EFFLUENT VOLUME (10^6 l/day)	SAMPLING DATE(s)	NO. OF SAMPLES	CADMIUM CONCENTRATION RANGE (mg/l)	AVERAGE CADMIUM CONCENTRATION (mg/l)
ACA Co-operative New Minas	E	0.61	July 19, 1978	1	N/A	0.001
Hostess Foods Products Limited New Minas	E	0.18	July 19, 1978	1	N/A	0.001
M.W. Graves Limited Berwick	E	3.0	July 18, 1978	1	N/A	0.003
Gulf Oil Refinery Point Tupper	F	15	July/77-April/79	3	0.001-0.006	0.003
Imperial Oil Limited Dartmouth	F	15	March 28, 1978	2	0.001-0.050	0.030
Michelin Tire Limited Bridgewater	G	.5	Sept./77-July/78	4	0.001-0.02	0.007
Michelin Tire Limited Granton	G	1.9	Dec./76-Jan./77	2	0.001-0.04	0.02

a Not Applicable.

TABLE 23 CADMIUM CONTENT IN FINAL EFFLUENTS OF NEW BRUNSWICK INDUSTRIES

INDUSTRY NAME AND LOCATION	INDUSTRIAL CLASSIFICATION	EFFLUENT VOLUME (10^6 l/day)	SAMPLING DATE(S)	NO. OF SAMPLES	CADMIUM CONCENTRATION RANGE (mg/l)	AVERAGE CADMIUM CONCENTRATION (mg/l)
Square D Company of Canada Limited Edmundston	A	0.012	Sept. 15/78	1	N/A[a]	<0.01
Brunswick Mining and Smelting Corporation Limited-Brunswick No. 6 Mine - Bathurst	B	3.0	Dec./77-July/79	4	0.001-0.010	0.006
Brunswick Mining and Smelting Corporation Limited-Brunswick No. 12 Mine - Bathurst	B	13.1	May/78-July/79	3	0.001-0.010	0.007
Heathe Steele Mines Newcastle	B	15.4	July/77-Oct./78	6	0.001-0.010	0.003
Consolidated Durham	B					<0.01
New Brunswick International Pulp and Paper Dalhousie	C	71.8	March 30/76	3	0.001	0.001
St. Anne Nackawick Nackawick	C	-	-	-	-	<0.01

Cont'd

TABLE 23 Cont'd

INDUSTRY NAME AND LOCATION	INDUSTRIAL CLASSIFICATION	EFFLUENT VOLUME (10^6 1/day)	SAMPLING DATE(s)	NO. OF SAMPLES	CADMIUM CONCENTRATION RANGE (mg/1)	AVERAGE CADMIUM CONCENTRATION (mg/1)
Lyon Industries	D	-	-	-	-	0.02
Chippin Brothers Limited Fredericton	E	-	-	2	0.01-0.0	0.03
McCain Foods Limited Florenceville	E	12.3	Feb. 21/78	1	N/A	0.003
McCain Foods Limited Grand Falls	E	3.02	Feb. 21/78	1	N/A	0.003
Irving Oil Refinery Saint John	F	-	Nov./76-Mar./78	3	all 0.009	0.009
Belledune Fertilizer Limited Belledune	G	13.0	Jan./76-Sept./78	4	0.07-1.6	0.50
Canadian Industries Limited Dalhousie	I	.64	Nov. 29/78	1	N/A	0.070

a Not applicable.

Industrial classification is indicated by the following notations:

A - electroplating
B - base metal mining
C - pulp and paper
D - textiles
E - foods
F - oil refining
G - tire manufacture
H - fertilizer manufacture
I - chemical manufacture

Concentrations reported are for total cadmium unless otherwise indicated. All analytical measurements were conducted by the EPS Atlantic laboratory utilizing atomic absorption spectroscopy. In most instances samples were directly aspirated, but in some cases pre-extraction with methyl iso-butyl ketone was employed.

Perusal of the data indicates that the cadmium content of the majority of effluents is less than 0.1 mg/l. The only industries exceeding this level are IMP-Aerospace, Enfield, Nova Scotia and Belledune Fertilizer, Belledune, New Brunswick.

IMP Aerospace operates an electroplating facility at the Halifax International Airport to assist in aircraft maintenance. Some 800-2400 litres of effluent per day are estimated to be discharged from the plant in a non-continuous manner. Effluent treatment consists of disposal to a dry well on the plant confines. The limited information on this final effluent suggests a significant cadmium content (0.85 mg/l), probably due to cadmium impurities in the plating metals used.

Belledune Fertilizer Ltd., located adjacent to Brunswick Mining and Smelting Corporation Limited, Smelting Division, uses the sulfuric acid produced at the smelter to convert imported, east coast (Florida) phosphate rock into diammonium phosphate fertilizer. The sulfuric acid is produced at the smelter from sulfur dioxide and surfur trioxide which is released during the sintering process. The SO_2 and SO_3 may be contaminated with cadmium volatilized during the same process, resulting in a significant cadmium content in the sulfuric acid. This, coupled with the fact that phosphate ores, used in the manufacture of fertilizer, may contain as much as 130 ppm cadmium (Reuss et. al., 1978) may possibly explain the elevated cadmium levels in the effluent. Cadmium levels as high as 1.6 mg/l have been recorded for the discharge water which has a flow rate of approximately 2,000 IGPM. Surface and non-process water runoff may also be significant sources of cadmium released to the environment in the area.

Industries in Prince Edward Island and Newfoundland have not been tabulated as cadmium has not been an analytical parameter in industrial monitoring programs conducted in these provinces.

Tables 24 and 25 incorporate recently published data for operating coal mining and beneficiation facilities in Nova Scotia and New Brunswick (EPS, 1979). The values recorded are for mine water drainage which, in large part, may represent rain water runoff.

TABLE 24 CADMIUM CONTENT IN THE DRAINAGE WATERS OF NOVA SCOTIA COAL MINING AND BENEFICIATION FACILITIES

MINE NAME AND LOCATION	EFFLUENT VOLUME	SAMPLING DATE(S)	NO. OF SAMPLES	CADMIUM CONCENTRATION RANGE (mg/l)	AVERAGE CADMIUM CONCENTRATION (mg/l)
Devco A-1 Colliery Dominion	-	June/77-Aug./77	5	0.02 -0.04	0.03
Devco No. 26 Colliery Glace Bay	-	June/77-Feb./78	7	0.007-0.05	0.02
Devco Lingan Coal Colliery Lingan	320 l/min.	June/77-Feb./78	12	0.003-0.05	0.02
Devco Prince Mine Point Aconi	~135 l/min.	June/77-Feb./78	10	0.004-0.04	0.02
Devco Princess Coal Wash Plant Sydney Mines	250,000 l 2/week	June/77-Feb./78	9	0.002-0.05	0.008
Devco Victoria Junction Coal Wash Plant - Sydney	~1500 l/min.	June/77-Aug./77	7	0.004-0.03	0.02
Evans Coal Mine St. Rose	180 l/min. 4 hrs/day	June, 1977	2	0.03 -0.03	0.03

Cont'd

TABLE 24 CONT'D

MINE NAME AND LOCATION	EFFLUENT VOLUME	SAMPLING DATE(s)	NO. OF SAMPLES	CADMIUM CONCENTRATION RANGE (mg/l)	AVERAGE CADMIUM CONCENTRATION (mg/l)
Brogan Brothers West Strip Mine Point Aconi	-	June/77-Feb./78	7	0.002-0.04	0.020
Brogan Brothers East Strip Mine Point Aconi	-	-	7	0.001-1.4	0.22
Stellarton Coal Wash Plant Stellarton	-	June/77-July/77	2	0.01-0.04	0.03

TABLE 25 CADMIUM CONTENT IN THE DRAINAGE WATERS OF NEW BRUNSWICK COAL MINING AND BENEFICIATION FACILITIES

MINE NAME AND LOCATION	EFFLUENT VOLUME	SAMPLING DATE(S)	NO. OF SAMPLES	CADMIUM CONCENTRATION RANGE (mg/l)	AVERAGE CADMIUM CONCENTRATION (mg/l)
New Brunswick Coal Limited Chipman Strip Mine Chipman	-	July/77-Feb./78	5	0.001-0.05	0.03
New Brunswick Coal Limited 500 W Strip Mine Minto	-	June/77-July/77	5	0.002-0.07	0.03
New Brunswick Coal Preparation Plant Minto	-	June/77-Feb./78	3	0.001-0.03	0.01

3.2 Cadmium in Water

3.2.1 Water Quality Data

The computerized National Water Quality Data Bank (NAQUADAT) is a repository of national water quality information including data on the cadmium content of surface and groundwaters in the Atlantic Provinces. This sytem has been functional since 1969 and includes values dating back to 1961. Atlantic regional data has originated, for the most part, from monitoring programs of the Inland Waters Directorate, however, information from water quality surveys conducted by the Environmental Protection Service is also incorporated into this data base.

The results of a NAQUADAT search for cadmium concentrations in water over the 1975-80 period are summarized in Tables 26-29. Although the time frame was limited to five years, this was adequate to ensure representative values for the majority of sampling stations in the Atlantic Provinces. Most of these values (90-95%) are less than the analytical detection limit (0.001 mg/l) and, consequently, only measurements above this value have been tabulated.

On the basis of NAQUADAT information, there is no indication of unduly high cadmium levels in the surveyed waterways.

The Canada-U.S. Committee on the St. John River Basin has prepared a report (Anon, 1979) on water quality conditions in the international section of this waterway and the relationship of those conditions to proposed water quality objectives. These data have been stored on

TABLE 26 CADMIUM WATER QUALITY DATA - NEWFOUNDLAND, 1975-1980 (NAQUADAT, 1980)

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) NUMBER OF MEASUREMENTS
Ste. Geneviere R. near Forresters Point	00NF02YA001	2	-	-
Torrent R. at Bristol's Pool Point	00NF02YC0001	3	-	-
Harry's R. at Black Duck	00NF02YJ0001	5	-	-
Grand Lake discharge canal	00NF02YK0001	1	-	-
Upper Humber R. near Reidville	00NF02YL0001	2	-	-
Indian Brook near Springdale, Green Bay district	00NF02YM0001	5	-	-
Exploits R. at Grand Falls	00NF02YO0001	5	-	-
Gander R. near Glenwood	00NF02YQ0001	2	-	-
Terra Nova R. at Terra Nova	00NF02YS0001	2	-	-
Isle aux Morts R. at Isle aux Morts	00NF02ZB0001	3	-	-
Garnish R. near Garnish	00NF02ZG0016	1	-	-
Pipers Hole R. at Mothers Brook	00NF02ZH0001	3	-	-
Come By Chance R. near Goobies	00NF02ZH0009	2	-	-
Rocky R. at Hwy 6 bridge at Colinet	00NF02ZK0001	6	-	-
Northeast Pond R. near Portugal Cove	00NF02ZM0002	1	-	-

TABLE 27 CADMIUM WATER QUALITY DATA - PRINCE EDWARD ISLAND, 1975-1980 (NAQUADAT, 1980)

STATION		NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l)	
DESCRIPTION	CODE		CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
Mill R. at WSC guage in Bloomfield Park north of St. Anthony	OOPE01CA001	8	.001	1
Carruthers Brook (Mill R.) 7.5 km west of St. Anthony at Hwy 143 bridge	OOPE01CA0002	6	.001	2
Dunk R. at road bridge 5.5 km east of Central Bedeque, Prince Co.	OOPE01CB0001	2	-	-
Dunk R. at Hwy 231 bridge Breadalbane, Prince Co.	OOPE01CB0005	5	.002	1
North (Yorke) R. at Hwy 246 bridge Milton Station, Queen's Co.	OOPE01CC0002	5	.001	1
West (Eliot) R. from Hwy 13 culvert, Brookvale, Queen's Co.	OOPE01CC0036	5	.001	1
West (Eliot) R. at Crosbys Mill about 1 km north of Bonshaw	OOPE01CC0037	6	.001	1
Winter R. at bridge behind Union Pumping Station, Queen's Co.	OOPE01CC0039	3	.001	2

Cont'd

TABLE 27 CONT'D

STATION		NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l)	
DESCRIPTION	CODE		CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
Morell R. from road bridge 1 km west of Bangor, Kings Co.	00PE01C00003	7	.001	1
Boughton R. from road bridge about 1.5 km north of Bridgetown	00PE01C00018	1	-	-
West branch Morell R. 2 km below Pisquid Pond at Hwy 320 bridge, Kings Co.	00PE01C00022	3	.001	-
Brudenell R. 1 km below Hwy 4 bridge at WSC guage, Kings Co.	00PE01CE0001	1	-	-
Marchbanks Pond on the Wilmot R. above Hwy 110 bridge, Wilmot Valley	01PE01CB0001	7	-	-
Montague R. above Hwy 320 bridge, Victoria Cross, Victoria Co.	01PE01CE0001	2	-	-

TABLE 28 CADMIUM WATER QUALITY DATA - NOVA SCOTIA, 1975-1980 (NAQUADAT, 1980)

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
Annapolis R. at bridge 650 m south of Hwy 1, Wilmot Station	00NS01DC0001	2	-	-
Annapolis R. at Hwy 10 bridge, Middleton, Annapolis Co.	00NS01DC0028	8	.001	2
Annapolis R. at Paradise from Hwy bridge, Annapolis Co.	00NS01DC0083	3	-	-
Annapolis R. 2 km east of Aylesford at Dalhousie Rd., Kings Co.	00NS01DC0084	4	.001	1
Sharpe Brook 3.6 km south of Hwy 1 at Cambridge Station, Lloyds	00NS01DD0002	4	-	-
Avon R. at Hwy bridge north of Windsor Forks, Hants Co.	00NS01DE0012	3	-	-
Stewiacke R. at Hwy 336 bridge, Eastville, Colchester Co.	00NS01DG0001	3	-	-
Shubenacadie R. at Hwy 2 bridge, Enfield, Hants Co.	00NS01DG0002	3	.002	1

Cont'd

TABLE 28 CONT'D

STATION		NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l)	
DESCRIPTION	CODE		CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
Shubenacadie R. 400 m above Nine Mile R., Hants Co.	OONSO1DG0008	10	.002	1
Gays R. at bridge below South Gays R., Halifax Co.	OONSO1DG0011	9	.001	2
Gays R. 2.1 km below Egmont Lake at road bridge, Halifax Co.	OONSO1DG0021	8	.001	1
Cook Brook at bridge 600 m above Ervin Brook, Cook Brook, Halifax Co.	OONSO1DG0022	8	.002	1
			.001	1
Fraser Brook at WSC guage, Archibauld, Colchester Co.	OONSO1DH0012	3	-	-
Salmon R. at Hwy bridge, Truro, Colchester Co.	OONSO1DH0020	4	-	-
Salmon R. at old Hwy 4 bridge, Kempton, Colchester Co.	OONSO1DH0027	3	-	-
East Brook at Maccan R. at Hwy 302 bridge, Southhampton, Cumberland Co.	OONSO1DL007	6	.001	1

Cont'd

TABLE 28 CONT'D

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) NUMBER OF MEASUREMENTS
Kelley R. at Nine Mine Ford Game Sanctuary, Cumberland Co.	00NS01DL0007	2	-	-
Maccan R. at Hwy 2 bridge, Southampton Cumberland Co.	00NS01DL0010	6	.001	1
Wallace R. at Wentworth Centre, Cumberland Co.	00NS01DN0001	5	-	-
River Philip at Hwy 204 bridge, Oxford, Cumberland Co.	00NS01DN0002	4	-	-
River Philip at TCH bridge, Oxford, Cumberland Co.	00NS01DN0010	4	-	-
Middle R. at bridge near Hwy 289, Rocklin, Pictou Co.	00NS01DP0001	3	-	-
East R. (west branch) at bridge, Hopewell, Pictou Co.	00NS01DP0008	3	.001	1
Mersey R. at outlet of George Lake, Eel Weir, Queen's Co.	00NS01ED0001	3	-	-
Mersey R. below Mill Falls SW of Maitland Bridge	00NS01ED0005	4	-	-

Cont'd

TABLE 28 CONT'D

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
Mersey R. at upper Hwy bridge, Potanook, Queen's Co.	00NS01ED0020	4	-	-
Medway R. at bridge, Charleston, Queen's Co.	00NS01EE0001	9	-	-
Medway R. at outlet of Eel Lake, Harmony Mills	00NS01EE0003	4	-	-
LaHave R. at West Northfield R. on Brown Road	00NS01EE0002	1	-	-
LaHave R. at Hwy 10 bridge, Cookville, Lunenburg Co.	00NS01EF0003	6	.002	1
LaHave R. at Hwy 10 bridge, Meisners, Lunenburg Co.	00NS01EF0013	5	.001	1
North LaHave R. at Hwy bridge, 2.2 km SE Maplewood, Lunenburg Co.	00NS01EF0014	4	.001	1
Gold R. at bridge 300 m east of Hwy 12, New Ross, Lunenburg Co.	00NS01EG0005	2	-	-
Gold R. at Hwy 103 bridge, Chester Basin, Lunenburg Co.	00NS01EG0006	2	-	-

Cont'd

TABLE 28 CONT'D

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
Sackville R. at Hwy 1 bridge, Bedford, Halifax Co.	00NS01EJ0001	3	-	-
Musquodoboit R. at Hwy 7, Musquodoboit Hbr., Halifax Co.	00NS01EK0007	2	-	-
West R. Sheet Hbr. at Hwy 7 bridge, Halifax Co.	00NS01EM0002	3	-	-
Liscomb R. at Hwy 7 bridge, Liscomb Mills, Guysborough Co.	00NS01EN0002	2	-	-
St. Mary's R. at Hwy 7 bridge, Stillwater	00NS01EO0001	5	-	-
Northeast Margaree R. at bridge, Margaree Valley	00NS01FB0001	9	-	-
April Brook 250 m above Hwy bridge, Gillisdale	00NS01FB0005	6	.001	2
Southwest Margaree R. at bridge above Upper Margaree	00NS01FB0011	8	.001	1
Cheticamp R. above Robert Brook at park campground	00NS01FC0004	3	-	-

Cont'd

TABLE 28 CONT'D

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
Clyburn Brook at Cabot Trail, Ingonish Centre, Victoria Co.	00NS01FD0003	2	-	-
Wreck Cove Brook at Cabot Trail, Wreck Cove, Victoria Co.	00NS01FD0007	4	-	-
Ingonish R. at South Ingonish Hbr., 360 m above Cabot Trail	00NS01FD0008	3	.001	1
Indian Brook at Cabot Trail, Indian Brook	00NS01FE0001	4	-	-
Grand R. at bridge at outlet of Loch Lomond	00NS01FH001	4	.002 .003	1 1
Unnamed Stream from Munroe Lake at bridge at northern tip of Lake Uist	00NS01FH0002	8	.001 .002 .003	1 1 1
Salmon R. at Salmon R. bridge, Cape Breton Co.	00NS01FJ0001	3	-	-
Gracie Brook north at road bridge on west edge of Lingan Mine property	00NS01FJ0011	8	.001 .002 .004	1 2 1

Cont'd

TABLE 28 CONT'D

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
Sydney Mines pond outlet into Lloyd Cove north of Hwy, Sydney Mines	00NS01FJ0012	8	.001 .002 .003 .014	1 3 1 1
Devco Mines Brook to Morrison Pond 40 m north of road on west side of property	00NS01FJ0013	8	.001 .004 .007	2 1 1
Devco Mines Brook 50 m east of road bridge north of McCreadyville	00NS01FJ0014	8	.001 .005	1 1
Falls Lake at bridge 700 m west of Hwy 14, Vaughan, Hants Co.	00NS01DE0001	4	.001	1
Middle R. at dam, Granton, Pictou Co.	01NS01DP0001	3	-	-
Rossignol Lake at Upper Falls Dam (NSPC1), Queens Co.	01NS01ED0032	2	-	-
Enon Lake east side 200 m north of mine effluent drainage pipe	01NS01FH0001	5	.002 .001 .003	1 1 1
LaHave R. estuary at Bridgewater, .6 mile upstream of Hwy 3 bridge about 150 m below Michelin outfall Lunenburg Co.	02NS01EF0002	1	.002	1
Shubenacadie R. in Shubenacadie from old Hwy 2 bridge, Colchester Co.	00NS01DG0001	8	.001	1

TABLE 29 CADMIUM WATER QUALITY DATA - NEW BRUNSWICK, 1975-1980 (NAQUADAT, 1980)

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l): CADMIUM CONCENTRATION (mg/l)	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l): NUMBER OF MEASUREMENTS
Saint John R. at Clair, at bridge boundary plaque	OONB01AD0001	33	-	-
Saint John R. at Hwy bridge, Edmundston	OONB01AD0008	2	-	-
St. Francis R. above mouth at picnic site, Madawaska Co.	OONB01AD0013	26	.001 .002	1 3
Madawaska R. 9.7 km NW of St. Jacques at Quebec border	OONB01AD0013	30	.002	1
Madawaska R. at power plant tailrace, Edmundston	OONB01AD0016	18	.001 .002	2 2
Saint John R. from centre of international bridge, St. Leonard	OONB01AF0002	26	.001 .002	2 1
Saint John R. at Brooks bridge near Limestone, Victoria Co.	OONB01AF0005	1	.002	1
Grand R. at Hwy 2 bridge, 26 km north of St. Leonard	OONB01AF0013	9	.001	1
Green R. 4 km above mouth at bridge, Madawaska Co.	OONB01AF0021	23	-	-
Grand R. at TCH bridge 3.3 km NNW St. Leonard, Madawaska Co.	OONB01AF0023	2	.002 .003	1 1

Cont'd

TABLE 29 CONT'D

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
Limestone R. at picnic site at Four Falls, Victoria Co.	00NB01AG003	27	.001 .002	3 1
Aroostock R. at Tinker headpond at AWQ monitor, Victoria Co.	00NB01AG009	9	.001	6
Tobique R. at Hwy 385 bridge, Riley Brook, Victoria Co.	00NB01AH0002	6	-	-
Presque Isle R. at bridge in Tracey Mills, Carleton Co.	00NB01AJ0006	3	-	-
Presque Isle R. 100 m E international border, near intake of AWQ monitor	00NB01AJ0012	22	.001 .003	1 1
Saint John R. at Grafton bridge at Woodstock, Carleton Co.	00NB01AJ0014	5	.001	1
Meduxnekeag R. at Belleville near intake of AWQ monitor, Carleton Co.	00NB01AJ0015	6	-	-
Meduxnekeag R. at bridge above junction with Millstream, Belleville	00NB01AJ0029	28	.001 .002 .003	1 1 1

Cont'd

TABLE 29 CONT'D

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) NUMBER OF MEASUREMENTS
North Nashwaaksis Stream at Hwy 620 bridge	00NB01AK0002	2	-	-
North Nashwaaksis Stream at Hwy 620 bridge on Sandwith Farm	00NB01AK0003	2	-	-
Nashwaak R. at bridge in Nashwaak Bridge, York Co.	00NB01AL0006	2	-	-
Nashwaak R. at CPR bridge, Barkers Point, York Co.	00NB01AL0007	2	-	-
Oromocto R. at Hwy 7 bridge, Oromocto, Sunbury Co.	00NB01AM0003	1	-	-
Salmon R. at Hwy 123 bridge, Gaspereau Forks, Queen's Co.	00NB01AN0001	1	-	-
Jemseg R. at old bridge abutment, Jemseg, Queens Co.	00NB01A00003	2	-	-
Saint John R. at Burton Bridge, Maugerville, Sunbury Co.	00NB01A00004	1	-	-
Canaan R. at Hwy 112 bridge, East Canaan, Queen's Co.	00NB01AP0001	2	-	-

Cont'd

TABLE 29 CONT'D

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) NUMBER OF MEASUREMENTS
Kennebecasis R. at Hwy 880 bridge, Apohaqui, King's Co.	00NB01AP0002	1	-	-
Otnabo R. at Hwy 102 bridge, about 5 km N of Queenstown	00NB01AP0021	1	.001	1
Kennebecasis R. at TCH bridge 19.2 km E of Sussex, King's Co.	00NB01AP0030	1	.001	1
Nerepis R. at Hwy bridge, Nerepis, King's Co.	00NB01AP0033	1	.001	1
Kennebecasis R. at bridge, Hampton, King's Co.	00NB01AP0034	1	.001	1
Saint John R. at Lower Gagetown from ferry in midstream	00NB01AP0035	2	.001	1
Lepreau R. at Hwy bridge, Lepreau, Charlotte Co.	00NB01AQ0001	5	-	-
Magaguadavic R. at covered bridge at Second Falls	00NB01AQ0002	5	.004	1
Magaguadavic R. at Hwy 3 bridge at Brockway, York Co.	00NB01AQ0031	5	-	-
St. Croix R. at international bridge, Milltown	00NB01AR0001	12	.001	1

Cont'd

TABLE 29 CONT'D

VALUES AT OR ABOVE STATION DESCRIPTION	CODE	NUMBER OF MEASUREMENTS	DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
St. Croix R. at International Bridge, York Co.	00NB01AR0002	7	-	-
Grand Lake outlet at Hwy 122 bridge, Forest City, York Co.	00NB01AR0011	7	-	-
Restigouche R. at Montgomery bridge above confluence with Kedgwick R.	00NB01BA0001	1	-	-
Kedgwick R. at confluence with Restigouche R., Restigouche Co.	00NB01BB0007	1	-	-
Restigouche R. at Hwy bridge below Kedgwick R.	00NB01BC0001	6	-	-
Upsalquitch R. at R.R. bridge, Upsalquitch Station	00NB01BE0001	5	.002	1
South Little R. at Theriault Road bridge, Gloucester Co.	00NB01BJ0009	9	.002	1
			.003	2
			.005	1
			.006	1
			.010	1
Little R. about 6.4 km SW of Bathurst at Carrolls Farm	00NB01BJ0010	11	.001	1
			.002	3
			.003	1
			.004	2
			.005	2
			.006	1
			.008	1
Nigadoo R. 400 m above mine area, NIG-3, Gloucester Co.	00NB01BJ0012	9	.001	1

Cont'd

TABLE 29 CONT'D

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
Nigadoo R. 1.6 km below mine at bridge at Tremblay Settlement	00NB01BJ0013	9	.002	1
Tetagouche R. 500 m below bridge on Tetagouche North Road	00NB01BJ0028	2	-	-
Jacquet R. about 3.2 km above mouth, Durham Centre	00NB01BJ0029	3	-	-
Little R. about 100 m below confluence with South Little River	00NB01BJ0051	8	.001 .002 .003 .004 .006 .007 .011	2 1 1 1 1 1 1.
Elmtree R. 200 m above R.R. bridge, Petit Rocher Nord, Gloucester Co.	00NB01BJ0052	8	.01 .001	1 2
Restigouche R. at Hwy bridge at Matapedia, Restigouche Co.	00NB01BJ0054	4	.002	1
Matapedia R. at Matapedia from bridge, Bonventure Co.	00NB01BJ0055	1	-	-
Restigouche R. at Rafting Ground Brook	00NB01BJ0056	2	-	-

Cont'd

TABLE 29 CONT'D

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
Knight Brook at confluence with Nepisiguit R., Gloucester Co.	00NB01BK0003	8	.002	4
			.005	1
			.006	1
			.010	1
			.012	1
Austin Brook at confluence with Nepisiguit R., Gloucester Co.	00NB01BK0006	8	.001	1
			.002	1
			.004	1
			.006	1
			.007	1
			.008	2
			.08	1
Nepisiguit R. 300 m above confluence with Austin Brook, Bathurst Mines	00NB01BK0007	9	.001	4
			.002	1
Forty Mile Brook at pulp site 800 m above Anaconda Brass Mine property	00NB01BK0012	8	.002	2
Forty Mile Brook just above confluence with Nepisiguit R.	00NB01BK0015	8	.001	3
			.002	2
Nepisiguit R. 1.3 km above Forty Mile Brook above Wedge Mine	00NB01BK0017	8	.001	2
			.001	1
Nepisiguit R. 4 km below Fortymile Brook at Hwy 430 bridge	00NB01BK0020	8	.002	1
			.003	1
Nepisiguit R. at Hwy 360 bridge near NLU mine, Gloucester Co.	00NB01BK0026	10	.002	1
			.006	1

Cont'd

TABLE 29 CONT'D

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
Nepisiguit R. at Bathurst at Irving Pier below Hwy 11 bridge	00NB01BK0030	9	.001 .002	2 1
Nepisiguit R. just above confluence of Fortymile Brook	00NB01BK0032	8	.002 .003	3 1
Nepisiguit R. 400 m above confluence of Portage Brook	00NB01BK0035	7	.001 .002	1 1
Nepisiguit R. about 50 km below confluence with Knight Brook	00NB01BK0050	8	.001 .002 .003	2 2 2
Nepisiguit R. at Hwy 11 Bridge, Gloucester Co.	00NB01BK0052	1	-	-
Tabusintac R. at Hwy 8 bridge, Jeanne Manse, Gloucester Co.	00NB01BL0004	3	.002	1
Tabusintac R. at bridge south side of Cain Point, Northumberland Co.	00NB01BL0032	1	-	-
S.W. Miramichi R. at bridge, Bloomfield Ridge, Northumberland Co.	00NB01BM0001	2	-	-
S.W. Miramichi R. 2.4 km above Burnthill Brook at Wardens Camp	00NB01BM0002	7	.002 .003	1 1

Cont'd

TABLE 29 CONT'D

STATION		NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l)	
DESCRIPTION	CODE		CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
S.W. Miramichi R., 1 km below Burnthill Brook, York Co.	00NB01BM0003	7	.001 .004	2 1
Cains R. at confluence with SW Miramichi R. at bridge	00NB01BN0001	3	-	-
S.W. Miramichi R. at bridge, Blackville	00NB01BO0001	6	.001	2
Renous R. 300 m above confluence of McGraw Brook	00NB01BO0001	3	-	-
Renous R. at Hwy 8 bridge, Renous, Northumberland Co.	00NB01BO0013	3	-	-
Bartibog R. at Hwy 8 bridge, Batibog, Northumberland Co.	00NB01BO0019	3	.001	1
Little S.W. Miramichi R. at bridge, Lyttleton	00NB01BP0001	3	-	-
N.W. Miramichi R. at Redbank, Sunny Corner Bridge	00NB01BQ0001	4	-	-
Little South Tomogonops R. 3 km above Tomogonops R.	00NB01BQ0017	8	.002 .003 .004 .006 .008	3 1 2 1 1

Cont'd

TABLE 29 CONT'D

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l): CADMIUM CONCENTRATION (mg/l)	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l): NUMBER OF MEASUREMENTS
Tomogonops R. at confluence with N.W. Miramichi R. 9 miles	00NB01BQ0018	8	.001 .003	1 1
N.W. Miramichi R. just above junction with Tomogonops R.	00NB01BQ0019	8	.001	1
Clearwater Stream at bridge 300 m above Chester Mine property	00NB01BQ0020	9	.001 .002	2 1
Clearwater Stream 800 m below mine, 4 km above south Sevogle R.	00NB01BQ0021	9	.002 .003	1 1
N.W. Miramichi R. at Wayerton Bridge, Northumberland Co.	00NB01BQ0044	11	.001	2
Tomogonops R. (north branch) at water supply dam by Hwy 430	00NB01BQ0045	9	.001 .005	2 1
N.W. Miramichi R. mine water monitoring station at Curventon Fence	00NB01BQ0053	7	.001 .002	6 1
South Sevogle R. at bridge 6 km above junction with Clearwater Stream	00NB01BQ0054	9	.001 .002	2 3
South Sevogle R. above 3 km above confluence with Sheephouse Brook	00NB01BQ0055	9	.001 .003	3 1

Cont'd

TABLE 29 CONT'D

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
N.W. Miramichi R. at Hwy 430 bridge, Northumberland Co.	00NB01BQ0056	10	.001	1
Kouchibouquac R. at Hwy 11 at Kouchibouguac, Kent Co.	00NB01BQ0011	3	-	-
Buctouche R. at bridge in Coates Mills, Kent Co.	00NB01BS0018	6	.003	1
Cocagne R. at Hwy 525 bridge, Notre Dame, Kent Co.	00NB01BS0019	4	-	-
Richibucto R. at Hwy 116 bridge Smiths Corner, Kent Co.	00NB01BS0046	5	-	-
Petitcodiac R. at control gates of Moncton-Riverview causeway	00NB01BU0004	3	-	-
Turtle Creek at inlet to Turtle Creek reservoir	00NB01BU0006	3	.001	1
Petitcodiac R. from Hwy 2 bridge, north of Petitcodiac	00NB01BU0031	2	-	-

Cont'd

TABLE 29 CONT'D

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/1) CADMIUM CONCENTRATION (mg/1)	NUMBER OF MEASUREMENTS
Point Wolf R. mouth, Fundy National Park, Albert Co.	00NB01BV0015	2	.001	1
Upper Salmon R. at confluence with Kinnie Brook, Albert Co.	00NB01BV0016	2	.001	1
Saint John R. above Grand Falls dam, Madawaska Co.	01NB01AF0005	32	.002 .001	1 4
Aroostock R. at Forebay Bridge, Tinker Dam, Victoria Co.	01NB01AG0001	23	.001	2
Tobique R. 150 m above dam at Narrows, Victoria Co.	01NB01AH0005	3	-	-
Tobique R. at Tobique Narrows Dam, Victoria Co.	01NB01AH0006	6	-	-
Saint John R. at dam, Beechwood, Carleton Co.	01NB01AJ0002	4	-	-
Saint John R. at New Nackawic Bridge, Pokiok, York Co.	01NB01AK0009	5	-	-
Saint John R. at Mactaquac Dam, York Co.	01NB01AK0010	4	-	-

Cont'd

TABLE 29 CONT'D

STATION DESCRIPTION	STATION CODE	NUMBER OF MEASUREMENTS	VALUES AT OR ABOVE DETECTION LIMIT (0.001 mg/l) CADMIUM CONCENTRATION (mg/l)	NUMBER OF MEASUREMENTS
Washademoak Lake at Hwy 695 bridge Cambridge-Narrows, Queen's Co.	01NB01AP0010	2	.001	1
East Branch Musquash R. at Penstock intake at East Reservoir	00NB01AQ0022	4	-	-
West Musquash Lake above dam, Saint John Co.	01NB01AQ0023	5	-	-
Woodland Lake near Woodland Junction from Maine Central Railway bridge	01NB01AR0015	2	-	-
Nepisiguit R. at power dam head-pond, Nepisiguit Falls, Gloucester Co.	01NB01BK009	11	.001 .002	4 2

either the NAQUADAT (Canada) or STORET (United States) data base. Cadmium was included in the assessment and was determined to be one of the parameters where objectives were met everywhere in the basin. Table 30 compares recent water quality data with the specific water quality objectives for designated uses of St. John River water. The tabulated values are the number of samples and percent frequencies with which each parameter exceeded its recommended level at each monitoring station. The number of samples is indicated in the upper half of each box in the table while the frequency with which the recommended level is exceeded is in the lower half.

3.2.2 Drinking Water

The present Canadian drinking water standard for cadmium established by Health and Welfare Canada is 0.005 mg/l (Guidelines for Canadian Drinking Water Quality, 1978).

Daily consumption of 2 litres of water containing the maximum acceptable concentration of cadmium would result in ingestion of only about 15% of the FAO/WHO estimated tolerable intake of 0.4-0.5 mg/week.

In Nova Scotia municipal water supplies have been tested for a number of heavy metals including cadmium and the results documented (Nova Scotia Department of Health, 1977). Of the 64 drinking water supplies sampled only 3 had cadmium concentrations exceeding the guideline. The locations and levels were:

1. Bridgewater municipal water supply
   - Hebb Lake - 0.01 mg/l
2. Canso municipal water supply
   - Hazel Hill - 0.009 mg/l
3. Sherbrooke municipal water supply
   - Sherbrooke - 0.02 mg/l

TABLE 30 CADMIUM IN THE INTERNATIONAL PORTION OF THE SAINT JOHN RIVER BASIN - PERCENTAGE OF OBSERVATIONS EXCEEDING WATER QUALITY OBJECTIVES (ANON, 1979)

SAMPLING STATIONS	AESTHETICS AND RECREATION CADMIUM (0.01 mg/l)	AQUATIC LIFE AND WILDLIFE CADMIUM (0.03 mg/l)	AGRICULTURE AND LIVESTOCK WATERING CADMIUM (0.05 mg/l)	PUBLIC WATER SUPPLY CADMIUM (0.01 mg/l)
Saint Francis River	12[a] 0[b]	12 0	12 0	12 0
Saint John River at Clair-Fort Kent	68 0	68 1	68 0	68 0
Saint John River above Ruisseau Deux Milles	5 -	5 -	5 -	5 -
Madawaska River above Saint Jacques	17 0	17 0	17 0	170 0
Madawaska River at Edmundston	- -	- -	- -	- -
Saint John River at Saint Basile	5 -	5 -	5 -	5 -
Green River at Highway 2	1 -	1 -	1 -	1 -
Saint John River at Saint Leonard	25 0	25 0	25 0	25 0

a Number of samples
b Percentage of observations exceeding water quality objectives

Cont'd

TABLE 30 Cont'd

SAMPLING STATIONS	AESTHETICS AND RECREATION CADMIUM (0.01 mg/l)	AQUATIC LIFE AND WILDLIFE CADMIUM (0.03 mg/l)	AGRICULTURE AND LIVESTOCK WATERING CADMIUM (0.05 mg/l)	PUBLIC WATER SUPPLY CADMIUM (0.01 mg/l)
Saint John River at Hamlin	- -	- -	- -	- -
Saint John River at Grand Falls	47 0	47 0	47 0	47 0
Aroostook River at Caribou Dam	1 -	1 -	1 -	1 -
Aroostook River at Tinker Dam	25 0	25 0	25 0	25 0
Aroostook River at Highway 2	64 0	64 0	64 0	64 0
Limestone River at Four Falls	55 0	55 0	55 0	55 0
Big Presque Isle Stream at Route 10	1 -	1 -	1 -	1 -
Big Presque Isle Stream at Border	30 0	30 0	30 0	30 0
Big Presque Isle Stream at Tracey Mills	102 0	102 0	102 0	102 0
Meduxnekeag River at Belleville	61 0	61 0	61 0	61 0

Newfoundland drinking waters are also monitored for cadmium with few instances of levels exceeding 0.005 mg/l reported.

3.2.3 Coastal Waters

There is a paucity of data on cadmium in Eastern Canadian coastal seawater. Two relevant studies (Bewers et. al., 1976; Yeats et. al., 1978) have, however, been conducted by the Atlantic Oceanographic Laboratory, Bedford Institute of Oceanography.

Bewers and co-workers determined the trace metal content of Atlantic Slope water, Central Atlantic water and two water bodies overlying the Scotian Shelf. Cadmium showed some variability among water masses but levels were so low that less than 50% of the samples registered above the detection limit (0.03 μg/l). The geometric mean concentration for cadmium was calculated to be 0.04 μg/l.

Yeats et. al. (1978) determined the levels of several heavy metals, including cadmium in eastern Canadian coastal waters. The concentration of trace metals was found to be comparable to other coastal waters of the world with no indication of significant modification by pollution. The distribution of metals in the waters of the Gulf of St. Lawrence and Scotian Shelf was examined. The results suggest that the precision with which trace metal levels, in a given water mass, can presently be measured is inadequate to enable changes in water composition resulting from increased anthropogenic activity to be detected.

Yeats has also reported (Pers. Comm.) that the average cadmium concentration (21 samples) for water from the western end of the Bay of Fundy in the vicinity of Point Lepreau was 0.043 μg/l in May, 1975.

3.3 Cadmium in Sediment

3.3.1 Harbour and Channel Sediments

The disposal of dredge spoils in offshore waters has been regulated since the enactment of the Ocean Dumping Control Act in 1975. Applications for proposed dredging operations must now be accompanied by analytical documentation describing the extent of contamination of restricted materials. Cadmium content is limited to a maximum of 0.6 µg/g dry weight in potential spoils. Most dredging in the Atlantic Region is undertaken to improve and maintain harbours and shipping channels, consequently, analytical data provided for the appproval process is a useful source of information on cadmium levels in sediments.

Figure 7 is a computer plotted map originating from this compliance program and provides a visual overview of relative cadmium concentrations in sediment in the Atlantic region. Data used in this mapping exercise is listed, on a provincial basis, in Tables 31-34. Values utilized cover the June, 1977-August, 1979 sampling period. In instances of replicate sampling an average value was determined. Included in these tables are values which have not been incorporated into the diagram; these are specifically indicated. The Environmental Protection Service, Atlantic Regional Laboratory conducted the latter measurements while the other tabulated values were performed by a variety of private laboratories in the Region. In some instances significant differences are observed between data from the same dredge area. This suggests either a lack of reproducibility in sampling and analytical techniques between laboratories or actual variation in the cadmium content of sediments collected from the same site.

FIGURE 7 COMPUTER PLOTTED MAP INDICATING RELATIVE CADMIUM CONCENTRATION IN DREDGED SEDIMENTS

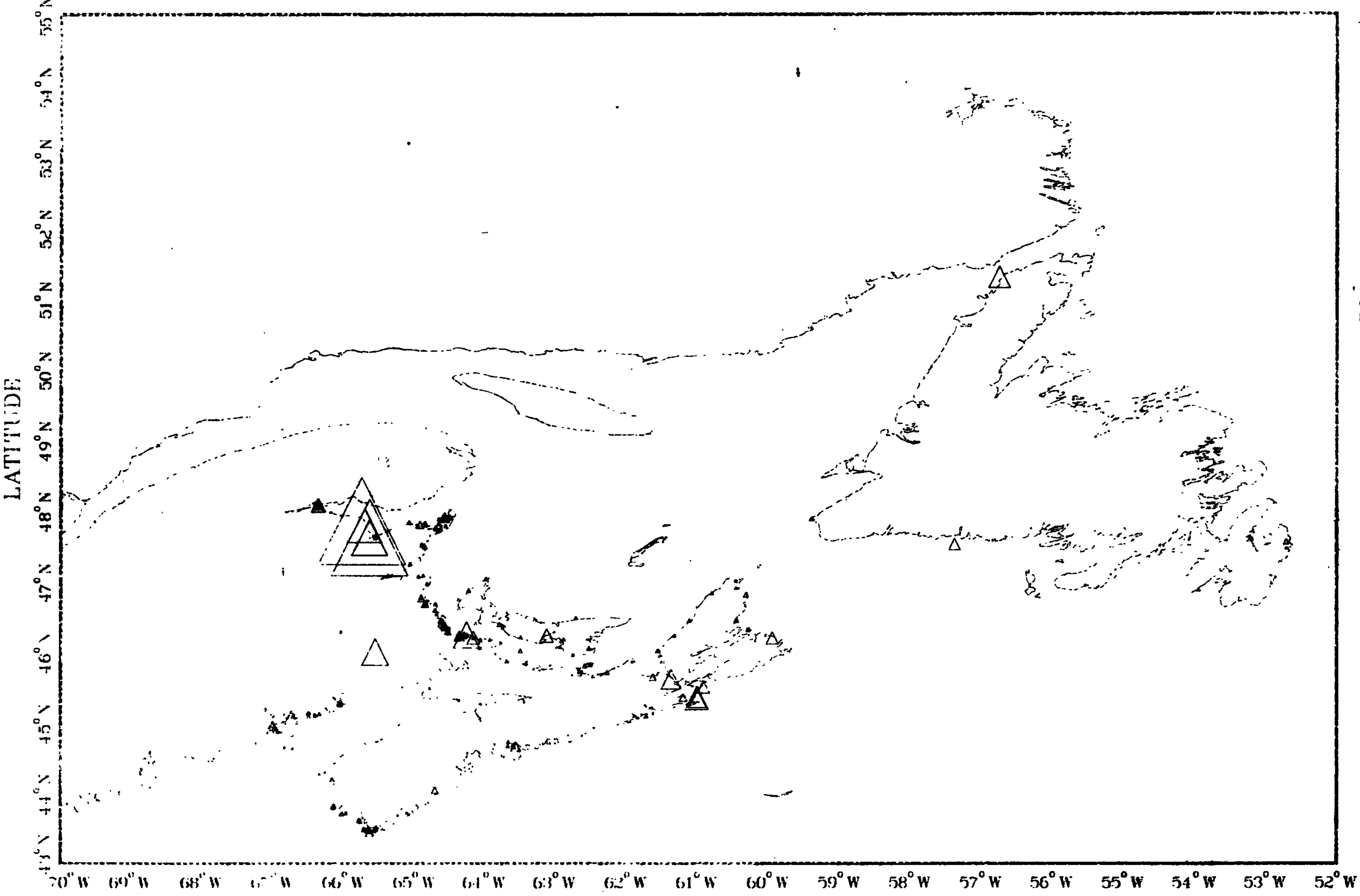


TABLE 31 CADMIUM LEVELS IN DREDGED SEDIMENTS FROM NEW BRUNSWICK, JUNE 1977-JULY 1979

LOCATION	NO. OF SAMPLES	CADMIUM CONCEN- TRATION RANGE (μg/g)	AVERAGE CADMIUM LEVEL (μg/g)
Charlotte County			
Beaver Hbr.	1	-	2.10
Fairhaven	1	-	1.05
Maces Bay	1	-	<0.50
Seal Cove	1	-	0.25
Stuarttown	1	-	<0.50
Welshpool	1	-	0.80
Whitehead	4	0.35-0.45	0.40
Glouchester County			
Bathurst	7	0.50-12.00	3.60
Blue Cove	2	0.60-0.90	0.75
Blue Cove	8[a]	0.30-0.90	0.78
Caraquet	1	-	1.15
Caraquet C.	1	-	0.45
Island River	1	-	0.50
Lameque	3	1.10-2.00	1.55
Little Shippegan	3	0.45-0.55	0.50
Lower Caraquet	1	-	0.85
Mid Caraquet	1	-	0.55
Miscou	2	0.85-0.85	0.85
Miscou Gulf	1	-	0.45
Miscou Hbr.	1	-	1.50
Miscou Hbr.	1	-	0.70
Petit Rocher	1	-	5.23
Pidgeon Hill	6	0.25-0.50	0.40
Pidgeon Hill	2[a]	1.0 -1.0	1.0
Pointe Verte	1	-	13.70
Shippegan	2	0.05-0.60	0.55
Shippegan Gulf	1		0.60
Shippegan Gully West	1	-	0.40
Shippegan, South Harbour wharf	1[a]	-	1.8
Shippegan, South-west breakwater	1	-	2.55
St. Marie Sur Mer	1	-	0.50
Tracadie	3	0.40-1.10	0.70
Tracadie	3[a]	0.10-0.20	0.17
Tracadie Channel	1	-	0.10
Tracadie Hbr.	3	0.05-0.45	0.30
Tracadie Wharf	1[a]	-	0.90
Val Comeau	1	-	0.60

Cont'd

TABLE 31 (Cont'd)

LOCATION	NO. OF SAMPLES	CADMIUM CONCENTRATION RANGE (μg/g)	AVERAGE CADMIUM LEVEL (μg/g)
Kent County			
Caissies Cape	1	-	0.40
Cap. St. Louis Hbr.	1[a]	-	0.80
Chockpish	1	-	<0.50
Cocagne Bar	3	0.50-1.20	0.70
Lower St. Lawrence	1	-	<0.50
Point Sapien	2	<0.50	<0.50
Richibucto	2	<0.50-1.10	0.75
Richibucto Cape	1	-	<0.50
St. Edouard	2	0.35-<0.50	0.40
St. Louis	1	-	1.10
St. Thomas	2	<0.60-0.85	0.70
St. Thomas Hbr.	1[a]	-	1.0
Northumberland County			
Escuminac	4	0.35-1.40	0.75
Huckleberry Island	2	<0.50	<0.50
Loggieville	1	-	0.50
Lower Neguac	1	-	0.60
Neguac Church	2	0.60-0.60	0.60
Newcastle	1	-	4.17
Restigouche County			
Dalhousie	1	-	0.05
Dalhousie (0-200 m)	5	0.40-3.3	1.42
Dalhousie:		-	
Cargo Wharf	2	0.35-0.60	0.45
Ferry Wharf	1	-	2.10
Main Channel	1	-	1.35
Public Wharf	2	1.95-2.10	2.00
New Mills	1	-	0.33
Jacquet River	1	-	0.25

Cont'd

TABLE 31 (Cont'd)

LOCATION	NO. OF SAMPLES	CADMIUM CONCENTRATION RANGE (μ g/g)	AVERAGE CADMIUM LEVEL (μg/g)
Saint John County			
Boynes Cove	2	0.50-0.95	0.70
Boynes Cove	1[a]	-	0.20
Chance Hbr.	1	-	<0.50
Courtenay Bay	16	<0.50-0.60	0.50
Dipper Hbr.	1	-	<0.50
Five Fathoms	1	-	<0.50
Saint John	1	-	0.50
Saint John Ferry Terminal	1	-	0.20
Saint John:			
Harbour	6	0.50-1.35	0.70
Long Wharf	8	0.35-0.35	0.35
Main Channel	1	-	0.50
Pugsley South	8	0.35-0.35	0.35
Shipbuilding		-	
Dry Dock	3	0.10-0.35	0.20
Westmoreland County			
Botsford	2	0.40-0.40	0.40
Cape Bauld	3	0.60-4.10	1.75
Emily's Point	2	0.50-0.50	0.50
Harshman Brook	4	0.45-1.00	0.60
Little Cape	3	0.50-2.00	1.00
Little Cape	1[a]	-	0.06
Point de Chene	1	-	0.45
Port Elgin	1	-	0.40
Robichaud	2	0.00-0.45	0.20
Kouchibouquac	3	1.00-1.60	1.33
Shediac Bridge	4	0.40-0.95	0.75

a Samples collected by DPW and analyzed by EPS.

TABLE 32 CADMIUM LEVELS IN DREDGED SEDIMENTS FROM NOVA SCOTIA, JUNE 1977-JULY 1979

LOCATION	NO. OF SAMPLES	CADMIUM CONCENTRATION RANGE (µg/g)	AVERAGE CADMIUM LEVEL (µg/g)
Antigonish County			
Arisaig	2	0.22-0.22	0.22
Ballantynes Cove	2	0.30-0.30	0.30
Barrios Beach	1	-	1.00
Barrios Beach	2[a]	0.10-0.20	0.15
Cape Breton County			
Alder Point	2	<0.50	<0.50
Glace Bay	4	1.90-2.70	2.20
Glace Bay	4[a]	0.10-0.60	0.38
Point Aconi	1	-	0.50
Cumberland County			
Pugwash	2	0.50-0.50	0.50
Digby County			
East Sandy Cove	3	0.08-0.12	0.10
East Sandy Cove	5[a]	0.10-0.10	0.10
Meteghan	4	<0.60	<0.60
Saulnierville	4	<0.10-0.80	0.45
Westport	2	0.60-0.60	0.60
Guysborough County			
Canso Tickle	1	-	3.50
Canso Wharf	1	-	2.80
Half Island Cove	1	-	1.20
Half Island Cove	1[a]	-	0.10
Little Dover Island	1	-	0.50
Port Bickerton	2	<0.60	<0.60
Halifax County			
Bedford Basin	6	0.05-0.90	0.65
Bedford Basin	6[a]	0.07-0.09	0.82
Dartmouth	2	1.50-1.90	1.70
Eastern Passage	7	0.30-0.90	0.50
Fairview Cove	11	<0.50-2.00	0.70
Halifax Dockyard	21	0.05-0.85	1.50
Halifax Shipyard	5	0.45-2.15	1.60
Prospect	2	0.45-2.15	0.95
Three Fathom Hbr.	2	0.10-0.10	0.10

Cont'd

TABLE 32 (Cont'd)

LOCATION	NO. OF SAMPLES	CADMIUM CONCENTRATION RANGE (μg/g)	AVERAGE CADMIUM LEVEL (μg/g)
Inverness County			
Cheticamp	1	-	0.10
Inverness	3	<0.50	<0.50
Judique Baxter	1	-	0.30
Little Judique Pond	2	0.30-0.30	0.30
Mabou Hbr.	2	0.10-0.10	0.10
Margaree	1	-	<0.50
Margaree Hbr.	1	-	<0.50
Pleasant Bay	2	0.50-0.50	0.50
Port Hawkesbury	1	-	3.10
Port Hawkesbury	1[a]	-	0.20
Port Hood Island	2	<0.60	<0.60
Pictou County			
Bailey Brook	1	-	0.65
Cariboo	1	-	<0.50
Pictou Island East	2	0.60-0.60	0.60
Pictou Island West	2	0.60-0.60	0.60
Queen's County			
Liverpool	4	<2.00	<2.00
Richmond County			
Petit de Grat	1	-	1.90
Shelburne County			
Atwoods Brook	1[b]	-	0.1
Bear Point	2	1.75-2.00	1.85
Bear Point	2[a]	7.4 -11	9.2
Bear Point	2[b]	0.1 -0.1	0.1
Centerville	1	-	0.2
Clarks Hbr.	1	-	1.20
Clarks Hbr.	1[b]	-	0.6
Criple Creek	2	<0.60	<0.60
Doctors Brook	4[b]	<0.1 -0.1	<0.1
Doctors Pit	3[b]	0.1 -0.9	0.37
Forbes Pit	1[b]	-	0.4
Lockeporte	2	<0.50	<0.50
Lower Jordan Bay	6	<0.1 -<0.6	<0.35
Lower Woods Hbr.	2	<0.60	<0.60
Lower Woods Hbr.	1[b]	-	0.5

Cont'd

TABLE 32 (Cont'd)

LOCATION	NO. OF SAMPLES	CADMIUM CONCEN-TRATION RANGE (µg/g)	AVERAGE CADMIUM LEVEL (µg/g)
Shelburne County			
Popes Pit	1[b]	-	<0.1
Prospect Point	1[a]	-	2.3
Prospect Point	1[b]	-	0.2
Sable Island Causeway	1[b]	-	0.1
Shag Hbr.	2	0.90-1.40	1.15
Shag Hbr.	2[a]	2.2 -2.4	2.3
Shag Hbr.	1[b]	-	0.2
Smithsville	3	<0.50	<0.50
Stoney Island	1	-	<0.50
West Head	3	<0.60-0.84	0.70
West Head	2[a]	0.20-0.40	0.30
Victoria County			
Dingwall	8	0.40-0.90	0.60
Little Narrows	1	-	0.10
Little River	2	0.40-0.70	0.55
Neil Hbr.	2	1.30-1.40	1.35
St. Lawrence Bay	4	0.20-1.40	0.75
St. Lawrence Bay	4[a]	0.10-0.70	0.32
Yarmouth County			
Dennis Point	2	<0.60	<0.60
Little River Hbr.	4	0.40-0.70	0.55
Lower East Pubnico	2	<0.60	<0.60
Pinkney's Point	6	0.05-0.45	0.23
Wedge Point	3	<0.05-0.90	0.65
Yarmouth	5	<0.02-1.30	0.70
Yarmouth Bar	3	0.40-0.70	0.60
Yarmouth, Lobster Rock Wharf	3[a]	0.09-0.28	0.20
Yarmouth Outer Channel	2	<0.60	<0.60

a Samples collected by DPW and analyzed by EPS.
b Samples collected and analyzed by EPS.

TABLE 33 CADMIUM LEVELS IN DREDGED SEDIMENTS FROM PRINCE EDWARD ISLAND, JUNE 1977-JULY 1979

LOCATION	NO. OF SAMPLES	CADMIUM CONCENTRATION RANGE (μg/g)	AVERAGE CADMIUM LEVEL (μg/g)
Kings County			
Bay Fortune	3[a]	0.10-0.10	0.10
Beach Point	2	<0.60	<0.60
Fortune	3	0.05-0.15	0.10
Georgetown	1	-	0.55
Georgetown Hbr.	1[a]	-	0.10
Launching	2	0.05-0.05	0.05
Mink River	1	-	<0.60
North Lake	3	0.01-0.02	0.01
North Lake	3[a]	0.10-0.10	0.10
Red Head	1	-	0.40
Savage Hbr.	3	<0.01-0.35	0.35
Savage Hbr.	3[a]	0.10-0.40	0.24
Prince County			
Alberton	1	-	<0.50
Alberton	3[a]	0.20-0.40	0.27
Brae Hbr.	6	<0.02	<0.02
Egmont Bay	3	0.20-0.25	0.20
Egmont Bay	3[a]	0.10-0.30	0.17
Fishing Cove	1	-	<0.40
Howard's Cove	1	-	<0.40
Malpeque	3[a]	0.10-0.20	0.13
Malpeque Cove	3	0.15-0.30	0.20
Milligan Shore	2	0.05-0.30	0.20
Miminegash	1	-	<0.60
Seacow Pond	2	<0.40-<0.60	<0.50
Summerside	2	<0.60	<0.60
Tignish	1	-	<0.40
West Point	1	-	<0.40
Queen's County			
Belle River	3	0.02-0.03	0.02
Belle River	3[a]	0.10-0.10	0.10
Charlottetown	1	-	2.10
Charlottetown	1[a]	-	0.50
McAuley W.	1	-	0.30
Rustico Hbr.	2	<0.40	<0.40
Vernon Bridge	1	-	<0.50
Victoria	1	-	<0.40
Wood Islands	5	0.10-0.50	0.30

a Samples collected by DPW and analyzed by EPS.

TABLE 34 CADMIUM LEVELS IN DREDGED SEDIMENTS FROM NEWFOUNDLAND, JUNE 1977-JULY 1979

LOCATION	NO. OF SAMPLES	CADMIUM CONCENTRATION RANGE (μg/g)	AVERAGE CADMIUM LEVEL (μg/g)
Bay of Islands			
Corner Brook	4	1.20-2.0	1.60
Fox Island River	2	0.60-0.85	0.70
Bonavista South			
Saltons Brook	2	0.35-0.35	0.35
Saltons Brook	1[a]	-	0.40
Burgeo Bay D'Espoir			
Ramea	2	1.60-1.80	1.70
Ramea	1[a]	-	0.10
Burin Placentia West			
Little Bay	4	0.40-0.55	0.45
Little Bay	1[a]	-	0.10
Grand Bank			
Fortune	4	0.60-0.60	0.60
Garnish	2	0.40-0.50	0.45
Lawn	1	-	0.55
Green Bay			
Rattling Brook	2	0.60-0.60	0.60
Rattling Brook	1[a]	-	0.10
Harbour Main-Belle Isle			
Long Pond	4	<0.50	<0.50
Petty Hbr.	4	0.40-0.65	0.55
Petty Hbr.	1[a]	-	0.10
St. John's	6	1.60-3.30	2.40
Labrador			
Cartwright	2	0.80-0.90	0.85
Cartwright	1[a]	-	0.10
Forteau	2	0.20-0.20	0.20

Cont'd

TABLE 34 (Cont'd)

LOCATION	NO. OF SAMPLES	CADMIUM CONCENTRATION RANGE (μg/g)	AVERAGE CADMIUM LEVEL (μg/g)
St. Barbe			
Flowers Cove	2	2.20-3.40	2.80
Parsons Pond	2	0.40-0.60	0.50
St. Georges			
Codroy	2	1.00-1.20	1.10
Codroy	1[a]	-	0.50
Crabbes River	2	0.20-0.20	0.20
St. Mary's-The Cape			
Branch	2	0.50-0.80	0.65
Branch	2[a]	0.10-0.10	0.10
Trinity South			
Dildo	2	0.50-0.60	0.55
Fermeuse	2[a]	0.6 -1.1	0.85
Fermeuse (Cores)		-	
top	3[a]	2.8 -5.3	3.8
middle	3[a]	2.6 -8.6	4.8
bottom	3[a]	2.7 -6.6	4.1
Fermeuse (Grabs)	4[a]	0.4 -1.0	0.6

a Samples collected by DPW and analyzed by EPS.

No direct correlation between cadmium concentration in sediment and the extent of industrialization in the surrounding area can be demonstrated on the basis of the tabulated data. There is little or no industrial activity in the immediate vicinity of a number of locations where high cadmium levels are detected. However, in two instances the cause of elevated concentrations is reasonably well established. At Dalhousie, New Brunswick zinc concentrate is temporarily stored at dock-side until loaded for shipment. Lack of a protective enclosure at this storage area and exposure to the elements has resulted in cadmium accumulation in the harbour sediments. Elevated levels in sediments from Pointe Verte and Petit Rocher, Gloucester County, New Brunswick are attributed to the zinc smelter at Belledune, which is situated 8 and 14 km away respectively.

In 1978, Public Works Canada contracted for the collection of sediment cores from 14 northeastern New Brunswick harbours (Figure 8). These samples were analyzed for total cadmium content in order to ascertain both vertical and horizontal distributions of the metal (McLaren Marex, 1979). Previous studies on sediments from these harbours had shown cadmium levels in excess of 0.6 mg/kg.

Analytical results for the sampling program are presented in Table 35. Sediments in Dupuis Corner, Shippegan Gully, Lameque Channel, Little Shippegan, and Caraquet were within the ODCA limit, in Tracadie and Cote St. Anne at or just above the limit, in Blue Cove,

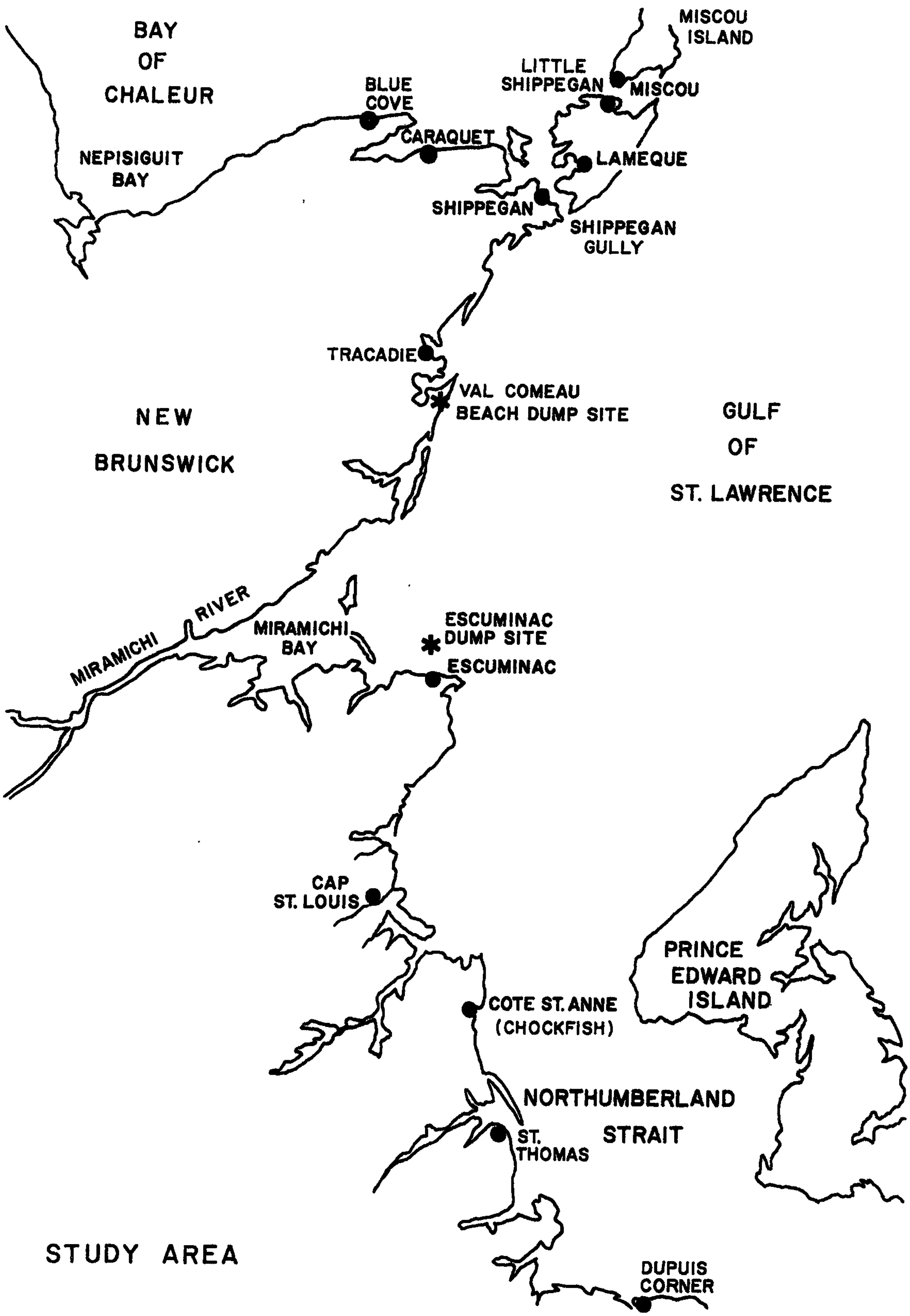


FIGURE 8 SAMPLING LOCATIONS FOR NEW BRUNSWICK HARBOURS SURVEYS (MacLaren Marex, 1975)

TABLE 35 CADMIUM CONCENTRATIONS IN SEDIMENTS FROM FOURTEEN HARBOURS IN NORTHEASTERN NEW BRUNSWICK (DRY WEIGHT)

HARBOUR	CORE Top (cm)	Cadmium (μg/g)	Core Middle (cm)	Cadmium (μg/g)	Core Bottom (cm)	Cadmium (μg/g)
Dupuis Corner Outer Bay (8/8/79)	grab	<0.02				
Dupuis Corner Outer Bay (11/8/79)	0-2	0.02	NA[a]	NA	20-22	0.125
Dupuis Corner Lobster Plt. Outfall	grab	<0.02				
St. Thomas	grab	0.95				
Cote St. Anne #1	0-2	0.049	13-15	<0.02	26-28	<0.02
Cote St. Anne #2	0-2	<0.02	16-18	<0.02	32-34	0.16
Cote St. Anne #3	0-2	1.0	10-12	1.3	23-25	0.09
Cote St. Anne #4	0-2	0.06	NA	NA	14-15	0.02
Cote St. Anne #5	0-2	0.08	NA	NA	15-17	0.02

Cont'd

TABLE 35 Cont'd

HARBOUR	CORE Top (cm)	Cadmium (µ g/g)	Core Middle (cm)	Cadmium (µg/g)	Core Bottom (cm)	Cadmium (µg/g)
Cap St. Louis #1	0-2	2.1	10-12	1.6	20-21	1.7
Cap St. Louis #4	0-2	2.0	12-13	0.56	24-25	0.77
Cap St. Louis #5	0-2	0.83	10-12	1.1	22-23	0.72
Escuminac (Inner Hbr.) #1	0-2	0.96	10-12	0.71	20-22	1.1
Escuminac (Inner Hbr.) #3	0-2	1.2	25-26	0.32	50-52	0.10
Escuminac (Inner Hbr.) #4	0-2	1.0	15-16	1.9	30-31	1.6
Escuminac (Outer Hbr.) #1	0-2	1.0	17-18	5.1	36-37	5.2
Escuminac (Outer Hbr.) #2	0-2	0.76	14-16	1.2	30-31	1.3
Escuminac (Outer Hbr.) #4	0-2	<0.035	14-16	0.41	29-30	<0.035
Escuminac (Dump Site)	grab	<0.02				
Tracadie Outside of Wharf	0-2	0.49	NA	NA	13-15	0.84

Cont'd

TABLE 35 Cont'd

HARBOUR	CORE Top (cm)	Cadmium (µg/g)	Core Middle (cm)	Cadmium (µg/g)	Core Bottom (cm)	Cadmium (µg/g)
Tracadie Inside of Wharf	0-2	0.61	11-13	0.38	22-24	0.07
Tracadie Dump Site (Val Comeau Beach)	grab	<0.02				
Shippegan South Hbr.	grab	0.65				
Shippegan Gully	grab	<0.02				
Lameque Channel	integrated core 4-5 cm	<0.02				
Lameque Outer Hbr.	0-2	0.04	18-19	0.18	38-39	<0.02
Lameque Inner Hbr.	white clay material at bottom of cove	0.02				
Lameque (Inner Hbr.)		0.53	(from grab)			
Little Shipp. Ferry	0-2	0.32	NA	NA	17-18	<0.02

Cont'd

TABLE 35 Cont'd

HARBOUR	CORE Top (cm)	Cadmium (μg/g)	Core Middle (cm)	Cadmium (μg/g)	Core Bottom (cm)	Cadmium (μg/g)
Miscou Hbr. #1	0-2	1.1	NA	NA	12-14	1.9
Miscou Hbr. #2	0-2	0.45	NA	NA	8-9	0.51
Miscou Hbr. #3	0-2	0.51	NA	NA	7-8	1.4
Caraquet New Hbr. #1	0-2	0.69	NA	NA	8-9.5	<0.01
Caraquet New Hbr. #2	0-2	0.14	NA	NA	11-13	<0.01
Blue Cove #1	0-2	2.7	NA	NA	6-8	0.2
Blue Cove #2	0-2	1.1	13-14	0.19	28-29	0.5
Blue Cove #3	0-2	0.94	10-12	2.2	18-10	1.1

a Not available for analysis.

Shippegan South Harbour, Lameque Inner Harbour, Escuminac, Cap St. Louis and St. Thomas in excess of the limit. The sediments in the latter harbours contained a high concentration of organic matter and a significant percentage of silt and clay; types of material recognized as transporters and "sinks" of a variety of pollutants such as cadmium. In these harbours, sediment dynamics were thought to promote the accumulation of fine-grained, organic-rich sediments leading to an accumulation of cadmium.

Vertical distributions within the cores showed a definite decrease with depth except for Blue Cove and Escuminac where the coring did not penetrate to the lower concentration strata. In most cases, high cadmium concentrations were directly associated with fine-grained sediments.

In order to assess the variability of cadmium contamination of sediments with depth, a core sampling survey was undertaken (Interprovincial Engineering Ltd., 1978) in an area proposed for dredging in the immediate vicinity of the Dalhousie, New Brunswick public wharf. Nine core samples were collected and sectioned at 25 cm intervals. The sampling sites are represented diagramatically in Figure 9 and the cadmium results listed in Table 36.

3.3.2 Stream Sediments

The Nova Scotia Department of Mines and Energy conducts an ongoing monitoring program to define the heavy metal content of stream sediments. Although it is hoped to eventually include the entire province, areas covered to date are located in northern Nova Scotia and Cape Breton. Figures 10-16 are a series of geochemical maps depicting cadmium concentrations in the surveyed streams. Table 37 lists the geographical areas surveyed and the county or counties in which these areas are located, as well as the mean value and concentration range of cadmium.

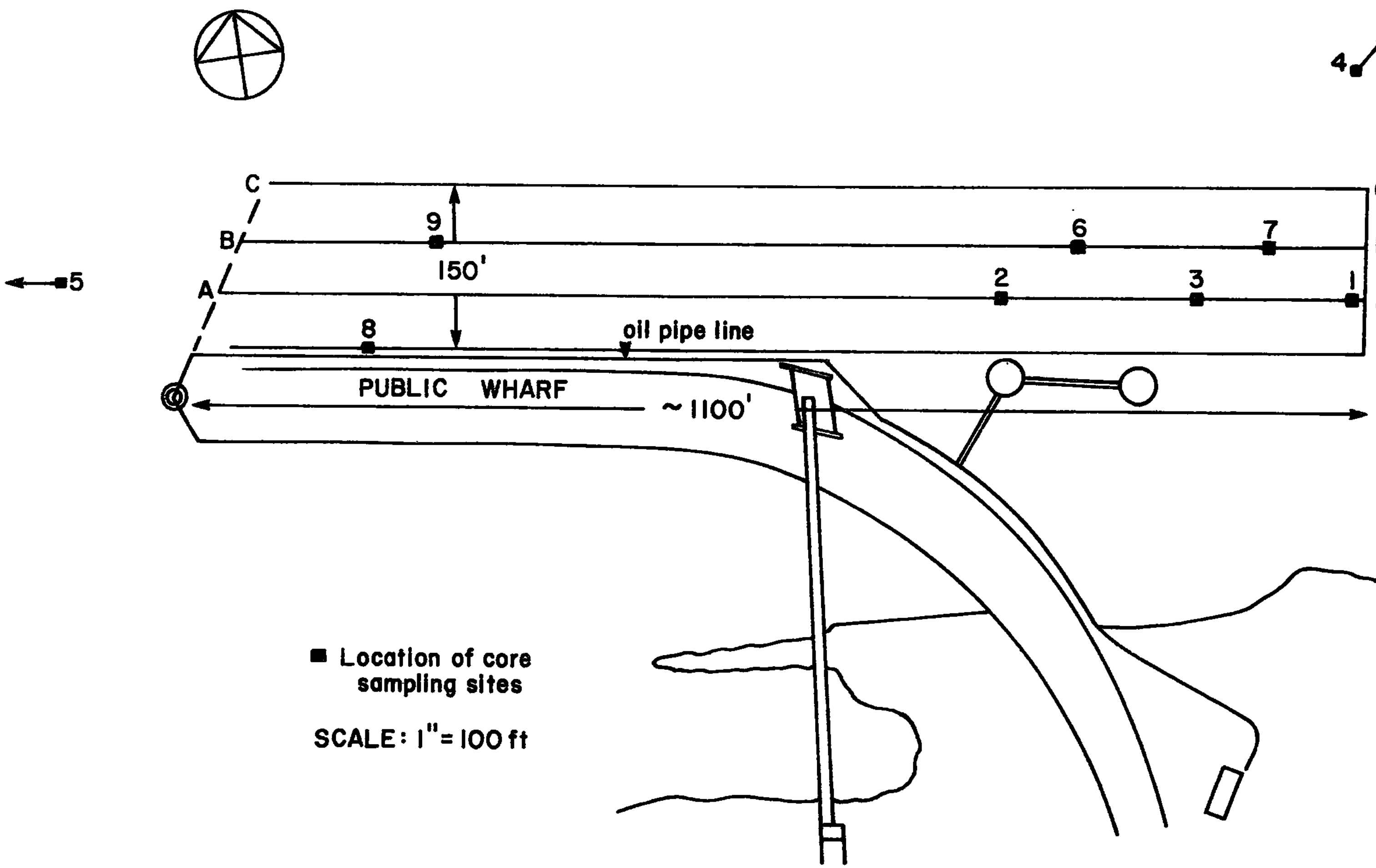


FIGURE 9 SOUNDING TRANSECTS AND CORING LOCATIONS FOR DALHOUSIE PUBLIC WHARF SURVEY (International Environmental Consultants, 1978)

TABLE 36 DALHOUSIE PUBLIC WHARF - CADMIUM CONCENTRATIONS IN SEDIMENT CORES

Depth	Cadmium (μg/g Dry Weight)								
	Core 1	Core 3	Core 4	Core 5	Core 6	Core 7	Core 8	Core 9	Core 2[a]
Top-25 cm	<0.5	2.6	1.5	<0.1	<0.1	0.8	0.7	<0.1	2.0(top-16 cm)*
25-50	<0.1	3.0	2.7	<0.1	<0.1	0.6	1.3	1.4	1.5(16-32)
50-75	<0.1	1.2	4.0	<0.1	<0.1	<0.1	1.6	<0.1	1.7(32-48)
75-100	0.8	1.4	1.4	<0.1	<0.1	1.0	0.8	<0.1	1.7(48-58)
100-125	0.8	1.7	1.8	<0.1	<0.1	0.8	<0.1	0.7	<0.1(58-68)
125-150	-	2.4	2.4	<0.1	0.5	<0.1	<0.1	<0.1	1.5(68-78)
150-175	-	1.9	1.2	-	-	<0.1	0.7	<0.1	1.2(78-88)
									2.0(88-98)
									1.9(98-108)
									1.3(108-118)

a Core 2 sectioned at different lengths than the other eight cores.

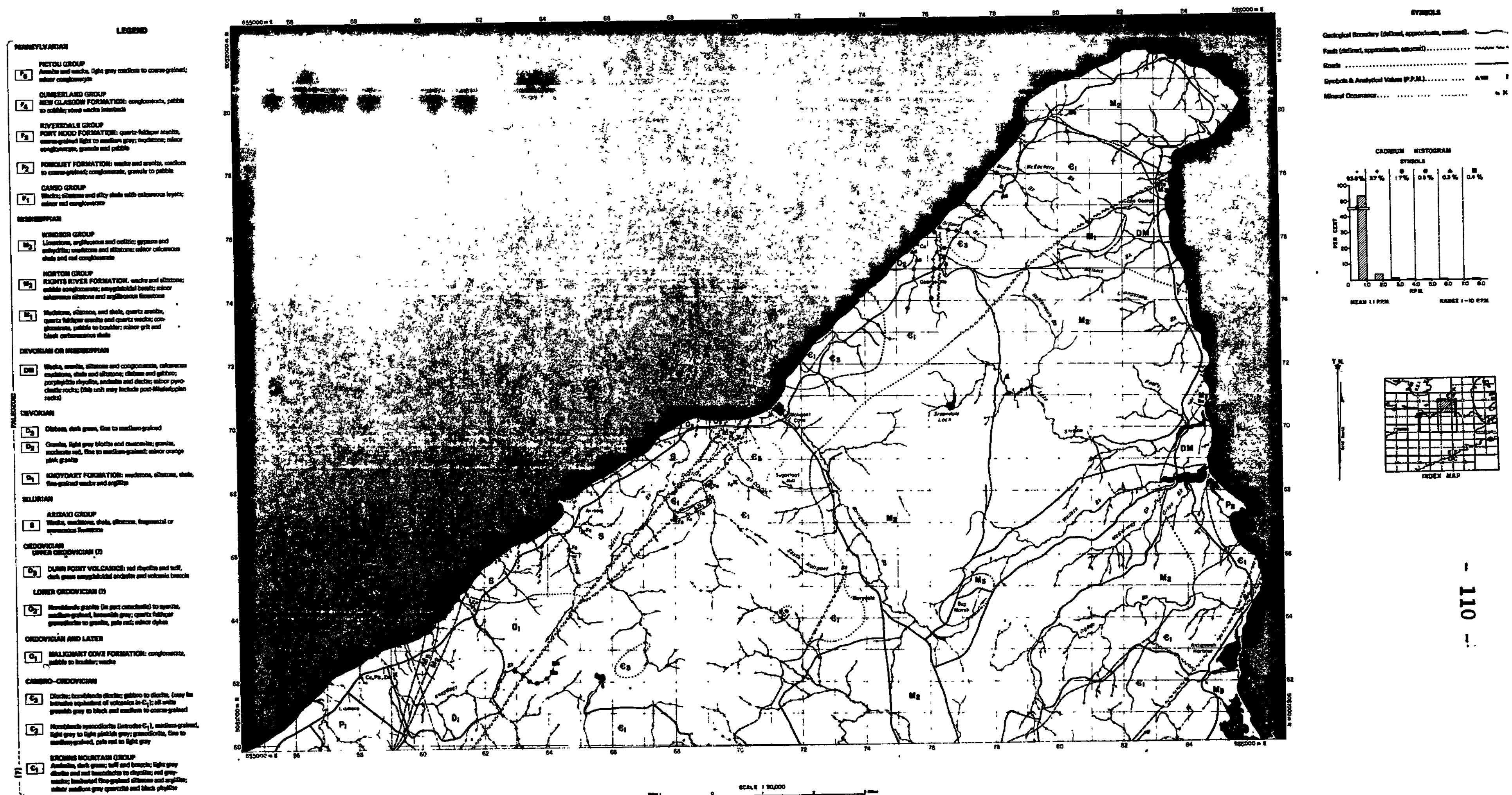


FIGURE 10 CADMIUM IN STREAM SEDIMENTS FROM THE CAPE GEORGE AREA

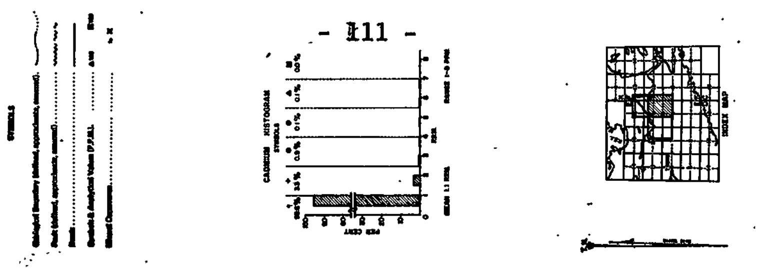
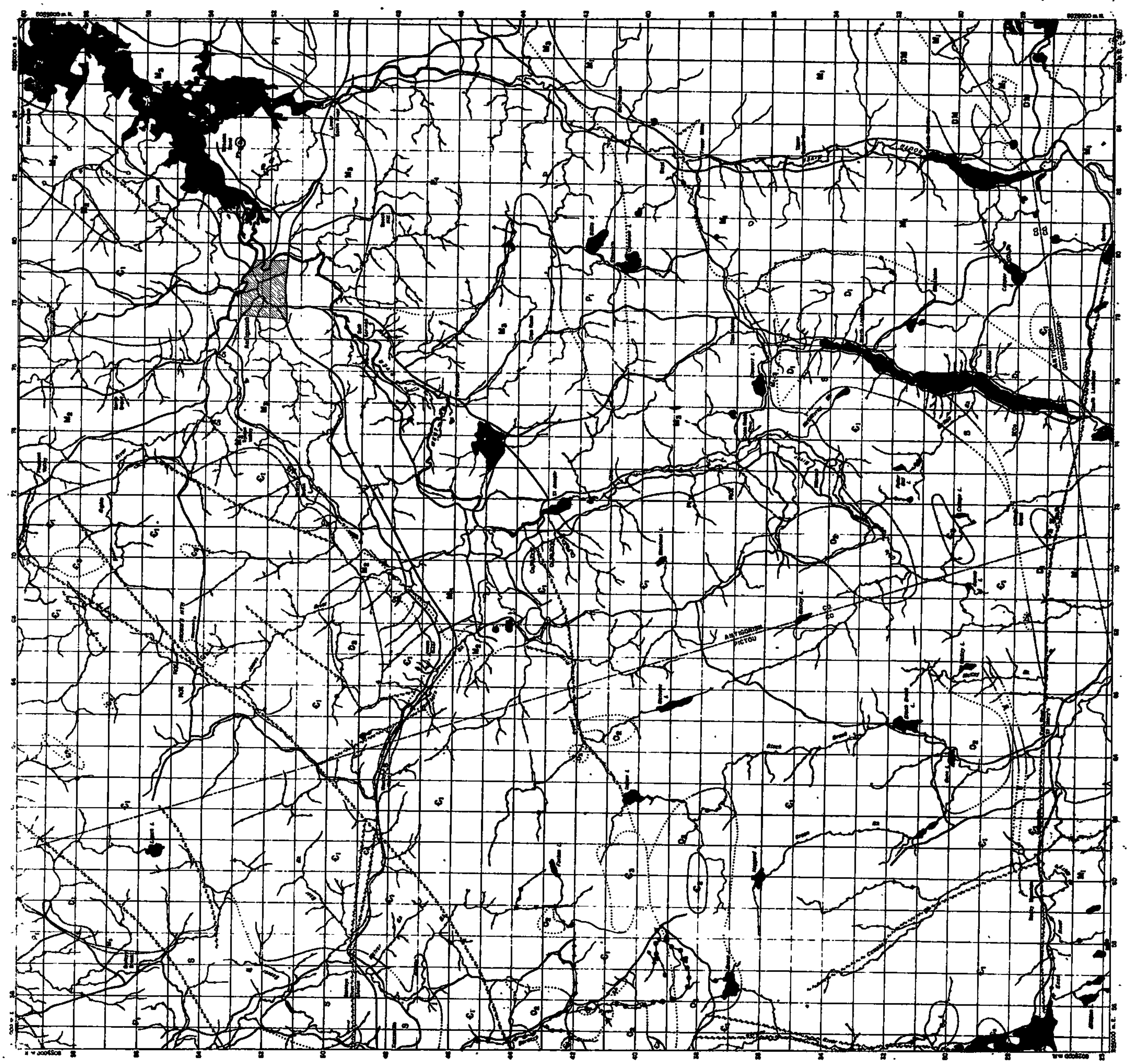
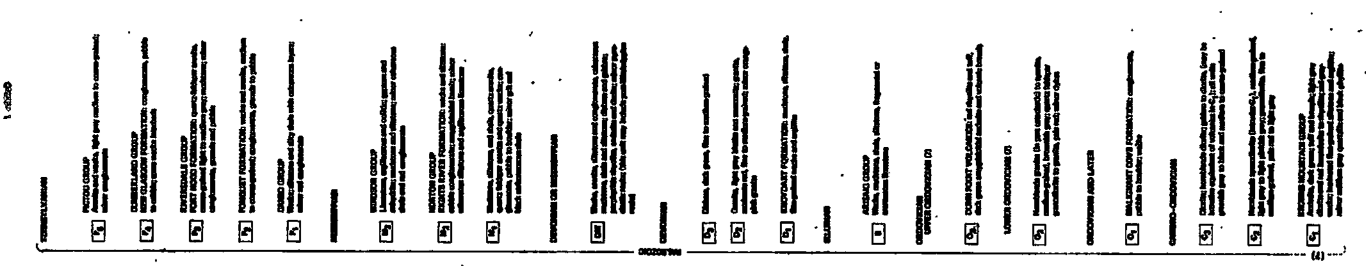
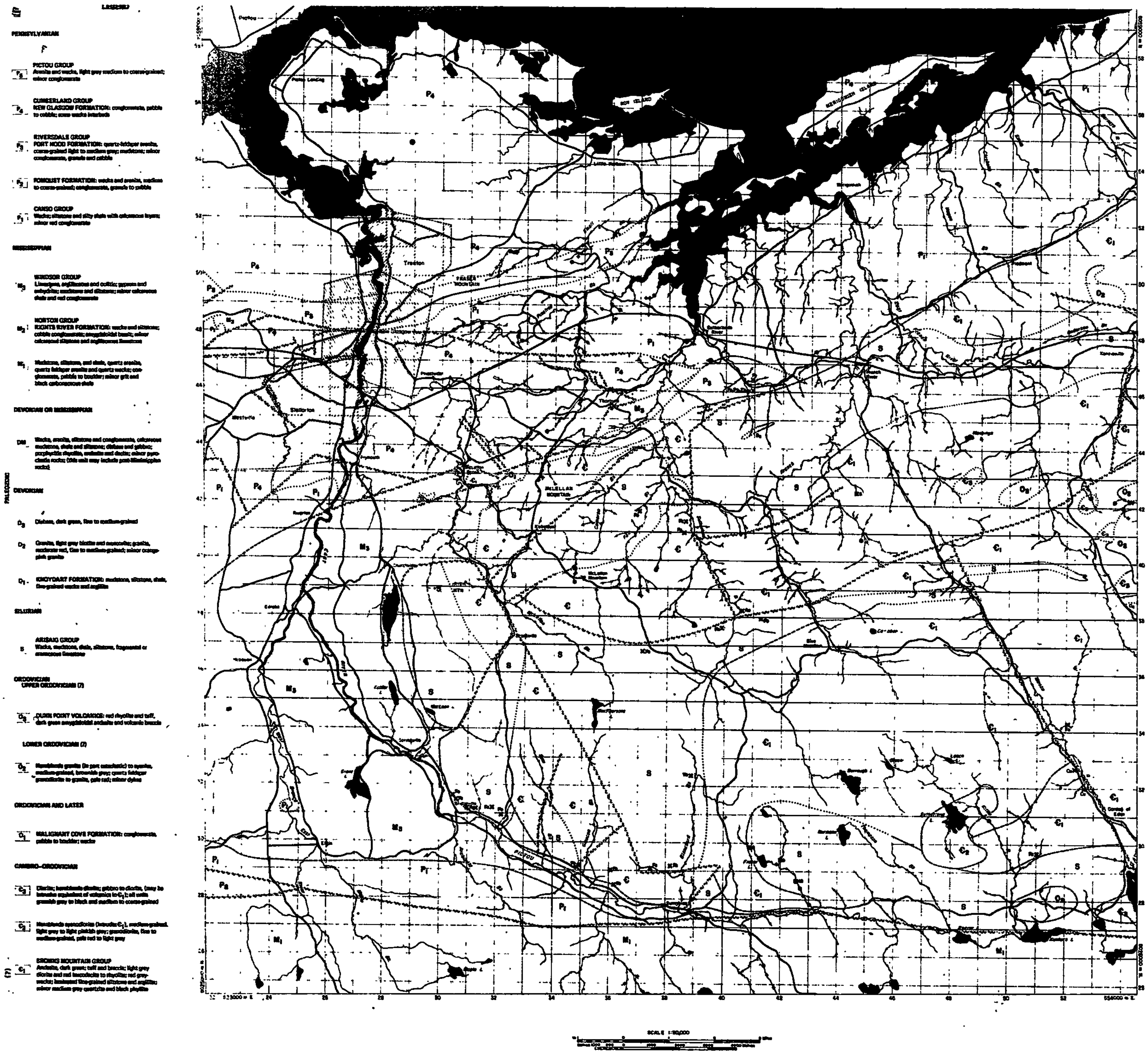


FIGURE 11 CADMIUM IN STREAM SEDIMENTS FROM THE ANTIGONISH AREA







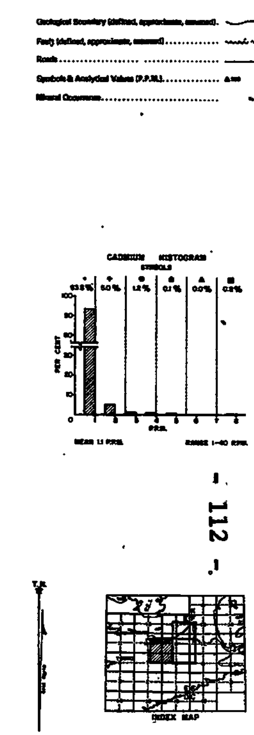


FIGURE 12
CADMIUM IN
STREAM
SEDIMENTS
FROM THE
NEW GLASGOW
AREA

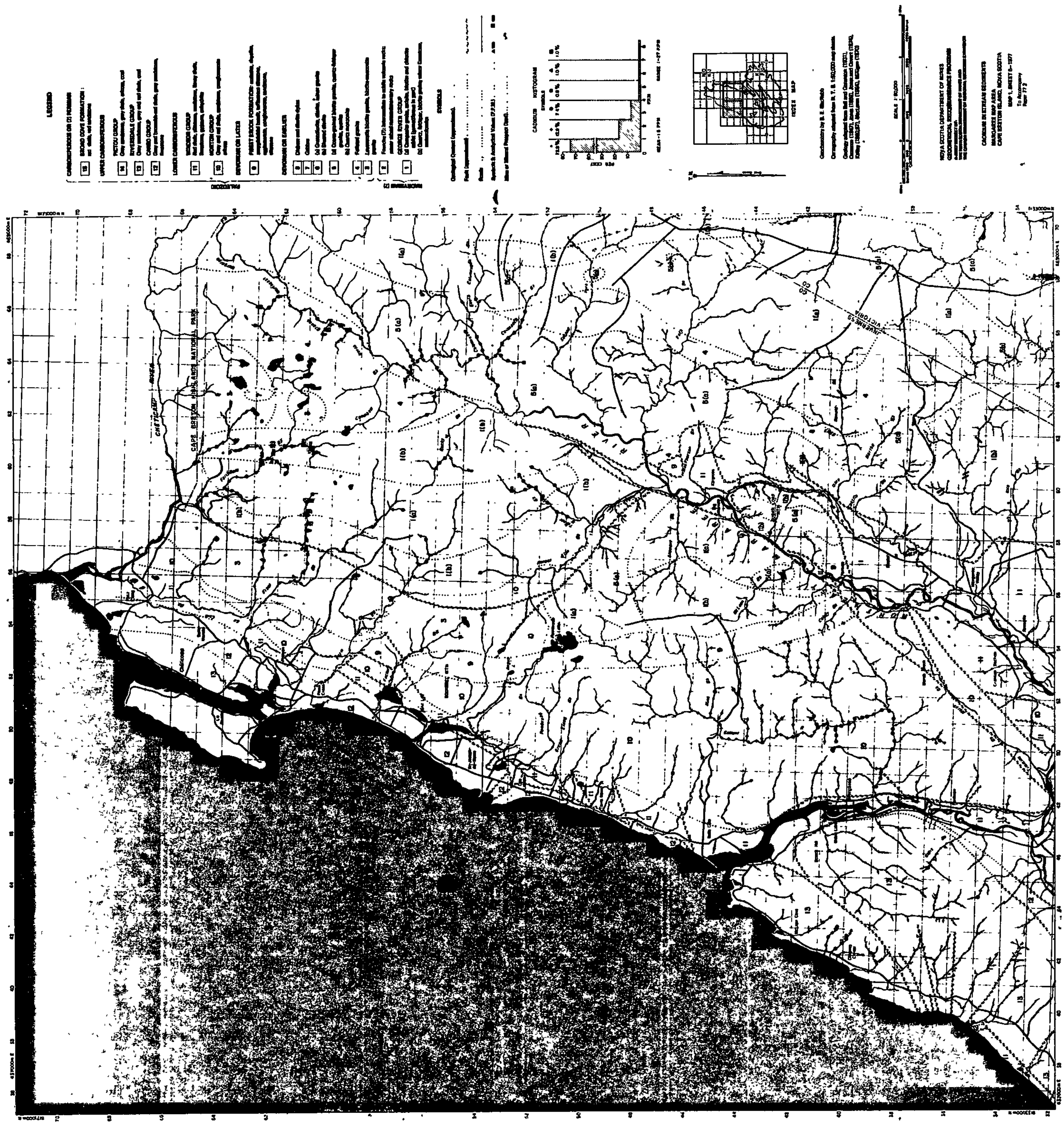
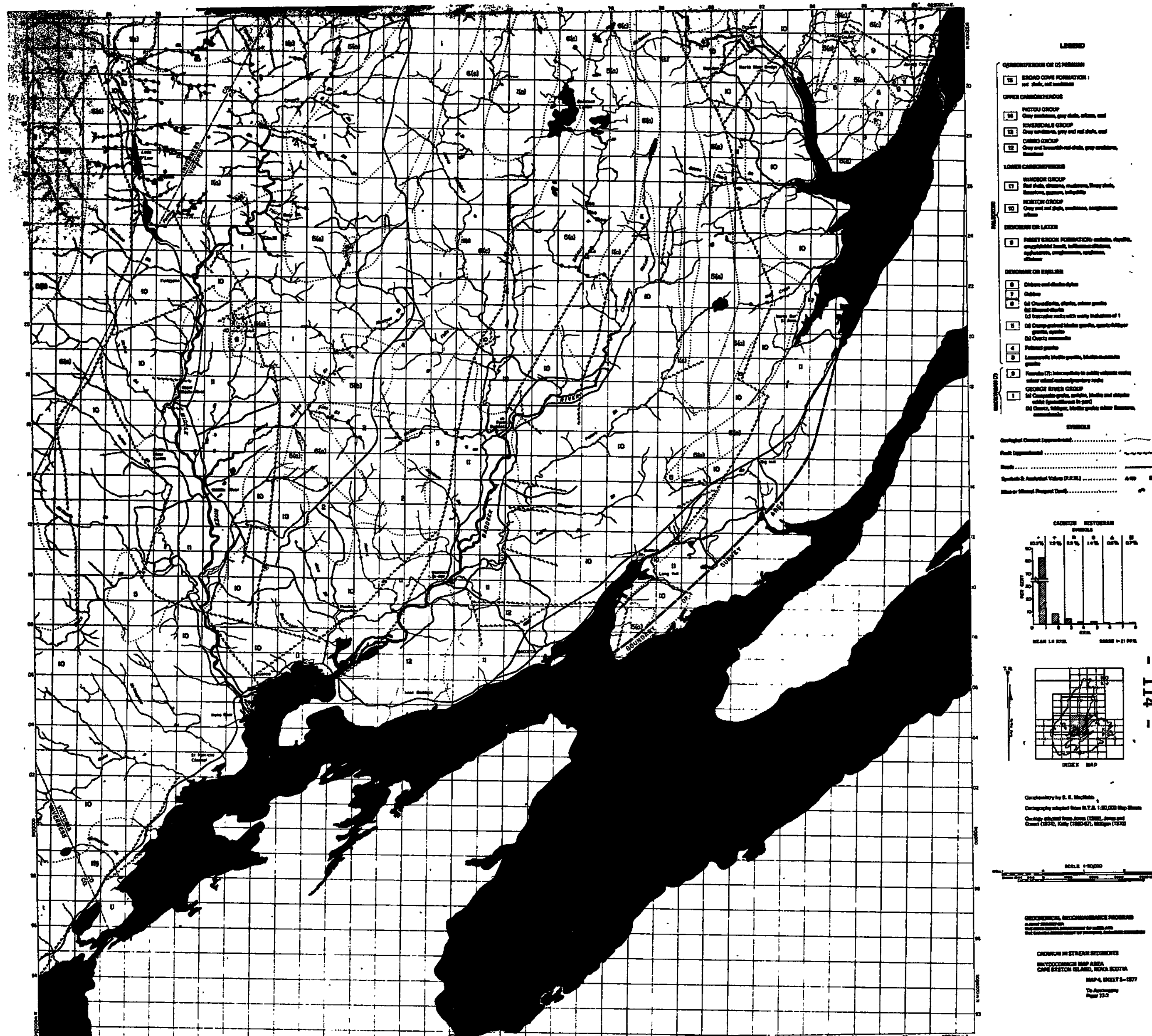


FIGURE 13 CADMIUM IN STREAM SEDIMENTS FROM THE MARGAREE AREA

FIGURE 14
CADMIUM IN
STREAM
SEDIMENTS
FROM THE
WHYCOCOMAGH
AREA



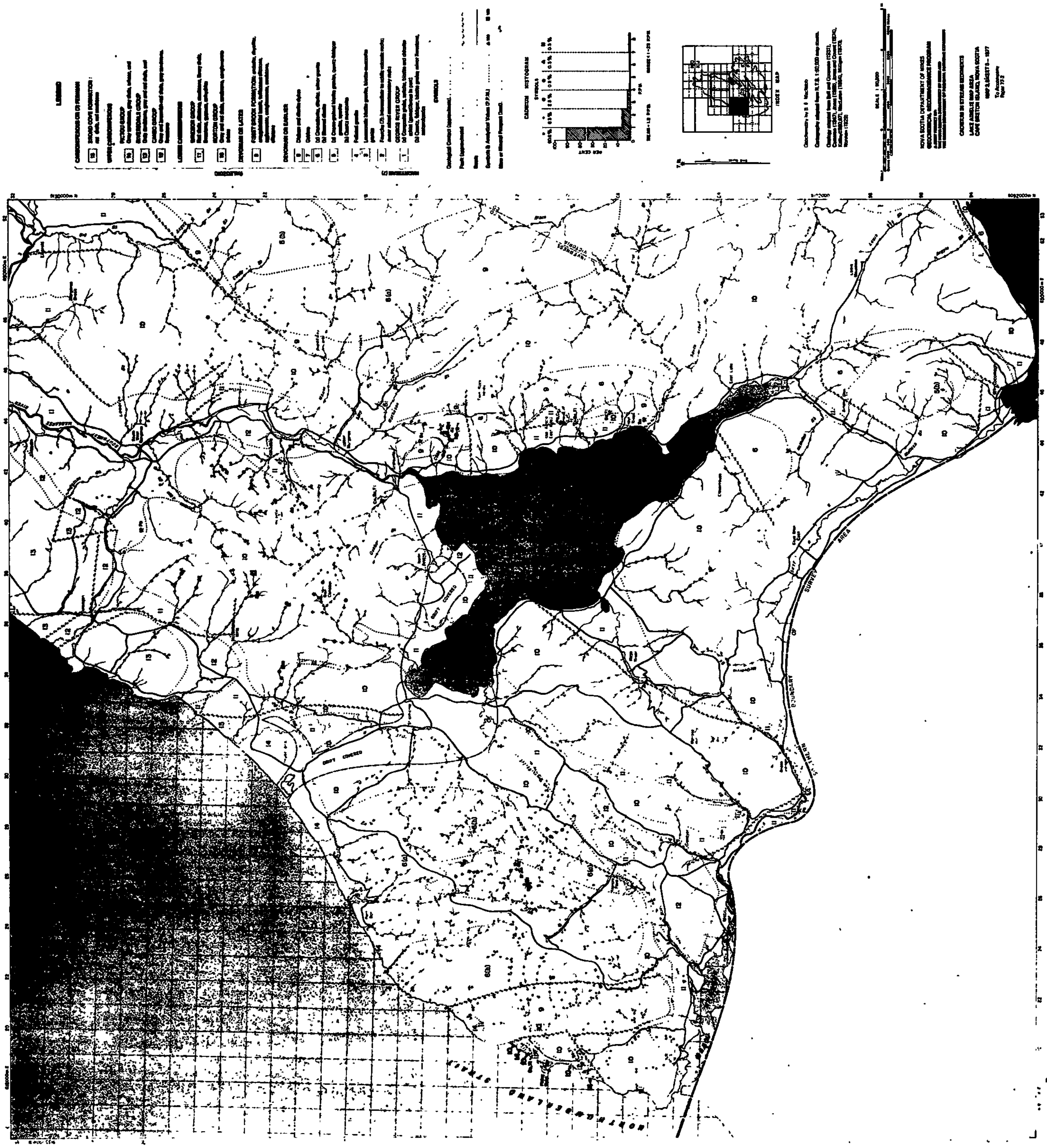


FIGURE 15 CADMIUM IN STREAM SEDIMENTS FROM THE LAKE ~~ANSLIE~~ AREA
AINSLIE

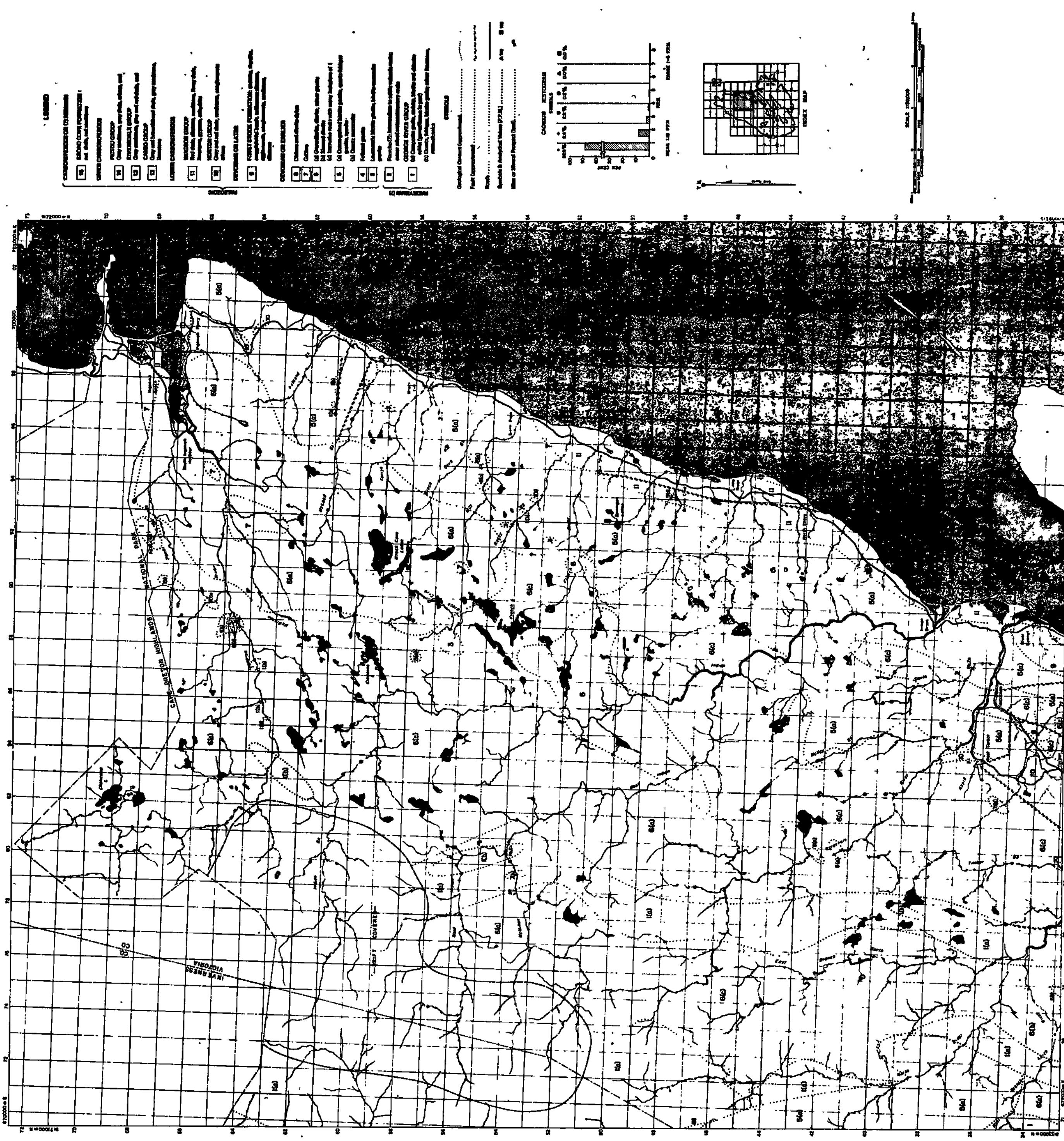


FIGURE 16 CADMIUM IN STREAM SEDIMENTS FROM THE WRECK COVE AREA

TABLE 37 SUMMARY OF NOVA SCOTIA DEPARTMENT OF MINES AND ENERGY SURVEY OF STREAM SEDIMENTS FOR CADMIUM CONTENT

MAP AREA	COUNTY OR COUNTIES	CADMIUM CONCENTRATION RANGE (μg/g)	AVERAGE CADMIUM CONCENTRATION (μg/g)
Cape George	Antigonish and Pictou	1-10	1.1
Antigonish	Antigonish, Pictou and Guysborough	1-8	1.1
New Glasgow	Pictou	1-40	1.1
Margaree	Cape Breton Island	1-27	1.5
Whycocomagh	Cape Breton Island	1-21	1.4
Lake Ainslie	Cape Breton Island	<1-25	1.2
Wreck Cove	Cape Breton Island	1-5	1.16

3.3.3 Estuarine Sediments

The cadmium content was measured in sediments collected from estuaries of three salmon-bearing rivers in northeastern New Brunswick: The Nepisiguit, Miramichi and Restigouche (Ray and White, 1977). The water quality of these rivers has deteriorated owing mainly to extensive mining activities in their catchment areas. Cadmium concentrations are listed in Table 38 and sampling locations are illustrated in Figures 17-19. In the Nepisiguit River estuary, the average is 1.51 μg/g and all sites excepting Site 10 exceed the 0.6 μg/g of the ODCA. In fact, two-thirds of the sampling sites have cadmium levels far in excess of the acceptable maximum. In the case of the Miramichi and Restigouche, one site in each river shows a cadmium concentration much in excess of 0.6 μg/g, however, an insufficient number of sampling sites allow only a qualitative picture to be obtained.

3.3.4 Coastal Sediments

The abundance and distribution of a number of heavy and transition metals, including cadmium, in the Bay of Fundy sediments has recently been investigated (Loring, 1979). Total cadmium concentrations were determined using a flameless atomic absorption technique. The average total cadmium concentration was calculated to be 0.24 μg/g dry weight. Unlike most of the other metals studied, cadmium levels showed only slight changes with sediment grain size. High cadmium anomalies were found near the dredge disposal site off Saint John Harbour and were assumed to reflect anthropogenic inputs to the local environment.

TABLE 38 CADMIUM CONCENTRATION IN NORTHEASTERN NEW BRUNSWICK SEDIMENT SAMPLES, JULY, 1973

LOCATION		CADMIUM CONCENTRATION
RIVER	SITE NO.	(μg/g air dry)
Nepisiguit	1	0.88
	2	0.53
	3	0.95
	4	1.2
	5	0.96
	6	2.0
	7	3.8
	8	2.8
	9	2.6
	10	0.42
	11	0.67
Miramichi	1	0.53
	2	0.51
	3	0.61
	4	0.94
Restigouche	1	0.60
	2	0.56
	3	1.1

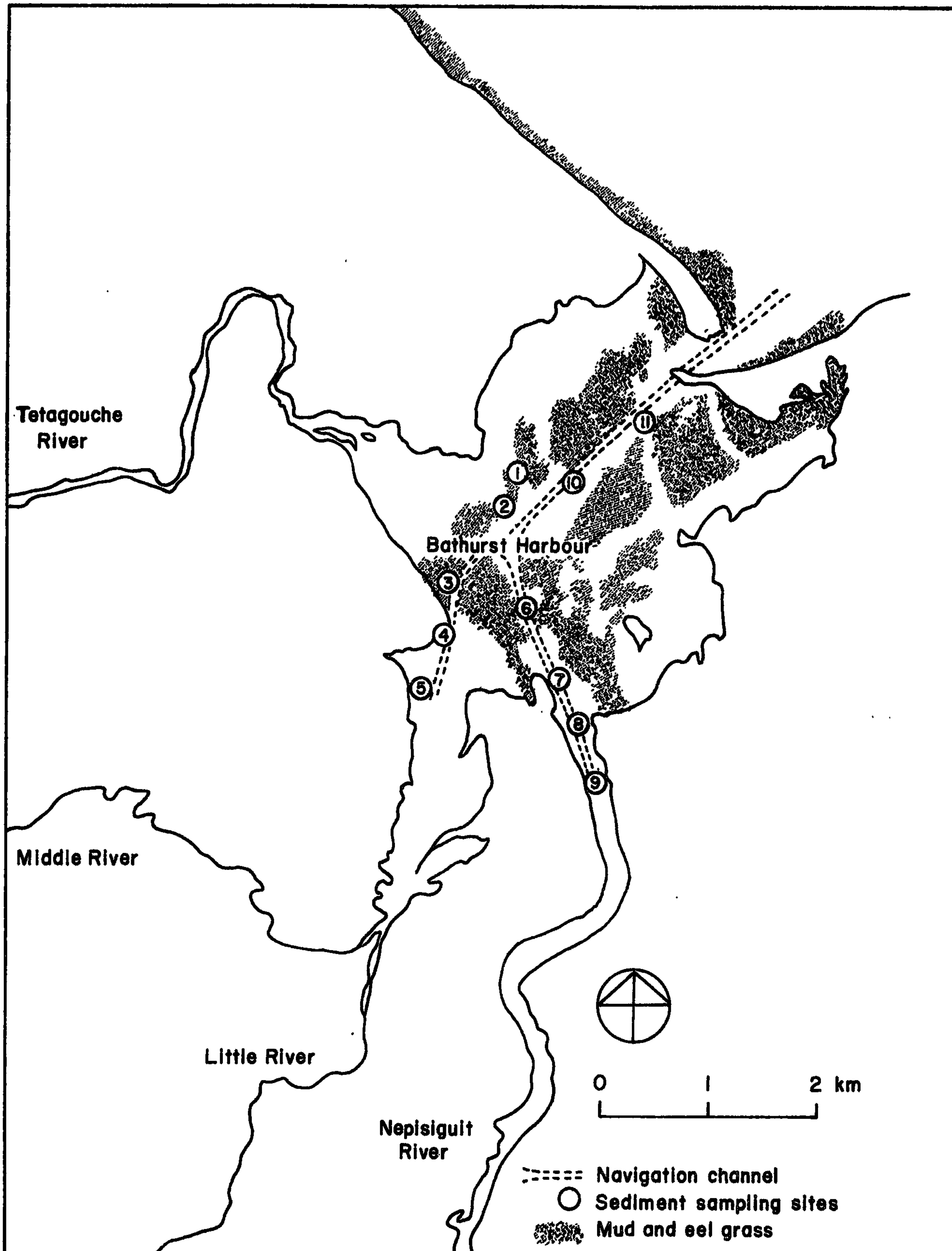


FIGURE 17 SAMPLING SITES IN THE NEPISIGUIT RIVER

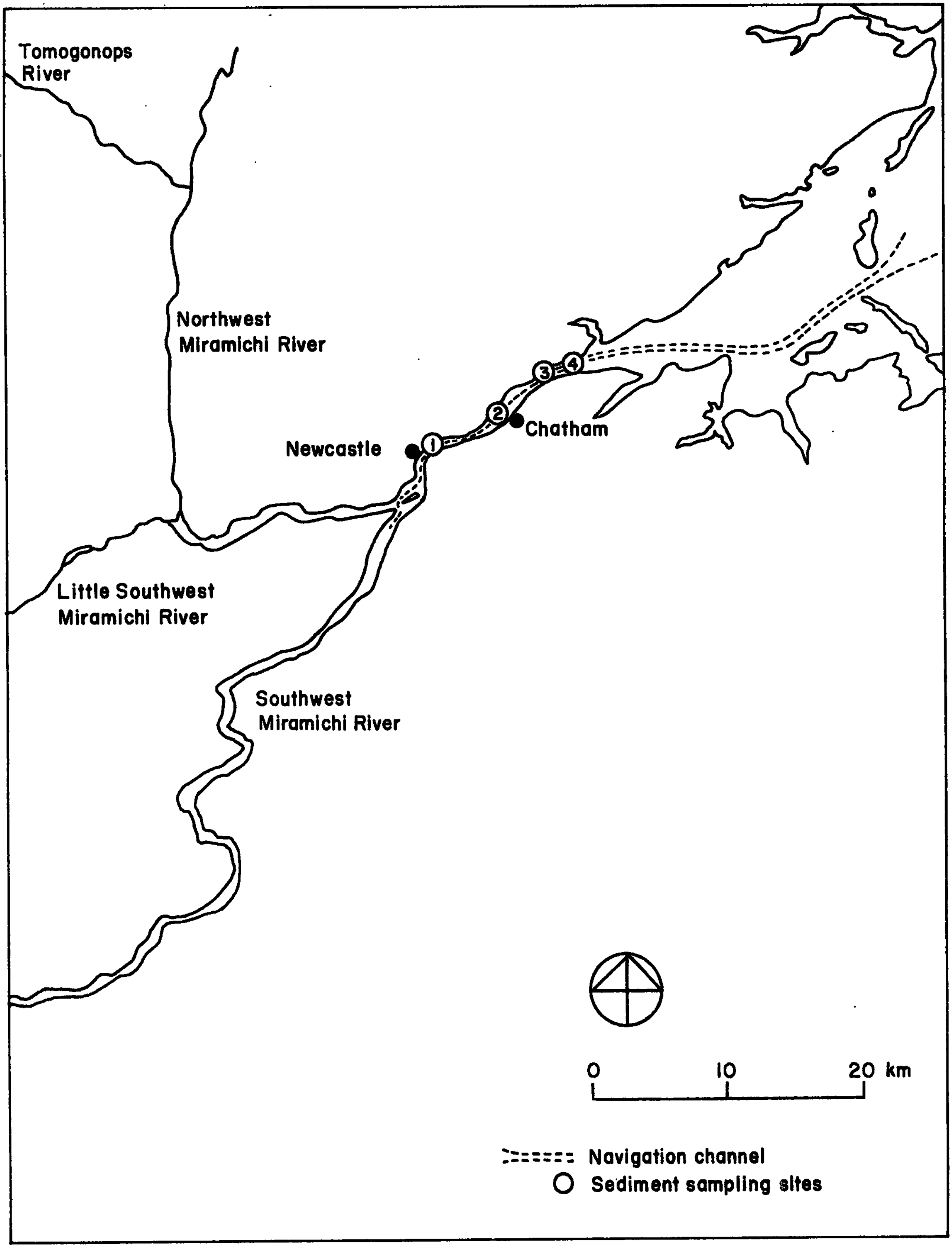


FIGURE 18 SAMPLING SITES IN MIRAMICHI RIVER

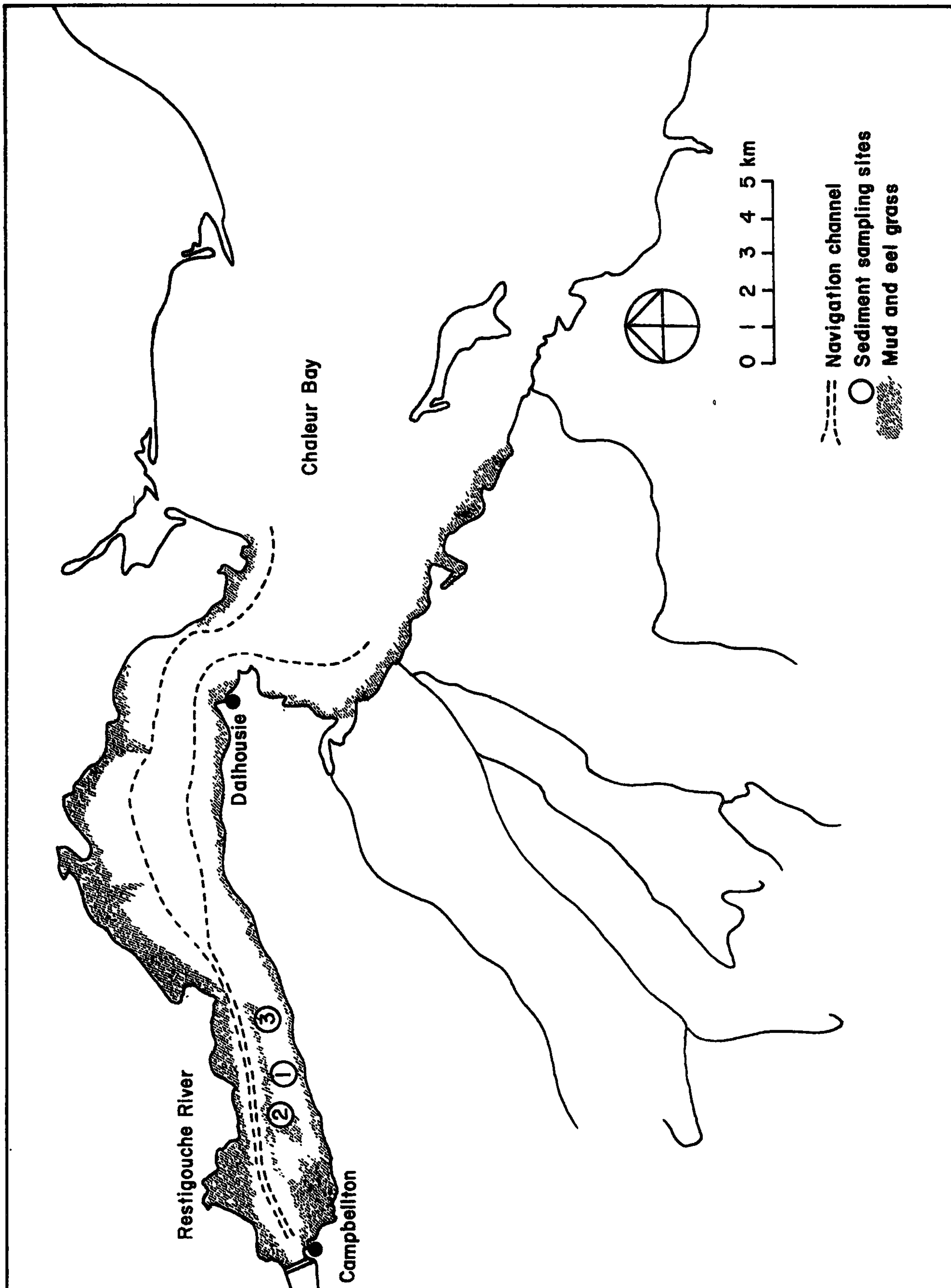


FIGURE 19 SAMPLING SITES IN THE RESTIGOUCHE RIVER

3.4 Cadmium in Soils

The only available source of information on the cadmium content of soils in the Atlantic Region is data from an on-going program of the Nova Scotia Agricultural College (MacLaren and Langille, 1980). Background levels of acid extractable (0.1N HCl) heavy metals in Nova Scotia soils were evaluated and the effects of pH, organic matter and clay content on these levels examined.

Soils were sampled in the agriculturally important North Shore and Annapolis Valley areas of Nova Scotia which include the counties of Cumberland, Colchester, Pictou, Antigonish, Hants, Kings and Annapolis. Samples were taken at the 0-15 cm. and 15-30 cm. depths at each location for a total of 864 samples. Sample sites were mainly sod covered fields representing pasture and unfertilized hay fields.

Natural background cadmium levels were found to be similar in both areas, with a range of 0.012-0.47 μg/g. Higher cadmium levels were found in the upper soil layers probably indicating the effect of atmospheric fallout, biological recycling and use of heavy motorized equipment. Results also indicate that fine textured North Shore soils are not as influenced by variations in organic matter content and pH as are coarse textured Annapolis Valley soils. Clay content has little effect on cadmium content in either area. A comparison of pH, organic matter, clay and cadmium content of the two areas is given in Tables 39 and 40.

TABLE 39 CADMIUM CONTENT OF NORTH SHORE SOILS

PARAMETER	0-15 cm.		15-30 cm.	
	AVERAGE	RANGE	AVERAGE	RANGE
pH	5.28	4.2-7.1	5.23	4.3-7.3
Organic Matter(%)	9.02	0.49-22.67	5.82	0.78-25.36
Clay(%)	20.88	1.0-47.0	20.52	1.0-54.0
Cadmium (μg/g)	0.120	0.012-0.430	0.069	0.012-0.376

TABLE 40 CADMIUM CONTENT OF ANNAPOLIS VALLEY SOILS

PARAMETER	0-15 cm		15-30 cm	
	AVERAGE	RANGE	AVERAGE	RANGE
pH	5.38	3.4-6.6	5.32	3.50-6.40
Organic Matter(%)	7.88	1.88-47.50	4.87	1.53-18.50
Clay(%)	16.86	3.0-43.0	16.15	3.0-50.0
Cadmium (μg/g)	0.099	0.012-0.469	0.065	0.012-0.349

3.5 Cadmium in Aquatic Biota

3.5.1 Cadmium in Aquatic Vegetation

Many aquatic plants are effective concentrators of cadmium. Ray and White (1976) demonstrated that some aquatic plants selectively accumulate specific metals, including cadmium, and can serve as biological monitors. Two vascular plant genera, *Potamogeton* and *Equisetum* and a blue alga *Oscillatoria* proved especially useful for monitoring metal pollution. The authors speculated that cadmium levels had reached an equilibrium value for the plants investigated in the Nepisiguit River system in New Brunswick, an area of base-metal mining. A summary of the cadmium concentration in various plants and the surrounding water is given in Table 41.

Ray and White (1979) also investigated the extent of cadmium accumulation in plant specimens (*Equisetum arvense*) collected from below the high water line of rivers in a highly metallogenic base-metal mining area of northeastern New Brunswick. Concentrations of cadmium in samples of water and plant tissue are listed in Table 42. The rhizomes and roots had higher metal contents than aerial stems in all cases. There was a definite trend of high cadmium levels in plants from polluted sites. In general, metal concentrations were higher in July, when the plants were growing, than later in the season. Seasonal variations in the cadmium content of E. *arvense* are given in Table 43. It was concluded that the differences in metal content of the tissues resulted from environmental differences and reflected the integrated metal concentrations in water over a long period.

TABLE 41 CADMIUM CONCENTRATIONS IN AQUATIC PLANT SAMPLES (µg/g DRY WEIGHT) AND SURROUNDING WATER (mg/l) FROM THE NEPISIGUIT RIVER SYSTEM IN NEW BRUNSWICK (RAY AND WHITE, 1976)

SITE	SPECIES/WATER	CADMIUM
1[a]	*Potamogeton richardsonii*	
	- Rhizomes and roots	1.32
	- Leaves and above ground stems	0.65
	- Water	<0.0005
2	*Equisetum fluviatile*	
	- Below ground	5.54
	- Above ground	6.08
	- Water	<0.0005
3	*Potamogeton richardsonii*	
	- Rhizomes and roots	6.73
	- Leaves and above ground stems	4.86
	- Water	<0.0005
4	*Oscillatoria*	0.85
	- Water	0.0050
5	*Oscillatoria*	0.98
	- Water	0.0005
6	*Equisetum fluviatile*	
	- Below ground	3.59
	- Above ground	0.92
	- Water	0.0026

a Uncontaminated site - above any mining.

TABLE 42 CADMIUM CONCENTRATION IN WATER (mg/l) AND *Equisetum arvense* (μg/g DRY TISSUE) COLLECTED IN A BASE-METAL MINING AREA OF NORTHEASTERN NEW BRUNSWICK (RAY AND WHITE, 1979)

SAMPLE NUMBER	SAMPLE TYPE	CADMIUM
1	Water	<0.0005
	Plant - above ground	0.5
	- underground	3.0
2	Water	<0.0005
	Plant - above ground	2.4
	- underground	7.3
3	Water	<0.0005
	Plant - above ground	0.5
	- underground	1.0
4	Water	<0.0005
	Plant - above ground	0.1
	- underground	0.3
5	Water	<0.0005
	Plant - above ground	0.1
	- underground	0.3

TABLE 43 SEASONAL VARIATION OF CADMIUM CONCENTRATION IN WATER (mg/l) AND *Equisetum arvense* (μg/g DRY TISSUE) (RAY AND WHITE, 1979)

SAMPLE NUMBER	SAMPLE TYPE	CADMIUM	
		JULY	SEPTEMBER
3	Water	<0.0005	<0.0005
	Plant - above ground	0.2	0.5
	- underground	2.2	1.0
5	Water	<0.0005	<0.0005
	Plant - above ground	0.1	0.1
	- underground	0.3	0.3

3.5.2 Cadmium in Aquatic Animals

Much of the available data on cadmium in aquatic animals is the result of studies conducted in the northeastern New Brunswick coastal areas adjacent to Belledune and Dalhousie...established areas of cadmium contamination. The two Noranda reports mentioned in Section 3.1.1.2 and the MacLaren Marex study summarized in Section 3.3.1 contain data on cadmium levels in shellfish and finfish collected in these areas. The results of an EPS survey in the vicinity of Belledune Point are listed in Table 44.

Additional data is available in a series of Co-operative Research Papers published under the auspices of the International Council for the Exploration of the Sea (ICES). Chou and Uthe (1978) analyzed the digestive glands of American lobsters, Homarus americanus, collected from the Atlantic coast of Canada for several heavy metals. In addition to lobster digestive gland, lobster claw muscle and rock crab, Cancer irroratus, were assayed. Concentrations of cadmium were not found to be highly inter-correlated with other heavy metal values. The results are presented in Table 45.

Freeman and Uthe (1974) determined cadmium levels in the edible portions of lobsters from selected areas chosen to sample the bulk of the lobster fishery in the four Atlantic provinces. Most of the cadmium was in the digestive gland (used for lobster paste) and area geometric means ranged from 2.82 to 16.73 μg/g. Muscle levels were less than 1.0 μg/g cadmium. Calculated cadmium levels in the total edible portion ranged from 0.51 to 2.98 μg/g. Most of the cadmium was thought to be of geologic origin. Data from this study are summarized in Tables 46 and 47.

TABLE 44 CADMIUM CONCENTRATION IN *Mytilus edulis* IN THE VICINITY OF BELLEDUNE POINT, NEW BRUNSWICK, 1977 (μg/g WET WEIGHT)

SAMPLING LOCATION	RANGE	AVERAGE CADMIUM CONCENTRATION
Little Belledune Point	0.9-27.0	9.8
Chapel Point	17.0-29.0	24.6
Belledune Point-South of Bar	3.7- 5.9	5.0
Hendry Brook	6.8-21.0	16.3
Quitard Brook	13.0-14.0	13.5
Pointe Verte	3.1- 5.9	4.5
Petit Rocher	1.2- 7.8	4.5

TABLE 45 GEOMETRIC MEAN AND RANGES OF CADMIUM IN LOBSTER DIGESTIVE GLAND, CLAW MUSCLE AND ROCK CRAB DIGESTIVE GLAND (CHOU AND UTHE, 1978)

SAMPLE AND LOCATION	CADMIUM CONCENTRATION (μg/g Wet Weight)
Halifax(N.S.) Lobster Digestive Gland (N[a] = 17)	8.59 (4.64-15.1)[b]
North Lake(P.E.I.) Lobster Digestive Gland (N = 20)	12.9 (5.48-38.9)
Shediac(N.B.) Lobster Digestive Gland (N = 20)	12.7 (4.37-47.4)
Victoria Beach(N.S.) Lobster Digestive Gland (N = 23)	7.02 (3.04-16.2)
Petit Rocher(N.B.) Lobster Digestive Gland (N = 20)	3.67 (1.69-10.07)
Victoria Beach(N.S.) Rock Crab Digestive Gland (N = 17)	2.02 (0.54-20.6)

a N represents number of samples analyzed.
b Blanket values represent minimum and maximum results.

TABLE 46 GEOMETRIC MEAN CADMIUM CONCENTRATION IN LOBSTER DIGESTIVE GLAND (μg/g Cd/g WET WEIGHT) FROM VARIOUS AREAS IN THE ATLANTIC LOBSTER FISHERY (FREEMAND AND UTHE, 1974)

SAMPLE SITE	N[a]	CADMIUM LEVEL	RANGE
NEWFOUNDLAND			
Arnold's Cove	50	8.82	2.5-48.9
Britannia	20	12.63	4.8-30.3
Comfort Cove	21	2.82	1.7- 6.9
Lark Harbour	25	10.89	3.8-33.6
Port Aux Basques	27	10.70	4.3-45.0
Bay L'Argent	26	10.83	4.6-20.2
NEW BRUNSWICK			
Gaspé (Quebec)	26	10.53	4.2-46.7
Chaleur Bay	26	4.30	1.8-10.7
Shippegan	26	3.79	1.6-11.3
Neguac	26	4.72	2.5-28.7
Richibucto	26	6.26	3.8-14.4
Tormentine	24	10.90	4.1-22.4
Grand Manan	26	6.93	2.6-31.5
PRINCE EDWARD ISLAND			
Tignish	25	14.03	5.5-37.8
French River	26	11.95	2.3-48.2
North Lake	24	16.73	7.2-53.4
NOVA SCOTIA			
Pictou	26	14.36	3.7-79.1
Chéticamp	23	9.14	2.1-36.3
Main-à-Dieu	26	12.58	4.9-47.2
Arichat	25	7.87	3.2-31.7
Tangier	26	6.53	2.4-20.0
Sambro	25	8.03	2.0-18.0
Liverpool	26	5.19	1.3-16.7
Pubnico	20	10.68	5.2-21.4
Digby	26	6.50	2.9-15.4

a Number sampled.

TABLE 47 AVERAGE CADMIUM CONTENT IN LOBSTER EDIBLE PORTION ASSUMING 98% OF THE CADMIUM IS IN THE DIGESTIVE GLAND AND THE LOBSTER DRESSES AT 30% INCLUDING DIGESTIVE GLAND (FREEMAN AND UTHE, 1974)

SAMPLE SITE	TOTAL AV. WT.(G)	AV. DIGESTIVE GLAND WEIGHT(G)	AV. CADMIUM/ EDIBLE PORTION(μ g/g)
NEWFOUNDLAND			
Arnold's Cove	532	32.1	1.81
Britannia	639	33.1	2.23
Comfort Cove	538	28.7	0.51
Lark Harbour	631	28.5	1.67
Port Aux Basques	476	29.5	2.26
Bay L'Argent	559	32.9	2.17
NEW BRUNSWICK			
Gaspé (Quebec)	561	27.3	1.74
Chaleur Bay	436	25.0	0.84
Shippegan	478	25.6	0.69
Neguac	350	21.2	0.97
Richibucto	460	22.2	1.03
Tormentine	561	27.0	1.78
Grand Manan	530	26.8	1.19
PRINCE EDWARD ISLAND			
Tignish	538	27.3	2.42
French River	491	24.5	2.03
North Lake	599	31.4	2.98
NOVA SCOTIA			
Pictou	482	23.1	2.34
Cheticamp	613	34.4	1.74
Main-à-Dieu	552	30.8	2.39
Arichat	536	21.0	1.30
Tangier	495	24.5	1.10
Sambro	680	30.1	1.21
Liverpool	547	26.5	0.86
Pubnico	475	24.5	1.87
Digby	467	22.3	1.06

Ray and co-workers (Ray et. al., 1979) compared the cadmium concentrations of several bottom-dwelling marine invertebrates with levels in sediments from the collection sites for three locations in coastal New Brunswick. The data, for the most part, indicated that the cadmium concentrations within the animals tended to be relatively constant regardless of the metal content of the sediment, at least over the range of concentrations studied. The data is listed in Table 48.

Pearce (1978) compiled heavy metal data for finfish and shellfish from the Northwest Atlantic for use as baseline data by ICNAF. A few of the collection sites were sufficiently close to the western end of the Nova Scotian coast to warrant inclusion in this report. Table 49 lists the fish species mean cadmium concentration and other available information. None of the samples contained mean levels of cadmium exceeding values presently acknowledged to be harmful from a human consumption point of view.

3.6 Cadmium in Air

A special National Air Pollution Surveillance (NAPS) program conducted in the Atlantic Region in April and May of 1975 showed cadmium levels well within the normal ranges reported in Section 2.3. Data from the survey (NAPS, 1975) are presented in Table 50.

TABLE 48 CADMIUM IN SEDIMENTS AND INVERTEBRATES FROM THREE COASTAL AREAS IN NEW BRUNSWICK (RAY *et. al*., 1979)

SEDIMENT/INVERTEBRATE	CADMIUM (μg/g WET WEIGHT)
Sediment	0.06 - 6.9
Crangon	0.40 - 1.45
Gammarus	0.6 - 1.85
Mysis	0.15 - 0.25
Polychaete	0.15 - 0.2
Macoma	0.10 - 0.45

TABLE 49 CADMIUM CONCENTRATIONS IN FINFISH AND SHELLFISH COLLECTED OFF THE WESTERN COAST OF NOVA SCOTIA (PEARCE, 1978)

FISH SPECIES	DATE OF COLLECTION	YEAR-CLASS OR LENGTH	TYPE OF TISSUE AND NUMBER OF SAMPLES	MEAN CADMIUM CONCENTRATION (μg/g Wet Wt.)
			muscle	
Cod (_Gadus morhua_)	-	-	8	0.056
Atlantic Pollock (_Pollachius virens_)	-	-	8	0.051
White Hake (_Urophyeis tenvis_)	-	-	8	0.074
			whole fish	
Ballyhoo (_Hemiramphus brasiliensis_)	-	-	24	0.095

TABLE 50 CADMIUM IN AIR (μg/m^3) AT VARIOUS ATLANTIC REGION LOCATIONS

PROVINCE AND LOCATION	DATE	CADMIUM
NOVA SCOTIA		
Halifax	April 18, 1975	0.003
-N. S. Technical College	April 24, 1975	0.000
	April 30, 1975	0.000
	May 6, 1975	0.001
	May 12, 1975	0.001
	May 18, 1975	0.001
	May 24, 1975	0.000
	May 30, 1975	0.003
Halifax	April 18, 1975	0.003
-Dalhousie Univeristy	April 24, 1975	0.003
	April 30, 1975	0.013
	May 6, 1975	0.000
	May 12, 1975	0.004
	May 18, 1975	0.001
	May 24, 1975	0.000
	May 30, 1975	0.000
Halifax	April 18, 1975	0.000
-Mount Saint Vincent University	April 24, 1975	0.000
	April 30, 1975	0.000
	May 6, 1975	0.004
	May 12, 1975	0.001
	May 18, 1975	0.001
	May 24, 1975	0.000
	May 30, 1975	0.000
Dartmouth	April 18, 1975	0.000
- C.F.B. Shearwater	April 24, 1975	0.000
	April 30, 1975	0.000
	May 6, 1975	0.004
	May 12, 1975	-
	May 18, 1975	0.006
	May 24, 1975	0.000
	May 30, 1975	0.000

Cont'd

TABLE 50 (CONT'D)

PROVINCE AND LOCATION	DATE	CADMIUM
NOVA SCOTIA (Cont'd)		
Sydney	April 18, 1975	0.000
	April 24, 1975	0.000
	April 30, 1975	0.000
	May 6, 1975	0.005
	May 12, 1975	0.005
	May 18, 1975	0.008
	May 24, 1975	0.000
	May 30, 1975	0.000
NEW BRUNSWICK		
Fredericton	April 18, 1975	0.000
	April 24, 1975	0.000
	April 30, 1975	0.010
	May 6, 1975	0.003
	May 12, 1975	0.000
	May 18, 1975	0.000
	May 24, 1975	0.000
	May 30, 1975	0.000
Saint John	April 18, 1975	0.000
	April 24, 1975	0.000
	April 30, 1975	0.003
	May 6, 1975	0.007
	May 12, 1975	0.004
	May 18, 1975	0.001
	May 24, 1975	0.000
	May 30, 1975	-
Moncton - C.F.B. Shearwater	April 18, 1975	0.000
	April 24, 1975	0.000
	April 30, 1975	0.003
	May 6, 1975	0.001
	May 12, 1975	0.004
	May 18, 1975	0.002
	May 24, 1975	0.000
	May 30, 1975	0.000

Cont'd

TABLE 50 (CONT'D)

PROVINCE AND LOCATION	DATE	CADMIUM
PRINCE EDWARD ISLAND		
Charlottetown	April 18, 1975	0.000
	April 24, 1975	0.000
	April 30, 1975	0.000
	May 6, 1975	0.007
	May 12, 1975	0.004
	May 18, 1975	0.007
	May 24, 1975	-
	May 30, 1975	-
NEWFOUNDLAND		
St. John's	April 18, 1975	0.003
	April 24, 1975	-
	April 30, 1975	-
	May 6, 1975	0.007
	May 12, 1975	-
	May 18, 1975	-
	May 24, 1975	0.000
	May 30, 1975	0.003

TABLE 51 CADMIUM EMISSIONS BY SECTOR IN THE MARITIME PROVINCES

SECTOR	EMMISSION SOURCE	CADMIUM (lbs)
Industry	Primary lead production	6,079
	Primary iron and steel production	1,359
	Iron and steel foundries	249
Fuel Combustion/ Stationary Sources	Power generation	16,210
	Industrial and commercial	32,543
	Domestic	1,588
Transportation	Motor vehicles	22
	Rail transport	108
	Shipping	-
	Aviation	negligible
	Tire wear	9
Solid Waste Incineration		393
Pesticide Application		5
TOTAL		58,565

TABLE 52 CADMIUM EMISSIONS BY SECTOR IN NEWFOUNDLAND

SECTOR	EMMISSION SOURCE	CADMIUM (lbs)
Industry	Iron and steel foundries	22
Fuel Combustion/ Stationary Sources	Power generation	840
	Industrial and commercial	597
	Domestic	314
Transportation	Motor vehicles	6
	Rail transport	42
	Shipping	-
	Aviation	negligible
	Tire wear	2
Solid Waste Incineration		-
Pesticide Application		5
TOTAL		1,828

A national inventory of cadmium sources and emissions in Canada was conducted in 1972. Of the total 560 tons of cadmium emitted to the atmosphere that year only 30.2 tons or 5.4% originated in the Atlantic Region. Tables 51 and 52 give cadmium emissions by sector for the Maritime Provinces and Newfoundland respectively.

4 SUMMARY

Discussion of the environmental hazard posed by cadmium and its ultimate fate in ecosystems has been deferred to the national report being prepared for the DOE/NHW Environmental Contaminants Committee. It will provide information concerning the need for new controls on cadmium and its compounds as provided by the terms of the Environmental Contaminants Act and by other applicable federal legislation.

In the Atlantic Region two instances of localized cadmium contamination have been identified. In the Belledune area of New Brunswick high levels detected in sediments and lobsters from the harbour are attributable to air and water emissions originating from a lead smelter operated by Brunswick Mining and Smelting and augmented by emissions from the adjacent Belledune Fertilizer Ltd. plant. The second "hot-spot" is Dalhousie Harbour where leaching from ore concentrate stored at the public wharf has resulted in cadmium contamination of the immediate area. Interestingly, the cadmium levels in sediments from a number of northeastern New Brunswick harbours (an area which includes Dalhousie and Belledune) are consistently in excess of the average value for other regional harbours. Whether this is a manifestation of discharges from Belledune or a reflection of the geological composition of the area is undetermined. The only other industry having a significant cadmium content in its liquid waste is IMP Aerospace. The environmental implications of the dry well disposal method used at this operation have not been assessed.

Cadmium concentrations in the waters of lakes and rivers which have been surveyed in the region range within normally accepted background levels. Minor variations are attributed to geological differences. Stream and river sediments in New Brunswick and Nova Scotia have, for the most part, cadmium levels between 1-2 μg/g whereas coastal sediments average approximately 0.2 μg/g. Values for aquatic plants located near base metal mining operations in New Brunswick appear to have abnormally high cadmium levels. These species apparently effect significant bioconcentration since water levels are not particularly elevated. There is considerable data substantiating contamination of aquatic animals, particularly lobsters, in the Belledune area. In a more general context, investigations have indicated considerable cadmium concentration in the digestive glands of lobsters captured in a regional survey; however, the source is suspected to be geological rather than anthropogenic in nature. Limited soil data indicated cadmium concentrations between 0.01 and 0.05 μg/g.

Cadmium values reported on permit applications for harbour and channel sediments are somewhat erratic and not easily interpretable. Areas of high concentration correlate poorly with the extent of shore based industrial activity. In addition, significantly different values from reasonably proximate locations seem to preclude geological variation as an explanation.

The limited data on regional air emissions suggest that the major sources of cadmium input are the lead smelter at Belledune and thermal power generating plants.

Analytical validity has not been discussed in this report; however, it is probable that some of the reported data is unreliable. Cadmium measurement, particularly at levels approaching the limit of detection, is an intricate analytical problem. The harbour and channel sediment data, much of which has originated in private laboratories, is particularly suspect. In the Laboratory Evaluation Program, First Quality Control Round Robin sponsored by RODAC in 1978 cadmium was found to be the most difficult of six analyzed elements to measure correctly and was done incorrectly by 55% (6 of 11) of the participating laboratories.

A paucity of air measurements is probably the most serious regional data gap. While enough evidence is available to suggest thermal power operations are responsible for substantial cadmium discharge, the extent and ultimate fate of such emissions are not well defined. The two identified regional hot-spots warrant continued monitoring so that improvement or deterioration of the situation may be assessed.

Nationally, as well as regionally, a clear understanding of the chronic and long-term effects of cadmium in different environmental matrices is required so that logical compliance and regulatory levels may be established.

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