

PR1981-014

EAST KEMPTVILLE PROJECT ENVIRONMENTAL ASSESSMENT

VOLUME II SUMMARY & IMPACT ASSESSMENT

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JACK J. LEYDON

PREPARED FOR
SHELL CANADA RESOURCES LIMITED
MINERALS DIVISION



THE ENVIRONMENTAL APPLICATIONS GROUP LIMITED

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NOVEMBER 26, 1981

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1. INTRODUCTION

1.1 BACKGROUND

Shell Canada Resources Limited proposes to develop a tin mining complex known as the East Kemptville Project in Yarmouth County in southwestern Nova Scotia (Figure 1). The project site would be located approximately 45 km northeast of the community of Yarmouth ($44^{\circ} - 09'$ north; $65^{\circ} - 41'$ west). The complex would include an open pit mine, a 6000 tonne/day capacity ore processing plant, a tailings management system, and associate infrastructure. Tin concentrate would be trucked, in sealed containers, to Halifax, where it would then be shipped abroad for further processing.

This report is an analysis of the potential environmental impacts associated with the development of the East Kemptville Project. A summary of the existing environmental and social conditions in the study area is provided as background to assist the reader in placing elements of the proposal in perspective. A detailed technical report of the baseline environmental setting has been prepared and submitted under separate cover.

Environmental studies have been under way at the East Kemptville Project since 1979, when The Environmental Applications Group Limited initiated a programme of water and sediment analyses, aquatic biological studies, and water level flow monitoring on a number of study area watercourses (Figure 2). The initial results of these surveys were summarized in November of 1979, and were submitted to the Nova Scotia Department of the Environment for review and comment (EAG 1979).

During 1980, the hydrology and water quality monitoring programmes continued throughout the year to examine seasonal variability in baseline data. A second progress report (EAG 1980) summarized these findings. In 1981, a wide range of ecological, socio economic and physical studies were undertaken to broaden the information base, in addition to the ongoing information being provided by the gauging and water quality sampling programmes which continue in operation.

Throughout these investigations, the study team has consulted with The Nova Scotia Department of the Environment, to ensure that concerns were identified and addressed at an early stage. The Environmental Applications Group Limited has worked closely with Shell Canada Resources Limited and its consultants in order that early environmental input into mine and facility layout and design could minimize the potentials for negative impacts.

1.2 THE PROJECT

Effective impact evaluation requires not only a knowledge of baseline conditions and possible environmental sensitivities, but also a sound appreciation of the facilities and processes involved in the development and operation of a tin mining complex which have the potential to affect the existing situation. This report is structured so as to consider each component of the project in turn.

As most readers will be aware, this document has been prepared during the feasibility stage of project planning, so that information regarding process and design options is subject to change if the project proceeds to the design engineering stage. Preliminary data have been provided to EAG by Shell Canada Resources Limited, by Kilborn Limited which has prepared the Preliminary Engineering Design Study, and by Jacques, Whitford and Associate Limited which has undertaken the geotechnical investigations and



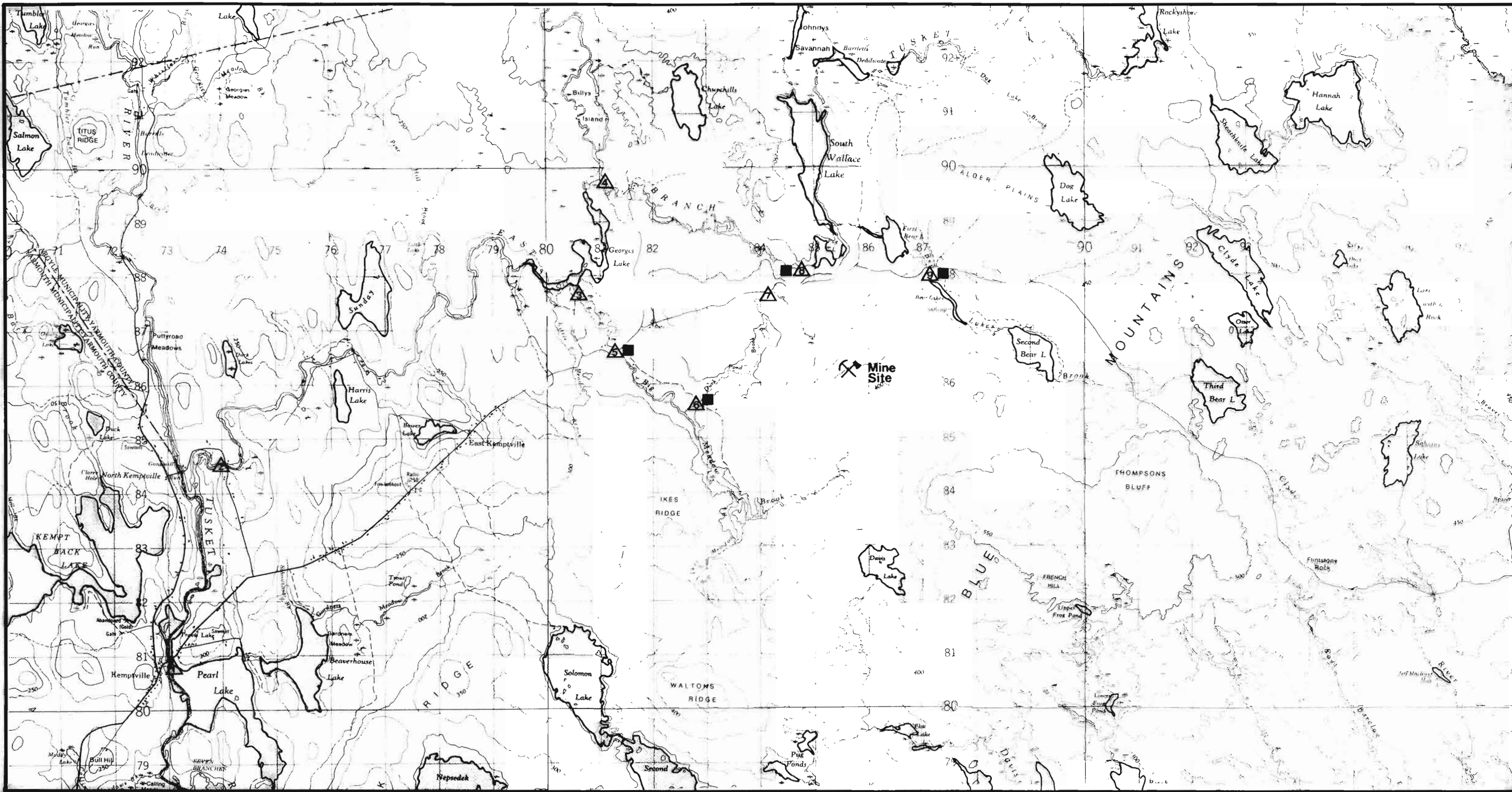
- ① CLAIR MUNICIPALITY
- ② YARMOUTH MUNICIPALITY
- ③ ARGYLE MUNICIPALITY
- ④ BARRINGTON MUNICIPALITY
- ⑤ SHELBURNE MUNICIPALITY

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FIGURE 1
PROJECT LOCATION

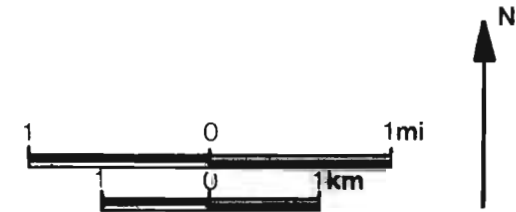


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▲ WATER QUALITY SAMPLING STATIONS

■ GAUGING STATIONS



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FIGURE 2
THE STUDY AREA

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preliminary design of the proposed tailings storage basin.

This report considers the nature and environmental implications of the following:

ROAD SYSTEM
SITE DRAINAGE
WATER SUPPLY
SEWAGE TREATMENT
TAILINGS SYSTEM STRUCTURES
TAILINGS SYSTEM HYDROLOGY
MATERIALS STORAGE
TRANSPORTATION
SOCIO-ECONOMIC IMPLICATIONS
OF PROJECT

Our studies indicate that intelligent design and sound engineering would ensure that the East Kemptville Project can be developed and operated without major negative impacts, even with respect to more sensitive components of the environment. Socio-economic benefits which would arise from the development, however, appear to be considerable.

2. SUMMARY OF BASELINE CONDITIONS

2.1 THE NATURAL ENVIRONMENTAL

2.1.1 Geology

The study area transects Late Cambrian - Early Ordovician metasediments of the Goldenville Formation (Meguma Group), and rocks of the southern Nova Scotia pluton, with the contact being in the immediate vicinity of the proposed mine site. Mineralizations occur along the contact face and in adjacent plutonic rocks. Granitic structures underlying eastern portions of the study area represent the western most occurrence of a massive granitic pluton which occupies much of mainland Nova Scotia. Areas underlain by granites tend to be higher in elevation than those underlain by more erosion prone metasediments.

Virtually the whole of the study area is mantled with a layer of coarse, sandy, stony till of uneven thickness. Large surface boulders are common in many areas with concentrations occurring in eastern and southern portions of the study area. Representation of more distinctive glacial features appears to be limited to scattered drumlinoid forms, knob and kettle terrains, and morainal complexes.

2.1.2 Forest Cover and Vegetation

The project site is situated along the East Tusket River and supports modestly productive forests of the Kempt Land System. Productivity rapidly decreases with distance from the river. Forests are largely mixed or coniferous, although some stands of oak and maple-beech occur. Few stands are either closed or mature. Generally, forest productivity has severe limitations because of infertibility and moisture status (Classes 4 to 7).

No significant or extensive wetlands occur within the project area. Nature reserves and an area designated under the International Biological Programme occur remote from the project. The closest (10 km away) contains several widespread heaths that are, in Nova Scotia, confined to the barrens of the southwest. None is likely to be influenced by the project.

2.1.3 Climatology

East Kemptville is located within the Atlantic Canada climatic region. The regional climate is modified continental, resulting, from marine interactions with predominantly west to east continental air masses. Influxes of moist Atlantic air may produce mild spells in winter and cool weather in the summer. Measurable precipitation days vary from about 160 near Yarmouth to about 100 to 120 days inland. Snowfall accounts for about 25% of precipitation.

Precipitation is seasonal with a winter maximum and late spring/early summer minimum. Annual total precipitation is in the 1200 to 1400 mm range. Median snow cover duration varies from 100 days along the coast to 130 inland. Based upon a small period of record, the 24 hr. rainfall amount for a 50 year storm is 103.7 mm and for a 100 year storm is 111.3 mm. The frequency of occurrence of hurricane remnants, and the short period of record limit the usefulness of these figures. Summaries of primary and secondary climatic elements are provided in Volume 1 of this submission.

2.1.4 Subsurface Drainage

Wells in the Appalachian hydrogeological region yield up to 20 litres per minute in paleozoic pre-carboniferous basement rocks. Drainage in depressional soils and peat is slow, largely because of topography, while in the Gibraltar series, soils which comprise the majority of the area, drainage is medium to rapid. Borehole

data near Second Bear Lake indicate bedrock drainage permeabilities of 1×10^{-5} to 1.5×10^{-3} cm/sec. The till layer appears to have very slow drainage in the area of the mine. Ground water quality, from the few data available, appears to be variable, with samples being near neutral, moderately coloured, soft waters. Iron and manganese concentrations exceeded drinking water objectives. In one sample, the arsenic concentration was slightly elevated.

2.1.5 Surface Waters

The East Kemptville Project is located within the watershed of the East Branch of the Tusket River. Water level recording gauges have been installed at four locations in the study area since 1979 (Figure 2). Long term hydrographs for the Tusket River show that flows have a prolonged but variable peak from December through April and an annual minimum in August.

Water falling into the northeastern section of the Tusket River watershed drains into the South Wallace Lake, Bear Lakes Brook and Big Meadow Brook sub-basins. Water falling to the east enters the Clyde, Roseway and Lake Rosignol watersheds. Hydrographs for site streams show a tendency towards higher discharges during November, December and March, and lower flows during summer. Flows ranged from 0.16 to 2.23 m³/sec at Big Meadow Brook and 0.01 to 2.34 m³/sec at Bear Lakes Brook. In general, these two sub-basins contribute about 5% of the total flow in the Tusket River Basin. Table 1 summarizes estimated long term monthly and annual flows for these watercourses and the East Tusket River below Pug Lake (Figure 2). Table 2 presents estimated daily mean flood peaks.

Water quality data for the Tusket River system show soft water with low levels of dissolved solids, major ions and nutrients. Water quality in general is good for most uses, although copper and mercury data for the main river may exceed objectives for aquatic life on occasion.

Of particular concern, particularly to anglers and fish managers, are the very low pH values observed in all branches of the Tusket system except the Carleton Branch, which appears to have greater buffering capacity (Table 3). These acid conditions, thought to result at least in part from acidic precipitation, have greatly reduced the reproductive success of Atlantic salmon in the system, even where other physical habitat conditions are suitable. Low pH may also contribute to the relatively low diversity and productivity apparent in the aquatic biota.

Water quality information collected near the project site (Table 4) shows all stations to have extremely soft water and pH values under 5. Lowest pH values were often associated with higher sulphate concentrations.

Water chemistry is to a great extent influenced by the ionic content of precipitation. Metal levels are generally well below objectives for surface water supplies and protection of aquatic life. Lead was not detectable and cadmium, in a few instances, was barely detectable at the 0.002 to 0.005 mg/l range.

2.1.6 Air Quality

Ambient air quality in the project area is near rural background levels due to remoteness from industrial and urban sources. Although ambient levels of most gaseous and particulate pollutants are expected to be low, the occurrence of acidic precipitation has been documented in the area. Monthly precipitation samples collected in Nova Scotia have generally had pH values below 5.0. A large part of sulphur deposition has been attributed to transport of distant emissions (Wiltshire 1979).

2.1.7 Soils

For the most part, soils are coarse textured, stony, sandy loams and gravelly sands. Organic soils are frequent in depressional areas

and on poorly drained flatlands. Hardpan development is a characteristic feature of many areas, particularly barrens of the Gibraltar series. Stoniness, poor drainage and topography make local lands suited to forest or blueberry production, but less so for more conventional agriculture.

2.1.8 Wildlife

Among the available habitat types, barrens (46.1%) and coniferous and mixed forests (50.5%) dominate the landscape. Wetland areas occupy about 3.4% of the land surface. White-tailed deer and moose occur, but caribou have long since disappeared. An approximate ratio of 100 deer per moose is likely in this area. The deer is the most important big game species although kill rates per unit area are lower in Yarmouth, Digby and Shelburne Counties than the provincial average.

The snowshoe hare is the most important upland game species and an important prey for local predators. Other game species include ruffed grouse, spruce grouse, American woodcock and common snipe. Fur returns for the area are typical for the province except for higher harvests of muskrat, mink and bobcat. Waterfowl capability is generally quite low in the study area. Habitats for raptors and other non-game species appear to be widely available in the area, with observed bird species being similar to those occurring in the Tobetic Resource Management Area.

Of the rare, endangered and sensitive species which likely occur in southern Nova Scotia, the great black-backed gull and the double-crested cormorant were noted feeding in the area during field studies, but there was no evidence to suggest local nesting for either species.

2.1.9 Aquatic Ecology and Fisheries

Studies of benthic invertebrate samples in the streams near the project site observed the generally low numbers of organisms and low levels of species diversity characteristic of cool, unproductive streams. While diversity indices were quite low (1.7 to 2.4) the species present suggested quite good water quality conditions. The factors which are likely to be most limiting to stream invertebrates, and other components of the aquatic food web, appear to be low pH and low nutrient levels.

Several fish species have historical importance in the Tusket River watershed. The Atlantic salmon once occurred, but barriers to migration (dams) and other factors resulted in the elimination of a self sustaining population. Low pH conditions currently inhibit natural reproduction of salmon (except in the Carleton Branch) and have prevented the re-establishment of the species, although good physical spawning and rearing habitat does occur, particularly in the East Tusket between George's Lake and North Kemptville. Big Meadow Brook and Bear Lakes Brook contain small areas of potential habitat for salmon.

Maintenance of a salmon fishery on a long term basis would require either continuous stocking of hatchery raised young fish which would grow in the river before going to the sea (sea ranching), or the raising of pH, particularly in the potential spawning areas, by adding limestone buffers. The latter is an experimental approach which has had modest success in Scandanvia and elsewhere, but the absence of suitable limestone in southern Nova Scotia makes this prospect expensive on a large-scale basis. Resident brook trout occur in the study area, particularly Little Meadow Brook, and are taken by anglers. Natural reproduction occurs but possibly is affected by acid conditions.

Other common resident species include yellow perch (abundant in lakes), bullhead and white suckers. The fishery for these species is minimal. Sea run species include the gas pareau, which spawns successfully in lakes and deadwaters (suitable habitat occurs in the East Tusket and tributaries), and is of considerable commercial interest in the lower Tusket. Striped bass occur only in the estuary, while shad are a minor resource. American eels are plentiful but little fishing effort now occurs on the Tusket.

TABLE 1
 ESTIMATED LONG TERM MONTHLY AND ANNUAL FLOWS¹
 (m³ s⁻¹)

<u>Station</u>	<u>Big Meadow Brook</u>	<u>Bear Lakes Brook</u>	<u>Pug Lake Outflow</u>
January	1.5	1.0	4.5
February	1.3	0.8	3.6
March	1.5	1.0	6.2
April	1.6	1.0	5.5
May	1.1	0.6	4.0
June	0.7	0.4	3.5
July	0.6	0.3	3.5
August	0.4	0.2	3.3
September	0.5	0.3	3.4
October	0.8	0.4	4.1
November	1.2	0.7	5.0
December	1.6	1.0	5.7
Annual	1.1	0.6	4.4

¹ by regression using Roseway River data

TABLE 2
 ESTIMATED DAILY MEAN FLOOD PEAK
 ($\text{m}^3 \text{ s}^{-1}$)

<u>Return Period (yrs)</u>	<u>Big Meadow Brook</u>	<u>Bear Lakes Brook</u>	<u>Pug Lake Outflow</u>
2	4 ± 2	6 ± 2	20 ± 7
20	10 ± 6	14 ± 8	50 ± 29
100	15 ± 11	20 ± 14	72 ± 50

TABLE 3
 SOME CHEMICAL CHARACTERISTICS OF SELECTED RIVERS IN
 NOVA SCOTIA DURING 1979-1980

River	Date	pH	Total		Specific Conductance (μ mho/cm)	Acidity (mg/L)	Total Alkalinity (mg/L)	Sulphate (mg/L)	Chloride (mg/L)	Apparent Colour (rel-units)
			Hardness (mg/L)	Alkalinity (mg/L)						
Tusket at Gavelton	Mar/79	4.55	4.2	<0.5	38.3	6.1	<0.5	-	-	70
	Sept/79	4.85	4.6	<0.5	37.3	8.5	<0.5	-	5.1	>100
	Feb/80	4.75	4.5	0.4	44.6	7.1	0.4	3.7	8.8	>100
Carleton at Reynardton	Mar/79	5.40	8.4	<0.5	45.2	4.5	<0.5	-	-	40
	Sept/79	6.09	7.0	1.0	42.0	2.7	1.0	-	7.3	25
	Feb/80	5.85	7.4	<0.5	41.6	3.9	<0.5	4.0	8.9	90
Quinan R. near Quinan	Mar/79	4.54	6.0	<0.5	46.0	6.2	<0.5	-	-	70
	Sept/79	4.99	5.0	<0.5	39.4	5.8	<0.5	-	7.5	90
	Feb/80	4.78	4.6	<0.5	40.3	7.2	<0.5	4.0	8.2	>100
North Br. Tusket above Nor- th Kempt ville	Mar/79	4.55	4.5	<0.5	39.9	6.2	<0.5	-	-	60
	Sept/79	4.69	5.4	<0.5	41.2	11.8	<0.5	5.2	5.9	>100
	Feb/80	4.90	6.3	0.5	44.8	6.1	0.5	4.1	8.7	90
Clyde R. at Middle Clyde	Mar/79	4.62	3.5	<0.5	37.5	7.6	<0.5	-	-	>100
	Sept/79	4.62	4.2	<0.5	38.6	11.3	<0.5	5.2	5.6	>100
	Feb/80	4.46	4.5	<0.5	43.6	8.7	<0.5	3.9	8.0	>100

Data Source: Farmer et al. 1980

TABLE 4

SELECTED SITE WATER QUALITY DATA

1979 - 1981

1. Tusket River at East Kemptonville (Station 1)

	pH (units)	Colour (units)	Total Hardness (mg/l CaCO ₃)	Sulphate (mg/l)	Total Phosphorus (mg/l)	Chloride (mg/l)	Total Iron (mg/l)	Total Manganese (mg/l)	Total Lead (mg/l)	Total Cadmium (mg/l)
Maximum	4.9	200	5.6	9.6	0.040	7.4	0.360	0.13	<0.01	0.004
Minimum	3.7	70	3.6	1.3	<0.005	3.5	0.112	0.014	<0.01	<0.001
Mean	4.2	127	4.6	4.8	<0.016	5.8	0.230	0.038	<0.01	<0.002

2. Bear Lakes Brook at Road (Station 9)

	pH (units)	Colour (units)	Total Hardness (mg/l CaCO ₃)	Sulphate (mg/l)	Total Phosphorus (mg/l)	Chloride (mg/l)	Total Iron (mg/l)	Total Manganese (mg/l)	Total Lead (mg/l)	Total Cadmium (mg/l)
Maximum	4.9	210	10.5	7.7	0.035	5.4	0.380	0.15	<0.01	0.005
Minimum	3.6	105	0.6	0.9	<0.005	3.7	0.060	0.004	<0.01	<0.001
Mean	4.2	133	2.8	4.5	<0.015	4.7	0.153	0.039	<0.01	<0.002

3. East Tusket River Below Pug Lake (Station 8)

	pH (units)	Colour (units)	Total Hardness (mg/l CaCO ₃)	Sulphate (mg/l)	Total Phosphorus (mg/l)	Chloride (mg/l)	Total Iron (mg/l)	Total Manganese (mg/l)	Total Lead (mg/l)	Total Cadmium (mg/l)
Maximum	4.8	210	14.0	8.6	0.028	5.9	0.315	0.32	<0.01	0.002
Minimum	3.7	84	1.8	1.0	0.005	3.8	0.078	0.005	<0.01	<0.001
Mean	4.2	128	3.6	4.6	0.012	4.2	0.175	0.074	<0.01	<0.002

2.2 THE SOCIO ECONOMIC ENVIRONMENT

2.2.1 Introduction

The development of a tin mine in Southwestern Nova Scotia will provide numerous social and economic benefits, resulting from employment and revenues as well as from the stimulation of spin-off industries. These benefits will accrue to a wide range of communities with many receiving between 0.7 and 3.7 percent population increases.

Economic benefits will involve deployment and distribution of manpower and materials for the mine during construction and operation phases, as well as benefits accruing from indirect effects of the mine operation.

2.2.2 Demographics

Most municipalities have experienced relatively uniform populations in recent times, with existing populations being scattered in villages of from 100 - 300 persons. Yarmouth is a major subregional centre with a population approaching 8000. The population is slightly female dominated with high percentages of persons under 15 and over 45. The latter category is male dominated.

The population structure appears to be indicative of some out-migration of young adults and immigration, possibly of previous residents, and older persons.

Ethnic distributional patterns are well-marked with Clare and Argyle being predominantly French speaking, while Yarmouth and Barrington are English speaking.

2.2.3 Labour Force and Industrial Structure

Approximatley 50% of the Yarmouth Census Division's 1976 population, 15 years and older, are within the work force. Male and female participation rates, however, are low, averaging 66% and 33%, respectively. As a result, a large potential to fill unskilled and semi-skilled jobs is available. Of particular interest to potential developments at the mine site is the availability of persons experienced, in occupations relating to transport, service and clerical duties. During August 1980, some 144, 231, and 290 persons, respectively, were available for work in these areas (Yarmouth Town office unemployment statistics).

2.2.4 Incomes

Average annual person incomes are somewhat low in the Yarmouth area averaging approximately 90% of Provincial values. During 1979, mean annual incomes averaged less than \$13,000, resulting in a per capita income of approximately \$5,000.

2.2.5 Transport and Communications

Road transportation within the region is predominantly coastal with access to Yarmouth from either the north shore and Annapolis Valley (Highways 1 and 101), or from the south shore (Highways 3 and 103). The system is well developed linking coastal communities with major arteries and the larger urban centers. Water transport remains important, and ferry services, utilized primarily by tourists and the travelling public, connect Yarmouth with Portland and Bar Harbour. Commerical airline facilities are provided by Air Canada with flights to and from Yarmouth via Halifax and Boston. Bus and rail services are also readily available.

2.2.6 Housing

Within the region, an estimated 6,000 plus housing units are in place. A large proportion of these (26%) are rental units, and many were constructed during the 19th century. Yarmouth is the only community with a sewerage connection and a municipal water supply. The latter is presently being upgraded. Real estate statistics show a low sales to listing ratio, indicating a present surplus of housing units. Within the last 10 years, numbers of building permits issued have been relatively stable at approximately 100 and 200 for the town and municipality of Yarmouth, respectively.

2.2.7 Utilities

The existing water system which transports water from Lake George to Yarmouth is being upgraded. Water supply to other areas is primarily derived from wells. A waste water communal sewerage system services Yarmouth. Outlying areas are on septic and related systems.

2.2.8 Medical, Education, Police and Fire Services

The Town of Yarmouth supports 3 elementary, 2 junior high and one senior high school, with combined enrolments of 723, 799 and 313 students, respectively. Yarmouth Municipality supports an additional 5 schools, 4 elementary and one junior high, with combined enrolments of 1230 and 625, respectively. Argyle Municipality supports 7 schools, each continuous over all levels, with a combined enrolment of 1885 students. Pupil teacher ratios are slightly higher than those considered normal for the Province, averaging 16.8, 19.3 and 17.3 for the Town of Yarmouth, Yarmouth Municipality, and Argyle Municipality, respectively.

Medical facilities are provided by a regional hospital and by a medical clinic in Yarmouth, and by clinics in Pubnico and Shelburne. Police service is provided to the town and municipality of Yarmouth by separate RCMP detachments. Fire prevention services are fully commensurate with local and regional demands.

2.2.9 Local Ammendities and Planning

A variety of recreational and related services are available, primarily in Yarmouth, but also to a lesser extent in surrounding communities. Included among these are sports facilities (arena, golf course, curling, bowling, gymnasium, etc.), playgrounds, theatres, libraries, museums, and various community groups. Also available, are a number of social service agencies such as the YMCA, CNIB, A.A. and family and childrens services.

2.2.10 Municipal Finance

The principal revenue sources in Yarmouth County are the taxation of real property and transfer payments from higher levels of government. Taxation and other local sources of revenue were valued at \$3,330,663 in 1981, whereas those from transfer payments were valued at \$1,977,329. Expenditures for Yarmouth County during this same period were valued at \$2,036,407, with protection services, public health and welfare, and transportation being the largest components.

3. ROAD SYSTEM

3.1 DESCRIPTION

The road infrastructure would require (Figures 3, 4, 4a, 4b):

- access from the existing public road to the plant site (500m)
- access from the plant site to the ore zone (600m)
- access road for tailings area (600m)
- road across main dam (550m)
- access/service road from dam to tailings line (600m)
- access road from public road to diversion dyke (450-650m) (distances approximate)

At this time, separate access is planned from the existing road to the mine/mill site and from the public road to the tailings area at Second Bear Lake. Access would be provided to service the tailings and reclaim fines. The road to the mine would follow the existing site access and be extended to the ore zone. The roads for the construction of the tailings system would approach from the nearest public road point to the north, about 1200 m east of Bear Lakes Creek.

At the mine site, roads and parking areas would be given a coarse base of 600 mm of crushed rock and a surfacing layer of 150 mm of granular material (Kilborn Limited - Preliminary Engineering Study). Grades would not exceed 8% for roads and 3% for parking.

Tailings access roads would be grubbed, subgrade prepared, and a 300 mm thick gravel base would be laid.

During construction, heavy earthmoving and other equipment will be moved to these sites and will operate on site. Most excavated material would be used on site. Additional crushed rock and other materials would be brought in via the public road system.

3.2 IMPACTS

Potential construction impacts relate to increased traffic levels, and associated increases in noise and dust levels along the public road system. The frequency of vehicular traffic would depend on the rate at which the project proceeds. During the construction period, private vehicles belonging to construction personnel would also contribute to increased traffic. Since a more detailed consideration of requirements for road and bridge upgrading for access to the mine area is now underway on the parts of Nova Scotia and Shell Canada Resources Limited, more complete studies of traffic were not included in this study. Speed limits would help to minimize noise from traffic.

Other construction related impacts would relate to work in and adjacent to watercourses where fish habitat occurs. The primary concern is the entry of excessive suspended solids into watercourses, which might provide an additional stress on aquatic organisms. These concerns can be mitigated at the East Kemptville Project by:

- maintaining a vegetative buffer strip between work areas and watercourses
- directing runoff during construction to temporary settling ponds prior to discharge to surface waters by using ditches and swales
- limiting the storage and activity of equipment and materials to designated areas
- using good construction practices to control vegetation removal and protect erosion prone areas
- avoid placement of culverts during high flow periods or during salmonid spawning and incubation periods (i.e. from October to March) to minimize silt problems
- rehabilitation of banks and riparian vegetation

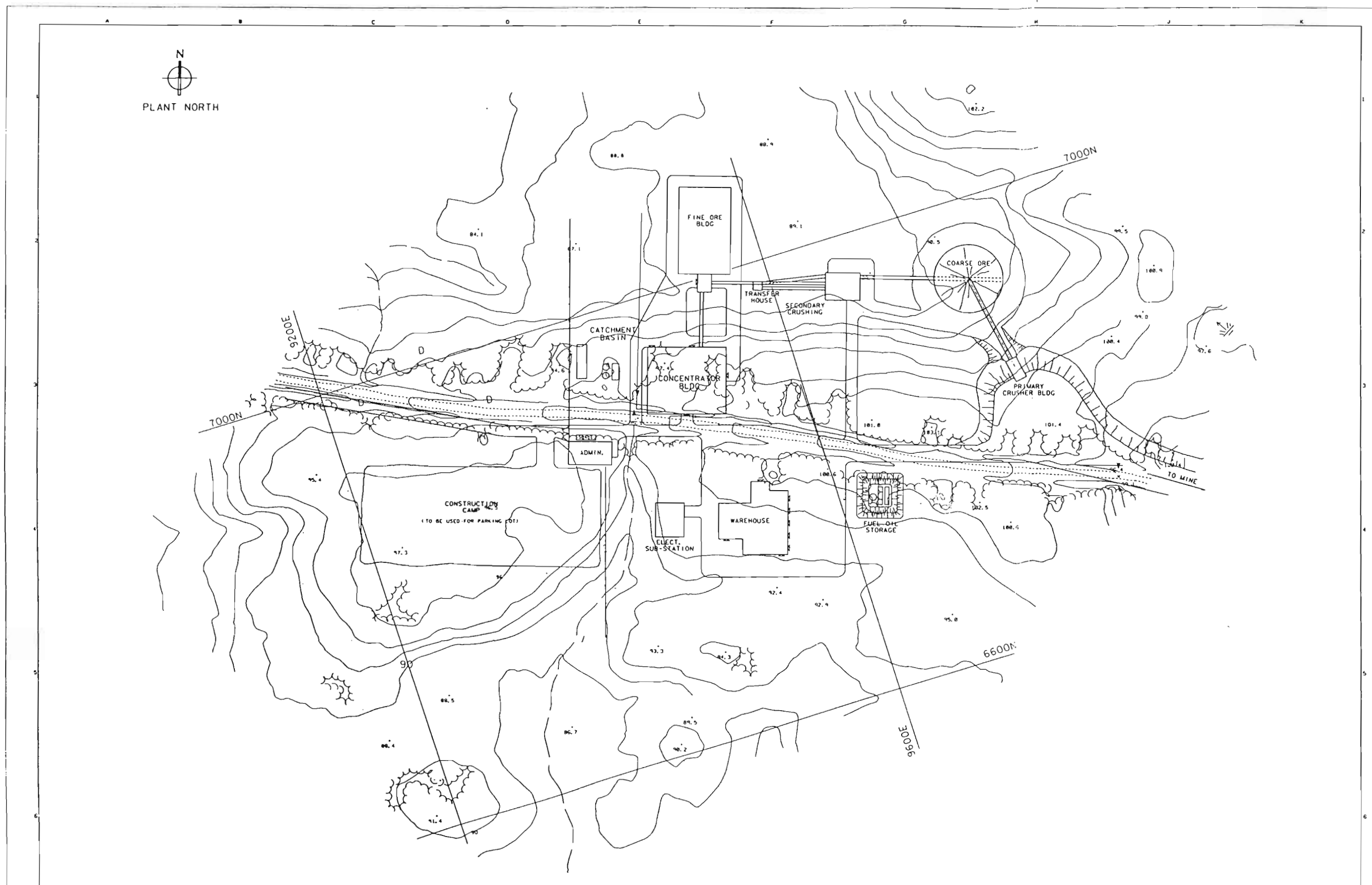
Guidelines for working at stream crossings and minimizing road construction impacts on watercourses in general would be prepared for the site based upon criteria widely accepted by the Fisheries and Marine Service (1978) and other sources, and adapted to specific site requirements.

Potential road operation concerns relate to runoff control, fish passage at culverts, noise and dust control. Runoff control would be by means of ditches leading to a settling basin prior to discharge to Pug Lake (see Section 4), so that good control over suspended solids could be achieved. Essentially, no major crossings of streams important to fish passage are planned. However, culvert placement should be such that discharges are within the hydraulic swimming capabilities of resident fish on most occasions. Dane (1978) provides criteria for installing and operating culverts while minimizing aquatic impacts.

During mine operations, truck noise would be limited to one transport daily which would bring supplies and remove a container of concentrate. The remaining traffic would be employee vehicles to and from the site. These do not constitute a significant acoustic impact.

Dust control of gravel site roads can be achieved to some extent by road maintenance and erosion control. There would be no dust released from concentrate containers leaving the site.

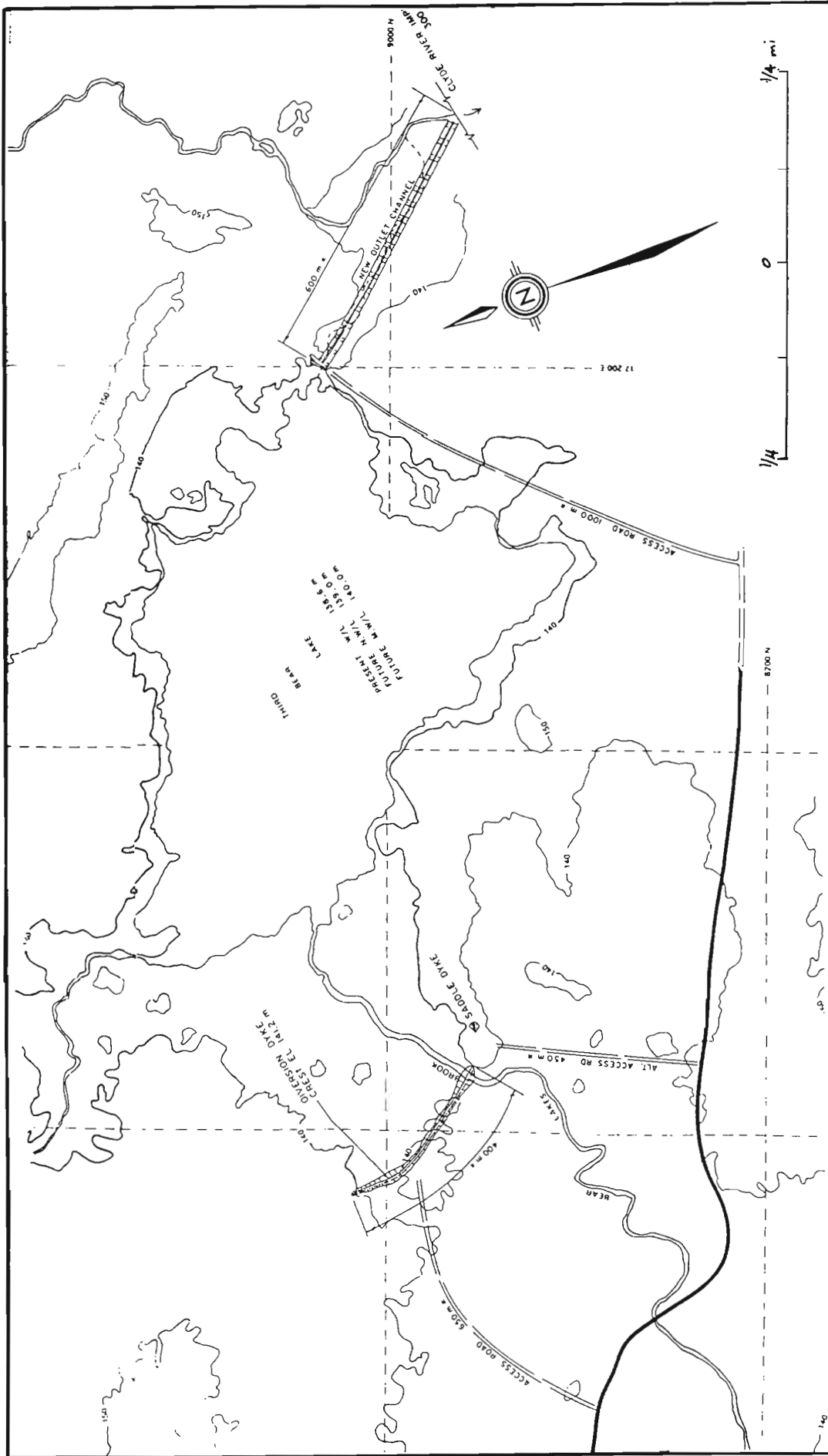
In summary, short term impacts associated with site roads relate to traffic noise, minor loss of terrestrial habitat, and the control of suspended solids entering the streams. The latter can be controlled by good site planning, erosion prevention measures, timing of crossings and runoff management. No major impacts are anticipated during the construction activities. Operation impacts are minor, and relate to erosion prevention and local dust and noise generation. They have been assessed as being minimal.



INFORMATION SOURCES:
 1. KILBORN LIMITED PRELIMINARY ENGINEERING STUDY 1981
 2. JACQUES, WHITFORD & ASSOC. LTD. PRELIMINARY TAILINGS STORAGE BASIN DESIGN 1981

FIGURE 3
 PRELIMINARY GENERAL AREA PLAN

FIGURE 4b
DETAIL OF DIVERSION DAM



3.3.1 Introduction

The construction of roads and bridges in forested areas can be undertaken without significant lasting impacts upon stream systems when good construction practices and informed supervision are used. This section provides a summary of the environmental concerns related to road development at the East Kemptville site, and includes a series of construction guidelines emphasizing environmental aspects, and does not consider the safety and engineering requirements which also influence the final plan for construction.

The least road that meets the mine's needs is usually the best road from the standpoint of water resources, as long as standards of safety and efficiency are met. This does not mean that it should be a poor road, but rather, that unnecessary watershed disturbance should be avoided.

3.3.2 Environmental Concerns

Sediment is the primary problem related to road or bridge building, but other characteristics of water yield may also be changed. Road surfaces are bare of vegetation, compact, and resist infiltration by design, as they must if they are to be usable. This means that virtually all the precipitation they receive becomes surface runoff, which is quickly concentrated into drainage ways and ditches, and in this case, would be directed towards a settling basin. Cut and fill surfaces, while not as compact and impervious as roads, are also potential sources of surface runoff.

Removal of vegetation, especially along stream banks, could increase stream temperature and stream bank soil erodability. Removal of stream bank vegetation can also reduce friction to water flows, so that channel resistance to flood flow is reduced. This may lead to bank erosion and sloughing. As well, removal of vegetation of slopes can lead to rapid erosive problems by reducing precipitation interception. Thus, efforts should be made to maintain vegetation buffer zones between

the roads and local streams and ponds. Exposed areas should be stabilized as quickly as possible.

Although there does not appear to be a viable population of Atlantic salmon in the Tusket River in the immediate vicinity of the mine, brook trout occur, and some suitable spawning and rearing areas for trout and salmon are available in the tributaries. As a result, overall levels of suspended solids in the system should be maintained as low as possible. There is also a spawning run of gaspereau in the Tusket River.

While the fish productivity of streams is influenced by a variety of interacting factors, the following are the most important of these:

- suitable range of temperatures
- adequate oxygen levels
- instream and overstream shelter
- maintenance of spawning and rearing habitat
- availability of food supplies

Potential negative impacts of increased levels of turbidity and suspended solids, due to sheet or channel erosion include mechanical or abrasive action of particles (e.g. clogging of gills), decreased light penetration, transport and release of adsorbed or absorbed nutrients or chemicals, reduction of temperature fluctuations and fouling of feeding and spawning areas.

Additional construction related impacts involve potential obstructions to fish migration. These may include complete obstructions which prevent upstream or downstream movement of all fish, or partial obstructions. The latter are normally significant only during low water levels, and/or in cases where certain portions of the fish community are denied free movement. Agents which may result in obstructions include debris, culverts, pollution barriers caused by inputs of toxic materials or sediment, and temperature barriers caused by removal of vegetation or entry of heated waste water.

While there are many potential environmental concerns related to road and bridge construction, an awareness of these concerns, good construction practices and local site characteristics can mitigate impacts. The catchment areas are now forested, or in grass cover, so that existing surface erosion is minimal.

3.3.3 Suggested Guidelines for Road Construction

- (a) Construction should be carried out so as to minimize the removal or disturbance to vegetation between the activity area and the neighbouring watercourses. In areas with slopes less than 12° , as throughout most of the site, a vegetational buffer of 20 metres is recommended. This buffer should be increased for steeper sloping areas.
- (b) In areas where a desirable vegetation buffer is not available, barriers or sediment traps could be developed to ensure that surface water runoff does not flow directly into the watercourse. Straw bales could be considered as an economical barrier with a short life expectancy (3 months).
- (c) Runoff from higher elevation areas should be diverted from exposed soil surfaces. This is considered particularly important in areas subject to intermittent high concentrations of runoff. Diversion of runoff may be accomplished by building a small diversion dyke consisting of a ridge of compacted soil, excavating a diversion swale to act as a temporary drainage way, or a combination of these two methods.
- (d) All debris and soil generated from clearing should be located away from watercourses. Tree tops or slash should not be permitted to enter standing or running waters.
- (e) Drainage ditches or push lanes should not be pushed to ponds or streams. Vegetation cover should be maintained to permit settling of silt prior to its reaching streams or ponds.

- (f) If cut and fill operations are required, avoid backfilling into ponds or streams. Gravel fill should not be removed from stream banks or beds, and slopes resulting from cutting and filling should be stabilized. The disturbed areas should be mulched and re-vegetated as soon as possible. Borrow pits should be at least 100 metres from watercourses.
- (g) Adequate toe support for fills should be installed to prevent sloughing and subsequent erosion. No excess fill should be left where it can subsequently be eroded.
- (h) In crossing streams with heavy equipment, the same place should be used for all crossings, and the use of heavy equipment in streams should be minimized.
- (i) While local river depths are shallow, some fill material will likely need to be placed in the water at crossings. This should be crushed stone or other clean material with minimum silt and clay fractions. After use of the fill, the crushed stone can be removed from the river for re-use, or evenly spread along the stream bottom to provide improved substrate for benthic organisms and fish spawning.
- (j) Although the roads do not cross valuable game fish spawning or migration areas, work at erosion-prone areas and stream crossings should preferably be scheduled during the dry summer months, if possible.
- (k) Care should be taken to prevent additions of lime, cement or petroleum products such as creosote, oils or gasoline to the water.
- (l) Prior to constructing a stream crossing, the existing stream bank erosion in the area should be noted. Rehabilitation of these crossings should be such that future stream bank erosion is minimized.

- (m) At least 8 inches (20 cm) of water should be maintained over the crossing at all times when natural flows permit.
- (n) Culvert installations, if required, should be made on existing natural grades, with the inlets and outlets protected against erosion.
- (o) Culverts should be designed and installed so as not to impede fish passage. They should also be large enough to handle peak flow and should be set at least 6 inches (15 cm) into the stream bed.
- (p) To allow passage of fish, culverts under 80 feet (24 m) in length should have a water velocity less than 4 ft/sec (1.2 m/sec).
- (q) Construction debris should be removed from the culvert area to a point above the high water mark, so that it will not be carried back into the watercourse. Culverts should also be checked frequently and cleaned of debris, if necessary.

4. SITE DRAINAGE

4.1 CAMP AND PLANT SITES

4.1.1 Construction Camp

The construction camp will cover an area of approximately 1500 m². During construction of the plant this site will provide accommodation and cafeteria facilities among others. Upon completion of the plant this site will be converted into a parking lot. It will be assumed here that all precipitation is routed into overland flow. Although some infiltration and evaporation is likely, this assumption does describe the worst possible case and thus, should represent an upper limit for runoff.

Total annual precipitation at Kemptville is about 1416 mm. Thus the total annual runoff would be approximately 2,120 m³. Monthly values will likely range from 125 to 240 m³ with minimum values most likely in the summer and maximum values in the late fall - early winter and spring periods.

4.1.2 Plant Site

Total area of the plant site was estimated from site plan maps at about 21,000 m². This would correspond to a total annual runoff of approximately 29,750 m³. Monthly values will likely range from 3,360 to 1750 m³ with the highest values expected during the late fall - early winter and spring periods and the lowest values during the mid-summer period.

Runoff from the camp and plant sites will contain solids, oils and grease and possibly a few chemicals. This water will pass into catchment basins before being discharged in the East Kemptville River at Pug Lake.

Liquid kitchen waste and sewage will be routed into a roto disk package plant. The water discharged from this treatment plant is of excellent quality and meets guideline regulations. Suspended solids are typically 15 - 25 mg/l and phosphates can be kept down to 1 mg/l in a well maintained system. Phosphates may, on occasion reach 5 mg/l. Although this water could be discharged directly into water courses this project intends to drain the water into a muskeg and wetland area where increased contact time will provide for better treatment. Organic matter will remove any metals in effluent (e.g. copper). About 95% will be retained by the organic matter. Phosphates and nitrates will also be reduced depending on season. From the wetland the water will flow into Duck Pond Brook and Big Meadow Brook and eventually into the East Branch of the Tusket River 3.5 km from the plant site. Therefore, effects in the downstream courses would be minimal.

4.1.3 Impacts

A storm retention basin (Figure 3) would be constructed to collect drainage from the camp site, parking area and plant site. Total volume of the basin would be 18000 m³ with a surface area of 12,300 m². This volume would be sufficient to store peak flows from all site runoff under. As well, in event of a power failure, 450 m³ of tailings and 350 m³ of reclaim water would be drained into the storm retention basin. Capacity is sufficient for these purposes and settled solid material would be removed, as needed. Water decanted from this pond would be low in suspended solids and would be returned to the upstream end of Pug Lake. The pond would not be effective at removing dissolved components of the runoff,

such as road salt, but the quality of water returned to the East Tusk River would be quite good. Not adverse impacts are anticipated from this source.

4.2 OPEN PIT

4.2.1 General Description

The anticipated maximum surface area of the open pit mine is approximately $6.62 \times 10^5 \text{ m}^2$. Enlargement of the pit will be accomplished by blasting. The anticipated depth of the pit is about 60 m and will have a benched profile. The annual precipitation input (1416 mm) will result in about $9.4 \times 10^5 \text{ m}^3$ of water collecting in the base of the pit. Several sumps will be used from which pumps will move water to the surface.

The sump water will contain fine grained material, sulphates, ammonia and nitrates. The sulphate originates in the pyrite of the host rock while the ammonia and nitrates result from blasting. The sulphates will not acidify the water as pilot plant have shown that the fragments have buffering capacity. The ammonia and nitrates will make the water alkaline. A pH volume of 8+ is likely. After settling in the sumps has occurred, the water is pumped to the surface where it can be put into the process stream or released to natural drainage courses. If the effluent is discharged directly it would require further settlement to reduce ammonia levels to acceptable standards.

Overland flow towards the open pit is estimated at $120,300 \text{ m}^3$ annually. This water will collect in ditches constructed around the perimeter of the pit. The 1 in 100 year 60 minute storm (51 mm) would result in an input of $43,350 \text{ m}^3$. This water would then be collected in a settling pond where suspended sediment could

be minimized. This water could then be discharged into existing water courses or used in processing.

4.2.2 Impacts

If drainage is directed to process water, it would replace water otherwise drawn from Pug Lake. In most cases, however, this runoff would be available during times when low flows in Pug Lake were not critical. Since process water would be discharged to tailings, no water quality impacts would result.

If drainage is directed to sumps and then pumped to a surface retention pond for stabilization and removal of nitrogen compounds, solids and sulphate prior to discharge to surface waters, effluent quality would be treated so as to meet regulatory objectives and guidelines.

5. WATER SUPPLIES

5.1 FRESHWATER SUPPLY AND DISTRIBUTION

Fresh water will be taken from Pug Lake via a submerged water intake pipe into a concrete wet well. Two vertical turbine pumps each rated at 140 m³/h at 60 m TDH, one running and one on standby, will be located within an insulated and heated pumphouse. Water will be carried to the plant site by means of an 8 inch insulated and heat traced, above grade high density polyethylene pipeline.

5.2 WATER REQUIREMENTS

The plant and facilities will have an estimated water requirement of 0.04 m³/sec. Mean flow in the East Tuskat at Pug Lake is about 1.8 m³/sec so that the withdrawal rate represents about 2.2% of the mean flow condition. At low flow, often August, discharges have been estimated at 0.5 m³/sec, of which 8% would be required for mine operations.

While surface runoff, via the settling pond would augment flows at Pug Lake on some occasions, this effect would be minimal in low flow period.

5.3 IMPACTS

Construction of the pumphouse, intake and concrete revetment would require considerable construction in and adjacent to the watercourse. Increased sediment inputs might be anticipated unless great care is taken to maintain shoreline vegetation where possible. Preferred work time would be in late summer when flows are reduced and rain is less frequent. At this time, impacts to resident and sea run fish would be at a minimum. The work schedule should be planned so

as to minimize construction time in the watercourse itself.

During operation, the only impact would be an 8% decrease in flow at the low summer discharges. Sufficient flow would remain to permit fish mobility and maintain pools to a similar extent to the existing situation. A minor decrease in aquatic productivity may result.

6. SEWAGE DISPOSAL

6.1 PACKAGE PLANT SYSTEM

Domestic sewage will be collected by means of high density polyethylene sewers buried below the frost line. A small pumping station and force main will serve the low-lying portion of the site.

A sewage treatment plant will be installed early to serve a construction camp population of 400 and would be retained permanently.

A Rotordisk Model L333 rated for an average flow of 110 m³/h would likely be selected. This type of unit is simple to operate and requires very little maintenance. It would have 24,000 square feet of shaft-mounted biological contact medium, and be equipped for chlorination of the effluent.

Effluent from the sewage treatment plant will be discharged to the Duck Pond Brook drainage basin to the south of the plant site. Duck Pond Brook is a reedswamp and marsh area which will provide impoundment and retention of effluent. Vegetation is largely Carex rostrata, C. stricta and other sedges. The predominant moss is Sphagnum which provides excellent retention of metallic ions. This moss has been shown to have the largest cation exchange capacity of any plant, and works effectively in neutral and acidic modes.

6.2 IMPACTS

Due to the long retention time of Duck Pond Brook, and the assimilative capacity of the wetland system, no significant increases in nutrient levels or bacterial contamination would be expected in Big Meadow Brook or the East Tusket River.

7. TAILINGS MANAGEMENT SYSTEM

7.1 INTRODUCTION

The present plans call for a daily mill feed of 6,000 tonnes a day for the life of the mine. This would yield an estimated annual two million tonnes of tailings for a long term storage of 30 million tonnes.

The tailings basin selected covers a surface area of approximately 36.5 hectares (90 acres) and is located within the Bear Lakes Brook watershed in the vicinity of a small lake called Second Bear Lake. The distance between the plant site and tailings disposal area is approximately 30 km. An overall plan of the area is provided in Figure 4.

In addition to the tailings disposal area, allowance has been made for the construction of a reclaim water pumphouse and an emergency tailings line dump pond. The reclaim water pumphouse will be located within a "reclaim barge" to provide for good water quality return to the plant.

The tailings system will consist of a main drain with a spillway (2) routing water above elevation 120 m to Bear Lakes Brook. This maintains a minimum free board of 1.2 m below the dam crest (122 m). This spillway routes water to an impoundment (approximately 1 hectare) which collects local drainage and minor stream flow. An additional spillway (1) routes water from the pond by a series of drops to Bear Lakes Brook.

7.2 TAILING LINE

Tailings discharge line would be routed from the concentrator building across country to the tailings ponds system. Final details of the

tailings alignment are not yet totally complete. It would be located above ground, and provided with an emergency tailings line dump pond. This would be required in the case of rupture or stoppage of tailings flow. The latter may cause freezing of the line in winter or solids settlement.

The total line volume would be 2,549 cubic metres. Approximately half of this would, in the case of an emergency, flow to tails or to the plant site, the remainder would flow to the dump pond.

The velocity within the 711 mm polyethylene line would be 1.6 metres per second to avoid settlement of solids. A combination air vent/vacuum breaker will be provided at the high point and the line would be self-draining in the event of power failure. A high velocity is required since the tailings are relatively coarse (approximately 40 percent minus 200 mesh). Tailings disposal would be by means of perimeter spiggotting. A parallel reclaim polyethylene line would be installed for maximum water re-cycle.

An access and service road would be built along the tailings and reclaim line. After clearing and grubbing of the site, boulder removal, 400 mm of 100 mm crushed rock would form the road bed, followed by 150 mm of granular "A". 450 mm(18") culverts would provide adequate road drainage.

7.3 DAM STRUCTURE

There would be two dam structures. The main dam will be approximately 780 m long, crest elevation at 122.0 m and an adjacent 280 m saddle dam. The dam configuration is shown in Figure 4a. The location of the dams was selected to protect as many mature and plantation trees as was possible.

Dams would be built to provide for long term stability. The permanence of dams and spillage after completion of mining is to be established to acceptable limits. An additional dam is to be constructed downstream of Third Bear Lake in order to provide for diversion of waters

to the Clyde River System (Figure 4b). All merchantable timber will be cut for use, the remainder of the storage area is to be cleared. Stripping and grubbing would occur in the vicinity of dam and spillway structures.

7.4 CHARACTERISTICS OF TAILINGS

Approximately 6,000 tonnes per day of siliceous tailings would be pumped by 711 mm plastic pipe to the tailings area. This amounts to approximately 2 million tonnes annually. The pulp density is approximately 12.4 percent (w/v). This is much lower than normally encountered and would result in cleaner tailings water reclaims. The tailings are relatively coarse-grained (Table 7) with about 50 percent less than 200 mesh. There would be about 25 percent fines within the tails. The chemical composition of tailings shows that only copper, iron, manganese, phosphate, sulphur, tin and zinc occur in concentrations larger than 0.05 percent. Cadmium, arsenic and mercury are all extremely low at concentrations of 0.002, 0.004 and 0.06 percent respectively. Most of these metals are in insoluble forms.

Tests from the Lakefield Research Pilot Plant running on typical East Kemptville ore gave analysis of tailings water presented in Table 6. Cadmium and mercury are both extremely low at 0.002 and 0.003 mg/l. Arsenic values are 0.013 mg/l. Analysis of the tailings water indicates that there would be some residual buffering capacity producing a neutral or slightly acid effluent.

During process, there would be flotation of sulphides away from the tin concentrate. To facilitate this process, small quantities of reagents would be added. These would include the following:

Potassium amyl xanthate	7.2 kg/day
Dowfroth 250	6.0 kg/day
Copper sulphate	7.2 kg/day

Xanthate would break down rapidly within the tailings area, while Dowfroth 250, which is a mixture of higher alcohols, will largely evaporate. Both should not be detectable within the pond. Copper would be largely adsorbed on to the tailings compounds. A small amount of sulphuric acid, up to 20 kg/day, would be used to reduce pH with the flotation cells below pH7.

7.5 IMPACTS

7.5.1 General

The overall impacts of the tailings disposal system would involve forest removal along the tailings and reclaim lines, degradation of water quality of water in the tailings pond (Second Bear Lake), reduction of flow in Bear Lakes Brook and some enhancement of flows in the Clyde River. The latter two effects are considered in Section 8.

7.5.2 Tailings Line

The construction of the tailings line requires cutting of forest and surface grubbing prior to road and tailings/reclaim line construction. Surface runoff would be restricted by the adjacent forest cover. In the event of a breakage approximately one thousand cubic metres of slurry would flow to the dump pond. This would contain approximately 125-450 cubic metres of tailings. This would provide for a 1-3 cm covering over the bottom of the 12,300 square metre pond. Tailings could be transferred later to the tailings pond. In addition, about 350 cubic metres of reclaim water could be dumped to the pond.

7.5.3 Dam Structures

The dams are to be constructed for long term stability. They will be provided with toe and internal drainage to ensure stability. The spillways would be covered by rip-rap or vegetation as appropriate for stability and to ensure that no erosion or solids removal occurs. The tailings pond is large, ensuring maximum settlement of solids.

Prior to dam construction, the immediate areas would be clear-cut and grubbed. Examination by EAG has indicated that no rare or uncommon species occur in the immediate area of the dams.

7.5.4 Tailings Effects

The large throughput of water and input of fresh make-up water from the East Tusk River will maintain reasonable low levels of dissolved ions. To a large extent, the existing fish populations which comprise largely perch and minnows would persist for some time; eventually disappearing because of the suspended solids loadings. The yield within the system is low (145 kg/year) and contains no sports fish species.

Overflow from the spillway will be around neutral and will increase pH values within the upper reaches of Bear Lakes Brook. No effects would be expected on the pH of the East Tusk which is currently too acid to respond to the low input.

TABLE 5
TAILINGS SYSTEM WATER QUALITY INFORMATION
SELECTED METALS

	<u>Copper</u> (mg/L)	<u>Lead</u> (mg/L)	<u>Zinc</u> (mg/L)
1/ EPS Metal Mining Liquid Effluent Guidelines*			
- Max. acceptable monthly mean conc.	0.3	0.2	0.5
- Max. acceptable composite conc.	0.45	0.3	0.75
- Max. acceptable conc. in grab sample	0.6	0.4	1.0
2/ Water Quality Objectives for Aquatic Life**			
- Maximum diserable conc.	0.002	0.012	0.05
- Maximum permissible conc.	depends on hardness	0.15	depends on hardness
3/ Public Water Supply Objectives**	1.0	0.05	5.0
4/ Tailing Effluent Quality***	0.030	0.03	0.200
5/ Bear Lakes Brook+			
- mean annual concentration (1979-81)	<0.004	<0.01	0.010
- low flow concentration (Aug. 1981)	0.002	<0.01	0.011
- high flow concentration (Dec. 1980)	0.005	<0.01	0.009
6/ East Tusket River+			
- mean annual concentration (1979-81)	<0.004	<0.01	0.019
- low flow concentration (Aug. 1981)	0.002	<0.01	0.008
- high flow concentration (Dec. 1980)	0.006	<0.01	0.012

* Environmental Protection Service Metal Mining Effluent Regulations and Guidelines (1977)

** Water Quality Objectives, Shubenacadie - Stewiacke River Basin Board (1978)

*** Pilot Plant Data - Lakefield Research

+ Site Water Quality Sampling Data - 1979 to 1981

TABLE 6
TAILINGS WATER QUALITY ESTIMATES
PILOT PLANT STUDY

<u>Parameters</u>	<u>Concentration (mg/L)</u>	<u>EPS Guidelines Monthly Mean Concentration (mg/L)</u>
Iron	0.70	
Copper	0.030	0.3
Nickel	0.070	0.5
Lead	0.03	0.2
Zinc	0.200	0.5
Bismuth	<0.05	
Cadmium	0.002	
Chromium	<0.005	
Manganese	0.58	
Mercury	0.0003	
U ₃ O ₈	<1.0	
Arsenic	0.013	0.5
Antimony	<0.1	
Tin	<0.1	
Sulphate	30.0*	
Phosphorus	2.0	
Aluminum	0.23	
Calcium	32.0	
Magnesium	2.81	
Total Dissolved Solids	226.0	
Hardness (CaCO ₃)	93.0	
Alkalinity (CaCO ₃)	NIL	

* likely higher than normal due to sulphuric acid being used at time of sampling

TABLE 7
TAILINGS CHARACTERISTICS FROM PILOT PLANT

A. Screen Analysis

<u>Tyler Screen Size</u>	<u>% Material Retained</u>
+ 35	0.8
- 35 + 48	5.5
- 48 + 65	16.2
- 65 + 100	15.7
-100 + 150	13.0
-150 + 200	9.1
-200 + 270	7.9
-270 + 400	6.8
-400	25.0

B. Chemical Analysis of Solids

<u>Parameter</u>	<u>Concentration (%)</u>
Tin	0.070
W03	0.007
Sulpher	0.40
Arsenic	0.004
Antimony	0.001
Bismuth	0.004
Mercury	0.006
Copper	0.064
Lead	0.003
Zinc	0.16
Cadmium	0.002
Iron	1.71
Nickel	0.001
Manganese	0.054
Nb ₂ O ₅	0.003
Uranium	<0.003
Thorium	0.002
P04	<0.002
Mg 0	0.60
	0.50

8. HYDROLOGY OF TAILINGS SYSTEM

8.1 FLOW CHARACTERISTICS OF BEAR LAKES BROOK

The Bear Lakes Brook annual discharge curve is bimodal with peaks in March and November-December. This reflects the annual precipitation pattern including the augmentation of spring rains with snowmelt runoff. Peak daily flows as large as $5 \text{ m}^3 \text{ s}^{-1}$ have been measured, while low flows are typically less than $0.1 \text{ m}^3 \text{ s}^{-1}$. The contributing basin is approximately 22 km^2 . Estimates of peak daily discharges for 2 and 20 and 100 year storms, using the regional flood frequency regression, are 3.7, 10.5 and $15.5 \text{ m}^3 \text{ s}^{-1}$. Using the rational method, the 2 and 25 year storms yield 5.4 and $8.2 \text{ m}^3 \text{ s}^{-1}$.

8.2 DIVERSION TO CLYDE SYSTEM

No long term flow measurements are available for the Clyde River system. However, the annual pattern appears similar to that for the Bear Lakes system. A regional flood regression formula was used to obtain an indication of peak mean daily and instantaneous discharges.

CLYDE RIVER BASIN

DISCHARGE (m^3/s)

Return Period	Peak Daily	Instantaneous
2	4.9	5.5
10	13.0	14.6
25	13.8	21.6

The augmentation of flows from sub-basins in the Bear Lakes system into the Clyde River system should be approximately proportional to area. This is estimated to be $0.11 \text{ m}^3/\text{s}$ and is relatively minor.

Shortcomings in the regional flood regression formula necessitated the use of the rational method for flood augmentation. For 2, 5, 10 and 25 year storms, the Third Bear diversion augments the flows from 3.3 to 5.0, 4.4 to 6.8, 5.2 to 8.1 and 6.2 to 9.7 m³/s.

8.3 DISCHARGE FROM BEAR LAKES BROOK TO EAST TUSKET RIVER

8.3.1 Discharge Characteristics

The location of the tailings pond at Second Bear Lake and diversion at Third Bear Lake will reduce the discharge of the Bear Lakes system into South Wallace Lake. Estimates based on changes in basin area indicate a mean annual discharge to South Wallace of 0.12 m³/s. The mean annual runoff in the Second Bear Lake sub-basin is 0.17 m³/s.

8.3.2 Flow Patterns

The annual flow pattern will still be bimodal with peaks in March and November-December. For 2 and 25 year storms, the estimated discharges using the rational method are 3.6 and 7.0 m³/s. The flows into Second Bear Lake are 8.1 and 14.1 m³/s for these events.

8.3.3 Effluent Quality

The existing water quality within the East Tusk River and Bear Lakes Brook is oligotrophic, nutrient poor and acidic. Levels of metallic cations are low with the exception of iron, manganese and aluminum which come into solution in such streams. Levels of most metallic ions do not appear to respond strongly to peak flows, and levels of suspended solids are not usually high under such flow conditions.

The expected water quality conditions within the adjacent watersheds during the operation of the mine are difficult to estimate since the final characteristics of ore grinding, reagent use and process water can only be determined when the mine is in operation. However, during pilot plant experiments, the quality of process waters has been extensively analyzed. As a result, it is possible to use this information with some degree of confidence to estimate the water quality in the tailings.

An additional complication occurs at the East Kemptville project since there will be no decant structure. A spillway will be incorporated into the system which would overflow at times towards Bear Lakes Brook. The system would not lose water to the system until completely full, and subsequently, would discharge only during periods of spring runoff and heavy rains when the normal flow in the rivers is high. During low flows, very minimal or no discharge would occur. This system provides good protection as no discharge would occur during times of low flow in rivers when the impact of effluent would be greatest. Conversely, when high flows are occurring, spillways would operate adding some water to already swollen rivers. Estimates considered have, under low flow conditions, assumed some effluent loss and probably provide higher concentration data than would be observed.

Within all estimates, we have assumed that the effluent loss would be $0.09 \text{ m}^3/\text{sec}$. This represents the watertake from the East Tusk mine pumphouse ($0.04 \text{ m}^3/\text{sec}$) and the mean flow within the tailings area ($0.05 \text{ m}^3/\text{sec}$). Under low flows, the expected effluent loss has

been estimated at 0.05 m³/sec.

The following table presents expected water quality in Bear Lakes Brook and East Tusknet under these flow conditions:

TABLE
WATER QUALITY IN BEAR LAKES BROOK AND EAST TUSKET RIVER

	Flow (m ³ /sec)	Copper		Lead		Zinc	
		Ambient	With Effluent	Ambient	With Effluent	Ambient	With Effluent
Bear Lakes Brook							
Low flow conditions	0.05	0.002	0.015	0.005	0.015	0.011	0.10
Mean flow conditions	0.12	0.003	0.012	0.005	0.012	0.010	0.085
East Tusknet River							
Low flow conditions	0.15	0.002	0.010	0.005	0.010	0.008	0.070
Mean flow conditions	1.8	0.002	0.003	0.005	0.003	0.019	0.029

From these estimates, it may be seen that all effluent concentrations meet existing EPS guidelines. Levels meet maximum desirable concentrations with the Bear Lakes Brook system for both copper and lead. Zinc levels are slightly higher, but are well below public water supply objectives. Water quality objectives are met completely for the East Branch of the Tusknet and no impacts can be foreseen at this time.

8.3.4 Treatment of Effluent

The effluent from the tailings area is expected to be excellent in all respects. Some high levels of suspended solids may occur in windy weather and be discharged to Bear Lakes Brook. No treatment of this water would be possible, other than the already provided spillway retention ponds between spillway 1 and 2.

No chemical treatment of effluent should be required unless pH values fall below pH 4.5 (ambient conditions in the river) and metallic cations are evident. Installation of a line feed at spillway 2 would then be required.

The construction of the tailings management system will cause a reduction from 0.17 to 0.12 m³/sec to the mean flows of the Bear Lakes Creek. This reduction in mean and in low flows will cause changes to the aquatic life in the brook system. Primarily, there will be a minor reduction in fish habitat including the loss of Second Bear Lake. The impact is not significant locally as the fishery is already restricted because of extreme acidity and low nutrient status. The increase in flows to the Clyde River system may contribute slightly to improved fish production in that system.

Water quality conditions within the Bear Lakes Brook system would be degraded slightly, but still fall well within existing guidelines. Some increase in pH in this system may be observed to pH5-6. This may encourage fish populations in the region. Increases in concentration of metallic cations with the East Tusket River system are expected to be low and well within existing objectives for protection of aquatic life, public water and potable water objectives.

9. MATERIALS STORAGE

9.1 FUELS

A bulk fuel storage facility would be located east of the warehouse and workshop building (Figure 3). Above-grade steel tanks would be located in a bermed area equipped with a Hypalon liner.

Diesel oil would be stored in three tanks with a combined capacity of 135 m³ (30,000 Imp. Gal.) connected to two dispensing/metering pumps.

Marked gasoline will be stored in a 23 m³ (5,000 Imp. Gal.) tank connected to one dispensing/metering pump.

Heating oil would be stored in a 45 m³ (10,000 Imp. Gal.) tank and pumped around a buried loop main, constructed of 1.5 inch fiberglass reinforced plastic, for distribution to all heated buildings.

9.2 MILL REAGENTS

The reagents required for sulphide flotation are potassium amyl xanthate, Dowfroth 250, copper sulphate and sulphuric acid. Similar quantities, in the order of 10 kg per day, of each reagent could be required. The first 3 reagents are water soluble and will be mixed to a solution strength of 5% in 1 m dia x 1 m high tanks with side mounted Lightnin mixers where required. Two tanks for each soluble reagent will be provided and the mixed solution will flow from either tank, through a common header to two Clarkson feeders which will meter the reagent to the flotation circuit. In the case of sulphuric acid, a single tank, fed manually from plastic containers, will dispense acid through a gravity line by a pH controlled valve.

Reagents will be stored and mixed in the tin dressing area and an elevated sump will discharge any spillage to tailings.

No environmental impacts would be associated with the normal operation of the fuel or reagent storage areas. The bulk fuel storage area would be bermed to prevent spillage movement. Mill reagents are used in small amounts and spillage would be removed from a sump to tailings. The facility would meet fire and safety standards. In case of accidental spillage of materials during shipment, a counter-measures plan on the part of the trucking firm would minimize risk. A direct spill into a watercourse might have quite significant toxic effects.

10. TRANSPORTATION

10.1 EMPLOYEE VEHICLES

During construction, approximately 280 workers will be employed, most using the 340-man camp that would be established on site. Daily commuting by workers would be therefore reduced. Parking facilities would be provided on site for a small number of vehicles. It is intended that the construction camp area would later become the parking lot for mine and mill employees. The surface would be granular material and drainage would be by means of open ditches to a storm retention basin to reduce suspended solids. Parking would be adequate for up to 300 employees.

Impacts associated with vehicular traffic would include exhaust emissions, noise, and road maintenance requirements such as snow removal, and sand/salt application. These are not major concerns.

10.2 SERVICE VEHICLES

During operation, one truck per day is scheduled to bring in supplies from Halifax. Deliveries of materials and supplies from local suppliers would be on an "as needed" basis and would represent no more than a few light trucks per day. No impacts are associated with service vehicles during operation. Vehicular traffic would include fuel trucks. Accidental spillage to watercourses is a possible hazard depending partly on road conditions. This is a potential occurrence anytime fuels or other similar materials are transported for domestic or commercial use, and supply companies normally have contingency plans for clean-up.

10.3 SHIPMENT OF CONCENTRATE

Following initial processing on-site, one closed, plastic-lined container of concentrate would be shipped by truck daily to Halifax. No escape of dust would occur in this system. The ground concentrate would not be an environmental hazard if spilled during a trucking accident. No impacts are associated with the routine shipment of concentrate.

11. SOCIO-ECONOMIC IMPACTS

Demographics

Development of the mine complex will involve the addition of an estimated 300-500 persons to the region. Approximately 40% of these are projected to settle in the vicinity of the Town of Yarmouth. Remaining persons are projected to be dispersed over a much wider area such that no one community is likely to receive a strong influx.

Labour Force and Incomes

Development of the mine complex will result in the direct employment of an estimated 280 persons during construction phases (1982 to 1983), and approximately 226 persons during operations phases. Man power and materials required to construct the mine-mill complex will be drawn primarily from local and regional sources including the whole of Nova Scotia. The distribution of source components will depend on how the construction is organized, the numbers of small contractors available locally, and on hiring practices.

Most of the jobs filled from local sources are likely to be of an unskilled and semi-skilled nature. However, as the operation develops it is anticipated that many of these persons would be trained into skilled positions. Also, in addition to direct employment, an estimated 84 to 113 further jobs are likely to be created locally and regionally result of spin-offs from developments at the mine.

With this new flow of capital into the area, and as a result of increased level of skill, incomes in the Yarmouth area are expected to increase by as yet an undetermined amount.

Transport and Communications

It is anticipated that development of the mine complex will have no appreciable effects on either transport or communications.

Housing

The influx of new families into the area, especially in and adjacent to Yarmouth, will create a demand for housing that is likely to place moderate stress on existing supplies. However, such stresses are expected to be temporary pending the development of additional accommodation units.

Services

Existing utility, security, medical and educational facilities are of sufficient capacity to accommodate any increased loadings generated as a result of development of the mine site. Enrolments in schools, for example, are presently declining and the influx of new families will serve to stabilize this decline.

Municipal Finance

Increased revenues expected from the generation of new housing are estimated to be in the order to \$200,000 plus dollars annually. Additional expenditures likely to be generated are estimated at \$17,000 and \$21,000 for the Town of Yarmouth and Yarmouth Municipality, respectively.

12. ADDITIONAL CONSIDERATIONS

12.1 WILDLIFE SENSITIVITIES

Virtually the whole of the study area has been subjected to human disturbances of one form or another during recent decades. Most notable among these are logging, fires, hunting, trapping, and acid rain. As a result, wildlife species present are accustomed to at least moderate levels of disturbance. This assumes that suitable food and shelter remain available. It is therefore likely that development of the mine site will have minimal effects on the area's wildlife, exclusive of those resulting from the localized removal of habitats for site preparation and tailings impoundment.

Habitats in the immediate vicinity of the mine site and proposed tailings area, totalling not more than 2-3 km², would be extensively disturbed during construction and operation phases of mine development. An assessment of sensitives is therefore best measured in terms of habitats which will be lost.

Community types present at the above locations include rock barrens (60%), mixed forests (25%), patterned barrens (10%) and predominantly deciduous forests (5%). Each of these habitats is well represented elsewhere within the study area, and at other locations within Yarmouth, Digby and Shelburne Counties. Also, from the perspective of species sensitivities, we have little reason to suspect that either of the above areas is in any way special, or that they support, on anything resembling a regular basis, wildlife species which are rare, endangered, or sensitive. Wildlife sensitivities therefore, appear restricted primarily to individuals which would be displaced from either the mine site or the tailings area. Depending on specific population pressures in adjacent habitats, these individuals may or may not be able to relocate. Less mobile species are likely to fare poorly.

A second aspect warranting consideration is project timing. A majority of species show increased sensitivity to area disturbance during the breeding and rearing period, which in most instances coincides with the spring and possibly early summer period. Hibernating species are also vulnerable during the winter months, but fewer species and individuals would be affected at this time. Construction activities timed to avoid the spring and early summer period would, therefore, greatly reduce the threat to individuals of most species.

12.2 FISHERY POTENTIAL OF SECOND BEAR LAKE

Under the proposed tailings management system, the fish habitat and fish production potential of Second Bear Lake would be essentially eliminated. While current recreational fishing is low, some fishing for yellow perch, and perhaps a few brook trout, occurs.

Ryder et.al. (1974) describe the morphoedaphic index, a widely used fish yield estimator based upon a morphological feature of lakes (mean depth) along with an edaphic feature (total dissolved solids concentration). When the ratio between these is plotted against fish yield from a large number of harvested temperate lakes, a regression line can be derived. The equation of this line is used to predict the sustainable fish yield per unit area of lake surface, presuming a reasonably balanced species harvest takes place.

For Second Bear Lake:

total dissolved solids \approx 55 mg/l

mean depth = 16.1 feet

$$\therefore \text{morphoedaphic index (MEI)} = \frac{55}{16.1} = 3.4$$

\therefore sustainable yield (Y) can be calculated as

$$Y = 2.094 (\text{MEI})^{0.4461}$$
$$= 3.62 \text{ lbs. per acre per year}$$

For Second Bear Lake, where the surface area is about 88 acres, about 318 lbs (145 kg) of fish (largely perch) could be taken from the lake on a sustained basis. This would represent the direct loss in fish production, which would be accompanied by a parallel loss in recreational fishing opportunities of fair quality.

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Government
of Canada

Gouvernement
du Canada

Fisheries
and Oceans

Pêches
et Océans

FILE 228
RECEIVED MAY 12 1981

May 8, 1981

Your file Votre référence

Our file Notre référence

5304-8-10

Mr. K. Lewis Yeager
The Environmental Applications Group Ltd.
114 Avenue Road
Toronto, Ontario
M5R 2H4

Dear Mr. Yeager:

Re: Proposed Tin Mine at East Kemptville, N.S.

This letter is to clarify our concerns about the establishment of a tailings containment area in a natural stream bed. We feel that eventually one or the other of the two proposed dams must fail and that a failure of the diversion dam on Third Bear Lake must increase the likelihood of a failure in the dam on Second Bear Lake by subjecting it to flows for which it was not designed. If the dam on Second Bear Lake fails the tailings behind it will quickly be eroded and will contaminate the Tusket River downstream from the tailings area. A dam failure during the life of the mine might not be very serious because it could be repaired quickly by the owners, but after the mine is abandoned this will not be the case forever. Therefore, we think that some alternate method of disposal of tailings should be looked for.

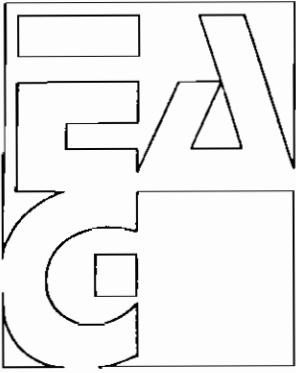
We are still looking forward to receiving your progress reports and water quality data from Shell Canada.

Yours truly,

W.J. White
Environmental Assessment Biologist
Resource Branch

WJW/bls

P.O. Box 550
Halifax, N.S.
B3J 2S7



May 14, 1981.

**THE ENVIRONMENTAL
APPLICATIONS GROUP
LIMITED**

114 AVENUE ROAD
TORONTO, ONTARIO M5R 2H4
PHONE: (416) 968-3684

Fisheries and Oceans Canada,
P.O. Box 550,
Halifax, Nova Scotia.
B3J 2S7

Attention: W.J. White,
Environmental Assessment Biologist,
Resource Branch.

Re: Shell Canada Proposed Tin Mine - East Kemptville, N.S.

Dear Mr. White:

Thank you for your letter of May 8, 1981, in which you express your concerns related to the long-term aspects of the proposed tailings containment area for the East Kemptville Project. We appreciate input from your group at this early stage so that known concerns can be addressed fully, and integrated with the mine development planning process.

I have forwarded a copy of your letter to J.M. Gibbs, Shell's Manager of Minerals Production in Calgary, and we will explore the possibility of examining alternative tailings locations, from environmental and other viewpoints, with him. While there is no reason that a well designed and engineered tailings containment system should fail in the manner outlined in your letter, we will ensure that Shell is fully aware of these views.

We are planning to begin studies at the site shortly, and I will have an opportunity to consult further with you and your colleagues on these and other matters.

Yours truly,

THE ENVIRONMENTAL APPLICATIONS GROUP
LIMITED

K. Lewis Yeager,
Vice President.

KLY/la

cc: J.M. Gibbs, Shell - Calgary

EAST KEMPTVILLE PROJECT - SHELL CANADA RESOURCES LIMITED

MINUTES OF MEETING HELD AUGUST 27, 1981 at 4th FLOOR CONFERENCE
ROOM - JOSEPH HOWE BLDG., HALIFAX

1. Present: Shell Canada Resources Limited
J.M. Gibbs, Manager - Minerals Production
- Nova Scotia Department of the Environment
Dr. John Underwood,
Hague Vaughn
- Jaques, Whitford and Associates Ltd.
Dr. John D. Brown, P.Eng.
- Fisheries and Oceans Canada
Wesley J. White
- The Environmental Applications Group Limited
Dr. John H. Sparling,
K.L. Yeager

2. Objectives

This meeting was organized by Jack Leydon of Nova Scotia Environment at the request of Lewis Yeager (EAG) in order to address potential environmental concerns raised by W. White related to the proposed utilization of Second Bear Lake for tailings disposal. The principal concerns focused on the possibility of failure of dams or structures and the long term integrity of the system and the potential for water quality impairment. At this meeting, Shell Canada, Jaques, Whitford & Associates Limited who is responsible

for design of the tailings containment system, and The Environmental Applications Group, the environmental consultant described the proposal, and discussed any questions from provincial and federal biologists related to the development.

3. Minutes of the Meeting

Mr. Yeager provided introductory remarks re. EAG's involvement with the project site - water quality, hydrological monitoring has been under way since 1979, other studies ongoing in 1981.

EAG sought concerns from individuals and agencies. Mr. Yeager then read letter of May 8, 1981 from W. White re. concerns of F. & O. about the potential for tailings containment failure. As a result, Mr. Yeager asked Jack Leydon, Environment Nova Scotia to convene a meeting with Shell Canada, EAG, and Jaques, Whitford to discuss all aspects of tailings systems.

Mr. Gibbs - outlined history of project, nature of deposit and processing methods, budget, and timetable.

Q. Mr. Vaughan - asked depth of deposit?

A. Maximum 80 m below surface.

Dr. Brown - outlined aspects of tailings disposal

-he noted that he has concentrated on Second Bear Lake because it involves least dam building

-a pipeline to conduct slurry (12% solids) 6000 tonnes of solids per day, 40,000 tonnes of water

-described old ways of dealing with tailings - had flow, erosion problems, no longer used

-we now want to build dam and place tails behind

-drew schematic of proposed layout

- With water dams, we are concerned about:
- 1) hydrostatic force
 - 2) seepage
 - 3) overtopping and other catastrophic events

However, with tailings dam, also have to store solids.

- large "beach" would build up next to dam.

Therefore, from a civil engineering viewpoint, tailings dam is inherently easier to design and safer than a reservoir

- water to be reused by mean of pumping
- looking at diversion of 3rd Bear Lake to Clyde R. System
- dam would be build in sections, beginning with starter dam - prepared schematic
- dam would be enlarged by spigotting - step wise increase in height and can go to 400 ft or more
- must be careful to control seepage by means of draining system
- at East Tusket - starter dam would be 8 m, successive steps up to 11 m, total 19 m or about 60 ft. - small by mining industry standards.
- at terminal condition, pond at elev. 123, dam at elev. 125, 100 m beach behind dam.
- after abandonment - must provide for permanent spillway system around end of dam - rip rap lined trench, large enough to take design flows from runoff - can be increased in width to handle water from Third Bear Lake if necessary - would be stepped down channel

Long term concerns

1. loss of strength? - no reason for this to happen.
2. slumping - filters will prevent undermining of system.

Foundation conditons are very favourable at this site.

Q. Mr. White - can plants be grown on tailings after abandonment?

A. Mr. Gibbs - yes, but expensive - may have to be fertilized, but can be done in most cases

A. Dr. Sparling - fine material of some tailings - often a problem with soil texture, - in this case, sand sized particles improve aeration properties of soil

Q. Mr. White - is it possible to grow trees on shrubs on dam?

A. Mr. Gibbs - yes, but difficult during operation, can start at bottom.

Q. Mr. White - what is tailings capacity?

A. Mr. Gibbs - 40 million tonnes

Q. Mr. White - what will design flow of spillway be?

A. Dr. Brown - have not yet done detailed study of flow frequency for design work

A. Dr. Sparling - discussed flow regimes and mean and storm flow conditions

Q. Mr. White - what return period for design?

A. Dr. Sparling - discussed 100 year storm so far, not final

Q. Mr. White - would there be cost increase by increasing return storm by 10?

A. Dr. Sparling - probably not a great increase in cost but, is more than just volume of spillway involved.

Q. Mr. White - concerned about possibility of dam being overtopped?

A. Dr. Sparling - have not yet done the detailed hydrology to answer in detail - will be doing modelling this fall

Q. Dr. Underwood - would beaver dams in spillway be a problem?

A. Mr. Gibbs - there is no spillway during operation. After abandonment, spillway is dry or moist, no normal flows to encourage beaver activity

Q. Mr. Vaughn - asked about water budget and excess pumping capacity?

A. Mr. Gibbs - yes, may also be bypass for extreme flows when cannot use excess in plant - any bypass water would have to meet quality standards.

Q. Mr. White - what would happen if dam were overtopped? wash away, erode?

A. Mr. Brown - depends on what stage happened - could erode a V - notch.

Q. Mr. Yeager - what sequence of events would have to occur to have an overtopping of dam? Is it likely?

A. Dr. Brown - 1) inadequate flow prediction,
2) faulty engineering design
3) obstructions to spillway, i.e. beaver dams
- overtopping of an engineered dam very unlikely

Q. Dr. Underwood - Deadfalls could work through system?

A. Dr. Brown - no timber upstream - mainly boulder fields

Q. Mr. White - wasn't there to be another dam on Third Bear Lake?

A. Dr. Brown - yes, he then outlined diversion plans on topo map

Q. Mr. White - have you explored it for soil type etc?

A. Dr. Brown - only on foot to this point - only a 10 ft minor structure also a minor outlet at other end of Third Bear Lake

Q. Mr. White - what would this dam be made from?

A. Dr. Brown - same native till material

Q. Dr. Underwood - asked Mr. White about spawning sites on Tuskett River

A. Mr. White - are well known - less is known about Clyde R. - discussion of experimental development of acid resistant strains of salmon. Mr. White stated he does not feel that diversion would have a negative effect on the Clyde system.

Q. Mr. White - how much water to be stored behind dam on Third Bear Lake?

A. Dr. Brown and Dr. Sparling - area about $1 \times 10^6 \text{ m}^2$ - probably 5 or 6 hundred thousand m^3 to a million m^3 storage.

Q. Mr. Yeager - are there any other points related to tailings dam?

Q. Mr. White - no, but would like to know about characteristics of tails themselves.

A. Dr. Sparling - discussed Lakefield analysis of tailings sample - low in sulphate, fairly high in alkalinity. Fairly high alk. & pH also in groundwater - not likely to contribute to acidity problem, anything that infiltrates would be near neutral pH - discussed trace metal makeup of tails.

Q. Mr. White - what metals normally associated with tin deposits?

A. Dr. Sparling - tungsten, bismouth

Q. Mr. White - tin is generally quite insoluble?

A. Dr. Sparling - yes except under very alkaline conditions.

- also have some analysis of tailings water - calcium fairly high - coming into soil in pH = 6.8 - metals; cadmium 2ppb etc.
- listed concentrations

Q. Mr. Vaugh - aluminum concentration?

A. Dr. Sparling - is lower than in surface water

Q. Mr. White - what is causing alkalinity?

A. Dr. Sparling - we were not expecting - possibly related to apatite - same in groundwater samples good for process and perhaps for river?

A. Mr. White - quite possible

A. Dr. Sparling - quite pleased with low levels of trace metals in effluents. - in Ontario, total metals (excl. Fe) must be less than 1 mg/l. Here, we have less than 0.1 mg/l

Q. Dr. Underwood - will these figures be in report?

A. Dr. Sparling - yes, Lakefield supplied us with data for comment so that EAG can participate in design, process etc. We can combine these data with EAG mine water samples to estimate likely effluent metal characteristics. Hardness of 93 mg/l quite favourable.

Q. Mr. Yeager - asked Mr. White how he now felt about tailings concerns?

A. Mr. White - with respect to the permanence of the containment system, ensure that mud and physical disruption of habitat in stream does not occur. Can it be guaranteed?

Q. Mr. Yeager - asked Dr. Brown to tie together the relevant information to answer this?

A. Dr. Brown - any structure or natural feature can fail, it is a question of probabilities. Generally, a catastrophic flood that could divert rivers is the only concern with a well designed system. Can build as wide a spillway as required at modest cost. This part of the design is at end of mine - capacity unsure until then.

Q. Mr. White - would it be feasible to provide extra storage capacity for dam?

A. Dr. Brown - yes, can dyke to provide extra freeboard. Would have freeboard of 2.5 m without adding extra, could add a couple of extra metres with no problem.

Q. Mr. White - what about failure of Third Bear Lake dam and flow to 2nd Bear Lake?

A. Mr. Brown - capacity of spillway would be designed to accomodate

Q. Mr. White - with sufficient storage and large spillway these concerns would be addressed. Is there adequate hydrological data base for flow prediction?

A. Dr. Sparling - we must be conservative with estimates and utilize other watershed to improve predictions - there will be years of data by time spillway is needed

Q. Mr. Yeager - asked Mr. White whether Fisheries and Oceans had had comments from public re: project?

A. Mr. White - no, no comments at all

A. Dr. Sparling - comments he has received generally favourable if at all

A. Mr. Gibbs - outlined location of mine and facilities on topo maps

Q. Mr. Vaughn - would open pit become a lake after abandonment?

A. Mr. Gibbs - yes, draining into swamp to north - he described B.C. dams of greater design heights

A. Mr. White - stated that he had no further questions related to these topics

Q. Mr. Yeager - asked if there were further concerns among those present?

Q. Mr. White - asked whether provincial water rights application could take into account final configuration of dam and spillway

A. Mr. Gibbs - Shell will know details of dam soon, and would be willing to agree to any reasonable spillway, based upon 15 years of hydrological data we will have by the time it is needed.

Mr. White agreed, as long as it is reasonable. Dr. Brown noted we can state that intention is to pass all water etc.

Q. Mr. White - is it expensive or feasible to armour downstream of dam?

A. Mr. Gibbs - very expensive, no suitable local rock - prefer to vegetate.

There being no further questions at this time, Mr. Yeager thanked all participants for an energetic and valuable session, and closed the Meeting.

Minutes Recorded by K.L. Yeager