MINISTRY OF ENVIRONMENT
PROVINCE OF BRITISH COLUMBIA

PEACE RIVER AREA

POUCE COUPE RIVER SUB-BASIN WATER QUALITY ASSESSMENT AND OBJECTIVES

TECHNICAL APPENDIX

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1. INTRODUCTION

The Pouce Coupe River sub-basin is one of seven priority sub-basins in the Peace River area for which water quality assessments are being conducted. The location of the Peace River area is shown in Figure 1, and Figure 2 shows the area and its seven priority sub-basins.

The Pouce Coupe River sub-basin has an approximate drainage area of 2850 km^2 (including Alberta) and is bounded by the Peace River to the north and the Alberta border to the east (Figure 3). The headwaters of the Pouce Coupe River arise in Alberta. The river enters British Columbia upstream from its tributary, the Tupper River, and re-enters Alberta close to its confluence with the Peace River.

This sub-basin lies within the Alberta Plateau Plains and is characterized by flat-to-gently-rolling upland topography underlain by conglomerates and carbonaceous sandstones and shales (E.L.U.S.C., 1977). It is the second most populated area in the Peace River Strategic Unit, next to the Fort St. John area, and contains the City of Dawson Creek and the Village of Pouce Coupe. Farming is presently the major economic activity in the sub-basin, although the population is projected to increase rapidly as a result of Northeast Coal, B.C. Hydro Site-C, and natural gas developments. The main effluent is treated municipal sewage from the two towns.

2. HYDROLOGY

The seasonal flow pattern of the Pouce Coupe River is characterized by snowmelt flood peaks from late March to June followed by declining discharge to a minimum in late-July, early August. Late summer and fall rain events raise the discharge through September to November. Minimum flows occur during the winter from December to late March (see annual hydrograph, Figure 4). Water Survey of Canada (Environment Canada) has maintained a flow gauge (station 07FD007) on the Pouce Coupe River below Henderson Creek continuously since 1971.

Low flow estimates were given by Obedkoff (1982). During the winter, the Pouce Coupe River is completely ice covered and with minimal flow. During a hot dry summer, the Pouce Coupe River almost dries up near the Village and very little dilution is provided for the sewage effluent entering the river. The seven-day average low flow, occurring once in ten years, expected in the Pouce Coupe River during the October-April period is 0.005 m^3/s, both at the Village of Pouce Coupe and at a point 5 km downstream from the confluence with Dawson Creek (Obedkoff, 1982). The mean low flow* for this period is 0.089 m^3/s at the Village and 0.15 m^3/s downstream from Dawson Creek. The mid-summer seven-day low flow (10 year return) is 0.04 m^3/s at the Village of Pouce Coupe and 0.04 m^3/s below the confluence with Dawson Creek. The mean August low flow* is 1.5 m^3/s at the Village and 2.4 m^3/s below Dawson Creek.

Dawson Creek is usually frozen solid from December to February or with minimal flow below the ice. During mid-summer, Dawson Creek almost dries out except for sewage effluent from the City of Dawson Creek (permit file PE 426. Waste Management Branch, Victoria, B.C.). The seven-day average low flow estimate (10-year return period) expected in Dawson Creek near the City is 0.0 m^3/s for both the August and the October-April periods (Obedkoff, 1982).

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* The seven-day average low flow, averaged yearly for the period of record.

3. LAKES

The only lake of significance in this sub-basin is Swan Lake at the headwaters of Tupper River adjacent to the Alberta border. Swan Lake is a shallow eutrophic lake (mean depth 3.2 m) occupying 6.1 km^2, and contains the only sport fish population known to be significant in the sub-basin. It receives extensive summer recreational use, although early summer-fall algal blooms limit its use. Recreational facilities include a Provincial Park, public boat launching sites, and numerous private cottages. There are no permitted, direct waste discharges entering Swan Lake (lake files, Inventory Operations Unit, Water Management Branch, Victoria, B.C.). Regional Waste Management Branch personnel (Prince George) do not suspect problems with diffuse unpermitted waste loading from sources such as faulty septic fields or agricultural fertilizers (R. Girard, personal communication).

4. WATER USES

Agriculture is important in this sub-basin, but there is little demand for irrigation water as natural precipitation is adequate. There are no existing water withdrawals downstream from existing discharges and no known proposed future withdrawals which would be affected by present discharges. Both the City of Dawson Creek and the Village of Pouce Coupe draw their domestic water supplies from the Kiskatinaw River which is outside the Pouce Coupe River Sub-basin. There are two water withdrawals from Home Creek, a tributary to Saskatoon Creek which enters the Pouce Coupe River downstream from both municipal effluent discharges. These withdrawals have no effect on effluent dilution in the Pouce Coupe River. There are two small domestic water withdrawals (Nowicki Creek, Frondizi Creek) upstream from the municipal discharges that have no impact on effluent dilution (Table 1, Figure 3). No known future withdrawals which could affect downstream dilution are being considered upstream from the municipal discharges.

Fisheries values are minimal in the Pouce Coupe sub-basin. The Regional Fisheries Biologist has rated the Pouce Coupe River mainstem as of medium to low capability, population unknown (Kumka, 1982). No salmonids are known to occur in the Pouce Coupe drainage, and the only game fish known to be present are northern pike and yellow perch in the vicinity of Swan Lake (Hammond, 1982). Both upstream and downstream from the Village of Pouce Coupe outfall, Hammond collected only forage species (trout perch, longnose dace, redside shiner, pearl dace, and longnose suckers). Fish habitat in the Pouce Coupe River has a low capability due to naturally high sediment levels, low flows, and abundant algal growth. No fish species have been recorded for Dawson Creek. On September 29, 1982, Hammond observed that Dawson Creek was broken into discontinuous shallow pools, with no capability of supporting fish.

Recreational use of Dawson Creek and the Pouce Coupe River is minimal because of low flows and sewage contamination. Canoeing and swimming in these systems are not known to be locally important, although children do play along the banks of both streams. Mr. B. Vath, Public Health Inspector (Dawson Creek), reported that some swimming had occurred in the Pouce Coupe River at Riley's Crossing (site 0410042) during the summer of 1982. The Village of Pouce Coupe is also interested in developing the recreational potential of the Pouce Coupe River: in 1972 the Chamber of Commerce unsuccessfully submitted a proposal to create an eight hectare Provincial Park along the river near the Village upstream from the effluent discharge (Block 5, Plan 2966, Section 32, Township 77, Range 14) which included a swimming area (Chess, 1983). The approximate location of the proposed park is shown in Figure 3.

5. WASTE DISCHARGES

The priority effluent discharges in this sub-basin are the treated municipal effluents from the City of Dawson Creek and the Village of Pouce Coupe. The only other active discharge to the river system is runoff from the Petro-Canada bulk loading terminal which is not considered by the regional Waste Management Branch to be a problem. Details of the waste discharge permits issued by the Regional Waste Management Branch for this sub-basin are summarized in Table 2.

5.1 THE VILLAGE OF POUCE COUPE

a) DESCRIPTION OF DISCHARGE

Pouce Coupe had an estimated 1982 population of 847. The population is projected to increase to 1151 in 1987 and 1400 in 1992 (Table 3). The village is predominantly residential and is projected to remain so for the next 10 years.

Permit PE 426 was issued to the Village in 1971 for an existing sewage system consisting of a septic tank discharging into a slough. These facilities were replaced by an engineered lagoon system in the summer of 1977 (the lagoon system was to be in operation by December 31, 1973; however, it was not constructed or ready until 1977). The treatment system consists of two anaerobic cells followed by two facultative lagoons in series. The effluent is discharged to the Pouce Coupe River approximately 2.7 km upstream from the confluence with Dawson Creek (Figure 3).

The permit originally authorized a maximum flow of 382 m^3/d of effluent with BOD_5 of 40 mg/L and suspended solids of 60 mg/L. Failing construction of the proposed treatment facilities by December 31, 1973, the permit was amended on September 3, 1976, retaining the discharge quantity, but downgrading BOD_5 and suspended solids each to 130 mg/L. On May 26, 1982, the permit was amended allowing a discharge of 2300 m^3/d of effluent only during the period April 1 to June 30. The permit limits were upgraded to a BOD_5 of 45 mg/L and suspended solids of 60 mg/L. Springtime discharge was deemed necessary because the absence of adequate dilution under summer and winter conditions presented a potential health hazard. During the winter, discharged effluent froze in ice-cover and accumulated until spring break-up. During a hot dry summer, flows in the Pouce Coupe River were too low to dilute the sewage effluent adequately.

A new 5.25 ha storage lagoon with outfall was added to the system in 1983. This will provide storage capacity necessary to allow discharge of the treated effluent during only the spring runoff period.

b) PRESENT WASTE LOADS

Ministry of Environment effluent monitoring data for the period 1977 to 1982 are summarized in Table 4. The results show that the treatment system generally met the 1976 permit. Construction of the new lagoon may bring the effluent into compliance with the upgraded limits in the 1982 permit. Ammonia concentrations have been high, and may be toxic to aquatic life. Additionally, fecal coliform densities present a public health hazard.

Flow. Few records of daily effluent flow have been kept. Flow measurements taken by Regional Waste Management Branch staff in 1979 indicated discharge quantities between 91-277 m^3/d. An annual outflow for 1981 has been estimated at 82 300 m^3. Assuming a constant discharge rate, the average daily effluent flows would have been 225 m^3/d which is considerably less than the former original limit of 382 m^3/d. It has been calculated that the Pouce Coupe River provides adequate dilution (>20:1) for this average daily discharge volume during mean flows occurring in August and October-April, but that inadequate dilution (<20:1) occurs during the 10-year low flows for the same periods (Table 7).

<u>BOD_5</u>. Eighty-three percent of the BOD_5 values were less than the 1976 BOD_5 permit limit of 130 mg/L. However, without improved treatment such as the storage lagoon planned for 1983, the system will be unable to meet the upgraded permit limits: 78 percent of BOD_5 values were greater than 45 mg/L. Of these measurements, approximately half occurred during the winter and half during the summer, although winter values were significantly higher (mean = 123 mg/L, n=15) than summer values (mean = 85 mg/L, n=13).

The maximum daily BOD_5 load which has occurred since 1978 is estimated to be 54 kg/d (March 9, 1981; Table 5). This may be an overestimate since it was calculated from a maximum winter concentration and an average effluent flow, which may not coincide. Effluent flows are usually highest in spring and during rainy periods due to runoff and infiltration to the sewer system. During winter low stream flows, (e.g., early March), effluent flows can also be expected to be low.

The effect of present BOD_5 loadings on dissolved oxygen (D.O.) in the Pouce Coupe River appears to be serious. During the winter low flow period (10-year return), the predicted maximum increase in receiving environment BOD_5 concentration was calculated to be 82 mg/L (Table 6). If this effluent freezes into the ice-cover and accumulates until spring (as reported; Section 5.1 a), there may be complete deoxygenation of the water column when higher temperatures and biological activity return. The predicted maximum increase in receiving water BOD_5 concentration for August (10-year return) was calculated to be 13 mg/L (Table 6) suggesting that significant oxygen reduction could also occur during summer low flows. These predictions assume that 1) water temperature = 20°C, 2) no reaeration occurs and 3) travel time to the river mouth = 5 days. Thus, the values given above are over-estimates of potential dissolved oxygen depletion: they do not take into consideration the variable effects of re-aeration, lower temperatures, and BOD exertion during the travel time from the waste source.

Suspended solids. The majority of suspended solids measurements (92%) recorded since 1977 have been less than the previous permit limit of 130 mg/L. Sixty-three percent of these values are less than the present permit limit of 60 mg/L. Completion of the new storage lagoon will mean improved effluent treatment and better compliance with the 60 mg/L limit.

The maximum suspended solids load is estimated to be 52 kg/d (Table 5), less than half of the present permitted loading level. Under conditions of such a loading, the maximum increase in receiving water suspended solids was calculated to be 79 mg/L during winter low flows (10-year return period) and 12 mg/L during the summer low flow (10-year return) (Table 6). The theoretical impacts of these increases in ambient suspended solids on the river cannot be fully assessed at this time since suspended solids concentrations upstream from the discharge have not been measured. It should be noted that the suspended solids contributed from the effluent are mainly organic in nature while the background suspended solids are mainly inorganic. However, these are significant increases which would be noticeable during low flow periods when background suspended solids levels are likely to be negligible.

Fecal coliform bacteria concentrations in the effluent have been high: densities ranged from 2 400 to 790 000 MPN/100 mL, and the geometric mean for 19 measurements was 38 000 MPN/100 mL (Table 5). Fecal coliform levels in the Pouce Coupe River during periods of minimum streamflow and maximum present daily loading were calculated to be 42 000 MPN/100 mL during the summer and 274 000 MPN/100 mL during the winter (Table 6). The predicted maximum summer fecal coliform concentration is approximately 100 times greater than the maximum concentration allowed by the Ministry of Health guideline for primary contact recreational waters. This guidelines states: "the fecal coliform content of primary contact recreational waters shall not exceed a running log mean of 200 MPN/100 mL nor shall more than 10 percent of total samples during any 30-day period exceed 400 MPN/100 mL" (Richards, 1983).

These values were calculated from the maximum theoretical load of 1.8 x 10^{12} MPN/d in the absence of actual loading values. As a result, the predicted receiving water concentrations may be overestimates. In addition, these extrapolated fecal coliform concentrations pertain to the immediate discharge zone and assume: 1) complete mixing; and 2) no die-off or growth in numbers.

Nitrogen. Ammonia-N levels in the effluent averaged 27 mg/L (n=5) over the period 1978 to 1981 when effluent was being discharged to the river. The present maximum daily ammonia load has been calculated to be 10 kg/d (Table 5). The predicted maximum increase in receiving water ammonia-N levels has been calculated to be 2 mg/L for the summer low flow (10-year return) and 15 mg/L for the winter low flow (10-year return) (Table 6). Using data presented by Trussell (1972) (and assuming Pouce Coupe River pH <8.4, T <20°C), it appears that 9 percent of the ammonia-N concentration (or 0.2 mg/L as N) would be present in the un-ionized form during the summer low flow. Assuming that during winter low flows T <5°C, 3 percent of the ammonia-N concentration (or 0.45 mg/L as N) would be present in the un-ionized form. Thus, during the winter and summer low flow period (10-year return) when the effluent dilution ratio is 18:1 or less (Table 7), the level of un-ionized ammonia-N in the Pouce Coupe River could be acutely toxic to fish (i.e., 96 h LC_{50} ≧0.2 mg/L; E.P.A., 1976).

Nitrite/nitrate levels in the effluent were low with a mean of 0.03 mg/L, although this may be biased by infrequent sampling (n=4).

Phosphorus. Dissolved (orthophosphate) and total phosphorus levels in the effluent averaged 9.2 and 7.5 mg/L, respectively (Table 4).

c) FUTURE WASTE LOADS

Projected future waste loadings are presented in Table 5. These have been calculated assuming permit compliance and a change to an April-June discharge upon completion of the new storage lagoon by December 31, 1983.

Predicted increases in receiving water concentrations at future loadings were calculated using a streamflow value of 0.10 m^3/s (Table 6). This is a derived value representing the end of April-June period 7-day low flow (10-year return) (Table 9). Receiving water concentrations calculated from this value should represent the maximum values expected during the discharge period. In practise, the Village of Pouce Coupe may be able to delay the discharge from the new storage lagoon until flows in the Pouce Coupe River are substantially higher, and thus receiving water concentrations may be even lower.

Flow. After completion of the new storage lagoon, all effluent has been discharged only during the period April 1 to June 30. In the absence of accurate design flow data for this lagoon, an average daily outflow for this 91 day period of 904 m^3/d was calculated from the total 1981 outflow (82 300 m^3). By 1987, a population increase of 41% will increase this outflow to 1275 m^3/d and by 1992 the daily outflow has been estimated to be 1567 m^3/d (Table 5).

If these effluent flows are released on a continuous basis during the discharge period, it has been calculated that during the one-in-ten year minimum spring streamflow, effluent dilution will be less than 10:1 (Table 8). However, if the effluent is discharged at a rate proportional to available streamflow, dilution will remain greater than 90:1 over the next 10 years (see Section 5.1 (d)).

BOD_5. Future maximum BOD_5 loadings are projected to increase to 57 kg/d by 1987 and to 71 kg/d by 1992 (Table 5) (again, these may be overestimates for the same reasons given in 5.1 b) BOD). However, future effluent discharge during spring flow (April 1-June 30) should eliminate the serious D.O. depletions presently predicted for the Pouce Coupe River downstream from the Village. The increase in receiving water BOD_5 concentration is predicted to be 6 mg/L in 1987 and 7 mg/L in 1992 (Table 6). The requirements for the complete exertion of such BOD values (T=20°C; no reaeration, travel time = 5 days) would not be fully realized and therefore reduction of ambient D.O. to levels acutely toxic to aquatic life (<4.0 mg/L) does not appear possible.

Suspended solids loadings are predicted to be 77 kg/d by 1987 and 94 kg/d by 1992 (Table 5). The increases in receiving water suspended solids concentrations resulting from such loadings are predicted to be 8 mg/L by 1987 and 9 kg/d by 1992 (Table 6) under worst conditions. These increases would not constitute impairment of ambient water quality during the spring run-off period when the effluent is discharged.

Fecal coliform bacteria densities in the effluent can be expected to be lower than present levels as a result of improved effluent treatment afforded by the new storage lagoon. A future maximum fecal coliform density of 35 000 MPN/100 mL can be assumed at BOD_5 = 45 mg/L based on a comparison of BOD_5 and fecal coliform values for the effluent (L. Pommen, Water Management Branch, Victoria, personal communication) for both 1987 and 1992. Assuming that this level of fecal coliform density in the effluent can be achieved, future fecal coliform loadings will be 4.5×10^{11} MPN/d in 1987 and 5.5×10^{11} MPN/d in 1992 (Table 5). Under a future regime of April to June discharge, receiving water densities of fecal coliforms are predicted to be 5 000 MPN/100 mL in 1987 and 5 800 MPN/100 mL in 1992 (Table 6) under worst conditions (i.e., an effluent dilution of 7:1 for 1987 and 6:1 for 1992). Maintaining a 20:1 dilution would reduce the fecal coliform densities to 1750 MPN/100 mL for both 1987 and 1992. These high receiving water densities would constitute a public health hazard because criteria for water-contact recreation are in the 200-400 MPN/100 mL range (Richards, 1983). However, if the effluent was discharged according to available streamflow during the period April 1-June 30, there would be sufficient dilution (116:1 for 1987 and 94:1 for 1992; Table 8) to reduce receiving water fecal coliform densities to the 300-400 MPN/100 mL range under worst conditions. These levels would not constitute a public health hazard. In any case, terminating the effluent discharge by June 30 would leave the prime July-September recreational period available for water-contact in the Pouce Coupe River between the Village and the confluence with Dawson Creek.

A ban on water-contact recreation in this reach of the river should be maintained during the spring discharge period if the effluent is not discharged according to available streamflow. If a regime of high effluent dilution (greater than 90:1) cannot be instituted and if water-contact recreation during April 1-June 30 is desired, then effluent chlorination/dechlorination should be considered.

Ammonia-N concentrations in the effluent should be lower in the future with improved treatment from the new lagoon. Future ammonia-N loads were calculated (Table 5) assuming that effluent concentrations would not exceed the minimum present concentration (15 mg/L). This is consistent with results for comparable systems reported in the literature (L. Pommen, personal communication). Ammonia-N loads projected for 1987 and 1992 were 19 and 23 kg/d, respectively. At these loadings, the projected increase in receiving water concentrations of ammonia-N were calculated to be 2 mg/L for both 1987 and 1992 (Table 6) under worst conditions. Using data presented by Trussel (1972), it appears that approximately 5 percent of the ammonia-N concentration would be present in the un-ionized form (for Pouce Coupe River water where pH = 8.4 and T = 15°C). Thus, the expected concentrations of un-ionized ammonia-N would be 0.1 mg/L for both 1987 and 1992 during extreme low flows. Although these concentrations are speculative, they conservatively indicate that un-ionized ammonia-N levels could exceed the working criteria for aquatic life (0.007 mg/L average, 0.030 mg/L maximum; Pommen, 1983) during the 10-year minimum spring flow.

If the effluent was discharged according to available streamflow during April-June, there would be sufficient dilution (116:1 for 1987 and 94:1 for 1992; Table 8) to reduce receiving water total ammonia-N concentrations to 0.13 mg/L in 1987 and 0.16 mg/L in 1992. At such concentrations, there would not be toxic levels of un-ionized ammonia-N.

d) SEWAGE TREATMENT AND DISPOSAL OPTIONS

As outlined above, effluent from the Village of Pouce Coupe does not consistently meet permitted levels at the present time. With inadequate dilution during the August and October-April low flows, the receiving waters probably experience significant dissolved oxygen reductions, high fecal coliform densities, and toxic levels of un-ionized ammonia-N.

Effluent quality is expected to improve in the future with the construction of an expanded lagoon capacity by December, 1983. This lagoon will allow year-round storage and discharge during spring flows, April 1 to June 30. However, effluent release at this time does not guarantee 20:1 dilution. Table 8 shows the dilution that would be achieved under a regime of continuous discharge. During the end of April-June period, dilution at maximum present effluent flow would be 10:1 after the peak spring flood has passed. Under this same low flow, dilution would decrease to 6:1 over the next 10 years. It must be emphasized that the low flow figure (8 640 m^3/d) used in these predictions was estimated from existing data for the Pouce Coupe River gauging site near Henderson Creek. To verify this estimate, the installation of a gauging site at the Village discharge site would be necessary.

Careful effluent discharge at a rate proportional to available streamflow during the April 1-June 30 period would provide greater than 20:1 dilution (Table 8). The minimum volume of Pouce Coupe River flow for this period is 13 400 000 m^3 compared to a present annual effluent volume of 82 300 m^3, the dilution ratio would be 163:1. As effluent volumes increase over the next 10 years, the dilution ratio is projected to fall to 94:1. Thus to ensure a high dilution, the installation of a staff gauge, and the development of a stage-discharge curve for the Pouce Coupe River at the Village would be necessary. Municipal staff could then refer to the curve to adjust the volume of effluent discharge according to the available streamflow.

As outlined in Section 5.1 c), without a regime of effluent discharge according to available streamflow, future receiving water fecal coliform densities would exceed the criteria for water-contact recreation. Effluent chlorination/dechlorination would then be required if water-contact recreation was desired during the April 1-June 30 discharge period.

5.2 THE CITY OF DAWSON CREEK

a) DESCRIPTION OF DISCHARGE

Dawson Creek had a 1982 population of 11 634. Its population is projected to increase to 15 791 by 1987 and up to 19 396 by 1992 (Table 3). The City serves the surrounding agricultural area and is predominantly residential with some light industrial development.

The sewage treatment facilities consist of a series of two anaerobic and three aerobic lagoons which discharge to a series of active beaver ponds. There are three main discharge points through the beaver dams to Dawson Creek. Regional staff believe that the ponds provide significant oxygenation and removal of suspended solids. There are, however, no data available with which to assess the purification performance of the beaver ponds. All effluent data were taken from the outlet of the last aerobic lagoon. Permit PE 311 was issued to the City on November 7, 1969, and allowed a discharge of 3 930 m^3/d with BOD_5 of 50 mg/L, suspended solids of 50 mg/L and average coliform bacteria densities of 200 000 MPN/100 mL.

The treatment facilities are being upgraded to handle increased sewage flows and to correct various problems. These have included failure of the lift station pumps, forcemain rupture, and overflow of the lagoon berms, causing discharge of sewage (ranging from raw to partially treated) to Dawson Creek. Improvments to date have included a new pump-station and forcemain. Mechanical aeration equipment will be installed in the aerobic lagoons, and the outfall will be extended to the main channel of Dawson Creek by December 31, 1984.

The permit was amended January 27, 1981, allowing an increased discharge of 7 600 m^3/d and upgrading BOD_5 to 30 mg/L and suspended solids to 40 mg/L (to coincide with the improved works). Until December 31, 1984, the permit will allow BOD_5 of 50 mg/L and suspended solids of 50 mg/L through December to March.

b) PRESENT WASTE LOADS

Ministry of Environment effluent monitoring data for the period 1972 to 1982 are summarized in Table 4. The results show that the treatment system produced good quality effluent relative to permit conditions. However, Dawson Creek flow may completely cease during low flow periods, and both present and future waste loads can be expected to result in dissolved oxygen depletions, levels of un-ionized ammonia-N acutely toxic to aquatic life, and fecal coliform densities indicating a hazard to human health.

Flow. Few records of daily effluent flow have been kept. Of the five flow values taken during the period 1973 to 1976 (1 440 - 5 900 m^3/d), the effluent flow on August 4, 1976, (5 900 m^3/d) exceeded the previous permit maximum of 3 930 m^3/d.

During 1981, effluent flow averaged 5 450 m^3/d (Brewer, 1982), well below the present permit limit of 7 600 m^3/d. This average flow value was calculated from an annual outflow of 1.2 million m^3 which occurred over a 228 day period, March 9-October 23, 1981 (Harcombe, 1983). These estimates were based on the hours of operation of the lift station pumps plus estimates of the unrecorded overflow from anaerobic cell #4. As a result of a faulty flow meter, accurate daily flow values are not available.

It is the general practice of the City of Dawson Creek not to discharge effluent during the winter months, January to March, when the Creek is usually frozen solid. Attempts are made to store the effluent over this period and to discharge it during the spring and summer.

Effluent BOD_5 averaged 39 mg/L. Eighty-one percent (43 of 53) of the BOD_5 measurements recorded were less than the permitted limit of 50 mg/L. Most results were below 25 mg/L and many were below 10 mg/L. The effluent exceeded the BOD_5 limits during the winter (December to April), probably as a result of poor cold weather treatment.

The maximum daily BOD_5 load recorded since 1973 is estimated to be 1 220 kg/d (Table 5), more than five times the permitted loading level (228 kg/d). This value may be an overestimate since it was calculated from a maximum concentration recorded in December (1981) and an average daily discharge recorded from March to October (1981), a period of high effluent discharge volume. Since effluent flow was not consistently recorded with BOD_5, a reliable pattern of actual BOD_5 loading cannot be established.

Present BOD_5 loadings are theoretically high enough to cause complete deoxygenation in Dawson Creek during all but spring flow conditions. With a seven-day low flow estimate of 0.0 m^3/s for both the August and October-April periods (Section 2) there would be no flow to dilute the maximum recorded effluent BOD_5 concentration of 224 mg/L, and consequently there would be no dissolved oxygen in the creek from the City to the Pouce Coupe River. The Water Survey of Canada began recording Dawson Creek flows upstream from the City in 1981 (Water Survey of Canada, 1982). According to Harcombe (1982), on March 16, 1981, there was no natural streamflow (presumably frozen solid) and therefore the BOD_5 concentration in the receiving environment would have equalled the effluent concentration (69 mg/L). At this time of the year, the effluent would likely freeze in the streambed and accumulate in successive layers. Upon final melting in the spring, the BOD load would likely cause a severe oxygen depletion in Dawson Creek.

Suspended solids values averaged 31 mg/L (Table 4) and 84 percent of the samples had suspended solids values lower than the permit limits of 50 mg/L. Those suspended solids concentrations exceeding permit limits occurred during the period, May to September, presumably due to algal growth in the lagoons.

The maximum present suspended solids load is estimated to be 1 046 kg/d (Table 5), considerably higher than the permitted loading of 304 kg/d. This value is the product of an average flow which occurred during the period March-October and a maximum concentration which occurred in August. For the few questionable flow data available, the maximum actual suspended solids load which occurred prior to 1981 was 198 kg/d (July 16, 1973). Another actual loading of 41 kg/d occurred on March 16, 1981, the day on which the largest single effluent discharge was recorded during 1981. These actual loading values are lower than the theoretical maximum because there was a large amount of unrecorded overflow during 1981. Too few flow data are available to verify a consistent pattern of lower loadings. The impact of such solids loadings on Dawson Creek is significant. Under conditions of maximum present loading and minimum flow in the summer, receiving water suspended solids concentrations could increase by up to 192 mg/L (Table 9). This would be in addition to the maximum concentration of 71 mg/L measured upstream from the City (September, 1973).

Fecal coliform bacteria densities in the effluent were greater than 5 000 MPN/100 mL in 36 percent of the samples (12 of 33). Densities in the effluent ranged from 2-920 000 MPN/100 mL (geometric mean of 58 300 MPN/100 mL; Table 4). It is evident that fecal coliform loadings have been extremely high in the past. The theoretical maximum load was calculated to be 5.0×10^{13} MPN/d (Table 5). Fecal coliforms in the Creek were measured on only two occasions in the past (1973) and cannot be used to verify the impacts of such extreme loading. Without streamflow dilution, effluent concentration equals receiving water concentrations (Table 10) and would exceed water quality criteria for all water uses.

High fecal coliform values appear to be related to winter treatment. Values from the recreational period, June-September, have been low (<920 MPN/100 mL). Of thirteen fecal coliform values for this period, twelve were less than 200 MPN/100 mL).

Nitrogen. Ammonia-N levels in the effluent were 6.9 mg/L (August 5, 1976) and 23 mg/L (March 16, 1981) on the two occasions when sampling occurred. The estimated maximum load is 125 kg/d. This value is the product of the maximum concentration and the average effluent discharge which occurred during March-October, 1981. This ammonia load would have frozen and accumulated in the Creek ice until spring melt. With the low dilution available at that time, the levels of un-ionized ammonia-N in the receiving environment probably would have been harmful to aquatic life (>0.030 mg/L). The same situation would prevail during the summer low flow (streamflow = 0.0 m^3/s) at an effluent concentration (hence, receiving environment concentration) of 6.9 mg/L. The un-ionized ammonia-N level in Dawson Creek during this summer period would have been approximately 0.14 mg/L, or several times greater than the maximum level recommended by Pommen (1983) for the protection of aquatic life (0.030 mg/L as N).

Nitrite/nitrate levels in the effluent have been sampled only twice (0.02 and 3.3 mg/L; Table 4).

Phosphorus levels were sampled on only two occasions. Dissolved (orthophosphate) phosphorus averaged 4.7 mg/L and total phosphorus averaged 5.0 mg/L.

c) FUTURE WASTE LOADS

Projected future waste loadings for key characteristics are presented in Table 5. These were calculated assuming permit compliance. Future increases in receiving water concentrations as a result of effluent discharge during minimum streamflow periods are presented in Table 10.

Effluent flow is projected to increase to 7 684 m^3/d by 1987 and to 9 430 m^3/d by 1992 (Table 5) as a result of 41% and 73% increases in population.

BOD$_5$. Future loadings are projected to increase to 230 kg/d by 1987 and to 283 kg/d by 1992 assuming that the effluent can comply with permit limits. Although these represent a decrease from present theoretical loadings, the impact on dissolved oxygen levels would be the same. For example, during average August low flows with no streamflow, an effluent (or receiving environment) BOD$_5$ concentration of 30 mg/L would mean complete oxygen depletion in Dawson Creek downstream from the outfall.

Suspended solids loadings are predicted to be 307 kg/d by 1987 and 377 kg/d by 1992. Without dilution from natural streamflow during the summer low flow, the suspended solids concentration in Dawson Creek would be 40 mg/L (Table 10).

Fecal coliform bacteria densities are correlated with the existing BOD$_5$ data ($r = 0.6$). The density of fecal coliforms (dependent variable, y) at the permitted BOD$_5$ limit of 30 mg/L (x) was determined to be approximately 30 000 MPN/100 mL by solving the linear regression equation ($y = a+bX = -17805 + 1599X$) ($n = 32$). If effluent BOD$_5$ conforms to the permit limit of 30 mg/L in the future, then fecal coliforms in the effluent can be expected to be 30 000 MPN/100 mL. Without natural streamflow dilution, the level of fecal coliforms in the receiving waters will also equal 30 000 MPN/100 mL and be well in excess of criteria for all water uses.

Ammonia-N concentrations in the effluent should be lower in the future, after installation of the aeration equipment. It has been assumed that future effluent concentrations will not exceed the present average concentration (15 mg/L) (Table 5). Therefore, without natural stream dilution during the summer low flow, the ammonia-N concentration in Dawson Creek would also be 15 mg/L (Table 10). At pH 7.9, T = 15°C, the maximum unionized ammonia-N concentration would be 0.32 (Trussell, 1972). This value is far in excess of the maximum level (0.030 mg/L) established for the protection of aquatic life (Pommen, 1983). Repeating these calculations using the minimum summer NH_3-N concentration recorded (6.9 mg/L), un-ionized NH_3-N levels would equal 0.15 mg/L, still in excess of the working criterion.

d) SEWAGE TREATMENT AND DISPOSAL OPTIONS

As previously outlined, discharge PE 311 (City of Dawson Creek) generally produced good quality effluent, although permitted levels were not consistently met. Effluent quality is expected to improve even further in the future with the planned installation of mechanical aeration in 1984. However, the attainment of the highest quality effluent in keeping with Provincial Effluent Objectives (Ministry of Environment, 1975) will not eliminate the severe water quality degradation projected for the receiving environment. Dawson Creek completely dries up during low flow periods resulting in a stream of undiluted effluent. Under these conditions, Dawson Creek will be characterized by extreme fecal coliform contamination, depletions of dissolved oxygen, high levels of suspended solids and nutrients, and toxic levels of un-ionized ammonia-N.

The water quality of Dawson Creek will continue to deteriorate over the next 10 years as effluent volumes increase, unless alternatives to present discharge practices are instituted. Several options may be available:

i. Effluent Discharge According to Available Streamflow. Table 11 shows the dilution that would be achieved if the effluent was discharged to Dawson Creek only during the three month spring flow period, April 1 to June 30. With an estimated average streamflow of 103 300 m^3/d for this period, dilution at maximum present effluent flow would be 8:1. Dilution is projected to decrease to 4:1 over the next 10 years. These dilution values are below the minimum acceptable dilution for municipal waste discharges, which is 20:1 (Ministry of Environment, 1975).

Year-round effluent discharge according to available streamflow would also not provide 20:1 dilution. The annual volume of Dawson Creek at the City of Dawson Creek is estimated to be 11.6 x 10^6 m^3. With this annual streamflow and a present annual effluent volume of 1.2 x 10^6 m^3, the dilution ratio would not exceed 10:1. Clearly, Dawson Creek cannot provide sufficient dilution for present or future waste loads under any discharge regime. Under present circumstances Dawson Creek cannot meet the effluent objectives for municipal waste discharges and other water uses downstream from the City will be severely limited.

ii. Construction of an effluent pipeline for discharge to a stream that would provide adequate dilution, i.e., lower Pouce Coupe River, Kiskatinaw River, Peace River.

Lower Pouce Coupe River

An effluent pipeline to the lower Pouce Coupe River would be the shortest of the three alternatives at 3.5 km in length. Table 11 shows the effluent dilution that would be achieved in the Pouce Coupe River if both the City of Dawson Creek and the Village of Pouce Coupe discharged into it during spring flows, April-June. During average spring streamflows, dilution would be more than adequate: ranging from 165:1 at present maximum effluent flow to 94:1 at projected 1992 effluent flows. However, during low spring flows (10-year return period) dilution is projected to be only 3:1 at present maximum effluent flows, falling to 1.6:1 by 1992, as effluent volumes increase. While spring flows may not be entirely reliable, year-round effluent discharge according to available streamflow would provide a minimum of 20:1 dilution. The lowest annual volume of Pouce Coupe River on historical record (1971-1982; Water Survey of Canada) is 88 million m^3/yr. With such a volume and present effluent volumes of 1.2 million m^3/yr for the City of

Dawson Creek and 82 000 m^3/yr for the Village of Pouce Coupe, the annual effluent dilution ratio would be 70:1. With a projected 73 percent increase in effluent volumes by 1992, the annual effluent dilution ratio would be 40:1 by 1992. Thus, careful discharge of the Dawson Creek effluent to the lower Pouce Coupe River would meet the minimum dilution standard of 20:1 over the next 10 years. However, most of the effluent would have to be discharged during spring freshet, thus necessitating effluent storage over the remainder of the year. The costs of such increased effluent storage capacity must enter any evaluation of this disposal option.

Other Pipeline Alternatives

The greater distances involved in a pipeline from the City of Dawson Creek to the Kiskatinaw River (18 km) or to the Peace River (40 km) make these expensive alternatives to local treatment.

The Peace River is capable of providing a minimum year-round dilution of 700:1 over the next 10 years (Table 11). At present maximum effluent flows during the winter low flow period, the Peace River would provide a dilution of 1200:1.

The Kiskatinaw River would not provide adequate dilution during the August low flow (7-day, 10-year return): at maximum present effluent flow, the dilution ratio would be 2.5:1 (Table 11). During the winter, dilution would be even lower since the winter low flow (0.08 m^3/s) is more severe than the August low flow (0.4 m^3/s). However, unlike the lower Pouce Coupe River, the Kiskatinaw River could provide greater than 20:1 dilution if the effluent was discharged during the April-June spring flow (Table 11). At maximum present effluent flow under conditions of minimum spring streamflow, the dilution ratio would be 37:1. By 1992, with projected increases in effluent flow, the dilution ratio would be 21:1. Judicious year-round discharge to the Kiskatinaw River according to available streamflow would also yield sufficient dilution: with a minimum annual volume of the Kiskatinaw River of 173 million m^3/yr (1948-1982; Water Survey of Canada) and a present effluent volume of 1.2 million m^3/yr, the annual effluent dilution ratio would be 144:1. With the projected increase in effluent volume by 1992, the annual effluent dilution ratio would be 83:1. However, it must be noted that since most of the effluent would have to be discharged to the Kiskatinaw River during spring freshet, greater effluent storage capacity would be necessary. The required capacity would be roughly 2-3 times present storage capacity and this would have to increase with future population growth.

In summary, the Peace River would provide a large year-round dilution, thereby eliminating the need for effluent storage capacity; however, the expense and technical difficulty of a 40 km pipeline are serious drawbacks to this alternative. Neither the Kiskatinaw River nor the lower Pouce Coupe River would provide 20:1 dilution during the 10-year low flow for the August and October-April periods. Since both sites would require judicious effluent release according to available streamflow under a regime of year-round discharge, the shorter distance to the lower Pouce Coupe River would favour its selection.

iii. Spray irrigation. This type of land disposal would involve storing the effluent until it could be distributed to farmers' fields during summer dry periods. It has been estimated that at least 800 ha of land and a storage volume of four times existing capacity (1.8 million m^3) would be needed. (Resume for Permit Amendment, 1980; Waste Management Branch file PE 311, Victoria). This alternative is made less feasible by the region's climate: summer rainfall is sufficient; and there is presently no demand for irrigation water. In addition, the tight clay soils of the area would resist rapid and continued infiltration.

iv. Advanced treatment. Sustaining water flow in Dawson Creek through the open-water season is desirable from an aesthetic viewpoint. While natural streamflows can be periodically inadequate to meet this need, discharge of the treated effluent can maintain a flow in the Creek during low flow periods. Furthermore, it may be possible for this flow to be brought up to recreational standards in the summer by disinfecting the effluent through chlorination (recommended 1-hour retention). Subsequent dechlorination would be necessary to protect the downstream fish and aquatic invertebrate fauna. Used in conjunction with alum coagulation, quiescent settling, and filtration, such treatment may allow the discharge to meet bathing water standards (200 MPN/100 mL geometric mean and 400 MPN/100 mL 90th percentile) (personal communication: D. Wetter, P. Eng., Waste Management Branch, Victoria). A study of fecal coliforms in Dawson Creek would be required prior to any implementation of chlorination.

The protection of downstream aquatic life could be afforded by two measures:

a. sufficient treatment aeration, along with the coagulation/settling/filtration mentioned above, to ensure a receiving water dissolved oxygen minimum of 5 mg/L, and
b. removal of toxic nitrogen ammonia concentrations. This may be accomplished with the lagoon aeration planned for start-up in 1984. Supplementary pre-discharge nitrification, if necessary, could be achieved by using a rotating biological disc or adding marsh plant lagoon treatment (see below).

v. Use of marsh plant species. Two marsh plants native to the area - bulrush (Scirpus sp.) and cattail (Typha sp.) - are capable of providing inexpensive tertiary treatment of both primary and aerated sewage (Lakshman, 1979; Ducks Unlimited, 1981). Although the research to-date has been experimental and of a pilot project nature, it does indicate that temperate aquatic biomass is effective at removing nutrients, lowering BOD, and reducing fecal coliform bacteria in domestic sewage. This concept may have application to Dawson Creek where the receiving waters cannot provide adequate dilution.

The Saskatchewan Research Council reported the following improvements in primary sewage effluent quality after marsh plant treatment:

- after 14 days of retention: 84 percent removal of total phosphorus, 75 percent removal of Kjeldahl nitrogen and 66-90 percent BOD reduction (Lakshman, 1982);
- 73 percent of fecal coliform densities were less than 200 MPN/100 mL (Lakshman, personal communication). It is believed that rhizome-exuded antibiotics are responsible for the coliform die-off.

In addition, preliminary studies have shown that many aquatic plants, including bulrush and cattail, can remove heavy metals, mercury, phenols, and PCB's (polychlorinated biphenyls) from sediments and water (Lakshman, 1979; Carbonneau and Tremblay, 1972).

Marsh plant treatment entails winter storage of the effluent and batch release of effluent during the growing season into shallow (<1.0 m) lagoons lined with gravel and planted with bulrush and cattail. After sufficient treatment has been achieved (2-3 weeks), effluent is discharged into the receiving stream and more sewage is pumped into the lagoon for treatment. Thus both the winter accumulation and the summer production can be treated before discharge. The size of the shallow lagoon is designed to treat the entire annual production in about six months of the growing season.

For a case like the Dawson Creek annual discharge of 1.2 million m^3 (assuming a two week retention period), under the batch release model there would be 12 separate batches each of 100 000 m^3. This would require 10 hectares of 1 m deep lagoon. Dr. Lakshmann believes that a combination of batch release and flow-through could be used for an effluent volume of this size, thereby reducing the required size of the treatment lagoon. One drawback would be the amount of winter storage required for the volume of Dawson Creek effluent. There is presently less than two months of storage available: thus, the present lagoons would have to be greatly increased in size to accommodate present and future effluent volumes.

While it may not be feasible to construct lagoons of the size required for this type of treatment, a natural marsh area may suffice. There is a large marsh (approximately 76 ha) 2 km south of the existing discharge which could be adapted for this purpose. Further study of this option is recommended in view of its possible economy and its proven treatment success. Potential impacts on wawterfowl utilization and aquatic life must also be assessed.

Feasibility studies will need to be undertaken to investigate the viable options in detail and to arrive at a waste management plan for the City of Dawson Creek.

5.3 COMBINED WASTE LOADINGS FROM THE VILLAGE OF POUCE COUPE AND THE CITY OF DAWSON CREEK

The Pouce Coupe River downstream from Dawson Creek receives waste input from both the Village of Pouce Coupe (PE 426) and the City of Dawson Creek (PE 311). The combined waste loading values are presented in Table 13. Predicted increases in receiving water concentrations for present and future projected waste loads during minimum streamflows are given in Table 14.

a) PRESENT WASTE LOADS

Effluent concentrations projected for present conditions are based on 10-year minimum flow estimates for the Pouce Coupe River at a point 5 km downstream from Dawson Creek (Obedkoff, 1982). Effluent dilution ratios for present combined loadings are presented in Table 17. During the summer (August 7-day low flow, 10-year return), the dilution ratio is predicted to be 1.6:1. During the winter (October-April 7-day low flow, 10-year return), the dilution ratio is predicted to be 1:1.

$\underline{BOD_5}$. The maximum possible combined daily load is estimated to be 1 274 kg/d. Based on this estimate, the BOD_5 concentration downstream from the confluence of the two waste discharges is predicted to be 143 mg/L during the summer low flow and 227 mg/L during the winter low flow (Table 14). It must be noted that these are worst case values calculated for one-in-ten year events. These values are likely over-estimates of potential dissolved oxygen depletion since they do not take into consideration the variable effects of re-aeration, temperature (i.e., <20°C), and BOD exertion during the travel time from the waste source. However, they do suggest that severe, if not complete, deoxygenation can be expected intermittently under conditions of severe low flow.

Suspended solids. The maximum possible combined suspended solids load is estimated to be 1 098 kg/d (Table 13). The increase in present maximum suspended solids concentration, predicted as a result of such loading, is 123 mg/L during the summer low flow and 196 mg/L during the winter low flow (Table 14). These concentrations would be deleterious to aquatic life during low flow periods.

Fecal coliforms. The present maximum combined fecal coliform load is estimated to be 5.2×10^{13} MPN/d (Table 13). Using this maximum theoretical load, the present receiving water concentrations have been calculated to be 600 000 MPN/100 mL during the summer low flow (10-year return) and 922 000 MPN/100 mL during the winter low flow (Table 14). The loading value upon which these concentrations are based, was calculated using maximum recorded effluent concentrations. Present receiving water concentrations, calculated using the geometric means of recorded fecal coliform data, are also presented in Table 14. Using these data, the receiving water concentration is expected to be 38 000 MPN/100 mL during the summer low flow and 58 000 MPN/100 mL during the winter low flow. Both projections of present fecal coliform levels in the Pouce Coupe River downstream from Dawson Creek indicate the presence of a serious public health hazard.

Ammonia-N. The maximum possible combined ammonia-N load is estimated to be 135 kg/d. Such loading is predicted to result in a summer low flow concentration of 15 mg/L (Table 14). Under summer conditions of pH 7.9 and a temperature of 12°C, the concentration of un-ionized ammonia would be 0.25 mg/L. The expected increase in ammonia-N concentrations for the winter low flow is 24 mg/L. The un-ionized ammonia-N levels resulting from such a concentration at T = 5°C would be 0.27 mg/L (Trussell, 1972). Both of these predicted increases exceed the working criteria for aquatic life (0.007 mg/L average; 0.030 mg/L maximum), and are near or at acutely toxic levels (Pommen, 1983).

b) FUTURE WASTE LOADS

Combined waste loadings projected to 1987 and 1992, (assuming permit compliance) are given in Table 13. Predicted increases in receiving water concentrations during minimum streamflows are given in Table 14. Effluent dilution ratios for future combined loadings are presented in Table 17. During the April-June discharge period for PE 426, under conditions of minimum flow, the effluent dilution ratio is expected to be 1.4:1 for both 1987 and 1992. During the October-April 7-day low flow, the effluent dilution ratio is projected to decrease to 1:1 for both 1987 and 1992.

April-June

In the future, the Pouce Coupe River will receive wastes from both PE 426 and PE 311 only during the spring, April to June. The predictions presented in this section are based upon extrapolations from the lowest streamflow recorded for the April-June period for the Pouce Coupe River below Henderson Creek. This is the only site downstream from Dawson Creek for which there are April-June flow data.

BOD_5. The BOD_5 load is expected to be 287 kg/d in 1987 and 354 kg/d in 1992 (Table 13). Such loads would result in increases in BOD_5 concentration of 21 mg/L in 1987 and 23 mg/L in 1992 during minimum streamflows (Table 14). Severe, if not complete deoxygenation would likely occur.

Suspended solids loading is projected to be 384 kg/d in 1987 and 471 kg/d in 1992 (Table 13). The increase in suspended solids concentration as a result of such combined loadings would be 29 mg/L in 1987 and 31 mg/L in 1992 at minimum flows (Table 14). This would be a substantial increase in suspended solids during low flows.

Fecal coliforms. Future fecal coliform loading is projected to be 2.8 x 10^{12} MPN/d in 1987 and 3.4 x 10^{12} MPN/d by 1992 (Table 13). During the spring when the river receives such loading from both sources, the predicted receiving water concentrations at minimum flows were calculated to be 18 000 MPN/100 mL in 1987 and 22 000 MPN/100 mL in 1992 during severe low flows (Table 14). These concentrations would constitute a public health hazard.

Ammonia-N. Future combined ammonia-N loading for this time of the year is expected to be 134 kg/d in 1987 and 165 kg/d in 1992 (Table 13). The ammonia-N concentrations expected in the Pouce Coupe River are 10 mg/L for 1987 and 11 mg/L for 1992 during severe low flows (Table 14) at minimum river flows. At these concentrations and under spring conditions (pH 7.9, T = 10°C), the level of un-ionized ammonia-N would be 0.15 mg/L and 0.16 mg/L for 1987 and 1992, respectively (Trussell, 1972). Both levels exceed the working criteria for aquatic life (0.007 mg/L average, 0.030 mg/L maximum: Pommen, 1983).

October-April

During future winter low flows, the Pouce Coupe River will receive wastes from only discharge PE 311, the City of Dawson Creek. To the extent that Dawson Creek can continue to avoid winter effluent discharge, the impacts outlined below could be avoided.

BOD_5. The BOD_5 load is expected to be 230 kg/d in 1987 and 283 kg/d in 1992 (assuming permit compliance) (Table 5). These loads would result in BOD_5 concentration increases of 35 mg/L in 1987 and 36 mg/L in 1992 at minimum river flows (Table 14). These are worst case values, but they do indicate that serious oxygen depletion in the Pouce Coupe River will continue to occur in the future, even with waste input only from Dawson Creek during the winter. During mean winter low flows (0.15 m^3/s), the BOD_5 concentration increases would be more than one order of magnitude lower and thus, would not be significant.

Suspended solids loadings are projected to be 307 kg/d in 1987 and 377 kg/d in 1992 as a result of discharge from PE 311 only (Table 5). Maximum suspended solids concentrations during the one-in-ten year October-April low flow are projected to be 47 mg/L for both 1987 and 1992 (Table 14). These levels would impair water quality. The suspended solids increases during mean winter low flows would be more than one order of magnitude lower and would not be significant.

Fecal coliforms. During the winter, October-April, maximum fecal coliform concentrations downstream from the confluence with Dawson Creek are expected to be 33 500 MPN/100 mL in 1987 and 34 000 MPN/100 mL in 1992 during the 10-year return low flow (Table 14). This is despite the fact that only PE 311 (Dawson Creek) would be discharging during this time. Although fecal coliform densities would be more than an order of magnitude lower during mean winter low flows, both the mean and one-in-ten year densities would exceed criteria for most water uses.

Ammonia-N. Future October-April ammonia-N loadings to the Pouce Coupe River will be equivalent to loadings in Dawson Creek: 115 kg/d in 1987 and 142 kg/d in 1992. The maximum ammonia-N concentrations expected in the Pouce Coupe River are 16 mg/L in 1987 and 17 mg/L in 1992 during the 10-year low flow (Table 14). At these concentrations, the level of un-ionized ammonia-N (under projected conditions of pH 7.9, T = 5°C) would be 0.16 mg/L for both 1987 and 1992. This concentration exceeds the working criteria (0.007 mg/L average, 0.030 mg/L maximum) for aquatic life (Pommen, 1983). Un-ionized ammonia at mean winter low flows would be an order of magnitude lower and would meet the working criteria.

The reader is referred to Section 5.2 d) of this report for a discussion of some treatment and disposal alternatives for the City of Dawson Creek and the Village of Pouce Coupe that could be considered to improve water quality.

5.4 DIFFUSE AND UNPERMITTED WASTE DISCHARGES

Agricultural activity in the Pouce Coupe River Sub-basin is fairly intensive. Most farms are situated on Class 2 and 3 soils. The land is used for hay and cereal production as well as for cattle grazing. According to Girard (1982), the most important potential non-point discharges are pesticides and nutrient additions from fertilizers and livestock. Data are not presently available which would allow the calculation of potential loadings of nutrients from these sources.

Storm sewer discharges of petroleum products are considered potentially significant by Girard (1982). Many of the gravel roads are oiled in the summer for dust suppression and this material may end up in the watercourses. To date, hydrocarbons have not been monitored in either Dawson Creek or Pouce Coupe River.

6. WATER QUALITY

6.1 DAWSON CREEK

There are five Ministry of Environment water quality sites on Dawson Creek, related to the municipal discharge from the City of Dawson Creek (PE 311). The locations of these sites are shown in Figure 3 and site descriptions follow:

Site 0410031 - Mile 4 of Alaska Hwy.; 33 m downstream from confluence with unnamed creek, 6 km upstream from the City of Dawson Creek.

Site 0410011 - Control; 33 m upstream from discharge PE 311.

Site 0410012 - 6 m downstream from discharge PE 311.

Site 0410013 - 45 m downstream from discharge PE 311.

Site 0410039 - 3 km downstream from discharge PE 311 at Rolla Crossing (site established but not sampled).

The water quality data for these sites are summarized in Table 15. There are too few data on which to assess the effects of the municipal effluent on Dawson Creek. Generally, there were only two or three samples taken in 1973; hence the need to rely upon predicted values for the important parameters as presented in Section 5.2. (Refer to Sections 5.2 b) and c) for an analysis of the projected effects of present and future waste loads on water quality).

Effluent dilution is presently non-existent during minimum streamflows (Table 10) and this situation is not projected to improve over the next 10 years. As a result, Dawson Creek becomes a stream of undiluted effluent during low flow periods, constituting a serious public health hazard. Present BOD_5 loadings are theoretically high enough to cause complete deoxygenation in Dawson Creek during all but spring flow conditions. Without streamflow dilution during the mid-summer and mid-winter, present suspended solids concentrations could increase by up to 192 mg/L, and fecal coliform bacteria densities could exceed water quality criteria for all water uses. Un-ionized ammonia-N concentrations could also exceed the level recommended for the protection of aquatic life.

Improvement of Dawson Creek water quality will occur if alternatives to present discharge practises are instituted. There is insufficient natural streamflow volume to provide adequate (20:1) dilution for present and future effluent volumes. The options available for proper sewage treatment and disposal are limited to some form of advanced treatment or transfer via pipeline to another watercourse which provides sufficient dilution. Discussion of these options can be found in the preceding section 5.2 d).

6.2 POUCE COUPE RIVER UPSTREAM FROM DAWSON CREEK

There are three Ministry of Environment water quality sites on Pouce Coupe River. The locations of these sites are shown in Figure 3 and descriptions follow:

Site 0410040 - 0.8 km upstream from confluence with Dawson Creek and 2.0 km downstream from PE 426.

Site 0410041 - immediately downstream from confluence of Pouce Coupe River and Dawson Creek (3 km downstream from PE 426).

Site 0410042 - Pouce Coupe River at Spirit River bridge, approximately 12 km downstream from the confluence with Dawson Creek.

There were no water quality monitoring sites upstream from discharge PE 426 to serve as a control for downstream sites. The water quality data for these sites are summarized in Table 16. This sampling occurred over the spring/summer period, April to September, 1974 (including the low flow period in August). No receiving water monitoring has occurred at these sites since 1975. Sampling has been too infrequent to be of any value in assessing the effects of the effluent on the river. Thus, the need to rely upon the analysis presented in Section 5.1, in which receiving water values are projected from existing waste loads.

Dilution of the effluent from the Village of Pouce Coupe presently (year-round discharge) averages 34:1 during the mean October-April low flow and 500:1 during the mean August low flow. However, during 10-year low flow conditions, dilution can be expected to decrease to 2:1 and 18:1, respectively, for these same periods (Table 7). Under these extreme conditions, the Pouce Coupe River would become a body of inadequately diluted sewage, since the minimum acceptable dilution ratio for municipal waste discharges is 20:1 (Ministry of Environment, 1975).

Present BOD_5 loadings could reduce receiving water dissolved oxygen to levels toxic to aquatic life. However, future effluent discharge during spring flow (April 1-June 30) should eliminate any serious D.O. depletions. Receiving water densities of fecal coliform bacteria presently constitute a public health hazard. Under a future regime of April-June discharge, receiving water fecal coliform densities are projected to increase even further. Future public health hazards during the spring discharge period can be avoided either by discharging according to available streamflow or by instituting chlorination/dechlorination. Un-ionized ammonia-N concentrations presently exceed the level recommended for the protection of aquatic life. Future un-ionized ammonia-N concentrations are also expected to exceed this level, but only during the 10-year minimum spring flow. These future toxic levels of un-ionized ammonia-N can be reduced to negligible levels through a regime of effluent discharge according to available streamflow. Thus, apart from infrequent high levels of un-ionized ammonia-N, there will be significant improvement in the water quality of Pouce Coupe River above Dawson Creek as a result of discharging the effluent according to available streamflow during April 1-June 30.

6.3 POUCE COUPE RIVER DOWNSTREAM FROM DAWSON CREEK

As mentioned in Section 6.2, there are too few water quality data for the Pouce Coupe River downstream from both discharges for a reliable analysis. Predicted maximum concentrations for the receiving waters downstream from Dawson Creek are presented in Table 14 and the predicted effects of these concentrations have been discussed in Section 5.3. Concentrations have been projected for present conditions of year-round discharge (at summer and winter low flows) and for future conditions involving two discharge regimes: spring discharge of both PE 311 and PE 426; and year-round discharge of PE 311 only.

Dilution levels for the combined effluents in the Pouce Coupe River downstream from Dawson Creek are presently projected to be 1.6:1 during the August (10-year return) low flow and 1:1 during the October-April (10-year return) low flow (Table 17). These unacceptable dilution ratios may not improve in the future, even if the discharges comply with permit conditions. During the April-June discharge period, future effluent dilution is expected to decrease to 1.4:1 at extreme low river flow (for both 1987 and 1992). During future winters (October-April) effluent dilution will be 1:1 (Table 17) at extreme low flows.

Using the average flow of the Pouce Coupe River for the period April 1 -June 30 (27.8 m^3/s), the dilution ratio for the combined effluents becomes 470:1 for 1987 and 383:1 for 1992. Thus, the timing of future effluent discharges during the spring period, April 1 - June 30, is critical if effluent dilution of greater than 20:1 is to be maintained in the Pouce Coupe River downstream from discharges PE 311 and PE 426.

As discussed in Section 5.2 d), there are several alternative treatment and disposal options available for the Dawson Creek municipal discharge. If a suitable option is implemented, the water quality of the Lower Pouce Coupe River should improve.

6.4 WATER QUALITY OBJECTIVES

There is presently insufficient water quality information available to set permanent water quality objectives for the Pouce Coupe sub-basin. The following provisional objectives are recommended until receiving water monitoring programs provide adequate data, and the Ministry has established approved water quality criteria for the characteristics of concern. These provisional objectives are subject to revision in light of new data as provided by the recommended monitoring program.

The objectives can be considered as policy guidelines for resource managers to protect water uses in the specified water bodies. For example, they can be used to draw up waste management permits and plans, regulate water use or plan fisheries management. They can also provide a reference against which the state of water quality in particular water body can be checked.

Water quality objectives have no legal standing and their direct enforcement would not be practical. Hence, although water quality objectives should be used when determining effluent permit limits, they should not be incorporated as part of the conditions in a waste management permit.

Depending on the circumstances, water quality objectives may already be met in a water body, or may describe water quality conditions which can be met in the future. To limit the scope of the work, objectives are only being prepared for water bodies and for water quality characteristics which may be affected by man's activity, now and in the foreseeable future.

a) POUCE COUPE RIVER UPSTREAM FROM DAWSON CREEK

The most sensitive present and potential use for the Pouce Coupe River upstream from Dawson Creek is contact recreation during the summer, i.e., swimming and children playing. Both activities presently occur, and there is some evidence of local demand for more recreational waters. There are no present or known potential uses of the following type between the municipal discharge and Dawson Creek: drinking or public water supply, livestock watering, irrigation, or industrial uses.

Aesthetic and visual considerations are also important in this watershed: water quality should be maintained to avoid floatables, odor, surface films, and fish kills. Prevention of the latter requires that the objectives also protect aquatic life downstream from the municipal discharge.

If future effluent discharge from PE 426 is regulated according to available streamflow during the April-June period, there should be little impairment of the water quality in this reach of the Pouce Coupe River. There should be no significant decreases in dissolved oxygen or increases in suspended solids concentrations, fecal coliform densities should be less than the criterion for water-contact recreation, and un-ionized ammonia-N concentrations should not exceed the criteria established to protect aquatic life. However, these projections depend upon a discharge regime closely coordinated with available streamflows. Until such a discharge regime is implemented, fecal coliform densities may reach levels hazardous to human health, and un-ionized ammonia-N may reach levels deleterious to aquatic life.

Provisional objectives are set for the Pouce Coupe River upstream from Dawson Creek to protect water-contact recreation, to prevent fish kills, and to avoid aesthetic problems caused by eutrophication.

b) DAWSON CREEK DOWNSTREAM FROM PE 311

There are no water uses downstream from the City of Dawson Creek municipal effluent discharge for the purpose of contact recreation, water supply, irrigation, livestock watering, or industrial consumption. The use of Dawson Creek as a possible play area for children should be discouraged.

As noted in sections 5.2 c), d), discharge PE 311 produces high quality effluent, but as a result of insufficient streamflow dilution, severe water quality degradation is projected for Dawson Creek downstream from the City. Improvement of the water quality for water-contact recreation or for aesthetic purposes is possible and could be achieved through advanced treatment or by removing the effluent from the creek (e.g., pipelining it to the Pouce Coupe River) (section 5.2 d)). The question of whether water-contact recreation, aesthetics, and the protection of aquatic life justify the cost of an alternative treatment and disposal method will require further study.

Provisional water quality objectives are set for Dawson Creek to protect aquatic life.

c) POUCE COUPE RIVER DOWNSTREAM FROM DAWSON CREEK

There are no recorded water uses for the Pouce Coupe River downstream from Dawson Creek (section 4). There is no development along the river banks in this reach and little public access to the water.

During future spring periods (April-June) this reach will receive treated sewage input from both PE 426 and PE 311. On a year-round basis, this reach of the Pouce Coupe River will receive sewage input from PE 311 (The City of Dawson Creek). The resultant water quality impairment is projected to consist of: severe D.O. depletions; substantial increases of suspended solids; acutely toxic levels of un-ionized ammonia-N (to aquatic life); and fecal coliform densities constituting a public health hazard. Improvement of water quality in this reach is dependent upon modification of sewage treatment and disposal for the City of Dawson Creek (PE 311) and the Village of Pouce Coupe (PE 426) as outlined in Sections 5.3 and 6.3. Provisional objectives are recommended to protect aquatic life, water-contact recreation, and aesthetics in this reach of the Pouce Coupe River.

Fecal Contamination

- the fecal coliform content shall not exceed a running log mean of 200 MPN/100 mL for a minimum of five weekly samples during the discharge period. No more than 10 percent of total samples during any 30 day period should exceed 400 MPN/100 mL (Richards, 1983).

This objective is set to protect water-contact recreation and applies:
- outside the initial dilution zone (i.e., 100 m downstream) of the Village of Pouce Coupe municipal discharge during the discharge period and through to the end of summer (April 1 -September 30).
- downstream from the confluence of the Pouce Coupe River and Dawson Creek to the mouth of the Pouce Coupe River on a year-round basis.

Total Chlorine Residual

- total chlorine residual not to exceed 0.01 mg/L (E.P.A. 1976).

This objective would be necessary in the event that chlorination of the waste discharges is instituted. This objective would apply to discrete samples outside the initial dilution zone of the municipal waste discharges (i.e., 100 m downstream from the discharges) on a year-round basis to protect aquatic life, including a non-salmonid fish fauna. This objective equals the minimum detectable concentrations of routinely available methods, and thus it may be necessary to calculate receiving water concentrations from effluent loadings and stream dilution.

Un-ionized Ammonia-N

- un-ionized ammonia-N is not to exceed a maximum of 30 μg/L at any time (Pommen, 1983).

This objective applies to discrete samples outside the initial dilution zones of the municipal waste discharges (i.e., 100 m downstream from the discharges) on a year-round basis to protect aquatic life.

Turbidity

- induced turbidity should not exceed 5 NTU when background turbidity is less than or equal to 50 NTU, nor should induced turbidity be more than 10 percent of background when background is greater than 50 NTU (Singleton, 1985).

  This objective applies to discrete samples outside of the initial dilution zones (i.e., 100 m downstream) of the municipal waste discharges on a year-round basis to protect aquatic life, aquatic habitat, and aesthetic values. Background turbidity and suspended solids are defined as the values measured upstream from a waste discharge at the time when downstream values are measured.

Suspended Solids

- induced suspended solids (nonfilterable residue) should not exceed 10 mg/L when background suspended solids are less than or equal to 100 mg/L, nor should induced suspended solids be more than 10 percent of background when background is greater than 100 mg/L (Singleton, 1985).

  This objective applies to discrete samples outside of the initial dilution zone (i.e., 100 m downstream) of the municipal waste discharges on a year-round basis to protect aquatic life, aquatic habitat, and aesthetic values.

Dissolved Oxygen

- a minimum of 5.5 mg/L (Davis, 1975).

This objective corresponds to the Davis level A of protection for a freshwater mixed fish population with no salmonids. It assures protection for the fish and other aquatic life in the Pouce Coupe River. This objective applies to discrete samples outside of the initial dilution zones (i.e., 100 m downstream) of the municipal waste discharges on a year-round basis.

Nitrite-N

- nitrite-N concentrations are not to exceed a maximum of 60 μg/L at any time (Pommen, 1983).

This objective applies to discrete samples outside of the initial dilution zones of waste discharges (i.e., 100 m downstream) on a year round basis.

Periphyton Growth

- periphyton growth 100 m downstream from waste discharges is not to exceed the upstream periphyton growth by more than 25 percent. Periphyton growth should be measured as biomass per unit area at sites subject to similar light and flow conditions.

This objective applies outside the initial dilution zone (i.e., 100 m downstream) of the municipal waste discharges on a year-round basis to protect aquatic life and prevent aesthetic problems. Nitrogen and phosphorus values cannot be specified above levels at which nuisance growth of periphyton and aquatic macrophytes would occur. Ambient nutrient concentrations and periphyton growth would require further documentation before specific objectives could be set.

7. MONITORING RECOMMENDATIONS

The following monitoring recommendations are made from a technical perspective. The extent to which the recommended monitoring is conducted in the Pouce Coupe River Sub-basin will depend on the overall priorities and monitoring resources available for the Region and the Province.

7.1 THE CITY OF DAWSON CREEK

Table 18 summarizes the requirements of the present effluent sampling program for discharge PE 311 (City of Dawson Creek). Table 19 presents revisions to the program, reflecting the findings of this assessment. Effluent monitoring should be conducted at the point of discharge from the beaver ponds until the outfall is extended to the main channel of Dawson Creek. Effluent should also be sampled at the outlet from the last treatment lagoon to determine the effectiveness of treatment through the beaver ponds.

Effluent sampling should coincide with effluent flow measurements so that accurate waste loadings can be calculated in the future. Effluent monitoring should also be carried out at the same time as monitoring of the receiving waters.

A systematic water quality sampling program is also recommended (Table 19) to verify the predictions made in this report, and to document the effectiveness of future treatment modifications.

The water quality program entails sampling four times per year at four sites on Dawson Creek and three sites on the Pouce Coupe River (five, if PE 426 is discharging). Receiving water sampling should coincide with the peak of effluent discharge (2 samplings). The latter is likely a critical time since it is a period of high water temperature, low flow, and possible recreational use by children. The receiving water monitoring should be conducted on the same day as the effluent monitoring. Visual observations of algal growth should be recorded to determine if a problem is developing.

Dawson Creek should be posted downstream from discharge PE 311 warning the public of sewage contaminated waters, and this situation should be checked continually to see that posting is effective. This posting requirement is in the permit and the creek is presently posted in two locations. All monitoring data collected by the permittee and the Ministry of Environment should meet Ministry data standards and be placed in the Ministry computer data bank.

7.2 THE VILLAGE OF POUCE COUPE

Table 20 summarizes the present effluent monitoring program required of the permittee for discharge PE 426. The recommended effluent sampling and receiving water monitoring program is presented in Table 21. Effluent sampling should coincide with effluent flow measurements. Timing the effluent release to occur with maximum spring flows during April-June, is one way of maintaining a minimum 20:1 dilution.

It is recommended that a systematic water quality program be conducted (Table 21). This program will have the capability of assessing the effects of waste loading on the Pouce Coupe River and will determine the effectiveness of the new lagoon and spring-flow discharge. The program entails sampling at six sites, three times during the spring discharge period. Receiving water sampling should be conducted on the same day that the effluent is sampled. Visual observations of attached algal growth and agricultural runoff should be recorded during the sampling periods. It is also recommended that all monitoring data collected by the permittee and the Ministry meet Ministry data standards and be placed in the Ministry computer data bank.

7.3 DIFFUSE AND UNPERMITTED WASTE DISCHARGES

The above recommended receiving water monitoring program is the "minimum" program. The "optimum" program would be to increase the frequency of sampling as well as to add water quality variables which could evaluate diffuse loading from certain land use practices. These include the use of agricultural pesticides and fertilizers, and the oiling of rural roads. The old crankcase oil used for oiling roads may contain unacceptably high levels of polynuclear aromatics (PNA's). Polychlorinated biphenyls (PCB's) have been found in some refuse oils used for this purpose. Their presence is unusual and is likely due to contamination from outside sources, i.e. not inherent in oil, or a product of the combustion process (Dr. M.J.R. Clark, Waste Management Branch, Environmental Chemist, personal communication). Hydrocarbons, PNA's and PCB's should be examined in the sediments and/or surface films, not in the water column. These data do not exist presently and the significance of such diffuse loadings remains unknown. Monitoring resources surplus to the achievement of the "minimum" program should be directed toward the "optimum" program.

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Figure 1.

STRATEGIC ENVIRONMENTAL PLANNING UNITS

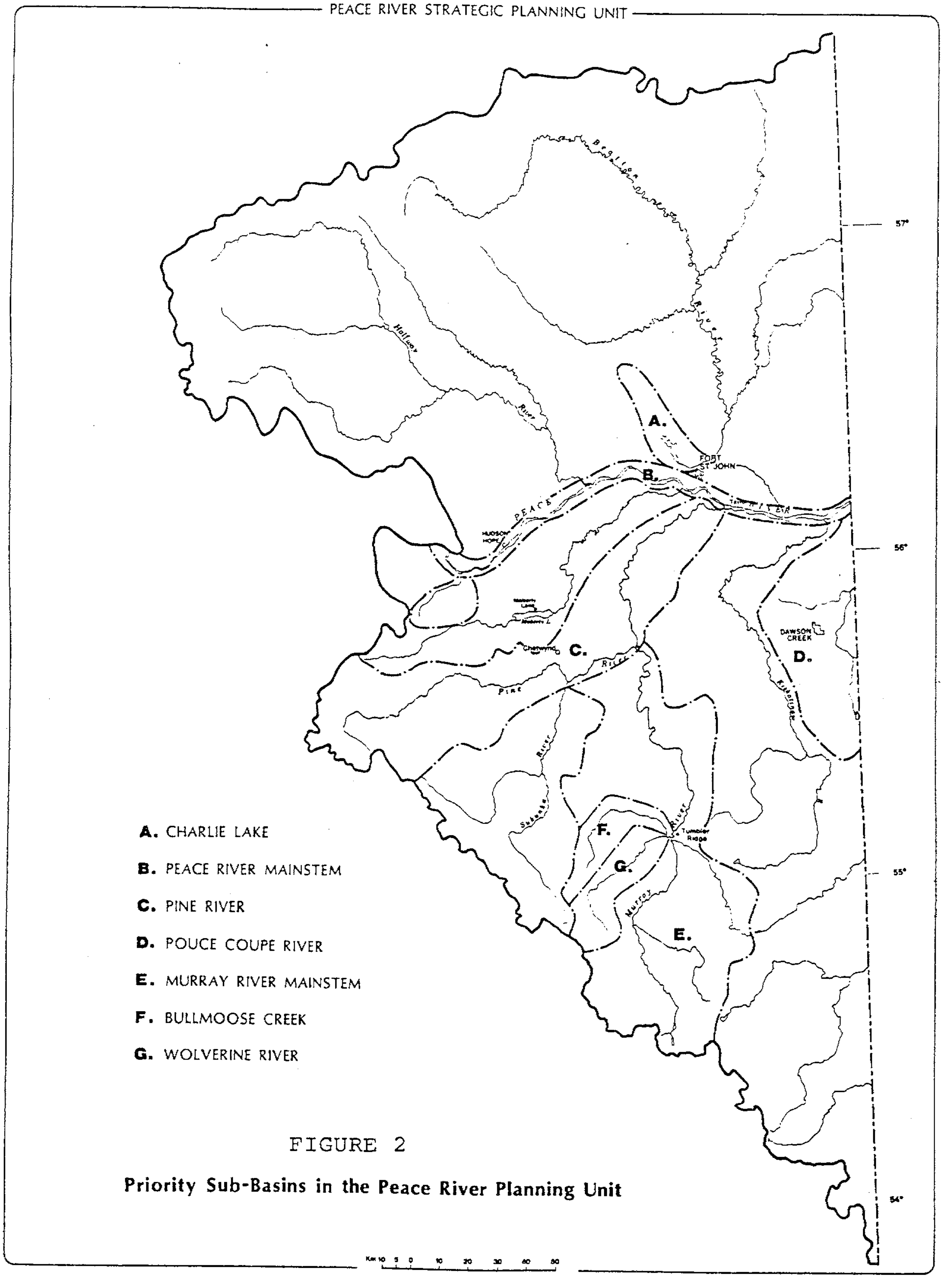

FIGURE 2

Priority Sub-Basins in the Peace River Planning Unit

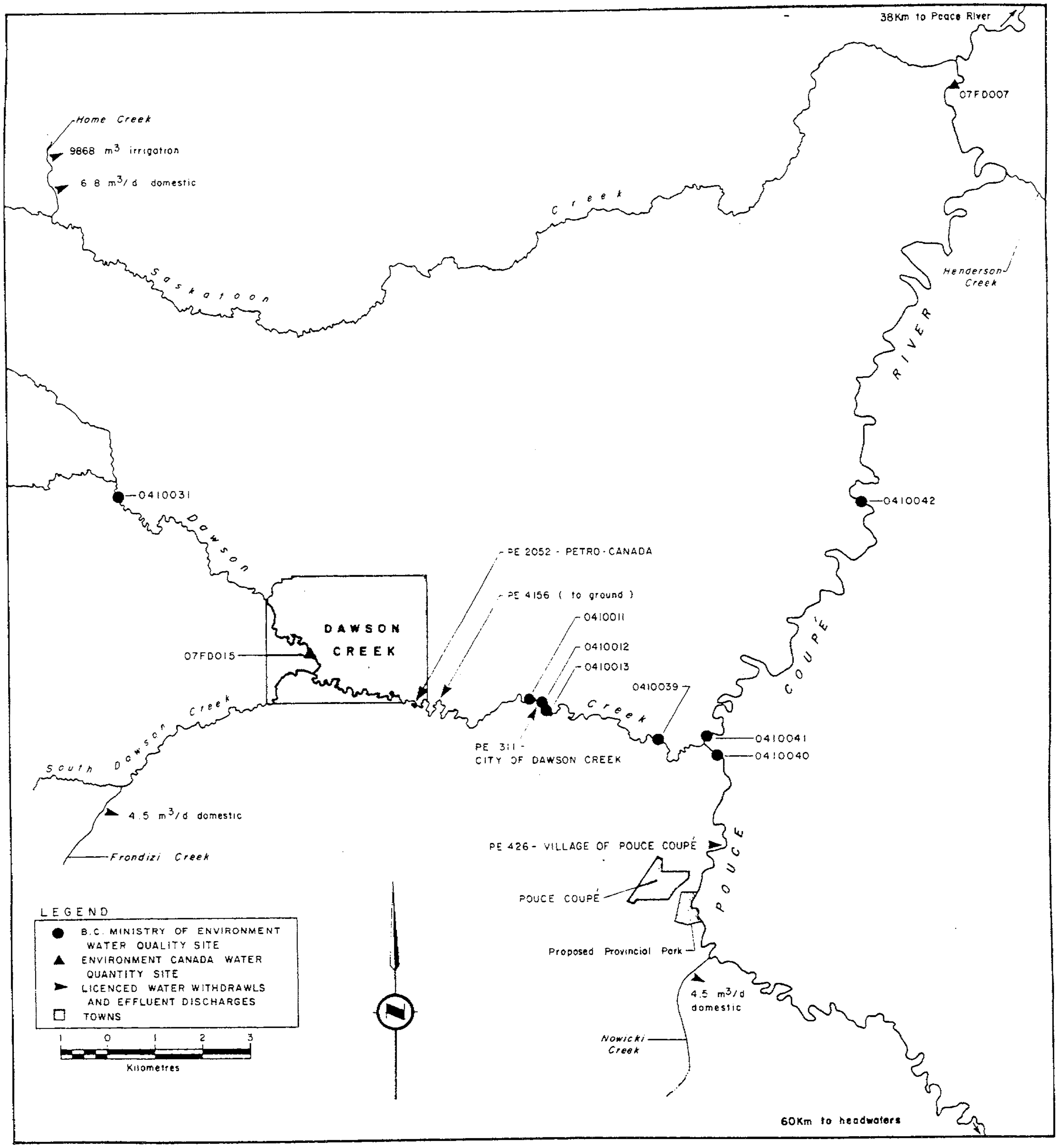

Figure 3 Map of the Pouce Coupe River Sub-basin showing effluent discharges, receiving water sites, and water withdrawals.

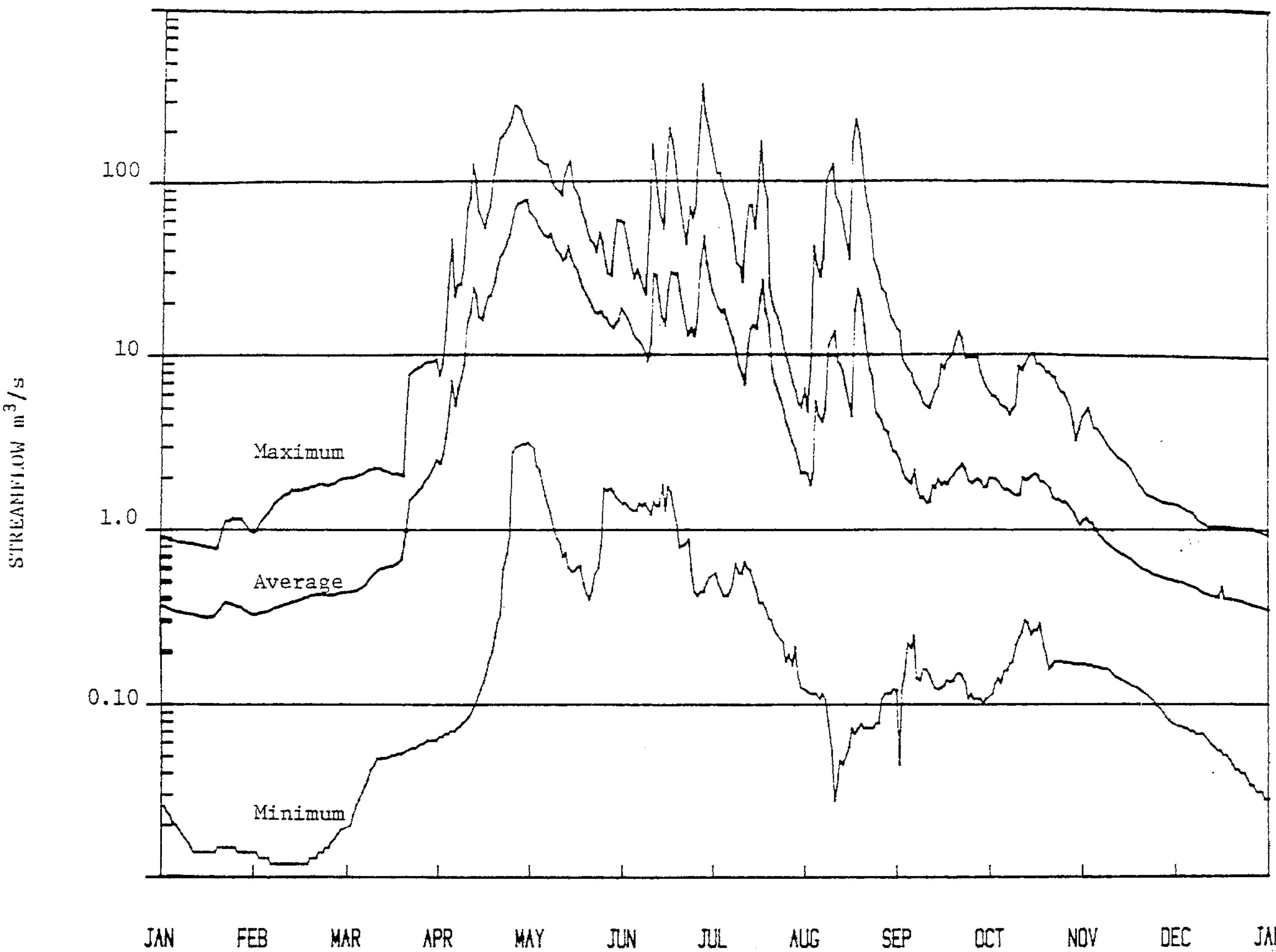

FIGURE 4 Hydrograph for Pouce Coupe River below Henderson Creek (Water Survey of Canada station 07FD007) showing maximum, minimum and average daily flows for the period 1971-1981.

TABLE 1

SUMMARY OF CONSUMPTIVE WATER WITHDRAWALS FOR THE POUCE COUPE RIVER SUB-BASIN*

SOURCE	NO. OF LICENSES	QUANTITY	PURPOSE
Tributary to Pouce Coupe River			
Nowicki Creek	2	4.5 m^3/d	domestic
Home Creek	2	6.8 m^3/d	domestic
	1	9868 m^3/yr	irrigation
Tributary to Dawson Creek			
Frondizi Creek	1	4.5 m^3/d	domestic

* there are no licensed water withdrawals from either Pouce Coupe River mainstem or Dawson Creek mainstem.

TABLE 2

SUMMARY OF PERMITS FOR EFFLUENT DISCHARGE

(EXCLUDING REFUSE SITES AND AIR EMISSIONS) FOR THE POUCE COUPE RIVER SUB-BASIN

PERMIT HOLDERS	PERMIT NUMBER	DISCHARGE TO	WASTE DISCHARGE FLOW m^3/d	TYPE OF DISCHARGE AND TREATMENT
Village of Pouce Coupe	PE 426*	Pouce Coupe R.	Max. - 2 300 (April 1-June 30)	municipal sewage/ anaerobic and aerobic lagoons, storage cell and pipeline.
City of Dawson Creek	PE 311*	Dawson Cr.	Max. - 7 600	municipal sewage/ anaerobic and aerobic lagoons.
Lawrence Meat Packing Co. Ltd.	PE 4156	ground	Max. - 45.5 (Max.-6 364 m^3/y)	slaughterhouse effluent and domestic sewage/ 3 settling ponds and 2 stabilization-evaporation lagoons.
Petro Canada	PE 2052	Dawson Cr.	Average - 110	bulk loading terminal effluent/collection pads, sumps, oil separator, settling pond and outfall.

* priority permits as determined by the regional Waste Management Branch.

TABLE 3

POUCE COUPE RIVER SUB-BASIN POPULATION PROJECTIONS (AFTER STONE, 1982)

	1981[a]	1982[a]	1987[b]	1992[b]	1992[c]
City of Dawson Creek	11,179	11,634	15,791	18,926	19,396
Village of Pouce Coupe	814	847	1,151	1,379	1,411

[a] - based on 1981 Census results.

[b] - based on a growth rate of 4.07% per annum with additions made for these resource developments: Teck Bullmoose Mine, Quintette Mine, B.C. Hydro Site C Project.

[c] - as for b above with additions made for: Monkman Mine and Willow Creek Mine.

TABLE 4
VILLAGE OF POUCE COUPE AND CITY OF DAWSON CREEK
SAMPLING OF TREATED EFFLUENT BY THE PROVINCE

CHARACTERISTIC	VILLAGE OF POUCE COUPE (SEPT. 1977 TO APRIL 1982)			CITY OF DAWSON CREEK (MAY 1972 TO JULY 1982)		
	Mean	Range of Values	Number of Values	Mean	Range of Values	Number of Values
BOD$_5$ mg/L	87.4	17-238	36	39.2	6-224	53
Coliforms, Fecal						
MPN/100 mL	38 000*[1]	2 400-790 000	19	58 300*[1]	2-920 000	23
Flow m^3/s	225*[2]	91-277*[3]	--	3,004	1 440-5 900*[4]	5
				5 450*[5]		53
Nitrogen, Ammonia mg/L	25.6	14.5-46	4	14.9	6.9-22.8	2
Nitrite/Nitrate mg/L	0.03	0.02-0.05	4	1.7	0.02-3.3	2
Total mg/L	34.8	25-52	4	18.2	11.3-25	2
pH	7.9	7-9.5	26	8.0	7.1-9.2	30
Phosphorus, Dissolved						
Orthophosphate mg/L	9.2	5.1-12.5	3	4.7	4.2-5.2	2
Total mg/L	7.5	5.4-10.5	3	5.0	4.4-5.5	2
Solids, Suspended mg/L	61.0	12-231	35	31.2	2-192	45

*[1] geometric mean

*[2] mean daily discharge calculated from annual inflow

*[3] range of flow values measured in 1979 by Regional Waste Management Branch staff

*[4] range of 5 flow values for the period 1973-1976

*[5] estimate of average daily discharge for the 228 day period, March 9-October 23, 1981

TABLE 5
SUMMARY OF ACTUAL AND PROJECTED FUTURE WASTE LOADS
FOR THE POUCE COUPE RIVER SUB-BASIN

PERMIT CONDITIONS		PERMITTED LOADING kg/d	PRESENT CONDITIONS	MAXIMUM PRESENT THEORETICAL DAILY LOAD kg/d	PROJECTED FUTURE LOADING (assuming permit compliance) 1987*[2]	1992*[3]
Village of Pouce Coupe					(April 1-June 30 discharge)	
Flow	2,300 m^3/d maximum		225 m^3/d*[1]		1,275 m^3/d*[4]	1,567 m^3/d
Suspended Solids	60 mg/L	138	12-231 $\bar{x}$=61 mg/L	52	77 kg/d	94 kg/d
BOD_5	45 mg/L	104	17-238 $\bar{x}$=87 mg/L	54	57 kg/d	71 kg/d
NH_3-N	--	--	15-46 $\bar{x}$=26 mg/L	10	19*[5] kg/d	23 kg/d
Fecal Coliform Bacteria	--	--	2,400-790,000 MPN/100mL geometric mean = 38,000	Theoretical 1.8×10^{12} MPN/d	4.5×10^{11} MPN/d*[7]	5.5×10^{11} MPN/d*[7]
City of Dawson Creek						
Flow	7,600 m^3/d maximum		5450 m^3/d*[6]		7,684 m^3/d	9,430 m^3/d
Suspended Solids	40 mg/L	304	2-192 $\bar{x}$=31 mg/L	1046	307 kg/d	377 kg/d
BOD_5	30 mg/L	228	10-224 $\bar{x}$=39 mg/L	1220	230 kg/d	283 kg/d
NH_3-N	--	--	7-23 $\bar{x}$=15 mg/L	125	115*[8] kg/d	142 kg/d
Fecal Coliform Bacteria	--	--	2-920,000 MPN/100mL geometric mean = 58,300 MPN/100 mL	Theoretical 5.0×10^{13} MPN/d	2.3×10^{12} MPN/d*[9]	2.8×10^{12} MPN/d*[10]

*[1] average daily discharge calculated from total yearly inflow (82,200 m^3).
*[2] assuming 41% population increase over the present 1982 estimate (and a concomitant 41% increase in effluent discharge).

*[3] assuming 73% population increase over the present 1982 estimate (and a concomitant 73% increase in effluent discharge).

*[4] this value was calculated from a 41% increase over 903 m^3/d which is what the present average daily discharge would be if effluent were discharged during the 91 day period (April-June 30).

*[5] future NH_3-N loads have been calculated assuming that improvements to the treatment system will produce effluent with NH_3-N concentrations not greater than the minimum level recorded (15 mg/L).

*[6] the average daily discharge for 1981, the most recent year for which data were available.

*[7] assumes that the effluent will meet a standard of 35,000 MPN/100 mL with BOD_5=45 mg/L (see Section 5.1(c)).

*[8] future NH_3-N loads have been calculated assuming that effluent in compliance with the permit, will have NH_3-N concentrations not greater than the average level recorded (15 mg/L).

*[9] assumes that with permit compliance, Fecal Coliforms will equal 30,000 MPN/100 mL at BOD_5=30 mg/L (see Section 5.2 (c)).

$\bar{x}$ = arithmetic mean value

TABLE 6

PREDICTED INCREASES IN RECEIVING WATER CONCENTRATIONS
FOR PRESENT AND FUTURE PROJECTED WASTE LOADS DURING MINIMUM STREAMFLOWS
FOR THE POUCE COUPE RIVER, DOWNSTREAM FROM THE VILLAGE OF POUCE COUPE

CHARACTERISTICS		PERMITTED EFFLUENT CONCENT-RATION	AT MAXIMUM PRESENT LOADING*$_1$ (YEAR-ROUND DISCHARGE)		AT FUTURE PROJECTED LOADING (ASSUMING PERMIT COMPLIANCE AND APRIL - JUNE DISCHARGE)	
			During Summer low flows (Q_{10})*$_2$	During Winter low flows (Q_{10})*$_3$	1987*$_5$	1992*$_6$
Suspended Solids	mg/L	60	12	79	8	9
BOD_5	mg/L	45	13	82	6	7
Ammonia-N	mg/L	--	2	15	2	2
Fecal Coliforms	MPN/100mL	--	42,000*$_4$	274,000*$_4$	5000*^{7}	5800*^{7}

Q_{10} 10-year return period

*$_1$ assuming a present daily effluent discharge of 225 m^3/d.

*$_2$ total summer low flow = August (10-year) minimum streamflow (0.046 m^3/s) + present effluent flow (225 m^3/d).

*$_3$ total winter low flow = October-April (10-year) minimum streamflow (0.005 m^3/s) + present effluent flow (225 m^3/d).

*$_4$ calculated from the maximum recorded fecal coliform density.

*$_5$ assuming a 41% increase in population to 1987 over 1982 values. Streamflow (April 1-June 30) = 0.10 m^3/s (see Table 9) + projected effluent flow.

*$_6$ assuming a 73% increase in population to 1992 over 1982 values. Streamflow (April 1-June 30) = 0.10 m^3/s (see Table 9) + projected effluent flow.

*$_7$ assuming that future effluent fecal coliform density = 35,000 MPN/100 mL; and that the effluent dilution ratio is 7:1 doe 1987 and 6:1 for 1992 (see Table 8).

TABLE 7

EFFLUENT DILUTION RATIOS FOR THE VILLAGE OF POUCE COUPE DISCHARGE UNDER PRESENT CONDITIONS OF YEAR-ROUND DISCHARGE AND AT VARIOUS LOW FLOW ESTIMATES (MINIMUM 7-DAY AVERAGE DISCHARGE FOR MEAN AND 10-YEAR RETURN PERIODS)

CHARACTERISTICS	PRESENT YEAR-ROUND DISCHARGE (225 m^3/d)			
	October-April Low Flow		August Low Flow	
	10-Year	Mean	10-Year	Mean
Streamflow m^3/s	0.005	0.089	0.046	1.3
Dilution Ratio	2:1	34:1	18:1	500:1

TABLE 8

EFFLUENT DILUTION RATIOS FOR THE VILLAGE OF POUCE COUPE DISCHARGE UNDER CONDITIONS OF THE SPRING FLOW

April 1-June 30 Discharge	At Maximum Permitted Effluent Flow	At Maximum Present Effluent Flow	At Projected Future Effluent Flow	
			1987	1992
(i) Continuous Discharge*[1]				
Minimum Spring Streamflow m^3/d	8,640*[3]	8,640	8,640	8,640
Effluent Flow m^3/d	2,300	904	1,275	1,567
Dilution Ratio	4:1	10:1	7:1	6:1
(ii) Discharge According to Available Streamflow*[2]				
Minimum Spring Volume m^3	13.4×10^6*[4]	13.4×10^6	13.4×10^6	13.4×10^6
Annual Effluent Volume m^3	207,000	82,263	116,025	142,600
Dilution Ratio	65:1	163:1	116:1	94:1

*[1] meaning continuous discharge during April-June, without regard to fluctuations in available streamflow.

*[2] optimal discharge so that the volume of effluent discharged is carefully regulated according to available streamflow

*[3] the end of April-June period 7-day low flow (10-year return period) = 0.10 m^3/s (see Table 9)

*[4] an estimate of the minimum volume for the Pouce Coupe River at the Village recorded during the April-June period (1971-1981 data; Water Survey of Canada). Since there is no gauging site at the Village this value was approximated as follows:

Volume for Pouce Coupe River near Henderson Creek ($48x10^6$ m^3; 1980 data) - Volume for Dawson Creek at the City ($11.6x10^6$ m^3; see Section 5.2 d)) - Volume for Henderson Creek ($23x10^6$ m^3; extrapolated from the drainage area; the drainage area of Henderson Creek is twice that of Dawson Creek, 570 km^2 compared to 266 km^2)

= $13.4x10^6$ m^3

TABLE 9

CALCULATION OF A MINIMUM FLOW VALUE FOR THE POUCE COUPE RIVER AT THE VILLAGE OF POUCE COUPE, DURING THE APRIL 1-JUNE 30 EFFLUENT DISCHARGE PERIOD

Pouce Coupe River at Henderson Creek
Water Survey of Canada Station 07FD007

a) low flow*[1] during April 1-June 30 = 0.48 m^3/s (Water Survey of Canada data, 1971-1981)
b) annual low flow*[2] = 0.023 m^3/s (Obedkoff, 1982)

Pouce Coupe River at Village

a) low flow*[1] during April 1-June 30 = x
b) annual low flow*[2] = 0.005 m^3/s (Obedkoff, 1982)

$$x = \frac{0.48\ m^3/s \times 0.005\ m^3/s}{0.023\ m^3/s} = 0.10\ m^3/s$$

*[1] this is the end of April-June period 7-day low flow (10-year return period)
*[2] the 7-day, 10-year return low flow estimate for the annual period

TABLE 10

PREDICTED INCREASES IN RECEIVING WATER CONCENTRATIONS FOR PRESENT AND FUTURE PROJECTED WASTE LOADS DURING MINIMUM STREAMFLOWS IN DAWSON CREEK, DOWNSTREAM FROM THE CITY OF DAWSON CREEK

CHARACTERISTICS		MAXIMUM PERMITTED EFFLUENT CONCENT-RATION	AT MAXIMUM PRESENT LOADING (Year-Round Discharge) During Summer and Winter Low Flows*1 (Mean and 10-Year Return Period)	AT FUTURE PROJECTED LOADING (Assuming Permit Compliance) During Summer and Winter Low Flows	
				1987	1992
Suspended solids	mg/L	40	192	40	40
BOD_5	mg/L	30	224	30	30
Ammonia-N	mg/L	--	23	15	15
Fecal Coliforms	MPN/100 mL	--	920,000	30,000*2	30,000*2

*1 Minimum 7-day average daily low flow estimates for both summer and winter = 0.0 m^3/s. Therefore streamflow = effluent flow. No dilution of effluent.

*2 value derived from a linear regression analysis of present BOD_5 and fecal coliform data. Future effluent concentration (30,000 MPN/100 mL) = future receiving water concentration under conditions of no effluent dilution.

TABLE 11
EFFLUENT DILUTION RATIOS FOR THE CITY OF DAWSON CREEK DISCHARGE UNDER PRESENT CONDITONS OF YEAR-ROUND DISCHARGE AND UNDER HYPOTHETICAL CONDITIONS OF DISCHARGE DURING SPRING FLOW

	AT MAXIMUM PERMITTED EFFLUENT FLOW	AT PRESENT MAXIMUM EFFLUENT FLOW	AT PROJECTED FUTURE EFFLUENT FLOW	
			1987	1992
Year-Round Discharge				
(i) to Dawson Creek				
Effluent flow m^3/d	7,600	5,450	7,684	9,430
Minimum streamflow m^3/d	0	0	0	0
Dilution Ratio	0	0	0	0
(ii) to Kiskatinaw R.				
Effluent flow m^3/d	7,600	13,650	19,000	24,000
Minimum streamflow m^3/d	34,560*[1]	34,560	34,560	34,560
Dilution Ratio	4.5:1	2.5:1	2:1	1.4:1
(iii) to Peace River (near Taylor)				
Effluent flow m^3/d	7,600	13,650	19,000	24,000
Minimum streamflow m^3/d	16,500,000*[2]	16,500,000	16,500,000	16,500,000
Dilution Ratio	2200:1	1200:1	900:1	700:1
Spring Discharge				
(i) to Dawson Creek				
Effluent flow m^3/d	7,600	13,650*[3]	19,000	24,000
Average streamflow m^3/d	103,400*[4]	103,400	103,400	103,400
Dilution Ratio	14:1	8:1	5:1	4:1
(ii) to lower Pouce Coupe River				
Effluent flow m^3/d				
Village of Pouce Coupe	2,300	903	1,275	1,567
City of Dawson Ck.	7,600	13,650	19,000	24,000
Combined flow	9,900	14,553	20,275	25,567
Mean streamflow m^3/d	2,400,000*[5]	2,400,000	2,400,000	2,400,000
Dilution Ratio	240:1	165:1	118:1	94:1
Minimum spring streamflow m^3/d	41,472*[6]	41,472	41,472	41,472
Dilution Ratio	4:1	3:1	2:1	1.6:1

(iii) to Kiskatinaw R.				
Effluent flow m^3/d	7,600	13,650	19,000	24,000
Minimum spring streamflow m^3/d	504,000	504,000	504,000	504,000
Dilution Ratio	66:1	37:1	27:1	21:1

*[1] the August 7-day low flow (10-year return period) for the Kiskatinaw River at the water intake for the City of Dawson Creek

*[2] the October-April 7-day low flow (10-year return period) for Peace River near Taylor (Water Survey of Canada station 07FD002)

*[3] the daily volume necessary to discharge 1.2 million m^3 of effluent over a 91 day period (April 1-June 30)

*[4] the average streamflow for Dawson Creek at the City of Dawson Creek. This value equals the sum of the mean discharges (for April-June; 1981, 1982 data) for Water Survey of Canada stations 07FD015 (Dawson Creek above South Dawson Creek) and 07FD016 (South Dawson Creek at mouth). There is no gauging site at the City of Dawson Creek.

*[5] the average streamflow for the Pouce Coupe River (Water Survey of Canada station 07FD007) for the April-June period (1971-1981)

*[6] this represents the low flow for the spring flow period. This estimate (0.48 m^3/s) is the end of April-June period 7-day low flow (10-year return period)

TABLE 12

CALCULATION OF ANNUAL VOLUME OF DAWSON CREEK AT THE CITY OF DAWSON CREEK

Annual volume at City of Dawson Creek = X m^3

Estimate of volume during April 21 - Sept. 21*[1]

Dawson Creek above South Dawson Creek (07FD015)
1981 volume = 3,190,234 m^3
1982 volume = 8,596,973 m^3
mean = 5,893,603 m^3
South Dawson Creek at mouth (07FD016)
1981 volume = 4,342,810
1982 volume = 5,760,202
mean = 5,051,506
Average volume at City = 5,893,603 m^3 + 5,051,506 m^3
= 10,945,109 m^3

Comparison to nearby streams with annual data

Spring flow as a percent of annual flow:
Dickebusch Creek (1981, 1982 data)
Mean annual volume = 23,210,000 m^3
Mean volume (April 21-Sept 21) = 21,424,392 m^3
% of annual = 92%
Pouce Coupe River (1982 data)*[2]
Annual volume (1982) = 191,000,000 m^3
Volume (April 21-Sept 21) = 183,847,968 m^3
% of annual = 96%
Estimate of annual volume of Dawson Creek at City (assuming April-June volume is 94% of annual volume):
X = 10,945,109 m^3 + (6% x 10,945,109 m^3)
= 11,601,816 m^3

*[1] there is no gauging site on Dawson Creek at the City of Dawson Creek. The flow at the City equals the sum of the flow in upper Dawson Creek and that in South Dawson Creek. Both stations have seasonal data for only 1981 and 1982.

*[2] recent data are complete only for 1982.

TABLE 13

ESTIMATES OF COMBINED WASTE LOADING FROM THE CITY OF DAWSON CREEK AND THE VILLAGE OF POUCE COUPE

CHARACTERISTICS		MAXIMUM PRESENT COMBINED DAILY LOADING POSSIBLE*[1]	FUTURE PROJECTED LOADING*[2]	
			1987	1992
Suspended Solids	kg/d	1098	384	471
BOD_5	kg/d	1274	287	354
Ammonia-N	kg/d	135	134	165
Fecal Coliform Bacteria	MPN/d	5.2×10^{13}	2.8×10^{12}	3.4×10^{12}

*[1] assumes no decrease in loading values from point of discharge to confluence of Dawson Creek and Pouce Coupe River, i.e., a summation of the separate loading values given for each discharge in Table 5.

*[2] assumes permit compliance

TABLE 14

PREDICTED INCREASES IN RECEIVING WATER CONCENTRATIONS FOR PRESENT AND FUTURE PROJECTED WASTE LOADS DURING MINIMUM STREAMFLOWS IN THE POUCE COUPE RIVER, DOWNSTREAM FROM BOTH DISCHARGES (PE 311, PE 426)

CHARACTERISTICS		AT MAXIMUM PRESENT LOADING POSSIBLE (YEAR-ROUND DISCHARGE)		AT FUTURE PROJECTED LOADING			
				APRIL-JUNE; COMBINED EFFLUENT FROM DAWSON CREEK (PE 311) AND POUCE COUPE (PE 426)		OCTOBER-APRIL*2; EFFLUENT FROM DAWSON CREEK (PE 311) ONLY	
		During Summer low flows (Q_{10})*1	During Winter low flows (Q_{10})*2	1987*3	1992*4	1987*5	1992*6
Suspended Solids	mg/L	123	196	29	31	47	47
BOD_5	mg/L	143	227	21	23	35	36
Ammonia - N	mg/L	15	24	10	11	16	17
Fecal Coliform Bacteria	MPN/100 mL	600,000*7 38,000*8	922,000*7 58,000*8	18,000	22,000	33,500	34,000

*1 August (10-Year return period) low flow = natural streamflow estimate for Pouce Coupe River downstream from Dawson Creek (0.04 m^3/s) + maximum effluent flow from Dawson Creek (0.06 m^3/s).

*2 October-April low flow = natural streamflow estimate for Pouce Coupe River (0.005 m^3/s) + maximum effluent flow from Dawson Creek (0.06 m^3/s).

*3 The lowest streamflow recorded for the April-June period for the Pouce Coupe River below Henderson Creek (1971-1981 data) = 0.065 m^3/s (Water Survey of Canada). April-June streamflow (1987) = natural streamflow estimate (0.065 m^3/s) + projected effluent flow from Dawson creek (0.09 m^3/s).

*4 April-June streamflow (1992) = natural streamflow estimate (0.065 m^3/s) + projected effluent flow from Dawson Creek (0.11 m^3/s).

*5 October-April streamflow (1987) = natural streamflow estimate (0.005 m^3/s) + projected effluent flow from Dawson Creek (0.09 m^3/s).

*6 October-April streamflow (1992) = natural streamflow estimate (0.005 m^3/s) + projected effluent flow from Dawson Creek (0.11 m^3/s).

*7 calculated using combined maximum theoretical present loads.

*8 calculated using geometric mean of present fecal coliform densities.

TABLE 15

WATER QUALITY OF DAWSON CREEK AS MEASURED BY THE PROVINCE, AUGUST TO NOVEMBER, 1973

CHARACTERISTICS	0410031 CONTROL Upstream from City near Mile 4 Alaska Hwy.			0410011 CONTROL 30 m upstream from discharge			0410012 6 m downstream from discharge			0410013 45 m downstream from discharge		
	Mean	Range of Values	Number of Values	Mean	Range of Values	Number of Values	Mean	Range of Values	Number of Values	Mean	Range of Values	Number of Values
BOD_5 mg/L			0	13	10-18	3	11.5	10-13	2	14	10-18	2
Coliforms, Fecal MPN/100mL			0	185	130-240	2	56	33-79	2	66.5	23-110	2
Nitrogen, Ammonia mg/L	0.02	0.02-0.03	5	0.8	0.58-0.99	2	1.2	0.8-1.5	2	1.2	0.6-1.7	2
Nitrate mg/L	0.05	0.04-0.09	6									
pH			0	7.7	7.6-7.8	3	7.8		2	7.85	7.8-7.9	2
Phosphorus, Dissolved mg/L	0.03	0.01-0.04	4	0.25		1	1.95		1	3.6		1
Orthophosphate												
Total mg/L	0.15	0.1-0.2	5	1.7		1	2.9		1	3.0		1
Solids, suspended mg/L			0	36	7.7-71	3	28.5	25-32	2	30		1

TABLE 16

WATER QUALITY OF POUCE COUPE RIVER AS MEASURED BY THE PROVINCE, APRIL 1974 TO JULY 1975

CHARACTERISTICS		0410040 0.8 KM UPSTREAM FROM CONFLUENCE WITH DAWSON CREEK			0410041 DOWNSTREAM FROM CONFLUENCE WITH DAWSON CREEK			0410042 DOWNSTREAM AT SPIRIT RIVER ROAD BRIDGE	
		Mean	Range of Values	Number of Values	Mean	Range of Values	Number of Values	Mean	Range of Values	Number of Values
Coliforms, Fecal	MPN/100mL	41.5	33-50	2	398	13-1100	3	36	2-70	2
Dissolved Oxygen	mg/L	11.2	10-12.9	4	10.8	10-12	4	11.3	8.9-14	5
Nitrogen, Ammonia	mg/L	0.07		2	0.06		2	0.05	0.04-0.07	4
Nitrite/Nitrate	mg/L	0.02		3	0.02		3	0.09	0.02-0.11	4
pH		8.1	7.9-8.3	3	8.1	7.9-8.3	3	8.1	7.9-8.4	5
Phosphorus, Dissolved (Orthophosphate)	mg/L	0.013	0.004-0.024	3	0.012	0.004-0.019	3	0.035	0.008-0.089	4
Total	mg/L	0.07	0.06-0.07	3	0.08	0.06-0.1	3	0.12	0.09-0.17	3
Solids, suspended	mg/L	45	12-84	4	35	14-79	4	305	23-1549	6

TABLE 17

EFFLUENT DILUTION RATIOS FOR THE COMBINED DISCHARGES (PE 311 AND PE 426) DOWNSTREAM FROM THE CONFLUENCE OF DAWSON CREEK AND THE POUCE COUPE RIVER AT EXTREME MINIMUM RIVER FLOWS

CHARACTERISTICS		AT PRESENT LOADING		AT FUTURE PROJECTED LOADING			
		YEAR-ROUND DISCHARGE PE 311 + PE 426		APRIL-JUNE*4 PE 311 + PE 426		OCTOBER-APRIL*2 PE 311 ONLY	
		Summer*1	Winter*2	1987	1992	1987	1992
Effluent flow	m^3/d	5,675	5,675	8,959	11,000	7,684	9,430
Streamflow*3	m^3/d	8,906	5,882	13,300	15,046	8,116	9,862
Dilution		1.6:1	1:1	1.4:1	1.4:1	1:1	1:1

*1 August 10-year low flow for the Pouce Coupe River 5 km downstream from Dawson Creek (0.04 m^3/s)

*2 October-April 10-year low flow for the Pouce Coupe River 5 km downstream from Dawson Creek (0.005 m^3/s)

*3 calculated from the sum of the low flow estimate (10-year) for natural streamflow plus the present (or projected) effluent flow for discharge PE 311.

*4 calculated using minimum flow data for this period from the Pouce Coupe River gauging site near Henderson Creek. April-June streamflow = natural streamflow estimate (0.065 m^3/s) + projected effluent flow from Dawson Creek (7,684 m^3/d for 1987 and 9,430 m^3/d for 1992).

TABLE 18

SUMMARY OF THE EXISTING SAMPLING AND MONITORING PROGRAM FOR PE 311
(City of Dawson Creek) Dated January 27, 1981

DISCHARGE MONITORING

1. Sampling - obtain one grab sample of effluent once per month.

2. Analysis - obtain analyses of the sample as follows:

Suspended solids	mg/L
BOD_5	mg/L
Fecal coliform density	MPN/100 mL

3. Effluent Flow Measurement - record weekly the volume of effluent discharged over a 24-hour period. By December 31, 1984, a continuous flow recorder is to be installed and daily measurements are to be taken.

TABLE 19

SUGGESTED EFFLUENT SAMPLING AND RECEIVING WATER MONITORING PROGRAM FOR DISCHARGE PE 311 (City of Dawson Creek)

A. REVISIONS TO THE EXISTING (EFFLUENT) SAMPLING PROGRAM, DATED DECEMBER 5, 1980

1. Sampling - no change (once per month)
2. Analysis - add ammonia-N (mg/L)
   - Regional Waste Management Branch will sample the effluent for phosphorus and nitrogen variables during the receiving water sampling
   - add the condition that discharge monitoring occur at the same time as the Ministry of Environment monitors the receiving environment.
3. Flow measurement - add "effluent sampling to coincide with effluent flow measurements"

B. SUGGESTED RECEIVING WATER MONITORING PROGRAM

1. Sites - 0410031, 0410039, 0410040, 0410041, 0410042
   - also sample discharge PE 426 and its control site if PE426 is discharging
   - delete site 0410013. This side is only 45 m downstream from PE 311 and thus within the initial dilution zone. A replacement site is needed and should be established at a point 100 m downstream from discharge PE 311
   - a new control site for discharge PE 311 should be established upstream from 0410011. The latter site has been influenced by illegal discharges and overflows from the anaerobic pond (R. Girard, Memorandum to L. Pommen, January 26, 1983). A suitable location, suggested by Region is at the end of 1st Street past Northern Meats Ltd. (Latitude 55°42'02"; Longitude 120°15'51").

2. Frequency - four times per year to coincide with:
   1. the peak of effluent discharge (2 samplings), and
   2. the summer and early fall low flow period (2 samplings)
   - the receiving water monitoring should be conducted on the same day as the effluent monitoring, outlined above.

3. Analysis - obtain analysis of the samples as follows:

Dissolved Oxygen	(mg/L)
pH	
Flow	(m^3/s)
Temperature	°C
Ammonia-N	(mg/L)
Residue, non-filterable	(mg/L)
Phosphorus, dissolved	(mg/L)
Fecal Coliform Bacteria	(MPN/100 mL)
Turbidity	(NTU)
Nitrite-N	(mg/L)
Nitrate-N	(mg/L)

- Analyses are to be carried out in accordance with procedures described in the second edition (February, 1976) of "A Laboratory Manual for the Chemical Analysis of Waters, Wastewaters, Sediments and Biological Materials", or by suitable alternative procedures as approved by the Director or Regional Manager.

TABLE 20

SUMMARY OF THE EXISTING SAMPLING AND MONITORING PROGRAM FOR PE 426
(Village of Pouce Coupe) Dated May 26, 1982

DISCHARGE MONITORING

1. Sampling

   - obtain a composite sample of the effluent monthly during the discharge period. The sample is to consist of four grab samples taken over a 2-hour period during maximum flow and mixed to form a single sample for subsequent analysis.

2. Analysis

   - obtain analyses of the sample as follows:

Suspended solids	mg/L
BOD_5	mg/L
Fecal coliform density	MPN/100 mL
Phosphorus, Total	mg/L

3. Effluent Flow Measurement

   - record weekly the effluent volume discharged over a 24-hour period during the discharge period.

TABLE 21

SUGGESTED EFFLUENT SAMPLING AND RECEIVING WATER MONITORING PROGRAM FOR DISCHARGE PE 426 (Village of Pouce Coupe)

A. REVISIONS TO THE EXISTING (EFFLUENT) SAMPLING PROGRAM, DATED MAY 1, 1982

1. Sampling - no change
2. Analysis - add ammonia-N (mg/L)
   - remove Total Phosphorus. Regional Waste Management Branch will sample the effluent for phosphorus and nitrogen variables during the receiving water sampling
   - add the condition that discharge monitoring occur at the same time as the Ministry of Environment monitors the receiving environment.
3. Flow measurement - add "effluent sampling to coincide with effluent flow measurements"

B. SUGGESTED RECEIVING WATER MONITORING PROGRAM

1. Sites
   - 0410040, 0410041, 0410042, 0410039. Two new sites are needed: one site 100 m downstream from PE 426 and a new control site to be established upstream from discharge PE 426. Monitoring site 0410039 will separate out the influence of discharge PE 311 on sites 0410041 and 0410042.

2. Frequency
   - an initial monitoring frequency of three times per year, during the spring effluent discharge period to coincide with effluent release. The receiving water monitoring should be conducted on the same day as the effluent monitoring outlined above.

3. Analysis
   - obtain analyses of the samples as follows:

Dissolved oxygen	(mg/L)
pH	
Flow	(m^3/s)
Temperature	°C
Ammonia-N	(mg/L)
Nitrite-N	(mg/L)
Nitrate-N	(mg/L)
Residue, nonfilterable	(mg/L)
Phosphorus, dissolved	(mg/L)
Fecal Coliform Bacteria	(MPN/100 mL)
Turbidity	(NTU)
